MSTP Pamphlet 7-0.1

Modeling and Simulation Operations and Planning

MAGTF Staff Training Program (MSTP)

U.S. Marine Corps

15 April 2023

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UNITED STATES MARINE CORPS
MSTP Center (C 467)
2301 Little Road
Quantico, Virginia 22134-5001

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FOREWORD

1. PURPOSE. MSTP Pamphlet 7-0.1, *Modeling & Simulation Operations and Planning*, is designed to assist the staff member in organizing, planning, and executing exercise activities for MAGTF level training events.

2. SCOPE. This pamphlet is intended to guide exercise planners through the processes and procedures necessary to plan and execute simulation-supported exercises. In order to address these topics, it is necessary to first introduce and discuss modeling & simulation (M&S) terms and concepts. M&S is a broad field that offers training support solutions from the individual Marine and Sailor to the Marine Expeditionary Force (MEF). MSTP generally applies M&S in the conduct of MEF and Marine Expeditionary Brigade- (MEB) level staff exercises. As such, this pamphlet will primarily focus on M&S as a tool for senior staff training. However, the methods and practices described herein can be applied to training at any level, with appropriate scaling.

3. SUPERSESSION. N/A.

4. CHANGES. Recommendations for improvements to this pamphlet are encouraged from commands as well as from individuals. The attached User Suggestion Form can be reproduced and forwarded to:

Director, MAGTF Staff Training Program Division
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Recommendations may also be submitted electronically to: mstp_ops@usmc.mil

5. CERTIFICATION. Reviewed and approved this date.

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From:
To: Director, MSTPD (C467), 2301 Little Road, Quantico, Virginia 22134-5001

1. In accordance with the Foreword, MSTP encourages individuals to submit suggestions concerning this pamphlet directly to the above addressee.

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Part I
Introduction

1001. Overview. All Marines, regardless of rank and entry method, experience modeling & simulation (M&S) during their time in service. From the chaos of yelling drill instructors, simulating the psychological stress of combat, to field training exercises (FTX), simulating the physical stress of combat, M&S is critical to ensuring Marines are prepared to fight and win wars at any stage in their careers. Marines intuitively understand the value of these two aforementioned examples of M&S, as they offer the closest realism to combat without being immersed in the actual thing. As computer and information technology improves at an exponential rate, M&S allows Marines to train with or against robust computer-generated forces (CGF). While training with CGF is generally considered to be another step removed from reality in comparison to an FTX, it allows Marines to expand the scope and scale of training events. Due to time, resource, and personnel constraints, an FTX is generally conducted with a Division or smaller, and training venues are limited to a handful of locations. However, CGF provides the opportunity to train with units of any size in any environment of the training audience's (TA) choosing. The categories of M&S and their benefits will be discussed in further detail in later paragraphs. However, regardless of its manifestation, M&S is a critical means to preparing Marines to experience the chaos, confusion, and friction of war**.**

1002. Fundamentals

M&S is a wide topic of discussion. While this pamphlet focuses on M&S in a training environment, M&S is also commonly used in an experimental and analytical role to evaluate and assess the

viability of new plans, equipment, and ideas. Irrespective of the reason for which M&S is employed, it is beneficial to learn the common terms and concepts that facilitate shared understanding when planning and employing M&S systems.

a. Model and Simulation

The words model and simulation are commonly interchanged in conversation. While their meanings are related, there is a distinct difference in their definitions.

- **Model.** A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process.
- **Simulation.** A method for implementing a model over time.

In simpler terms, a model represents some real-life entity. Using an aircraft as an example, it can be represented as a physical, scaled replica or as a mathematical equation that calculates the thrust of its engines. The replica and equation are not the actual aircraft, but a model representing some aspect of the aircraft. Taking the case of the aircraft further, if the replica is put inside a wind tunnel to test the aerodynamics or values are input into the thrust equation to estimate engine output, it is now a simulation of how the aircraft would perform over time under certain conditions.

b. Simulation and Taxonomy

Simulations can be categorized as being live, virtual, or constructive. The Department of Defense M&S Coordination Office (MSCO) defines live, virtual, and constructive as:

- **Live.** A simulation involving real people operating real systems.
- **Virtual.** A simulation involving real people operating simulated systems.

- **Constructive.** Simulations involving simulated people operating simulated systems. Real people can be allowed to stimulate (make inputs) to such simulations.

Figure 1-1 provides examples of simulations that fall under each category.

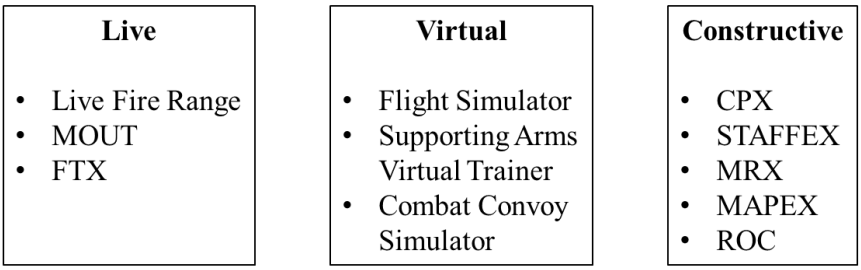

Figure 1-1: Live, Virtual, and Constructive Construct

The collective term live, virtual, and constructive (LVC) is commonly used to describe exercises or training events that employ two or more simulation categories. For example, an exercise that combines a regimental command post exercise (CPX) with a battalion FTX and a section of aircraft in flight simulators would be considered an LVC event. Of note, these simulations must be meaningfully networked and connected in order to meet the LVC concept. Simulations that run in parallel, but with no influence on each other, are not LVC. In the previous example, if the regiment commands and controls both the live and constructive battalions and the virtual flight simulators provide effects on constructive forces, then this would qualify as an LVC event.

c. Force Representation

Simulations can represent units and forces in two different ways. An entity-level simulation breaks down units and forces to the individual person, vehicle, ship, and aircraft. In combat, these individual entities move, sense, and engage other entities based on their respective capabilities. These entities still belong to a parent unit and can be commanded and controlled as such. On the

other hand, an aggregate-level simulation represents forces as holistic objects, with the combat power of personnel and equipment summarized at the unit-level. Personnel and equipment can still be damaged or destroyed, but this is manifested in the overall effectiveness of the unit.

Entity-level and aggregate-level simulations each have their own complementary strengths and weaknesses. An entity-level simulation can provide detailed tactical combat adjudication, but will not easily support operational- or strategic-level conflict. Conversely, an aggregate-level simulation can scale to accurately represent combatant command and theater operations, but will lack fidelity for small unit engagements. Some simulations, refrerred to as multi-level resolution, are capable of conducting both entity- and aggregate-level combat. While this seems to combine the best of both types, combat is usually restricted between entity- and aggregate-units and more time and personnel are needed to build detail into large formations.

d. Simulation Interface. Simulations are either human-in-the-loop (HIL) or human-out-of-the-loop (HOL). HIL simulations require a person to provide inputs in order to change unit behavior. An example would be a war game, where human players act in sequence to move and engage units across a map. HOL simulations still require human input, but only in the beginning when designing forces and planning maneuvers. Once the simulation is initiated, automated behaviors govern the movement and activities of forces. Upon conclusion of the simulation, statistics and other data can be generated and relayed to a human controller. Most training simulations are HIL, although there are exceptions. An organization that interfaces with an HIL simulation during an exercise is referred to as a response cell (RC). RCs will be discussed in detail in later paragraphs.

e. Simulation Interoperability. Every simulation is designed and developed for a unique purpose and set of requirements. As a result, it is highly unlikely that two simulations will be seamlessly interoperable. Consequently, the M&S community

has established and implemented standards that allow simulations to connect and communicate in a structured manner. Two of the most common standards are distributed interactive simulation (DIS) and high level architecture (HLA). The technical difference between these standards is beyond the scope of the pamphlet. The important take away is that DIS is most effective when connecting two simulations in a binary manner and HLA when networking three or more, as HLA tends to scale more efficiently. The term for a collection of two or more networked simulations is federation, with each individual simulation referred to as a federate.

f. Simulation Equipment

As alluded to above, M&S can manifest itself in varying ways. A constructive simulation may consist of CGF hosted on a powerful server or it may be a physical table-top war game. Both simulations have their strengths and weaknesses, and must be employed in accordance with the desired end state. Simulations may also combine physical and digital tools. The Indoor Simulated Marksmanship Trainer, a virtual simulation, employs physical replicas of weapon systems to assist Marines in building muscle memory but resolves shots fired using a physics-based computer model that tracks lasers emitted from the barrel of the weapon. As an additional example, trainees may maneuver units as physical pieces on a hex-based war-game board but ajudicate combat with a digital simulator, as opposed to rolling dice.

