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AIR POWER CONSIDERATIONS FOR A SMALL STATE

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INTRODUCTION

Air power has, over its century of existence, matured from experimental status to a preferred, versatile, and rapid instrument of military power for states, able to deliver effects in various offensive as well as defensive roles, from bases outside the conflict area.[1] The development from the haphazard flight of the Kitty Hawk to "an F-22 Raptor or a B-2 Spirit able to stealthily dispense 60 JDAM to specific addressees" is a remarkable development that should be accompanied with similar development in theory and strategic thought.[2]

Air power in this article draws on the definition by Gray, "The ability to do something strategically useful in the air".[3] Hence, air power is neither limited to flying platforms and weapons, nor to air force assets alone. A Ground-Based Air Defence (GBAD) system contributes to air power regardless of its organisational place. Likewise, if a strike at an air base is delivered by cruise or ballistic missiles, it is still a matter for air power since the strike is

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1. John A. Olsen, "Introduction", in John A. Olsen, ed., *Routledge Handbook of Air Power* (London: Routledge, 2018), pp. 1-5.
2. Colin S Gray, *Air Power for Strategic Effect* (Air University Press, Air Force Research Institute, Maxwell Air Force Base Alabama, 2012), p. 262.
3. Ibid., p. 276.

A small state can tailor its air power design to better effect by using its geography and teaming up with a partner, combining multi-role aircraft with GBAD, and nourishing domestic aircraft industries.

delivered in the air domain. How can small states tailor air power skillfully for sustained effect? As Higham and Harris point out early in *Why Air Forces Fail*, using Taylor Mahan's tools for analyses is a good start. For the study of air forces specifically, recommended additions are "location and sufficiency of air bases, the terrain they overfly, the efficiency ratings of machines and weapons, and the political managerial factor".[4] To cut a reasonable portion for this article, the political managerial factor will be left out. The article will cover geographical aspects and several angles on the machines and weapons. Consequently, the article does not comprehensively cover what Higham and Harris recommend but aims to present interesting findings within a more limited scope and provide further granularity to their recommendations. Further, as Pashakhanlou rightly observes, "Due to the inherent limitations of social science, definitive predictions cannot be made".[5] This article maintains the same caution and, in similar manner, seeks to recommend efforts that make a small state more likely to succeed, and not to deterministically assure such outcomes.

More specifically, this article argues that a small state can tailor its air power design to better effect by using its geography and teaming up with a partner, combining multi-role aircraft with GBAD, and nourishing domestic aircraft industries. Similarly, developing an agile Observe, Orient, Decide, Attack (OODA) loop[6] and taking advantage of Unmanned Aerial Vehicle (UAV) systems is beneficial. Further, mobility should be considered as a vital functionality regarding important assets and a system of ballistic missiles/ missile defence is a strong addition to deterrence. To demonstrate how these

4. Robin Higham and Stephen John Harris, *Why Air Forces Fail: The Anatomy of Defeat,* Revised and expanded edition (Lexington, Ky: University Press of Kentucky, 2016), pp. 1-7.
5. Arash Heydarian Pashakhanlou, "The Underdog's Model: A Theory of Asymmetric Airpower", *Air & Space Power Journal*, vol 35, issue 4, Winter 2021, p. 8.
6. A cognitive process; Observe, Orient, Decide, Act (OODA) for decision-making.

factors are important, the article first presents each argument based on the theoretical stance and then draws from three case studies, Israel, Singapore, and Norway, to present evidence to support the thesis. Finally, conclusions and recommendations are presented in the form of dicta.

The situation for each state in conflict is unique, and theory and best practice can bring only guidance, not definite answers.

The article is based on secondary sources and open-source material; no classified information has been incorporated. Consequently, there are limitations to the depth of the data and how strong the conclusions drawn from the study can be. However, even a small step, consciously taken in the right direction is valuable and the article aims to make an addition to the air power discourse related to small states. Bearing Gray's caution in mind, the situation for each state in conflict is unique, and theory and best practice can bring only guidance, not definite answers.[7]

LITERATURE REVIEW

The main body of air power theory emanates from the Anglo-Saxon world and deals with air power from the perspective of Europe or the USA. The early thinkers leaned towards strategic bombing, targeting of the population or the enemy forces, or enemy supply lines. During the second part of the 20th century, Boyd[8] added the theoretical perspective concerning manoeuvre warfare and the related cognitive processes, OODA, highlighting the importance of relative tempo. Subsequently, in the era of precision strike and stealth, Warden[9] brought the systemic approach and the Five Rings Model, which led to a revival for the strategic air strike.

7. Gray, n. 2, pp. 301-303.
8. More insight on John Boyd is available in Grant T Hammond, *The Mind of War, John Boyd and American Security* (Washington: Smithsonian Books, 2001).
9. More details concerning Warden's theory is available in John Warden III, *The Air Campaign—Planning for Combat* (Washington: NDU Press, 1988), pp. 13-24, https://apps.dtic.mil/dtic/tr/fulltext/u2/a259303.pdf

The early 21st century saw Deptula[10] further structuring this approach into Effects-Based Operations (EBOs), where targeting and damage assessment were central, based on a thorough intelligence picture. Mostly, this body of theory builds on the ability to gain air superiority or air supremacy.[11] For a small state, this is not always suitable or even possible. The accessible literature on air power theory focussing on small states is sparse. One major contribution is *Strategy, Air Strike and Small Nations*, which discusses the limitations of small states but then narrows down to a strong argumentation for the capability to strike.[12] Another angle for understanding air power is learning from failure, as presented in *Why Air Forces Fail* by Higham and Harris in 2016, where examples from Poland and Argentina may be relevant for small states. Likewise, they offer a framework for analyses developed from Taylor Mahan's six criteria. Further analysis of the small state dilemma appears in "Air Strategy and the Underdog", which focusses on asymmetric methods of countering an overwhelming adversary.[13] This is a valuable complement but must be moderated with methods a small state may use in other situations. Just recently, the underdog theme is developed further into an "Underdog Model" with six factors where the underdog should strive to outperform the adversary to gain the upper hand: "(1) creativity, (2) self-sufficiency and external support, (3) commitment, (4) intelligence, (5) dispersion and concentration, and (6) the engagement of vulnerable military targets".[14] This model brings valuable tools for a small state's air power design, but also touches on areas outside the air domain and leaves out the important geographical aspect. Another contemporary study, *The Defence Capabilities of Small States*, draws on a comparison between Singapore and Taiwan, but studies the total defence capabilities and not just

10. Further regarding Deptula's theory in David A Deptula, "Effects-Based Operations – Change in the Nature of Warfare", *Defence and Airpower Series*, Aerospace Education Foundation, Arlington, 2001.
11. Philip S Meilinger, "Air Power Theory", in Olsen, ed., n. 1, pp. 1-5.
12. Shaun R. Clarke, *Strategy, Air Strike and Small Nations* (Aerospace Centre, RAAF Base Fairbairn, Australia, 1999).
13. Philip Sabin, "Air Strategy and the Underdog" in Peter W Gray ed., *Airpower 21*, C*hallenges for the New Century*, (London: The Stationary Office, 2000).
14. Pashakhanlou, n. 5, pp. 6 and 8.

air power.[15] In conclusion, small states are still underrepresented when it comes to literature specifically focussed on air power and what such a state should consider when designing its air power resources.

A SMALL STATE: A THIRD RANKED STATE?

