

The Second Nagorno-Karabakh War

Takeaways for Singapore's Ground-Based Air Defense

BEN HO

Over the years, the defense commentariat has widely acknowledged that the Republic of Singapore Air Force (RSAF) is arguably the most potent of its kind in Southeast Asia.¹ The service's esteemed repute derives in large part from its tactical aircraft force comprising some 100 F-15s and F-16s, many of which are late variants of their types.² And with the F-35B Lightning II stealth fighter slated to be delivered to the RSAF around 2026, Singapore's air force will undoubtedly cement its *primus inter pares* status in the region.³ Playing a no less significant role in protecting the Lion City's skies, however—and they are often overshadowed by the fast jets—is the RSAF's ground-based air defense (GBAD) force. In fact, with asymmetric threats in the air domain such as unmanned aerial vehicles (UAVs), popularly known as drones, as well as rocket, artillery, and mortar (RAM) fires becoming more ominous, GBAD is perhaps more relevant than ever. After all, it is better suited to deal with these two threats compared to traditional fighter planes and would complement the latter well in the overall scheme of things.⁴

The air war over Nagorno-Karabakh in autumn 2020 offers three broad takeaways (two material and one nonmaterial) for Singapore's military planners as they fine-tune the city-state's Island Air Defense (IAD) system going forward.⁵ The three lessons are: (1) an integrated air defense system is critical; (2) the role of electronic warfare should be accentuated; and (3) the human factor is key, and it underpins the other two factors. To be sure, these insights—which should be applicable to any state's air defense—are hardly groundbreaking, for various other commentators have already made them—but only in relation to major powers such as the United States and medium powers in Western Europe.⁶ This analysis therefore adds to the discourse on the lessons of Nagorno-Karabakh 2020 by distilling what is pertinent from the war for Singapore.

Although the war in the Caucasus seems far-flung from Singapore both geographically and in terms of their respective security environments, the conflict is relevant to the Southeast Asian state in that it offers valuable broad insights on how better to strengthen its defense against unconventional aerial challenges that may surface *beyond the near future*. This is in view of the potentially volatile strategic environment in Singapore's immediate environs, whose security outlook seems

fairly optimistic for the near future, but it is anybody's guess beyond that.⁷ What is more, the increasing democratization of technology going forward would enable malign entities, *perhaps in the more distant future*, to gain access to higher-end capabilities, especially in terms of unmanned systems, which could be used to threaten Singapore's interests. Indeed, this is a point not lost on members of the republic's defense establishment.⁸ Ultimately, the Lion City's potential adversaries (whether state or nonstate) should be cognizant of the republic's overwhelming conventional military superiority and realize that to confront it head-on would likely be courting defeat. Therefore, expect asymmetric capabilities such as massed UAVs and RAM fires to dominate any aerial operational calculus of Singapore's likely foes.⁹ All that being said, before delving into the three insights, a short account of Nagorno-Karabakh 2020 is in order.

Brief Overview of the War

The fighting in 2020 between Azerbaijan on one side and Armenia as well as the self-proclaimed Republic of Artsakh on the other was the most recent escalation of tensions over the much-disputed Nagorno-Karabakh enclave.¹⁰ This clash of arms, variously known as the "second Nagorno-Karabakh War" or the "Six-Week War," began on 27 September 2020 when Baku launched an offensive into the southern Nagorno-Karabakh with the aim of conquering that area's less mountainous districts. In the words of one expert, Yerevan was "out-fought, outnumbered, and out-spent" in the war.¹¹ Forty-four days later, on 10 November 2020, a cease-fire agreement was signed whereby Baku emerged as the clear victor. Among other terms, Azerbaijan was allowed to retain control of land captured during the war. What is more, all Armenian-occupied territories surrounding Nagorno-Karabakh were ceded back to Azerbaijan by 1 December 2020. Currently, some 2,000 Russian peacekeepers are stationed along the strategic Lachin Corridor between Armenia and Nagorno-Karabakh.

