Evolving Technology Impacting Future Military Intelligence Analysts Between 2030-2035

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U.S. Army War College

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"The reason we have intelligence is to answer three questions: what's new, what's true, and what's next."

-Robert Cardillo, former National Geospatial-Intelligence Agency Director

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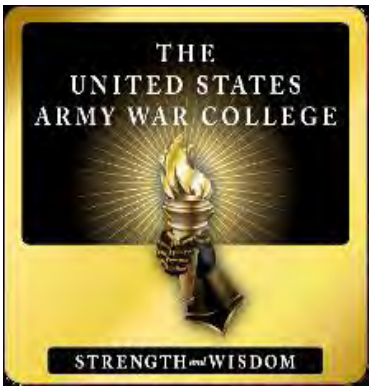

United States Army War College
Class of 2021

About This Document

A research team at the United States Army War College (USAWC) completed this research and wrote this document as a part of the Futures Seminar for Academic Year 2021. This report answers a strategic research question posed by LTG Laura Potter, G2, US Army, based on open-source information. Specifically:

Requirement

How can evolving technologies[1] likely help optimize future military intelligence analysts[2] to enable operations against and better understand near-peer threats in a time sensitive and complex, adaptive environment between the years 2030 and 2035?

The team's findings were published in multiple mediums, including a PDF (primary version), and a soft-bound book. Multiple methodologies were used to determine key findings and convergences, including Interviews, Case Studies, Statistical Analysis, Multi-Criteria Decision Making (MCDM), Social Network Analysis, Nominal Group Technique, Prediction Markets, and Sentiment Analysis. The result of these analyses is a compilation of short estimative reports which are each focused on a single, critical aspect of the overarching question.

Analytic Confidence

Unless otherwise indicated, the analytic confidence in the findings in this report is MODERATE. The questions asked were complex and the timeline was relatively short due to competing academic requirements of the USAWC core curriculum. Source reliability and corroboration were moderate to high. The analysts (non-subject matter experts) worked both individually and collaboratively to answer the questions. They utilized a combination of structured analytic techniques. The team evaluated their analytic confidence utilizing Peterson's Analytic Confidence Factors coupled with the Friedman Corollaries.

Words of Estimative Probability

Analysts leveraged the Kesselman List of Estimative Words as their Words of Estimative Probability (WEP) for determining the likelihood of a technology's impact ranging from 5– 20 years.

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[1] Research priority for this project will likely focus on the following technologies (listed in order of priority) and target their utilization: quantum computing, 5G communications technology (to include 6G and potentially 7G fielding), signature management technology, synthetic biology, machine learning, and other evolving technologies as identified.

[2] This project will study potential future impacts and application at all echelons (tactical through strategic.)

Source Reliability

Source reliability is noted at the end of each citation as low (L), moderate (M), or high (H). The citation is hyperlinked to the source. Source reliability is determined using Standard Primary Source Credibility Scale and the Trust Scale and Website Evaluation Worksheet.

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Team Porrima Requirement

"How can emerging technologies likely help future military intelligence analysts to enable operations against and better understand near peer threats in a time sensitive and complex adaptive environment between the years 2030-2035?"

Key Findings

Based on interviews with 20 experts from the private sector, academia, and allied governments, coupled with extensive review of over 700 sources on evolving technologies to help future military intelligence analysts, it is highly likely 19 technologies at three distinct echelons; individual, tactical, and enterprise, will be available on or before 2035. They are:

Analyst	Virtual ACE	Enterprise
No- or Low-Code Software	Distributed Computing Architecture	6G Networking
Pharmacological Cognitive Enhancers	Hyperautomation	Advanced Multi-Domain Sensors
Digital Assistants / Companions	Machine Learning	Non-Fungible Blockchain Tokens
Neurofeedback Devices	Edge Computing	Fully Homomorphic Encryption
Extended Reality Displays	Cyber Foraging / Tactical Cloudlets	
Holographic Displays	Li-Fi Wireless Networks	
	Free Space Optics Wireless Networks	

At the individual level, it is likely that no- or low-code software, pharmacological cognitive enhancers (PCEs), digital assistants/companions enabled by edge AI and neurofeedback devices, extended reality (XR), and holographic displays, will provide the intelligence analyst of 2035 with enhanced abilities to focus on validating feedback veracity, conduct critical analysis to determine recommendations, and effectively communicate these recommendations to decision makers.

Whether speaking with former CIA and NSA Director, General (GEN) Michael Hayden or Rear-Admiral Scott Bishop, Chief of Defence Intelligence (CDI) and the current Commander of Canadian Forces Intelligence Command (CFINTCOM), every expert we consulted with firmly asserted the requirement for a "human in the loop," even in 2035, to compensate for those areas, such as navigating ambiguity, where technology is not able to compete with the human mind as well to ensure the confidence of the supported decision makers. It is highly likely this human analyst will be augmented with a number of technologies to enable them to manage the uncertainty of the near-future battlefield. First, no- or low-code software, which allows non-experts in data science to manipulate robust data sets more easily, is an innovation area which the current pandemic is actually helping to fuel research into overdrive.

Figure 1. Team Porrima rendered vision of the future individual intelligence analyst.

Figure 2. Human in the Loop diagram to Optimize Artificial Intelligence

- According to Forbes, by the end of 2022, investment in no- or low-code will likely top $25 billion with over 65% of new application development leveraging this technology by 2024.
- Alicja Mincewicz, Facebook Reality Labs Research Strategy Lead, when asked about requirements for the future analyst, stated they would require "critical thinking, logical thinking, mathematics, and [formal training in] data science combined with the ability to think outside the box."
- Describing the future intelligence analyst, Steve Zidek, Director of Analysis, Government of Australia, stated, "they'll need to have a data science analyst; the analyst will have to be trained in big data, somebody to process that data and make sense of it – data analytical skills."

Given that future intelligence analysts will face increased demand to manage information overload and navigate uncertainty, other innovations, including pharmacological cognitive enhancers (PCEs) and digital assistants/companions enabled by edge AI and neurofeedback devices, will likely be available to improve cognitive functions in a complex, adaptive environment.

- Six PCEs, including the racetam family, designed to enhance memory, and alpha GPC, which improves learning, are currently available without prescription. Current research suggests that these, and other drugs currently in testing, would likely improve intelligence analyst cognitive functions in a variety of ways. Reports and Data, a technology research firm, projects the PCE market to be over $5.3 billion by 2026.
- According to Juniper Research, individuals, companies, and other organizations utilized 4.25 billion digital voice assistants, such as Siri, Alexa, and Cortana, in 2020. Juniper Research also projects over 8.4 billion devices in use by 2024. Current investors in digital companions, digital assistants that respond personally and proactively, include Toyota AI Ventures, iRobot Corp, Samsung Next, and Union Tech Ventures.

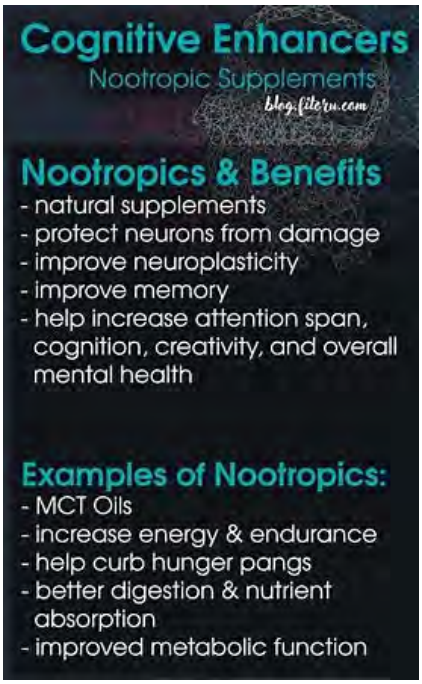

Figure 3. Potential Benefits of Pharmacological Cognitive Enhancements

- While Edge technologies are likely to be most impactful at the tactical level, it is also likely that these technologies, including distributed computing coupled with

continued advances in processing power and memory, will be small and light enough between 2030-2035 to assist the individual analyst.

- Finally, neurofeedback is currently widely used in clinical situations. However, both Elon Musk's Neurolink and gaming powerhouse, Valve, are developing commercial brain-computer interfaces. Combined, these technologies will likely be available to assist the intelligence analyst between 2030-2035 in three specific ways: cognitive enhancement, emotional regulation, and stress resilience.

It is highly likely advanced XR, which mixes augmented reality (AR), virtual reality (VR), and mixed reality (MR) capabilities, coupled with large scale holographic display technology, will be the primary way future intelligence analysts learn new skills, integrate data to enable operations, and communicate their findings.

- While the U.S. Army has recently contracted with Microsoft for $22 billion of HoloLens enabled headsets over the next 10 years, this purchase is dwarfed when compared to efforts in the commercial sector. Twenty percent of Facebook's staff is currently engaged in AR/VR research, and PriceWaterhouseCoopers estimates that the global economy will gain $1.92 trillion through XR by 2030.
- Darran Milne, CEO of VividQ, a UK based holographic display start-up states, "Holographic displays will be the dominant display technology of the next decade in multiple sectors." Texas Instruments, Samsung, Qualcomm, Apple, Panasonic, Microsoft, Konica, Minolta, and even L'Oreal are all investing in holographic display technology.

Figure 4. Holographic Display Using Microsoft Mesh Technology

- John Zuur Platten, Senior Game Designer, Niantic Labs (an alternative reality gaming company) projects full mass market of AR less than 5 years away, stating, "AR is most promising [near term] since it is sensory enhancing; VR is about creating deception and will not be as successful until [designers] get rid of headgear that can obscure observables."

Moving from the individual analyst impacts, one of the more revelatory findings focuses on disposition and composition of intelligence assets supporting the tactical fight. While the human element will almost certainly continue to be essential, it is unlikely that these personnel will need to be collocated to effectively operate. In fact, a combination of

distributed computing architecture, machine intelligence (leveraging Edge AI, machine learning, and hyperautomation), light fidelity (Li-Fi) technology, and free-space optics (FSO) will likely enable this virtual Analysis and Collection Element (ACE). **The virtual ACE** will likely not only improve analytic functions, but also provide increased survivability through signature reduction in the anticipated disrupted, intermittent, and latent (DIL) environments of the 2030-2035 timeframe. While distributed computing architectures have been around for decades, innovations to this legacy design concept will likely allow a network to optimize the processing and transmission resources of all

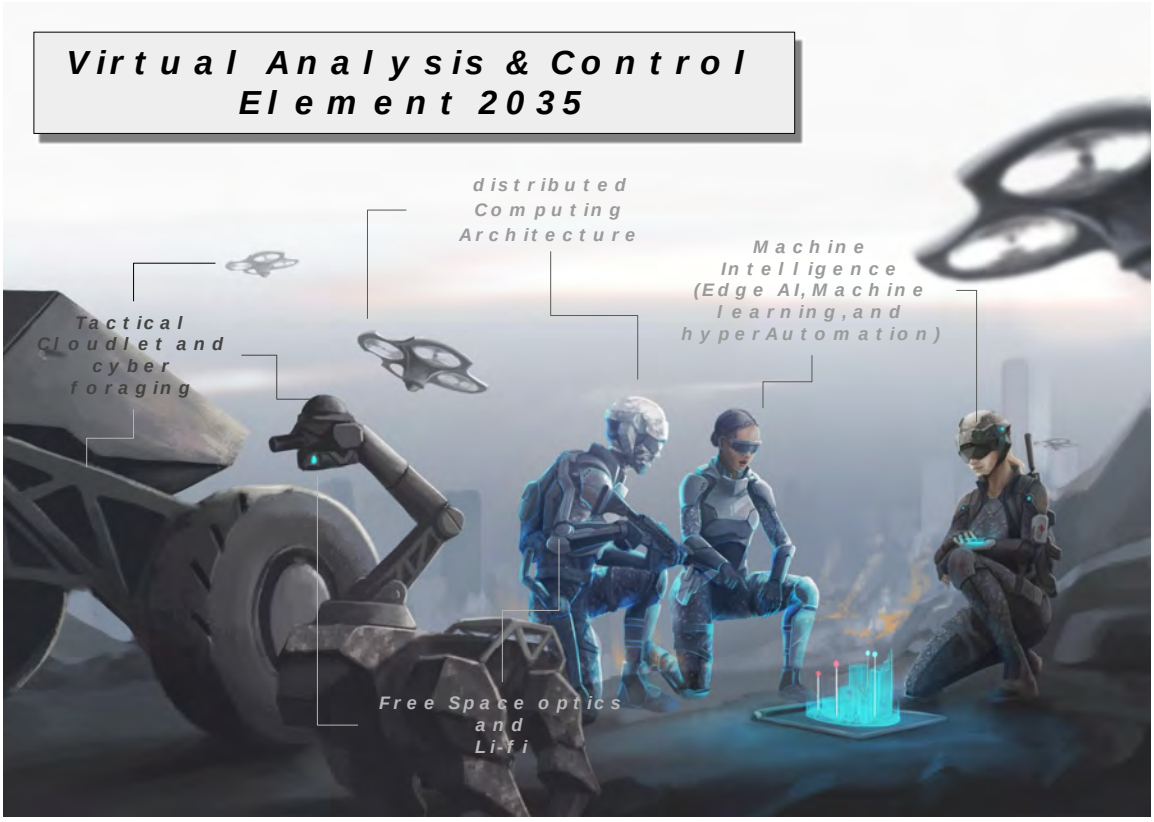

Figure 5. Team Porrima rendered vision of the future Virtual Analysis and Control Element (ACE).

the devices in the network managed by AI located at the edge of the battlefield.

- Scott Jones, chief security official for a Fortune 500 company, when talking about the array of operation centers stated “dispersion of network people is current in industry” and “rooms full of people are dead and [in-person] global security operations centers are becoming vanity plays.”
- Palantir, the current producer of software upgrades to the Army intelligence analyst’s tool called Distributed Common Ground System – Army (DCGS-A), is already incorporating Edge computing concepts in its most recent update called Capability Drop One and Two.

- 2020 IBM Notice of Annual Meeting and Proxy Statement reflected a growth in cloud revenues to over $25 billion with strong double digit growth year over year, now comprising 34% of total IBM revenue; announced strategic acquisitions to expand hybrid cloud and AI capabilities.

In addition to distributed computer architectures, two new concepts, tactical cloudlets and cyber foraging, will also likely be developed sufficiently by 2030 to further enable intelligence analysts in the virtual ACE.

Tactical cloudlets, according to researchers at Carnegie Mellon University's Software Engineering Institute, are "discoverable, generic, stateless servers located in single hop proximity of mobile devices." Cyber foraging allows less powerful mobile systems to offload or augment their computational and storage requirements through opportunistic discovery and exploiting of proximate servers.

- By 2030, of the seven different systems for accomplishing cyber foraging currently under research, it is likely at least one will have proven successful.
- Basic tactical cloudlet and cyber foraging technology are already available and is being integrated into the U.S. Department of Defense (DoD) architecture through projects like Joint Enterprise Defense Infrastructure (JEDI) cloud and is being optimized through extensive research in DoD partnerships with universities such as Carnegie Mellon University.

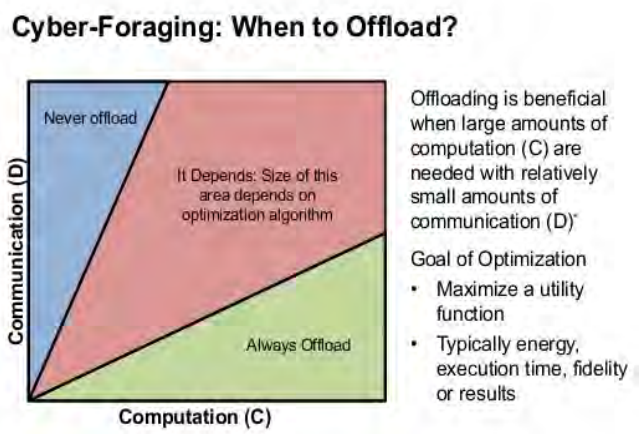

Figure 6. Carnegie Mellon Cyber Foraging Diagram

Other developing technologies critical to this evolution are machine intelligence – the synchronization of Edge AI, machine learning, and hyperautomation. With the responsibilities of "sense, identify, exploit, and share" being executed by this combined machine intelligence architecture, all undergirded by hyperautomation advances able to meet the "sensor to shooter" speed required of tomorrow's leaders, the future analyst will likely be focused, according to U.S. Air Force Lieutenant General (Lt. Gen.) VeraLinn Jamieson, Deputy Chief of Staff for Intelligence, Surveillance, and Reconnaissance (DCS-ISR), on "assessing the information and making decisions, inside the decision [or] action loop of the enemy."

- The Air Force's "Next Generation ISR Dominance Flight Plan" is already leveraging these technologies to automate their processing, exploitation, and dissemination requirements within their sensor architecture over the next ten years.
- Leveraging today's technology, a recent Deloitte study estimated processing, exploitation, and dissemination (PED) automation would remove up to 17.5% of the daily workload from the military intelligence analyst.

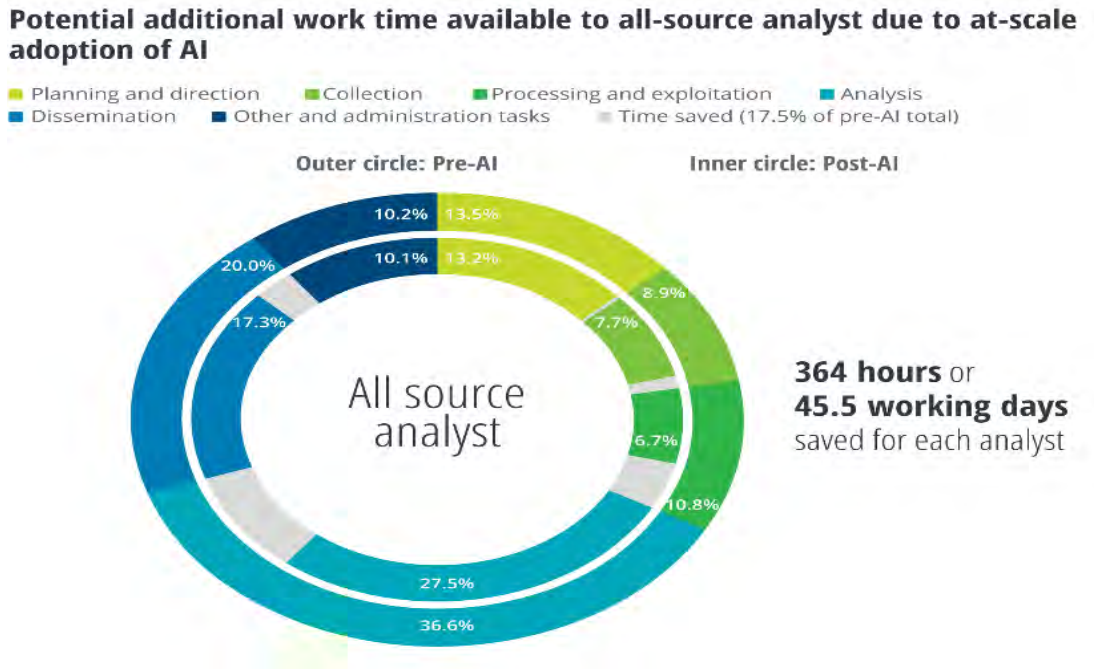

Figure 7. Potential Added Analyst Capacity Using AI. Source: Deloitte Graph

New communication technologies like Li-Fi and free space optics/visible light communications (FSO/VLC) will likely provide a more secure, more resilient, and faster connectivity on both the battlefield and to the rear.

- Using these technologies (Li-Fi and FSO) in tandem during a 2019 U.S. Army Europe and Africa Command (USAREUR-AF) exercise, a senior Army Warrant Officer pioneered and field-tested a technique blending Li-Fi technology with another emerging capability called FSO. This exercise successfully established secure communications between two Tactical Operation Centers, separated by 16 kilometers of complex terrain, under dynamic weather conditions, and maintained 95% communications availability over the ten-day exercise.
- Over the next 10-15 years, wireless traffic will grow by 60% and the Internet of Things (IoT) is expected to grow by the billions causing the demand for band-width to expand by 12,000 times its current use according to Harold Haas, inven-tor of Li-Fi and Cofounder of Pure Li-Fi. There is not enough bandwidth in the

radiowave and microwave frequencies within the electromagnetic spectrum alone to accommodate this growth.

At the enterprise level, technological innovation is likely going to be focused on expanding and improving the sensor network, securing its data, reducing transmission latency, and validating inputs and outputs. Sixth generation (6G) telecommunication technologies are almost certain to be available by 2028, with widespread use by 2030 enabling the future intelligence analyst access to the massive data streams coming from the sensor network.

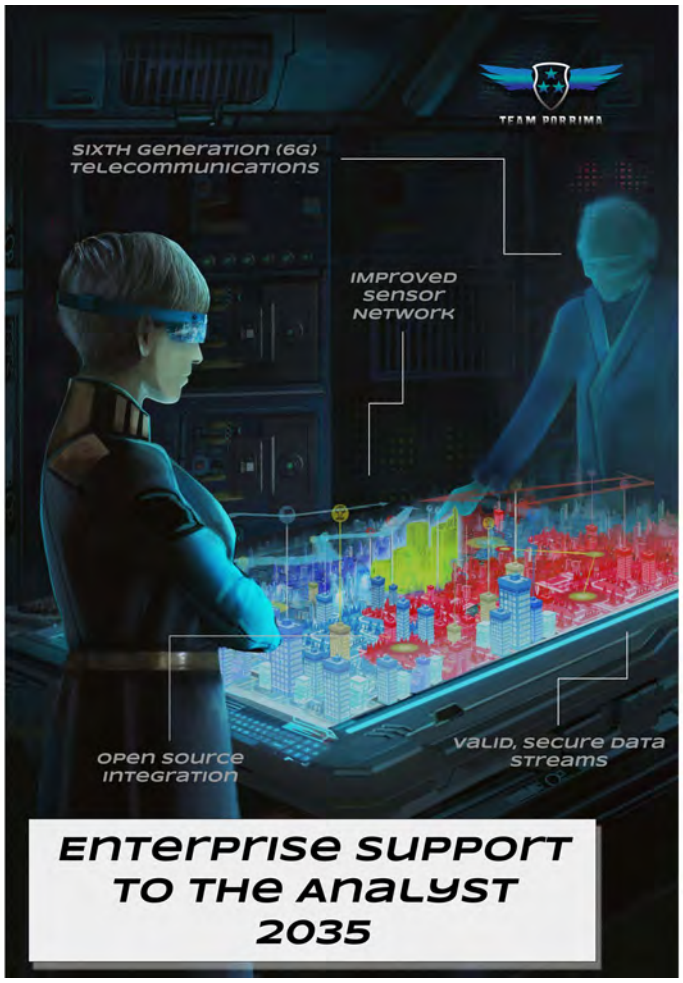

Figure 8. Team Porrima rendered vision of the future Intelligence Enterprise.

- Robert Cardillo, former National Geospatial-Intelligence Agency Director, stated "the reason we have intelligence is to answer three questions: what's new, what's true {referring to deceptive sensor data], and what's next." When discussing the use of commercial capabilities to enhance collection, he added "this challenge of working in the open [commercially available sensor architecture], brings the challenge of veracity in a chaotic world."
- Nokia, Bell, Erickson, and Samsung all agree 6G is almost certain to be available between 2028-2030. This will help accelerate the IoT and Internet of Military Things (IoMT) with speeds in the gigabit per second range and eventually in the terabit per second range, enabling instantaneous access to data and IoT devices.

Several technologies currently in development or being deployed will likely be available to help validate and secure these future data streams including non-fungible blockchain token ecosystem, as well as fully homomorphic and quantum encryption.

- Verizon recently introduced, "Full Transparency" incorporating [non-fungible token] blockchain technology to set the standard for corporate communications enabling secure and unalterable published news releases.
- Companies, such as Microsoft, IBM, and Cornami, are offering advanced developments in encryption solutions by conducting continuous research. For instance, in July, 2020, IBM announced success in the field trials conducted for the fully homomorphic encryption and it also made the fully homomorphic encryption toolkit available for the MacOS and iOS platforms.

Figure 9. Examples of Fungible and Non-Fungible Tokens. https://blockchainsimplified.com/blog/understanding-fungible-non-fungible-tokens/. Source: Blockchain Simplified.com

Despite increasingly sophisticated efforts to deceive (or at least camouflage activities against) new and emerging sensor technologies (including but not limited to technologies like deep fakes and thermal cloaking), open-source sensors, crowdsourcing, and commercial collection and analysis platforms will likely offer timely and valuable insights to the future analyst. The growth in publicly available or "for sale" sensor data is highly likely to continue growing in availability and quality.

- Chris Pallaris, Director, i-Intelligence, a Swiss commercial intelligence agency, on discussing the proliferation of commercial sensors, "work on sensors, utilization of sensors and wearable technology and the convergence of those platforms into Machine Learning (ML) and decision support system giving us an [unprecedented] understanding of the battlespace."
- Hany Farid, a computer science professor and digital forensics expert at the University of California at Berkeley told the Financial Times when discussing deep fake technology's exponential improvement, "In January 2019, deep fakes were buggy and flickery. Nine months later, I've never seen anything like how fast they're going. This is the tip of the iceberg."

The requirement to provide sensor data validation will likely grow significantly as the IoT transitions to the Internet of Everything (IoE) and militaries around the world

recognize the necessity to tap into these ubiquitous sensor arrays. Recognizing legitimate data from various forms of deep fakes will require a multitude of capabilities ranging from defensive encryption options highlighted above, as well as analyst generated algorithms to help detect fraudulent or spoofed information which will become increasingly more difficult to discern without automated capabilities.

Additional Findings:

Ensuring the future military intelligence analyst is fully able to optimize the evolving capabilities likely to be fielded by 2035 suggests a few actions to consider implementing in the near term.

- An area to highlight involves the training pipeline to develop an analyst. The panel of experts we spoke with were unanimous in their recommendation that future training focus on developing generalists as opposed to specialists. They also reinforced the criticality of incorporating a data science element to the schoolhouse.
- Although software coding is not likely to be a necessary requirement for developing targeting tools or enabling predictive analysis, strategic forecasting methodology will be an imperative in the future. We strongly recommend considering additional focus on this in military occupational specialties (MOS) training platforms.
- The proliferation of nearly ubiquitous sensor data, available via commercial or open-source mediums, may initiate a reversal of traditional analyst methodology. Using "*Open-Source First*" with classified and clandestine collection data being reviewed thereafter may become a necessary business practice for future analysts. To maximize this methodology, a level of "*digital fluency*" will also be necessary for the future military intelligence analyst.

All of the technologies are currently seeing levels of development which indicate a likelihood of being fieldable to the future military intelligence analyst by 2035. As the writer William Gibson noted over three decades ago, "The future is already here, it's just unevenly distributed."

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Individual Analysts Short Form Analytic Reports

Future Intelligence Analysts Almost Certain to Need Data Science Skills; Likely Enabled Through Advances in No- or Low-Code Software Over Next 5 Years

Executive Summary

Recent advancements in development of applications and other capabilities requiring no or limited coding, offer the potential for future analysts to leverage data science competencies with limited or no coding training. This innovation is likely to significantly enhance the capacity of analysts to leverage data science techniques for modeling and predictive analysis with minimal software or coding experience. While limitations remain on no-code programming's ability to design intricate applications, recent events such as the pandemic have raised the prioritization and investment into more comprehensive no-code development.

Discussion

Team Porrima, as part of its research, recently interviewed intelligence professionals throughout government, academia, and the private sector. When asked what skill sets future intelligence analysts would need to thrive in the next 10-15 years, most experts pointed to the field of data science as a clear imperative.[H] The ocean of data available to the world continues to grow. Recent estimations predict a factor of 10 increase over current holdings by 2025, resulting in over 163 zettabytes.[M] The ability to analyze, process, and ultimately communicate useful insights from this growing repository of information has helped make data scientists one of the highest demand professions and fastest growing career fields in the world today.[M]

The exponential growth of collection sensors is a major reason for this explosion in future data. Expenditure in Internet of Things (IoT) related defense items topped $29.7 billion in 2020 and is expected to climb over $48 billion by 2028.[H] Whether filtering this information, determining insightful patterns from it, or confirming the data's veracity, the need

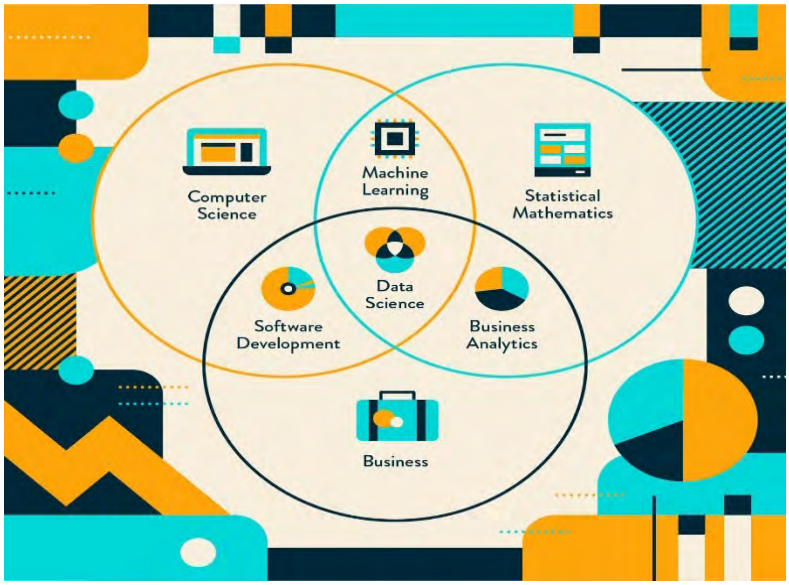

Figure 1. Illustration depicting key skill sets for field of data science in industry. Source: Data Science Venn Diagram

for personnel able to design algorithms as well as the software applications to conduct these actions will fall under the dominion of data science expertise.[H]

As noted in Figure 1 above, a major area of concentration in the education and training of current data scientists involves extensive study in computer science.[H] This training is necessary for developing the software coding skill required to devise algorithm enabled applications or leverage machine learning against large data sets.[H] An ability to code and develop software applications designed to enable intelligence analysis at scale will become an increasingly more vital part of most steps within the analytic process.[H] Data aggregation will become dependent on designing queries able to filter and discern relevant information within extremely large databases.[H] Validating data and delineating pertinent feedback from the terabytes of data ingested currently requires a trained data scientist adept in code development in computer languages such as Python or Structured Query Language (SQL).[H] Such training requires months of course study just to develop a novice level of fluency.[M]

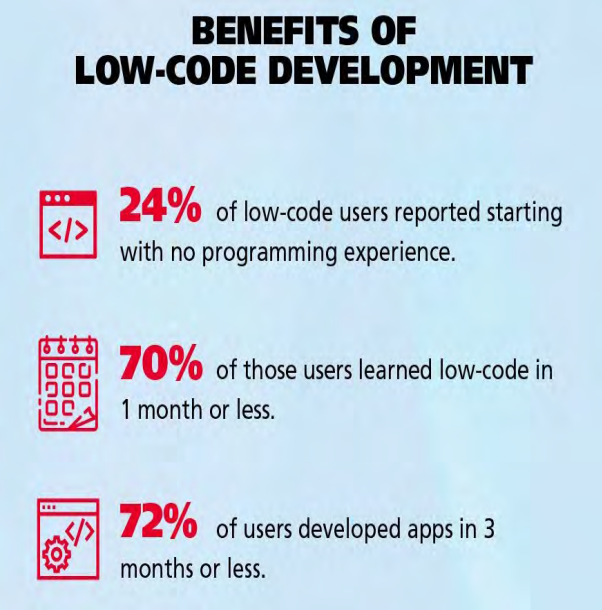

Figure 2. Low-code statistics. Source: Benefits of Low-code Development

The development on no- or low-code software development offers the ability to design increasingly more complex software applications without significant training in coding.[H] The pandemic has accelerated the demand for no- or low-code design throughout the software community.[H] One projection recently suggested over 60% of software design activity will involve this new methodology by 2024.[M] As reinforced by Figure 2, this capability offers a significantly reduced training period and can be utilized by personnel with no previous programming background.[M]

Continued investment and adaption of no- or low-code methodologies will broaden its spectrum of potential uses as well as improve potential areas of concern such as vulnerability to cyber security threats.[H] It is also important to point out the fact no- or low-code software does not negate the requirement for some coding expertise within an organization.[M] However, once the no- or low-code architecture is established, it allows novice analysts, without significant training, to build and manipulate tools on their own to support intelligence analysis.[M]

Other current limitations with no- or low-code technology is its restrictiveness to developing advanced or complex programming. Most of today's no-code application is designed to solve single problems, not complex ones.[M] Another challenge with no- and low- code designed applications is a lack of scalability.[M] For this reason, a triage approach of no- or low-code utilization will be necessary to enable most requirements and the most complex will still require development by a trained programmer.[M]

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and could be routinely corroborated by other sources. There was adequate time, but the analyst worked alone, and did not use a structured method. Furthermore, given the lengthy time frame of the estimate projection and recent surge in emphasis as well as research and development investment, this report is sensitive to change if presented new contradictory information.

Author: COL Joseph T. Sheridan

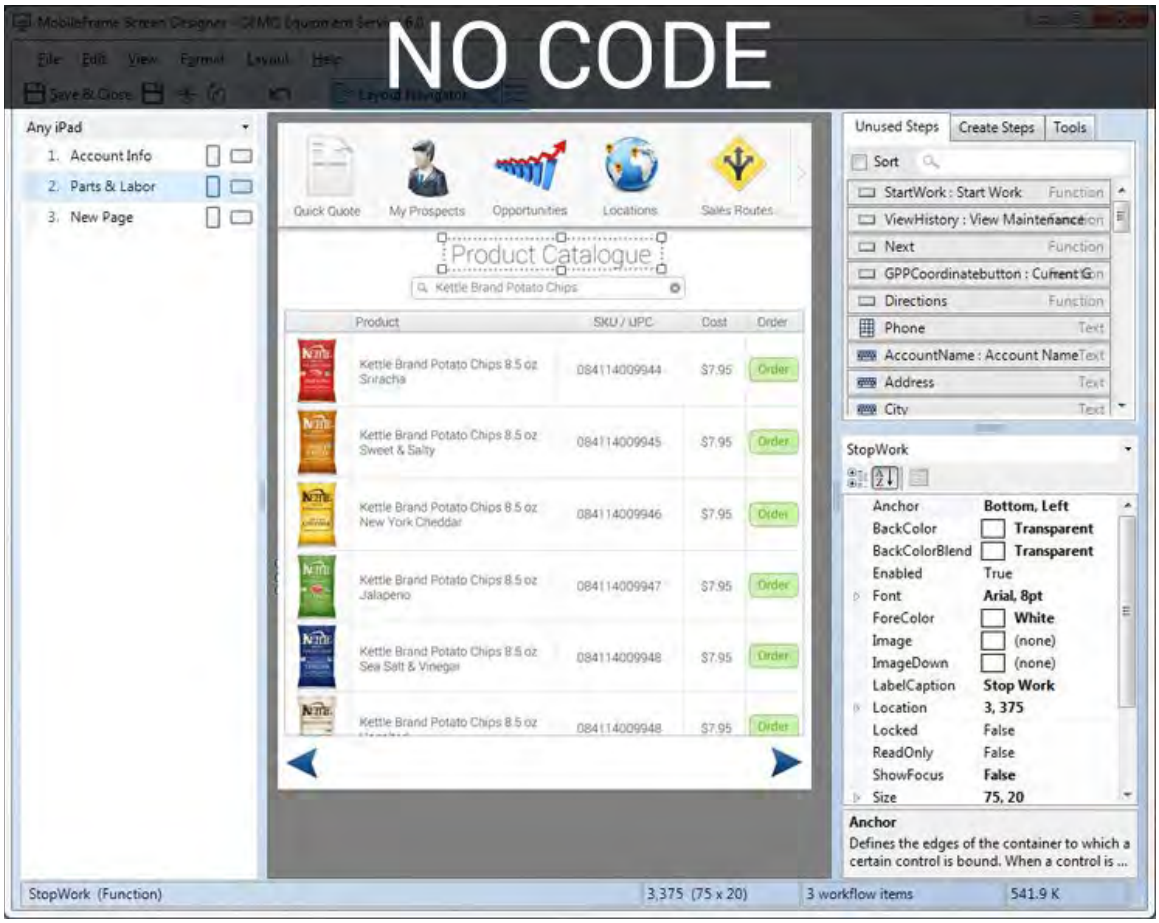

Figure 3. Example of a no-code interface. Source: No-Code Illustration

Combat Use of Pharmacological Cognitive Enhancers (PCEs) Among All Military Occupations Likely Within 5-7 Years; PCEs With Euphoric Psychoactive Properties Unlikely By 2035

Executive Summary

Despite this potential for nefarious use, the widespread availability, and the benefits of PCE will likely drive continued research and development on combat use of some PCEs, resulting in their expansive use by military and civilian professions by 2028. PCE use is common among select U.S. military forces, such as special forces and pilots. These drugs are widely available, some without a prescription. Some PCEs have shown positive effects of reducing fatigue, increasing wakefulness, and improving overall cognitive function. Unfortunately, certain PCEs also have a dark side for their ability to instill a euphoric psychoactive state, a force multiplier that foreign combatants use to create a superior fighter able to overcome fear, fatigue, stress, and pain. The U.S. is unlikely to engage in employing this type of PCE based on the lack of research and ethical concerns.

Discussion

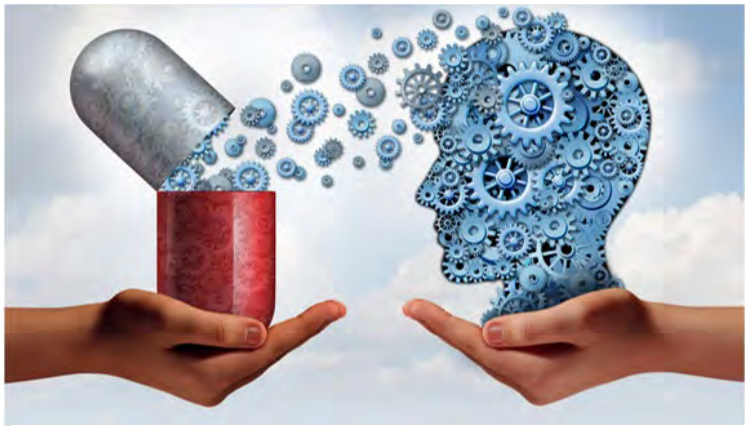

Figure 1. Modafinil.
Video: https://www.youtube.com/watch?v=ThYLTfh08Xg.

Cognitive enhancers refers to substances that help restore or improve human performance via delivery of neurological effects such as mood lifting, energy boosting, increased concentration and wakefulness, and reduced memory loss.[H] Advances in fields such as biotechnology, engineering, neuroscience, and computing make physical and cognitive enhancement possible.[M] Recently, attention has focused on the enhancement of cognitive competencies through pharmacological interventions, i.e., PCE, to assist surgeons, pilots, and other occupations that require significant concentration and focus over extended periods of time.[H] Militaries in the West are also exploring pharmacological solutions to improve soldier strength, mental capacity, recovery, and resistance to fatigue and trauma.[M]

U.S. forces have been utilizing PCE substances since World War II (WWII) and the Korean War, and their use continues even today.[H] U.S. military pilots consider amphetamines and tranquilizers, i.e., "go pills" and "no-go pills", as standard practice to support a force that likes to fight at night.[H] Modafinil (see Figure 1) is another PCE that

has demonstrated reversing the negative effects of combat fatigue in military pilots.[H] Due to their historically safe track records for limited combat use, PCEs such as amphetamines and modafinil can highly likely assist military intelligence analysts in maintaining focus when facing excessive volume of data and demands for quick-turn analysis, especially during the heat of battles. However, further Research and Development (R&D) to achieve safe and optimal desired effects for combat use among all military occupations is dependent on demands stemming from U.S.' preparation for large scale combat operations/multi-domain operations, and their timelines, which will likely push field testing to 2024 and widespread combat utilization to 2028.

Former and potential U.S. adversaries are also interested in the potential of PCEs.[1] ISIS has been using Captagon to induce fearlessness, suppress pain, and gain remarkable human energy, allowing combatants to stay wide awake for days and fight with a reckless abandon.[M,2] Other militant groups such as those in Somali, Liberia, Sierra Leone, Uganda, Pakistan, and the Democratic Republic of Congo have also used psychoactive substances to embolden their fighters to compensate for lack of training, equipment, and other military inadequacies.[M] However, it is unlikely that U.S. forces will adopt the use of PCEs in this manner by 2035, due to lack of supporting medical research contributed by grave ethical concerns.

Figure 2. The Real Life Creation of Super Soldiers, The Future of War.. *https://www.youtube.com/watch?v=TXBybQEGt0M.*

Many of the drugs presently used as cognitive enhancers got their start in treating other diseases such as Alzheimer's, narcolepsy, and Adult Attention-Deficit/Hyperactivity Disorder (ADHD). The literature is rich with these drugs, majority of which have not seen wide usage outside the clinical realm. The U.S.

[1] In 2018, Maghawir al-Thawra, a crew allied to the Free Syrian Army, uncovered a cache of 300,000 Captagon tablets during the conducting of operations in opposition to ISIS. Captagon is known as the Jihad pill and is considered a key combat enabler in Syria.
[2] Captagon is an amphetamine-based drug, with the trademark name of Fenethylline and is a very addictive stimulant impacting the central nervous system, creating euphoric psychoactive properties. The World Health Organization lists this drug as a controlled substance and the buying and selling is unlawful in most countries.

military in general and military intelligence analyst can likely benefit from exploring the warfighting effects and combat-use safety of these drugs:

- Adderall, as a treatment for ADHD, has also been shown to increase motivation in healthy subjects.[M]
- Racetams is a group of smart drugs, which include piracetam, aniracetam, oxiracetam, and phenylpiracetam. These drugs have demonstrated enhancement of long-term memory, spatial memory, and working memory. These medications do not require a prescription.[M]
- Alpha GPC is another smart drug that enhances memory development and learning. This drug directly impacts a neurotransmitter called acetylcholine.[3] This medication does not require a prescription.[M]
- Adrafinil is an earlier version of Modafinil, with similar effects though not as profound. This medication does not require a prescription.[M]
- Noopept has similar effects as the Racetams group of drugs; however, it is more powerful and does not require a prescription.[M]

Cognitive enhancers are prolific; many do not require a physician prescription to use. Such enhancement can highly likely deliver profound advantage on the battlefield, where any enhancement in the cognitive, physical, or emotional skills of a soldier increases survivability and mission success.[H] However, there are significant ethical implications that are likely to limit increased use within the military (see Figure 2). Decisions made in combat represent the ethical values of the society on whose behalf soldier's fight. The introduction of PCE soldiers poses a potential strain on these ethical values. The military must consider the legal context in which soldiers' function, incorporating international humanitarian law, human rights law, and relevant domestic laws. In addition, the following questions should be addressed to fully evaluate the ethical considerations, does the use of PCEs by soldiers dehumanize warfare? Can a soldier using PCEs remain capable of complying with the laws of war? Under what circumstances is it acceptable to use PCEs? What sort of consent is required? What are the implications of military drug use for wider society, including veteran care?[H] Despite the ethical concerns and lack of clinical research or field testing, the U.S. military can still reap the benefits by smartly exploring certain PCEs' efficacy and safety outside of clinical use.

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked

[3] Acetylcholine is a neurotransmitter, which is a chemical messenger released by nerve cells, instructing nerve cells to send signals to other nerve cells.

alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Gregory P. Frazier

Next-Generation Digital Assistants Likely Within 5 Years, Field Deployable Between 2030-2035

Executive Summary

Rapid advances in next-generation digital assistants utilizing open-source technology make it likely that several companies, including Mycroft, OpenAssistant, Jasper, LinTO, Rhasspy, Aimybox, Oracle, and Leon, will develop advanced digital assistants over the next five years with military-grade deployment between 2030-2035. Open-source technology reduces data security and privacy concerns associated with first-generation digital assistants; however, makes training next-generation digital assistance utilizing artificial intelligence (AI) more challenging.

Discussion

Digital assistants are not a new concept, for example, Apple's Siri began life in the early 2000's as a DARPA project focused on providing better technology that could learn from experience, take instructions and explain what it was doing for Soldiers to use in the field.[H] As demonstrated by a former competitor (Fin) in Figure 1, the digital assistant's innovation hype cycle arguably peaked in 2015-2016 and the technology lifecycle is currently on an upward trajectory as new technological breakthroughs and competitors enter the market space.[M]

Figure 1. Phocuswright – Spotlight: The Future of Digital Assistants lecture by Sam Lessin, co-founder of Fin. Click on picture or go to: https://youtu.be/RKR1ofMIiW4 to view video.

Several militaries (U.S., UK, Russia, and China) have entered the market space, and have *Next Generation AI Development Plans* which seek to "robotize" military equipment as early as 2025.[H] One specific initiative is the British Royal Navy's STARTLE project, which plans to use Intelligent Virtual Assistant (IVA) to enhance situational awareness and battlespace decision making.[H] Similarly, the US Navy plans to develop an AI based command and control (C2) intelligent digital assistant, (like Apple Siri, Google Now, or Facebook's M which are common in industrial settings) to enhance a military commander's ability to manage increasingly complex battlespaces.[H] As demand for increased human productivity and freedom from routine tasks across a wide range of

activities continues to trend upward, the digital assistant marketplace will continue to grow.[M]

Major competitors in the western market space are Apple Siri, Google Assistant, Amazon Alexa, Microsoft Cortana, Mycroft, OpenAssistant, Jasper, LinTO, Rhasspy, Aimybox, Oracle, and Leon.[H,H,H,M,M,H] Eastern market spaces include iFlytek and Nuance, each of which are valued at $10.8 billion and $5.3 billion respectively, which is similar to their western counterparts.[M] Specific differences between western and eastern markets center on data privacy and data security.

Figure 2. Web Summit – Beyond Siri and Alexa: The Next-Generation of Digital Assistants Get Personal interview with Xabi Uribe-Etxebarria, CEO of SHERPA. Click on picture or go to: https://youtu.be/6MD91hIKX-4 to view video.

Security concerns over the potential for Chinese intelligence services ordering Chinese manufactures to build electronic "backdoors" into digital assistants as part of China's Military-Civil Fusion (MCF) Development Strategy has European Union (EU) and U.S. policymakers reviewing policies that may result in future trade barriers imposed on Chinese devices.[H,H] A rise in security concerns is also creating growth in open-source digital assistant AI (see Figure 2) such as Mycroft and SHERPA.[M,M] With an estimated 1.8 billion digital assistants "continually listening" in homes and offices by the end of 2021, it is no wonder open-source digital assistants are getting much more attention.[M]

Figure 3. Bloomberg Businessweek, "Alexa, What's Privacy?", December 16, 2019.

