



# SMALL WARS JOURNAL

## U.S. Army Mega City Operations: Enduring Principles and Innovative Technologies

By [Frank Prautzsch](#)

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Frank Prautzsch

“...and the worst policy of all is to besiege walled cities. The rule is, not to besiege walled cities if it can possibly be avoided. The preparation of mantlets, movable shelters, and various 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 still remains untaken. Such are the disastrous effects of a siege. Therefore the skillful leader subdues the enemy's troops without any fighting; he captures their cities without laying siege to them; he overthrows their kingdom without lengthy operations in the field.”

-- Sun Tsu – The Art of War, 500 B.C.

### Introduction

By 2050, urbanization will arguably be the most consequential event in the history of mankind. Out of every 100 children born at that time, 57 will be Asian, and 22 will be African. The majority of those new babies will live in cities. Over the last two decades, developing nations have added 3 million new people per week. This is the equivalent of adding the city of Seattle to the planet *daily*. Starting in 2018 the world's global rural population will peak at 3.5 billion and then proceed to fall by almost a billion new migratory city citizens.<sup>1</sup>

In conjunction with a massive demographic shift to urbanization, there are also shifts in wealth and in aging. The developed world is losing its edge over developing nations in wealth, while Central and South America bear the brunt of a radically aging population.<sup>1</sup>

For the U.S. Army to conduct future missions, Sun Tsu's principles may be more fitting than ever. While U.S. Army may not always lay siege to a city, the preparation for any military urban operation is not a short term event, nor is the planning ad hoc. The spectrum of operations spanning non-combat and combat missions in the face of natural or adversarial threats, makes this preparation a multi-dimensional problem requiring significant attention and forethought. As we proceed to investigate and plan for Mega

City operations there are a few key points that must be made:

1. Mission success is contingent upon the will of the population, as well as the coalitions, governments, religions and tribes in occupancy not purely the strategy, tactics and planning of the U.S. Army.
2. The U.S. Army cannot “fight its last war”. Lessons learned from battles such as Fallujah, Aleppo, or throughout densely populated Palestine don’t scale well, and are miniscule in size and scope compared to a Mega City battle.
3. Mega City warfare is a highly 3 dimensional event. Unlike rural warfare with focus upon capturing mountaintops, resources, and roads, urban key terrain belongs to the defender and suggests skyscrapers, bridges, tunnels, subway systems, energy and water distribution, telecommunications, airports and rail stations are the discriminators.
4. Mega Cities with a subterranean network, capable of threat transit (subway, water drainage, sewage) will offer a compounded advantage to a defender or asymmetric threat. Most subterranean geospatial data is a non-integrated stack of reference materials, maps, and overlays. Often these references don’t exist or are completely unreferenced or surveyed resulting in C2 and situational awareness failures.
5. The U.S. Army must understand that technologies that would be used for missions in 2040 Mega Cities don’t exist yet. However, those technologies that do exist, may point towards needed future technical capabilities in some form or function.
6. The U.S. Army must assume that if specific technologies exist for supporting future operations, that an adversary may also have access to a derivative of such technology.
7. The value of C4ISR, mobile networks and unmanned/autonomous systems are exponentially more significant than today. With this comes an implied task to have spectrum supremacy or the above capabilities are useless.
8. The resources of the U.S. Army may be called upon in more non-combat missions to protect or sustain life. (Power generation, water purification, water pumping, health care, engineer support, air drops, evacuations, psychological operations, sanitation, graves operations)
9. A determined adversary or a disgruntled population has time and mass on their side.
10. Logistics and energy rule. The “Achilles Heel” for a Mega City involves the lines of communication for power, water and food supplies.

