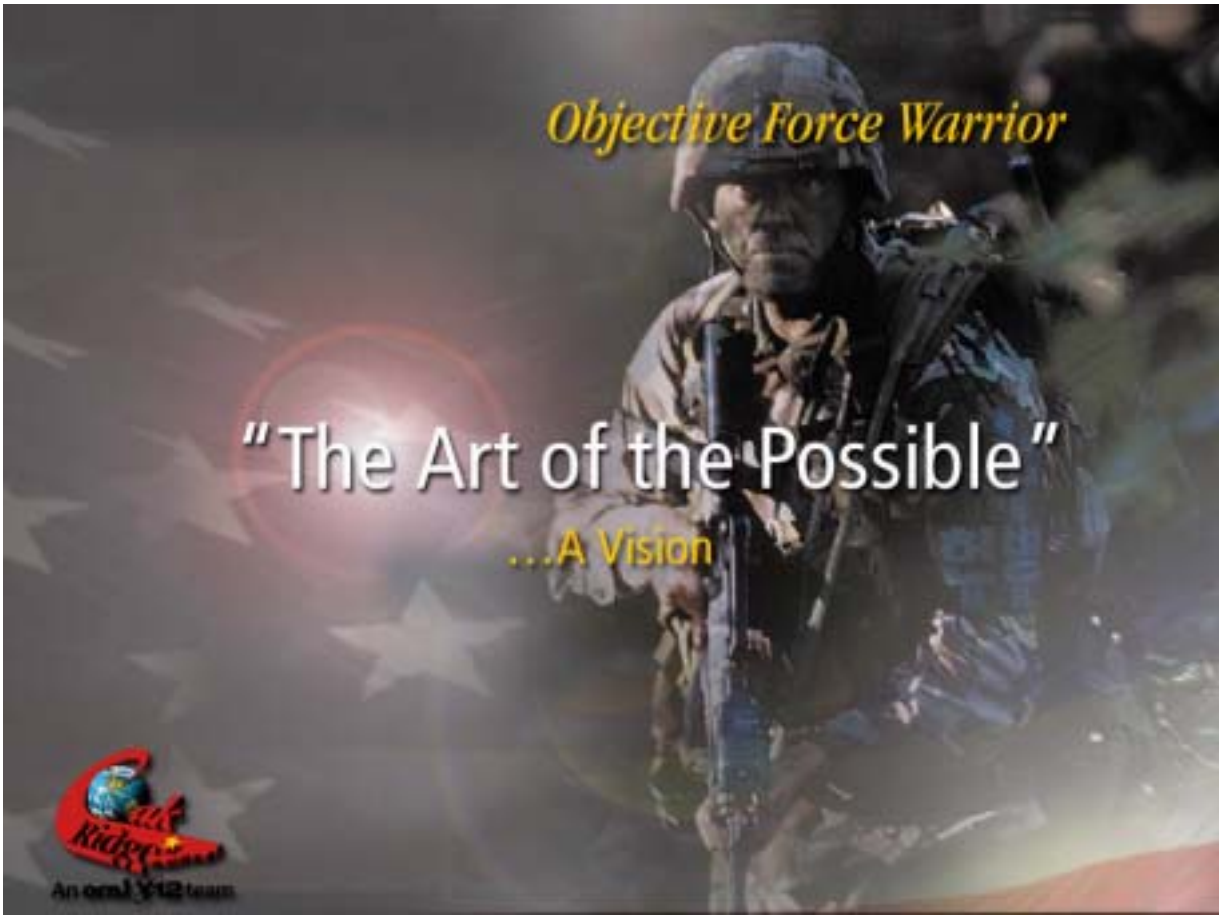
Objective Force Warrior

"Another Look"



Prepared for the

Deputy Assistant Secretary of the Army
(Research and Technology)

by the National Security Directorate
Oak Ridge National Laboratory

December 2001

Objective Force Warrior
"Another Look"

Overview

On October 12, 1999 the Army's leadership unveiled their vision for creating a force for the future that is strategically responsive and dominant at every point on the spectrum of conflict. After "The Army Vision" was unveiled, the Army conducted a series of transformation studies, experiments and wargames to support the sweeping internal transformations necessary to achieve the objectives described in the vision. Building on this foundation, the Chief of Staff of the Army published a white paper providing the framework for further development of the Army's Objective Force. This white paper describes the Objective Force as "our future full spectrum force: organized, manned, equipped and trained to be more strategically responsive, deployable, agile, versatile, lethal, survivable and sustainable across the entire spectrum of military operations." General Shinseki's white paper and *FM 1-0, The Army,* stresses that soldiers will "remain the centerpiece of our formations" and will be the "heart" of the Objective Force.

Recognizing this human dimension, the Army saw the need for a component of the transformation effort specifically focused on the soldier. In Fiscal Year 2001, three separate groups were chartered to develop and review visions and concepts for the "Objective Force Warrior". The Independent Review Team recommended that the Objective Force Warrior supporting science and technology programs could yield a revolutionary capability this decade certain program and resource realignments. The Army Science Board performed a study specifically focused on the Objective Force Warrior. This study identified selected technology opportunities and provided a sample roadmap for technology integration. They also found the greatest opportunities for performance gain were beyond 2012. The Army also formed a special studies group to derive warfighter needs, determine capabilities to meet needs, and identify broad-base technologies for these needs. In spite of the hard work and dedicated efforts of all those involved in each of these studies, a clear actionable vision for the Objective Force Warrior has not emerged.

The Deputy Assistant Secretary of the Army (Research and Technology), Dr. Mike Andrews saw the need for an actionable vision for the Objective Force Warrior that would steer the Army Science and Technology program and provide a focus for the Request for Proposals and the development process. Dr. Andrews commissioned and independent Objective Force Warrior "Another Look" workshop and asked the National Security Directorate at the Oak Ridge National Laboratory to orchestrate this process.

The specific tasking Dr. Andrews described for the "Another Look" Workshop was to develop an Objective Force Warrior Vision based on aggressive application of emerging technologies using an innovative system of systems design approach. Dr. Andrews also challenged the workshop to consider new ways to fight, enabled by the application of new technical and system capabilities. The objective of these concepts was to set the warrior performance "bar" as high as possible and still be just inside the bounds of technical feasibility. Specifically, Dr. Andrews asked the "Another Look" workshop participants to answer these three questions:

- What capability is possible with a technology freeze in Fiscal Year 2006?
- How do we achieve a paradigm shift in warrior capability?
- How significantly will the Objective Force Warrior exceed Land Warrior capabilities?

The expected outcomes of the "Another Look" workshop were a graphical representation of the concept, achievable performance metrics, prioritization of the critical enabling technologies, and identification of compelling performance advantages over Land Warrior.

In response to Dr. Andrew's tasking Oak Ridge orchestrated the formation of four Tiger Teams to take an independent look at a vision, metrics, and enabling technologies for the Objective Force Warrior. The Tiger Teams were formed from highly qualified experts from various fields (military, technology, futurist, systems engineers, biologists, etc.). Professional facilitators from the public sector and the Army War College were assigned to work with each team. The Tiger Teams participated independently in a concept and analysis process designed to envision innovative approaches for Objective Force Warrior.

The "Another Look" workshop was held during two three-day sessions (October 1-3, and 29-31) at Oak Ridge, TN. During Session 1, the Tiger Teams received baseline information on soldier systems and a description of 20 leading edge technologies that could impact soldier systems through presentations given by experts in their field.

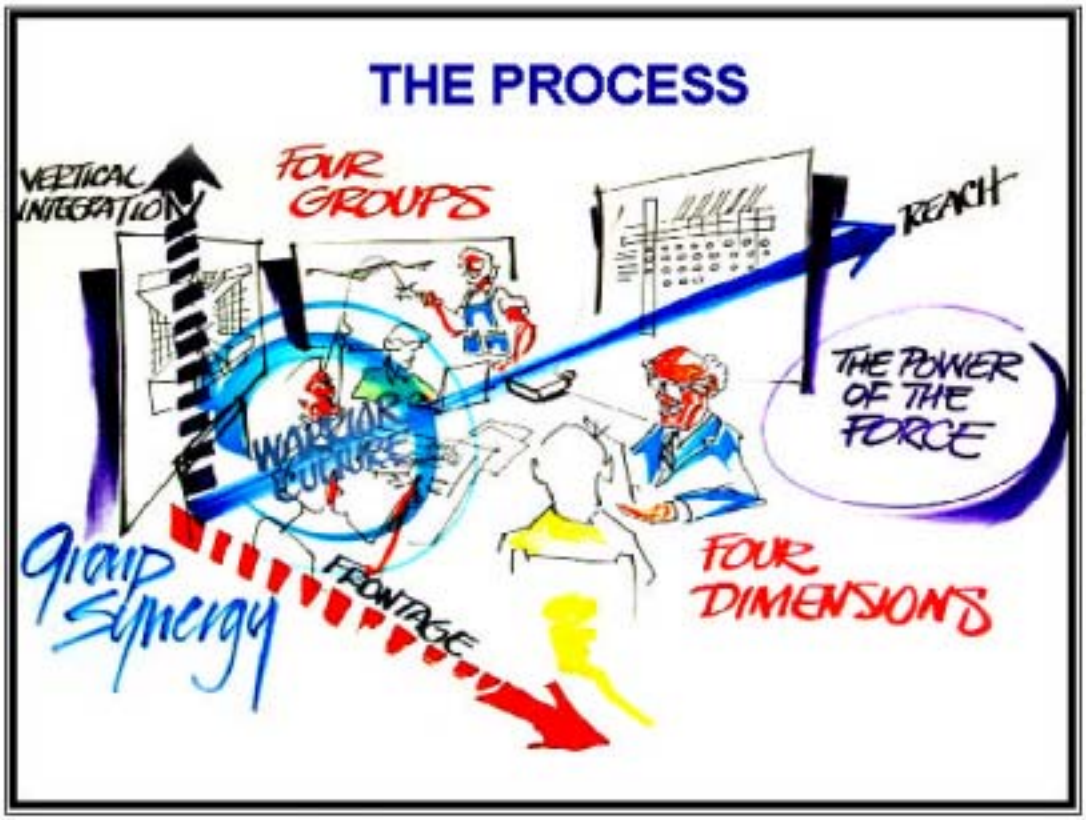
During Session 2, the Tiger Teams convened to consider the potential for a leap-ahead vision, metrics, and the technologies that could enable such a concept. The teams considered the various areas of soldier performance, the technologies that could take these to the next level, and how these capabilities could be combined to produce a new dimension of results. Session 2 culminated in an out brief presentation to Dr. Andrews. Each Tiger Team briefed the concept they developed and the achievable performance metrics, presented a prioritization of the critical enabling technologies, and identified compelling performance advantages over Land Warrior.

Following Session 2, a group convened to review the products of each team and develop a composite vision that combined the best aspects of each of the four visions produced during the Objective Force Warrior "Another Look" sessions. The Composite Vision forms a concept more powerful and complete than any of the individual visions singly. While each of the groups took a different approach to the vision, many of the essential components and enabling technologies converged into a relatively well-focused set.

This report includes a narrative of the composite vision and a narrative of each of the four panel visions. Each section includes an introduction and a narrative of the PowerPoint slides describing the vision. Following the narratives are specific descriptions of the vision, metrics, enabling technologies, a comparison with Land Warrior 2004, a discussion of potential breakthrough technologies for Future Warrior, recommendations, and a summary.

A Vision for the Objective Force Warrior

The Composite Vision selects the best aspects of each of the four panel visions produced during the Objective Force Warrior “Another Look” sessions. The Composite Vision forms a concept more powerful and complete than any of the individual visions singly. While each of the groups took a different approach to the vision, many of the essential components and enabling technologies converged into a relatively well-focused set.



A central theme among each of the four groups was the concept of expanding the ability of the Objective Force Warrior (OFW) to affect the battle space three dimensionally by bringing the total power of the Objective Force to bear. This provides significantly more capability gain than individual improvements to the soldiers’ on-person suite; in essence, exponential versus on-the-margin capability advances.

The Objective Force Warrior

**“The soldier of today is thrust far forward.
He is the point of the Army spear.
It is very lethal and very lonely out there.
The soldier of tomorrow will never be alone
and he will advance on his enemy shielded by
dominant information.
His leaders will be able to say this to him:**

> **‘Soldier, you are the master of your battlespace. You will shape the fight. The network will enable you to see all that can be seen. You will out think, out maneuver, and out shoot your enemy.
> The Force is with you.
> You are one with the Force.’”**

—General Paul Gorman

General Paul Gorman framed the effect the four panels wanted to achieve in eloquent fashion. The soldier of tomorrow will bring the power of the force to bear without having to carry the assets directly. The Objective Force Warrior must be able to employ the full range of national and joint capabilities to see first, understand first, act first, and finish decisively.

Objective Force Warrior “Another Look” – Composite Vision

The Objective Force Warrior poster portrays a capability to expand the effect of the soldier by a factor of twenty across the spectrum of conflict. It captures the effect the panels believed was achievable with a dedicated focus on a few essential capabilities.

VISION — Essential Principles

- "Overmatch" for the Soldier
  - Dominate through Information
- Apply the Power of the Force
  - Collaborative massed effects
- Three-dimensional Aspect of Effects
  - Vertical integration
  - Stand-off
  - Extended frontage
- Warrior Culture
  - Human performance - centric design
  - Extended cohesion
  - Paradigm shifts in recruiting, manning, and training
- Open Architecture
  - Integrate emerging capabilities continuously

This vision conceptualizes the ability to achieve netted communications leading to collaborative situational awareness for the soldier. It also envisions the ability to apply netted fires to achieve the massed effects of the force. These two capabilities (netted communications and netted fires), if fully achieved, provide the twenty-fold increase in capability for the Objective Force Warrior. All of the other technology advances together, were judged to provide a one or two-fold increase in capability. Thus, a very focused approach to achieving soldier overmatch emerged.

Certain aspects of the Warrior Culture are essential and require consideration in the design of the system to achieve performance-centric results. The manning and management aspects of a force of this complexity will require new approaches.

Particularly in the C^4ISR arena, a move to open architecture designs, which would allow easily integrated capabilities as they matured, was considered essential for success. This would require a more refined vision of future possibilities, but would avoid the "outdated when fielded" syndrome.

VISION

The Objective Force Warrior (OFW) concept achieves “overmatch” at the individual soldier and unit of action level. It leverages and focuses the power of the entire Force, empowering the OFW to dominate the battlespace.

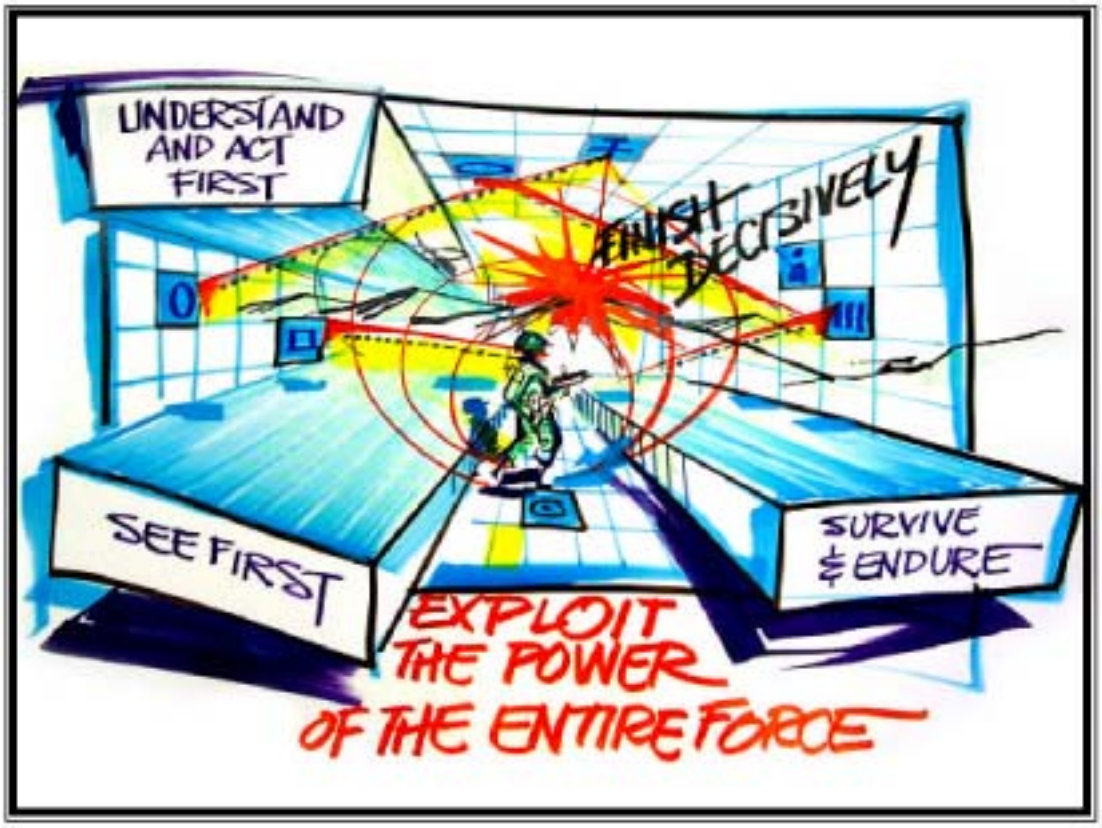
Netted communications and collaborative situational awareness affords the OFW unparalleled knowledge. The application of the full range of FCS combat multipliers and fires expands the effect of the OFW three dimensionally.

Technological capabilities are woven in a synergistic manner to optimize fightability and the indomitable spirit of the warrior culture.

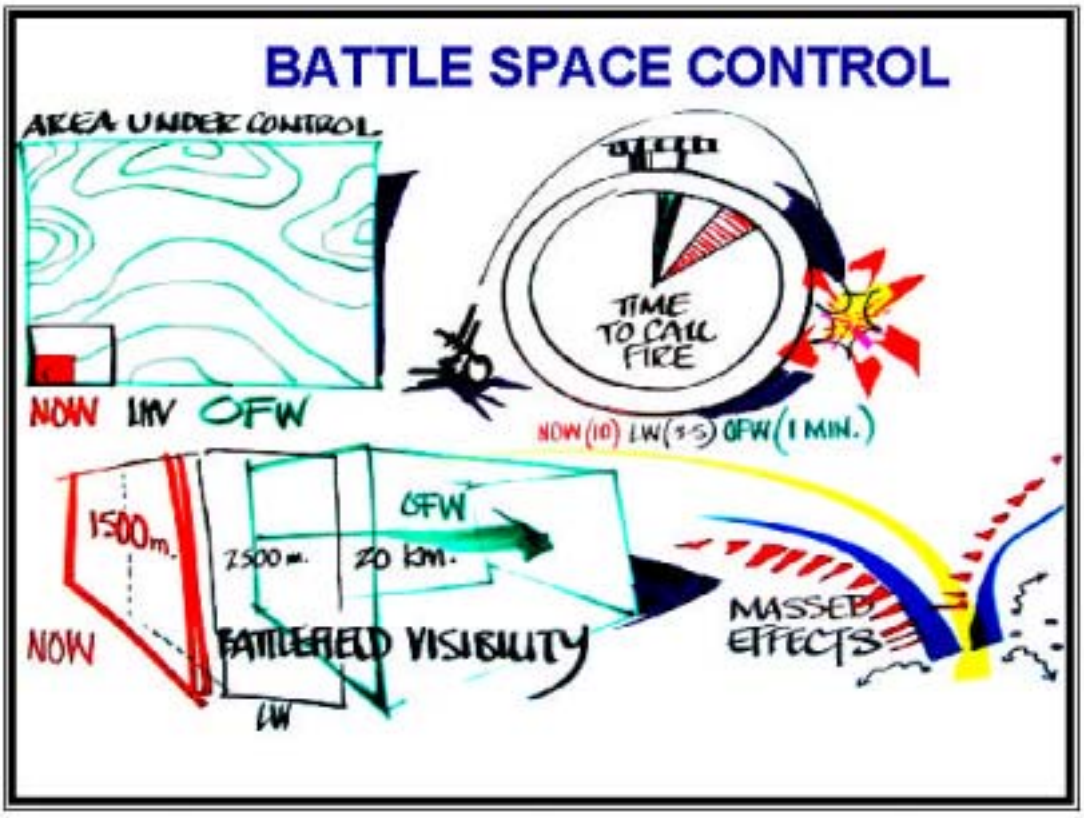
The integration of emerging capabilities occurs continuously through open architecture designs to optimize potential and keep pace with the exponential growth of technology.

The essential elements of the Objective Force Warrior vision involve providing the ability for the individual soldier and his unit of action to achieve “overmatch” over their opponents across the entire spectrum of conflict. This overmatch is achieved by leveraging the combat power of the entire Objective Force. Emerging information technology provides the means to leverage the full range of combat multipliers inherent in the Future Combat System and those of joint service systems. A robust C^4ISR architecture is the common thread that links the Objective Force Warrior to the fully netted communications and fires of the Objective Force and provides the essential situational awareness to greatly increase lethality and enhance survivability.

These technological capabilities must be woven together in a manner that supports the warrior culture and optimizes the warrior’s fightability and spirit. Open architecture designs provide the opportunity to optimize potential and keep pace with the exponential growth of technology.



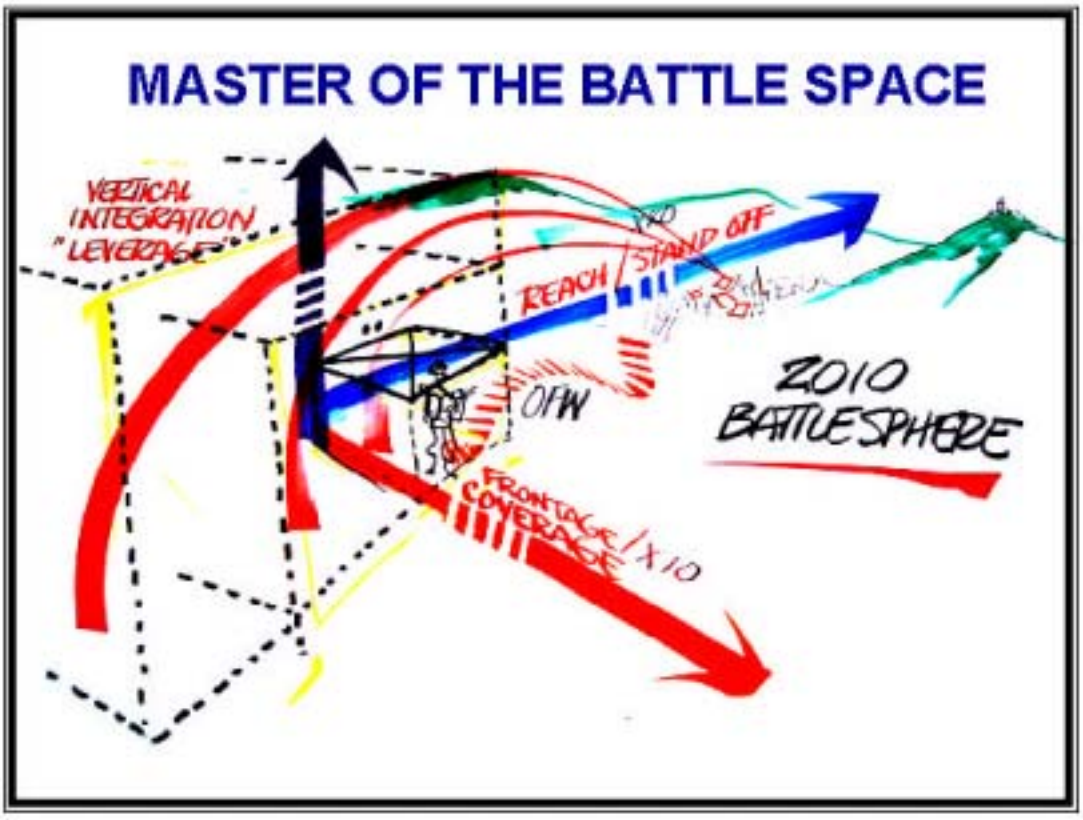
The vision exploits the power of the entire force and integrates with the Future Combat System of systems. It optimizes the Army’s doctrinal concepts of *see first, understand first, act first, and finish decisively*. The soldier is the enabler of collaborative massed effects. It is critical that the full range of national and joint capabilities, which will enable the Objective Force to *see first, understand first, act first, and finish decisively* at the strategic, operational, and tactical levels be extended to the Objective Force Warrior and his unit of action.