Open-source digital assistant AI is *self-host* technology, which means the security is as good as users make it leveraging virtual local area network (VLANs), routing rules, firewall rules, and any other security elements which are relevant to maintaining obfuscation

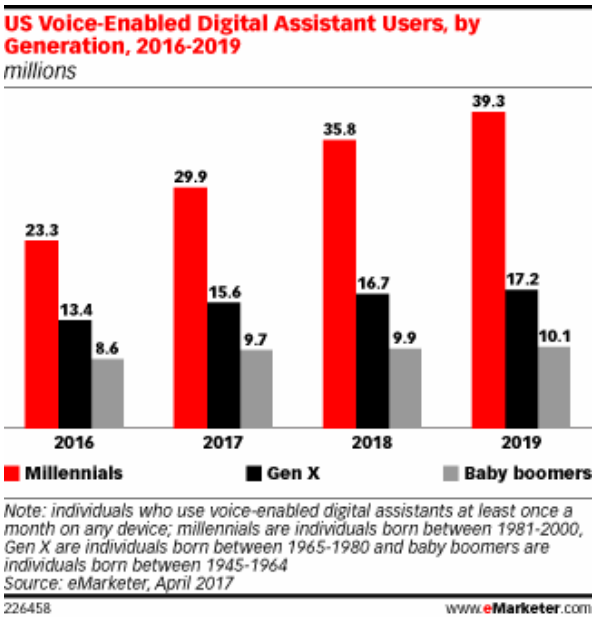

Figure 4. WordStream Blog: 33 Voice Search Statistics to Prepare You for the Voice Search Revolution. Click on picture or go to: https://www.wordstream.com/blog/ws/2018/04/10/voice-search-statistics-2018.

from the outside world at large.[M] One of the largest challenges then becomes training open-source digital assistants because the task requires vast datasets (examples such as Google or Amazon) of natural language samples to learn speech and transactional conversation patterns.[H] Stanford's Open Virtual Assistant Lab (OVAL) has developed "Almond," which is one example of how emerging open-source digital assistant competitors seek to develop an inexpensive approach for training digital assistants while supporting growing demands for privacy and data security.[H]

Although security and privacy concerns exist with voice digital assistants, many users reduce that concern by confining voice digital assistants to common spaces, (family room, living room, kitchen), undercutting drivers for voice open-source digital assistants, and continued steady adoption of voice digital assistants (see Figure 4).[H,H] Commercially, mixed (voice, and text) digital assistance are also growing in popularity, and security and privacy concerns are currently reduced by human backed chatbots to interact and increase productivity.[H] As with most technologies, there will always be some level of security risk; however, the benefits to increased productivity from digital assistants make it likely that next-generation digital assistance will continue to grow in popularity and use across multiple markets.[H]

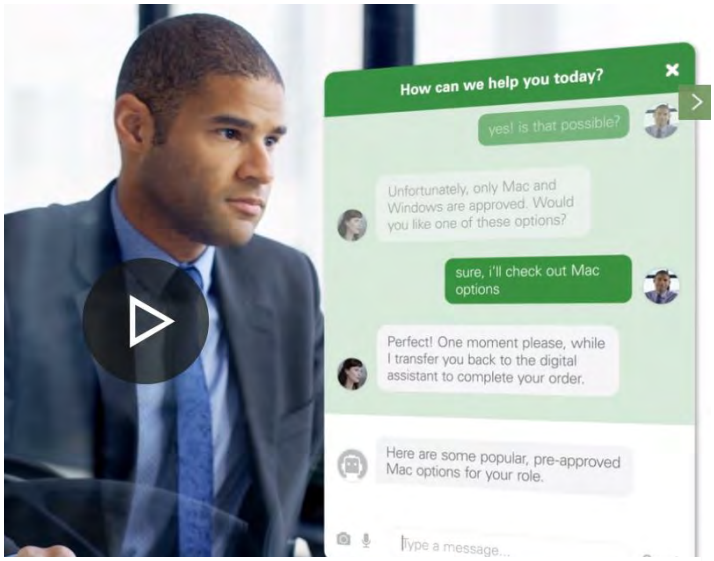

Figure 5. Oracle Digital Assistant: The Power of AI at Your Fingertips. Click on picture or go to: https://www.oracle.com/chatbots/?bcid=5834629272001

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and

tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: LTC Matthew C. Williams

Advanced Digital Companions Likely Within 5 Years, Field Deployable Between 2030-2035

Executive Summary

Rapid advances in the technological evolution of digital assistants to digital companions, such as the U.S.' Intuition Robotics ElliQ, China's Xiaoice X Suite, and Japan's Vinclu Inc. Gatebox, combined with accelerated consumer digital companion adoption stemming from the worsened loneliness epidemic exacerbated by the Coronavirus Disease 2019 (COVID-19) pandemic, make it likely that advanced digital companions will be developed over the next five years with military applications fielded between 2030-2035. Current challenges to advanced digital companions center on cybersecurity and data privacy protection, data infrastructures and networks [5th generation (5G)], and potential information overload associated with hyper-connectivity. However, mutual parallel and synergistic research and development initiatives across multiple fields (entertainment, business, medical, etc.), coupled with investors such as, Toyota AI Ventures, iRobot Corp., Samsung Next, Sompo Holdings, Union Tech Ventures, Happiness Capital, Capital Point, and Bloomberg Beta, will drive the innovation and adoption cycle for continued and rapid advances in digital companions and associated supporting technologies.

Discussion

According to Statista, around 3.25 billion digital voice assistants (such as Siri, Alexa, and Google Assistant) were used in 2019, and 8.4 billion are anticipated to be used by the end of 2024, indicating individual and societal acceptance of digital assistants to increase productivity and save time on routine tasks.[H] Digital companions seek to take digital assistants to the next level of technological evolution (see Figure 1). Instead of passively standing by to carry out user commands like current digital assistants, digital companions, such as the U.S.' Intuition Robotics ElliQ[H], China's Xiaoice X Suite[H], and Japan's Vinclu Inc. Gatebox[H], seek to act like a teammate or

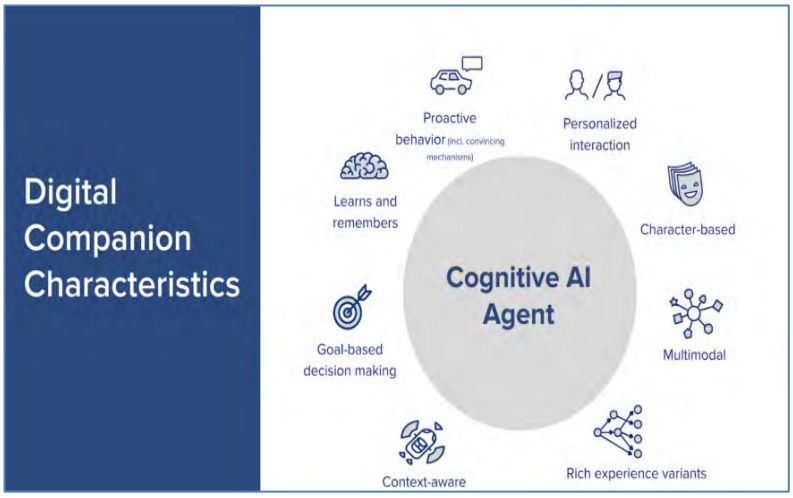

Figure 1. Digital Companion Characteristics. Click on picture or go to: https://medium.com/swlh/digital-assistants-vs-digital-companions-whats-the-difference-a4eefd0ba5db to view source.

sidekick (smartphone or other hardware based) that senses and interacts with users in a predictive and personalized way.[H]

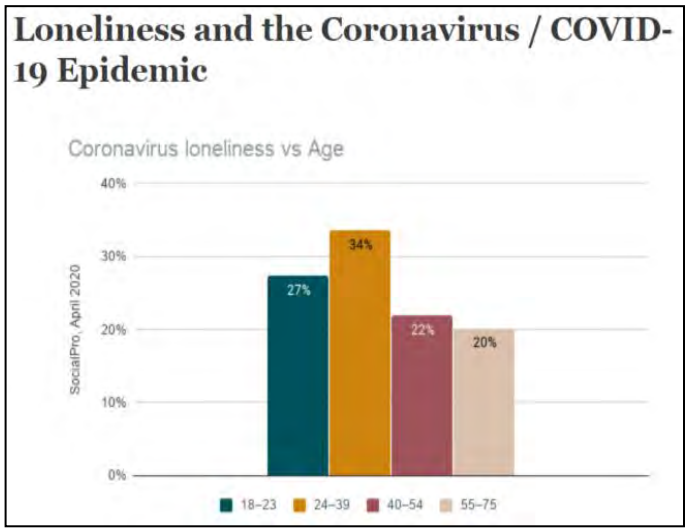

Figure 2. U.S. Loneliness Statistics. Click on picture or go to: https://socialpronow.com/loneliness-statistics/#1 to view source.

Several companies, such as the Florida-based Realic[H], were working on creating digital companion technology that combined artificial intelligence (AI), virtual reality (VR), and augmented reality (AR) for users to create customizable digital companions (Hybri) to combat loneliness prior to the coronavirus pandemic.[H] Since the coronavirus outbreak, social distancing and stay-at-home orders have worsened the loneliness epidemic (see Figure 2) and provide opportunity for accelerated consumer digital companion adoption across the globe.[H,M] Similar observations of accelerated digital companion adoption have been made across several parallel fields, in particular, the medical field.

A recent Medisafe article asserts that 75% of patients indicate they will continue to use digital companions beyond the pandemic, boasting a 90% "excellent experience" rating of the technology by users.[H] Additional findings in the medical field support that virtual companions, such as Replika[M], improve medical screenings because patients often feel more comfortable and willing to self-disclose health information than they would to a human medical professional.[M] Supporting this claim, a similar study focused on mental health discovered that less than one in five people prefer talking with humans over robots, and four out of five were open to having a robot therapist.[H] Venture capitalists, such as Chris Dixon, are taking note and investing in digital companion opportunities,

Figure 3. Gatebox – Promotion Movie "KANPAI." Click on picture or go to: https://youtu.be/bBOXQz7OHqQ to view video.

stating “the next big thing will start out looking like a toy;” (see Figure 3) however, it is not just China that individuals are realizing the value of virtual relationships such as digital companions.[M]

Figure 4. Japan Video Topics: Life with Virtual Companions. Click on picture or go to: https://youtu.be/H0F1W-2sD4Y1 to view video.

China is working to become the global leader in AI by 2030, and according to Lt. Gen. Michael Groen, director of the Joint Artificial Intelligence Center, “the biggest competitive threat is our [U.S. Military’s] own obsolescence” coupled with an unwillingness or delay in AI adoption across the department.[H] Groen further states, “I could walk out into the parking lot of the Pentagon, turn on my iPhone and join a data-driven, completely integrated environment,” which would arguably consist of an AI enabled and informed digital companion (see Figure 4) that could aid in interactive decision making based upon real time global information.[H] “Transformation of warfare accompanies the transformation of the economy,” and investment in digital companions such as that of, Toyota AI Ventures, iRobot Corp., Samsung Next, Sompo Holdings, Union Tech Ventures, Happiness Capital, Capital Point, and Bloomberg Beta seem to support Groen’s assertion.[H,H]

Early challenges to digital companions appear to be centered on ensuring cybersecurity and establishing data privacy protection, servicing the demand for more efficient data infrastructures and networks (5G), and avoiding information overload potential associated with hyper-connectivity.[H] However, with mutual parallel and synergistic research and development initiatives across entertainment, business, medical and other fields, it is likely that advanced digital companions and associated supporting technologies (security, bandwidth, safety, etc.) will continue to progress at an increased pace over the next five years.

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: LTC Matthew C. Williams

Neurofeedback Field Testing Highly Likely Within 5-7 Years, Field Deployable Between 2030-2035

Executive Summary

Neurofeedback (NFB) has been capturing attention of medical research since the 1960s. However, research and development in performance enhancement applications of NFB is a relatively new field. The advent of this low-cost, mobile, and user-friendly technology drives robust applications in commercial and medical settings. The military application includes cognitive enhancement, emotional regulation, and stress resilience. NFB will most likely replace brain-altering medications while providing the same benefits. NFB will highly likely transition to military field testing within the next five to seven years, driving refinements for deployable systems in place between 2030 and 2035. Despite the plethora of NFB research, current medical and technological understanding of NFB and its full potentials in military applications is still limited, causing significant ethical concerns and likely delaying the utilization of this technology for advanced combat manipulation and execution of lethal actions to beyond 2035.

Discussion

Neurofeedback (NFB), also known as Electroencephalograph (EEG) biofeedback, is an advanced form of biofeedback using brain waves to represent different forms of cortical activity.[H] NFB requires an individual to learn and recognize aspects of their brain wave activity and attempt to manipulate these brain waves in real-time (see Figure 1). This includes learning to modify the amplitude, frequency, and coherence [1] of specific brain waves and patterns of one's brain.[H] The goal of NFB is to teach the individual what specific states of cortical arousal feel like and how to activate these states on demand.[H] During NFB training sessions, the individual is connected to an EEG device, which records the EEG activity in real-time and provides feedback[2] to the

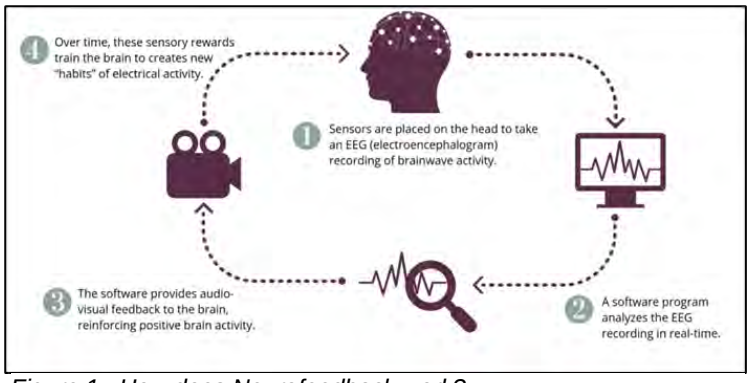

Figure 1. How does Neurofeedback work?
Video: Tune Your Brain with Wearables, Not Drugs. Click on the picture or go to https://www.youtube.com/watch?v=m8pMbiyWPxc.

[1] Brain wave activity is measured in real-time using an EEG. Brain waves are measured using the following terms: amplitude, frequency, and coherence. Amplitude is the strength of the brain wave measured in microvolts. Frequency is the number of times a specific brain wave is repeated in one second. Coherence measures how different areas of the brain can link or unlink to share information.

[2] An example of this feedback could be provided to the individual in the form of a bar on a screen, representing components of the brain wave activity, such as a bar with the amplitude of a frequency represented by the bar's size. The individual then must attempt through thought to manipulate this bar. As

individual using audio, visual, or combined audio-visual information, thus creating a feedback loop.[H] NFB training focuses on five brain wave types[3] - delta, theta, alpha, beta, and gamma - in order from slowest to fastest, with each associating with a specific function or capability (see Figure 2).

Unconscious	Conscious				
Delta	Theta	Alpha	SMR	Beta	Gamma
Instinct	Emotion	Consciousness	Focused	Thought	Will
Survival, deep sleep, coma, repair, complex problem solving	Drives, feelings, dreams, creativity, insight, deep states	Aware of the body, integration of feelings, alert and peaceful, reading, meditation	Mental alertness, physical relaxation	Perception, mental activity, thinking, focusing, sustained attention	Extreme focus, energy, ecstasy, learning, cognitive processing

Figure 2. Brainwaves, Frequency Bands, and Functions. *https://www.biofeedback-tech.com/articles/2018/5/4/types-of-brain-waves.*

Researchers have conducted experiments on NFB for peak performance training since the mid-1990s.[H] Research findings indicate that NFB improves cognitive skills (e.g., attention and problem solving), emotional regulation, and psychophysiological functioning.[H,4] For example, the alpha brain waves are associated with cognitive efficiency and intellectual performance, causing study participants to feel sluggish or experience memory challenges when their alpha waves are low.[H] Through training the alpha waves in NFB sessions, the sluggishness decreases, resulting in an increase of ten points on intellectual test scores.[H] Training of specific brain waves through NFB is likely to improve cognitive performance, especially with the commercially available wireless EEGs that function with smartphone applications.[H] Despite this availability, the stigma around historical use of EEGs for post-traumatic stress disorder (PTSD) treatment and complicated wiring requirement of existing devices make NFB systems for personal cognitive enhancement use unlikely for field deployment before 2025.

Neurofeedback is a safe, non-invasive form of therapy, and an alternative to medications.[H] A study on the use of NBF for improving soldier resilience to prevent stress-induced psychopathology found that training brain waves could improve stress coping skills and prevent development of PTSD.[H,5] NFB training allows soldiers to gain

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the individual achieves the desired goal, feedback such as a sound or symbol appears to indicate a point scored, intending to score as many points as possible.[H]

[3] In addition to these waves, there is another called the sensorimotor rhythm (SMR), which is characterized by a repetitive variation of harmonized electric brain activity.[H]

[4] Psychophysiology is the study of the relationship between biological functions and cerebral phenomena.

[5] This study targeted deep-brain limbic areas, specifically the amygdala, an area known for emotional processes. The amygdala's crucial role was demonstrated in a study with healthy soldiers showing that amygdala hyperactivation is an influencing factor for military stress vulnerability. Thus, learning to

control over their neurological responses, physiological arousal, and emotional reactions caused by combat-related PTSD.[H] Just as how drugs alter the brain's chemical activity, NFB allows soldiers with PTSD to manipulate their brain's electrical activity without the risks of developing drugs addiction or overdose.[H] However, there are ethical concerns regarding numbing of soldiers through neurological interventions turning conflict into an unfeeling undertaking, whereby soldiers would be cognizant of their actions, but feel no associated emotions, they would also not be able to recognize the psychological costs of their behavior. This dampening of the senses in war could have damaging effects on the honorable conduct of soldiers.[H] As this technology becomes more mainstream, military adoption for deployment stress management and PTSD treatment and prevention as alternative to drugs treatment is highly likely available by 2035.

The study of NFB has been around since the 1960s. However, the applications for healthy individuals is a relatively new area of research and practice. NFB provides several benefits in a short period with minimal side effects. NFB can stimulate enhancement and efficiency through manipulation of the right brain wave, at the right time, for the right task. Despite this progress, additional research is necessary to fully understand NFB's benefits and limitations for military use, especially in combat situations. The development of NFB training protocols for healthy individuals is under significant debate, the specific wave, and frequency level of manipulation has not yet coalesced into best practice protocols.[H] As more research is conducted, and the complexities of these brain waves is better understood iterative research results will become more reproducible leading to standards of NFB application centered around the desired effect. However, based on current trajectory of NFB technology, it is highly likely that the military will conduct field testing within five to seven years, with a deployable NFB system likely available by 2030. This opens doors for more advanced NFB systems to be available beyond 2035, with capabilities to assist in complex operating environments, delivering significant benefits to future military intelligence analysts.

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Greg Frazier

regulate one's amygdala activity may diminish detrimental stress responses and facilitate adaptive stress-coping mechanisms.

Extended Realities (XR) are Almost Certain to Significantly Impact Military Intelligence Analysts Over the Next 5-10 Years, Field Deployable Between 2025-2035

Executive Summary

Extended reality (XR) technologies' level of capability and utility will almost certainly continue to improve over the next 15 years. As a result, XR will almost certainly have a significant impact not only in the way service members train, but also how they function in garrison and field situations. It is almost certain that the U.S. Department of Defense (DoD) will expand its fledgling use of XR beyond the current utilization for training and combat arms specialties to support the military intelligence analyst by 2030. Various XR capabilities will almost certainly become more powerful with the convergence of faster microchips, better power sources, improved displays, faster networks, and computing. Analysts will likely remotely link to data from a host of sensors that was processed by artificial intelligence machine learning interfaces to provide meaningful linkages, assessments, and predictions. The analysts will then likely remotely interact with peers, staff, and commanders via a virtual field workspace that provides a professional, yet personal, experience while creating a minimal footprint for efficiency and safety.

Discussion

The DoD has long known the benefits of enhanced and simulated realities for training.[H,H] Recent advances in reality technologies have resulted in transformational changes in the way the DoD uses altered realities.[H,H] Extended reality is the new umbrella term that includes the three primary reality types of virtual reality (VR)[1], augmented reality (AR),[2] and mixed reality (MR)[3].[H,H] Holograms are a special type of MR that are

Figure 1. AFC IVAS "2020 Maneuver Warfighter Conference". Click on picture or go to: https://youtu.be/jdE-Dm4I02A to view video. Source: Benning.army.mil/mcoe/maneuverconference.

[1] Virtual reality (VR): A simulated experience that can be similar to or completely different from the real world.
[2] Augmented reality (AR): An interactive experience of real-world environment where the objects reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities.
[3] Mixed reality (MR): The merging of real and virtual worlds to produce new environments and visualizations, where physical and digital objects co-exist and interact in real time.

available now and are highly likely to be integrated into command centers or generated from mobile devices by 2035.[H,H]

Figure 2. VR Tech "Virtual Reality Contact Lenses are Already Here". Click on picture or go to: https://www.youtube.com/watch?v=QYgWFBoLmpg&t=400s *to view video. Source: YouTube.com.*

Currently, most user interface devices provide XR via a head mounted display.[H,H] It is almost certain that interface devices will become smaller and lighter over the next five to ten years to eventually resemble normal glasses.[H,H] Mojo Vison is taking this a step farther, as it continues to advance its research on contact lenses to provide users with an XR experience using an almost imperceptible device.[H,H]

According to the *Visual Capitalist*, XR is a multi-hundreds of billions of dollars industry that will become mainstream in the next four to ten years.[H,H] This includes uses within the DoD. Current XR capabilities are causing a paradigm shift in the way some service members will perform their future jobs.[H,H] The primary example of this is with the Microsoft Integrated Visual Augmentation System (IVAS) designed for dismounted close combat forces.[H,H]

While most of the current focus is on the infantry soldier and related combat arms specialties, leadership tools like virtual maps, sand tables, and knowledge access points are being developed to help with plans and operations.[H,H,H] Therefore, it is almost certain that convergence of multiple technologies including faster microchips, better power sources, enhanced motion tracking,

Figure 3. AFC IVAS "2020 Maneuver Warfighter Conference". Click on picture or go to: https://youtu.be/jdE-Dm4I02A *to view video. Source: Benning.army.mil/mcoe/maneuverconference.*

improved displays, faster networks, Mesh software, along with Cloud and Edge computing will lead to XR that will significantly enhance the military analyst of 2030-2035.[H,H,H,H] These technologies, possibly along with holographic displays, will likely support telepresence by creating a high definition digital twin[4] to interact with team members in a virtual tactical operations center (vTOC)[5] and a virtual analysis and collection element (vACE)[6].[H,H,H] Additionally, further convergence of XR with a future digital assistant or digital companion technology will empower the military intelligence analyst with greater abilities to access and analyze various data.[H,M]

Figure 4. Gundersen Health System "Paul Kuck, MD, on The Dangers of Using Virtual Reality Glasses". Click on picture or go to: https://www.youtube.com/watch?v=mCovUSKs3Qk to view video. Source: GundersonHealth.org.

However, there are issues that make XR a challenge for some individuals or situations. Some individuals experience physiological symptoms when wearing XR headsets that range from mild or moderate, to severe.[H,Annex B] Also, some users experience a period of disorientation, balance issues, and visual disturbance when they remove their device.[H,Annex B]

Additionally, some individuals have psychological challenges after wearing user display devices for extended periods of time.[H,M,Annex B] This is more associated with VR and gaming, than AR and MR which are the more commonly used for work and military environments.[H,Annex B] Research is ongoing to find ways to improve the technology to avoid this issue and also to discover what can be done to attenuate these side effects with training exercises, supplements, etc.[H,H,Annex B]

[4] Digital twin: Virtual representation serving as a real-time digital counterpart to a physical object.
[5] vTOC: Virtual Tactical Operations Center-a future tactical operations center that utilizes available technology to conduct much of the daily activities and meetings virtually with individuals displaced across a theater, COCOM, or globally.
[6] vACE: Virtual Analysis and Collection Element-a future military intelligence analyst tactical and operational level workspace that utilizes available technology to conduct much of the daily activities and meetings virtually with individuals displaced across a theater, COCOM, or globally.

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Jason M. Seery

"Advanced Brain Chips" Merging Human and Artificial Intelligence (AI) Likely Within 5 Years, Field Deployable Between 2030-2035

Executive Summary

Rapid advances in merging artificial and human intelligence through Brain Computer Interface (BCI) technology across multiple fields make it likely that several companies, including Elon Musk's NeuraLink, Japan's Meltin, and France's NextMind, will develop advanced and next-generation wearable or implant AI and BCI capabilities over the next five years with military-grade deployment between 2030-2035. Certain countries or fields are likely to question the ethics and/or safety of such devices; however, countries such as China are already clearing such hurdles and moving towards a more rapid adoption cycle.

Discussion

Figure 1. TEDxCEIBS - New Brain Computer interface technology lecture by Steve Hoffman, captain of Founders Space. Click on picture or go to: https://youtu.be/CgFzmE2fGXA to view video. Source: idstch.com (International Defense, Security & Technology).

Merging the human brain with technology, either directly or indirectly, is not a new concept and has been part of the medical community since Hans Berger discovered human brain electrical activity in 1929 and the subsequent development of electroencephalography (EEG) science.[H] Every action a human performs (deliberate or automatic) begins with a thought and is also a result of an electrical or chemical signal in the brain (See Figure 1). Many countries, including the U.S., China, Russia, and South Korea, are developing or testing varying forms of AI and BCI) technologies that detect and translate these electrical or chemical signals into machine or computer actions in commercial, medical, or military applications.[M] Specifically, China is seeking to erase distinctions between how AI and the human brain operates and interacts through wearable devices or implanted neurologically linked technologies.[H] In August 2019, a Tianjin University Neural Engineering and Rehabilitation Laboratory student won a BCI World Robot Conference competition when her "mental typing" technology allowed her to mentally type 691 Chinese characters per minute – exceeding the 600 bits per minute people can physically type on phones.[M]

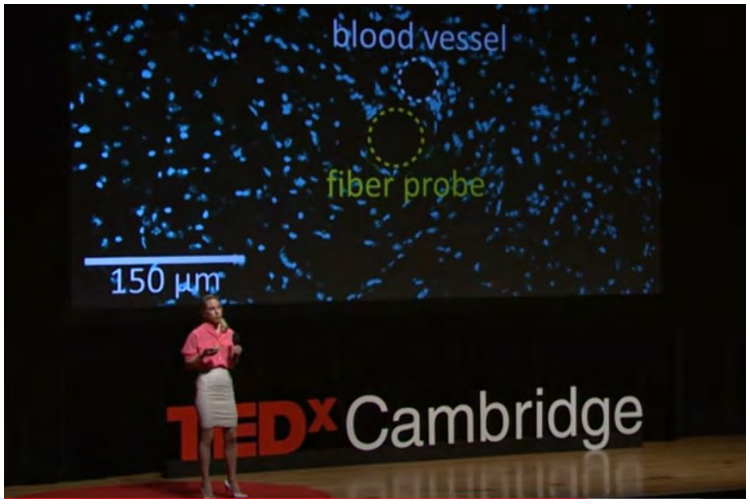

Figure 2. TEDxCambridge – Blurring the Boundaries Between the Brain and Machines lecture by Polina Anikeeva. Click on picture or go to: https://www.youtube.com/watch?v=6Qi5uoNYXqg to view video.

These recent developments, and demonstrated proofs of concept, that increase human abilities will likely continue to fuel the AI/BCI competition amongst multiple countries and private companies such as, Elon Musk's NeuraLink, Japan's Meltin, and France's NextMind.[H,H,H]

Due to the overwhelmingly complex nature of the human brain, research and development of technologies are not limited to any single field or investing entity. Medical and academic[H] entities seem to focus more on implant-type devices (see Figure 2), while commercial applications[M] tend to focus more on wearable devices. Due to the wide range of interrelated fields and applications, an exact estimate of current and future evaluations varies by type (wearable vs. implant). However, Grand View Research estimated that the global brain computer interface market in 2019 was $1.2 billion with a projected 15.5%[M] continued growth rate, while others projected a growth rate of 13.8% and a 2027 market valuation of $3.47 billion.[M] Academic and medical investments are equally ambiguous; however, multiple individual organizations, such as The BRAIN Initiative, award grants and funding nearing $500 million annually.[H,H]

Deploying AI/BCI technology is likely to face some ethical and technological challenges. During an interview in February 2021 with John Zuur Platten, a former senior game designer at Niantic Labs, he asserted that, "wearable AI/BCI is here now and the widespread proliferation of such devices is mere years away from a full mass-market rollout that enables seamless augmented applications" (see Figure 3).[(Annex B),H] He further asserted that,

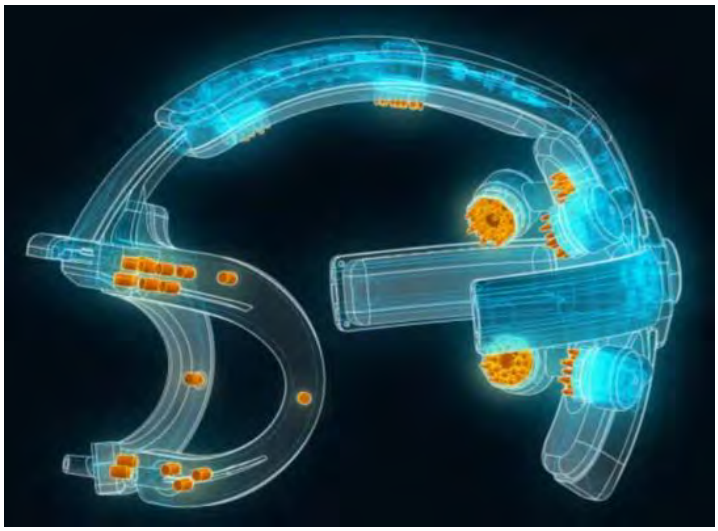

Figure 3. Example BCI headset, Galea, from OpenBCI. Click on picture or go to: http://www.openbci.com to view source.

"implants, outside of medical applications, are much further away[1] due to their invasive nature, underdeveloped technology, and current associated moral/ethical stigmas," which corroborates a recent RAND Corporation report.(Annex B),H However, competing views exist on how near-peer threats, such as China, intend to employ AI/BCI type technologies.

Figure 4. TEDxCambridge – Why You Shouldn't Upload Your Brain to a Computer lecture by Polina Anikeeva. Click on picture or go to: https://www.youtube.com/watch?v=MZ3Q638aMlA to view video.

During a February 2021 interview with Greg Porpora, an IBM Cyber Security and AI Engineer, he asserted that, "China is at pace, or ahead of not only the U.S. but most of the world in multiple technology spaces based on their differing ethical views to have humans in the loop, on the loop or off of the loop," along with differing state-sanctioned freedoms to conduct invasive/non-invasive neuroscience research. (Annex B),H,M,M Neuroscience research is complex and requires invasive multimodal electric, mechanical, chemical and other yet known interactions with the physical human brain to glean the full complement of human and AI/BCI possibilities (see Figure 4).M Current wearable AI/BCI technologies lack the sensitivity or sophistication to glean the anticipated full capabilities of implanted devices; however, until medical and mechanical advances progress to a more advanced state, it is highly likely that most countries will rely on their medical fields to further advance invasive technologies and commercial investors to advance wearable technologies.M,M

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: LTC Matthew C. Williams

[1] He estimated 20 years for initial commercially available AI/BCI implants, and in 50 years implants for full emersive AI/BCI experience will be common place.

Next-Generation Holographic Displays Likely Within 5-8 Years, Field Deployable Between 2030-2035

Executive Summary

Rapid advances in next-generation holographic display technology such as Looking Glass' 8K immersive display, Microsoft's HoloLens 2, VividQ real-time computer-generated holography software, and the University of Sussex Interact Lab's Acoustic Trap display make it likely that next-generation holographic displays will be developed over the next five to eight years with military applications fielded between 2030-2035. Current limitations to achieving *true* next-generation holographic displays center on data processing and transmission speeds; however, growing demand (individual, educational, business, government, etc.) and competitors entering the market will drive the innovation and adoption cycle for continued and rapid advances in parallel or supporting technologies necessary for next-generation holographic display advancement.

Discussion

Holographic Displays are not a new concept or technology. However, advances in parallel or supporting means lead some experts in the field, like VividQ's[H] Darran Milne, to assert that "holographic displays will be the dominant display technology of the next decade" in multiple sectors.[M] A hologram by strict definition is "an image that appears to the naked eye to be three dimensional;" however, most industries have grouped holograms into a more broad category of *holography* that includes wearables [such as augment reality (AR), virtual reality (VR), and mixed reality (MR) goggles Microsoft's HoloLens 2[H]] and particle or screen assisted displays (Looking Glass' 8K immersive display,[H] and University of Sussex Interact Lab's Acoustic Trap[H]).[M,M] Leapfrogging advances in materials, photonics, optics, and electronics along with growing competition in the three-dimensional (3D) display market by Japan, Taiwan, Korea, and China lead some experts to believe the 3D display market will grow to over $100 billion in the next five years.[H]

Figure 1. DW Shift – Holograms: What is possible in the near future? Click on picture or go to: https://youtu.be/Dq0OmKsQHpU to view video.

A February 2021 report by The Insight Partners, estimates that the 3D display market will grow from a 2019 evaluation of $491.4 million at a rate of 22.6% during 2020-2027 to reach $2,253.2 million by 2027.[H] Key findings from the report support that autostereoscopic and stereoscopic 3D displays that do not require the use of glasses

(glasses-free 3D) are likely to see the most growth in media and entertainment markets.[H] However, other industries, such as automakers and consumer goods retailers, are also exploring 3D display market technology.[H,H]

Figure 2. TechAcute – Ceres Holographic and Covestro Create Holographic Display for Vehicles, available at: https://techacute.com/ceres-holographics-and-covestro-create-holographic-display-for-vehicles/.

Texas Instruments, Ceres Holographics, and Covestro are a few companies that are exploring 3D displays in vehicles that seek to improve driver safety as well as passenger experience.[H,H] Likewise, Skinceuticals (L'Oreal Chinese-based subsidiary) is exploring glasses-free 3D technology to improve consumer experience and enables users to *see* how different ingredients and herbal extracts can bring different effects to the skin without having to repeatedly apply and remove physical products.[M] However, *touchable* holographic displays are another growing aspect of holography.[M]

Touchable holographic displays will enable users to directly interact with holographic images in two and three dimensions and current market research leaders include: AV Concepts, Displair, Holoxica, and Real View Imaging.[H] However, based on current data processing and transmission speeds, *true interactive holographic displays* (not aided by glass or particles – see Figure 3) are not likely until the advent of 6th Generation (6G) technology which Hong Kong based market research company Antiprohense anticipates arriving 2030.[H] In the interim, countries and industries continue to explore 3D imaging and holographic display capabilities throughout vast military, healthcare, manufacturing, and education applications.[M,M]

Figure 3. CNET – You can feel and hear these holograms. Click on picture or go to: https://youtu.be/tzWP-NL3Lck to view video.

WiMi, China's largest holographic AR application platform, is mostly focused on advertising services and entertainment products that account for 91% of its total revenue.[M] However, as part of China's Dream Classroom program, WiMi is working with China Education Television to create a holographic classroom that provides a high-quality education environment enabling students to learn from home and to be taught by

world-renowned teachers from across the globe.[H] This initiative seeks to merge multiple technologies including holographic space imaging, light and shadow art, MR, real-time motion capture, somatosensory interaction, and algorithm art to deliver the most comprehensive and interesting learning experience to students.[H] The merging of such technologies is likely to further the adoption of digital representatives[H] as well as ultrahigh-definition dynamic 3D holographic displays.[M]

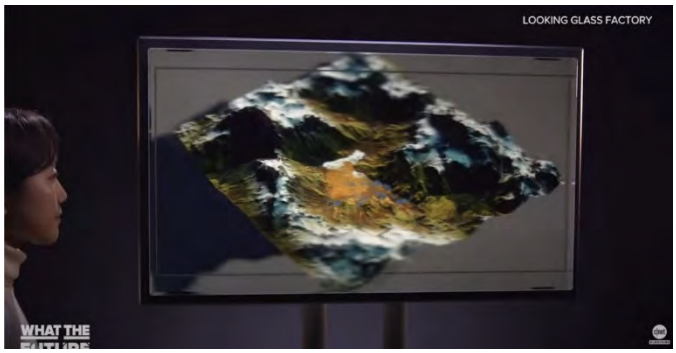

Figure 4. CNET – What the Future – The world's highest-resolution holographic display. Click on picture or go to: https://youtu.be/EMUdmE0lKIU to view video.

Digital representatives, as well as ultrahigh-definition dynamic 3D holographic displays (see Figure 4) are still early in the development cycle.[H] Aside from the Coronavirus Disease 2019 (COVID-19) delays[H] and current technological limitations,[H] there do not appear to be any catastrophic limitations to the further development of next-generation holographic display technologies. Some individuals such as Lian Shi, a Ph.D. student in Massachusetts Institute of Technology (MIT's) Department of Electrical Engineering and Computer Science department, assert "it's often been said that commercially available holographic displays will be around in 10 years, yet this statement has been around for decades," which further affirms that holographic displays are not a new technology, but one that stands to continue to advance as parallel and supporting technologies continue to mature.[H]

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: LTC Matthew C. Williams

Tactical Unit Level Short Form Analytic Reports

Hyperautomation Enabled by Artificial Intelligence / Machine Learning Applications Highly Likely Within 5 Years, Widespread Integrated System Fielding Between 2030-2035

Executive Summary

Rapid advances in concepts known as “digital process automation” and “intelligent process automation” along with increased private sector investment in Artificial Intelligence and Machine Learning (AI/ML) make it highly likely that several companies such as Amazon, Google, UiPath, SolveXia, and Wipro will develop Hyperautomated systems over the next five years with widespread military integrated systems fielded between 2030-2035. Challenges such as data processing and transmission speeds may slow the broad adoption and implementation of hyperautomated systems; however, companies developing and utilizing forecasting and learning algorithms will drive near-peer competition in the commercial sector to increase efficiencies and profits while minimizing risks.

Discussion

Hyperautomation is a concept that involves the integration of advanced automation technologies to augment and enhance human intelligence across several technologies including: robotic process automation, artificial intelligence, machine learning, process mining, decision management, and natural language processing.[H] More simply stated, hyperautomation the combination of multiple technologies that seek to automate, simplify, discover, design, measure and manage workflows and processes across a given enterprise, freeing human capital from routine tasks that can be automated.[H] Several countries are already exploring and fielding military applications of technology such as unmanned vehicles and drones; however, these systems still require human interface (control) and respond at the speed (limitation) of their human decision-maker. China, for example, is embracing technology as the ongoing Revolution in

Figure 1. Artificial Intelligence in Military: How will AI, Deep Learning and Robotics Change Military. Click on picture or go to: https://youtu.be/HwWiLH20Q6Y to view video. Source: IntroBooks Education.

Military Affairs (RMA) to seize the initiative over other competitors to transform the characterization of conflict from "informatized" warfare to "intelligentized" warfare.[H]

AI/ML possess a wide variety of applications ranging from computer vision, natural language processing, robotics, and data mining – which easily translate to military applications such as surveillance, reconnaissance, threat evaluation, underwater mine warfare, cybersecurity, intelligence analysis, command and control, and education and training.[H] Many countries such as the U.S.,[M] Russia[H], and China[H] have tested individual AI/ML systems; however, limited examples of hyperautomation, such as the Office of Management and Budget[H], as well as the U.S. Air Force[H], indicate that hyperautomation is still in the early stages of the adoption cycle which is reported to reduce human routine workloads by as much as 69% by 2024.[H] Research by Gartner indicates that 53% of current AI/ML projects successfully make it from prototype to full production – citing system maintainability, scalability, governance and failed hoped-for returns as leading obstacles.[M] Integrating and processing data associated with AI/ML will likely occur in the civilian sector first; however, the market size of military ML solutions is expected to reach 19 billion by 2025, and 23.7 billion by 2027.[M,M] These forecasts, coupled with multiple countries and companies, such as Amazon, Google, UiPath, SolveXia, and Wipro, competing for market share, will likely accelerate the timeline for hyperautomation and integration of multiple AI/ML systems.[H]

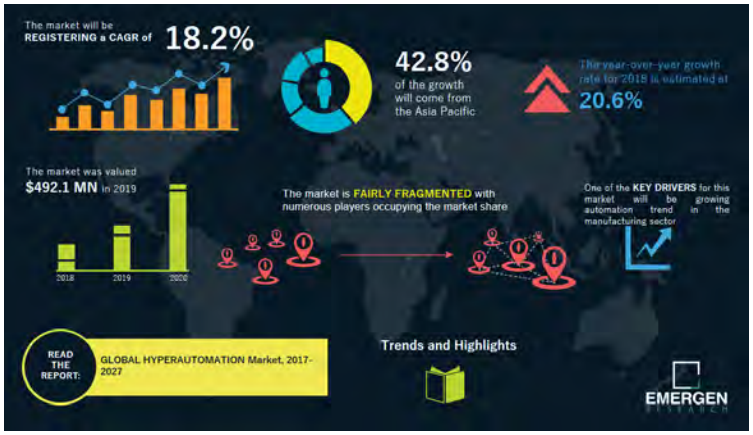

Figure 2. Emergen Research: Hyperautomation Market by Technology (Robotic Process Automation, Artificial Intelligence, Machine Learning, Biometrics, Chatbots, Natural Laungage Generation), Industry Verticals (BFSI, Retail, Manufacturing, Automotive, Healthcare), Forecasts to 2027. Click on picture or go to: https://www.emergenresearch.com/industry-report/hyperautomation-market to view report.

The overwhelmingly competitive nature of hyperautomation and integration of AI/ML systems by public and private global entities makes it likely the Defense Advanced Research Projects Agency (DARPA) will be able to maintain a competitive advantage over the Chinese People's Liberation Army (PLA) National Innovation Institute of Defense Technology through 2035. However, China seeks to invest tens if not hundreds of billions of dollars in a national team of AI champions who include: Baidu, Alibaba, Tencent, iFlytek, and Sensetime with a unified strategy of military-civil fusion focused on "leapfrogging" the U.S. economically and militarily.[H] Beyond

monetary investment, China also seeks to gain a competitive advantage in hyperautomation and integration of AI/ML by closely studying and adapting lessons learned from U.S. concepts and initiatives where there is oftentimes a significant asymmetry of information where China's AI research and applications receive less attention from the U.S.[H,H]

AI/ML is increasingly finding its way into cybersecurity systems and could likely assist with combating intellectual theft or spying by hardening hyperautomation related transactional systems, communications networks, and digital activity and websites on both the public and private sectors - and by extension militarily.[M] Commercial development of AI/ML technology that learns to identify threats to hyperautomation systems, including variants of previous threats would likely translate to military applications and combat adversarial information attacks on the electromagnetic spectrum, as well as extend the U.S. DoD's informational advantage over near-peer competitors for several years.[M]

Developing hyperautomation AI/ML is likely to face several challenges ranging from data processing and transmission speeds to social acceptance of fully autonomous AI/ML systems and the moral and ethical dilemmas that may arise. However, as technology continues to become a more pronounced part of daily life – Transforma Insights forecasts Internet of Things (IoT) market will grow to 24.1 billion devices in 2030, generating $1.5 trillion in revenue – it is likely that all of these devices will become interconnected through hyperautomated systems driven by AI/ML.[M]

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time; however, the analyst worked alone and did not use a structured method. Given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: LTC Matthew C. Williams

Innovation in Edge Computing, Cyber Foraging, and Tactical Cloudlet Architectures Highly Likely to Enable Mitigation Strategies for System Connectivity Issues in Denied, Disrupted, Intermittent, or Limited (DDIL) Operating Environments

Executive Summary

Ongoing advances in the field of distributive computer architecture (DCA) such as Edge Computing, Cyber Foraging, and Tactical Cloudlet development are highly likely to offer future U.S. forces, to include intelligence analysts, options to effectively mitigate many of the impacts of denied, disrupted, intermittent, or limited (DDIL) Operating Environments as it relates to utilizing technology innovations over the next 10-15 years. Use of these DCA technologies are highly likely to enable continued automation functionality as well as continued connectivity when utilized in conjunction with other developing technologies designed to thwart electronic jamming and enable tactical edge access to data. Challenges still exist with maintaining DCA connectivity to Internet of Things (IoT) sensors in DDIL environments but are likely to be addressed through other technological developments.

Discussion

The U.S. Department of Defense (DoD) historically enjoyed the benefits of technological overmatch over its adversaries.[M] Recently, near-peer adversaries like China and Russia expended significant resources into areas like electro-magnetic pulse weapon systems, as well as offensive cyber capabilities with the intention of offsetting this advantage.[H] Recognizing the U.S. reliance on cyberspace to execute military operations, both China and Russia pursued

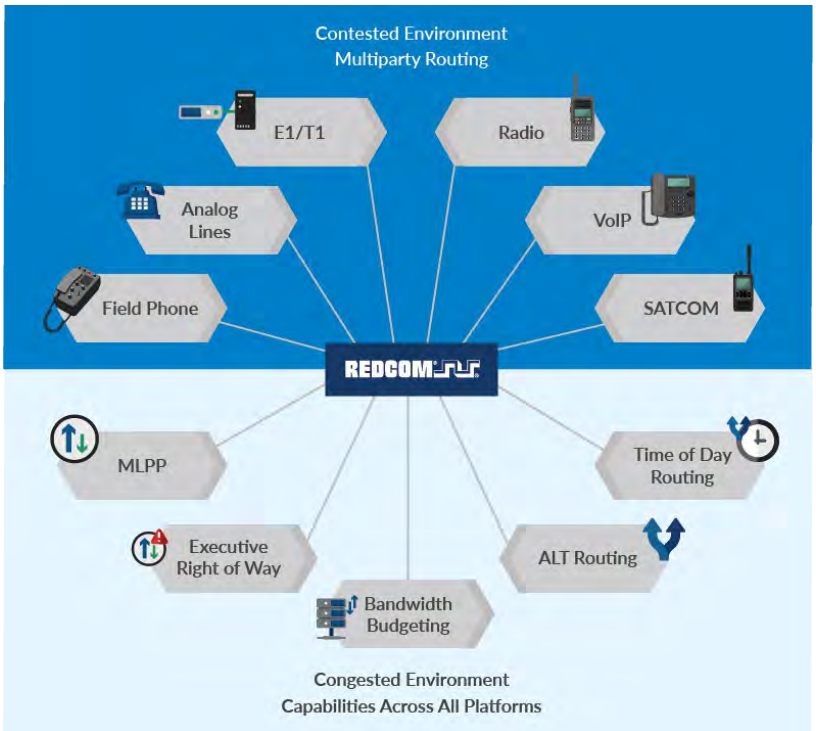

Figure 1. Illustration depicting various communication platforms. Source: Data Science Venn Diagram

technologies and developed supporting strategies to take advantage of this potential vulnerability.[H,H]

As a result, current U.S. military doctrine stipulates the likelihood of soldiers operating in a DDIL environment.[H] This has the potential to significantly impede the ability of intelligence analysts to fully leverage emerging tools and technologies (such as artificial intelligence or machine learning) currently being designed to execute much of the Processing, Exploitation and Dissemination (PED) functions of the future.[H] In response to this threat, the Army and DoD are looking at establishing resilience and redundancy in future battlefield systems, as well as considering alternate computing architectures to mitigate these potential negative impacts.[H]

One example of a new design concept currently drawing interest from the DoD and showing application in both the private and military sector is the field of distributive computer architecture research and development.[H] This framework has been around for decades as an innovative way to increase computing power by combining multiple computer systems for the execution of a large task.[H] This evolving technique sets conditions for incorporating another approach intended to overcome DDIL situations called edge computing.

