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# **The Urban Littoral: A Framework to Understand Command and Control in Complex and Unpredictable Environments**

**Andrew Catoire**

**RESEARCH PAPER**

**Operational Concepts**

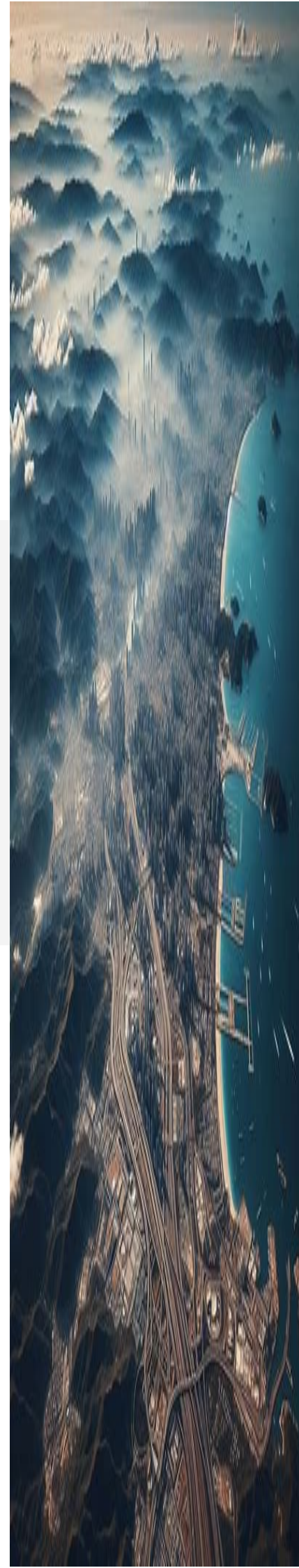


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# RESEARCH PAPER

## Operational Concepts

**Andrew Catoire, “The Urban Littoral: A Framework to Understand Command and Control in Complex and Unpredictable Environments,” Research Paper, coll. *Operational Concepts*, n°3, June 2024.**

### Abstract

The trends of rapid population growth, urbanization, littoralization, and hyper-connectivity from a communications and information point of view portend a new age of warfare centered around the urban-littoral operating environment. With this understanding, the study of this environment, and more specifically the conduct of war within it, seems increasingly important for military theorists, practitioners, and leaders. The complexity of this truly joint and all-domain milieu, which is highly interconnected and underscored by a multitude of characteristics to include dense civil populations, complex man-made terrain, communications and information hyper-connectivity, coastal geography and terrain, rapidly changing weather, various meteorological phenomena, and the effects of hydrography and oceanography, presents many challenges with respect to the execution of command and control (C2). This study seeks consequently to determine the ideal conception of C2 in the urban littoral, which should serve as a framework for understanding this function of warfare across the spectrum of complex and unpredictable multi-domain environments.

### Résumé

Les tendances à la croissance rapide de la population, à l'urbanisation, à la littoralisation, et à l'hyper-connectivité du point de vue des communications et de l'information laissent présager une nouvelle ère de guerre centrée sur le milieu opérationnel urbain-littoral. Dès lors, l'étude de cet environnement, et plus particulièrement de la conduite de la guerre en son sein, apparaît essentielle. La complexité de ce milieu naturellement interarmées et multi-milieus multi-champs (M2MC), fortement interconnecté et caractérisé par des populations civiles denses, un terrain artificiel complexe, des services assurant le fonctionnement de la vie quotidienne, les particularités de la géographie et du terrain côtiers, l'évolution rapide du temps et de divers phénomènes météorologiques, et les effets de l'hydrographie et de l'océanographie, entre autres, posent de nombreux défis pour l'exécution du commandement et de la conduite des opérations (C2). Cette étude cherche ainsi à déterminer la conception idéale du C2 dans le milieu urbain-littoral, qui devrait servir de cadre pour appréhender cette fonction de la conduite de la guerre au travers du spectre des environnements complexes et incertains.

### About the author

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*The views in this article reflect solely the opinions of the author and not the official policy or position of the United States government, the United States Department of Defense, or the IESD.*

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## The Urban Littoral: A Framework to Understand Command and Control in Complex and Unpredictable Environments

The notion that “wars are fought where the people are” is an oft repeated statement these days, evoked with the intent to portend the coming age of war and warfare, which will presumably consist of significant combat in densely populated urban areas.<sup>1</sup> Upon further reflection though, one cannot ignore the simple fact that people are becoming increasingly concentrated in urban conglomerations situated on or near coastlines, and thus, militaries should wholistically consider this environment, i.e., the urban littoral, when assessing the future of warfare.<sup>2</sup> To this point, the statistics

are quite striking, showing that roughly 80% of the world’s population lives within sixty miles (approximately 100 kilometers) of the sea, while 75% of large cities reside on a coastline, including 80% of the world’s capitals.<sup>3</sup> Of the world’s 20 largest cities in 2023, only four are not situated on either a coastline or major river delta (Cairo, Egypt sits on the Nile River Delta approximately 160 kilometers from the Mediterranean coast),<sup>4</sup> and U.N. demographic predictions for 2030 reaffirm this urban littoralization trend.<sup>5</sup>

In this vein, given the rapid growth of the world’s urban littorals, which are becoming increasingly densely populated, expansive, built-up, and digitally connected at a seemingly exponential rate,<sup>6</sup> coupled with the strategic importance of cities in a globalized world<sup>7</sup> and the increased possibility of

<sup>1</sup> See David Kilcullen, *Out of the Mountains: The Coming Age of the Urban Guerrilla* (London: Hurst & Company, 2015); Kenneth K. Goedecke et William H. Putnam, “Urban Blind Spots - Gaps in Joint Force Combat Readiness” (Belfer Center for Science and International Affairs Harvard Kennedy School, November 2019); General Stephen J. Townsend, “Multi-Domain Battle in Megacities” (Fort Hamilton, New York, 3 April 2018), [https://www.youtube.com/watch?v=ARzOI\\_evGAE](https://www.youtube.com/watch?v=ARzOI_evGAE).

<sup>2</sup> Kilcullen, *Out of the Mountains*, 239.

<sup>3</sup> *Ibid.*, 30-31; Milan Vego, “On Littoral Warfare,” *Naval War College Review* 68, n° 2 (2015): 2.

<sup>4</sup> “Largest Urban Areas Globally by Population 2023,” Statista, consulted 5 December 2023, <https://www.statista.com/statistics/912263/population-of-urban-agglomerations-worldwide/>. This report, presenting data aggregated by Wendell Cox Consultancy, an American firm specialized in demographic research, lists the 20 largest cities in 2023 as Tokyo-Yokohama, Japan; Jakarta, Indonesia; Delhi, India; Guangzhou-Foshan, China; Mumbai, India; Manila, Philippines; Shanghai, China; Seoul-Incheon, South Korea; Cairo, Egypt; Mexico City, Mexico; Kolkata, India; Sao Paulo, Brazil; New York, U.S.; Karachi, Pakistan; Dhaka, Bangladesh; Bangkok, Thailand; Beijing, China; Moscow, Russia; Shenzhen, China; Buenos Aires, Argentina. Only four of these cities are not located near a coastline or major river delta (Mexico City, Moscow, Delhi, and Beijing).

<sup>5</sup> United Nations, “The World’s Cities in 2016” (United Nations, 16 September 2016), 4, <https://doi.org/10.18356/8519891f-en>; United Nations, “The World’s Cities in 2018” (United Nations), 4-5, consulted 4 December 2023, <https://doi.org/10.18356/8519891f-en>. Of the top 10 most

populated cities on the planet (Tokyo, Japan; Delhi, India; Shanghai, China; São Paulo, Brazil; Mexico City, Mexico; Cairo, Egypt; Mumbai, India; Beijing, China; Dhaka, Bangladesh; Osaka, Japan) according to the United Nations report “The World’s Cities in 2018,” seven are located on a coast or a major river delta. The UN predicts in “The World’s Cities 2018” that there will be 41 megacities (population greater than 10 million) in the world, of which 30 are located on/near coastlines or major river deltas (cities on this list not located in the littorals include: Mexico City; Moscow; Delhi; Beijing; Bogota, Colombia; Kinshasa, DRC; Johannesburg, South Africa; Paris, France; Lahore, Pakistan; Hyderabad, India; Bangalore, India).

<sup>6</sup> Kilcullen, *Out of the Mountains*, 17, 25-29, 30-31; United Nations, “The World’s Cities in 2016,” 4; United Nations, “The World’s Cities in 2018,” 4-5; Vego, “On Littoral Warfare,” 2.

<sup>7</sup> Max Bouchet et al., “GLOBAL METRO MONITOR 2018,” *Metropolitan Policy Program at Brookings*, June 2018, 1; Goedecke et Putnam, “Urban Blind Spots - Gaps in Joint Force Combat Readiness,” 1-2; Marc Harris et al., “MEGACITIES AND THE UNITED STATES ARMY PREPARING FOR A COMPLEX AND UNCERTAIN FUTURE” (United States Army, June 2014), 4-5, <https://apps.dtic.mil/sti/citations/ADA608826>. As referenced in the article “GLOBAL METRO MONITOR 2018”: “More than half the world’s population now lives in urban areas and the 300 largest metropolitan economies in the world account for nearly half of all global output. ... Between 2014 and 2016, the 300 largest metro areas accounted for 36 percent of global employment growth and 67 percent of global GDP growth. ... Emerging economy metro areas continued to disproportionately drive growth, accounting for 80 percent of the 60 best-performing metropolitan areas.”

instability in these urbanized agglomerations,<sup>8</sup> the future battlefield begins to appear ever more urban and littoral, thus necessitating greater reflection concerning this environment and the conduct of war within it.

According to author, military strategist, and counterinsurgency expert David Kilcullen:

Rapid urban growth in coastal, underdeveloped areas is overloading economic, social, and governance systems, straining city infrastructure, and overburdening the carrying capacity of cities designed for much smaller populations. This is likely to make the most vulnerable cities less and less able to meet the challenges of population growth, coastal urbanization, and connectedness. The implications for future conflict are profound, with more and more people competing for scarcer and scarcer resources in crowded, underserved, and under-governed urban areas.<sup>9</sup>

Although Kilcullen's *Out of the Mountains* focuses mainly on guerilla warfare in the urban littorals of the less developed regions of the world, the potential for other forms of warfare in this environment, such as large-scale conventional combat, certainly exists. One must look no further

than the current conflict in Ukraine regarding this fact, where a large portion of the front is fixed within the coastal expanses of the Black Sea and Sea of Azov, with significant fighting having occurred throughout various urban areas and large cities in these littoral regions, to include Mariupol and Kherson. The South China Sea (SCS), which constitutes in and of itself a massive littoral, is another pertinent case study regarding this possibility.<sup>10</sup> The strategic importance of this maritime zone relative to global commerce,<sup>11</sup> decades of rising tensions from an inter-state competition perspective, and the proliferation of Chinese anti-access/aerial denial (A2/AD) and sea denial capabilities<sup>12</sup> – all of this manifesting itself within the confines of a region home to numerous territorial disputes as well as several of the world's largest cities and most dynamic urban conglomerations<sup>13</sup> – also illustrate the potential for more traditional forms of state-on-state conflict in the urban littorals of the world.

Regarding combat in the urban milieu, certain military scholars and practitioners postulate that this is the most difficult type of warfare due to the environment's truly three-dimensional nature consisting of multiple levels of human-made terrain, infrastructure, and dense civil populations;<sup>14</sup> and this is the reason why attacking armies have historically attempted to bypass cities

<sup>8</sup> Hannah Ritchie et Max Roser, "Urbanization," *Our World in Data*, 10 November 2023, <https://ourworldindata.org/urbanization>; Harris et al., "MEGACITIES AND THE UNITED STATES ARMY PREPARING FOR A COMPLEX AND UNCERTAIN FUTURE," 4-5; "Sustainable Service Delivery in an Increasingly Urbanized World" (USAID, October 2013), 1, <https://2017-2020.usaid.gov/policy/sustainable-urban-services/>; "The World's Cities in 2016" (United Nations), 4-5; "The World's Cities in 2018" (United Nations), 4-6.

<sup>9</sup> Kilcullen, *Out of the Mountains*, 36.

<sup>10</sup> Vego, "On Littoral Warfare," 33.

<sup>11</sup> "How Much Trade Transits the South China Sea?", *CSIS ChinaPower Project*, 2 August 2017, <https://chinapower.csis.org/much-trade-transits-south-china-sea/>.

<sup>12</sup> Vego, "On Littoral Warfare," 33; U.S. Department of Defense, "Military and Security Developments Involving the People's Republic of China 2023," 50, 88, consulted 8 December 2023, [https://media.defense.gov/2023/Oct/19/2003323409/-1/-](https://media.defense.gov/2023/Oct/19/2003323409/-1/)

1/1/2023-MILITARY-AND-SECURITY-DEVELOPMENTS-INVOLVING-THE-PEOPLES-REPUBLIC-OF-CHINA.PDF.

<sup>13</sup> Laurent Amelot et Hugues Eudeline, "Du Japon au Vietnam en passant par Taïwan : Quelle stratégie pour les Européens face aux revendications territoriales chinoises?", *Institut Thomas More*, 7 July 2021, <https://institut-thomas-more.org/2021/07/07/du-japon-au-vietnam-en-passant-par-taiwan--quelle-strategie-pour-les-europeens-face-aux-revendications-territoriales-chinoises/>; "Largest Urban Areas Globally by Population 2023," Statista, consulted 5 December 2023, <https://www.statista.com/statistics/912263/population-of-urban-agglomerations-worldwide/>; United Nations, "The World's Cities in 2016"; United Nations, "The World's Cities in 2018."

<sup>14</sup> John Spencer, "The City Is Not Neutral: Why Urban Warfare Is So Hard," *Modern War Institute*, 4 March 2020, <https://mwi.westpoint.edu/city-not-neutral-urban-warfare-hard/>; "Joint Publication 3-06 Joint Urban Operations" (Chairman of the Joint Chiefs of Staff, 20 November 2013);

with respect to ground combat from the era of Sun Tzu around 500 B.C. up until World War II (WWII), preferring instead to isolate them in hopes of engaging the enemy in more open terrain.<sup>15</sup> However, although the urban milieu is an undoubtedly highly complex and unpredictable operational area given these aforementioned characteristics, it is important to note that the littoral aspect of many of the world's cities necessitates a deeper reflection concerning the exact nature of the urban warfare question, particularly with respect to the challenges associated with this physical space when considered as a single joint and multi-domain operational environment (the urban littoral), vice distinct problem sets from doctrinal and operational concept perspectives.<sup>16</sup>

In understanding that littoral elements add further complexity and unpredictability to military operations in an urban environment, warfare at the intersection of the littoral and the coastal city can arguably be considered as occurring in the most difficult environment, one that is truly joint and multi-domain consisting of at least nine intersecting spaces where military maneuver must take place either simultaneously or in close synchronization. These interconnected spaces include the seabed, the submarine environment, the sea surface, and the naval airspace (airspace over the sea), which comprise the maritime domain; the land surface, subterranean space, and super-surface space (to include tunnel systems, canals, sewers, basements, exterior street-level surfaces, building

interiors, high-rise structures, and rooftops), which make up the land domain; the airspace domain; and the cyberspace domain.<sup>17</sup> Add to these the extra-atmospheric space (outer space), the information environment, and the electromagnetic spectrum, and there is absolutely no avoiding the truly interconnected and joint all-domain nature of the problem set.

Given the numerous geographical, infrastructure, terrain, and meteorological constraints of this milieu, which tend to complicate maneuver, communications, ISR (intelligence, surveillance, and reconnaissance) collection, precision fires, logistics, and the protection of forces,<sup>18</sup> military units conducting operations in the urban littoral become naturally disaggregated and dispersed.<sup>19</sup> This complexity and tendency towards decentralization, dispersion, and disaggregation becomes even greater in cases where the environment is legitimately contested, such as a zone or region outfitted with A2/AD or sea denial capabilities as seen in the previous SCS example, where the dispersion of forces reduces the chances of being detected and targeted by the adversary.<sup>20</sup> It is for this reason that there exists a substantial body of doctrine and operational concepts advocating the execution of some form of distributed type operations (decentralized decision making, adaptive force packages, largely independent tactical units dispersed across the battlespace) in both the littoral and the urban environments, as well in other contested

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Goedecke et Putnam, "Urban Blind Spots - Gaps in Joint Force Combat Readiness".

<sup>15</sup> Kilcullen, *Out of the Mountains*, 265; Goedecke et Putnam, "Urban Blind Spots - Gaps in Joint Force Combat Readiness," 6, 26; "Joint Publication 3-06 Joint Urban Operations," I-10; Sun Tzu, *The Art of War*, ed. par Dallas Galvin, trad. par Lionel Giles (New York: Barnes & Noble Classics, 2003), 15-16.

<sup>16</sup> From a U.S. military perspective, in the joint publication on urban operations, "JP 3-06 - Joint Urban Ops" (November 2013), the close ties between major urban and littoral areas are certainly recognized, but the operational and tactical implications of the littoral aspects of urban warfare remain largely underdeveloped. In July of 2022, the U.S. Army and U.S. Marine Corps jointly published the doctrine "ATP 3-06/MCTP 12-10B - Urban Operations," which highlights the understanding that this problem set should be considered

more jointly and wholistically, however, the littoral elements of urban combat remain still largely underdeveloped in the doctrine.

<sup>17</sup> Kilcullen, *Out of the Mountains*, 269.

<sup>18</sup> See particularly Vego, "On Littoral Warfare," regarding the constraints associated with the littoral environment; and Goedecke et Putnam, "Urban Blind Spots - Gaps in Joint Force Combat Readiness," concerning these constraints in the urban environment.

<sup>19</sup> See Kilcullen, *Out of the Mountains*, 105-6, 283-86; "Joint Publication 3-06 Joint Urban Operations," regarding the themes of decentralization, disaggregation, and dispersion in the urban environment.

<sup>20</sup> Vego, "On Littoral Warfare"; "Littoral Operations in a Contested Environment" (U.S. Marine Corps, 2017).



domains.<sup>21</sup> Despite the significant academic rigor applied to this subject, there still seems to be a lack of appreciation for this environment when considered as a single physical space, and there is a need to unify certain key themes and concepts that are hitherto presented in a somewhat divergent, disjointed, and compartmentalized fashion. In doing this military scholars, practitioners, and leaders will better understand how warfare should be conducted, and more specifically how to command and control (C2) in a dynamic, hyperconnected, and often contested and degraded milieu such as the urban littoral, which requires a truly joint and all-domain approach.