When it comes to states, size is a relative matter. A small state like Sweden is, on the one hand, large in comparison to the Vatican state, but on the other, it is small considering that the pope is the spiritual leader of all the world's Catholics. Drawing from that, states can be small in different aspects, like geography, population, economy, and military power. The relative smallness is dependent on the context. One approach to structuring state power and size and ranking them in four categories is presented by Edström, et al. (2019). This article subsequently looks at the third of their categories,

> "The political leadership of a third ranked state recognises that it cannot obtain security against an attack from a first or second ranked state primarily by use of its own capabilities or lead and organise multilateral military operations. The political leadership of a third ranked state does, however, believe that it can defend itself against a third or fourth ranked state and that it can make significant contributions to multilateral military operations".[16]

The important thing in an air power context is that the small state lacks at least quantity and has limited means and resources. "Small nations know who they are", as Clarke writes, but for this article, a small state is still big enough to have a potent air force and instruments of air power.[17] In this article the "small state" equals the third ranked small state that Edström

15. Shang-su Wu, *The Defence Capabilities of Small States, Singapore and Taiwans's Responses to Strategic Desperation*, (Basingstoke: Palgrave Macmillan, Critical Studies of the Asia-Pacific Series, 2016).
16. Håkan Edström, Dennis Gyllensporre, and Jacob Westberg, *Military Strategy of Small States: Responding to External Shocks of the 21st Century* (London: Cass Military Studies, Routledge, 2019). http://search.ebscohost.com.proxy.annalindhbiblioteket.se:2048/login.aspx?direct=true&db=nlebk&AN=1881014&site=ehost-live. Accessed on March 22, 2021.
17. Clarke, n. 12, pp. 67-69.

et al. define. The cases examined in this article, Singapore, Norway, and Israel, are chosen because they fit the criteria above but are also distinctly different. The intention is to get a better understanding of how the air power considerations play out in different contexts. Geography, material, and adversarial aspects are distinctively different in these cases. The geography varies significantly in size, with Singapore being the smallest and Norway the largest, as well as in actual climate, vegetation, and outline. From a "material" perspective, they all have historical differences concerning platforms and systems, even if the trend is towards more similarity. One reason to choose Israel is the country's rich combat experience, which provides a benchmark for the others, even if context must always be considered. However, the case studies are not in-depth analyses of each country, rather a representative overview of characteristic elements in the selected aspects. Another important factor is the availability of unclassified information, which is deemed sufficient in these cases.

CONTEXTUAL AND METHODOLOGICAL LIMITATIONS

The use of air power has shifted over the years in parallel with developments in technology, the character of conflict, and doctrine. One approach to examining contemporary air power is to reference conventional warfare, counter-insurgencies, and PSO and R2P[18], as Fedorchak argues.[19] However, that approach does not directly focus on the air power of small states. Fedorchak finishes the analysis by presenting several medium to large state case studies, with Sweden being the sole representative of a small state. After an overview of Sweden's capabilities and personnel, Fedorchak concludes that greater inter-service integration and interoperability is favourable. Moreover, "smaller air forces can sustain a very multifaceted and capable air power".[20] Nevertheless, the optimum design for a small state's use of air power remains undistilled, even more so when considering category three states as defined by Edström et al. While the past 20 years have seen

18. PSO: Peace Support Operations, R2P: Responsibility to Protect.
19. Viktorya Fedorchak. *Understanding Contemporary Air Power* (London: Routledge, 2020).
20. Ibid., pp. 147-167.

a growing discourse related to ”small wars” or ”air power in small wars or low intensity conflict”, which often focus on counter-insurgency, PSO and R2P, and are largely based on experiences from conflicts like Afghanistan, Iraq, and Lebanon, the specific research approach of ”small states' use of air power in small wars” is still understudied. Consequently, material and literature related to “air power in small wars” is not the focus of this article, rather it is specifically the air power dilemma faced by small states that is the concern here. Specifically, this article focusses on providing more granularity to a few of Higham's and Harris' criteria with regards to a category three small state. The countries chosen for cases studies are intentionally diverse in nature and circumstance in order to illustrate a variety of challenges regarding the use of air power: Norway as a North Atlantic Treaty Organisation (NATO) ally posturing during the Cold War, Singapore as a city-state surrounded by competitive neighbours, and Israel surrounded since conception by existential threats. Notwithstanding, the chosen methodological path leads to a focus on national defence, while expeditionary use of air power tends to fall outside the scope.

This article neither provides a standard (measuring rod) for a small state's air power, nor draws on any such standard. Such an interesting and valuable framework analysis remains insufficiently explored in the discourse on air power of small states. Moreover, since this article confines its analysis to the Edström et al “category three” definition, not all small states are covered and thus any chosen standard would have to be modified. Furthermore, this article references Gray claiming that all air forces are distinct and there is no ”one size fits all”, wherefore any such standard would have to be used with great caution.[21] Further, for the analysis of a specific air power design, Gray recommends Mahan's criteria of: “(1) geographical position; (2) physical conformation, including, as connected therewith, natural production and climate; (3) extent of territory; (4) number of population; (5) character of the people; and (6) character of the government, including therein the national institutions”. Accordingly, this article provides more granularity in some

21. Gray, n. 2, pp. 301-303.

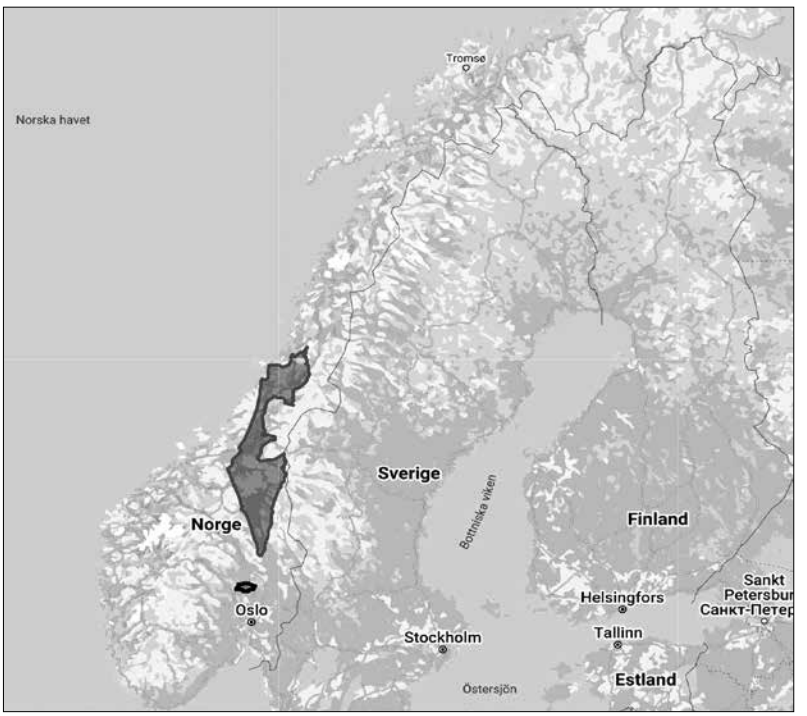
aspects of such an analysis, arguing that such granularity does not need a standard or measuring rod to be relevant.

AIR POWER CONSIDERATIONS COVERING GEOGRAPHICAL ASPECTS AND SEVERAL ANGLES ON THE MACHINES AND WEAPONS

Fig 1 gives a geographical introductory comparison between the case countries: Norway/Norge, Israel (grey), and Singapore (black).

This is a rudimentary illustration of the differences in size, made with the toolset at www.truesize.com, with the ambition to provide an idea of the differences related to strategic depth. Other layers like climate, land elevation and line of sight have to be added if a deeper analysis is the objective. Notwithstanding, the map is a good starting point.

Fig 1: Geographical Comparison: Norway-Israel-Singapore



Source: https://www.thetruesize.com

THE FIRST CONSIDERATION: EXPLOIT THE GEOGRAPHY AND FIND A PARTNER

From an air power perspective, geography provides a base area to operate from as well as sets timing conditions for detection, warning, response, and counterattack. Concerning air warfare, you count by minutes or seconds even at the centralised strategic level and it is normally favourable to fight over your own ground, giving you the upper hand concerning sensor and Command, Control, Communications, Computers, Intelligence (C4I) coverage while forcing the adversary to fight closer to the limits of his range. There are certain aspects of detail to consider here that mainly are given but anyhow harbour potential for possible improvement. Geography and basing options have great impact on air warfare. Built on the basing areas and the front battle lines, Warden argues that there are five cases of air superiority. The differences are related to whether one or either side can reach the adversary with attacks. In the best case, your airfields and rear bases are safe, but you can reach those of your adversary, while in the worst case the opposite situation prevails.[22] A small state is most likely looking at the worst case and must find ways to adapt.