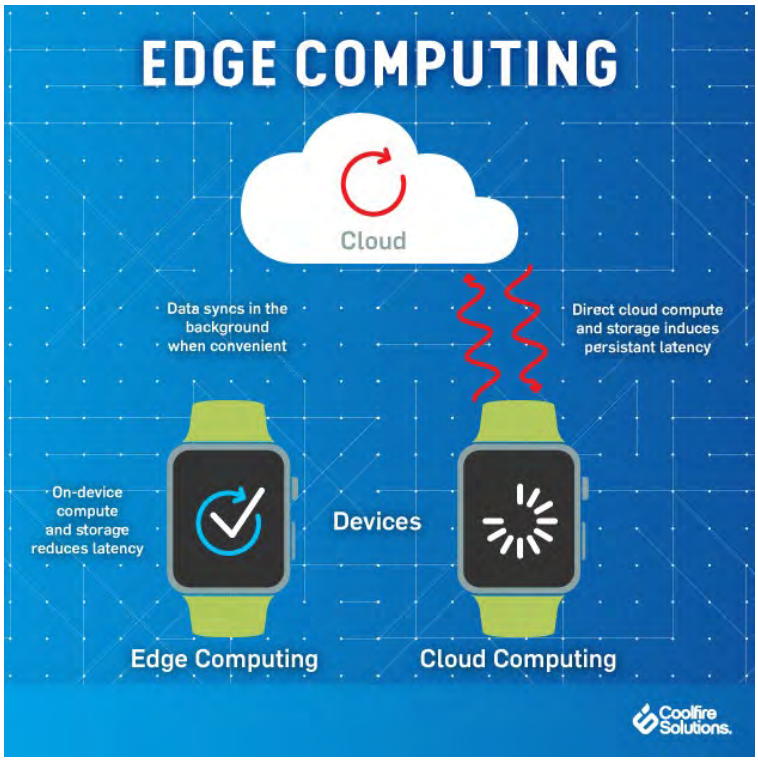

Figure 2. Illustration of edge computing connectivity. Source: Edge Computing

Edge Computing, simply put, involves establishing and leveraging sufficient computing power, on-site, to enable the preponderance of technology or database access need by the user.[H] Palantir, the current producer of software upgrades to the Army intelligence analyst's tool called Distributed Common Ground System – Army (DCGS-A), is already incorporating edge computing concepts in its most recent update called Capability Drop One.[H] In speaking with lead developer, Bryant Choung of the Palantir development

team, Team Porrima learned future updates to DCGS-A will build on the ability to leverage cloud-based systems when connected, and leverage edge computing locally when a DDIL environment presents itself.[H] Depending on the parameters of the action being performed by the user, the system either leverages existing communication architecture to communicate with external assets or makes the determination to leverage on-site capability. Even in environments without DDIL issues, this concept creates increased efficiencies by determining which approach best optimizes equipment and reduces latency.[M]

Another technique incorporating these concepts to enable continued communications despite DDIL environments impacts on connectivity is an architecture called tactical cloudlets.[M] Cloudlets, in this case, are defined as discoverable, generic, stateless servers positioned within single-hop proximity of a user's mobile devices.[M] Whereas distributive networking and edge computing were originally designed to offset issues with limited operating system capacity of mobile devices and divert functions detrimental to mobile system battery life, the tactical cloudlet concept was specifically designed to defeat battlefield challenges with DDIL environments.[H] By leveraging a technique called cyber foraging, computers can focus additional processing power to a system and establish a limited communications net through artificial intelligence (AI) enabled queries of available systems in the proximate network.[H] This technology is already available and is being integrated into the DoD architecture through projects like Joint Enterprise Defense Infrastructure (JEDI) cloud and is being optimized through extensive research in

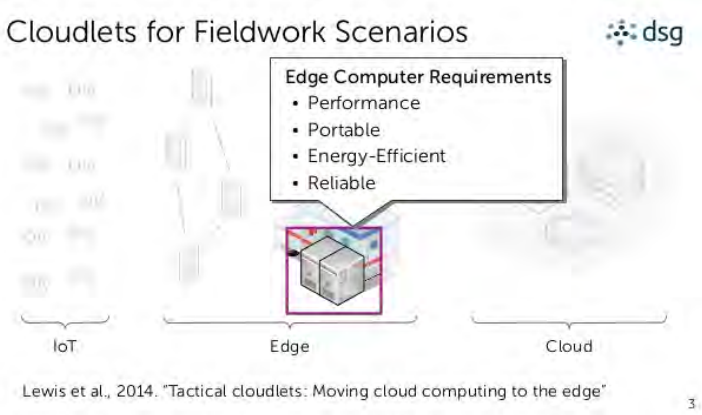

Figure 3. Illustration of tactical cloudlet array. Source: Edge Computing

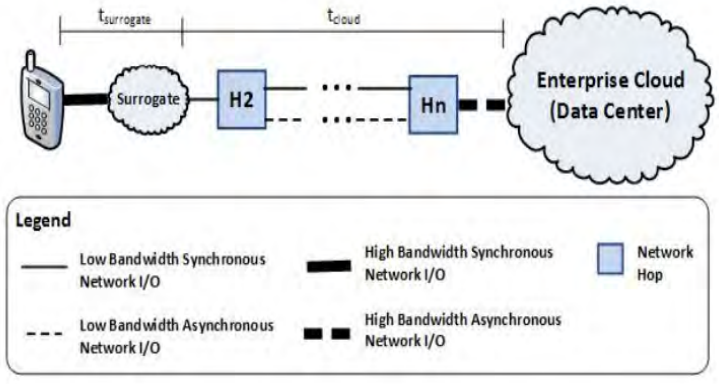

Figure 4. Illustration of cyber foraging. Source: Carnegie Mellon University Cyber Foraging Diagram

DoD partnerships with universities such as Carnegie Mellon University.[H,H]

The use of these technological arrays solves several of the issues confronting the future analyst by positioning data repositories in proximity to the user and offering enough shared computing power to enable various technologies like artificial intelligence, machine learning or holographic projections.[H] However, these technologies do not solve the issue of continual connectivity with the outside "Internet of Things."[H] Several other communication technologies are being tested to potentially solve this issue.[H]

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were generally reliable and could be routinely corroborated by other sources. There was adequate time, but the analyst worked alone, and did not use a structured method. Furthermore, given the lengthy time frame of the estimate projection and recent surge in emphasis as well as research and development investment, this report is sensitive to change if presented new contradictory information.

Author: COL Joseph T. Sheridan

Advances in Emerging Technologies Highly Likely to Reduce Analytic Footprint, While Increasing Speed and Capacity, Thus Enabling a Virtual Analysis and Collection Element (ACE) By 2030-2035

Executive Summary

Current glidepaths in innovation and development with emerging technologies (Edge Computing, Artificial Intelligence, Machine Learning, 6th generation (6G) communications, Augmented Reality, No- or Low- Code software development, and Digital Assistance) are highly likely to enable the future Army Intelligence Analysis and Collection Element (ACE) to operate with minimal Military Occupational Specialist, 35F, Army intelligence analysts' on site. Although technology will likely be advanced enough to assume execution of many of the processing, exploitation, and dissemination tasks required of current analysts, it will not be able to replicate the ability of humans to reason and make decisions in ambiguous situations. Technological advances will help optimize future analysts, allowing focus on data validation, analysis, and communication with decision makers. Despite concerns with near-peer threats creating a denied or disrupted communications environment, innovation in resilient communications architecture is likely to also enable unprecedented "reach back" integration with subject matter experts and other intelligence enterprise partners.

Discussion

The convergence of multiple technologies is highly likely to create sufficient capacity to redirect large portions of the intelligence analytic targeting workload to advanced automation.[M] However, after speaking with dozens of experts throughout the intelligence and technological communities, there is a clear belief that the "human in the loop" requirement will still be necessary for a multitude of reasons.[H] Whether validating artificial intelligence derived target nominations, reviewing questionable data for authenticity, or determining and communicating refined analysis, it is unlikely military leaders would be willing or able to accept intelligence products which were not reviewed by an individual or small group first.[H]

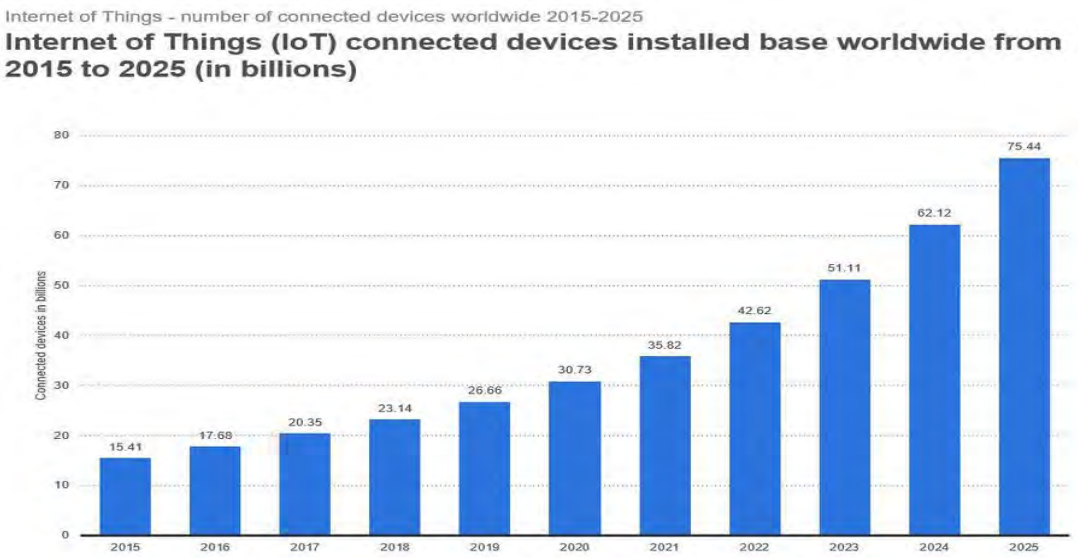

Figure 1. Internet of Things (IoT) connected devices installed base worldwide from 2015 to 2025. Source: Projected Growth in IoT Systems through 2025

Exponentially growing numbers of sensors will offer this technology increasingly comprehensive coverage of areas of interest.[M] Current estimates indicate over 35 billion devices are currently connected by the Internet of Things (IoT) with that number more than doubling by 2025.[M] By 2035, there is a high likelihood the sensor proliferation, enabled by this growing IoT comprehensive coverage, will create both near ubiquitous penetration as well as massive amounts of data requiring filtering.[M] The ability to ingest this large volume of data, identify meaningful patterns or targets, and then quickly push the applicable data to the appropriate recipients at the speed of the future battlefield will mandate the transition to technology.[M] In short, the missions of Processing, Exploitation, and Dissemination (PED) will be delegated, in large part, to a machine intelligence architecture likely to be in use in the future.[M]

Although the human in the loop requirement is highly likely to exist in the future, the integration of technology will likely enable an ACE requiring a far smaller human footprint by the timeframe of 2030-2035. Emerging technologies are already being used by the military to autonomously find and confirm likely enemy targets.[M] Advances in machine learning (ML) will continue to refine the ability of these artificial intelligence (AI) enabled algorithms to accurately find targets.[M] Leveraging AI and ML, analysts will benefit from dramatically improved efficiency, accuracy, and speed.[M] Advances in these technologies continue to expand their ability to autonomously execute much of the "hunting and pecking" chores in the future, to quote Amazon's head of New and Experimental Thinking (NEXT), Scott Jones, which are currently performed by today's analysts.[M] This emergence, coupled with technology's ability to operate without break, will likely significantly minimize the number of individuals and shifts necessary to provide the "human in the loop" management of the future ACE.[M] A smaller footprint will result in additional efficiency and will enhance analysts' ability to operate at the

machine speed required in sensor to shooter methodology and reduce unnecessary additional signatures associated with a larger footprint.[M]

Figure 2. Holographic Display Using Microsoft Mesh Technology

The confluence of several other emerging technologies further increase the likelihood of a virtual ACE construct. The continued progression of digital assistance technology, coupled with advances in holographic technologies and augmented reality, will likely replicate many functions performed by junior analysts, including the ability to leverage natual language understanding software, improved predictive analysis capabilities, and technology to improve communication methods to decision makers.[M,M,H] Additionally, significant recent advances in no- or low-code application development will allow the analyst of the future to design new algorithms and supporting modeling without the need for on-site programmers.[H] These capabilities will allow human analysts to focusing on areas where computers will not provide superior capabilities such as managing uncertainty.[H]

To power these new innovations, advances in the field of distributive computing architecture are being designed and already incorporated into battlefield systems. Software developer Palantir is already leveraging concepts like edge computing into various systems already in use by Army analysts.[H] These systems will not only increase the likelihood of being operational in a Denied, Intermittent, or Low Bandwidth (DIL) environment but also increase the processing speed and power through an arrayed architecture.[M]

Another area where technology will enable the future analyst is in the ability to have "reach back" abilities which empower improved analysis and expertise without having to have the capability resident to the battlefield location. Innovations like Microsoft Mesh's mixed reality and other augmented reality, powered by emerging 6G communications bandwidth, will improve the ability to collaborate with distant experts as well as improve communications with decision makers.[M,M] These capabilities, in conjunction with other external analytic resources such as crowd sourcing, will allow the ACE of the future to exceed today's capacities with only a minimal footprint of human analysts on site.[M]

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and could be routinely corroborated by other sources. There was adequate time, but the analyst worked alone, and did not use a structured method. Furthermore, given the lengthy time frame of the estimate projection, multiple technologies discussed, and recent pandemic-driven research and development investment, this report is sensitive to change if presented new contradictory information.

Author: COL Joseph T. Sheridan

Li-Fi Wireless Networks Highly Likely to Impact Military Intelligence Analysts Within 5 Years, Field Deployable Between 2030-2035

Executive Summary

Rapid advances in Light Fidelity (Li-Fi) technology, and a need for wireless networking within the U.S. Department of Defense (DoD), make it highly likely that several companies will develop military grade systems over the next five years with widespread military deployment by 2030 for garrison and field environments. The unique capabilities of this technology will empower future military intelligence analysts in many ways. This includes providing faster access to data on a network, in a more secure manner, and with a more reliable connection. Also, access that is energy efficient, giving off minimal to no radiofrequency (RF) or electromagnetic (EM) signal signature, with no interference with RF or EM devices, and all while providing mobility since it is a "nontethered" wireless technology.

Discussion

Current networks within the DoD are primarily hard-wired to enhance security. While this is one way used in securing networks, it tethers the device and its user to a stationary location, often limiting the efficiency and productivity of the user.[H]

Figure 1. Phillips Lighting Systems "Introducing Li-Fi technology". Click on picture or go to: https://www.youtube.com/watch?v=e0XxTiThgVo to view video. Source: Signify.com.

Therefore, wireless broadband network technology is currently a rarity within the DoD due to the difficulty to fully secure it from unauthorized access.[H] Currently, the primary method of creating a wireless local area network (WLAN) utilizes wireless fidelity (Wi-Fi) technology.[H] Wi-Fi uses RF to send and receive data that presents many security risks.

A typical Wi-Fi network system uses an omnidirectional signal that provides a usable signal to about 150 feet maximum radius indoors and 300 feet radius outdoors.[H] This gives intended authorized users access to the network without being tethered by a wire. However, it is possible for unauthorized individuals within the radius of the wireless signal to access the network. In addition to being omnidirectional, RF can penetrate most building materials, allowing for unauthorized access outside of the intended area.[H]

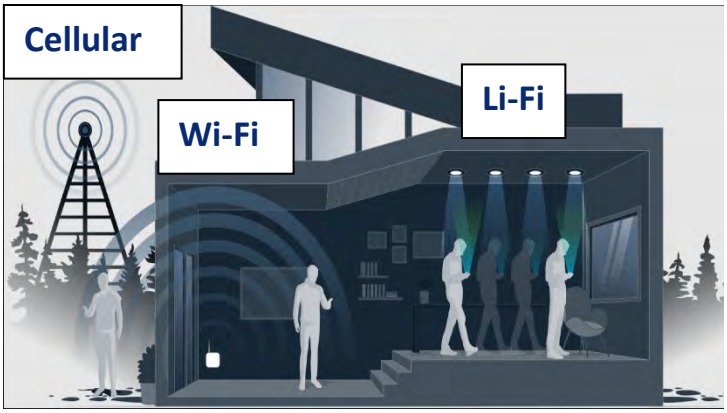

Figure 2. Pure Li-Fi "Works with or independent of Cellular and Wi-Fi". Click on picture or go to: https://purelifi.com/wp-content/uploads/2017/06/tech-illustration-1.png to view image. Source: Purelifi.com.

Li-Fi uses special light emitting diode (LEDs) to send and receive a digital binary code to an authorized receiver-transmitter within a narrow angle beam.[H] This significantly reduces the potential for unauthorized access since the signal is not spread over a very large area.[H] Additionally, Li-Fi signals cannot pass through solid or translucent materials, further limiting the range to its intended area and increasing security.[H] These features make it ideal for use in military fixed structures and tents in a field setting.

The second benefit of Li-Fi technology is its speed. Li-Fi current bandwidth and speed is 10-100 times faster than typical Wi-Fi with future download speeds up to 400 gigabit per second (Gbps).[H] Additionally, the latency is three times lower than Wi-Fi, resulting in faster access and a more reliable connection.[H]

Given that Li-Fi uses infrared, visible light, and ultraviolet frequency ranges, another advantageous feature is that Li-Fi does not give off radiofrequency or electromagnetic signals. Equally, it does not interfere with radiofrequency or electromagnetic signals.[H]

Li-Fi has additional features that make it ideal for military application. One is that the use of inexpensive LEDs to create a network will lead to the widespread use of this technology.[H] Since Li-Fi uses very efficient LEDs, its power consumption is less than that of a Wi-Fi system.[M] Additionally, this technology has options for Li-Fi to function within infrared and ultraviolet bandwidths, or at such a low luminosity of visible light that the room will appear dark.[H,H]

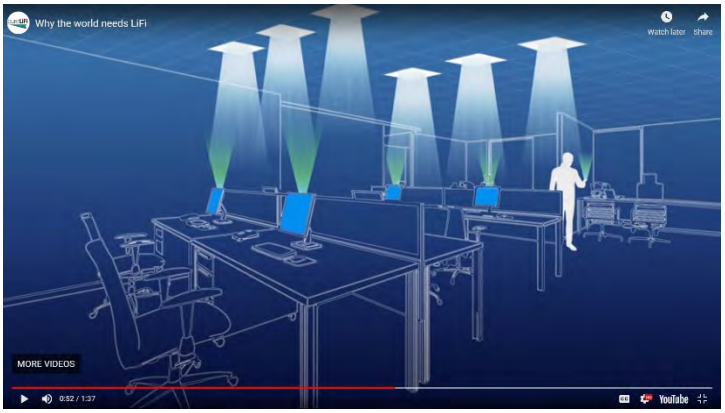

Figure 3. Pure Li-Fi "Why the world needs Li-Fi". Click on picture or go to: https://purelifi.com/lifi-technology/ to view video. Source: Purelifi.com.

Li-Fi is poised to converge with other current and emerging technologies that can take advantage of its speed and security. Li-Fi will link to Edge computers for faster analysis of data, integrate with brain-computer interface and other Internet of Things (IoT) devices, and increase the use of virtual rooms for operations, plans and analysis.[M]

A final consideration is that lights are often the first things established in a headquarters or administrative element in a tactical or operational unit. Therefore, you can have network access within minutes instead of the normal hours it can take to run ethernet local area network (LAN) wires from servers to terminal devices.

The above features of the Li-Fi technology make it highly likely that it will have widespread use across the DoD in many facilities. It will empower future military intelligence analysts by providing faster terminal access that is more reliable, more secure, more energy efficient, with minimal signal signature, with no interference with RF or EM devices all while providing mobility that a nontethered wireless technology provides.

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Jason M. Seery

Use of Free Space Optics and Visible Light Communications Very Likely to Enable Military Connectivity, Outside of Tactical Edge, in Disconnected, Intermittent, or Limited Bandwidth Conditions Within 3-5 Years

Executive Summary

The Department of Defense (DoD) is expending significant investment and research focus on developing the ability to access computing power and data through tactical edge or distributed computing architecture (DCA). While this strategy offers the ability to sustain most automated operations and communicate with those in proximity of the DCA array, it does not solve the issue of maintaining connectivity and access to external enablers such as the Internet of Things (IoT) in a Disrupted, Intermittent, or Limited (DIL) bandwidth environment. To address this shortfall, evolving technologies such as Free Space Optics (FSO) and Visible Light Communications (VLC) are likely to offer viable solutions in the near term with military fielding and testing taking three to five years. Although both technologies have critical limitations when used by themselves, when used in tandem these capabilities offer extremely fast, radio frequency (RF) signature free, secure data and voice communications not jammable by traditional electronic warfare (EW) systems.

Discussion

The acronym DIL, when used in military parlance, usually refers to battlefield conditions which prevent the military from having stable access to internet and communication networks. Over the last decade, the U.S. military focused extensive resources to ensure U.S. technological overmatch is not neutralized thru near-peer adversary use of EW measures designed to deny the U.S. forces the ability to communicate and synchronize.[H] As a result, much of DoD's future communications planning is leveraging multiple technologies, using a variety of architectures to build redundancy as well as various options to ensure communication is maintained.[H] The acronym PACE (primary, alternate, contingency, and emergency) is routinely leveraged when discussing the future use of various communications technologies to ensure some level of continued connectivity.[H]

Figure 1. Original Li-Fi Ted Talk. Source: Harold Haas

The Army's current plan to mitigate DIL is through an architecture it calls the Integrated Tactical Network (ITN).[M] This layered approach leverages technologies, both new and

old, to better ensure battlefield connectivity.[M] The Army plans to begin fielding ITN in 2021 and has designed it with many planned future enhancements over the next five years.[M] After review of the various components of ITN, no communication system is clearly identified which could ensure connectivity with the IoT, and the array of necessary sensors it can provide, if the ITN infrastructure came under pervasive EW attacks.[M]

A potential solution to overcome this gap may have recently been identified through the utilization of two promising technologies: VLC and FSO communications. VLC or "Li-Fi" leverages the light spectrum to facilitate data transmission.[H] In addition to offering superior data capacity and a speed up to 250 times faster than wireless fidelity (Wi-Fi) options, its inherent physics also make light fidelity (Li-Fi) far more secure than other options.[M] Future projections estimate a potential bandwidth capacity of around 10 gigabytes per second.[M] The one major drawback to this technology is that Li-Fi is best utilized in indoor spaces due to a very limited range. Whereas the standard Wi-Fi signal has a range of approximately 32 meters, the radius of a Li-Fi signal maxes out around 10 meters.[M] Additionally, its signals do not penetrate walls since they are light-based.[M] For this reason, the over $80 million projected to be spent on Li-Fi development by 2023 will be focused on use in enclosed spaces like hospitals or government Sensitive Compartmented Intelligence Facilities (SCIF) where the lack of RF based signals reducing interference or the potential for adversarial intercept.[M]

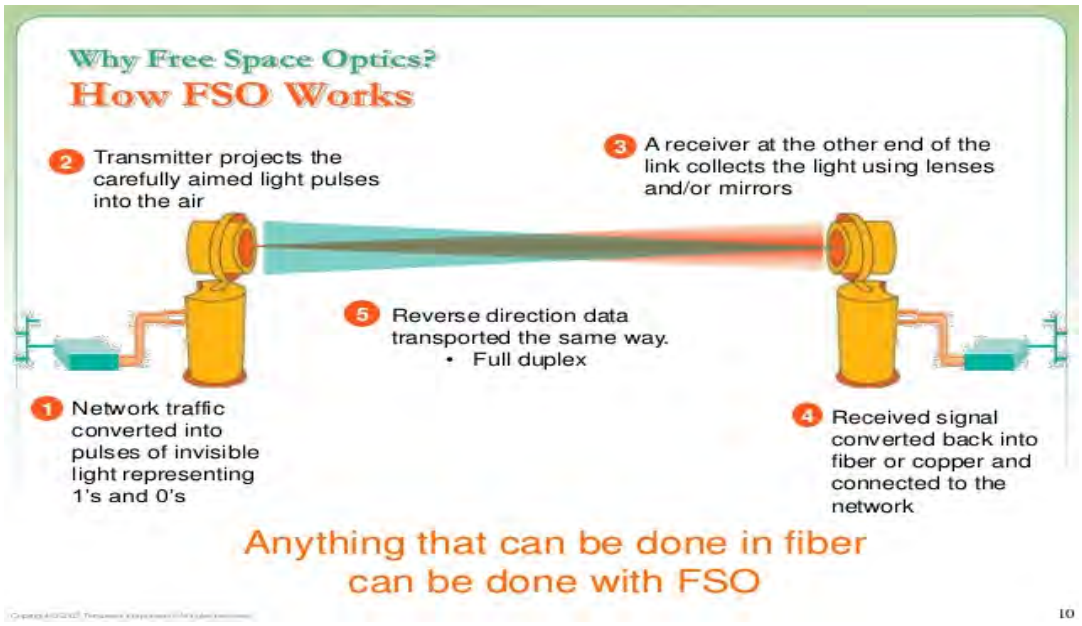

Figure 2. FSO explanatory diagram. Source: How FSO Works

Recognizing this limitation with Li-Fi, a senior Army Warrant Officer pioneered and field-tested a technique blending Li-Fi technology with another emerging capability called FSO.[M] FSO is a communication method which leverages a highspeed spectrum

"wireless fiber" capability.[M] FSO uses an optical wireless broadband access capability leveraging the infrared light spectrum.[M] Using these technologies in tandem during a 2019 field exercise, the test successfully established secure communications between two Tactical Operation Centers, separated by 16 kilometers of complex terrain, under dynamic weather conditions, and maintained 95% communications availability over ten days.[M] Not only did this innovation create a communications platform able to transmit data with the "rear" and IoT under EW created DIL conditions, but it also accomplished this with no RF signature, making it extremely difficult for an enemy to locate and near impossible for an enemy to jam.[M]

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were predominantly reliable but corroborating information was limited due to recency of discovery. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate and relative speed of new technology breakthroughs, this report is sensitive to change if presented new contradictory information.

Author: COL Joseph T. Sheridan

Enterprise Level Short Form Analytic Reports

5G Wireless Communication Networks Highly Likely to Impact Some Aspects of Military Intelligence Analyst Within 5 Years, Field Deployable Between 2025-2035

Executive Summary

Periodic advances in broadband network technology, along with convergence with other technologies, make it highly likely that several companies will develop core hardware, software, and a variety of peripheral items within the internet of things (IoT) to connect to the U.S. Department of Defense Information Network (DoDIN) within the next five years. This is a transformational change that will be widespread throughout the military and impacting military intelligence analyst between 2025 and 2035. Significant security risks, investments, and interoperability will need to evolve in parallel to ensure overall success.

Discussion

Data is king during times of uncertainty" and is essential in avoiding, and if necessary, winning armed conflict.[H] One evolving technology to aid in the flow of data are broadband cellular networks. Global broadband networks are currently undergoing a planned decennial upgrade to 5th generation (5G) technology.[H] It is one of the most significant leaps in wireless networking that will move beyond mobile devices and also function as an internet service provider.[H] This will revolutionize how we access and use data.[H] While this is a civilian commercial led effort, the military can capitalize on it due to new security protocols like enhanced user authentication and stronger 256-bit data encryption[H,H] The new capabilities will allow for historic cellular security vulnerabilities to be mitigated by military specific hardware and software options, making it the first globally available cellular network that the DoD can integrate into.[H]

Figure 1. IEEE Spectrum video "Everything You Need to Know About 5G". Click on picture or go to: https://www.youtube.com/watch?v=GEx_d0SjvS0 to view video. Source: Spectrum.ieee.org.

Additionally, using higher frequency wave lengths and full duplex antennas will enable access to data at speeds at 10 to 100 times faster than the 2010-2020 4th generation (4G) predecessor.[H] Download speeds will start at one gigabit per second (Gbps) and increase to around 10 Gbps by the end of the decade.[H,M] Latency time about will be almost one-

fifth of 4G with overall improved reliability.[H] Another useful feature for the military is that 5G can support over a thousand more devices per single antenna.[H] This will greatly enable the U.S. military to connect data storage, processing, sensors, and access devices to increase our access to knowledge. It is also highly likely that it will be the backbone for convergence of other emerging technologies like management of unmanned aerial, ground, and sea vehicles; "swarming"[1] capabilities; artificial intelligence; advanced simulation platforms and virtual tactical operations center (vTOC) using "immersive technologies"[2]; and synthetic biology and brain computer interface technologies.[H,H,M]

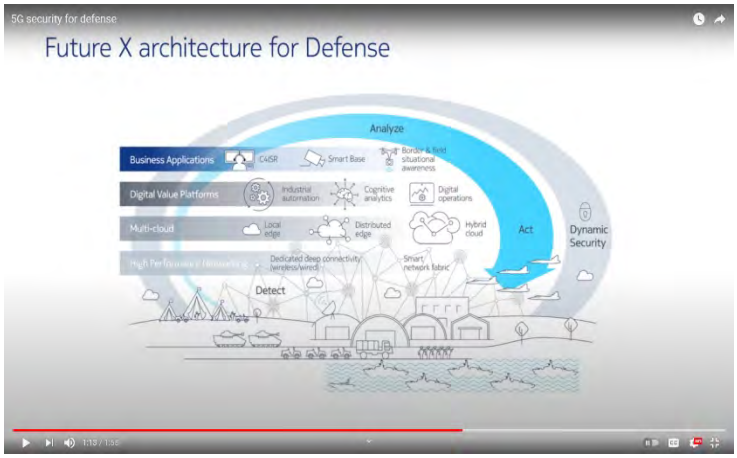

Figure 2. Nokia 5G Security for Defense. Click on picture or go to: https://www.youtube.com/watch?v=Y_NHX0QSN94 to view video. Source: Nokia.com.

Several allied and adversary countries and their militaries are looking into this same technology. Estonia is taking the lead for the NATO Cooperative Cyber Defence Centre of Excellence (CCD COE) to prepare for the European rollout of 5G by 2025.[H] Additionally, they are looking into how to integrate 5G into its autonomous technologies.[H] Poland is building a completely integrated civil-military 5G system that will make it more military friendly within its borders while providing civilians with military grade cyber security.[H]

However, there are downsides and challenges to integrating 5G. From a military intelligence analyst perspective, some of the past security vulnerabilities were actually opportunities for various intelligence agencies in accessing and collecting sensitive adversary data.[M,M] Another major issue that will take years to address is that the current DODIN is almost exclusively networked over wired systems using coaxial, fiberoptics, or twisted pair technology.[H] The DoD has ongoing projects integrating wireless 5G technology at 12 continental U.S. (CONUS) installations with a focus on logistics, simulation, other infrastructure systems, and similar fields.[H] In tandem, Cyber Command (CYBERCOM) is working to develop a DODIN that will have much of the current military data in a secure "Cloud" system.[H] Wireless broadband may work for Non-Secure Internet Protocol Router (NIPR), and possibly Secure Internet Protocol Router (SIPR) networks, since they currently use a commercial wired network for flow into and

[1] Swarming: collective behavior of decentralized, self-organized systems.
[2] Immersive Technologies: technology that is used to create a virtual world. Examples include virtual reality, augmented reality, and mixed reality.

out of a military installation. However, it is still not clear at this time if the DoD will be able to overcome some of the security risks a wireless system brings to its other network systems like Releasable Internet Protocol Router Network (RIPR), Combined Enterprise Regional Information Exchange System (CENTRIX), Crisis Response Operations in NATO Operating Systems (CRONOS), Joint Worldwide Intelligence Communications System (JWICS), and others using improved encryption. Of note, current wired networks can deliver the same or better speed, latency, and reliability as early 5G wireless networks.[H] Therefore, unless a specific network that military intelligence analyst use needs to have highspeed wireless to improve function, it may be of no value to change from a wired network during the 5G era. Also, some of the higher classified systems mentioned above already have dedicated satellite links that already use DoD technologies that are using this bandwidth and technology for years and would not need to convert to a civilian network.[H]

Another consideration is that much of this technology lasts approximately eight to ten years. Therefore, infrastructure and peripherals will likely be outdated and replaced in the late 2020's to early 2030's. Daily data flow is projected to increase by 700-fold over the next decade and require a 6th generation (6G) evolution around 2030 to manage this.[M,H] China has already started developing its vision of 6G with multiple active satellites linked to ground based networks.[H] 6G speeds are predicted up to one terabit per second with decreased latency, and improved reliability.[M] With the DoD current timeline of being fully prepared for next generation armed conflict by 2035, it is highly unlikely that the DoD will solely be using 5G between 2030 to 2035. Instead, it is highly likely that we will primarily be using 6G, with some niches in the DoD using military specific 7th generation (7G) technology. Civilian research and development for 7G will likely begin around 2030, if not earlier, given the average decennial advances that have occurred since 3rd generation (3G).[M] These two next generations of cellular technology aim to create a completely networked world to power the Internet of Everything (IoE). Limits to 6G and 7G developing on this schedule will be due to unforeseen overwhelming technical challenges and global economics of the future.

Figure 3. Samsung's 6G White Paper parameters comparison diagram. Click on image or the link or go to: https://cdn.codeground.org/nsr/downloads/researchareas/20201201_6G_Vision_web.pdf to view video. Source: Samsung.com.

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Jason M. Seery

Future 6G Wireless Communication Networks Highly Likely to Significantly Impact Military Intelligence Analysts Within 10 Years, Field Deployable Between 2028-2035

Executive Summary

Future advances in wireless communication technology make it highly likely that the U.S. Department of Defense (DoD) will significantly change how it accesses and utilizes data over the next 15 years. Sixth generation (6G) wireless communication data networks will provide greater speeds, enhanced security, and improved reliability over the newest 5th generation (5G) technology. While there will be overlap in 5G and 6G's technology early in the 2030's, eventually 6G will link together billions of computing capabilities and electronic devices will bring in an era of the Internet of Everything (IoE) and further advance the Internet of Military Things (IoMT) globally. This new era will allow for artificial intelligence (AI) and machine learning (ML) interfaces, as well as truly immersive extended reality (XR), high-fidelity mobile holograms, and digital replica technology to become fully functioning realities. This will significantly impact the daily functions of the future military intelligence analyst making it highly likely that the DoD will employ them much differently in future garrison and combat situations.

Discussion

Figure 1. Digital Trends "What is 6G." Click on picture or go to: https://www.youtube.com/watch?v=8OZ2ulCDY6s to view video. Source: DigitalTrends.com.

Networks within the DoD are currently undergoing significant changes to improve speed, access, reliability, security, and mobility to enhance service members' ability to access data using various end user devices.[H,H] The DoD is achieving this by the use of cloud computing, mobile devices, 5G wireless networks, and other technologies.[H,H] The continued improvements in wireless communication technology have advanced at a generational rate averaging 10 years since 1991 [15 years to develop and rollout 3rd generation (3G) down to eight years for 5G].[H] International research teams state that 6G will be available by 2028 and common by 2030.[H,H]

Multiple countries and companies are already working with the International Telecommunications Union (ITU) on 6G technological standards and conducting research to achieve them.[H,H] Nokia-Bell Labs, Samsung, Erickson, and Hauwei are leading 6G research that uses sub-millimeter waves.[H,M] Sixth generation (6G) technology will achieve

peak transfer speeds up to one terabit per second, making historical concerns like latency and capacity of minimal to no concern.[H] Overall network reliability will improve by 100 times that of 5G.[H] These metrics will provide near real-time awareness and access to data via computing that is split over networks and devices.[H]

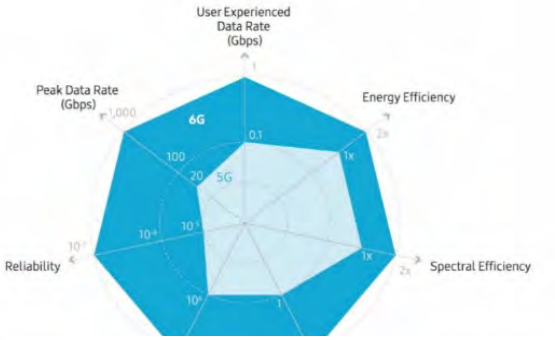

Figure 2. Samsung's 6G White Paper parameters comparison diagram. Click on image or the link or go to: https://cdn.codeground.org/nsr/downloads/research areas/20201201_6G_Vision_web.pdf to view video. Source: Samsung.com.

In the past, 4th generation (4G) enabled new technology and capabilities like smart phones and access to cloud computing wirelessly. Fifth generation (5G) will enhance linkage of the Internet of Things (IoT) with access to Edge computing. Sixth generation (6G) will go beyond that and connect humans to the IoE via the linkage of billions of computing and end user devices.[H] Sixth generation (6G) will provide a hyperconnected experience for all.[H] For the military, 6G can provide the infrastructure and capability to support the IoMTs including data-carrying, data-capturing, sensing and actuating, and general use devices.[H,H]

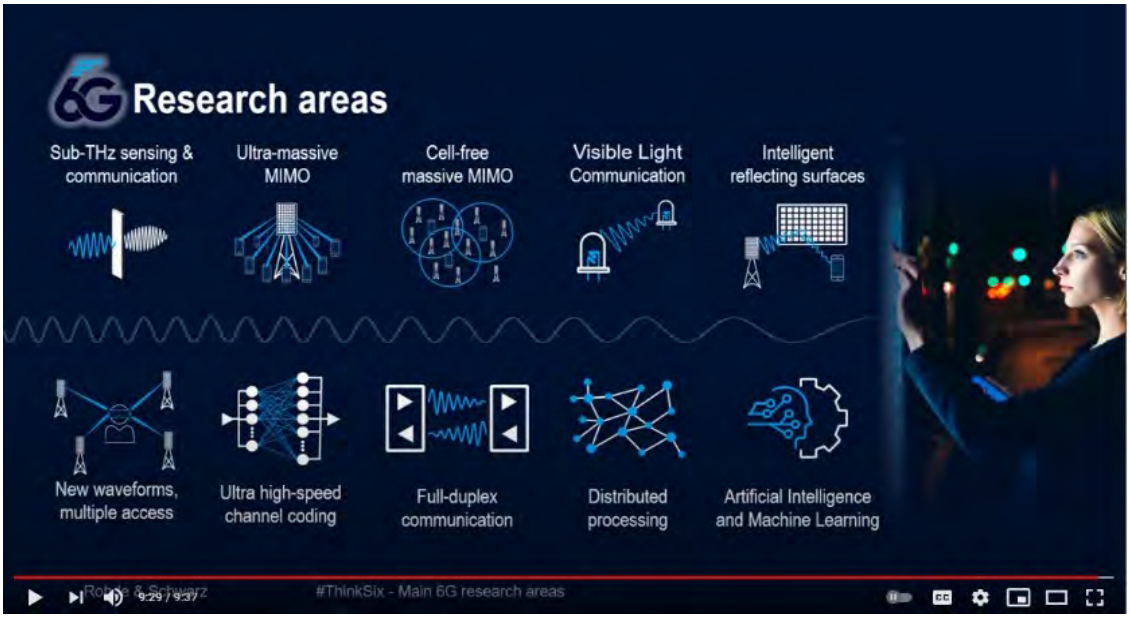

Figure 3. T&M Solutions for Wireless Communications "Main 6G Research Areas." Click on picture or go to: https://www.youtube.com/watch?v=mv0EYJhnncw to view video. Source: Rhode&Schwarz.com.

Fifth generation (5G) capabilities will require 4G, and in some cases 3G, to provide full terrestrial network coverage in areas that 5G cannot penetrate. Sixth generation (6G) will likely use the same concept initially but will then overcome this and possibly be able to

run fully on 6G. This is accomplished by multiple newer technologies and concepts in antenna and communication data processing.[H] Some potential technologies to achieve this are use of AI, visible light communication (Li-Fi), intelligent reflecting surfaces, and others.[H] The use of distributed processing by making everyone's mobile device a part of an integrated network of transmitters and receivers will link signals with the closest ultra-massive Multiple-In Multiple-Out (MIMO) antenna to access Edge, Cloud, and other networks.[H,H] Sixth generation (6G) will also integrate with high-altitude platform systems (HAPS) and satellites.[H] This will provide global coverage including to those non-terrestrial networks (NTN) over the oceans and austere land locations.[H]

Seventh generation (7G) would be the next planned advancement in wireless communications networking. Given the historical cycle for newer technologies, 7G could be operational in seven years or less after 6G, for a target of 2034.[H,M] However, this projected date is currently considered to be unlikely since economics and the need for entirely new infrastructure may delay 7G until 2040 or later even though the technological challenges in developing it will have been resolved.[M] Seventh generation (7G) capabilities are only theoretical at this time but have aims to acquire "space roaming" that will make the world completely wireless with everything connected, and most things automated.[M,M]

Military intelligence analysts will benefit from advanced wireless communication networks technology like 6G, and eventually 7G, since its speed, security, and reliability will enable the further enhancement of AI, extended reality, high-fidelity mobile hologram, and brain-computer interface devices, as well as other technologies and devices that have not been envisioned or created at this time.[H] With the continued advancement of AI, Edge computing, and related technologies, the military intelligence analysts will evolve and focus more on actual analysis and recommendations and less on collecting, organizing, and researching data.[H] Future network's ability to integrate the IoE, and more specifically the IoMT, will provide the backbone to new tactics, techniques, and procedures like virtual Tactical Operations Centers (vTOC)[1] and virtual Analysis and Collection Element (vACE)[2].[H] These virtual capabilities will be much faster and streamlined that what we currently use, have significantly less requirements for sustainment of humans and equipment, and provide an overall reduced footprint to decrease risk to the unit and personnel.[H]

[1] vTOC: Virtual Tactical Operations Center-a future tactical operations center that utilizes available technology to conduct much of the daily activities and meetings virtually with individuals displaced across a theater, COCOM, or globally.
[2] vACE: Virtual Analysis and Collection Element-a future military intelligence analyst tactical and operational level workspace that utilizes available technology to conduct much of the daily activities and meetings virtually with individuals displaced across a theater, COCOM, or globally.

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Jason M. Seery

Multi-Domain Sensor Technology Highly Likely Within 5 Years, Field Deployable Between 2030-2035

Executive Summary

Recently, the Army has taken proactive steps in pursuing the Multi-Domain Sensing Systems (MDSS), a self-healing sensors network system that is capable of delivering information from all operational domains, with initial capability development occurring in Feb 2020, estimated operational testing to occur in the mid-2020s, and full operational capability in 2035. Various existing battlefield sensors provide intelligence analysts real-time information, allowing expedient information flow. Despite the prevalence of sensor technologies, the lag in adoption of wearable battlefield sensor devices and in the Research and Development (R&D) of a centralized meta-sensors system that analyzes all individual sensor feeds are among the main causes for the delay in battlefield applications of this technology. However, with aggressive development of other sensor technologies such as LifeBEAM, ExoAtlet, Ground Warfare Acoustical Combat System (GWACS), SPaRK, and high-altitude balloon-borne radar, and the need to apply advanced sensor technologies for combat use, adoption of MDSS and development of its future generations are likely.

Discussion

The future battlefield will employ densely deployed battlefield sensors, including weapons, vehicles, robots, and human wearable devices.[H] Command, control, communications, and intelligence (C3I) systems will integrate this information to influence real-time decision making.[H]

Figure 1. Scientist develop high-altitude balloon-borne radar. Click on the picture or go to https://www.youtube.com/watch?v=LurbzrKVGrk to view the video. Source: thedrive.com.

For the individual soldier, more recent developments of wearable sensors/devices include:

- LifeBEAM, a helmet that uses an optical sensor to measure heart rate.
- GWACS, a wearable tactical system with a sensor that identifies and locates hostile fire. It also detects and tracks small Unmanned Aerial Vehicles (UAVs).
- ExoAtlet, a lower body-powered exoskeleton, providing mobility assistance.

•SPaRK, an energy-scavenging exoskeleton that utilizes collected energy and turns this energy into electricity that can recharge a battery or directly power a device.[H]

The use of sensors to monitor the physiological status is not a new phenomenon. However, the monitoring of soldiers in a combat environment demonstrates the convergence of medical technology to the military realm. Researchers are taking the aggregation of physiological sensor information (heart rate, respiratory rate, temperature, speech, and galvanic skin response[1]) to measure the physical, emotional, and mental stress experienced by soldiers.[H] Researchers at the Army Research Lab are also studying the concept of utilizing genetically modified microbes as sensors, to monitor soldier fatigue, stress, sleep deprivation, or even a possible onset of an infection.[H] It is the aggregation of this data and intel data obtained from other sensor feeds that will likely enable intel analysts to assess and analyze both friendly and enemy units' combat readiness at the physiological level to make effective battlefield decisions. This example also emphasizes the need for a centralized sensor network system capable of integrating all sensor feeds across the battlefield.

Another unique sensor platform that North Atlantic Treaty Organization (NATO) is exploring is the utilization of high-altitude balloons that fly into the stratosphere (see Figure 1). These balloons act as sensors themselves, using synthetic aperture radar or as a launch platform for other unmanned sensors. These unmanned sensors can almost certainly fly over targets or fall to the ground to collect intelligence information. Additionally, these balloon platforms will likely deliver weapons, serve as communication relays, or create electronic warfare effects (cyber and jamming).[M]

In addition to domain-specific and individual-use sensors, significant plans are underway to develop collective Multi-Domain Operations (MDO) sensor platforms. MDSS is such a system. The Army approved the Initial Capabilities Document (ICD) for this system in February 2020, indicating significant forward momentum in the development of this capability.[M] A budget of $52 million for MDSS in Fiscal Year (FY) 21 will fund sensor development and prototyping.[M] The development and funding of MDSS not only operationalizes the Joint All-Domain Operations (JADO) concept, but also highly likely compels adoption of wearable sensors and R&D of future integrated sensor network systems to overcome disadvantages of disjoined sensor systems currently operating in silo.

[1] The galvanic skin response (GSR) refers to the electrodermal changes in sweat gland activity.

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the estimate's lengthy time frame, this report is sensitive to change due to new information.

Author: COL Greg Frazier

Non-Fungible Blockchain Token Ecosystem Likely to Impact Intelligence-Sharing By 2030-2035

Executive Summary

Developers continue to create innovative uses related to the non-fungible blockchain token ecosystem, and the feasibility of commercial companies continuing to transform global solutions make it likely to impact intelligence-sharing capabilities by 2030-2035. Due to the array of blockchain solutions in the past couple of years, the vision of non-fungible token ecosystems widens. Despite the benefits of non-fungible tokens (NFTs), the mass adoption of NFTs is low due to inaccessibility, the newness of the technology, difficulty in linking real-world assets, and regulatory compliance.

Discussion

Before diving into non-fungible tokens (NFTs), it is helpful to understand the difference between "fungible" and "non-fungible" (see Figure 1). Fungible means an item is interchangeable and holds the same value. Dollar bills are fungible; two bills of the same value are identical.[H] A non-fungible item contains unique attributes that differentiate it from something else, even though it may appear similar.[M] NFTs are physical (tangible) or digital (intangible), and some are invisible.[M] The token refers to a unique and verifiable digital signature stored on a secure distributed ledger or database called a blockchain.[M] As the name implies, a blockchain is a chain of blocks managed by a peer-to-peer (P2P) network and contains digitally time-stamped data linked using cryptography. Data recorded in a blockchain can be challenging to change; it requires verification and consensus from all peers in the P2P network. NFT examples include collectibles, gaming, art, tickets, songs and recordings, licenses and certificates, real estate investing, and property ownership. It also allows a flexible way to store, control, and protect the information related to one's identity.[M]

Figure 1. Examples of Fungible and Non-Fungible Tokens. https://blockchainsimplified.com/blog/understanding-fungible-non-fungible-tokens/. Source: Blockchain Simplified.com

Witek Radomski created the first NFT when he wrote the code in June 2017.[M] The creation of NFTs using blockchain technology allowed the emergence of new markets for provable ownership of digital assets, and these new markets, like the cryptocurrency markets, are highly speculative.[M] Yet in October 2020, a Miami-based art collector Pablo Rodriguez-Fraile purchased a 10-second video artwork for $67,000 that he could have watched for free online – last week, he sold it for $6.6 million.[M] An NFT authenticated the video designed by the digital artist Beeple on a blockchain platform token (see Figure 2).[M] Blockchain virtual gaming jammed the internet after NFTs were created.[H] One of the world's first popular blockchain games, CryptoKitties, allows players to adopt, raise, and trade virtual cats; the game does not involve any digital currency and offers security that each cat is one-of-a-kind and 100% owned by the player.[H] These examples depict a small selection of how far NFTs have come since 2017.