Thus, given the complexity and unpredictability of this environment, its importance to the future of warfare, and the evolution in military thinking over the years towards a true all-domain form of command and control,<sup>22</sup> the analysis of C2 against the backdrop of the urban littoral seems a worthwhile endeavor to the advancement of warfare studies at the tactical level. With this understanding, the premise guiding this research is that **a “distributed operations” methodology is the most appropriate way to command and control military operations in the urban littoral given the complex and unpredictable nature of this operating environment.**

To validate this postulate it will be necessary to examine several themes, which come together at the crossroads of C2 in the urban littoral. This will consist first and foremost of a study of the urban littoral as an operating area by considering its multi-domain nature and relevance to future warfare. Next, using the operational environment as a canvas, the intricacies of command and control from philosophical, force employment, and technical perspectives will be studied through the examination of pertinent doctrine, operational concepts, and literature. The fusion of these

analyses – the operational environment (urban littoral) and the operational function (C2) – will then be tested via practical application by examining them in relation to other doctrine, operational concepts, and the current strategic environment as represented by the war in Ukraine. This should permit *in fine* the validation of the distributed operations methodology as well as a better understanding of C2 in the urban littoral and other complex and unpredictable environments.

## The Operational Environment

A thorough deconstruction of the urban littoral operational area through an examination of its nature and various characteristics serves to provide a better understanding of the complex and unpredictable nature of this environment, and thus its implications for C2. Before embarking on this analysis it is however necessary to define the terms “complex” and “unpredictable,” as this will provide a reference point to comprehend the functioning of C2 in the urban littoral and other challenging operational environments.

In citing Stanley McChrystal, the former U.S. Commanding General of Joint Special Operations Command and ISAF (International Security Assistance Force), from his book *Team of Teams*, the author Anthony King explains the nuances between things that are complex and those that are complicated.

Being complex is different from being complicated. Things that are complicated may have many parts, but those parts are joined, one to the next, in relatively simple ways... Complexity, on the other hand, occurs when the number of interactions between components

<sup>21</sup> The list of doctrine and concepts includes, but is not limited to, “Littoral Operations in a Contested Environment” (U.S. Marine Corps); “Distributed Lethality and Distributed Maritime Operations” (U.S. Navy); “Multi-Domain Operations” (U.S. Army) and “ATP 3-06/MCTP 12-10B Urban Operations” (U.S.

Army/U.S. Marine Corps); “Mosaic Warfare”; and “JP 3-06 - Joint Urban Operations.”

<sup>22</sup> John Gerlach, “The Evolution of Command and Control (C2) in Multi-Domain Operations,” *Institut d'études de Stratégie et de Défense*, December 2019, [https://iesd.univ-lyon3.fr/en/notes\\_de\\_recherche/940/](https://iesd.univ-lyon3.fr/en/notes_de_recherche/940/).

increases dramatically...; this is where things quickly become unpredictable.<sup>23</sup>

Expounding further on this idea, King asserts that “the elements of a complex system are heterogeneous, interconnected with each other in multiple ways.”<sup>24</sup>

With respect to the urban littoral, a physical space where numerous elements constantly interact with one another in a multitude of ways – whether that be the geography, terrain, hydrography, meteorology, and oceanography of the littoral,<sup>25</sup> or the urban triad (population, complex man-made terrain, infrastructure) in the urban area<sup>26</sup> – one observes a truly complex operational environment. Given the number of interdependent and interwoven connections present in this physical domain it becomes extremely difficult to predict the second and third order effects that will arise in response to certain actions and events occurring within the system,<sup>27</sup> evoking thus the famed principles of the fog and friction of war advanced by the Prussian military theorist Carl von Clausewitz in his seminal work *On War*.

Accordingly, within the context of war and warfare, the complexity of the urban littoral environment generates significant fog, i.e., uncertainty, as well as friction, i.e., the arrival of unforeseen events and changing circumstances,

this ensemble often resulting in missteps and setbacks.<sup>28</sup> In returning to the idea of the operational environment being a system composed of many interdependent and interwoven parts as presented in King’s previous citation, one can draw further connections to von Clausewitz’s assertions regarding friction, as he states: “This enormous friction, which is not concentrated, as in mechanics, at a few points, is therefore everywhere brought into contact with chance, and thus facts take place upon which it was impossible to calculate, their chief origin being chance.” That being said, “friction is [thus] the only conception which, in a general way, corresponds to that which distinguishes real war from war on paper.”<sup>29</sup>

The principles of fog and friction affirm consequently the relative impossibility of accounting for all the uncertainties and unforeseen events that will arise during war, particularly in an operational environment as complex as the urban littoral, where chance and missteps can produce countless subsequent cascading effects. It is thus either the result of superior military skill and decision-making, or mere chance, that one is capable of overcoming these difficulties,<sup>30</sup> a premise that will be revisited throughout this study while attempting to ascertain a viable C2 methodology for complex and unpredictable environments.

<sup>23</sup> Stanley McChrystal’s *Team of Teams* cited in Anthony King, *Command: The Twenty-First-Century General* (Cambridge: Cambridge University Press, 2019), 10.

<sup>24</sup> King, *Command: The Twenty-First-Century General*, 10.

<sup>25</sup> Vego, “On Littoral Warfare.”

<sup>26</sup> “Joint Publication 3-06 Joint Urban Operations,” I-2.

<sup>27</sup> Spencer, “The City Is Not Neutral.”

<sup>28</sup> Carl von Clausewitz, *On War*, trad. par J.J. Graham, vol. 1, Strategy Six Pack - Various Artists (The War Vault, 2019), 580-81, 607. Clausewitz states in Book II/Chapter II/Part 24 relative to the fog of war: “Lastly, the great uncertainty of all data in war is a peculiar difficulty, because all action must, to a certain extent, be planned in a mere twilight, which in addition not unfrequently—like the effect of a fog or moonshine—gives to things exaggerated dimensions and an unnatural appearance. What this feeble light leaves indistinct to the sight, talent must discover, or must be left to chance. It is therefore again talent, or the favour of fortune, on which reliance must be placed, for want of objective knowledge.” Regarding friction,

from Book I/Chapter 7 (Friction in War): “Everything is very simple in war, but the simplest thing is difficult. These difficulties accumulate and produce a friction, which no man can imagine exactly who has not seen war. Suppose now a traveler, who, towards evening, expects to accomplish the two stages at the end of his day’s journey, four or five leagues, with post horses, on the high road—it is nothing. He arrives now at the last station but one, finds no horses, or very bad ones; then a hilly country, bad roads; it is a dark night, and he is glad when, after a great deal of trouble, he reaches the next station, and finds there some miserable accommodation. So in war, through the influence of an infinity of petty circumstances, which cannot properly be described on paper, things disappoint us, and we fall short of the mark. A powerful iron will overcomes this friction, it crushes the obstacles, but certainly the machine along with them.”

<sup>29</sup> *Ibid.*, 1:580-81.

<sup>30</sup> *Ibid.*, 1:607.

### *The Littoral*

Beginning with the littoral environment, the word "littoral" comes from the Latin *litoralis*, meaning "of or pertaining to the seashore," which is derived from *litor-* or *litus*, meaning "shore." In basic terms the littoral refers to a "coastal region," or a "shore," which in geographic terms signifies a coastal zone between extreme high and low tides.<sup>31</sup> According to the U.S. Marine Corps document "Littoral Operations in a Contested Environment," which uses U.S. Navy and joint doctrine as references, the littoral consists of the "portion of the world's land masses adjacent to the ocean within direct control of and vulnerable to the striking power of sea-based forces." This space comprises "two segments of operational environment: 1. Seaward: the area from the open ocean to the shore, which must be controlled to support operations ashore. 2. Landward: the area inland from the shore that can be supported and defended directly from the sea."<sup>32</sup>

Given the range and capabilities of modern-day military weapons systems and platforms, even targets or regions far removed from coastlines could be considered as being part of the littoral environment. As noted by David Kilcullen: "Modern naval forces can thus bring areas far from the sea into the littoral influence zone: the whole of Southeast Asia, the entire Mediterranean basin, and large parts of Australia, Africa, South America, and Central America are thus 'littoral' in this sense, even when far from the sea."<sup>33</sup> One example that comes to mind regarding this perspective is the longest amphibious helicopter raid and airfield seizure in history, which was executed by U.S. forces on November 25, 2001 during the invasion of Afghanistan, a completely landlocked country. The mission was flown 371.5 nautical miles (NM) inland from the USS Peleliu (a

U.S. Navy amphibious assault vessel) located offshore Pasni, Pakistan to a desert airstrip later dubbed "Rhino" situated 85 NM southwest of Kandahar, Afghanistan.<sup>34</sup>

Although this operation demonstrates an impressive utilization of amphibious capabilities from the littoral by successfully reaching into the heart of Afghanistan from the Arabian Sea, the fact remains that there is nothing "coastal" about this enclaved territory.<sup>35</sup> It is for this reason that military theorists such as Milan Vego prefer to concentrate on relevant geographical conditions, albeit a wide range, when defining the littoral environment. With this in mind, Vego classifies littorals as regions that "encompass areas bordering the waters of open peripheral seas, large archipelagoes, and enclosed and semi-enclosed seas."<sup>36</sup>

More precisely, littorals that border open oceans, for example the coasts of North and South America, Africa, and India, extend from the shore to the edge of the continental shelf, while "peripheral" (or marginal) seas constitute the parts of an ocean bordering the continental landmass that are partially enclosed by peninsulas, island chains, or archipelagoes (East and South China Seas). Large archipelagoes are completely or partially surrounded by open ocean and include areas such as the Malay (or Indonesian) and Solomons Archipelagoes. Enclosed seas, such as the Baltic and the Adriatic, are situated within the continental shelf and are surrounded by landmasses, with the exception only of the strait that connects them to an ocean or another enclosed or semi-enclosed sea. Because of their limited connection to the open ocean, enclosed seas have small tidal ranges or are tideless, while semi-enclosed seas, such as the North Sea, are contiguous to a continent and linked by two or

<sup>31</sup> "Definition of LITTORAL," 9 November 2023, <https://www.merriam-webster.com/dictionary/littoral>; Vego, "On Littoral Warfare," 33.

<sup>32</sup> "Littoral Operations in a Contested Environment," 25.

<sup>33</sup> Kilcullen, *Out of the Mountains*, 32.

<sup>34</sup> *Ibid.*, 31; Capt Jay M Holtermann, "The 15th Marine Expeditionary Unit's Seizure of Camp Rhino," Marine Corps

Gazette, March 2016, 90. It is important to note that this amphibious raid was launched from waters in a non-contested environment.

<sup>35</sup> Kilcullen, *Out of the Mountains*, 31.

<sup>36</sup> Vego, "On Littoral Warfare," 33.

more straits or narrows to the open ocean, and thus experience large tidal ranges.<sup>37</sup>

The littoral presents thus many challenges with respect to the employment of military forces and capabilities, the planning of operations, and tactical maneuver given the multitude of geographical, terrain, meteorological, hydrographic, and oceanographic conditions associated with this operating environment. No littoral operational area is the same and factors such as the contour and shape of the coastline, the presence of coastal islands, archipelagos, cliffs, and mountains that descend directly onto the shore, the proximity of the waters to a landmass, the position on the earth (latitude/longitude), the tides, the temperature (of both the water and the air), civilian maritime traffic, seasonal weather patterns (monsoon, El Niño), and weather phenomena (jet stream) all contribute to what is a complex and rapidly and drastically changing operational environment.<sup>38</sup> An example of this would be the major differences in the environments of the Atlantic Ocean off the coast of South America, the Pacific Ocean off the coast of North America, the English Channel, the Baltic Sea, the Sea of Azov, the Persian Gulf, and the South China and East China Seas. Each of these areas have distinct geographical, meteorological, hydrographic, and oceanographic properties that create uncertain and unpredictable (rapidly and drastically changing) operational

environments favoring “tactical action,” which is in stark contrast to the major, or “decisive” naval battle often associated with the open ocean. It is because of this inherent complexity and tendency towards rapidly and drastically changing tactical situations that Vego emphasizes the need for a highly decentralized form of C2 via the application of a true German-style mission command during the execution of littoral operations.<sup>39</sup>

These numerous environmental conditions that contribute to the rapidly and drastically changing and thus unpredictable nature of the littoral operational area create in turn both challenges and opportunities for military forces. For example, deeper and more open littoral waters support the employment of larger and more powerful surface and subsurface vessels since it better facilitates maneuver and dispersion, which become ever more important when operating in a contested area outfitted with A2/AD and sea-denial capabilities similar to those employed by China in the SCS.<sup>40</sup> To lessen the chances of being located, targeted, and ultimately struck by the adversary in such an environment – while simultaneously maintaining the ability to go on the attack – maneuver, dispersion, and decentralized decision-making are key, as put forth in the U.S. Navy’s “distributed lethality” operational framework,<sup>41</sup> which recognizes the need to “out-think, out-scout, and out-shoot the enemy.”<sup>42</sup>

<sup>37</sup> Ibid., 33-34.

<sup>38</sup> Ibid., 34-41.

<sup>39</sup> Ibid., 30-31, 59. The theory of the decisive naval battle is attributed to the great 19th century naval practitioner and theorist Alfred Thayer Mahan, and is associated with major naval battles in the open ocean, vice a potentially distributed form of littoral operations. Outside of the major naval operations of the Second World War, the Falklands/Malvinas War of 1982 is the most recent example of the major naval battle.

<sup>40</sup> Ibid., 31-32, 38-39; J Michael Dahm, "Introduction to South China Sea Military Capability Studies," Johns Hopkins University Applied Physics Laboratory, July 2020, 4-5. As noted by Vego, the primary A2/AD capabilities in the littoral include land-based aircraft, diesel-electric attack submarines, multipurpose corvettes, fast attack craft, coastal missile/gun batteries, unmanned aerial vehicles, midget submarines, sophisticated mines, medium- and short-range ballistic

missiles, and antiship cruise missiles. An example of an intricate and inter-connected A2/AD system would be that employed by China in the SCS, which extends hundreds of miles from its coastline, taking advantage of various coastal bases on the mainland as well as island-reefs in the region, such as those in the Paracel and Spratly Archipelagos, to house and deploy various airborne, surface, and subsurface platforms; integrated air defense systems; ISR systems; radars; and C2 nodes.

<sup>41</sup> Vice Admiral Thomas Rowden, Rear Admiral Peter Gumataotao, et Fanta Rear Admiral Peter, “Distributed Lethality,” U.S. Naval Institute, Proceedings, 1 January 2015, <https://www.usni.org/magazines/proceedings/2015/january/distributed-lethality>; Jeffrey E. CAPT Kline USN (ret), "A Tactical Doctrine for Distributed Lethality," Center for International Maritime Security, 22 February 2016, <https://cimsec.org/tactical-doctrine-distributed-lethality/>.

<sup>42</sup> Kline, "A Tactical Doctrine for Distributed Lethality."

During littoral operations in environments characterized by enclosed and semi-enclosed seas as well as coastal islands and archipelagos, maneuver and dispersion become more difficult due to the constraints of physical space, but are nonetheless necessary to avoid detection and counter the channeling effects of the geography and terrain. The specific features of these zones including their smaller surface areas, the presence of straits and channels and often shallower depths, as well as the increased congestion from civilian maritime traffic create channeling effects that ultimately reduce the maneuverability of maritime assets. That said, these conditions also provide opportunities for cover, concealment, and to blend in with the clutter and the ambient noise (acoustic, electromagnetic, and increased maritime traffic).<sup>43</sup>

Regarding the question of geography and terrain, the configuration of the coastline is important, as it dictates how and where coastal surveillance and defensive capabilities can be employed. Natural harbors, bays, channels, and coastal islands all provide opportunities for military forces to hide, take refuge, and mask movement, while also providing potential expeditionary basing options and anchorage points. As stated previously, these conditions restrict maneuver, specifically for a large-scale deployment of forces, and normally benefit the defense, while the presence of coastal islands and archipelagos also require the defense of more territory. Coastlines characterized by mountains and jagged cliffs create challenges for the installation and employment of surveillance and communications systems while also serving as points of refuge and concealment, as is the case for indented cliffs, which are favorable to temporary submarine and

small surface combatant shelters. A flat coastline without offshore islands is more advantageous for larger scale beach landings and the deployment of ground forces, while the presence of swamps, marshes, and river deltas can impede movement, maneuver, and landings.<sup>44</sup>

Additional concerns with respect to coastal geography and the contour and shape of the coastline are their effects on tides, which can play a pivotal role in the conduct of littoral operations, specifically those requiring the amphibious landing of troops, as is highlighted by the planning and execution of allied beach landings on the coast of Normandy during Operation Neptune, D-Day, June 6, 1944. The successful execution of this operation, the largest military amphibious invasion in history, hinged upon the first landings occurring in the early hours of the morning just after low tide, which served to expose and thus minimize the effectiveness of German obstacles, obstructions, and mines placed on the beaches, while also providing enough light to maximize the effects of naval fires targeting German defensive positions on the coastline.<sup>45</sup>

Although first and foremost affected by astronomical factors, i.e., the gravitational interactions of the sun, moon, and earth, tides are also considerably influenced by non-astronomical factors, which concern predominantly the geographical features of the littoral.<sup>46</sup> These features include the width of the continental margin,<sup>47</sup> the proximity of the water to a continental landmass, and the shape and contour of enclosed and semi-enclosed seas as well as their connection to the open ocean, all of this affecting the overall depth of the water and the shape of the seafloor. This illustrates why the Bay

<sup>43</sup> Vego, "On Littoral Warfare," 34-43.

<sup>44</sup> *Ibid.*, 37-38.

<sup>45</sup> Troy Kitch et Greg Dusek, "Turning the Tide: D-Day and Tide Prediction," NOAA Ocean Podcast, consulted 26 February 2024, <https://oceanservice.noaa.gov/podcast/june20/nop36-dday-tides.html>.

<sup>46</sup> The Maury Project, "Ocean Tides Teacher's Guide" (The American Meteorological Association, 2018), 2-5, <https://www.ametsoc.org/index.cfm/ams/education->

[careers/education-program/k-12-teachers/project-ocean/training-opportunities/maury-project-peer-led-training/maury-project-peer-training-resources/ocean-tides/](https://www.ametsoc.org/index.cfm/ams/education-careers/education-program/k-12-teachers/project-ocean/training-opportunities/maury-project-peer-led-training/maury-project-peer-training-resources/ocean-tides/).

