Section 3

FUTURES

PEO LS Vision: Focus the Future Faster via the Concept to Capability Process

The ultimate goal of PEO LS S&T remains clear: to "Focus the Future Faster" in support of transitioning affordable, reliable, and relevant capabilities into PEO LS programs of record and ultimately into the hands of the warfighter. The capabilities required are in part based on a wide-ranging consideration of threats, trends, constraints, opportunities, and customer demands to ensure an informed understanding of the technological art of the possible. However, they also must be based on our institutional operating concepts and their underlying functional and enabling concepts. PEO Land Systems works within a well-defined process to anticipate future demands and bring cutting edge technologies to the MAGTF.

The Concept to Capability Process outlined in this plan is initiated by the Combat Developer, and specifically by DC, CD&I's recently established Futures Directorate (Figure 3-1). Existing concepts, as well as new ones being addressed by the Futures Directorate, are the foundation upon which we base our future required capabilities. Those concepts, and the process that follows to produce the capabilities needed, are driven by wide-ranging assessments of the future that include everything from adversary capabilities to fiscal constraints.

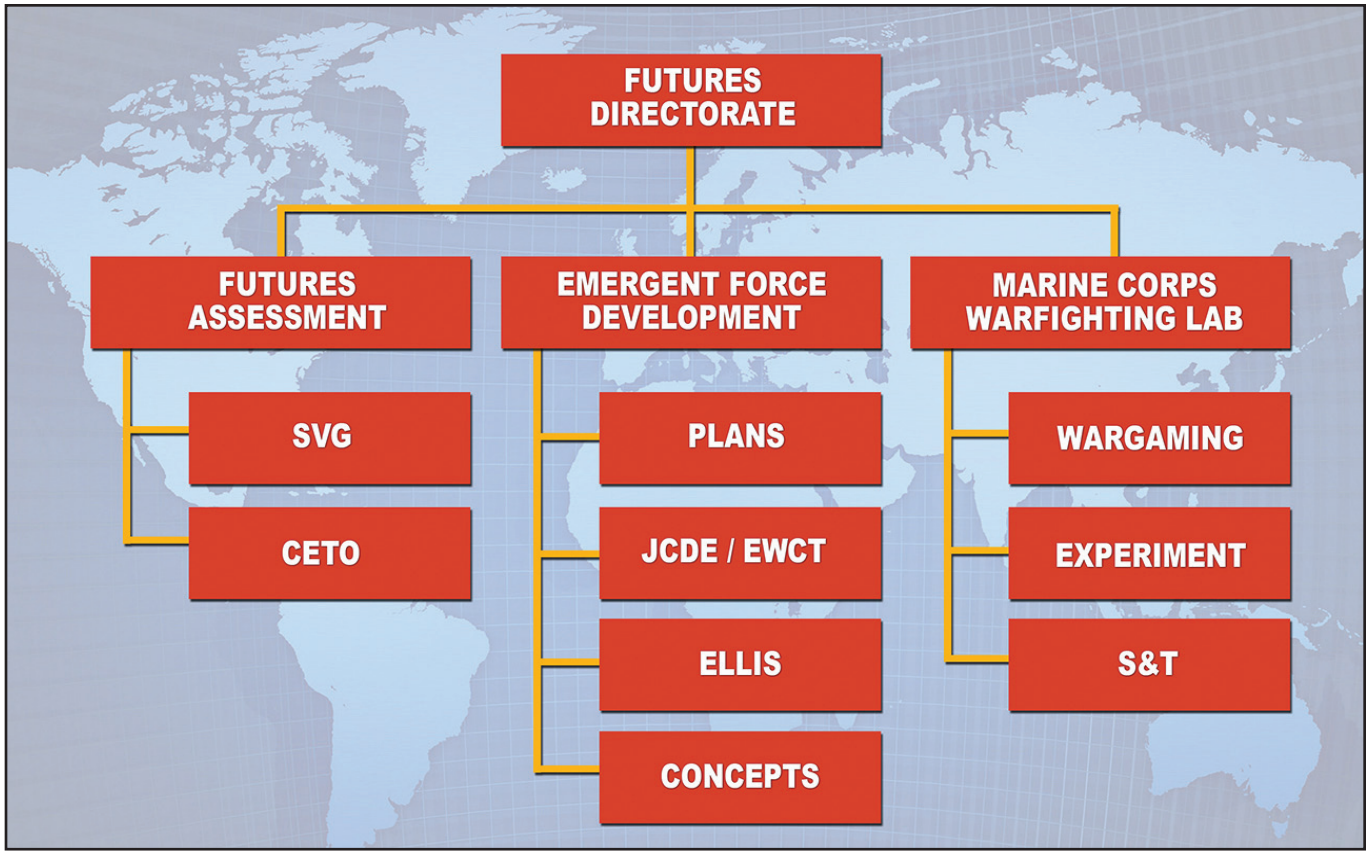


Figure 3-1. Futures 101: Strategic Foresight Illustration

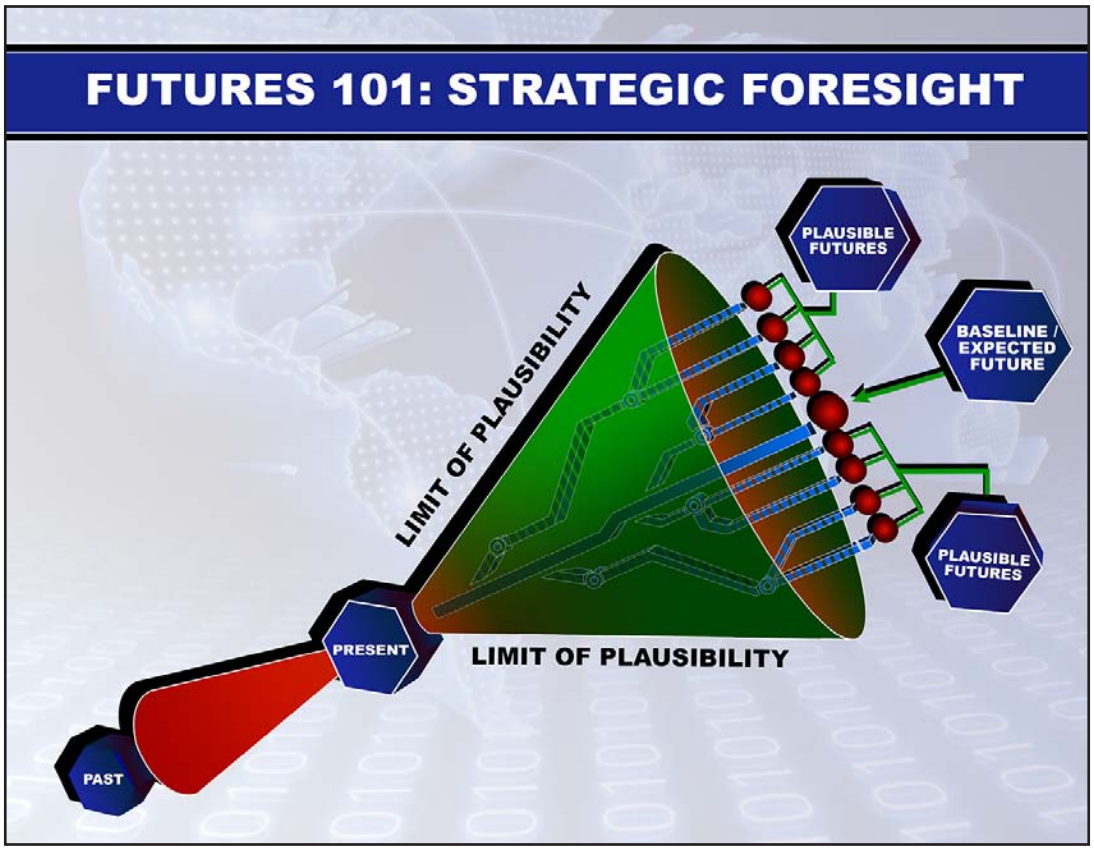


Figure 3-2. Futures Directorate Organizational Chart

For PEO LS S&T, a wide variety of sources and perspectives are used to develop and validate futures assessments, but in the end our focus remains squarely on those directly related to the U.S. defense establishment. The Concept to Capability process employs a strategic methodology that addresses current (and future) capability gaps to inform the ATIP by providing relevant context to our understanding of the world's most likely future security environment. This methodology, as reflected in this plan, references and responds to DoD, Joint, and Service guidance relative to what the future is expected to hold. It also considers other likely and plausible futures (as well as less probable scenarios) as espoused by experts from industry, academia, and the international community.