Figure 2. How a 10-second video clip sold for $6.6M. Click on picture or go to: https://www.theglobeandmail.com/arts/video-how-a-10-second-video-clip-sold-for-66-million/ to view video. Source: TheGlobeandMail.com

Commercial companies are transforming distributed ledgers and databases globally, and implementing the non-fungible blockchain token ecosystem. IBM Blockchain tokenization helps optimize business processes and enables new platforms with partners in the supply chain, global trade, financial services, vaccine distribution, and trusted identity management.[H] "IBM Verify Credentials" presents the decentralized approach to identity management and allows individuals control when, where, and with whom credentials are shared.[M] In October 2020, Verizon introduced "Full Transparency" incorporating blockchain technology in an effort to set the standard in corporate communications that enables secure and unalterable published news releases.[H] Despite the benefits of NFTs, the mass adoption of NFTs is low due to inaccessibility, the newness of the technology, difficulty in linking real-world assets, and regulatory compliance.[M]

Regardless of commercial barriers, the argument for the non-fungible blockchain token ecosystem in the military is strong. The military's supply chain can leverage blockchain technology to manage and sign contracts and audit product provenance, breaking away from legacy processes and paperwork.[M] Detecting counterfeit information by associating

NFTs to military documents, intelligence reports, digital videos, and digital satellite photographs provides an added security layer, whereas forgeries or alterations are alleviated. In the Center for Strategic and International Studies (CSIS) report titled *Maintaining The Intelligence Edge, Reimagining and Reinventing Intelligence through Innovation*, dated January 2021, recommends the Office of the Director of National Intelligence (ODNI), with assistance from In-Q-Tel and the Intelligence Advanced Research Projects Activity (IARPA), "should explore investments in distributive ledger and blockchain technology for enabling rapid intelligence sharing outside the Intelligence Community networks in zero or near-zero trusted environments, such as the U.S. private sector and foreign liaison."[H] As the commercial sector redefines industries through trust, transparency, and collaboration applying the non-fungible blockchain token ecosystem[M], numerous non-fungible blockchain token intelligence-sharing capabilities implemented in the military are likely in the next 10-15 years.

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were reliable and corroborate one another. The analyst had adequate time for research but the worked alone and did not use a structured method. Moreover, given the timeline associated with this estimate, this report is sensitive to change due to new information.

Author: Ms. Bernice A. Parkhill

Fully Homomorphic Encryption Likely to Enhance Military Intelligence Analyst Operations By 2030-2035

Executive Summary

Researchers and major technology companies are aggressively pursuing the development of fully homomorphic encryption, virtually guaranteeing that message traffic remains secure throughout a military operation. Given the high level of industry collaboration employed in this effort, it is likely to enhance military intelligence analyst operations by 2030-2035. Despite developments in the cryptography field, the starting point must focus on solving the mathematical computational problem and computer performance challenges.

Discussion

Data encryption strategies require that before processing, data is decrypted, which presents security and privacy concerns.[H] Data encryption goal is to protect digital data confidentiality as it is stored on the system and transmitted using the internet or other computer networks.[H] Fully homomorphic encryption (FHE) provides data security that delivers mathematical proof of encryption using cryptographic means, ensuring with certainty around how data is stored and manipulated.[H] FHE relies on something far more complicated called lattice cryptography, encoding data as coordinates on a lattice.[M]

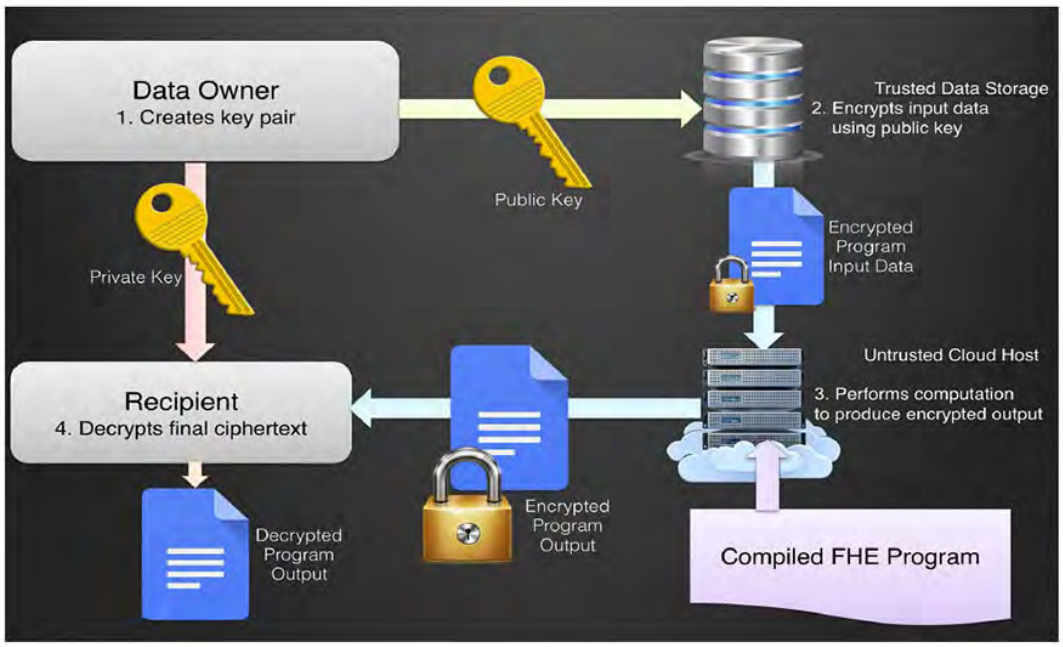

Figure 1. How homomorphic encryption process works. https://www.uscybersecurity.net/csmag/revolution-and-evolution-fully-homomorphic-encryption/. Source: LiveScience.com

Lattice-based cryptography uses high-dimensional geometric structures to hide information and creates problems considered impossible to solve without the

cryptographic key even by quantum computers (see Figure 1).[M] There is no known quantum algorithm for solving the lattice cryptographic problem; however, several research efforts are on-going to solve this problematic computational program.[M] Although quantum computing is still many years away, lattice-based cryptography is a complex cryptic method meant to protect our data and secure us from cyber threats against our adversaries in the future.[M] With this in mind, solving high-dimensional lattice problems can be used to make cryptographic constructions that are not just only secure against attacks from quantum computers but can form the basis of alternate types of cryptographic systems.[M]

A challenge that impacts future FHE operations is that existing computers operate at 64-bit compute width with unencrypted data, whereas FHE systems must be large enough to operate with a minimum 1024-bit compute width level with encrypted data.[M] In parallel, interconnections – how processing units communicate in a multi-processor system, packet switching in communication networks, servers in data centers, and memory storage width (the entire data pipline) – must equally expand in an FHE system.[M,M] Another challenge deals with solving the mathematical computational problem to maintain encryption throughput. The computations involve intensive calculations creating performance issues with noise introduced in the plaintext.[M] The noise grows exponentially with each additional computation, impacting the process's overall efficiency and security.[M,M] Until these challenges are solved, it is unknown when computers will operate in a constant encryption mode.

In March 2021, the Defense Advanced Research Projects Agency (DARPA) awarded contracts to Duality Technologies, software company Galois, nonprofit SRI International, and Intel, as part of a broader DARPA research program called Data Protection in Virtual Environments (DPRIVE).[H,H,H] DPRIVE seeks to develop a hardware accelerator for FHE computations that will dramatically reduce the compute runtime overhead compared to software-based FHE approaches.[H] Intel announced it would collaborate with Microsoft on a multi-year program aimed to develop an accelerator for FHE.[H] In the

Figure 2. Security system in network (Image Credit: Yuichiro Chino / Getty Images). https://techcrunch.com/wp-content/uploads/2019/05/GettyImages-1027924112.jpg?w=990&crop=1. Source: Techcrunch.com

first phase of the program, Intel will create FHE chip hardware building blocks, the necessary software, and plans to invest in academic research into FHE.[H] In the later phases of the program, Microsoft will test the Intel chips jointly with DARPA by incorporating them into Microsoft Azure cloud services and developing international standards around FHE, which could lead to commercializing the technology.[H] The cross-team integrated approach emphasizes the importance of tackling "the final frontier" in data privacy, computing on encrypted data without access to decryption keys.[H]

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were reliable and corroborate one another. The analyst had adequate time for research but the worked alone and did not use a structured method. Moreover, given the timeline associated with this estimate, this report is sensitive to change due to new information.

Author: Ms. Bernice A. Parkhill

Additional Short Form Analytic Reports

Quantum Information Technologies Unlikely to Significantly Impact Intelligence Analysis By 2030-2035

Executive Summary

Despite continuing advances in the understanding and application of Quantum science over the last several decades, significant obstacles continue to limit the current functionality of quantum technology by the defense industry and will likely continue to do so over the next decade. It is therefore also unlikely that quantum, as a standalone technology, will be mature enough to significantly impact the capacity or capabilities of future Army intelligence analysts by the 2030-2035 timeframe. One potential exception to this statement involves quantum encryption. Although not directly applicable to the mission requirements of an Army analyst, quantum encryption will likely be sufficiently evolved by the 2030-2035 timeframe to significantly enhance the level of security for classified information and communication used by Army analysts of the future.

Discussion

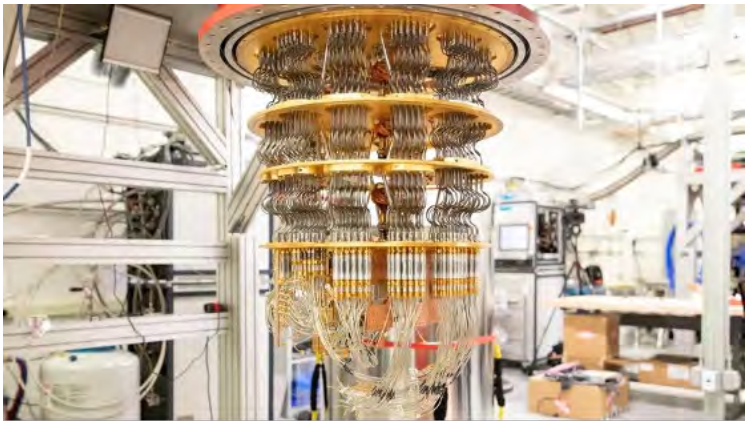

Figure 1. Google's "Sycamore" quantum computer, currently believed to be most powerful quantum system in the world.

German physicist Max Born, upon learning of Paul Dirac's combination of quantum mechanics with the theory of relativity, exclaimed "physics as we know it will be over in six months."[M] This quote was voiced in the year 1930 and while quantum science has advanced significantly since Born's quote, quantum information technology is still not yet at the point of inflection to provide a quantum advantage over classical computers.[M] The potential for quantum technologies to revolutionize the fields of computer processing and storage, data collection and analysis, as well as information or security is clear.[M,M] Scientists also have theorized numerous ways in which quantum technologies could greatly enable machine learning as well as artificial intelligence.[H] However, despite significant advances in quantum understanding and application, the majority of the advantages gained from the employment of quantum technology are still hypothetical and are likely still decades away; if they are realizable at all.[M]

The first quantum computer, built by IBM in 1998, leveraged two qubits of processing power. By 2007, the qubit power increased sufficiently to enable a quantum computer to solve a Sudoku problem.[H] Since then, the industry leaders in American development

such as IBM and Google have expanded the computing power; the current leader believed to be from Google which most recently announced a prototype featuring 72 qubits in 2018.[M] Even with this evolution, current technology in classical computers still exceeds the capacity of the most advanced quantum systems.

Despite multiple promises of a new system capable of establishing quantum supremacy, the term used for a quantum-based system able to clearly outperform classical computers, to date this system is still only hypothetical. The most recent candidate to receive attention for another leap in the quantum realm is California based company, Rigetti, which touts a 128-qubit processor in development. However, this system, first promised in 2018, is still in development over three years later with only a 32-qubit processor in current used.[M,H]

There are several issues which continue to present obstacles to attaining quantum advantage and in doing so with sufficient ability to reproduce it on a mass scale. These issues fall into the categories of operational and engineering obstacles.[M] From an engineering standpoint, the current quantum computer prototypes throughout the U.S. and much of the world require extreme cooling (15 millikelvin or near absolute zero) for the qubits to achieve superposition (the ability for an object to exist in two states simultaneously which allows quantum computing to potentially operate at orders of magnitude faster than classical computers).[M] Maintaining a quantum processor at near absolute zero creates logistical problems for either mainstream or military field use.[M,M]

Another challenge presented by quantum engineered computers is the instability of today's qubits.[M] These particles are extremely fragile and can be affected by environmental conditions such as vibrations or temperature change.[M] These factors result in the computers experiencing a high error rate.[M] In fact, much of the limited quantum computing power achieved through the more than 12 known active quantum computers in the world, is dedicated to correcting the errors in their computations.[M]

Operationally, qubits cannot be cloned and as a result much of classical computer programmer's reliance on copying the value of a variable in code is not possible.[H] For the same reasons, a qubit cannot be read twice.[H] As a result, the same physics that make quantum computers so attractive from a security standpoint, make it incredibly difficult to test or "debug" a program prior to executing it.[H]

While the U.S. may lead the world in total resources focused on achieving Quantum supremacy, China continues to play a leading role in certain aspects of developing the technology. In 2016, China launched satellites into space with communication encryption enabled through quantum technology.[H] Additionally, China claims its

quantum computer has crossed the quantum advantage threshold.[M] This claim occurred after a Chinese designed system solved a bosun-sampling problem in roughly 200 seconds.[M] Scientists compared this to classical computer processing would have taken roughly 2.5 billion years to complete, even on China's most advanced classical supercomputer. China's system used quantum photonics to solve the problem and avoid

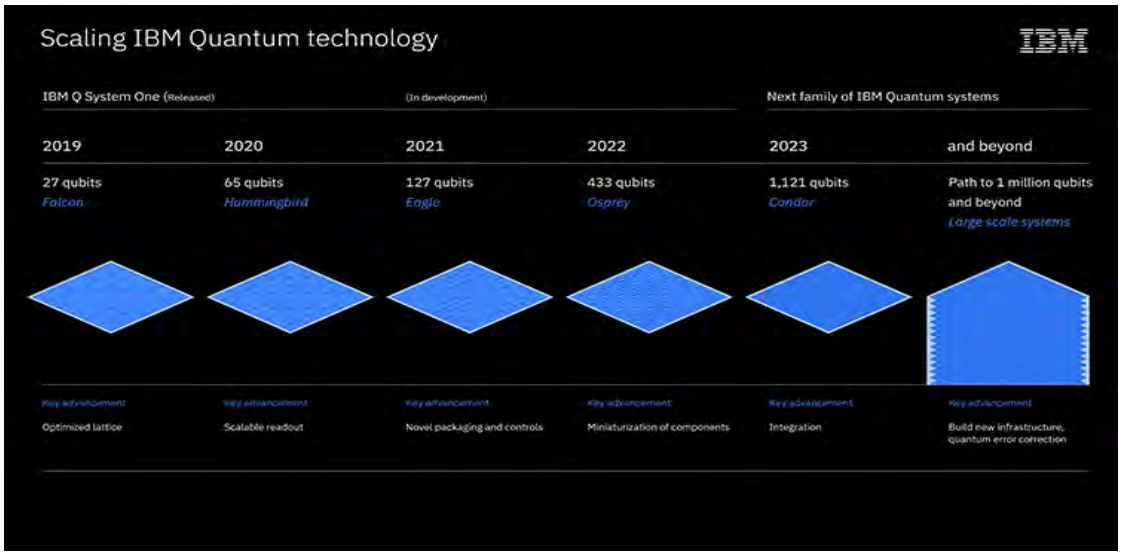

Figure 2. IBM's Quantum timeline proposing 1121- qubit by 2023. IBM Quantum Roadmap

many of the issues identified in U.S. based systems.[M] However, this technology presents significant new challenges because photonic circuits are not programmable and therefore cannot be used for practical problem solving at this point in development.[M]

Despite significant evidence (see Figure 2), demonstrating the relatively still nascent progress towards quantum computing supremacy, there is some data which suggests a breakthrough may be sooner than expected. The 2020 IBM Quantum roadmap promises to deliver a functional 128-qubit processor by 2021.[M] It also stipulates a strategy with exponentially increasing qubit growth reaching 1121 by 2023 and crossing the million-qubit threshold within the next 10 years.[M]

Two utilizations of quantum technology which is showing a likelihood to impact the military, and to a lesser degree, the military analyst, is the field of quantum encryption and quantum metrology. Quantum Key Distribution (QKD) is showing great promise as an exceptionally secure communication enabler with clear potential for military secure communications.[M] Additionally, Light Detection and Ranging (LIDAR) technology, or quantum radars, is offering multiple potential options for enabling stealth use in sensors and protection from various jamming threats.[M]

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and could be generally corroborated by other sources. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate and relative speed of new technology breakthroughs, this report is sensitive to change if presented new contradictory information.

Author: COL Joseph T. Sheridan

Quantum Network Highly Unlikely to Enable Military Intelligence Analysts By 2030-2035

Executive Summary

Researchers estimate achieving a global quantum internet within the next 15-20 years makes it is highly unlikely that it will enable military intelligence analysts by 2030-2035. Despite increased international investment levels in quantum research, researchers must solve the entanglement distribution between nodes before constructing a prototype global quantum network – the Quantum internet.

Discussion

In December 2018, President Donald Trump signed into law the National Quantum Initiative Act (NQI Act) that expedited quantum research and development for the U.S. economic and national security.[H] The NQI Act commits the U.S. to maintain and expand its leadership in Quantum information science (QIS) and developing new Quantum capabilities.[H] While the NQI Act provided funding of $1.2 billion over five years, private sector funding committed approximately the same amount for quantum research.[H,H,H] The Department of Energy's (DOE) 17 National Laboratories serves as the backbone of the coming quantum internet, relying on quantum mechanics laws to control and transmit information more securely than ever before.[H] In March 2021, a team of researchers at DOEs Oak Ridge National Laboratory, with colleagues at Purdue University, took an important step toward harnessing the frequency, or color, of light.[M] Such capabilities could contribute to more practical and large-scale quantum networks exponentially more powerful and secure than today's classical networks.[M] A challenge to creating a quantum network has been photon loss or a loss of information when photons travel through fiber-optic networks.[M] "The Purdue researchers used a wavelength-selective switch (WSS) to adjust how much data goes to each user by selecting and redirecting wavelengths of light carrying the different data channels, making it possible to increase the number of users without adding to

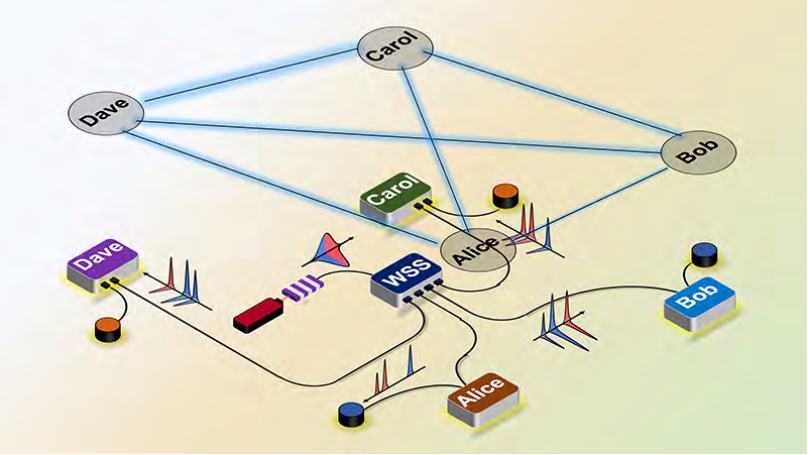

Figure 1. Using a programmable wavelength-selective switch (WSS) can help increase the number of users in a quantum network without increasing photon loss from the switching device, a new study shows. https://purdue.edu/newsroom/releases/2021/Q1/a-quantum-internet-is-closer-to-reality,-thanks-to-this-switch.html. Source: Purdue.edu.

photon loss as the network equally increases (see Figure 1)."[M] Despite this WSS development, until there is the broader deployment of quantum networks, what criteria or communications priorities should guide entanglement distribution will remain unclear.[M] Quantum entanglement allows qubits, or quantum bits, separated by incredible distances to interact with each other instantaneously; no matter how great the distance between the correlated particles, the qubits remain entangled as long as they are isolated.[M]

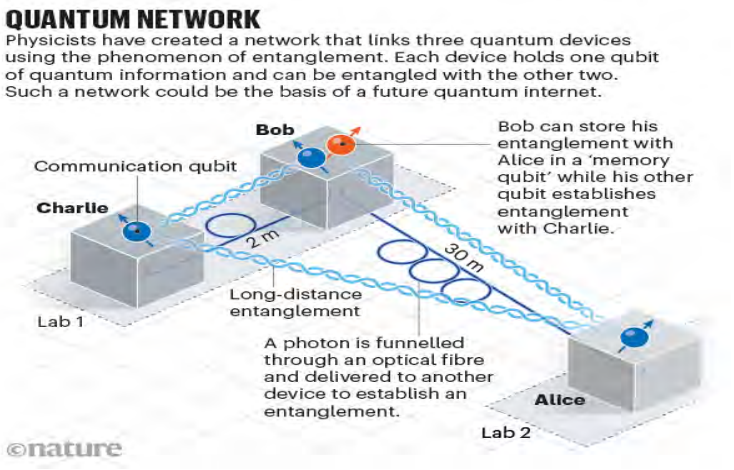

Figure 2. The research at Delft University created a three-party entanglement using a nitrogen atom inside a synthetic crystal structure to create a memory of the first entanglement. https://www.nature.com/articles/d41586-021-00420-5. Source: Nature.com

China has reportedly poured $10 billion into its quantum programs, and other countries, including Germany, the Netherlands, Canada, India, and several Asia-Pacific nations, accelerated investments into quantum technologies.[H,H,H] At the Delft University of Technology in the Netherlands, researchers created a three-way entangled network between three "users" by embedding one entangled pair in a "memory" element, which can enable three users to share secret information (see Figure 2).[M,M] "The Delft research team is not the first team to link three quantum memories: in 2019, a team led by the University of Science and Technology of China in Hefei did so using a different type of qubit, based on clouds of atoms rather than individual atoms in a solid object, but that experiment could not yet produce entanglement on demand."[M]

Globally, the general agreement acknowledges quantum computing represents one of the most critical technological frontiers of the 21st century.[H] Despite increased international investment levels in quantum research (see Figure 3), researchers must solve the entanglement distribution between nodes before constructing a prototype global quantum network – the Quantum internet.[H] Researchers estimate achieving a global quantum internet within the next 15-20 years makes it is highly unlikely that it will enable military intelligence analysts by 2030-2035.[M,M,M]

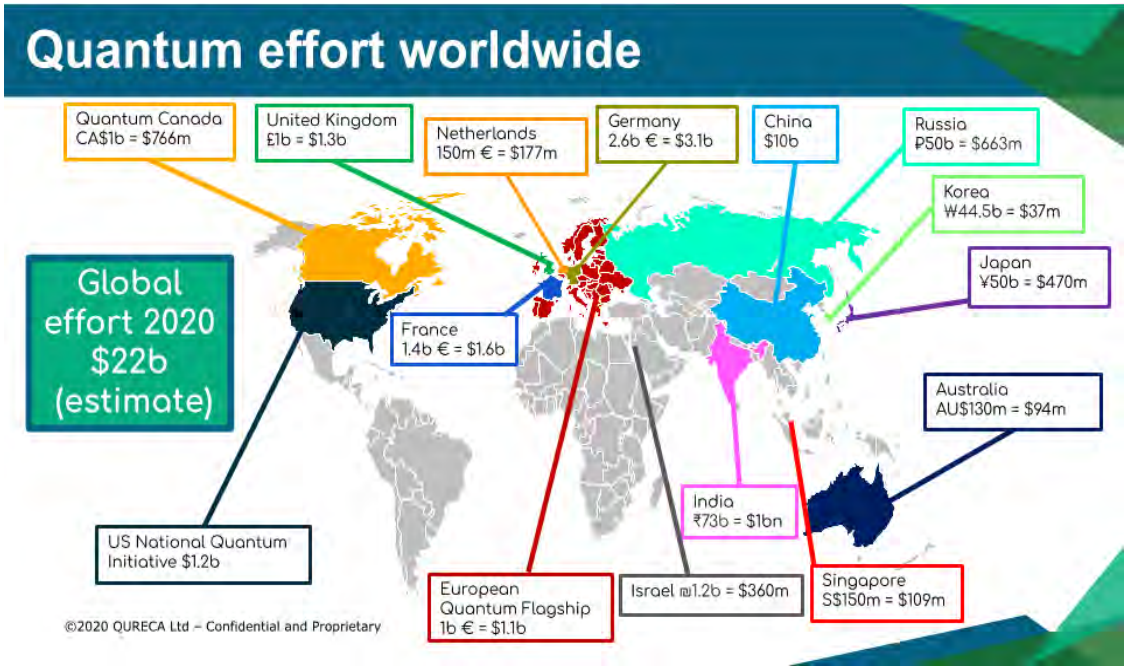

Figure 3. Worldwide investments to develop quantum technology. https://qureca.com/overview-on-quantum-initiatives-worldwide/. Source: Qureca.com

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were reliable and corroborate one another. The analyst had adequate time for research but the worked alone and did not use a structured method. Moreover, given the timeline associated with this estimate, this report is sensitive to change due to new information.

Author: Ms. Bernice A. Parkhill

Implanted Brain-Computer Interfaces (BCIs) For Sophisticated Decision Support Unlikely Within 15 Years; External BCI, Niche Applications Likely In 3-5 Years, Field Testing Likely In 5-7 Years

Executive Summary

Brain Computer Interface technology is relatively immature, and currently functions like a peripheral device to a computer e.g., a wireless mouse or keyboard. Based on current developments, niche commercial BCI applications e.g., video gaming systems, will be likely widely available in the next three to five years. Successful development in niche commercial applications will likely translate into development of military applications within the next five to seven years. However, it is highly unlikely that implantable BCIs integrated with sophisticated decision support systems to support military analysts will be available by 2030-2035. Despite this unlikeliness, the current development trajectory of this technology is promising, with both commercial and government entities aggressively conducting BCI research. Successful developments of NextMind's DEVKIT and Neuralink's "the Link" provide early proof of concept and signal military applications of BCI at both tactical and strategic levels.

Discussion

A BCI permits a user interaction with a computer system using only thought.[H] Historically, the preponderance of military and civilian research on BCIs has focused on the restoration of lost motor or sensory function.[M] BCIs also provide military personnel the ability to assess their cognitive workload or link with a prosthetic limb.[M] However, BCIs have many possible combat-related applications.[M] For example, the creation of a "bidirectional neural interface" - a technology that allowed a volunteer participant to simultaneously steer a simulated drone while maintaining a formation of two additional simulated drones - likely one day enables military operators full mind control of drones or robots.[M] Although full mind control is still a long way off, significant improvement in recent years in the acquisition, filtering, and processing of brain wave signals suggests its fast-approaching to reality.[M]

Figure 1. NextMind Dev Kit-Let Your Mind Take Control. Click on the picture or go to https://www.youtube.com/watch?v=RR7tHXV14xkto to view the video. Source: Next-mind.com.

Most BCI technologies are still in the early stages of development. However, the potential market for BCI has drawn tech competitors to advance BCI technologies, stimulating competition and early adoption; for example:

- Neurable developed an electroencephalogram (EEG) headset that allowed video game control.[M]
- Kernel is working on developing technology to store memories outside of the brain and upload new memories into the brain's memory center.[M]

In 2018, the value of the global neurotechnology market is $9 billion, expecting to reach $19 billion by 2026, with a compounded annual growth rate of 15% between 2018 and 2026.[M]

One of the most promising developments of BCIs is by NextMind, a recent tech start-up company that built a first-of-a-kind wearable brain-sensing device – the DEVKIT (see figure 1).[M] This device uses machine learning to convert EEG activity into commands, as well as eye-tracking software to examine cognition and measure intent in a non-invasive manner.[M] The ultimate goal of this device is to decode and understand live information from the brain in real-time.[M] This niche commercial technology will likely serve as a catalyst for military use as a peripheral device.

BCIs also come in invasive forms. The Link by Neuralink is an invasive implantable BCI device with micron threads inserted into the brain.[M] At this point, Neuralink is developing this technology to help people with paralysis, injuries, and neurological disorders.[M] However, future development of implanted neural threads in the visual cortex area will likely increase speed of information processing from the eyes, which will almost certainly enhance the military intelligence analyst's critical thinking. However, it will be unlikely available for military use in the next 15 years due to its invasive nature.

Applications of BCIs have garnered attention from the Department of Defense (DoD), who has invested in exploring their potentials in delivering superior physical and cognitive power during combat.[H] Continued advancement and integration of BCIs in capabilities that involve human-machine decision making, human-to-human communication, system control, and performance enhancement on the battlefield will almost certainly set the stage for sophisticated decision support BCIs for military intelligence use beyond 2035.[H]

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked

alone and did not use a structured method. Furthermore, given the estimate's lengthy time frame, this report is sensitive to change due to new information.

Author: COL Greg Frazier

Transcranial Direct Brain Stimulation Utilization Among Civilian and Military Professions Likely Within 5-7 Years; Widespread Application Likely By 2035

Executive Summary

The literature on Transcranial Direct Brain Stimulation (tDBS) (electric current passed through skull) in the past 50 years has demonstrated promising applications in improving cognitive function, impacting soldier lethality, and enhancing multitasking. Many do-it-yourself instructions for creating personal tDBS stimulators are available on the internet. While medical tDBS devices require Food and Drug Administration (FDA) approval and licenses to own, commercial devices for both personal and medical therapeutic utilization are available for purchase without government regulations. As word-of-mouth efficacy of these personal devices continues to spread, civilian and military professions will likely be willing to utilize tDBS as a form of cognitive enhancement, inclusive of the military analyst. However, existing tDBS devices still deliver imprecise results, pointing current research efforts towards identifying more precise areas within the brain to stimulate the desired effects. Refinement of accurate electrical stimulation will likely lead to widespread adoption and utilization of this technology by 2035.

Discussion

Transcranial Direct Brain Stimulation (tDBS) - "the thinking cap of the future" - is a noninvasive and painless brain stimulation that utilizes direct electrical currents[1] to stimulate specific regions of the brain (see Figure 1).[H] With this technology, approximately half of the electrical current distributed to the head reaches and stimulates the brain. The effect of this electrical stimulation is detectable up to 24 hours after the initial stimulus.[H] This electrical stimulation has shown benefits in improving cognitive functions for both diseased and healthy subjects.[H]

Figure 1. Can You Use Electricity to Supercharge Your Brain? (tDCS). https://www.youtube.com/watch?v=Lv1fFcrveqY

[1] Electrical current passes through electrodes placed on the scalp, which modulate neuronal activity. Two types of stimulation include anodal and cathodal stimulation. Anodal stimulation excites neuronal activity while cathodal stimulation stops or decreases neuronal activity.[H] An electroencephalograph most directly measures neuronal activity. Brain tissue can generate these rhythmic patterns by activating a single neuron or stimulation groups of neurons within the central nervous system.

Warfighters operate in a complex environment, with rapid development and fielding of new equipment, weapons, and systems. This places a high demand on cognitive capability of the end-users. Additionally, the ever-increasing decision speed and data volume processing requirements gradually surpass current human capabilities, especially under combat conditions. tDBS is likely to close this cognition gap.[H] An increasing body of literature indicates that tDBS techniques can modify brain activity, benefiting aspects of human cognition directly linked to learning, acquisition, and performance.[H] With commercial tDBS devices being available today without government regulations, military adoption and utilization of such devices for day-to-day, non-combat related cognitive enhancement for troops is forthcoming.[H] However, due to its current limitation, i.e., imprecision in delivery of electrical current to targeted areas of the brain, widespread utilization of tDBS to close the cognition gap mentioned above will likely occur by 2035.

One of the priorities for Army modernization consists of soldier lethality, where tDBS has exhibited promising applications. At the tactical level, this electrical stimulation makes an ideal candidate for military applications because it is relatively safe, portable, and has minimal side-effects.[H] However, what makes tDBS most effective in the battle field is its ability to assist in rapid target identification and execution of kill/no-kill choices using lethal means, thus enhancing soldier lethality.[H] These choices rely on target detection's cognitive processes, visual search ability, visual attention, and memory recall.[H] Enhancing these cognitive processes most likely gives warfighters an edge over adversaries.[H] Additionally, tDBS will highly likely improve performance of other soldier tasks such as caring for combat casualties and aircrew flight operations.[H] The Army Medical Research and Development Command has evaluated the safety and effectiveness of tDBS in improving soldier cognitive performance.[H] Despite the military's aggressive intent, lack of precision in targeted brain areas will most likely hinder the effectiveness of tDBS in combat, making utilization of tDBS for critical kill/no kill decisions unlikely within 10 years.

Figure 2. Air Force Using Brain Stimulation.
https://www.youtube.com/watch?v=wFbuF8CZJZc

Another area of research in the applications of tDBS relates to the capability of multitasking. The Air Force has a particular interest in evaluating manned or unmanned flight operations, which require the pilot to monitor and respond to multiple events simultaneously over an extended period.[H] Due to these monotonous kinds of tasks and information overload in a multitasking environment, pilot performance degrades over time. Research has demonstrated that tDBS improves information processing capability and the ability to augment and enhance multitasking capability in human subjects (see Figure 2).[H] Therefore, it is likely that military aviators will begin field testing of tDBS within five to seven years. In addition, adoption of this technology by other military/civilian professions requiring significant multitasking will likely occur by 2035.

tDBS is generally safe. However, in animal studies, when researchers applied high levels of electrical current, permanent brain damage occurred.[H] As the electrical current increases, there is a risk of causing tissue damage through tissue heating. In some studies, after tDBS, participants experienced temporary mood, personality, and behavioral changes.[H] Despite this risk, it is highly likely that this technology will benefit the military analysts in non-combat environment in the 2030-2035 timeframe.

Analytic Confidence

The analytic confidence for this estimate is high. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Greg Frazier

Increased Image Intensification Capabilities Highly Likely with Widespread Military Deployment Between 2023-2025

Executive Summary

Recent advances in Near-Infrared (NIR) imaging technology, make it highly likely industry will develop and combine thermal imaging with image intensification capabilities in the next two years with widespread military deployment between 2023 and 2025. Despite the growing use of commercial infrared technology, it raises privacy and civil rights concerns – data being collected on individuals and used without their permission.

Discussion

Global investments in near-infrared and thermal imaging research lead to sensor advancements in technologies and techniques.[M] China developed passive scanning sensors, most notably electro-optical and infrared (EO/IR) sensors, which search for heat signatures and recognizable shapes within the infrared and visible light bands of the electromagnetic spectrum.[M,L,L] EO/IR systems provide holistic situational awareness during the day and night and in minimally lit conditions.[M]

Figure 1. Army surveys industry for high-resolution infrared and color cameras to enhance night vision vehicle driving. Click on link https://www.militaryaerospace.com/sensors/article/14035150/night-vision-infrared-vehicles to view article. Source: Military and Aerospace Electronics.

NIR and thermal imaging technology extend to other fields ranging from medical and veterinary monitoring, thermal vision for mobile phones, vehicle vision driving assistance, enhanced night vision goggles, and aircraft detection. These fields provide the military with improved situational awareness during limited conditions (See Figure 1).[M] An Israel-based international defense electronics company, Elbit Systems, develops NIR and thermal imaging technology applications for European and Asia-Pacific countries and the U.S. In November 2020, Defense Advanced Research Projects Agency (DARPA) awarded an Other Transaction Authority (OTA) contract to Elbit Systems of America for Enhanced Night Vision Goggle – Binocular (ENVG-B) system. The potential contract value under the OTA contract could reach a maximum of approx. $442M. An initial order of approx. $22.5M for low-rate initial production (LRIP) of

systems with a performance period through December 2021.[H] Incorporating these continued developments, along with competition from multiple state partners and industries, make it highly likely infrared and thermal imaging devices will accomplish widespread military deployment within two to three years.

During the COVID-19 pandemic, Raytheon Vision Systems (RVS) and Seek Thermal developed an infrared sensor system to control the virus's spread.[H] The device, Seek Scan, analyzes the heat radiating from an individual's skin, then an algorithm converts it to the core body temperature.[H] The system uses a microbolometer, an uncooled thermal sensor, similar to defense-grade sensors that go into forward-looking infrared systems distributed across military and commercial platforms.[M,M]

The application of thermal imaging technology extends to mobile phones. FLIR Systems developed a thermal camera module that attaches to a smartphone and can be used to solve household problems (water leaks, electrical issues, etc.), nighttime photography, monitoring the breathing of at-risk individuals, and detecting human or animal presence when out at night.[M] Thermal imaging is becoming increasingly widespread, and commercial technology uses will continue emerging in the future.[M] Despite the growing use of commercial infrared technology, it raises privacy and civil rights concerns – data being collected on individuals and used without their permission.[M]

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Moreover, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: Ms. Bernice A. Parkhill

Invisible Cloaking of Large Object Heat Signatures Likely By 2030-2035

Executive Summary

Developments combining nanotechnology, metamaterials, and multispectral imaging delivers invisible cloaking of large object heat signatures for military personnel and equipment, make next-generation camouflage prototypes likely by 2030-2035. Despite an invisibility cloak sounding like science fiction, many scientists and engineers dedicate much time to develop the concept and push it closer to reality.

Discussion

Understanding what and how small nanotechnology is not simple. Nanotechnology is the understanding and control of matter at the nanoscale, at dimensions between approximately 1 and 100 nanometers, where unique phenomena occur.[H] A nanometer is a microscopic unit of length – a billionth (10^{-9}) of a meter (for scale, a single human hair is about 80,000 to 100,000 nm wide) (see Figure 1).[H]

Figure 1. Nanotechnology allowed scientists and engineers to create the nanotubes on which this ladybug is walking. https://nationalgeographic.org/encyclopedia/nanotechnlogy. Source: NationalGeographic.com

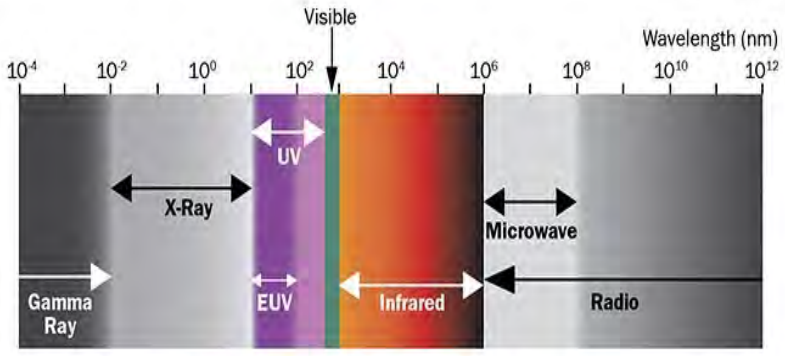

Figure 2. Wavelength regions outside of the visible spectrum are used in hyperspectral and multispectral imaging. https://www.photonics.com/Articles/Hyperspectral_and_Multispectral_Imaging/a65595. Source: Photonics.com

Transitioning from nanotechnology to metamaterials – materials science – combines tiny (nano) engineered structures from an existing composite used to manipulate light, sound, and wavelength ranges.[H] A multispectral image captures image data within specific wavelength ranges across the electromagnetic spectrum and may detect the wavelengths via the use of instruments that are sensitive to particular wavelengths, including frequencies beyond the visible light range (i.e., infrared (IR) and ultra-violet) (see Figure 2).[H] Multispectral

imaging can detect and track military targets due to its ability to measure mid-wave infrared and long-wave infrared, measuring the radiation inherent to an object known as thermal imaging.[H]

Coleoid cephalopods (octopus, cuttlefish, and squid) extraordinary ability to blend in with the surroundings and disrupt their body outlines makes them much more challenging to locate by sight, and it has inspired researchers to reproduce this intriguing ability to readily camouflage in the IR and visible spectrum on demand (see Figure 3).[H] Coleoid cephalopods rely on sophisticated epidermis and organ tissues to integrate different visual information types into a cohesive, matching pattern that sends out the correct commands to camouflage.[H] On the other hand, human skin does not exhibit such a trait despite its outstanding tactile senses and versatile functionalities.[H]

Figure 3. An octopus of the common species Octopus vulgaris reacts to the approach of a diver by completely changing its camouflage within two seconds. Initially camouflaged to match the mottled greenish color, pattern, texture, and reflective intensity of the surrounding algae, it quickly changes to match the white sea floor. https://researchgate.net/figure/An-octopus-of-the-common-species-Octopus-vulgaris-reacts-to-the-approach-of-a-diver-by_fig4_235289760. Source: Research Gate.net

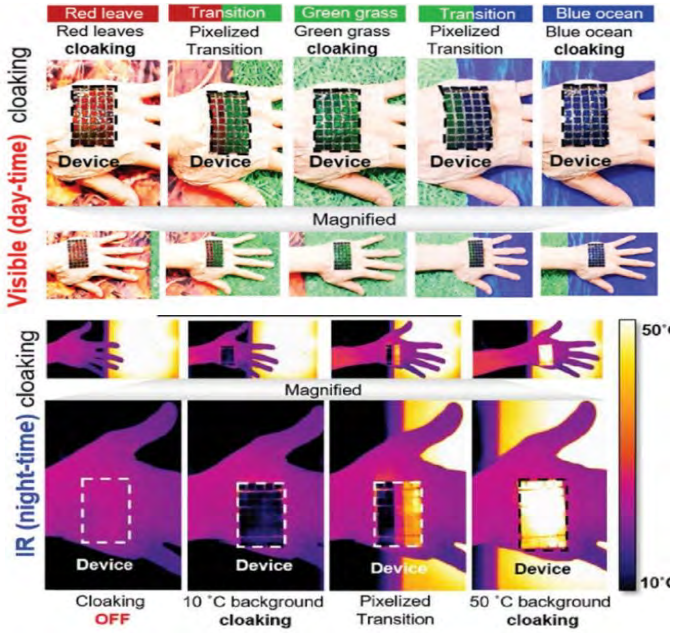

Figure 4. An illustration of thermal and optical cloaking. https://www.iflscience.com/technology/scientists-create-artificial-skin-that-could-render-wearers-almost-invisible/. Source: IFLScience.com

A recent research project led by a team at Seoul National University details a new cloaking composed of artificial skin that use active heating and cooling to mimic either the visible colors or thermal characteristics of the environment and can switch from one to the other in about five seconds, similar to the IR and visible spectrum on demand cloak found in coleoid cephalopods.[M] The artificial skins contain pixels of thermochromic liquid crystals, which changes the light reflectance based on its temperature, allowing the generation of a diverse number of colors by

controlling temperature and the cloaking in the visible range is achieved separately by matching the ambient color.[M] The upper and lower snapshots in Figure 4 demonstrate the pixelized transition from one background to another as the hand moves across different backgrounds (whether it is a visible or IR cloaking mode).[M] Each pixel sequentially switches its color and temperature based on their relative positions.[M]

In 2019, a Canadian company, Hyperstealth, came close to an invisible cloak when it developed a shield that renders anything behind it difficult to see by bending light waves around an object.[M,M] Recently, the World Intellectual Property of Office (WIPO) approved 73 claims related to a patent application.[M] Unfortunately, errors in the prototype still exist.[M] The shield is visible as a matted shroud; however, Hyperstealth thinks it is possible to develop a crystal clear shield and not betray itself.[M]

Other developments in this field highlight the interest in electronic skin (e-skin) and artificial skin. Research teams from the University of Hawaíi at Mānoa and Northwestern University developed a skin-mounted sticker that absorbs sweat and changes color to provide an accurate, easy-to-read cystic fibrosis diagnosis within minutes.[M] Additionally, researchers at the Royal Melbourne Institute of Technology in Australia developed an electronic artificial skin prototype that senses and reacts to pain just like human skin.[M]

The multispectral imperceptible skin cloak requires further development and additional testing advances on larger heat signature versions; however, forecasts predict significant contributions to wearable military covert applications likely by 2030-2035.[M] Due to the technology's newness, research continues to address the external hot and cold temperatures that may adequately influence the covering's ability to function in extreme weather conditions.[M] Despite an invisibility cloak sounding like science fiction, many scientists and engineers dedicate much time to develop the concept and push it closer to reality.[M]

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were reliable and tend to corroborate one another. The analyst had adequate time for research but worked alone and did not use a structured method. Furthermore, given the timeline associated with this estimate, this report is sensitive to changes based on new information.

Author: Ms. Bernice A. Parkhill

Advanced Battery and Capacitor Technology Almost Certain to Impact Military Intelligence Analysts Over the Next 5-10 Years, Field Deployable Between 2025-2035

Executive Summary

Rapid developments in battery and capacitor technology will almost certainly improve end user devices within the Internet of Things (IoT). Both power sources will almost certainly become smaller, lighter, more powerful, faster charging and discharging, and longer lasting. Industries can then develop future Internet of Military Things (IoMT) to support military intelligence analyst devices. Extended reality hardware, numerous sensors, and computing equipment are a few of the essential devices that future batteries and capacitors will almost certainly more efficiently, reliably, and safely power.

Discussion

Batteries and capacitors are essential enabling technologies that limit the capacity and capabilities of many devices.[H] Only in the past decade has battery technology significantly changed from its prior 50 years of production.[M] Currently, most electronic end user devices are powered with the latest lithium ion (Li-Ion) batteries.[H] While these far exceed the capabilities of classic lead and alkaline batteries of the past, they still fall short of many of the desired future power capabilities.[H] It is almost certain that future portable and rechargeable power solutions will come from advancements in both battery and capacitor technologies.[H]

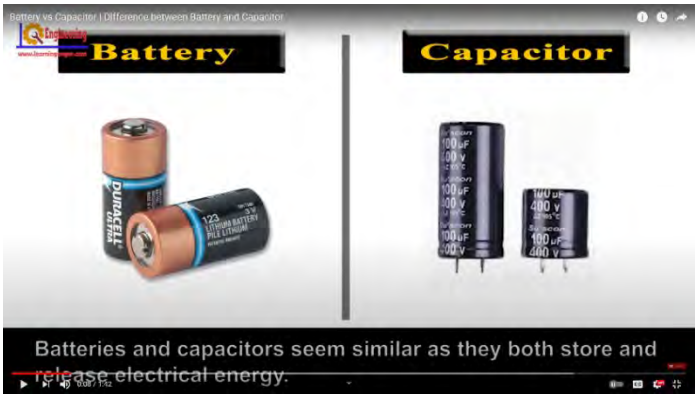

Figure 1. Learning Engineering "Battery vs Capacitor". Click on picture or go to: https://www.youtube.com/watch?v=2S1nIORiGls to view video. Source: Learningengnr.com.

Batteries and capacitors have similarities, but a few distinctive differences make each better at providing power to different things.[H] Both are capable of discharging electricity, are made of varying sizes, have similar operating temperature ranges, and can be recharged multiple times.[H] However, batteries convert chemical energy into electrical energy while capacitors physically store static electricity while awaiting discharge.[H] This allows for batteries to traditionally have a higher energy density[1], longer discharge and

[1] Energy Density: Amount of energy stored in a given system per unit volume or per unit mass.

charging time, but lower power density[2], and decreased longevity compared to capacitors.[H] So even though capacitors can recharge in seconds and discharge large amounts of power almost instantly, batteries have qualities slightly more ideal for most mobile devices.[H]

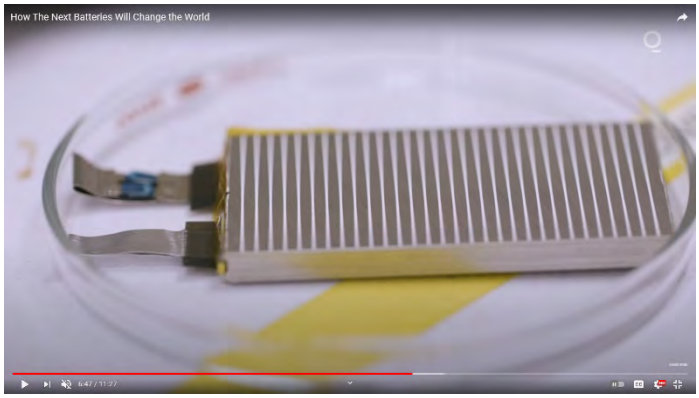

Figure 2. Bloomberg Quicktake "How the Next Batteries Will Change the World". Click on picture or go to: https://www.youtube.com/watch?v=oh5ULFMsQHU to view video. Source: Bloomberg.com/qt.