A small state should, thus, maximise its basing and dispersal options. Greater geographical depth brings greater advantages regarding detection, tracking and possible actions against intruding aircraft. Depth can be present in all directions provided it is measured from adversary bases. This factor makes it possible for a small state to limit the damage from attacks through dispersal and redundancy, factors clearly identifiably as beneficial when "inferior air powers have been least vulnerable", according to Sabin.[23] A small state can increase the depth by several measures, the ways of mitigating differ according to the specific circumstances. Likewise, Pashakhanlou mentions Sweden's use of highways as a dispersal strategy in his Underdog Model.[24] When land isn't available, artificial islands can

22. John Warden III, *The Air Campaign—Planning for Combat* (Washington: NDU Press 1988), pp. 13-24, https://apps.dtic.mil/dtic/tr/fulltext/u2/a259303.pdf Accessed on April 26, 2021.
23. Sabin, n. 13, pp. 71-73.
24. Pashakhanlou, n. 5, pp. 6 and 18.

When land isn't available, artificial islands can be built to increase the depth and provide additional landing strips, as China has demonstrated. A dispersal strategy should also include engineering capabilities that can reconstruct bases previously attacked or improve temporary landings strips.

be built to increase the depth and provide additional landing strips, as China has demonstrated.[25] A dispersal strategy should also include engineering capabilities that can reconstruct bases previously attacked or improve temporary landings strips.[26] Further, efforts to conceal and deceive have been effective in the past and should also be incremental parts of the strategy. Even if the sensors on platforms are better today, there is still room for deception.[27] Moving to the external side, one option is to be granted basing access in neighbouring countries, either through bilateral agreements or by joining an alliance.

Geographically tiny Singapore, just 714 sq km, nevertheless has four air bases spread across the island from east to west.[28] Reaching approximately 30 miles across from east to west, at a speed of 620 miles per hour (mph) an overflight of Singapore takes less than five minutes.[29] The geography is flat, mainly lower than 15 m above sea-level.[30] Looking at dispersal and redundancy, Wu writes that the ability to absorb a first strike from an adversary has been developed, through "underground constructions" and "utilization of highways as alternative runways".[31] The Singaporean Air Force has a presence on several bases around the world. France hosts a squadron at Cazeaux, and

25. Luiz Martinez, "Why the US Navy Sails Past Disputed Artificial Islands Claimed by China", ABC News, May 6, 2019, at https://abcnews.go.com/Politics/us-navy-sails-past-disputed-artificial-islands-claimed/story?id=60993256. Accessed April 12, 2021.
26. Sabin, n. 13, pp. 71-74.
27. Ibid., pp. 85-87.
28. MAphotoSG, Singapore Air Bases, at https://www.maphotosg.com/constraints-rsaf-air-bases/. Accessed on April 22, 2021.
29. CIA World Factbook, Singapore, at https://www.cia.gov/the-world-factbook/countries/singapore/#military-and-security. Accessed on April 22, 2021.
30. Geography of Singapore, at https://en.wikipedia.org/wiki/Geography_of_Singapore. Accessed on April 3, 2022.
31. Wu, n. 15, p. 66.

the USA and Australia host Singaporean units at some of their bases but this is limited to training and exercises.[32] Evidently, Singapore tried to establish an external base in New Zealand, but the negotiations were discontinued in 2019.[33] With the USA, Singapore has developed a strong alliance-like partnership with several layers. The Changi naval base is open to US deployment and has been built to accommodate an aircraft carrier, and rotational deployment of US P-8 Poseidon aircraft in Singapore, for example.[34]

Extending 1,752 km from north to south, Norway is the "longest" European country but just about 430 km wide. Norway has currently eight main air bases, dispersed from the north to the south.

Norway has geographical depth north to south and has spread its bases accordingly. Its land mass covers 3,85,200 sq km, including the Svalbard and Jan Mayen Islands in the Arctic. Svalbard is, under a treaty, non-militarised, but Jan Mayen has a Norwegian military station with an airstrip and various sensors and transmitters.[35] The terrain consists mainly of high plateaus and "rugged mountains broken by fertile valleys" creating an average elevation of 500 m. Norway's highest peak reaches 2,500 m. Extending 1,752 km from north to south, Norway is the "longest" European country but just about 430 km wide.[36] Norway has currently eight main air bases, dispersed from the north to the south.[37] Norway also has the "Banak base" for temporary basing

32. "Singapore's Air Force: Hosted All Over the World", *Asean Today,* August 18, 2017, at https://www.aseantoday.com/2017/08/singapores-air-force-hosted-all-over-the-world/. Accessed on April 22, 2021.
33. "What's Behind the Nixed Singapore-New Zealand Fighter Jet Base Deal?", *The Diplomat*, January 11, 2019, at https://thediplomat.com/2019/01/whats-behind-the-nixed-singapore-new-zealand-fighter-jet-base-deal/. Accessed on April 22, 2021.
34. The US-Singapore Partnership, Brookings, at https://www.brookings.edu/research/the-u-s-singapore-partnership-a-critical-element-of-u-s-engagement-and-stability-in-the-asia-pacific/. Accessed on April 22, 2021.
35. Jan Mayen, Global Security Website, at https://www.globalsecurity.org/military/world/atlantic/jn.htm. Accessed on June 11, 2021.
36. Norway, location and size, at https://www.nationsencyclopedia.com/Europe/Norway-LOCATION-SIZE-AND-EXTENT.html. Accessed on June 7, 2021.
37. Norwegian Air Force, Air Bases, at https://www.forsvaret.no/om-forsvaret/organisasjon/luftforsvaret. Accessed on June 10, 2021.

of fighter aircraft.[38] Additionally, the US 426th Air Base Squadron operates in Stavanger.[39] Further, Norway is a member of NATO and has historically developed its air power with extensive support from the USA.[40]

Israel covers 22,000 sq km, the main parts being desert in the south, the low coastal plain and the central mountains.[41] Israel is aubergine-shaped, only around 60 km in the northern parts, meaning an overflight at 620 mph takes 5-10 minutes.[42] Israel's ten air bases are spread from Ramat David (north) to Ovda (south).[43] Another mitigation is that consecutive wars have increased the geographical depth: the Golan Heights, the West Bank, and the Gaza Strip.[44] Further, resilience is increased on permanent bases with underground basing constructions[45] Israel is also considering use of roads and highways.[46] Israel is not part of any alliance, rather relying on a "patron-client relationship" with the USA, retaining relative self-sufficiency concerning armament and manpower, backed up by a nuclear option, according to Rodman.[47] Similarly, the US has units in Israel, cooperating with missile defence.[48]

In the case studies, one obvious similarity is the importance of the external factor and the possibility to either have bases abroad or strong

