TEST CAPABILITY REQUIREMENTS DOCUMENT (TCRD)

FOR

Joint Urban Test Capability (JUTC)

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Michael D. Landers
Project Director
Phone: 407-384-3530
Email: michael.landers@us.army.mil
PEO STRI
Orlando, FL

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Prepared by:

Michael D. Landers Date: 23 Nov 11
Michael D. Landers
Deputy Project Director, Joint Urban Test Capability
Office of the Project Manager for Instrumentation, Targets and Threat Simulators

Reviewed by: Approved

Date: 12 Dec 11
Edward Lee
Chief, Strategy and Resource Division
Deputy Under Secretary of the Army Test and Evaluation

AF non-concurs with the additional requirements.

non-concur Date: 7 Dec 11
Carolyn Zavadil
Chief, Test Resources and Infrastructures
United States Air Force

Deborah Giordano Date: 12/13/11
Deborah Giordano
OPNAV ~~N435~~ N913
United States Navy

Approved by:

Date: 18 Jan 12
Gerald Christeson
Program Manager
Central Test and Evaluation Investment Program

Edward Lee
Chief, Strategy & Resource Division
DUSA T&E

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TCRD COORDINATION SHEET

Organization	Name
NAVAIR 5.4	Mr. Ray Solt
ATEC	Mr. Donald Timian

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EXECUTIVE SUMMARY

The majority of US military forces presently operates in an urban environment and will continue to do so in the foreseeable future. The US military has an immediate need for a robust urban environment test capability to support developmental and operational testing. Four key documents identify and successively refine the basis of need for an urban environment test capability. They are the 2006 and later the 2010 Quadrennial Defense Review Reports, an Issue Paper and a directed study. The 2006 Quadrennial Defense Review (QDR) Report identified the ability to operate in urban terrain as a critical capability requirement. This was further amplified in the 2010 QDR Report regarding rapid urbanization of littoral regions and the "capability to succeed in large-scale counterinsurgency (COIN), stability and counterterrorism (CT) operations in environments ranging from densely populated urban areas and mega-cities." In addition, the Testing in a Joint Environment Roadmap Strategic Planning Guidance for Fiscal Years (FY) 2006-2011identifies the need to develop representative, operationally relevant joint mission environments to effectively test systems in a joint context. A 2008 Issue Paper from the Test Resource Management Center (TRMC) describes the necessity for the "development and integration of an urban environment (UE) test capability" and outlines desired program enhancements.

TRMC also sponsored The Urban Environment Test Capability (UETC) Study which was co-led by the Joint Forces Command's (JFCOM) Joint Irregular Warfare Center (JIWC) and the Army Test and Evaluation Command's (ATEC) Test Technology Directorate (TTD) from August 2008 through June 2010. The UETC Study investigated and identified required urban environment test capabilities and existing test capabilities within the Department of Defense (DOD). The UETC study attempted to identify the standards to define an urban environment, surveyed existing test and training ranges to identify their current urban test capabilities, and compared the existing capabilities to the standard. The second step was to prioritize the criticality of the urban environment test capability gaps identified, and evaluate the test and training sites for their potential for hosting the implementation of test capability gap solutions.

To develop additional drivers for urban test capability development, several near-term urban Test and Evaluation (T&E) shortfalls for programs of record were also identified and vetted. The programs include the Next Generation Jammer (T&E Need IT&E 4QFY16, IOT&E 1QFY19), the Joint Allied Threat Awareness System (T&E Need IOT&E FY14), and the F/A-18 Small Diameter Bomb (SDB II Integration (FY16). For Joint Direct Attack Munition (JDAM), Tomahawk and other modern multi-mode munitions systems, an end-to-end urban T&E capability is required, including modeling and simulation (M&S) for large-scale urban T&E and live urban targets for end-game. For Joint Allied Threat Awareness System (JATAS), validated databases are required to test urban missile warning system performance. For Next Generation Jammer (NGJ), a capability is required to test blue jamming of red communications networks in an urban high-density radio frequency (RF) environment.

Advanced technologies are fielded to assist military leaders and tactical units in target identification, mission command, and combined arms and joint tactical engagements. Although Joint Service leaders continue to develop new tactics, techniques, and procedures, modify organizational structures, and increase training and testing in urban environments, existing urban facilities are inadequate for testing these technologies prior to fielding.

A realistic urban environment is required that poses operationally representative challenges to air and ground systems and Systems of Systems (SOS). While limited representations of small urban environments exist, these urban environments have deficiencies in size, complexity, realism, and control that prevent them from completely fulfilling this requirement. They are not large enough to support testing in today's joint operational environment nor are they sufficiently instrumented to measure the performance of the weapons systems in both developmental and operational testing. Therefore, development of the Joint Urban Test Capability (JUTC) is necessary to fully evaluate weapons systems' performance and military utility in a realistic operational urban environment.

The JUTC components will provide representative Live, Virtual and Constructive (LVC) urban environments, from small towns to cities of sufficient size to support military Decisive Action (formerly Full Spectrum Operations). The urban environments will include representative urban topography, population, infrastructure, and urban environmental effects in addition to integrating friendly and hostile effects for test events. JUTC will have the capability to link with other live ranges, as well as virtual and constructive simulations that provide a scalable augmented urban test capability and hardware in the loop simulation and stimulation. JUTC will provide the test infrastructure necessary to accurately capture the information needed to accurately assess performance in these complex test events. This infrastructure will include advanced data collection systems sufficient not only for weapon system performance evaluation, but the development as well as the verification, validation, and accreditation of multi-spectral urban models. These models will support a wide range of simulation and hardware-in-the-loop systems beyond JUTC and provide valuable data for advancements in the field of urban modeling and simulation such as behavioral inputs to refine existing algorithms.

Additional JUTC components provide specific LVC urban test capabilities to address known shortfalls. Live components are transportable, reconfigurable, attributable urban target structures. Virtual and Constructive components are electronic warfare (EW) urban communications generators for jamming T&E and attributed urban databases for infra-red (IR) and ultra-violet (UV) scene generators to support cost effective M&S for improved large-scale System Under Test (SUT) sensor urban testing.

TRMC directed specific SUT use cases to further define and validate JUTC requirements. These use cases are representative samples of new and emerging technologies requiring testing in an urban environment. JUTC used the following SUTs: Early Infantry Brigade Combat Team (EIBCT) SOS; Urban–Unmanned Ground Sensors (U-UGS); Tactical–Unmanned Ground Sensors (T-UGS); XM1216 Small Unmanned Ground Vehicle (SUGV); Class I Unmanned Aerial Vehicle (CL I UAV); Multi-Mission Unmanned Ground Vehicle (MM-UGV); Joint Tactical Radio System (JTRS), including the Rifleman, Manpack, and Ground Mobile Radio (GMR); Joint Air-to-Ground Missile (JAGM); and MQ-1C Warrior Extended Range Multi-Purpose (ERMP/GRAY EAGLE) Unmanned Aircraft System. Following this initial review and use case development, additional key testing shortfalls were identified in support of the F/A-18 Small Diameter Bomb (SDB) II Integration, Next Generation Jammer and Joint Allied Threat Awareness system. These test capability gaps will be met by three additional capabilities within JUTC: Weapons System Urban Test Capability (WS-UTC), Communications Jamming Urban

Test Capability (CJ-UTC), and Infrared Countermeasure (IRCM) Systems Urban Test Capability (IS-UTC). Developing urban test capabilities will enable focused development of critical technologies to support planned tests that address the specific shortfalls, while simultaneously developing a test capability modernized to address shortfalls for future tests.

The JUTC Test Capability Requirements Document (TCRD) provides the fundamental requirements which resulted in approximately 130 threshold urban requirements. The key performance parameters are summarized in Table ES-1 below. The "Ref." column identifies the section within this document for full text of the requirement. The "KPP", "Threshold" and "Objective" columns are a shorthand description of the requirement. For full text, refer to the section identified.

Table ES-1 JUTC Key Performance Parameters (KPP)

Ref.	KPP	Threshold	Objective
3.3.1	**JUTC air/ land dimensions and Army site location (KPP)**	• **Urban Area: 200m x 240m** • **Maneuver Area: 16km^2 (preferred configuration: 4km x 4km)** • **Buffer Area: 100km^2 (preferred configuration: 10km x 10km)** • **Airspace: 40,000 MSL** • **Location: White Sands Missile Range, NM**	• **Urban Area: 900m x 900m** • **Maneuver Area: 64km^2 (preferred configuration: 8km x 8km)** • **Buffer Area: 400km^2 (preferred configuration: 20km x 20km)** • **Airspace: T=O** • **Location: T=O**
3.3.2	**Urban Building Replicas (KPP)**	**Provide replicas that are a modular, reconfigurable, and transportable system capable of representing all of the requisite building types for the UTZs. In addition, the exterior walls and roof types shall have the ability to be changed to sufficiently represent the electromagnetic spectral characteristics of the designated UTZ. The following amounts of replicas are required *(refer to Appendixes B and C for a detail description of building types and UTZs)*:** • **Industrial (Dc4) building replicas (UTZ IV) - 1** • **Commercial(Dc5) building replicas (UTZ II) - 15** • **Residential (Dc3) building replicas (UTZ III) - 16** • **Apartments(Do2) building replicas (UTZ V) - 4**	**In addition to Threshold requirements, the following amount of replicas are required:** • **Industrial (Dc4) building replicas (UTZ IV) - 3** • **Commercial (Dc5) building replicas (UTZ II): T=O** • **Residential (Dc3) building replicas (UTZ III) - 32** • **Apartments (Do2) building replicas (UTZ V) - 7**
3.4.1	**Urban Radio Frequency Effects (KPP)**	**EME within the frequency band of 1MHz to 8GHz**	**EME within the frequency bands of 1MHz to 20GHz and 26GHz to 95GHz**

3.8.1	**Distributed Connectivity (KPP)**	**DREN/SDREN connectivity, OC-12**	**DREN/SDREN connectivity, OC-48**
3.9.1	**WS-UTC Scene Generator Bands (KPP)**	**IR, MMW**	**VIS, IR, MMW, SAL-band**
3.9.18	**WS-UTC Target Buildings (KPP)**	**Transportable, Reconfigurable, Attributable 1 & 2 Story**	**Transportable, Reconfigurable, Attributable 1 to 5 Stories**
3.10.1	**CJ-UTC Number of High Fidelity Signals (KPP)**	**Number of programmable, testable signals: 10**	**>20**
3.10.11	**CJ-UTC Open-air free-space directional emitters (Programmable, Testable) (KPP)**	**2**	**>5**
3.11.1	**IS-UTC Scene Generation Bands (KPP)**	**UV, MWIR**	**UV through LWIR**

1. GENERAL DESCRIPTION OF THE NEED

1.1 DESCRIPTION AND BASIS OF NEED

The 2006 and 2010 Quadrennial Reviews identified the conduct of military operations within urban terrain as an ongoing projected requirement. Military operations frequently occur in complex, dense urban settings and current military systems do not effectively operate in this environment. Evaluating the essential Joint Capability Areas (JCA) of Force Application, Command and Control, Battlespace Awareness, and Net-Centric systems require testing in an instrumented urban environment to determine the robustness of their tactical networks and sensor systems in the presence of naturally occurring urban effects (e.g., multipath, restricted line of sight (LOS)).

The Joint Urban Test Capability (JUTC) will include a set of urban test capabilities and a robust, realistic urban environment that includes representation of a live urban environment, urban effects, modeling and simulation (M&S), data collection and instrumentation, test planning and control, distributed test capability, weapons systems urban test capability, communications jamming urban test capability, and infrared countermeasures system urban test capability to support Developmental Testing (DT) and Operational Testing (OT). The urban test environment will provide the capability to create a representative worldwide urban morphology with sufficient quantity, density and orientation, and variety of building structure representations, including representative building materials.

JUTC identified several near-term urban test and evaluation (T&E) shortfalls for programs of record. The programs include the Next Generation Jammer (T&E Need IT&E 4QFY16, IOT&E 1QFY19), the Joint Allied Threat Awareness System (T&E Need IOT&E FY14), and the F/A-18 SDB II Integration (FY16). For Joint Direct Attack Munition (JDAM), Tomahawk, and other modern multi-mode munitions systems, an end-to-end urban T&E capability is required, including M&S for large-scale urban T&E and live urban targets for end-game For Joint Allied Threat Awareness System (JATAS), validated databases are required to test urban missile warning system performance. For Next Generation Jammer (NGJ), a capability is required to test blue jamming of red communications networks in an urban high-density radio frequency (RF) environment.

1.2 SYSTEMS ENGINEERING AND LIFE SPAN

JUTC has integrated industry standard systems engineering principles and practices into the development effort by conducting analyses to define the JUTC requirements, concept definition, functional definition, system architecture, system taxonomy, solid model, and physical implementation. JUTC requirements were derived from Working Integrated Product Team (WIPT) and subject matter expert (SME) input, identified System Under Test (SUT) use case requirements, Urban Terrain Building Types, 2nd Edition,[7] and the Urban Environment Test Capability (UETC) study. In addition, the Test Resource Management Center (TRMC) suggested development of SUT-specific use cases to further define and validate JUTC requirements. JUTC examined the following SUTs to develop use cases and define project requirements:

- Early Infantry Brigade Combat Team (EIBCT) System of Systems (SOS)

- Urban–Unmanned Ground Sensors (U-UGS)
- Tactical–Unmanned Ground Sensors (T-UGS)
- XM1216 Small Unmanned Ground Vehicle (SUGV)
- Class I Unmanned Aerial Vehicle (CL I UAV)
- Multi-Mission Unmanned Ground Vehicle (MM-UGV)
- Joint Tactical Radio System (JTRS) including Rifleman, Manpack, and Ground Mobile Radio (GMR)
- Joint Air-to-Ground Missile (JAGM)
- MQ-1C Warrior Extended Range Multi-Purpose (ERMP/GRAY EAGLE) Unmanned Aircraft System.

These systems provided a representative sample of the myriad technologies used across the spectrum of military systems and potentially tested at JUTC.

Following this initial use case review, test shortfalls for three major programs of record requiring urban environment T&E were subsequently identified. The programs include the Next Generation Jammer (T&E Need IT&E 4QFY16, IOT&E 1QFY19), the Joint Allied Threat Awareness System (T&E Need IOT&E FY14), and the F/A-18 SDB II Integration (FY16). By leveraging the urban-characterization information provided by the UETC study, JUTC can address the shortfalls for the Next Generation Jammer, the Small Diameter Bomb II (SDB II) and the Joint Distributed Infrared Countermeasure Ground-test System (JDIGS). Other programs that will benefit from JUTC, but do not have scheduled test dates, include other sensor, jammer and weapons programs going through upgrade cycles, such as the Joint Allied Threat Awareness System (JATAS), and aircraft such as F-35 needing integration testing against threats in urban areas.

The JUTC life span is anticipated to be at least 20 years. Evolving worldwide urban areas will shape future development as the JUTC accommodates the emerging DT/OT needs of new and emerging military systems. The JUTC SOS architecture will emphasize open architecture methodologies to enable modular development and implementation of the JUTC urban environment. The architecture will provide flexibility to permit reconfiguring JUTC to accommodate testing a range of systems in conditions representing a variety of worldwide urban environments. The JUTC test environment's modularity and flexibility will enable streamlined technology insertion on a subsystem and component level. Designated contractors will develop the JUTC subsystems in accordance with Government acquisition guidelines or leveraged from existing range capabilities. The JUTC environment shall be available to any system developer required to conduct system or subsystem DT/OT test event in an urban setting.

2. SHORTCOMINGS OF EXISTING CAPABILITIES

The Department of Defense (DOD) has no capability for realistic, reconfigurable, instrumented urban test environments, replicating the aggregate urban effects sufficient to support developmental and operational testing within a multi-dimensional battlefield; and capable of supporting up to a battalion sized force structure and joint operations. DOD urban facilities are available for Military Department-specific small-unit training, but are not adequate for test and evaluation (T&E) in a joint urban environment across Decisive Action (formerly Full Spectrum Operations). These facilities add realism to training exercises, providing urban-like maneuver constraints, but they are inadequate for T&E, lacking test instrumentation and the holistic effects

of construction, clutter, electromagnetic (EM) masking, electro-optic noise, and day-to-day non-combatant activities and infrastructure of realistic urban environments. These urban facilities do not satisfy the need for testing performance capabilities, networks, intelligence systems, sensors, and other advanced technologies interacting with or are affected by the real urban environment.

Testing in a realistic urban environment is essential to DOD to evaluate system of system (SOS) performance and capabilities required by the Warfighter. The Fiscal Year 2010 Office of the Secretary of Defense Operational Test and Evaluation Special Interest Oversight List identified many programs that have an urban operations requirement. While limited representations of urban test environments exist, they are not sufficient to fulfill the requirements for urban testing. Most of existing urban facilities were established to accommodate Military Operations on Urban Terrain (MOUT) training where the operational performance of the military unit such as a squad or company is evaluated.

A picture from a Mojave Viper exercise at the Marine Corps Air Ground Combat Center (MCAGCC) at Twentynine Palms is shown below. Note the elaborate use of connex structures and the limited use of facades. While this site is effective for training, it does not have the real signatures required to test military and weapons systems replying on Electro-Optical/Infrared (EO/IR) and Radio Frequency (RF) spectral bands.

Figure 2-1 Mojave Viper training exercise at Twentynine Palms MCAGCC

In addition, these training facilities do not, in all cases, incorporate geographically and culturally significant features, including building composition, height, depth, orientation, and urban "clutter" such as automobiles, carts, or trash. Moreover, the static structures typically found in a Combined Arms Collective Training Facility (CACTF) not only misrepresents the EM

conditions but also cannot efficiently be modified or reconfigured to accommodate the physical morphology found in disparate theaters or even disparate conditions found within the same urban area. Finally, the instrumentation in these facilities does not capture all of the data necessary to accurately assess a technologically diverse set of systems and subsystems. These limitations on testing resources mean that the "test as we fight" requirement cannot be accomplished. If the military department test agencies cannot adequately test systems in an operationally representative urban environment, then the fielded systems can experience unknown degradations in system performance during combat operations. All of these facts lead to an understanding that the test community must provide a comprehensive testing environment with facilities, tools, data collection, and analysis that can evaluate the performance of warfighting systems and their operational effectiveness, suitability, and survivability in complex urban environments.

Most current urban facilities are training facilities with deficiencies in size, complexity, realism, data collection, and test control capabilities that limit their ability to fully support high-fidelity test requirements. To adequately test and evaluate developmental systems, the DOD test community must account for the effects of urban terrain during DT and OT events—a requirement that is best met by a Live, Virtual, Constructive (LVC) urban environment.

The DOD Strategic Planning Guidance for Fiscal Years 2006–2011 states—

- "The most significant differences between current capabilities and required capabilities are driven by the restrictions and limitations of present 'urban test sites' which are essentially MOUT [Military Operations in Urban Terrain] training capabilities. Also, current capabilities only accommodate serial testing of a limited representation of the force structure needed for joint Decisive Action (formerly Full Spectrum Operations). Status quo testing and the limited urban test environment do not allow the tester to thoroughly address performance and suitability issues associated with a network-centric SOS exposed to the combined/aggregate effects of an urban environment.

- Realistic joint urban test capabilities are virtually non-existent….As an example, consider establishing a test environment similar to Operation Al Fajr in Fallujah, Iraq. Combat and combat support forces from the US Army, US Marine Corps, US Air Force, Iraqi Army, Iraqi Security units, and US Government agencies operated in a 3-dimensional (3-D) battlespace that covered 1,000 city blocks or about 20 square kilometers."

In August 2008, TRMC sponsored an initial issue paper to examine the necessity of an Urban Environment Test Capability. This initial issue paper addressed the development and integration of an urban environment (UE) test capability to effectively test military systems, Systems of Systems, networks and Tactics, Techniques, and Procedures (TTPs) in a joint urban environment across Decisive Action.

The issue paper proposed funding the Central Test and Evaluation Investment Program (CTEIP) to develop, test, validate and implement realistic, reconfigurable, instrumented slices of the urban environment, replicating the aggregate urban effects to support developmental and operational UE testing. Three key enhancements were identified: 1) Build a live (open-air range) urban test

environment; 2) Develop distributed LVC technologies for UE simulations; and 3) Procure common instrumentation across the ranges for specific urban tests.