While there are many emerging advances in battery technology five areas are almost certain to impact devices that military intelligence analysts will use. The first technology uses different rare earth metals to create better lithium air (Li-O_2) batteries.[H] The University of Illinois is researching into the use of molybdenum disulfide, instead of a traditional carbon lattice.[H] They have increased the recharging cycles from 11 to 700.[H] A Massachusetts Institute of Technology team is looking into using viruses to create the nanotubes to develop more efficient Li-O_2 batteries.[H] NASA is separately looking at increasing the traditional power output to six times their current output using wax between the plates.[H,H] This technology not only has potential to power end user devices but can also be used to store solar energy to recharge IoMT devices.[H]

The second area to improve battery performance is nanotechnology.[H] Purdue University is developing a microscopic porous structure from nanochains that significantly increases the surface area available to store electrical charges for the same volume or weight of a battery.[H] Many companies are looking into the versatility of graphene to improve batteries. Graphene is a semi-conductor, that is 200 times stronger than steel, that can store energy more efficiently that traditional materials, and undergo hundreds of charging cycles.[H] While early versions of graphene batteries will be available in a few years, researchers over the next decade will greatly expand graphene capabilities.[H,H]

A third area of research is with the use of sulfur and silicone.[H] This technology has a theoretical energy to weight ratio 7.5 times greater than traditional lithium batteries.[H] However, current research can only produce 1.5 greater energy at this time.[H] Another challenge is that sulfur and silicone batteries use liquids and therefore still suffer from the dendritic growth[3] that can cause the battery to overheat leading to fires or explosions.[H,H]

[2] Power Density: Amount of power per unit of volume or per unit of mass.
[3] Dendritic Growth: A characteristic tree-like structure of crystals growing as molten metal solidifies.

The fourth area of emerging technology is the creation of solid-state batteries.[H] Batteries currently contain semi-conductive liquids separating the anode from the cathode.[H] Dendrites form in this liquid layer and make batteries susceptible to fire and explosion.[H] Major automotive and leading technology companies like Panasonic, Samsung, Enovix, and Quantum Scape are researching into different solids that can be used here.[H,H]

The fifth area of research is called "dual carbon." This technology focuses on the use of nontoxic and common materials instead of traditional toxic and rare earth minerals.[H] They charge 20 times faster than Li-Ion batteries, do not generate as much heat, and can charge for thousands of cycles. However, their output is not ideal yet. Eventually these can be made from renewable sources.[H,H]

Emerging advances in capacitor technology are focused on merging a traditional capacitor with battery characteristics.[H] The new hybrid is known as a super-capacitor (SC).[H] The two primary technological advances for SC are porous surfaces to increase the total surface area and putting the surfaces closer together between an insulator.[H] Additional research is looking at expanding polymers, graphene nanotubulars, bipolar fluids, and laser etching technology.[H,H,H,H]

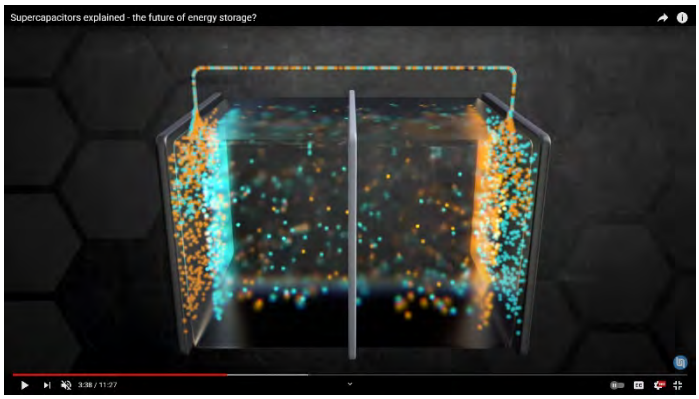

Figure 3. Undecided with Matt Ferrell "Supercapacitors Explained". Click on picture or go to: https://www.youtube.com/watch?v=-7T-6XdiRTw to view video. Source: Undecidedmf.com.

The bulk of current research for batteries and capacitors is focused on the electronic vehicle (EV) industry. However, there are dedicated studies looking into mobile devices and much of the EV research will spill over into various global power needs.[H] It is almost certain that advances in battery technology applicable to mobile IoT devices will come sooner than that of capacitors and impact IoMT of 2025-2035.[H,H] However, it is highly likely that supercapacitors will impact IoMT by 2035 too.[M,M,M] This will come in the form of storing energy for recharging of mobile devices or when used in combination with batteries to provide the best of both technologies.

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked

alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Jason M. Seery

Integrated Short Form Analytic Reports

AI And Machine Learning Advances Highly Likely to Increase Analytic Capacity as Much as 15-20% By 2025 With IMINT/ELINT/SIGINT Disciplines Likely Main Beneficiaries

Executive Summary

Significant advances in the fields of artificial intelligence (AI) and machine learning (ML) are highly likely to enhance the capacity and speed of future intelligence analysts, especially in the technical intelligence disciplines, by leveraging technologies able to filter, identify, and process large volumes of data. Many of these traditional analyst functions will likely become automated over the next several years, and according to a recent report by Deloitte, may offer, per analyst, as many as 45 days (15-20%) of additional capacity to be focused on areas such as critical analysis and improved communication through data science tools. Despite the significant advances in these technologies, there is still difficulty replicating human's abilities in generalized intelligence areas. As a result, current trends in AI and ML development leverage both human and technology synergy to ensure common sense reasoning is still fully integrated into the process.

Discussion

Advances in emerging technologies continue to demonstrate significant impacts on the field of intelligence and will likely impact all facets of the intelligence cycle.[H] These

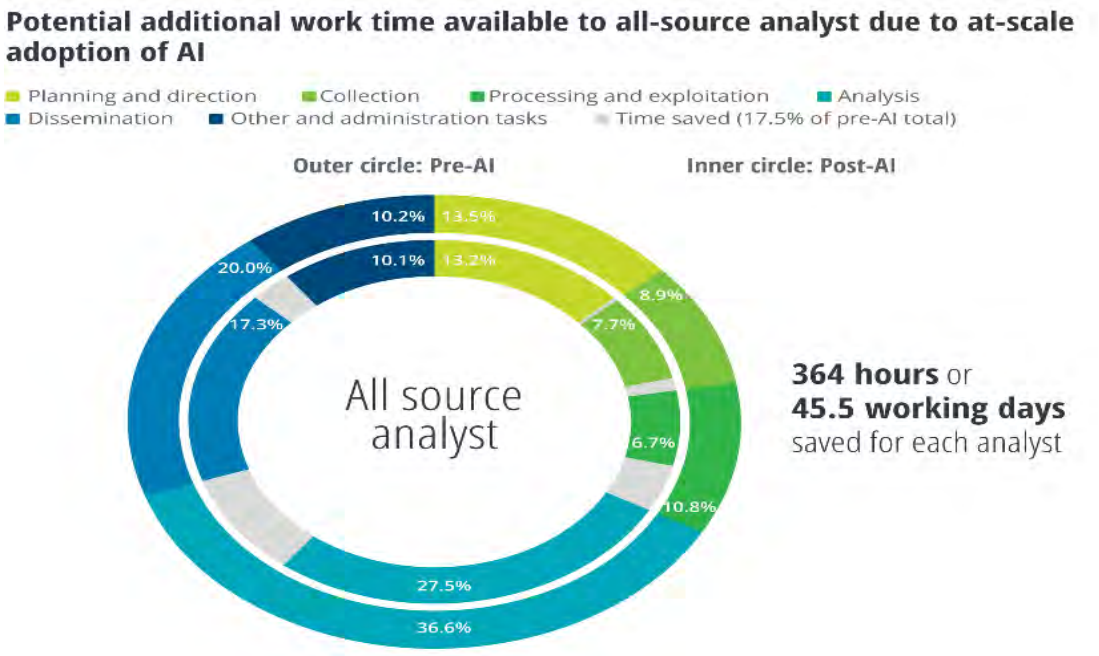

Figure 1. Potential Added Analyst Capacity using AI. Source: Deloitte Graph

advances are occurring largely due to advances in AI algorithms and other applications well-designed to aid intelligence work, growth of multimodal sensors and supporting

networks, continued expansion of "big data" capabilities, and ever-increasing computing speed and power.[H] These advances are critical to ensuring intelligence analysts can filter and process the ever-increasing amounts of data available; also resulting from technological innovations.[H]

The intelligence community is seeing the most readily applicable benefits from artificial intelligence and supporting emerging technologies in the more technical disciplines like imagery intelligence (IMINT), electronic intelligence (ELINT) or signals intelligence (SIGINT) where technology is allowing collection and coverage at a rate and in areas previously unattainable to the intelligence community.[M] AI is consistently used both to label information as well as process it through exponentially growing volumes of raw data.[H] As a result of this technology infusion, analysts are gaining additional capacity, with one study projecting all-source analysts potentially could gain approximately 45 days a year in additional capacity with full AI integration.[H] Many researchers believe this represents only a small portion of the potential for AI moving forward, claiming AI can also enable this analytic extra capacity to improve the ability for analyst to improve their value and contributions to leaders.[H] One specific area identified for analysts to leverage AI moving forward is to improve their abilities to effectively deliver information to decision makers through enhanced modeling and other vehicles.[H]

Despite the current advances in AI capabilities, one area where the technology continues to languish is in generalized intelligence areas.[H] Whereas computer technology offers a clearly superior ability to process large volumes of data compared to a human, a typical five-year old child can currently surpass technology's ability to handle dynamic situations or negotiate situations involving high levels of interpersonal interaction to accomplish.[H] The human brain continues to be the most powerful system when it comes to application of previously learned information to new situations.[M] It is for this reason those in the military continue to invest heavily in human-AI teaming.[H]

The synergy created by optimizing the ability for analyst and AI-enabled machine to operate holds the promise of a sum greater than its individual parts.[H] Ongoing research in creating machine language which allows for more conversational interface with analysts as well as focused research into how best to train future analysts on incorporating and interacting with AI enabled technology will continue to expand the maximum potential over the coming years.[H]

There are arguments which counter the claims of artificial intelligence and machine learning's growing impact on the future employment and ability of intelligence analysts. Because modeling is a mathematically enabled practice, some antagonists claim the binary nature of mathematics cannot possibly replicate the complexities or intricacies of

the world.[M] Their contention is a data driven paradigm, in an inaccurate digital construct, inevitably creates distortions which negate the accuracy and utility the technology. It is for this reason that any advantage garnered from technology is likely unrealized without direct human scrutiny and review.[M]

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were predominantly reliable and could be generally corroborated by other sources. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate and relative speed of new technology breakthroughs, this report is sensitive to change if presented new contradictory information.

Author: COL Joseph T. Sheridan

Convergence of Neuroscience and Sensor Technology to Benefit Military Intelligence Analysts Likely Field Deployable by 2035

Executive Summary

Neuroscience and sensor technologies are becoming less expensive, more mobile, and easier to converge with other technologies to speed up data inputs and processing. These technologies focus on the brain as the future battlefield and the conquest for cognitive supremacy. The military analyst likely will utilize components of neuroscience and sensor technologies for daily cognitive enhancement by 2035. Despite the active US research in neuroscience, China poises to obtain the strategic advantage in the great power competition currently underway, threatening the effectiveness of these technologies and their future convergence.

Discussion

"Power is in tearing human minds to pieces and putting them together again in new shapes of your choosing." - George Orwell, “1984”

Neuroscience and technology continue to evolve, making this quote on the cusp of reality. According to the Army TRADOC, the future's operating environment will extend beyond conflict in the domains of land, air, sea, cyber, and space, making the brain as the new battlefield domain.[H] Attacks in this domain will be through direct attacks and exploitation of soldiers and noncombatant's brains.[H] This battlefield may be laden with pharmacological land mines designed to discharge drugs to incapacitate soldiers, brain wave scanners for target acquisition, and brain waves to determine truth during

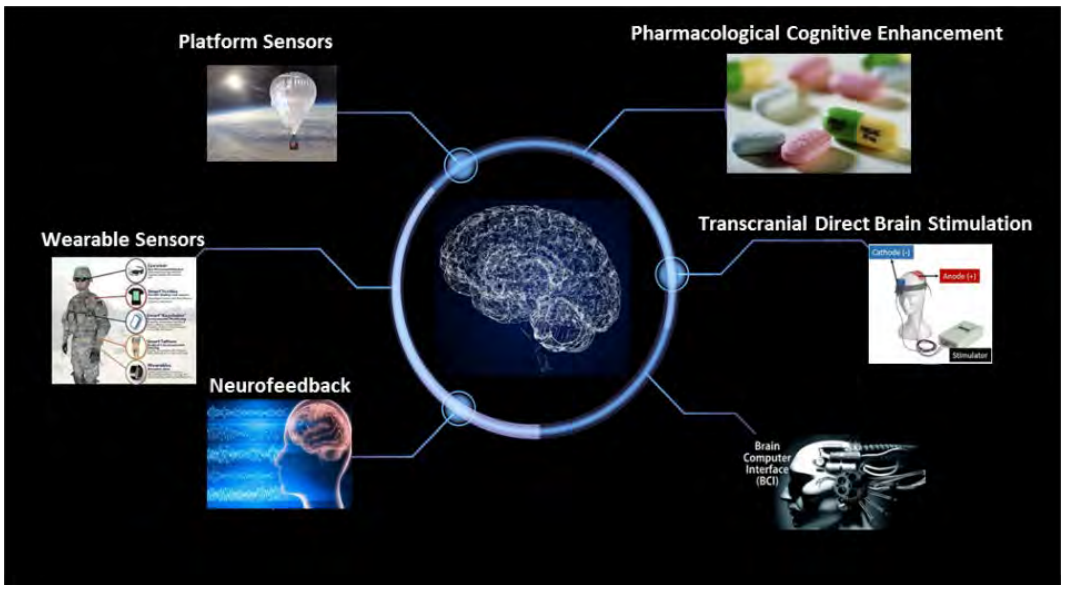

Figure 1. Presented Technologies.

interrogation.[M] Therefore, the use of neuroscience to counteract these effects, coupled with the use of sensors to detect enemies' targets within the neural domain of the future battlefield is likely to be ready for field testing by 2030, with a selective few ready for deployment by 2035. However, current ethical concerns surrounding the controversial use of neuroscience for lethal actions make widespread adoption for combat use unlikely by 2035.

There are rapid advances in neuroscience and sensor-technology that likely impact the military intelligence analyst by 2035. These technologies focus on information inputs and cognitive enhancement aimed at quickly processing data. Leveraging these technologies can increase decision-making speed and reduce the time necessary to initiate the kill chain (Annex A). Technologies examined (see Figure 1) include:

- Sensors - The future battlefield will employ densely deployed battlefield sensors, including weapons, vehicles, robots, and human wearable devices.[H] Command, control, communications, and intelligence (C3I) systems will integrate this information to influence real-time decision-making, contributing to a more robust understating of the military analyst's operating environment.[H]

- Brain Computer Interface (BCI) - This technology allows for control of computers using the power of thought.[H] The utilization of BCIs by future military analysts will enhance processing of data inputs. However, these devices currently operate in a peripheral mode, e.g., mouse or wireless keyboard.

- Pharmacological Cognitive Enhancement (PCE) - Cognitive enhancement refers to substances that help restore or improve human performance via delivery of neurological effects such as mood-lifting, energy-boosting, increased concentration and wakefulness, and reduced memory loss.[H]

- Transcranial Direct Brain Stimulation (tDBS) - "The thinking cap of the future" - is a non-invasive and painless brain stimulation that utilizes direct electrical currents to stimulate specific regions of the brain.[H]

- Neurofeedback (NFB) - Electroencephalograph (EEG) biofeedback, or NFB, is an advanced form of biofeedback using brain waves that represent different forms of cortical activity.[H]

Despite aggressive efforts in advancing neuroscience and sensor technologies, the U.S. will likely find some applications lending themselves ineffective when competing with adversaries such as The People's Republic of China (PRC). The PRC is a rising

powerhouse across a range of emerging technologies, with the full intent of utilizing these technologies to achieve military strategic advantage.[H] Current PRC research includes several interconnected research tracks, including brain monitoring to quantify and measure the military mental work, brain modulation aimed at the mind-controlling targets and effects, brain damage, and brain promotion focusing on training methods.[H] Chinese Communist Party (CCP) General Secretary Xi Jinping has professed, "In circumstances of increasingly intense global military competition, only the innovators win."[H] Therefore, the U.S. must be selective in choosing which neuroscience and sensor technologies that most likely contribute to cognitive supremacy and to achieve successful convergence with new or existing technologies. At the minimum, a combination of the above mentioned technologies, e.g., PCE and NFB, that is highly likely to be field deployable for daily-use can significantly benefit military analysts by 2035.

Figure 2. Dr. James Giordano: The Brain is the battlefield of the Future. https://www.youtube.com/watch?v=N02SK9yd60s.

Science continues to unravel the brain's mysteries. The U.S.' race to cognitive supremacy is briskly underway, with rapid development and fusion of both neuroscience and sensor technology – BCI, PCE, tDBS, NFB, and sensors. There is clear evidence that China is eroding U.S. technological advantage, with ambitions to take the lead in developing strategic technologies, making military innovation a priority and national imperative.[H] The US military is in a precarious position and must determine how best to employ these rising neuroscience and sensor technology (see Figure 2). Based on the research conducted in this work, these technologies are likely to impact the U.S. military and the military analyst by 2035.

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Greg Frazier

Technological Convergence of Digital Assistants / Companions, Hyperautomation, Holographic Displays, and Brain Chips Likely to Help Optimize Future Military Intelligence Analysts Between 2030-2035

Executive Summary

The technological convergence of multiple next-generation or advanced technologies like digital assistants, digital companions, hyperautomation, holographic displays, and "brain chips" across parallel fields make it likely that optimized intelligence analysts will be able to compete and survive in complex adaptive environments between 2030-2035. Current obstacles like data processing and transmission network bandwidths, and data security and privacy concerns, may initially delay synergistic benefits from technological convergence. However, as competition and investment across multiple fields continue to grow during an anticipated long-term technological revolution, synergistic advances will likely fuel innovation to meet consumer and commercial demands in a more connected and technologically advanced world.

Discussion

Technological convergence is nothing new, and by definition describes "the layers of abstraction that enable different technologies to interoperate efficiently as a converged system (see Figure 1)."[H] Advantages to technological convergence include multiple tasks being performed on a single device, simplifying the use of technology, and synergistic advances beyond originally intended applications; all of which save space, time, energy, and simultaneously fuel innovation across multiple fields (entertainment, business, medical, military, etc.).[M,M] Several countries, such as the U.S., China, Russia, North Korea, and Iran, as outlined in the 2021 Interim National Security Guidance, are racing to develop and deploy emerging technologies to gain and maintain a competitive advantage across multiple Diplomatic, Informational, Military, and Economic elements of power.[H] More specifically, each nation seeks to leverage emerging or advances in existing technologies to gain an

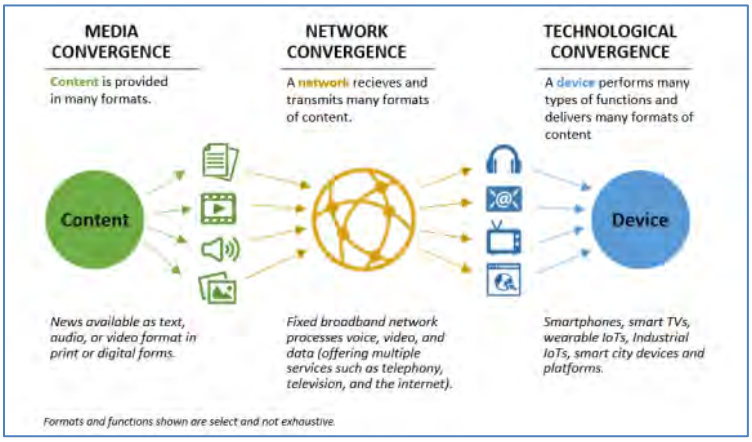

Figure 1. TEDxRuppin: Technology convergence = innovation, lecture by Kobi Richter. Click on picture or go to: https://youtu.be/Nw-fYXWk4Hs to view source. Image from: http://pascalobservatory.org/pascalnow/blogentry/news/being-human-era-fourth-industrial-revolution-and-ai

advantage in speed, agility, and integrity in decision-making in observe-orient-decide-act (OODA) loop cycles over competitors.[H]

Specific to the Military element of power, strategic leaders are seeking advanced technologies across multiple fields that will potentially shape and define the future of warfare through resilient networks, autonomy, data-driven decision-making platforms, and artificial intelligence (AI).[H] More specifically, strategic leaders are asking focused questions as to how can evolving technologies optimize the performance of their military personnel, increase the speed and confidence in which they receive, process and act on information, and ultimately increase survivability in anticipated complex adaptive future environments.[Annex A] Several next-generation or advanced technologies such as digital assistants, digital companions, hyperautomation, holographic displays, and "brain chips" are likely to converge and provide answers to strategic leaders on how forces can remain competitive and avoid obsolescence.

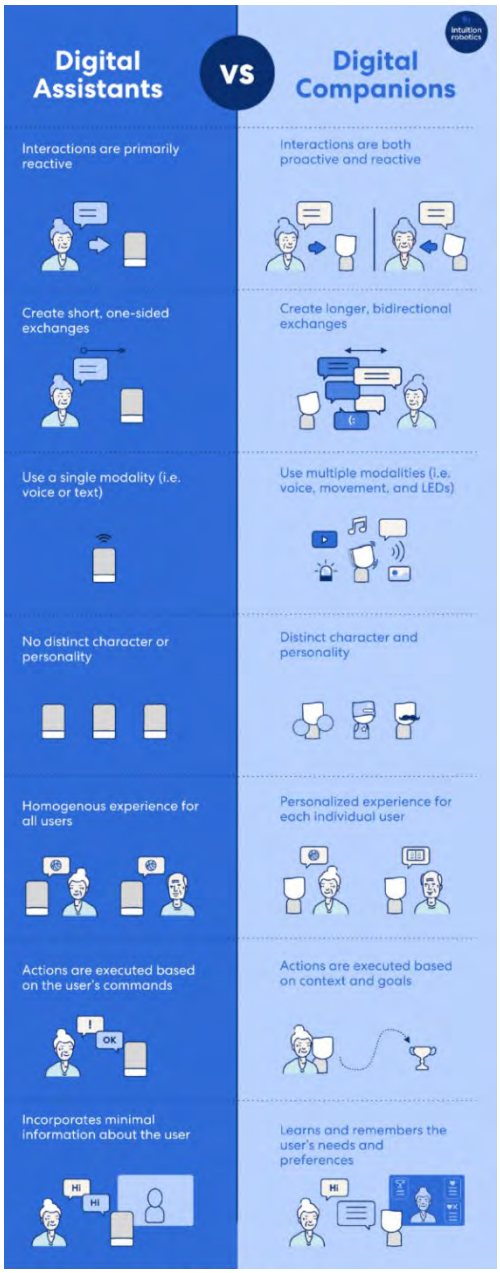

Figure 2. Digital Assistant vs. Digital Companion comparison. Click on picture or go to: https://medium.com/swlh/digital-assistants-vs-digital-companions-whats-the-difference-a4eefd0ba5db to view source.

Specific to intelligence analysts, the convergence of rapid advances in next-generation digital assistants and advanced digital companions utilizing AI and machine learning (ML) make it likely that the processing, exploitation, and dissemination (PED) tasks of intelligence analysts will be faster, more accurate, and driven by the tenet that "machines should do analytics, people should do analysis."[H] Currently, digital assistant interactions are passive; however, digital companions, which are the next evolutionary step in technology, seek to be predictive and learning devices (see Figure 2) that are believed will *grow* with their user and boost efficiency and analytic confidence over time.

It is highly likely that hyperautomation will also converge with the anticipated convergence of

next-generation digital assistants and/or advanced digital companions to free human capital from routine PED tasks, and enabling intelligence analysts to focus on analysis instead of analytics.[H,H] Freedom from routine PED tasks, therefore, will allow intelligence analysts to maintain a competitive advantage over adversaries and provide best possible information to decision-makers across multiple domains.[H]

Convergence between next-generation holographic displays and "advanced brain chips" is likely to assist intelligence analysts with analysis and validation, survivability, and speed with which information is provided to decision-makers in the OODA loop cycle.[M,M] The U.S. Army is already investing in wearable "heads-up display" technologies as part of the Integrated Visual Augmentation System (IVAS), such as the $21.9 billion Microsoft HoloLens contract, which is believed will keep soldiers safer, make them more effective, enhance situational awareness, and enable information sharing and decision-making across the force.[H] Convergence between these systems will likely include the addition of "advanced brain chips" and next-generation holographic display technology that would potentially enable hands-free and non-verbal communications between not only squad members, but intelligence analysts and commanders from across dispersed locations, and real-time holographic intelligence briefs or updates.[M,H]

Current obstacles that impact the convergence of these technologies are variations in parallel development cycles, current technological limitations such as data processing and transmission network [4th Generation (4G), wireless fidelity (Wi-Fi), etc.] bandwidths, and data security and privacy concerns.[H,H,M] However, as competition and investment across multiple fields (entertainment, business, medical, military, etc.) continues to grow, many are anticipating "a new long-term technological revolution called the age of connected intelligence" where connected devices leverage advanced hardware and software systems manifested in artificial intelligence across large and robust cloud-based data networks.[H] During this long-term technological revolution, it is likely that synergistic advances in parallel fields will fuel innovations, leverage technology to meet consumer and commercial demands, and ultimately save users space, time, and energy in a more connected and technologically advanced world.

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, and the reliance on multiple future convergences, this report is sensitive to change due to new information.

Author: LTC Matthew C. Williams

Evolving Technologies are Highly Likely to Significantly Impact Future Military Intelligence Analysts of 2030-2035

Executive Summary

Numerous enabling and primary technologies are currently undergoing evolution at an unprecedented pace. These technologies will individually, or via convergence, lead to major changes to the global Internet of Things (IoT), and Internet of Military Things (IoMT). This will change the way future military intelligence analysts perform their daily tasks in garrison and field settings. Data will become one of the most important assets on the future battlefield when analyzing situations, assessing risk, making decisions, and when engaging or stopping the kill chain. Many tasks will be automated allowing analysts to focus on performing work that is better suited for a human with their attributes and training. Numerous new sensor technologies and methods of employing them will provide unequalled amounts of data. Artificial Intelligence within Edge computers or end user devices using machine learning will rapidly collect and analyze data. Analysts will connect to this information remotely via fast, secure, and reliable wireless networks. By 2030, technology will enable them to do all of this via an extended reality environment. Analysts will work in a hybrid world with full access to peers, staff, and commanders while occupying a small footprint for efficiency, security, and safety.

Discussion

The U.S. Army is currently undergoing a period of increased focus on modernization to attain its vision of what is needed for future large scale combat operations and small armed conflict.[H] The military industrial complex and civilian sector have numerous current, emerging, and theoretical technologies that can empower the U.S. Department of Defense (DoD) to maintain military overmatch.[H] Military intelligence analyst is essential in collecting, processing, and analyzing data in order to provide information and recommendations to senior staff and commanders.[H] In the future, it is almost certain that much of this will be automated to increase the speed, quality, and overall efficiency of their information and recommendations.[H] While there are numerous enabling and primary technologies

Figure 1. Science Time "4th Industrial Revolution". Click on picture or go to: https://www.youtube.com/watch?v=1ezqG29uymo to view video. Source: YouTube.com.

undergoing evolution, this integrated short-form analytical report will focus on wireless networks, extended reality (XR), and future power requirements.

In 2019, the world started to roll out the 5th generation (5G) of wireless communications networks (WCN).[H] It promises to significantly change the way the world uses its end user devices within the IoT.[H] It is certain that the DoD, our allies, and our adversaries are all testing the use of 5G for the IoMT.[H,H] This is a major change from how the worlds' militaries viewed prior generations of WCNs. The ability to access powerful Cloud and Edge computer systems using untethered mobile devices will be a paradigm shift in how the DoD employs its service members, as well as its overall tactics, techniques, and procedures.[H]

Figure 2. Cat 5 Technology TV "Samsung Expects 6G to Launch as Early as 2028". Click on picture or go to: https://www.youtube.com/watch?v=mah7q7i27As to view video. Source: Cateory5.tv.

Given historical advancements in wireless communications technology, it is almost certain that 6th generation (6G) WCN will be initially available between 2028 and 2030.[H] Additionally, it is highly likely to be integrated into the life of a military intelligence analyst by 2035.[H] Sixth generation (6G) promises speeds, reliability, and access that will take the world into the Internet of Everything (IoE) where billions of devices are linked together.[H] This advancement in WCN will allow for data flow to be almost instantaneous for analysts to evaluate and then synchronize with key leaders in a virtual workspace.

While 5G can achieve gigabits per second speeds, 6G and beyond will provide speeds at the terabit per second and unequalled reliability.[H] However, unique characteristics of its technology prevent it from being universally available globally.[H] Traditionally within the DoD, a local area network (LAN) is created

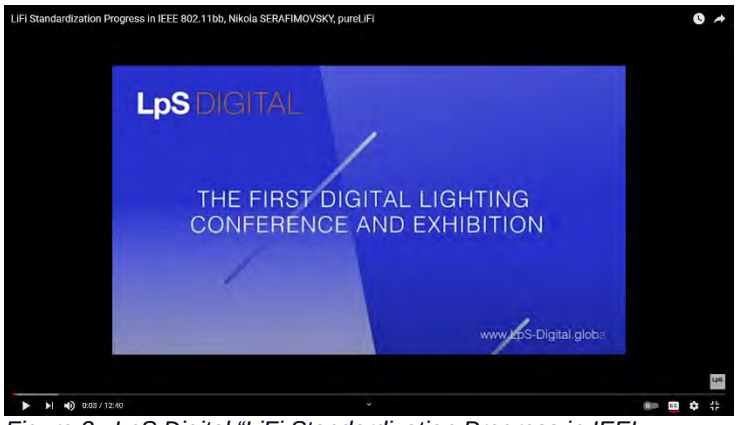

Figure 3. LpS Digital "LiFi Standardization Progress in IEEI 802.11bb". Click on picture or go to: https://www.youtube.com/watch?v=vE9y-kD3kGo to view video. Source: YouTube.com.

with a wired system all the way to the end users. This is primarily done for cyber security reasons.[H] While this is an effective security measure, it tethers users to a fixed location. The DoD is relaxing its policy on using wireless signals using wireless fidelity (Wi-Fi), as well as 5G.[H] The security risks of Wi-Fi for a unit's LAN can be reduced using an emerging technology referred to as light fidelity (Li-Fi). With Li-Fi, light emitting diode (LED) lights transmit data over a smaller and more secure area than Wi-Fi.[H] Li-Fi also currently has the ability to transfer data at speeds in the gigabit range, much faster than Wi-Fi's megabit range.[H] As with WCN, wireless LAN via Li-Fi is highly likely to enable computer access, information processing, and XR to empower our military intelligence analysts.[H]

Figure 4. AR MR XR "US Army Augmented Reality". Click on picture or go to: https://www.youtube.com/watch?v=69D7pQw3v8a to view video. Source: YouTube.com.

It is almost certain that XR, to include virtual reality (VR), augmented reality (AR), and mixed reality (MR) will also greatly change the way future military intelligence analysts interact with data and peers between 2030-2035.[H,H,H] The current XR headsets will also be much smaller, more powerful, and with increased user friendliness features over the next decade.[H,H] It is likely that XR will be integrated with digital assistants and digital companions too.[H,M] This will help analysts more easily perform their duties and successfully function in an austere environment.

To support the above technological advances, smaller enabling technologies will need to be advanced too. Following historical trends, microchips will become smaller, faster, and more efficient.[H] Additionally, materials will become stronger, lighter, and multifunctional that can enhance primary technologies.[H] Devices will become more efficient while at the same time, power sources will become more powerful for the same weight and volume. Battery and supercapacitors will also become more efficient, with faster recharging and longer durability.[H]

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Jason M. Seery

Convergence of Signature Management and Encryption Technologies Likely to Impact Intelligence Analysts Between the Years 2030-2035, and Quantum Network Highly Unlikely to Enable Military Intelligence Analysts by 2035

Executive Summary

The convergence of technologies demonstrated by the government, industry, and academia makes for a promising outlook in signature management and encryption developments that will likely provide increased image intensification, secure encryption, and data authentication capabilities for future military intelligence analysts between the years 2030 and 2035. Researchers must solve the entanglement distribution between nodes before constructing a prototype global quantum internet within the next 15-20 years making it highly unlikely that it will enable military intelligence analysts by 2030-2035. The military intelligence analyst likely will use stealth technologies to understand better and deter near-peer competitors, hostile state and non-state actors in a time-sensitive and complex adaptive environment. Despite proactive research developed in the U.S. and its allies and partners, China threatens to overtake the U.S. in great power competition through advanced military technology developments and capabilities.

Discussion

Innovation is the key to the future, but basic research is the key to future innovation.
-Jerome Isaac Friedman, Nobel Prize Recipient in Physics (1990)

Similar to the quote above from Jerome Isaac Friedman . . . Investment is the key to future military modernization, but Congressional budget appropriation is the key to future investment. Technology convergence depends simultaneously on investment and modernization, and strategic decision-makers must adjust the force structure and readiness rheostat, balanced with risk, using the Strategic Choices Framework[1] to boost modernization programs.[H] Recently, General James McConville, U.S. Army Chief of Staff, stated readiness would be impacted by accepting risk in training by being more efficient and more effective, hinting at reductions in overseas exercises, and conducting small unit-level training with brigade-level training at combat training centers.[H] The concerted focus on modernization resources is understandable as the Army recognizes technology vulnerabilities to compete against our near-peer threats properly.[H]

[1] Strategic Choice Framework refers to providing strategic leaders a means to determine resource priorities across the major activities of force structure, modernization, and readiness balanced with risk.

Researchers have developed advanced technology transformations in signature management and encryption that likely will enhance future military intelligence analysts between the years 2030 and 2035. The technologies researched include:

- Image Intensification Capabilities: Electro-Optical and Infrared (EO/IR) systems combined with thermal imaging provide holistic situational awareness during the day and night and in minimally lit conditions.[M] Incorporating these continued developments, along with competition from multiple state partners and industries, make it highly likely infrared and thermal imaging devices will accomplish widespread military deployment within 2-to-3 years.

- Invisible Cloaking of Large Object Heat Signatures: An artificial skin-based invisibility cloak will likely be the next-generation camouflage prototypes.[M] The multispectral imperceptible skin cloak requires further development and additional testing advances on larger heat signature versions; however, forecasts predict significant contributions to wearable military covert applications.[M]

- Non-Fungible Blockchain Tokens: Non-fungible tokens (NFTs) refer to a unique and verifiable digital signature stored on a secure distributed ledger or database called a blockchain.[M] The non-fungible blockchain token will likely enable rapid intelligence sharing outside the Intelligence Community networks in zero or near-zero trusted environments.[H]

- Fully Homomorphic Encryption (FHE): FHE provides data security that delivers mathematical proof of encryption using cryptographic means, ensuring with certainty around how data is stored and manipulated.[H] Although quantum computing is still many years away, lattice-based cryptography is a complex cryptic method meant to protect our data and secure us from cyber threats against our adversaries in the future.[M]

- Quantum Network: A challenge to creating a quantum network has been photon loss or a loss of information when photons travel through fiber-optic networks.[M] Globally, the general agreement acknowledges quantum computing represents one of the most critical technological frontiers of the 21st century.[H]

Figure 1. Mitigating security risks from emerging technologies. https://www.army-technology.com/features/mitigating-security-risks-from-emerging-technologies/. Source: Army-Technology.com

Despite proactive research developed in the U.S. and its allies and partners, China threatens to overtake the U.S. in great power competition through advanced military technology developments and capabilities. China unveiled its five-year economic plan, emphasizing advanced technologies and innovation, and identified artificial intelligence, quantum computing, integrated circuits, genetic and biotechnology research, neuroscience, and aerospace as essential to "national security and overall development."[H,H] Basic research increases by 10.6% in 2021 (approximately $25.4 billion), and research and development spending rises more than 7% annually (approximately $404.5 billion) over the next five years.[M,M,M,M] In comparison, the Army plans to invest $111 billion in 2021 for Research, Development, Test, and Evaluation activities.[M] Additionally, the U.S. Army plans to invest $57 billion across the next five years in modernization efforts, a 137% incremental increase from the prior five years plan.[H] Senior military leaders recognize modernization efforts require transformation, and by 2023 many systems will be fielded to soldiers.[H]

Evolving technologies markedly improve how the future military intelligence analyst will operate on the future "battlefield," and the ability to mitigate security risks in a multi-domain operational environment involves innovative and integrated solutions (see Figure 1).[M] Rapid advances in technology lead to an increase in the volume, velocity, and variety of intelligence data accessed by adversaries.[M] Therefore, continued investments in technological developments to validate and secure future data streams must remain the focus. The technologies presented will equip the U.S. Army with advantages against near-peer threats, whether from China, Russia, and other authoritarian states as captured in the 2021 Interim National Security Strategic Guidance.[H]

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were reliable and corroborate one another. The analyst had adequate time for research but the worked alone and did not use a structured method. Moreover, given the timeline associated with this estimate, this report is sensitive to change due to new information.

Author: Ms. Bernice A. Parkhill

Annexes

Annex A

Terms of Reference:
How Evolving Technologies Can Optimize Future Army Intelligence Analysts

For:

LTG Laura Potter
HQDA DCS G-2

By:

Team Porrima
USAWC

November 19, 2020

Terms of Reference:
How Evolving Technologies Can Optimize Future Army Intelligence Analysts

Requirement:

How can evolving technologies[1] likely help optimize future military intelligence analysts[2] to enable operations against and better understand near-peer threats in a time sensitive and complex, adaptive environment between the years 2030 and 2035?

Methodology:

Over the next five months, the project team will use open-source information and intelligence techniques to gather and analyze data. The team will analyze their findings with various qualitative and quantitative methods. Qualitative methods used will provide nonnumerical aspects of life, culture, belief, and imagination to assess the social reality related to the question. Quantitative methods used will provide numerical analysis data through comparisons and statistics. Methodologies might include, but are not limited to:

- *Interviews* – Will conduct interviews with topic or technology subject matter experts within the DoD, universities, and industry to gain qualitative information related to the question.

- *Case Studies* – Will review published Op-Eds, studies, and other publications for useful facts related to the question.

- *Statistical Analysis* – Will review published quantitative information related to the question and conduct basic statistical analysis on new findings.

1 Research priority for this project will likely focus on the following technologies (listed in order of priority) and target their utilization: quantum computing, 5G communications technology (to include 6G and potentially 7G fielding), signature management technology, synthetic biology, machine learning, and other evolving technologies as identified.

2 While some of these technologies might improve analysis across the Army, the primary focus of this study will be at Corps, Division and Brigade levels.

- *Multi-Criteria Decision Making (MCDM)* – Will use MCDM to evaluate multiple conflicting criteria in decision making related to the question to help forecast the best future.

- *STEEP Analysis* – Will use to analyze driving Social, Technological, Economic, Ecological, and Political trends in the marketplace. This tool can assist in better understanding the potential characteristics and variables unique to the future generation of Army intelligence analysts.

- *Delphi Method* – Will use this structured communication method to systematically evaluate interactive forecasting provided from experts in the field and among the project team.

- *Prediction Markets* – Will use prediction markets to forecast the likely availability of useful related technologies over the question period out to the year 2035.

- *Sentiment Analysis* – Will use opinion and emotion mining techniques to identify, extract, and study affective stats and subjective information.

The research team will complete the project in phases, totaling approximately 20 weeks once approved by the Army G-2. For planning purposes, the team will consider the following timeline:

- *Phase One* - Research team will conduct an initial collection phase of approximately eight weeks after the submission of this Terms of Reference. During this period, team will ideally execute required research and case studies.

- *Phase Two* - The second phase of this project will likely last four weeks and will focus on all SME outreach and interaction as well as potential travel to technology research hubs or agencies with applicable mission sets.

- *Phase Three* - Also lasting approximately four weeks, this period will focus on execution of modeling or analytical methodologies in order to frame analytic findings and develop recommendations.

- *Phase Four* – Covering approximately three-weeks, this portion will address the fusion and refinement of findings as well as development of analytical reports and supporting documentation to be delivered to the Army G-2.

- *Phase Five* – The final week-long phase will be reserved for rehearsals and execution of project outbrief to LTG Potter. The final outbrief will ideally occur on or around the last week of April 2021.

Challenges:

The research team has identified the challenges that will need to be considered during this project. Some of the challenges are:

- *Classification* - This project is limited to unclassified sources only. The inability to leverage classified data may impact the comprehensiveness of the results.

- *Time Available* - The proposed timeline is dependent on approval of this Terms of Reference for initiation within two weeks of submission. Additional deliberation will result in reduction of time available for phased completion of the project. The project team will only have 5 months to research and develop a strategic intelligence product given the completion requirement of mid to late April 2021. Also, the project team is doing this on a part-time and not full-time manner since they have normal weekly duties as resident students at the US Army War College.

- *Money* - The project team has access to limited funds for TDY and production of a final hard copy print of their research, findings, and analysis.

- *Limited access to information and intelligence* - All data collected will be from open-sources and therefore may lack insight into known or ongoing work in these areas at a classified level.

- *Impact of current COVID-19 pandemic* - Local, state, and federal policies will affect project team members' ability to have traditional, direct face-to-face contact time and classically integrate as historically done.

- *Technology Proprietary Information* - Several of the areas specified for researching are new or emerging technologies. For proprietary reasons, many companies may be reluctant or legally limited on what they are able to share with Team P0rrima for inclusion into the project.

Resources:

Despite the challenges described in the previous section, the research team collectively possesses several resources that will potentially mitigate the aforementioned challenges. These resources include:

- *Personnel* - The eclectic makeup of the research team will enhance the final product by incorporating the unique backgrounds of each member. This team is made up of innovative and successful entrepreneurs, medical experts, with significant experience solving complex, time-sensitive problems, financial professionals with exceptional research ability and acute attention to detail, as well as intelligence professionals with significant insights on the intelligence enterprise and critical analysis application.

- *Institutional* - As students assigned to the US Army War College (AWC), this team possesses access to a wealth of databases with proprietary insights and information on developing technologies. Additionally, the AWC affiliation offers access to a comprehensive network of government agencies as well as private research and technology development leaders. This access will help ensure the quality and comprehensiveness of the team's deliverables.

- *Money* - Limited funding is provided for essential TDY and miscellaneous expenses to support the success of this project.

- *Communication technology* - To help mitigate the challenges brought on by COVID-19 pandemic social distancing measures, the team will use numerous current modalities to maximize teamwork and communication to overcome these historical challenges.

Administration:

- Final Product –
    - Format: Electronic .pdf with hyperlinks document, executive summary, bounded written book, and a formal briefing
    - Date: end of April (actual date and time TBD)

- All correspondence between the research team and the decision maker will occur through the primary point of contact, COL Rhett R. Cox (Email: rhett.r.cox.mil@mail.mil, Comm: 703-695-3033). If the primary point of contact is unavailable, all correspondence will be handled by the secondary point of contact, Alexander T. Miller (Email: alexander.t.miller2.civ@mail.mil, Comm: 703-695-4093).

- Team Members:

POC	Team Member	Email
Primary	COL Joe Sheridan	joseph.sheridan@armywarcollage.edu
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	COL Matt Williams	matthew.williams@armywarcollage.edu

Annex B

Subject Matter Expert Interviews[1]

[1] These transcriptions are rough and largely unedited. Team members utilized compiled notes of the meetings to determine what went into the estimative documents.

Alicja Mincewicz Interview 02/02/21

Facebook Reality Labs Research Strategy Lead

- Quick intros
- ToR Question stated
    - she relies on corporate experience, no military background
    - tech companies are slow to implement techs into their process, in 2030-2035 need to rely more on technologies
    - learn how to properly use techs
    - AI/ML is as smart as we make them, we have to be cautious what info we're using
    - technologies do fail, they're not always precise, trial and error
- From the business perspective, approach in new techs, what methods?
    - the delay is caused by bureaucracy and lack of understanding
    - DMs don't fully understand the techs and don't think out to the future
    - listen to the expertise and those on the ground
    - at Microsoft, data scientist worked on tech, there wasn't a lot of interaction between data analysts and the data scientists, need to get rid of the borders and have proactive engagements; DMs need to rely on the operators as the SMEs on a daily basis
    - FB is good and listen to what we have to say, position has changed and not in intel right now
    - GSOC: global security operations centers
- Finding techs
    - those are normally outsourced, try to find services that do data aggregation (data miner) and then pushes alerts to companies based on their requirements, relying on other companies and their techs
    - if you have a data analyst that know data science, they have a better background on integrating
    - good idea to train the intel in AI and ML; social media is very important right now and the first place to report is Twitter; going Tweet by Tweet is ignoring so using an algorithm it saves time than figuring it out on your own; if the people we already have
- Collecting Tweets, is there a background process about gathering large sums of data using AI and ML, along with accurate predictions?
    - need to know exactly what we're looking at and the best way to analyze it
    - graduate work: it took a lot of time to determine what to identify, social unrest and the most used words
    - deep learning model was used to clear the language semantics, the model being used can go through trial and errors
    - how to work for the future is to retrain the model, have to constantly be looking at it and adjust/improve/change
    - with new techs, ML should make changes automatically

  - remember the limitations of techs we have, could only 7 days back, not able to go 100 days back; there are limitations that techs have and they shouldn't limit us
  - how do we make sure 10 years from now it's working, we have no way to confirm, we have to go back to the model and tool and we as humans have to validate the data
  - cannot completely rely on techs, humans must validate the data, with society changing today isn't what the future will hold its constantly changing
- Problem of modeling, any software/techs that are being developed?
  - trial and error, there isn't anything specific, relying on what other people are saying and literally go to google to see what other people used for a similar problem
  - it's still very human based, the parameters need to be determined, the more we do it the more we understand what works and doesn't work
- Our data science experience is low, user level interface, joe is intel analyst
  - with language moving forward we'll still have to rely on humans
  - many of the models are English based, there are libraries, but it's mainly English based
  - ask colleagues, the DLI are taught military languages and he struggled with it's not being taught in the sense of how people are using it, he didn't understand how language is used in the social media, they need to understand the language and the culture of the society and the social media, there may be a code they're speaking on social media
  - it also depends on what language you're looking at, when developing the model
  - she used a pretrained model, part of it was pretrained and part she trained; the pretrained model was trained on Wikipedia pages
  - data science and tech is very US based; ML model might not work in other languages, such as in Africa
- Do you know of any companies that might do that type of thing?
  - best way is to hire someone that speaks English and the other language
  - there are still difficulties based on slang; people will say things the way they things
  - go to Rosetta stone, candles in your eyes examples
- Imagine you're in 2030-2035 and all will be solved in AI/ML by then
  - there would still be human involved, techs are evolving so fast, it is possible and with tech she thinks it will happen and AI/ML will do it for you, would still want human
  - especially with humans using new terms and vocab, still would like to have a human to validate the data
  - the hope is techs will pick up on the slang fast and what the info is we're looking at, are they provided by authorities and common people are using it
  - it depends if the AI and ML will be properly implemented and depend on the people fully understanding the tech

    - the most tech savvy person, I would still want an analyst to integrate the data
- ML and data science you wished you had more experience, what skill sets are needed?
    - sentiment analysis is not enough, not very accurate
    - natural language data processing, you don't have to do everything from the very beginning such as writing the codes, but running MLP codes would be beneficial, I would focus here and image processing especially the increasing number of pics posted
    - UC Berk – predicting violence based on pics from Twitter, the model was to predict if the pic was from a violent demonstration or not
    - it's being used now and video processing may be in the future
    - there are tools, Code Monkey, if you could teach basic code for ML, basics of python and be able to create a basic algorithm would be beneficial
    - teach the regular intel methods, but also teach code would be great
- Looking for future analyst, what are you looking for when hiring?
    - techniques that look at critical thinking, logically thinking, mathematics, a data science, a person that is creative and can think out of the box
    - intel mixed with cyber security, risk analysis/management and data science and languages
    - at least teach the basics
    - huge proponent of intel analysis?
    - she was prepared when entering the corporate world
    - had to write SFARs,
    - applied intel and learn the methodologies and tools
- Center for Strategic and International Studies did a study on AI and intel studies, will send the link
- There are lots of tools available to code, when you look into data miner and be cautious of privacy, they have to have your parameters and they store this info perhaps in the cloud

Add'l notes-

- Tech is as smart as we make it. Social media analysis done manually vs. Automated. Microsoft fought automating data collection.
- Recommended analysts get trained in machine learning and data science***
- Machine learning (need context and semantics)
- Everything changes, constantly revolving
- Can't use tech in place of humans for intel
- Data science training in SQL, cybersecurity, and Python
- Learn algorithms for things like NLP, image processing
- Sentiment is important but inaccurate and not enough need to be able to run NLP codes and image processing (monkey something)
- College degrees in critical thinking, data science, language, risk analysis, intel studies.