Computer-based simulations usually take one of two forms. Simulations that require a significant amount of computing power will control and ajudicate combat on a central server, while allowing users to make inputs on individual clients that are networked to the server. Simulations that are not as computing intensive may host both the interface and ajudication system on the same machine. Large staff training exercises that simulate hundreds, if not thousands, of units will normally require a server-client structure.

g. Verification, Validation, and Accreditation. Verification, Validation, and Accreditation (VV&A) is the process through which simulations are approved for specific purposes and uses. Broken down individually, verification is the act of ensuring each individual component of the simulation, such as a piece of code in the case of CGF, performs as designed. Validation assesses whether all the collective components of the simulation, such as the entire code library, accurately reflects the desired environment. Lastly, accreditation is the approval of the simulation for a specific task. Simulations are not universal tools that can be adapted to any or all functions. A simulation that has been through VV&A for a training use case may not be appropriate for experimentation or analysis. Consequently, using a simulation outside of its approved use case may provide misleading or incorrect results.

Part II
Exercise Planning

2001. Overview. MSTP focuses on designing and executing exercises for MEF and MEB command elements (CE) and their major subordinate commands (MSC) and major subordinate elements (MSE). The planning process is essential for ensuring training goals and objectives are clearly identified, the scenario and master scenario events list (MSEL) support these goals and objectives, and the appropriate personnel and systems are employed to simulate a realistic environment. **The most important consideration for an M&S planner to remember, whether CGF or a physical war game, M&S is a means to support the objectives and goals of the TA and not an end onto itself.**

2002. Exercise Life Cycle / Joint Event Life Cycle

The MSTP Exercise Life Cycle (ELC), based on the Joint Event Life Cycle (JELC), provides an orderly method to planning, preparing, and executing an exercise. A large, robust exercise will likely require full implementation of the ELC; however, smaller training events may employ a shorter, tailored version. Regardless, the ELC and its respective events should be considered as the starting point when designing an exercise. Figure 2-1 depicts the ELC with its respective phases, events, and milestones. The JELC is similar in construct and timing to the ELC, except that the ELC includes additional training events such as the warfighting seminar (WFS), planning practical application (PPA), and TA operations order (OPORD) review. From a procedural point of view, M&S planning for an MSTP-driven exercise and a Joint-exercise are indiscernible. Key differences in preparation and execution will be discussed in later paragraphs.

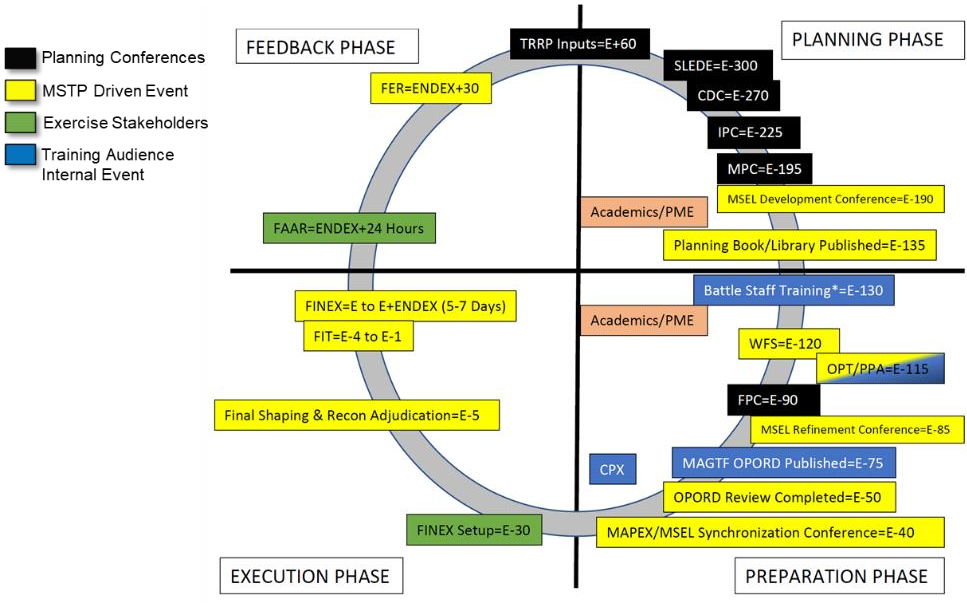

Figure 2-1: MSTP Exercise Life Cycle

Most MSTP exercises employ M&S to some extent, as exercises are either model-driven, script-supported or script-driven, model-supported. That is, either the simulation primarily drives and determines the outcome of exercise events, with a script supporting events outside of simulation capability, or a pre-written script drives the scenario, with the simulation supporting the stimulation of command and control (C2) systems. In either case, M&S planners must coordinate with exercise designers throughout the entire ELC to ensure employed systems are capable of simulating the desired environment and friendly and enemy forces are portrayed correctly. M&S planners should look to accomplish the following objectives for each of the planning conferences contained within the ELC:

- **Concept Development Conference (CDC).** Based on the participating TAs and overall scenario, M&S planners should identify the main M&S systems to be employed during the exercise.

- **Initial Planning Conference (IPC).** The M&S working group should start drafting the simulation database and subordinate unit response cell (SURC) requirements. M&S planners should engage with the information management / knowledge management (IM/KM) officer to identify C2 system requirements. A draft simulation and C2 system architecture, with network requirements, should be an output of the IPC.

- **Mid Planning Conference (MPC).** The M&S working group should finalize the exercise database and the SURC structure and manning. A complete simulation and C2 system architecture, identifying all participating nodes and their respective networks, should be an output of the MPC.

- **Final Planning Conference (FPC).** The TA should cross-check and approve the simulation database and provide the names for SURC officers-in-charge (OIC), if not the entire SURC. The number of simulation and C2 system clients and servers at each exercise location should be confirmed and annotated.

- **Map Exercise (MAPEX)/MSEL Synchronization Conference.** M&S planners should cross walk all MSEL injects with the force list built in the simulation database and, if available, the air tasking order (ATO).

2003. Scenario Requirements. The overarching scenario will be agreed upon during the CDC and further developed in detail until the MSEL refinement conference. The scenario will drive what types of simulations are employed during the exercise and

requires M&S planners be familiar with the capabilities and limitations of the simulations at their disposal. An exercise scenario that involves major combat between large ground formations may be sufficed with a single constructive, aggregate-level model. On the other hand, a scenario that seeks to train staffs in the command, control, communications, computers, combat systems, intelligence, surveillance, reconnaissance, and targeting (C5ISRT) process may require a federation consisting of a constructive, entity-level simulation and a virtual simulation representing an unmanned aerial system feed. Determining which simulations are appropriate to satisfy scenario and training requirements is an underlying element of exercise success.

2004. Simulation Architecture

Once the simulations supporting the exercise have been selected, the locations of servers and clients and the federation architecture must be designed. Simulation servers and clients should be centrally located in a facility that affords network access and provides sufficient space for RCs and senior control operations. In the event RCs must be geographically separated from each other, the simulation server should be located in an area that facilitates remote simulation client connection. While simulation servers and clients can be physically separated, care must be taken to ensure the distance does not impose unnecessary latency on the system.