<sup>47</sup> The continental margin refers to "the region of transition from the land to the deep seafloor, i.e., between continental and oceanic crust." Paul Webb, "1.2 Continental Margins," 7, <https://rwu.pressbooks.pub/webboceanography/chapter/1-2-continental-margins/>.

of Fundy in Nova Scotia, which has a wide funnel-shaped opening with respect to the Atlantic Ocean, experiences one of the highest tidal ranges in the world, while the Pamlico Sound, an inland bay off the coast of North Carolina on the East coast of the United States, is classified as non-tidal despite its direct proximity to the Atlantic Ocean, from which it is shielded via the presence of a chain off-shore islands that present only a few narrow openings to the greater ocean.<sup>48</sup>

The convergence of land, water, and air in the littoral produces many interesting effects regarding the utilization of electronic sensors and the propagation of electromagnetic (EM) energy, which in turn affects the conduct of military operations. A general rule of thumb is that sensors and communications equipment employed in the littoral are degraded due to a variety of meteorological, EM, atmospheric, and hydrographic conditions. To begin, temperature, pressure, and humidity differences between the sea and the air lead to anomalies in the propagation of EM waves via phenomena known as subrefraction, super-refraction, and ducting, which consequently affect the performance of radar and other forms of radio communications, as well as electro-optical sensors.<sup>49</sup>

In basic terms, subrefraction causes EM waves to bend up and away from the earth's surface in non-standard ways, while super-refraction causes waves to bend down and strike the sea surface before reflecting upward again, downward, and so on and forth in this pattern. Subrefraction reduces the range of radars and radio communications while super-refraction increases ranges and at the

same time distorts radar readings, making objects seem closer and higher than they are. Ducting is an extreme case of super-refraction where EM waves become trapped between a layer of warmer air (on top) and cooler air (on bottom). Ducting can significantly increase the propagation of EM waves while also creating blind spots, specifically for radars.<sup>50</sup>

Clutter is another environmental phenomenon that significantly affects the performance of sensors, in particular radars. Clutter occurs when electronic sensors receive unwanted echoes, or returns, and can originate from both the land and the sea, creating false targets while making it more difficult to spot actual targets. Sea clutter is particularly pronounced in the littoral and is caused by wind, waves, swells, and precipitation, all things which create sea spray and interfere with the propagation of radio frequency (RF) waves. Clutter benefits thus those forces wanting to mask their movement, specifically smaller surface craft with lower radar cross sections, while radar operators must continually adjust their systems (angle, frequency, power, polarization) to the extent possible in trying to overcome these effects.<sup>51</sup>

Further noise is created simply by the quantity of communications systems employed in the littoral, particularly in areas that experience high maritime traffic and are near coastlines with highly developed commercial or military communications infrastructures, all of this tending to interfere with the performance of one's organic communications systems. In shallow littorals and those containing numerous islands, acoustic noise can be

<sup>48</sup> National Oceanic and Atmospheric Administration, "Tides and Water Levels: What Affects Tides in Addition to the Sun and Moon?", National Ocean Service Education - National Oceanic and Atmospheric Administration, consulted 26 February 2024, [https://oceanservice.noaa.gov/education/tutorial\\_tides/tides08\\_othereffects.html](https://oceanservice.noaa.gov/education/tutorial_tides/tides08_othereffects.html); Vego, "On Littoral Warfare," 33.

<sup>49</sup> Vego, "On Littoral Warfare," 40.

<sup>50</sup> Ibid., 40; UCLA Atmospheric and Oceanic Sciences, "Weather Radar Fundamentals," consulted 15 December 2023, [http://research.atmos.ucla.edu/weather/C110/Documents/tmp/basic\\_wxradar/navmenu.php\\_tab\\_1\\_page\\_3\\_4\\_1\\_type\\_text.htm](http://research.atmos.ucla.edu/weather/C110/Documents/tmp/basic_wxradar/navmenu.php_tab_1_page_3_4_1_type_text.htm). To explain more precisely these phenomena, subrefraction

occurs when air temperature decreases or humidity increases rapidly with height, and super-refraction arises when the relative humidity of the air steadily decreases with altitude instead of remaining constant, or when the air temperature decreases at a rate less than standard. "Standard" atmospheric conditions for the propagation of EM waves are present when temperature and moisture both decrease with height in the troposphere.

<sup>51</sup> Vego, "On Littoral Warfare," 41; "Sea Clutter - an overview | ScienceDirect Topics," consulted 13 December 2023, <https://www.sciencedirect.com/topics/engineering/sea-clutter>.

significant due not only to the depth but also to significant variations in water temperature, salinity, waves, and tides, as well as the presence of underwater obstructions (rocks, obstacles, debris) and habitats (coral reefs). All of this can result in high rates of false returns for sonar sensors, which provides another opportunity for vessels to hide, specifically those operating subsurface, while also obstructing the maneuver of both surface and subsurface platforms, as well as the ability of forces to conduct amphibious landings.<sup>52</sup>

The fact that the littoral is a rapidly and drastically changing environment is extremely relevant when discussing the phenomena of subrefraction, super-refraction, and clutter. Meteorological conditions in the littoral can change at a moment's notice, thus amplifying or minimizing the effects of these conditions in a random and unpredictable manner. This has serious implications for the efficacy of various sensors and communications systems and ultimately necessitates creative, intelligent, and adaptive forces that are ready to seize the initiative and take advantage of opportunities when they present themselves, whether on offense or defense.

With that said, tactical forces need to be prepared to maneuver, disperse, and hide in the clutter and noise as well as to operate in deteriorating weather conditions. This must all be done with an understanding that organic communications systems and electronic sensors will be degraded, thus making friendly force communications and detection of the enemy more difficult. The same is true regarding geography and terrain, as forces need to be prepared to adapt to the physical environment to maneuver, disperse, and rapidly make decisions while using geography to their advantage for cover,

concealment of movement, and refuge. These ideas refer once again to the assertion of theorist Milan Vego put forth earlier in this section, which affirms that the complex and unpredictable nature of the littoral operational environment favors "tactical action," and thus a highly decentralized form of C2.<sup>53</sup>

*Given the complexity of this milieu and the multitude of interacting and interdependent environmental characteristics, a summary of the various elements impacting littoral operations is included in Annex 1.*

### *The Urban Environment*

According to John Spencer, chair of urban warfare studies with the Modern War Institute, fighting in cities constitutes the "most difficult form of warfare because the environment is both the most physically constraining and also involves the most constraints from a policy perspective."<sup>54</sup> These constraints arise due to three interrelated elements defined in the U.S. Military's "Joint Publication 3-06 Joint Urban Operations" as the urban triad (Figure 1), which consists of "complex man-made physical terrain, a population of significant size and density and varying sociocultural groupings, and an infrastructure."<sup>55</sup>

In studying the concept of the urban triad, one can begin to understand the complexity of this milieu, and thus the challenges associated with C2 and military decision-making in the urban environment. To begin with a simple explanation, "urban areas are and always have been ... groups of man-made structures."<sup>56</sup> Complex man-made terrain is built upon the existing natural terrain of an area and is comprised of man-made structures of various sizes, types, and materials, that are arranged in a way to support the overall

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<sup>52</sup> Vego, "On Littoral Warfare," 40, 42. As stated by Vego: "In shallow water, sound propagation is generally difficult to predict, because of great seasonal and daily variations of sea temperature, salinity, waves, tides and currents, any influx of freshwater, and the reflection and absorption due to variations of the seabed. In addition, natural and man-made ambient

noise compounds the problem of hunting for submarines in shallow waters."

<sup>53</sup> Ibid., 30-31.

<sup>54</sup> Spencer, "The City Is Not Neutral."

<sup>55</sup> "Joint Publication 3-06 Joint Urban Operations," I-2.

<sup>56</sup> Goedecke et Putnam, "Urban Blind Spots - Gaps in Joint Force Combat Readiness," 7.

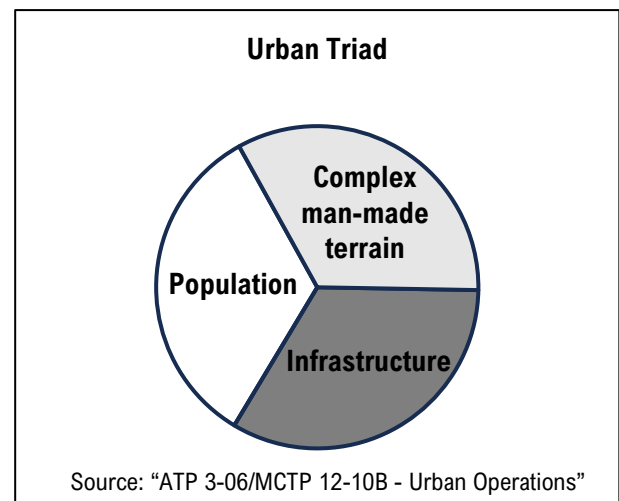
environment, i.e., the people and the corresponding infrastructure. These structures include buildings with all their corresponding features (basements, stairwells, various levels and interior layouts, balconies, and rooftops), streets, roadways, sewage systems, tunnels, bridges, and the like. Depending on factors such as modernity, level of investment, and planning, the area could be organized in a somewhat orderly or in a random manner.<sup>57</sup> Think of the skylines of New York City and Tokyo, horizons dotted with gigantic and magnificent skyscrapers, as compared to the expansive urban sprawls of a Lagos, Nigeria or a Dhaka, Bangladesh, replete with improvised and temporary structures and neighborhoods.

Next, there is the question of a population of significant size and density as well as various socio-cultural groupings, which occupies and ultimately utilizes the man-made and natural terrain of the urban environment. Urban areas are normally classified according to size and include villages of fewer than 3,000 inhabitants as well as large cities with more than 100,000 inhabitants. Large cities vary greatly in size, housing populations ranging from 100,000 to over 20,000,000 people (the U.N. classifies a mega-city as more than 10 million inhabitants) and having surface areas stretching from several to hundreds of square miles. The social, economic, and cultural make-ups of these populations (and their sub-populations) are extremely important when trying to comprehend the character of an urban environment.<sup>58</sup>

Finally, there is the infrastructure of an urban environment, which depends on and occupies both the man-made and natural terrain of the area while also providing services and cultural and political structure. Think of all the basic services that comprise the functioning of a city including transportation, water, energy, sanitation, sewage, communications, finance, police, and organizations and administrations spanning the local, national,

and international levels. All these functions influence the internal operational capacity of the urban area while also having potential implications at the national, regional, and global levels.<sup>59</sup> Imagine the consequences at the domestic and international levels if New York City's internal infrastructure ceased to function properly and support the daily activities of the city, which constitutes a global financial hub home to countless national and international institutions, organizations, and companies.

*Figure 1*



Added to this conception of the urban triad is the understanding of the hyper-connectivity of modern urban areas from both a communications and information perspective.<sup>60</sup> This means that cyber, information, and electromagnetic warfare will continue to play roles of increasing importance with respect to combat in this milieu, while military forces must also be cognizant of the fact that the vast proliferation of communications technology and rapid advancements in smart city infrastructure development mean that everything that takes place on the battlefield can be captured and transmitted within the blink of an eye – e.g., social media, messaging platforms, networked cameras, and other sensors installed throughout cities that can

<sup>57</sup> "Joint Publication 3-06 Joint Urban Operations," I-2.

<sup>58</sup> Ibid.

<sup>59</sup> Ibid.

<sup>60</sup> In returning to David Kilcullen's *Out of the Mountains*, this communications and information hyper-connectivity represents one of the main strategic issues that will drive the future of warfare into the urban littoral.



serve as ISR platforms or means to support information and cyber warfare.<sup>61</sup> Indeed, today's cities are connected to such a degree that it might make more sense to speak of an urban quad rather than a triad (network connectivity comprising the fourth element), as is currently recognized by NATO for instance.<sup>62</sup>

In returning to the question of infrastructure, this element of the triad is explained by Kilcullen in *Out of the Mountains* via the principles of "flow" and "urban metabolism," where the city is compared to a living organism that "flows and breathes."<sup>63</sup> "Like other complex systems, when it is touched, it changes, and the system's complexity makes it nearly impossible to truly know the second- or third-order effects of those changes."<sup>64</sup> In basic terms, flow consists of "people getting around to do what they have to do," and constitutes an "agreed level of service." In using counter-insurgency operations as an example, Kilcullen explains that when military forces try to project security in an urban environment, major disruptions in the flow of a city are equivalent to mission failure, as establishing security is only one piece of the greater puzzle.<sup>65</sup>

In addition to the idea of flow, the urban environment, characterized as a living organism, also possesses a metabolism, where certain inputs (air, food, water, fuel, construction materials, other forms of energy) are necessary to maintain the functioning of the system and support the lives of its inhabitants. These inputs and their resultant outputs, or waste products, must be appropriately metabolized via either natural processes or basic services, i.e., the city's infrastructure, otherwise toxicity will develop and infect the system.<sup>66</sup>

It is thus the constant interaction and the associated density of the elements of the urban triad, joined with the concepts of flow, metabolism, and connectivity in the communications and information domain (with corresponding ambient noise), that render military operations, and thus command and control, so complex in the urban environment.<sup>67</sup> The challenges military units face due to these conditions include the collection of ISR and the resultant detection and locating of enemy forces, fire and maneuver, the execution of strikes, the maintaining of civil order and the continuation of basic services, and the protection of forces and of the civil population.<sup>68</sup> The convergence of these elements increases uncertainty and unpredictability within this environment, specifically with respect to military decision-making, and thus makes C2 significantly more complex.

Additionally, the nature of the urban environment as defined by the urban triad and the preceding elements favors defensive operations, while simultaneously reducing both the technological and fire superiority advantages of the "stronger" opponent.<sup>69</sup> Although modern day urban areas have evolved significantly since the age of Sun Tzu some several hundred years before the common era, cities have historically favored the defense. In *The Art of War*, Sun Tzu advises avoiding cities given their fortifications, high walls, and thus defensible nature, all attributes which render military commanders impatient and likely to employ poor tactics in pursuit of piercing these heavily guarded fortresses.<sup>70</sup> He states precisely:

The rule is not to besiege walled cities if it can possibly be avoided. The preparation of mantlets, movable shelters, and various

<sup>61</sup> Liam Collins et John Spencer, *Understanding urban warfare* (Havant, Hampshire: Howgate Publishing Limited, 2022), 71-84.

<sup>62</sup> *Ibid.*, 35-36.

<sup>63</sup> Kilcullen, *Out of the Mountains*, 19, 41-43.

<sup>64</sup> Spencer, "The City Is Not Neutral."

<sup>65</sup> Kilcullen, *Out of the Mountains*, 19.

<sup>66</sup> *Ibid.*, 41-43.

<sup>67</sup> "Joint Publication 3-06 Joint Urban Operations," I-2-I-3; "ATP 3-06 Urban Operations" (Headquarters, United States Army &

Headquarters United States Marine Corps, July 2022), 1-2; Collins et Spencer, *Understanding urban warfare*, 35-36.

<sup>68</sup> Kilcullen, *Out of the Mountains*, 19-20, 28, 41-43, 238-39; "Joint Publication 3-06 Joint Urban Operations," I-2-I-3; "ATP 3-06 Urban Operations," 1-2.

<sup>69</sup> Spencer, "The City Is Not Neutral"; Boris Laurent, "Ukraine : dans l'enfer des combats urbains, la technologie ne fait pas tout," *Areion24.news*, consulted 12 December 2023, <https://www.areion24.news/2023/11/08/ukraine-dans-lenfer-des-combats-urbains-la-technologie-ne-fait-pas-tout/>.

<sup>70</sup> Sun Tzu, *The Art of War*, 15-16.

implements of war, will take up three whole months; and the piling up of mounds over against the walls will take three months more. The general, unable to control his irritation, will launch his men to the assault like swarming ants, with the result that one third of his men are slain, while the town remains untaken.<sup>71</sup>

Although Sun Tzu could not have fully imagined the complexity of modern-day urban areas, the truth remains that these environments are highly favorable to defensive operations and present many challenges to commanders from a decision-making perspective. Despite significant evolution in the character of war throughout the course of history, the siege, as described in the citation just above, rests in effect the preferred tactic for attacking a city and trying to overcome its defensible nature. History is replete with examples of this fact, ranging from the battles of the Greeks and the Romans in antiquity to the Battle of Mosul in 2017.<sup>72</sup> However, given important advancements in military technology, tactics, and rules of engagement over the ages, the sieges of modern day warfare look vastly different than those of antiquity, the Middle Ages, and WWII, and thus are normally not labeled as such. Nonetheless, the underlying premise remains the same – cities favor defensive operations and present many challenges for command and control.

Thus, modern-day urban areas, no longer protected by high walls and fortifications but rather consisting of structures composed of building materials such as steel and reinforced concrete, are often impenetrable with respect to small-caliber weapons systems, creating consequently natural “instant fortifications” that require no additional time or resources to reinforce – as compared to

other physical environments where trenches, bunkers, hides, pillboxes, towers, and the like need to be erected, fortified, and maintained.<sup>73</sup> To overcome the impenetrable nature of these interconnected structures and target enemies hiding amongst the many layers of this complex man-made terrain, which is favorable to the execution of ambushes and hit-and-run attacks by defensive forces, the offensive army has two options: 1) employ increasingly powerful high explosive munitions to include artillery, mortars, bombs, and missiles; 2) engage the enemy in close-quarters combat.<sup>74</sup>

The first choice tends to create a disproportionate number of civilian casualties and significant destruction, as the density of the urban environment’s man-made terrain negates the range, accuracy, and effects of many heavy weapon-systems. Increases in civilian casualties, the destruction of civilian structures, and the degradation of infrastructure (services) in turn creates problems from a law-of-armed conflict (LOAC) perspective as well as with respect to influencing the behavior of non-combatants.<sup>75</sup> Additionally, this increased destruction, which can negatively affect maneuver for offensive forces, also creates additional fortified defensive structures for the adversary.<sup>76</sup> This is highlighted by General Stephen Townsend, former Commanding General of U.S. Army TRADOC and AFRICOM,<sup>77</sup> when discussing the 2017 Battle of Mosul at a conference regarding multi-domain battle in megacities. General Townsend describes how during the battle rubble from destroyed and collapsed buildings created bunkers so protective for ISIS (Islamic state in Iraq and Syria) forces that one could not purposely design a more effective defensive structure.<sup>78</sup>

<sup>71</sup> Ibid.

<sup>72</sup> Spencer, "The City Is Not Neutral"; Collins et Spencer, *Understanding urban warfare*, 267, 278.

<sup>73</sup> Spencer, "The City Is Not Neutral."

<sup>74</sup> Collins et Spencer, *Understanding urban warfare*, 3.