Dr. Jim Cox 02/02/21

Governor, Council of Governor, Canada and former Dep J2, SHAPE

- Dr. Cox's career spanned in the army during the Cold War, concluded in SHAPE, acquired an education in intelligence and it's more than we were told in the military, returned to school and obtained masters/doctorate, studied it as a body of knowledge as opposed to training in the military, position in parliament in security and defense, from there drifted into teaching – intelligence master's course
- Team Porrima introductions
- Was there any particular portion of our question that caught your attention?
    - the questions are focused on military vs Army intel analyst, they're a bit different and broader
    - the intel analyst role is what we call a purple trade in Canada, the analyst includes those in uniform and civilians (e.g. US IC organization equivalents – CIA, DIA, NHS, etc.)
    - anywhere in the world if your trade is as an analyst you can have a job
    - Canadian forces are smaller and will train to other careers outside the military
    - it's a whole system/team, if you're an analyst you're a player on the team and it plays into if you're effective on the team
    - he's uncertain if there's a future of an army intel analyst and the focus on jointness
    - in your armed forces, if you're an intel analyst and wearing a uniform you will be exposed to a joint environment early on and that's the path he followed
- Greg served with Canadian forces and understands that concept of joint, looking at what intel analyst will be called upon to do
    - is going to do exactly what they're doing today and what they did in the past, predictive analysis and provide that assessment for a cdr in a smart and effective way
    - he can't see it changing, it can be harder, but the analysis will be constant
- As you worked with analysts and what techs do you see them filling the gaps?
    - attended a conference on geo intel, big on AI and modeling, and that whole area of computers/techs/AI/ML/cyber and that's what all is changing, playing on the point earlier the role of the analyst will stay the same, but with all the other stuff, the analyst will be challenged to find a way to fuse all of that in their brain and come up with a prediction; that act of fusing is where tech will come into play, a portion of it should be handled with AI and the amount of the workload to be handle through AI is growing; the challenge is now to be sure the analyst is place in the part of the workload where human wisdom and knowledge can be predicted; and all of what we understand of info can be handle through AI; all is new and complicated, the analyst role will still be exactly the same

- Intel Model (background info: met Kris at a conference and thought through this as there were more helpful with steps in a model that is empirical, better in the military and training the commanders, not as clear in other areas of society, he wanted to refine the operational entities have aggregated their evolution of the intel enterprise; attend course in school and most attendees are mil intel analysts; found the role wasn't as developed as it should have been; wanted to describe a line bet. the data and it has to go into analysis that the analyst isn't playing, that's where he sees the analyst as the same; amended the presentation and integration and added precision)
    - the production of the intel product has to be appropriate to the DM, it depends on who they are, carrying the message is a skill, and as he played on the capacity it's on achieving an advantage and the after decision made and this is where he arrived at the model
    - the intel enterprise has influences and things happening all the time and at all the stages, this is a modern idea added to intel and need separate review and evaluation to ensure its operating as it should be; that's what he uses now to react to events
- You talked about the analyst being on the tail end, using your model, do you think tech will ever help?
    - it's possible and the way is through modeling capability, he's a champion of the human, the final step has to be human; open to any techs of where it stops and human steps in; it can be effectively completed by a machine, but human is important
    - the human has to make the final judgment
- Based on your experience and intel remaining the same, are there areas where tech could provide a quicker response?
    - in the OE, is timing, time available; I would see it almost on a spectrum – collection, apart from human, collection involves tech on the ground into space, validation/collation, but still arrives at the point where the human is engaged and the machine stops; depends on the smarts and experience of the analyst
    - human and mental thing, it's the brain power and doesn't think there's anything that can help that
- Are there any techs AI/ML, are you hearing of other techs out there that may improve the analytics?
    - the idea of championing intel education, meaning advance masters/doctoral
    - in Canada, there isn't any intel ed program in government
    - don't know the analytical part should be wasted on the young, experience plays a big part, giving them the education is important than go for career
    - would expect to see a TOC maybe about the same as today or smaller, the analytical power isn't resident in the TOC, viable to reaching out to higher HQs
    - the size may not be larger, but colors will be varied, the amount of what you'll be drawing on will be immense and unable to have it all in one HQs
- What does training and developing intel analysts 15 years from now look like?

  - immediately say, I would worry about decision making, that's the role of the commander, the skills necessary – there's no easy way to acquire them; an intel analyst must make it their profession and stay in it
  - it's hard to say what a perfect intel analyst should be, education and experience, a doctorate and be available for employment; this whole area is exciting and future oriented and doesn't see any way to have all the brain power
- Are there any additional resources or individuals to talk to?
  - will send a couple of names
- Intel as a system with analyst as a role; may not have a future as a stand alone MOS
- Data fusion is where tech helps analyst; place analyst later in workflow where judgment and evaluation need occur. Champions humans as last step. Moral aspect
- Presentation of info is its own talent; judgment also big

Ted Yang 03 Feb 21

Security Analyst Rand - SSO

- Opening comments
- Team Porrima introductions
- Ted: previous deployments (including Djibouti) where language was a critical factor in human collection.
- Currently sees technologies will enable smarter faster analysis but does not replace need for human element. Discussion on biometrics that are currently in use; analyst notebook, Palantir, heat maps – focus on digital storytelling – modeling enabled by AI. Private sector is making great strides in these areas and will likely lead the way to balanced military investment/benefit.
- Q: What gaps are in analysts now?
- Ted: ability to effectively and rapidly process huge sums of data. Internet speeds and bandwidths are some of the limitations that will need to be overcome along with confidence in systems.
- Ted: feels that analyst have a habit of presenting facts and are not good at telling DMs the "so what". Future tech will assist by providing a digital "story telling" capability. AI will assist in this by analyzing the data so analyst can focus on the story.
- Much of the software and apps Ted and RAND currently use is created internally and not off the shelf. This is mostly simulation and not AI or other tech.
- Need to increase quality and type of training to improve analyst outcomes.
- DoD will need to look at quality of job/life satisfaction, pay, etc to recruit and retain the types of analyst they need.
- Currently DoD is constrained by analyst job descriptions. One consideration is Passion-Projects to keep analyst engaged in a niche or general topic they are interested in.
- Future analyst will need to increase use of internet (Cloud and Edge) for computing and communication with peers.
- Sees growth in future specifically with biometrics – facial recognition (tentacle?)
- Yes : contact again/follow on questions

Scott Jones 05 Feb 21

Head of New and Experimental Thinking (NEXT) – Amazon

- Opening comments
- Team Porrima introductions
- Scott: Early discussion on future analysts/what he looks for in hires: wide education backgrounds, TTPs and how to train/share, learn and be curious mindsets, technical acumen, worldly thinking, language exposure, sociology (over indexed on STEM – seeks journalists, musicians, artist, diverse backgrounds), Liberal arts and social sciences – need to learn code – universal language. Diversifying analysts – machines get better / faster results. Look at bio-investment by China. (something about 2016 – civ. replaced analysts?)
- Q: GSOC – What does it look like?
- Scott: Liquefaction of information. Tech – intel and GSOC at same time (voice and automated collection); people – rooms full of people is dead – dispersion of networked people is current in industry; future of military. Frugality as a norm – less formal infrastructure reduces costs and is what will become competitive advantage. Data direct to DMs. Automated sorting and classifying. Layered systems that reduce risk.
- Q: What does the future analyst look like?
- Scott: Job will remain mostly the same (threat analysis, intel, forecasting, risk, continuity) how they do it will be radically improved by technology. Envisions centers of excellence, expanded networks, differentiation between digital natives vs. digital immigrants. Sees tech such as hyper-automation, quantum computing, edge AI / computing (look at Microsoft – EC2 – elastic computing), virtual reality (look at Oculus), hyper local computing. Generalist forward, specialist in rear (psychological art, financial, sociologist).
- Day 1 Jeff Bezos – mindset shift, data more important than technology.
- Look to medical realm for advancements as well.
- Q: What passion project would he try to solve?
- Scott: Broad center of excellence – recruit and train tech hackers with global mindsets to fill future intel space.
- Yes: contact again/follow on questions
- Ideal analysts attributes – curious, decision making/good judgment, tech acumen, worldly, diversity of experience, not myopic;
- Over indexed on STEM, art and music majors see life differently
- Language req. Diminished; more code and ability to code
- GSOC's are a vanity play; not a req.
- Gov't analysts are too slow and being phased out.
- AI enabled machines can do charting, forecasting, data aggregation;
- Not just threats but impacts
- Require all source/ generalist instead of specialists
- Edge AI (hyperlocal) talked amazon edge, EC2, elastic computing
- Need day 1 mindset not Year 30 (Jeff Bezos)

Nick Rossman 09 Feb 21

IBM - Global Lead for Threat Intelligence

- Opening comments
- Team Porrima introductions
- Nick: In response to initial base question – Observes that future analysts will be swimming in data requiring the merging of data sets; hypergraph data sets – likely a better model. IBM bought Analyst Notebook – look at "the vertex project" of DARPA.
- Sensors on IoT devices – "Shift 5" company
- Sees cloud-based computing and quantum prevalent in 2030/2035 – specifically with encryption required for decentralizing the web and use of human/machine assistants. Data storage – limiting factor for time-based processing.
- Skills of analysts: modeling of big data sets – python and "no code machine learning"
- Q: How will collectors collect?
- Nick: Strategic analysts obsolete – automation will fill the traditional role. Focus area on fewer strategic level analysts, move towards lower echelon high processing and sensing capabilities. All analysts will need to be analyst and developer – coding and cyber security. Python with data entry; computer science. Analysts will need to be more rounded inclusive of psychologist and sociologist backgrounds – specialist vs. generalist range
- Recommend talking with Greg Porpora.
- Yes: contact again/follow on questions
- Hypergraph database – node + edge standard allows for relationships amongst any set of nodes. crosses databasing, edgeless graph, cloud based. Vertex Project (DARPA)
- Quantum computing will be a cat and mouse between countries minimizing long term benefit to one side.
- Strategic analyst down; modeling up

Genevieve "Gen" Lester Interview 10 Feb 21

Francis W. Deserio Chair for Strategic and Theater Intelligence, US Army War College

- Team Porrima introductions
- Gen is a theorist, political scientist, looks at institutions and behaviors, don't think techs solves all problems; happy to talk about emergence issue
- Joe: helping us shape the future of intel analysts; supporting project from G2; states the ToR question; need to focus on what an intel analyst is going to be doing; tech might not be the answer with the lack of C2, internet connectivity issues; are they going to be ready to be fielded in that time; the commercial sector is talking about a footprint reduction
- Gen: what tasks are you asking to take off the analyst, thinking of giving more bandwidth back; how do we invest enough resources; how are we using intel in d-m; what is intel doing to support that process; grounded in more knowledge; how do cut down on the uncertainty; what is the IM supposed to be doing; what is AI and how to we depend on it?; when you're saying AI what do you mean?
- Joe: trying to open their bandwidth; what might be missing?
- Gen: we're talking about integration; integration of a wide range that we get passed the open source; hubris of secrecy or the primacy of secrecy is still very important; tech can't smooth personal interaction, but we need to integrate the full range of information; having a hard time getting past the hurtles; shifting from need to know to need to share; not all info was shared equally, it wasn't integrated; how do you deal with these floods; we haven't gotten better at sharing, need to get to an even playing field; how do we integrate our allies, we need to think this through; integrating to death
- Joe: What emerging tech is there as a potential solution to combat the compartmentalization?
- Gen: there's AI and emerging techs, and the cultural aspect and how do we break down the cultural hurtles; easy to say science will solve this
- Joe: need to get the IC to embrace sharing and witness the problems inherent with that
- Gen: how do you integrate the mil intel with the national level, prioritization is crucial
- Jason: as a realist, the thing of all things human will go away, the human is the weak link
- Gen: when you say realist, what do you mean?
- Gen: the human link is where the cognitive action happens; what are the trends now and where do I think we're going, can't do it w/o the human piece
- Joe: where are you seeing gaps in those humans in those areas and where would you focus on?
- Gen: here for 5 years, teach intel and foreign policy; elective on strategic intel for leaders; what are the different tools; wants to help students consume intel better; think of intel as a bigger framework, it's in a lot of places you don't expect it; why does one country get to undermine the govt of another country; how do you

challenge your own biases; start at the basics and the relationships and get as quickly as possible to what it can do for you and how to use it; how do you use it for your own needs, your strategy, understand yourself enough; how do you get the max knowledge for the areas you're in; at Georgetown, it was different, those students were interested in getting in the IC, thinking more critically getting a sense of the different components of intel; the comparative institutional, clinical and operational way; what are the local indicators; intel in literature can learn a lot about what intel is, what it does and how it functions

- Joe: if intel is using AI, it comes to the ethical; critical thinking – how do you take that young adult and teach it?
- Gen: taking text, taking apart the argument, looking at assumptions, looking at what the evidence, pull apart the data; looking at readings and take apart the arguments, test their own assumptions; first gen college students and helping them look at their own myths about security and intel of thinking; take apart assumptions from home experience; start old school with text about argumentation, then looking at how info is portrayed; they were inexperienced with the sources of authority and how to push back on that; final point, intel literatures is based on anecdote and personal memoirs – how does that impact where you're sitting and how does that impact what you're saying; how their own experiences impact thinking
- Kris: fascinating and jump starting ; during the Canadian interview – raised the idea of education – is that traditional academia can be useful way for people to enter into intel; what's your feeling on college and universities to provide education in intel analysis as supposed to traditionally we teach them when we hire them?
- Gen: agencies would say don't mess them up, give them to us to train; we'll recruit them and train them to what we want them to be; uncertain what the answer is, has her own bias with her education it helped her think through these issues; a fundamental sort of liberal philosophy;
- Kris: they didn't have a self-cleaning affect; at Mercer students were required to take law enforcement and business intel – going into anti-money laundering, banks were pulling them into the fold quickly; every Mercer student is required to take data science; what is the future analyst going to look like, but where will they come from
- Joe: building on question Kris asked - are we trending more to generalist or specialist?
- Gen: the big data and how to do that analytics, the generalist you can see the tradeoffs and AI can take the tasks away without the analysts being so engaged, but then it's a shame to lose that expertise that AI can't replace; a balance is necessary, an analyst would be a generalist at 70% and a specialist at 30%
- Gen: **can't underestimate the power of shock,** 9/11 shifted everything; we have a tendency of getting foreclosed on emergent thread; we are losing our capability to think about Russia and China and the types of conflict; climate change, access to water and population movement; we have to think about human security; adjust through the pandemic; build in resilience, a set of institutions that can withstand change is going to very crucial tech point

- Gen: interested to see what we end up with
- Matt: disassembling logic chains and testing assumptions; are there any things on the horizon from an educator standpoint?
- Gen: there are reports, CSIS about a month ago about reinventing the IC; it jumps up and down about China and rising techs; will send report to Joe; you hear emerging techs and what does that mean; AI is a concept in some ways; Tom Spahr
- Matt: you can't replace the human element, but how do you refine that confidence and apply a reasonable level of certainty?
- Gen: you can have automatic translators

Dr. Genevieve Lester, Title: Francis W. Deserio Chair for Strategic and Theater Intelligence, US Army War College.

James "JJ" Mikulek Interview 10 Feb 21

Senior Analyst, Gates Foundation

- Kris opening comments
- Team Porrima introductions
- JJ: big topic and looking out a long way doesn't envy us; undergrad at Mercy Hurst, middle east politics, CIA – terrorism analyst, state dept – foreign service dept; gates foundation – we have people in Pakistan, Nigeria and Congo dealing with the threats, you name an intel challenge and we've got it
- Matt: compartmentalization of information, are you looking at far out and how are you addressing?
- JJ: not to the extent that we are, much more focused on the here and now, not heard the year 2030 in a security context, the last year has shown the benefits of that given we're dealing with diseases and conspiracies; his team is risk intel, foundation is relatively good at that
- Matt: if you were trying to formulate a team, what skills are you looking for, backgrounds, baseline capabilities?
- JJ: 3 teams, risk intel (smallest of the 3) assessing the threat levels, cyber related threats, and protective and security ops team – planning security for different components; before covid we all sat in the same room, free flowing conversation and that specific way promotes cooperation and dialogue
- Matt: were there specific skills when hiring?
- JJ: risk intel – strong analytical backgrounds, strong critical thinking background, stong background data analytic techniques; one sits in South Africa and he's a security expert for that location, strong background in military combat ops or in either cyber defense or designing cyber networking
- Matt: would you say you have more regional experts that are forward and accessible to the team?
- JJ: the regional office personnel are more specialist; this is a classic intel dilemma; back to govt day, I was more specialized; on any one day I could be asked questions about any number of those several dozen countries
- Matt: Are there emerging techs you'd recommend?
- JJ: less so at Gates Foundation, hire people with more experience, not so much with methodological training;
- Matt: the mil is targeting 17-24 years old
- Kris: do you have freedom to pick training as you need it? do you have that authority?
- JJ: there has been those opportunities, language expertise is ?? and took up Sahili; the foundation does support
- Matt: how do you leverage the large sums of data you receive?
- JJ: been trying to do more reading on; think its going to be bigger, trying to match up the right tech with the right problem; super computer with the deep thought – the computer will answer the question; certain types of intel questions with this

type of tech will be most helpful; military doing it with wargaming; Watson winning on Jeopardy, there are knowable answers, it's the questions that require creativity that are going to be more difficult; replicate the chess playing computers – the brute power of a chess computer with the creativity; there's no replacing that human element; ML and QC will not satisfactorily answer that question

- Jason: talking to a plethora of individuals and with your background and bringing in the tech, what would you like to see what would you like to see, what would be the useful thing to be successful?
- JJ: first, the research has shown analytic teams are a plus esp. as a group of critically trained people; the data sets we have access to, and then being able to apply the right data to the right problem; techs are hard to predict since they advance so quickly
- Kris: you have this data pouring in and have to figure out a way to do it – the soft and hard communication skills, but you've added on this data pile, do you see them as being a data scientist, where do you see that line being drawn?
- JJ: its probably unrealistic that intel analyst will become data scientist, each of these pots of experts have their own way to converse; another challenge - we'll have to become continuous learners, keep learning and updating those skills; related to that too is given the way techs are going is breaking down hierarchies
- Joe: several things you saw government intel doing well and what bounced over to the most innovative company in the world?
- JJ: the ability to change with the Gates Foundation, it's not an easy process on the govt side; mission driven agility is the way to go
- Joe: tech solutions put in place?
- JJ: the disease modeling and the forecasting that is shared back and forth
- Matt: the volume of data and processing; when you tackle the integration, how do you go about synergize those efforts?
- JJ: the joint staff model, doing a lot with east Africa group and are regularly meeting on a weekly basis and coordinating – it that interoperability focus
- Kris: having everyone in the same together, the 3 components – and now you're not with teleworking, how's that working so far, but also picking up signals in the press this is a new way of working; looking out 5-10 years is this an inevitable trend in a virtual env; are you familiar with any techs like virtual reality?
- JJ: the working from home has been a mixed bag, the answer lies somewhere in between, surprised how much we could do at home; we have a big conference and scheduled for India that couldn't work, some things may stay, E&Y and FB can work from home as long as possible, there will be a lot more flexibility, that's ultimately good with personal issues going on; there are certainly things that are lost, the meeting after the meeting isn't happening anymore; heard about augmented reality but hasn't tried it; for Africa employees what's been a big problem is having electricity and bandwidth has been a major concern
- Kris: how much interface with Microsoft, any overlap?
- JJ: hasn't had much interface, but have used products
- Joe: talked about spreading misinformation, from your vantage point are you seeing any new techniques?

- JJ: the algorithms that determine what is seen or not seen is a challenge; leaning on the social media platforms, still mostly online
- Kris: education and whether you could educate intel analysts or the institution can train that individual, what's your take?
- JJ: there is a certain amount that can't be taught; it's very possible that you learn the ways in which you write and brief and thinking, I think that's something you can be taught; the other part is the critical thinking, you can teach people a certain amount of methodologies.
- Matt: can we contact you in the future?
- JJ: yes
- Matt: who else should we be talking with? emerging techs or skill sets?
- JJ: Suki?
- Kris: yes, she would be good. anyone else you'd recommend?
- JJ: will definitely share
- JJ: another issue we wouldn't have anticipated years ago is when govts decided to take down the internet and phone networks when a crisis happens and would think DoD would have a solution to that

Sheridan additional input – Info wars and leveraging social media, ai for misinformation, identify and neutralize

Robert Cardillo Interview 10 Feb 21

Former DNGA

- Team Porrima introductions
- Kris: thank you and explains we're still in the middle of figuring things out in answering this question
- Joe: problem set came from LTG Potter, states question, focusing about 10-15 years out; to kick things off you started your career and where do you see things going?
- Robert: join an analog profession and departed a digital service, when he left NGA they'd bring out a light table for the interns and show them the antiquated equipment; it's what we should be struggling with; learned the tradecraft when the govt owned it, it was a protected world, it was closed; the near entirety of the govt was focused on the Soviet Union and broadly speaking we had one target; we had a false comfort, the tables were quite different, we know the world is flattening and know America has a lot to contribute; our challenge will be less that can we build a widget , the adversary is going to have what we have; one has remained constant and why we have intel – we are to answer 3 questions, what's new, what's true and what's next; the difference is your having the dialogue with the DM while the adversary is operating in the same cycle; you're increment of sooner is about a millisecond, DM is getting chaotic info so needs to determine then what's true; under Obama he was called chaos and destruction, as Putin was running for President – Putin didn't like the internet billionaire so they planted photos in the media (the worst photoshop); you can no longer look at a pixel let alone an algorithm; this challenge of working in the open, the challenge of veracity in a chaotic world and they want us to hesitate and need to pursue the increment
- Joe: are there any emerging techs to offset the veracity?
- Robert: the office of geo and assurance, NGA has been forwarded leading than usual and deserves their reputation; called AAA (automation, augmentation and AI); Project Maven was stood up for that reason; challenged companies to come help, the Russia Strategic Air with fixed equipment; even though the 4000 imagery analyst saw it as job security – not looking to eliminate, but to elevate them; wants you to answer the question why and wants them in the what's next; had uneven success there; it was interesting where I had more people it was harder to get tech in.
- Joe: how as an analyst do you build the curriculum or skill set?
- Robert: it was mandated an analytic integrity office be stood up and adhere to the standards we were asking them to do; alternative hypotheses scored low in and documenting creating analytical judgments that were measurable; the measurability – analysts would make calls that weren't useful – what is more likely, the best or worst consequences and assessment that were measurable; this is a broader reflection on Civil Service mentality and you tend to get promoted by not making mistakes; it's a bit cultural and procedural in the way we hire and

promote people; assurance question – he waited too long that we were falsely assuming that since we were a trusted source for so long that we would go on into the future; what is China's NGA look like and how does it work, how do you know this ; the commander is trying to out think and outact the other commander; if advantage is still the outcome we have to find different ways to provide advancement from the old way

- Robert: might learn something about how they're funding proliferation; ICITE – the plumbing was all different and let's get everything integrated; the IC is more integrated today than 10/20 years ago; was at the center of the storm in 2013 of a chemical event in the Damascus suburbs, it was a social media event, he briefed the next day and the lead item was the initial assessment and got it 90% right, with attaché reporting, NSA collection, open sourcing, Obama kicked it over to Congress to vote on, he was the intel rep over at Congress; we have lots of issue with culture; we're way more integrated and will help the IC, there will still be compartmentalization
- Joe: having all coordinating info and impacting latency
- Robert: if you're the Treasury, you're not allowed to hold hostage the PDP
- Jason: the man orbital program and got cancelled because of the space program, in coupling that with the position you were in, what recommendations would you give to answer the people aspect, is there something that will be revolutionary?
- Robert: strongly believe that codes better is going to win and he or she that protects their code is going to win, it's human decisions and at the end of the day the entity that makes best use will come out ahead; we'll still stuck in 1947, we have got to go out and steal something, think of the pie chart of advantage, the entities that do better out in the open will win; CSIS report on tech in the future of intel report, it's in the theme of integration

Office of GEOINT Assurance: AI, Automation, Augmentation

What's new, what's true, what's next

He who codes better and protects better, wins.

Proliferation of private capability

Steve Zidek Interview 16 Feb 21

Director of Analysis, Government of Australia

- Team Porrima introductions
- Steve: let's talk about these issues outside Army, Director for analytics and intel, USMC as an active-duty infantry officer, Marine reserves for 15 years, looking at military doctrine how countries decide to fight, Dir for intel specialist training reserves, private sector looks at intel very different, infantry – intel –
- Greg: explains the question from LTG Potter, tech based or
- Steve: background is non-tech, his job was to put it together, Covid is a great example, QC – how did Covid start?, QC – how does an intel analyst handle that – don't think it's reasonable, might be better to deal with it as a team; QC is the game changing, can be used in cyber security ops, China has developed a cyber security system with QC; the potential applications for both good and evil, some specialties like signature mgmt., don't know much about SB, could that be used in mil ops, absolutely, BLUF, all these techs is probably easier to answer, you're seeking alternative ways to look at this problem, seeking resilience and capability, you can't expect an intel analyst to learn everything
- Kris: introducing Kathleen Moore, data scientist, refrain the questions – what is that future analyst going to do, thinking of that near peer competitor, what is the analyst in 15 years going to be doing, whose sitting in the TOC, what skills package?
- Steve: enlisted analyst is to have a data science analyst, they'll have to be trained in big data, somebody to process that data and make sense of it, data analytical skills; officers who are generalist and also have knowledge in the applications and capabilities, will have synthetic fusion teams, human and COIN, at the operational level – you need a field adaptative intel team, data science, tech deployment team that can quickly operational the data, provide the So What that doesn't have your full attention, how do you present that information, visualization is important and this needs to be added to the intel analyst; trends analysis, what are their strengths. (operational like SF team – Off., NCO, offense/defense - tech deployment team, data scientists)
- Greg: tension between the specialist and generalist, what are your thoughts?
- Steve: friction is not necessarily a bad thing, it's getting them to work together
- Steve: better to have collaboration areas, but better to go back to their specific areas, also need the time to prepare your findings, not a fan of open work areas
- Joe: GSOC, open TOC
- Steve: at the TOC level, intel guys were on the side and important for them to put data together, can be done at the tactical level, they need direction and encouragement; in the intel world, we have to do a good job on identifying their strengths and weaknesses to assess (visualization of information, predictive risk modeling, trend analysis, data analysis)
- Joe: selection criteria, what changed on the list?

- Steve: business intel in the private sector is much different from military, learning certain tools and methods, they can't communicate, a bit social awkward, looking for social skills, tech skills are easy to list (tech skills can be learned; soft skills are the challenge), the soft skills – communicate and write, and what's the so-what
- Joe: list of some of things you were talking about – comms, visual, data science piece; what would you prioritize?
- Steve: give a good assessment at the front end of all students and here's the specialist type of traffic you might be happy here, getting the specialist with the generalist side by side, exploiting the data you have and having that data scientist to analyze by applying new techniques, looking at holistically and synergizing strengths
- Kris: leadership and culture, raised the issue of career paths, how do you create and educate; what does the leader look like?
- Steve: it's really on personality, self-assessment is critical (360) – being self-reflective and know their strengths and weaknesses, humility, warrior scholar, in marines – we want warrior scholars – think of the solution don't think of the process, flexible
- Matt; communication gap, leaning out towards 2030-2035, the hyper automation of systems, are there any techs that would answer catastrophic system failures?
- Steve: the impact of tech should have viable plans and capabilities to build, EDGE computing; in Japan, can put brain chips insert in your brain to augment your thinking capability, can start reading minds by looking at images, should have that capability at the operational division, corps level; QC may make military obsolete
- Greg: as techs come online, what does human interaction look like?
- Steve: put together a simple predictive risk model to identify individuals; this is where a generalist is really needed
- Kris: the value of formal education, what are your thoughts, are we going to continue training internally?
- Steve: at the adult level is both, that's going to continue, the high school level every student needs to know data analytics – when they go to the military or college they'll know it; STEM should be big part, the analytics and the critical thinking; the private sector is playing a bigger role in propelling this cadre of well-trained individuals
- Greg: are there any other individuals or resources we should speak to?
- Steve: contact someone from the National intel council – Matthew (indications and warnings); State Dept I&R – global sessions on analytics
- Greg: if we have additional questions, can we reach out?
- Steve: Yes, of course

Greg Porpora / Geoffrey Williams Interview 17 Feb 21

IBM GBS WW Public Sector - Distinguished Engineer Cyber Security and AI

- Team Porrima introductions
- Greg: retired Navy CAPT, 27 years, specialized in weapons systems, works closely with the IC – cyber security, actively engaged with the
- Geoff: IBM cognitive analytics practice, focused on the DoD intel space, former MI officer, transferred over into the 75th Innovation Command AI portfolio (Houston office), direct support to AFC and focus on AI/ML
- Matt: trying to identify LTG Potter's question and telling her info she doesn't already know, skill set – what do MI analysts look like, those teams or different things that make them more effective and efficient?
- Greg: the timeframe struck him the most, we can't wait, the Chinese are going to clean us out in the next 18 months, they are very advanced, we have compromised supply chain, they have extraordinary capabilities and are on par, if not ahead of us
- Joe: clarifying the question, are there any evolving and emerging techs?
- Geoff: those techs are going to play a key role with how we'll do business in the future that's going to impact the analysts, the human will be impacted by these techs, the ability to crutch #s will change how we protect our information through friction and how we provide secure comms, the Chinese are showing signs of have comms bet. a satellite and the ground base station that cannot be intercepted; the proliferation of sensors within the environment, goes with signature mgmt. as well; QC is going to drive what we are able to do with ML and AI to do more with Edge devices, being able to identify the anomalies in that data and to be more effective; object recognition to track and identify them, need to start moving towards automation, we do a lot with human in the loop but other nations may look at it from outside the loop, need to be more tech savvy, the future analyst know how to code or how to use low code apps; the soldier led factory in TX and will see that trend
- Greg: end of last year, discussions with IC and noise suppression – classic case of cocktail party, noise is not monolithic but very complex, the array of UAV focus on imagery, infrared, but nothing on the acoustic realm – missing this in the operational space, no drones do that currently, an area the Army should consider; we are in a counter measure game with AI and ML in every dimension, the Chinese are working in direction and deception, they are intentionally doing this; need to learn to how to hearken those models and they're using this to shape our behavior on the battlespace, use ML to how to do ML – operating against the data; the other dimension is with the tactical edge, it's going to be a cyber-attack, you'll have to have a centralized area for analysis to operate autonomously
- Geoff: users need to be familiar with AI and ML and know what deception looks like, will see the rise of AI vulnerability of what's possible in the future to explain why the model made the decision it did; should also talk about neuro symbolic AI

– narrow apps that have a very clean eye – and combined with neuro nets that can adapt to a greater number of tests and is in the early stages

- Greg: with the SolarWinds attack, they defeated us on every dimension, FireEye (accidentally) detected this and certain they didn't catch it all, worked on the ability to catch signal in a high end environment, they have a spectral signature, over the summer took the malware and encrypted it, you can see the battle electromagnetic spectrum, they use space blankets and seeing their heat signature, look at acoustic and check multiple spectrums simultaneously
- Kris: neuro symbolic AI – what do you see as the intersection and the emerging world of brain computer interfacing, curious as to what you're thought are, is there a nexus there?
- Geoff: he's not involved in the neuro symbolic AI research, knows there's a lot of companies that are working on human brain computer interface, Elon Musk is working on that, being able to reason on that computer vision, doesn't see a nexus
- Kris: human like reasoning process and the other to talk to a computer, where are these techs going to converge in this 15 year space?
- Geoff: we know that if you are recognize, you can see that recognition in the brain and similar if you train the model to recognize a car in full motion, you want to do more than recognition, the ability to better train models, one thing that has been difficult is how to train models at scale, something new can be easily recognized, for computers it can be difficult, computers need high quality data
- Greg: 3 core components – the contextual, geospatial and ?, the fourth is relevance, the other dimension is deception and misdirection, deception is to exchange something for something else, misdirection is to look for something else
- Kris: there's a need for data scientists to have forward, not enough ways to train them, where do you see low code and no code modeling go?
- Greg: thinking about a MAC, when PCs first came out, you had to be a network engineer, all the complexity has been abstracted out and can use quickly, same with ML, we need to use deep learning to know how to do deep learning
- Geoff: the 18 year old that's going to forward to perform trend analysis, apps should be able to pull that data and how we automate that data to visualize that data, the 18 year old has the tools at his fingertips, the tools augment the data scientist
- Kris: question is how fast is that going to come of ML for enlisted to use?
- Greg; the tech is already here, we not applying it
- Kris: Microsoft has the Lobe software, is there anything else, who's the Steve Jobs of ML?
- Geoff: as companies focus on these techs, they focus on commercial apps because that's where the money is, it's another story to get on SIPR, JWICS; companies are starting to do that
- Matt: mentioned the tactical, what is your vision of corps and brigade and above?
- Greg: There's different echelons and Edge
- Geoff: need to think about all those sensors that provide information; Elon Musk launched low earth orbit microsatellites into space to provide internet connection to the community and collecting data, going to start see non-state actors

- Matt: unless they purchase it individually
- Greg: the edge is multi spectral, wants full spectral capability
- Matt: get more tech down to the tactical edge, do you see the gate to reduce the need for higher echelons, need for less folks?
- Greg: lower echelons have geospatial constraints, at higher echelons they have a strategic/global space
- Geoff: as we reduce the burden the higher echelons may take on roles in other areas, may see that shift happen, intel analyst compartmentalize and focus individual, they don't have the larger picture, if you have the myopic focus you have a larger edge; AFC is looking at can you develop models that can automatically match resource needs with the ability to attack and automate that process
- Joe: Machine in/out of the loop, human in the loop is basically to overcome, how long will human in the loop will we be contending with and competitors w/o the loop?
- Geoff: yes, it can be used as an advantage, if human is out of the loop there's no one to identify that model is now off course, always better to have human in the loop
- Greg: uncertain if we will ever be able to train a true AI, shaping the adversary – misdirection while I move other elements or perform other activities
- Joe: when can they use that stop gap to use AI?
- Greg: hard to predict, tech today is extraordinary and will happen sooner than later, next 5 years will look nothing like today
- Geoff: have a border where you don't care about casualties, have no qualms implementing a model and taking the human out of the loop (other nations may not have the same issue with humans out of the loop – from US perspective – risk of deception and misdirection seems too great)
- Greg: having the humanin the loop is so critical, it provides that ethical employment in AI (humans – from a US perspective – will always be a part of the system / fine tune models)
- Geoff: Geoffrey.m.williams1.mil@mail.mil
- Jason: find it fascinating with the acoustics and the other spectrums, the CO2

John Zuur Platten 18 Feb 21

Niantic Labs – game designer

- Opening comments (were an ongoing discussion with John and Kris)
- Team Porrima introductions
- John: Initial response to base question – tech will be more mobile. Augmented reality (defied as the world you know and see with additional information overlayed) over virtual reality (deception of whole). Further explanation – 3D TVs – why did they fail? Technology was fantastic but failed due to one simple factor – having to have physical glasses to participate in the experience.
- Q: What companies are looking at AR?
- John: Niantic Labs, Apple, Google, and EA. Entertainment arena: Jurassic Park, Harry Potter. Projects full mass market of AR less than 5 years away. Retail applications currently exist and are in use. 10-15 years out – seamless augmented applications (example – heads up displays from phones transitioning to car screens/windshields). 20 years – sees implants beginning to be more realistic/applicable. 50 years – implants for full immersive experience.
- Digital assistants – Improvements with crowd sourcing and machine learning
- 10-15 years near seamless communication at all levels. Widely dispersed robotics and manned information. Man portable robotics with advanced sensor capabilities that feed to networked HUDs.
- Q: Alternate communication networks?
- John: Ability to code and decode communications will be critical. Speed of encryption and network security will be key jobs in the future. Even if the advantage is momentary, will need to outpace adversaries (minutes, seconds, nano-seconds). 5G bandwidth and latency currently does not support this. Believe true "real time" speeds will not be seen until 6G or some alternate.
- Q: What role does a digital assistant look like in the future?
- John: Humanizing the digital assistant to create emotional connection is critical. Several examples of humans rejecting digital voices/images – personalities matter and characters matter. Digital immortality – available today – however becoming increasingly more advanced. Deep fakes currently in use and supported by audio and video. 10-15 years deep fake and digital immortality will enable continuity on the battlefield and will be widely available (most technology - no bar to entry from use friendly/enemy/other). Will potentially be further aided by BCI, but just another additive piece to the human element.
- Q: What's next?
- John: VR – not until you can get rid of the headset, obscures observables – training and familiarization most likely. AR – most promising as it is sensory additive. Real-time translators enabled by digital assistants – humanizing the winning of hearts and minds portion of fighting wars.
- Q: Who else should we be talking with?
- John: Flynn (?) DARPA; Jeff Hardy (?) Tech.com?
- Yes : contact again/follow on questions

Cameron Bajus Interview 24 Feb 21

Muse Games – game designer

- Team Porrima introductions
- Cameron: studied game design, hire out of college and working for them for 2 ½ years, level design – more player focused, has to keep the aspect of the tech available so they work in an optimal way, also discuss emerging techs
- Matt: the optimization – save question for later, game design, are you familiar with low or no code tech, developing the algorithms?
- Cam: have visual code programming, traded as traditional coder, making small artsy products,
- Jason: is visual coding more in depth?
- Cam: blocky is an introductory area
- Joe: visual sounds like low/no code, can you provide expectation mgmt., can you design games that are complex?
- Cam: works in a game engine, with visual tools there a bit more onboarding involved, programmer support is important and can specialize them more
- Joe: still need a coder to start the process?
- Cam: yes, to get creative you'll need a more traditional coder to support
- Matt: similar to modularity – reach back capability will build essential modular cubes and forward individual can put it into sequence
- Cam: coder and designer can work asynchronously,
- Matt: talk to other that mentioned language, you could code for it to look for what you want?
- Cam: that's a less exotic thing, diff. for searching the word – not unique to low/no code
- Matt: What do you envision for augmented reality and virtual reality?
- Cam: more focused on VR, but the other side we're interested in is bringing existing tech, VR requires equipment/hardware and ? doesn't need the hardware, the US infrastructure isn't up to par with east Asia countries, the google stadia I'm familiar with, keeping up with google buffers; the VR pin is how does the game space change – there's a limited workable space, star wars ex-wing fighter pilot game might be useful for us, VR games will lean away from games of today
- Matt: looked at augmented reality, the eyeglasses, will the mil intel analyst of the future to use them?
- Cam: that's pushing the limitation and ability of processing and moving data, the tech is expanding faster than the data, the data processing isn't there
- Joe: latency problems, what else does that enable?
- Cam: more focused on home computing than can speak to 5G/6G, our concern is how we able to picking it up soon, the average consumer has no problem, the intel analyst will need the 5G/6G for his headset, don't anticipate the tech anytime soon
- Matt: AR/VR thread more, emerging techs that excite you with AI?

