Report on **Understanding the Military and Science & Technology (S&T) Implications of the new NATO Capstone Concept**, Virtual Workshop 23-24 May 2019.

1. **Background**. The workshop was conceived in Paris during the February 2019 STO Plans and Programs Workshop when the Operations in Contested Urban Environments (OCUE) Theme syndicate identified that the NATO Capstone Concept "Joint Military Operations in an Urban Environment" contained valuable work and information that could provide very beneficial inputs into the Collaborative Program of Work. In March 2019, the Military Committee (MC) approved the capstone concept further emphasizing its importance to NATO. The STO System Analysis and Studies (SAS) Panel teamed up with Allied Command Transformation's (ACT) Strategic Plans & Policy Directorate (SPP), Concept Development (CNDV) Branch to develop an online workshop focusing on the new NATO Capstone Concept on Urbanization. It was hosted through the ACT Innovation Hub at Old Dominion University in Norfolk and had 25 participants from the STO and other NATO Organizations (see Annex A *Participants List*).

2. **Workshop Aim and Intent.** The aim of the workshop was to leverage the new Capstone Concept to explain the complexities associated with modern cities, convey the military importance of urban operations and develop an appreciation for the new capabilities and technologies needed to help NATO win in an urban environment. The first day of the workshop focused on providing information on the concept to the participants with the second day focused on discussing the key outputs and S&T implications of the concept.

3. **Day 1 Overview and Results**. On Day 1, there were a number of presentations from participants involved in the development of the concept (see Annex B *Workshop Agenda*). The primary intent for the day was to provide information on the Urban System and the Urban Concept for the S&T participants. The workshop began with introductions by Col Stephan PILLMEIER, SPP CNDV Branch Head and Dr. Pavel ZUNA, the CSO Director. There were strong key messages from both leaders highlighting the necessity of the Concept Development and Experimentation (CD&E) process, the collaboration between military and civilian Subject Matter Experts (SMEs) as well as the mutual and beneficial support from each side in order to achieve the desired effects. The following highlights the presentations and key comments from Day 1.
   a. LTC Jozsef BODNAR, (SPP CNDV staff officer, Project lead) provided an overview of the Urbanization Project. He detailed the development of the concept starting from the initial Urbanization study in 2013, provided an overview of the concept and its development process, which included the background on the actions and events that contributed to the concept. This presentation provided the context for understanding the outputs contained in the concept. He highlighted that the implementation phase of the concept will require inputs from the S&T community to support the Alliance capability development. The project team also emphasized the importance of the support provided by the S&T community through the wargames and experiments which was essential for developing the capability cards.
   b. Professor Allan SHEARER from the University of Texas at Austin, an expert involved in the project and concept-development, provided an exemplary presentation on the Characteristics of the Future Urban Environment. He emphasized seeing future cities should be considered as a 'system of systems' and discussed the structural features of the system.
   c. LTC Jozsef BODNAR followed with a detailed overview of the capstone concept, highlighting the guiding questions and scope of the concept, the urban problem for NATO and the urban operations environment, the conceptual framework, the capability requirements identified and finally ended with a Bi-SC's recommendation for a way forward.

d. Mrs. Sue COLLINS, Senior Operations Research Analyst from Capability Development Directorate, Analysis of Alternatives Branch, presented the results and outputs from the preceding wargames and experiments that developed and tested the capability requirements and validated the concept. The project team conducted three different experiments/ wargames over the period of three years, a 2015 Discovery Game, a 2016 Seminar Wargame and a 2018 Matrix-Style Wargame. Each provided specific insights into the urban challenge and Mrs. Collins discussed the key outputs from each of the wargames. The capability cards from the Seminar Wargame can be found in Annex D *Capability Cards*.
e. LTC (ITA-A) Luca PALOMBI from the NATO Modeling & Simulation Center of Excellence (M&S COE) presented an overview of the 'Archaria' Urban Model that was developed for the Urbanization project. This model provided a key tool for the participants in the wargame to visualize the urban system. LTC PALOMBI, with SME support from FABARIS Company, provided an overview of the model and gave a live demonstration of the model. This model is available for use upon request by NATO and Alliance members.
f. Mr. Bas KEIJSER (TNO Netherlands) provided an overview of the 'Marvel' Model. The model was utilized during the past experiments as well as the concept validation wargame to demonstrate the first, second and third-order impacts of decisions. He provided an overview of the model and a demonstration of how it was used to support the wargaming process and how it could be used to assist in planning.

4. **Day 2 Overview and Results**. The primary goal of Day 2 was to review the capability requirements (CR) identified in the concept in more detail, to explore their S&T implications and to determine how current STO research supported the CRs. LTC BODNAR provided an overview of the ACT Transformation Network Portal (TRANSNET), an unclassified SharePoint platform where all of the studies, the concept and experiment/ wargame design documents are available. Following that, Prof. Maurus TACKE, STB OCUE Theme Mentor and LTC Tim POVICH, the SAS Panel Executive, went through the CRs identified in the concept, discussed with the participants any implications for the S&T community and looked at what activities from the Program of Work (POW) supported the CRs. LTC POVICH led the group through a detailed look at the Material CRs and some of the Training and Command and Control CRs. There were a number of key comments that were presented by the S&T participants to clarify as well as demonstrate the S&T needs in the different areas. LTC POVICH also highlighted the current activities from the POW that could contribute to the CRs. Key comments and discussion are contained in Annex C, *Urban Capabilities Crosswalk,* categorized by the individual capability requirements. The day ended with a brief discussion of the way ahead both in concept development and for the S&T community. LTC BODNAR discussed the way forward to support the Operating and Functional Concepts that would assist in the implementation of the Capstone Concept. The first functional concept will be a multi-domain operations in an urban environment operating concept.

   During the Day 2 discussion, participants identified several key S&T insights:
   a. **Persistent ISR/C4ISR and Persistent Flexible C2**. There was significant discussion of the first two material CRs discussed. Many nations are exploring the use of Autonomous systems and Artificial Intelligence and Machine learning in the collection and analysis of data and this has direct impacts in the urban enviroment. Participants identified numerous challenges that were not necessarily specific to the urban environments (i.e. data overload, data capture and processing) but the high volume of data that results from the city system presents special challenges for S&T and needs to be explored. In both of these areas, the challenge of cognitive

overload for soldiers in the urban environments was recommended as a potential topic for STO research.

b. **Engaging the City as a System**. Future forces will need to be able to leverage technologies to tap into the city system to gain information to assist in operational decisions to avoid tactical engagements. Some of the technologies that allow you to do this are commercial technologies and should be explored further. Exploitation of the "Internet of Things" is key in current and future urban environments.

c. **Understanding the Urban Challenges**. The implications of operating in urban terrain are significant. The multidimensional nature of a city and the urban terrain features provide constraints on the use of many technologies. Scientists need to understand the unique challenges posed by operating in a city (such as Counter UAS in urban environments) to help develop or modify the technologies to operate in the urban environment.

d. **Urban Technology Roadmap to 2035**. The point was raised that many of the CRs identified in the concept could be fulfilled within five years with existing/developing technologies and that maybe the concept is not looking out far enough in time. The response from the concept development team was that the CRs in the Capstone Concept are for NATO and even if individual nations attain them in the short term, they will need to be integrated for effective use in a coalition environment. Therefore, a technological roadmap would be beneficial at the NATO level to bridge the gap between now and 2035. By looking out to 2035 and developing an intermediate roadmap, it would provide more visibility to NATO nations and help pave the way for how we will attain these capabilities in 2035. The Capstone Concept is a first step towards developing these capabilities but integration with the S&T community is needed to help get there.