<sup>75</sup> Ibid., 3-4.

<sup>76</sup> Ibid., 2-3; Spencer, "The City Is Not Neutral"; Townsend, "Multi-Domain Battle in Megacities."

<sup>77</sup> TRADOC is the U.S. Army’s Training and Doctrine Command, responsible for recruitment, training, education, and the development of doctrine for the U.S. Army. AFRICOM is the U.S. military’s Combatant Command responsible for military operations in Africa.

<sup>78</sup> Townsend, "Multi-Domain Battle in Megacities." According to Townsend in reference to the final combat of the Battle of Mosul in 2017: “The buildings had been turned into bunkers.

The second choice, which consists of engaging in block-by-block ground operations highlighted by violent close-quarters battle, ultimately results in increased risk for the attacking army. The combat is grueling, slow, and restrictive to maneuver, as the dense urban terrain, with its city-block layout and narrow streets, is generally unfriendly to the speedy and effective movement of large military formations composed of heavy armored vehicles, tanks, and helicopters, often splitting up forces into “disconnected small fighting elements.” In this maneuver constraining environment units are susceptible to ambushes and hit-and-run attacks at the hands of an adversary hiding amongst the complex man-made terrain and the civilian population.<sup>79</sup>

Given these risks, offensive forces usually begin a campaign by employing more powerful high explosive munitions via artillery, missile strikes, and aerial bombardments in an attempt to “soften”<sup>80</sup> the target area prior to beginning ground operations, which are ultimately necessary to fully overcome enemy forces.<sup>81</sup> However, as highlighted previously, this strategy can prove counter-productive in certain situations, as it has the potential to restrict the maneuver of offensive forces by filling the streets with rubble and debris, to create additional fortified defensive structures for the enemy, to adversely influence the civilian population, to generate LOAC concerns, and to produce oppositional political sentiment at the international level, all of this in turn weighing on political and military decision-making, and thus C2. The operations waged currently by Israel in Gaza, a territory comprised of several significant urban

areas in the littoral space, demonstrate this dilemma regarding the two choices presented above.

Returning to the complexity of the dense man-made terrain of urban areas, it is essential to note two other important elements of C2 that are significantly degraded in this operational environment: ISR and communications capabilities (two functions that are extremely interdependent).<sup>82</sup> Firstly, the effects of ISR platforms, specifically those which are airborne or satellite-based in nature, are severely degraded due to the “urban canopy” created by the dense physical structures of the urban area. This canopy allows one to see what is on top and maybe outside of structures, but not within, which is extremely detrimental from a targeting perspective.<sup>83</sup>

Secondly, from a communications perspective, the density of urban structures and the materials from which they are made, as well as their multiple layers, severely disrupt the transmission of radio frequency waves and other forms of electromagnetic energy, which has serious implications for coordination and the sharing of situational awareness amongst military units. This refers to intrateam and inter-team communications, as well as those with higher echelons of command and various sensors and external platforms.

This communications dilemma is further complicated by the significant amount of ambient RF noise present in today’s hyper-connected urban areas, which are replete with cell phone, wireless, radio, and satellite communications of all varieties

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Imagine a five-story building and the top four floors are gone. They’re rubble now, and that rubble is twenty and thirty feet deep on top of the first floor and the basement floor. And now what you have... You couldn’t build a better bomb-proof shelter than that.”

<sup>79</sup> Spencer, “The City Is Not Neutral”; Collins et Spencer, *Understanding urban warfare*, 3; Kilcullen, *Out of the Mountains*, 238, 264.

<sup>80</sup> “Softening” the target area, sometimes called shaping fires, consists normally of employing fires (artillery, missiles, aerial bombardments) to weaken or destroy the opposing forces’ defensive systems and infrastructure, weapons systems and

arms caches, and command and control systems to prepare the battlefield for follow-on ground operations.

<sup>81</sup> It is important to note that this strategy describes primarily offensive operations from a more traditional perspective, i.e., seizing an area controlled by opposing forces, vice other forms of operations that can often take place in the urban area (humanitarian assistance, disaster relief, stabilization, and COIN operations), where this approach would be generally unwarranted.

<sup>82</sup> Kilcullen, *Out of the Mountains*, 238-39; Spencer, “The City Is Not Neutral.”

<sup>83</sup> Collins et Spencer, *Understanding urban warfare*, 2; Kilcullen, *Out of the Mountains*, 238-39.

that can in turn interfere with the transmission of military grade communications and the targeting of the enemy via the tracking of their various communications systems.<sup>84</sup> All the aforementioned difficulties regarding the urban operating environment are compounded when the area is contested from a communications and air defense perspective, that is, a situation where the enemy possesses electromagnetic warfare capabilities such as communications jamming equipment, C-UAS (counter unmanned aerial systems) systems, and air defense systems. Additionally, this communications hyper-connectivity turns every cell phone, computer, and camera on the street into a sensor with the ability to instantly transmit information regarding enemy forces' movements and activities, as well as to participate in cyber and information warfare.<sup>85</sup>

In concluding this section, the totality of challenges associated with operations in the urban space can be succinctly summarized by citing the former Commandant of the U.S. Marine Corps, General Charles C. Krulak, in his article "The Strategic Corporal: Leadership in the Three Block War." General Krulak, in addressing mid-intensity conflict and operations other than traditional warfare in densely populated coastal urban areas, describes "contingencies in which Marines may be confronted by the entire spectrum of tactical challenges in the span of a few hours and within the space of three contiguous city blocks," i.e., "the three-block war." In referring specifically to the Battle of Mogadishu (October 1993) and other military operations from that time period (Bosnia, Haiti), Krulak acknowledges that whether operations consist of "humanitarian assistance, peace-keeping, or traditional warfighting, their outcome may hinge on decisions made by small unit leaders, and by actions taken at the lowest level. ... Success or failure will rest, increasingly,

with the rifleman and with his ability to make the right decision at the right time at the point of contact."<sup>86</sup>

This notion of making the right decision at the right time against the backdrop of the complexity and unpredictability associated with the urban littoral operating environment thus sets the stage for the next section of this study, where the operational function of command and control will be examined to determine the most effective C2 methodology with respect to the urban littoral, and thus military operations in complex and unpredictable multi-domain environments.

### **The Operational Function: Command and Control in the urban littoral**

As defined by the U.S. Military's "Joint Publication (JP) 3-0 - Joint Operations," command and control consists of "the exercise of authority and direction by a commander over assigned and attached forces to accomplish the mission," as well as a number of other subordinate tasks including the establishment and operation of a joint headquarters (HQ), the organization of forces, coordination and communications amongst the various echelons of the organization and with supporting and supported entities to ensure the flow of information, the allocation of resources, and the employment of military capabilities.<sup>87</sup>

In deconstructing this term further, although command "involves a great many things, not all of which can be clearly separated from each other," it ultimately boils down to decision-making, an authority which is invested to commanders.<sup>88</sup> This notion of command consists subsequently of three functions: mission definition (the most important),

<sup>84</sup> Kilcullen, *Out of the Mountains*, 238-39; Spencer, "The City Is Not Neutral"; Collins et Spencer, *Understanding urban warfare*, 2-3.

<sup>85</sup> Kilcullen, *Out of the Mountains*, 169-231. This chapter of the book, "Conflict in Connected Cities," focuses on the cyber and information aspects of urban guerilla warfare.

<sup>86</sup> Charles C. Krulak, "The Strategic Corporal: Leadership in the Three Block War," *Marines Magazine*, 1 January 1999, 4-5, <https://doi.org/10.21236/ADA399413>.

<sup>87</sup> Chairman Joint Chiefs of Staff, "Joint Publication 3-0: Joint Operations," 22 October 2018, III-2.

<sup>88</sup> Martin van Creveld *Command in War* cited in King, *Command*, 56-57; King, *Command*, 56-57.

mission management, and leadership.<sup>89</sup> “Control is inherent to command” and constitutes the ability to implement decision-making via the management and direction of “forces and functions consistent with a commander’s command authority.”<sup>90</sup> According to Anthony King, control refers specifically to the management of operations, but given that this distinction is somewhat ambiguous and ultimately difficult to make, military doctrine links the two terms, resulting thus in the concept of command and control.<sup>91</sup>

Command and control, like the conduct of war, can be considered both an art and science. According to this prescription:

Various aspects of war fall principally in the realm of science, which is the methodical application of the empirical laws of nature. The science of war includes those activities directly subject to the laws of ballistics, mechanics, and like disciplines; for example, the application of fires, the effects of weapons, and the rates and methods of movement and resupply. However, science does not describe the whole phenomenon. An even greater part of the conduct of war falls under the realm of art, which is the employment of creative or intuitive skills. Art includes the creative, situational application of scientific knowledge through judgment and experience, and so the art of war subsumes the science of war. The art of war requires the intuitive ability to grasp the essence of a unique military situation and the creative ability to devise a practical solution.<sup>92</sup>

Another interesting interpretation of this art-science question aligns each element with a commensurate component of C2, where “the art of

command is the creative and skillful use of authority, instincts, intuition, and experience in decision-making and leadership ..., [and] the science of control is about the systems and procedures that improve a commander’s understanding and support the execution of missions.”<sup>93</sup> Nonetheless, “owing to the vagaries of human behavior and the countless other intangible factors which influence war, there is far more to its conduct, [and thus C2], than can be explained by art and science.”<sup>94</sup>

In building off this initial understanding, this section of the study will focus on a largely tactical level analysis of the command-and-control function through the lens of a “distributed operations” methodology. Before doing so however, it is necessary to define what is meant by distributed operations, as well as by the relation of this term to other concepts often utilized interchangeably such as decentralized operations, decentralized execution, and decentralized command and control.

According to Paul Baran in the 1964 RAND Corporation report “On Distributed Communications,” a C2 system characterized by a distributed communications network is the most survivable type given its extremely redundant internodal connections (see Figure 2). Although one can design a wide variety of network structures, they all come down to two architectures: centralized (star) and distributed (grid or mesh).<sup>95</sup>

In using Figure 2 to analyze these two architectures one notices first that a centralized network (A) is the most vulnerable, as it consists of a single central node that controls network information flow across the various nodes in the system, while operating as the central point of

<sup>89</sup> King, *Command*, 437-438.

<sup>90</sup> Chairman Joint Chiefs of Staff, “Joint Publication 3-0: Joint Operations,” III-6.

<sup>91</sup> King, *Command*, 59-60, 87.

<sup>92</sup> U.S. Marine Corps, “MCDP 1 - Warfighting” (Department of the Navy, 1997), 18.

<sup>93</sup> Gary (General Retired) Luck et JS J7 Deployable Training Division, “Mission Command and Cross-Domain Synergy,” March 2013, 1,

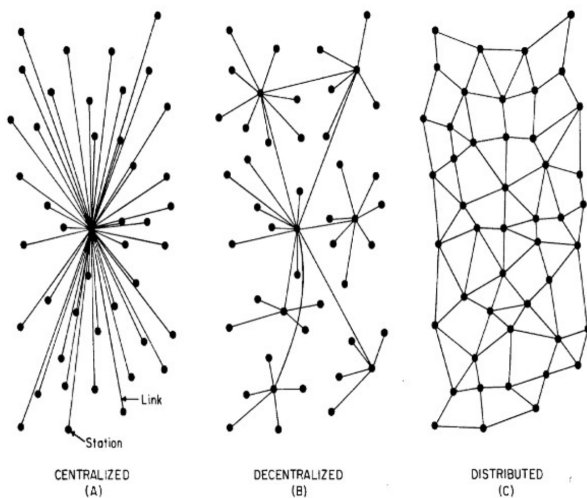
[https://www.jcs.mil/Portals/36/Documents/Doctrine/fp/mission\\_comm\\_fp.pdf?ver=2018-03-29-142405-290](https://www.jcs.mil/Portals/36/Documents/Doctrine/fp/mission_comm_fp.pdf?ver=2018-03-29-142405-290).

<sup>94</sup> U.S. Marine Corps, “MCDP 1 - Warfighting,” 18.

<sup>95</sup> Paul Baran, “On Distributed Communications: I. Introduction to Distributed Communications Networks.” (Santa Monica, California: The Rand Corporation, août 1964), 1-3, [https://www.rand.org/content/dam/rand/pubs/research\\_memo\\_randa/2006/RM3420.pdf](https://www.rand.org/content/dam/rand/pubs/research_memo_randa/2006/RM3420.pdf).

connectivity. All information must pass through this central node before reaching another end station, with the consequence of its loss or destruction being the termination of information exchange within the network, making it thus a single point of failure.<sup>96</sup>

*Figure 2: Centralized, Decentralized, and Distributed Networks*



Source: Baran, "On Distributed Communications"

A decentralized network (B) combines one or more centralized networks into a larger networked system of systems that consists of a hierarchical structure of various stars connected to form a greater star. In this system, the loss of a single central node (star) degrades the functioning of the network and its overall capability, but does not completely disable it. Nodes that were once connected to a central node that becomes disabled need to recognize this loss of connectivity and reconfigure to connect to a different node, i.e., resiliency, otherwise they will become isolated from the larger network. Severity of node loss is dependent on the role said node plays within the

greater C2 structure, and the destruction of just one or of a few key nodes could wreak havoc on the functioning of the entire system, or at a minimum break it up into multiple individual centralized networks. Given these characteristics and its overall structure (star), a decentralized network is in fact a variation of a centralized network.<sup>97</sup>

Lastly, a distributed (or mesh) network (C) "can survive the loss of any node or network connection path ..., [as] each node has two or more paths for C2 network connectivity." Loss, disruption, or destruction "of any single path allows the network to retain functionality" given the redundancy of internodal connections.<sup>98</sup> Thus, when using a distributed C2 network, "loss of any node only impacts the lost node," although it must be understood that a complex attack could in essence fracture the network, resulting in several disparate but isolated distributed networks of different sizes.<sup>99</sup>

Although this distributed network concept as envisaged by Baran in his 1964 study "On Distributed Communications" concerns a digital C2 communications architecture, its guiding principle of redundant internodal connections spread out across a vast distributed network supports the development of a greater "distributed operations" command-and-control methodology for complex and unpredictable environments such as the urban littoral. Here, the tenets of speed, resiliency, adaptation, and flexibility are key, with no one node or cluster of nodes serving as a single point of failure with respect to the functioning of the entire C2 system, as the redundant network structure is constructed for speedy repair and re-composition in the event of lost, disrupted, or degraded connections.

<sup>96</sup> Ibid., 1-2; Logan Corbett et al., "Command and Control for Distributed Lethality" (Monterey, California: Naval Postgraduate School, 2017), 18, <http://archive.org/details/commandndcontrol1094555534>.

<sup>97</sup> Baran, "On Distributed Communications: I. Introduction to Distributed Communications Networks.", 1-2; Corbett et al., "Command and Control for Distributed Lethality," 18-19.

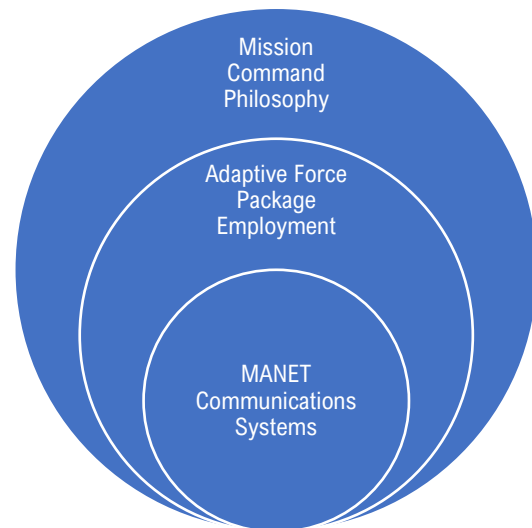
<sup>98</sup> Corbett et al., "Command and Control for Distributed Lethality," 19.

<sup>99</sup> Paul Beery et al., "Command and Control for Distributed Lethality," 2019, 4, <https://doi.org/10.1109/SYSCON.2019.8836803>; Baran, "On Distributed Communications: I. Introduction to Distributed Communications Networks.", 1.

This model provides thus an appropriate framework for the understanding of C2 in the urban littoral, a complex and unpredictable multi-domain environment consisting of rapidly changing conditions and situations on the battlefield, which are brought about by its specific geography, difficult terrain (man-made and naturel), particular weather phenomena, large human population with corresponding infrastructure, and hyper-connectivity from a communications and information perspective.<sup>100</sup> This environment in turn both causes and necessitates the disaggregation and dispersion of forces, while also demanding rapid and decisive decision-making at the tactical level so that military units can take advantage of fleeting battlefield opportunities and out-maneuver the adversary.<sup>101</sup> The question next becomes: ***What is the optimal C2 construct that considers all these elements and ultimately embraces the complexity and unpredictability of this operational environment?*** – the answer lying in the “distributed operations” C2 methodology.

Thus, when considering the C2 function from philosophical, force employment structure, and technical communications points of view, the application of the concepts of mission command (C2 philosophy), adaptive force packages (force employment model), and mobile ad-hoc network (MANET) communications systems (technical support infrastructure) converge to form a distributed operations C2 methodology, as seen in Figure 3. With this understanding, this study endeavors next to dissect each of these concepts, which should in turn lead to a clear-eyed view of C2 in the urban littoral.

Figure 3: Distributed Operations C2 Methodology



*Auftragstaktik: Mission Command for Distributed Operations C2*

According to “Joint Publication 3-0,” mission command “enables military operations through decentralized execution based on mission-type orders ..., [and] is built on subordinate leaders at all echelons who exercise disciplined initiative and act aggressively and independently to accomplish the mission.” This concept is focused from a command perspective on the promulgation of mission-type orders (or mission tactics) and commander’s intent, which concern the purpose of an operation and its resultant key objectives and tasks, vice details and instructions on how to perform said assigned tasks.<sup>102</sup> In layman’s terms, in practicing a mission command philosophy, commanders determine to subordinate elements what needs to be accomplished but not how to accomplish it; or, as evoked by Prussian field marshal Helmuth von Moltke: “As a rule, an order should contain only what the subordinate for the achievement of his goals cannot determine on his own.”<sup>103</sup>

<sup>100</sup> Vego, “On Littoral Warfare”; Collins et Spencer, *Understanding urban warfare*, 17-37; “Joint Publication 3-06 Joint Urban Operations,” I-2-I-3.

<sup>101</sup> Kilcullen, *Out of the Mountains*, 105-6, 264.

<sup>102</sup> Chairman Joint Chiefs of Staff, “Joint Publication 3-0: Joint Operations,” II-2.