- Cam: techs are emerging, human augmentation isn't feasible in 10-15 years, for a cochlear implant or brain stem to interact might be in the early stages but wouldn't consider it anything to safe
- Matt: EEG headsets, used term fully immersible experience – glasses, contact lenses, sounds, smells; predicted about 50 years out?
- Cam: the side effects are questionable, the Killer app – the thing that gets people to adopt a new way or platform, VR hasn't had that platform
- Joe: background in python – is it a fairly teaching time? What's the time length?
- Cam: python is an easier, don't use it for games because its slow, we use C+ and C++, use C sharp and converts it into C++; python unknown the length or ability to convert
- Jason: high fidelity stimulation for medical training, your experience at gaming conferences, is there something they do at that level, natural skills?
- Cam: design of these games, collaborative effort, they discover the meta of the game, found and pushed collaboratively, push the new way of playing the game to the limit
- Matt: C+, C++, C Sharp – momentary competitive edges, security and encryption is built into systems
- Cam: put very minimal into ours, other games are competitive and don't want people messing with the code, peer-peer connections – all the game is running on the person computer whereas the peer-server connection it limits the ability to change the system
- Joe: any tech that'll break future?
- Cam: VR and game streaming, the 2 most promising especially with outer hardware; there's game literacy – intuitively know how to play games
- Jason: reference for VR expert?
- Cam: doesn't know anyone in VR development

Canadian Forces Intelligence Interview 24 Feb 21

Rear-Admiral Scott Bishop, Chief of Defence Intelligence (CDI) and Commander of Canadian Forces Intelligence Command (CFINTCOM); and Madame Marie-Hélène Chayer, Assistant Chief of Defence Intelligence (ACDI) and responsible for all strategic defence intelligence production in the Department of National Defence (DND

- Team Porrima introductions
- Marie-Helene: responsible for assessments for global and regional trends, recruiting and training of analysts
- Rear Admiral: graduate of naval WC, naval warfare officer, rabbit consumer of intel, been in current position for 5 years, in process on big effort defense intel env and how we work in the future, we're not leveraging tech effectively and have a lot to do, need to completely reimagine how to work in the future and how tech will integrate, knows LTG Potter – critical intel, season tickets to Penguins and Steelers, pass on greetings
- Greg: about mil analyst and what you see them having to do in the future, 2030-2035
- Marie-Helene: it depends, there will always be a lot of variety and tools that will need to be used, don't think the work will change that much, incorporating more techs, but it's hard to incorporate those big machines – to buy, train, and operate; seeing incremental changes, hope to use data analytics and AI more than now
- Rear Admiral: the US moves at a different pace than in Canada, the way tech is going and how we'll be using it, in the distant future and what are our outputs going to be, now – writing assessments
- Marie-Helene: mil intel analyst work is so wide
- Rear Admiral: customize the work-set, AI techs will be integrated, the DM wanting to be able to pull AI and their decision support tools to make decisions at the tactical level, using data to produce assessments, but need to procure data to , should think about the future state and what the customer wants and how we approach that
- Marie-Helene: need to think about tech and how do you acquire that data, trust the individual providing the data, will you need a human to shift through
- Rear Admiral: with the pacing of tech, we find that with emerging tech there are significant policy issues, thinking about charters, rights and privacy; some techs get our policy and legal folks excited
- Marie-Helene: recruiting and train analyst
- Rear Admiral: need to think about with techs on how they provide the feedback, when meeting with FVEYS – do you use the assessments? are we writing about what you need?; useful assessments and integrated with techs; being about to leverage AI intel would be helpful; tech will give us the ability to be amazon or google of intel and may drive us to use other techs
- Marie-Helene: the timing is important, there will be disjunction as we won't be able to fill the gaps as the US

- Greg: emerging techs, is there any other not on the list be to more efficient or present data in quicker and concise way?
- Rear Admiral: possibilities are endless
- Jason: understanding the requirements of your customer, is there a process that you have looking back historically and confirming the accuracy, such as a learning type of organization
- Marie-Helene: there isn't a tech in place, there are diff. exercises, usually asking an individual coming in and assessing our intel, it's not enabled by tech and could be part of the performance assessments enabled by tech in the future, the exercises are a huge undertaking and assessment all aspects is difficult to do considering how big it is, having tools would be able to apply assessments more quickly esp. on areas to improve
- Rear Admiral: using probabilistic factors are being used
- Marie-Helene: it's likely this regime will fail or it won't fail, difficult to do an accurate assessment
- Rear Admiral: having tech could help with an on-going basis and would reassure clients
- Greg: big data, interested to know will that change in what you look for in an analyst and what are the skills
- Rear Admiral: the tactical level they need to understand how to manipulate data, infer data, use data, and think that'll be a requirement for the intel enterprise at large, need people with diff. kinds of skills set, struck by individuals that build their own tool sets versus using what's provided
- Rear Admiral: big focus is leading to more integration of people and skill sets, diff. levels of expertise and throw them together to work, all the 'ints' integrating together, private and health sector is doing this now, need to think how we build the interdisciplinary teams and how to get to the questions we're trying to answer.
- Kris: don't see intel analyst doing fundamentally diff. things, put on imagination cap and look at the TOC of the future and what do you see, specific to intel, skills and techs that you see
- Rear Admiral: despite focus on tech, more emphasis on people, still have analyst in the TOC and supported with new tech, think in the future google assistant show me the red forest disposition, use google and AI driving the rapid analysis, people and tech will be there; who's going to curate the data the AI is pulling and how human will be involved
- Marie-Helene: data visualization needs to be worked on, we have access to the data and write assessments, take AI data and product visual product
- Kris: emerging techs, talked to Hollywood movie producers, we won't have TOC, 6G/7G will be in place and hyper reality will be in place
- Rear Admiral: thinks it's entirely possible, the reluctance of reach back, strategic intel, we're already reaching back and working on support for field commanders, as long as the techs are mature; land forces and comms about being in conflict with a cap adversary – how do you get more distribute and how do you become a harder target

- Kris: near peer competitors, C2 will be degraded, how does reach back that change in the C2 degraded env and what do we need to integrate with techs
- Rear Admiral: need to design the reach back capability built into architecture, need to be prepared to lose things for a bit and resilient to obtain it back
- Joe: talent mgmt. future of having google asst, what do you put on that human analyst vice what do you expect tech to handle on their behalf
- Marie-Helene: how do you recruit and train – you need to hire someone that is curious and open minded, read beyond, be open to know there are tools out there and to leverage those tools, not completely a geek, more of a generalist
- Rear Admiral: have conversations with analyst and they embrace techs, underlying fear of tech and what their place will be, the human analyst will always be needed, take co off their plate, talking talent mgmt. and think about what the value-added insight is helping in talent spotting, need more diversity in analyst then we have, ethnic, gender diversity; all the same doesn't provide much diversity; expand to multiple lenses
- Rear Admiral: using social media info, created his own bot for the kind of info, he understood how the social media worked, will need people that are savvy with techs and that's what we want to see; crowd sourcing intel and we're looking at how do we leverage latent capacity in our workforce, esp. in Reserves – part of enterprise renewal

Chris Pallaris Interview 4 Mar 21

Director, i-intelligence, Zurich

- Team Porrima Introductions
- Chris Introduction: Started career at Price Waterhouse doing fraud investigation, Swiss Federal Institute of Tech, Security Dept of Foreign Affairs, last 10 years working as a consultant for his own business, clients range from multinational to small range businesses
- Kris: Know you've thought about the broad part of this question and understand you have a strong opinion about the tech aspect, you have a global view of this problem; we've talked to a wide range of people on this problem, trying to triangulate on this target
- Chris: Started sketching out a few ideas, sharing screen, approach he took was based upon his definition of intelligence, intel analyst of the future is interested in being surprised, fall victim to confirmation bias, look for info, has to be a learning machine, trained; intel is the conscious deliberate mgmt. of the uncertain, embracing the ignorance; an analyst is paid for what they don't know; intel is any item of info that lets you make a good decision faster – liken it to people who read the NYT every morning; good intel doesn't appear as a package; there are a series of techs we're looking at and put together ideas of what he thought and these techs are in their infancy, very experimental; what significance will they have
    - Quantum Computing (QC): the big deal is that info can be expressed as 1 and 0s, challenging to put QC to work for analyst as it will challenge our fundamentals; in theory, model multiple states to determine the multiple actions; haven't seen anything that says this is going to viable
    - 5G/6G Comms: significance is the speed with which we can move info around, will have greater redundancy, not relying on a single architecture, lowering costs, believes it'll accelerate the adoption and deployment and exploitation; enable ops – accelerated data collection, greater op security as will adversaries, use of autonomous techs, improved simulation techs (Virtual Reality - VR), more tech advance the more the target can infiltrate – will require radically new skill sets; enable understanding – effective use improved the information signatures of adversary targets/infrastructure, can harvest info from them, improved target profiling will have highly centralized understanding of your target, improved signals and better analytics, need people that will interpret that info
- Greg: work on sensors, utilization of sensors and wearable tech and the convergence of those platforms into Machine Learning (ML) and decision support system giving us an understanding of the battlespace
- Jason: broadband covered, with 5G that's really the cellular wireless and there's talk about how it's going to help, is that because of a convergence in that area or a shift?
- Chris: yes, it's more efficient, he has a rule of thumb that all techs will become more efficient, called the "Pallaris rule of thumb"

- Chris: Synthetic Biology (SB), knows the least about, development of new materials, utility of technology; can use to develop new materials, more env tech modeling and intel, intel on the fly; enable understanding, if we can model systems, we can better understand them, understanding Complex Adaptive System (CAS) can integrate one or more variables in simulated environments, the number of variables to factor in is considerable and can impact the environment
- Joe: how do you think SB is going to improve predictive intel?
- Chris: humans can replicate across different systems and we can try to model them in different environments, can we simulate a cities behavior when attack by cyber, can we simulate a neighborhood by a pandemic, looking at diff variables and how they will perform over time
- Chris: ML – assume process to continue in this vein and greater operational efficiency and cost, stress there is one activity that cannot be eliminated is the mgmt. of uncertainty in an intel env., the more ML we throw at the problem and we can solve the problem but this isn't accurate, can use ML to automate but cannot eliminate uncertainty, can have improved target profiling, social and societal engineering, data verification and validation, and vulnerability discovery and analysis; if the algorithms target the weapon this is the optimal approach; should improve our capacity for misinformation, disinformation, message amplification, public information; improved behavioral modeling and prediction, improved language processing leading to better use of foreign language media in your intel gathering
- Matt: agree with greater operational efficiency, 2 questions, you alluded to training, do you see a shift how they will be analyst of the future will be trained and will it be possible in the range of 2030-2035.
- Chris: to be an analyst you must have a higher degree of digital literacies – that won't wash, if tech is driving the intel analysis, then they need to know how to operate the system, would rather have tech literate people that are rounded in history, anthropology and put it all into context, if literate, but context literate is a problem.
- Matt: describing fewer people being more empower, how do you envision the TOC and their interaction?
- Chris: flexibility is the watch word
- Kris: what is the min viable cell in that env, take only 2-3 people what would they look like?
- Chris: take my queue from Lawrence of Arabia – sensitivity to the operational environment (OE), all the techs will not help you, the most power tech in his time was his brain, if they can exercise critical thinking, empathy, having empathy creates opportunity to operate against them; is it resilience, resourcefulness – if you don't know how to use tech effectively it's a brick in the end
- Joe: digital literacy, what does tech take off in the current curriculum?
- Chris: will talk to that shortly
- Chris: signature management (SM) – use of tech to profile assets / targets in the battlespace, the careful study of the profiles of those individuals, that did take a lot of computer power, needed to understand the language, natural language;

challenge is do we understand the target well enough, even crypted info has a signature; improved; improve understand leads to improve

- Chris: the mindset/skillset/toolset (see Pallaris Analysis document)
    - QC – twilight of binary thinking, the challenge of managing fake news so difficult, we should study it, you can't eliminate fake news, we must be infinitely more tolerate of ambiguity – ability to integrating info; if successful will upend the laws of physics and information; irrational reasoning; need the ability to classify and reclassify targets and assess their value, the analyst no longer works to establish the truth but rather to manage and manipulate the states of mind
    - QC skillsets: the analyst is operating in multiple environments, better capacity of pattern, signature and anomaly detection, a quantum state is never static, by virtue, you will elevate customer expectations, analyst will have to have good interpersonal and communication skills
    - QC toolsets: need better data processing, real-time, multi-variable correlation and analysis, new tools and frameworks to support structured analysis, and information energy weapons
    - 5G mindset: need to think of a multi-role analyst, don't compartmentalize the analyst, but need to go further with information, given the speed of information we need to rethink, info overload is an operational advantage, if everything is connected then everything is target, need to significantly rewire how we approach the target, whoever can tell a better story is going to win
    - 5G skillset: if anything is connected it talks, the ability to retell a story on the fly will need to be able to tell a compelling story, if you have a DM that can't decide the story will continue to change and need to provide a counter narrative to support that, the narrative (center of gravity) training, ability to corrupt the attention of the adversary – the ability to focus the skill is important
    - 5G toolset: automated systems for collection
    - SG mindset: nee a capacity for systems thinking, how that system drives the behavior of an adversary, need to think in scales across system boundaries - too many analysts lack this ability, need to think in terms of causal loop factors – relationships bet. entities, networks; all models are useful, and some models are useful some of the time
    - SG skillset: understanding systems modelling
    - SG toolset: stealthy
    - ML mindset: think of playing with diff. variables in your env
    - ML skillset: need to be able to problem identification and analysis, important that supports the information literacy is necessary as a skillset for intel analyst
    - ML toolset: target simulations, scenario development
    - SM mindset: better anthropologist, people that can think like anthropologist to make effective use of the signatures you're picking up, in the OE they're willing to sit and start with the signals

- Chris: comfortable with the OE, think in time and understand where they stand in relation to the events they are located, they need to bring to bear a rich mindset, skillset and toolset; training is important as a part of their job description, discounting the human and compounding the tech; more demanding of the people you let into intel – start in secondary school – scoping early on – training early on; need to start at the high school level and plugging the gaps, need to be literate of Microsoft office out of high school; building strategically and start educating them young; enlighten them of what a front-line env will be like and what's happening globally; kids needs coding skills and important to learn/understand geography – gives them a capacity to think – introduce concepts and ideas that work earlier on in age; have to tie these techs in relation to Clausewitz's trilogy (people, military, and govt); need a radically diff. approach and central to this is information and the analyst is the most important aspect of the system, we collect most information through our 5 senses; need to cultivate those other senses – history, extensive networks and the analyst will be used as a weapon
- Chris: some things remain constant and how the tech affects the conduct of war – rethink the curriculum for education.
- Matt: Are we able to reach out if there are any additional questions?
- Chris: Yes
- Kris: thanks, the time and effort; couple of quick questions – do you think a good analyst is born or made?
- Chris: MADE – a good analyst is trained over the years; the army training methodology – you can train to be a better analyst – it also touches on nature and nurture, also talks about readers, people that are bookish – processing is jumped over because it's boring, time consuming, heavy lifting; analysis should be a graduate program
- Chris: take your cue from the French – that individual is still an asset of the state

Enabling Operations

Technology	Significance	How Does it Enable Operations?	How Does it Enable Understanding?
Quantum Computing	• Improved system modelling and analysis • Improved simulations embracing multiple actors, agents, variables in a hypothetical battlespace • Improved machine learning	• Faster code breaking • Secure communications • Faster data processing • Improved target modelling and profiling • Improved targeting / impact analysis • Improved scenario modelling • Improved course of action analysis • Greater security via improved intrusion detection / quantum key detection	• Quantum sensing / metrology leads to improved measurement accuracy of specific phenomena or adversary assets
5G / 6G Communications	• Faster speeds • Lower latency • Greater connectivity • Distributed / decentralised systems • Greater redundancy Lower operating costs • Accelerates the adoption and deployment and exploitation of related technologies including: o AI and machine learning o IoT / IoMT / IoBT o Commercial and battlefield specific sensors	• Accelerated data collection, synthesis and processing • Greater operational security / communications security • Improved use of autonomous technologies / collection agents • Improved simulation technologies • The more technologically advanced the adversary, the more entities one can target and exploit • Possibility to co-opt adversary sensors and technologies	• Effective use of sensor technologies improves the information signatures of adversary targets / infrastructure • Improved target profiling • Highly localised understanding of target environments • Improved SIGINT and COMMINT • Real time analytics • High definition images / video
Synthetic Biology	• System modelling • Development and deployment of new materials • Biological computation to study complex systems • Deployment of biosensors to the battlespace	• Improved systems modelling • Improved vector detection / target profiling • New materials, composites with intelligent surfaces • Improved environmental intelligence (ENVINT) and modelling • Improved cloaking materials / stealth technologies	• Complex systems modelling and simulation • Manipulation of one or more variables in simulated environments to improve predictive intelligence
Machine Learning	• Algorithms that improve through learning and experience • Ever-greater operational efficiency • Improved problem / anomaly detection and resolution • Reduced labour / operating costs (in theory)	• Improved target profiling • Improved social and societal engineering • Improved data verification and validation • Improved vulnerability discovery and analysis • Automated operations / custom attacks • Improved information operations	• Improved target profiling and analysis • Improved pattern recognition • Improved behavioural modelling, analysis and prediction • Improved natural language processing leading to better use of adversary media in routine

	• However, learning is always proportional to the quality of: o Available "training data" o Access to the learning environment o The human operator	o Misinformation o Disinformation o Message amplification o Agenda setting o Deep fake media • Improved capacity for simulation	intelligence / information operations
Signature Management	• Effective use of sensor technologies to profile assets / targets in the battlespace	• Improved targeting / target profiling / behavioural profiling • Improved surveillance / countersurveillance • Improved intelligence exploitation • Improved signatures allow for more nuanced approached to deception • Greater detection of anomalous trends and behaviours	• Improved SIGINT / COMINT • Improved signature tracking of specific entities / targets (ENIGMA) • Improved target monitoring and reporting • Improved modelling of information / psychological operations

Intelligence Impact

Technology	Mindset	Skillset	Toolset
Quantum Computing	• The twilight of binary thinking (intelligence can be good / bad or right / wrong at the same time) • Ambiguity tolerance • The arrival of opposable / integrative thinking • Superpositional thinking (acknowledgement that two states create a third, which is equally legitimate) • Irrational reasoning as a legitimate analytic pursuit • Truth becomes a variable commodity • Ability to classify / reclassify targets and assess their value, and the ethical implications of attacking them • The analyst no longer works to establish the truth but rather to manage and manipulate states of mind • The management and manipulation of paradox as a strategic advantage	• The ability to navigate / exploit parallel environments (physical, digital, cognitive, etc.) • Hypothetical reasoning • Opportunity identification and exploitation • Decision modelling and decision making • Pattern, signature and anomaly detection and analysis • Management of decoherence – loss of information resulting from changes in quantum states • Workflow optimisation • Elevated customer expectations; which in turn will necessitate better customer management • An entirely new cadre of intelligence leaders • Strong interpersonal skills • Strong communication skills	• Data processing • Realtime, multi-variable correlation and analysis • New tools / frameworks to support structured analysis • Information-energy weapons
5G / 6G Communications	• Multi-role intelligence analyst (media monitor, curator, analyst, communicator) • Information overload as an operational advantage • If everything is connected, everything is a target • If everyone is connected, everyone is either an intelligence agent, a weapons platform, or a target • Spatial thinking as a prelude to intelligence targeting • Narrative / storytelling as an instrument of war	• Identification and exploitation of digital signatures; if it's connected, it talks. If it talks who is listening and what is it saying? • Counterintelligence • Digital security • Quantitative and qualitative reasoning • Statistical reasoning • Narrative framing / reframing • Counternarrative development • Schwerspunkt targeting • Critical node detection and exploitation • Bandwidth analysis and exploitation • Attention corruption	• Automated systems for collection, processing, visualisation and analysis • Improved systems to support sensemaking and situational awareness
Synthetic Biology	• Systems thinking; an ability to see systems as	• Systems modelling	• Stealthing / unstealthing technologies

	causes rather than objects • Forrest thinking • Thinking in scales (local, regional, national, global) • Boundary thinking / mapping • Integrative thinking • From straight line to closed-loop thinking, i.e. viewing causality as an ongoing process, not a one-time event • Relational analysis • Scientific thinking; all models are working hypotheses with limited (i.e. time-bound or context specific) applicability	• Systems targeting – functional or hierarchical systems • structural systems that inform decision making • interpretive systems of systems stakeholders • Variable mapping / modelling • Indicator mapping and modelling • Quantitative / qualitative analysis	
Machine Learning	• The machine as customer and consumer of intelligence • The machine as the final decision maker • Algorithmic thinking (e.g. in the form of if / then variable modelling) • All intelligence requirements are approached as problems to be solved. • Abstraction and classification as tools to support modelling and data discovery • Code / machine dependence can dull our thinking • What machines learn is not always relevant. Even if relevant it may not be operationally useful. • Contextual ignorance dulls the intelligence value of machine learning	• Problem identification, analysis and solving • Conceptual thinking and modelling • Operational thinking – understanding how the algorithm works and how that informs what we do • Source discovery and exploitation • Data processing and optimisation • Data management • Workflow optimisation • Quantitative / qualitative analysis • Elevated customer expectations will necessitate better customer management	• Tools to support: o Target simulations o Scenario development o Course of action analysis
Signature Management	• Everything talks; are we listening? Are we listening to the right signals? • Every entity / surface is an intelligence object	• Linguistic, cultural, digital anthropology • Attention as a competitive advantage • Target modelling and manipulation • Opportunity modelling and exploitation	• Tools to support: o Data collection o Data collation o Target profiling

Clausewitz's Trinity

Technology	People Primordial Violence	Armed Forces Chance and Probability	Government Policy
Quantum Computing	• Social perceptions as a target / instrument of war • Manipulation of public states / traits through manipulation • People are the key variable; control of the public is necessary before conflict begins	• Victories are won / lost before combatants take to the battlefield • All plausible probabilities / variables anticipated; the computer determines the most favourable outcome • Chance eliminated; paradoxically, opportunities created all the time	• No government is ever fully legitimate, so no policy is ever fully rational or worthy of support
5G / 6G Communications	• Anyone with a cell phone is a legitimate target • Any sensor / connected device is a tool for engagement	• Fog of war will thicken • Too much information may stunt situational awareness and impact decision confidence	• Government policy is equal to its narrative capacity • Control the narrative and you control the government • Isolating one's systems and structures may make them more vulnerable. AN attack on these wil not impact your own infrastructures
Synthetic Biology	• A target's attractiveness is equal to its systemic properties • A target's intelligence potential its equal to its absolute level of connectivity	• An army's intelligence capability is equal to: o The surface it wishes to attack o The total surface of the force it wishes to deploy	• Government authority is equal to its systems of control • Delegitimise those systems to facilitate military outcomes
Machine Learning	• Humans are predictable and thus exploitable; the more we know of them the easier they are to target, manipulate into behaviours that run counter to their interests	• Technological dependence erodes individual capacities for opportunity identification and exploitation	• Government policies can be anticipated, analysed, modelled. Consequently, dependent variables can be manipulated to ensure the favourable outcomes
Signature Management	• The public is the single biggest information surface • Ergo, it constitutes the biggest surface for exploitation / attack	• Increased risks of artificial signatures undermining targeting and analysis • Risk too that we become dependent on passive approaches to signature detection and management	• All policies have an information signature. Thus, all policies can be manipulated to an adversary's ends

Issue	Considerations
Evolving Technologies	• Does a technology have to be "advanced" to be effective? • STI / strategic foresight and as army-wide capabilities
Military Intelligence Analysis	• What constitutes a military threat? • What will be the nature of conflict in 2035? • Who / what qualifies as a legitimate target?
Near-Peer Threats	• What if peer capabilities exceed our own? • How do we fight a foe whose technological competence exceeds our own? • How do we fight a foe whose technological immaturity is a strength?
Time Sensitivity	• How do adversary cultures perceive time? • How do these perceptions challenge our own? • How might our perceptions undermine intelligence collection / strategy?
Complex Environments	• Which environment(s) are we contesting and why? • Complexity as absolution for analysis and action • Clausewitz's centre of gravity remains just as relevant

Dr. James Brekenridge 5 Mar 21

- Introductions of team
- Dr. James Brekenridge – AWC provost for 4 years, previously at Mercer w/ Kris
- Jason / James - Discussion on Team Porrima
- Kris – discussion on team project and number of interviews
- Jason – listing/discussion on previous interviews
- Kris – what we are interested in from your experience is what does the future intelligence analysts look like 15 years from now, what skill sets do they need – are they created or how does that occur? Trying to triangulate the problem for LTG Potter. Wanted to provide that background.
- James – past – present – future and what the future analyst may look like and where they'll come from. Past – discrete and idiosyncratic pipelines. The national, business, and security/law enforcement communities have a need for these types of analysts. They overall seek to reduce uncertainty. General skills – robust collection, analysis, producing skills. Deconstruction of a requirement – typically analogue – was largely trainable. Example – if an individual went to a company (say Exxon) their education level and ability to read essentially made them qualified. Largely it was accepted that with basic skills the individuals could be trained.
- Present / future – the national education system has not equipped current individuals with basic skills that were previously presumed. They lack the necessary background to do basic analytic functions. Technology can assist but does not tackle the core issue which is the technical background and experience. A sensor will not be able to overcome the technical shortfalls. Contextual background is like what we look at for war college students.
- Jason – If it's an educational issue, that we cannot directly impact from a military perspective – do you feel it's possible to reach out from a game perspective?
- James – Agree – DoD will not be able to solve the education problem. It requires them to be more aware of the skills or lack of skills that individuals are arriving to you at. If you don't know where you are (or what they do or do not know) you do not have a roadmap to produce the skills, you need. If individuals are not able to communicate what they do and do not know – the challenge is teaching basic math, statistical, and other analytic skills. If they are not going to arrive with these set of skills – the DoD will have to invest in identifying and training to each's needs. Recruitment efforts will likely need to fundamentally change at the lowest levels. Example of Russia and space race – new math, foreign languages. Future analysts will need to be equipped – maybe the future analysis is not an American citizen? Maybe we outsource the requirement and recruit and train the best talent? Example – Coceria (?) – large number of initial participants, reduced by self-selection and then rank-ordered. At the end of the selection process the varying demands from the top down. OR the DoD solicits the private sector and pulls from experienced analysts there.

- Joe – CM / UT – academic partnerships – is that a solution?
- James – Higher education is a little behind how it educates its students, but the DoD could leverage partnerships from the education relationships and tailor some of those skills.
- Joe – Training platforms focused on what gaps to address.
- James – Cyber and safe space – training and generating likely does not work at the AIT model (basic training, etc.). Likely more experienced and skilled individuals who have worldly experience.
- Joe – A more DA Civ or contracted type measure?
- James – That may be a way – bringing on or changing how intel community is managed.
- Jason – CH, Drs, SJA – managed differently – is that a possibility? Paradigm shift as who fills the role?
- James – Deployments in the future will be different – look at individuals flying drones in AZ – you solve all types of problems by altering how these individuals are employed. The analysts who want to fill these roles will expect something different, be employed differently. Otherwise you'll end up with the 11Bs who happen to be a little smarter than the others. Platforms and sensors – are great, exquisite – but are not going to solve the human aspect.
- Joe – Crowdsourcing as a diversity mechanism
- Kris – example of fiver and how capabilities are being outsourced – freelancing platforms. Not necessarily having to have specialized capabilities
- James - Talent management and education piece – gives you an extraordinary advance. Chinese and Russia are also not able to do it because of a host of reasons. If we are going to compete at that level we will need to leverage partnerships. Chinese will outpace us on the technology spectrum, but can not compete with us on the talent management portion. How gender and ethnicity is employed – how we are able to recruit and leverage skills with partners.
- Joe – Chinese / Russia – talent management discussion.
- James – Russia is more of a regional concern than a global concern. Russia has its own cultural concerns that we don't. Yes, we have some baggage, but we can recruit from all over the world. If we can get past our immigration problems, we can gain an extraordinary advantage that no other nation can mine.
- Joe – gender / ethnic inclusion
- James – We have less of a problem bringing in female analysts than other countries do.
- Joe – language / cultural reference
- James – I believe that is true. It is fine to know the language, the cultural and historical piece is critical. Let's take the technical analyst and they are much more on the technical side. The degree to what they need to be skilled in liberal arts is questionable. Much more will be required of them on the STEM side – less on the "arts" side.
- Kris – do you see anything the current analyst is doing that will go away?

- James – yea, I think the emphasis on certain areas of "the diagram" will change. The analytic and production piece will be interesting. There may be less emphasis on collection as systems fill that role. On the analytic side of the house, that will require more emphasis – not sure exactly what that will look like. But that is where the literacy skills become more critical. What is going away – more of the analog and collection. May be fewer individuals that require clearances (TS). Classification systems that do not support the current need.
- Joe – humanistic desire to have a physical being next to the CDR – generalist if you will
- James – yes at the operational and strategic level – yes, we will still have those individuals.
- Kris – how do we find the unicorn?
- James – the unicorn may be too ambitious, but we know we should be able to produce an inter-disciplined individual who can fill most of these roles. The AIT solution is not it.
- Joe – do we split the baby? Two job descriptions?
- Kris – the industrial side has split the two – tech and (?) who is the guy that fills the highly skilled side of this (analog)
- James had to go – cut short.

GEN Michael Hayden Interview 9 Mar 21

- Introductions (Joe, Jason, Bernice, Greg, Matt, Kris)
- looking out 15 years and what will the Army intel analyst look like and what techs may they engage with
- GEN: first, it's the meaning of truth and he's worried about truth, from an intel officer is knowing the truth, it's very important; misinformation is a problem (Trump); wrote 2 books, Meaning of Truth for Intel Officers – first book was a bestseller and the last one was as well and the 2nd one is more important; "IDK", things are different now, for me I wanted to see something about Korea, I read about Korea – the same with the Balkans, sometimes we don't think we do it so much; throughout the week, you want to read more and more; you've got a lot of things going on and you have to know what's going on broadly – 10 years ago, in the Middle East was going crazy, well perhaps you should have said something about it, Pres Obama asked what's going on and I'll look around; for last 2 years, people would come to me for dinner, academics and so-on, and would ask what do I think;
- Joe: truth was a major focus, spoke of the kill chain and the intel analyst is being removed
- GEN: he doesn't like that at all
- Joe: what do you see the role of the analyst
- GEN: the analyst knows what's going on and it's important for them to do some things and what do you think about that, he has to know the truth because it's not easy to do, actually, let's not do that and I'll tell you why, let's talk about that; he wants to tell the truth, it's a moral decision and yes, I know, but we're not going to do that; in NSA and CIA – I know what you want to do, but we're not going to do it yet;
- Joe: technologist have talked about to the table and that tech will not help us in period of uncertainty
- GEN: that's correct
- Matt: the week outline is having someone that thirsts for knowledge, they're smarter, competent, and well-versed . . . in your opinion, are analysts made or discovered
- GEN: they're not made, they're discovered; when in Sarajevo, you were there for 2-3 months and we could discuss it later on about this or that and that's very important;
- Kris: is there a personality type that's analytical or make a person into it
- GEN: at CIA, 3-4 people would talk to him and go to the WH and come back with back brief, he could point out someone that was more involved and talk to me about this and this, later I would say this is important and he would re-engage with that individual
- Joe: analysist makeup, tech know-how
- GEN: it's a bit different
- Joe: what did you need at both agencies and where do you see the training

- GEN: for CIA and NSA, it's important, frankly they're good people, but CIA has a little better people; realizing there are exceptions, CIA and NSA are more involved, they know a lot, but not more; at CIA they're more involved;
- Joe: worked w/analysis from both agencies, what is CIA doing differently
- GEN: at CIA, we have a lot, and at NSA, we don't – only signals intel; at CIA, we had everything involved
- Joe: multi-discipline approach
- GEN: at NSA, why don't you do more things that are intrusive and the response is that we don't do that; CIA was more involved
- Jason: looking at the important of the mil intel analyst, what do you think is the most essential things that you spoke to with truth, what is just a mundane task
- GEN: I don't know the answer to that because it's very hard, there's a lot we can do because machines can do this and we will; for example, in North Africa – 10 years ago, in Tunisia and was talking about how did you do – not so good because of Bengali and 3-4 days he was going and we could because this and this and this was going on; we should have said this before, but it'll be okay;
- Kris: how important is for an analyst to communicate to the DM
- GEN: it's very important,
- Kris: BHATCH enclave and understood how the Croatians were operating
- GEN: we were right, but it was very hard and people didn't want to hear what we had to say; I'm glad we did it, but it was very hard
- Jason: 90% of recorded data and situations where we misinterpreted, was there a decent process looking at the estimated words in confidence and ?
- GEN: yes, indeed, and have to know what's the problem; in Sarajevo he asked what's the problem and it was the altitude; it's important, 3000 feet more and the warring factions would go on and
- Kris: in a short span of time and distance, and it's the localized knowledge
- GEN: that's interesting and 3000-4000 feet there's a problem; Mostar was a problem, but by and large the people were okay and all of a sudden it's not okay
- Kris: explains the fractions in Bosnia; the difficult in establishing what's right and wrong is figuring out what the question is and the question can be hard; we don't have a system for grading how difficult the question is; the analogy I use is diving
- GEN: at CIA, first year, there were 10-12 people involved in the stock market and he was questioning those things and oh, that's okay, talking about Iraq and Syria, BTW, how much do you have confidence in the answer and well, many options are provided and some options we don't do at all – perhaps 5 or 6
- Kris: uses this story all the time, meeting with investment bankers and how good are you guys – anything above a 7 is good question
- GEN: friend of Mike Mulwell, talking about bin Laden – do we do it or not?, the president asks if this is right or wrong and it's 50/50; my best analyst say 50/50 and the president says that's not good
- Joe: as an intel I appreciate that answer; while at NSA, there was a focus to look at QC and having been sensitized is that any tech you see
- GEN: IDK, it's become difficult to read and he knows that; while in Bosnia, I read everything from the library and you have to do that if you want to do it right;

today, at CIA this is probably right and I would say are you sure and it's interesting when the response if not really; if 1 in 10 chances and sometimes they're right and it's still a problem

- Joe: recurrent focus of knowledge and education, reading a book, an expertise is becoming broader
- GEN: yes and yes; last year at NSA and there was a problem with Russia and Georgia and received a call from Steve Hadley?, give me an hour and get the Russian and Georgian analyst right here and we have analyst in Georgia and I didn't know them, but they did very good
- Kris: remember the Greek crisis and I was the Greek analysis and there was a lack of depth and didn't have anyone that understood
- Joe: the level of expertise is few and far between, the reach back capability of a virtual TOC; concerned the future fight will be in blackout conditions and w/o access to systems; do you have any thoughts on the paradigm moving forward
- GEN: at NSA, we had a breakdown for 3 days didn't know what was going on and now what's going on is now, it's still a problem and it's hard to do; for example, in Iraq, we were doing okay, but not really and what we did at the brigade level, they had 3-4 people and we shouldn't have done that but we did that and we shouldn't have, chief scientist was in Iraq and was saying he's going to stay for 2 weeks and went back to Ft. Meade saying we're not doing well at the brigade level, the US army was the problem; sometimes we have to do it at the HQS level, but not in the field
- Kris: you also did that in Bosnia, rotating us in and out that gives credibility and it worked well
- GEN: that's what we did in Iraq also, but at NSA I shouldn't have done that, it's different but we're going to do it anyway
- Kris: the reach back is more than a machine
- GEN: yes, sooner or later you have it, but it doesn't work, we did it at the battalion level also; NSA shouldn't have done that, but we did it anyway
- Bernice
- GEN: that's a problem, there was a problem with Microsoft, it's better now , the answer is that you're there in the govt and perhaps for 2 years in private sectors; cross training with industry
- Joe: where is the one area deficit
- GEN: not too much going on in school, the education system isn't doing well, 2LT what does he know of the Middle East, Iraq and that's a problem, but they're doing something different, I can do some reading that tech might fill some of those gaps, but sooner or later you have to some things
- Kris: tech has its limits and you need that analyst
- GEN: the final solution is me and not the book
- Kris: not the tech, but I have to be the one making the call
- GEN: in Tunisia, we should have known that, but we didn't
- Joe: there will still always be a requirement for the human in the loop
- GEN: you think about people being killed
- Joe: ?

- Kris: Thank you so much for doing this and for talking to my team
- GEN: ?
- Kris: the future is already here, but it’s not evenly distributed

Palantir Interview 12 Mar 21

Dan Rickert

Bryant Choung

- Introductions (Joe, Greg, Bernice, Matt, Kris)
- Dan: armour and special forces officer, with Palantir now
- Bryant: with Palantir for 9 years, supporting the IC for 15 or 19 years, developed most of Army programs
- Joe: states the question we're focused on, looking 15 years out, focusing on emerging techs – AI and ML already integrated into what Palantir is doing, feel for what the analyst is pivoting to do – what will they be responsible for, what is the train up for the analyst to leverage the emerging techs
- Bryant: exp. from the past 10-15 years and where the current state of the art is, where are you in discovery
- Joe: all are an inch deep
- Bryant: develop over the past 10-15 years, collections of QRCs, there were silos down to the analyst, breaking it apart and developing those tech; pivoting down to now near peer competitions and looks at the next MDO, specifically, it's less about going after high value targets, but understanding order of battle and employ that new junior officer in a time extensive area, can we give the soldier a laptop to accomplish all that's necessary; been interesting to see how we employ techs; taking into consideration weather, training analysis, but it's important how to train the soldier through automation; we don't envision AI displacing the soldier, make them super human by giving them new tools; CID2 – make data usable, make analysts to punch up their plate, make systems more interactive, the solider iterating with the systems in the field; Project Titan – exploring a cloud based capability and ?, training AI models in the cloud in the competition phase and will have capabilities employed in the vehicles
- Kris: are you going to low code/no code – is that where you're going with this?
- Bryant: absolutely, that's a significant element in this, there's a wide spectrum how these will be employed, during conflict – focus on easy to use systems, need to be able to provide turn key solution in a high intensity environment
- Kris: digital assistants playing a role
- Bryant: absolutely, not going to be Alexa or Siri; doesn't think we're going to depend on asking a DA the best reaction to scenario, but to flag things that are anomaly or weird
- Kris: when you look out what are the things that are worrying you to get to ironman 28 or 35
- Bryant: it depends on the part of the spectrum we're in; looking at intel will definitely change by that time, the amount of data from open sources, everything is a sensors, the very notion of tasking is going to change and have appropriate planning for it, the appropriate algorithm
- Kris: bandwidth and super computer will have the power to process streams

- Bryant: yes, not much thought what a Russian near peer will be and what a Chinese near peer will be;
- Joe: low code/no code, on battalion level and below is that the no code we're getting at
- Bryant: yes, I think so; surprising that some folks have the background in python and the pockets of tech aptitude, make the tools available to anyone and making them allowable to go one level deeper
- Joe: RFPs being dumbed down to come up with the stop gaps
- Bryant: difficult to come up with 1000 requirements, with CD1 came up with 100 requirements; and getting what's useful in the field; it's been captured well and developed into the system
- Joe: trends that soldier will be doing
- Bryant: they have tools they use outside of 9 to 5 and know how to use them, soldiers are comparing the tools at work with what's outside the job and in the commercial setting
- Joe: convergence 21, different techs being fielded and how are they being integrated
- Bryant: great events to have, great place to explore the limits and things that are still in infancy, helps the army understand where the development of tech is going and what skills the army will need, great breeding grounds
- Joe: expectation mgmt. and what will be turned off
- Bryant: not enough thought has gone into this specific area, exploiting commercial sources, exploring AI at the edge, there's more room to think of worst case scenarios and what comms will look like
- Joe: talk about security and the tech slant on it, solutions as to the next best thing
- Bryant: grapple with the concept of security; SCIFs and other secure areas are antiquated, need to adjust , encryption and data mgmt.
- Kris: encryption techs aware of – news releases on blockchain
- Bryant: definitely have thoughts in the future, but looking to secure data now, going a step further and how you use blockchain is looking at and keeping it in the rearview mirror; need to look at Verizon and how they're securing their digital assets
- Joe: has the govt shown getting out of JWICS, SIPR
- Bryant: haven't seen that, multi-level security and driven by the notion of sharing more with joint and partner; haven't seen anyone leaning forward in that vein
- Joe: taking the analyst out of the equation, how do you see tech enabling the analyst being a part of that
- Bryant: the analyst will not be taking out, tasking and collection will change, what might change is that the AI and ML will task the analyst – tipping and queuing an analyst and directing who
- Joe: AI and ML is the tech dominating the convo in DoD today, what about QC, which will be the game changer
- Bryant: QC is a fascinating area, that completely changes the game for us and in developing for a while, the env it will be place in is in question until we have a better roadmap, computational efficiency to ?; encryption of data may change

with QC; AI/ML has had great advantages and we lack creativity to understand the ?; need to think of what are the creative solutions that we do have, harnessing the ability to get feedback from soldiers, getting rid of the processes that are time consuming for a soldier, looking at those small things here and there will be

- Joe: as we write proposals and don't have the expertise of what's out there, what are we getting wrong
- Bryant: depends on the framing of how the business owner knows the problem; the govt should objectively state the problem set and defining it to get to the outcome, DoD is a bit to descriptive, words like agile have been overused and abused;
- Joe: look at near peer fight and seeing the Chinese are able to get QC advantage and the Russians are doing some things, what are we going to have a hard time being prepared for?
- Bryant: from a policy perspective that our adversaries can do and they farm out the data for them, we as the US don't have the framework to do so, being aware of how our adversaries are benefiting from that; how they leveraging multiple aspects is important
- Kris: saw back in 2001, have systems by and large systems from the cold war and evolved in the Baltics, get to the counter insurgency – is there effort to add flexibility to allow it to be module to drop tools into it
- Bryant: a couple concepts here, different company now than we were 20 years ago, counter terrorism space and transitioned to? , looking at how you do data mgmt., they built a decision platform vice an intel platform – what is the route thing we're trying to solve; investing in the next 20 years is to look retrospectively – countless hours we spent on one data model and lure them all;
- Kris: what are the big moving pieces of that model
- Bryant: see the DM is at a disadvantage and needs to break down decision silos, understanding what you have at every echelon and being able to design a system around that;
- Joe: what is the diff in the training requirement for the future analyst and what will get taken off their plate
- Bryant: no longer any manual dissemination, creating new creative products, getting rid of a lot of stuff that is time wasting
- Dan: still doing the map boards and hoping we're hitting that inflection point soon, the speed is not there and we're still doing stuff in PowerPoint
- Joe: appreciates your time and don't want to keep you
- Dan: would love to read the final report

E-mail interview excerpt with Cortney Weinbaum

From: Joseph Sheridan
Sent: Saturday, February 20, 2021 8:22 AM
To: Weinbaum, Cortney; Williams, Heather
Subject: RE: Introductions and request for discussion on future intelligence analysts

Courtney,

This is really helpful and exactly the kind of insights we are hoping to get. I'd like to crunch through the links you provided and then see if you are available for a follow-on discussion. Really appreciate you taking the time to outline this for me and I hope we can chat in the near term.

Best,

Joe

Sent from Mail for Windows 10

From: Weinbaum, Cortney
Sent: Thursday, February 18, 2021 11:54 AM
To: Williams, Heather; Joseph Sheridan
Subject: RE: Introductions and request for discussion on future intelligence analysts

Hi Joe,

I'd be happy to talk. Also, here are a few document's your team might include:

- Our colleague Michael Mazarr has been leading an interesting area of research for the DNI over the past few years about "virtual societal warfare": https://www.rand.org/pubs/research_reports/RR2714.html
- Rand Waltzman (yes, that's actually his first name) led an Air Force study that compares the US's competitiveness in AI to China: https://www.rand.org/pubs/research_reports/RRA200-1.html
- A few years ago I published an article with LtGen Shanahan (before he was Director of JAIC) where we provide a vision of the future of AI in the intelligence community. (Attached)

Youre going to find more research and analysis around AI than you're likely to find around other topics. Quantum is still very immature and most analysis about the implications of quantum is really hypothetical at this point in my opinion. Blockchain has probably been an under-researched technology, particularly in the national security ecosystem. The implications of 5G is probably something you should include in your study.

I personally believe that some of the most exciting advancements over the next ten years will be in space; and I think the biggest hurdle to advancements on the ground will be human, mainly the national security ecosystem's utter inability and unwillingness to share data at the scale needed for true AI.

Let me know if you want to talk and when.

Cortney

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Dr Barry Issenberg 20210403

Chair, University of Miami Gordon Center for Simulation and Innovation in Medical Education

1. Reality Tech
    a. VR-
    b. AR-
    c. MR-
    d. XR-Hub of VR, AR, MR; integrated fluid
        i. Future will be seamless transition from one to the other
        ii. Holographic part of the MR of XR
            1. Especially if its dynamic
    e. Holographic vs headset
        i. Holographic will replace the HS, maybe contacts use too
    f. Mobile device vs fixed equipment
        i. Will be a combination of both, with end goal of end user mobile devices
    g. Digital Twin
        i. Image of true
        ii. Image of shared
2. Major academic centers involved in XR
    a. University of Michigan
    b. Mayo
    c. Stanford
    d. Duke
    e. Univ of Washington
    f. Harvard/MIT
    g. Univ Pit
    h. Carnegie Mellon
3. Major companies/money
    a. (See below)
4. Major users/applications for
    a. Entertainment
    b. Medical
    c. Office/business
    d. Education
    e. Military
5. Challenges
    a. Tech-
        i. Human factors (mental, emotional, and social) using new tech. Many humans don't like the tech
        ii. Some get physically sick, nausea, vertigo, etc

iii. Overall use and reliability of systems (need specific equipment designed for the field use and not the other way around)
    1. Comfort
    2. Heat
        a. Tech will not work
iv. One size fits all is not good
    1. Modalities per soldier
        a. Visual, auditory, tactile, etc preference
        b. Location of data
            i. Some like left, right, centered, top, bottom, etc
            ii. Brightness, Contrast, saturation, color, etc
                1. Bascom Plamer is researching into this
            iii. Customize may be key
        c. Width of screen causes physiological issues in some
        d. Period of time to get oriented to XR and also to get back to reality. Important for system failure, or other need to emergently change from using tech to going back to normal.
        e. What are the long term affects of long term use of XR on individual physiology and organs (eyes, ears, vestibular, neuro, etc)
        f. How do we find who will be affected to XR vs those that will not
            i. Can we attenuate this with RX or training
v. Analog as a backup

b. Politics-
    i. Extreme right and left sided people and politicians
        1. Security
        2. Data collecting of PII, PHI, etc
c. Economics-
    i. Biden infrastructure commitment will help over the next decade
    ii. Tech industry leads the way
        1. Military and Healthcare follows in the application of this tech
        2. Businesses will provide tech hardware for low cost or free
            a. Make money off services provide
        3. Initial adoption is the largest investment
            a. Example is Epic and Cerna
                i. Up front loss due to changes in processes
                ii. Tail end increases due to quality and reliability

   d. Ethic-
      i. Privacy of individual and their data
      ii. A.I. to support this and what that will do
         1. Need human in the loop
   e. Cultural-
      i. Older and more senior usually have more influence and power and usually resistant to change
      ii. Younger are earlier adaptors
      iii. Find senior earlier adaptors and focus on them; allies
      iv. Current environments are not designed to use new tech in clinics, offices, training. We are using tech to fit the spaces and not the changing spaces to use the max of the tech
      v. May current structures have bad wireless (wifi, cellular, etc) signals for access
6. Training
   a. Rehearsal of complex procedures and operations before actual use
      i. Complex cancer
      ii. Conjoined twins
      iii. Etc
   b. Can add olfactory to other senses affected by XR, if its critical to the outcome otherwise it's just a niche/interesting thing but not important or ROI
7. What enabling tech needs to be achieved
   a. Faster network
   b. Reliable connections
   c. Cloud, Edge, etc
   d.
8. What tech will XR impact
   a. Components that make up headsets
   b. All networks that support software and headsets
9. What is the benefits of all this XR?
   a. TNTC
10. Miscellaneous notes:
   a. 2 trillion-dollar infrastructure investment-Biden
   b. Headsets will be smaller/lighter like normal glasses/googles. Widespread contacts unlikely.
   c. Need 5G or higher for gigabit or higher. AR must be real-time to be instant with user. Latency is important. However recent research (4G, Wi-Fi) showed quality of image was the biggest negative impact. Wired fixed it. So we need better 5G/advanced Wi-Fi, etc. Edge is key too.
   d. Multiple data streaming for reaching the goal faster via BT, WiFi, 4G, etc until full 5G and 6G.

e. Human factors of users comfort, interference with job function, if they wear glasses. Strain starts around 20 min (what is gaming community say).
f. Real Magic-20z all in one XR, improved but not there yet
g. PicoNeo 2 all in one XR, improved but not there yet
h. Some don't want to wear it since it messes up hair
i. Need to use sterilization technology for shared use
j. Holographic will be built in or via mobile UE for clinical care, admin area, training, etc. Will replace headsets by 2030-2035.
k. Tech is being driven by "super gamers". Common person have Human Factors and Physiological challenges. "not everyone could be a pilot in the past if they had visual, physical, or physiological challenges"
l. UCF working with AF about the above
m. Devices and Apps are being provided by industry that also wants to run the servers, etc. FB, Microsoft, etc as well as smaller company
n. Healthcare is concerned about use of HPI, encryption, etc since the company's want to hold all the data.
o. Butterfly IQ?
p. Amzon can DISRUPT this if they become new healthcare platform????
q. The people that will use this in 2030-2035 are currently XX years old. What will they look like, education pathway, etc as compared to us. How do we use that for adoption

LTC Sean McCafferty, US Signal Corps, US CYBERCOM 20210303

Chair, University of Miami Gordon Center for Medical Education and Simulation Research

1. Basic IT structure and function
    a. U.S. DoD primary computer systems and networks function on a commercial backbone of wired fiber and coaxial cables to get to the primary servers on installations.
    b. Once they link into the NIPR and SIPR gateways/firewalls, almost all terminal end user devices are connect via twisted pair (CAT) wire that is controlled by DoD (both garrison and tactical settings).
        i. Similar to how we use public roads, rail, waters, and air to move military resources.
    c. Very few items use Wi-Fi, Bluetooth, or similar radio wave technology to get to the terminal devices due to security concerns with this technology
    d. Currently use 4G telecommunication networks for DoD issued phones that access NIPR outlook, and a variety of websites directly or via a VPN
    e. Some SIPR mobile devices work on commercial backbone with increased use during COVID pandemic to allow for remote work without degradation of access to key information
    f. DoDIN is managed by the Defense Information Systems Agency
    g. References:
        i. DoDI 8420.0 “Commercial Wireless Local-Area Network Devices, Systems, and Technologies”
        ii. DA PAM 25-2-9 “Wireless Security Standards”
2. Future
    a. Wireless
        i. Starting to use more wireless
        ii. Li-Fi has potential use in the future due to increased security
        iii. Some sites will get 5G, but its too expensive and will not be commercially available to all place for many years. (Fort Irwin, Fort Polk, etc)
        iv. 5G is fast enough to be an Internet Service Provider that will work along side current fiber and coaxial ISPs. As above, will need improved cybersecurity hardware, software, and policies/procedures before it becomes widespread
        v. BCPS
        vi. There will be satellite technology (tactical and non- NIPR/SIPR systems) updates, but I’m not the expert to speak on that
    b. Storage and processing
        i. “Big data” is a significant part of the DoD future
        ii. Much of the data on current local servers will be put in the milCloud (currently milCloud 2.0) to provide essential data to end user devices/end users.

iii. Improved cybersecurity hardware, software, and policy/procedures will be essential to having improved access to data that is secure
iv. Newer “edge” computers will enhance the milCloud so universal information is placed nearer the end user.
v. Will use A.I. to help via machine learning, etc

c. Misc
i. The above will help with various sensors technologies and devices, drone swarming, etc

Annex C

Peterson's Analytic Confidence Worksheet

	Points Possible	Points
Use of Structured Method(s) In Analysis	(1-10)	
For example: ACH, IPB, Social Networking, Bayes, Simulation, etc…		
10 indicating highest possible score when considering factors below		
Consider		
Number of		
Applicability of methods to the analysis		
Level of robustness of method		
Degree to which methods' results coincide		
Overall Source Reliability	(1-10)	
A rating of 10 indicates the highest reliability		
Source Corroboration/Agreement: *Level of conflict amongst sources*	(1-5)	
5: No confliction amongst sources		
4: Very little conflict amongst sources		
3: Moderate conflict amongst sources		
2: Significant conflict amongst sources		
1: Sources conflict on nearly all points		
Level of Expertise on Subject/Topic & Experience	(1-5)	
5: Deep intimate knowledge and understanding & 3+ years experience with topic		
4: Wide knowledge & 1-3 years experience with topic		
3: Moderate knowledge & 6-12 months experience with topic		
2: Minimal knowledge & 0-5 months experience with topic		
1: No knowledge & no experience with the topic		
Amount of Collaboration:	(1-5)	
5: Part of aggregated individual analyses		
4: Work on a team		
3: Worked with a partner		
2: Casual discussion		
1: Completely individual work		
Task Complexity	(1-5)	
5: Minimally complex & challenging		
4: Somewhat complex & challenging		
3: Moderately complex & challenging		
2: Quite complex & challenging		
1: Very complex & high challenging		
Time Pressure: *Time given to make analysis*	(1-5)	
5: No deadline		
4: Easy to meet deadline		
3: Moderate deadline		
2: Demanding deadline		
1: Grossly inadequate deadline		
	Score:	
	Total Possible:	**45**
	Score/Total Poss:	
		X10
	Analytic Confidence Adjusted Score:	

Annex D

Friedman Corollaries

Two questions a researcher should ask oneself in order to reassess bias and improve validity to an estimate.

1. Is my estimate within the range of reasonable opinion surround the question?
2. How likely is it that new information will change my estimate?