If multiple simulations are to be employed, planners must decide whether a DIS or HLA federation is more appropriate. As previously stated, HLA is generally the preferred choice when connecting three or more simulations. Designing a viable simulation architecture is a complex task that may be achieved through multiple courses of action, whence why “design” is a more appropriate description than “plan.” An example simulation architecture is displayed in Figure 2-2 below. Note that the servers are co-located with the preponderance of simulation clients.

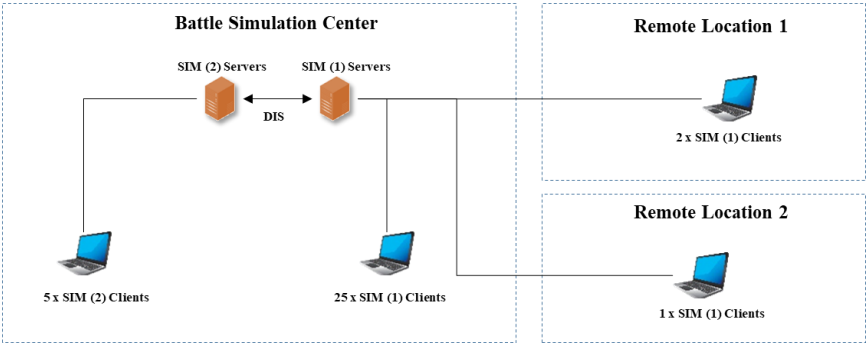

Figure 2-2: Example Simulation Architecture with DIS Federation

2005. C2 System Architecture. While the simulation architecture is crucial to creating the simulated training environment, the TA should not be directly interfacing with the simulation. Rather, the TA should be operating with the actual C2 systems they would use in combat. Most training simulations have the capability to directly, or indirectly, feed simulation data to the C2 systems located in the TA's combat operations centers (COC). Consequently, M&S planners should work with the TA IM/KM officer to identify the C2 systems that the simulation will populate. More importantly, M&S planners should ensure that the selected simulations are, in fact, capable of populating the TA's C2 systems. Figure 2-3 displays a simple C2 system architecture with the simulation feeding data to Global Command and Control System (GCCS), Common Aviation Command and Control System (CAC2S), and Command and Control Personal Computer (C2PC) via over-the-horizon gold (OTH-Gold), variable message format (VMF), and Link-16 messages.

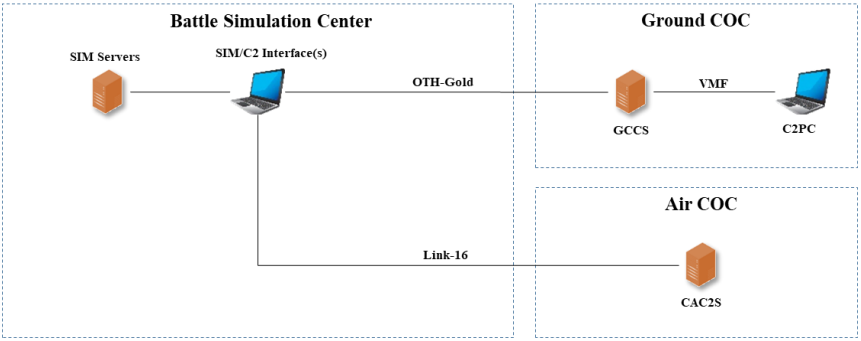

Figure 2-3: Example C2 System Architecture

2006. Network Architecture. Designing the simulation and C2 system architecture must be done concurrently with the network architecture, as a distributed simulation architecture will be ineffective if nodes cannot be connected together. M&S planners must work closely with the MSTP and TA communication planners in order to ensure simulations and C2 systems are authorized to operate on target networks and disparate networks have authority to connect (ATC). The MSTP Communication & Information Systems (CIS) section will generate a concept of communication support which will outline the logical network connections between exercise sites. Figure 2-4 shows an example of a network architecture overlaid onto a simulation architecture.

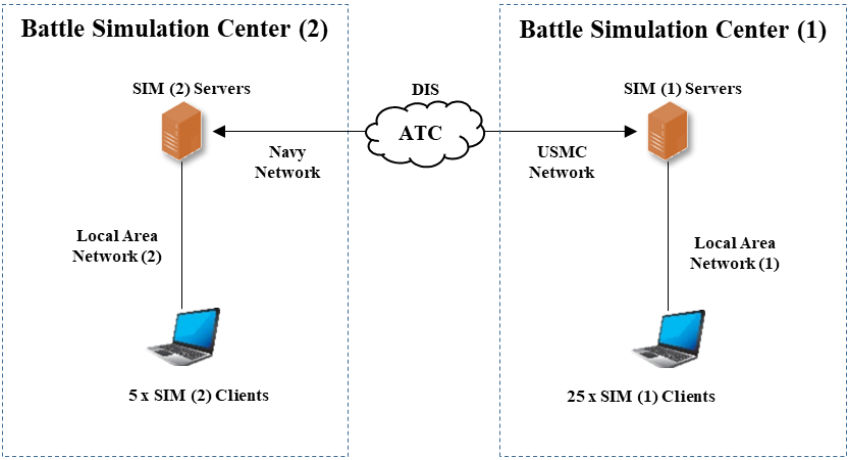

Figure 2-4: Network Architecture imposed on Simulation Architecture

2007. Response Cells

Broadly speaking, a Response Cell (RC) is an organization that interacts with the TA to provide reports and information or receive and execute orders. As described in Part I above, RCs also interface with the simulation to effect or relay change in the simulated environment. There are multiple categories of RCs, which include higher & adjacent headquarters (H&AHQ), SURCs, adversary forces (ADFOR), and green cells. Regardless of its purpose, RCs are tailored in structure according to the unique needs of each exercise, although, standardized RC templates often provide a sufficient starting point in planning. M&S planners will be primarily focused on SURC design when planning an exercise, although exercises that focus on interactions with higher headquarters or external organizations may shift this focus to H&AHQ and green cells. The exercise support manning document (ESMD) captures RC expertise and manning requirements, and MSTP exercise control has primary responsibility for managing and updating the ESMD.

H&AHQ is an eclectic RC that simulates the higher headquarters of the TA and those adjacent units with whom the TA will

regularly interact. The information requirements of the TA will drive the level of M&S integration into the H&AHQ, but, at a minimum, the H&AHQ will require access to a common operational picture (COP) that depicts the status of all friendly, enemy, and neutral forces and other C2 systems to communicate with the TA. In the event the H&AHQ is required to provide detailed input into the simulated environment, such as through Joint air assets or a Navy task force, it may be provided simulation clients and operators as well.

The green cell collectively represents coalition partners, non-state actors, and other cultural groups that may impact the scenario. Depending on the extent of its involvement, the green cell may simply provide input to the scenario through scripted MSEL injects or actively interact with TA forces in the simulation. During the planning process, M&S planners should identify and account for any potentially unique green cell requirements, which may entail researching and collecting data on various foreign weapon systems and force structures. MSTP Pamphlet 2-0.1, *Red Cell – Green Cell,* provides thorough discussion on the purpose and operations of a green cell.

SURCs represent the simulated subordinate units assigned to the TA, inputting orders and commands from the TA into the simulation and relaying battle damage assessment (BDA) and spot reports (SPOTREP) from the simulation back to the TA. SURCs may also be expected in some exercises to conduct limited planning and integrate with the TA battle rhythm. SURCs are critical to successful exercise execution and must be appropriately manned with sufficient subject matter experts (SME) that understand the TA's standard operating procedures (SOP) and can communicate effectively with their COC. The TA is responsible for equipping the SURCs with all necessary C2 and information systems that will enable them to pass information in a realistic manner. These system requirements must be captured during the planning phase and validated prior to exercise execution.