5. **Future Steps**.

a. **Further S&T review of Urban capability requirements.** Through the workshop, participants identified a significant amount of current research in the STO that supports the CRs and would be beneficial to provide to capability developers. The capability requirements could also provide STO research teams with ways to motivate/expand their research and provide additional challenges in development of the science and technology. The STO Level 2 Panels and Group workshop participants are asked to provide feedback to their individual Panels/Group. The Panels/Group are also asked to review key information reference the capability requirements in Annex C in order to identify possible areas of research to support the capability development.

b. **S&T Support of Future Concept Development**. One central theme that came out of the Day 1 discussion was the necessity of integrating the S&T Community into the concept development process. The concept development team highlighted the contributions from the S&T community into the wargames and experiments as a major success. It is highly encouraged that the S&T community remain connected to future concept development efforts within ACT. Future opportunities identified could be:

   i. S&T involvement in future urban exercises for experiment/demonstration opportunities for new technologies to demonstrate current and emerging technologies to operators.

   ii. Participation in the development of future functional and operating concepts that support the Capstone Concept. The first functional concept will be a Multi-domain Operations in a City which is in its initial development.

c. **Operator-Scientist Feedback Loops**. The STB OCUE Mentor identified the lack of venues to bring together operators and scientists to share their knowledge of both the technologies and the operational problems as a major challenge. Several members from the concept

development team highlighted the value of the wargames they conducted in bringing together scientists and operators to explore new technologies and get practical feedback on operational needs. Wargames with scientists and operators in an urban scenario helps to educate soldiers on the art of the possible and scientists on the needs of the soldiers. Previous SAS activities (SAS-062 on *The Impact of Potentially Disruptive Technologies* and SAS-082 on *Disruptive Technology Assessment Game – Evolution and Validation* and *SAS-086 The Concept Development Assessment Game*) have looked at this and developed methodologies to facilitate this interaction. This type of wargaming is currently being done effectively within the The Technical Cooperation Program (TTCP) Complex Urban Environments initiative as well as in NATO and NATO Nations, however implementing this more within the STO framework should be explored to increase operator-scientist interaction, perhaps taking advantage of wargaming community created by SAS-139.

d. **Educating Scientists and Operators on Urban Complexities.** Future urban environments contain special challenges that will shape new scientific research and the development of new technologies. Many ongoing research activities have applications within urban environments. For example, counter-UAS has different requirements in Urban Environments because of line-of-sight challenges and the density of non-combatants. The S&T community would benefit from understanding these unique challenges and gaining a better understanding of urban complexities. The STO currently has a technical course on urban complexities planned for June 2020 which should help assist in this area.

e. **Urban Technologies Roadmap.** A good first step may be to get the current list of STO activities on a roadmap out to 2035 and to discuss which steps might be taken first that could lead to both short-term and long-term improvements. This process has not started and had previously not received national support within the STO but it still might be a common goal of STO, ACT and the nations.

6. **Conclusions**. The workshop highlighted the need for NATO to develop the capabilities to operate in an urban environment and the necessity of integrating the Science and Technology community into this process. Although small in scale, it provided a first step to discuss these ideas and better inform the S&T community of the requirements. A lot of information was presented that chould be explored more within the STO Panels and Group to help inform future research and development. Which technologies are mature enough and feasible to move forward to developing capabilities in these areas and how to demonstrate the technical capabilities to the leadership to help them to see the benefits in the technology are two open questions that the S&T community can help address.

LTC Timothy Povich STO SAS Panel Executive	LtCol Jozsef Bodnar Staff Officer ACT SPP CNDV	Ms. Sue Collins Senior OR Analyst ACT CDD AOA Branch	Prof. Maurus Tacke STB, OCUE Mentor

Annex A: Participants List
Annex B: Workshop Agenda
Annex C: Urban Capstone Capability Requirements and STO Program of Work Crosswalk
Annex D: Capability Cards

Title	Last Name	First Name	Nationality	Company	Email	Representation
Mr	ROBSON	David	GBR	NSC	david.robson@nsc.co.uk	ACT
Mr	BERRY	Daniel	USA	Allied Command Transformation	daniel.berry@act.nato.int	ACT
LTC	BODNAR	Jozsef	HUN	ACT	Jozsef.Bodnar@act.nato.int	ACT
Mr	PENDLETON	Gordon	GBR	Cordillera Applications Group	gp@cordillera-apps.com	ACT (DRDC)
Mr	LOHSE	Ronald	USA	Joint Warfare Centre	ronald.lohse@jwc.nato.int	ACT (JWC)
Ms.	TAJUELO	BEATRIZ	ESP	Technology and Security Developments S.	btajuelo@tsdinternational.com	Industry
Dr.	SHEARER	Allan	USA	The University of Texas at Austin	ashearer@austin.utexas.edu	Presenter
LTC	PALOMBI	Luca	ITA	NATO Modelling&Simulation Centre of Excellence	mscoe.ms07@smd.difesa.it	Presenter
MSc	KEIJSER	Bas	NLD	TNO	bas.keijser@tno.nl	Presenter
COL (MC)	MAYER	Dominique	DEU	Bundeswehr Medical Academy	dominiquemayer@bundeswehr.org	STO (HFM)
Dr.	GOODMAN	Len	CAN	Defence R&D Canada	len.goodman@drdc-rddc.gc.ca	STO (HFM)
Dr.-Ing.	WUNDER	Michael	DEU	Fraunhofer	michael.wunder@fkie.fraunhofer.de	STO (IST)
mr	BAKER	Simon	GBR	Hampshire	spbaker@dstl.gov.uk	STO (IST)
Mr.	YU	Leigh	USA	US Dept of Defense	leigh.g.yu.civ@mail.mil	STO (NMSG)
OF4	POVICH	Timothy	USA	NATO STO CSO	timothy.povich@cso.nato.int	STO (SAS)
Mr.	DAVIS	Austin	USA	US Army ERDC	austin.v.davis@erdc.dren.mil	STO (SAS)
Dr	DAVIS	Bert	USA	Engineer Research Development Centre	bert.davis@erdc.dren.mil	STO (SAS)
Mr.	VELDHUIS	Guido	NLD	TNO	guido.veldhuis@tno.nl	STO (SAS)
Professor Dr.	RIZZO	Gabriele	ITA	Leonardo	gabriele.rizzo@leonardocompany.com	STO (SAS)
Dr. rer. nat.	EISELE	Christian	DEU	Fraunhofer IOSB	christian.eisele@iosb.fraunhofer.de	STO (SCI)
Professor	HENSHAW	Michael	GBR	Loughborough University	m.j.d.henshaw@lboro.ac.uk	STO (SCI)
Dr	SCHLEIJPEN	Ric	NLD	TNO	ric.schleijpen@tno.nl	STO (SCI)
Dr	RIAL	Fernando	ESP	Fraunhofer FHR	fernando.rial@fhr.fraunhofer.de	STO (SET)
Mr.	TACKE	Maurus	DEU	Fraunhofer IOSB	maurus.tacke@iosb.fraunhofer.de	STO (STB)
Mr.	LYLE	Stuart	GBR	Dstl	SDLYLE@dstl.gov.uk	STO(SAS)