<sup>103</sup> Jörg Muth, “An Elusive Command Philosophy and a Different Command Culture,” *Foreign Policy*, 22 January 2024,

Along with mission-type orders and commander's intent, other key components of mission command include the implementation of boundary conditions and trust. Boundary conditions, or as sometimes referred to in military lexicon "go/no-go criteria," serve to specify the precise goal of the mission and thus to limit excessive ad-hoc decision-making where subordinate elements could deviate from commander's intent.<sup>104</sup> Trust, built over time via a conscious and collaborative approach, necessitates a personal relationship between the commander and subordinates, which is fostered through training, education, professional development, and practice. This in turn instills confidence from the commander in subordinate elements' ability to follow commander's intent and make the necessary tactical decisions on the battlefield. Thus, when employing a C2 philosophy predicated on mission command: "Commanders delegate decisions to subordinates wherever possible, which minimizes detailed control and empowers subordinates' initiative to make decisions based on the commander's guidance rather than constant communications."<sup>105</sup>

To fully depict a distributed operations C2 methodology anchored in a philosophy of mission command, the German concept of *auftragstaktik* serves as a useful tool. *Auftrag* (mission) and *taktik* (tactics) come together to form *auftragstaktik* (mission tactics), often referred to as "flexible command."<sup>106</sup> This was von Moltke's solution to combatting the uncertainties of war, as he viewed an aggressive army on the march as one that needs "to be ready for anything, not hamstrung by rigid orders." For him, "the commander devised a mission (*auftrag*), explained it in a short, clear order, and then left the methods and means of achieving it to the officer on the spot."<sup>107</sup>

According to Donald Vandergriff in *Small Wars Journal*, *auftragstaktik*, translated imperfectly as mission tactics, mission-type orders, or even mission command, "is a cultural philosophy ..., [and] the highest form of military professionalism." In this vein, "the overall commander's intent is for the member to strive for professionalism, in return [for which] the individual will be given latitude in the accomplishment of their given missions." *Auftragstaktik* is thus in its simplest form a "culture of professionalism."<sup>108</sup>

Yet, given the nuances of translation, the true essence of *auftragstaktik* often escapes many non-German speakers, as well as those who have not significantly researched the subject. The term traces its roots back to Frederick the Great, an exigent military leader known to lament the lack of initiative of his regimental commanders, who despite their high level of military experience were afraid to act, preferring instead to call back to higher command for orders, thus wasting precious time on the battlefield. The concept was later formalized by field marshal Helmuth von Moltke in the latter half of the 19<sup>th</sup> century, in particular due to his experiences in the Austro-Prussian War of 1866 and the Franco-Prussian War of 1870-1871, and subsequently inculcated into German military education and culture throughout the late 19<sup>th</sup> and first half of the 20<sup>th</sup> centuries, up until WWII.<sup>109</sup>

As a result of the military successes of the German army during this period, other countries, and specifically the United States, studied and attempted to imitate this practice known as *auftragstaktik*, even if its underlying meaning often eluded them. It is for this reason that translations such as mission tactics, mission-type orders, and mission command tend to distort the signification of the term and limit a true application of its

<https://foreignpolicy.com/2011/09/09/an-elusive-command-philosophy-and-a-different-command-culture/>.

<sup>104</sup> King, *Command*, 64-66.

<sup>105</sup> Chairman Joint Chiefs of Staff, "Joint Publication 3-0: Joint Operations," II-2.

<sup>106</sup> Robert Michael Citino, *The German Way of War: From the Thirty Years' War to the Third Reich*, Modern War Studies (Lawrence, Kan: Univ. Press of Kansas, 2005), 32.

<sup>107</sup> Ibid., 152.

<sup>108</sup> Donald E. Vandergriff, "How the Germans Defined Auftragstaktik: What Mission Command is - AND - is Not," *Small Wars Journal*, 21 June 2018, <https://smallwarsjournal.com/jrnl/art/how-germans-defined-auftragstaktik-what-mission-command-and-not>.

<sup>109</sup> Muth, "An Elusive Command Philosophy and a Different Command Culture"; Citino, *The German Way of War*, 142-90.



principles, often transforming it into some type of procedural mechanism for issuing orders, when it truly concerns a command philosophy of professionalism that impregnates the culture of a military unit.<sup>110</sup>

To cultivate this culture, the German army took a “progressive and innovative approach” to leader development, teaching officers “how to think, [but] not what to think.”<sup>111</sup> The system sought to define explicitly what type of officers and soldiers the military needed to achieve success on the battlefield, valuing three interrelated qualities in leaders: knowledge, independence, and the joy of taking responsibility. Knowledge provided the foundation for making a decision, giving leaders the tools to know what to do and when to act, while also generating trust between commanders and subordinates. Independence, which refers to independence in decision-making, signified that one cannot be afraid to act in the absence of explicit orders, as they might be the only person present with the authority, awareness, or capacity to make a decision at a given moment. And finally, the joy of taking responsibility, pride in and ownership of one’s decisions, is what kept a leader on the battlefield, even while enduring the horrors of war.<sup>112</sup>

At the tactical level this philosophy prizes speed and initiative, German military officers believing that they had a relative advantage in combat because they could operate “mentally faster” than their opponents, with faster decision-making resulting in faster physical maneuver with respect to adversarial forces. Regarding initiative, it is important to note the term *selbständigkeit*, meaning to change an order, as the leader on the ground with the best situational awareness was empowered to modify an order based on changing circumstances, in assuming that he stayed within

the boundaries of commander’s intent. German military culture instilled in leaders the belief that “it was better to make a good decision immediately than to wait and make a better decision later,” as this practice could lead to missing a fleeting battlefield opportunity. With this understanding, inaction was seen as the most unforgivable of sins in combat, and it is for this reason that commanders in the German army “rarely, if ever, reproached a subordinate for showing initiative.” Within this culture technology was considered valuable, but always subordinate to the principles of *auftragstaktik*, as it was solely a means of enhancing the commander’s decision-making ability.<sup>113</sup>

Thus, as defined by Richard E. Simpkin in *Race to the Swift: Thoughts on Twenty-First Century Warfare*: “*Auftragstaktik* is a broad concept ... embracing aspects of ... a theory of the nature of war, character and leadership traits, tactics, command and control, senior subordinate relationships, and training and education. It ... [is] a comprehensive approach to warfighting.”<sup>114</sup> Given the characteristics of the urban littoral, an environment where forces become disaggregated and dispersed due to the complexity of the terrain and the rapidly changing circumstances of the combat, a C2 decision-making philosophy based on this wholistic concept of *auftragstaktik*, highlighted by quick and decisive decision-making and tactical action, is necessary to confront the inevitable fog and friction that will arise on the battlefield.

In the littoral, this requires leaders that are creative and prepared to seize the initiative when opportunities present themselves to out-maneuver, or “out-think, out-scout, and out-shoot the enemy.”<sup>115</sup> This can be accomplished through the dispersion of forces and by changing bases and anchorage points rapidly, taking refuge in protected

<sup>110</sup> Vandergriff, “How the Germans Defined Auftragstaktik: What Mission Command is - AND - is Not”; Muth, “An Elusive Command Philosophy and a Different Command Culture.”

<sup>111</sup> Vandergriff, “How the Germans Defined Auftragstaktik: What Mission Command is - AND - is Not”; Pierre Sprey and Franklin C. Spinney cited in Vandergriff, “How the Germans Defined Auftragstaktik.”

<sup>112</sup> Vandergriff, “How the Germans Defined Auftragstaktik: What Mission Command is - AND - is Not.”

<sup>113</sup> Ibid.

<sup>114</sup> Richard E. Simpkin *Race to the Swift: Thoughts on Twenty-First Century Warfare* cited in Vandergriff, “How the Germans Defined Auftragstaktik.”

<sup>115</sup> Kline, “A Tactical Doctrine for Distributed Lethality.”

bays or channels, masking movement behind islands, blending in with the ambient acoustic and electromagnetic noise, and taking advantage of meteorological conditions such as clutter and ducting, all of this enabling one to strike the enemy when they are not expecting it.<sup>116</sup>

This type of ingenuity, adaptability, and decisiveness with respect to decision-making has been displayed on multiple occasions by Ukrainian forces since the full-scale invasion of their territory by Russia in February of 2022, which has allowed them to hold off and push back Russian forces in the littoral environment, while at the same time complicating Russian decision-making processes and creating confusion amongst the military and political ranks.

Examples of this include the creative use of dispersed artillery, missile, and air forces in the coastal regions of the Black Sea to sink the Russian Black Sea fleet's flagship vessel, the *Moskva* cruiser, in April of 2022, as well as to subsequently force Russian troops to abandon Zmiinyi (Serpent) Island just off the Ukrainian coast (June, 2022), reducing thus their ability to conduct attacks into the Ukrainian mainland. Additionally, the creative use of surface maritime drones, unmanned aerial systems, and cruise missiles to harass the Russian Black Sea fleet and bases in Sebastopol, as well as to conduct attacks on the Kerch bridge connecting Crimea to the Russian mainland, have ultimately rendered Russia's Black Sea fleet and superior naval forces (numerically and capability wise) ineffective in the conduct of littoral warfare.<sup>117</sup> These same principles can be applied to the urban milieu, where given the tendency of this environment to disaggregate combat and disperse military forces much like in the littoral, leaders across the battlefield need to be prepared to act in the absence of strict orders by maneuvering their elements and seizing opportunities to take key

terrain, overcome enemy forces, and ultimately achieve success.<sup>118</sup>

Yet upon deeper reflection of the ideas presented above, it is necessary to further clarify the concepts of mission command and *auftragstaktik* with respect to quick and decisive decision-making in the face of a complex and unpredictable environment, as there are multiple naming conventions that are often used interchangeably and ultimately mean different things. With this understanding, in lieu of viewing a mission command philosophy based on *auftragstaktik* as a "highly decentralized" form of command and control as put forth in Milan Vego's "On Littoral Warfare"<sup>119</sup> or as referenced throughout numerous military doctrines such as "Joint Publication 3-0," it is more advantageous to scrutinize the term through the prism of a distributed operations C2 methodology.

This does not imply that the military chain of command ceases to exist, that there is a "free for all" with respect to decision making on the battlefield,<sup>120</sup> or that commanders are ultimately not responsible for the actions of their subordinates, but signifies rather that decision making is distributed to leaders across the battlespace at the tactical level, allowing them to appropriately take initiative and seize opportunities to meet commander's intent without the need to reach back to higher command for authorization. The idea is that the responsibility for making decisions (command) is distributed to leaders across the battlespace within the confines of a particular mission, ergo mission command, creating thus a distributed network of command and control as seen in Figure 2 (p. 22). This concept and the resultant decision-making responsibility become ever more important in environments such as the urban littoral, where do to a multitude of elements – geography, terrain (man-made and natural), large

<sup>116</sup> Vego, "On Littoral Warfare."

<sup>117</sup> Michel Goya et Jean Lopez, *L'ours et le renard: histoire immédiate de la guerre en Ukraine* (Paris: Perrin, 2023), 118-19, 218-19, 250-54; Andrew E. Kramer, "In a Tough Year on Land, Drones Give Ukraine Some Success at Sea," *The New York Times*, 20 December 2023, sect. World,

<https://www.nytimes.com/2023/12/20/world/europe/ukraine-drones-sea.html>.

<sup>118</sup> Kilcullen, *Out of the Mountains*, 105-6, 264.

<sup>119</sup> Vego, "On Littoral Warfare," 30-31.

<sup>120</sup> Vandergriff, "How the Germans Defined Auftragstaktik: What Mission Command is - AND - is Not."

human populations with corresponding infrastructure, ambient noise, areas of saturated communications and RF energy, meteorologic and oceanographic phenomena – military formations are forced to disperse, with their communications often becoming disrupted and degraded.

The proliferation of terms such as “decentralized execution,” “decentralized operations,” and “decentralized command and control” in contemporary doctrine, all implying in fact a form of centralization where the removal of one or several key nodes can jeopardize the functioning of the entire system, could consequently adversely impact the ability or willingness of leaders to make the necessary decisions in such an environment.<sup>121</sup> This sentiment is highlighted in the U.S. Center for Strategic and Budgetary Assessments report on mosaic warfare, where decision-centric warfare is seen as more advantageous than network-centric warfare, which is based on a technologically enhanced decentralized network that seeks nonetheless to establish certain central nodes with unfettered access to information to enhance situational awareness and thus decision making. These types of networks, decentralized as they are, ultimately centralize decision-making at certain nodes, creating points of vulnerability that reduce initiative and decisiveness while slowing down decision-making processes.<sup>122</sup>

It is thus more of a question of mentality and culture vice tactics, techniques, and procedures, the idea being that in the presence of uncertain and changing circumstances on the battlefield, and in the absence of leadership, strict orders, or clear communications, officers, soldiers, sailors, and airman are trained, prepared, and empowered to act; because as General Krulak highlights in “The Strategic Corporal” regarding the challenges of combat in the urban littoral: “Outcome[s] may hinge on decisions made by small unit leaders, and by actions taken at the lowest level ..., [and] success

or failure will rest, increasingly, with the rifleman and with his ability to make the right decision at the right time at the point of contact.”<sup>123</sup>

In concluding this section, it is worth taking another look at Figure 3 located previously in “The Operational Function” portion of this study (p. 23), as it depicts the distributed operations C2 methodology with respect to its component parts. Given that war is a human endeavor, i.e., it is waged by humans with its outcomes depending on their decisions, the component of a mission command philosophy is placed at the top of the hierarchy, subsuming consequently the other elements, which play nonetheless important roles in the functioning of the overall system. However, in the heat of combat in complex and uncertain environments such as the urban littoral, it is ultimately the rapport between the human-centric functions of decision-making and mission command that are the most influential to the outcome of the battle. With that said, the next sections will attempt to provide different mechanisms for facilitating and implementing this mission command C2 philosophy via force employment structure and technical communications perspectives.

### *Adaptive Force Packages: An Operational Structure for C2 at the Tactical Level*

As stated in the beginning of this section concerning the operational function of C2, while the primary purpose of command and control is decision-making, the concept also consists of a number of subordinate tasks to include the establishment and operation of a joint headquarters, the organization of forces, coordination and communications amongst the various echelons of the organization and with supporting and supported entities to ensure the flow of information, the allocation of resources,

<sup>121</sup> Baran, "On Distributed Communications: I. Introduction to Distributed Communications Networks.", 1-3.

<sup>122</sup> Bryan Clark, Dan Patt, et Harrison Schramm, "Mosaic Warfare - Exploiting Artificial Intelligence and Autonomous

Systems to Implement Decision-Centric Operations" (Center for Strategic and Budgetary Assessments, 2020), iv-v.

<sup>123</sup> Vego, "On Littoral Warfare," 30-31; Krulak, "The Strategic Corporal," 4-5.

and the employment of military capabilities.<sup>124</sup> Decision-making in the form of mission command based on *auftragstaktik* having just been dissected, this section of the study will focus on the management of operations, i.e., the control function of C2, by examining the tasks of “the organization of forces” and “the employment of military capabilities” via the application of adaptive force packages. This analysis should in turn reveal a force employment construct that facilitates quick and decisive decision-making in complex and unpredictable environments such as the urban littoral.

As evoked several times in this study, the complexity of the urban littoral environment tends to disaggregate and disperse military forces, which necessitates a C2 methodology capable of supporting truly distributed operations at the tactical level. Although referring specifically to ground forces operating in an urban area, the following citation from David Kilcullen’s *Out of the Mountains* succinctly summarizes the type of model necessary to facilitate distributed operations C2 in the urban littoral and other complex environments that require a joint and multi-domain approach. Kilcullen postulates: “There is a clear need to structure ground forces so that they can rapidly aggregate or disaggregate forces and fires, enabling them to operate in a distributed, small-unit mode while still being able to concentrate quickly to mass their effect against a major target.”<sup>125</sup>

After reflecting on this excerpt, which reminds one of certain classic warfare principles such as objective, offense, mass, and maneuver,<sup>126</sup> it becomes clear that the development of a flexible and adaptive force employment model that embraces independent and distributed formations

capable of quick and decisive decision-making, as well as the rapid aggregation and disaggregation of forces and fires, is necessary to support C2 in the urban littoral. With that, the adaptive force package (AFP) construct, conceptualized as part of the U.S. Navy’s distributed lethality doctrine published in 2016 under the Commander for Naval Surface Forces’ document “Surface Force Strategy – A Return to Sea Control,” aligns nicely with this intent.

Conceived primarily as a surface force strategy for the employment of forces in complex and contested environments, distributed lethality seeks to gain localized sea control at the time and place of the operational commander’s choosing by deploying warships as part of adaptive force packages in dispersed formations across a wide expanse of geography, with the intent being the deception of enemy forces and the facilitation of distributed fires.<sup>127</sup> The main tenets of this AFP model include thus the ability of operational commanders to create scalable task-oriented force constructs based on specific threats and the conditions on the battlefield, which are capable of operating in a dispersed manner across a wide expanse of geography, often in a contested environment.<sup>128</sup>

The ideas of localized control and the deployment of forces in dispersed formations across a wide expanse of geography are both key, because regardless of the numerous types of operations that can be executed in the urban littoral – sea control, sea denial, support to ground forces operating on the coast, humanitarian assistance and disaster relief, counter-insurgency and stabilization operations, low intensity asymmetric operations, large-scale high intensity warfare – many of these having the potential to

<sup>124</sup> King, *Command*, 56-57; Chairman Joint Chiefs of Staff, “Joint Publication 3-0: Joint Operations,” III-2.

<sup>125</sup> Kilcullen, *Out of the Mountains*, 107.

<sup>126</sup> This refers to the American principles of warfare, of which there are nine, that differ slightly from the Anglo-Saxon principles (British/Australian), of which there are 10. The French principles of warfare, credited to the Maréchal Foch, number three, and could be considered to cover more broadly

those of the more numerous American and Anglo-Saxon constructs.

<sup>127</sup> Commander Naval Surface Forces, “Surface Force Strategy – Return to Sea Control,” 9 January 2016, 9, [https://news.usni.org/wp-content/uploads/2017/01/Surface-Force-Strategy\\_29-Dec-1.pdf#viewer.action=download](https://news.usni.org/wp-content/uploads/2017/01/Surface-Force-Strategy_29-Dec-1.pdf#viewer.action=download).

<sup>128</sup> Ibid.; Kline, “A Tactical Doctrine for Distributed Lethality”.

occur simultaneously as part of a larger campaign, the concept of localized control is universal and required for all these types of missions, while the complexity of the environment will likely dictate the need to operate in dispersed formations across a vast area.