SURCs are generally manned with a combination of active-duty TA personnel and MSTP instructor/controllers (IC). An IC is an individual, usually a contractor, who has both warfighting experience and in-depth simulation knowledge. For small exercises with limited simulation interface, MSTP ICs may make up the preponderance of the SURC manning as terminal operators (TO), with general guidance from a few TA-provided SMEs. Figure 2-5 shows an example of how a SURC might be structured for a small exercise in which simulation input is minimal or scripted and TA information requirements are scoped. Note the interfaces between the training audience and the simulation.

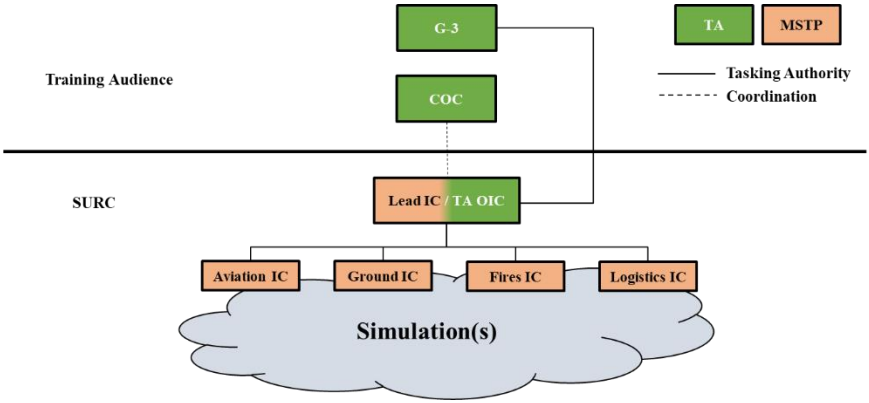

Figure 2-5: Conceptual SURC Structure for a Small Exercise

On the contrary, if significant simulation activity is anticipated or the TA has extensive information and reporting requirements, then a more robust SURC will be required. In this case, the TA will provide additional SMEs to support various functional areas, as well as personnel to serve as TOs of the simulation. It may also not be possible, or practical, to consolidate all functions under a single SURC, requiring multiple SURCs to be designed each according to its specific purpose. For a large, multi-SURC construct, MSTP ICs will be paired with each SURC OIC to provide guidance and advice as to how best generate the desired combat effects in the simulation. Figure 2-6 displays how a

ground maneuver SURC may be structured for a large exercise. Note that the TA personnel requirement significantly increases.

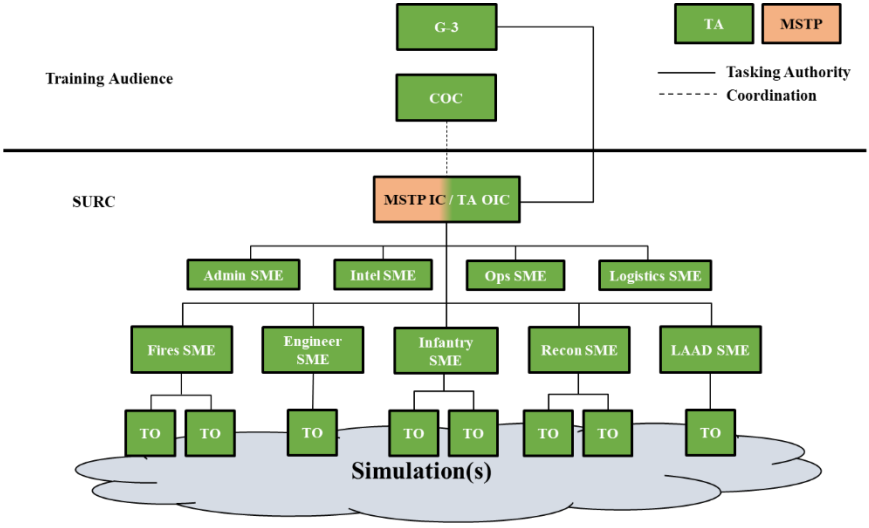

Figure 2-6: Conceptual SURC Structure for Simulated Ground Forces

SURC design is another complex process that requires a thorough understanding of the exercise scenario and TA training goals and objectives. TAs will typically seek to gain manpower efficiencies through reducing SURC manning and expertise; however, this directly decreases the throughput capacity and capability of the SURC. Thus, SURCs must be carefully structured such that the information requirements of the TA are met, but valuable manpower is not misaligned. MSTP Pamphlet 7-0.3, Subordinate Unit Response Cell Officer-In-Charge, provides more in-depth information on the structure, manning, and operation of SURCs**.**

2008. Summary of Key Activities

The following are key events from the planning phase:

- Identify simulation(s) to support exercise training objectives

- Design simulation architecture
- Design C2 system architecture
- Provide input to network architecture
- Design SURC structure and identify personnel requirements
- Identify H&AHQ and green cell requirements

Part III
Exercise Preparation

3001. Overview. Exercise preparation consists of those activities that help refine and validate the architectures and products developed in the planning phase. For an MSTP exercise, whether Joint or stand-alone, the preparation phase consists of three main activities – database development, system testing, and pre-exercise deployment.

3002. Database Development

A simulation, in and of itself, is similar to an artist's blank canvas. Simulations are powerful tools with incredible potential, but require a planner to build out the environmental data, unit tables of organization and equipment (TO/E), and underlying performance data. Each simulation is different with respect to ease of database construction. Some simulations contain standardized TO/Es and performance metrics, with minimal opportunity for the user to modify the underlying data. Other simulations are highly flexible, allowing a user to equip individual simulated Marines and Sailors with unique combat loads. However, flexibility and customization must be balanced. A highly detailed database requires significant manpower investment for both MSTP and the TA to design, build, and test.

- **Terrain and Maps.** Without any modification, most simulations contain a simple, non-detailed map of the world. This may be sufficient for small exercises, or in cases where activity is primarily scripted as opposed to simulation driven. However, for most exercises, terrain and maps will be imported to provide additional realism to force movement, sensing, and combat. The Joint Staff and National Geospatial-Intelligence Agency are excellent resources for map and terrain data.

- Terrain files provide the underlying data that govern the rates of movement for various units and limit their sensing capabilities and effective ranges of their weapons. Terrain files can be quite large, so M&S planners should identify the areas of the world in which terrain will affect combat and limit the import of data to those locations.

- Maps contain graphics useful in orienting the simulation operator to their area of operations, but usually do not directly impact the physics of simulated unit behavior. While map files are generally smaller than terrain files, M&S planner should still identify and limit the areas and regions of the world that require map coverage. All map data is not equal, and environmental and political factors may reduce the resolution available for certain areas.

- **Task Organization TO/E.** The scenario and TA training objectives and goals will define which enemy and friendly forces are employed and how they are equipped. This portion of database development requires the most input from the TA, as they must specify, at a minimum, the task organization, but potentially down to the TO/E of each unit. Joint and MSTP-led exercises will typically differ in database format requirements and deadlines for product submission.
  - Task organization can typically be derived from Annex A in the TA's, MSCs', and MSEs' OPORDs. In the event the TA wants to simulate units down to the platoon-level or lower, respective MSCs and MSEs must provide additional detailed information on task organization. When participating in a Joint or federated exercise, task

organization will need to be developed in a file format common to the entire federation.

- Standardized unit TO/E templates can be pulled from various Marine Corps or Joint databases. These templates may suffice TA needs, but in most cases will serve as a starting point for refinement. M&S planners will need to work with TA representatives, mostly from the MSCs and MSEs, to validate that TO/Es are current and then construct them within simulated units. For Joint and federated exercises, TO/E items must be assigned a common enumeration code recognized across all federated simulations. A tank developed in isolation in one federate may appear as a truck, or an aircraft carrier, or a satellite in another federate if enumerations do not match. Database testing helps identify mismatched enumerations prior to exercise execution.