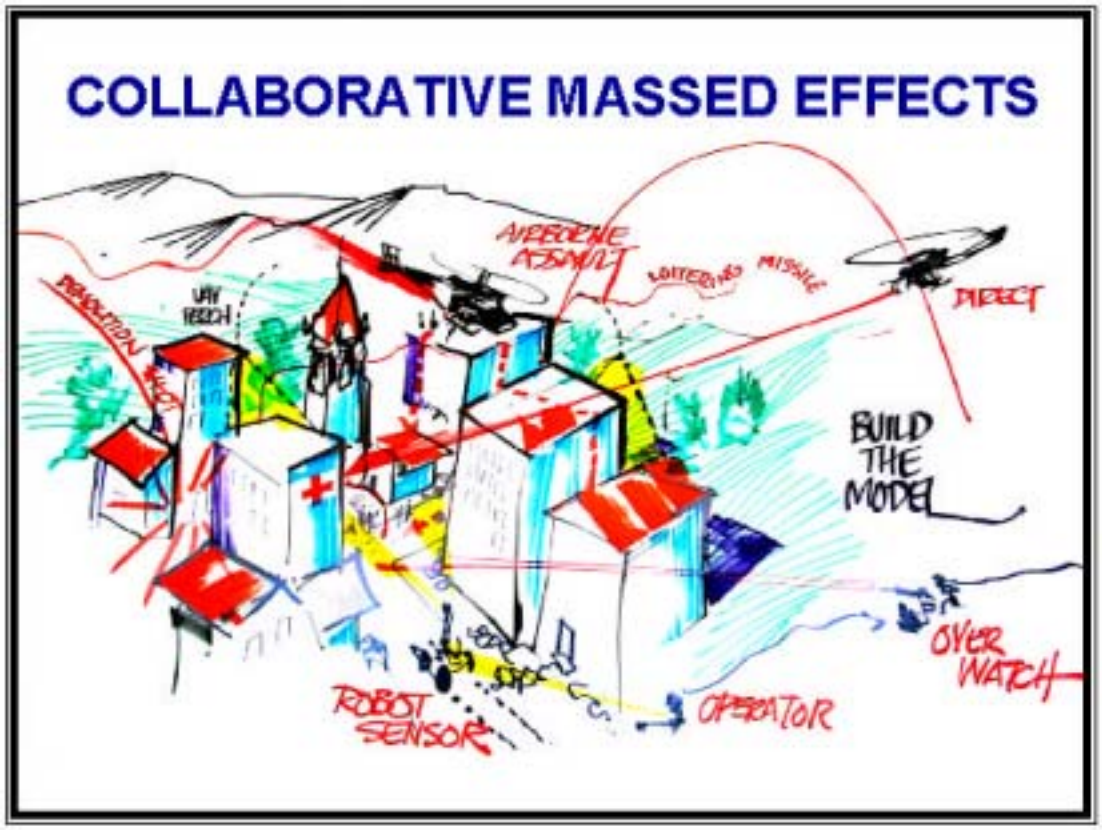
Under this concept, the Objective Force Warrior’s potential to exponentially expand battle space control and effect is achieved in three dimensions and time. The advanced C^4ISR architecture of the Objective Force will be integrated from the strategic to the tactical level. This information superiority backbone will provide the means for the Objective Force Warrior to achieve revolutionary situational understanding and establish, maintain, and distribute a tailored common operating picture.

Extended range redundant communications and networked beyond line of sight fires will extend the Objective Force Warrior’s reach and influence over an exponentially expanded battle space. Improved organic and joint sensor-shooter linkages will reduce response time and expand the means and rapidity with which targets can be engaged with the massed effects of the entire force. Through technological improvements in weapons and munitions, the Objective Force Warrior will have the ability to engage and destroy the enemy at longer ranges, with greater precision, and with effects that are more devastating.

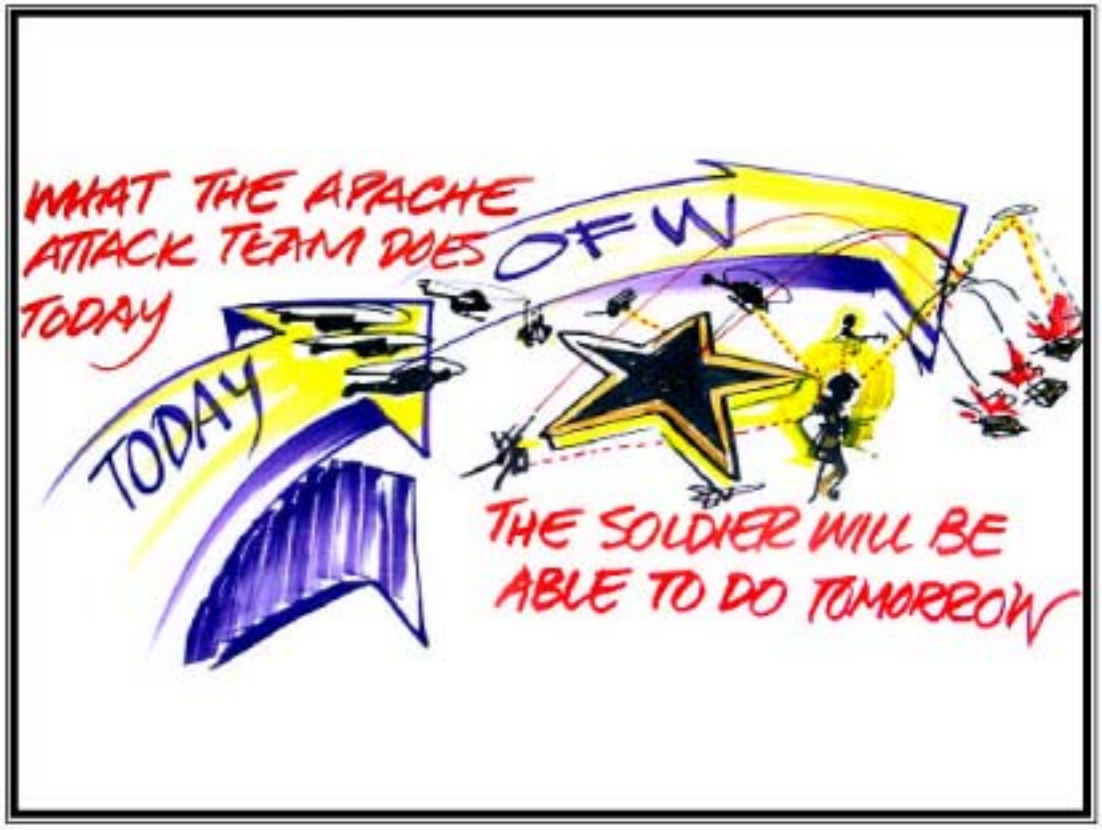
Objective Force Warrior “Another Look” – Composite Vision



Battle space is the volume of area in which the Objective Force Warrior will dominate the enemy. Through dramatically improved battlefield visualization, the warrior will decide where, when, and how he will dominate the enemy within his battle space. The multiplier aspects of vertical integration and standoff are achieved. As these massed effects are achieved, the soldiers’ concomitant risk is lowered. By seizing and maintaining the initiative and seeing, understanding, and acting first, the Objective Force Warrior will enhance his own survivability.



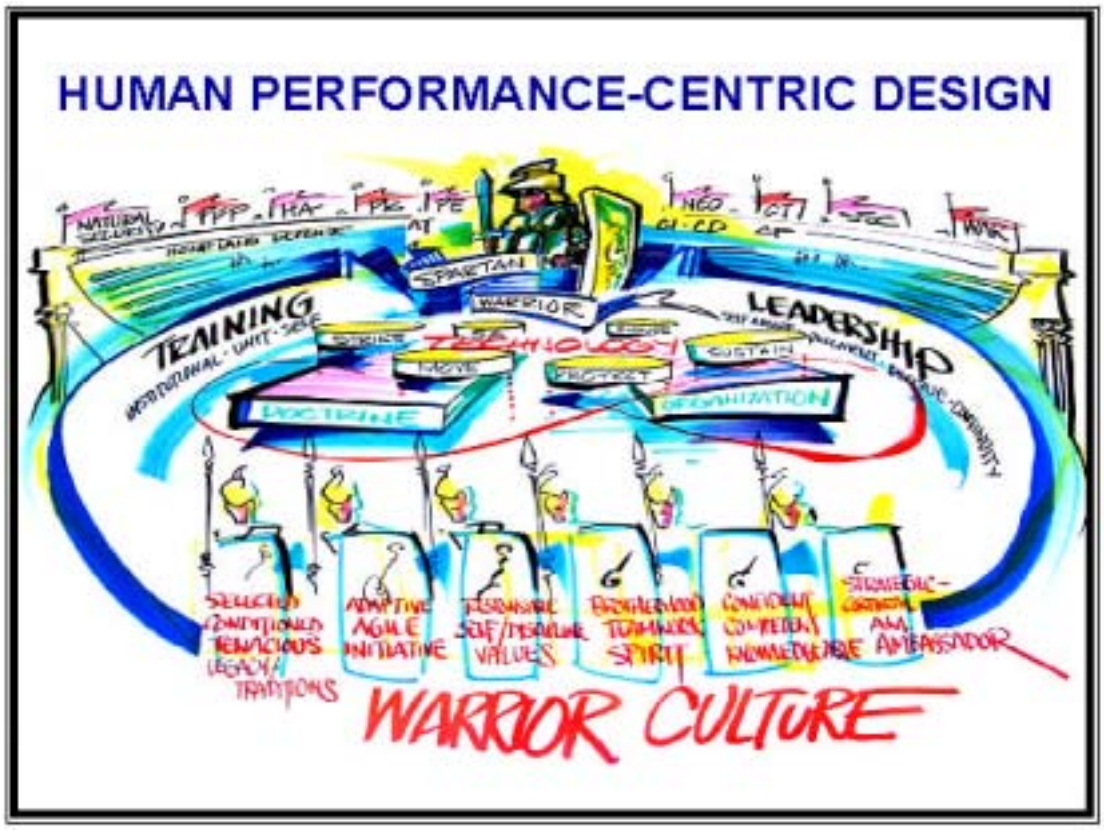
The urban conflict situation provides a good example of the Objective Force Warrior’s capability to bring integrated, collaborative massed effects to bear with a three-dimensional perspective.



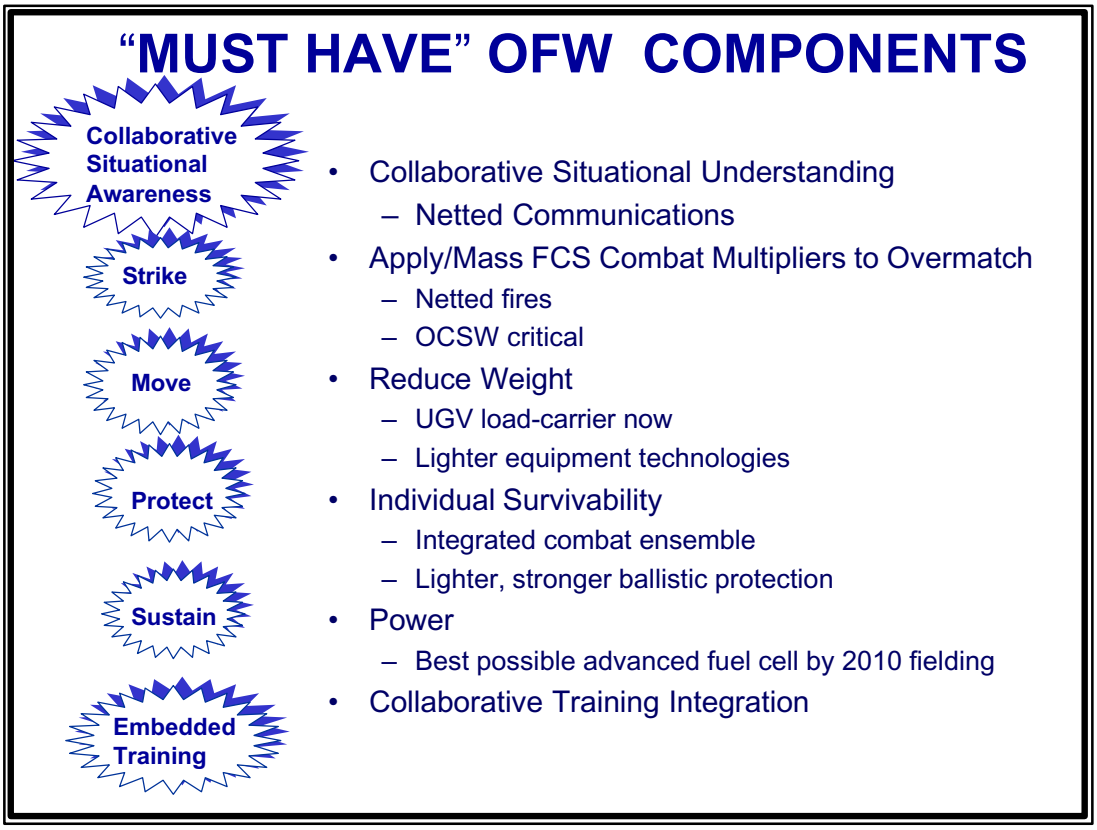
Another analogy is that we want tomorrow’s soldier to be able to achieve the effect that the Apache attack team does today.

Through centuries of warfare, the human dimension has played the most critical role. Those fundamental principles, elevated by technology, provide the most dynamic potential for decisive results.

Soldiers and leaders will be the heart of Objective Force units. These disciplined, physically tough, and mentally conditioned warriors will have the perseverance and technical and tactical competence to be adaptive and decisive across the full spectrum of conflict. Technology will serve as an enabler to allow them to remain persuasive in peace and invincible in war.

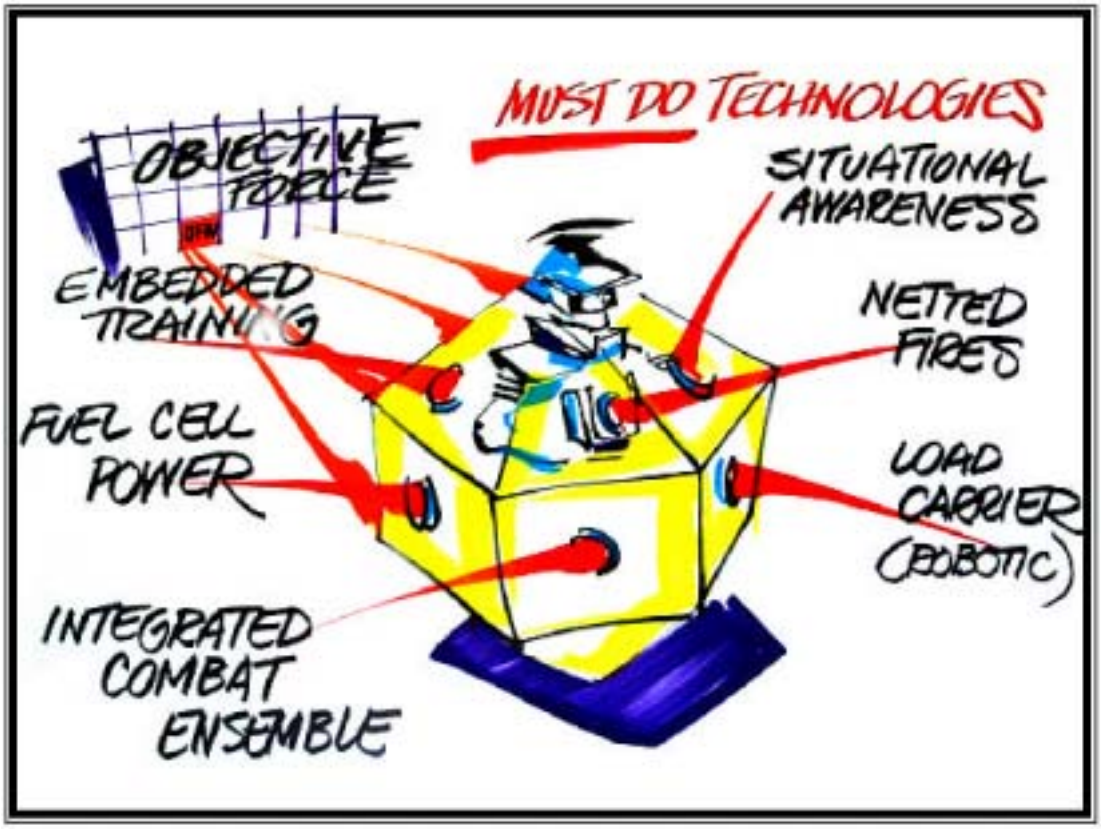


It is essential that the Objective Force Warrior systems be designed around the critical operational elements of the Warrior Culture. The resulting mosaic, shown above, illustrates the philosophy that allows us to gain optimum utility from our technology. Technology becomes the catalyst that enables an effective integration of leadership, training, doctrine, and organization. It elevates our capability to the next level in a way that the soldier recognizes as valuable and usable.

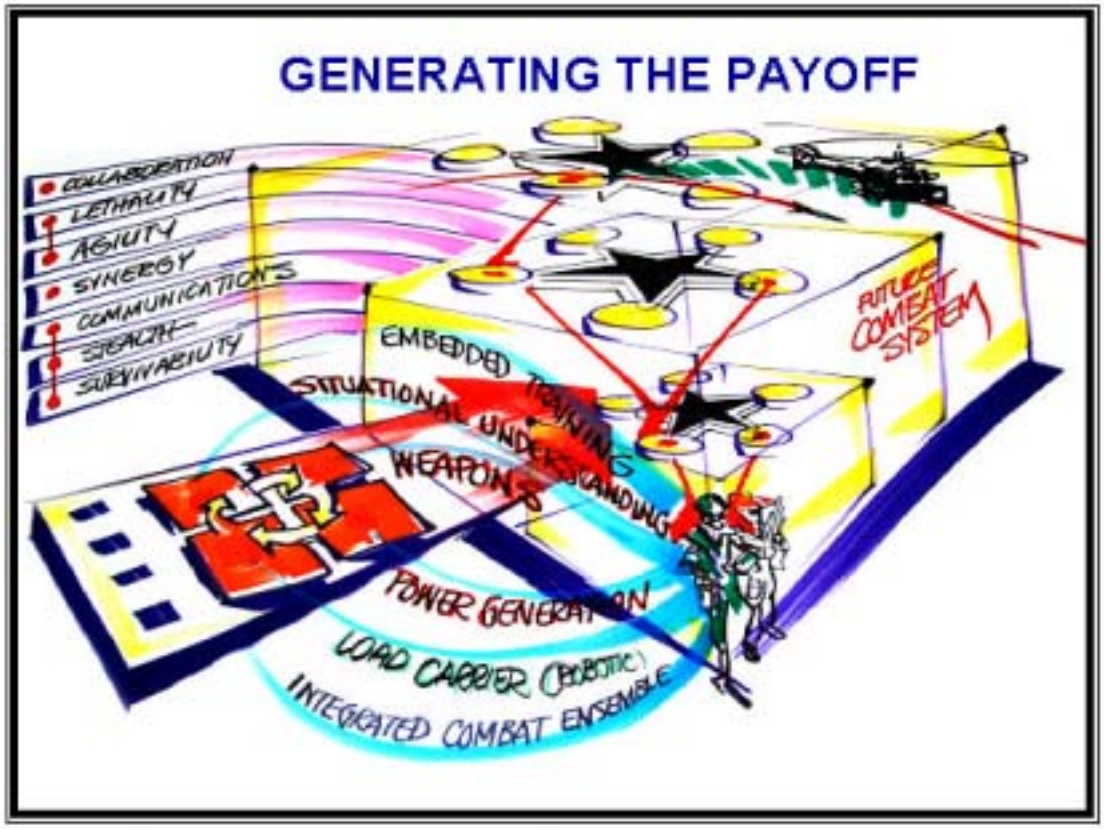


Six essential components were identified as crucial for an Objective Force Warrior fielding in 2010. The first two, Collaborative Situational Understanding (netted communications) and Netted Fires, were by far the most important. Even if 100% capability cannot be achieved by 2010, maximum focus and resources should go to optimize these two areas. Collaborative Situational Understanding and Netted Fires are where the big payoff lies in capability. These two items allow the soldier to “know” what the system knows and apply the power of the force.

Other supporting key components emphasize providing a robotic load carrier now, producing an integrated combat ensemble, developing the best advanced power source possible, and providing integrated embedded training capabilities.

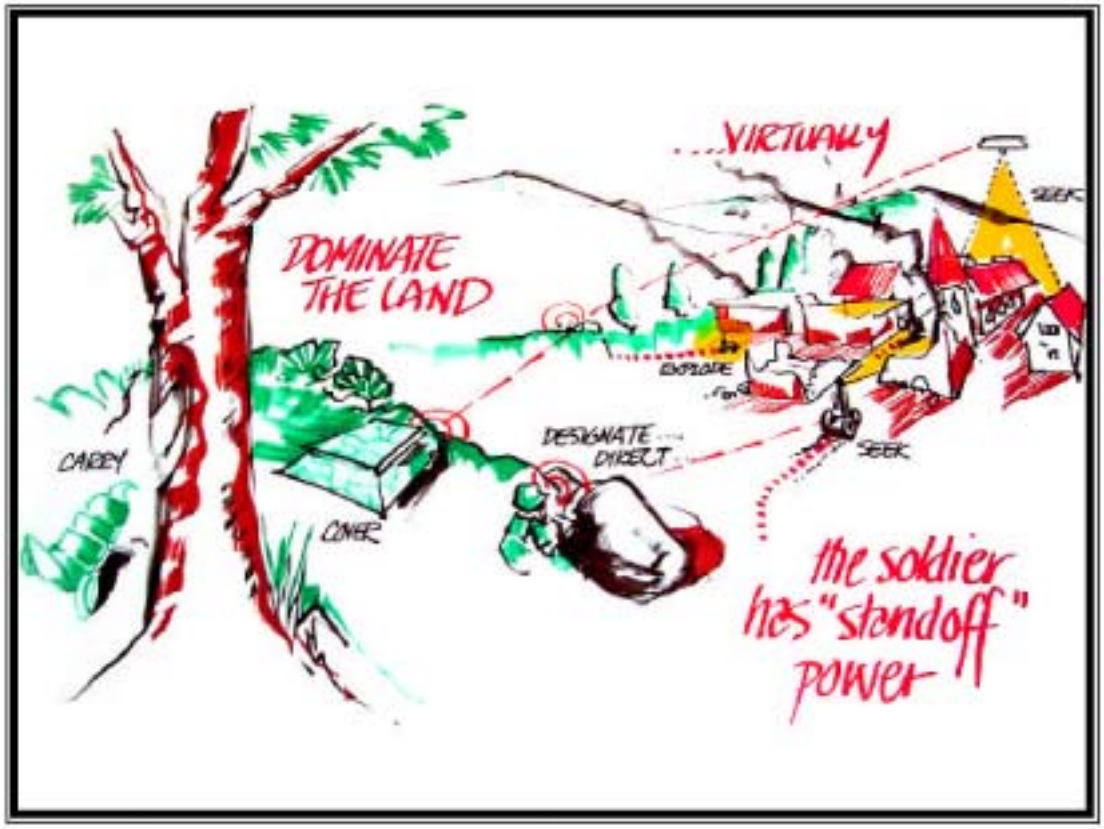


This graphic portrays a powerful Objective Force Warrior capability as part of the Objective Force concept, hinged on the six “Must Do” technology components.

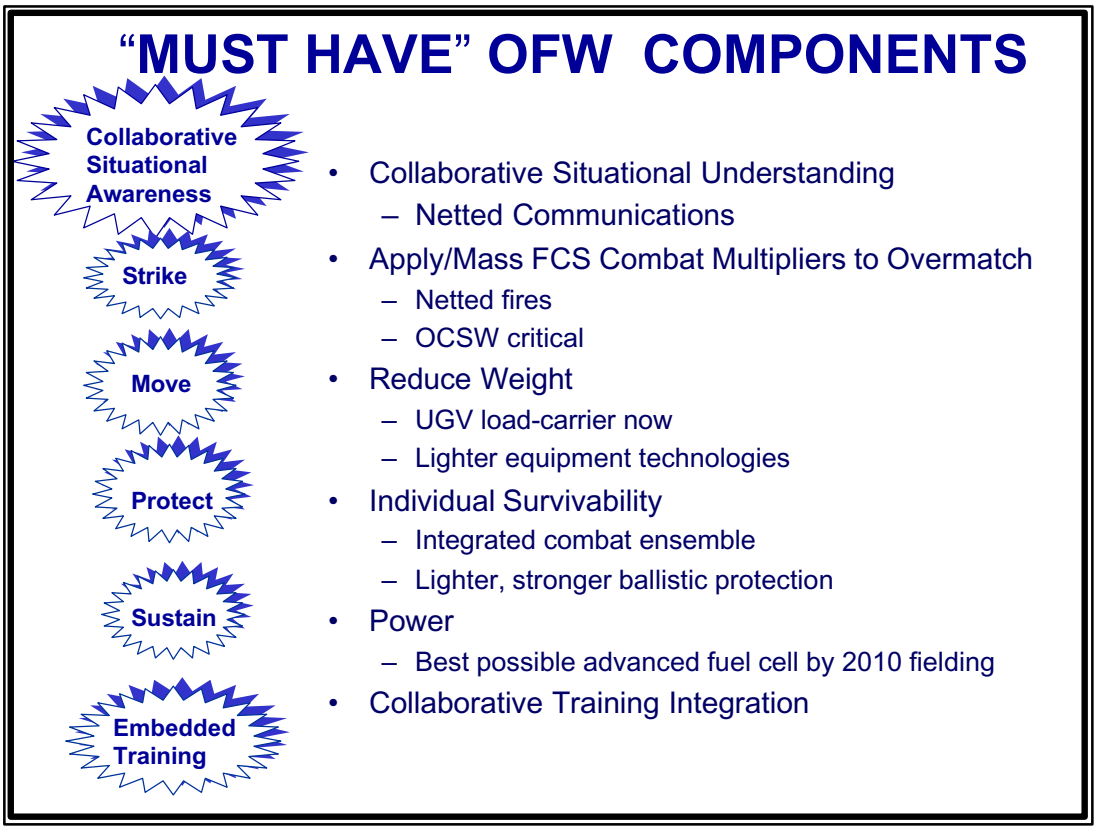


These critical components allow the Objective Force Warrior to operate within the unit of action and Future Combat System structures to optimize the capabilities of the whole force and produce output “ilities” at a higher scale.