Time (EST-US)	Day-1. Thursday 23 MAY	Day-2. Friday 24 MAY
08:00-08:15	Opening remarks and introduction of participants (Colonel Stephan Pillmeier, SACT SPP CNDV Branch Head , LTC Jozsef 'Joe' Bodnar, SACT SPP CNDV)	Discussion of the capability requirements and implications and the general impacts on the STO Community of Interest (Prof Maurus Tacke, LTC Tim Povich)
08:15-09:00	Background – Overview of the development and history of the concept (LTC Bodnar)	
09:00-10:15	The Characteristics of the (Future) Urban Environment: Complexities of Urban Environments/ Smart Cities (Prof Allan Shearer, University of Texas, Austin) Capstone Concept Deep Dive: Capstone Concept Central Ideas and Findings; (LTC Bodnar)	Discussion of Possible impacts for S&T in representative Panel/Group Areas and Ongoing Research that could address the Capability Requirements (Prof Maurus Tacke, LTC Tim Povich)
10:15-10:30	Coffee Break	
10:30-11:15	The Use of Wargaming to Identify Capabilities and Validate Concepts + Identifying Needed Capabilities and the use of Capability cards (Intro and Expert talk Ms Sue Collins, NIC, SACT CAPDEV Section Head, Solutions Analysis Branch)	Discussion on future concepts – including military/ACT and S&T stand points; Recommendations (Joint ACT and CSO/STO Led) Cross-talk: all ACT and CSO, invited guests/speakers
11:15-12:00	Modelling & Simulation as supporting 'tool'/ roll in Capability Development Archaria model: LTC Luca Palombi (M&S COE) MARVEL model: Mr Keijser Bas (TNO, NLD)	