- **Parametric Data.** Unit equipment and performance data is equally as important as ensuring the task organizations and TO/Es are built correctly. Each simulation structures performance data, known as parametric data, in different ways, but there are common characteristics such as speed, endurance, lethality, and survivability. For some simulations, an authoritative source may control parametric data, such that the user is unable to modify it. In other simulations, it may be up to the user to individually set and assign parametric data for each combat system. M&S planners should give careful consideration to parametric data, as the specifications of some systems may reside at the SECRET or TOP SECRET level. Understanding the overall classification of the exercise will ensure that weapon and system performance does not inadvertently cause a spillage. Regardless of whether an exercise is Joint or federated, testing must be conducted prior

to exercise execution in order to validate that simulated forces interact correctly.

3003. Simulation and Database Testing

Throughout the entire ELC, or JELC, system testing is essential in order to ensure systems and databases are performing as desired. Testing between simulation and C2 systems early in the process identifies any network or software interoperability issues while there is still time for correction. As discussed in the paragraph above, testing also validates that simulated units and weapon systems interact correctly within the simulated environment. Joint exercises will usually contain a minimum of three tests – risk reduction test (RRT), event function test (EFT), and exercise operational test (EOT). While MSTP-led exercises do not necessarily need to follow the same testing arrangement, thorough testing is still critical to assuring success.

- **Risk Reduction Test.** The RRT is one of the earliest tests in the ELC or JELC, as its primary purpose is to reduce the risk associated with the collective simulation, C2 system, and network architecture. The RRT usually occurs in the planning phase, at a point where deficiencies, particularly with software, can be identified and corrected. The RRT will also examine fundamental interactions between forces, weapon systems, and equipment, although database development is usually nascent at this point in the planning.

- **Event Function Test.** An EFT is a follow-up to the RRT, verifying that technical discrepancies and architecture flaws have been corrected. Depending on the complexity of the exercise and the results of previous tests, there may be multiple EFTs within a single ELC or JELC. While an EFT is usually not conducted with the final database, it should

include all the weapon systems and equipment to be simulated during the exercise.

- **Exercise Operational Test.** The EOT is the last testing opportunity prior to exercise execution and is typically conducted with all systems deployed at their respective exercise sites. The EOT provides the opportunity to make minor refinements and adjustments to the database and rehearse simulation control (SIMCON) operations. With exception to minor technical corrections, simulation, C2 system, and network issues should not be manifested, as this would indicate a failure to properly plan or execute previous testing events.

3004. Personnel and Equipment Deployment

The final activity in the preparation phase is the physical deployment of personnel and equipment to their assigned exercise locations.

- Depending on the location and scale of the exercise, equipment may be drawn from local resources or shipped from MSTP. M&S planners must crosswalk simulation and C2 system requirements with resources available local at the exercise site in order to determine what equipment and systems will need to be shipped. MSTP Operations branch has the lead on managing and scheduling shipments, but relies heavily on M&S and CIS to ensure all equipment is appropriately documented prior to shipping. Shipment times vary, based on classification and destination, so M&S planners need to coordinate closely with MSTP Operations to ensure all requisite equipment is shipped by established deadlines.

- Exercise requirements will drive the specific number of M&S technicians and ICs needed at the exercise locations.

Small or scoped exercises may allow M&S personnel to operate from home station, but most exercises will require a significant deployment of personnel. When executing an exercise from a forward location, a small advance element of technicians and ICs will deploy to establish systems and participate in the EOT. While the travel process for personnel, government or contractor, is more flexible than the equipment shipping process, M&S planners must consider human factors and appropriately balance tasks against manpower. In the event there is a manpower shortfall, additional personnel can potentially be drawn from other battle simulation centers (BSC), although this requires prior coordination with both the BSC leadership and any supporting contracting entities. All supporting M&S manpower should be reflected in the ESMD.

3005. Summary of Key Activities

The following are key events from the preparation phase:

- Acquire requisite map and terrain data
- Build task organization and TO/E databases for simulated exercise forces
- Refine exercise parametric data
- Conduct simulation and C2 system testing
- Deploy equipment and personnel to the exercise site

Part IV
Exercise Execution

4001. Overview. The execution phase consists of all activities conducted on-site at exercise locations to prepare for and execute the final exercise (FINEX). This includes all events from EOT through end exercise (ENDEX). Figure 4-1 depicts a typical exercise execution schedule in the form of a piano chart.

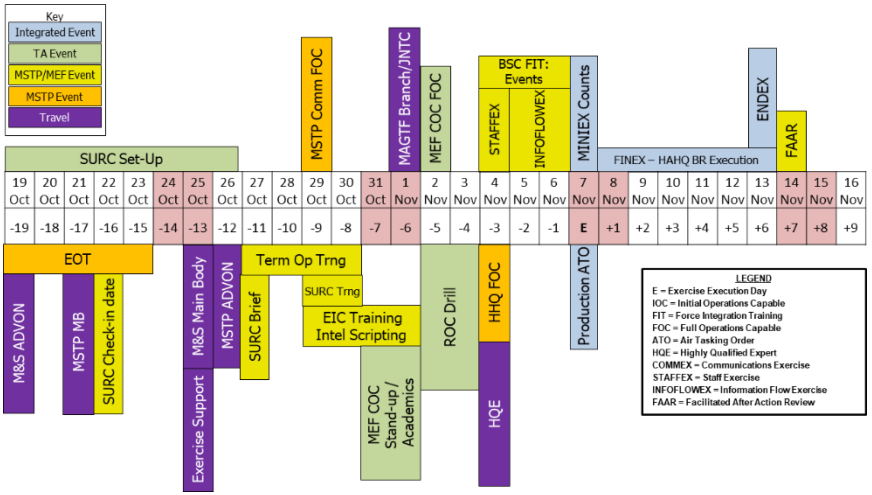

Figure 4-1: Sample Exercise Execution Piano Chart

Regardless of how thorough and detailed planning and preparation was conducted, M&S planners should remain flexible during execution and be prepared to adjust plans as needed. M&S responsibilities during this phase will primarily be reactionary, maintaining and troubleshooting systems and facilitating adjudication of simulated combat.

4002. Exercise Control and Simulation Control

Exercise Control (EXCON) refers both to the exercise control group, depicted in Figure 4-2 below, and the exercise action officer. EXCON, the action officer, is an MSTP Director-

appointed individual who is responsible for leading exercise planning efforts and supervising FINEX execution. EXCON is an active-duty individual, but is directly assisted by a contractor civilian, denoted as EXCON-A. Similarly, Simulation Control (SIMCON) refers both to the simulation control group and the simulation control officer. SIMCON supports EXCON throughout the planning and preparation phases and directly reports to him or her during the execution phase. For purposes of clarity, EXCON and SIMCON will be used in this pamphlet to address the individuals, as opposed to the organizations.

While SIMCON reports directly to EXCON during execution, there are other individuals and entities with whom SIMCON will interact and coordinate. Observer, trainer, collectors (OTC) are primarily embedded with the TA to facilitate and assess staff processes, but may draw information from M&S to gain an understanding of ground truth. Additionally, SIMCON will coordinate with the local BSC, training and exercise control group, or G-37 force development section on administrative and support matters.

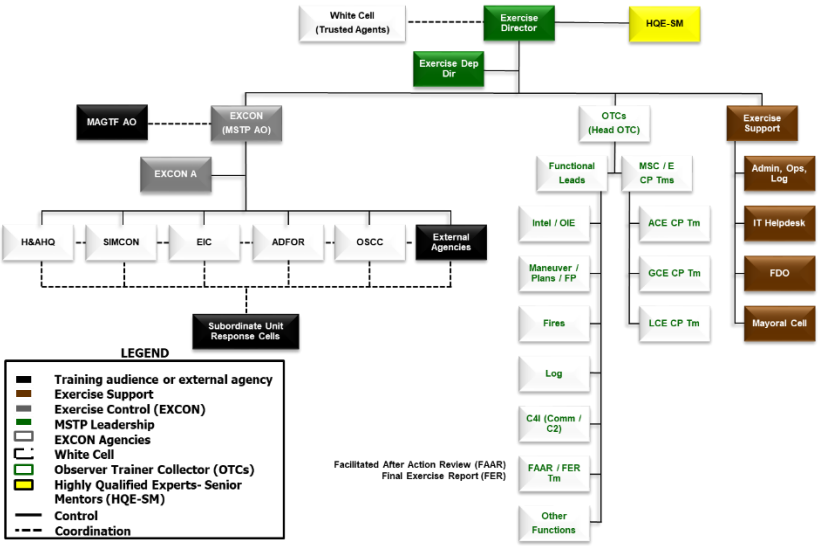

Figure 4-2: MSTP Deployed EXCON Organization

During the execution phase, SIMCON responsibilities can be summarized as the following:

- Remain apprised of the status of all M&S and C2 systems. In the case of an emergent issue, SIMCON should be prepared to brief EXCON and MSTP or TA staff on possible solutions and their respective timelines.