These "expected futures" are derived from baseline forecasts that extrapolate existing trends into the out years. To gain a better understanding of the expected landscape, we have a responsibility to look not only at the most likely futures and the progression of historical trends, but also to look at less likely but potentially significant threats and opportunities that could lead to strategic or tactical surprise.

Trends and forecasts used to support our examination of the most likely future security environments are outlined in a number of key U.S. defense-related publications:

- *DoD Sustaining U.S. Global Leadership: Priorities for 21st Century Defense (2012);*
- *Capstone Concept for Joint Operations: Joint Force 2020 (CCJO) (2012);*
- *Joint Operational Access Concept (JOAC) (2012);*
- *CJCS Mission Command White Paper (2012);*
- *Naval Operations Concept 2010 (NOC 2010);*
- *Marine Corps Operating Concepts 2010 (MOC);*

- *Marine Corps Vision & Strategy 2025 (MCV&S 2025) (2008);*
- *The 35th Commandant of the Marine Corps Commandant's Planning Guidance 2010 (CPG);*
- *The Marine Corps Service Campaign Plan 2012-2020 (2012); and, most recently*
- *Expeditionary Force 21.*

The future holds a variety of relatively predictable threats, challenges, and opportunities. The trends and forecasts outlined in these seminal documents that are relevant to PEO LS include:

- An era of fiscal austerity and government debt.
- Technological diffusion – weapons of mass destruction proliferation.
- Increased urbanization, particularly in the littorals.
- The traditional view of the three primary domains (air, land, and sea) within the "global commons" in context, with the addition of the space, cyberspace, and human domains.
- The demand for critical resources is likely to continue to exceed supply, even with advanced conservation and efficiency measures coupled with alternative sources.
- Transnational crime, regional instability, and violent extremism.
- An increased emphasis on a forward-postured crisis response force in readiness to address an unstable and uncertain operating environment, with an emphasis on Phases 0 through 2 (Shape, Deter, Seize Initiative).

The PEO LS S&T Directorate monitors Marine Corps, Navy, and Joint efforts in the areas of futures analysis and concept development in order to articulate the potential impacts and influences across the PEO LS portfolio. This plan identifies and prioritizes the PEO LS Top Technical Issues and technology needs in order to inform, influence, and align S&T investment in support of transitioning critical capabilities to the warfighter to meet both current and future threats.

PEO LS' Concept to Capability approach provides a validated, repeatable process for addressing an uncertain future within the context of the evolving Marine Corps Force Development System. Future risks are minimized by selecting well researched areas of focused investment based on technical issues that share common warfighting connections to multiple programs within the PEO. Focusing S&T funding on these key areas enables the Marine Corps to maximize its return on investment (ROI) and to be better prepared as it moves into the future.

Through our futures analysis we developed PEO LS key focus areas: 1) Power and Energy, 2) Survivability and Mobility, 3) Open Plug and Play Communications Architecture, and 4) Modeling and Simulation. These focus areas serve as the primary means for identifying critical technology enablers and resolving critical capability challenges. These critical areas—along with their associated subsets of fuel efficiency, intelligent power and thermal management, autonomy, corrosion resistance, crew visibility, fuel containment/fire suppression, safety, and weight reduction—provide relevant focal points to credibly inform future investments.

PEO LS Focus the Future Faster - Concept to Capability Vision

As depicted in Figure 3-3, on the following page, achieving a lighter and more lethal Naval expeditionary force while improving force protection within current fiscal constraints will require innovation, dedication, and focused professionals who are intent on mission accomplishment. As current maritime forces are constrained by limits of scale in the organization of forces and platforms, future maritime assets will face even greater challenges in meeting the goals of effectively resourcing the Naval expeditionary force