38. Station Group Banak, at https://en.wikipedia.org/wiki/Station_Group_Banak. Accessed on August 20, 2021.
39. US Air Force, 501st Combat Support Wing, at https://www.501csw.usafe.af.mil/Units/423rd-ABG/426th-ABS/. Accessed on June 9, 2021.
40. Oistein Espenes and Nils E Naastad, "The Royal Norwegian Air Force: A Multipurpose Tool During the Cold War", *Air Power History*, Spring 2000, 47, 1, pp. 41-51.
41. CIA World Factbook, Israel, at https://www.cia.gov/the-world-factbook/countries/israel/#military-and-security. Accessed on May 11, 2021.
42. CIA World Factbook, Singapore, at https://www.cia.gov/the-world-factbook/countries/singapore/#military-and-security. Accessed on April 22, 2021.
43. Wikipedia, Israeli Air Force, at https://en.wikipedia.org/wiki/Israeli_Air_Force. Accessed on May 12, 2021.
44. UNISPAL, Occupied Territories, at https://www.un.org/unispal/document/auto-insert-201336/. Accessed on May 12, 2021.
45. John F. Wall Jr, "Managing Construction of Israeli Air Bases in Negev—A Personal Perspective, *Journal of Management in Engineering*, vol. 1, issue 4, October 1985, pp. 233-243, at https://doi.org/10.1061/(ASCE)9742-597X(1985)1:4(233). Accessed on May 14, 2021.
46. Wu, n. 15, p. 66.
47. David Rodman, "If I Am Not for Myself… Methods and Motives behind Israel's Quest for Military Self-Reliance", *Israel Journal of Foreign Affairs*, 4:1, 2010, pp. 53-61. DOI: 10.1080/23739770.2010.11446400. Accessed on May 17, 2021.
48. Defence News, "New US Base in Israel", at https://www.defensenews.com/breaking-news/2017/09/18/us-breaks-ground-for-new-permanent-base-in-israel/. Accessed on May 12, 2021.

links with a patron state like the USA. Internally, a small state can exploit possible temporary basing options either closer to, or further away from, the adversary, facilitating variations in operational tempo as well as endurance. Such temporary facilities need a smaller organisational footprint and manning and can be activated when needed for training or in crises. Another approach is to increase the resilience of some permanent bases. This may limit attackers to specific ranges of weapons to achieve sufficient destruction, but the base still becomes a well-known target. Nevertheless, such measures hinder the single blow knock out. If these dispersal, deception, and fortification efforts are combined, the small state clearly increases resilience against attacks.

In sum, a small state benefits from teaming up with a patron state or alliance and using assets like roads and highways for dispersal and temporary basing, preferably in combination with deception efforts and engineering capabilities. If such measures are adopted, it follows that any aircraft procured must be able to use highways as landing strips.

SECOND CONSIDERATION: CONTROL OF THE AIR COMBINING MULTI-ROLE AIRCRAFT WITH GROUND-BASED AIR DEFENCE

Exercising "control of the air" is strategically important and a fundamental consideration for the air power of any state. Such control promotes a higher level of freedom of manoeuvre in almost any aspect.[49] Control of the air is often explained as having air superiority, meaning having a limited degree of air control, in which one side has the necessary degree of control in time and place without any effective interference from the enemy.[50] A small state is likely to have limited capacity for sustaining air superiority. Related to this is the ability to sustain a campaign, which, in turn, is related to the ability to self-sustain manufacturing and possession of a focussed logistical structure that can match the required production tempo. Accordingly, the small state likely depends on external support during a time of conflict.[51] The dilemma of possessing fewer assets than

49. Gray, n. 2, pp. 283-284.
50. Australian Air Power Manual, 2013, p. 52.
51. Clarke, n. 12, pp. 68-69.

your adversary can, to some extent, be offset using multi-role aircraft. This generates more options in how to apportion its assets and leaves the adversary in doubt regarding the number of aircraft it will encounter in different tactical roles. GBAD systems then add capabilities that are a potent deterrence and capable of destroying adversary air assets. Such GBADs may force the opponent to "stick to high altitude with consequent penalties in effectiveness".[52] Together, multi-role fighters and GBAD can create or contest air superiority efficiently.

Looking at the cases, in the aftermath of World War II, Wu notes that Singapore faced insurgency threats related to the expansion of Chinese Communism. Singapore was nevertheless established as a city state in 1965 following a separation from Malaysia. External partners like Israel, Britain, the USA, and Taiwan were crucial when it came to officer training and development of naval and aerial capabilities. The defence industry was established and expanded, meeting requirements to either design and produce or upgrade and overhaul defence material. Looking in detail at the air force, Wu argues that it was basically founded in 1968. From the 1990s, Singapore pursued the path of the "Revolution in Military Affairs", focussing on qualitative technological aspects and related doctrinal and tactical development as Singapore had many of the prerequisites in place like industrial and educational frameworks.[53] Singapore today has an Integrated Air Defence (IAD) system that is a multi-layered, networked air defence system, including advanced sensors, modern ground-to-air weapons, command and control elements and decision-making tools.[54] This is combined with multi-role F-15 SG aircraft, maintained and upgraded to the latest standards.[55] Further, Singapore operates the multi-role F-35.[56] An air force with 100 modern fighters keeps Singapore competitive in both

52. Sabin, n. 13, pp. 79-80.
53. Wu, n. 15, pp. 19-70.
54. "Detect and Shoot", at https://www.mindef.gov.sg/web/portal/mindef/news-and-events/latest-releases/article-detail/2020/December/17dec20_fs
55. "How a Tiny City-State Became a Military Powerhouse with the Best Air Force and Navy in Southeast Asia", *Business Insider*, at https://www.businessinsider.com/singapore-military-best-air-force-navy-southeast-asia-2018-4?r=US&IR=T. Accessed on April 22, 2021.
56. Wu, n. 15, p. 183.

quality and quantity.[57] Moreover, six tanker aircraft enhance their range and endurance.[58] Increasingly, Singapore has turned to the US for procurement of its aircraft, which is "beneficial for logistics and maintenance".[59] The GBAD systems, Spyder and Aster, with 70km range, are fully integrated into Sinapore's IAD system.[60]

The Israeli Air Force was founded during the war of independence in the late 1940s and has continued evolving through periods of conflict and war. The inventory after the war of independence showed 173 different types of aircraft and the pilots had come from all over the world, according to Brun. Brun further argues that the overall Israeli doctrine focussing on ground force manoeuvre and moving the battlefield to enemy territory influenced the focus of the air force; achieving air superiority, and support to ground operations became the focus for air power with the addition of a strategic "capability to attack national, military, and civil infrastructure in enemy territory". Already in the 1990s, the US sold a special version F-15 Eagle I to Israel[61]. As for inventory, Israel has over 200 modern fighters and enough missiles to arm them.[62] These capabilities are enhanced by a large fleet of ten tanker aircraft and eighteen reconnaissance aircraft.[63] Likewise, the Israel Aerospace Industries (IAI) group and the Rafael Company produce a great variety of capable ground systems; active and passive sensors as

57. n. 55.
58. Airforce Technology, "RSAF's A330 MRTT Aircraft Achieves Full Operational Capability", April 21, 2021, at https://www.airforce-technology.com/news/rsaf-a330-mrtt-full-operational-capability/. Accessed on April 5, 2022.
59. Wu, n. 15, p. 61; n. 55.
60. "Singapore Confirms Delivery of Aster 30 Missile with Video Post", *Defence News*, at https://www.defensenews.com/land/2018/03/29/singapore-confirms-delivery-of-aster-30-missile-with-video-post/. Accessed on April 4, 2022.
61. Itai Brun, "Israeli Air Power" in John Andreas Olsen, *Global Air Power*, vol. 1st ed. (Washington DC: Potomac Books, 2011), pp. 138-140 and 164-165.
62. Rafael, Missile Systems, at https://www.rafael.co.il/worlds/air-and-space/missile-systems/ Accessed 19 May 19, 2021 and Miltary Wikipedia, "List of Munitions", at https://military.wikia.org/wiki/List_of_munitions_used_by_the_Israeli_Air_Force. Accessed on May 19, 2021.
63. Defence Update, "CAEW – Business Jets Taking Control", at https://defense-update.com/20180715_caew.html accessed 11 May 2021 and https://www.wdmma.org/israeli-air-force.php#onorder

Israel in recent decades has combined the build-up of internal industry with reliance on the US for procurement of aircraft. This narrows down the logistical challenges.

well as different GBAD with ranges up to 150 km.[64] This enables Israel to establish a multi-layer missile and air defence system, housed outside the air force but included in air power.[65] As for sustainment, Israel in recent decades has combined the build-up of internal industry with reliance on the US for procurement of aircraft. This narrows down the logistical challenges.[66]