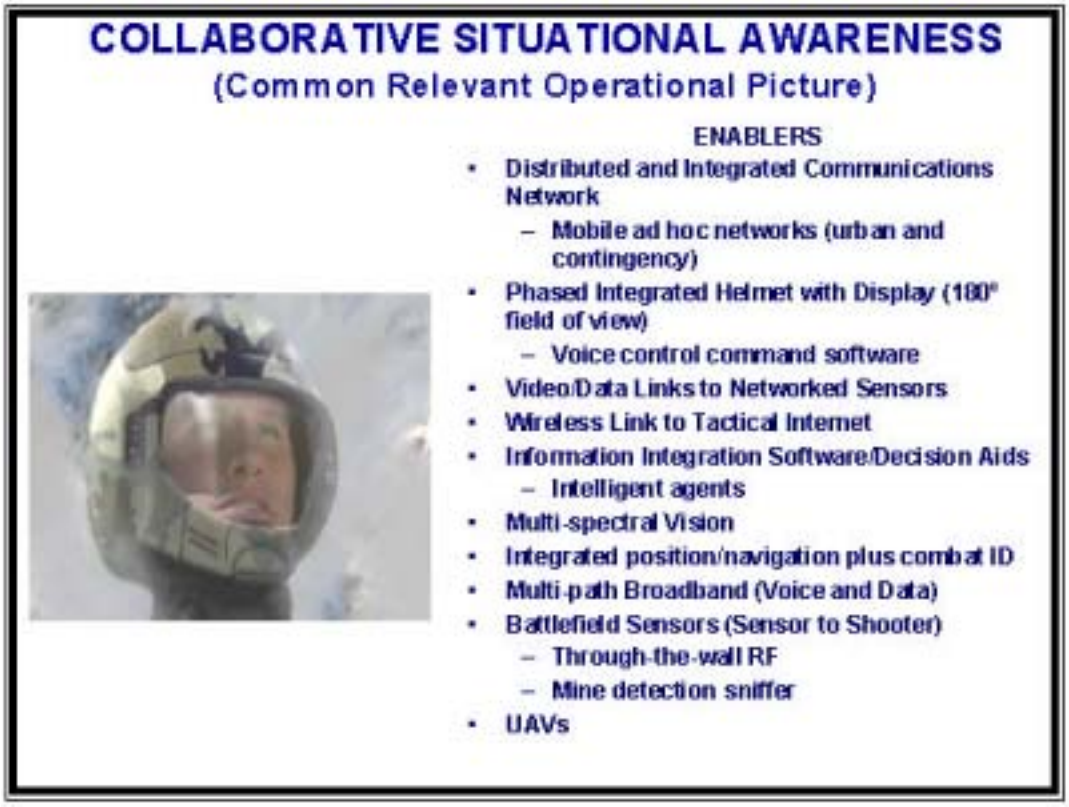
For Objective Force Warrior 2010, it is essential that we field an initial capability to search data sources, sort the information, and select the pieces that fit the query. This must be done at machine speed using intelligent agent technologies. This capability then allows the assets of the force to be used to create the mass effects. We have then vastly expanded the soldiers’ battle space.



As this capability for netted communications and netted fires is achieved, we see fewer and fewer instances where the soldier actually has to “close with” the enemy to defeat him. This advantage ripples through all the aspects of survivability, mobility, and lethality, reinforcing each proportionally.



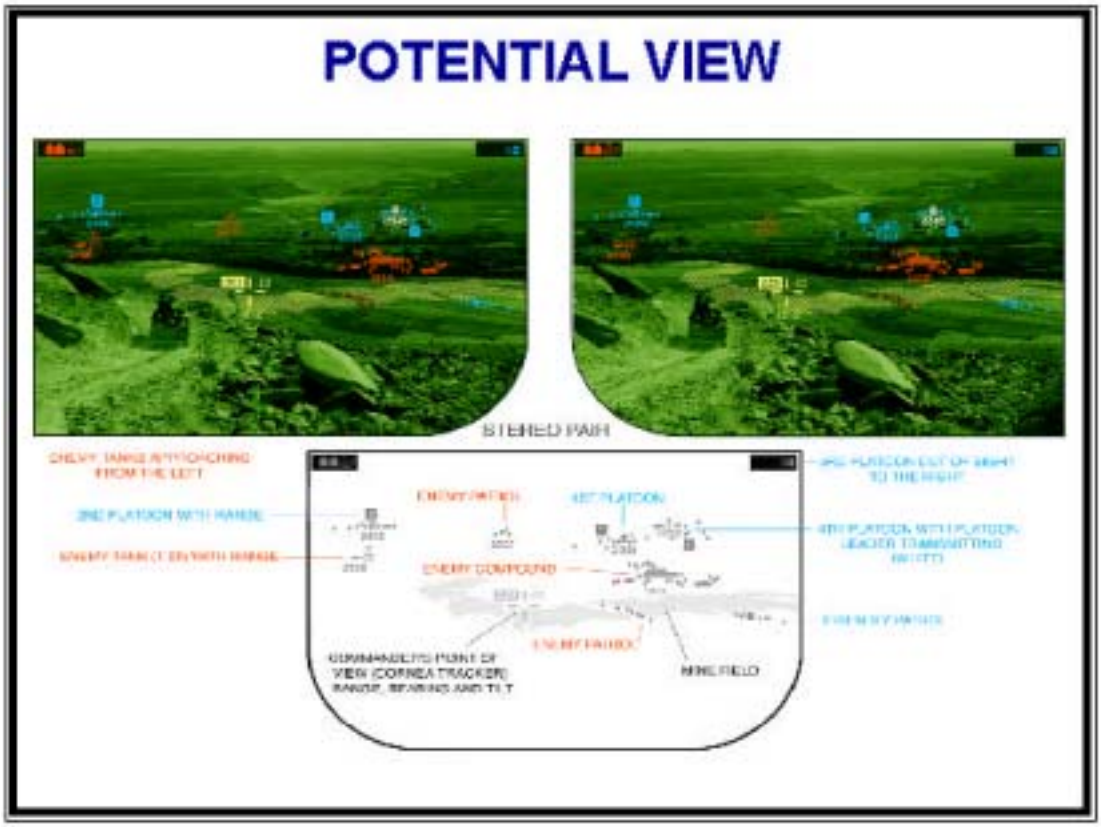
Each of the Objective Force Warrior “must have” components is composed of a set of prioritized enabling technologies. These will be discussed component by component.



This is the most important capability to achieve in Objective Force Warrior; it produces the common relevant operational picture. It is understood that some aspects of these technologies might not be achieved by the 2010 Objective Force Warrior. However, the maximum possible in this area must be achieved through focused effort, priority, and resourcing.

Netted communications establishes the baseline. This capability must be mobile ad hoc (continuously reconfiguring) communications, which does not require any infrastructure or fixed antenna locations. These communications are reinforced by the ability to search, sort, and find specific information needs at machine speed from available data (satellite, UAV, sensor, reports, adjacent unit, reconnaissance elements, etc.). The association, linkage, and portrayal of this information produces the understanding we seek.

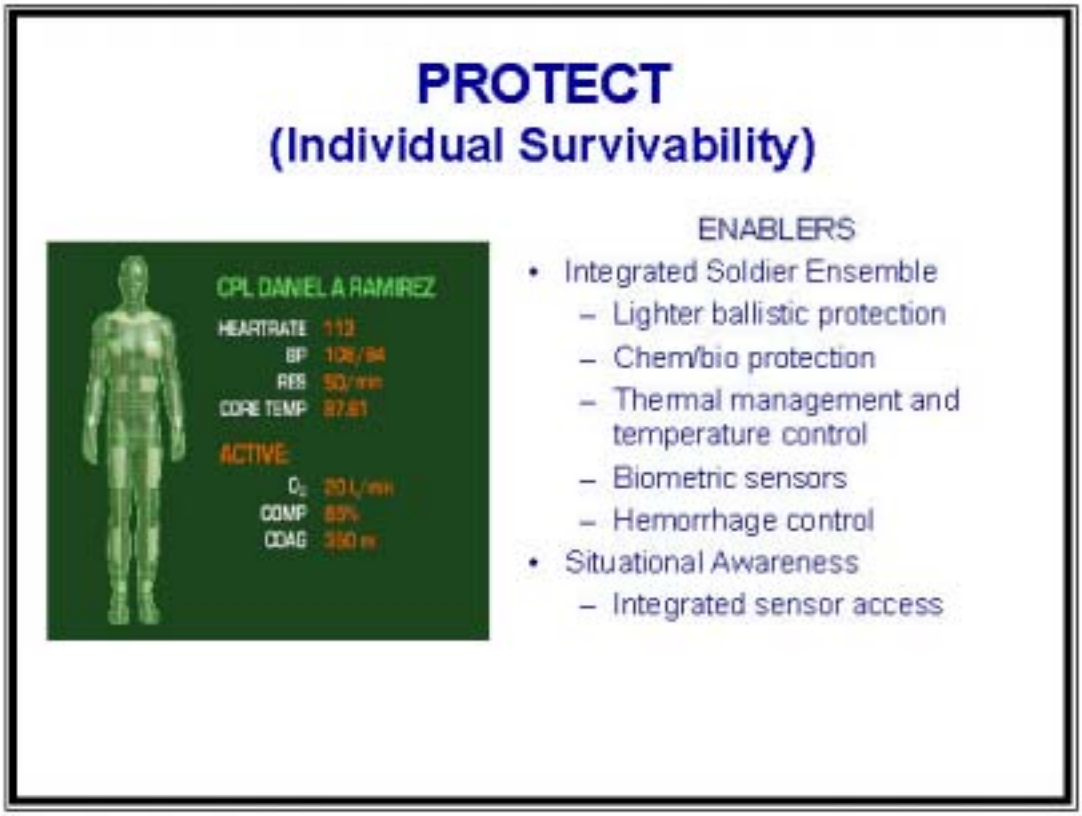
Integration of this information portrayal into a helmet system with voice activation software and multi-spectral vision is important to the concept.



This night view is illustrative of the kind of coded information replication that is possible. Enemy, friendly, and terrain coding are visible without destroying the panoramic context of the view.

The second most important capability is the ability to use our situational understanding to achieve massed effects in a collaborative fashion from the total networked suite of Future Combat System fires and combat multipliers. This should include smart munitions and a full BLOS/NLOS capability.

The Objective Individual Combat Weapon and Crew Served Weapon are crucial to the fight across the spectrum and should be fielded as soon as available.



The soldier of tomorrow needs a fighting ensemble that is designed for functionality. It should include, in an integrated way, all the sensors and protective capabilities that are ready for fielding by 2010. First priority should go to lighter, stronger ballistic protection for the close and urban fight.

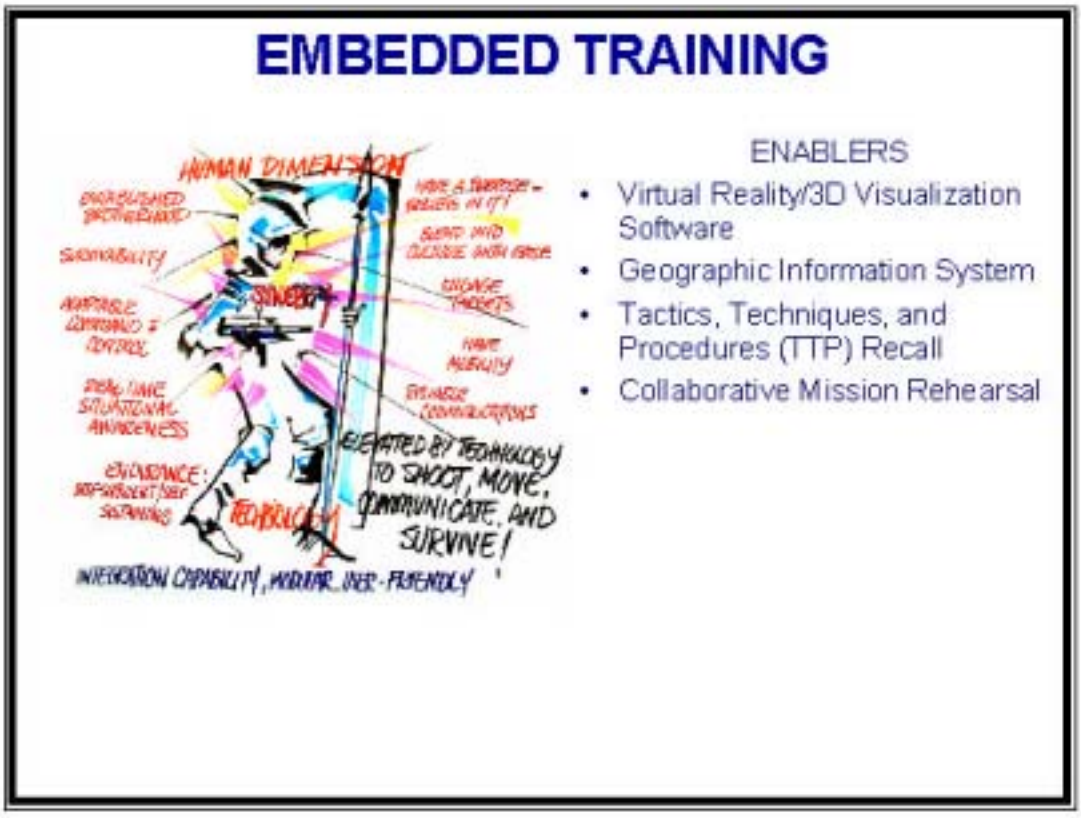
The single most important mobility dynamic is the need to reduce the soldiers’ load. It must be a mixed strategy of offloading (80%) and lighter materials (20%) for Objective Force Warrior 2010. There is an immediate need for a robotic follower within the next 2-3 years, which the panels believe technology will allow.

Each device or sensor employed or worn by the soldier should have its own internal power source instead of having to draw from one large source. This allows optimization of current miniaturization capabilities and reduces demand. Multi-function integration also gives us excellent economy of scale potential and weight savings.

The most important challenge in this area is solving the power problem and the associated weight aspects. The most advanced hybrid fuel cell possible should be produced for Objective Force Warrior. Resources and effort should be focused on the power, weight, configuration, and fuel aspects to optimize the potential in the next 4-5 years.

The technology exists to purify water from almost any source. The capability needs to be engineered and miniaturized to optimize size and on-person distribution. A larger unit of action capability can mature even faster and could possibly be integrated on a robotic follower.

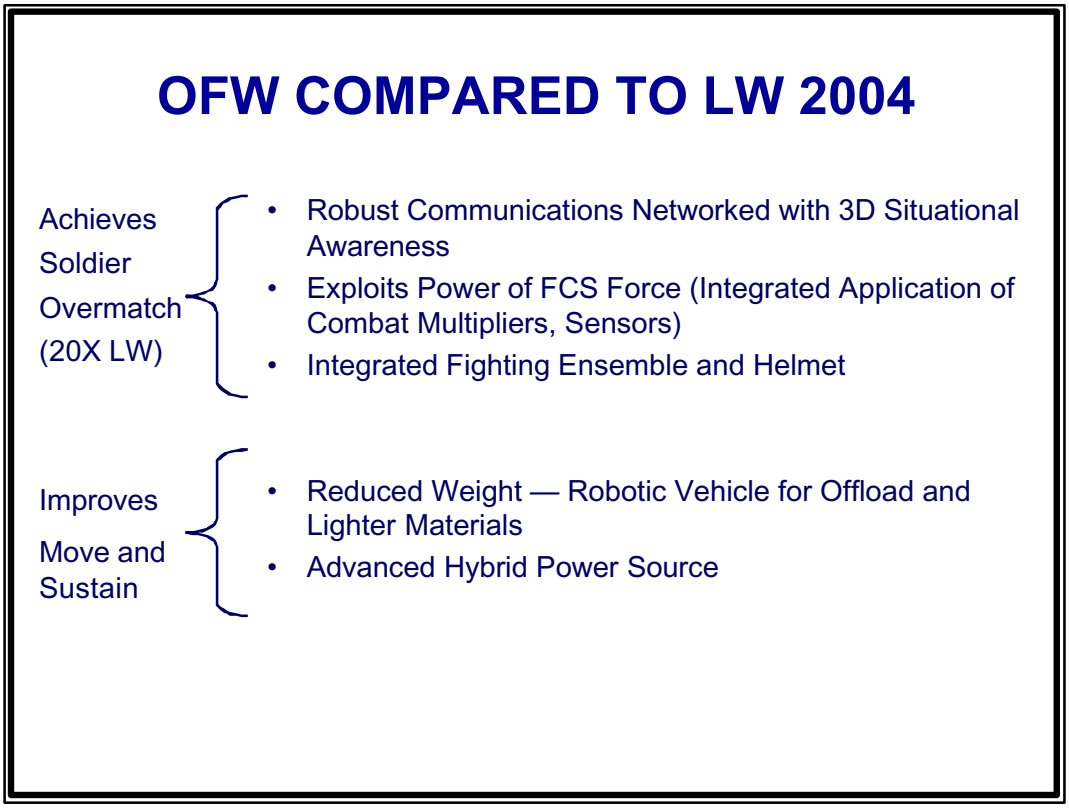
A contingency for solving resupply in terrain too difficult for robotic followers was an unmanned GPS air-cargo delivery system, which would enable delivery of supplies to specific coordinates using low cost, precision aerial vehicles.



Several critical training multipliers should be achievable for Objective Force Warrior. Most important is collaborative mission rehearsal and 3D-visualization software that allows virtual training at small unit level.

A ready visual reference on demand to display the essential doctrinal components of tactics, techniques, and procedures (TTP) is also important.

Objective Force Warrior Comparison with Land Warrior 2004



Reasonably robust achievement of netted communications, collaborative situational understanding, and netted fires can produce an Objective Force Warrior twenty times more capable than the 2004 Land Warrior. Realization of these capabilities allows the soldier and the unit of action to leverage the entire power of the Force and the Future Combat System of systems. We are not just improving the individual’s capability on the margin in a local battle space. We are expanding it dramatically in all three dimensions and in time.

The integrated fighting ensemble and helmet is important to efficient management of these capabilities and to survival and endurance. As illustrated in the chart above, these three aspects should be the focus of effort and investment in Objective Force Warrior because they provide the huge growth in potential.

Clearly, the last two areas of emphasis, reducing the load through robotic offloading and achieving a more efficient and potent power source, are important and should be pursued for Objective Force Warrior. However, their contribution to end-state capability is on a smaller scale proportionally.

Metrics

For each of the essential components of the vision, metrics achievable by the enabling technologies are listed. In some cases, these metrics are quantitative. In other cases, the achievement of the capability is the important factor.

KEY COMPONENT METRICS (2010 OFW System)

Collaborative Situational Awareness/Understanding

Collaborative Situational Awareness

Metrics
- Tailored Common Relevant Operation Picture Accessible at all Levels of Command
- Compatible with Joint Service Systems
- Networked Using Mobile Ad Hoc Architecture (Wireless, Continuously Reorganizing)
- Architecture Supports Beyond Line of Sight Communications (BLOS)
- Open Architecture

Strike

Application of All Combat Multipliers

Metrics
- Direct/Indirect Netted Engagement (Integrate with FCS)
- Automated (Intelligent Agent) ISR Control with Sensor Integration at all Levels
- Compatibility with FCS and Joint Service Systems
- Open Architecture

Move

Reduce Weight Robotics

Metrics
- Reduce Soldier Fighting Load Below 40 Pounds (offload & lighter materials)
- Robotic Load Bearing System (follower)

KEY COMPONENT METRICS (cont.)

Protect

Individual Survivability

Metrics
- Protective Equipment Provides Full Spectrum Protection from Ballistic, Chem/Bio Threats
- Fully Integrated Combat Ensemble
- Health Status Monitoring of Vital Biological Functions

Sustain

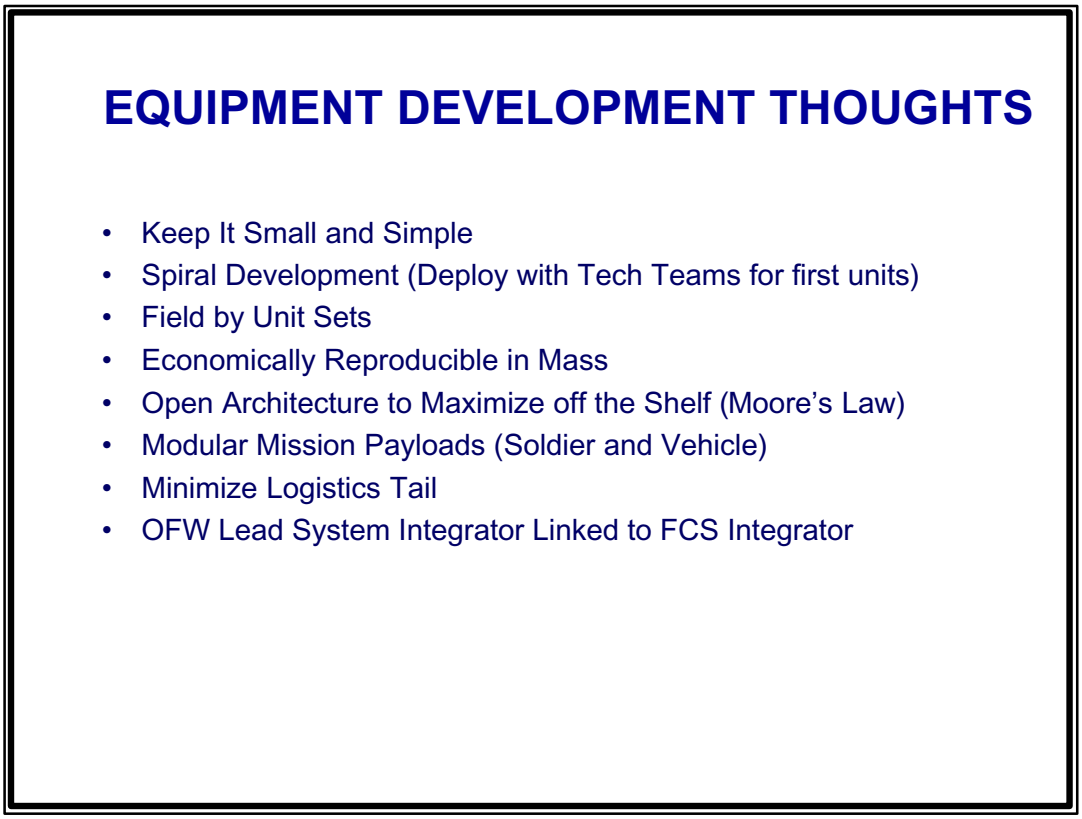
Power

Metrics
- Safe, Reliable, Light, Power Source
- Sufficient Power Available to Support OFW System for 72 hours

Embedded Training Integration

Embedded Training

Metrics
- Embedded Individual and Collective Training Simulations with Visualization Software
- Integrated Mission Rehearsal Capability Embedded in OFW system



Equipment development feedback from the panels is reflected above. The open architecture development strategy and a lead system integrator linked to the Future Combat System integrator are the two most important points.

The panels felt strongly that we had to move away from force-wide fieldings with periodic block upgrades. Instead, we should develop open architectures in key areas, procure as the technology matures, and field in unit sets. We can manage matching the suitable unit with the right mission.

Future Warrior 2018

By a fielding date of 2018, truly exponential leap-ahead potential is achievable with a focused effort in the right areas. Full collaborative situational understanding supported by intelligent agents and netted communications can allow the soldier to know everything the "system" knows. Fully netted fires and the next generation of weaponry and smart munitions can take lethality to the next level.

New ballistic protective materials and total environmental management with a fully integrated combat ensemble will produce a new dimension in survivability for the warrior. The next generation of power sources will allow miniaturization and one-source power. Robotic systems from sensor to load carrying and fighting functions will allow the soldier maximum flexibility with minimum burden.

New dimensions of individual performance can be reached with performance-centric design and fully collaborative virtual training software. At this point, the soldier may no longer need to close with the enemy to destroy him.

2018 TECHNOLOGIES - WHERE TO INVEST

- Distributed Collaborative Self-organizing, 3-D Network Architecture
  - Intelligent Agents
  - Ultra-Wide Band
  - Stratospheric, Terrestrial, Space Based Nodes
  - 3-D Graphics on Demand
  - Networked Fire Control with FCS and other Shooters (BLOS/NLOS) and sensors
  - Soft-launch, Smart Munitions
- Robotics
  - Remote sensing using Micro UAV & UGV
  - Autonomous Supporting Robots
- Directed Energy Weapons
  - Lasers
  - Radio Frequency
  - Intensity Focused Ultrasound
  - Lethal and Non-lethal Effects
- Integrated Warrior Ensemble (Advanced)
  - Nanofibers for Lighter Materials, Armor, and Signature Management
  - Active/reactive Ballistic Protection (solve energy dissipation problem)
  - Environmental Protection
  - Directed Energy Protection
  - Micro Climate Conditioning
  - Signature Management
  - Chem/Bio Detection and Protection
  - Biomonitoring/Triage
  - Exoskeleton Components
  - Forward Counter Mine
- Advanced Training
  - Enhanced Embedded Training and Rehearsal Processes
  - Enhanced Distributed Learning
  - Neural Entrainment

These technologies provide a specific recommendation for the major focus and investment areas for the 2018 Future Warrior. These technologies will provide the maximum combat payoff for the investment.

SUMMARY

The Old Wisdom Endures —	Move, Shoot, Communicate, Along with Survive and Endure, Still Wins
The Future Champion —	Netted Communications Leading to Situational Awareness, Collaboration, Massed Effects, Sensing, and Synergy is the Key to the Future
The Over-Arching Gestalt —	Exploit the Power of the Entire Force
Four Technology Imperatives —	Information, Power, Miniaturization, and Robotics
The Urgent Cry —	Passionate Call for a “MULE” like Tool
The “OTHER FORCE” —	The Human-centric Battlefield Dynamics of the WARRIOR CULTURE are Key Combat Multipliers

The Objective Force Warrior is more than a list of technology “eaches” to improve individual soldier capability. It is a concept that allows the soldier to bring the total power of the Force to bear through knowledge, netted communications, and netted fires. The resulting collaborative massed effects generate a twenty-fold increase in capability.