Source: Jeffrey A. Friedman

Annex E

Standard Primary Source Credibility Scale

Source reliability is noted at the end of each citation as low L, moderate M, or high H. The citation is hyperlinked to the source, unless the source is a paid subscription; in that instance a footnote is provided at the end of each writing illustrating the source for credibility. Source reliability is determined using the Trust Scale and Website Evaluation Worksheet found in Annex F

Importance	Factor	Description	Satisfies Criteria (Yes /No)
HIGH	Has a good track record	Source has consistently provided true and correct information in the past	
	Information can be corroborated with other sources	Information provided by the source corroborates with information from other primary and/or secondary sources	
	Information provided is plausible	High probability of the information being true based on the analyst's experience of the topic/subject being investigated	
	Information is consistent and logically sound	Information provided is consistent when queried from different angles and is logically sound	
	Perceived expertise on the subject	Source is perceived to be an expert on the subject / topic being investigated and/or is in a role where subject knowledge is likely to be high	
	Proximity to the information	Source is close to the information – a direct participant or a witness to the event being investigated	
	Perceived trustworthiness	Source is perceived to be truthful and having integrity	
MEDIUM	No perceived bias or vested interest in the subject / topic being investigated or on the outcome of the research	Source has no perceived bias or vested interest in the subject / topic being investigated or on the outcome of the research	
	Provides complete, specific and detailed information	Information provided is specific, detailed and not generic	
LOW	Is articulate, coherent and has a positive body language	Source is articulate, coherent, has a positive body language and does not display nervousness or body language that can be construed to be evocative of deceptive behavior	
	Recommended by another trusted / credible third party	Source is recommended by others the analyst trusts but the analyst herself does not have any direct experience working with the source	
	Sociable	Source comes across as outgoing and friendly. Easy to get along with and talk to	
	Perceived goodwill to the receiver	Perceived intent or desire to help the receiver or the analyst	

Annex F

Trust Scale and Web Site Evaluation Worksheet

Trust Scale and Web Site Evaluation Worksheet
(Updated OCT 2013)

Piece of Evidence #:												Score:	Trust Scale:
Criteria	Tips	Value	Y or N	Y or N	Y or N	Y or N	Y or N	Y or N	Y or N	Y or N	Y or N	0	15-20 High
Content can be corroborated?	Check some of the site's facts	2											11-15 Moderate
Recommended by subject matter expert?	Doctor, biologist, country expert	2											6-10 Low
Author is reputable?	Google for opinions; ask others	2											5-0 Not Credible
You perceive site as accurate?	Check with other sources; check affiliations	1.5											
Information was reviewed by an editor or peers?	Science journals, newspapers	1.5											
Author is associated with a reputable org?	Google for opinions; ask others	1.5											
Publisher is reputable?	Google for opinions; ask others	1.5											
Authors and sources identified?	Trustworthy sources want to be known	1											
You perceive site as current?	Last update?	1											
Several other Web sites link to this one?	Sites only link to other sites they trust	1											
Recommended by a generalist?	Librarian, researcher	1											
Recommended by an independent subject guide?	A travel journal may suggest sites	1											
Domain includes a trademark name?	Trademark owners protect their marks	1											
Site's bias is clear?	Bias is OK if not hidden	1											
Site has professional look?	It should look like someone cares	1											
Total		20											

19 Dec 2001: The criteria and weighted values are based on a survey input from 66 analysts. For details see: http://dazmorman.googlepages.com/analysis. Edited for simplicity by Kristen J. Wheaton, OCT 2013
3 Feb 2012: Excel Spreadsheet which adds auto-sum was produced by Bill Welch, Deputy Director, Center for Intelligence Research Analysis and Training, Marchurst College
26 Jan 2013: Trust Scale and Web Site Evaluation Worksheet is in the PUBLIC DOMAIN.

Annex G

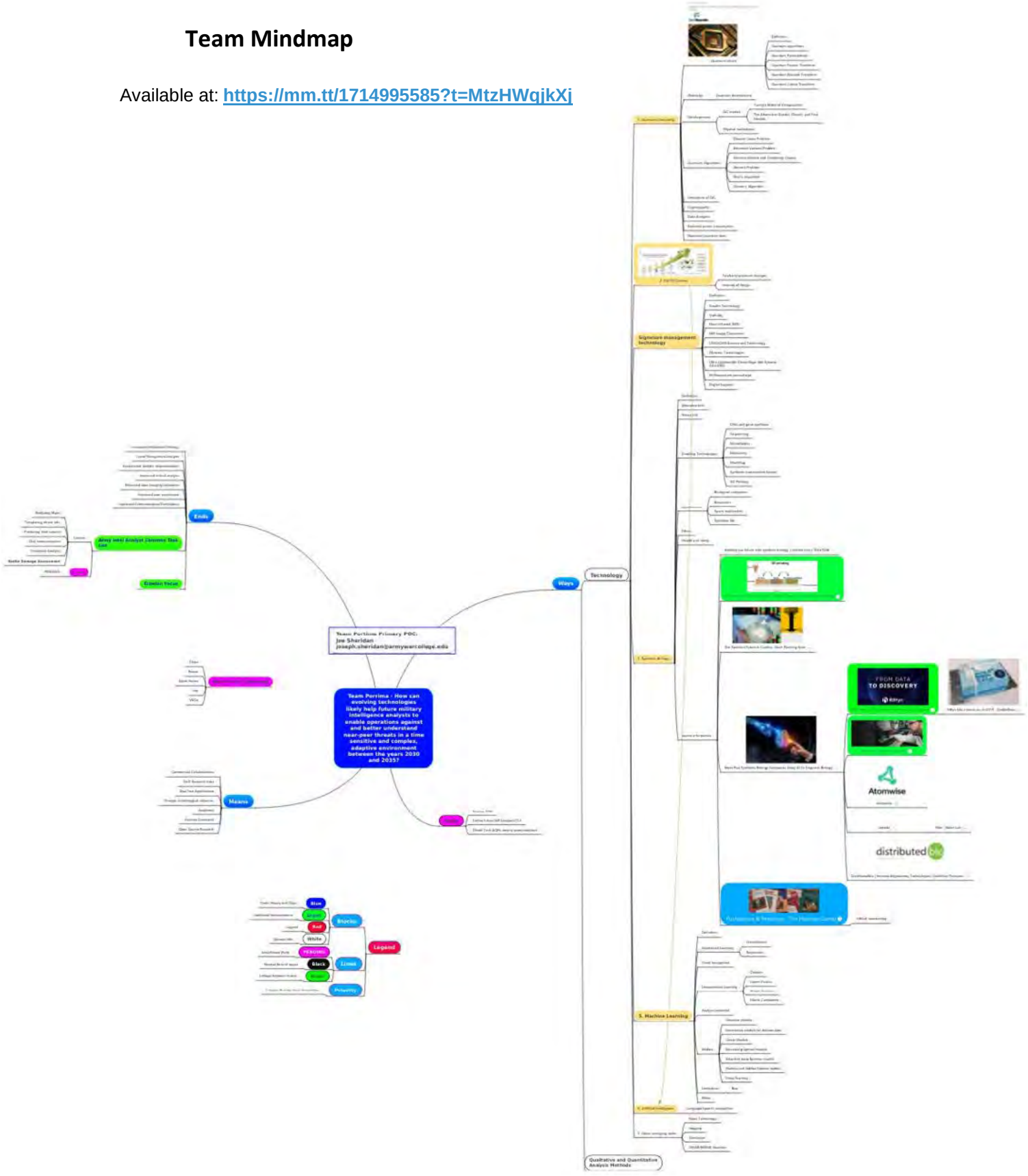
Kesselman List of Estimative Words of Probablility

Certainty 100%			
Almost Certain	86-99%		Likelihood
Highly Likely	71-85%		
Likely	56-70%		
Chances a Little Better (or Less)	46-55%		
Unlikely	31-45%		
Highly Unlikely	16-30%		
Remote	1-15%		
Impossibility 0%			

Annex H

Team Mindmap

Available at: https://mm.tt/1714995585?t=MtzHWqjkXj



Annex I

Team Porrima Final Presentation

The following presentation was presented to LTG Laura Potter, G2, US Army on 27 April 2021 remotely via Microsoft Teams.

Key Findings_version final draft_V12_mediu

Key Findings

COL Joseph Sheridan
Ms. Bernice Parkhill
COL Greg Frazier
COL Jason Seery
LTC Matthew Williams

20210427

Kesselman Estimative Words of Probability

Certainty 100%			
Almost Certain	86-99%	↓	Likelihood
Highly Likely	71-85%		
Likely	56-70%		
Chances a Little Better (or Less)	46-55%		
Unlikely	31-45%		
Highly Unlikely	16-30%		
Remote	1-15%		
Impossibility 0%			

Analytic Confidence

LOW **MODERATE** HIGH

TEAM PORRIMA

How can evolving technologies likely help future military intelligence analysts to enable operations against and better understand near-peer threats in a time sensitive and complex adaptive environment between the years 2030-2035?

Key Technologies

Individual	Unit	Enterprise
No- or Low-Code Software	Distributed Computing Architecture	6G Networking
Pharmacological Cognitive Enhancers	Hyperautomation	Multi-Domain Sensors
Digital Assistants / Companions	Machine Learning	Non-Fungible Blockchain Tokens
Neurofeedback Devices	Edge Computing	Fully Homomorphic Encryption
Extended Reality Displays	Cyber Foraging / Tactical Cloudlets	
Holographic Displays	Li-Fi Wireless Networks	
	Free Space Optics Wireless Networks	

Individual Level

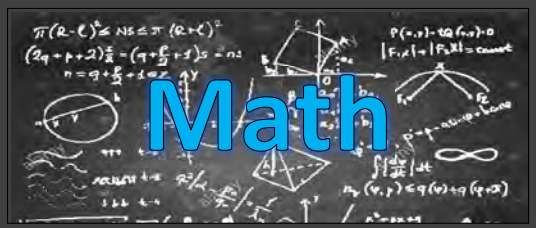
- No- or Low-Code Software
- Pharmacological Cognitive Enhancers
- Digital Assistants / Companions
- Neurofeedback Devices
- Extended Reality Displays
- Holographic Displays

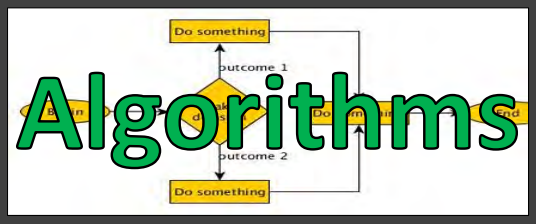
“Human in the Loop”

GEN(R) Michael Hayden,
former Director of the CIA

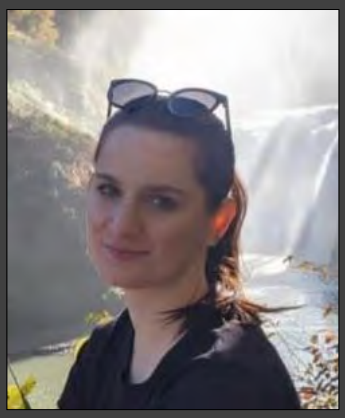
Rear Admiral Scott Bishop,
Commander of the Canadian
Forces Intelligence Command

Data Science Competencies





Data Science Competencies



Alicja Mincewicz, Strategy Lead at Facebook Reality Labs

"Critical thinking, logical thinking, mathematics, and [formal training in] data science."

No- or Low-Code Software

- Minimal training required
- Robust data sets
- Intuitive programing

Forbes

The Most Disruptive Trend Of 2021: No Code / Low Code

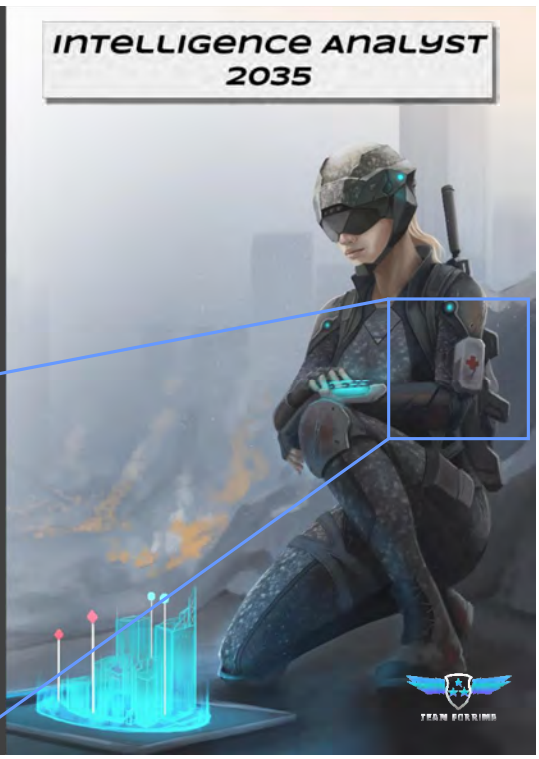
Betsy Atkins Contributor ⓘ

Markets

I'm a board vet writing about corporate governance & business trends

Pharmacological Cognitive Enhancers (PCE)

- Researching multiple compounds
- Enhance Memory
- Improve Learning
- $5 Billion



Digital Assistants / Companions and Neurofeedback Devices

Digital Assistants / Companions and Neurofeedback Devices

- Auditory and visual inputs
- External Brain Computer Interface

- Active security
- Automation system management
- Health monitoring

Future Digital Assistants and Companions

alexa

Cortana

HYBRI

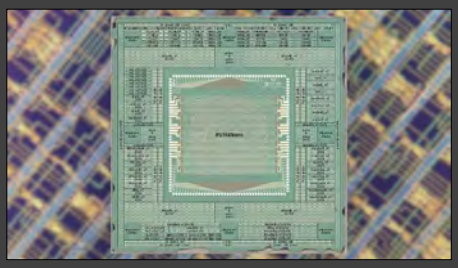
TOYOTA AI VENTURES

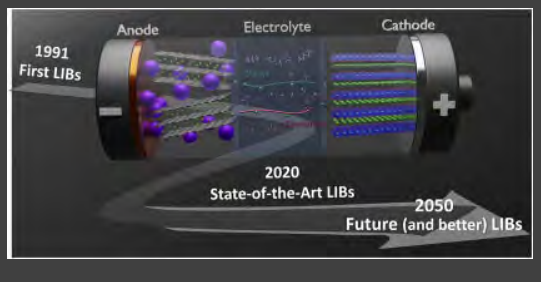
iRobot

SAMSUNG NEXT

UNION
TECH VENTURES

Improved Enabling Technologies





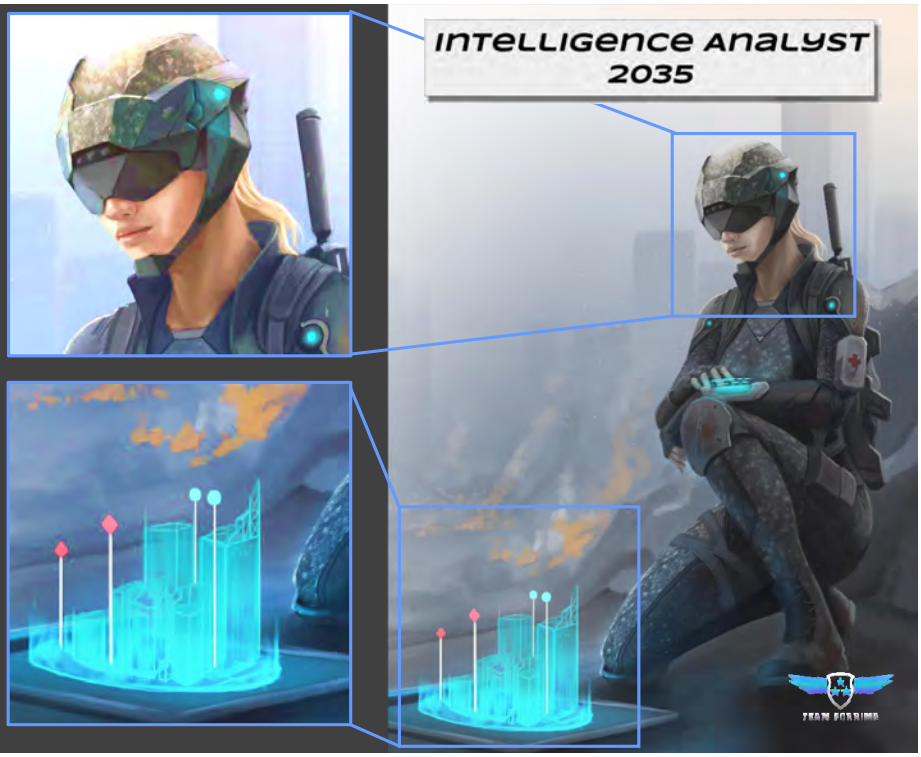
Elon Musk, Co-Founder of Neuralink

- Cognitive Enhancement
- Emotional Regulation
- Stress Resilence

Tobii, Valve, and OpenBCI prototype Brain Computer Interface platform

Extended Reality (XR) Displays

- Augmented Reality
- Virtual Reality
- Mixed Reality
- Holographic Displays



Microsoft

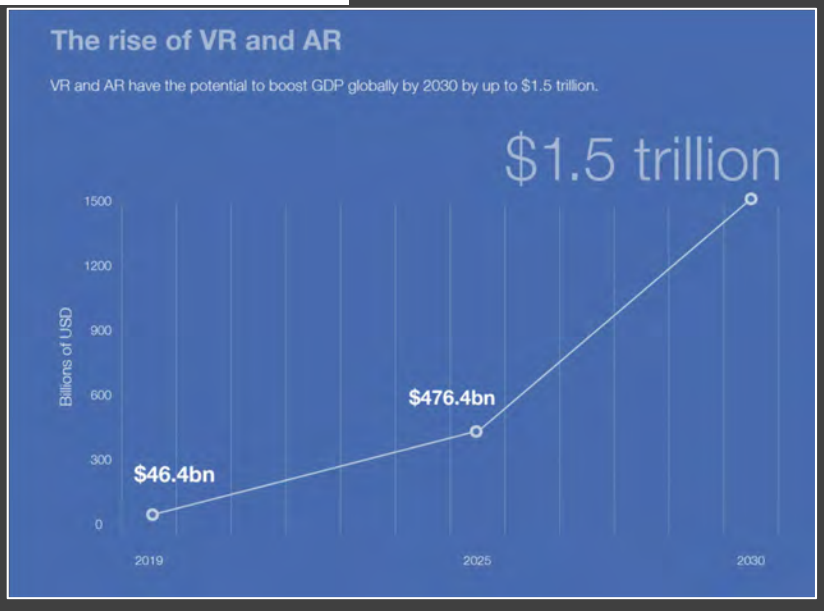
US Army is deploying Microsoft HoloLens-based headsets in a $21.88 billion deal

The hardware is moving to production phase.

Scott Stein | March 31, 2021 2:18 p.m. PT | LISTEN · 02:44

20% of Facebook staff working on Augmented or Virtual Reality

PRICEWATERHOUSECOOPERS



VIVIDQ

"Holographic displays will be the dominant display technology of the next decade…"

Texas Instruments

Panasonic

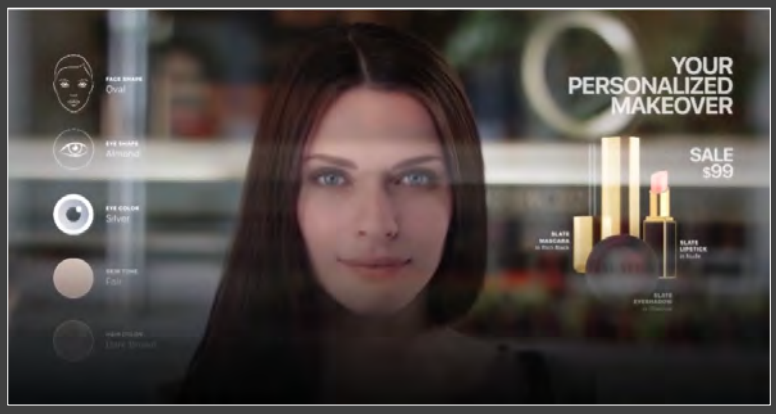
SAMSUNG

Microsoft

QUALCOMM

KONICA MINOLTA

L'ORÉAL



NIANTIC

John Zuur Platten, Writer and Senior Game Designer

Individual

- No- or Low-Code Software
- Pharmacological Cognitive Enhancers
- Digital Assistants / Companions
- Neurofeedback Devices
- Extended Reality Displays
- Holographic Displays

Unit Level

- Distributed Computer Architecture
- Hybrid Cloud
- Edge Computing

“Dispersion of network [analyst] is currently occurring…”

“Rooms full of people are dead and (in person) Global Security Operations Centers are becoming vanity plays”

Research and Development Expert for a Fortune 500 Company

Palantir

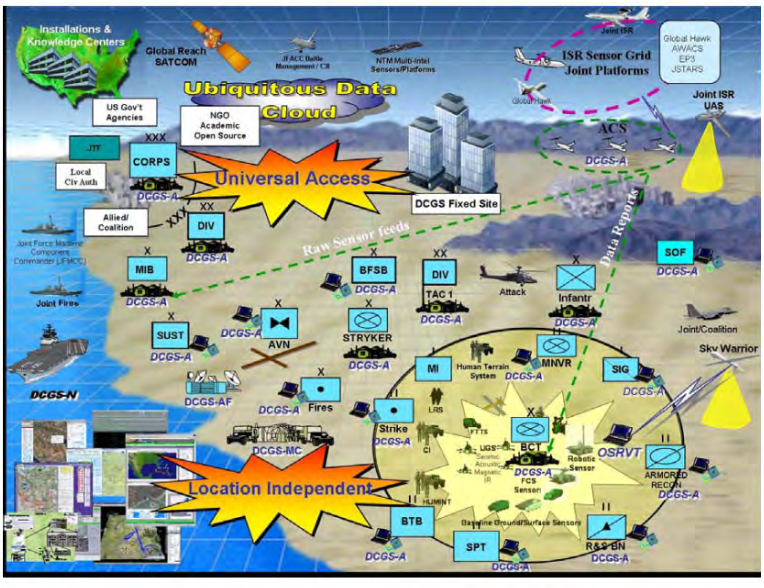
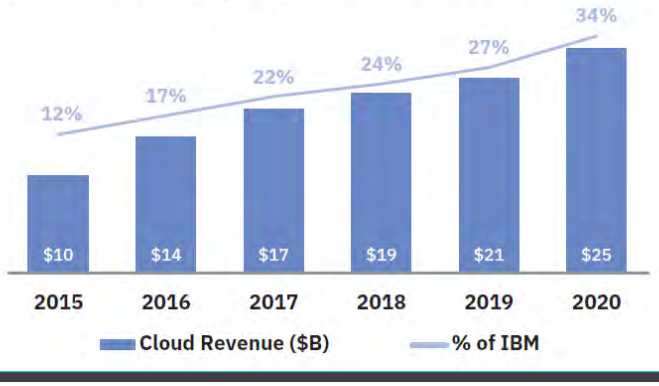


Figure 1-1. DCGS-A OV-1 and Future Force.

IBM 2020 Annual Report

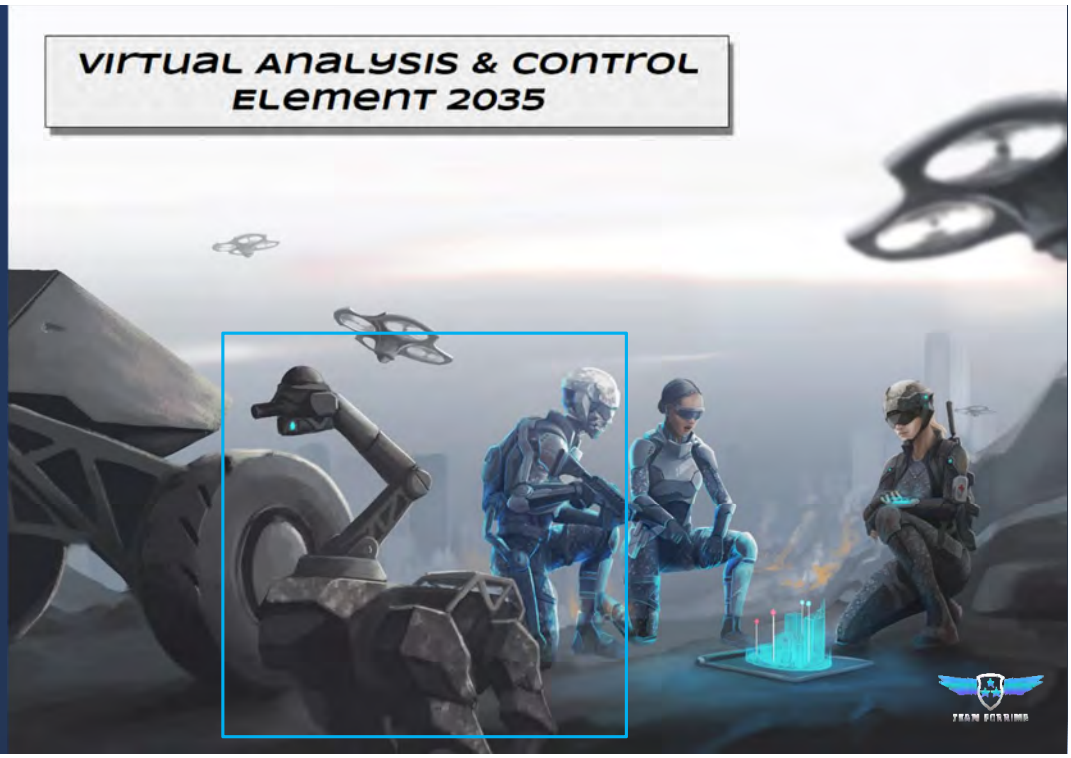
IBM Cloud Revenue

Over $25B total Cloud revenue, more than doubling since 2015, and now making up over 34% of IBM revenue.



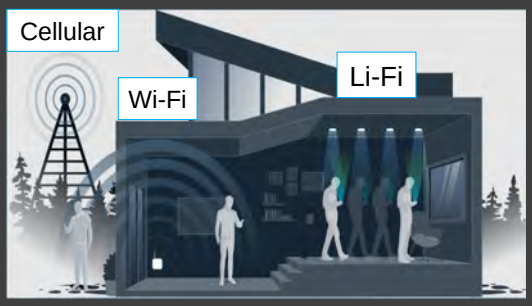
Li-Fi and Free Space Optics

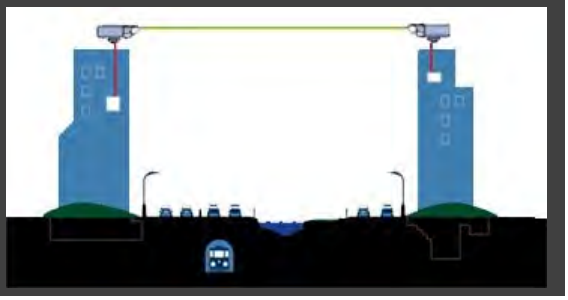
Li-Fi and Free Space Optics



Li-Fi and Free Space Optics

- More secure
- More resilient
- Faster speeds



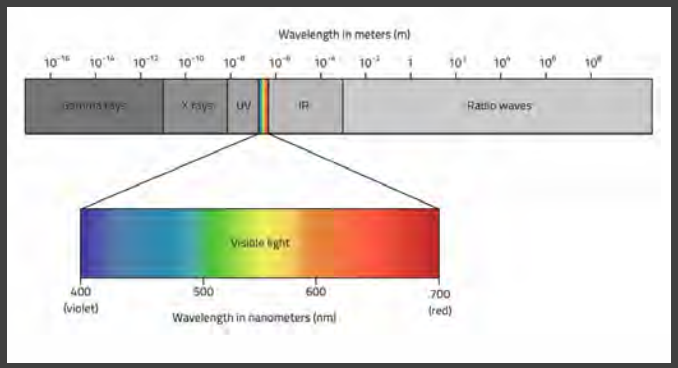


USAREUR-AF Experience

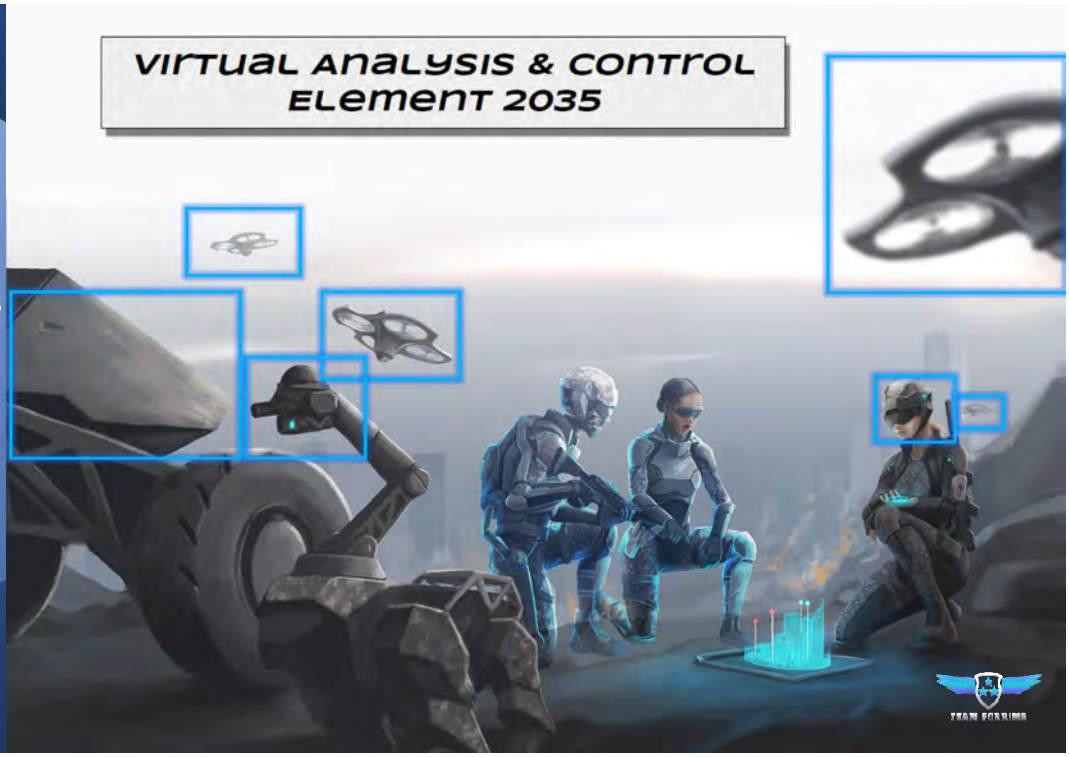
95%

Reduced Signature

- Does not give off radio or microwave frequencies
- Does not interfere with other equipment
- Directed signal is more secure

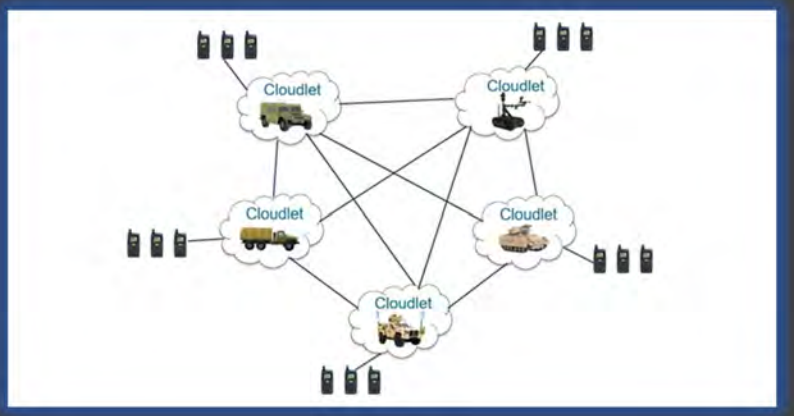


- Tactical Cloudlets
- Cyber Foraging



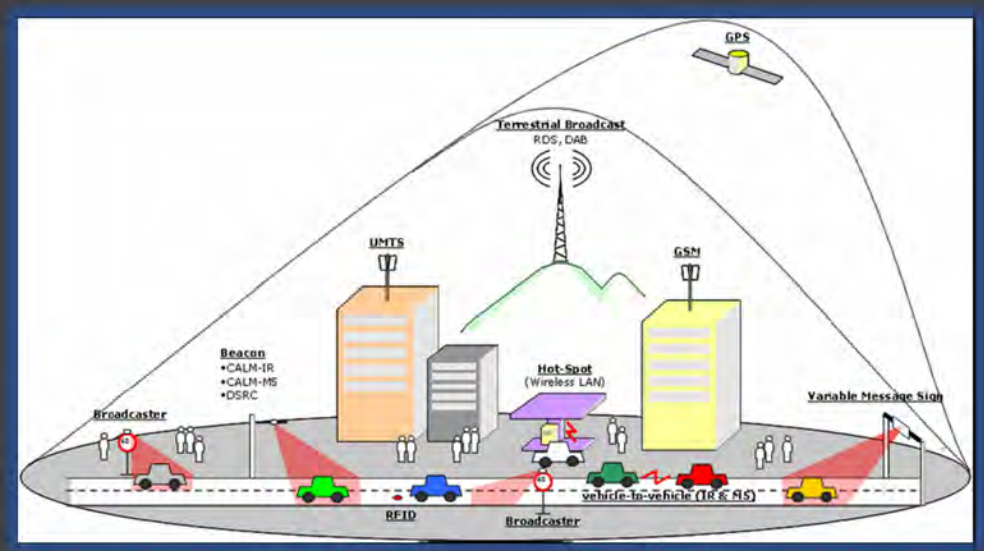
Tactical Cloudlets

"…discoverable, generic, stateless servers located in single hop proximity of mobile devices"

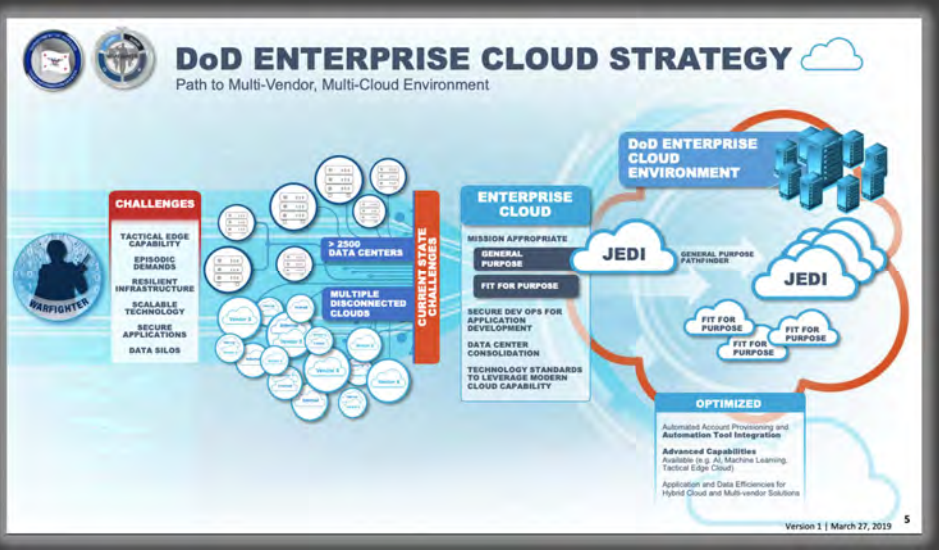


Cyber Foraging

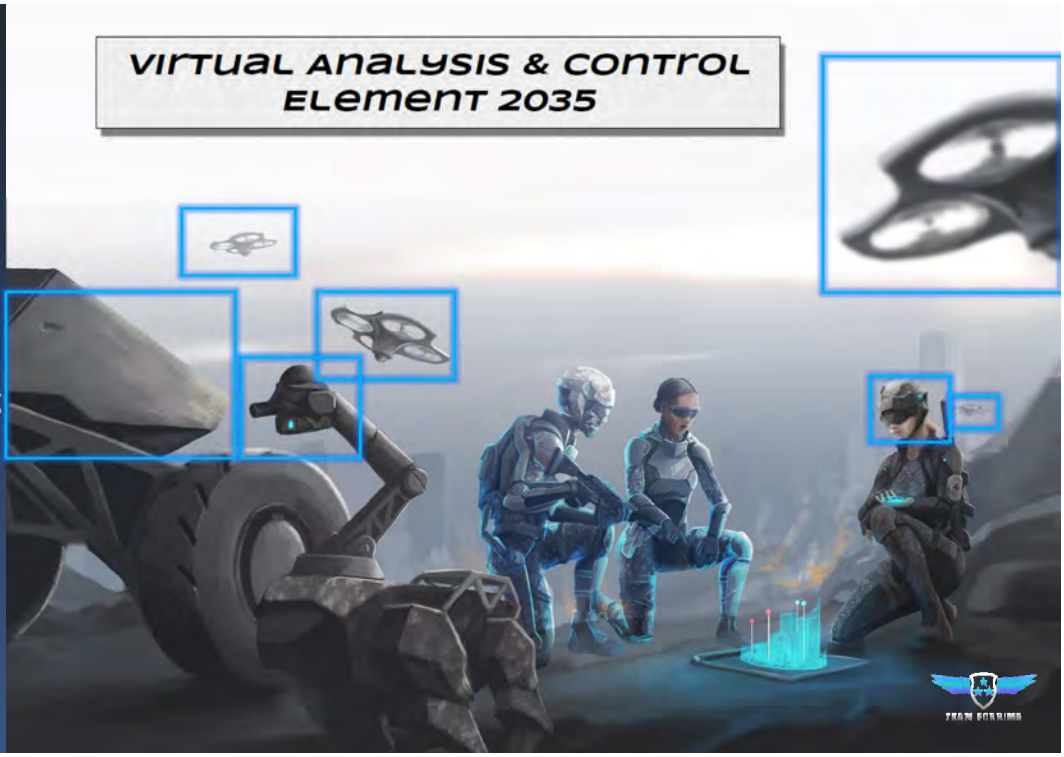
~7 design prototypes



Joint Enterprise Defense Infrastructure (JEDI) Cloud



- Machine Intelligence
- Machine Learning
- Edge Artificial Intelligence
- Hyperautomation



- Sense
- Identify
- Exploit
- Share

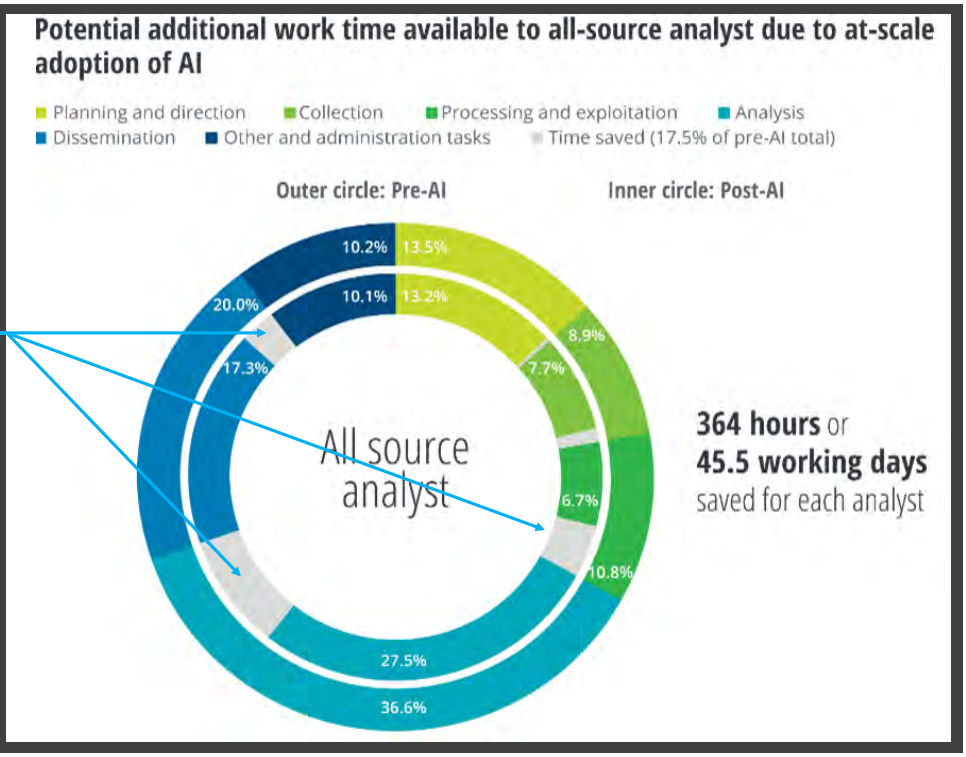
"…assessing the information and making decisions inside the decision / action loop."

Lt Gen VeraLinn Jamieson, Deputy Chief of Staff for Intelligence, Surveillance, Reconnaissance and Cyber Effects Operations

Air Force Next Generation ISR Dominance Flight Plan

Deloitte.

17.5% Reduction in daily workload



Light becomes data
pureLiFi

…60% growth…12,000 times current use

Professor Harald Haas, Co-Founder and Chief Science Officer of pureLiFi

Unit

- Distributed Computing Architecture
- Hyperautomation
- Machine Learning
- Edge Computing
- Cyber Foraging / Tactical Cloudlets
- Li-Fi Wireless Networks
- Free Space Optics Wireless Networks

Enterprise Level

- Improving sensor network
- Reducing latency
- Securing sensor data
- Validating inputs and outputs

NOKIA Bell Labs

SAMSUNG

ERICSSON

- 1GB/second to 1TB/second

- 2028 and 2030

Robert Cardillo, former National Geospatial-Intelligence Agency Director

"The reason we have intelligence is to answer three questions: what's new, what's true, and what's next?"

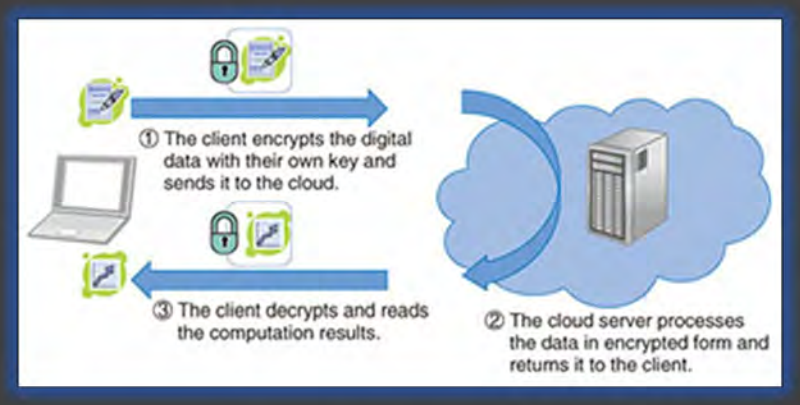
verizon

Verizon unveils “Full Transparency”

CORNAMI Intelligent Computing

IBM

Microsoft



Fully Homomorphic Encryption (FHE)

Deep Fakes

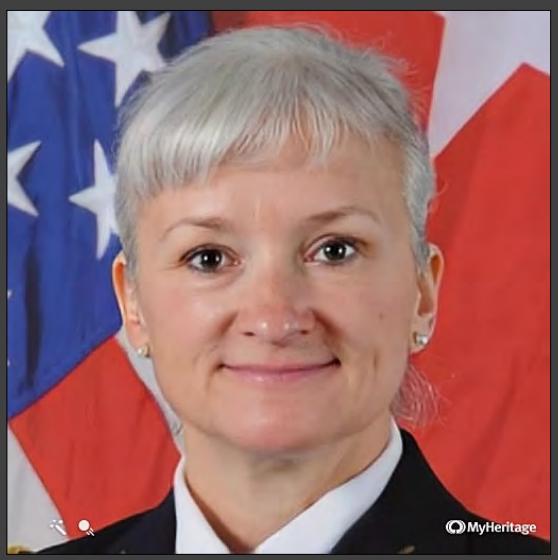
- 30 seconds on Google Images

+

- 30 Seconds on commercial deep fake app

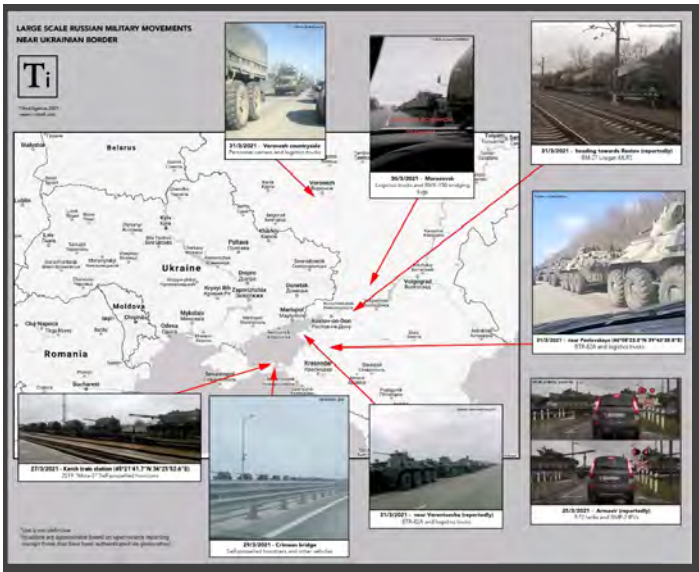
=

- “Priceless .gif”

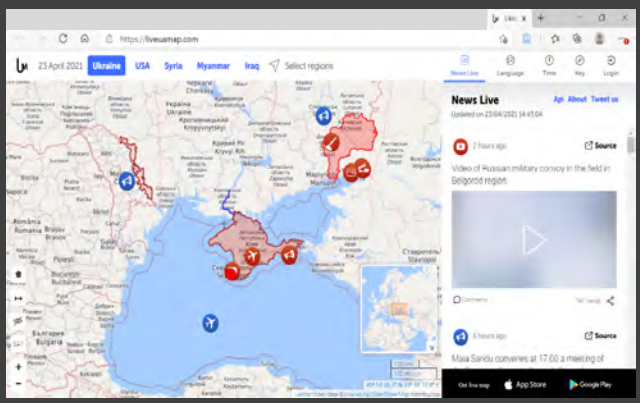


"…this is the tip of the iceberg"

Hany Farid, Professor of Computer Science and Digital Forensics at University of California at Berkeley



ReportPlus
Affordable Analytics For All



I-INTELLIGENCE

"…(unprecedented) understanding of the battlespace"

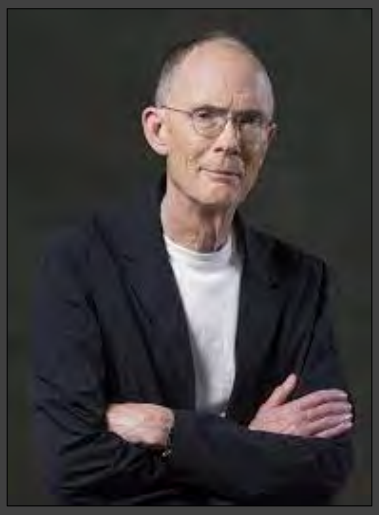
Chris Pallaris, Founder and Director of I-Intelligence

Enterprise

- 6G Networking
- Multi-Domain Sensors
- Non-Fungible Blockchain Tokens
- Fully Homomorphic Encryption

2035

- Generalist v. Specialist
- Data Science “lite”
- Strategic Forecasting Methodology
- “Open-Source First”
- Digital Fluency



“The future is already here; it’s just unevenly distributed.”

Futurist Author – William Gibson

TEAM PORRIMA

Discussion

"AR IS THE MOST PROMISING [NEAR TERM VISUAL TECHNOLOGY] SINCE IT IS SENSORY ENHANCING; VR IS ABOUT CREATING DECEPTION AND WILL NOT BE AS SUCCESSFUL UNTIL [DESIGNERS] GET RID OF HEADGEAR AND CAN OBSCURE OBSERVABLES.

John Zuur Platten, Niantic Labs

"HOLOGRAPHIC DISPLAYS WILL BE THE DOMINANT DISPLAY TECHNOLOGY OF THE NEXT DECADE IN MULTIPLE SECTORS."

Darran Milne, CEO of VividQ

"THE FUTURE IS ALREADY HERE, IT'S JUST UNEVENLY DISTRIBUTED."

William Gibson, Futurist Author

"IN JANUARY 2019, DEEP FAKES WERE BUGGY AND FLICKERY. NINE MONTHS LATER, I'VE NEVER SEEN ANYTHING LIKE HOW FAST THEY'RE GOING. THIS IS THE TIP OF THE ICEBERG."

Hany Farid, University of California at Berkeley

[WHEN ASKED ABOUT REQUIREMENTS FOR THE FUTURE ANALYST] "ALL WILL REQUIRE CRITICAL THINKING, LOGICAL THINKING, MATHEMATICS, AND [FORMAL TRAINING IN] DATA SCIENCE."

Alicja Mincewicz, Facebook Reality Labs


TEAM PORRIMA