### **Emerging, Enduring, and Endearing Technologies.**

The U.S. Army should carefully evaluate, mature and mutate selected commercial technologies that aid Mega City operations. Each of these technologies exists or is emerging today and has some value in further research:

1. Broadband over power lines (BPL): Simply stated one key asset that most Mega Cities have is a reasonably well defined power grid. Today BPL technologies allow for networked and point-to-point transmission of 200-500 Mbps over simple modems and integrated network control capabilities. This is significant to spectrum supremacy, covert operations, remote sensing, and C2. Most wireless phone antennas are horizontally polarized and start to lose service at altitude above about 600 feet. Thus, communications in the highest floors of a skyscraper can be complicated by a lack of wireless quality of service which can be somewhat offset by BPL. Many BPL and Network Control capabilities can also interface on ad hoc with fiber, terrestrial and satcom systems at some designated nodes.
2. Tethered and untethered C4ISR Sensors: In a Mega City environment the need for persistent surveillance is paramount. While UAVs are vogue in 2016, the need for small positive buoyant gas envelopes with sensors and visualization for hours-days is of necessity. Numerous systems exist today that are controlled or on tether. Additionally, controlled small airships afford the ability to conduct sustained observation of a target or area of interest, and also perform such functions as

bottom side bridge inspection or bomb sniffing.

3. Manned, Unmanned and Autonomous Systems: Such capabilities are not limited to urban airspace, but also littoral and harbor areas with USVs, streets, tunnels and high risk areas with UGVs, and undersea operations along coastal and harbor areas with UUVs. New systems such as VTOL jetpacks, manned quad copters and air mules need to be considered for rapid equipment and team displacement, remote sensor placement, security and vantage of urban high ground, sniper and counter sniper operations, incident response, combat evacuation, and search and rescue.
4. Subterranean vehicles: More research is in order at developing capabilities that can allow the US Army to more effectively use rail and subway systems within a Mega City. This could include a rail gauge-scalable light armor assault and recovery vehicle that is both road and rail capable for supporting a squad infiltration or an evacuation/recovery of critical area when/if mass transit fails. (e.g. towing a metro rail train without power during a mass casualty evacuation)
5. Internet of Things: If there was ever a consideration that plays heavily into remote sensing, security, and situational awareness in a future Megacity, it will be the Internet of Things. Retail wireless companies already have the option of purchasing 15 thousand edge sensor devices smaller than a credit card, and an integrated router system that can aggregate all the devices, (one and 2-way), and wireless connectivity at up to 2.5 miles in unlicensed spectrum. Such COTS capabilities are both an enabler and a threat as they are not ITAR and can be implemented across a Mega City in hours.
6. Tunnel and Bridge Emergency Management: By far the biggest choke points and symbolic targets for a Mega City relates to bridges, tunnels and ferryboat operations. Inflatable plugs and barriers exist for sealing tunnels both to fire and to catastrophic breaches in their outer walls. While the Army has a longstanding history and portfolio of expeditionary bridging capabilities, the expertise and experience for tunnel operations, advanced bridge security, and the security of ferryboat operations is perhaps an important future competency needed. In addition, most bridges and tunnels are conduits to Mega Cities for power, telecommunications, and in some cases, gas and water lines. Robotic and sensor integrity and inspection systems are essential. Failure to control and secure bridges and tunnels make any Mega City operation impossible.
7. Non-Lethal Weapons: Many missions in Mega Cities will likely have the potential of migrating from a peaceful and organized event, to a limited engagement and disorganized chaotic event. Intermediate capabilities to control crowds, and incapacitate via non-lethal means can retain the will of the people with the U.S. Army whereas casualties, however justified, could instigate disastrous consequences. While the Marine Corps continues to research future joint non-lethal weapons, much more must be done in non-lethal weapons research, breaching and riot systems, IT and PNT denial, micro-area cyber operations, localized Marx generation to incapacitate electronics, and non-lethal weapons for incapacitating insurgents or riotous masses.
8. Disease, WMD and CBRNE Detection: Mega Cities are both an incubator and a target for the worst of all scenarios. Greater sensor and detection systems and field response systems are now emerging in the scientific and consumer market. Such systems allow for field optical stereoscopy and spectroscopy for characterization of substances, DNA sequence analysis and Chemical- Biological Pathogen detection and field vitals and triage in handheld or small portable devices.
9. Augmented Reality, Night Vision and Situational Understanding: Electronics now exist that introduce affordable augmented reality in high resolution for the war fighter. These systems will mature dramatically in form factor, and content over the next two decades. It is safe to say that some form of augmented reality eyewear or headwear will be normal attire for the war fighter in Mega City operations. Current technologies in EO/IR have taken away the “ownership of the night” from the U.S. Army. Night vision modules that attach to intelligent phones cost less than most of the phones. Innovation in graphene points to phase shift single molecular layer carbons that will ultimately introduce a night contact lens. Of greater importance than the greatness of gadgetry, is the need for integrated understanding of intelligence and sensor feeds. It will not be adequate to have situational awareness, but understanding. The motives, patterns, behaviors, and predicted next steps of a threat will be the “new normal” for missions. In a Mega City, future commanders won’t decide

courses of action without understanding the motives and intent of the adversary.