CLOSING THOUGHTS

- The paradigm shift in warrior capabilities must be mirrored across Army programs: recruiting, training, retention, and personnel management.
- Human factors research is critical to shape the array of information and technological tools envisioned for OFW.
- System architecture, operational architecture, standards and specifications must be engineered/approved by the Army. Do not allow industry to steer this course.
- Acquisition processes have never been more critical than they are now…paradigm shifts resulting from leap ahead technology have tremendous potential if we can design architectures to accept these capabilities as they become available.

Key to producing and maintaining such an overmatch is the necessity to visualize architecture for the 2018 end-state. Design it now and field it with Objective Force Warrior in 2010. This open architecture approach will allow us to build to the full 2018 capability as technology matures without a new design or a new fielding.

Vision

The Objective Force Warrior (OFW) concept achieves "overmatch" at the individual soldier and unit of action level. It leverages and focuses the power of the entire Force, empowering the Objective Force Warrior to dominate the battlespace.

Netted communications and collaborative situational awareness affords the OFW unparalleled knowledge. The application of the full range of Future Combat System combat multipliers and fires expands the effect of the Objective Force Warrior three dimensionally.

Technological capabilities are woven in a synergistic manner to optimize fightability and the indomitable spirit of the warrior culture.

The integration of emerging capabilities occurs continuously through open architecture designs to optimize potential and keep pace with the exponential growth of technology.

This vision conceptualizes the ability to achieve netted communications leading to collaborative situational awareness for the soldier. It also envisions the ability to apply netted fires to achieve the massed effects of the force. These two capabilities (netted communications and netted fires), if fully achieved, provide the twenty-fold increase in capability for the Objective Force Warrior. All of the other technology advances together were judged to provide a one or two-fold increase in capability. Thus, a very focused approach to achieving soldier overmatch emerged.

The vision exploits the power of the entire force and integrates with the Future Combat System of systems. It optimizes the Army's doctrinal concepts of *see first, understand first, act first, and finish decisively*. The soldier is the enabler of collaborative massed effects. It is critical that the full range of national and joint capabilities, which will enable the Objective Force to *see first, understand first, act first and finish decisively* at the strategic operational, operational and tactical levels, be extended to the Objective Force Warrior and his unit of action.

Particularly in the C^4ISR arena, an initiative to open architecture designs, which would allow easily integrated capabilities as they matured, was considered essential for success. This would require a more refined vision of future possibilities, but would avoid the "outdated when fielded" syndrome.

The essential elements of the Objective Force Warrior vision involve providing the ability for the individual soldier and his unit of action to achieve “overmatch” over their opponents across the entire spectrum of conflict. This overmatch is achieved by leveraging the combat power of the entire Objective Force. Emerging information technology provides the means to leverage the full range of combat multipliers inherent in the Future Combat System and those of joint service systems. A robust C^4ISR architecture is the common thread that links the Objective Force Warrior to the fully netted communications and fires of the Objective Force and provides the essential situational awareness to greatly increase lethality and enhance survivability.

Under this concept, the Objective Force Warrior’s potential to exponentially expand battle space control and effect is achieved in three dimensions and time. The advanced C^4ISR architecture of the Objective Force will be integrated from the strategic to the tactical level. This information superiority backbone will provide the means for the Objective Force Warrior to achieve revolutionary situational understanding and establish, maintain, and distribute a tailored common operating picture.

Extended range redundant communications and networked beyond line of sight fires will extend the Objective Force Warrior’s reach and influence over an exponentially expanded battle space. Improved organic and joint sensor-shooter linkages will reduce response and expand the means and rapidity with which targets can be engaged with the massed effects of the entire force. Through technological improvements in weapons and munitions, the Objective Force Warrior will have the ability to engage and destroy the enemy at longer ranges, with greater precision, and effects that are more devastating.

Certain aspects of the Warrior Culture are essential and require consideration in the design of the system to achieve performance-centric results. The manning and management aspects of a force of this complexity will require new approaches. Technological capabilities must be woven together in a manner that supports the warrior culture and optimizes the warrior’s fightability and spirit. Open architecture designs provide the opportunity to optimize potential and keep pace with the exponential growth of technology.

Metrics

Collaborative Situational Awareness/Understanding

- Tailored Common Relevant Operation Picture Accessible at all Levels of Command
- Compatible with Joint Service Systems
- Networked Using Mobile Ad Hoc Architecture (Wireless, Continuously Reorganizing)
- Architecture Supports Beyond Line of Sight Communications (BLOS)
- Open Architecture

Strike

- Direct/Indirect Netted Engagement (Integrate with the Future Combat System)
- Automated (Intelligent Agent) ISR Control with Sensor Integration at all Levels
- Compatibility with Future Combat System and Joint Service Systems
- Open Architecture

Move

- Reduce Soldier Fighting Load Below 40 Pounds (offload & lighter materials)
- Robotic Load Bearing System (follower)

Protect

- Protective Equipment Provides Full Spectrum Protection from Ballistic, Chem/Bio Threats
- Fully Integrated Combat Ensemble
- Health Status Monitoring of Vital Biological Functions
- Sustain
- Safe, Reliable, Light, Power Source
- Sufficient Power Available to Support OFW System for 72 hours

Embedded Training Integration

- Embedded Individual and Collective Training Simulations with Visualization Software
- Integrated Mission Rehearsal Capability Embedded in OFW system

Enabling Technologies

Each of the Objective Force Warrior “must have” components is composed of a set of prioritized enabling technologies. These will be discussed component by component in the following paragraphs.

Collaborative Situational Awareness

- Distributed and Integrated Communications Network
  - Mobile ad hoc networks
- Phased Integrated Helmet with Display (180° field of view) with Voice Control Command Software
- Video/Data Links to Networked Sensors
- Wireless Link to Tactical Internet
- Information Integration Software/Decision Aids
  - Intelligent agents
- Multi-spectral Vision
- Integrated position/navigation plus Combat Identification
- Multi-path Broadband (Voice and Data)
- Battlefield Sensors (Sensor to Shooter)
  - Through-the-wall RF
  - Mine detection sniffer
  - Unmanned Aerial Vehicles

This is the most important capability to achieve in Objective Force Warrior; it produces the common relevant operational picture. It is understood that some aspects of

these technologies might not be achieved by the 2010 Objective Force Warrior. However, the maximum possible in this area must be achieved through focused effort, priority, and resourcing.

Netted communications establish the baseline. This capability must be mobile ad hoc (continuously reconfiguring) communications that does not require any infrastructure or fixed antenna locations. These communications are reinforced by the ability to search, sort, and find specific information needs at machine speed from available data (satellite, UAV, sensor, reports, adjacent unit, reconnaissance elements, etc.). The association, linkage, and portrayal of this information produces the understanding we seek. Integration of this information portrayal into a helmet system with voice activation software and multi-spectral vision is key to the concept.

Strike

(Apply Full FCS Combat Multipliers)

- Real-time Distributed Networked Fires (direct, BLOS, NLOS)
- OICW/OCSW
- “Fire and Forget” Javelin
- Improved Munitions/Explosives
- Smart Ammo
- Scalable Lethality

The second most important capability is the ability to use our situational understanding to achieve massed effects in a collaborative fashion from the total networked suite of Future Combat System fires and combat multipliers. This should include smart munitions and a full BLOS/NLOS capability.

The Objective Individual Combat Weapon and Crew Served Weapon are crucial to the fight across the spectrum and should be fielded as soon as available.

Protect

(Individual Survivability)

- Integrated Soldier Ensemble
  - Lighter ballistic protection
  - Chem/bio protection
  - Thermal management and temperature control
  - Biometric sensors
  - Hemorrhage control
- Situational Awareness
- Integrated sensor access

The soldier of tomorrow needs a fighting ensemble that is designed for functionality. It should include, in an integrated way, all the sensors and protective capabilities that are ready for fielding by 2010. First priority should go to lighter, stronger ballistic protection for the close and urban fight.

MOVE

(Reduce Soldier Load)

- Robotic Team "Mule" — Offload
- Lighter Advanced Materials
- Integral Power Source for Devices/Sensors
- Multi-function Integration (suit, helmet, sensors, radio, computer, antennas)

The single most important mobility dynamic is the need to reduce the soldiers' load. It must be a mixed strategy of offloading (80%) and lighter materials (20%) for Objective Force Warrior 2010. There is an immediate need for a robotic follower within the next 2-3 years, which the panels believe technology will allow.

Each device or sensor employed or worn by the soldier should have its own internal power source instead of having to draw from one large source. This allows optimization of current miniaturization capabilities and reduces demand. Multi-function integration also gives us excellent economy of scale potential and weight savings.

SUSTAIN

(Power and Weight Advances)

- Advanced Hybrid Fuel Cells (72+ hours)
- Lightweight Weapons and Ammunition
- Water Generation, Purification, and On-person Distribution
- Low Cost, Precision Resupply - Flying “mules”
- Improved/Efficient Rations

The most important challenge in this area is solving the power problem and the associated weight aspects. The most advanced hybrid fuel cell possible appears to be the best candidate for Objective Force Warrior. Resources and effort should be focused on the power, weight, configuration, and fuel aspects to optimize the potential in the next 4-5 years.

The technology exists to purify water from almost any source. The capability needs to be engineered and miniaturized to optimize size and on-person distribution. A larger unit of action capability can mature even faster and could possibly be integrated on a robotic follower.

A contingency for solving resupply in terrain too difficult for robotic followers was an unmanned GPS air-cargo delivery system that would enable delivery of supplies to specific coordinates using low cost, precision aerial vehicles.

Embedded Training

- Virtual Reality/3D Visualization Software
- Geographic Information System
- Tactics, Techniques, and Procedures (TTP) Recall
- Collaborative Mission Rehearsal

Several critical training multipliers should be achievable for Objective Force Warrior. Most important is collaborative mission rehearsal and 3D-visualization software that allows virtual training at the small unit level.

A ready visual reference on demand to display the essential doctrinal components of tactics, techniques, and procedures (TTP) is also important.

Comparison with Land Warrior 2004

- Achieves Soldier Overmatch (20X Land Warrior)
  - Robust Communications Networked with 3D Situational Awareness
  - Exploits Power of the Future Combat System (Integrated Application of Combat Multipliers, Sensors)
  - Integrated Fighting Ensemble and Helmet
- Improves Movement and Sustainability
  - Reduced Weight — Robotic Vehicle for Offload and Lighter Materials
  - Advanced Hybrid Power Source

Reasonably, robust achievement of netted communications, collaborative situational understanding, and netted fires can produce an Objective Force Warrior twenty times more capable than the 2004 Land Warrior. Realization of these capabilities allows the soldier and the unit of action to leverage the entire power of the Force and the Future Combat System of systems.

We are not just improving the individual’s capability on the margin in a local battle space. We are expanding it dramatically in all three dimensions and in time.

The integrated fighting ensemble and helmet is important to efficient management of these capabilities and to survival and endurance. These three aspects should be the focus of effort and investment in Objective Force Warrior because they provide the huge growth in potential.

Clearly, the last two areas of emphasis, reducing the load through robotic offloading and achieving a more efficient and potent power source, are important and should be pursued for Objective Force Warrior. However, their contribution to end-state capability is on a smaller scale proportionally.

Breakthrough Technologies for 2018

By a fielding date of 2018, truly exponential leap-ahead potential is achievable with a focused effort in the right areas. Full collaborative situational understanding supported by intelligent agents and netted communications can allow the soldier to know everything the “system” knows. Fully netted fires and the next generation of weaponry and smart munitions can take lethality to the next level.

New ballistic protective materials and total environmental management will provide a fully integrated combat ensemble that will produce a new dimension in survivability for the warrior. The next generation of power sources will allow miniaturization and one-source power. Robotic systems from sensor to load carrying and fighting functions will allow the soldier maximum flexibility with minimum burden.

New dimensions of individual performance can be reached with performance-centric design and fully collaborative virtual training software. At this point, the soldier may no longer need to close with the enemy to destroy him.

These technologies provide a specific recommendation for the major focus and investment areas for the 2018 Future Warrior. These technologies will provide the maximum combat payoff for the investment.

- Distributed Collaborative Self-organizing, 3-D Network Architecture
  - Intelligent Agents
  - Ultra-Wide Band
  - Stratospheric, Terrestrial, Space Based Nodes
  - 3-D Graphics on Demand
  - Networked Fire Control with the Future Combat System and other shooters (BLOS/NLOS) and sensors
  - Soft-launch, Smart Munitions
- Robotics
  - Remote sensing using Micro UAV & UGV
  - Autonomous Supporting Robots

- Directed Energy Weapons
  - Lasers
  - Radio Frequency
  - Intensity Focused Ultrasound
  - Lethal and Non-lethal Effects
- Integrated Warrior Ensemble (Advanced)
  - Nanofibers for Lighter Materials, Armor, and Signature Management
  - Active/reactive Ballistic Protection (solve energy dissipation problem)
  - Environmental Protection
  - Directed Energy Protection
  - Micro Climate Conditioning
  - Signature Management
  - Chem/Bio Detection and Protection
  - Biomonitoring/Triage
  - Exoskeleton Components
  - Forward Counter Mine
- Advanced Training
  - Enhanced Embedded Training and Rehearsal Processes
  - Enhanced Distributed Learning
  - Neural Entrainment

Recommendations

Key to producing and maintaining an overmatch at the warrior and his unit of action level is the necessity to visualize architecture for the 2018 end-state. Design it now and field it with Objective Force Warrior in 2010. This open architecture approach will allow us to build to the full 2018 capability as technology matures without a new design or a new fielding.

The paradigm shift in warrior capabilities must be mirrored across Army programs: recruiting, training, retention, and personnel management.

Human factors research is critical to shape the array of information and technological tools envisioned for Objective Force Warrior.

System architecture, operational architecture, standards, and specifications must be engineered and approved by the Army. Do not allow industry to steer this course. Otherwise, the result will be various proprietary subsystems that are not easily interoperable and are not compatible.

Acquisition processes have never been more critical than they are now. Paradigm shifts resulting from leap ahead technology have tremendous potential if we can design architectures to accept these capabilities as they become available.

The Objective Force Warrior system must be kept small, lightweight, and simple to operate. The system should incorporate modular mission specific items. Where possible, use a spiral development process to develop these modular components. Design the system with an open architecture that maximizes off-the-shelf technology to facilitate taking advantage of rapid advances in technology.

Objective Force Warrior Lead System Integrator must be linked to Future Combat System Integrator. The two systems of systems must be completely and absolutely interoperable and complement each other in every respect.

Summary

The Objective Force Warrior is more than a list of technology “eaches” to improve individual soldier capability. It is a concept that allows the soldier to bring the total power of the Objective Force to bear through knowledge, netted communications, and netted fires. The resulting collaborative massed effects generate a twenty-fold increase in capability.

The Old Wisdom Endures - Move, shoot, communicate effectively, along with survive and endure still creates the wining combination.

The Future Champion — Netted communications enabling situational awareness, collaboration, massed effects, sensing, and synergy is the key to the future.

The Over-Arching Gestalt — Exploit the power of the entire force.

Four Technology Imperatives — Information, Power, Miniaturization, and Robotics.

The Urgent Cry — Passionate call for a “MULE” like tool to help carry the load.

The “Other Force” — The human-centric battlefield dynamics of the Warrior Culture are essential combat multipliers.

Introduction

The Panel One addressed Objective Force Warrior visualization and concept development in a systematic manner. Their first task was to develop a vision for the Objective Force Warrior. The Panel started this process by identifying words and phrases that they believed best described the Objective Force Warrior's required capabilities and operational environments. These "vision key words" provided the foundation for their ultimate vision statement. The key words that led to their vision statement are as follows:

- Master
- Global
- American warrior
- Dominance/powerful presence/preeminence
- American interests and values
- Challenges
- Uncertain
- Full spectrum
- Decisive
- Land
- Boots on the ground
- Enabled
- Empowered

After agreeing to what the supporting functions and guiding principles should be, the Panel drafted two vision statements and had a lengthy discussion before developing a final product.

Panel One's final vision statement was as follows:

"The American Warrior…an adaptive brotherhood…elevated by technology…decisive across the spectrum of conflict."

Objective Force Warriors are first and foremost members of a brotherhood whose traditions trace back to the heroic acts of their forebearers and the values of their Army and nation. Technology elevates America's warriors, increasing operational capability, adaptability, agility, and knowledge—and inspiring continuous technological development.

The strong bond of shared experience, mutual respect, common self-discipline, personal responsibility and judgment is the lynchpin of the strategic warrior culture. The traditions, values and attitudes of Objective Force Warrior enable units to apply their assets with laser focus. These attributes are achieved through a rigorous and ongoing training program. The Strategic Warrior Culture enables the Objective Force Warrior to prevail in a wide variety of environments.

The individual soldier enjoys a synergistic relationship between the technology and the larger force that is guided by human factors research. The needs of the individual and the tactical unit reinforce and guide the development of technology in service to the mission of Objective Force Warrior. However, the culture of the Objective Force Warrior can never be sacrificed at the expense of technology.

The spectrum of conflict ranges broadly from peacekeeping to major theater war all the unpredictable challenges in between. Adaptability is an essential capability.

Panel One next looked at the current Land Warrior. This analysis provided a baseline for them to determine where improvements could be made for the Objective Force Warrior. The group then took the unique approach of starting with what they called the “Naked Warrior” - a warrior with no individual equipment or systems. Their logic was that before you could add technology to a warrior, you had to have a cultural strategy. Throughout all of the deliberations, they kept coming back to the concept of the Naked Warrior. There was a consensus that if the warrior did not have certain attributes, the addition of technology would not prove beneficial. The panel outlined the following cultural strategy for the Naked Warrior:

- Brotherhood (strong bond with colleagues)
- Confidence
- Adaptive/Agile
- Knowledge base to draw on
- Self-discipline
- Discriminate judgment
- Initiative
- Responsible
- Competence
- Teamwork (team is stronger than the individual)
- Culture

With the Naked Warrior culture defined, they next determined those capabilities that were critical to the survival of the Objective Force Warrior. To make this determination, the panel members launched into a very innovative brainstorming exercise. The phrase, “Wouldn’t it

be cool if . . . ”, was used to gain responses from panel members on what they thought the Objective Force Warrior needed. An example of a response was, “Wouldn’t it be cool if the Objective Force Warrior could destroy any target, and bring resources to bear within seconds?” They quickly developed a list of about twenty “Wouldn’t it be cool if . . . ” that translated into their desired Objective Force Warrior capabilities. Numerous metrics were then identified for each of the given capabilities (see section III).

The capabilities selected were as follows:

- **C4ISR**
  - Reliable communications
  - Command and control
  - Situational Awareness

- **Sustainability** - Self-sufficient

- **Mobility**
  - Rapid ground movement
  - Individual vertical envelopment/obstacle avoidance
  - UAV logistics platform
  - No batteries

- **Lethality**
  - Engage any target in all terrain; bring to bear resources in seconds
  - Win with information operations

- **Survivability**
  - Be invisible
  - Blend into the culture with ease
  - Rapid resuscitation; immediate response for trauma
  - Brotherhood: Acceptance of diversity; have shared experience

- **Leadership Development and Training**
  - Institutional development
  - Operational development
  - Self-development

- **Interface and Integration**
  - Soldier integrated system
  - Objective Force Warrior integrated into Objective Force

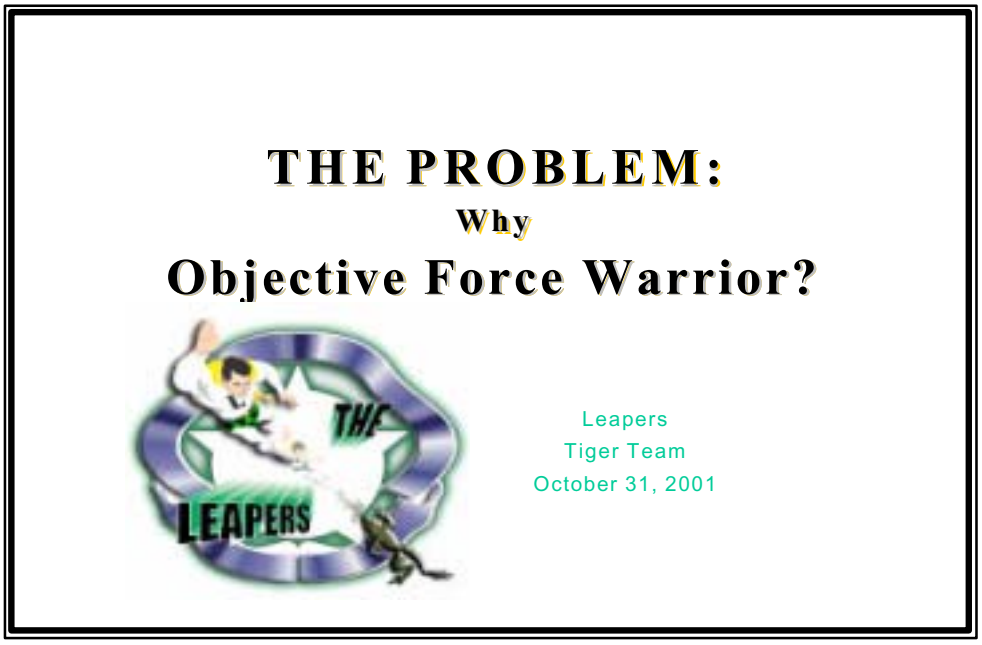
The panel then turned to using a software program titled “Qualitative Function Deployment (QDF)”, which has been used by the big three automobile manufacturers to design automobiles. The software supports understanding, consensus and decision-making, especially when complex relationships and trade-offs are involved. More importantly, for the manner in which the panel used the software, the product characteristics are derived primarily from identified customer requirements, rather than being driven by technology or inspired by “hunches”.

The Qualitative Function Deployment method allowed the panel members to establish relationships of varying degrees (strong, medium, weak or none) between the Objective Force Warrior capabilities and the strategic warrior culture functions, while simultaneously addressing the metrics.

The panel determined the degree of relationship for each matrixed item. The computer then calculated the Objective Force Warrior capabilities by the use of a “weighted importance” scale. This provided a list in rank order (based on panel input) of required capabilities from most important to least important. Although the Qualitative Function Deployment method was a valuable tool in allowing the panel to rapidly simplify some very complex relationships, the panel further refined the data until they were in agreement on what the final rank order should be. It is interesting to note that while the final list was not identical to the output provided by the Qualitative Function Deployment software, it was very similar. The panel then matched their top five capabilities to a technology that would allow the capability to be enhanced or strengthened.

Panel One Out Brief

The following PowerPoint slides were presented to Dr. Mike Andrews as the Panel One out brief of the Objective Force Warrior “Another Look” Session Two on October 31, 2001.



Slide 1

Slide 2

Slide 3

As currently organized, trained and equipped, many American soldiers are not prepared to meet some of the most likely threats they will face in the future. Technology development and Army doctrine have historically focused on developing and integrating major equipment end items into the Army inventory. None of these efforts focused specifically on equipping the individual soldier. The focus has been on manning the equipment.

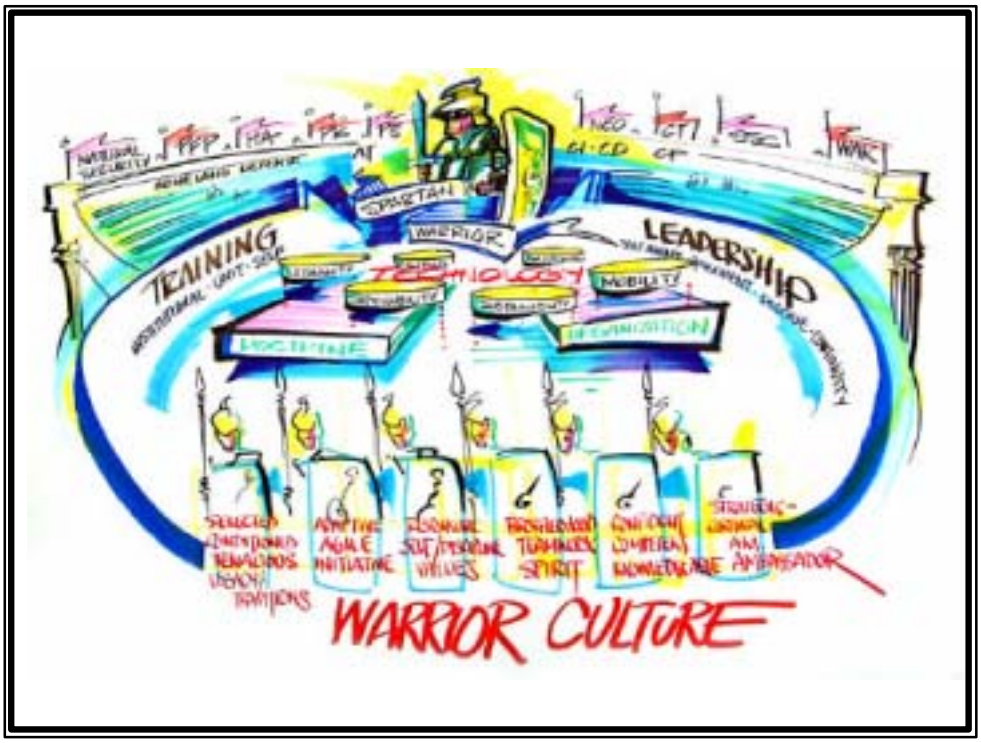
The rapid advances in technology we have witnessed in the last decade combined with the wide proliferation of commercially available technology has created a situation in which the latest technology is sometimes available to our potential adversaries but not to many of our own soldiers. The Army acquisition process as been unable to keep up with what is available off the shelf commercially.

America has the greatest soldier in the world today; a soldier imbued with a warrior culture. We owe it to them to provide the technical tools that will allow them to exploit that culture.