"Focus the Future Faster" Concept to Capability

It's All About The Warfighter

US Marine Corps Concepts to Capability

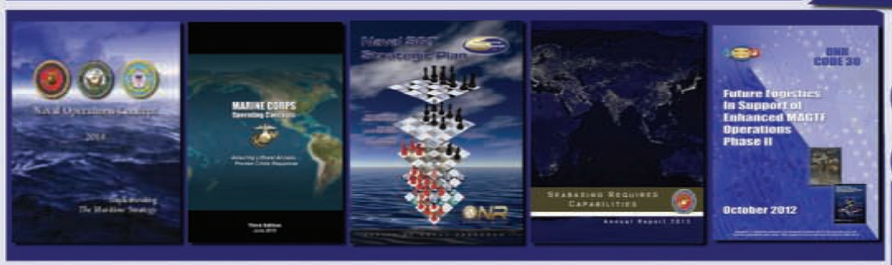
PEO LS Programs

- AAA
  - AAV, ACV 1.1
- AC2SN
  - CAC2, CTN, MACCS
- GBAD - G/ATOR
  - GBAD, G/ATOR
- LTV
  - JLTV, HMMWV, ITV
- M & H TV
  - MTVR, LVSR, FRC, M870-MHET, P-19
- MRAP
  - Buffalo, Cougar, M-ATV
- TAS
  - LW155

PEO LS S&T Focus Areas

- POWER & ENERGY
  - Fuel Efficiency
  - Intelligent Power & Thermal Management
- SURVIVABILITY & MOBILITY
  - Autonomy
  - Corrosion Resistance
  - Crew Visibility
  - Fuel Containment & Fire Supression
  - Safety (SYS & Armor)
  - Weight Reduction
- MODELING & SIMULATION
- OPEN PLUG AND PLAY COMMUNICATIONS ARCHITECTURE

Naval Expeditionary Concepts to Capability



Shaping & Enabling The Balanced Marine Corps of Tomorrow

- CBM
- M&S
- OCP
- Autonomy
- Energy Efficiency
- Holistic Modularity
- Open Architecture

Lighten the MAGTF

Affordability Reliability Capability

Legacy to Modernization
Era of Fiscal Austerity

Inform Influence Align

Operationalize the Seabase

- EMO to FMO
- LOG-IT
- Cyber
- Austerity
- Asia Pacific

Future Naval Capabilities 2025 and Beyond

and operationalizing the seabase. These goals are a key focus within the PEO LS "Legacy to Modernize" investment strategy as outlined in the 2013 investment plan. However, as the Marine Corps positions itself for a future security environment that is likely to involve operations quite different than those of the past decade, our investment focus must be centered on "Sustainment and Modification" to implement the Legacy to Modernize strategy given the effects of fiscal constraints. This Sustainment and Modification approach is based on the cornerstones of *modularity*, *scalability*, *commonality*, and *affordability*. While PEO LS is still focused on reducing the weight and cube of the MAGTF and maximizing efficiencies across all domains, with particular attention placed on energy and logistics, resource challenges demand that both the process and products include the dimension of *adaptability*. The intent is to provide technologies that are not only affordable, reliable, and capable but also flexible and therefore enduring in order to support the Marine Corps' expeditionary doctrine and operational imperatives "beyond the Future Years Defense Program."

PEO LS Futures Focus – Anticipated Technology Needs

Autonomy and Robotics

Autonomous and robotic capability sets are quickly establishing a strong foundation in every aspect of the DoD. Semi-autonomous systems are being employed in every segment of society (commercially and militarily), with research into fully-autonomous (cognitive) systems that target development efforts as forecasted in the Autonomy Maturity Horizon. Currently, the majority of autonomous and robotic systems employed by the Marine Corps are used in Unmanned Ground Vehicle (UGV) applications such as Counter-Improvised Explosive Device (C-IED) detection, breaching operations, and defensive systems.

Left Page: Figure 3-3. Concept to Capability

Increased use of robotics in dangerous applications can ultimately increase the Marine Corps' mission performance and combat effectiveness as increasing numbers of personnel are removed from hazardous tasks and assignments. The range of operations for autonomous robotic systems is vast and includes logistics, physical security, urban warfare and virtually crosses all Warfighting domains.

Future seabasing concepts seek to employ autonomy and robotics in sustainment and firefighting operations, both above and below decks. By being smaller, stronger, and faster, robotic Material Handling Equipment (MHE) and connector-to-connector autonomous assets can be more easily deployed to operational areas without increasing airlift or sealift requirements. Autonomy and robotics provide a way forward to improve agility at the tactical edge with better throughput, smaller logistics overhead and more efficient energy management.