Capabilities	Activities							
	AVT	HFM	IST	NMSG	SAS	SCI	SET	Workshop Key Remarks
Enhanced, persistent, autonomous, and interoperable ISR and C4ISR systems, including space-based. To include signature analysis and predictive analytics, and able to conduct wide-area surveillance of the many city layers within a large urban littoral area (e.g. sub ground and water, building interiors, as well as super-surface).			1. Mission-Oriented Research for AI and Big Data for Military Decision Making (IST-173 RST) 2. Federated Interoperability of Military C2 and IoT Systems (IST-176)				1. Machine Learning for Wide Area Surveillance (SET-278/RTG); 2. Interoperability & Networking of Disparate Sensors and Platforms for ISR Applications (SET-256/RTG); 3. Swarms Systems for Intelligence Surveillance & Reconnaissance (SET-263/RTG)	1. The UK is developing networks of UAS to conduct persistent ISR below the rooftop level. Also examining how to use this network for rebroadcast for assured communications in urban terrain. 2. The UK is also looking at a system to process ISR data feeds and then disseminate to troops. Program is called SAPIENT and was used in a tech demonstration in Quebec last year. There are some open source reports on this. 3. UK is also developing a system to provide situational awareness for vehicles in the urban canyon. It fuses the sensors on the platform and identifies real or potential targets. 4. Autonomous Systems (STRATUS) for ISR and Communications in Urban Environments (a 5-Eyes Initiative) has an ongoing technology demonstration and next one will take place in New York. 5. Autonomy is being looked at to support ISR using AI and Machine learning to process the inputs from sensors and get them back to the soldiers. 6. USA Army S&T is looking at 6 Modernization Priorities and autonmous ISR is spread across all of the priorities. 7. A USA initiative, Digital Soldier Squad, is an effort to integrate sensor feeds for targeting, tracking, handoff, etc, and utilizing AI/ML to do this. Getting Training Data Sets in these areas is the challenge. 8. How one distributes computing in complex environments to be able to leverage all of the data and how you facilitate passing the key information needed from the different points of view on the battlefield is a major technology challenge. 9. There also need to be efforts looking outside of organic resources to capture the information. For example, ARM (the chip maker) estimates that by 2035 there will be over 1 trillion connected devices on the Internet of Things; self driving cars are expected to generate 4,000 gigabytes per day. We need to look at ways to plug into the city systems prior to entering the city and how do we leverage this information. 10. There are loads of data available in the city, the challenge is enabling/distributing/processing the data. We need to leverage the civilian information but how to access, translate and make sense/use of the information and how to translate it into actionable intelligence is a major challenge. 11. We need to look at 2035 and the seamless integration with the land component of the communication (GC) - integration with the existing civilian capabilities
Persistent, flexible C2 that makes use of AI for routine functions. AI and human-machine interfaces could support commanders for routine coordination functions, and assist with decision-making and data analysis. The C2 HQ needs the ability to operate remotely (e.g., on a sea-base) and deploy into the city once the threat has reduced.		1. Meaningful Human Control of AI-based Systems: Key Characteristics, Influencing Factors and Design Considerations (HFM-322)	1. Mission-Oriented Research for AI and Big Data for Military Decision Making (IST-173 RST) 2. Adaptive Information Processing and Distribution to Support Command and Control (IST-168-RTG) 3. Efficient Group and Information Centric Communications in Mobile Military Heterogeneous Networks (IST-161-RTG)	1. Operationalization of Standardized C2-Simulation Interoperability (MSG-145) 2. Data Farming Services (DFS) for Analysis and Simulation-Based Decision Support (MSG-155)	1. Agile, Multi-Domain C2 of Socio-Technical Organizations in Complex Endeavors (SAS-143 RTG)			1. Before entering into combat operations, the ability to access the full range of city systems in the planning stage will allow you to increase your Intelligence Preparation of the Battlefield (IPB), ISR and C2 processes. It will also allow you the option of a comprehensive approach rather than non-kinetic approach. All of these rely on accessing and processing information from the city system. 2. C2 needs to focus on not only the tactical level but also the operational level, cities have a lot going on in them so we need to be able to tap into the city system to gather information to enable C2, we have to look at it in a comprehensive approach. The technology must be used to support all levels, see how the city works to help facilitate how we do this. 3. A major challenge in the urban environment is cognitive overload from the significant amount of information to soldiers and leaders. This needs to be an area of focus.
Multi-dimensional forces/target location reference system								1. Multi-dimensional forces: covers the fact that forces operate in many dimensions, not just 3 but more like 9 - subsurface, supersurface (tops of buildings), inside the buildings etc. how do we locate or target them when targeting systems use 2-D map location coordinates system? Also multi-dimensional, wide range of operations (policing, crowd control etc. Also joint (land / sea / air etc) 2. UK is struggling with the Multi-dimsional aspect of the urban environment - there are no easy solutions (aviation flying in, through, and land on buildings); understanding the impacts of tall building on air flow (UK is looking)
Enhanced SIGINT technologies; improved information management systems and cyberspace capability to collect and process publicly available information and open source data to better understand populations both within and beyond the theatre of operations.			1. Social Media Exploitation for Operations in the Information Environment (IST-177 RTG)					
Enhanced Information Operations Capability to be able to effectively understand, engage and interact with very large city populations. This capability must be able to keep up with the tempo and amount of available information. Data analytics / Modelling and Simulation capability to rapidly model and analyse city data		1. Digital and Social Media Assessment for Effective Communication and Cyber Diplomacy (HFM-293)	1. Social Media Exploitation for Operations in the Information Environment (IST-177 RTG) 2. Exploitation of Cyber Space for Intelligence (IST-159 RTG) 3. Data Hiding in Information Warfare Operations (IST-ET-106) 4. Federated Interoperability of Military C2 and IoT Systems (IST-176)	1. Dynamic Synthetic Environments for Distributed Simulation (MSG-156) 2. M&S Support for Crisis and Disaster Management Processes and Climate Change Implications (MSG-147) 3. Reference Architecture for Human Behaviour Modelling in Military Training Applications (MSG-127)				1. An Information operations capability is key in cities: there must be a lot of this in the civilian world - how to engage and interact with large populations is key - both how to do this from an ID standpoint and the technology to support it. 2. There is a need for autonomy in information operations, with the amount of information coming form the city systems it is difficult for a person to absorb, analyse and react to the information gathered in a timely manner and there needs to be some algorithmic way of doing this.
Unmanned aerial systems providing a vertical aspect for small unit manoeuvre for friendly forces, resupply methods suited for the urban environ ment (e.g., Persistent Autonomous Sustainment from the Air, a Vertical lift and Rooftop Landing System, etc.) and means to provide enhanced medical support.	1. Low noise aero-acoustic design for turbofan powered NATO air vehicles (AVT-318 RTG) 2. Assessment and reduction of installed propellier and rotor noise from unmanned aircraft (AVT-314 RTG) 3. Unsteady Aerodynamic Response of Rigid Wings in Gust Encounters (AVT-282) 4. Rotorcraft Flight Simulation Model Fidelity Improvement and Assessment (AVT-296) 5. Risk-Based Safety Assessment of Operational Airworthiness and Certification Requirements for RPASs (AVT-278) 6. NexGen Rotorcraft Impact on Military Operations (AVT-329)	1. Development of Autonomous Medical Systems for Tactical Evacuation (HFM-ET-167)		1. Low Slow Small Threats Modelling and Simulation (MSG-154) 2. Drone Detectability: Modelling the Relevant Signature (MSG-SET-183)				
Deployable port infrastructure								
Technologies to enable military operations among dense civilian populations including precision fires, cyber fires, indirect fire systems, and scalable on-demand weapons systems and munitions capable of delivering more precise and more accurate and integrated effects.	1. Advanced Selectable Yield Unitary (SYU) Warheads (AVT-ET-338)				1. Directed Energy Weapons Concepts and Employment (SAS-140 RTG) 2. Assessment/analysis support to facilitate the introduction of NLW by addressing line of development obstacles (SAS-133 RTG)	1. Demonstration and Research of Effects of RF Directed Energy Weapons on Electronically Controlled Vehicles, Vessels and UAVs (SCI-294)	1.Remote Intelligence of Building Interiors (RIBI) (SET-ET-106)	1. There needs to be a combined effort to systematically look at these technologies that are on hand today and the best way to develop them to meet the military capability requirements. 2. TTCP Complex Urban Environments (CUE) effort is wargaming the new technologies in coordination with the Army and AF, this assists the scientists in understanding what is specifically needed from the technology to solve the operational problems. A combination of modeling and simulation and wargaming of the technologies helped look at the new technologies. (46:00)
Mobility platforms to deal with narrow routes, rubble, and overhead protection, etc. To increase flexibility, these platforms should have the ability to rapidly re-roll for different uses.	to be adressed 44th AVT PBM							
Compact, rapidly deployable and networkable electronic warfare systems.			1. Electromagnetic Environment Situational Awareness for NATO (IST-146 RTG)	1. Physics-Based Electro-Optic/Infrared Simulations – Best Practice Recommendations for Decision Support (MSG-181) 2. Drone Detectability: Modelling the Relevant Signature (MSG-SET-183)		1. UAV swarms for electronic warfare in urban environment (SCI-ET-041) 2. Evaluation of Swarm Systems for Military Application (SCI-ET-044) 3. Distributed EW Operations in the Modern Congested RF Environment (SCI-297) 4. Electronic Support (ES) Techniques Enabling Cognitive Electronic Warfare (EW) (SCI-326)		1. There are efforts utilizing Artificial Intelligence and Machine Learning to detect EM threats. The biggest challenge is that there is a lack of data for training these algorithms. 2. There are researcj efforts on the use of Swarms for detecting and jamming.
Kinetic protection and cyber resilience, the means to counter adversary anti-air capabilities, the means to manage force signature, and the means to minimize collateral damage and non-combatant casualties.	1. Hypersonic Operational Threats (AVT-ST-008)		1. Cyber Security of Military Systems (IST-151) 2. Cyber Monitoring and Detection Capability for Military Systems (IST-162) 3. Intelligent, Autonomous and Trusted Agents for Cyber Defense and Resilience (IST-152) 4. Securing Unmanned and Autonomous Vehicles for Mission Assurance (IST-164)		1. Gamification of Cyber Defence/Resilience (SAS-129 RTG)	1. Distributed EW Operations in the Modern Congested RF Environment (SCI-297)		
Transportable jammers for imagery systems and **encryption for communication systems** to counter adversary actions.								1. SET work in dazzling lases may be a direct application into jamming cameras and imagery systems in urban environments, a key capability for counter adversary actions.
A multi-mode system capable of detecting, identifying and engaging Unmanned Aerial Vehicles (UAVs), suitable for destroying small, low altitude and low speed UAVs and loiter munitions. Means to rapidly fortify and defend critical infrastructure and key NATO and host nation installations within an urban environment, to include hardening against kinetic attack, electronic attack including electro-magnetic pulse (EMP), cyber-attack, chemical attack, industrial accidents, biological attack, and weather effects				1. Low Slow Small Threats Modelling and Simulation (MSG-154) 2. Drone Detectability: Modelling the Relevant Signature (MSG-SET-183) 3. Physics-Based Electro-Optic/Infrared Simulations – Best Practice Recommendations for Decision Support (MSG-181)	1. Directed Energy Weapons Concepts and Employment (SAS-140 RTG) 2. Assessment/analysis support to facilitate the introduction of NLW by addressing line of development obstacles (SAS-133 RTG)	1. Defeat of Low Slow and Small (LSS) Air Threats (SCI-301) 2. Distributed EW Operations in the Modern Congested RF Environment (SCI-297)	1. Multi-functional EO/IR sensors for counter-surveillance (SET-266/RTG) 2. Assessment of EO/IR technologies for detection of small UAVs in an urban environment (SET-260 RTG) 3. Multi-dimensional Radar Imaging (SET-250 RTG) 4. Drone Detectability: Modelling the Relevant Signature (SET-282/RSM)	1. UAV detection might be an optimum topic for NATO exercises opening some space and time to STO and other actors in sort of a contest. 2. Non-lethal efforts are ongoing in experimenting with counter-UAS - recent demonstration NATO Non-lethal technologies exercises. 3. NATO Emerging Security Challenges Division is currently exploring a framework to develop TTPs and guidance for C-UAS. 4. Kinetic engagement is not always an option. Clutter and chaos creates detection challenges as well as hinders the ability to distinguish between Civilian and Enemy UAS. The nature of the urban environment creates other issues. 5. One example is in Africa where medical delivery drones are creating challenges at current NATO bases. 6. Unmanned AITM (IFF and Counter) – Identify Friend or Foe is key to success. 7. Protection against Autonomy is also a relevant issue that needs to be looked at.
Assured global communications to facilitate real-time reach-back and enable the chain of command to execute C2. Advances in automation and artificial intelligence (AI) may allow allocation of routine battlespace coordination functions to a human-machine interface, with commanders and staffs remaining in the loop in an oversight role.			1. Electromagnetic Environment Situational Awareness for NATO (IST-146-RTG) 2. Communication in Contested EW Environment (IST-ET-108)	1. Operationalization of Standardized C2-Simulation Interoperability (MSG-145) 2.Data Farming Services (DFS) for Analysis and Simulation-Based Decision Support (MSG-155)		1. Collaborative Space Domain Awareness Data Collection and Fusion Experiment (SCI-311) 2. Autonomy in Communications-Limited Environments (SCI-288)	1. Multifunction RF Systems (SET-ET-114)	
Distributed mesh networking for tactical communications.			1. NATO Core services profiling for Hybrid tactical networks (IST-150-RTG)				1. Interoperability & Networking of Disparate Sensors and Platforms for ISR Applications (SET-256/RTG);	
Access to **space-based capabilities** such as GPS and ISR services to access **space-based data**, enhancing decision-making down to the individual level.						1. Collaborative Space Domain Awareness Data Collection and Fusion Experiment (SCI-311)	1. Space-based SAR and Big Data Technologies to support NATO Operations (SET-279); 2. Cooperative Navigation in GNSS Degraded and Denied Environments (SET-229)	