Slide 4

American warriors are the first and foremost members of a brotherhood in an established culture that is continually nurtured. These warriors are loyal to their country and each other and believe the team is more powerful than the sum of the parts. Their bond is more important than technology. The warrior should be served by technology that enhances his performance, not driven or encumbered by it. Technology will never be a substitute for the American warrior. Technology does not make the warrior; it makes the warrior more capable.

The multi-functional warrior is trained how to think not what to think. At one time, the warrior was trained only for certain missions. We are now breaking down this linear environment. Task organization is becoming increasingly fluid. We often move from one force mix to another depending on the mission. American warriors will conduct operations that yield decisive results across the spectrum of conflict from humanitarian assistance to major wars. The warrior is deployable anywhere around the globe at anytime. The area of operations is the world. The American warrior will dominate with boots on the ground to win. The Warrior must be considered the dominant component of joint, multi-dimensional military operations.



Slide 5

The Army must devote conscious and focused attention to improving the operational capability of the individual warrior. Warrior culture is based on several attributes.

The Objective Force Warrior must be specially selected and conditioned to meet the full range of conflict. He must be tenacious in his actions and uphold the traditions of his predecessors. He must be adaptive to that which he encountered and yet at the same time agile enough to deal with it. The warrior must have initiative and know when to use it. Total responsibility and self-discipline are the earmarks of the warrior, and he will not lower nor sacrifice his values. The all-important aspects of brotherhood, teamwork and spirit make the warrior an invincible force. He is confident, competent, knowledgeable, and unmatched in his ability to be resourceful.

The warrior is both a strategic corporal and an American ambassador. His individual actions can directly affect the outcome across the full spectrum operations, and he represents the best our nation has to offer.

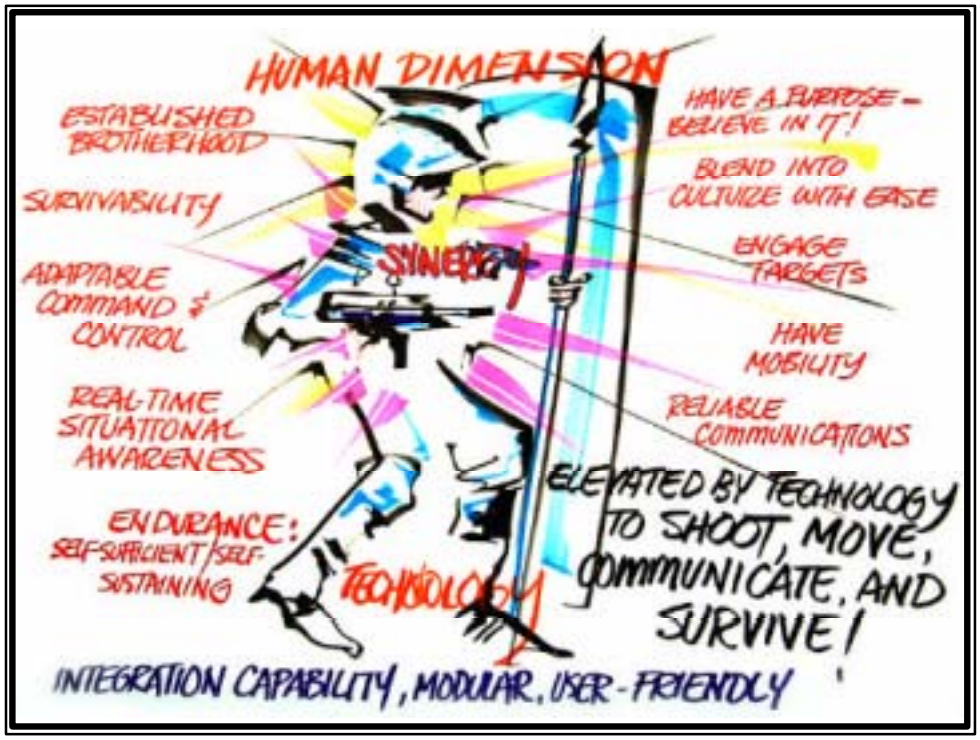
There are two vectors that emerge from this foundation to make the Objective Force Warrior: one is leadership and the other is training. Training must take a multi-echelon approach. The overall institution must provide the broad

training that is aggressively reinforced and refined at the unit level. A key component of the training vector is the aspect that the warrior is always training and teaching himself — always motivated to be better. Training supplies the warrior with the tactics, techniques and procedures.

The other vector, leadership, encompasses all ranks from Corporal to General. Leaders must use the correct judgment and be decisive in their actions. They are self-aware and provide the continuity for the warrior and the warrior culture.

Central to all of this, the warrior must have certain capabilities: lethality, mobility, sustainability, survivability, education/training, command, and control. These capabilities must match both the doctrine and the organization. Technology drives change in both our organization and our doctrine.

Unlike Desert Storm, we may no longer have a technological edge in certain situations. The individual soldier is left with piecemeal technology. Instead of building a force to take on the entire spectrum, the focus has been designed to take on high-end items, assuming that all the lesser functions can be done. Technology is a tool not only used to enhance one particular capability, but also a tool used to meld the capabilities together so that a warrior can act across the full spectrum of operations. The American warrior is the only factor that can make a difference throughout the spectrum of conflict and is adaptable to any situation and dominant in all circumstances.



Slide 6

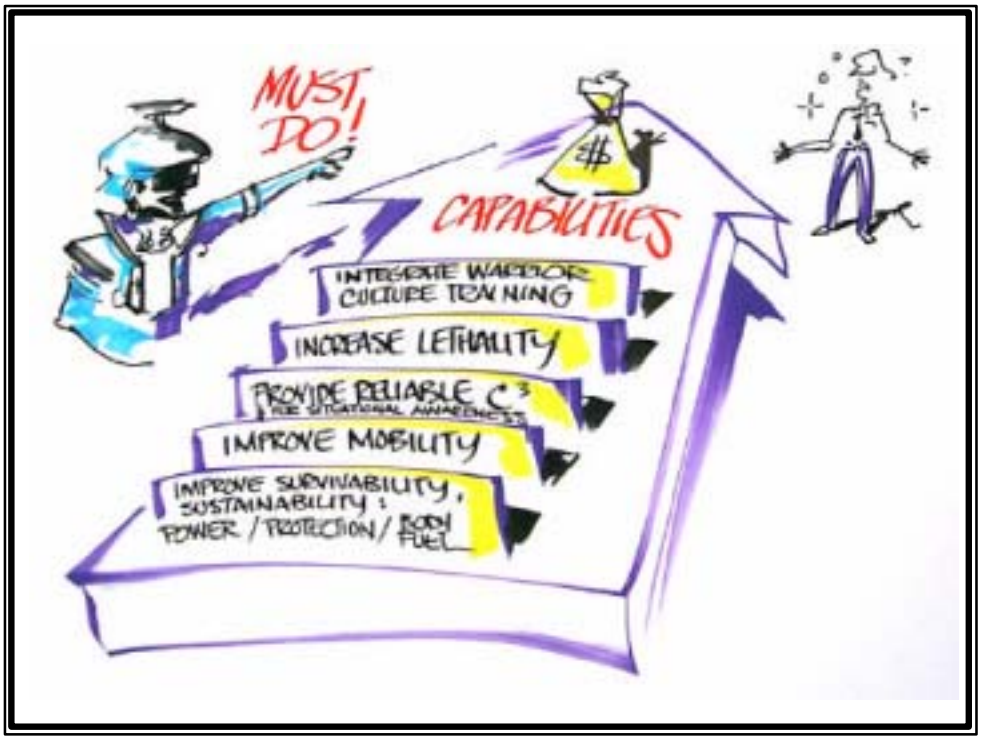
There is a relationship between technology and the human dimension of the warrior that creates a powerful synergy. Certain attributes and capabilities imbue the warrior. Capabilities considered in terms of the human dimension, elevated by technology, provide a synergistic result. The attributes of an established brotherhood and the warrior’s belief in his purpose add a powerful bond to the overall warrior system.

Survivability is an essential capability the warrior must have regardless of where he is in the spectrum of operations. We must have an adaptable command and control structure that allows us to tailor the force to the task at hand. Real-time situational awareness is mandatory so that the warrior can make the proper decision at the proper time.

The warrior must be able to blend into the culture with ease while, at the same time, have the capability to engage targets day and night, without worrying about weather or terrain. Mobility is essential to victory. Reliable communications that allow leaders to talk over ridgelines in urban areas is another critical capability.

The bottom line is that technology must elevate all these capabilities to allow the warrior to move, shoot and communicate more effectively. None of these capabilities

are stand-alone capabilities. They must be integrated in a modular method and be user friendly. The modular method will provide the warrior capability when ready. Thus, he does not have to wait for the entire system to be fielded.

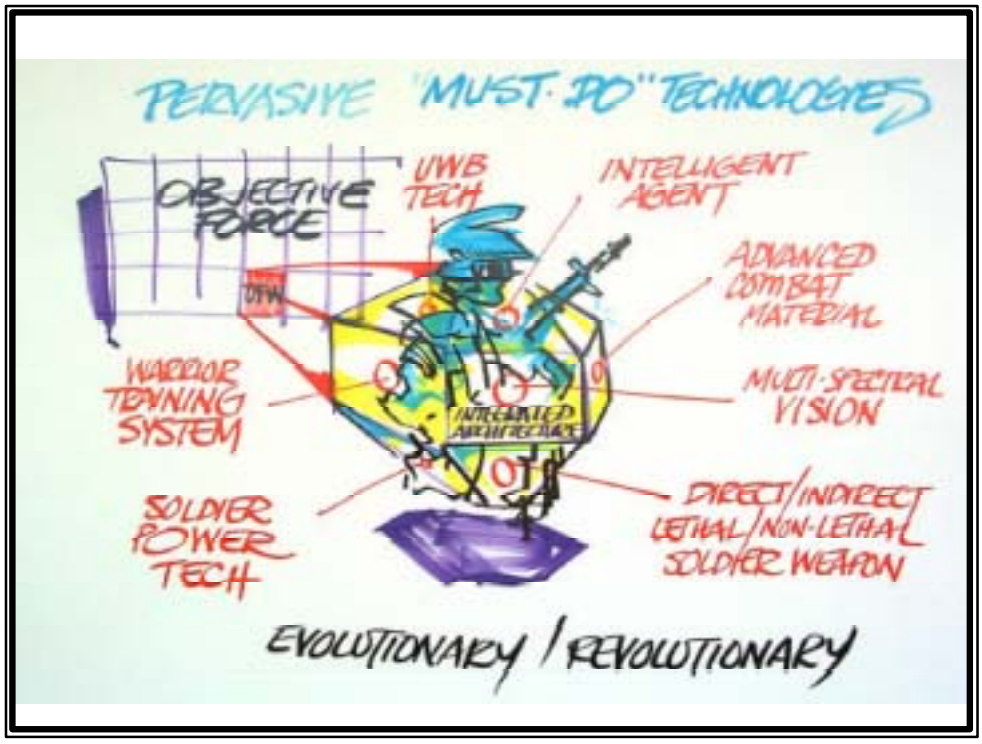


Slide 7

We must focus our attention and resources on these must-do improvements. An architecture that integrates these capabilities so that the warrior gets the best overall benefit is critical. Available technology must continually be enhanced and improved so that the warrior has the best available equipment now. We should not allow our warriors to use the same equipment that fielded 30 years ago.

The warrior must be able to move to and from the objective area more rapidly and to have reliable C3 once there. He needs a power suite that is both efficient and properly managed to meet all his demands, and a weapon that can engage targets both directly and indirectly with increased lethality.

Since the warrior culture is the foundation of all that is done, we must ensure that training is integrated across all the other capabilities.



Slide 8

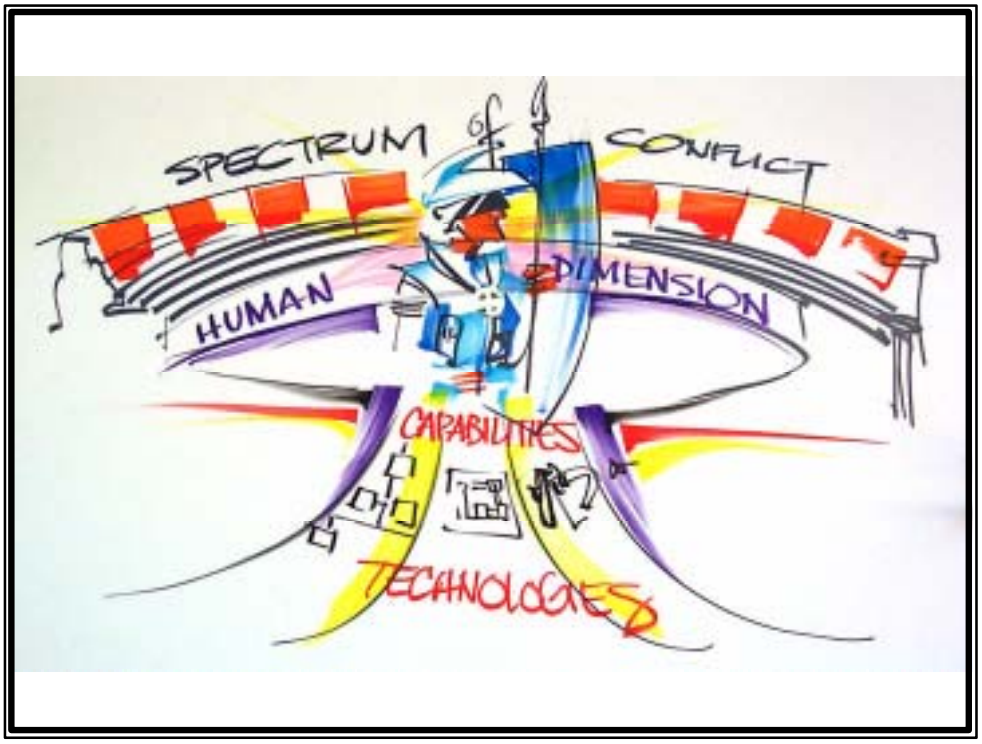
There are several pervasive “must do” technologies that are required if we are to maximize the Objective Force Warrior’s capabilities. These technologies were cross-walked against the capabilities discussed previously.

As mentioned several times already, a warrior training system is of utmost importance. We must determine how to best imbue the warrior with the warrior culture, and develop a system that is uniquely designed to do this. Soldier power technology could be the Achilles Heal if we do not develop a fuel cell to power the warrior’s systems. The warrior needs a weapon capable of both direct and indirect fires that provide both lethal and nonlethal effects.

Technology must negate the enemy’s use of cover, and provide the warrior with graduated options. A multi-spectral vision capability is essential to the warrior’s ability to see and engage targets under all conditions. Advanced combat material will provide the warrior with ballistic protection, signature management and chemical-biological protection. Intelligent agents must turn complexity into simplicity. They will act as a smart filter to assist in speed and agility and to keep technology user friendly. Ultra-wideband (UWB) technology will provide a secure mode of communications allowing for

an extremely high data rate for passing voice, text and video. Ultra-wideband technology may provide landmine detection and Identification Friend or Foe (IFF) capability. Ultra-wideband is extremely versatile, providing hierarchical systems from individual bodynets to wide area networks. It will be multi-functional and eventually allow for a “see through the wall” capability.

We must have revolutionary goals, but be evolutionary in our implementation.



Slide 9

All of these “must-do” technologies must have a revolutionary purpose, but we want to implement them on an evolutionary schedule. These technologies must serve the warrior and be integrated with the individual warrior, who is imbued with the warrior culture. These technologies allow the warrior to operate throughout the spectrum of conflict – anytime and anywhere.

Vision

“The American Warrior…an adaptive brotherhood…elevated by technology…decisive across the spectrum of conflict.”

Objective Force Warriors are first and foremost members of a brotherhood whose traditions trace back to the heroic acts of their forebearers and the values of their Army and nation. Technology elevates America’s warriors, increasing operational capability, adaptability, agility, and knowledge — inspiring continuous technological development.

The strong bond of shared experience, mutual respect, common self-discipline, personal responsibility and judgment is the lynchpin of the strategic warrior culture. The traditions, values and attitudes of an Objective Force Warrior enable units to apply their assets with laser focus. These attributes are achieved through a rigorous and ongoing training program. The Strategic Warrior Culture enables the Objective Force Warrior to prevail in a wide variety of environments.

The individual soldier enjoys a synergistic relationship between the technology and the larger force that is guided by human factors research. The needs of the individual and the tactical unit reinforce and guide the development of technology in service to the mission of Objective Force Warrior. However, the culture of the Objective Force Warrior can never be sacrificed at the expense of technology.

The spectrum of conflict ranges broadly from peacekeeping to major theater war and all the unpredictable challenges in between. Adaptability is an essential capability.

METRICS

The panel members examined the metrics issue from several perspectives. They first discussed what they believed to be the key differences between Land Warrior and Objective Force Warrior (section V), and then developed several additional metrics for their Objective Force Warrior vision that are beyond the Land Warrior FY2004 metrics. Finally, they took the information from their “wouldn’t it be cool” exercise and developed metrics and technologies to match the given capabilities.

The panel referenced six Key Performance Parameters (KPP) for Land Warrior version 1.0 metrics-command and control,

common picture (2), mobility and sustainability (2). The new/additional Objective Force Warrior metrics that were added were

- System Integration—Metrics for evaluating different system architecture (power, weight, latency, response time and bandwidth)
- Warrior Culture Training/Leadership Development—Need new and dynamic training and leader development model along with appropriate metrics for full spectrum warfare training/education
- Lethality Capability—Metrics for evaluating both lethal (Prob. Kill) and nonlethal effects (Prob. of Disabling) and tradeoffs between
- Reliable C3 and Situational Awareness—Metrics for evaluating security, robustness, quality of service, graceful degradation, reconfigurability and self-healing of the Objective Force Warrior Battlefield Operating System Network (BOSN)
- Improved Mobility—Time/distance/safety metrics for addressing use of 3rd dimension, and integrated soldier system
- Human Machine Interface—Mission Task workload analysis and metrics
- Improved Survivability—Multi-spectral signature management, all known Chem/Bio (6 months with filter change) and ballistic protection for 7.62 ball

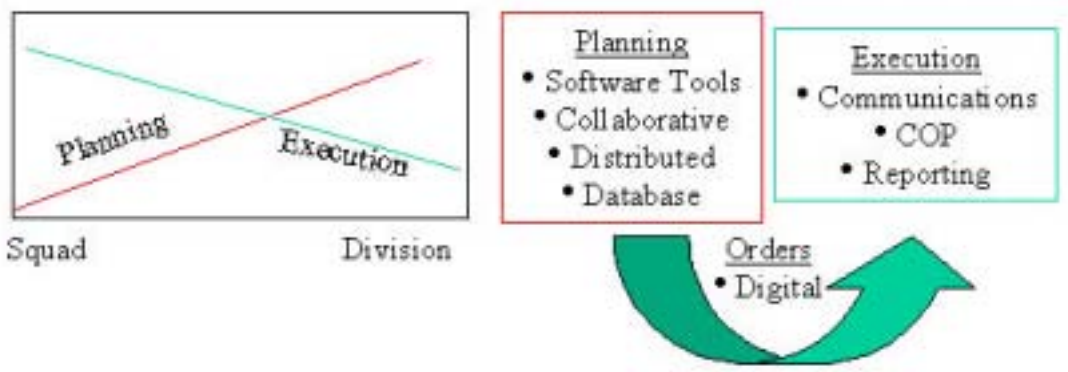
For each capability that was looked at, the panel developed a comprehensive list of metrics and associated technologies. The "wouldn't it be cool" exercise resulted in the collection of the following information:

Command and Control

- Reliable communication
- Command and Control is not a technology; it's a function; do not provide systems solutions to Command and Control
- Metrics:
  - Span of communications must be up and down
  - Reliable, streamlined communications/critical information at the level/sphere of influence and interest (two levels up and down; levels are driven by filters, not capabilities)

- Intelligent Agents filter necessary information
- Voice/Tone
- Digital
- Video

- Technology:
  - Secure C^4 integrated into multifunction suite
  - High-speed, mobile, wireless voice over data capability
  - Ultra Wideband and software technology to accompany it
  - Embedded cross-training
  - Self-healing networks



- Command and Control at the Warrior and his Unit of Action level must focus on execution
- Most important elements are Communications, Common Operational Picture (COP), and Reporting
- Command and Control functions must adapt to the situation
- Must be able to instantaneously redesign and configure the network as mission and task organization changes; the warrior becomes a mobile antennae and cannot be targeted

Situational Awareness

- See yourself; see the enemy; see the battlespace
  - Metrics:

  - **See**--Battle track friendly unit status and enemy situation (SALUTE)
  - **Understand**--Decisions based on CCIR (EEFI, FFIR, PIR) and Common Operateral Picture
- Technology:
  - Wireless soldier network (soldier is the goal/software must report status (sensor)/LDR SW aggregates by unit/supports rapid task organization (scannable)/filter by unit or range/battlespace)
  - Micro-sensor network (Individual soldier environment/chem-bio/squad organic for early warning and reconnaissance e.g., UAV and ground)/access to platoon and higher sensor network)

- Always know where the enemy is. Capability to see in all conditions (over, through, and around objects to the maximum effective range of the weapon) with embedded countermeasures
  - Metric: based on level of influence and interest
    - know enemy locations within hot zone/area of influence via embedded display; directional heads-up display with auditory warning; enemy cannot detect signal mechanism
    - relevant intelligence analysis feedback
    - see through objects; detect motion
  - Technology:
    - Multispectral optics and acoustics in one-piece helmet; squad-deployable sensors, UAVs, and robotics

Sustainability

- Self-sufficient, always self-sustaining (food, water)
  - Metrics:
    - Enhanced Rations
    - Capability to convert what's in the environment to nutrition
    - Know what the daily calorie requirement is and weight of ration
    - Automatic, autonomous, individual resupply mechanism; ability to ping data on status of supplies
    - Replenish own water source; water regeneration system
  - Technology: Integrated rations, water, and waste management
    - Micro-Water Purification System
    - Water Regeneration System
    - Assault Rations (small size, large calories)
    - Database with local indigenous food sources and food and water threats
- Self-sufficient, always self-sustaining (ammunition)
  - Metric: Always have ammunition
  - Technology:
    - Directed Energy Weapons
    - Smart Bullets
    - Brassless Ammo

Mobility

- Feet never get tired
  - Metric:
    - Reduce weight
    - 50 lb. max combat load
    - 25 lb. max fighting load
    - Movement of 25 kilometers/day (4 kilometers/hour)
  - Technology:
    - Unmanned Aerial Vehicle logistics package
    - Individual vertical envelopment/obstacle avoidance capability
    - Robotic “mule” logistics capability

Power

- Do not have to deal with batteries
  - Metric:
    - individual power supply; self-generating
    - lightweight power source for equipment
  - Technology:
    - Compact power and power management
    - one power source for all equipment
    - electrochemical system
    - thermal development
    - radioisotopic
    - embedded kinetically generated power supply

Survivability

- Be invisible throughout spectrum of light
  - Metric:
    - Chameleon suit/equipment to adapt to environment so the enemy never knows where you are
    - Multispectral signature management; chameleon uniform
    - Defeat enemy's ability to see
  - Technology:
    - Photosensitive Nanofibers
    - Spanish Chameleon
    - Thermal
      - Missions must match background temperature
      - Phase Change Materials (PCM)
      - HideX
      - Mesophase-derived graphitic foam
    - Overpressure through micro-channel fabric
    - Harvesting body heat over 400 to 500 watts
- Be invincible
  - Metric
    - Ballistic/other weapons
    - Absorb, disperse, or deflect energy
    - Heated and cooled uniform; no snivel gear
    - Multifunction, lightweight/not cumbersome, self-contained, self-sustaining
    - Complete chem/bio protection/warning
  - Technology: Technology created in areas from material science (e.g., metals, ceramics, polymers) to modeling and simulation to sensor development
    - Kinetic energy absorbing/dispersing
    - Detection
    - Mass deflection (EMF, reactive armor)
    - Thermal reflection

  - Integrated environment “uniform”
  - Sense, monitor, and respond to predetermined stimuli

- Monitor Physiological Functions
  - Metric: Monitor and detect changes in blood flow/tissue profusion of major (potentially catastrophic) wounding
  - Technology:
    - Deploy “smart tourniquet”
    - Start intravenous fluids (via implanted venous access port)
    - Notify leader and medic
    - Set of physiologic status monitors for medic to query as needed
    - Heart rate, blood pressure, temperature, oxygen saturation
    - Osmolality monitor to alert to fluid need (oral or IV)
    - Detect sleep deficit
    - EEG sensor--automatic stimulus for dozing
    - Leader query for performance risk
    - Pharmacology intervention for sleep/wake cycle

Lethality

- Engage any target with varying degrees of lethality in all types of terrain; bring to bear resources within seconds
  - Weapons for the individual soldier
  - This capability must be coupled with the ability to acquire, assess, designate, and decide on a target
  - Metric: Ability for rifleman to acquire targets and designate them for engagement by other systems
  - Technology:
    - Bring to bear the right weapon to destroy the target (interactive, networked fires)
    - Heads-up aiming
    - Individual weapon
    - Small arms (caseless ammo)
    - Grenade launcher (HE, AP, bunker) 20 mm; airburst
    - Nonlethal capability
    - Lightweight, durable, all weather
    - Multi-spectral optics
    - Range finder/wind compensator/laser
    - Modular
    - 7.62mm Round capable
- Win with Information Operations
  - Technology:
    - Language model to communicate PA/CA/PSYOPS messages
    - Embedded voice amplification (language adaptable)
    - Means to employ deceptive unit locations/activities

Cultural Awareness

- Metric: To blend into the culture with ease; cultural awareness, understanding, and integration
- Technology:
  - Improve voice recognition to have automatic translator (listen and speak in a variety of native languages)
  - Database of customs, background of nation you're going into/your area of operations (that is, embedded orientation videos); includes localized dialects, how to identify enemy leaders
  - Requires concise, accurate knowledge in advance
  - Ability to transfer/access information quickly to level of influence/interest
  - Improve individual's cognitive ability/retention

Brotherhood

- Acceptance of diversity; have shared experience of mental and physical hardship (ensure that the technologies nurture and don't detract from brotherhood); use of Spartan technology (just the right technology) to enhance brotherhood;
- Exportable, integrated, and tailored training packages focused on the warrior culture
- Train for harsh conditions, uncertainty, and ambiguity
- Focus is dependency on each other in the team
- Cross train for flexibility and redundancy
- Always understand and believe in what you are doing; always have a purpose
  - "Strategic Corporal" needs to be given and understand why he or she is committed--and what mission accomplishment will look like
  - Commander's endstate communicated
  - Create lessons learned database/distribute/share

Key Components

- Improved survivability and sustainability (power, protection, ‘body fuel’)
- Improved mobility
- Reliable C3ISR for increased situational awareness
- Increase lethality
- Integrated warrior culture training

Enabling Technologies

- Warrior Training System
- Direct/Indirect, Lethal/Non-Lethal soldier weapon
- Soldier Power
- Advanced Combat Material
- Multi-Spectral Vision
- Advanced Combat Material
- Intelligent Agents
- Ultra Wide Band

Comparison to Land Warrior 2004

After comparing Objective Force Warrior to Land Warrior, the panel noted many key differences. The comparison yielded the following information:

- **Land Warrior**
  - Evolutionary (Blocks 1-3)
  - Structured to ensure Army Battle Command System (ABCS) interoperability and interim force capability
  - Establishes a baseline soldier load to begin a total systems management process
  - Key performance parameters/metrics tied to four performance categories: Command and Control, Common Operational Picture, mobility and sustainability.
  - System capabilities are technology driven.