The toll of the war was high. There were more than 6,000 combat deaths (about 3,360 Armenians and 2,820 Azeris), as well as some 150 civilians killed.¹² Yerevan also suffered much heavier matériel losses. While definitive information about the war is limited (and is still being revealed with the passage of time), an informed source puts Armenian equipment losses as including 245 main battle tanks, while the corresponding figure for Azerbaijan is only 36.¹³ A similar disparity—profoundly in favor of Baku—is also seen in other categories such as artillery pieces and infantry fighting vehicles lost.¹⁴ Azeri dominance in the air through its UAVs is one key factor behind this lopsided state of affairs. Uzi Rubin, the first director of the Israel Missile Defense Organization, describes the war as "the first post-modern conflict, in that it was the first in which unmanned aircraft overwhelmed

a conventional ground force, grinding it down to the point of impotency and paving the way for the Azeri ground forces to roll in.”¹⁵ And what underpins this was the neutralization of Armenia’s (weak) air defenses, largely by Azeri drones. This constitutes the war’s first lesson for Singapore’s GBAD and will be discussed next.

Takeaway 1: Air Defense Must Be Integrated

According to a report by the Center for Strategic and International Studies, the primary lesson from the air war over Nagorno-Karabakh is the necessity of an integrated air defense system (IADS) to counter modern aerial threats.¹⁶ Such a setup, with different layers of modern and well-networked capabilities, would better enable handling the plethora of challenges ranging from traditional jets on one end to UAV swarms on the other.

Armenia did not have such a system in place during the war, and this contributed profoundly to its defeat in the field. While Yerevan possessed various GBAD capabilities for different threats, those capabilities were not properly integrated. It is a truism in air defense planning that simply owning individual capabilities to counter a range of threats does not translate automatically into an IADS.¹⁷ To compound matters, most Armenian surface-to-air missile (SAM) platforms were designs several decades old. For example, the Soviet-designed short-range 9K33, which was fielded in the early 1970s, was the mainstay of Karabakh’s air defense. To be certain, Yerevan had made upgrades to this system throughout the years, but the inescapable fact is that these tweaks improved incrementally at best a Cold War relic. It is also telling that Armenia’s most capable SAM—the long-range but 40-odd-year-old S-300—was conceived to handle higher-end threats such as larger-signature manned aircraft (which played a minuscule role on either side in the conflict). However, the S-300 was unsuited to counter smaller UAVs such as the Israeli-made Harop loitering munitions and the Turkish-made TB2 drones in Baku’s arsenal. In fact, Azeri UAVs managed to destroy undetected several Armenian S-300s.

A credible short-range air defense (SHORAD) system is what is needed to alleviate the drone threat, and there was a substantial Armenian capability gap in this regard during the conflict. After all, Yerevan’s SHORAD inventory consisted largely of the obsolescent 9K33s. What is more, Armenia did not seem to take heed of the Azeris’ nascent UAV fleet following the latter’s exploits during the 2016 Four-Day War and continued to let its decrepit SHORAD capabilities wither in the period since.¹⁸ The exploits of drones in various Middle Eastern and North African conflicts in recent years should also have made Armenia’s military bigwigs sit up and take note, but this did not seem to be the case.¹⁹ It is telling

that Yerevan had bought 27 secondhand 9K33s from Jordanian sources for \$35 million as recently as January 2020. Unsurprisingly, Azeri drones destroyed many of these Armenian platforms during the fight for Nagorno-Karabakh.²⁰ To be certain, experts have urged caution over reading too much into the ascendancy of UAVs over GBAD in the war, as this was achieved under highly favorable conditions unlikely to be repeated elsewhere, but the fundamental lesson of the relevance of an IADS still holds true.²¹

This takeaway about Armenia's unintegrated and obsolescent air defenses therefore affirms Singapore's prudence in constituting a sophisticated, layered, and networked system in the form of the Island Air Defense setup.²² In principle, at least, the IAD is properly designed and integrated to function in the twenty-first-century air domain. The Singapore Ministry of Defense (MINDEF) states that the IAD system is "multi-layered, networked, and intelligent," adding that it "integrates advanced sensors, capable weapon systems, command and control elements, and decision-making tools."²³ A sophisticated Combat Network fuses these components of the IAD into an integral whole. MINDEF also says that the IAD is "capable of neutralising a wider spectrum of air threats to protect Singapore's skies day and night."²⁴ On that note, given the rising threat posed by UAVs and RAM fires, it is laudable that the Island Air Defense system pays close attention to capabilities that would be instrumental in countering those two threats. After all, there is a capability overlap between the anti-UAV and -RAM portfolios. In this regard, the IAD has credible assets. Regarding sensors, for example, the Agile Multiple Beam Radar is designed for surveillance of drones and RAM fires. As for shooters, the IAD has the high-tech SPYDER SAM platform.