Thus, contingent upon the complexity of the operational environment as well as the tactical situation, an AFP can be organized for an ad-hoc mission or tailored for specific effects, with each platform in the package constituting a sensor, a communicator, a shooter, a situational commander, and ultimately a C2 node.<sup>129</sup> To use an engineering term, the package is modular, and can thus be modified by adding or detaching various capabilities, platforms, and troop formations depending on the specific mission and tasks to be accomplished. While this construct is at its core predicated upon the employment of surface combatants, i.e., warships, it supports the incorporation of various other assets including subsurface vessels, aircraft, supply ships, and unmanned systems (surface, subsurface, aerial). Additionally, depending on the expanse of the operational environment, several AFPs could be employed to conduct multiple missions.<sup>130</sup> In the end, the goal is a flexible model of organizing and employing forces (the AFP) that allows the operational commander, normally situated over the horizon and out of range of enemy fires, to facilitate tactical action and effective decision-making in complex and unpredictable environments through *auftragstaktik*-based mission command.<sup>131</sup>

However, in using the adaptive force package construct as a framework to analyze current widely employed force employment concepts based on combined arms and joint task force type structures, one could be left wanting with respect to the necessary flexibility required to confront the very specific tactical level challenges associated

with complex multi-domain environments such as the urban littoral. As evoked in the report entitled "Mosaic Warfare - Exploiting Artificial Intelligence and Autonomous Systems to Implement Decision-Centric Operations":

Today, U.S. forces consist predominantly of manned multi-mission units such as aircraft, ships, and troop formations that are self-contained, or monolithic, and incorporate their own sensors, C2 capabilities, and weapons or electronic combat systems. The relatively inflexible configuration of monolithic multi-mission units, as well as constraints on communications interoperability between different units, results in a given force package only being capable of executing a small variety of effects chains. This reduces the adaptability of the force, makes its operations more predictable, and limits the ability of U.S. forces to confuse an enemy as part of operational concepts focused on gaining a decision-making advantage. DoD could better pursue decision-centric warfare by decomposing some of today's monolithic multi-mission units into a larger number of smaller elements with fewer functions that would be more composable.<sup>132</sup>

This passage returns to the idea of modularity, i.e., the ability to attach and detach capabilities and forces to the AFP dependent on the tactical and operational situations, arguing that the way contemporary U.S. military capabilities and units are designed and formed – highly integrated, multi-mission, and monolithic platforms, systems, and formations – is inflexible and ill-adapted to the complexities of the modern-day battlefield. One example of this is the F-22 fighter aircraft, a highly sophisticated and technologically advanced stealth platform specialized in air superiority missions, which lacks in the end the capabilities necessary to smoothly integrate with other forces and systems to meet the needs of a rapidly changing

<sup>129</sup> Corbett et al., "Command and Control for Distributed Lethality," 38-39.

<sup>130</sup> Ibid., 9-10.

<sup>131</sup> Ibid., 12.

<sup>132</sup> Clark, Patt, et Schramm, "Mosaic Warfare - Exploiting Artificial Intelligence and Autonomous Systems to Implement Decision-Centric Operations," vi.

environment.<sup>133</sup> Additionally, although from a conceptual standpoint the AFP construct can be applied to any joint and multi-domain environment, it was conceived within the framework of naval surface operations, and therefore one must understand the particularities of naval force employment and C2.

As ships are generally self-contained and self-supporting platforms accustomed to operating alone or with significant dispersion amongst elements, often in electromagnetic emissions control, or simply emissions control (EMCON) protocol,<sup>134</sup> mission command has historically constituted a central tenet of the overall command and control philosophy of the Navy, specifically before the advent of satellite communications.<sup>135</sup> To this point, via force employment constructs such as the surface action group (SAG),<sup>136</sup> the carrier strike group (CSG),<sup>137</sup> and the amphibious readiness group/marine expeditionary unit (ARG/MEU),<sup>138</sup> this culture of operating in a self-contained and often highly distributed fashion is further amplified, as naval forces are accustomed to conducting a wide spectrum of operations from the open sea to the littoral environment without

necessarily needing to integrate traditional air or ground force elements at the tactical level. Indeed, from a force employment model perspective, the U.S. Navy (surface, subsurface, naval aviation forces), in including its U.S. Marine Corps and special operations forces, can execute the full spectrum of operations conceivable in the urban littoral environment in a self-contained fashion.

This construct presents thus a potential problem for the effective employment of distributed operations C2 in the urban littoral – a complex multi-domain environment where success will most likely hinge upon an AFP that can adapt to the changing circumstances on the battlefield via the utilization of forces from across the various physical domains of warfare – given that operations in this space are inherently joint and sometimes even multi-national, requiring a more integrated approach than standard combined arms models.<sup>139</sup> Although thus viable from a conceptual point of view, a lack of contemporary tactical-level integration between joint forces in the urban littoral, and particularly between traditional naval and ground (Army) forces, could present a significant challenge to the employment of the AFP

<sup>133</sup> Ibid., 12-13.

<sup>134</sup> EMCON is “the selective and controlled use of electromagnetic, acoustic, or other emitters to optimize command-and-control capabilities while minimizing, for operations security: detection by enemy sensors, mutual interference among friendly systems; and/or enemy interference with the ability to execute a military deception plan”. Combined Communications-Electronics Board (CCEB), “Glossary of Communications-Electronics Terms,” March 2008, 2-63, <https://www.yumpu.com/en/document/view/4877974/glossary-of-communications-electronics-terms-multilateral->

<sup>135</sup> Corbett et al., “Command and Control for Distributed Lethality,” 5.

<sup>136</sup> A surface action group (SAG) is defined as “a temporary or standing organization of combatant ships, other than aircraft carriers, tailored for a specific tactical mission.” The fact that this construct is tailored to a specific mission makes it the most comparable construct to the AFP. Lieutenant Kyle Cregge, “Every Ship a SAG and the LUSV Imperative,” *Center for International Maritime Security*, 2 March 2023, <https://cimsec.org/tag/operational-concepts/>.

<sup>137</sup> A carrier strike group (CSG) is composed of a combination of ships, submarines, aircraft, and personnel that support a wide range of naval operations from peace time (power

projection, deterrence, humanitarian assistance, and disaster relief) to full scale war. Normally, this composition consists of a nuclear-powered aircraft carrier, a cruiser, 4-6 destroyers, a submarine, a supply ship, and associated aircraft. Aircraft Carrier Industrial Base Coalition, “CARRIER STRIKE GROUPS: THE FORMATION OF SEAPOWER AND POWER PROJECTION,” consulted 30 January 2024, <https://www.acibc.org/wp-content/uploads/2019/09/Strike-Group-Infographic.pdf>.

<sup>138</sup> The amphibious readiness group/marine expeditionary unit (ARG/MEU) force employment construct consists of U.S. Marine combat forces embarked on U.S. Navy vessels to conduct expeditionary amphibious, crisis response, and limited contingency operations. This structure includes an amphibious assault ship (LHA/LHD), a transport ship (amphibious transport dock-LPD), and a landing ship (dock landing ship-LSD) constituting the ARG, and a ground combat element, an aviation combat element, and a logistics combat element composing the MEU. U.S. Marine Corps, “Amphibious Ready Group And Marine Expeditionary Unit Overview,” consulted 30 January 2024, <https://www.marines.mil/Portals/1/Amphibious%20Ready%20Group%20And%20Marine%20Expeditionary%20Unit%20Overview.pdf>.

<sup>139</sup> Vego, “On Littoral Warfare,” 48.

construct, and consequently to the overall functioning of a distributed operations C2 methodology.

With this understanding, imagine a scenario consisting of the need for low signature small boat units operating in a semi-contested littoral environment to pass off organic aerial ISR with strike capabilities to ground forces located 50 kilometers away operating at the far edge of a dense urban coastal sprawl. These ground forces, who are part of the same AFP as the small boat unit, have determined it necessary to neutralize an enemy target, and have consequently initiated a call for fire support within the AFP, to which the boat unit responds. This sort of hand-off between two distinct formations could prove extremely difficult if one only considers the elements of mission command and adaptive force packages within the distributed operations C2 construct, specifically since these two distinct formations have no historical experience of integration, neither on the battlefield nor in training. This pairing needs thus to be supplemented by some sort of joint-capable technical support infrastructure, and it is for this reason that the next section of this study will focus on the command-and-control task of “coordination and communications,” by analyzing the application of mobile ad-hoc network (MANET) communications technology to distributed operations command and control.

### *MANET Communications Systems: A technical “boost” for distributed operations C2*

As noted in the previous section on adaptive force packages, the complexity of operational areas such as the urban littoral dictates the need to organize forces to operate in a small-unit and distributed fashion, while retaining the ability to quickly aggregate, mass fires and effects against a specific target, and then disaggregate once again.<sup>140</sup> However, given the constraints and the dynamic nature of such environments, dispersed

military formations require something more than simply decisive decision-making and flexible force employment structures while they seek to coordinate maneuver and mass fires in pursuit of their objectives on a complex battlefield. In doing this, these formations need to be as precise as possible to avoid detection by enemy forces, as well as to minimize or avoid friendly and non-combatant casualties, the destruction of civilian infrastructure, and the disruption of services and the normal pattern of life within the greater ecosystem. With this in mind, MANET communications systems represent the most viable and effective technology to complete the distributed operations C2 methodology, as they permit coordination amongst dispersed military elements operating in a complex multi-domain environment, supporting both mission command decision-making and adaptive force package employment constructs, and ultimately leading to enhanced precision on the battlefield.

According to Anthony King in *Command: The Twenty-First Century General*, secure digital communications constitute the most important innovation for command in the past two decades, as they allow for the “transmission of a hitherto-unconceivable quantity of information at previously unachievable ranges.” Military leaders today, and particularly those commanders situated in robust and highly connected operations centers, have extremely heightened levels of situational awareness (or perceived situational awareness), as well as the ability to communicate almost instantaneously across vast battlespaces and theaters of operations, largely due to the ubiquity of satellite communications.<sup>141</sup> Understanding the importance of digital communications to the current conception and employment of C2, the question next becomes how to best preserve the functioning of these systems when operating in complex environments such as the urban littoral, which are known to degrade and disrupt radio-frequency based communications, to include those dependent on satellites. MANET communications systems, which do not in and of

<sup>140</sup> Kilcullen, *Out of the Mountains*, 107, 283.

<sup>141</sup> King, *Command*, 290.

themselves rely on satellites for functionality, represent a viable option at the tactical level for improving coordination and situational awareness amongst dispersed military elements.

A mobile ad-hoc network (MANET) is a “data network suitable for voice, data, and video traffic ..., [which] is ad-hoc because it is not reliant on any pre-existing infrastructure. Data traverses the network by ‘hopping’ from one network node to another until it reaches its destination.” In lieu of utilizing a central node or router to transmit network traffic, each node acts as a router, or “hop,” forwarding data dynamically to other nodes within the system based on a specific algorithm that considers node availability, link status, environmental interference, network neighbor status, and the ratio of the signal (data) to noise (interference). These types of networks are “self-forming” and “self-healing,” meaning that if certain nodes within the network become unavailable and unable to forward traffic, the algorithm will re-route the traffic via the most efficient path available.<sup>142</sup>

Conceptually, the mobile ad-hoc network is a mesh network as explained in Figure 2 (p. 22) and in Paul Baran’s “On Distributed Communications” presented at the beginning of the command-and-control section of this study. However, from a technical nomenclature standpoint, there is one major difference between a MANET and a standard digital communications mesh network, or a wireless mesh network as it is often called in today’s hyper-connected world. Standard digital communications mesh networks depend on fixed infrastructure and static routers, with certain

central nodes consisting of wired connections that support access to the greater internet. Although these networks are self-forming and self-healing from a wireless connection standpoint, these fixed routers supported by wired connections create points of centralization and vulnerabilities with respect to the overall network architecture.<sup>143</sup>

In certain cases, these standard mesh systems will contain a “master node,” as indicated in Figure 4, which maintains the functioning of the entire network by monitoring the flow of traffic, deciding the most efficient routing of data, and distributing DHCP (dynamic host configuration protocol)<sup>144</sup> addresses to all other nodes in the network. This master node constitutes in this way the “brains” of the network, serving thus as a single point of failure in the case of its loss. MANET communications architectures are, on the other hand, “entirely dynamic and use an adaptive routing approach.” At the conceptual level, there are no wired connections or master nodes required to support the functioning of the network, as all the individual nodes collaborate via the network’s algorithm to support connectivity and a robust link, as seen in Figure 5.<sup>145</sup> This highlights once again the importance of having a true understanding of the differences in various communications networks (centralized, decentralized, and distributed) and warfare concepts (network centric warfare versus distributed operations or decision-centric warfare),<sup>146</sup> as terms are often used interchangeably without a true appreciation for the nuances amongst the different systems and concepts.

<sup>142</sup> "What Is a Mobile Ad-Hoc Network (MANET)?", Steatite Communications, 3 June 2020, <https://steatite-communications.co.uk/what-is-a-manet/>.

<sup>143</sup> Ibid.; Jungfang Wang, Bin Xie, et Dharma P. Agrawal, "Journey from Mobile Ad Hoc Networks to Wireless Mesh Networks," in *Guide to Wireless Mesh Networks*, Computer Communications and Networks (London: Springer, 2009), 1-30, [https://doi.org/10.1007/978-1-84800-909-7\\_1](https://doi.org/10.1007/978-1-84800-909-7_1).

<sup>144</sup> DHCP (dynamic host configuration protocol) is a network management protocol that dynamically assigns an internet protocol (IP) address to any device (node) in a network so that it can communicate with other connected devices. The master

node, via DHCP, automates and centrally manages these configurations and the assigning of addresses within the network.

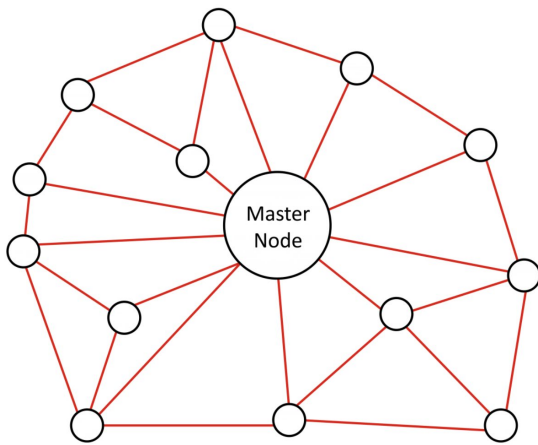
<https://www.techtarget.com/searchnetworking/definition/DHCP>

<sup>145</sup> "What Is a MANET?"

<sup>146</sup> See Clark, Patt, et Schramm, "Mosaic Warfare - Exploiting Artificial Intelligence and Autonomous Systems to Implement Decision-Centric Operations," iv-v, for a distinction between network-centric and decision-centric warfare, decision-centric warfare having many similarities to the concept of distributed operations.



Figure 4: Mesh Network with Master Node



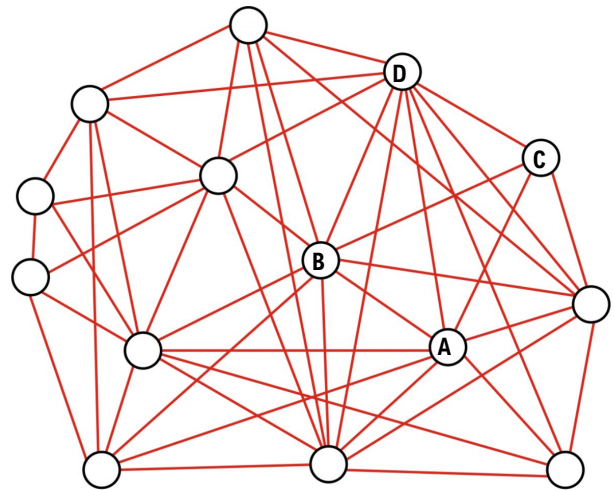
Source: "What is a Mobile Ad-Hoc Network (MANET)?"

It is thus this robust, redundant, self-forming, and self-healing network architecture that makes MANET communications the ideal technical infrastructure to support distributed operations C2 in complex and unpredictable operational areas such as the urban littoral, where military formations are dispersed, radio-frequency communications are often degraded or disrupted, and nodes are susceptible to being attacked or destroyed. In this environment, if one military element (node) needs to transmit information to another and the connection is blocked, the network will find another route to pass the information, assuming there are various other independent and dispersed nodes connected to the network.

A simplified explanation of this process is represented by Figure 5. Imagine that node A represents an Army infantry platoon that needs to send a message to node D, a mechanized unit forming part of the same AFP. Since these units are operating in a dense urban environment, the communications pathway between nodes A and D is blocked by several buildings, however, there is a clear pathway between node A and node B (a small unmanned aerial system), and then again between node B and node D. Under these circumstances, the network will automatically identify that the best way to send the message from node A to node D is

to pass it through node B, and will consequently complete the message transfer via this route. With this logic, the network becomes more effective and reliable as more nodes are added in a dispersed fashion.

Figure 5: MANET Communications Architecture



Source: "What is a Mobile Ad-Hoc Network (MANET)?"

Now, layer on top of this process other forms of ubiquitous technology with secure and high throughput wireless digital communications capacity, such as smart phones, tablets, and laptop computers, and one can imagine any small-unit formation being transformed into a tiny mobile C2 cell with the capability to monitor almost instantaneously changes on the battlefield, and thus make decisions more effectively. Conceptually, the implementation of such a network would also consist of the ability to see the real-time position of various other elements within the AFP and adjacent AFPs, assuming that they can connect to the network via compatible communications systems, on a common operational picture (COP);<sup>147</sup> to connect to, hand-off, and control various unmanned systems within the network; to send and receive situational updates and transmit up to date intelligence information; to view ISR video feeds; to request fire support; to conduct kinetic strikes; and

<sup>147</sup> A common operational picture, or COP, consists of a map of the battlefield or the area of operations which highlights the

positions of friendly force elements, various points of interest, enemy targets, and other important battlefield information.

to accomplish a host of other activities.<sup>148</sup> Theoretically, the interconnection of all these functionalities via MANET communications technology should render more effective both decision-making and the adaptive force package construct, improving thus a leader's ability to both command and control via the distributed operations methodology.