Capabilities	AVT	HFM	IST	NMSG	SAS	SCI	SET	Workshop Key Remarks
Access to **biometric technology** for target enrolment, human network and identity intelligence analysis.					1. Analysis of Factors involved in Interalliance Biometric Sharing (SAS-135)			1. Biometrics have been in use by USA Army for some time in Middle East. Their success depends upon if the bad guys have been enrolled and how effectively the large data bases are linked together through all of the cooperating nations and Interpol which is a data sharing problem. Problems with security and privacy have become a huge issue in this area in recent years. 2. What excercises will be utilizing biometrics in the future?
Multi-dimensional orientation systems for precision targeting, intelligence, communication and manoeuvre.	1. Standardization Recommendation (STANREC) Development for Next-Generation NATO Reference Mobility Model (NRMM) (AVT-327) 2. Assessment Methods and Tools for Mobility of Autonomous Military Ground Systems(AVT-ET-134)						1. Multidimensional Radar Imaging and ATR (SET-273)	
Urban operations may require a flatter C2 structure with decision authority residing at lower levels. It should put in place the necessary safeguards to ensure that such decision authority continues to implement the commanders intent to avoid or at least minimise harm to civilians.			1. Capability Concept Demonstrator for Interoperability within Unmanned Ground Systems and C2 (IST-149-RTG)	1. Operationalization of Standardized C2-Simulation Interoperability (MSG-145)	1. Agile, Multi-Domain C2 of Socio-Technical Organizations in Complex Endeavors (SAS-143 RTG)			1. The more we develop augmented reality systems into Soldiers (i.e. helmet integrated systems), the more we have to look at what information is transferring key information to individual soldiers and how the soldiers transfer the information back to C2 nodes. 2. The flatter C2 Structure is a mix of new technologies but there also need to have changes in the culture in doctrine of how units operate. There is a huge need for interoperability and joint experimentation and exercises. The technologies have to be tied to doctrinal changes -- how do we best to this? The doctrine writers may be a little behind the power curve because it does not integrate the new technologies and the impacts they have on the doctrine and operations.
Training should include small-unit leaders to improve their ability to carry authority and decision-making, and operate independently in a dispersed manner. Virtual reality could be employed to simulate non-physical aspects of the environment and stress the intellect capacity of the participants.				1. Urban Combat Advanced Training Technology - Live Simulation Standards (UCATT-LSS) (MSG-140 RTG) 2. Urban Combat Advanced Training Technology Live Simulation Standards (UCATT-LSS) – 2 (MSG-174 RTG) 3. Simulation for Training and Operation Group-Land (STOG-L) (MSG-146 RTG) 4. Dynamic Synthetic Environments for Distributed Simulation (MSG-156 RTG) 5. Operational Requirements for Training Interoperability (MSG-158 RTG)				1. Much work goes on with respect to Augmented Reality, integrating key information in a collaborative way onto the see-through displays under development. 2. The USA Army has stated a need for seamless transition from VR training to AR rehearsal to AR-enhanced operations, precidely to support flatter more automated dispersed formations. 3. Advances in non-obtrusive soldier activity tracking technologies (GPS, actigraphy) may be a huge advantage in urban ops training. This enables an understanding of soldier movements, energy expenditure, fatigue, etc 4. The USA is exploring how to integrate training with the Mission Command system itself, involving all phases of planning through OPS at a tactical level. 5. HILDAGO and Hawaiin are two technologies that are very good. They are still oriented to the lab or field research setting, but could be applied to training - as the technologies improve. The missing piece still however, is data fusion and developing simple clear methods to inform a unit commander on overall soldier health status - not providing too much detailed bio/performance info. Commanders want 'green" "amber", "red light" status. i.e., solider(s) are good to go, or in a stress mode, or not good to continue. 6. There is ongoing work on identifying all of the different national urban training centers and trying to link them together to create combined centers (the work is being done in coordination with the Modern Warfare Institute at the USA Military Academy). 7. The UCATT system is being used significantly but there is need to integrate ISR, EW, Cyber, etc, to help get the full impacts.
NATO military personnel deployed in urban areas will require **experience, skills and knowledge** to understand and effectively use the new types of sophisticated technologies that are expected to have a significant impact on urban military operations. Nations should review the experience and training of those who may deploy to an urban area.					1. Basics Of Complex Modern Urban Functions And Characteristics (SAS-149 RTG)			1. The new technical course (SAS-149) will help educate operators and scientists to help them understand the intricacies of the urban systems. 2. Urban Operations Wargames looking at technology can help build this experience. It does not need to be a full blown wargame but can utilize an urban scenario to explore the value of technologies with operators and soldies in a seminar wargame format.
Countering Human Perfomance issues in Urban Environments		1. Arctic Medicine and Human Performce (RTC 318)						1. Urban zones could be austre environments - as challening to soldiers as desert, tropical, arctic. Both physiologically , emotionally and cognitively. When things go bad, it is an austere environment. 2. If critical infrastructure is damaged, soldiers and populations suffer: no heat in winter; no AC and cooling in summer. Heat exhaustion and illness could be widespread. 3. CBRN mass casualties pose a huge challenge in the built up urban environments. 4. Contamination of water supplies and scarcity of food (soldiers and civil. populations) as well as air - borne contamination attacks. 5. All health records of military and civilian population could be hacked - leaving vulnerabilies. 6. Mass ballistic medical treatment is a challenge. Shortages of medical supplies, blood banks (refrigeration needs) are different aspects of this challenge. S&T in these areas is needed.