- **Objective Force Warrior**
  - Significant design departure.
  - Structured to ensure NCW interoperability and objective force capability.
  - Establishes a revolutionary approach.
  - Key performance parameters/metrics are performance and process-oriented (lethality, mobility, survivability, sustainment, C4ISR, leader development training and interfaces/integration)
  - System capabilities are warrior culture driven.

Breakthrough Technologies For 2018

- Biomimetics
- Nanobots
- Smart Bullets
- Metal Laser Gun
- Exoskeleton
- Ability To Deflect Ballistic Objects
- Self-Generating Power
- Individual Vertical Mobility
- Broadcasting Power—Wireless
- Electromagnetic Field Weapons
- Reversible Logic
- Smart Dust

Recommendations

The panel was in total agreement that the acquisition and procurement cycles needed to be modified to allow for incremental fielding of equipment. To wait to field an entire Objective Force Warrior system at one time is detrimental to ability of the warrior to fight effectively and survive. A partial solution in the near term is better than a total solution in the long term. The panel remarked that modularity in the design of equipment would better allow this objective to be met. Their bottom line was that evolutionary change in pursuit of the Objective Force Warrior system is more important than revolutionary change.

Other Issues

Panel members identified several areas that needed to be improved upon as compared to the way business is currently conducted. They made the following observations:

- We are not taking an unconventional, asymmetrical approach because we have set up boundaries.
- We are no longer working in a linear environment, lock step, set piece.
- Not interactive with the environment; we are reactive (must be more than proactive, even interactive).
- We are not focused on the human factor; yet the strongest and weakest link is the human being.
- Must be able to put troops at the right place and operate at the right time, with the right force mix.
- High technology must be integrated and support the soldier.
- We do not have real situational awareness.

Summary

Panel One’s members were given the task to provide certain information at the end of the session. These deliverables included an Objective Force Warrior vision statement, a listing of achievable metrics, leap ahead or breakthrough technologies by 2018, a comparison of Objective Force Warrior metrics with Land Warrior 2004 metrics, and a list of capabilities and enabling technologies. The diversity of the panel members ideally suited them for the task they were given, and ultimately ensured that the final product was not biased by any one person’s experiences or thought processes.

The Panel systematically attacked the problem by using a building block approach. Their initial discussions revolved around the “naked warrior” concept, allowing them to incrementally build their Objective Force Warrior from the ground up. To this “Naked Warrior” they added a “Warrior Culture”, which became an integral part of every decision they made.

In-depth discussions followed that led to the selection of more than 20 capabilities required by the Objective Force Warrior. To reduce the capabilities to a manageable format, the group used a software program called “Quality Function Deployment” which was selected and operated by a panel member with a background in systems engineering. This program allowed them to compare Objective Force Warrior systems capabilities with Objective Force Warrior strategic warrior culture to determine the most important capabilities, without disregarding the metrics they had developed. Although the Quality Function Deployment played a major role in filtering the capabilities, the panel members made additional subjective judgments before finalizing their list. The panel members then used information that was presented to them during the Session 1 technology briefings, in addition to any technology information that they were personally aware of, to develop a list of all possible technologies that would support the capabilities.

The theme throughout the panel’s deliberations was that the warrior and the warrior culture were the key to any system being built, that any system design should be evolutionary rather than revolutionary and based on modularity.

Introduction

The overarching vision produced by Panel Two is that the Objective Force Warrior must *dominate the land, virtually*. Stated another way, technology must afford the U.S. Army the opportunity to achieve its missions while simultaneously protecting its soldiers by reducing their physical presence on or near the line of fire to the maximum degree possible. The panel recognized, additionally, that U. S. soldiers have to close with and control the enemy and/or interact with the local people to successfully achieve the dominance objective. This panel’s intent was to recommend the technology means and deployment approach to provide a continuously sustainable advantage to the Objective Force Warrior (OFW) in pursuing that mission.

The panel recommends that a migration path from soldier presence in the battlefield to soldier remote control to autonomous operation be started immediately for devices that can carry equipment, survey the enemy and deliver force in a pinpointed manner. Dominating the land, virtually, is a revolutionary, long-term goal to ultimately remove the soldier from harms way, and while it may not be fully accomplished, this clear mission can guide the contributions and development requirements of the Objective Force Warrior system of systems for many years to come.

While virtual land dominance was the panel’s revolutionary goal, improving the soldier’s potential on the battlefield immediately by evolutionary application of available technology was of particular near-term concern. The panel believes that technology is readily available that can provide strategic advances in performance needed by the Objective Force Warrior in the near term. By leveraging sources of existing or advanced development stage technologies from within the Army science and technology base, national laboratories, universities and industry, significant battlefield strategic advantages could be field implemented rapidly for the Objective Force Warrior. The panel urged that streamlined procurement policies, institution of a counter-measures team and a skunk-works team, smaller fast-track experimental deployments and use of off-the-shelf disposable devices be programmatically considered to assure continued battlefield dominance into the future.

Future Operational Environment

The consensus of the panel was that the operational environment in which the Objective Force Warrior will operate would arguably be more difficult than it is today. The long-term extrapolation of this consensus was that battlefield weapons of destruction (explosives, guided projectiles, biological agents, satellite surveillance, etc.) were becoming so capable that it made the traditional soldier extremely vulnerable on the battlefield. The panel concluded that it was reasonable to assume that the Objective Force Warrior will fight in unpredictable locations, often be outnumbered, may find the level of intensity of any hostilities to be uncontrollable, and future ground engagement would appear more and more like today’s “special operations.” Religious, ethnic and ancient rivalries have, in many places, replaced competition among nation states as the main sources of conflict making friend/foe determination increasingly difficult. While the U.S. must always be able to defeat any conventional force or threat, its Army has to be trained and equipped to fight a variety of other adversaries as well. Thus, the overarching challenge is to train and equip soldiers so that they are prepared to operate effectively across the full spectrum of warfare, including asymmetric conflicts. The equipment ultimately provided to the Objective Force Warrior must be robust enough to take on conventional forces and flexible enough to be used in peace keeping or humanitarian missions.

Historically, the constants of soldiering have been the “… ilities”, i.e. lethality, survivability, mobility, sustainability and several others. The challenge is to provide the Objective Force Warrior soldier with these constants, but integrate them in such a way as to enhance and augment capabilities rather than add weight and limit function. Stated another way, what can be done to use technology that allows the Objective Force Warrior soldier to “feel and smell” the battlefield rather than be closed off from it.

All of these requirements can be achieved through the integration of technology. However, the fundamental question remains – is the best approach to the future to improve on the existing foundation (evolutionary development) or to define the future by seeking a paradigm-shifting advance (revolutionary research)?

Technology Development Approaches

To what degree should the Army pursue known, evolutionary improvements of equipment versus revolutionary technologies that could result in discontinuous engagement-shifting advancements? While technology implementation can be fairly well scheduled and deployed, scientific revolution is much more difficult to recognize and to determine its value when available. However, nations that have been able to do this have enjoyed significant advantages over their rivals.

The consensus of the group was that both approaches should be adopted with an intentional focus that guided both. That is, substantially improve the equipment that will be used by the Objective Force Warrior and get it into the soldier’s hands now with an incremental and continuously improving capability plan (evolutionary) while constantly and consistently scanning for and investing in potential breakthrough technologies that hold promise for use between the years 2010-2020 (revolutionary).

Clearly, there are technologies available now that could be in the field in use between 2006 and 2010, particularly in regards to providing a transport that could offload the Objective Force Warrior weight burden. While specific technologies will be discussed in detail in Section II, they can generally be described here.

Perhaps the immediate consideration in an evolutionary sense is to get weight off the soldier. It’s long been a joke in the Army that a soldier’s rucksack is full of 90 pounds of lightweight equipment. Advances in electronics, miniaturization, materials, batteries and a variety of other technologies can serve to lower the amount of weight the soldier carries. The most important tool in migrating equipment and functions off the soldier while easing his burden without sacrificing mission essential equipment is to provide the Objective Force Warrior a mechanical companion and a charging capability for the support of Objective Force Warrior’s batteries. A simple and continuous migration path to the revolutionary approach is to advance the vehicular control through teleoperated, semiautonomous, to autonomous stages completely removing the Objective Force Warrior from harm’s way. Once the opposition has been defeated or neutralized then the Objective Force Warrior can occupy the ground and interact with local populations.

Improvements in weapons are also required. In the short term, the Objective Individual Combat Weapon (OICW) and Objective Crew Served Weapon (OCSW) can supply the needed firepower and improved accuracy needed for overmatch of any future opponents.

In the revolutionary approach, fire and forget weapons featuring one-shot, one-kill technology are needed. Indeed, enhanced lethality of weapons that include improved explosives in smaller packages with extended ranges is key given difficult terrain and asymmetric opponents.

The Objective Force Warrior must be able to link weapon systems with the appropriate sensors to provide Beyond Line of Sight (BLOS) fires. The soldier must also be able to request, or have access to, Non Line of Sight Fires (NLOS). BLOS can be defined as not being able to see a target directly, but observing it through an organic or other accessible sensor and engaging it. NLOS fires occur when one soldier is looking at a target directly, or observing it with an organic or some other accessible sensor, but someone else, who cannot see it, shoots it.

Central to the effective use of the Objective Force Warrior is information or C4I. In the near future, the Objective Force Warrior must get relevant information as quickly as possible. As a minimum, the tactical Internet must be extended to include the individual soldier as well as provide him robust voice and data communication. This information access must take place in a secure environment that allows the soldier access to the Infosphere and it must be provided in such a way that he is provided relevant, actionable information. The soldier interface must not distract him from his immediate duties. Over time, this C4I capability should be integrated fully into the soldier’s ensemble (uniform and helmet).

Beyond what is provided by evolutionary technology is the promise of significant advances in capability through the development of revolutionary advancements in information technology. The goal is to totally control and dominate the information environment. Through a totally “netted” capability to understand the operational environment, the Objective Force Warrior can control more terrain through networking not only his own systems, but also those of higher echelons and headquarters. In effect, the individual soldier is transformed from a sentry to a member of a dynamic collective whole.

Of equal importance to the Objective Force Warrior effort, in both the evolutionary and revolutionary sense, is the ability to sustain and protect the Objective Force Warrior soldier when deployed. This aspect of technology has far reaching repercussions because success or failure in this area has an immediate impact on the health of the soldier – and in the success or failure of the mission, sometimes at the strategic level.

It is entirely possible to provide soldiers in the future with equipment/uniforms that increase protection from NBC weapons as well as to reduce the body’s signature in all spectra. The uniform can also be enhanced through designs that protect areas vulnerable to injury such as ankles, knees, lower back and elbows, especially in urban environments as well as providing better ballistic protection, both from penetration and kinetic energy. Finally, the uniform of the Objective Force Warrior will be able to manage the soldier’s internal temperature (cool and/or warm under extreme conditions). This capability is needed to reduce the soldier’s burden and enhance endurance.

The future holds even greater promise in providing protection through advances in biomimetics, nanotechnology, directed energy protection, biomonitoring and enhanced environmental sensing that goes beyond what human senses can do. In fact in many ways, while a soldier today can be considered a sensor, the suite of technologies that will be available to the Objective Force Warrior fulfills the promise of the Objective Force concept of “See First, Understand First, Act First.”

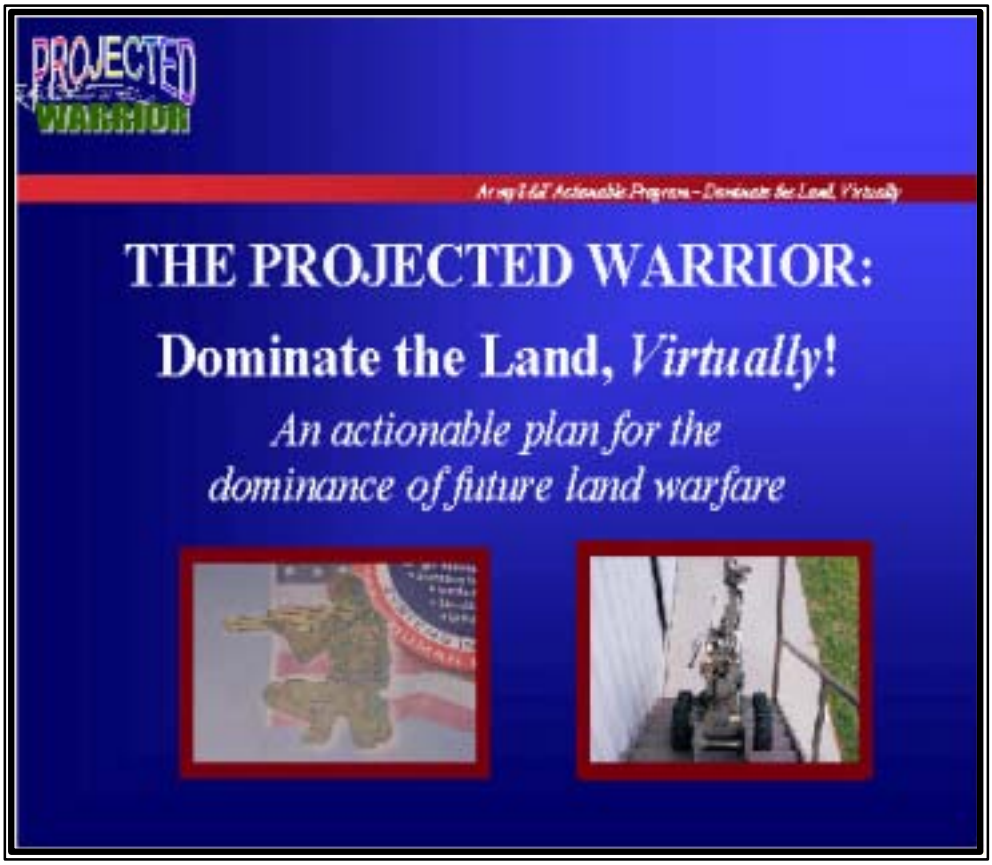
Sustainment, in terms of nourishment for soldiers, can be achieved through genetically engineering plants to grow rapidly. It is also envisioned that repair parts for equipment can be manufactured on the battlefield or in remote sections of the area of operations through advances in stereolithography and the use of natural materials. Indeed, advances in engine technology and biology may allow for vehicle fuel to be produced from plants or grass while the logistic footprint can be reduced through the reduction or elimination of batteries because of the development of new energy sources and power supplies. Similarly, technology can be developed to reclaim water from the body itself or to generate it from the air.

FCS and OFW Compatibility

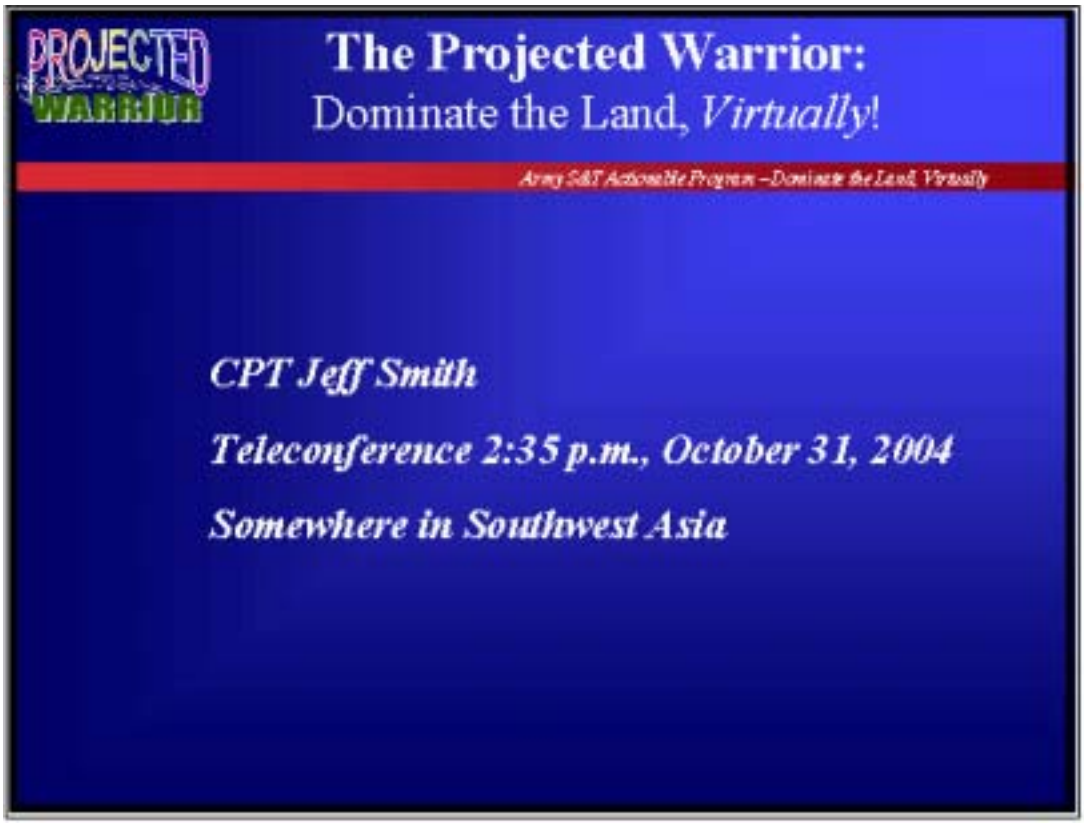
Although it was outside the focus of the panel, the group recognized the absolute requirement to make Objective Force Warrior systems compatible with the Future Combat System of Systems (FCSS). Since both efforts are systems of systems, each must be synchronized with the other to give the maximum amount of capability and flexibility to soldiers and commanders.

Panel Two Out Brief

The following PowerPoint slides were presented to Dr. Mike Andrews as the Panel 2 out brief of the Objective Force Warrior “Another Look” Session Two on October 31, 2001.

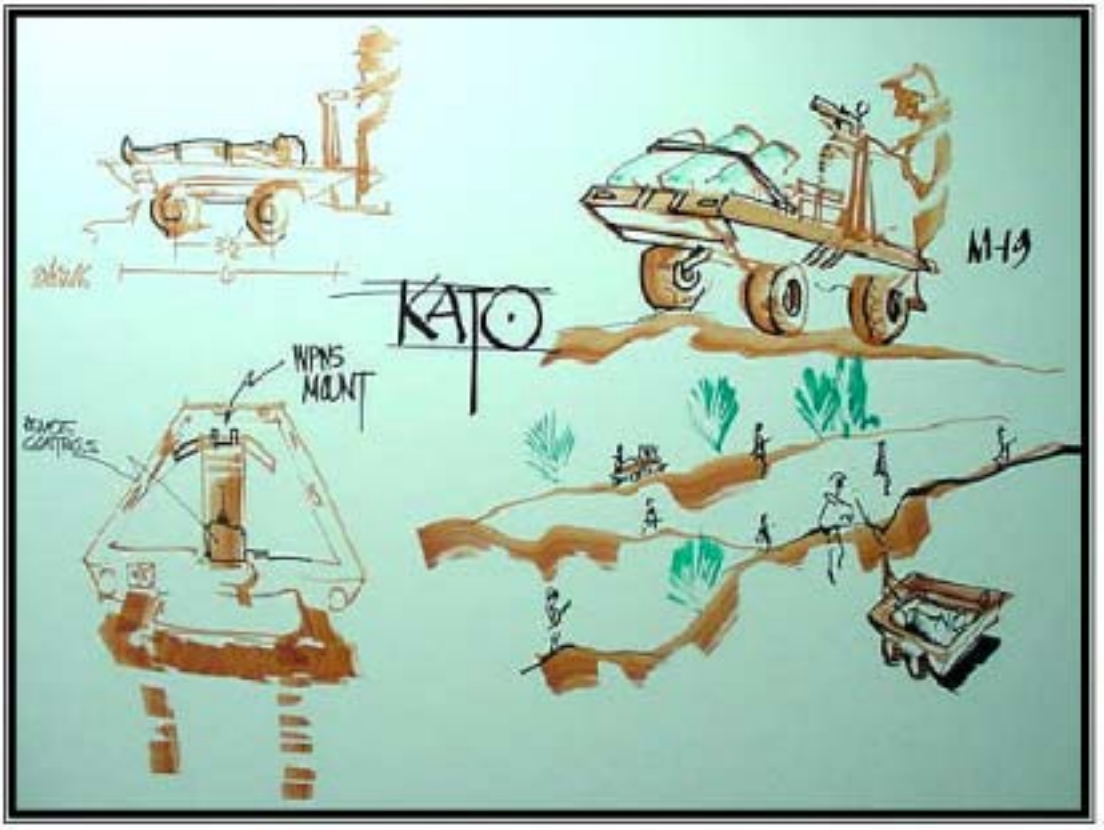


Slide 1



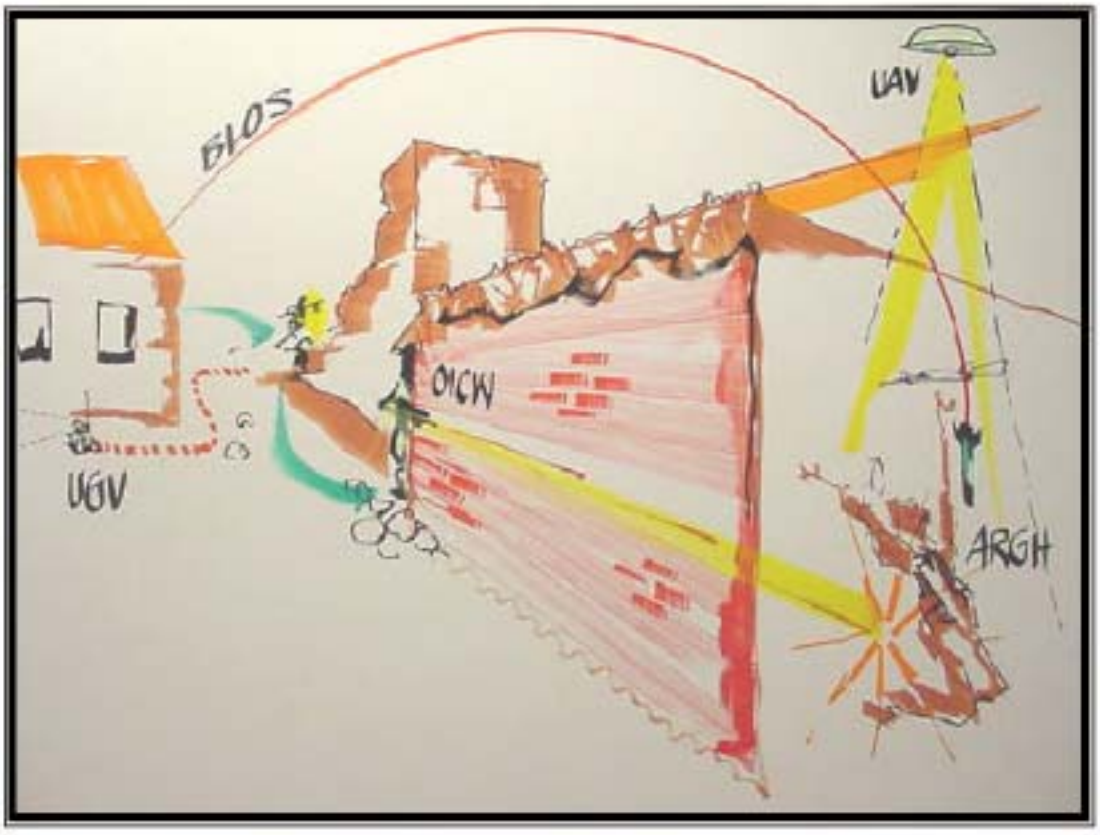
Slide 2

A scenario of a soldier’s field success with the evolutionary devices of Panel Two was used to begin the Session Two out brief presentation to Dr. Mike Andrews on 31 October 2001.