A key S&T autonomy capability under development in support of sustaining distributed operations via autonomous delivery systems is the ONR Autonomous Aerial Cargo & Utility System (AACUS). An Innovative Naval Prototype (INP), the technology targeted within this INP includes open architecture, tremendously enhanced processing speeds, and technology that is platform agnostic. The system focus will provide a substantial leap in levels of cognitive/full autonomy and targeted reductions

> *"Modularity is the practice of applying capabilities in modules from a broad MAGTF perspective. This is not simply a modular packaging system or a modular Combat Operation Center capability. This represents a factory-to-foxhole look at modular capabilities."*
> **Future Logistics in Support of Enhanced MAGTF Operations Phase II Report October 2012**

in size, weight, and power. All parameters align closely to key issues and identified focus areas within PEO LS programs.

PEO LS Futures Focus – Logistics

Although the PEO Land Systems portfolio influences all of the warfighting functions, the operations, maintenance and movement of our large vehicle portfolio both impact and will be impacted by future logistics innovations. The efficient and effective use of logistics capabilities can change the outcome of any engagement. Whether in general support of Distributed Operations or in direct support of a maneuver combat element, logistics provides the critical sustainment that allows the continued projection of combat power. While it is a major functional area within the Marine Corps, logistics is also a science that requires constant development in regard to R&D as well as S&T investment.

Future logistics directly impact two major tenets that are determining the direction of the Marine Corps: *lightening the MAGTF* and *operationalizing the seabase*. Additionally, the logistics community has highlighted the need for more modular systems. These concepts will drive how the PEO looks at future vehicle development and will play a large role in guiding future logistic development to include *autonomy*, *modularity*, and *robotics*.

Holistic Modularity

Concept

Future fiscal constraints will almost certainly impact the development of new programs of record to lighten the MAGTF and operationalize the seabase. Therefore, it is critical that the Marine Corps maximize capability with proven legacy systems and platforms and "modernize" those capabilities with purposeful capability packages and systems applications.

Analysis of potential future logistics capabilities tells us that a key approach to developing a lighter, more fiscally responsible capability is *holistic modularity*, a design philosophy incorporating a multi-disciplinary design approach that is optimized for delivering requirements. The design, development, and implementation of holistic modularity presents significant 2nd and 3rd order effect technical challenges but will ultimately provide an enabling framework to lighten and modernize the future Marine Corps.

Vehicle Agnostic Modularity (VAM)

One example of holistic modularity research is VAM, an ONR 30 project supported by PEO LS Program Offices that will explore the bounds of vehicle modularity with the goal of demonstrating its benefits and characterizing its challenges. The project directly addresses one of the biggest challenges facing an expeditionary force - transporting a large inventory of tactical vehicles to support the required mission capabilities. To provide future commanders the flexibility to successfully execute their mission within the expected fiscal and operational constraints, VAM will define and demonstrate an agnostic modularity concept on multiple vehicle types using multiple capability "sets."

A number of results that will influence future vehicle design and acquisition decisions include:

- Seamless and intelligent mission module exchange.
- Technology pass-through from legacy vehicles to future military vehicles.
- Reduced logistical footprint.
- Reduced aggregate weight/cube.

Modular Application with the MTVR

Another example of holistic modularity is the concept of employing modularity in future improvements to

Figure 3-4. Modularity Packages / Applications

the legacy Medium Tactical Vehicle Replacement (MTVR), a proven warfighting asset programmed for employment through 2035.

The use of a modular MTVR illustrates how modularity can modernize legacy platforms to deliver tremendous operational impact and significant benefits to our warfighters (see Figure 3-4), such as:

- Leverages the flexibility of MTVR with Onboard Vehicle Power (OBVP) and offers the commander multiple options for mission sets, to include: mobile Command and Control (M2C2), Mobile Trauma Bay, Gunslinger Force Protection, Mine Neutralization, Expeditionary Power/H2O purification, Counter Rocket Artillery and Mortar, Universal Lift and Loaders, and Ground Based Air Defense on the Move.
- Provides the seabased Commander with mission package flexibility once embarked.
- Reduces the number of vehicles required in theater.
- Reduces the MAGTF maintenance burden.
- Reduces the MAGTF footprint afloat and ashore.
- Provides an integrated digital backbone with

modular interfaces and architectures networked together to enable seamless interchange and operation of "plug and play" mission modules.

- Future Autonomy - Select vehicles equipped with autonomous capability sets and employing a leader/follower Concept of Operations will further reduce MAGTF footprints as well as manning and associated force protection requirements.