Historically, during the Cold War, Norway's location and requirements from NATO influenced the force structure and numbers of the air force, prioritising air defence fighters, fighter bombers, maritime patrol, and reconnaissance. These factors in combination with internal political and economic constraints led to a heavy reliance on the USA and its Military Assistance Programme (MAP), which influenced the structure, role, and build-up during 1945-60. Norway has prioritised the US partnership and procured platforms like the F-16 and F-35.[67] The goal has been to establish control of the air through defensive counter-air operations.[68] The original number was 72 F-16s, all equipped with drag chutes to increase braking power and reduce length of landing as well as handling wet and icy runways.[69] The air force currently has 46 upgraded F-16s but aims to replace them with 52 F-35, also with drag chutes, by 2025.[70] Looking at GBAD, Norway has the short range Norwegian Advanced Surface-to-Air Missile System (NASAMS)

64. IAI website, air defence, at https://www.iai.co.il/defense/air/air-defense-systems. Accessed on November 30, 2021.
65. Jewish Virtual Library, Israeli Missile Defence System, at https://www.jewishvirtuallibrary.org/israel-missile-defense-systems. Accessed on May 10, 2021.
66. Rodman, n. 47, pp. 53-61.
67. Espenes and Naastad, n. 40.
68. Ibid., pp. 41-51.
69. Tor Arheim, et al, *Fra Spitfire til F 16, Luftforsvaret 40 år 1944-1984* (Oslo: Sem & Stenersen A/S, 1984), pp. 66-67.
70. F-16 Net, F-16 Air Forces—Norway. Accessed June 15, 2021. And https://www.f35.com/f35/global-enterprise/norway.html

and is procuring an additional short range capability based on the IRIS-T missile.[71] The three Norwegian NASAMS batteries are protecting the Ørland and Evenes air bases as well as the US Marine Corps storage facility in Tröndelag.[72]

A small state must weigh its options, whether to expand the military-related industrial base to reach a high level of self-sufficiency or engage in partnerships with providers trusted even in times of conflict.

Singapore and Israel gravitate towards high quality multi-role fighters in substantial numbers, combined with a developed GBAD missile defence system. The case of Norway differs historically, showing lower quality as well as lesser quantities of systems, though the quality currently has been increased with the F-35. Secondly, looking at GBAD, Norway does not have the layer-structured capacity as Singapore and Israel, only the short-range capacity for point defence. This could be explained or balanced with NATO membership and support from allies, with the caveat that those assets are not available immediately. Norway has a greater geographic challenge: clearly a larger country is more difficult to cover, and in need of more GBAD systems. To conclude, most evidence point towards a small state benefiting from achieving effective control of the air built on modern multi-role aircraft in sufficient numbers combined with capable GBAD systems.

THIRD CONSIDERATION: NOURISHING AN INTERNAL AIRCRAFT INDUSTRY

A small state must weigh its options, whether to expand the military-related industrial base to reach a high level of self-sufficiency or engage in partnerships with providers trusted even in times of conflict. This

71. Army Technology website, "Diehl Defence to Support Norway's Ground-Based Air Defence System", https://www.army-technology.com/news/diehl-defence-norway-air-defence/. Accessed on June 18, 2021. And Kongsberg Website, "NASAMS AIR DEFENCE SYSTEM", at https://www.kongsberg.com/kda/products/defence-and-security/integrated-air-and-missile-defence/nasams-air-defence-system/. Accessed on June 18, 2021.
72. Forsvarsforeningen, *Forsvarssjefen vil ha mer luftvern*, at https://www.forsvarsforeningen.no/norges-forsvar/norges-forsvar-2-2020/forsvarssjefen-vil-ha-mer-luftvern/. Accessed on August 20, 2021.

might be difficult as, for instance, Sweden experienced as World War II drove close and several procurement efforts were stalled, leaving Sweden to rely heavily on its in-house but juvenile aircraft industry.[73] Similarly, the Underdog Model recommends a high level of self-sufficiency and to "uphold, sustain, and project air power on its own to the maximum extent possible"[74]. This is an argument for a home-grown industrial base related to air power. Further, Clarke notes that even as part of an alliance, a certain level of self-reliance is needed, as well as expected by the other alliance members.[75] Either way, peace-time storage of vital material is helpful. The path of partnerships potentially brings constraining policy dependencies but may be economically favourable in comparison with bearing the brunt of a military industrial complex. As Česnakas argues, certain partnerships with technologically superior states in combination with the capability to fight in a degraded command and control environment are likely necessary for a small state.[76] Similarly, streamlining logistics could be cost saving and one main industrial partner as well as multi-role aircraft are ways to achieve this. The logistical concept should be balanced against the level of technology needed.

Singapore, during the Cold War, established and expanded a national defence industry. These earlier steps including performing overhaul and upgrades of older platforms laid the ground for a national defence industry that could match Singapore's needs. Already in the 1990s it had a "complex and integrated aircraft industry" that was "one of the leading centres of aircraft maintenance" in the region.[77] The later procurement of the F-15 multi-role fighters in the 2000s established a relationship with the US as its main

73. Arash Heydarian Pashakhanlou, "Swedish Air Power History : A Holistic Overview", *Air Power History*, vol. 65, no. 3, Fall 2018, pp. 7-14. WWW.AFHISTORY.ORG
74. Pashakhanlou, n. 5, pp. 6 and 18.
75. Clarke, n. 12, pp. 74-75.
76. Giedrius Česnakas, "The Implications of the Technological Trends in Military on the Defence of Small States", *Lithuanian Annual Strategic Review,* 17, 2020, pp. 273-293. 10.2478/lasr-2019-0012.
77. Bilveer Singh, "Singapore's Defence Industries", *Canberra Papers on Strategy and Defence,* No. 70, Strategic and Defence Studies Centre Research School of Pacific Studies, Australian National University, Canberra, 1990, pp. 21-26.

supplier.[78] The idea is to be technologically superior to potential adversaries and is backed up by a substantial defence industry, exemplified by a capable space industry and the launch of a series of small satellites.[79]

The Israeli Air Force initially had industrial cooperation with France from the mid-Fifties to the early Seventies. This transfer of knowledge enabled Israel to build its own combat aircraft such as the "Kfir", according to Brun.[80] The Israeli armament industry today supports much of Israel's needs and exports to other states, including the US and Germany. "Ballistic missiles, anti-ballistic missiles, cruise missiles, and reconnaissance satellites have also come off of its assembly lines", Rodman notes.[81] Likewise, the Israeli IAI group and the Rafael Company produce a great variety of capable GBAD systems.[82] Further, the strong cooperation with the US in missile defence also includes significant funding.[83] Additionally, Israeli defence industries have been able to accomplish innovative and state-of-the-art products over time, indicating a high level of research capability within the state as a whole.[84]

Norway, historically, has turned to the US for procurement of its aircraft fleet, consequently, building a trusted partnership.[85] However, Norway does not have a similar industrial base related to military fixed wing fighters enjoyed by Israel. That said, the Norwegian defence company Kongsberg has the capability to overhaul and maintain helicopters and has competence in missile systems, command and control systems and GBAD systems. Moreover, Norway has a small but growing sector related to space, fed

78. Wu, n. 15, p. 19.
79. Ron Matthews and Collin Koh, "Singapore's Defence-Industrial Ecosystem", in Jean Belin and Keith Hartley, eds., *The Economics of the Global Defence Industries* (Routledge, 2019), pp. 9-11.
80. Brun, n. 61, pp. 141-148, 157-158, http://search.ebscohost.com.proxy.annalindhbiblioteket.se:2048/login.aspx?direct=true&db=e000xww&AN=388811&site=ehost-live.
81. Rodman, n. 47, pp. 53-61.
82. IAI website, air defence, at https://www.iai.co.il/defense/air/air-defense-systems. Accessed November 30, 2021.
83. Israel's Missile Defence Systems, at https://www.jewishvirtuallibrary.org/israel-missile-defense-systems. Accessed on November 30, 2021.
84. Richard Bitzinger, "Military-Technological Innovation in Small States: The Cases of Israel and Singapore", *SITC Research Briefs*, Series 10 (2018-4), at https://escholarship.org/uc/item/7vp2x155. Accessed on May 19, 2021.
85. Espenes and Naastad, n. 40, pp. 41-51.

both by suitable ground infrastructure in the north and Arctic region and industrial support from several Norwegian companies.[86]

In conclusion, Singapore and Israel have followed the path of sustainment through domestic air space industries and Norway has not, even though Norway has defence related industrial competence. As for streamlining logistics, all three countries evidently rely on the US as a trusted partner. The extent of peace-time storage is classified information, but such facilities are understood to exist. Summing up self-sustainment and focussed logistical structures, the evidence indicates that a small state benefits from domestic air power related industries, peace-time storage of vital material and a trusted relationship with the main provider of its technology and aircraft.