Slide 3

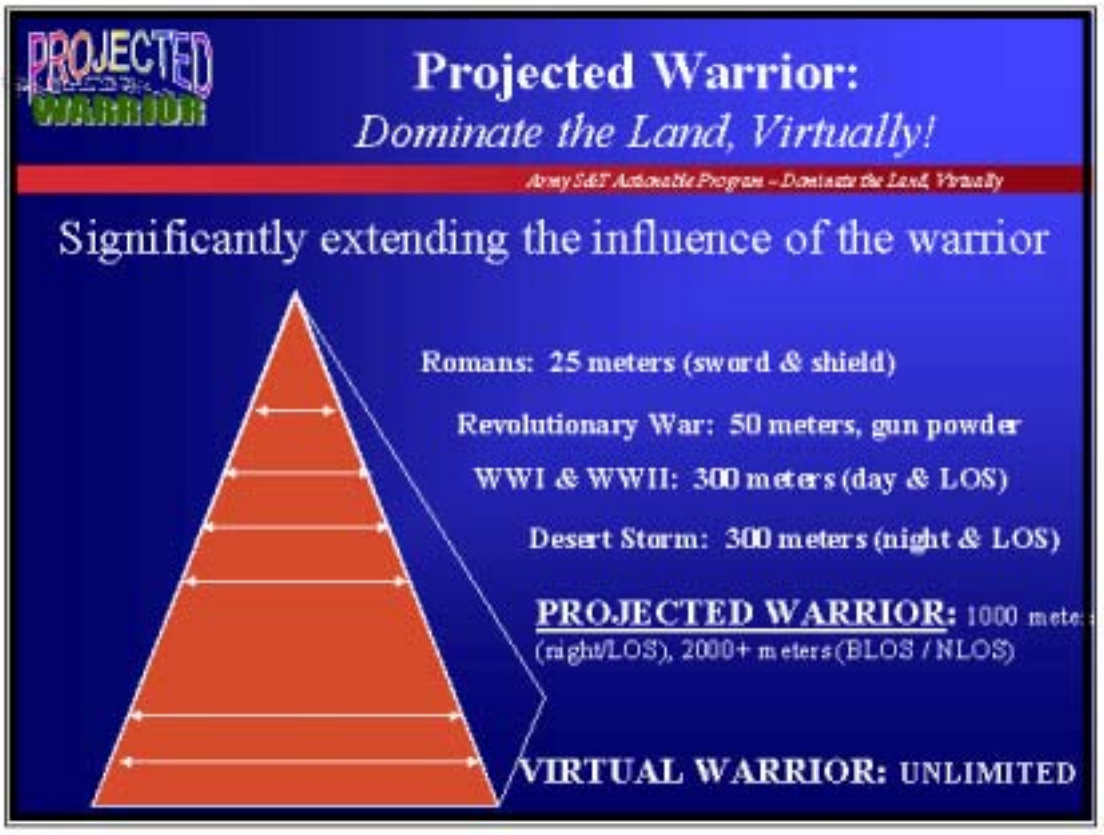
If the Objective Force Warrior is to become more agile, the load carried will have to be the minimum necessary to accomplish the mission, whether a movement to contact or a deliberate assault. The heavy loads used to be carried by pack animals. Today, the soldier does. Panel Two believes that a mechanical companion is imperative. It must still be determined whether the companion would follow autonomously, be called forward or be teleoperated by a soldier. Typical tasks would be as a crew-served weapons mount, a launch platform, evacuation vehicle or a non-mission essential equipment carrier.



Slide 4

This slide captures several essential components of Panel Two’s concept of dominating the land, virtually. An Unmanned Aerial Vehicle (UAV) under the control of the Objective Force Warrior offers non-line of sight awareness and understanding of the operational environment. Real-time images from the UAV are terminated at the Objective Force Warrior, or can be transmitted to higher headquarters to enhance its situational awareness and understanding. The Objective Force Warrior who is protected from the direct observation and fires of the enemy delivers both direct and indirect fires.

NOTE: In the original presentation to Dr. Andrews on 31 October, both slides 3&4 were framed as email attachments by a solider in the future describing to his father how technology enabled him to accomplish his mission. After he described how these new systems were used, the presentation turned into a more conventional presentation.



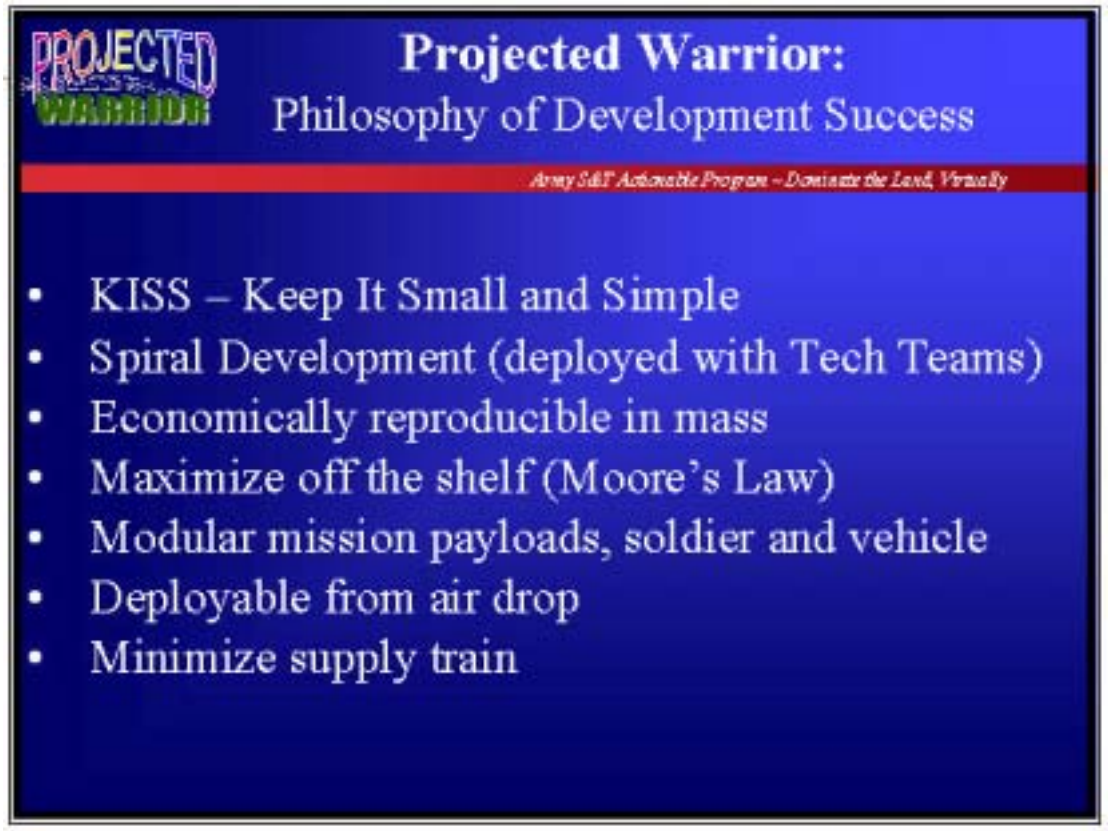
Slide 5

The triangle chart represents the trend of the distance/area soldiers have been able to control as warfare techniques have advanced throughout history. Clearly, the Objective Force Warrior is a soldier within his unit of action expected to observe/control greater area. In this chart, a nine-man squad is expected to control and dominate about 9 kilometers of ground using equipment and capabilities developed over the next decade. Hence, *dominating the land virtually* resembles an army of “special ops” forces made possible by technology dominance not unlike the current Army recruiting theme – an Army of One!

The essential point in dominating the land, virtually, is to embark on a cohesive development program that extends all capabilities of the warrior. These extended capabilities include sensing, communicating, seeing, acting, delivering force from today’s line of sight limitation to tomorrow’s time of flight limitation (time delay effects the ability to project useful action) and ultimately to no limitation in distance or time in much the same way as the Air Force has systematically put greater distances between pilots and the enemy (better sensors, smart projectiles, drones, etc.)

Side 6

The focus of Panel Two was to provide a plan that was actionable. The panel looked at what equipment and devices could be provided to soldiers within the near-term (evolutionary) while simultaneously pointing to technology developments that could provide breakthroughs (revolutionary) in equipment and capabilities around 2015. This chart describes what the panel thought was important and the specific topics they addressed.



Slide 7

In any endeavor as important, massive and far reaching as the planning of the Objective Force Warrior, it is of the ultimate importance to have guiding philosophies that are clear, simple and understood by all contributors. The panel shared a few of the most fundamental and important philosophies that have guided their efforts in the public and private sector as recommendations for the fundamental philosophies to guide the prioritization of efforts for the Objective Force Warrior.

KISS - The first principle of designing a philosophy for development success was to follow the advice contained in the acronym KISS. In this case, KISS means, “Keep It Small and Simple”. The panel used this principle in developing actionable plans leading to systems for the Future Warrior.

As an adjunct to KISS, the panel also thought that the Army should adopt a spiral development approach to technology. Under this approach, the idea is to develop technology quickly, get it in the hand of the troops as fast as possible, let them use it and provide feedback to technology teams, and incorporate any

changes to the equipment as fast as possible. Then, the process starts all over again with the modified equipment.

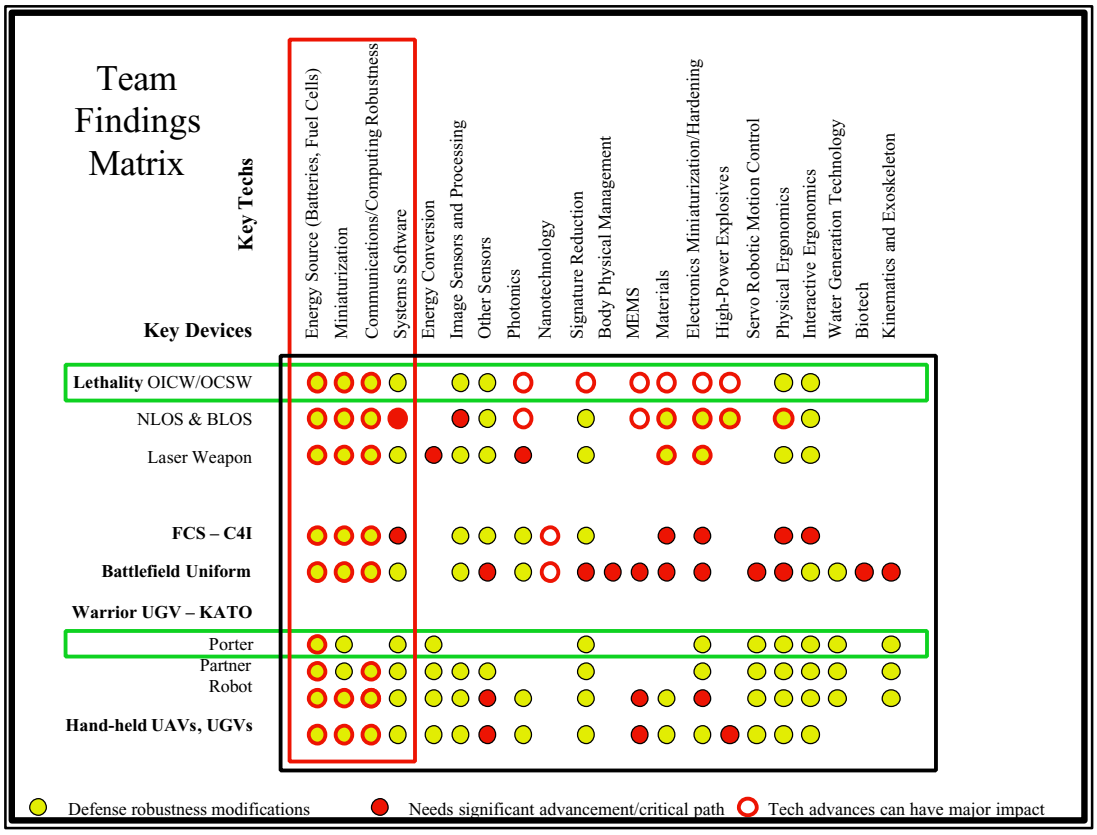
Central to this philosophy is that the equipment cannot be prohibitively expensive. It must be reproducible in mass, robust, easy to operate and maintain, and reliable under austere conditions.

The development of equipment and technology for the Objective Force Warrior is based on a philosophy that maximizes the use of commercially available technology that extends the capability of the soldier available in 2001 with a view toward improving equipment rapidly. The realities of Moore’s Law show that technology improves so fast that the Army must be able to incorporate these improvements as quickly as possible.

To the maximum degree possible, equipment designs should be modular so that they can be both replaced and updated as time and technology allow.

Any equipment developed for the Objective Force Warrior should be able to be dropped from an aircraft.

Over time, any equipment developed should not place any great burden on the Army’s logistical tail. If it meets the criteria outlined in bullet three, that development goal should be achieved.

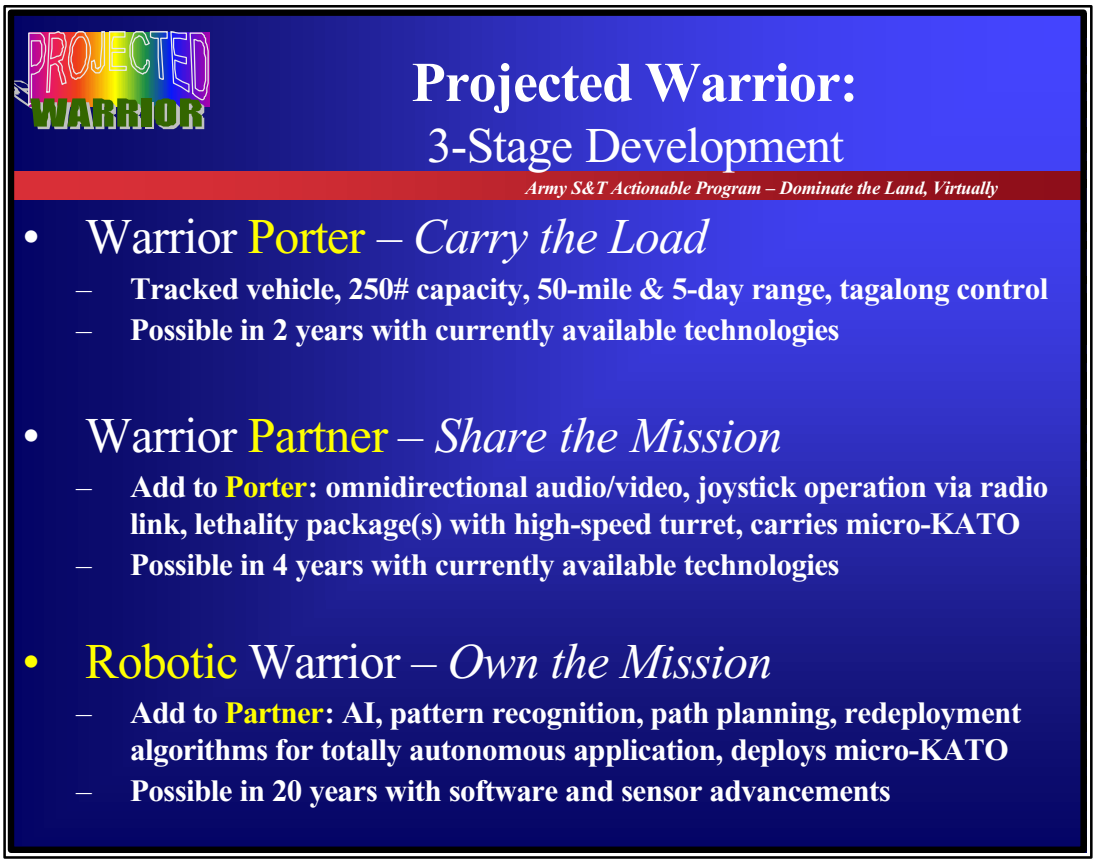


Slide 8

The matrix in Slide 8 represents technology improvements, enhancements, or breakthroughs required by the Objective Force Warrior in order for this soldier system to reach its full potential. In the short term, within the next three to six years, the advancements in technology will provide evolutionary improvements in equipment. In the longer term, 10-15 years from now, the acceleration of technology will allow the Objective Force Warrior to control terrain either in person or by a virtual presence.

The horizontal items on the left of the chart are the essential devices and systems the panel felt would positively affect the Objective Force Warrior in the greatest manner. The vertical items on the top of the chart are technologies that are needed to support the implementation of the devices for the Objective Force Warrior. The colored circles represented the panel's opinion of the readiness of the technologies. The two horizontal boxes outlined in green represent the two systems that the panel believed should be fielded as soon as possible (OICW/OCSW and the KATO porter) because of their strategic advantage and the availability of the supporting technologies.

The green vertical block captures the enabling technologies (energy source, miniaturization, communications and computing robustness, systems software) that must be developed and robust enough to provide a strong technology basis for all the devices listed here and for other equipment for the Objective Force Warrior. The red, open circle identifies enabling technologies that would have a major impact if they became available. Thus, the highest and quickest payoffs for the Objective Force Warrior were within the intersections of the horizontal and vertical rectangles.



Slide 9

We must drive weight off the soldier. Packing lists, mission requirements and limited re-supply often drive the weight that a dismounted soldier has to carry to 90 pounds or more. If the soldier could be given an assistant to carry at least a portion of the weight, then that soldier could move faster and not become fatigued as rapidly. Objective Force Warrior could also use this platform to store other equipment, re-charge batteries and serve a multitude of other tasks that could develop over

time as technology improved. The panel envisions three variants to be developed over the next 20 years.

The working name of this system is KATO. KATO was the sidekick to the Green Hornet on the TV show and this platform will serve as the partner to Objective Force Warrior soldiers. Our KATO acronym was affectionately translated as the Kick-A Tele-Robot.

In its initial design, the platform is a simple porter of equipment. Members of the squad could put some of their gear on this machine (see metrics on the slide) and it would follow along with them. This vehicle could be in the field within two years with wheels/treads that allowed it to traverse any pedestrian terrain.

In the next version, the vehicle would serve as the soldier’s partner and share in the accomplishment of the mission. The add-ons from the original would include a lethality package, omnidirectional audio/video and joystick operation via a radio link. It would also carry or launch miniature platforms for reconnaissance or attack options.

In it’s ultimate version, KATO itself would own almost all the mission. Based on artificial intelligence, pattern recognition, path planning and redeployment algorithms for totally autonomous application, the vehicle could perform a number of functions by itself. It too would deploy micro versions of itself to extend its reach or observation of the battlefield (a cheaper single-use, disposable version).

Slide 10

The Projected Warrior/KATO vehicle must be designed with modularity in mind. It should be built so that upgrades can be made quickly and in concert with changes to the soldier’s equipment and infrastructure (i.e., linkages with the Infosphere). These modules include, but are not limited to, lethality and C^4I. The lethality module package must be designed so that the soldier’s weapon can be used by KATO.

The Projected Warrior/KATO system must be designed to tie into existing and future radio networks, LANS/WANS, mobile ad hoc networks, etc. Its capacity must grow with the development of the Infosphere.

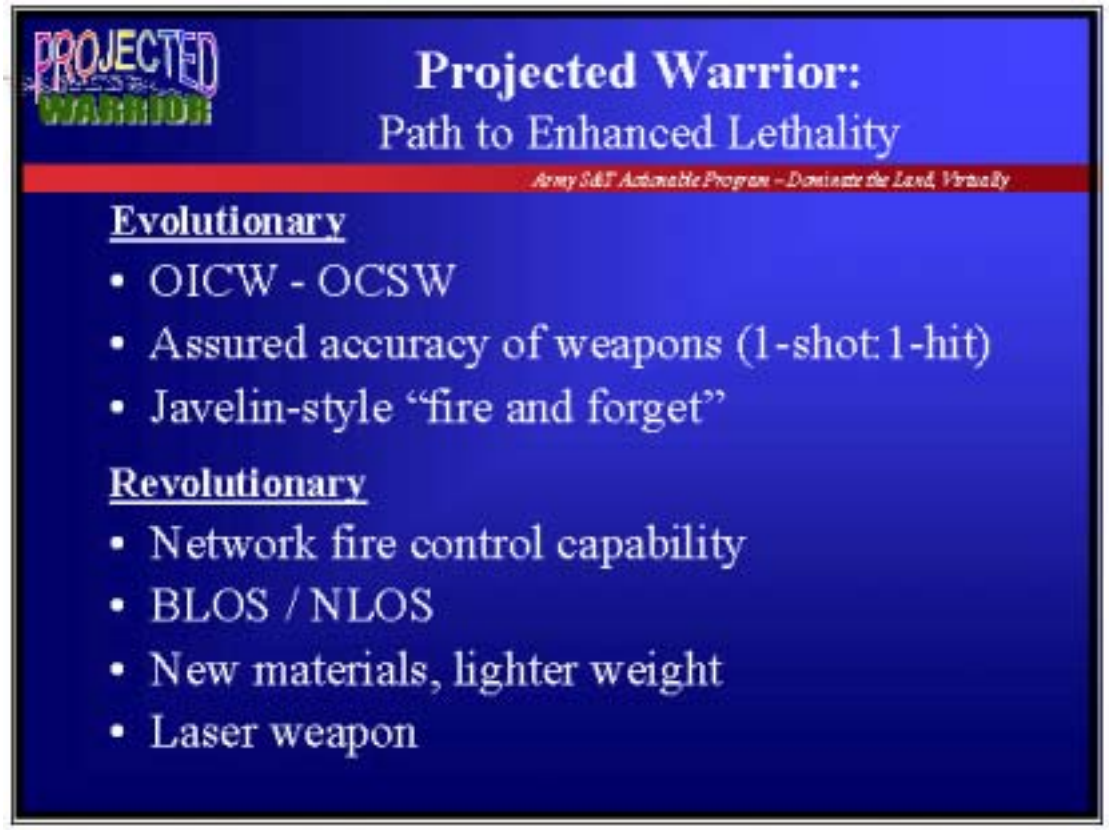
The companion vehicle must climb steep hills, stairs, and obstacles that are at least 12” high and be able to swim for a limited distance. Its power supply cannot be drained quickly, and it has to have endurance of several days with limited fuel. It must also be able to go in a variety of directions and the motors on it have to be quiet and reliable.

The design has to be flexible enough to both carry and, if necessary, launch unmanned aerial vehicles (UAVs) and unmanned ground vehicles (UGVs).

Slide 11

A potent addition to the soldier’s arsenal is small, handheld UAVs and UGVs. These devices are launched by soldiers to perform “niche” reconnaissance of dangerous areas such as sewers, cellars, alleys, etc., and are ideal for combat in cities (MOUT). While they may have limited range and endurance, they perform the function of “looking over the hill” to let the Objective Force Warrior know what’s on the other side.

The next four slides discuss the merits of starting immediately to pursue technologies in three areas. These three areas hold the promise of evolutionary improvements now and revolutionary developments for the Objective Force Warrior in the future.



Slide 12

Enhanced Lethality

One of the concerns the panel had was that in some scenarios the Objective Force Warrior could be on the ground without the support of sufficient or robust field artillery, armor, or aviation assets. In this instance, or in the case of peacekeeping operations where large crowds may be present, the soldier may be forced to fight unsupported. In those instances, the panel concluded that the Objective Force Warrior needed more lethal weaponry than is available today.

Evolutionary Developments - The Objective Individual Combat Weapon (OICW) and the Objective Crew Served Weapons (OCSW) are key to a rapid improvement in the capabilities of the Objective Force Warrior. The focus is to give the soldier the ability to hit a target with one shot without being exposed. While to some

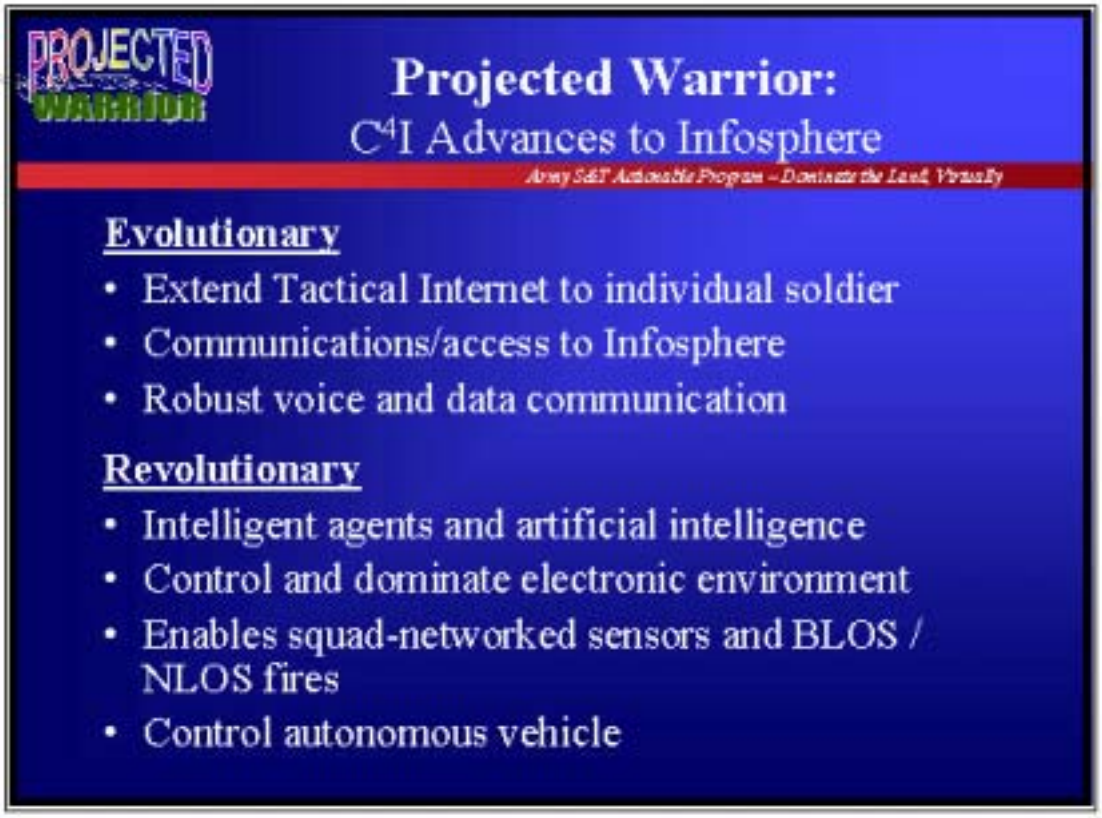
degree that can be done now, with more emphasis these weapons could be made to have the accuracy of 1-shot, 1-hit or with improvements in target acquisition, even become a fire-and-forget system for the infantry and similar to today’s Javelin.