- Track the progress of simulated combat and deliver updates on the status of simulated forces. This includes maintaining a current ground-truth COP for the exercise control group.

- Prior to FINEX, provide the SURCs with sufficient training in simulation operations. During FINEX, SIMCON must ensure the SURCs properly inject events from the MSEL and sustain satisfactory performance.
- Support EXCON in making an adjudication decision in the event activity occurs within the simulation that is unrealistic or detrimental to exercise objectives. If the decision is to change the outcome of a particular engagement, SIMCON must ensure that the correct force disposition is reflected in the simulation. Adjudication support is one of the most common SIMCON duties during FINEX execution.

4003. Senior Control

Senior control is the leading technical M&S organization, with direct responsibility for monitoring, troubleshooting, and resolving any issues with simulations or their supporting C2 systems. MSTP ICs will also report to senior control for any simulation or administrative issues. The senior control officer (SCO) leads senior control and reports directly to SIMCON. The SCO is usually the most senior, experienced M&S contractor. Figure 4-3 shows a typical simulation control organization chart with senior control and SURCs.

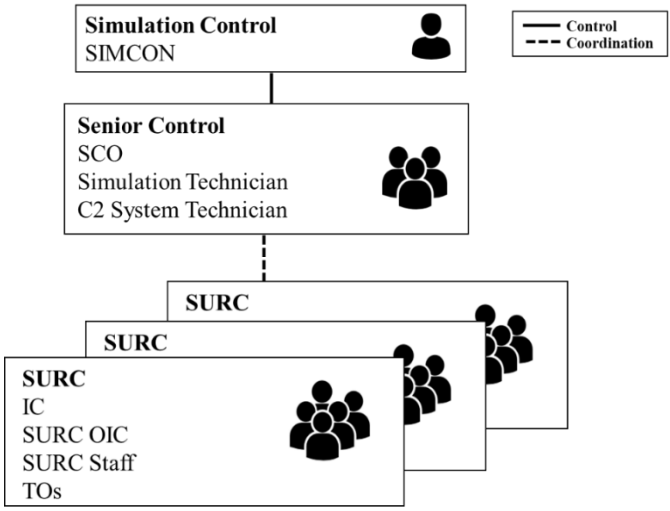

Figure 4-3: Exercise Simulation Control Organization

Of note, neither SIMCON nor SCO exert direct control over the SURCs. SURCs report to and follow the commands of their respective TA higher headquarters. Although, SIMCON and SCO will coordinate activities within the SURCs to generate a specific training effect on behalf of EXCON.

4004. Subordinate Unit Response Cell Activities

As described previously, SURCs are the primary organizations through which the TA interfaces with the simulation, translating orders into combat effects and relaying reports back to their respective COCs. The SURCs are also one of the means for EXCON to inject an event from the MSEL or shape the direction of the exercise. As such, effective and proficient SURCs are essential for exercise success.

- **Formation and Battle Rhythm**

  SURCs are complex organizations, as they are non-doctrinally structured and usually composed of personnel from different units. Consequently, a SURC OIC has the challenging task of forming a new unit, training it to execute battle drills and orders in the simulated environment, and then employing the SURC in accordance with the TA's intent. Adding to the complexity, this is all completed over the course of a three- to four-week time span. The life cycle of a SURC generally consists of the following events and can be viewed in relation to other exercise milestones on the piano chart in Figure 4-4:

  - *Check-In*. Check-in is a two-day period that usually occurs a week before initial SURC training is set to begin. It allows SIMCON to account for all individuals assigned on the ESMD and ensure they have access to the appropriate systems. Check-in also provides an opportunity to identify personnel with issues or conflicts and coordinate with their parent command for a replacement, if needed. After check-in, individuals are usually released back to their parent command with instructions to return for training at a later date.
  - *Training*. SURC training is broken down into two phases, TO training and collective SURC training. TO training is a two-day period dedicated to teaching TOs how to effectively operate the simulation with which they will be interfacing. This is achieved via computer-based classes combined with practical application. The second phase of training, collective SURC training, brings the rest of the SURC staff in to rehearse battle drills and other combat actions in the simulation.
  - *Force Integration Training (FIT)*. Directly prior to start exercise (STARTEX), the TA and MSTP participate in the FIT. FIT consists of the communications exercise

(COMMEX), staff exercise (STAFFEX), and information flow exercise (INFOFLOWEX). COMMEX is a one-day operational test of all C2 and information systems. STAFFEX is a subsequent one-day drill to identify and communicate with all key HAHQ points of contact. Lastly, INFOFLOWEX is a one- or two-day evolution in which the TA works through progressively more difficult battle drills. As indicated in the name, INFOFLOWEX rehearses the flow of information through the various TA and MSTP nodes. The SURC OIC should take the opportunity during the FIT to integrate into his or her higher headquarters battle rhythm and gain familiarity with their concept of operations for the exercise.

- *FINEX*. FINEX is the culminating CPX of the ELC or JELC. During FINEX, the SURCs execute their primary responsibility of representing the subordinate units of the TA and perform tactical actions in the simulation. SURCs communicate SPOTREPs, BDA, and other information over C2 and information systems in accordance with TA SOPs and TTPs.

- Systems and Layout

  - The TA has primary responsibility for equipping the SURCs with the appropriate C2 and information systems needed to effectively communicate with its higher headquarters. For example, a SURC that represents an aviation unit may not need a full theater battle management core system (TBMCS) suite, but will still likely require access to the execution status (ESTAT) tool on the parent unit's TBMCS in order to update the status of sorties and flights. The SURC will also need a chat application to coordinate and communicate with higher and adjacent COCs. This necessitates both the physical systems and permissions

to connect to the TA's tactical network. These requisite systems and connections should have been identified in the planning phase and established during exercise preparation, but the SURC OIC must verify the SURC is sufficiently equipped during SURC training and the FIT.

- SURCs operate in spaces that are optimized for simulation and C2 system connections, such as a BSC. Although many of these locations are renovated in an effort to improve synergy, they may not always be ideal for collaborative operations and planning. SURC OICs will work with their IC counterparts to identify the best means of physically organizing their personnel within assigned spaces. Figure 4-4 displays an example of how a ground combat SURC may physically organize itself within its allocated spaces. An M&S planner should keep in mind that the location of Ethernet ports and power outlets may constrain where certain systems may be emplaced.