Supreme
Allied
Commander
Transformation

Urban Matrix Wargame 2018
Blue Future Capability Cards

Future Capability Card Index

#	Name
1	Persistent C2 - Remote and Deployable
2	Enhanced Information Operations Capability
3	Persistent Autonomous ISR
4	Autonomous, Persistent and Non-Contiguous Sustainment
5	Vertical Lift and Rooftop Landing Capability
6	Multi-Role Urban Vehicles
7	Variable Lethality Weapons Systems
8	Electronic Warfare Superiority
9	Enhanced Policing Capability
10	Rapid and Light Force Protection
11	Countering Unmanned Systems and Platforms
12	Advanced Cyber Capability
13	Access to Space Based Capabilities

Persistent C2
Remote and Deployable

What is it?

A reliable and flexible C2 system for Urban Areas. It can be operated and controlled remotely (e.g. from a sea-base) but also has resilient infrastructure in theatre through network redundancy. It enables constant connectivity throughout the network down to squad / section level and makes use of Artificial Intelligence (AI) for automatically coordinating routine functions.

Why do you need it?

In Urban areas, traditional communications are unreliable due to scattering effects and signal strength reduction. The communications network ashore is 'unplugged' from the city communications system and is therefore more resilient. AI is used to match the tempo and complexity demanded by the urban environment.

Establishing a remote C2 HQ allows for a more safe and secure C2 structure, and reduces the footprint ashore. It can be used in the pre-conflict phase to gather information remotely.

How does it work?

A remote C2 HQ is established outside of the city (either on a sea-base or in a different region). The C2 HQ has the ability to deploy into the city once the threat has reduced. Technology allows for constant connectivity into theatre and Artificial Intelligence is used to automatically coordinate and allocate battlespace.

In theatre, communication channels are ad-hoc and use a combination of radio relay systems (UAVs) and non-grid communications (using mesh networks or aerostats – air balloons) to ensure continuity of communications for forces operating in urban spaces.

Any planning considerations?

In theatre the C2 system is still vulnerable, either to enemy activity (e.g. electronic warfare) or coordination and endurance challenges. Troops should also be capable of fighting without access to C2.

A sea-based C2 HQ requires sustainment and protection and will likely face A2AD threat.

Any shut-down of existing city communications systems will cause widespread disruption.

Enhanced Information Operations Capability

What is it?

The ability to more effectively understand, engage and interact with the city population through social media and other internet communication channels, exploiting these communication channels to achieve operational advantage and counter adversary messaging. Artificial Intelligence (AI) is used to quickly assimilate and analyse relevant information.

Why do you need it?

In 2035 social media networks are the principle means of communication between individuals and groups. The ability to engage directly with these actors through these networks for the purposes of understanding, influence and intelligence collection will be a standing requirement throughout all phases of the operation. AI is necessary to be able to keep up with the tempo and sheer amount of information posted daily in social media.

How does it work?

Enhanced Information Engagement Activities consists of three lines of operation: A virtual and trusted presence with the target audience across the full spectrum of social media; the ability to conduct influence operations through social media channels in pursuit of the mission and the capability to use AI to automatically obtain a level of insight and understanding about the urban environment and the actors within it in real-time.

Any planning considerations?

ROE restrictions may prevent the full exploitation of social media networks.

Distinguishing truth from fake news may be challenging, and social media may not show the full picture.

Information about NATO can be easily manipulated and turned negative; speed of dissemination may restrict the ability to effectively react to adversary counter-messaging.

Persistent Autonomous ISR

What is it?

The use of Unmanned Autonomous Systems (UAxS) to enable a force to conduct wide-area continuous surveillance of a large urban littoral area. The UAxS are capable of executing different ISR tasks and different systems can respectively operate above and underwater, in the air and on the ground. Intelligence gathering at a distance is possible with loiter times in excess of 24 hours. The systems collect detailed intelligence in real time and feed back to a common operating picture (COP), displaying the complexity of the environment across all layers of interest.

Why do you need it?