FOURTH CONSIDERATION: MANOEUVRE WARFARE OUTPACING THE OPPONENT

The coordination of a complex and high tempo air campaign is a demanding if not unattainable task for a small state.[87] Nevertheless, tailoring your command and control system to outpace the OODA loop of the adversary is a ”low cost way to achieve a sizeable advantage” and achieves ”getting inside the adversary´s OODA loops, thereby magnifying the adversary’s friction and stretching out his time”[88]. A small state is likely to possess fewer forces to orchestrate and fewer organisational layers to navigate, factors that enable a faster information flow as well as decision-making. The first steps of the OODA loop concern observation and orientation to gain situational awareness. To facilitate this, sensors and C4I[89] systems must provide coverage, taking dispersal and redundancy into account. The goal is to create a situational awareness that provides as much warning

86. Kongsberg Website, at https://www.kongsberg.com/kda/ and International Trade Administration Website, at https://www.trade.gov/country-commercial-guides/norway-defense-and-aerospace-technologies. Accessed on August 17, 2021.
87. Clarke, n. 12, p. 69.
88. Grant T Hammond, *The Mind of War, John Boyd and American Security* (Washington: Smithsonian Books 2001), p. 165.
89. C4I is Command, Control, Communications, Computers and Intelligence

time as possible and is robust against attack. To mitigate the threat from anti-radiation missiles, passive or bi-static sensors can be part of the inventory and placing them at the perimeter, on mountain tops, islands, oil rigs or other offshore installations, can be favourable. In a similar way, the threat from ballistic and cruise missiles as well as attack by aircraft can be managed using mobile and/or airborne sensors, which by this logic becomes a clear recommendation for a small state. To complete the loop, Decide and Act must follow the first two steps. Using technology to gain tempo in decision-making will be advantageous and integration of Artificial Intelligence (AI) may increase the tempo. In any air power focussed conflict, such time is vital due to the unique ability to perform parallel operations and "compress time"[90]. If the tempo is combined with variation and unpredictability of own actions, adaptability to evolving situations as well as surprise and deception, the OODA loop approach is used to the maximum benefit.[91] Following, the increased mobility of air power assets both increases resilience against attack and creates advantages in the cognitive domain.

Israel has allocated extensive resources to develop its situational awareness and early warning capabilities, stimulated by a history of conflicts and attacks. The overall Intelligence, Surveillance, Reconnaissance (ISR) sensors vary from static to various levels of mobility, such as airborne sensors on Gulfstream aircraft or tactical UAVs.[92] Further, a variety of sensors is produced by Israeli companies; from strategic warning sensors to tactical ones, be they aerostat, airborne or highly mobile ground-based systems. Similarly, the air force has unmanned ISR units that on short notice can deliver data to increase the tactical and operational awareness.[93] Moreover, Israel has a multi-layer

90. Gray, n. 2, pp. 271-274.
91. Frans P. B. Osinga, "The Enemy as a Complex Adaptive System: John Boyd and Airpower in the Postmodern Era" in John Andreas Olsen, ed., A*irpower Reborn* (Annapolis: Naval Institute Press, 2015), pp. 76-79.
92. Israeli Air Force, "Watching from Above: The RPAV Division in Operation", at https://www.iaf.org.il/9331-53038-en/IAF.aspx Accessed 19 May 2021 and Israel Aerospace Industries, "Air Defence", at https://www.iai.co.il/defense/air/air-defense-systems. Accessed on May 19, 2021
93. Ibid.

In Norway, situational awareness and early warning is produced by a Control and Reporting Centre (CRC) which is integrated in the NATO system and the Combined Air Operations Centre (CAOC) in Uedem, Germany.

missile defence system to counter short to long range missiles and rockets, including the "Iron Dome" and "David's Sling"[94]. Evidently, Israel strives for a fast and solid OODA loop.

Singapore has an inventory similar to Israel's and invests heavily in this area.[95] Moving to "the loop", Singapore, historically, has allocated extensive resources and has several dedicated capabilities. These include four airborne early warning Gulfstream aircraft, ground based sensors as well as aerostats and UAVs.[96] All the resources are integrated in a multi-layered, networked Air Defence (AD) system, including advanced sensors, modern ground-to-air weapons, command and control elements and decision-making tools.[97] The network is managed by a Combat Management System (CMS) that makes it agile as well as "more resilient"[98]. Singapore has evidently striven to shorten the OODA loop.

In Norway, situational awareness and early warning is produced by a Control and Reporting Centre (CRC) which is integrated in the NATO system and the Combined Air Operations Centre (CAOC) in Uedem, Germany. Ground-based sensors are located throughout Norway, even if

94. Army Technology, "Iron Dome Air Defence Missile System", at https://www.army-technology.com/projects/iron-dome/ Accessed 19 May 2021 and Rafael, "David's Sling", at https://www.rafael.co.il/worlds/air-missile-defense/long-range-air-missile-defense/. Accessed on May 19, 2021.
95. Singapore Air Force, at https://www.mindef.gov.sg/oms/rsaf/careers/about-us/our-capabilities.html, accessed on April 22, 2021 and *Flight Global*, 2009 https://www.flightglobal.com/picture-singapore-takes-delivery-of-first-g550-aew/85244.article. Accessed on April 22, 2021.
96. Ibid.
97. n. 54.
98. Channel News Asia, "RSAF Combines Sensors, Shooters and AI in 'State-of-the-Art' System to Better Defend Singapore's Airspace", at https://www.channelnewsasia.com/news/singapore/rsaf-sensors-shooters-ai-island-air-defence-system-13791410. Accessed on April 26, 2021.

not in great numbers.[99] Further, the sensors have been recently upgraded to the latest standard by SAAB, and new mobile long range THALES sensors are under procurement.[100] Norway has no Airborne Early Warning (AEW) aircraft but can draw upon the NATO Airborne Warning and Control System (AWACS). Considering Norway's mountainous geography, the radar range in the lower flight levels is likely to be very constrained in certain areas or sectors. Concerning the Norwegian OODA loop, the evidence does not support similar development as in Singapore and Israel towards high tempo but being integrated in the NATO command and control system likely shortens the multinational loop and the reaction time for allied support.[101]

Dispersal and mobility require a command and control system to match it, supporting both cognitive and physical manoeuvres. Further requirements would include well trained personnel and mission-oriented leadership.

These cases highlight that a small state can build air power structures that achieve a fast OODA loop and enable manoeuvre. In conclusion, therefore, applying manoeuvre warfare is beneficial for a small state since outpacing the opponents' OODA loop has several benefits, like gaining initiative and creating confusion. It concerns both the sensor-to-shooter cycle as well as the more long-term mobility and sustainment cycle related to mobility of sensors and dispersal at and from air bases. However, dispersal and mobility require a command and control system to match it, supporting both cognitive and physical manoeuvres. Further requirements would include well trained personnel and mission-oriented leadership. If applied, a small state may be

99. Teknisk Ugeblad webpage, "SINDRE -1 Radar", October 13, 2017, at https://www.tu.no/artikler/nato-radarerene-langs-kysten-skal-oppgraderes-etter-25-ar/409343. Accessed on December 14, 2021.
100. "Saab to Upgrade SINDRE I Air Surveillance Radars in Norway", *Airforce Technology*, at https://www.airforce-technology.com/news/newssaab-to-upgrade-sindre-i-air-surveillance-radars-in-norway-5948440/ Accessed on June 10, 2021. And "Norway and Netherlands Partner on Thales' Multi Mission Radar Ground Master 200 MM/C", Thales website, at https://www.thalesgroup.com/en/group/journalist/press_release/norway-and-netherlands-partner-thales-multi-mission-radar-ground. Accessed on June 10, 2021.
101. Ibid.

able to outpace the opponent in both short- and long-term planning and execution.