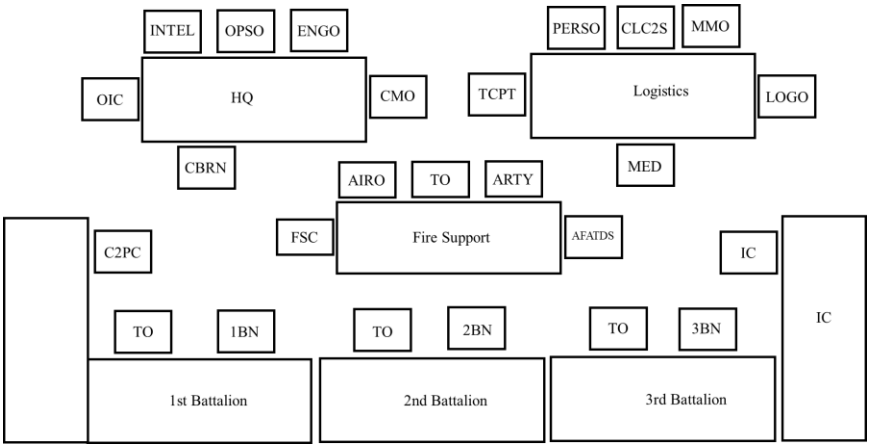

Figure 4-4: Notional Ground Combat SURC Layout

4005. Summary of Key Activities

The following are key events from the execution phase:

- Establish and function-check simulation and C2 systems on exercise site, via the EOT if applicable
- Supervise SURC check-in and training
- Monitor simulation and C2 system status through FIT and FINEX
- Advise EXCON on all matters pertaining to simulations and C2 systems
- Supervise operation of the SURCs

Part V
Exercise Feedback

5001. Overview. Immediately after ENDEX is called, the transition to the feedback phase begins. The feedback phase's sense of importance can be lost in the euphoria after an exercise concludes, as personnel will begin breaking down and accounting for equipment and systems. In addition to maintaining accountability during the retrograde process, SIMCON must ensure that systems are not prematurely terminated before data can be collected and processed. MSTP provides a facilitated after-action review (FAAR) and final exercise report (FER) to the TA, which may require analysis of information contained within the simulation and C2 systems.

5002. Support to After-Action Review

- **Facilitated After-Action Review (FAAR).** The FAAR is a senior-level brief, usually conducted the day following ENDEX, that provides formal feedback to the TA and discusses MSTP observations. SIMCON must support both EXCON and the OTCs as they build products in support of this event, as information from the simulation and C2 systems can be used to illustrate simulated actions and engagements. SIMCON may or may not be invited to the FAAR itself, but should brief EXCON and MSTP leadership on any simulation issues that were manifested during FINEX. FAAR participants normally include the MAGTF commander and staff primaries, MSC and MSE commanders, and other staff officers as designated. Additional participants can include the Commandant Marine Corps, Marine Corps Combat Development Command representatives, or representatives from the MAGTF's chain of command.

- **Final Exercise Report.** The FER is a written document that expands on points discussed during the FAAR and explores other warfighting topics. OTCs are the primary authors of the FER, but will pull resources from other branches and sections of MSTP as needed. M&S planners may be asked to provide data from FINEX execution, planning diagrams of C2 systems, or other general observations gleaned over the course of the ELC or JELC. The FER is delivered to the MAGTF commander, from the MSTP Director, approximately one month after ENDEX.

- **Internal After-Action Review (IAAR).** The IAAR identifies exercise shortfalls that MSTP can remedy in an effort to improve performance and procedures prior to the next exercise. The output of the IAAR may include working groups or other tasks intended to analyze and refine the exercise design and execution process. M&S planners will be expected to share their observations from the all phases of the ELC or JELC and provide constructive feedback to the rest of the organization. An M&S planner may be assigned as a working group lead or member based on the results of the IAAR.

5003. Data Archival. Data archival is the last major activity of the feedback phase. Archiving the simulation databases containing the exercise task organization, TO/E, and parametric data will allow analysts to re-access or recreate events from a previous exercise and can potentially serve as the starting point for developing a future exercise. Aside from simulation and C2 data, the planning documents and diagrams that served as the framework for the architectures and organizations employed during execution should also be preserved, as these can be used as examples or templates for future events. Regardless of its purpose, data should be stored in a logical manner that facilitates seamless searching and retrieval.

5004. Summary of Key Activities

The following are key events from the feedback phase:

- Conduct post-ENDEX equipment accountability
- Support FAAR and FER development
- Participate in IAAR
- Archive exercise data
- Retrograde personnel and equipment to home station

Appendix A
Exercise Checklists

Sample Exercise Check List / Task List

a. Planning Phase

☐ Design Simulation Architecture

☐ Identify Simulation(s)

☐ Identify Federation Schema (If Applicable)

☐ Design C2 System Architecture

☐ Coordinate with IM/KM Officer for Information Requirements

☐ Coordinate with TA COP Manager for Internet Protocol Address Schema

☐ Identify Exercise Locations

☐ Identify SURC Locations

☐ Identify H&AHQ Locations

☐ Identify Green Cell Location

☐ Identify Simulation Server Locations

☐ Identify Simulation Client Locations

☐ Identify C2 System Locations

☐ Identify Network Requirements

☐ Validate System/Network ATCs

☐ Validate Network ATOs

☐ Design RC Structure

☐ Identify MSCs/MSEs Requiring SURC

☐ Identify Billets Required for SURC(s)

☐ Identify Billet Experience/Expertise

☐ Identify SURC Information and C2 System Requirements

☐ Identify H&AHQ Simulation and C2 System Requirements

☐ Identify Green Cell Simulation and C2 System Requirements

☐ Consolidate All Personnel Requirements on the ESMD

b. Preparation Phase

☐ Build Task Organization / Order of Battle

☐ Review TA Annex A

☐ Identify database file format requirements

☐ Build Unit TO/E

☐ Pull TO/E from Total Force Structure Management System

☐ Refine TO/E from TA inputs

☐ Coordinate DIS enumerations for new equipment/systems

☐ Research Performance Data for New Combat Systems

☐ Build Unclassified Parametric Data Set (If Applicable)

☐ Build Classified Parametric Data Set (If Applicable)

☐Conduct Simulation and C2 System Testing (As Applicable)

☐Conduct RRT

☐Conduct EFT #1

☐Conduct EFT #2

☐ Resolve Equipment Requirements at Exercise Site

☐ Crosswalk equipment on-site with requirements

☐ Identify equipment shortfalls

☐ Ship Equipment to Exercise Site

☐ Build Unclassified Shipping Manifest

☐ Build Classified Shipping Manifest

☐ Coordinate with Operations for Shipment Delivery

☐ Identify Personnel Requirements at Exercise Site

☐ Crosswalk On-Site Requirements with Available Personnel

☐ Request Additional Personnel Support Outside of Contract (If Applicable)

☐ Complete Travel Authorization Requests / Defense Travel System Authorizations

c. Execution Phase

☐ Execute Travel to Exercise Locations

☐ Conduct Operational Test of Simulation and C2 Systems

☐ Conduct EOT

☐ Supervise SURC/RC Set-up

☐ Establish C2 Systems

☐ Establish Simulation Systems

☐ Facilitate SURC Check-In

☐ Validate SURC Personnel Access to Simulation, Information, and C2 Systems

☐ Provide Training Schedule

☐ Provide SURC OIC Contact Information

☐ Supervise SURC Training

☐ SURC TO Training

☐ Collective SURC Training / Battle Drills

☐ Support FIT

☐ Complete COMMEX

☐ Complete STAFFEX

☐ Facilitate INFOFLOWEX

☐ Support FINEX

☐ Supervise SURCs

☐ Monitor Simulation and C2 Systems

d. Feedback Phase

☐ Conduct Post-ENDEX Equipment Inventory

☐ Classified Material Inventory

☐ Equipment List Inventory

☐ Ship Equipment to Home Station

☐ Validate Unclassified Equipment Manifest

- ☐ Validate Classified Equipment Manifest
- ☐ Stage Equipment for Shipping

☐ Retrograde Personnel to Home Station

☐ Support FAAR Development

- ☐ Provide Data from Simulations
- ☐ Provide Data from C2 Systems

☐ Support FER Development

- ☐ Provide Data from Simulations
- ☐ Provide Data from C2 Systems

☐ Participate in IAAR

- ☐ Submit AAR points to EXCON

☐ Archive Exercise Data (as applicable)

- ☐ Archive Force Laydown / Order of Battle File
- ☐ Archive TO/E Files
- ☐ Archive Parametric Data
- ☐ Archive Simulation and C2 System Diagrams
- ☐ Archive Miscellaneous Planning Documents