The complexity of the urban environment including the many layers (subsurface, supersurface etc) means that traditional surveillance methods are ineffective. The use of UAxS means soldiers are less exposed to threats, and coverage is much wider. UAxS are well-suited for expeditionary intelligence gathering purposes, especially for long term operations in the littoral.

How does it work?

UAxS can be deployed in versatile swarms, the platforms are independent but work cooperatively sharing information across the network. They are able to provide automatic pattern recognition (e.g. behavior of large groups) to determine their intent, human network analysis, the use of artificial intelligence combined with facial recognition means the system can automatically detect intelligence issues of interest. They can detect movement and threats within buildings, beneath ground and beneath the water surface. Maritime systems can be deployed from a combat ship via torpedo tube; ground systems are lightweight, rugged and throwable from a driving vehicle.

Any planning considerations?

The systems are vulnerable to jamming and cyber-attack. The systems are cheap and expendable but NATO has a limited number. There proliferation of autonomous ground, air and sea vehicles in 2035 means an effective battlespace control and communications plan is required. UAxS will also be likely available to the adversary, meaning counter-measures are required.

Autonomous, Persistent and Non-Contiguous Sustainment

What is it?

A sustainment system that delivers supplies (Water, POL, food and ammunition) just-on-time and just-on-target from a sea-base direct to troops via Unmanned Autonomous Systems (UAxS) and shallow draft sea lift, negating the need for warehouses on-shore or establishing main supply routes. Supplies can be delivered to different locations directly and rapidly and can be ordered either on demand or automatically when supplies are low. This increases the flexibility of the operational plan and creates resiliency within the logistics system.

Why do you need it?

The urban environment in 2035 poses severe challenges for sustainment, with increased crowds and clutter, constricted sea approaches, congested land approaches, crowded airspace and lack of open space. Traditional sustainment plans which rely on predictable supply routes and warehousing of stocks are not effective. The city cannot be relied on a single source of sustainment as it is already under severe stress.

How does it work?

A large number of small unmanned air assets combined with shallow draft sealift can enter the cluttered urban space and still maintain freedom of movement, using laser detection and ranging technology to operate in poor visibility or at night. They deliver supplies to troops –either on demand or using artificial intelligence to program a resupply schedule. Sheer weight of unit numbers overwhelms an opposing force's ability to interdict. In addition, additive manufacturing will allow the mass-production of parts in theatre (e.g. on a seabase), limiting the need for large stock supplies.

Any planning considerations?

The sustainment process will be severely constrained without a comprehensive airspace control plan. The system is vulnerable to cyber-attack. Restrictions concerning load capacity, range etc. will depend on the platform and threat level. The control station will be a high-profile target and will need to be protected.

5

Vertical Lift and Rooftop Landing Capability

What is it?

A Vertical Lift System that can land in extremely constricted spaces including rooftops, used to transport personnel and supplies. They allow a squad to enter a building from an unexpected entry point (e.g. the 27th floor window).

Specialist adaptations can also be used for MEDEVAC, delivering medical assistance on board including placing casualties into stasis to increase the 'golden hour'

How does it work?

These air platforms are of variable sizes enabling a range of personnel or equipment to be carried. They can land and manoeuvre in extremely constricted spaces, and even enter underground. They are flown autonomously negating the need for pilots and reducing pilot error in difficult conditions.

Why do you need it?

The urban environment has limited spaces for landing and manoeuvre. This capability provides increased options for moving personnel, logistics and MEDEVAC.

Any planning considerations?

Although armored and lightly weaponized, force protection might be necessary in heavily contested areas.

They are operated autonomously but loading a wounded soldier will require human assistance.

5

Multi-Role Urban Vehicles

What is it?

A multi role fighting vehicle able to simultaneously destroy enemy forces, clear routes, and transport supplies which will increase commanders' flexibility and ability to accomplish assigned missions.

Why do you need it?

The urban environment demands a flexible and agile response due to the myriad of situations a force will face in a city. Simultaneously executed tasks through one platform vehicle will reduce the number of combat and combat support vehicles necessary to operate in an urban environment. It will increase the forces' freedom of movement in the urban environment.

How does it work?

The vehicle can be rapidly re-rolled for use. The weapons system allows for high angle of engagement and can be fitted with variable-lethality weapons that deliver a temporary immobilizing effect. The vehicle is well equipped for protection against A2AD threats. Route clearance systems work autonomously and the vehicle has the ability to detect all kinds of explosive threats while driving at least 30 mph.

Any planning considerations?

These vehicles still need to be brought ashore or airlifted in. Firing units have no dismounted capability and are reliant on other units or shared situational awareness for target designation. A multi role fighting vehicle has a reduced capability itself in each of the available capabilities. Such a vehicle is a high value target for the enemy.

Variable Lethality Weapons Systems

What is it?

Directed energy weapons that have been miniaturized and are sufficiently powerful to deliver an effect against personnel, vehicles, optics, electronic components and aircraft. The amount of directed energy can be changed to deliver a variable level of lethality – e.g. it can immobilize a vehicle without killing the people in it.

Why do you need it?

Collateral damage is of big concern in an urban environment. These variable-lethality weapons will reduce collateral damage when compared to the use of explosive projectiles. They can decrease the manpower requirement and increase flexibility through giving a wider range of options for the amount and type of firepower available.

How does it work?

The directed energy weapons use enhanced laser systems, heat beams, subsonic and ultrasonic wave technology, and visual disruption systems. They are capable of engaging air, ground, sea and space-based targets with pinpoint accuracy and at the speed of light, and vary its effects.

Any planning considerations?

They are dependent on a reliable energy supply and storage. They may have maintenance issues under high military demand. The effectiveness of a system increases when the output power of the system as well as the dwell time (time of the beam on the target) is increased.

Electronic Warfare Superiority

What is it?

The ability to decrease the adversaries' ability to use the radio frequency within urban spaces and therefore disrupt their means to communicate. They allow unimpeded use of the electronic spectrum and can be used for acquisition and defeat of electronic targets.

Why do you need it?

This capability allows you to achieve superior advantage over the adversary in electronic warfare. It gives you the ability to conduct EW down to the squad / company level, which can disrupt adversary unmanned systems or other electronic targets.

How does it work?

Compact, rapidly deployable and networkable EW packages are deployed by ground forces or unmanned ground or air platforms. Distributed packages are networked together and with a system manager capable of controlling either individual package operations or tasking a team of packages to create a desired effect.

Any planning considerations?

Larger jamming systems might require force protection and will not be as dynamically task-able as small packages pre-deployed or carried on unmanned platforms. Reactive jamming requires signal detection, classification and therefore increases response time. Hostile emissions using blue force frequencies will be difficult to detect, classify and jam.

Enhanced Policing Capability

What is it?