10. **Illumination:** Technology now exists to provide high lumen lighting in an area the size of a football field in a hand-carry device. LEDs give us a distinct advantage in crisis lighting for subterranean, catastrophic point-of-event, and emergency services operations. Such systems are now DC powered and operate with up to 400w/45000 lumens in hand carry form factor. Such a capability would also be practical for integration on selected autonomous or unmanned systems and selected urban terrain vantage points.
11. **Through-obstacle detection and characterization:** Current systems exist that can detect life under up to 27 feet of rubble by measuring the displacement of the lungs and processing respiratory level and pulse rates. While such ultra wideband systems are a mercy tool for earthquakes, explosions, and bombings it can also be an important tool in determining threats behind closed doors or walls. Additionally, such a system can identify elevated heart and respiratory rates in a crowd, acting as a physiological marker to a potential threat. In 2016, mobile technology to monitor through-walls is smaller than a breadbox. For free space monitoring of heart and respiratory rates the entire module is the size of a small paperback book.
12. **3D/4D Geospatial Referencing:** By 2050, most all image sciences will be 3D and also include a fourth dimension of time. Current systems in LIDAR, light field camera techniques, 2/3D orthorectification against point clouds, and structure internal GIS mapping and referencing will be the norm for navigation and negotiation of Mega City movements and coordination. This will also include 3D synthetic geospatial night vision mosaics. 3 and 4D systems will not only aid the war fighter in understanding context, but also vertical, subterranean, and hidden threats. In addition, the geospatial data will be essential to autonomous systems operation.
13. **Weather and Micro-weather:** Weather is not limited to trafficability and complications to operations in rural areas. Mega City operations in adverse weather introduce unexpected threats, opportunities and consequences. Systems exist now to introduce micro-weather prediction by analyzing weather formations and road conditions from traffic cameras. One system today has an aggregate capacity of over 165K cameras that provide integrated hyper local weather and environmental intelligence.
14. **Specialty Vehicles:** Consideration should be given to vehicles that can operate in more than one domain. Platforms exist today that can cover transitions between land and water, air and sea, surface and subsurface and air and land. These systems are essential in Mega City operations for mission agility, selected concepts of operation, surprise, and range extension.
15. **Communications:** By 2050, the world will have embraced 5 and 6 G wireless services and ad-hoc networks between mobile platforms and users will involve transmission=s from 5 Gbps-1 Terabyte/second. 5G starts fielding in 2020 and should move to consumer acceptance by 2025. Laser high fidelity communications are currently under demonstration and testing. LI-FI will soon supplement or replace selected WI-FI applications in urban areas. Since LI-FI does not consume RF spectrum and operates at significantly higher data rates, it will gain acceptance for selected network applications. Basic 5G speeds will exceed 4G LTE service by a factor of 65000. 4D Virtual reality, instantaneous downloads, mission rehearsals, and multi-intelligence, multi-language machine learning systems will be commonplace. With communications and networks our ability to rationalize the future is most difficult and we have successfully written requirements for capabilities that have been surpassed by technology time and time again. Additionally, old technologies in acoustics and older spectrum such as HF may have a calling for mission specific support, operations during RF spectrum denial, or surprise.
16. **Gunshot and Explosive Detection and Characterization:** Force protection will always be an issue with Mega Cities. While the need for new and protective forms of armor and TALOS-like exoskeletal capabilities are needed, the ability to deal with snipers and improvised explosives, and trigger systems can only expand exponentially in a gigantic population center. The ability to disguise and surprise with asymmetry, calls for improved acoustic geolocation, predictive crime models, and new sensors such as graphene trough sensors or piezo-electric cantilever sensors that can detect explosive particle residue at range.