However, deploying the latter, with its limited missile magazine capacity (of only four weapons), against massed drones/air munitions would put Singapore on the much-talked-about "wrong side of the cost curve."²⁵ Put simply, it would be financially unfeasible to deploy SAMs priced at many thousands of dollars or more against targets costing much less. On this note, Defense Minister Ng Eng Hen of Singapore has stated that it would neither be "proportionate cost-effective nor sustainable" to use sophisticated assets to take down improvised aerial threats such as hobbyist drones.²⁶

It bears consideration that the drones used in the September 2019 attack on Saudi oil installations had a unit cost of \$20,000 or less, while Riyadh's Patriot SAM that should have protected the kingdom against attack but did not for various reasons was priced at \$3 million.²⁷ In the same vein, engaging with pricey missiles \$800 per unit homemade rockets, such as the Qassam frequently used by Palestinian militants, does not make much financial sense.²⁸

It is also worth noting that Indonesian authorities in August 2016 foiled a jihadist plot to launch rockets from the Indonesian island of Batam at Singapore's upscale Marina Bay area. It is not known what kind of weapons the Islamic State-linked militants possessed. Nevertheless, experts maintain that, for the attack to succeed, it would necessitate capabilities of higher sophistication than the Qas-sam.²⁹ However, even if such weapons cost significantly more, they would still seem low-cost in comparison should they be engaged with high-end missiles.

Looking ahead, as mentioned earlier, advancements in dual-use technologies and their increasing off-the-shelf availability portend cheaper yet more lethal weaponized drones. The democratization of technology could also accentuate the RAM threat to Singapore. Therefore, what is needed is a solution to put the defender on the correct side of the cost curve. Singapore's IAD system, which has been based solely on missiles ever since its 35mm Oerlikon guns were phased out years back, is possibly one area for improvement. Interestingly, recent editions of the *Military Balance* cite Singapore as possessing anti-aircraft artillery (AAA), but this capability is not listed in the RSAF's order of battle on the MINDEF website.³⁰ The flagship publication of the International Institute of Strategic Studies, however, lists the 20mm GAI-C01 cannon in the city-state's inventory. Even if Singapore does have the GAI-C01, it is unsuited to counter swarm threats given its relatively small magazine size and low rate of fire.

In view of the massed drone/RAM threat, some have argued that there should be perhaps greater emphasis placed on cost-effective solutions. For one, Mike Yeo asserts in a piece for the Singapore state media outlet *CNA* that Singapore should consider reintroducing the old-fashioned AAA—in its modern incarnations, of course.³¹ Citing the Phalanx and Skyshield, he is on point, as such weapons have a much higher rate of fire—a vastly desirable attribute against swarms—compared to missile launchers, and the interceptors AAA use have a much lower unit cost in comparison to missiles.³² AAA is useful as it meets both the anti-drone and RAM requirements. What is more, certain anti-aircraft gun platforms, such as the Oerlikon Skyranger 30, can also engage ground targets.³³ Thus, beside further strengthening the IAD, the AAA capability could also dovetail with the trope of “doing more with less (or the same)” in Singapore's military discourse given the city-state's projected manpower shortfalls.³⁴

Takeaway 2: Electronic Warfare Is Crucial in the Antidrone Effort

Another salient point about the Nagorno-Karabakh air war is how easily Azeri UAVs took out many Armenian air defense systems. That Azeri drones managed to remain undetected at close range might hint at electronic warfare (EW), which blinded Armenian radar.³⁵ After all, there were instances where Armenian radars

could not pick up the Azeris' Turkish-made TB2 unmanned aircraft, which has a significant radar signature.³⁶ In fact, the Turkish-made Koral EW system was possibly used to enable Azeri drone operations akin to what Turkish forces did in Libya and Syria. And much like how electronic warfare could “kick down the air defense door” of the enemy, the other side of the coin is that it also provides for a credible air defense—and therein lies the next lesson from the second Nagorno-Karabakh War: EW contributes to a credible antidrone edifice. Indeed, Michael Kofman of the CNA Corporation avers that it is “a truism that air defense should be supported by electronic warfare and specialized counter-unmanned aircraft systems.”³⁷ This view is echoed by Russia, which has experience in dealing with hostile drones in theaters such as Syria and Ukraine. According to the Russian defense ministry, a robust EW suite is central to the “echeloned defense” deemed adequate against UAVs.³⁸