The ability to rapidly re-role into a more civil-oriented force capable of carrying out policing activities at the company level. Activities may include training local police, countering serious and organized crime, and improving intelligence. The aim is to improve governance and legitimacy through providing security and reassuring the population.

Why do you need it?

In an urban environment, especially during a stabilization phase, it may be more effective to provide policing using military personnel that act like police rather than forces deployed on the street

How does it work?

The stability policing force are able to temporarily replace the Indigenous Police Forces or preferably reinforce them through training and partnerships. The police capability would come with supporting unmanned systems, crime and forensic labs. They would use existing prisons or have the ability to rapidly create a fully functioning prison. The full spectrum of weaponry – from non-lethal to lethal – will be available and the force will be adequately trained and equipped.

Any planning considerations?

The deployment of these forces will require the full cooperation and agreement of the local government. The deployed force will need an internationally recognised authority to carry out policing activities

Rapid and Light Force Protection

What is it?

Rapid hardening of existing buildings as well as rapid creation of new structures in order to protect against blast, fragmentation, overpressure, thermal pulse and penetration. As forces advance through the city they will rapidly be able to set up hardened positions.

How does it work?

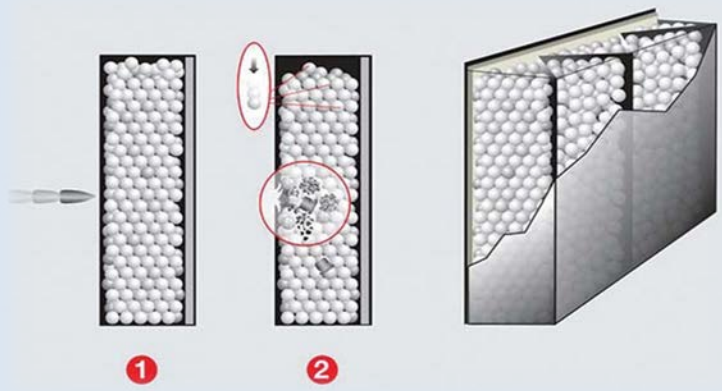
Troops have access to rapidly-deployable barriers using spray-on polymers to harden them to withstand damage. The spray-on polymers can also be used on existing buildings.

Why do you need it?

This will increase force protection and survivability of the force at small unit level. Rapid hardening systems can also prevent an adversary from occupying or traversing an area or location. Alternatives are labour/time consuming (e.g. mine fields, abatis, road cratering obstacles and anti tank ditches).

Any planning considerations?

The polymers and rapid-deployable barriers will need to be carried by ground forces reducing their ability to carry other requirements.



Countering Unmanned Systems and Platforms

What is it?

A multi-mode system capable of detecting, identifying and engaging Unmanned Aerial Vehicles (UAVs), suitable for destroying small, low altitude and low speed UAVs up to 1500m. It can defeat UAVs both through jamming and physical destruction.

Why do you need it?

The system can shield and protect Blue's own freedom of action in airspace and reduce opponent air threat up to 1500m.

How does it work?

Technologies to automatically detect, identify and destroy UAVs operating over an urban space without unacceptable risk to civil populations. The system can monitor, collect and disrupt information feeds and command-and-control links between UAVs and ground stations, including over very long distances. Each unit is capable of locating, identifying and destroying enemy drones up to fast air ground attack in its mounted role.

Any planning considerations?

A downed UAV might harm people below.

Once dismounted the counter-UAV system units are no longer able to self-protect. In an urban environment buildings can hamper the range of actions of these systems.

Advanced Cyber Capability

What is it?

A team of military-cyber experts will have the technology to manipulate cyber data streams in order to either collect intelligence, conduct surveillance, and, if ROEs permit, deliver kinetic effects that can be both lethal and non-lethal.

Why do you need it?

This capability not only provides a rich source of data for intelligence and surveillance but also can deliver effects remotely, impacting the adversaries' freedom of movement. This is all done remotely, reducing the footprint on the ground.

How does it work?

This takes advantage of the "Internet of Things" where virtually everything in the future smart city is connected to the internet, including power grid systems, vehicles and even people through wearable technologies. By tapping into the cyber data streams, the team can use artificial intelligence to construct a multi-layered representation of the urban environment that can depict the operation of its critical systems and the actions of the city Actors to gain real-time intelligence and surveillance. Taking a step further, the team can also deliver lethal and non-lethal cyber effects (e.g. disabling vehicles, shutting down electricity systems) if ROEs permit.

Any planning considerations?

Exploitation of cyber capabilities within the city will require robust ROE and the Commander retains the responsibility for tasking and coordination of effects. Delivering kinetic effects through cyber runs a high-risk of unintended consequences on the population.

Access to Space-Based Capabilities

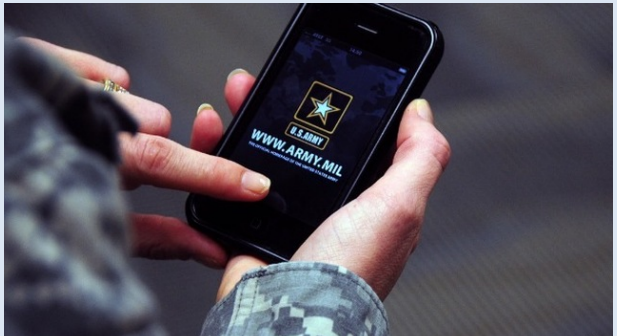
What is it?

Space is no longer used solely by sovereign states. Commercial enterprises will launch satellites and operate ISR and GPS capabilities nearly as effectively as the most capable government space programmes. Such space capabilities will be available to all end-users globally, in real-time, and accessible on personal mobile devices.

Why do you need it?

Operations will occur on a much shorter timescale – in minutes or seconds as opposed to days and hours. Commanders must decide if/how much control to give to individuals making immediate tactical decisions with potentially strategic implications.

Both NATO and its adversaries will have access to high fidelity real time GPS and ISR services. NATO has the risk of losing its tactical surprise from adversarial access to space as well as the risk of losing its own access through hostile denial.



How does it work?

Combined with autonomous strike vehicles and weapons, the capability will exist for NATO and its adversaries to both direct fires without direct personnel engagement.
Combat operations will be globally discoverable, visible and recordable in real time. This may negate the element of surprise and underwrite negative propaganda.
Public access through the media or directly to real time operational video.

Any planning considerations?

Space based GPS and ISR services and products will be available through alliance and commercial capabilities. Low cost, personal communications devices enabled by commercial terrestrial and space-based communications services will permit individual access to space based data in the field under a broad range of operational conditions. Decision superiority is informed through a network of space capabilities, internal and external to the NATO Command structure and positioned across the Alliance. Vulnerabilities to the network are significant with ground stations and data transfer capabilities critical nodes.