17. **Armor and Blast:** While the metallurgical and ceramic armor communities continue to develop plating solutions, new inventions in flexible body armor from spider silk, tight woven hemp, advanced plastics, kevlar, and graphene are redefining ballistic protection that is flexible and agile, while still maintaining the performance of plating techniques. The use of syntactic foams with tailored density resins and tailored size micro-balloon glass particles introduces unique blast protection features as the foam distributes energy radially and radically from the highest point of an acoustic wave impact and distributes that blast energy in effective nullification. Such a capability offers progressive and aggressive force blast protection by introducing such capabilities in the platforms, building processes, and troop protection. Advanced electro spray techniques allow for the development of active armor that has different molecular composition at different levels in the armor. Such armor changes the Vickers Index properties of the materials from which it is made (e.g. aluminum armor) and allows for boutique armor capabilities against different threats using heat or shaped charges, higher grade explosives, or high velocity projectiles from the blast effect.
18. **A New “MacGuyver<sup>2</sup>” Squad:** For each prevailing Mega City, a subject matter expert cadre should be passively maintained, that are versed *in that Mega City*, have lived in that Mega City, or have insight on capabilities involving its government and its infrastructure. Such a Squad must be able to facilitate host nation and Mega City support, telecommunications, emergency shelter, fuel, energy, water, and how to operate critical infrastructure, such as transportation, with or without city employees. This should include HUMINT and several insights on technical, religious, and political intelligence about that Mega City. This squad should be “doers” that can improvise anything, and not be totally contract/transactional support.

## Conclusion

Mission support within Mega Cities, across the continuum, on an objective timeline 24 years away, requires vision, invention, innovation, technical ingenuity, commercial off-the-shelf solutions, host nation support, and legacy systems integration. The technology vectors professed in this paper are critical future Mega City missions. They will emerge with or without U.S. Army involvement, since in various forms, each of these technologies **already exists in 2016**. It is our charge to challenge the “Art of the Possible”, not await or monitor it. The U.S. Army cannot simply study or analyze Mega City warfare. Failure to prepare for statistically inevitable Mega City peaceful or violent missions is beyond foolhardy. Unlike Sun Tsu’s warnings about impatient generals that will not tolerate 6 months of preparation to besiege a city, the U.S. Army may not have such luxury of time.

## End Notes

<sup>1</sup> Laurence C. Smith, *New North: The World in 2050*, (London: Dutton Publishing/Penguin Group, 2010)

<sup>2</sup>Richard Dean Anderson, *MacGuyver*. TV Series, ABC TV, Hollywood, CA and Vancouver Canada, 1985-1992.

## About the Author



## **Frank Prautzsch**

In his current role as President of Velocity Technology Partners LLC, Mr. Prautzsch (LTC, Ret. Signal Corps) is recognized as a technology and business leader known for exposing or crafting innovative technology solutions for the DoD, SOF, DHS and Intelligence community. His focus is upon innovation and not invention. His waking moments are spent in the process of identifying and contriving use cases for global commercial technologies that the government is unaware of, or at best has yet to assume a use case for that could support their needs. Prior to his own consulting program, Mr. Prautzsch served as the Sr. VP for Government Programs for ORBCOMM, the Director of the Raytheon Rapid Initiatives Group (RIG), and Director of Army Requirements for Hughes Space and Communications Company

While on active duty in the US Army, Mr. Prautzsch held a variety of Command, Staff, and Engineering positions. He served on numerous Joint Task Force, Army, and contingency missions across all operational environments and was instrumental in defining many of the Army's MILSATCOM concepts of operations and doctrine used today. He was the Secretary of the Army's selection to Lead the DoD MILSATCOM Architecture under the DoD Space Architect. During this process, he was instrumental in formulating a \$42B investment plan for wideband, protected and narrowband communications for the Nation.

Mr. Prautzsch holds a Bachelor of Science in Engineering from the United States Military Academy at West Point, is a distinguished graduate of the Marine Corps Signal Advanced Course, Army Airborne School, Ranger School, and Command and General Staff College. He attended Raytheon's University of Chicago Business Development School, and is Six Sigma qualified. He also holds a Master of Science Degree from Naval Postgraduate School in Monterey, California with a degree in Systems Technology (C3) and Space.

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