In order to define specific urban environment (UE) test gaps and requirements, TRMC and the US Joint Forces Command's (USJFCOM) Joint Irregular Warfare Center (JIWC)/Joint Urban Operations Office (JUOO) cosponsored the UETC Study to identify detailed and relevant requirements and capability gaps from August 2008 through June 2010. The UETC Study consisted of three primary activities: 1) identification of required capabilities; 2) identification of current urban environment test capabilities; and 3) identification and prioritization of gaps. The study's products, analysis, and recommendations served as a primary source to guide identification of project requirements. To aid in the gap analysis the UETC working group made extensive use of the *Army Research Laboratory Study, ARL-TR-439,* "Urban Terrain Building Types, Second Edition (2008)," (Ellefsen, Richard, and Fordyce, David) [hereafter referred to as "the Ellefsen Study"]. This study provided a precise and comprehensive set of standard geotypical building and urban terrain zone (UTZ) descriptions on a worldwide basis using an established and accepted methodology.

While senior staff elements have recognized and acknowledged the increased probability that US forces will operate within an urban terrain, actual examples of the impact of urban operations on military equipment and technology is readily available from Operation IRAQI FREEDOM. A simple cursory review of after action reports, documentation, briefings and lessons learned revealed that the experience of US forces operating within an urban environment confirm the senior staff's position regarding urban operations significant issue.

- Unmanned Aerial Vehicle (UAV) optics and satellite imagery are not sufficient for the details needed for urban operations. [Initial Impressions Report, Operations in Mosul, Iraq; Stryker Brigade Combat Team 1, 3rd Brigade, 2nd Infantry, 21 December 2004]

- The [Inter-Squad Radio] radio is not good in urban environments due to the operators' inability to communicate around corners, between floors or rooms, nor is the range adequate. [Field Report, Marine Corps Systems Command Liaison Team, Central Iraq, April 2003]

- Communications were sometimes limited due to the urban terrain and the unit did not use the soft-skinned High Mobility Multipurpose Wheeled Vehicle (HMMWV) retrans platform due to the obvious enemy threat. [Initial Impressions Report (IIR), 25th Infantry Division (25ID) & 1st Cavalry Division (1CD); Observations from Modular Force Divisions in Operation Iraqi Freedom (OIF); September 2007]

- Force XXI Battle Command Brigade and Below-Blue Force Tracker (FBCB2-BFT) subject to masking in urban and mountainous areas. [Platform Battle Command/Combat Identification 27th Infantry Brigade Combat Team (IBCT) Key Leader Brief; 31 May 2007].

The JUTC Working Integrated Product Team (WIPT) conducted analyses of directed SUTs to determine system-specific requirements for an urban test environment. This WIPT was directed to examine the urban test environment needs of nine directed programs. These programs are:

- Early Infantry Brigade Combat Team (EIBCT) System of Systems (SOS)
- Urban–Unmanned Ground Sensors (U-UGS)
- Tactical–Unmanned Ground Sensors (T-UGS)
- XM1216 Small Unmanned Ground Vehicle (SUGV)
- Class I Unmanned Aerial Vehicle (CL I UAV)
- Multi-Mission Unmanned Ground Vehicle (MM-UGV)
- Joint Tactical Radio System (JTRS) including Rifleman, Manpack, and Ground Mobile Radio (GMR)
- Joint Air-to-Ground Missile (JAGM)
- MQ-1C Warrior Extended Range Multi-Purpose (ERMP/GRAY EAGLE) Unmanned Aircraft System.

Collectively, these systems represent air, ground and radio-frequency based systems indicative of the type of systems that would need DT and OT in an urban environment. The analysis team coordinated with the program management offices to identify urban environment challenges for these systems. Use cases for each of the systems were developed which describe intended operational performance and operational conditions. From these analyses, specific characteristics were identified as important in providing a realistic urban test environment. Among these characteristics were:

- Structures of accurate material, heights, and density to inhibit maneuverability, line-of-sight, and electromagnetic performance.

- Presence of an "urban canyon", which is defined as a 3:1 building height-to-building spacing ratio.

- Replication of the urban electromagnetic (Radio Frequency and Infrared) environment.

- Replication of physical cultural effects (e.g., vehicles, signage, urban clutter, etc).

- Minimum physical surface urban area of 200 meters x 240 meters.

By incorporating System Under Test (SUT)/Tactics Techniques & Procedures (TTPs) analyses, basic physics of electromagnetic signal transmission, and the Ellefsen Study's building and UTZ classification, the JUTC Urban Area Development Analysis (September 2010) derived possible configurations of the physical structures. Configuration #2 (Figure 3.1-3) appeared to be the most promising comprehensive layout. The Urban Area Development Analysis was presented to and accepted by the JUTC WIPT and became the basis for deriving requirements.

After completion of the Urban Area Development Analysis, additional urban test capability requirements were identified in June 2011 to support solutions to specific T&E shortfalls for current major programs of record. These programs are:

- Next Generation Jammer (NGJ)
- Joint Allied Threat Awareness System (JATAS)

Similar to the initial analysis, these program management offices and their test offices were contacted to clarify their specific test needs. These program specific test needs also identified when testing in an urban test capability would be required. In addition, other programs that will benefit from JUTC, but do not have scheduled test dates, include other sensor, jammer and weapons programs going through upgrade cycles after FY15 such as the Joint Allied Threat Awareness System (JATAS), and aircraft such as the F-35 needing integration testing against threats in urban areas. For Joint Direct Attack Munition (JDAM), Tomahawk, and other modern multi-mode munitions systems, an end-to-end urban T&E capability is required, including M&S for large-scale urban T&E and live urban targets for end-game T&E. For NGJ, a capability is required to test blue jamming of red communications networks in an urban high-density RF environment. For JATAS, validated databases are required to test urban missile warning system performance. This new analysis varied the methodology and followed a sequence to identify program specific test needs, identify existing test capabilities or gaps in test capability and then define requirements to bridge the test capability gaps. Three types of desired urban test capabilities aligned with the three programs above were then characterized:

- Weapons System Urban Test Capability (WS-UTC)
- Communications Jamming Urban Test Capability (CJ-UTC)
- Infrared Countermeasure (IRCM) Systems Urban Test Capability (IS-UTC)

Developing these three types of urban test capabilities will enable focused development of critical technologies to support planned tests that address the specific shortfalls while developing a test capability that can be modernized to address shortfalls for future tests. Further explanation of the specific shortcomings and alignment to the WS-UTC, CJ-UTC and IS-UTC desired capabilities follows.

End-to-End Weapons Testing in Urban Environments: The F/A-18 SDB II Integration program has a shortfall in end-to-end weapons testing related to targeting and assessing the damage to urban structures and inhabitants. SDB II requires validated M&S for large-scale urban targeting, and smaller-scale open-air T&E against different types of Transportable, Reconfigurable UTZ Targets (TRUTs), in order to test end-game damage against tanks moving between buildings and damage to building occupants (e.g. manikins). Structures include 3rd world buildings, including adobe type facades.

The M&S capability requires collection of real data from urban environments, and developing and validating M&S for T&E. The M&S capability needs to be integrated at AMRDEC in the Common Scene Generator for large-scale targeting for T&E. The open-air end-game T&E requires building and tank targets in various TRUT configurations. The required capability needs to be at China Lake for Navy T&E to support AH-1 and F/A-18 weapons T&E. While many inert shots are planned, there is also a need for T&E with limited live rounds, which will destroy the TRUTs. Therefore, there is a requirement for rapid reconstruction of the TRUTs.

Modern Comms and C2 Jamming in a High-Density Urban Environment: The Next-Generation Jammer (NGJ) requires chamber-based (1st Priority) and open-air-based (2nd Priority) test resources for T&E of C2 and comms jamming in open-loop and closed-loop

configurations in urban environments. In the 2010 Test Resource Management Center (TRMC) Tri-Service Electronic Warfare Test Capabilities Study (TEWTCS), this shortfall was referred to as the C2 and Urban Background Environment Simulator (CUBES), and chamber-based requirements come from the inability of NGJ to radiate at all frequencies and power levels in the open-air environment, and the difficulty in creating a high enough RF density in the open-air environment. The capability should be transportable, but initially it should be integrated into the Navy's large anechoic chamber at Patuxent River Naval Air Station, supported by NAVAIR 5.4, to be part of planned NGJ DT/OT T&E in the chamber. The open-air part of this shortfall also needs to be transportable and reconfigurable to test against different urban terrain zones (UTZs) and different EME environments. For example, testing is required against communication networks in urban canyons of different building types, sizes and spacings. Testing is required to take place at China Lake NWS, where the F/A-18 VX-9 detachment is located, and where other integrated EW open-air threats are located. Note that the CUBES shortfall requires a capability to test blue jamming of red threat networks, which is different than the FY12 Army project called the Synthetic Battlefield Emitter Systems (SBES), which develops a capability to test blue communication networks against red jamming. There should be an opportunity for synergy between these projects.

IRCM System Urban Performance: Two on-going projects, the Navy's Joint Allied Threat Awareness System (JATAS) and the Army's Common IRCM (CIRCM) have requirements to work in all operational environments, which includes urban environments. For JATAS, only urban environments in the CONUS are planned for use in T&E. For example, during JATAS Technical Demonstration phase, data collections were done over Baltimore and New York cities. Urban data from UTZs other than typical large American cities is required to fully test the operational requirements. Note that data collection and database attribution efforts for M&S T&E should also meet this requirement, if data in the appropriate bands is properly collected.

3. GENERAL CAPABILITIES

3.1 GENERAL DESCRIPTION

The JUTC will support both DT and OT of new and emerging systems and SOS, in an operationally realistic environment. The JUTC program will provide technical solutions that create an environment with representations of urban structures, electromagnetic effects (EME), and friendly and hostile system effects. These environmental considerations will be supported with data collection systems, test planning and control systems as well as net-centric connectivity. Other capabilities aligned with specific programs will support end to end weapon testing, communications jamming and Infra-Red Counter Measure systems. As shown in Figure 3.1-1, JUTC will consist of a live urban environment, a distributed test capability, and M&S within a brigade context. By offering an extensive portfolio of effects to represent a realistic urban environment, testing can be tailored to each specific SUT. Such effects include but are not limited to EME, weapons effects, clutter, and threat and cultural representations. To control costs, JUTC will leverage as many existing network and range resources as possible.

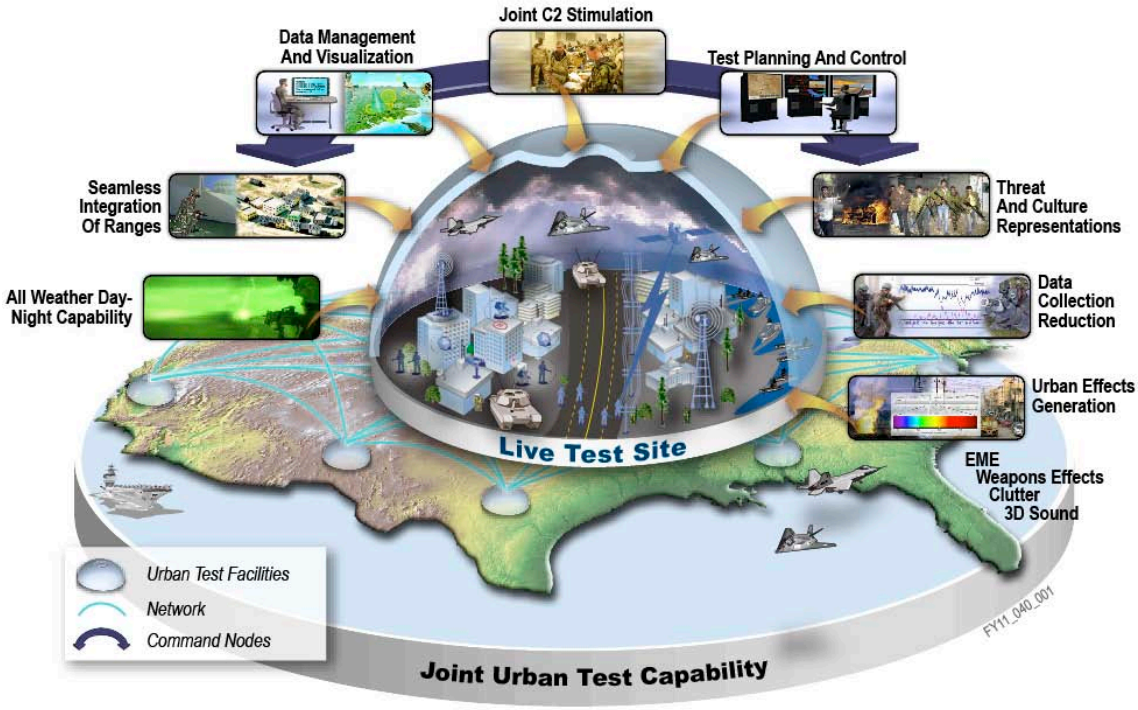

Figure 3.1-1 Joint Urban Test Capability

The following figures are representative of possible configurations of urban environments. Flexibility in altering the configuration and array of representative buildings enables the tester to portray varied geographically accurate UTZs as a test environment for new and emerging systems and SOS.

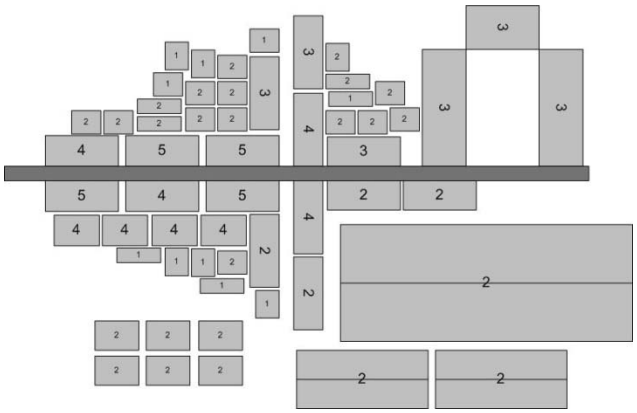

Figure 3.1-2 Possible Configuration #1

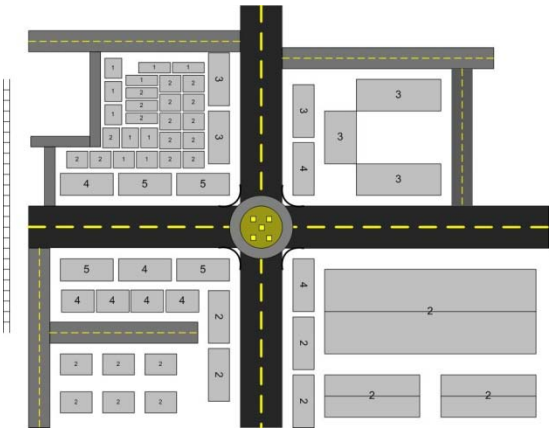

Figure 3.1-3 Possible Configuration #2

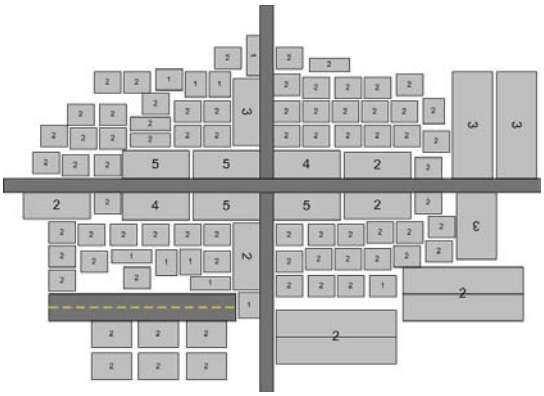

Figure 3.1-4 Possible Configuration #3

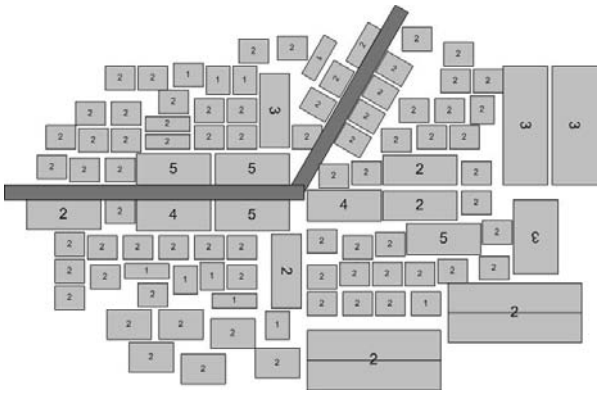

Figure 3.1-5 Possible Configuration #4

The Army selected White Sands Missile Range (WSMR) as a site for this live urban test capability. This selection should provide sufficient test site terrain, inherent environmental conditions, airspace, linkage to distributed testing architecture, and test support infrastructure.

Candidate sites for the three capabilities of WS-UTC, CJ-UTC and IS-UTC are China Lake and Patuxent River Naval Air Station. Developing these combined urban test capabilities will enable developing a test capability that can be modernized to address shortfalls for future tests while also focusing development of critical technologies to support planned tests that address specific shortfalls.

3.2 JUTC KEY PERFORMANCE PARAMETERS (KPP)

Table 3.2-1 identifies the capabilities considered essential for an urban test capability. The Reference column in Table 3.2-1 identifies the specific sections in the TCRD that further describe these requirements. The description in the KPP, Threshold and Objective columns are a short version. The full text is in the specific section paragraphs.

Table 3.2-1 JUTC Key Performance Parameters

Ref.	KPP	Threshold	Objective
3.3.1	**JUTC air/ land dimensions and Army site location (KPP)**	• **Urban Area: 200m x 240m** • **Maneuver Area: 16km^2 (preferred configuration: 4km x 4km)** • **Buffer Area: 100km^2 (preferred configuration: 10km x 10km)** • **Airspace: 40,000 MSL** • **Location: White Sands Missile Range, NM**	• **Urban Area: 900m x 900m** • **Maneuver Area: 64km^2 (preferred configuration: 8km x 8km)** • **Buffer Area: 400km^2 (preferred configuration: 20km x 20km)** • **Airspace: T=O** • **Location: T=O**

3.3.2	**Urban Building Replicas (KPP)**	**Provide replicas that are a modular, reconfigurable, and transportable system capable of representing all of the requisite building types for the UTZs. In addition, the exterior walls and roof types shall have the ability to be changed to sufficiently represent the electromagnetic spectral characteristics of the designated UTZ. The following amounts of replicas are required *(refer to Appendixes B and C for a detail description of building types and UTZs)*:** • **Industrial (Dc4) building replicas (UTZ IV) - 1** • **Commercial(Dc5) building replicas (UTZ II) - 15** • **Residential (Dc3) building replicas (UTZ III) - 16** • **Apartments(Do2) building replicas (UTZ V) - 4**	**In addition to Threshold requirements, the following amount of replicas are required:** • **Industrial (Dc4) building replicas (UTZ IV) - 3** • **Commercial (Dc5) building replicas (UTZ II): T=O** • **Residential (Dc3) building replicas (UTZ III) - 32** • **Apartments (Do2) building replicas (UTZ V) - 7**
3.4.1	**Urban Radio Frequency Effects (KPP)**	**EME within the frequency band of 1MHz to 8GHz**	**EME within the frequency bands of 1MHz to 20GHz and 26GHz to 95GHz**
3.8.1	**Distributed Connectivity (KPP)**	**DREN/SDREN connectivity, OC-12**	**DREN/SDREN connectivity, OC-48**
3.9.1	**WS-UTC Scene Generator Bands (KPP)**	**IR, MMW**	**VIS, IR, MMW, SAL-band**
3.9.18	**WS-UTC Target Buildings (KPP)**	**Transportable, Reconfigurable, Attributable 1 & 2 Story**	**Transportable, Reconfigurable, Attributable 1 to 5 Stories**
3.10.1	**CJ-UTC Number of High Fidelity Signals (KPP)**	**Number of programmable.testable signals: 10**	**>20**
3.10.11	**CJ-UTC Open-air free-space directional emitters (Programmable, Testable) (KPP)**	**2**	**>5**
3.11.1	**IS-UTC Scene Generation Bands (KPP)**	**UV, MWIR**	**UV through LWIR**

3.2.1 JUTC Air/Land Dimensions and Army Site Location (KPP)

JUTC will require a site that can provide the appropriate airspace and land dimensions at a host site with an established T&E infrastructure. The land requirements were determined by the use case analysis, the JUTC Urban Area Development Analysis [(10)], and the TRMC Urban

Environment Test Capability (UETC) study [4]. These land requirements are further identified as an Urban Area, a Maneuver Area and a Buffer Area. The full description of these delineated land areas is in Section 3.3.1.

The Urban Area size was derived from analyzing SUT performance, RF propagation in urban areas, and the physics of wave propagation in urban areas. The Maneuver Area is required to support vehicle and personnel movement for a battalion-sized unit around the urban area in conjunction with a test event. This area will primarily include open terrain and road networks to transverse in and out of the urban area, and may also include additional urban features based on future SUT requirements. The Buffer Area is based on standard operating procedures on DOD test ranges. JUTC will support test scenarios involving aircraft, UAVs, possible inert munitions dispenses, various forms of high power RF emissions, and other test effects that extend beyond the maneuver space. To minimize risk to the surrounding community and reduce the RF propagation effects emanating from the JUTC live environment, a buffer area is required. JUTC will require airspace from surface to 40,000 MSL to support testing airborne platforms that conduct ISR, Command and Control, and air-surface Force Applications (including non-lethal) functions.