FIFTH CONSIDERATION: UNMANNED FORCE MULTIPLIER FOR THE SMALL STATES' AIR POWER

Moving from the manned to the unmanned—the UAVs are here to stay, especially as their capabilities continue to evolve.[102] One development is having unmanned aerial systems fly missions as "loyal wingmen" together with manned systems.[103] This still lies in the future and is not driven by small states with limited budgets. However, unmanned aerial systems can save costs and possibly manpower for a small state. The platforms are cheaper than manned platforms, training of pilots is easier and the turnaround and maintenance is less demanding, not mentioning a more limited exposure of own troops in hostile or contested areas.[104] There are logical benefits with the larger UAVs that can position sensors for much longer periods than manned platforms. But also smaller tactical UAV systems may be useful for a small state, evidently in asymmetric conflicts but probably also as part of a larger air defence system.[105] A small state needs to consider own as well as adversary use of UAV systems and their role from an air power perspective. As with any new capability, it must be developed, structured, and organised before it can give operational effect in an Order of Battle (ORBAT).

In the cases under scrutiny, Singapore has invested significantly in UAVs like the Searcher, Hermes, and Heron from Israel, especially focussing on tactical long-endurance types for monitoring and surveillance with a variety

102. Gunnar Hult, "Technology and Warfare: A New Chapter of an Old Relationship?", in Gudrun Persson, Carolina Vendil Pallin and Tommy Jeppsson, eds., *Military Thinking in the 21st Century*, (Stockholm: The Royal Swedish Academy of War Sciences, 2015), pp. 249-250.
103. Michael Abrams, "ROBOTIC WINGMAN", *Mechanical Engineering*, 07, 2020, p. 64. at https://login.proxy.annalindhbiblioteket.se/login?url=https://www-proquest-com.proxy.annalindhbiblioteket.se/magazines/robotic-wingman/docview/2434746562/se-2?accountid=8325. Accessed on April 2, 2022.
104. Česnakas, n. 76, pp. 273-293.
105. Stefan Borg "Below the Radar: Examining a Small State's Usage of Tactical Unmanned Aerial Vehicles", *Defence Studies*, 20:3, 185-201. DOI: 10.1080/14702436.2020.1787159. Accessed on May 3, 2021.

of sensors.[106] The UAV systems are organised in their own UAV Command, comprising three squadrons.[107] Further, the domestic industry has developed the Skyblade family of mini-UAVs for the Singaporean Army. The current ones are close-range tactical UAVs with a takeoff weight of 50 kg and a 12 kg payload with an endurance of up to 12 hours and a range of up to 100 km.[108] Recently, this has been enhanced with the small surveillance UAV, Orbiter-4, from Israel.[109] On the counter-UAV side, Singapore is enhancing capability with the support of the domestic industry.[110]

Israel has long developed and operated UAVs in different versions, roles, and functions, like the Scout and the Searcher.[111] The air force today has unmanned ISR units that on short notice can deliver data to increase tactical and operational situational awareness.[112] Such systems have both expanded their role and proved their importance, especially concerning the intelligence picture enabling precise and timely targeting for Israeli air power in asymmetric and low intensity conflicts.[113] Borg argues that Israeli UAV systems have delivered strategic effect through significantly increased situational awareness, enabling a "better control of the battle rhythm" as well

106. Wu, n. 15, pp. 59-60.
107. Ibid., p. 62.
108. Barry Desker and Richard A. Bitzinger, "Prolifierated Drones, A Perspective on Singapore", http://drones.cnas.org/reports/a-perspective-on-singapore/. Accessed on April 7, 2022.
109. Military Leak, "Republic of Singapore Air Force Acquires Orbiter 4 Close-Range Unmanned Aerial System", at https://militaryleak.com/2022/03/04/republic-of-singapore-air-force-acquires-orbiter-4-close-range-unmanned-aerial-system. Accessed on April 7, 2022.
110. Singapore Science and Technology webpage, at https://www.htx.gov.sg/news/featured-news-keeping-singapore-safe-against-rogue-drones Accessed on April 7, 2022, and "TRD Singapore Takes Aim at Global C-UAS Opportunities following Major Successes in Southeast Asia", *Asian Military Review*, June 2, 2021, at https://www.asianmilitaryreview.com/2021/06/trd-singapore-takes-aim-at-global-c-uas-opportunities-following-major-successes-in-southeast-asia/. Accessed on April 7, 2022.
111. Brun, n. 61, pp. 161-162, http://search.ebscohost.com.proxy.annalindhbiblioteket.se:2048/login.aspx?direct=true&db=e000xww&AN=388811&site=ehost-live.
112. Israeli Air Force, "Watching from Above: The RPAV Division in Operation", at https://www.iaf.org.il/9331-53038-en/IAF.aspx Accessed 19 May 2021 and Israel Aerospace Industries, "Air Defence", at https://www.iai.co.il/defense/air/air-defense-systems. Accessed on May 19, 2021
113. Tamir Libel, "IAF's Small Wars: Israeli Air Force Experience in Low Intensity Conflicts, 1982–2006", *Baltic Security and Defence Review* 11, 2009, pp. 40-59, at https://www.researchgate.net/publication/268388627. Accessed on May 20, 2021.

as "enhanced the IDF's [Israel Defense Force's] operational sustainability"[114]. Strikingly, in 2018, around 80 per cent of Israeli Air Force operations were flown by UAVs.[115]

Norway's UAV systems are mainly tactical and in support of various ground forces. Norway does have a drone producing industry, focussed on small sized "nano drones", like the Black Hornet, and has exported this to other militaries.[116] A tactical size version, the "Indago 3", has recently been procured from Lockheed Martin and will be used for ISR purposes.[117] However, this is not a capability that will improve the situational awareness at the operational level of air power.

It can be surmised, therefore, that a small state can clearly enhance its air power with UAV systems, and ISR capabilities are a natural starting but not finishing point. Evidently, such systems also can improve OODA loop precision and tempo as well as sustainment. Finally, counter-UAV measures also should be considered when designing the overall system.

SIXTH CONSIDERATION: BALLISTIC MISSILES COMPENSATION FOR DISADVANTAGEOUS GEOGRAPHICAL DEPTH?

Coming back to Warden's five cases of air superiority which are framed on the basing areas and the front battle lines. In the best case, your airfields and rear bases are safe, but you can reach the ones of your adversary, while the worst case is the opposite situation.[118] A small state must adapt to the

114. Stefan Borg, "Assembling Israeli Drone Warfare: Loitering Surveillance and Operational Sustainability", *Security Dialogue*, vol. 52(5) 2021, pp. 401-402. Accessed on April 7, 2022.
115. Breaking Defence, EXCLUSIVE: Drones Now Dominate Israeli Flying Operations, at https://breakingdefense.com/2019/09/exclusive-drones-now-dominate-israeli-flying-operations/. Accessed on May 23, 2021.
116. DroningON website, "THE $40,000 NANO DRONE USED BY BRITISH, GERMAN AND NORWEGIAN ARMY", June 1, 2017, at https://www.droningon.co/2017/06/01/flir-pd-100-40k-nano-reconnaissance-drone/. Accessed on December 13, 2021.
117. Unmanned Systems Technology Website, "Indago 3 UAV to be Provided to the Norwegian Armed Forces", November 29, 2020, at https://www.unmannedsystemstechnology.com/2020/11/indago-3-uav-to-be-provided-to-the-norwegian-armed-forces/. Accessed on December 13, 2021.
118. Warden, n. 22, pp. 13-24.

situation as best as it can. The adversary's order of battle has immediate impact on the outlook. An adversary with a strong long-range strike capability clearly can threaten the rear bases of a small state. The rear bases may also be threatened by ballistic and/or cruise missiles, providing a favourable stand-off situation for the attacker. Conversely, as Vick notes, acquiring ballistic and/or cruise missiles is an "economic" way for a small state to level out an unfavorable case of air superiority without risking own aircraft and pilots in a stretch towards adversary basing areas.[119] Further, this also upgrades the strike option advocated by Clarke. However, in the case of a small state, this capability will most likely have to be combined with a strong doctrinal stance regarding self-defence use only. Another way is to mitigate the threat with a missile defence shield. This improves resilience but does not provide a strike option.