PEO LS Futures Focus – (The Monster Garage) Analytical Process

The challenging fiscal realities and the return to shipboard operations in the Pacific requires the Marine Corps to find innovative ways to repair, improve, modernize, and enhance the agility of our vehicles within the framework of planned maintenance cycles. ONR 30 Logistics and Maneuver PMs are coordinating to develop a rigorous analytical process, with a goal of improving vehicle and component readiness while decreasing scheduled and corrective maintenance requirements. This analytical process will define problems down to root cause of failure, allow for a predetermination of acceptable ROI, and then provide a recommended S&T specialization for examination of the problem and selection of possible material solutions. The goal of the material solution would be either a vehicle type improvement or a vehicle fleet improvement, e.g., improved material for all vehicle belts that offers a significant increase to belt lifespan at the same or at less than the current cost point.

Prognostic Maintenance

Prognostic maintenance is not a new concept within the Marine Corps, but with the publication of MCO 4790.25 *Ground Equipment Maintenance Program (GEMP)*, it has taken on a new life and sense of urgency. Condition Based Maintenance (CBM), a maintenance concept with a considerable amount of historical effort, has been incorporated as a central component of Total Productive Maintenance (TPM). CBM is the application and integration of processes, technologies, and knowledge-based capabilities to achieve target availability, reliability, and operation and support costs of Marine Corps systems and components across their life cycles. TPM is a comprehensive approach to maintenance intended not only to prevent and correct equipment failures, but also to optimize equipment performance and extend equipment life cycles. Another key component of TPM is Reliability Centered Maintenance (RCM), which is a method of analysis that captures and assesses operational and maintenance data to enable decisions that improve equipment design, operational capability, and readiness. RCM is a logical decision process that enables CBM by providing the evidence of need for both reactive and proactive maintenance tasks that support CBM processes. In execution, RCM involves performing only those maintenance tasks that will reduce the probability of a failure or mitigate the consequences of a failure, based on analysis of each failure mode and the consequence of failure.

CBM and RCM are expected to provide the capability within the operating forces to utilize ground combat equipment to automatically generate and transmit critical system data from the battlefield to monitoring stations. Monitored systems parameters could include diagnostic (heat, fuel, relays, rpm, pressure, etc.) data, prognostic data, cargo monitoring data, ammunition levels, etc. This capability, when transmitted over today's remote and wireless technology, would provide near real-time data that could either be queried upon request or transmitted when triggered by an event (time, movement, or pre-set thresholds). Not only would implementation of CBM and RCM to select ground combat vehicles enable anticipatory logistics, it would also allow efficiencies across the entire logistics spectrum: strategic, operational, and tactical. Maintenance cycles and other programs, e.g., Inspect and repair only as necssary (IROAN), could benefit as vehicle platforms are kept operational well past expected life cycles and maintenance periods. S&T research into

the implementation of sensory-based technology for placement in several ground-based programs could result in further preservation of equipment as well as extended life cycles for the programs. Sensor technology is currently in use in the commercial automobile industry.

S&T investments to support prognostic maintenance should focus on:

- Use of modular sensor-based technology integrated into existing platforms to significantly improve the readiness and combat effectiveness of operating units.
- Employment of sensor technology to indicate when a system (e.g., transmission, engine, electrical components) is not performing within desired parameters or when critical maintenance is required.
- The prediction of required maintenance for major end items, which will increase the turn-around rate for assets in the maintenance cycle, reduce parts storage requirements, and increase the requisition process rate.
- Deploy cyber protected sensor-based technology integrated into existing platforms and monitor on a secure and live network, which will enable the Marine Corps to take full advantage of a CBM System.

Big Data

Digital War Room

The PEO LS Science and Technology Integration Center (STIC) war room has become a critical part of the PEO S&T ATIP process. The ability to discover, manage, analyze, and display the vast amount of data associated with S&T efforts is necessary to make prudent investment decisions. The digital war room will provide an invaluable forum for collaboration, information exchange. and visualization of complex technologies and operational concepts. Although the rich data resources that drive collaboration