3.2.2 Urban Building Replicas (KPP)

An understanding of how complex urban areas affect military systems is essential to the design and fielding of robust systems and SOS that will be used by future Warfighters. At the present time, there are no test facilities that accurately represent an urban area with respect to the density, size, configuration, and electromagnetic spectral response characteristics of the manmade terrain. However, these attributes have been shown to affect the performance of military systems. Thus, the inclusion of an area in JUTC consisting of replicas of different building types typically associated with and found in urban areas around the world is required to support DT and OT of new and emerging military systems. In addition, this live environment will be critical to support the validation, verification, and accreditation (VV&A) of future JUTC M&S urban models. Without a realistic physical capability, all other JUTC requirements have limited utility. The full description of the building replicas are in Section 3.3.2.

3.2.3 Urban Radio Frequency Effects (KPP)

The replicas in the urban area will produce effects such as reflection, refraction, scattering, multipath, absorption, and attenuation that are unique to complex urban environments. However, additional urban environmental effects exist that cover a broad range of phenomena associated with the urban terrain that result from the physical properties of the urban triad (topography, population, and infrastructure). This KPP is associated with the effects described in Section 3.4, Augmented Urban Environment Effects. These effects refer to the myriad Electromagnetic (EM) emanations specifically associated with civilian communication systems, including radio, television (TV), telephone, microwave, cellular telephone, and public address (PA). The effects do not typically occur in isolation, and the number of possible combinations of the aggregate effects is immense and not easily represented without exorbitant expense. In addition, these effects would change in frequency and magnitude across the differing UTZs. Thus, the ability to generate EM effects throughout JUTC is required to provide a test facility that accurately represents an urban environment. Without this capability, the JUTC will lack a significant source of system interference necessary to create a true representation of the operational conditions

within which the system must be able to perform and survive. The full description of the urban radio frequency effects are in Section 3.4.1.

3.2.4 Distributed Connectivity (KPP)

JUTC will support test events that vary in size from small sensor tests involving a few participants up to large SOS tests involving hundreds of participants and many simulator/stimulator M&S tools located at separate physical locations. The live JUTC environment will support the smaller test events. Larger tests will require M&S augmentation and the command and control (C2) software wraparound capability needed to support joint SOS test events. A distributed test capability with DREN/SDREN connectivity will be required to support distributed testing. The full description of distributed connectivity is in Section 3.8.1.

3.2.5 Weapon System UTC M&S T&E Capability: Scene Generator Bands (KPP)

The WS-UTC M&S T&E Capability KPP is the scene generator operating bands, which drives many other lower level requirements, such as data collections, database development and scene generator integration. The databases will be integrated into the US Army Aviation and Missile Research Development and Engineering Center (AMRDEC) and the Integrated Battlespace Arena (IBAR) scene generators at China Lake and validated against the data collections in the bands of interest. The full description of this KPP is in Section 3.9.1.

3.2.6 Weapon System UTC Open-air T&E Capability: Target Buildings (KPP)

The KPP for the WS-UTC Open-air T&E capability is the target buildings, which shall be transportable, reconfigurable and attributable. Transportable means they can be moved from one location to another, such as from China Lake's north range to China Lake's south range. Reconfiguration means they can be restacked and reoriented to support different live-fire tests. Attributable means the target structures can support different facades, depending on the weapon sensor bands to be tested. The full description of this KPP is in Section 3.9.18.

3.2.7 Comms Jamming UTC Chamber T&E Capability: Number of High Fidelity Signals (Programmable, Testable) (KPP)

The KPP for the CJ-UTC Chamber T&E capability is the number of high-fidelity programmable, testable, signals initially incorporated into the system. This KPP drives many other requirements, including system sizing. Because the Urban Communications Simulator (UCS) leverages the Next Generation Electronic Warfare Environment Generator (NEWEG) software architecture and much of the physical hardware, the cost driver is the programming associated with processing the signal set. Limiting the initial signal set puts constraints on the total cost of the system, while still allowing the CJ-UTC Chamber T&E capability to meet key NGJ urban comms jamming T&E requirements. The full description of this KPP is in Section 3.10.1.

3.2.8 Comms Jamming UTC Open-air T&E Capability: Number of free-space directional emitters (Programmable, Testable) (KPP)

The KPP for the CJ-UTC Open-air T&E capability is the number of high-fidelity programmable, testable, directional emitters that represent modern comms links. Because the open-air system is based on the chamber Urban Communications Simulator (UCS), costs are reduced compared to

developing a wholly new system. The CJ-UTC Open-air T&E capability leverages the NEWEG software architecture and much of the physical hardware, the cost driver is the programming associated with processing the signal set. Limiting the initial signal set puts constraints on the total cost of the system, while still allowing the CJ-UTC Open-air T&E capability to meet key NGJ urban comms jamming T&E requirements. The full description of this KPP is in Section 3.10.11.

3.2.9 IRCM Systems UTC Modeling and Simulation T&E Capability: Scene Generator Bands (KPP)

The KPP for the IS-UTC M&S capability is the scene generator operating bands, which drives many other lower level requirements, such as data collections, database development and scene generator integration. The databases will be integrated into the US Navy Air Combat Environment Test and Evaluation Facility (ACETEF) and US Army Redstone Test Center (RTC) scene generators and validated against the data collections in the bands of interest. The full description of this KPP is in Section 3.11.1.

3.3 JUTC LIVE URBAN AREA

The Army JUTC live urban area will consist of replicas representative of urban buildings and additional attributes that are consistent with a physical representation of urban terrain. The JUTC Urban Area Development Analysis [10] identified that these representations will be placed in an area of land that will JUTC live urban area will provide sufficient space for an urban area where structures and effects will be positioned, a maneuver area that provides sufficient space for maneuver of forces around the urban environment, and buffer area for safety and operational considerations. The JUTC live urban area will support Decisive Action in developmental and operational tests of military systems and SOS.

Table 3.3-1 Live Urban Area

3.3	JUTC Live Urban Area	Threshold	Objective
3.3.1	**JUTC air/land dimensions and Army site location (KPP)**	• **Urban Area: 200m x 240m** • **Maneuver Area: 16 km^2** (preferred configuration: 4km x 4km) • **Buffer Area: 100 km^2** (preferred configuration: 10km x 10km) • **Airspace: 40,000 MSL** • **Location: White Sands Missile Range, NM**	• **Urban Area: 900m x 900m** • **Maneuver Area: 64 km^2** (preferred configuration: 8km x 8km) • **Buffer Area: 400 km^2** (preferred configuration: 20km x 20km) • **Airspace: T=O** • **Location: T=O**

3.3.2	**Urban Building Replicas (KPP)**	**Provide replicas that are a modular, reconfigurable, and transportable system capable of representing all of the requisite building types for the UTZs. In addition, the exterior walls and roof types** shall have the ability to be changed to sufficiently represent the electromagnetic spectral characteristics of the **designated UTZ. The following amounts of replicas are required** ***(refer to Appendixes B and C for a detail description of building types and UTZs)*****:** • **Industrial (Dc4) building replicas (UTZ IV) - 1** • **Commercial(Dc5) building replicas (UTZ II) - 15** • **Residential (Dc3) building replicas (UTZ III) - 16** • **Apartments(Do2) building replicas (UTZ V) - 4**	**In addition to Threshold requirements, the following amount of replicas are required:** • **Industrial (Dc4) building replicas (UTZ IV) - 3** • **Commercial (Dc5) building replicas (UTZ II): T=O** • **Residential (Dc3) building replicas (UTZ III) - 32** • **Apartments (Do2) building replicas (UTZ V) - 7**
3.3.3	**Roads**	**A single graded trafficable roadbed**	**Two concrete roads**
3.3.4	**Roundabout**	**1**	**T=O**
3.3.5	**Intersection**	**1**	**T=O**
3.3.6	**Sidewalks**	**One section of 100m**	**T=O**
3.3.7	**Vertical Obstacles (e.g., curbs)**	**One section of 50m**	**One section of 100m**
3.3.8	**Railroad section**	**One section of 50m**	**Two sections of 50m**
3.3.9	**Bridge**	**1**	**T=O**
3.3.10	**Overpass**	**1**	**T=O**
3.3.11	**Commercial Communication Towers**	**Two towers**	**Three towers**
3.3.12	**Power Distribution (e.g., transformers)**	**50% of all building replicas**	**100% of building replicas**
3.3.13	**Interior and Exterior electrical wiring of building replicas**	**50% of all building replicas**	**100% of building replicas**

3.3.1 JUTC Air/Land Dimensions and Army Site Location (KPP)

JUTC will require a site that can provide the appropriate land dimensions (urban area, maneuver area, and buffer area) at a host site with an already established T&E infrastructure. The land requirements were determined by the JUTC use cases, the JUTC Urban Area Development Analysis [(10)], and the TRMC Urban Environment Test Capability (UETC) study[(4)]. The Urban Area size was derived from analyzing SUT performance, RF propagation in urban areas, and the

physics of wave propagation in urban areas. The Maneuver Area is required to support vehicle and personnel movement for a battalion-sized unit around the urban area in conjunction with a test event. This area will primarily include open terrain and road networks to transverse in and out of the urban area, and may also include additional urban features based on future SUT requirements. The Buffer Area is based on standard operating procedures on DOD test ranges. JUTC will support test scenarios involving aircraft, UAVs, possible inert munitions dispenses, various forms of high power RF emissions, and other test effects that extend beyond the maneuver space. To minimize risk to the surrounding community and reduce the RF propagation effects emanating from the JUTC live environment, a buffer area is required.

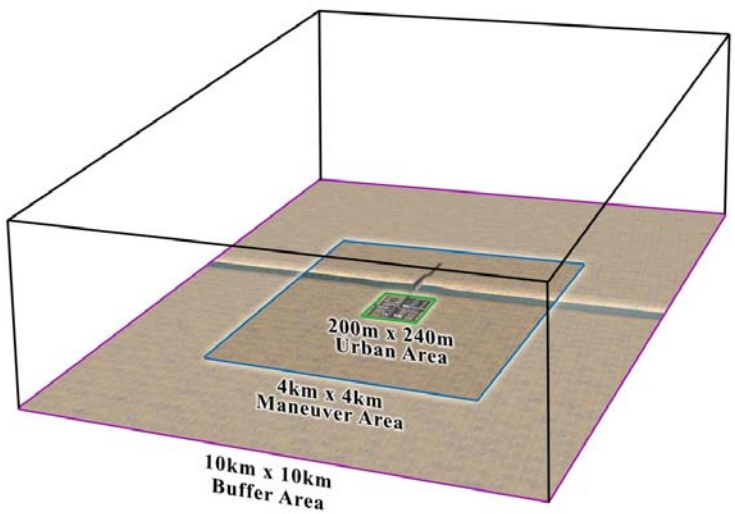

Figure 3.3.1-1 JUTC Live Urban Test Site minimum land dimensions

- **Threshold:**
  - **Urban Area**. The JUTC urban area land dimensions shall be a minimum size of 200 meters (m) by 240m.
  - **Maneuver Area.** The JUTC maneuver area shall be a minimum of16km^2 (preferred configuration: 4km x 4km). All vehicle (wheeled and tracked) and personnel movement shall be limited only by environmental exclusion areas.
  - **Buffer Area.** The JUTC buffer area shall be a minimum of 100km^2 (preferred configuration: 10km x 10km).
  - **Airspace.** The controlled airspace requirement over the urban, maneuver, and buffer areas shall be 40,000 feet Mean Sea Level (MSL).
  - **Location.** White Sands Missile Range (WSMR), New Mexico.

- **Objective:**
    - **Urban Area.** The JUTC urban area dimensions shall be a minimum of 900m by 900m.
    - **Maneuver Area.** The JUTC maneuver area shall be a minimum of 64km^2 (preferred configuration: 8km x 8 km).
    - **Buffer Area.** The JUTC buffer area shall be a minimum of 400km^2 (preferred configuration: 20km x 20km).
    - **Airspace.** Threshold equals Objective.
    - **Location.** Threshold equals Objective.
- **Rationale:** All of the land requirements were derived from detailed analysis. The JUTC maneuver space is required to augment the smaller urban area and will support battalion-sized operations. The JUTC buffer area is required to safely execute all urban test scenarios. Test ranges require buffer areas for test events involving aircraft and RF emissions. Furthermore, a separate Army analysis determined that WSMR provides the best established T&E infrastructure to host JUTC.

3.3.2 Urban Buildings Replicas (KPP)

The JUTC urban area will include replicas of buildings capable of being arranged to represent different Urban Terrain Zones (UTZ) with respect to size, height, density, depth, and electromagnetic spectral response characteristics. The capability of the replicas to be modular, reconfigurable, and transportable will support the ability to customize the JUTC urban area by tailoring any UTZ for a test event. Reconfigurable replicas will be able to be assembled, disassembled, and moved. Figure 3.3.2-1 uses the preferred configuration (Figure 3.1-3, Possible Configuration #2) and identifies Threshold replicas in green and Objective replicas in red.

Figure 3.3.2-1 Possible JUTC configuration

- **Threshold:** Provide building replicas as a modular, reconfigurable, and transportable system capable of representing all of the UTZs. In addition, the exterior walls and roof types of the replicas shall have the ability to be changed to sufficiently represent the electromagnetic spectral response characteristics of the designated UTZ. A total of 36 building replicas in the following amounts are required (refer to Appendixes B and C for further descriptions of each UTZ):

    - Industrial (Dc4) building replicas (UTZ IV): One (1)
    - Commercial (Dc5) building replicas (UTZ II): Fifteen (15)
    - Residential (Dc3) building replicas (UTZ III): Sixteen (16)
    - Apartments (Do2) building replicas (UTZ V): Four (4)

- **Objective:** A total of 57 replicas are required to achieve Full Operational Capability (FOC):

    - Industrial (Dc4) building replicas (UTZ IV): Three (3)
    - Commercial (Dc5) building replicas (UTZ II): Threshold equals Objective
    - Residential (Dc3) building replicas (UTZ III): Thirty two (32)
    - Apartments (Do2) building replicas (UTZ V): Seven (7)

- **Rationale:** An accurate measurement of system performance requires a test area that accurately represents the buildings that are part of the complex topographical landscape created by man-made structures in a densely populated urban area. Ellefsen, et.al. (7), defined and characterized the buildings which make up the man-made terrain in urban areas which will be represented by building replicas in the JUTC live urban environment. These studies, and others, note that urban terrain is typically not uniform but composed of pockets of similar structures in close juxtaposition to other pockets of completely

dissimilar purpose and characteristics. To accurately reflect the real-world conditions, it is not only necessary to be able to create a variety of UTZs, it is essential to be able to create multiple UTZs simultaneously.

3.3.3 JUTC Urban Area Roads

The JUTC will include roads with characteristics consistent with urban areas. This additional feature will enhance the realism of the urban area and present challenges to SUTs unique to a complex urban environment.

- **Threshold:** The JUTC urban area shall include a graded trafficable roadbed that is five (5) meters in width with road segments not to exceed 400 meters in length.

- **Objective:** The JUTC urban area shall include two (2) concrete roadways that are five (5) meters in width and 200 meters in length.

- **Rationale:** Roads consistent with urban areas enhance the realism of the live urban area, improving the accuracy of system performance measurements.

3.3.4 JUTC Urban Area Roundabout

The JUTC will include a roundabout with characteristics consistent with urban areas. This additional feature will enhance the realism of the urban area and present challenges to SUTs unique to a complex urban environment.

- **Threshold:** The JUTC urban area shall include one roundabout with dimensions consistent with a two lane road.

- **Objective:** Threshold equals Objective.

- **Rationale:** Roundabouts consistent with urban areas enhance the realism of the live urban area, improving the accuracy of system performance measurements.

3.3.5 JUTC Urban Area Intersection

The JUTC will include an intersection with characteristics consistent with urban areas. This additional feature will enhance the realism of the urban area and present challenges to SUTs unique to a complex urban environment.

- **Threshold:** The JUTC urban area shall include one intersection with dimensions consistent with a two lane road. Note: this requirement could be satisfied by a roundabout.

- **Objective:** Threshold equals Objective.

- **Rationale:** Intersections consistent with urban areas enhance the realism of the urban area, improving the accuracy of system performance measurements.

3.3.6 JUTC Urban Area Sidewalks

The JUTC will include a sidewalk with characteristics consistent with urban areas. This additional feature will enhance the realism of the urban area and present challenges to SUTs unique to a complex urban environment.

- **Threshold:** The JUTC urban area shall include one sidewalk of least 1.2 meters in width and 100 meters in length which is adjacent to one of the urban area roads. The sidewalk shall be modular and transportable.

- **Objective:** Threshold equals Objective.

- **Rationale:** Sidewalks consistent with urban areas enhance the realism of the live urban area, improving the accuracy of system performance measurements and increasing the number and types of systems that can utilize the test area.

3.3.7 JUTC Urban Area Vertical Obstacles

The JUTC will include vertical obstacles (e.g., curbs) with characteristics consistent with urban areas. This additional feature will enhance the realism of the urban area and present challenges to SUTs unique to a complex urban environment.

- **Threshold:** The JUTC urban area shall include one section of curbing with a height which varies from 15 centimeters to 30 centimeters and a length of 50 meters. The vertical obstacles shall be modular and transportable.

- **Objective:** The JUTC urban area shall include one section of curbing with a height which varies from 15 centimeters to 30 centimeters and a length of 100 meters.

- **Rationale:** Vertical obstacles consistent with urban areas enhance the realism of the live urban area, improving the accuracy of system performance measurements and increasing the number and types of systems than can utilize the test area.

3.3.8 JUTC Urban Area Railroad track

The JUTC will include a section of railroad track with characteristics consistent with urban areas. This additional feature will enhance the realism of the urban area and present challenges to SUTs unique to a complex urban environment.

- **Threshold:** The JUTC urban area shall include a single section of railroad track of standard gauge and a length of 50 meters. The railroad track shall be modular and transportable.

- **Objective:** The JUTC urban area shall include two sections of railroad track of standard gauge and a length of 50 meters.

- **Rationale:** A section of railroad track consistent with urban areas enhances the realism of the live urban area, improving the accuracy of system performance measurements.

3.3.9 JUTC Urban Area Bridge

The JUTC will include a bridge with characteristics consistent with urban areas. This additional feature will enhance the realism of the urban area and present challenges to SUTs unique to a complex urban environment.

- **Threshold:** The JUTC urban area shall include one bridge with dimensions consistent with a two lane bridge spanning an urban canal.

- **Objective:** Threshold equals Objective.

- **Rationale:** A bridge consistent with urban areas enhances the realism of the live urban area, improving the accuracy of system performance measurements.

3.3.10 JUTC Urban Area Overpass

The JUTC will include an overpass with characteristics consistent with urban areas. This additional feature will enhance the realism of the urban area and present challenges to SUTs unique to a complex urban environment.

- **Threshold:** The JUTC urban area shall include one overpass which is four (4) meters in height and wide enough to span a road five (5) meters in width.

- **Objective:** Threshold equals Objective.

- **Rationale:** An overpass consistent with urban areas enhances the realism of the live urban area, improving the accuracy of system performance measurements.

3.3.11 JUTC Urban Area Commercial Communications Towers

The JUTC will include commercial communications towers with characteristics consistent with urban areas. This additional feature will enhance the realism of the urban area and present challenges to SUTs unique to a complex urban environment.

- **Threshold:** The JUTC urban area shall include two (2) commercial communications towers that can be erected and set at appropriate heights and can be capable of supporting one TV broadcast antenna; one public radio broadcast antenna, and one cell phone antenna. The towers shall be modular and transportable.

- **Objective:** Three (3) commercial communications towers with the same threshold capabilities.

- **Rationale:** Commercial communications towers are prevalent in urban areas and will enhance the realism of the live urban area, improving the accuracy of system performance measurements.

3.3.12 JUTC Urban Area Power Distribution

The JUTC will include a reconfigurable power distribution network with the ability to vary the system (e.g., vary transformers, amperage, voltage).

- **Threshold:** Power shall be distributed to 50% of the urban building replicas.
- **Objective:** Power shall be distributed to 100% of the urban building replicas.
- **Rationale:** Electric power is required to support various urban effects and data collection requirements.

3.3.13 JUTC Building Replica Interior and Exterior Electrical Wiring

The building replicas will be pre-wired for electricity with connections on the inside, outside and on the roof.