Analysis of Armenia's EW performance against enemy drones paints a largely dismal picture. One analysis contends that Armenian EW was “completely incapable of hindering UAV operations over Nagorno-Karabakh even in the slightest way.”³⁹ Another, more balanced report notes that Yerevan's Russian-made Polye-21 jammer had some success, but only for a few days.⁴⁰ That Armenia's counterdrone EW capabilities could be inherently ineffective could explain their travails; there could also be the issue of “operator fault,” discussed in the next section.

Nevertheless, there is definitely a place for EW in a counterdrone system given that most UAVs are reliant on data links to function. In fact, even the high-end unmanned platforms of the American and British militaries have faced challenges in Syria from Russian EW.⁴¹ However, as one study incisively puts it: “EW alone, however, is no panacea and needs to be integrated with other air defense systems to effectively defend against aerial threats.”⁴² It should also be noted that electronic warfare has limited effects on UAVs utilizing the Global Positioning System for navigation. These vehicles could fly a preprogrammed route to its target and need not communicate with their operators. Under such circumstances, a kinetic response might still be necessary.

Coming back to the Singapore context, Yeo has correctly stressed the need for the republic's IAD to defend against EW being applied against it considering its role in the Nagorno-Karabakh War.⁴³ The flipside of the issue is true as well, and one way the role of electronic warfare in Singapore's Island Air Defense should be accentuated is through the acquisition of dedicated EW assets. Currently, the IAD does not possess a stand-alone EW component (as opposed to one this is organic to another platform such as the republic's F-15SG multirole jet and *Formidable*-class frigate). This is so according to open sources, such as the infographic on the IAD that MINDEF has released.⁴⁴ In the same vein, according to

the 2021 edition of the authoritative *Military Balance*, the Lion City's armed forces do not own any dedicated EW platforms whatsoever.⁴⁵

Obtaining individual EW capabilities would layer another level of redundancy into Singapore's air defense system. However, acquiring single-role platforms such as a standalone EW asset would seem counterintuitive considering the Singapore military's desire of "doing more with less." Nevertheless, this issue is something that bears deliberation for Singapore's military planners given the increasing significance of electronic warfare (and not just for air defense purposes) in the twenty-first-century operational environment. At the very least, there should be a conversation about the possibility of acquiring dedicated air defense platforms with some EW capabilities, such as the Oerlikon Skyranger 30.⁴⁶

Singapore's IAD setup should also emphasize electronic warfare given that another appeal of the latter reduces collateral damage. While kinetic measures (whether they be missiles or AAA shells) certainly have a place in any air defense system, stray projectiles, jettisoned missile boosters, or remnants of a successful missile kill could land on civilian areas. In fact, the risk of collateral damage from these due to Singapore's highly urbanized and built-up landscape could potentially be more serious than anything inflicted by the hostile platform itself. Indeed, a jettisoned missile booster over the republic's highly industrialized Jurong Island or the Senoko Power Plant on mainland Singapore itself could be disastrous.⁴⁷

All that being said, Singapore's aerial threat landscape currently and in the near future does not necessitate the utmost urgency in acquiring AAA and/or EW assets, as the most pressing security challenges the city-state faces do not emanate from the air domain. Of course, circumstances can change. For example, Indonesia could significantly beef up its armed UAV fleet, which currently stands at only six Chinese-made Rainbow CH-4s.⁴⁸ Or Malaysia could procure longer-range munitions for its Astros II multiple rocket launchers that could target its southern neighbors from farther out.⁴⁹ Additional electronic warfare and/or anti-aircraft gun capabilities are useful to the extent that they add more layers of insurance to Singapore's already credible IAD setup.

Takeaway 3: The Human Factor is Key

The Armenian side clearly did not show a serious attitude to the preparation of defense, long-term fortification, camouflage, reconnaissance. Moreover, all these shortcomings in Armenian planning were noticeable even during previous outbreaks of conflict with Azerbaijan, starting in 2016, but Armenia did not draw any conclusions.