From a survivability standpoint, the employment of this MANET communications architecture offers another significant advantage with respect to the organization of forces. As alluded to at the beginning of this section, C2 has become extremely reliant on digital communications technology over the past couple of decades, and Western forces carrying out counterterrorism and counter-insurgency operations in Iraq and Afghanistan have grown accustomed to large, fixed, and hyper-connected operations centers in the execution of this operational function.<sup>149</sup> Although this is a feasible model at the operational level when the operations center is located over-the-horizon and out of range of enemy fires, or in a more permissive tactical-level environment where the enemy does not possess the requisite mass or fires capabilities to threaten the existence of these installations, at the tactical level on today's battlefield, which is envisioned as contested and largely non-permissive, this construct could prove highly detrimental and even deadly. As postulated by David Kilcullen in *Out of the Mountains* concerning the future battlefield:

In a complex fight in the urbanized littoral, there will be none of the fixed installations, lavish intelligence infrastructure, or constant cell-phone and Wi-Fi coverage of counterinsurgency operations. The garrison mind-set, with its short-duration operations and frequent access to bases with hot showers, air-conditioned dining halls, and sleeping cots, will need to give way to a mobile, improvisational, expeditionary mentality. Troops will have to become hikers again, not campers.<sup>150</sup>

As evoked by this citation, mobility, improvisation, and an expeditionary mentality are key when operating in the urban littoral, even for C2 elements. This point highlights the merit of MANET systems, which in the face of dynamic and fast-changing tactical conditions can support this required mobility and permit any node within the network to serve as a C2 node. In situations where more robust infrastructure and hardware are needed to accommodate data storage and processing for various high throughput technologies, these systems can be set-up on mobile platforms such as vehicles, boats, and aircraft, including those that are unmanned, to meet necessary space and power requirements while still maintaining the underlying MANET communications system architecture. Satellite communications can be incorporated into this overall architecture and utilized if and when available, specifically to communicate with operational headquarters over the horizon, whereas the tactical-level architecture within the AFPs rests predicated on line-of-sight or beyond line-of-sight (non-satellite dependent) communications facilitated via a MANET architecture. The range and effectiveness of the network can be enhanced by adding additional nodes to the system as relays, most notably via unmanned aerial platforms.

Various studies and practical experiences prove the efficacy of such a system, specifically from a communications architecture perspective and when compared to more centralized C2 structures. There exist several Naval Post-Graduate school sponsored studies that test the efficacy of various centralized, decentralized, and distributed communications structures in relation to the distributed lethality operational concept and adaptive force packages. These studies indicate that in environments where communications are likely contested, a distributed communications architecture, which can be likened to this MANET model, outperforms centralized and decentralized networks in the transmission of C2 messages, specifically with respect to the speed of message

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<sup>148</sup> Kilcullen, *Out of the Mountains*, 292.

<sup>149</sup> *Ibid.*, 292-94.

<sup>150</sup> *Ibid.*, 294.

transmission, message dropout rates, and the rapidity of the completion of an entire effects chain (kill chain).<sup>151, 152</sup>

A basic example of this type of MANET communications system is studied from an urban guerilla informational perspective in *Out of the Mountains*, where David Kilcullen explains how cell-phone Bluetooth technology was used to form wireless mobile ad-hoc networks that helped local populations communicate and coordinate during uprisings associated with the Arab Spring. This tactic was executed very effectively in Egypt in 2011, when the government of Hosni Mubarak disabled internet and GSM (global system for mobile communications) communications to suppress the organization of the popular movement and the sharing of information, a measure that was nonetheless circumvented through the implementation of these expedient Bluetooth mobile ad-hoc networks.<sup>153</sup>

At the joint and multi-national level, Link 22, employing robust, redundant, and secure tactical data link communications architecture, is both an advanced and widely proliferated solution with respect to this type of MANET communications capability.<sup>154</sup> It is secure, multi-domain, and built to work across the spectrum of physical environments (including those that are contested), in inclement weather, and even beyond line-of-sight (up to 300

nautical miles), giving it further advantages when compared to traditional mobile ad-hoc networks.<sup>155</sup> The diffusion of systems such as Link 22 are essential to interoperability amongst joint and multinational forces, especially those that are not accustomed to working together at the tactical level and use various types of technology and equipment that are not always compatible, as this ensures that a robust and reliable communications architecture is already set up to support integration and the employment of adaptive force package type models.

In concluding this section, it is once again beneficial to refer to Figure 3 (p. 23), which depicts the nature of the distributed operations C2 methodology through its component parts. MANET communications systems are a technical tool meant to supplement and ultimately improve the functioning of the other two elements within this command-and-control construct: mission command and adaptive force package force employment constructs. This in turn supports military operations in complex and unpredictable multi-domain environments such as the urban littoral, where leaders are expected to be decisive yet flexible given the rapidly changing and uncertain nature of the milieu. The application of MANET communications networks to the overall distributed operations C2 methodology, with their robust and redundant, self-forming and self-healing properties,

<sup>151</sup> Beery et al., "Command and Control for Distributed Lethality"; Corbett et al., "Command and Control for Distributed Lethality," 55-71.

<sup>152</sup> An effects chain, also commonly referred to as a kill chain because it is often completed after striking a target with explosive munitions, is a multi-step targeting process that begins with locating an enemy target, and ultimately ends after achieving desired effects against said target. In the U.S. Air Force, this process consists of six steps: find, fix, track, target, engage, and assess. This process is based on the interconnection and synergy between human decision-makers and various machines, to include military platforms, weapons systems, and the underlying communications infrastructure connecting the various components of the overall system. The chain does not always complete itself via the employment of munitions or kinetic effects, and can be applied to achieve other desired battlefield effects, such as cyber effects. Heather Penney, "Winning the Kill Chain Competition," *Air & Space Forces Magazine*, 28 July 2023,

<https://www.airandspaceforces.com/article/winning-the-kill-chain-competition/>.

<sup>153</sup> Kilcullen, *Out of the Mountains*, 189-93.

<sup>154</sup> Tactical data link (TDL) is a type of military grade mobile ad-hoc network defined as "the means to disseminate processed information from radars, electronic warfare (EW), identification friend or foe (IFF), sonars, and information related to various combat functions between the far-fighting units on a battlefield. TDL exchanges digital information on a near-real-time basis over a common network, with the tactical data updated continuously and automatically by each of the nodes." "JOINT WAVEFORM INTEROPERABILITY SYSTEM - COMMON TACTICAL DATA LINKS FOR THE FORCE OF 21ST CENTURY," 6.

<sup>155</sup> Vivek Gopal, "JOINT WAVEFORM INTEROPERABILITY SYSTEM - COMMON TACTICAL DATA LINKS FOR THE FORCE OF 21ST CENTURY," 8 June 2021, 8-11, <https://doi.org/10.13140/RG.2.2.23398.55362>.

aims to ensure, to the extent possible, that technological capabilities proven to aid in decision-making and the direction of operations at the tactical level are available to forces, even if in the end they are simply that, an aid. Ultimately, the fact remains that technology is but a tool exploited by humans, who rest indeed the central part and determining factor of command and control.<sup>156</sup>

### Practical Application via Real-World Case Studies

With the preceding sections having provided a solid foundation with respect to the urban littoral operational environment and accompanying distributed operations command and control, the final portion of this study consists of the “so what,” or more specifically, of an analysis of the validity of this concept – ***Does it bring something new to current concepts and studies and can it be proven legitimate via real-world case studies, or does it rest purely theoretical at this point?*** In asking this question, this section serves to emphasize the distinctive characteristics of the distributed operations C2 methodology as compared to other pertinent doctrine and operational concepts, while also using the war in Ukraine as a case study to test the construct’s applicability to real-world operations.

To begin, distributed operations command and control is in fact a synthesis of various principles that comprise contemporary military doctrine, operational concepts, and academic reflection concerning warfare in the urban and littoral spaces, as well as in other complex and contested multi-domain environments. When organized under the distributed operations methodology, these principles – *auftragstaktik* mission command, adaptive force package employment structures, and MANET communications technical support infrastructure – form a command-and-control construct that is conceptually built to support tactical action in complex and unpredictable multi-domain environments such as the urban littoral. With that, what differentiates this study and the

distributed operations methodology from other pertinent doctrine, concepts, and literature on the subject is threefold:

1) The treatment of the urban littoral as a unique and specific operational environment worthy of its own doctrine, operational concepts, and academic reflection.

2) The interconnection and hierarchical nature of the three principles of distributed operations C2 as represented in Figure 3 (p. 23). The human element – *auftragstaktik* mission command based on professionalism, initiative, and decisive decision-making – stands as the most important component, as it is ultimately humans who wage war and make the decisions that create its outcomes. Next, the adaptive force package structure employed to facilitate *auftragstaktik* mission command and to ensure the necessary flexibility to operate in a distributed fashion across a vast, complex, and rapidly changing operational environment constitutes the second element. Lastly, resilient MANET communications infrastructure utilized to enhance coordination, communication, and situational awareness in support of the first two elements, i.e., amongst independent and distributed formations operating across an expansive battlespace, serves as the third and final element of this tiered structure.

3) The emphasis placed on distributed command and control and decision-making as opposed to decentralized command and control and decision-making.

Regarding the first point above, a significant number of sources consulted for this study recognize the importance of the trends of urbanization and littoralization, and thus the fact that military operations will in the future be increasingly conducted in the urban-littoral milieu. This is however largely viewed as a problem concerning the execution of urban operations in littoral regions, with the littoral aspect being considered as subordinate or supporting with

<sup>156</sup> Laurent, "Ukraine."

respect to the conduct of urban operations.<sup>157</sup> With that, the development of doctrine and operational concepts for the urban-littoral environment is primarily focused on the urban area, and potentially rightfully so given the fact that “that is where the people are,” with research and concept development remaining thus relatively compartmentalized. Naval and naval infantry (Marine Corps) forces tend to generate doctrine and concepts on littoral combat that largely ignore urban combat considerations, while ground (Army) forces focus on urban operations doctrine development (with the Marine Corps participating as well) that does not fully consider littoral elements. The urban littoral as a single operational environment is not the subject of significant doctrine or concept development, whether that be from a joint perspective or specific to the different branches of military forces.

While understanding that its focus is urban operations, joint doctrine for the urban littoral has evolved since the publication of the U.S. Military’s “JP 3-06 - Joint Urban Operations” in November 2013, specifically with the release of the U.S. Army and U.S. Marine Corps publication of “ATP 3-06/MCTP 12-10B Urban Operations” in July 2022. In “JP 3-06,” the link between urbanization and littoralization is mentioned briefly to provide context concerning the execution of joint urban operations, while the document also dedicates an appendix to “Maritime Considerations in Urban Operations.” These considerations include the potential missions of Navy and Coast Guard coastal and riverine forces in the urban littoral, e.g., port and key infrastructure security, as well as the ability to provide logistics, reserve forces, and administrative support via sea-basing, which serves to minimize the military footprint ashore.<sup>158</sup>

Published jointly by the U.S. Army and the U.S. Marine Corps, “ATP 3-06/MCTP 12-10B Urban Operations” presents a more up to date vision concerning the littoral aspects of urban operations, providing once again context on the interconnected problem sets of urbanization and littoralization, while also acknowledging through the dedication of a section of the doctrine to the question of the “urban littorals” the need to further analyze littoral impacts on urban combat.<sup>159</sup> The doctrine notes that intelligence collection on littoral terrain and geography are necessary for the planning of urban operations, while it also discusses the threats of coastal and maritime defense (A2/AD) systems within the urban battlespace.<sup>160</sup> A final interesting point is that “ATP 3-06/MCTP 12-10B Urban Operations” recognizes that urban training environments rarely address the littoral aspects associated with many of the world’s urban areas, a potentially significant training gap when one reflects on the future of warfare for the joint force.<sup>161</sup> In the end, despite these improvements in doctrine development over the years, it has not yet reached a point where the urban littoral is considered as a specific operational environment possessing its own category of warfare with associated doctrine and concepts, as is the case for the jungle, the mountains, the desert, the urban area, and like milieus.

With respect to the second and third points, the evolution of warfare throughout the twentieth and twenty-first centuries continues increasingly to place a premium on the integration of high-level technology into military operations, and thus, much of the doctrine and concepts centered around command and control follow suit.<sup>162</sup> As noted by Anthony King in *Command*, since the Gulf War in 1991, smaller numbers of military forces have been

<sup>157</sup> The following are just some of the major sources recognizing the trends of urbanization and littoralization: Kilcullen, *Out of the Mountains*; Collins et Spencer, *Understanding urban warfare*; “Joint Publication 3-06 Joint Urban Operations”; “ATP 3-06 Urban Operations”; Harris et al., “MEGACITIES AND THE UNITED STATES ARMY PREPARING FOR A COMPLEX AND UNCERTAIN FUTURE”; Vego, “On Littoral Warfare.”

<sup>158</sup> “Joint Publication 3-06 Joint Urban Operations,” I-4, IV-32, C-1, E-1-E-2.

<sup>159</sup> “ATP 3-06 Urban Operations,” ix, 1-1, 6-1, 1-8-1-9.

<sup>160</sup> *Ibid.*, 1-8-1-9, 2-5.

<sup>161</sup> *Ibid.*, D-9.

<sup>162</sup> Regarding this point, see “The U.S. Army in Multi-Domain Operations 2028 TRADOC Pamphlet 525-3-1” (U.S. Army, 6 December 2018),

expected to do more across vaster battlespaces and larger fronts, which results in greater dispersion, extended lines of communication, and more reliance on increasingly sophisticated technologies, specifically those in the digital communications field.<sup>163</sup> Thus, although Western military doctrine puts significant emphasis on mission command in the execution of multi-domain operations in complex environments, or decision-centric warfare as it is called in the Center for Strategic and Budgetary Assessment's concept on Mosaic Warfare, this ever-increasing emphasis on attaining maximum and "unfettered" battlefield situational awareness, while at the same time being able to communicate with everyone at all times across vast operational theaters via digital communications technology, tends to increase centralization in command and control and decision-making, as commanders far removed from the battlefield feel increasingly aware and connected, even if they are in fact "being suffocated with information."<sup>164</sup>

Regarding this question, certain studies advance the idea that the "mission command of forces can become increasingly difficult due to the high reliance on signal emitting communication platforms," which is an indicator of this over-reliance on technology in the contemporary command and control hierarchy, reinforcing the assertion presented earlier in this study stating that many military practitioners have in fact a distorted perception of the true meaning of mission command.<sup>165</sup> This type of thinking is further supported by the white paper titled "Modern Positional Warfare and How to Win It," released by the former Ukrainian Commander-in-Chief of the Armed Forces, Valerii Zaluzhnyi, in November 2023,

who claims that one of the ways to break technological and electronic warfare parity on the battlefield, and thus the return to positional warfare in the conflict in Ukraine, would be through the "widespread use of information technology [and the] implementation of elements of situational awareness systems into command and control processes ... for automated transmission and display of data about the flight of small UAVs ..., [and] for collecting, processing, and displaying data and managing radio-electronic assets."<sup>166</sup> It seems that over the course of the past few decades and as highlighted by current conflicts, technology has come to achieve parity with, or in some cases outrank true mission command with respect to Western conceptions of command and control, particularly in complex and multi-domain environments such as the urban littoral.

In pivoting now to battlefield application, the current conflict in Ukraine, where the theater consists of a large littoral façade with several important urban areas, provides an opportunity to test certain elements of the distributed operations C2 methodology, although mainly from a general command and control perspective rather than from the level of granularity necessary to fully validate the functioning of this construct at the tactical level. Nevertheless, given the significant combat that has occurred in urban areas and the littoral regions of the Black Sea and the Sea of Azov, as well as the political, strategic, economic, and cultural importance of several urban littorals – Mariupol, Kherson, Odessa, and Mykolaïv – to the overall conduct of this war, an analysis of the conflict in Ukraine is merited.

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<https://adminpubs.tradoc.army.mil/pamphlets/TP525-3-1.pdf>; and Clark, Patt, et Schramm, "Mosaic Warfare - Exploiting Artificial Intelligence and Autonomous Systems to Implement Decision-Centric Operations".

<sup>163</sup> King, *Command*, 289-90.

<sup>164</sup> "The U.S. Army in Multi-Domain Operations 2028 TRADOC Pamphlet 525-3-1," 21-24, D-5; Clark, Patt, et Schramm, "Mosaic Warfare - Exploiting Artificial Intelligence and Autonomous Systems to Implement Decision-Centric Operations," iv; King, *Command*, 289-91.

<sup>165</sup> Artur M Dominiak et John F Bassette Jr, "THE APPLICATION AND EMPLOYMENT OF SPECIAL FORCES TO EFFECTIVELY OPERATE IN THE MULTI-DOMAIN OPERATIONS ENVIRONMENT OF LARGE-SCALE COMBAT OPERATIONS" (Monterey, California, Naval Postgraduate School, 2021), 39.

<sup>166</sup> Valerii Zaluzhnyi (Commander-in-Chief of the Armed Forces of Ukraine, Kyiv, Ukraine), "Modern Positional Warfare and How to Win It," consulted 17 November 2023, [https://infographics.economist.com/2023/ExternalContent/ZALUZHNYI\\_FULL\\_VERSION.pdf](https://infographics.economist.com/2023/ExternalContent/ZALUZHNYI_FULL_VERSION.pdf).

Firstly, although the tides of combat have ebbed and flowed over the course of the past two years, with each side possessing the momentum and holding the strategic advantage at certain points, the war indicates the importance of mission command within the overall command and control hierarchy, the advantages of the employment of flexible and adaptive force packages, and the utility of the creative use of communications technology to support operations.

After the initial shock of the full-scale invasion beginning February 24, 2022, outnumbered Ukrainian forces, more decisive, creative, independent, and flexible than their Russian adversaries, achieved success in pushing back the attacking forces along several important axes, most notably on the approaches to Kiev and the areas around Kharkiv and Kherson. Meanwhile, rigid, hierarchical, and accustomed to a more centralized form of command and control, Russian forces suffered significant losses during the opening months of the war, specifically with respect to the number of senior officers killed and wounded, which is seen as a result of poor communications discipline and the fact that these officers needed to approach the front lines to confirm the battlefield situation and to pass orders to subordinate elements. This methodology runs contrary to the principles of mission command and distributed operations and allowed these high-ranking military officers to be more easily targeted and consequently struck by Ukrainian forces.<sup>167</sup>

From a Ukrainian perspective, small and distributed units sometimes mounted on quads while using small tactical commercial drones modified for military operations, organized themselves to launch harassing attacks on the long and slow-moving Russian armored and mechanized

columns approaching Kiev, managing in turn to inflict significant losses on these enemy forces while thwarting their advances.<sup>168</sup> In Mariupol, Ukrainian forces composed primarily of personnel from the Azov Regiment, outnumbered approximately eight-to-one by the attacking Russian troops, were able to hold out for 80 days of brutal combat by taking advantage of the dense urban terrain of the city, and in particular by hard-pointing in the steel factory of Azovstal, a defensive bastion serving as the equivalent of a city within a city for these troops and the local civilian population. While assuming an effective defensive posture inside Azovstal, Ukrainian forces slipped into the surrounding city, employing lightning raids and ambushes to slow the Russian advance and bring back supplies and rations to the factory.<sup>169</sup>

Additionally, helicopter transport missions (numbering at least seven) dubbed "Operation Air Corridor" served to evacuate wounded personnel and drop off supplies and fresh soldiers, allowing Ukrainian forces to prolong the defense of the city and occupy Russian forces that would have otherwise been free to support operations in other regions. The arrival of a Starlink internet terminal to Azovstal during one of the first helicopter transport missions changed the game from a technology perspective, as previously cut-off forces and civilians now had access to the internet to support tactical and operational communications, while also contributing to the information warfare campaign.<sup>170</sup>

The utilization of Starlink satellites by Ukrainian forces for secure and reliable internet communications throughout the course of the war is another interesting test case for distributed operations C2. Although this does not constitute MANET infrastructure based on line-of-sight or

<sup>167</sup> Goya et Lopez, *L'ours et le renard*, 76-80, 116-17, 220-24.