- **Threshold:** Fifty percent (50%) of the building replicas shall be pre-wired for electricity with connections on the inside, outside, and on the roofs.
- **Objective:** One hundred percent (100%) of the building replicas shall be pre-wired for electricity with connections on the inside, outside, and on the roofs.
- **Rationale:** Electric power is required inside along with connection capability on the outside and rooftops of the building replicas to support various urban effects and data collection.

3.4 AUGMENTED URBAN ENVIRONMENT EFFECTS

Urban environmental effects are a broad category of phenomena associated with the urban terrain that result from the physical properties of the urban triad (topography, population, and infrastructure). As shown in Figure 3.4-1, the elements of the triad do not typically occur in isolation (e.g., buildings with no EM emissions, an RF transmitter that is not in proximity to other RF emitters). The number of possible combinations of the aggregate effects is immense. The building replicas described in Section 3.3.1, Live Urban Area, will produce some effects such as reflection, refraction, scattering, multipath, absorption, and attenuation. Actual physical effects, such as street noise, are not easily represented in underlying infrastructure without exorbitant expense and will require the use of augmented effects. For example, without the actual presence of the thousands of vehicles, personnel, and other sources of background noise found in a populated urban area, it is impossible to represent the actual atmospheric pressure waves these disparate sources create in terms of tone, frequency variation, intensity, and directionality without some form of augmentation such as sound systems. In addition, the sound effects in a commercial UTZ would be dissimilar to the sound effects in a residential UTZ.

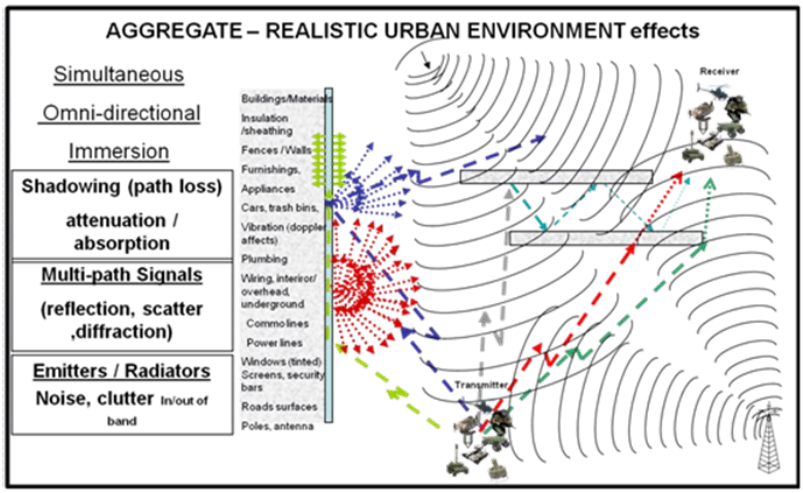

Figure 3.4-1 Aggregate Urban Environment Effects

The required JUTC urban environment augmented effects serve as stimulators that inject urban environment effects at varying levels of fidelity to support the real-time live test environment. The method to achieve the augmentation is not currently defined. Indeed, it is possible that some effects requirements can be satisfied in the live urban environment, depending on the approach. As shown in Table 3.4-1, the threshold and objective levels for these parameters are specified. To the extent possible, the table reduces the ambiguity of the effect by defining the threshold levels of fidelity required and by providing a context for the effect's emulation. This clarification is achieved by identifying, when possible, the presumed proximate cause for the observed effect.

Table 3.4-1 Augmented Effects Requirements

3.4	Augmented Urban Environment Effects	Threshold	Objective
3.4.1	**Urban Radio Frequency Effects (KPP)**	**EME within the frequency band of 1MHz to 8GHz**	**EME within the frequency bands of 1MHz to 20GHz and 26GHz to 95GHz**
3.4.2	External Electrification Effects	Effects of low-frequency Electromagnetic Interference (EMI) and 50/60 hertz (Hz) systems.	EMI environment radiation effects between 1 MHz and 2 GHz associated with the physical components supporting electrical power generation and distribution (selectable 50/60 Hz).
3.4.3	Consumer Product Effects	3 Effects sources	10 Effects sources
3.4.4	Exterior Lighting Effects	25% of building replicas; 2 street lights	100% of building replicas; 4 street lights
3.4.5	Interior Lighting Effects	25% of building replicas	100% of building replicas
3.4.6	Power Generator Effects	10 Effects sources	20 Effects sources
3.4.7	Industrial Effects	2 Effects sources	5 Effects sources

3.4.8	Civilian Vehicles	10 vehicles (of which 5 must be fully functional)	15 vehicles (of which 5 must be fully functional)
3.4.9	Utility Poles	4 to span approximately 200m (1 per 38 meters or 125 ft)	8 to span approximately 200 meters (1 per 38 meters/125 ft)
3.4.10	Overhead wires	200 meters (2x distance of utility pole placement)	400 meters (2x distance of utility pole placement)
3.4.11	Signage	10 Road Signs, 1 Commercial Neon Sign, and 1 Commercial LED sign	20 Road Signs, 2 Commercial Neon Signs and 2 Commercial LED Signs
3.4.12	Commercial Dumpsters, Residential Trash Cans, Steel Barrels, and Steel Tanks	1 Dumpster 5 Trash Cans 1 Steel Barrel 1 Steel Tank	2 Dumpsters 10 Trash Cans 2 Steel Barrels 2 Steel Tanks
3.4.13	HVAC units	5 rooftops, 5 window units	10 rooftops, 10 window units
3.4.14	Satellite Dish	3 Satellite Dish representations	5 Satellite Dish representations
3.4.15	Antennas	5 Rooftop Antennas	10 Rooftop Antennas
3.4.16	Open and Contained Flame Thermal/IR Effect	5 Effects sources	10 Effects sources
3.4.17	Seismic Effects	1 Effects sources	T=O
3.4.18	Acoustic Effects	1 Effects sources	T=O
3.4.19	Obscurant Effects	1 Effects sources	T=O

3.4.1 Urban Radio Frequency Effects (KPP)

RF effects refer to the myriad EM emanations associated with military systems and civilian communication systems (e.g., cellular/radio/TV towers, telephone lines, microwave dishes).

- **Threshold:** Provide the EME within the frequency band of 1 MHz to 8 GHz, including, but not limited to, wireless and cellular telephone, home and network emissions (900 MHz, 1.9 GHz, 2.4 GHz, and 5.8 GHz), public TV and radio emissions, PA system emissions, commercial radio traffic (e.g., emergency service radio networks and taxi trunk radio networks), and global system for mobile communications (GSM) broadcast and control emissions representative of the particular UTZ and world region. It will include the ability to adjust frequency and signal strength to be representative of the particular UTZ and world region. Any effects generated by external/detached sources shall be transportable.

- **Objective:** Provide the EME within the frequency bands of 1 MHz to 20 GHz and 26 GHz to 95 GHz, including microwave emissions (e.g., Worldwide Interoperability for Microwave Access [WiMax] networks), satellite communications (SATCOM), and antenna farm emissions. It shall include the capability to adjust directionality and provide full signal modulation representative of the particular UTZ and world region. These effects shall be designed to support transportability of the effects.

- **Rationale:** EM emissions representative of the urban environment are an important factor that influences military system performance.

3.4.2 External Electrification Effects

External electrification effects refer to a broad range of specific effects that result from transporting electricity for industrial, commercial, and residential purposes. This process includes the generation of and distribution (e.g., transformers, power lines) of electricity. The live urban environment must include the emulation of the effects of electrical transportation (e.g., static, corona, EM fields) and may include the physical structures (e.g., power plants, elevated transformer emulators, and overhead distribution lines).

- **Threshold:** Provide the EM environment radiation effects associated with electrical power distribution, including, but not limited to, distribution points, elevated transformers, low-voltage transmission lines, and unshielded electrical wiring (e.g., three-phase power) representative of the particular UTZ. It will include the effects of low-frequency electromagnetic interference (EMI) and 50/60 hertz (Hz) systems (selectable based on JUTC need). The EME shall be adjustable to suit various UTZs and world regions.

- **Objective:** Provide the EMI environment radiation effects between 1 MHz and 2 GHz associated with the physical components supporting electrical power generation and distribution (selectable 50/60 Hz), including power generation facilities, substations, high-voltage transmission lines (with transformers and gap discharge noise sources), and solar panels.

- **Rationale:** EM emissions and associated EMI representative of the urban environment are an important effect that can influence military system performance.

3.4.3 Consumer Product Effects

Provide an electronic representation of consumer product effects as experienced within a specified UTZ.

- **Threshold:** Provide three (3) consumer products (e.g., refrigerators, microwaves) effects sources. These sources may represent the composite electromagnetic effects of consumer products found in a single residence within the specific UTZ. Any effects generated by external/detached sources shall be transportable.

- **Objective:** Provide ten (10) consumer products effects sources.

- **Rationale:** Near-field EM emissions cause interference with military radio communications and can help provide the load for the power distribution system.

3.4.4 Exterior Lighting Effects

Provide an electronic representation of exterior lighting effects (e.g., building lights, street lights) as experienced within a specified UTZ.

- **Threshold:** Provide 25% of the building replicas with a means of "exterior building lights". Provide two (2) exterior street lights. Any effects sources by external/detached sources shall be transportable.

- **Objective:** Provide 100% of the building replicas with a means of "exterior building lights". Provide four (4) exterior street lights.

- **Rationale:** Near-field EM emissions cause interference with military radio communications.

3.4.5 Interior Lighting Effects

Provide an electronic representation of interior lighting effects (e.g., residential and commercial) created as experienced within a specified UTZ.

- **Threshold:** Provide 25% of the building replicas with interior lighting effects. The source may represent the composite interior lighting electromagnetic effects found within a single specific UTZ. Any effects sources by external/detached sources shall be transportable

- **Objective:** Provide 100% of the building replicas with interior lighting effects.

- **Rationale:** Near-field EM emissions cause interference with military radio communications.

3.4.6 Power Generator Effects

Provide an electronic representation of portable power generation effects (e.g., 2k household generators) as experienced within a specified UTZ.

- **Threshold:** Provide ten (10) power generator effects sources. The generator may represent the composite power generator electromagnetic effects found within a single specific UTZ of interest. Any effects generated by external/detached sources shall be transportable.

- **Objective:** Provide twenty (20) power generator effects sources.

- **Rationale:** Near-field EM emissions cause interference with military radio communications.

3.4.7 Industrial Effects

Provide an electronic representation of industrial area effects (e.g., heavy construction equipment, milling machines) as experienced within a specified UTZ.

- **Threshold:** Provide two (2) industrial area effects sources.

- **Objective:** Provide five (5) industrial industry effects sources. These sources may represent the composite of electromagnetic effects found within a single specific industrial area. Any effects by external/detached sources shall be transportable.

- **Rationale:** Near-field EM emissions cause interference with military radio communications.

3.4.8 Civilian Vehicles

Provide civilian vehicles (e.g., cars, SUVs, bus) to provide the unique aggregate effect of automobiles with regards to the electromagnetic, Doppler, thermal, infrared, acoustic, seismic, obscurant effects in addition to being physical obstacles (obstruction) within the urban area.

- **Threshold:** Provide ten (10) civilian vehicles; one (1) of which must be a commercial/municipal vehicle (e.g., bus) and five (5) in total must be fully functional. The vehicles shall be able to be transported between test sites.

- **Objective:** Provide fifteen (15) vehicles; one (1) must be a commercial/municipal vehicle (e.g., bus) and five (5) in total must be fully functional. The vehicles shall be able to be transported between test sites.

- **Rationale:** All urban areas contain the physical presence of automobiles that can disturb SUT performance by contributing to the overall EM environment and creating obstacles that increase overall mission time.

3.4.9 Utility Poles

Provide utility poles (e.g., telephone/electrical) as expected within a specified UTZ.

- **Threshold:** Provide four (4) utility poles to span approximately 200 meters (1 per 38 meters/125 ft). These shall be transportable between test sites.

- **Objective:** Provide eight (8) utility poles to span approximately 200 meters (1 per 38 meters/125 ft). These shall be transportable between test sites.

- **Rationale:** All urban areas contain the physical presence of utility poles that can disturb SUT performance by creating obstructions that increase overall mission time and contribute to the overall EM environment.

3.4.10 Overhead Wires

Provide overhead utility wiring (e.g., telephone/electrical) as expected within a specified UTZ.

- **Threshold: P**rovide 200 meters (2x distance of utility pole placement) of utility wiring. The JUTC-provided population effects shall be transportable between test sites.

- **Objective:** Provide 400 meters (2x distance of utility pole placement) of utility wiring.

- **Rationale:** All urban areas contain the physical presence of overhead utility wiring that can disturb SUT performance by creating obstructions that increase overall mission time and contribute to the overall EM environment.

3.4.11 Signage

Provide signage as expected within a specified UTZ.

- **Threshold:** Provide ten (10) road signs, one (1) neon sign, and one (1) LED sign as applicable to the specific UTZ. The JUTC-provided population effects shall be transportable between test sites.

- **Objective:** Provide twenty (20) road signs, one (2) neon sign, and two (2) LED sign as applicable to the specific UTZ. These shall be transportable between test sites.

- **Rationale:** All urban areas contain the physical presence of signs that can disturb SUT performance by creating obstructions that increase overall mission time and contribute to the overall EM environment.

3.4.12 Dumpsters, Trash Cans, Steel Barrels, and Steel Tanks

Provide commercial dumpsters, trash cans, steel barrels (e.g., 50gal drums) and steel tanks (e.g., small water storage containers) as expected within a specified UTZ.

- **Threshold:**
  - Provide one (1) dumpster as applicable to the specific UTZ.
  - Provide five (5) trash cans.
  - Provide one (1) steel barrel (e.g., 50 gal drum).
  - Provide one (1) steel tank suitable for water storage.

- **Objective:**
  - Provide two (2) dumpsters as applicable to the specific UTZ.
  - Provide ten (10) trash cans.
  - Provide two (2) steel barrels.
  - Provide two (2) steel tanks.

- **Rationale:** All urban areas contain the physical presence of these items that can disturb SUT performance by creating obstructions that increase overall mission time and contribute to the overall EM environment.

3.4.13 HVAC

Provide functional rooftop and window mounted HVAC systems in order to present the unique aggregate effects with regards to the electromagnetic, Doppler, thermal, infrared, acoustic, seismic, and physical effects within the urban area.

- **Threshold:** Provide five (5) rooftop HVAC systems and five (5) window units.

- **Objective:** Provide ten (10) rooftop HVAC systems and ten (10) window units.

- **Rationale:** Local environmental elements influence EO/IR systems' performance, stress targeting systems and contribute to the overall EM environment.

3.4.14 Satellite Dishes

Provide a physical representation of rooftop satellite dishes as experienced within a specified UTZ.

- **Threshold:** Provide three (3) representations of rooftop satellite dishes.

- **Objective:** Provide five (5) representations of rooftop satellite dishes.

- **Rationale:** Local environmental elements influence EO/IR systems' performance, stress targeting systems and contribute to the overall EM environment.

3.4.15 Antennas

Provide rooftop antennas as experienced within a specified UTZ.

- **Threshold:** Provide five (5) representations of rooftop antennas.

- **Objective:** Provide ten (10) representations of rooftop antennas.

- **Rationale:** Local environmental elements influence EO/IR systems' performance, stress targeting systems and contribute to the overall EM environment.

3.4.16 Open and Contained Flame Thermal/IR Effect

Provide an open and contained flame thermal/IR effect source.

- **Threshold:** Provide five (5) flame thermal/IR effects sources. These sources shall be capable of replicating open flame sources (e.g., bonfires, fire pits, fires in open trash cans, and open cooking fires) as well as contained flame sources (e.g., heaters, ovens). Any effects by external/detached sources shall be transportable.

- **Objective:** Provide ten (10) flame thermal/IR effects sources.

- **Rationale:** IR and thermal effects are part of the urban environment and are an important factor that influences the performance of IR sensors on military systems.

3.4.17 Seismic Effects

Seismic effects refer to the passive vibration effects of moving equipment or pedestrians that can be felt by personnel and detected by military sensors.

- **Threshold:** Provide one (1) seismic effects source. This source will represent effects such as vehicle and pedestrian traffic to include industrial and construction effects. Any effect by external/detached sources shall be transportable.

- **Objective:** Threshold equals Objective.

- **Rationale:** Seismic sensor performance assessment requires representation of the aggregate urban seismic environment.

3.4.18 Acoustic Effects

Provide an acoustic effects source capable of producing a realistic acoustic environment to distracts military personnel, and produces communications challenges.

- **Threshold:** Provide one (1) urban acoustic effects source. The source shall be able to produce, including, but not limited to, the following sources and decibel (db) levels: Busy Street – 60db; Heavy Truck Traffic – 80 db; Subway – 100 db; Power Tools – 100 db. The noise, volume level, and frequencies shall be representative of an urban area associated with a specific geographic region and UTZ. The noise quality shall approximate the directionality and distances of the sources of the noise. Any effects generated by external/detached sources shall be transportable.

- **Objective:** Threshold equals Objective.

- **Rationale:** Testing of acoustic sensors on military systems and operational test events requires representative noise to support realistic environments.

3.4.19 Obscurant Effects

Provide obscurant effects sources capable of replicating the various elements and particulates found in urban air that result from human activity. Represented elements and particulates may be generated by cooking, industrial activity, other effluents, or the presence of explosives.

- **Threshold:** Provide one (1) obscurant effects source. The source may be capable of generating a variety of obscurants effects, including, but not limited to, smoke (e.g., open pit fires, burning trashcans), vehicle exhaust representative of an urban area, multispectral obscurants, blowing sand/dust, and pollution (e.g., smog, haze, water vapor). Any effects by external/detached sources shall be transportable.

- **Objective:** Threshold equals Objective.

- **Rationale:** Sensors located on laser systems and operational testing events necessitate atmospheric conditions representative of the particular UTZ and world region to support a realistic environment.

3.5 VIRTUAL AND CONSTRUCTIVE URBAN ENVIRONMENT

The JUTC defines environments as "live" when they contain people operating real systems, "virtual" when they contain people operating or interacting with simulated systems, and "constructive" when they contain computer-generated forces stimulating computer-generated systems. This section addresses the virtual and constructive environments.

For these environments, JUTC has three attributes:

- A three-dimensional (3D) virtual and constructive engineering model of the live JUTC environment that includes urban replicas, augmentation effects, surrounding terrain, and all controllable entities. This capability will be used to support JUTC test planning and test control.

- A multi-spectral reconfigurable constructive model of the live JUTC environment, including empirical data collected from the live JUTC environment that will be used to support model VV&A. This capability will support numerous hardware in the loop (HWIL) simulators and other virtual simulations.

- A 1 km by 1 km multi-spectral constructive model containing the live JUTC environment surrounded by a representative model urban template. This model will support larger model requirements and support test scenarios involving brigade context operations.

These requirements, which increase in complexity and build on capabilities developed by the previous requirements, are listed in Table 3.5-1. .

Table 3.5-1 Virtual and Constructive Urban Environment Attributes

3.5	Virtual and Constructive Urban Environment	Threshold	Objective
3.5.1	3D Engineering Model	3D Engineering Model of JUTC Live urban area	Model will include day/night variations and terrain features
3.5.2	Multi-Spectral Reconfigurable Constructive Model	EO/IR spectra: visible, long wavelength infrared (LWIR), mid-wavelength infrared (MWIR), near infrared (NIR), Ka-Band; VV&A	S-Band, X-Band, acoustic, UV
3.5.3	1km x 1km Multi-Spectral Model	1km x 1km	T=O

3.5.1 3D Engineering Model of the Live JUTC Environment

A 3D engineering model will be developed for JUTC. This model will provide a dynamic, interactive module that allows customization and reconfiguration based on the live urban area configuration. It will be used for test planning and test control, and will be the basis for the multi-spectral engineering model defined in Section 3.5.2. This model will interface to the JUTC Test Plan Composer (see Section 3.7.1) and the 3D Interactive Situational Awareness System

(see Section 3.7.5). The model will also include terrain features and elevation information surrounding the live environment.