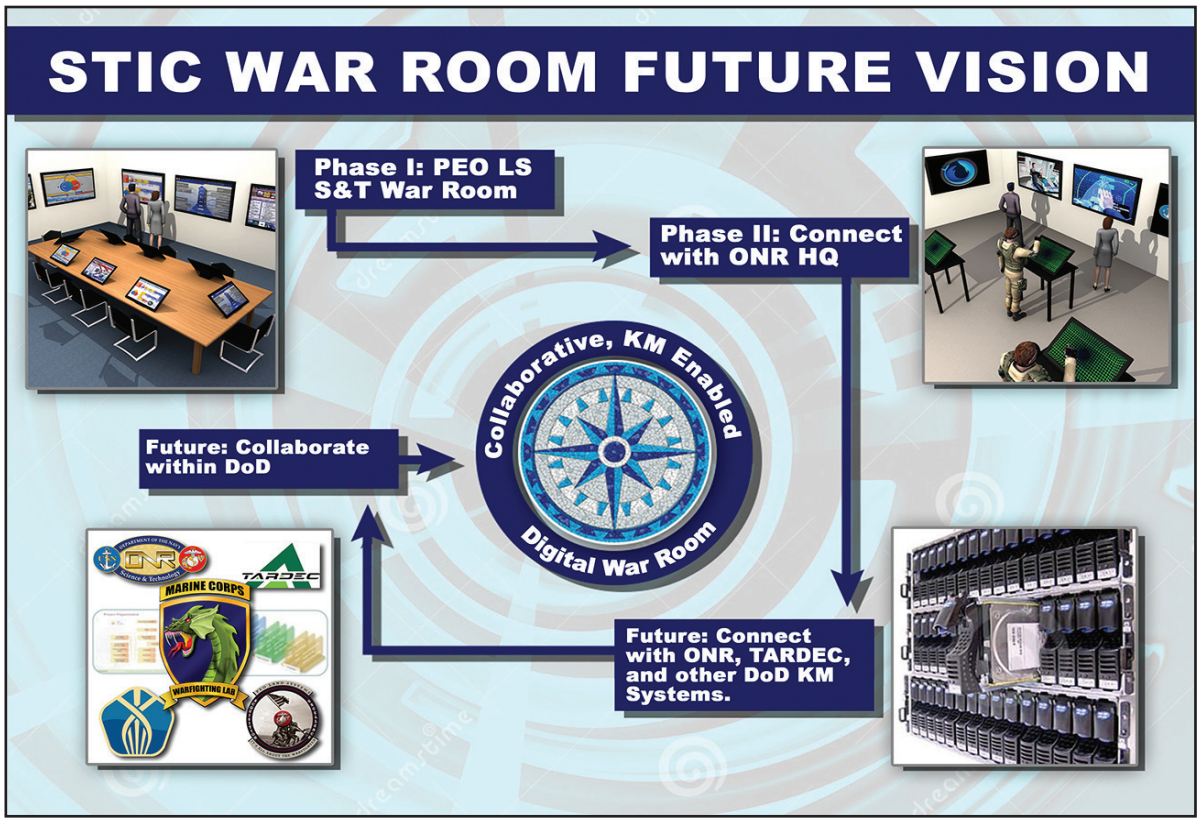


Figure 3-5. Science and Technology Integration Center War Room Future Vision

in the war room are relatively portable through presentations and publications, the current format does not take advantage of emerging technologies to maximize the PEO LS staff's ability to visualize and analyze S&T opportunities.

The PEO LS digitized STIC war room supports cutting edge capabilities to provide for more effective collaboration, data discovery, data management, analysis, and tailorable presentations that are useful to stakeholders across the S&T Enterprise. PEO LS is leading the way for similar efforts at ONR, at ONR Global, and at other stakeholder organizations to come together in a virtual collaborative S&T war room work space. Achieving this goal will be a long term project that eventually will result in virtual collaboration, data discovery, and presentation; 3D simulation based on advanced models; and multi-participant synchronous and asynchronous collaboration and data sharing.

PEO LS Futures Road Ahead

As PEO LS continues to "Focus the Future Faster" by evaluating both current and future threats/capability gaps with respect to potential S&T investments and material solutions, it is imperative that closer coordination and collaboration between the 3 Circles continues.

Working within the constraints of an increasingly austere resource environment, it is imperative that the Marine Corps fully embrace S&T as a means to not only mitigate program risk but also as a means to sustain and modify equipment within the Legacy to Modernize strategy. By leveraging all available resources to inform, influence, and align S&T investments to address the requirements of the future Marine Corps, PEO LS is committed to providing affordable, reliable capability transitions into our programs of record because at the end of the day, "It's All About The Warfighter."