—Vasily Kashin

These words, by Carnegie Moscow Center's Vasily Kashin, are echoed by various other pundits who maintain that Armenian military personnel did not carry

themselves well against Azerbaijan and that this contributed substantially to Armenia's defeat.⁵⁰ One expert poignantly notes that, while Baku revamped its military instrument, this was hardly the case for its adversary, which was "preparing its army for military parades."⁵¹ Although such comments are directed at the Yerevan's military as a whole, they also apply to its GBAD force or any other military arm. And this brings us to the third and arguably the most important takeaway for air defense from the second Nagorno-Karabakh War: the aphorism that "the human factor is the most crucial in warfare" must be always borne in mind. Ultimately, the most exquisite military capability is only as good as its handler. One may possess on paper the best EW, SAM, or any other capability, but all would be for naught if their users lack competency.

Examples abound of how Armenian forces often appeared tactically inept and disorganized in the field. For instance, former U.S. Army officer Robert Bateman writes in *Foreign Policy* that armored platforms were often found "clumped together in tight clusters . . . not maneuvering while dispersed widely as the conditions in combat would warrant," and this is evidence of poor training and/or general tactical incompetence.⁵² It will be surprising if Yerevan's air defense forces were an exception to this. According to an informed source's account of the travails of Armenian SAM sites: "During the war, Bayraktar TB2s literally flew circles near three S-300 sites while waiting for the ballistic missiles and loitering munitions directed against them to strike their targets before doing damage assessment and flying away. Shockingly, the launchers in some of these SAM sites were not even in deployment mode, as if no war was going on in the first place."⁵³

The last sentence, on the total lack of combat readiness, is particularly noteworthy, especially for a country that was in the middle of a war. While Azeri EW could explain this anemic situation, it is also conceivable that operator ineptness was responsible.⁵⁴ One Armenian commentator also makes an informed speculation that his country's GBAD personnel could suffer from "lack of situational awareness."⁵⁵ Armenian battlefield incompetence in terms of air defense could also be seen in the fact that the SAMs were deployed in "relatively exposed fixed positions, in a mountainous region where air defense is even more difficult by virtue of the terrain."⁵⁶ To be sure Azeri forces also displayed signs of field ineptness, especially during the initial stages of the war.⁵⁷ However, these were arguably mitigated to some degree by their material superiority.

There were already cautionary tales of operator fault vis-à-vis air defenses prior to the second Nagorno-Karabakh War, and Armenia ostensibly did not heed them. For one, think of how the lack of training time by Syrian forces on their Russian SAM systems has bedeviled air defense over their country in recent years. In the same vein, Saudi Arabia owns on paper a high-end air defense system

made up of Western assets such as the American Patriot SAM. Operator fault due to lack of proficiency, however, contributed to the failure of Riyadh to defend against the September 2019 drone and cruise-missile strike.⁵⁸ Last of all, the tragic accidental shootdown of a Ukrainian airliner in January 2020 by Iranian forces shows how complex and error-prone air defense can be, even with a modern SAM system such as the Russian-made Tor-M1.

Relating this lesson about the centrality of the human factor to the Singapore context, the republic's air defense chieftains should consider measures to beef up the "soft" aspects of the Island Air Defense edifice. One way to do this is to hold a drill that tests the IAD system in its entirety against unconventional aerial threats such as massed drones/RAM fires. (Let us just call this notional "Exercise Red Aegis" in reference to its protective nature as well as one of the city-state's two national colors.)

To be sure, the Lion City has held major air defense drills in recent years, but they were not directed against UAV/RAM threats. Case in point: Exercise Vigilant Shield.⁵⁹ This whole-of-government event (the police and civil aviation authority were also involved on top of air force jets and GBAD units), last held in 2019, stimulated responding to a passenger plane hijacked by terrorists. In years past, the RSAF also held the Flaming Arrow Challenge, which pitted land-based air defense units against one other. However, it merely tested these units' "ability to engage fighter aircraft and helicopters simulating as aerial threats" and not explicitly against nontraditional challenges such as massed UAVs and RAM fires.⁶⁰