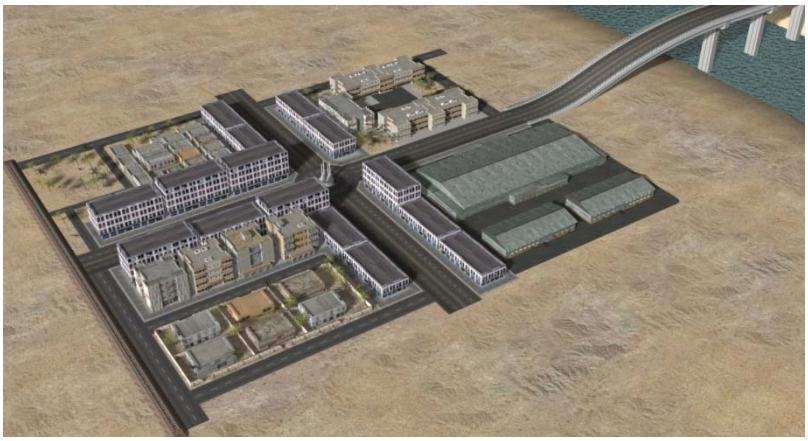

Figure 3.5.1-1 Notional 3D Engineering Model

- **Threshold:** Provide a 3D engineering model of all exterior surfaces of the JUTC live environment to support mission test planning and control. The model will provide a dynamic, interactive module that allows customization and reconfiguration based on the live urban area configuration. The model shall include all structure information and augmentation effects and status information for all controllable environment entities (e.g., lights on/off). The model shall interface to the JUTC Test Plan Composer (Section 3.7.1) and 3D Interactive Situational Awareness System (Section 3.7.5). The model shall support cropping, duplication, and stitching based on test configuration. VV&A shall be completed against the developed JUTC live site as defined in DA Pamphlet 5-11. Accompanying the model shall be a data collection plan defining the type of data needed to support model development and VV&A completion.

- **Objective:** Model shall include interior surfaces, seasonal and day/night variations, sun illumination, and terrain features (e.g., elevation, foliage).

- **Rationale:** Consistent test control requires real-time monitoring of test asset location and status. In an urban environment with multi-story structures, a 3D representation of the JUTC environment is required. This model will interface to the JUTC Test Plan Composer for mission planning. For test control, the model will interface to the 3D Interactive Visualization System.

3.5.2 Multi-Spectral Constructive Model

A multi-spectral constructive model will be developed to support SUT HWIL simulations that provide virtual performance evaluation before exposure to the live JUTC environment. This model will support SUT evaluation throughout the acquisition lifecycle. The model will incorporate all spatial and construction information contained in the JUTC live environment and parameters for multiple spectra, including UV, visible, near-IR, hyper-spectral 1&2, MWIR, LWIR, radio bands, acoustic, seismic, and EM. Prioritization of the spectra to develop and incorporate into the model will be determined based on test requirements. The model will

provide a dynamic interactive module that allows customization and reconfiguration based on the live urban area configuration. The model will also contain IR sources such as cooking fires, HVAC units, streetlights, vehicles, and organic life forms. The model will allow each spectrum incorporated to be enabled and disabled. To support the simulation of weapon system effects on urban environments, the model will also provide parameters for material combustibility, ductility, brittleness, yield strength, material hardness, impact resistance, and chemical makeup. Results from live JUTC tests can then be used to support the VV&A of the model.

This model will also be designed to allow maximum usability by a large number of existing simulations, as well as to allow those simulations to feed the JUTC test events. To support this usability, a model framework and architecture will be developed in conjunction with interface or protocol definitions to ensure maximum utilization.

A JUTC goal is to incrementally add to the information (e.g., spectra, characteristics) included in the urban model to increase the use of M&S for urban T&E purposes. VV&A of the urban model and definition of model realism is needed to support this requirement. A methodology will be provided in parallel with the model that includes framework definition, collection of field data, and modeling of the UETC urban templates, development of multispectral models and material characterization, and incorporation of collected data from the JUTC live environment.

- **Threshold:** Provide a multi-spectral constructive model of the JUTC live urban environment with medium fidelity (.5 m resolution) physical characterization of the dimensions of the environment and its defining elements, including structures, road networks, and other fixed features such as clutter. Propagation characteristics for visible (390–750 nanometers [nm]), LWIR (8–12 µm), MWIR (3–5 µm), NIR (0.78–3 µm), and Ka-band microwave (27–40 GHz) shall be defined and co-registered for all surfaces of all structures. The model shall be reconfigurable to accommodate changes to the live environment. The model shall provide IR sources such as fire and streetlights, diurnal effects, sun intensity, and adverse weather conditions, including rain, mist, fog, temperature, wind, humidity, and atmospheric pressure representative of each world region. VV&A shall be completed against the developed JUTC live site as defined in DA pamphlet 5-11. Accompanying the model shall be a data collection plan defining the type of data needed to support model development and VV&A completion.

- **Objective:** The model fidelity shall be improved to 10 centimeters (cm) resolution and shall incorporate characterization of solid structure physical dimensions and construction type as well as thicknesses and material composition of walls, roofs, and doors. The model shall include interior surfaces for all structures. The model shall also add the aggregate RF effects, including modulated signals and power at each frequency for the JUTC environment. Additional multi-spectral propagation characteristics for all surfaces shall be defined with spectra that include S-Band microwave (1750–2400 MHz), X-Band microwave (8–10 GHz), acoustic (20 Hz–20 kilohertz (kHz)), and UV (10–400 nm). mmW Doppler generation sources for realistic clutter effects shall be included in the model.

- **Rationale:** A high-fidelity, multi-spectral validated model will significantly increase the number of test programs using JUTC capabilities as well as support existing DOD virtual and constructive simulations. This capability will also advance the state of urban M&S utilization.

3.5.3 1km by 1km Multi-Spectral Model

To support larger events, including brigade-sized and joint SOS tests, a larger test environment will be required. To meet this requirement, a 1km by 1km multi-spectral model will be developed. This model will combine the live environment spectral model developed in Section 3.5.2 with a comparable model of the notional urban template. This model will use the spectral information of the live environment model to populate the template model. The model fidelity will be lower than that of the Section 3.5.2 model but will interface with the same HWIL simulators and the JUTC test control display systems.

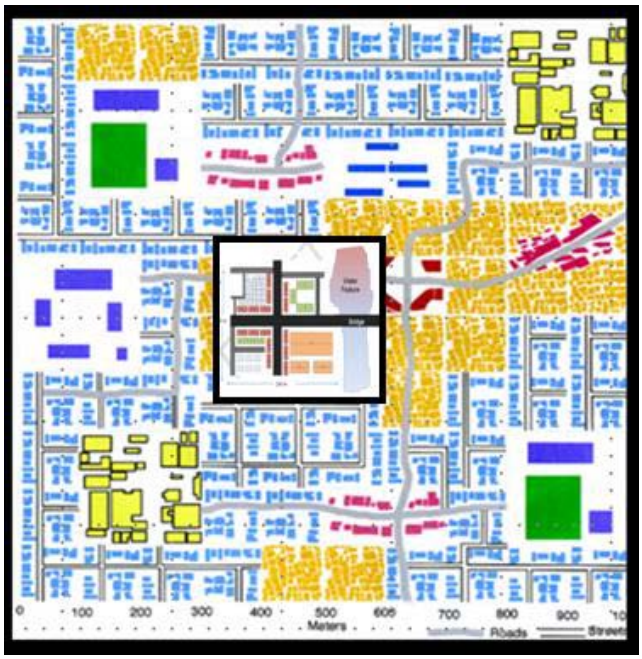

Figure 3.5.3-1 Notional 1km by 1km Multi-spectral Model

- **Threshold:** Provide a multi-spectral constructive model of the 1km by 1km urban template with the live environment model embedded. The model shall have 0.5 m resolution of the dimensions of the environment and its defining elements, including structures, road networks, and other fixed features such as clutter. The model shall incorporate propagation characteristics for visible (390–750 nm), LWIR (8–12 µm), MWIR (3–5 µm), NIR (0.78–3 µm), and Ka-Band microwave (27–40 GHz) and shall be defined for all surfaces of all structures. VV&A shall be completed against the developed JUTC live site as defined in DA pamphlet 5-11. Accompanying the model shall be a data collection plan defining the type of data needed to support model development and VV&A completion.

- **Objective:** Threshold equals Objective

- **Rationale:** A large high-fidelity, multi-spectral model supports brigade-sized test events and SUTs requiring wide FOV urban environments. This capability will also advance the use of urban M&S.

3.6 DATA COLLECTION, REDUCTION, AND ANALYSIS

JUTC will provide data collection capabilities to support testing within the live/maneuver/buffer areas. Existing range capabilities will be leveraged whenever possible to address these requirements. The following have been identified to provide the necessary test coverage for an urban event.

Table 3.6-1 Data Collection Capability

3.6	Data Collection, Reduction, and Analysis	Threshold	Objective
3.6.1	Video Cameras	Standard Definition (SD) (640 by 480 pixels, 30 fps), IR/Visible, 10% interior room coverage	High Definition (HD) (1,280 by 720 pixels, 30 fps), IR/Visible, 20% interior room coverage
3.6.2	Mobile Tower Platform	Two 80 ft. lookdown, 3 tracking gimbals, mobile, 2 view angles	4 Towers
3.6.3	Acoustic Data Collection	20 Hz–20kHz, 10% interior room coverage, time stamped	20 Hz–20 kHz, 20% interior room coverage
3.6.4	EM Spectrum Data Collection	1MHz-20GHz, automatic	Geo-locate signals, mobile recording
3.6.5	Multi-Spectral Data Collection	0.5m resolution, EO/IR spectra; visible, LWIR, MWIR, NIR, Ka-band	10cm resolution; S-band, X-band, acoustic, UV
3.6.6	Video/Audio Data Analysis System	Fuse video/audio, 1 hr playback, edit	Fuse all data sources with virtual and constructive entity overlay

3.6.1 Optics: Video Camera Data Collection

JUTC requires real-time video recording of soldier, vehicle, non-verbal communications, and SUT performance. These systems will record the visible and IR bands and provide fixed coverage of streets, building entrances, and building interior rooms and hallways. Mobile placement (e.g., tripod) will also be supported to provide customization based on specific SUT test requirements. Camera quantities will be sufficient to provide simultaneous coverage of all streets and alleys, all building entrances, and at least 10 percent of all rooms. Video from these cameras will be transmitted to the JUTC test control cell for real-time viewing through the 3D Interactive Situational Awareness System. The optics imagery will be recorded on dedicated optics servers and interfaced to the Video/Audio Analysis System for data analysis playback. These systems will operate reliably inside and outside buildings and in the presence of the JUTC urban augmentation effects. Camera placement will have minimal impact on test events and will support camera relocation among rooms and buildings.

- **Threshold:** Provide cameras with standard definition (640 by 480 pixels, 30 fps), shall support IR and visible spectra, and shall be time synchronized at 1 millisecond accuracy. Camera quantities shall provide simultaneous coverage of 90% of the streets, alleys, and building entrances, and 10 percent of all rooms in the JUTC live area. Mobile placement and camera relocation between rooms shall be supported. All camera imagery shall be transmitted to the JUTC Test Control Cell for display and recorded on dedicated optics servers. Recorded data shall interface to the Video/Audio Analysis System for data analysis and after action report (AAR) functions. Cameras shall operate while systems and participants are immersed in a theater-accurate EM environment, augmented by friendly and hostile EM assets within the JUTC urban terrain. JUTC shall support collection and processing of classified data up to the Secret level.

- **Objective:** Provide cameras with high definition or greater (1,280 by 720 pixels, 30 fps). Additional quantities of cameras shall increase simultaneous coverage to the Threshold plus 20 percent of all rooms in the JUTC live area.

- **Rationale:** Video recording capability provides optical imagery for SUT performance analysis and real-time situational awareness and is a standard customer requirement for most urban test events.

3.6.2 Optics: Mobile Tower Platform Data Collection

JUTC requires operators to track individual test items or manually pan/tilt/zoom throughout the test area. Because of the height of JUTC buildings and infrastructure, camera placement up to 80 feet above ground level will be required to provide unobstructed lookdown angles with adequate FOVs. This elevation also places the cameras above atmospheric boundary layer turbulence, thus significantly improving image quality. The tower platform will also include three independent gimbals (pan and tilt) to allow operator-selectable tracking of three test items. This capability must be mobile to allow customized placement throughout the live area and shall support 24/7 remote control operation from the 3D Interactive Situational Awareness System located in the JUTC Test Control Cell. Automatic tracking will be available for any test item installed with a TSPI data source. These platforms will be configured with cameras providing visible/IR wavelength imagery and zoom lens capability.

- **Threshold:** Provide two (2) tower platforms that provide 80-foot lookdown capability, 500-pound payload capacity, three independent tracking gimbals, mobile capability, and 24/7 remote control operation. Cameras installed on each gimbal unit shall include: (1) color camera (1600 by 1200, 33 fps, 10X zoom lens), (2) infrared day/night operation camera (IR 640 by 480 indium antimonide (InSb) focal plane array (FPA), 120 fps, 150 mm/500 mm dual FOV lens, (3) color analog national television system committee (NTSC) 768 by 494 pixel camera with 35x zoom lens. Each camera shall be installed in a fully weatherized enclosure. Each camera shall be controlled through the 3D Interactive Situational Awareness System and shall provide automatic tracking of test items with TSPI data outputs. The tower platforms shall operate properly when immersed in a theater-accurate EM environment, augmented by friendly and hostile EM effects within the JUTC urban terrain. JUTC shall support collection and processing of classified data up to the Secret level.

- **Objective:** Provide four tower platforms to simultaneously provide views from each corner of the JUTC live area.

- **Rationale:** This capability provides high-fidelity visible/IR imagery and automatic test item tracking capability, which is a standard product provided for most urban test events. These systems will be used for every JUTC test.

3.6.3 Acoustic Data Collection

JUTC will require acoustic recording with adequate fidelity to monitor and analyze SUT acoustic performance throughout the JUTC live area. These sensors will provide fixed coverage of 90% of the streets, building entrances, and building interior rooms and hallways. Fixed placement will be collocated with JUTC video cameras to allow synchronized audio and video measurements. Mobile placement will also be supported to provide customization based on unique SUT test requirements. Directional microphones will be placed as needed to monitor specific points of interest, SUTs, and test participants.

- **Threshold:** Provide audio recording across the entire acoustic frequency band (20 Hz–20 kHz) and time stamped within 1 millisecond accuracy. The acoustic instrumentation shall provide 24 hours of continuous recording. Sensor quantities shall provide simultaneous coverage of all streets and alleys, all building entrances, and 10 percent of all rooms in the JUTC live area. Directional microphones shall be emplaced as needed to monitor specific points of interest, SUTs, or test participants. Mobile placement and sensor relocation between rooms shall be supported. Sensor placement shall have minimal impact on test events and shall support relocation among rooms and buildings. Mobile placement collocated with participants and SUTs shall be supported. The acoustic recording system shall operate while systems and participants are immersed in a theater-accurate EM environment, augmented by friendly and hostile EM assets within the JUTC urban terrain. JUTC shall support collection and processing of classified data up to the Secret level.

- **Objective:** Provide 20-percent coverage of all rooms in the JUTC live area.

- **Rationale:** Acoustic data measurements will be required to analyze acoustic SUT performance within the JUTC live area. This capability also complements the video recording system when evaluating soldier performance during operational test events.

3.6.4 EM Spectrum Data Collection

JUTC will create a realistic urban EM environment to support SUT testing that will require EM spectrum recording for three reasons: 1) to ensure unwanted external EM emissions are not radiating into the test environment and possibly affecting the SUT performance, 2) to ensure the SUT or complementary systems are not radiating out into the surrounding area and possibly violating range EM radiating approvals, and 3) to measure and characterize EM levels within a specific SUT test environment. For example, if a test procedure requires a SUT to work properly when exposed to a certain frequency and power level, JUTC must validate proper RF levels before testing commences.

- **Threshold:** Detect, identify, and locate EM emissions throughout the entire JUTC live area, maneuver area, buffer area, and airspace. Identify emission types, including amplitude modulation (AM), frequency modulation (FM), pulse code modulation/frequency modulation (PCM/FM), pulsed microwave radar, frequency hopping, cellular communications, wireless networks, spread spectrum systems, quadrature/amplitude/phase-shift-keying, and newer modulation techniques as they become threats. Signal strength readings shall be used to establish thresholds for operator alerts and further characterization of detected emitters. Recorded frequency band shall be 1 MHz to 20 GHz. The EM spectrum recording system shall provide automatic operation and warning capability. The EM spectrum recording system shall operate while systems and participants are immersed in a theater-accurate EM environment, augmented by friendly and hostile EM assets within the JUTC urban terrain. JUTC shall support collection and processing of classified data up to the Secret level.

- **Objective:** Provide the capability to geo-locate detected signals and mobile placement collocated with SUTs, including airborne SUTs.

- **Rationale:** The ability to measure and characterize the EM environment is a core requirement for testing in an urban environment.

3.6.5 Multi-Spectral Data Collection

There are two primary requirements for multi-spectral data collection: 1) provide ground truth data in support of a live test event, and 2) provide data to support VV&A of the constructive urban models in Section 3.5.

For test events, a wide range of sensor technologies will be tested in the JUTC urban environment. These sensors will operate in different frequency bands and will require ground truth data, including spectral (e.g., NIR, MWIR, LWIR, mmW, visible) measurements of all targets and surrounding urban clutter. This data will be used to analyze system performance. For example, if an IR sensor is attempting to detect a tank located between two buildings, temperature and IR measurements of the tank and surrounding buildings will be required before the test. If the tank is moving, measurements of multiple buildings and anything along the test course will also be required.

A second purpose for multi-spectral data collection is to support the VV&A of the constructive urban models described in Section 3.5. These models will represent the JUTC live area and will provide multi-spectra characteristics of all buildings and urban features. To validate these models, real data must be collected in a systematic and repeatable method and tagged with supporting meteorological information, including temperature, humidity, and time of day/year. As these models improve in accuracy, model utilization for T&E will increase.

- **Threshold:** Data measurement capability shall have a 0.5 m resolution. Provide radiometric data collection capability in the frequency bands of visible (390–750 nm), LWIR (8–12 µm), MWIR (3–5 µm), NIR (0.78–3 µm), and Ka-Band microwave (27–40

GHz). Real-time measurements of all urban structure external walls and urban clutter shall be performed (e.g., wired thermistor measurements). The multi-spectral data collection system shall operate stand alone or mountable to the Optics: Mobile Tower Platform (Section 3.6.2) tower system. This shall provide measurements and controlled azimuth and elevation angles to support SUT field of views. The multi-spectral data collection system shall operate while systems and participants are immersed in a theater-accurate electromagnetic environment, augmented by friendly and hostile EM assets within the JUTC urban terrain. JUTC shall support collection and processing of classified data up to the Secret level.

- **Objective:** Data measurement capability shall be improved to 10 cm resolution. Collected frequency bands shall also include S-Band microwave (1750–2400 MHz), X-Band microwave (8–10 GHz), acoustic (20 Hz–20 kHz), and UV (10–400 nm). The multi-spectral data collection system shall interface with the helicopter air platform to support data collection points of 100 m to 6 km from urban structures. This air platform capability shall allow dynamic data collection capabilities to provide additional data collection locations

- **Rationale:** Detailed multi-spectral characterization of the live urban environment is necessary to support ground truth measurements of live test events and to facilitate VV&A of the multi-spectral constructive urban model requirements in Section 3.5.

3.6.6 Video/Audio Data Analysis System

As described in earlier sections, JUTC will have a core video and audio recording capability with equipment quantities sufficient to simultaneously provide coverage of all streets and alleys, all building entrances, and at least 10 percent of all rooms. This will create an enormous amount of data that must be time synchronized and fused together for display and analysis. Many customers will also require this function to be performed quickly, to allow support of AARs held shortly after the test event. It will also be important to fuse this data with the other collected data such as TSPI or spectrum measurements. The video/audio analysis tools will also need interactive editing features such as rewind and pause as well as extraction of data subsets. For example, a test might involve video recordings from multiple cameras for a 4-hour period but the customer wants a 5-minute section extracted for a specific use. The video/audio analysis tools must provide fusion with virtual and constructive entities and be viewable on virtual situational awareness displays of the entire JUTC environment as illustrated below in Figure 3.6.6-1.