Israel has a multi-layer missile defence shield but also the "most technologically advanced missile arsenals in the Middle East". The missiles are produced domestically and include both cruise and ballistic missiles, some of which have been exported to other countries.[120] It is worth noting that there is some ambiguity over Israel's nuclear capacity as well as the exact ballistic missile arsenal to deliver it, especially regarding the Jericho family with ranges up to 4,500 km.[121]

Singapore has its Island Air Defence System, which is a multi-layered, networked air defence system including advanced sensors, modern ground-to-air weapons, command and control elements and decision-making tools.[122] The surface-to-air missile system, the Aster 30, has the capability to protect against cruise as well as ballistic, missiles.[123]

119. Alan J. Vick, *Air Base Attacks and Defensive Counters, Historical Lessons and Future Challenges* (RAND Corporation, 2015).
120. CSIS Missile Threat Website, "Missiles of Israel", August 10, 2021, at https://missilethreat.csis.org/country/israel/. Accessed on April 7, 2022.
121. IISS Website, "Israel's Ballistic-Missile Programme: An Overview", August 25, 2021, at https://www.iiss.org/blogs/analysis/2021/08/israel-ballistic-missile-programme. Accessed on April 7, 2022.
122. n. 54.
123. MBDA Website, ASTER 30-SAMP/T, at https://www.mbda-systems.com/product/aster-30-sampt/. Accessed on April 7, 2022.

Long range strike missiles are an 'economic' way to even out the odds, especially in combination with a missile defence system and, together, seem beneficial for a small state.

Norway has neither a missile defence system, nor ballistic missiles in its order of battle. Regarding domestic industry though, Kongsberg has competence in missile systems, command and control as well as GBAD. NATO has the task of Ballistic Missile Defence (BMD), one of NATO's permanent missions, and "part of the Alliance's response to this threat, as a component of the NATO Integrated Air and Missile Defence (IAMD)". As a member, Norway is under its umbrella but has no permanent installations related to the IAMD. So, in all likelihood, this provides Norway with some protection but with a multinational decision-making process, more time-consuming than a national one.

The importance of missile defence is evident in all the cases, though in various forms. The strike capability is only apparent in the Israeli case as of now. Nevertheless, the logical argument from the theoretical perspective still stands. Summing up, long range strike missiles are an 'economic' way to even out the odds, especially in combination with a missile defence system and, together, seem beneficial for a small state.

SUMMARY AND CONCLUSIONS

As noted in the beginning, each state has a unique history and context and must weigh its options carefully and individually when choosing the design of its air power system. This article has shed light on some of those considerations: "location and sufficiency of air bases, the terrain they overfly, the efficiency ratings of machines and weapons" and provided guidance on how a small state may utilise its limited resources to best effect. It has argued that a small state can improve its air power stance if it cunningly considers how to maximise the possibilities of geography, acquires multi-role fighters and GBAD systems to uphold control of the air, increases its industrial resilience via domestic aircraft industries, develops

an agile OODA loop to outpace the opponent's, takes advantage of the unmanned dimension, and has mobility as a core functionality for its assets. Further, the deterrent factor can be increased with a ballistic/cruise missile system able to strike adversary air bases while remaining under the protective umbrella of own or allies' missile defence system. Completing, the recommendations for a small state apropos managing the considerations are presented below as dicta. Of course, more research is needed related to small states concerning other aspects such as political management, personnel, and training as well as the influence of space on air power. Similarly, small states' use of air power in small wars, and what a framework for a successful air power design of a small state could look like also merit further research.

The cases indicate that a small state should use all means to create multiple domestic air bases and promote dispersal to maximise resilience and mitigate the effect of enemy strikes.

Dicta 1: Maximise the Advantages of Geography and Team up with a Partner

The cases indicate that a small state should use all means to create multiple domestic air bases and promote dispersal to maximise resilience and mitigate the effect of enemy strikes. Road bases are a recommendable measure that adds flexibility, and which is also backed by the "Underdog Model". Preferably, this is underpinned with engineering and reconstruction assets in combination with deception efforts. Moreover, external basing options abroad or support from external partners are valuable force multipliers, achieved either via strong partnerships or alliances. Accordingly, the main air assets must be robust enough to use highways and road bases.

Dicta 2: Uphold Control of the Air, Combining Multi-role Aircraft with Ground-Based Air Defence

Control of the air is the fundamental task for any air force. Creating a strong deterrent posture, based on a capable defensive counter-air fighter

capability, and supported with GBAD systems creates a threshold that forces adversaries to re-calculate their risk/benefit model. Multi-role fighter aircraft give the small state more options and create uncertainty for the adversary. If those fighter aircraft can operate within a friendly "bubble" created by the GBAD, the effect increases significantly. Similarly, within a limited economic budget, a potent GBAD capability is a favourable option to create, or challenge for, control of the air.

Dicta 3: Internal Aircraft Industry is a Force Multiplier

The importance of self-sustainment is advocated by theories such as the "Underdog Model" and "Strategy, Air Strike and Small Nations" and is demonstrably evident in the cases of Israel and Singapore. An internal aircraft industry will greatly improve self-sustainment in dire situations. Evidence further indicates that peace-time storage of vital material and a trusted relationship with the main provider of technology and aircraft is beneficial and facilitates a streamlining of logistics. Altogether, this greatly enhances the resilience in times of conflict.

Dicta 4: Use Manoeuvre Warfare—Outpacing the Opponents' OODA Loop

The small state has the possibility to trim its OODA loop through a wise combination of assets together with well-structured systems for information flow and decision-making. This enables a relevant and timely employment of the fewer assets a small state has in its orders of battle. Knowledge of the home ground, combined with agile processes and well-trained personnel will likely lead to a faster OODA loop than that of the adversary. Tempo is vital due to air power's unique ability to perform parallel operations and, if the tempo is combined with variation and unpredictability of own actions, adaptability to evolving situations as well as surprise and deception, the OODA loop approach will be very beneficial for a small state.

Dicta 5: Unmanned is a Force Multiplier for Small States' Air Defence Efficacy

For a small state, unmanned aerial systems save costs and possibly manpower. The platforms are cheaper than manned ones, training of pilots is easier and the turnaround and maintenance is less demanding. Moreover, the exposure of expensive manned platforms and risking lives of pilots that may be present only in small numbers is minimised. A small state can clearly enhance its air power with UAV systems, having ISR capabilities as a starting point, which can be followed by similar systems able to deliver weapons.

Dicta 6: A Ballistic Missile Component is a Great Deterrent

In the chess game of control of the air and the quest for air superiority, protecting one's own bases and posing a threat to adversary bases is one crucial factor. A small state may not have sufficient numbers of aircraft to both maintain defensive counter-air operations as well as forming strong enough strike packages against the adversary. A missile defence system increases protection from attacks along the conflict scale. Adding a ballistic/cruise missile attack component could even out the odds concerning strike-reach and further increase the deterrent factor.