Another element of Exercise Red Aegis should be to incorporate the newest capabilities introduced into Singapore's Island Air Defense system, an example being the Aster-30 SAM system. After all, the most recent iterations of Exercise Vigilant Shield and the Flaming Arrow Challenge saw the venerable I-HAWK SAM deployed, and this is a capability that is gradually being replaced by the Aster-30. Red Aegis should also purposely allow "leakers" past the outer rings of the IAD to better gauge its SHORAD performance, which would be crucial in defending against drones. To be certain, an endeavor such as Red Aegis would take up a great deal of time and resources in terms of planning and execution. However, it is arguably the only way to test the credibility of a system that was conceptualized in 2006 and will continue to serve Singapore for decades to come. Equally significant is the fact that a well-run Red Aegis would no doubt strengthen deterrence and make potential malign actors think twice about targeting Singapore with unconventional air threats.

Overall, the centrality of the human factor in warfare cannot be overemphasized, and one critique of the 2020 Nagorno-Karabakh War and its lessons for the American military makes the following points, which are just as applicable to the

Singapore context (or any nation's armed force): "Materiel solutions are not enough by themselves. Nonmatériel solutions (e.g., doctrine, training, etc.) must be synchronized with materiel to maximize their effectiveness. The right system with the wrong TTPs [tactics, techniques, and procedures] for employment will be ineffective."⁶¹

This brings us to another instructive point made about the importance of the soft elements for air forces (or any military entity in general): "[I]n its totality, airpower is a complex amalgam of equipment and less tangible but equally important enabling ingredients bearing on its overall effectiveness, such as employment doctrine, concepts of operations, training and tactics, leadership quality, adaptability, operator proficiency, boldness in execution and practical combat experience. . . . They also largely account for why some air forces are simply better and more combat effective than others."⁶²

The Singapore Armed Forces (SAF) no doubt already has the hardware. But the software is especially important for Singapore given that its military is a relatively small one in terms of numbers. In such an organization, the competence (or lack of it) on the part of its personnel would be amplified.

Conclusion

In the final analysis, the Caucasus and Singapore are certainly worlds apart in many ways. Besides the more than 7,000 kilometers separating them, a high-intensity clash along the lines of Nagorno-Karabakh 2020 is extremely unlikely to occur in Singapore's environs in the near future given the current trajectory of regional geopolitics. A conflict of this nature involving the Lion City would be the rarest of black swans. And there is a danger that the recent Armenia-Azerbaijan duel has unique features that make generalizations difficult, and there is the risk that the wrong observations will be drawn from it. Nonetheless, the conflict offers valuable general takeaways for Singapore's military planners in various aspects going forward, not least in terms of air defense.

Three insights, which cut across any GBAD force, stand out: (1) the cruciality of an integrated air defense system against modern aerial threats; (2) the role of electronic warfare should be accentuated, especially in the light of the rising drone challenge; and (3) the human factor is key, as it matters most in any military entity. In an ideal world, the Singapore government could heed *all* the suggestions put forth above by procuring anti-aircraft guns and electronic warfare capabilities, as well as running a full-scale drill involving the Island Air Defense system. The main challenge in implementing these suggestions, if it comes to that, would be resource limitations. While Singapore has often spent generously on defense, hard choices must be made in the real world. A dollar spent on a certain area or capa-

bility means a dollar less in another place, unless MINDEF's share of the budget pie could be enlarged. Indeed, as the Singapore Armed Forces transitions toward a next-generation fighting force as per the SAF's 2030 vision, acquisitions of new land and naval platforms, not to mention a possible purchase of more F-35B jets, will impact whether the suggestions put forth in this analysis can be implemented.⁶³ Ultimately, it boils down to Singapore's more pressing defense needs. While more assets such as fighter planes no doubt strengthen the Lion City's deterrence, a case can also be made for its GBAD force, especially in view of the changing operational environment.