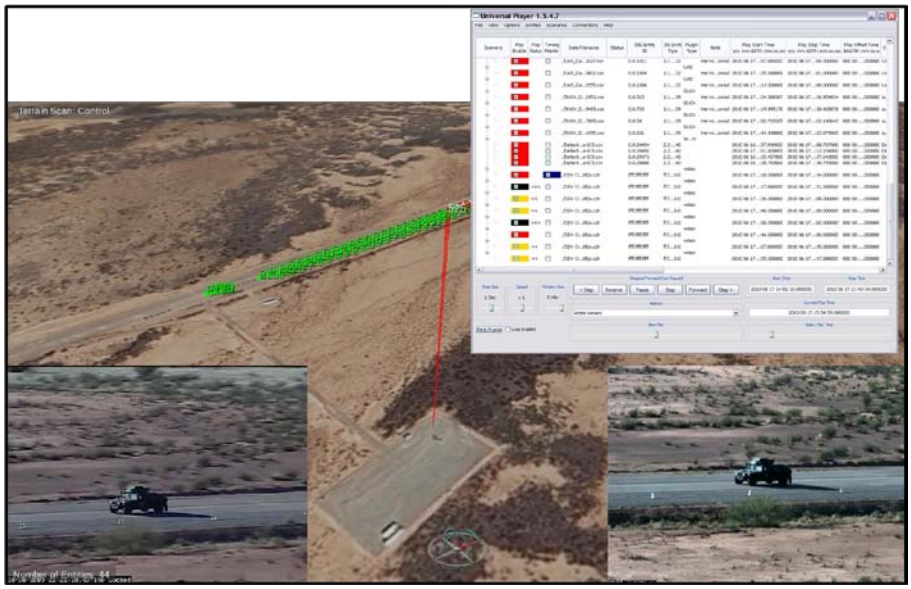

Figure 3.6.6-1 Notional screenshot of a Video/Audio Data Analysis System

- **Threshold:** Fuse all live JUTC video and audio data collection sources into a single interactive data product. The video/audio analysis system shall provide edit capability. All networked data shall be available for playback within 1 hour, and non-networked data shall be available for playback within 24 hours. The JUTC network shall have the capability to store (locally and remotely), dispose, backup, and archive, and, if necessary, convert test data into the information standard data format in accordance with Information Management System Policy. The JUTC environment shall provide a common AAR function that assesses, monitors, records, and plays back exercise and operational events. JUTC shall support collection and processing of classified data up to the Secret level.

- **Objective:** Provide fusion of all other JUTC live data sources with virtual and constructive simulation data sources.

- **Rationale:** Effective data analysis of large test events requires efficient data fusion and display systems.

3.7 TEST PLANNING AND CONTROL

Test Planning and Control can be described as a series of steps that begins with a customer requirement and ends with a successful test event that collects all required test data. Test planning involves the following steps: (1) Capture customer requirements; (2) identify test requirements (e.g., urban structures, structure augmentation changes, data collection tools, threats, virtual support elements, urban augmentation effects, other range support elements; (3) develop the design and test layout for the event; (4) identify test control and scenario scripts; (5) develop cost estimates; and (6) coordinate range scheduling requirements for all support elements. The planning process finishes when the test event begins. Test control involves the following functions: (1) Monitor the status of all test items, including the SUT and supporting vehicles/personnel; (2) ensure all data collection assets are functioning properly; (3) manage the

test countdown and test script execution; (4) maintain situational awareness of the entire test event and adjust in real time as required; and (5) provide collected data to JUTC elements responsible for data reduction and analysis. Many of these steps are capabilities inherent to the test range, such as range scheduling systems or test countdown systems. Other steps might result in paper products such as a test plan or cost estimate.

Table 3.7-1 Test Planning and Control

3.7	Test Planning and Control	Threshold	Objective
3.7.1	Test Plan Composer	Develop planning tools to provide the ability to design a test plan at one test site.	Will be able to support multiple sites in distributed and virtual test scenarios.
3.7.2	Urban Test Site Database	JUTC site database	Methodology for updating the database
3.7.3	Test Control Cell	Support one range location	Support multiple ranges
3.7.4	After Action Review Cell	Support 100 personnel	Support 200 personnel
3.7.5	3D Interactive Situational Awareness System	3D view of test event	Six (6) displays of the SUT, participants, and data collection systems

3.7.1 JUTC Test Plan Composer

The ability to plan and compose an urban test environment (LVC) that supports land and air operations will be developed. The JUTC 3D engineering model developed in section 3.5.1 will enable planners to virtually lay out a test in the urban environment by placing test entities (e.g., SUTs, threats, urban clutter, personnel, noise and EMI generators, data collectors) and evaluate LOS, distances, effects overlap, and void areas. This virtual tool will support cropping, duplication, and stitching.

This tool will support resource planning, cost estimating, and documenting all test event support requirements. Test planning tool products will be preliminary schedule, draft cost estimate, event design plan outline, effects listing, and customized 3D engineering model showing all support entities. These elements will then be used for test control and detailed test planning.

- **Threshold:** Develop planning tools to support test plan development at one live urban test site, augmented by virtual and constructive components. This 3D tool shall provide instrumentation requirements and placement, situational awareness display requirements, and cost and schedule estimates.

- **Objective:** The JUTC planning tools shall support multiple sites, distributed, and virtual test scenarios and enable the test planner to run a simulation of the live test.

- **Rationale:** The urban environment creates unique challenges associated with data collection and data analysis. Automation mitigates some of the time-consuming and error-inducing aspects of the test planning process. A 3D capability is required because the urban environment is 3D (e.g., the JUTC will have sensors and test entities on

different floors of a building). 3D visualization will be required to provide clarity on location.

3.7.2 Urban Test Site Database

To support the JUTC test planning process, a database of urban test site capabilities will be provided. This database will include information on physical structures, augmentation effects, range infrastructure, and data collection capabilities for each database entry. This tool will help facilitate maximum utilization of existing urban test capabilities and ensure that all available capabilities are considered during the test plan development. For example, if the planner is developing a plan that includes a tunnel complex, multi-story urban structures, and a cellular telephone network, the database will provide information on where these capabilities reside and then develop a distributed test scenario using the test plan composer tool described above.

- **Threshold:** The test site database shall provide a repository for all known urban site capabilities. Minimum database content shall include JUTC urban test site capabilities, other collocated test range urban capabilities, and any site survey results.

- **Objective:** JUTC shall provide the methodology for updating the database.

- **Rationale:** Using an urban test site database will ensure maximum utilization of existing capabilities and will support the design of realistic urban test events.

3.7.3 Test Control Cell

JUTC requires a mobile test control cell where test conductors and support personnel execute tests. The cell will provide status and location information for all SUTs, supporting vehicles/personnel, data collection systems, augmented urban effects, and communication/ network layers.

- **Threshold:** The test control cell shall provide location/status/control of all SUTs, supporting vehicles/personnel, data collection systems, augmented urban effects, and communication/network layers. The cell shall also provide status displays for range-provided support elements, including TSPI/RTCA systems, meteorological systems, airspace monitoring systems, and EM spectrum recording systems. The cell shall reside in a JUTC-provided mobile shelter (e.g., van, trailer) of adequate size with sufficient console space to perform all display and control functions. JUTC shall support collection and processing of classified data up to the Secret level.

- **Objective:** The test control cell shall support multiple sites.

- **Rationale:** Test control is a required function to support JUTC test events. A dedicated mobile test control cell in close proximity to the primary JUTC test site serves this function.

3.7.4 After Action Review Cell

After action reviews are a standard requirement for many test events and are normally performed within an hour of the completed test. This function involves the interactive playback and review of test data for the completed test. JUTC will support large SOS test events involving hundreds of test participants; consequently, the AAR cell must be of adequate size to support a large audience. The display systems must also be sized to support a large audience, and the AAR support tools must provide interactive playback and review functionality. The use of a Government supplied or portable building to provide the AAR cell is not precluded. MILCON solutions will not be considered.

- **Threshold:** The AAR cell shall be large enough to support 100 personnel. All test data shall be networked into the AAR cell, and interactive playback and review tools shall allow AAR events within 1 hour of test completion. The AAR cell shall be located within 10 miles of the primary JUTC test site and will have DREN/SDREN connectivity.

- **Objective:** The AAR cell shall be large enough to support 200 personnel. The AAR cell shall be located within 1 mile of the primary JUTC test site.

- **Rationale:** An AAR cell is a required function to support JUTC test events.

3.7.5 3D Interactive Situational Awareness System

JUTC will need 3D interactive situational awareness displays that combine a 3D virtual urban terrain model with overlays of video/camera display and TSPI positional information of SUTs and supporting vehicles/personnel. Various display configurations will be selectable. The system also provides operator controls for the (Section 3.6.2) "Optics Mobile Tower Platform cameras." The operator selects a camera, chooses auto or manual track mode, and then sets camera zoom/pointing information. This system will reside inside the JUTC test control cell.

- **Threshold:** The JUTC 3D situational awareness system shall provide a 3D view of the entire test event, including the urban structures, the instrumentation locations, the SUTs, and any other items pertinent to the test event. The 3D view shall blend live camera feeds with the virtual model. The Section 3.5.1 3D Engineering Model shall be integrated into the 3D virtual model. This system shall provide operator control for the (Section 3.6.2) Optics Mobile Tower Platform cameras. JUTC shall support collection and processing of classified data up to the Secret level.

- **Objective:** Provide six (6) displays of the SUT, participants, and data collections systems.

- **Rationale:** Real-time 3D displays of the SUT, participants, and data collection systems are critical for safe and successful test execution.

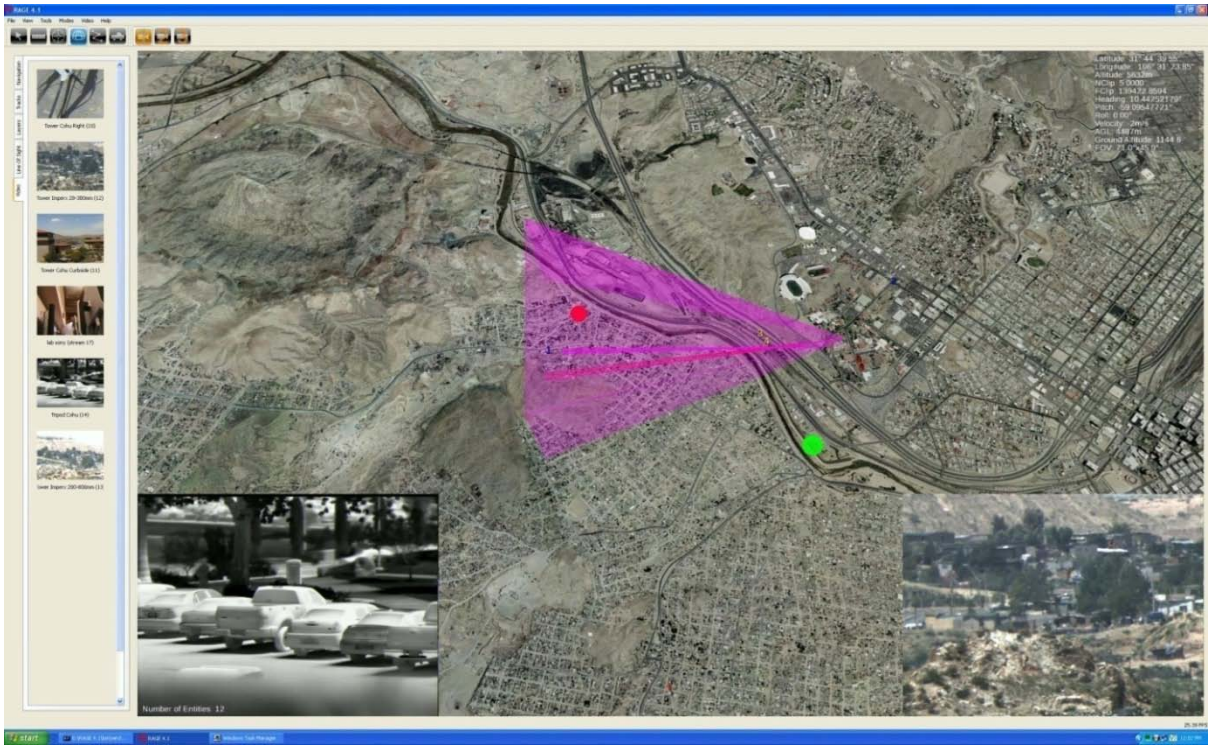

Figure 3.7.5-1 Notional screenshot of a 3D Interactive Situational Awareness System

3.8 TEST ARCHITECTURE AND NET-CENTRIC INTEROPERABILITY

The JUTC test architecture and supporting infrastructure will support all requirements defined throughout this document. The architecture must provide scalability to support test events that may vary in size from a single site with a few participants up to a distributed test event involving multiple sites and hundreds of participants. The architecture must provide flexibility to add new capabilities or instrumentation to the network, and must work seamlessly across multiple test ranges. Table 3.8-1 lists specific JUTC architectural requirements.

Table 3.8-1 Test Architecture Requirements

3.8.	Test Architecture and Net-Centric Interoperability	Threshold	Objective
3.8.1	Distributed Connectivity (KPP)	DREN/SDREN connectivity, OC-12	DREN/SDREN connectivity, OC-48
3.8.2	TENA Compliance	TENA Level 1 compliance, TENA middleware version 6	T=O
3.8.3	Range Gateway Interface	One (1) test range	Multiple test ranges

3.8.1 Distributed Connectivity (KPP)

The JUTC architecture must support test events that will vary in size from a single site with a few participants up to a distributed test event involving multiple sites and hundreds of participants. The architecture will also support interoperability and SOS testing by providing

connectivity to tactical networks and simulate or stimulate C2. To support these requirements, JUTC will require connectivity to the DREN and SDREN networks.

- **Threshold:** The JUTC architecture shall have DREN and SDREN connectivity with OC-12 (622.08 Mbps) bandwidth to support distributed test events.

- **Objective:** The JUTC architecture shall have DREN and SDREN connectivity with OC-48 (2488.32 Mbps) bandwidth to support distributed test events.

- **Rationale:** Distributed connectivity allows the JUTC to create a more robust test environment by interfacing to multiple ranges and M&S facilities.

3.8.2 Test and Training Enabling Architecture Compliance

The JUTC test architecture will maintain Level 1 compliance with TENA. Level 1 compliance states that the TENA middleware will be used and that objects traversing the middleware will be defined as TENA objects. This compliance level allows JUTC to take full advantage of the JMETC tools and other TENA compliant tools. This also allows reuse of legacy tools that may be fully mature and capable through the use of a TENA Gateway.

- **Threshold:** The JUTC architecture shall support TENA compliance Level 1 as defined to use TENA middleware and the object definition policies for JUTC objects using the middleware.

- **Objective:** Threshold equals Objective.

- **Rationale:** TENA is a common architecture for designing, developing, and employing interoperable live range applications. The JMETC has also been developed on TENA. By specifying TENA Level 1 compliance, it will be more efficient to identify, select, employ, and/or develop additional tools that can be used in support of the JUTC but also employed for the JMETC or other LVC systems. TENA will reduce the overall lifecycle costs and will increase interoperability between distributed urban sites.

3.8.3 Range Gateway Interface

A range gateway provides an interface layer between all internal data collection systems and any external systems to the range that require that data. For example, a telemetry data stream can be converted to TENA, input to the range gateway, and then transmitted to a HWIL simulator at a different location. The JUTC test architecture must be compatible with the range gateway to allow maximum flexibility for distributed test events involving multiple sites.

- **Threshold**: The JUTC architecture shall be compatible with the range gateway at the primary JUTC live urban area.

- **Objective:** Threshold plus: The JUTC shall be compatible with the range gateway at a second selected live urban site.

- **Rationale:** Flexible and robust JUTC test control distributed test support requires connectivity to range gateways.

3.9 WEAPONS SYSTEM URBAN TEST CAPABILITY (WS-UTC) REQUIREMENTS

The WS-UTC has two major groups of requirements focused on separately testing the early and end-game parts of an urban weapon engagement, respectively. Because of the large scale required, testing the early part of the weapon engagement requires modeling and simulation of large urban areas, which in turn requires data collection and validation of scenes. Testing the end-game part of the weapon encounter requires small-scale live urban environments incorporating attributed and instrumented target buildings. Both weapon sensor and warhead testing will be supported by the WS-UTC, as the Navy test fires both inert and live weapons during testing.

A target building structure is "attributable" if the attributes of the structure (e.g. façade materials) can be modified so as to change how the structure is seen by a SUT sensor. For example, for the synthetic aperture radar (SAR) sensor of a weapon of interest, the structure's base material cannot be metal and the outer façade may be attributed with brick-over-brick or brick-over-block. The attribution requirement drives toward development of new *composite* Connex structures with built-in placeholders for bricks and blocks to enable rapid development of effective rigid target structures, which support both sensor and warhead testing. For an EO/IR sensor, the requirement for attribution drives toward development of target structures with accurate Bi-directional Reflectance Distribution Functions (BRDFs) to provide proper signatures to EO/IR sensors. EO/IR sensors also require attribution in the form of heat sources to model humans and other building heat sources (e.g. furnace, fire places, etc). Table 3.9-1 lists the requirements for both the WS-UTC modeling and simulation components for T&E of the early part of the weapon urban engagement, and the WS-UTC open-air components for the end-game T&E requirements.

Table 3.9-1 WS-UTC Modeling & Simulation and Open-Air T&E Requirements

3.9	WS-UTC M&S Requirements	Threshold	Objective
3.9.1	**Scene Generator Bands (KPP)**	**IR, MMW**	**IR, MMW, VIS, SAL**
3.9.2	Location of Urban Area	CONUS, ME, SWA	CONUS, ME, SWA, SEA, CA, Africa
3.9.3	Map Size including at least one Urban Area	50 km x 50 km	>200 km x 200 km
3.9.4	Number of Different Maps	3	6
3.9.5	Spatial Resolution	1ft	3 in
3.9.6	Urban Terrain Zones	A1, Dc5	A1, Dc5, Dc3
3.9.7	Spectral Attribution Bands	VIS, IR, MMW, SAL	UV, VIS, IR, MMW, SAL
3.9.8	Spectral Attribution Resolution	5 nm	1 nm

3.9.9	Material Attribution	Roofs, Walls, Sidewalks, Roads, including Reinforced Concrete, Brick, Block, Metal, Adobe,	Roofs, Walls, Sidewalks, Roads, including Reinforced Concrete, Brick, Block, Brick-on-Brick, Brick-on-Block, Metal, Adobe
3.9.10	Bi-directional Reflectance Distribution Function (BRDF) Coverage	-30 to +30 about zenith	-80 to +80 about zenith
3.9.11	Bi-directional Reflectance Distribution Function (BRDF) Resolution	10 degrees	5 degrees
3.9.12	Clutter (Temporal & Spatial Statistical)	IR, MMW	IR, MMW, SAL Band
3.9.13	Clutter and Potential False Alarm Sources	IR (e.g., Lamps, fires, cars), MMW (e.g., Cars, awnings)	IR (e.g., Lamps, fires, cars), MMW (e.g., Cars, awnings, misc. metal structures)
3.9.14	Scene Generator Frame Size	256x256	1024x1024
3.9.15	Scene Generator Frame Rate	100 Hz	400 Hz
3.9.16	Validation	Test and Evaluation Threat Resource Activity (TETRA)	TETRA
3.9.17	Scene Generators	Army (AMRDEC), Navy (IBAR)	Army (AMRDEC), Navy (IBAR)
	WS-UTC **Open-Air Requirements**	**Threshold**	**Objective**
3.9.18	**Target Buildings (KPP)**	**Transportable, Reconfigurable, Attributable 1 & 2 Story**	**Transportable, Reconfigurable, Attributable 1 to 5 Stories**
3.9.19	Location of Urban Area (where aircraft have detachments)	China Lake	China Lake,
3.9.20	Mountable Target Façades	Cement, Brick, Block, Adobe	Cement, Brick, Block, Adobe, Metal
3.9.21	Target Building Types	Metal, Composite, Plastic Conex w/facades, Brick-on-Brick, Brick-on-Block, Adobe	Metal, Composite, Plastic Conex w/facades, Brick-on-Brick, Brick-on-Block, Adobe
3.9.22	Target Building Sizes	10x16x10, 1 story	10x16x10, 2 story
3.9.23	Number of Instrumented Target Buildings	1	3
3.9.24	Number of non-Instrumented Clutter Target Buildings (perimeter)	8	16

3.9.25	Internal Instrumentation	Video, Accelerometers, Thermographic, Barometric	Video, Accelerometers, Thermographic, Barometric
3.9.26	External Instrumentation	Video & IR Cameras running at 200 Hz	Video & IR Cameras running at 1000 Hz
3.9.27	Clutter and Potential False Alarm Sources	IR (e.g., Lamps, fires, cars), MMW (e.g., Cars, awnings)	IR (e.g., Lamps, fires, cars), MMW (e.g., Cars, awnings, misc. metal structures)
3.9.28	Target Building - Initial Development	3 months	1 month
3.9.29	Target Building - Rebuild Time	1 month	Two weeks
3.9.30	Remote Site Connectivity	Yes	Yes
3.9.31	Roadways	1	2
3.9.32	Roadway Const. - Initial Development	3 months	1 month
3.9.33	Roadway Const. - Rebuild Time	1 month	Two weeks
3.9.34	Ground-based Radar Truth-Tracking	Yes	Yes
3.9.35	Validation	TETRA	TETRA
3.9.36	TENA Compliance	TENA Gateways translating existing interfaces	Fully compliant TENA Interfaces
3.9.37	Range Gateway Interface between Remote Site and Range Control Center (RCC)	China Lake	China Lake

One Key performance parameter (KPP) is identified for each of the in the requirement titles in the table.