<sup>168</sup> *Ibid.*, 146-49. The Aerorozvidka unit, specialized in aerial reconnaissance and drone operations, received significant attention in the media for their quad and drone exploits, but various Ukrainian infantry units, such as the 72<sup>nd</sup> Mechanized Infantry Brigade, were also extremely successful in using distributed formations to ambush Russian forces and halt their march towards Kiev.

<sup>169</sup> Michael Schwartz, "Last Stand at Azovstal: Inside the Siege That Shaped the Ukraine War," *The New York Times*, 24 July 2022, <https://www.nytimes.com/2022/07/24/world/europe/ukraine-war-mariupol-azovstal.html>.

<sup>170</sup> Laurent, "Ukraine"; Schwartz, "Last Stand at Azovstal."

beyond line-of-sight communications, the Starlink satellite constellation consisting of a web of thousands of small low Earth orbit satellites functions as a redundant, high-speed, and secure wireless communications network that provides reliable and constant internet, making it comparable to MANET communications from a conceptual standpoint. This system has been creatively used by Ukrainian forces for command-and-control functions, to coordinate tactical action, and potentially even to pilot long-range unmanned surface attack drones, while reports indicate that Russian forces have learned to take advantage of this reliable communications technology as well.<sup>171</sup>

The most important lessons with respect to the application of distributed operations command and control in this conflict may well rest with combat in the littoral environment however, where vastly outnumbered Ukrainian forces with a practically non-existent fleet have sought to disperse themselves and operate in a distributed fashion, tailoring force packages to meet the demands of the tactical situation and managing consequently to neutralize the effectiveness of the more powerful Russian Black Sea Fleet. Via the use of distributed formations, Ukrainian elements in the littoral have conducted a highly successful campaign of artillery and missile strikes, which thwarted Russia's ability to wage an assault on Odessa. Additionally, they have used both surface and aerial drones to attack Russian vessels operating on the Black Sea, as well as bases in Sebastopol and Novorossiysk.<sup>172</sup>

Pertinent examples of this include the use of artillery, missile, and air forces to sink the Russian Black Sea fleet's flagship vessel, the *Moskva* cruiser, in April of 2022, and to subsequently force

Russian troops to abandon Zmiinyi (Serpent) Island just off the Ukrainian coast at the end of June 2022, which greatly reduced their ability to conduct attacks into the Ukrainian mainland or to lead an amphibious offensive into Mykolaïv or Odessa.<sup>173</sup> The creative use of small swarms of naval surface attack drones (upwards of fifteen different times) has resulted in the damaging and even sinking of several Russian vessels, and has included attacks as far reaching as Novorossiysk on the Russian mainland coast of the Black Sea (there are approximately 600 kilometers straight-line distance between Odessa and Novorossiysk), as well as potentially two strikes on the Kerch Bridge, a strategic point connecting Crimea to Russia proper.<sup>174</sup>

If nothing else, the conflict in Ukraine illustrates the difficulty and brutality of military operations in the urban littoral, whether that be the siege of Mariupol, a coastal city that was completely leveled by a numerically superior force trying to gain its control, or Kherson, a large urban area situated at the southern portion of the Dnieper River at its opening into the Black Sea, where the marshy environment replete with small islands, streams, and meadows has greatly restricted mobility and hindered maneuver, becoming instead "a quagmire of mud and bomb craters filled with water." Ukrainian soldiers participating in the river crossings attempting to retake the Western bank have described the effort as "brutalizing and futile."<sup>175</sup>

Ultimately, it appears that Ukraine has experienced a certain level of success through embracing a distributed operations C2 methodology. This consists first and foremost of

<sup>171</sup> Goya et Lopez, *L'ours et le renard*, 114; "Starlink | How Starlink Works," Starlink, consulted 28 February 2024, <https://www.starlink.com/technology>; "Ukraine Intelligence 'Confirms' Russian Forces Using Starlink," *Al Jazeera*, 11 February 2024, <https://www.aljazeera.com/news/2024/2/11/ukraine-intelligence-confirms-russian-forces-using-starlink>.

<sup>172</sup> Goya et Lopez, *L'ours et le renard*, 118-19, 218-19, 250-54; Kramer, "In a Tough Year on Land, Drones Give Ukraine Some Success at Sea."

<sup>173</sup> Goya et Lopez, *L'ours et le renard*, 118-19, 218-19, 250-54.

<sup>174</sup> Kramer, "In a Tough Year on Land, Drones Give Ukraine Some Success at Sea"; Joseph Henrotin, « Guerre navale : l'émergence des K-USV », *Areion24.news*, January 2024, <https://www-areion24-news.cdn.ampproject.org/c/s/www.areion24.news/2024/01/25/guerre-navale-lemergence-des-k-usv/amp/>.

<sup>175</sup> Carlotta Gall et al., "Ukrainian Marines on 'Suicide Mission' in Crossing the Dnipro River," *The New York Times*, 16 December 2023, sect. World, <https://www.nytimes.com/2023/12/16/world/europe/ukraine-kherson-river-russia.html>.



their use of mission command highlighted by initiative and independent and decisive decision-making at the tactical level; followed by their organization of dispersed and mobile units, to include mobile coastal artillery and missile units as well as small formations of aerial and surface drones, all employing effective fires to harass and at times wreak havoc on a numerically superior enemy; and lastly their innovative integration of communications solutions into operations, albeit using Starlink low Earth orbit satellite networks rather than standard MANET communications infrastructure.

Furthermore, although the focus of this analysis concerns largely Ukrainian efforts, as it is their forces that have embraced what is most like a distributed operations command and control methodology, Russian forces have nonetheless adapted to the exigencies of combat in important ways, particularly from a structural and industrial perspective. To this respect, they have put into place certain lessons learned on the battlefield to counter attempted Ukrainian advances and counter-offensives since September 2022, to include the utilization of new defensive tactics, the widespread employment of more effective electronic warfare and GPS jamming techniques and equipment, and the implementation of better dispersion of ground forces, artillery, and logistics to avoid being targeted by adversary fires. This along with a relative parity in capabilities, in particular from a technological perspective, has contributed to the relative freezing of the nearly 620-mile (1,000 kilometer) front and a resultant return to positional warfare, Russia proving itself potentially more apt at strategic-level adaptation, while Ukraine has potentially been more successful with respect to tactical-level adaptation via the employment of a distributed operations C2 methodology.<sup>176</sup>

## Conclusion

Since the earliest wars human beings have greatly invested in achieving a better understanding of this most ancient of human social phenomena so as to best prepare for the future battlespace. With trends indicating that warfare in the coming years will be increasingly urban and littoral in nature, as witnessed by the current conflicts in Gaza and Ukraine, it stands to reason that increased efforts should be dedicated to studying this environment to develop concepts, capabilities, tactics, and training to confront the challenges posed by its complexity and unpredictability, specifically from decision-making and maneuver perspectives. After having thoroughly analyzed the multitude of interconnected elements constituting the urban littoral environment in this study, it has been determined that a distributed operations C2 methodology does indeed present a conceptually viable, although only partially battlefield-proven construct for command and control in both the urban littoral and other complex and unpredictable multi-domain environments.

In aspiring to further advance academic reflection concerning distributed operations C2, recommendations for future research include the continued study of this methodology within the framework of the war in Ukraine to obtain more concrete examples of what works and what does not work with respect to the application of distributed operations command and control on the battlefield. With this, a clearer understanding of the specific information, communications, and electronic warfare technologies being used in the field, as well as those systems that have been able to avoid, or more appropriately limit detection by adversary forces, would help to better establish the role and overall importance of information and

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<sup>176</sup> Mick Ryan, "Russia's Adaptation Advantage," *Foreign Affairs*, 5 February 2024, <https://reader.foreignaffairs.com/2024/02/05/russias-adaptation-advantage/content.html>; Valerii Zaluzhnyi (Commander-in-Chief of the Armed Forces of Ukraine, Kyiv,

Ukraine), "Modern Positional Warfare and How to Win It," consulted 17 November 2023, [https://infographics.economist.com/2023/ExternalContent/ZALUZHNYI\\_FULL\\_VERSION.pdf](https://infographics.economist.com/2023/ExternalContent/ZALUZHNYI_FULL_VERSION.pdf).

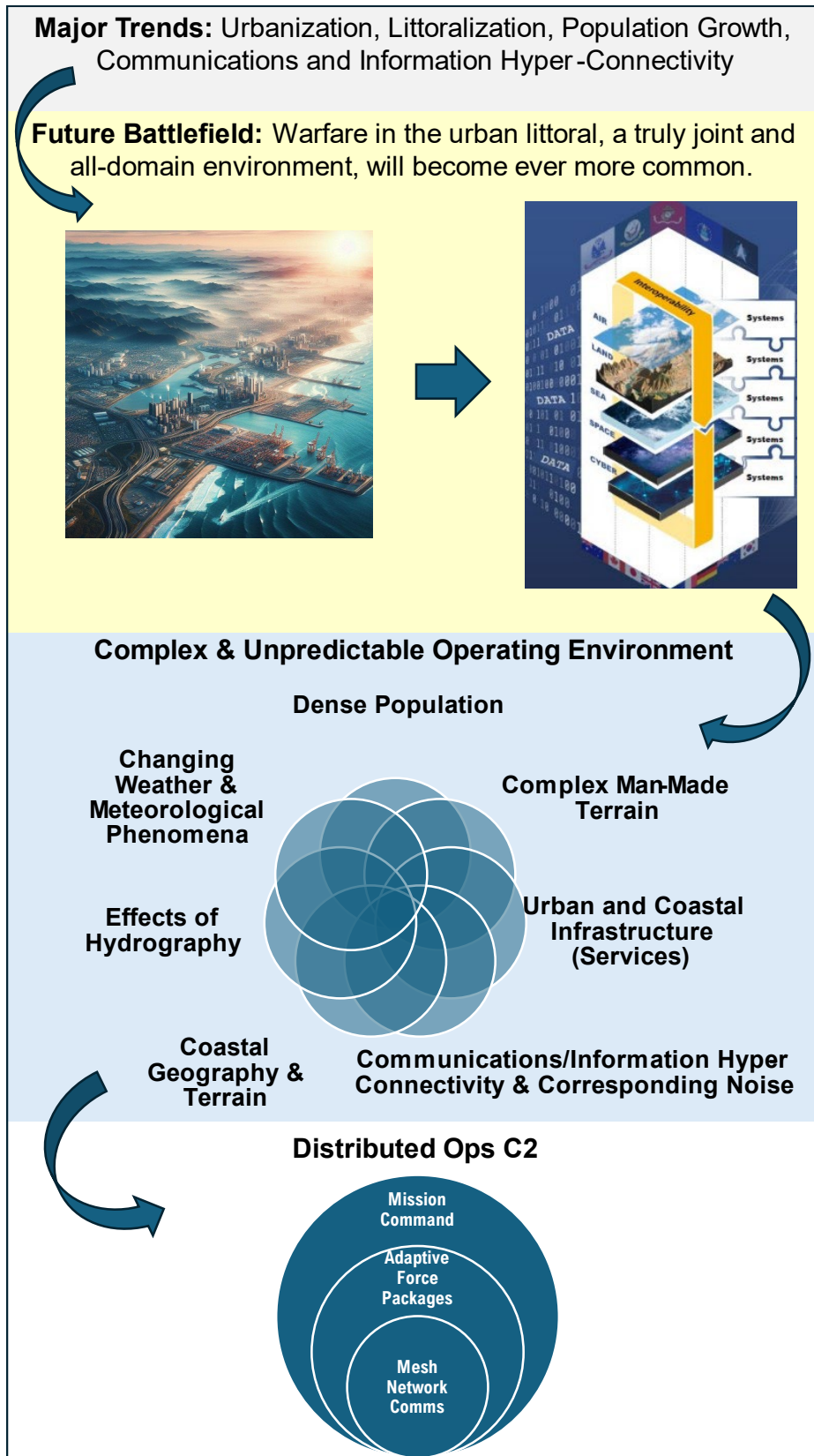
communications technology within today's command and control hierarchy.

Additionally, it would be beneficial to place more academic rigor into the study and development of doctrine and concepts for the urban littoral as a singular operational environment to reach a more comprehensive understanding of joint operations in this space. This should be done not simply from the aspect of how littoral combat can support urban operations, but also from how the urban area can contribute to littoral mission sets such as sea control and sea denial for example. Ukrainian efforts in the maritime domain have

highlighted the important role littoral operations can play in a major theater of war containing a significant littoral facade, even when the primacy of fighting takes place on land and in and around urban areas.

In conclusion, Figure 6 on the following page serves as a final résumé of the key trends, domains, and environmental factors associated with military operations in the urban littoral, which result in the need for a distributed operations C2 methodology to counter the complexity and unpredictability of this milieu.

Figure 6



Source: Images in the second box, "Future Battlefield," from left to right, are sourced from Microsoft Bing Image Creator (generated with AI) and the document "Summary of the Joint All-Domain Command & Control (JADC2) Strategy," March 2022.

**Annex 1***Table 1*

<b>Littoral Geography</b>	<ul style="list-style-type: none"> <li>• Contour &amp; shape of coastline</li> <li>• Presence of coastal islands, archipelagos, and cliffs and mountains that descend onto the shore</li> <li>• Characteristics of the continental margin/relationship &amp; interaction between the water and the landmass</li> </ul>
<b>Hydrography</b>	<ul style="list-style-type: none"> <li>• Depth of the water</li> <li>• Presence of coastal islands, archipelagos, and cliffs and mountains that descend onto shore</li> <li>• Shape, contour and slope of the continental shelf, the continental slope</li> <li>• Underwater or surface obstructions and obstacles, both natural (reefs, islands, rocks) and man-made (debris, shipwrecks)</li> </ul>
<b>Oceanography</b>	<ul style="list-style-type: none"> <li>• Characteristics of the water: temperature, salinity, density</li> <li>• Differences in chemical and biological properties of the water and the air and their resultant interactions</li> <li>• Presence and health of littoral ecosystems</li> </ul>
<b>Meteorology</b>	<ul style="list-style-type: none"> <li>• Seasonal weather patterns and weather phenomena</li> <li>• Storms, wind, and rain and their interaction with the water's surface (sea spray, waves, swells) creating sea clutter</li> <li>• Temperature and humidity changes, and the differences in properties between the water and the air, as well as their interaction with landmasses</li> </ul>

The multitude of characteristics associated with the littoral operational area ensure that no two are alike. The dynamic and rapidly changing nature of this milieu results from the convergence and interconnection of the four principal elements affecting its nature, which are presented on the left side of Table 1. These elements result in specific environmental conditions presented in the boxes on the right side of Table 1, that via their interaction and interdependence impact the execution of littoral operations. These specific impacts, represented by Table 2 (following page), present both advantages and disadvantages for forces operating in a littoral zone, and it is tactical action underpinned by creative, intelligent, and ultimately decisive decision-making that is best able to respond to the exigencies of the littoral operational area.

Table 2

Impacts of environmental factors on littoral operations
<b>Open ocean:</b> littorals with deeper and more open waters support the operational employment of larger, more powerful surface and subsurface vessels, and better facilitate maneuver and dispersion
<b>Enclosed and semi-enclosed seas, coastal islands, and archipelagos:</b> maneuver and dispersion are more difficult, but there are opportunities for cover, concealment, as well as to blend in with the clutter and the ambient noise (acoustic, electromagnetic, and the increased maritime traffic)
<b>Natural harbors, bays, channels, and coastal islands:</b> opportunities for military forces to hide, take refuge, and mask movement, with potential expeditionary basing options and anchorage points
<b>Coastal islands and archipelagos:</b> permit the deployment of defensive capabilities (surveillance, A2/AD), while requiring the defense of more territory
<b>Coastal cliffs and mountains:</b> limit the installation and employment of defensive capabilities (communications/surveillance systems), while also serving as points of refuge and concealment, as is the case for indented cliffs, which are favorable to temporary submarine and small surface combatant shelters
<b>Flat coastline without offshore islands:</b> more advantageous for larger scale beach landings and the deployment of ground forces
<b>Swamps, marshes, and river deltas:</b> impede movement, maneuver, and amphibious landings
<b>Tides:</b> affect amphibious landings as well as the execution of many other operations occurring in the littoral zone, specifically those occurring in the immediate near-shore area (reconnaissance, sabotage)
<b>Temperature, pressure, and humidity:</b> differences in these elements between the sea and the air lead to anomalies in the propagation of EM waves via phenomena known as subrefraction, super-refraction, and ducting, which consequently affect the performance of radar and other forms of radio communications, as well as electro-optical sensors. This presents more opportunities for forces to mask movement and hide from adversaries.
<b>Sea clutter:</b> caused by wind, waves, swells, and precipitation, it interferes with the propagation of RF waves, allowing forces to mask their movement, specifically smaller surface craft with lower radar cross sections, while radar operators must continually adjust their systems in trying to overcome these effects
<b>High maritime traffic:</b> coupled with coastlines with highly developed commercial or military communications infrastructures creates ambient RF and acoustic noise that interferes with the performance of one's organic communications systems, while also allowing one to "blend in" with the ambient noise
<b>Shallow littorals and those containing numerous islands:</b> acoustic noise can be significant due to the minimal depth and significant variations in water temperature, salinity, waves, and tides, as well as the presence of underwater obstructions (rocks, obstacles, debris) and habitats (coral reefs). This results in high rates of false returns for sonar sensors, which provides another opportunity for vessels to hide.

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