Speaking in December 2020 on the IAD's completion, Singapore Defense Minister Ng said: "Even with these air defense systems, you can never be immune. But you can significantly reduce the level of threat so I take great comfort in that."⁶⁴ Incorporating even partially the above-mentioned insights from the second Nagorno-Karabakh War should go some way toward making the IAD more future-ready and alleviate even greater aerial threats. After all, as Yeo puts it: "[J]ust because the system appears ready to deal with potential adversaries today, it would be foolish to assume that the status quo would hold in the long or even medium term."⁶⁵ On that note, in an essay on black swans penned by three RSAF officers, they rightly state that "[e]ven if solutions [to such low-probability scenarios] are impractical or prove to be too costly to implement, the very fact that debates and discussions have been carried out would already enhance the preparedness of the commanders and planners."⁶⁶ Thus, at the very least, just bringing the three main takeaways into Singapore's air defense discourse should stand the republic in good stead as the Lion City, in Ng's words, looks "towards the next phase of the Island Air Defense System . . . to threats that are not only on horizon, but I am sure will be developed over the years."⁶⁷

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Notes

1. Western observers have often lauded Singapore's air force. To illustrate, a 2011 analysis describes the RSAF as "Southeast Asia's preeminent air power: capable, well balanced, technological advanced, and staffed by skilled personnel." It adds that "[a]dvanced weapon systems are complemented by excellent indigenous technical services, a first-class training organization, and modern command control practices." Alan Stephens, "The Asia Pacific Region," *Global Air Power*, ed. John Andreas Olsen (Lincoln, NE: Potomac Books, 2011), 327. Similarly, a 2020 report speaks of the RSAF as "unmatched" among regional air forces. Greg Waldron, "Singapore's Air Force Eyes Long-Term Challenges," *FlightGlobal*, 4 February 2020, <https://www.flightglobal.com/>.

2. *The Military Balance 2021* (London: International Institute of Strategic Studies, 2021), 298.

3. With Singapore joining the F-35 club, the republic will be the first in Southeast Asia to operate fifth-generation aircraft. For the possible reasons behind the purchase, see Ben Ho, "Analysing Singapore's F-35B Acquisition," *Asian Military Review*, 2 April 2020, <https://asianmilitaryreview.com/>.

4. RAM munitions are simply too fast for fighters to counter. The latter may also have difficulty keeping station and maintaining visual contacts with low-flying and relatively slow drones, which is why the Apache helicopter gunship typically used in surface attack also has an air-defense portfolio in the RSAF. See Mike Yeo, "Singapore Confirms It's Using Apache Helicopters in Air Defense Role," *Defense News*, 13 February 2018, <https://www.defensenews.com/>.

5. For a concise and cogent analysis of the aerial domain in the second Nagorno-Karabakh War, see Shaan Shaikh and Wes Rumbaugh, "The Air and Missile War in Nagorno-Karabakh: Lessons for the Future of Strike and Defense," *Center for Strategic and International Studies*, 8 December 2020, <https://www.csis.org/>.

6. A good source for the lessons for US armed forces would be Nicole Thomas, Matt Jamison, Kendall Gomber, and Derek Walton, "What the United States Military Can Learn from the Nagorno-Karabakh War," *Small Wars Journal*, 4 April 2021, <https://smallwarsjournal.com/>. For the war's relevance for medium powers, the following video conference is particularly thoughtful: International Institute of Strategic Studies, "The Nagorno Karabakh Conflict: Military Lessons for Middle Powers," *YouTube*, 18 December 2020, <https://www.youtube.com/>.

7. Chinese-majority Singapore is sandwiched between two Muslim-majority states, Malaysia and Indonesia. Over the decades since Singapore's independence in 1965, bilateral ties with its two neighbors have occasionally been fraught with tensions over various issues. While the near-term regional security outlook for Singapore seems positive, the volatile nature of regional geopolitics means that the situation could deteriorate unexpectedly.

8. To illustrate, when asked during a media interview about the aerial challenges Singapore faces in the future, Defense Minister Ng Eng Hen stressed the need to "deal with the whole spectrum," whether the threat be "longer range munitions, as we saw for example in the missiles [attack] against the oil depots in the Middle East, or non-traditional from terrorist attacks, things that you can buy on the web, or the dark web." "Transcript of Doorstop Interview with Minister for Defence Dr Ng Eng Hen During Visit to RSAF Island Air Defence Operations," *MINDEF Singapore*, 17 December 2020, <https://www.mindef.gov.sg/>. In recent years, a number of RSAF officers have also spoken of the need to counter aerial asymmetric threats such as massed drones, as they argue in *Pointer*, the official journal of the Singapore Armed Forces. See, for example, Captain (CPT) Daryn Koh, "How Singapore and the SAF Can Get Ready for the Era of Swarm UAVs," *Pointer* 46 No. 2 (2020): 32–42; Lieutenant-Colonel (LTC) Ho Sen Kiat, Major (MAJ)

Lee Mei Yi, and CPT Sim Bao Chen, “The Emergence of Small Unmanned Aerial Systems: Opportunities and Challenges,” *Pointer* 44 No. 2 (2018): 35–44; as well as LTC Ong Tiong Boon, MAJ Joseph Peh, and CPT Daxson Yap, “The Future of Singapore’s Ground-Based Air Defense,” *Pointer* 40 No. 2 (2014): 14–23.