The M&S requirements listed in Table 3.9-1 support development of a virtual test capability for Small Diameter Bomb II, Tomahawk and other weapons systems T&E. Urban area data collections in and outside of the CONUS are required to gather real data to support map database development, attribution and validation. Requirements for map size and resolution are also included. Note that only small parts of the map need to be attributed, for example the city of Baghdad is only 15 km x 15 km. The remainder of the map is terrain and mountainous regions that come into sensor view when flying an aircraft at altitude. As SDB II, Tomahawk and other weapons use M&S for large scale targeting T&E, scene generator performance specifications are also included to ensure that the new larger, more detailed, maps are effectively presented to the SUT. It is important to integrate the new databases into upgraded Army and Navy scene generators to ensure a complete functional test concept is available for T&E.
Table 3.9-1 also contains the requirements for the end-game portion of the WS-UTC. Note that the end-game portion requires a small-scale urban environment for live-fire T&E. Different types and configurations of structures are required to fully test urban performance of the weapon against buildings, enemy personnel and target vehicles. For example, one instrumented target

building surrounded by 8 non-instrumented clutter buildings in a square configuration, would support live fire tests planned by COTF. The initial location of the capability is required to be at China Lake NWS, where Navy Live-Fire OT&E is scheduled to take place. Target buildings must be transportable to different locations, such as the North and South ranges on China Lake. The structures must be reconfigurable in order to simulate different types of UTZs. Structures also require different base construction materials and facades to ensure the weapon's sensors are effectively tested, and instrumentation is required inside target structures and vehicles for gathering test data. Electromagnetic effects that specifically support WS-UTC are listed at the end of the Open-air WS-UTC section of Table 3.9-1.

It should be mentioned that the JUTC program is not simply building buildings for T&E purposes, because building buildings is not generally a technology development activity. The CTEIP JUTC technology effort is focused on technologies to develop and rapidly attach meaningful facades to transportable and reconfigurable structures. Technology is also required to instrument the target structures and then send the data from remote range sites back to range control sites.

It should also be mentioned that the data collection requirements for the large-scale M&S part of the WS-UTC is subtly different than the data collection for the end-game open-air capability development. The large-scale data collection is primarily conducted by high and low altitude flight recording of data in different bands of sensors. The end-game data collection requires ground-based detailed collections of BRDF of different materials for validation of facades. Ideally, both collections should be done in parallel.

3.10 COMMUNICATIONS JAMMING URBAN TEST CAPABILITY (CJ-UTC) REQUIREMENTS

The Navy's requirements for urban comms jamming T&E come primarily from the TEWTCS Study and the "C2 and Urban Background Environment Simulator" (CUBES). The Navy currently has an outdated Joint Communications Simulator (JCS) at the Pax chamber. JCS, when it is working, supports a standard set of conventional comm signals. JCS does not support modern and C2 comms and other signals encountered in urban environments. The CJ-UTC addresses the TEWTCS identified gap, which is tied to an NGJ test shortfall highlighted by COMOPTEVFOR as required for effectiveness testing for OT&E.

To address the shortfalls, the CJ-UTC has two major groups of requirements focused on testing the jamming of threat communications in a chamber and on an open-air range, respectively. Because of restrictions and limitations for radiating jamming signals, NGJ has scheduled substantial chamber time at NAS Patuxent River for T&E, and urban comms signals are required to augment and improve the planned testing. For open-air T&E, limited jamming engagements are to follow at China Lake, and urban comms signals are required to augment and improve the final OT tests. Note that both indoor and outdoor test sequences are required for end-to-end testing of open-loop and closed-loop communications jamming.

Table 3.10-1 lists the requirements for the chamber-based and open-air threat jamming T&E capabilities. Note that there is no requirement for any buildings or MILCON at China Lake as part of the CJ-UTC. The open-air urban comms emitters and receivers will be in mobile vans to enable testing on any range.

Table 3.10-1 CJ-UTC Chamber and Open-Air T&E Requirements

3.10	CJ-UTC Chamber Requirements	Threshold	Objective
3.10.1	**Number of High Fidelity Signals (Programmable & Testable) (KPP)**	**>10**	**>20**
3.10.2	Chamber Location	NAS Pax River	NAS Pax River
3.10.3	Portability	Transportable	Transportable
3.10.4	Frequency Range	20 MHz – 8 GHz	2 MHz – 18 GHz
3.10.5	Number of Low Fidelity Signals (Externals)	>250	>1000
3.10.6	Low-Fidelity (Externals) Signal Parameters	Frequency, Amplitude, Bandwidth, Duration	Frequency, Amplitude, Bandwidth, Duration
3.10.7	High Fidelity Signal Parameters	Frequency, Amplitude, Bandwidth, Duration, Angle-of-Arrival, Pulse Structure, Data Words	Frequency, Amplitude, Bandwidth, Duration, Angle-of-Arrival, Pulse Structure, Data Words
3.10.8	Chamber free-space emitters	>12	>25
3.10.9	Urban Comm System (UCS)	>260 Signals	>1020 Signals
3.10.10	Injection Interface	E/A-18G	E/A-18G, F-35
	CJ-UTC Open-Air Requirements	**Threshold**	**Objective**
3.10.11	**Open-air free-space directional emitters (Programmable, Testable) (KPP)**	**2**	**>5**
3.10.12	Open-Air Test Location	NWS China Lake	NWS China Lake
3.10.13	Portability	Transportable	Transportable
3.10.14	Placement	Standalone, Among existing AEA threats	Standalone, Among existing AEA threats
3.10.15	Open-air free-space omni emitters	>12	>25
3.10.16	Copy of UCS from Chamber with Tx/Rx	2	4
3.10.17	Open-air free-space omni receivers	>12	>25

3.10.18	Open-air free-space directional receivers (Programmable, Testable) (KPP)	2	>5
3.10.19	Instrumentation	RF Monitor, Video Cameras running at 200 Hz	RF Monitor, Video Cameras running at 200 Hz
3.10.20	3D Interactive Situational Awareness System	Single Operator Display and Interface	Six Operator Display and Interfaces
3.10.21	TENA Compliance	TENA Gateways translating existing interfaces	Fully compliant TENA Interfaces

For the CJ-UTC chamber-based T&E capability, the test location is required to be the chamber at Pax River NAS, where NGJ has already committed to substantial chamber hours (>5000 hours) of testing. The system shall be transportable to support Army and Air Force tests at other chamber locations.

Note that it is easier to generate a high-density signal environment with up to 1000 signals due to the injection interface. The Urban Comm System (UCS) is a capability upgrade to the Navy's Joint Communication Simulator (JCS) to handle modern communication and command and control signals.

For the CJ-UTC open-air T&E capability, the test location for the open-air testing is required to be at Naval Weapons Station (NWS) China Lake, where planning on testing for several months utilizing existing threats that can augment the planned test events. The JUTC CJ-UTC open-air T&E capability shall be transportable and reconfigurable to support Army and Air Force tests at other locations.

Note that fewer signals are required, largely due to cost and complexity. The chamber-based UCS is employed to generate the signals, where upconverters, power amplifiers and antennas are added, along with distributed emitters interspaced in a small-scale live urban environment. Because jamming may need to occur through a sidelobe, directional emitters are required. Note that very few specific emitters are the target of the jam signal, hence the size of the UTZ need not be large, but the configuration needs to be specific (e.g. urban canyon of specified heights) to support the tests of interest.

It is envisioned that the Open-air CJ-UTC will leverage the physical structures of the WS-UTC, where different building spacings and heights create different UTZs for comms jamming T&E.

3.11 IRCM SYSTEM URBAN TEST CAPABILITY (IS-UTC) REQUIREMENTS

The IRCM system urban test capability is focused on developing databases to support improved ground-testing of end-to-end IRCM systems. The M&S urban databases developed under JUTC support the Joint Distributed IRCM Ground-test System (JDIGS). Open-air IRCM T&E requirements are being met by the Multi-spectral Sea And Land Target Simulator (MSALTS).

Table 3.11-1 IS-UTC Modeling and Simulation Requirements

3.11	IS-UTC M&S Requirements	Threshold	Objective
3.11.1	**Scene Generation Bands (KPP)**	**UV, MWIR**	**UV through LWIR**
3.11.2	Spectrum Collected	UV, MWIR	UV through LWIR
3.11.3	Spectrum Resolution	5 nm	1 nm
3.11.4	Time of Day	Day & Night	Morning, Afternoon, Early Evening, Late Evening
3.11.5	Location of Urban Collections	CONUS, ME, SWA	CONUS, ME, SWA, SEA, CA, Africa
3.11.6	Airborne Collection Altitude	<1000 ft. AGL	>1000 ft & <300 ft AGL
3.11.7	Meta-Data	Humidity, Ozone, Visibility, Temperature, Pressure	Humidity, Ozone, Visibility, Temperature, Pressure
3.11.8	Seasonal Collection	Summer, Winter	Spring, Summer, Winter, Fall
3.11.9	Airborne Large-Scale Collection	Existing Assets (e.g., Sensors, Cameras, Radiometers, Spectrometers)	Existing Assets (e.g., Sensors, Cameras, Radiometers, Spectrometers)
3.11.10	Ground-based Detail Collection	Existing Assets (e.g., Sensors, Radiometers, Spectrometers)	Existing Assets (e.g., Sensors, Radiometers, Spectrometers)
3.11.11	Urban Map Resolution	1 ft	3 in
3.11.12	Spectral Bands Database Attribution	UV, MWIR	UV through LWIR
3.11.13	Material Attribution	Three Angles (e.g., Forward, Glint & Back Scattering)	10 degree BRDF
3.11.14	Clutter (Temporal & Spatial Statistical)	UV, IR	UV through LWIR
3.11.15	Potential False Alarm Sources	Point (e.g., Arc Welders, Lights) & Distributed Sources (e.g., Fires, Hot Features)	Point (e.g., Arc Welders, Lights) & Distributed Sources (e.g., Fires, Hot Features)
3.11.16	Scene Generator Integration	Army (RTC), Navy (ACETEF)	Army (RTC), Navy (ACETEF)

The requirements listed for the IS-UTC modeling and simulation have embedded data collection requirements. The IS-UTC M&S requirements are compatible with the M&S requirements of the WS-UTC. Ideally, the WS-UTC and IS-UTC capabilities should be developed in parallel.

4. LOGISTICS AND INFRASTRUCTURE SUPPORT REQUIREMENTS

This section provides the logistic requirements that will affect design and supportability alternatives. Logistics requirements are discussed in general terms. Detailed logistics concepts will be documented in the JUTC Life Cycle Support Plan (LCSP).

4.1 LOGISTICS AND READINESS

In general, it is anticipated that the maturity of the attributes that comprise JUTC will ensure supportability is incorporated throughout the systems engineering process and overall design. It is expected that the extensive use of Commercial-off-the-shelf (COTS), Government-off-the-shelf (GOTS) and Nondevelopmental Items (NDI) will ensure supportability and commercial best practices are achieved in addition to supporting DOD initiatives regarding sustainment processes and reducing total ownership cost.

The modular design approach is the principal design feature that will ensure high Reliability and Availability. The ability of maintenance personnel to efficiently disconnect and connect key components is the underpinning of Availability. Consistent Reliability will be upheld, if not improved, by inserting the latest technological upgrades during normal maintenance cycles. The modular design approach should have an emphasis on Line Replacement Units (LRU) as its key design factor.

The same modular design approach is also the foundation of Maintainability. The large use of COTS and GOTS throughout JUTC will further substantiate proven support techniques and common practices that will be incorporated at the gaining installation. As a result of the unique content and stable design of JUTC, appropriate Reliability, Availability and Maintainability (RAM) requirements will be added to each subsystem specification.

Each Service Command will have complete sustainment responsibility for funding and conducting all logistics, operations, and maintenance upon the acceptance of JUTC for the duration of the Operations and Support (O&S) phase to include disposal. To minimize life cycle cost and supportability demands on the gaining installations, Original Equipment Manufacturer (OEM) warranties should be implemented to the greatest extent possible. OEM warranties support O&S cost efficiencies by controlling sustainment cost (e.g.; maintenance tasks/Manpower), help to mitigate obsolescence, and ensure commercial best practices are continuously implemented.

4.2 MAINTENANCE CONCEPT

Sustainment will be performed by government/military resources in collaboration with each of the Service's respective on-installation Life Cycle Contractor Support (LCCS) providers. The Service User will immediately assume all sustainment responsibilities upon acceptance of JUTC. OEM warranties and Line Replacement Units (LRU) will be used to the greatest extent possible to minimize the increase of maintenance personnel and reduce overall maintenance tasks/hours. Each of the Service's gaining installations will be responsible for incorporating JUTC within their existing range supportability strategy.

4.3 INFRASTRUCTURE SUPPORT EQUIPMENT

JUTC will require some range provided equipment in addition to ordinary garrison/base support when it is incorporated as another range asset on the installation. This includes incorporating JUTC within the installation's test infrastructure and test architecture. The particular on-installation and/or range provided equipment (e.g.; Material Handling Equipment), facilities and resources needed to support JUTC will be coordinated with the Service User and identified in the LCSP.

4.4 HUMAN SYSTEMS INTEGRATION

JUTC will not introduce any new federal workforce job categories, additional skill identifiers, or Military Occupational Specialties (MOS) for either test operations personnel or maintenance personnel that are not already required at the range installation by the Service User. The Service User will evaluate and identify all of the appropriate Force Structure personnel requirements necessary to support JUTC for their respective test range/installation. Any additions or adjustment to existing Post/Base/Range Force Structure (e.g.; Basis of Issue Plans) will be accomplished by the Service.

New Equipment Training (NET) for both test operations personnel and maintenance personnel will be provided to the gaining installation. Additionally, a training support package will accompany the fielding of JUTC to provide sustainment training for the Service User.

4.5 COMPUTER RESOURCES

The JUTC test control cell or the host Post/Base/Range test center will require some additional support equipment, hardware and software to satisfy JUTC test planning and management functions. The specific test center requirements will be directly coordinated with each Service User. And all hardware and software automation requirements will adhere to DOD Information Assurance policies. The Service User's requirements will be identified in the LCSP.

4.6 TRANSPORTATION

To fully support the Service test agencies, essential JUTC components must be able to be moved and transported within the actual test site (e.g., for test event configuration), throughout the host installation (e.g., to/from maintenance and warehouse facilities) and from one Post/Base to another Post/Base. Furthermore some aspects of JUTC such as the effects generators and instrumentation package may contain sensitive equipment and may require special handling procedures when moved. All items identified for transport will meet the guidance of either Military Standard (MIL-STD) 1472-F, Military Standard: Human Engineering, Design Criteria for Military Systems, Equipment, and Facilities, or best commercial practices. The JUTC Life Cycle Support Plan (LCSP) will cover all Integrated Logistics Support (ILS) requirements to include identifying the necessary material handling equipment (MHE).

4.7 ENVIRONMENTAL SUPPORT

All environmental considerations and requirements will be conducted on a range-by-range basis depending on the integration requirements. These include, but are not limited to environmental clearances for location of urban structures, roads, vehicle trails; installation of underground fiber;

identification of maneuver area restrictions; and identification of protected environmental or cultural areas.

5. STANDARDIZATION, INTEROPERABILITY, AND COMMONALITY

JUTC will meet all of the policies, test infrastructure and test architecture requirements of the host Major Range and Test Facility Base (MRTFB).

5.1 STANDARDIZATION

JUTC will incorporate the Joint Mission Environment Test Capability (JMETC) family of products to the greatest extent possible. JMETC provides the Service User a readily available, persistent connectivity with network security accreditation, common integration software for linking sites and accredited test tools for distributed testing.

The use of existing JMETC tools will benefit the Service User by providing:

- Tools for planning
- Technical support for network requirements and operations
- Integration of software
- Help Desk Functions
- Network performance analysis
- Field support with experienced engineers

The use of JMETC will provide the Service User with a core, reusable and easily reconfigurable infrastructure consisting of the following products:

- Persistent connectivity
- Middleware
- Standard interface definitions and software algorithms
- Distributed test support tools
- Data management solutions
- Reuse repository

The use of JMETC connectivity will support the Service User by providing:

- Distributed trusted connectivity on the Secure Defense Research and Engineering Network (SDREN)
- Encrypted for Secret-System High
- DISA registered IP address space
- Active monitoring of network performance
- Capable of supporting multiple simultaneous test events

5.2 INTEROPERABILITY

JUTC will use existing test range instrumentation, data collection systems and infrastructure where possible. This will include range fiber networks for passing data and control information; range safety, airspace and frequency monitoring systems; range test control systems; and

distributed connectivity systems for communication outside the test range. As urban test capabilities are developed, they will be designed to integrate and interoperate within the range infrastructure. JUTC will incorporate efficient networking and configuration management tools, address the instrumentation encryption needs and multi-level security requirements, and ensure compliance with IA network certification and accreditation requirements. These tools will interoperate with current DOD networking architectures and protocols.

5.3 COMMONALITY

To prevent duplication of effort and to promote compliance and use of common tools, JUTC will implement architecture requirements, technical standards, and interoperability standards such as utilizing Test and Training Enabling Architecture (TENA) compliant capabilities.

6. SCHEDULE CONSIDERATIONS

The Vice Chief of Staff of the Army (VCSA) Execution Order (EXORD), dated 17 September 2010[(11)], provides direction for the Army to conduct formal network IT&Es starting 1 March 2012. This will be the first of several future integrated events. A complex urban environment of sufficient size to support brigade-level operations is a requirement. This will include live Warfighters and equipment in a live urban environment.

Anticipated major tests in the out years that require urban environments include:

- Network Integration Exercise (NIE) (Semi-annual test/exercise)
- EIBCT Network Interface Kit (NIK) (TBD)
- Ground Combat Vehicle LUT/IOT (TBD)

With regards to other possible Army tests in the out years, it currently appears that both the Joint Tactical Radio System (JTRS) and Warfighter Information Network–Tactical (WIN-T) Increment 2 will be fielded between now and 2014. While not currently scheduled, it is very likely that Product Improvement Programs (PIP) for both JTRS and WIN-T will occur in the 2016+ time frame so the potential exists for these systems to require JUTC.

For the Navy, the following additional programs were surveyed:

- Next Generation Jammer (NGJ)
- Joint Allied Threat Awareness System (JATAS)
- Common IR Counter Measure (CIRCM)
- Joint Direct Attack Munition (JDAM)

Of these, projected test dates requiring an urban environment capability are:

- F/A-18 SDB II Integration (FY16)
- NGJ IOT&E - CJ-UTC (FY16)
- NGJ - CJ-UTC IOT&E (FY17)
- JATAS IOT&E - IS-UTC (FY13)
- JATAS IOT&E - IS-UTC (FY14)

7. DISCUSSION

Near-term urban T&E shortfalls have been identified for programs of record such as the F/A-18 SDB II Integration (FY16), the Next Generation Jammer (T&E Need IT&E 4QFY16, IOT&E 1QFY19) and the Joint Allied Threat Awareness System (T&E Need IOT&E FY14). For F/A-18 SDB II Integration, Tomahawk, and other modern multi-mode munitions systems, an end-to-end urban T&E capability is required, including M&S for large-scale urban T&E and live urban targets for end-game T&E. For NGJ, a capability is required to test blue jamming of red communications networks in an urban high-density RF environment. This was supported by the Tri-Service Electronic Warfare T&E Capability Study (TEWTCS). For JATAS, validated databases are required to test urban missile warning system performance. This was supported by the IRCM Test Resource Requirements Study (ITRRS).

To help focus the JUTC development activities to support required planned tests, the JUTC program will develop three types of urban test capabilities, aligned with the three key testing shortfalls:

1. Weapons System Urban Test Capability (WS-UTC)
2. Comms Jamming Urban Test Capability (CJ-UTC)
3. IRCM Systems Urban Test Capability (IS-UTC)

Developing these three types of urban test capabilities will enable focused development of critical technologies to support planned tests that address the specific shortfalls, while developing a test capability that can be modernized to address shortfalls for future tests.

8. REFERENCES

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4. TRMC Urban Environment Test Capability (UETC) Study, 2010. This study analyzed current urban environment test capabilities, weapon system test requirements, and performed gap analysis of urban environment test requirements.

5. US Army TRADOC G2 Handbook No. 1.

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7. Ellefsen, Richard, and Fordyce, David. "Urban Terrain Building Types, Second Edition." *Army Research Laboratory Study, ARL-TR-4395*. 2008. This study defines the seven UTZs in theater and their attributes and basis for templates in the 2007 Strategic Plan for DOD T&E Resources. It includes an appendix that describes the current urban area T&E shortfalls and requirements.