Appendix B
Common C2 Systems and Training Simulations

C2 Systems

Name	Function(s)
Agile Client	C2, Intelligence
Advanced Field Artillery Tactical Data System	Fires, Logistics
Command and Control Personal Computer	C2, Planning
Common Aviation Command and Control System	Aviation C2, Fires
Common Logistics Command and Control System	Logistics
Global Command and Control System	C2, Fires, Intelligence
Joint Automated Deep Operations Coordination System	Fires
Joint Range Extender	Aviation C2
Marine Corps Common Intelligence System	Intelligence
Theater Battle Management Core System	Aviation C2, Planning
Transportation Capacity Planning Tool	Logistics

Training Simulations

Name	Primary Domain	Category	Level
Air and Space Constructive Environment – Intelligence Operations Suite - ACE–IOS	Air	Constructive	Entity
Air Force Synthetic Environment for Reconnaissance and Surveillance - AFSERS	Air	Virtual	Entity
Air Warfare Simulation - AWSIM	Air	Constructive	Entity
Air Base Simulation - ABS	Ground (Aviation)	Constructive	Entity
GPS Environment Generator - GEG	Space	Constructive	Entity
Joint Conflict and Tactical Simulation - JCATS	Ground	Constructive	Entity
Joint Deployment Logistics Model - JDLM	Ground	Constructive	Entity
Joint Semi-Automated Forces - JSAF	Naval	Constructive	Entity
MAGTF Tactical Warfare Simulation - MTWS	Ground (Amphibious)	Constructive	Aggregate
Multiple Unified Simulation Environment - MUSE	Air	Virtual	Entity
Next Generation Threat System - NGTS	Air	Constructive	Entity
The Warfighter's Simulation - WARSIM	Ground	Constructive	Aggregate
Virtual Battle Space - VBS	Ground	Virtual	Entity

Appendix C
Glossary

Section I Acronyms

ADFOR..... adversary force
ATO .....air tasking order
ATC ..... authority to connect
BDA .....battle damage assessment
BSC..... battle simulation center
C2.....command and control
C2PC..... command and control personal computer
C5ISRT command, control, communications, computers, combat systems, intelligence, surveillance, reconnaissance, and targeting
CAC2S..... common aviation command and control system
CASEVAC .....casualty evacuations
CDC ..... concept development conference
CE ..... command element
CIS .....communication and information systems
COC.....combat operations center
COMMEX..... communications exercise
COP .....common operational picture
DIS.....distributed interactive simulation
ELC.....exercise life cycle
ESMD .....exercise support manning document
ESTAT.....execution status and monitoring
ENDEX..... end exercise
EXCON ..... exercise control
FINEX .....final exercise
FIT.....force integration training
FPC.....final planning conference
GCCS.....global command and control system
H&AHQ .....higher & adjacent headquarters
HIL .....human-in-the-loop
HLA..... high level architecture
HOL..... human-out-of-the-loop

HQ..... headquarters
IC ..... instructor controller
INFOFLOWEX.....information flow exercise
IM/KM ..... information management / knowledge management
IPC..... initial planning conference
JELC..... joint event life cycle
LVC ..... live, virtual, and constructive
M&SCO .....modeling and simulation coordination office
MEB..... Marine expeditionary brigade
MEF ..... Marine expeditionary force
MSC..... major subordinate command
MSE ..... major subordinate element
MSEL .....master scenario events list
MSTP.....MAGTF staff training program
NCO.....non-commissioned officer
OIC .....officer-in-charge
OPORD .....operations order
OSCC.....operational system control center
OTH-Gold.....over-the-horizon gold
PPA..... planning practical application
RC..... response cell
SCO..... senior control officer
SIMCON .....simulation control
SME..... subject matter expert
SOP..... standard operating procedure
SPOTREP .....spot report
STAFFEX.....staff exercise
STARTEX.....start exercise
SURC..... subordinate unit response cell
TA ..... training audience
TBMCS.....theater battle management core system
TO.....terminal operators
TO/E ..... table of organization and equipment
TTP..... tactics, techniques, and procedures
VMF.....variable message format
VV&A..... verification, validation, and accreditation
WFS.....warfighting seminar

Section II Definitions

A

aggregate (unit) — A group of entities or a group of other aggregates considered as a single unit. The substitution of the word "unit" is used to avoid phrases like "aggregate aggregate." (IEEE Std 1278.1-2012)

B

behavior — For a given object, how attribute value changes affect or are affected by the attribute value changes of itself, other objects, or the simulation environment.

C

command post exercise (CPX) — An exercise in which the forces are simulated, involving the commander, the staff, and communications within and between headquarters. (JP 1-02)

computer simulation— A simulation that is executed on a computer, with some combination of executing code, control/display interface hardware, and, in some cases, interfaces to real-world equipment.

computer-generated forces (CGF) — A generic term used to refer to computer representations of forces in models and simulations that attempts to model human behavior sufficiently so that the forces will take some actions automatically (without requiring man-in-the-loop interaction). Types of CGF include automated forces - computer-generated forces that require little or no human interaction. Semi-automated forces - computer-generated forces in which the individual platform simulation is operated by computer simulation of the platform crew and command hierarchy.

constructive simulation — Simulations involving simulated people operating simulated systems. Real people can be allowed to stimulate (make inputs) to such simulations.

F

federation — A system of interacting models, simulations, and a supporting infrastructure that are based on a common understanding of the objects portrayed in the system. In HLA, a named set of federate applications and a common federation object model (FOM) that are used as a whole to achieve some specific objective. (IEEE Std 1516-2000)

G

Green Cell — The Green Cell assists the commander and staff in understanding the effect of the civil environment on both friendly and threat forces. The cell articulates the actions and dynamics of selected individuals, groups, tangible assets, and societal-cultural factors in the civil environment that may significantly impact friendly operations. (MSTP Pamphlet 2-0.1)

L

live simulation — A simulation involving real people operating real systems. (DoD M&S Human Capital Strategy)

live, virtual, and constructive (LVC) simulation — A broadly used taxonomy describing a mixture of live simulation, virtual simulation, and constructive simulation. (LVCAR Final Report)

M

Master Scenario Events List (MSEL) — A chronological list that supplements the exercise scenario with event synopses; expected participant responses; capabilities, tasks, and objectives to be addressed; and responsible personnel. It includes specific scenario events (or injects) that prompt players to implement the plans, policies, and procedures that require testing during the exercise, as identified in the capabilities-based planning process.

It also records the methods that will be used to provide the injects (i.e., phone call, radio call, e-mail).

model — A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process. (DoDI 5000.61, DoDI 5000.70)

Modeling and Simulation (M&S) — 1. The discipline that comprises the development and/or use of models and simulations. (DoDD 5000.59, DoDI 5000.61) 2. The use of models, including emulators, prototypes, simulators, and stimulators, either statically or over time, to develop data as a basis for making managerial or technical decisions.

R

resolution — The degree of detail used to represent aspects of the real world or a specified standard or referent by a model or simulation.

S

scenario — An identification of the major systems/players that must be represented by the simulation, a conceptual description of the capabilities, behavior, and relationships (interactions) between these major system/player over time, and a specification of relevant environmental conditions (e.g., terrain, atmospherics). Initial and termination conditions are also provided.

simulation — A method for implementing a model over time. (DoDD 5000.59, DoDI 5000.61, DoDI 5000.70)

simulation environment — The operational hardware, software including databases, communications, and infrastructure in which a simulation operates.

simulation exercise — An exercise that consists of one or more interacting simulation applications. (IEEE Std 1278.1-2012)

simulator — A device, computer program, or system that performs simulation. (IEEE 610.3-1989)

stimulator — A hardware or software device that provides input into an operational system or subsystem.

V

virtual — An entity or data that is derived from a modeled or simulated representation of the actual or anticipated system.

virtual simulation — A simulation involving real people operating simulated systems.