9. Unconventional aerial threats to the city-state are not new. In 2016, for example, Indonesian jihadists plotted to fire a rocket at a popular Singapore waterfront. And in 2002, extremists planned to hijack a plane and crash it into the republic’s Changi Airport. See Kanupriya Kapoor, “Police Find Bomb-Making Materials for Alleged Singapore Attack,” *Reuters*, 6 August 2016, <https://www.reuters.com/>.

10. For a thoughtful overview of the conflict and its genesis, see Cory Welt and Andrew S. Bowen, *Azerbaijan and Armenia: The Nagorno-Karabakh Conflict* (Washington, DC: Congressional Research Service, 2021).

11. John Antal, “The First War Won Primarily with Unmanned Systems: Ten Lessons from the Second Nagorno-Karabakh War,” *United States Special Operations Command*, <https://www.socom.mil/>.

12. Welt and Bowen, *Azerbaijan and Armenia*, 11.

13. Stijn Mitzer and Joost Oliemans, “The Fight for Nagorno-Karabakh: Documenting Losses on The Sides of Armenia and Azerbaijan,” *Oryx* (blog), 27 September 2020, <https://www.oryx-spioenkop.com/>. The *Oryx* military affairs blog is considered one of the most authoritative open sources when it comes to documenting losses on both sides during the second Nagorno-Karabakh War.

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16. Shaikh and Rumbaugh, *The Air and Missile War in Nagorno-Karabakh*.

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33. Paolo Valpolini, "Rheinmetall Air Defence Unveils Its Skyranger 30 (Upgraded)," *European Defence Review*, 3 March 2021, <https://www.edrmagazine.eu/>.
34. "Speech Transcript by Minister for Defence Dr Ng Eng Hen at the Ministry of Defence Committee of Supply Debate 2018," *MINDEF Singapore*, 30 June 2018, <https://www.mindef.gov.sg/>.
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36. Rubin, 13.
37. Kofman, "A Look at the Military Lessons of the Nagorno-Karabakh Conflict."
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39. Stijn Mitzer and Joost Oliemans, "Aftermath: Lessons of The Nagorno-Karabakh War Are Paraded Through the Streets of Baku," *Oryx*, 26 January 2021, <https://www.oryxspioenkop.com/>.
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42. Franz-Stefan Gady and Alexander Stronell, "What the Nagorno-Karabakh Conflict Revealed About Future Warfighting," *World Politics Review*, 19 November 2020, <https://www.worldpoliticsreview.com/>.
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45. *The Military Balance 2021*, 297–98.
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48. Ridwan Rahmat, “Indonesia Receives First Batch of Chinese-Made AR-2 Missiles for Its CH-4 UAVs,” *Janes*, 13 April 2021, <https://www.janes.com/>.

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51. Sergey Sukhankin, “The Second Karabakh War: Lessons and Implications for Russia (Part One),” Jamestown Foundation, 5 January 2021, <https://jamestown.org/>.

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64. “Transcript of Doorstop Interview with Minister for Defence Dr Ng Eng Hen During Visit to RSAF Island Air Defence Operations,” *MINDEF Singapore*, <https://www.mindef.gov.sg/>.

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66. LTC Goh Sim Aik, Military Expert 4 Soon Yi Xiang, Andrew, and CPT Vanessa Lim, “Black Swans Need Not Be Black: Preparing the RSAF to Succeed in Spite of Future Uncertainties,” *Pointer Supplement: Beyond the Horizon: Forging the Future RSAF* (2016), 67.

67. “Transcript of Doorstop Interview with Minister for Defence Dr Ng Eng Hen During Visit to RSAF Island Air Defence Operations.”

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