8. Director, Test Resource Management Center. 2007 Strategic Plan for DOD Test and Evaluation Resources. 30 September 2007. This plan specifies urban environment T&E requirements and defines a broad roadmap methodology.

9. Urban Test and Training Range Study, ADSS Project No. 2006-DT-EPG-FCSUS-D0955, EPG Publication No. SS06-05-001. 2006. This study provides extensive analysis of urban test requirements to support Future Combat Systems (FCS) and other net-centric weapon systems.

10. Radford Jr., Denzil J. JUTC Urban Area Development Analysis, 2010.

11. TRMC Program Objective Memorandum (POM) 08 AUG 08. This issue paper outlines the basis of the need, the description of the capability and the proposed funding for the program.

APPENDIX A - ACRONYMS

1CD	1st Cavalry Division
25ID	25th Infantry Division
3-D	three-dimensional
4DWX	Four-Dimensional Weather System
AAR	After Action Review
ABCS	Army Battle Command System
ACETEF	US Navy Air Combat Environment T&E Facility
AFATDS	Advanced Field Artillery Tactical Data System
AM	Amplitude Modulation
AMDWS	Air and Missile Defense Work Station
API	Application Programmers Interface
ASAS	All Source Analysis System
ATEC	Army Test and Evaluation Command
BFT	Blue Force Tracker
C2	Command and Control
C3	Command, Control, and Communications
CACTF	Combined Arms Collective Training Facility
CDRL	Contract Data Requirements List
CL I UAV	Class 1 Unmanned Air Vehicle
cm	Centimeter
COIN	Counterinsurgency
COMINT	Communications Intelligence
CONOPS	Concepts of Operations
COTS	Commercial Off the Shelf
CPoF	Command Post of the Future
CSSCS	Combat Service Support Control System
CT	Counterterrorism
CTEIP	Central T&E Investment Program
DCRA	Data Collection, Reduction, and Analysis
DIACAP	Department of Defense Information Assurance Certification and Accreditation Process
DOD	Department of Defense
DREN	Defense Research and Engineering Network
DT	Developmental Test
DT&E	Developmental Test and Evaluation
DTIC	Defense Technical Information Center
E-IBCT	Early-Infantry Brigade Combat Team
ELINT	Electronic Intelligence
EM	Electromagnetic
EME	Electromagnetic Effects
EMI	Electromagnetic Interference
EO	Electro-optical

EPLRS	Enhance Position Location Reporting System
ERMP/GRAY EAGLE	Extended Range Multi-Purpose
EW	Electromagnetic Warfare
EXORD	Execution Order
FBCB2	Force XXI Battle Command Brigade and Below
FCS	Future Combat Systems
FM	Frequency Modulation
FOT	Final Operational Test
FOV	Field of View
FPA	Focal Plane Array
fps	Frames per Second
FY	Fiscal Year
GHz	Gigahertz
GMR	Ground Mobile Radio
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HD	High Definition
HLA	High Level Architecture
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HVAC	Heating, Ventilation, Air Conditioning
HWIL	Hardware in the Loop
Hz	Hertz
IA	Information Assurance
IBCT	Infantry Brigade Combat Team
IIR	Initial Impressions Report
Insb	Indium Antimonide
IOT	Initial Operational Test
IR	Infrared
IRCC	Inter-Range Communication Center
ISR	Intelligence, Surveillance, and Reconnaissance
IT&E	Integration Test and Evaluation
ITTP	Installation, Test, and Transition Plan
ITTS	Instrumentation, Targets, and Threat Simulators
JAGM	Joint Air-to-Ground Missile
JADM	Joint Direct Attack Munition
JCA	Joint Capability Areas
JMETC	Joint Mission Environment Test Capability
JTRS	Joint Tactical Radio System
JUO	Joint Urban Operations
JUTC	Joint Urban Test Capability
kHz	Kilohertz
km	Kilometer
KPP	Key Performance Parameters
LCSP	Life Cycle Support Plan

LOS	Line of Sight
LRU	Line Replaceable Unit
LUT	Limited User Test
LVC	Live-Virtual-Constructive
LWIR	Long Wavelength Infrared
m	Meter
M&S	Modeling and Simulation
Mbps	Megabits per Second
MCS	Maneuver Control System
MCAGCC	Marine Corps Air Ground Combat Center
MEDEVAC	Medical Evacuation
MHz	Megahertz
MIL STD	Military Standard
MM-UGV	Multi-Mission Unmanned Ground Vehicle
mmW	Millimeter Wave
MOS	Military Occupational Specialty
MOUT	Military Operations on Urban Terrain
Mpx	Megapixel
MSL	Mean Sea Level
MTOE	Modified Table of Organization and Equipment
MTS	Modernization Through Spares
MWIR	Mid-Wavelength Infrared
NTSC	National Television System Committee
NDI	Non-Developmental Item
NEPA	National Environment Policy Act
NEWEG	Next Generation Electronic Warfare Environment Generator
NIK	Network Integration Kit
NIR	Near Infrared
Nm	Nanometer
O&M	Operations and Maintenance
OC	Optical Carrier
OE	Operational Environment
OIF	Operation Iraqi Freedom
OSD	Office of the Secretary of Defense
OT	Operational Test
OT&E	Operational Test and Evaluation
PA	Public Address
PCM	Pulse Code Modulation
PIP	Product Improvement Program
PM ITTS	Project Manager For Instrumentation, Targets and Threat Simulators
QDR	Quadrennial Defense Review
RAM	Reliability, Availability, and Maintainability
RF	Radio Frequency
RTC	US Army Redstone Test Center

SA	South America
SATCOM	Satellite Communications
SD	Standard Definition
SDREN	Secret Defense Research and Engineering Network
SINCGARS	Single Channel Ground and Airborne Radio System
SME	Subject Matter Expert
SOS	System of Systems
SRW	Soldier Radio Waveform
SUGV	Small Unmanned Ground Vehicle
SUT	System Under Test
SWA	Southwest Asia
T&E	Test and Evaluation
TCRD	Test Capability Requirements Document
TDA	Table of Distribution and Allowances
TENA	Test and Training Enabling Architecture
TRADOC	Training and Doctrine Command
TRMC	Test Resource Management Center
TSPI	Time-Space-Position Information
TT	Test Technology
TTP	Tactics, Techniques, and Procedures
T-UGS	Tactical–Unmanned Ground Sensors
TV	Television
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
UE	Urban Environment
UETC	Urban Environment Test Capability
UHF	Ultra High Frequency (328.6 MHz–2.9GHz)
UTTR	Urban Test and Training Range
UTZ	Urban Terrain Zone
U-UGS	Urban–Unmanned Ground Sensors
UV	Ultraviolet
VCSA	Vice Chief of Staff of the Army
VPN	Virtual Private Network
VV&A	Validation, Verification, and Accreditation
WiMAX	Worldwide Interoperability for Microwave Access
WINT	Warfighter Information Network–Tactical
WIPT	Working Integrated Product Team
WNW	Wideband Network Waveform

APPENDIX B - UTZ DEFINITION

Appendix B contains a summary of the UTZs as defined by the 2010 UETC study. Each of the seven UTZ building types (e.g., attached and closely spaced inner-city buildings, wide-spaced high-rise office buildings, attached houses, closely spaced industrial/storage buildings, widely spaced apartment buildings, detached houses, widely spaced industrial/storage buildings) is shown in Figure B-1. The UTZ Summary Table B-1 lists the types of buildings contained within each UTZ. Detailed descriptions of the size and construction materials of these buildings, as well as their intended use/purpose are provided in the subsequent tables.

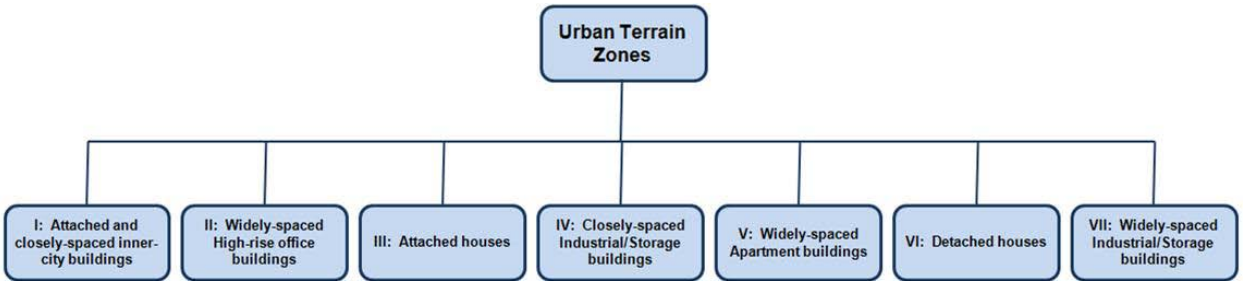

Figure B-1 Urban Terrain Zones

Table B-1 UTZ Summary

UTZ Summary	
UTZ	**Building Summary**
UTZ I: Attached and Closely Spaced Inner-City Buildings	A1: Commercial offices A2: Apartments/hotels A5: Commercial ribbon development A9: Commercial residential only slightly modified old city core
UTZ II: Widely Spaced High-Rise Office Buildings	Dc1: Commercial office Dc5: Commercial office (“Outer City”)
UTZ III: Attached Houses	A3: Apartments and abutted-wall houses Dc2:Residential apartments/row houses Dc3: Residential houses Dc7: Residential dominant, former nucleated agricultural village Dc8: Residential “Shanty Town”
UTZ IV: Closely Spaced Industrial/ Storage Buildings	A4: Industrial/storage; near core area Dc4: Industrial storage, linear building pattern
UTZ V: Widely Spaced Apartment Buildings	Do2: Residential apartments and row housing
UTZ VI: Detached Houses	Do3: Residential houses
UTZ VII: Widely Spaced Industrial/ Storage Buildings	Do1: Shopping centers Do4: Industrial/storage Do5: Commercial ribbon development Do6: Administrative/cultural (e.g., government, schools, hospital complexes)

Table B-2 UTZ I: Attached and Closely Spaced Inner-City Buildings

UTZ I: Attached and Closely Spaced Inner-City Buildings
A1: Commercial offices, retail, etc.; core area; low- to high-rise; mass and framed construction; to present— In the Commercial Core, buildings are abutted to one another along the street, have little or no setback from the sidewalk, and occupy all or nearly all of the lot on which they sit. Brick buildings are commonly found in the oldest parts; framed, heavy-clad structures in the next-to-oldest parts, and a concentration of framed, light-clad buildings in the newest parts. The zone is highly valuable. It is the headquarters for commercial/financial activity and usually has important cultural and government buildings. Significant subterranean features exist in the form of basements, underground parking/ shopping areas, and transportation facilities. A wide variety of building usages create extremely complex surfaces and topologies. Examples include London and Frankfurt. **A2: Apartments/hotels; near core area; virtually complete filling of block frontage; four and more stories high; mostly pre-World War II—**The Apartment/Hotel Core is normally located just beyond a city's commercial core zone. Land value is high, so buildings occupy all lot space and are at least four stories high. Little or no open space exists between buildings. Nearly all buildings are apartments; consequently, the terrain is more uniform than the Commercial Core. All three basic construction types exists (mass, heavy-clad, and light-clad framed) **A5: Commercial ribbon development; on some arterials outward from core and elsewhere; virtually complete filling of block frontage along street; low-medium rise (to five stories); to present—**In commercial ribbon development, attached buildings are erected to get the most out of high-value land along main streets extending outward from the city center. Medium-rise buildings are typically only one deep with detached buildings behind. Examples include Tel Aviv and Bangkok. **A9: Commercial residential only slightly modified old city core; near modern core; commonly two to six stories—**The Old Core Vestigial is not found in all cities but is common in Europe. Streets are designed for pedestrians and consequently are narrow, often winding. Buildings are typically low-rise, multi-story structures with mass construction (both stone and brick). There are few open spaces between buildings, and they are small. An example is Jerusalem.

Table B-3 UTZ II: Widely Spaced High-Rise Office Buildings

UTZ II: Wide-spaced High-rise Office Buildings
Dc1: Commercial office; core area; high rise; light clad framed—Unlike the Commercial Core, in the Redeveloped Core Area, buildings are typically tens of meters apart; the high value of the land is offset by the great height of the buildings. Open space is usually in the form of small landscaped courts and parks. Most of the buildings are offices and banking headquarters. Extensive subterranean features exist, principally in the form of basements and underground parking. **Dc5: Commercial Office ("Outer City"); at metropolitan area periphery; high-rise; light clad framed—**The Outer City has all the physical characteristics of the Redeveloped Core Area but has been built in more recent years with newer construction methods away from the city center. The Outer City stands out sharply from surrounding suburban zones (having low buildings).

Table B-4 UTZ III: Attached Houses

UTZ III: Attached Houses
A3: Apartments and abutted-wall houses; adjacent to core area; fewer than four stories—Apartment/Row Houses, Four Stories and Lower zone is typically large in overall expanse, covering tens of blocks. The terrain is monotonous rows of houses and apartments that are relatively low in height but are either attached or very close together. Buildings typically have backyards but are located close to streets. Vehicular and pedestrian traffic is restricted to streets. Only a few open spaces exist, which are mostly parks and school grounds. **Dc2: Residential apartments/row houses, 75 percent and more block frontage; varying locations—**The Apartments/Row Houses, Greater than 75-percent frontage zone is very similar to that described above, with the exception that the buildings are not continuous. The separation is, however, very small (less than 4 meters) **Dc3: Residential houses, 75 percent and more block frontage; varying locations; to present—**Houses, Greater than 75-percent frontage is usually composed of single-family houses with various construction methods. The aggregate area is generally very large, but dense construction means little space between structures. **Dc7: Residential dominant, former nucleated agricultural village; at city periphery (sometimes engulfed); low rise, old construction—**Engulfed Agricultural Villages is a phenomenon of rapid expansion of urban sites. Village houses and barns have been converted into housing and commercial buildings. Streets are narrow and twisting and contrast markedly with the planned suburban development typically surrounding them. **Dc8: Residential "Shanty Town"; city periphery, temporary construction; low-rise; post 1945**—Shanty towns tend to be lean-to structures built on unoccupied, low-value land in underdeveloped countries. Structures are made of scrap metal, lumber, cloth, palm fronds, etc. Streets are irregular and narrow.

Table B-5 UTZ IV: Closely Spaced Industrial/Storage Buildings

UTZ IV: Closely-spaced Industrial/Storage Buildings
A4: Industrial/storage; near core area; on ordered blocks with little or no set-back; medium-rise; mass and framed construction, mostly pre World War II—In the Industrial/Storage, Ordered Blocks class, buildings are attached to each other and cover most of the lots on which they sit. Buildings are strong (heavy construction) with brick or heavy clad materials. Buildings tend to be of uniform height at approximately five stories. **Dc4: Industrial storage, linear building pattern; railroad and dock-related; low-rise; to present—**Closely related is the Industrial/Storage, Truck, Dock-Related class. However, instead of occupying most of the lot, buildings tend to conform to the type of transportation involved with the building's purpose. In most cases, the buildings are long and narrow, and any open spaces are located at the ends.

Table B-6 UTZ V: Widely Spaced Apartment Buildings

UTZ V: Widely-spaced Apartment Buildings
Do2: Residential apartments and row housing, less than 75-percent block frontage; low-medium rise; varying locations; post 1945—The Apartments/Row Houses, Less than 75-percent frontage class is similar to Dc2 except that buildings are farther apart and are often set in a uniform pattern within a planned project. When viewed from the street, the open spaces between building structures are wide enough to form more than a quarter of the frontage of buildings along the block. Openings range from 5 to 75 meters.

Table B-7 UTZ VI: Detached Houses

UTZ VI: Detached Houses
Do3: Residential houses, less than 75-percent frontage; low-rise; varying locations; to present—Houses, less than 75-percent frontage is very common, covering typical suburban subdivisions. Houses are set back from the street and separated by more than 5 meters. Maximum wall thickness is 30 cm with block and brick construction.

Table B-8 UTZ VII: Widely Spaced Industrial/Storage Buildings

UTZ VII: Widely-spaced Industrial/Storage Buildings
Do1: Shopping Centers; beyond core; low-rise, mass construction dominant; post 1945—Shopping Centers are mostly for commercial purposes and are set in clusters to support automobile transportation. Buildings are designed to have large areas of unrestricted, un-partitioned interiors.
Do4: Industrial/storage, truck-related; varying locations; ordered pattern within zone (buildings fairly evenly spaced, separated by parking lots, storage area); low-rise; post 1920—Industrial/Storage, Truck-Related has widely separated buildings designed to provide sufficient space for trucks to provide service and have extensive parking lots. In addition, open space around buildings serves as outdoor storage for raw materials.
Do5: Commercial ribbon development; along some new arterials; open pattern (buildings separated by intervening parking lots and open storage areas); low-rise (fewer than five stories); post 1945—The commercial ribbon zone consists of large, one- or two-story buildings or groups of buildings fronting a major arterial street. They have open spaces between structures and large parking lots. Their location is often coincidental with important transportation structures, such as bridges or major intersections.
Do6: Administrative/cultural (e.g., government, schools, hospital complexes); low-medium rise; varying locations; ordered building pattern; to present—Administrative/Cultural zones are made up of clusters of buildings that were constructed according to a master plan that specified a considerable separation from one building to another. Examples include college campuses and military reservations. Buildings are often very stout.

APPENDIX C - URBAN TERRAIN ZONE (UTZ) CHARACTERISTICS

Table C-1 Urban Buildings Replicas

		High Density Residential Dc3	Residential Apartments Do2	Commercial Dc5	Industrial Dc4	Administrative Do6
Urban Buildings Replicas						
Footprint (sq. meters)		64 - 100	399 -1353	235 - 928	263 - 3535	791 - 2195
Height (stories)		1-2	5-8	2-5	1-4	3-6
Roof Tops	Type	Flat	Flat	Flat	Pitched	Flat
	Material	Reconfigure	Reconfigure	Concrete/ Tile	Concrete/ Steel	Concrete
	Re-configurable	Y—e.g. adding pitched roof	Y—e.g. adding pitched roof	N	N	N
Material Effects						
Mass Brick or CMU		15%-100%	0%-6%	0%-12.5%	NA	NA
RCF/Light Cladding		NA	0%-3.5%	0%-4%	NA	0%-3%
RCF/Infill		79%-100%	75%-100%	65%-92%	0%-75%	93%-100%
Steel Framed Light Clad		NA	0%-25%	0%-21%	25%-100%	0%-4%
Steel Framed Heavy Clad		NA	0%-15%	0%-8%	NA	NA
Separation (meters) between replicas		2-6	8-31	3-22	3-20	26-32
Percentage of UTZ representation within an urban area		48% - 96%	1%-5%	1%-20%	1%-5%	1%-5%

Table C-2 Road Network Characteristics

		High Density Residential Dc3	Residential Apartments Do2	Commercial Dc5	Industrial Dc4	Administrative Do6
Road Network Characteristics						
Street Widths (Meters)	**Primary**	NA	NA	14	NA	NA
	Secondary	4 -10	7 - 17	14 -22	10 -12	12 - 15
	Paths/Alleys	4–5	NA	4–5	NA	NA
Street Material		Gravel	Asphalt	Concrete	Concrete/ Gravel	Concrete
Sidewalks		N	N	Y	N	Y
Setbacks		N	Y	Y	N	Y
Curbs		N	N	Y	N	Y
Round About		N	N	Y	N	Y
Intersection		Y	Y	Y	Y	Y

Table C-3 Additional Urban Characteristics

	High Density Residential Dc3	Residential Apartments Do2	Commercial Dc5	Industrial Dc4	Administrative Do6
Additional Characteristics					
Urban Canyon	An urban canyon is characterized by streets cutting through dense blocks of structures, especially tall buildings, which are separated by a street or alley of a width no greater than 1/3 the height of the buildings. Urban canyons should exist in residential, commercial and industrial UTZs.				
Power Distribution	Overhead/ Underground 20%-30% served	Overhead/ Underground 100% served	Overhead 100% served	Overhead 20%-100% Served	Overhead/ Underground 100% Served
Truck Loading Ramps	N	N	Y	Y	N
Parking	N	Y	Y	Y	Y
Domed Roof	N	N	N	N	Y
Low/High Walls with Gates	Y	N	N	N	N
Loading/Parking Ramps	N	N	N	Y	Y
Clutter	Clutter such as building rubble, trash, etc. is common.				
Courtyards	Courtyards are common around administrative buildings.				
Vertical Obstacles	Curbs along roads are often representative of vertical obstacles 6–10 inches high.				
Courtyard Walls and Gates	Walled yards and courtyards are common.				
Trees/Foliage	Small bushes/trees are common in residential areas and in open areas around administrative buildings.				
Cell/TV/Radio Towers	Antenna towers for public broadcasts, civil communications, and cellular transmissions are examples.				