Revolutionary Developments - Ultimately, the squad or squads can engage targets seen or observed by Unmanned Aerial Vehicles (UAVs) and/or Unmanned Ground Vehicles (UGVs) or other squads. The key to this capability is the development of a network architecture that can support target acquisition, secure communications, etc.

The improvements required to develop this network also lend themselves to be used by small units or individuals to prosecute Non Line of Sight (NLOS) and Beyond Line of Sight (BLOS) targets. NLOS is defined as targets that are identified and engaged by any one of several systems. BLOS is key for the Objective Force Warrior since one soldier is responsible for the acquisition of a target while another shoots at it even though the second soldier can’t see it.

The panel thought the development and maturity of such technologies as new materials, MEMS and new explosives could enhance lethality while driving the weight of any weapon system down.

The most revolutionary development of all in this area is the use of lasers in weapons. There are clearly improvements being made with this technology and ultimately weaponizing lasers provides the Objective Force Warrior with a truly significant capability across the operational continuum.



Slide 13

C^{4}I Advances to Infosphere

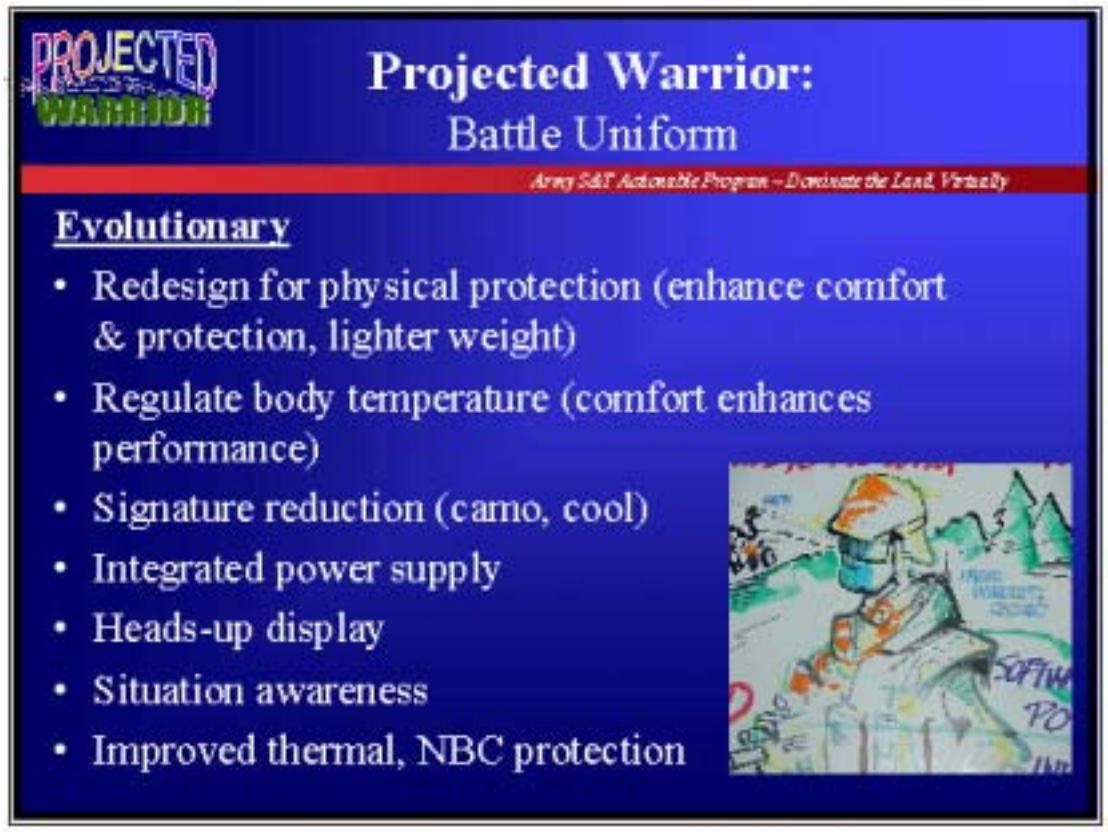
Fundamental to realizing the potential of the Objective Force Warrior is the creation of the dynamic, collective unit of action, harnessing current and near-term information technology.

Evolutionary Developments - Bring the tactical Internet to the soldier now but it has to be robust and easy to use. The soldier has to be able to tie into the Infosphere but any communication has to be secure. The soldier needs communication’s systems that allow him to download data as well as talk. If one system is unavailable there needs to be enough redundancy to complete any transmission of information or data.

Revolutionary Developments - In extending the awareness of the Objective Force Warrior’s environment, using artificial intelligence (AI) and autonomous intelligent agents (AIAs) to provide only the information required for the mission or task provides the necessary speed to react to any tactical situation.

Through this equipment and awareness the squad controls and dominates the information environment. This networked environment also provides the ability to tie into Non Line of

Sight and Beyond Line of Sight engagements as well as to control the KATO/Squad vehicle remotely.

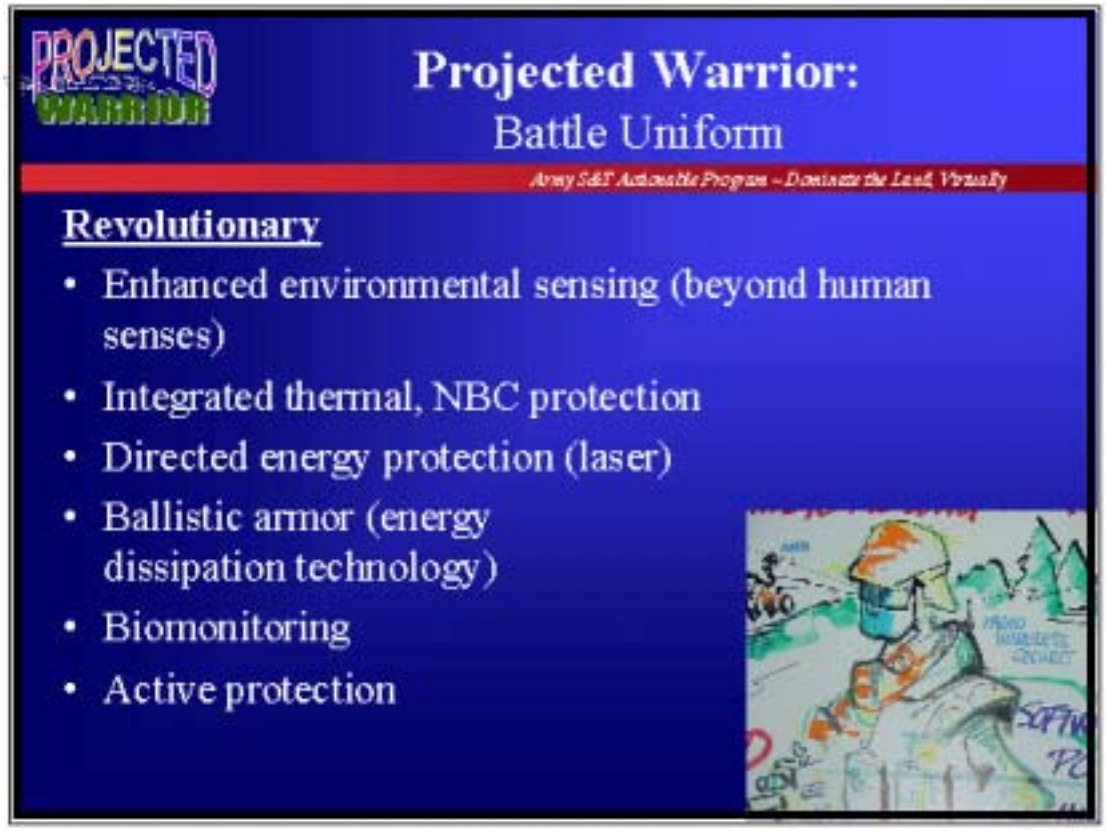


Slide 14

Battle Uniform

Evolutionary Developments - The next step in developing uniforms for use by Objective Force Warrior soldiers is to lighten the load by improving the materials that go into ballistic protection and the frame of the rucksack. The uniform must also provide better protection for ankles, knees, lower back and elbows to mitigate against impact injuries, particularly in urban environments. The uniform should also regulate and monitor body temperature to improve soldier performance and reduce fatigue.

Future uniforms must reduce signatures by providing environment-based camouflage, thermal masking and temperature control to keep the body cool or warm. An integrated power supply is essential to operate and control uniform functions and requirements. An improved Heads-Up-Display provides enhanced situational awareness. The uniform must give better protection against NBC attack and dissipate the heat generated by the body.



Slide 15

Battle Uniform

Revolutionary Developments: The future uniform for the Objective Force Warrior will and must detect danger beyond the senses. This includes having the uniform detect bioagents, blend into the environment as well as “sniff” for explosives. The uniform must also hide the soldiers’ physical signature (heat, smell, moisture) and to protect from NBC threats.

The uniform can be constructed to deflect incoming rounds through directed energy sources and improve ballistic protection by more efficiently dissipating energy from bullets. Use the uniform to evaluate the soldier’s overall health and program it to let medical personnel know if the individual is fatigued or sleep deprived.

Soldiers have historically had shields to protect them in battle. It is possible to miniaturize “Star Wars” or Brilliant Pebbles technology and use it as a shield. The uniform can also be constructed to protect the Objective Force Warrior soldier from laser and microwave weapons.

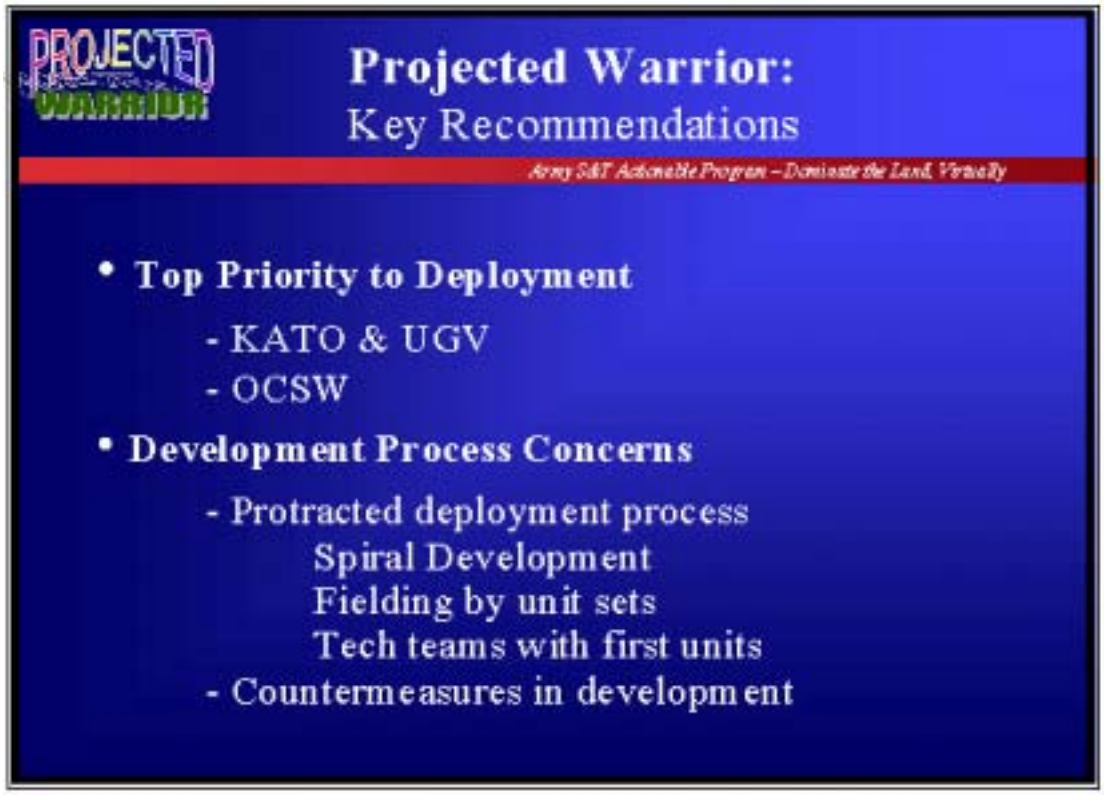
Slide 16

In order to dominate the land and reduce soldier exposure to danger, the blending and maturation of all the technologies on this slide is required.

Software and software systems have to be reliable, robust, and self-healing. All systems that require power will have to be smaller, lighter, and last longer than they currently do by a factor of two or more. Power will have to be derived, reclaimed, or scavenged from any number of resources.

Soldiers will have to be able to tap into the Infosphere and be able to draw from it only the information they need and then be able to communicate up or down the chain of command rapidly.

The Objective Force Warrior will have to be protected from weapons and weapons effects. Finally, the Objective Force Warrior will need a companion on the battlefield that can provide mobility, sustainability, lethality, and reliability. The Warrior gets this through an innovative, lightweight, rugged, and adaptive vehicle that can follow the soldier or be controlled through teleoperation, semi-autonomously or autonomously.



Slide 17

The panel’s assessment was that there were two priorities for investment: The first was that the companion vehicle and its associated UGVs/UAVs be developed as rapidly as possible. Concurrent with the development of those technologies was the need to develop the OCSW and to field as rapidly as possible the OICW.

The panel also had two concerns. First, the current deployment process of technologies is too slow to take advantage of rapidly evolving technology. With a 10-15 year acquisition cycle time, by the time troops get systems, they are already outdated. The panel believes equipment does not necessarily need to be fielded by the entire Army or upgraded across the force in blocks that take years. It would be better to rapidly field equipment to selected units, evaluate it in use under real conditions by the troops who use it, provide immediate feedback to technical advisors, and get the revised product out quickly.

The second concern was that the Army needs to understand and build into any development process an understanding of how to anticipate countermeasures to U.S. equipment. Whether the challenge is advanced (i.e., EMP hardening) or primitive, equipment designers must understand where the vulnerabilities are.


dominate the land ....virtually
THE PROJECTED WARRIOR
MICRO UGV
KATO
SOFTWARE
POWER
INFOSPHERE
COMMUNICATIONS
MINIATURIZATION · PROTECTION
KEY TECHNOLOGIES

Slide 18

Vision

Dominate the land virtually is an actionable vision for providing the Objective Force Warrior with an ever increasing span of control by focused development and deployment of technologies that expand the sensing and force delivery capabilities of the soldier offering a continuously advancing strategic overmatch capability. The underlying premise is that through a judicious, but rapid migration of remotely controlled mechanical devices that off-load the warrior's burden (KATO) and limit the degree of risk a soldier is exposed to (UAVs and UGVs. This is done while simultaneously delivering effective direct and or indirect fires, it will be possible to provide U.S. forces with a continuing combat advantage.

This can be done by giving investment priority to evolve technology from where it is today to the point where real revolutionary breakthroughs will allow for the achievement of this vision.

Key Philosophy of the Vision

- The modern soldier is overloaded because of the weight of his equipment. Without a change in the paradigm of the approach to this burden, no amount of incremental weight reduction is going to allow for deployment of new Objective Force Warrior technologies. Offload the Objective Force Warrior burden with a squad or personal vehicle capable of pedestrian terrain.
- Determine what devices are needed to develop an advantage over potential adversaries both now and into the future.
- Identify what technologies will enable or deliver the devices.
- Ascertain if those technologies, given time and money, can have a major impact on capabilities for the Objective Force Warrior.
- Build those systems/technologies and send to selected units.
- Spiral development – get the device out to the troops, test it in a realistic environment, provide feedback to technical advisors and incorporate any changes and start the process over again.
- Use this evolutionary approach to identify a path toward revolutionary technologies.
- Maximize commercial off the shelf equipment; identify where defense will drive the technology, not the market.

Metrics

Projected Warrior or KATO

- Version I (The Warrior Porter): Wheeled vehicle, with a 250-pound carrying capacity and a 50-mile and five-day range. Possible in 2 years with currently available technologies.

- Version II (The Warrior Partner): Added on to the original is an omnidirectional audio/video capability, joystick operation via radio link, lethality packages, and some micro-KATO capability. This is possible in 4 years with currently available technologies.

- Version III (The Robotic Warrior): Added on to the partner is an artificial intelligence capability, path planning, redeployment algorithms for totally autonomous application, and the ability to deploy micro-KATOs. Possible within 20 years with software and sensor advancements.

Enabling Technologies

(Not necessarily in order)

- Energy Source (Batteries, Fuel Cells, Biomass)
- Miniaturization
- Communications/Computing Robustness
- Systems Software
- Energy Conversion
- Image Sensors and Processing
- Other sensors
- Photonics
- Nanotechnology
- Signature Reduction
- Body Physical Management
- Micro-Electro Mechanical Systems (MEMS)
- Materials
- Electronics Miniaturization/Hardening
- Improved/High Power Explosives

Comparison with Land Warrior 2004

By changing the paradigm of the Objective Force Warrior to include the offloading of burden that incorporates battery recharge capabilities, the comparison to the Land Warrior 2004 becomes at once both easy and difficult because it is the comparison of totally different ideas and does not represent incremental improvement. With the burden off loaded and a continuous source of battery power, the deployment speed and endurance of Panel Two's *Projected Warrior* far exceeds anything that the Land Warrior can personally carry.

By augmenting the *Projected Warrior* with the eyes and ears of the UAV/UGV, the ability to safely obtain personal battlefield information far exceeds anything currently in the field. By augmenting the *Projected Warrior's* firepower with radio controlled directable charges and NLOS firepower, the Projected Warrior can dominate the Land Warrior 2004 remotely (but not yet virtually). The fundamental key is the ease of use and reliability of these devices with their supporting communications in the heat of battle.

Breakthrough Technologies for 2018

(Not in order)

- **Self-Sustainment**
  - Live off the environment by growing fresh produce from genetically altered seeds. A seed could be planted and produce fresh produce or fruit within two hours.
  - Take chemicals or materials from the environment and produce replacement parts for equipment through stereolithography.
- **Brilliant Pebbles** - Provide the Objective Force Warrior a shield by using Brilliant Pebbles technology.
- **Water Reclamation** - Provide a water reclamation device that gives a soldier an inexhaustible supply of fresh water by processing sweat and urine.
- **Uniform as a Shelter** - The uniform itself could not only be configured to hide and protect the soldier but be used as shelter.
- **Uniform as a Cloaking Device** - Biomimetics can be improved so that the soldier can be as invisible as a chameleon; body armor can use overlapping scales of lightweight, high strength materials as some animals do.

- **Nonlethal weapons from the electromagnetic spectrum** (low-frequency ultrasound, temporary laser or light flash).

- **Lethal Energy Weapons** – Create directed energy weapons using other portions of the electromagnetic spectrum (specific lasers, high intensity focused ultrasound, etc.)

- **Remote Sensing** – Conduct remote sensing using micro-UAV or pre-placed sensor network. Movement, biowarfare agent detection and other parameters for long-range "out-of-sight-awareness."

- **Local/body Sensing** - Create methods to detect the immediate environments and threats (e.g., BW agents, hidden enemy, etc.).

- **False Avatars and Holographic Surrogates** - Develop these devices for training or for deception/PSYOPS.

Recommendations

- Field the Objective Individual Combat Weapon (OICW) and Objective Crew Served Weapon (OCSW) as soon as possible.

- Start development of a companion vehicle for the Objective Force Warrior and begin a migration path to allow this vehicle to be a teleoperated then semi-autonomous and finally autonomous device that removes the Objective Force Warrior from harms way. Do not wait on autonomous planning/controls/navigation to get a useful vehicle in the field and to begin reliability testing/improvements and refinements from field experience.

- Begin a deployment program for UAVs and UGVs that can be field tested to remove the Objective Force Warrior from harms way for simple surveillance and key extension-of-force opportunities.

- Concentrate on technology development assuring a reliable foundation for Objective Force Warrior electronics keying on energy storage, communications robustness and security, Electro-magnetic Pulse (EMP) survivability and miniaturization.

- Invest in a number of basic research opportunities with an eye toward paradigm-shifting technologies that establish a new strategic asymmetry in the battlefield.

- Streamline the field testing/deployment process and the procurement process to reduce time from laboratory to field implementation while making use of industry advances where possible, particularly in computers and electronics.

Other Issues

While not a specific deliverable as part of Panel 2’s charter, several issues developed that do affect creating technologies for the Objective Force Warrior.

The first issue is economics. An essential component of war and conflict has been, and will continue to be, economics. A device, idea, or implementation is not a viable solution if it is not economically feasible in the deployment stage. Since land war often involves numbers of both men and machines, most devices targeted for use by the warrior must be

- Reproducible in quantities sufficient to field the entire Objective Force, although the development cost may be great
- Manufactured at a reasonable cost
- Reliable under field conditions
- Sufficiently robust to function well in battle
- Easy to operate and maintain
- Deployable without creating massive burdens on the logistics/maintenance systems

If any technology, device or system fails to meet these criteria, it is never going to be acquired by the Army. If any robotic system is going to be fielded for use by the Objective Force Warrior, it will have to meet and pass the affordability test.

The second issue identified by the panel is the Army’s acquisition process. While this is a windmill that everyone seems to tilt at with no effect, it’s key to the future of Objective Force Warrior, since modularity and expandability are central tenets for growing technology over time. This development process will be hindered if the service continues to adhere to the traditional acquisition process. This is why the program needs a spiral development process.

Providing troops technology quickly, working with it and providing modifications on a timely basis for further development aren’t going to work if the upgrading process proceeds in terms of years Army-wide. The basis of issue has to change to fielding specific units with a basic model. That model can then be upgraded and modified over time as each unit gains experience with it and offers ideas on improvements. Introducing new technologies, both military and commercial that are developed over the next 10-15 years enhances this process.

Since the original design was based on an open architecture, incorporating new technology will be much easier and faster. The changed variant would then be fielded to a new unit or units (but not Army-wide) and the process started over again.

Providing technology to troops quickly, working with it, and providing modifications on a timely basis for further development aren’t going to work if the upgrading process proceeds in terms of years Army-wide. The basis of issue has to change to fielding specific units with a basic model, upgrading and modifying it, and then issuing the changed variant and starting the process over again.

The third issue is training. The Objective Force Warrior will force training to change as well. It has to. If technology is going to advance, then technology for training has to keep pace. Holograms, false avatars, database development, and network archives all have to be available to soldiers and units to use to provide realistic training and feedback. While Panel 2 never dedicated a lot of time on this topic, the group thought that ultimately training may be the most important facet of the technology that is ultimately used by the Objective Force Warrior.

The fourth issue relates to solving some important technology “Achilles heel” issues for the Objective Force Warrior. The “heels” are the lack of robustness of NLOS battlefield communications, lasting Electro-Magnetic Pulse (EMP) effects on battlefield electronics and sufficient battery/fuel cell power to operate emerging electronic devices. The Panel saw these as significant challenges that had to be overcome for the Objective Force Warrior to reach its full potential, but did not have the depth of the status of the current technology or the magnitude of the threat to know if these were truly significant concerns.

The fifth and last issue that the panel discussed were two specific recommendations for the Army:

- Create a “Skunk Works” in Army Science and Technology to make the best use of off the shelf equipment and use it to compete with systems in the traditional development path.
- Create a counter-measures group to try to determine ways to defeat the emerging technology systems as a final performance measure of robustness.

Summary

The overarching vision produced by Panel Two is that the Objective Force Warrior must *dominate the land virtually*. The group's intent was to recommend the technology means and deployment approach to provide a continuously sustainable advantage to the Objective Force Warrior (OFW) in pursuing that mission. It is imperative to invest in the technology that shows the most promise for delivering the capabilities needed by the Objective Force Warrior to pursue this mission. The panel felt it was important to move essential equipment to the field for initial deployment testing as rapidly as possible. To that end, the panel makes the following recommendations in technology investments so that the equipment that will be available between the years 2006-2010, if not sooner:

- Provide sufficient investment to field both the Objective Individual Combat Weapon (OICW) and the Objective Crew Served Weapon (OCSW) as soon as possible as well as to develop technologies that will support Non-Line of Sight (NLOS) and Beyond Line Of Sight (BLOS) fires.
- Develop a robotic "companion" vehicle to carry some of the Objective Force Warrior's load. While these two technologies should receive development priorities, over this same period other relevant technologies have to be developed. These include technologies for the Objective Force Warrior uniform/helmet, UAVs/UGVs, sustainment, new materials, improved energy sources (fuel cells, biomass, etc.), signature reduction and the development of robust and reliable software and communications equipment. This can be done in two phases over the next four years.
  - Phase I is the simplest variant. The vehicle will tag along behind a soldier, be able to carry @250 pounds of gear and have a 50-mile, five-day range.
  - Phase II is a planned upgrade that would share the Objective Force Warrior's mission. The additions would include an omnidirectional audio/video capability, joystick operation via radio link, lethality packages and an ability to carry micro-UAVs/UGVs. These companion UAVs/UGVs, in order to be compatible with the vehicle, may need development/modification for those types of systems already under construction.

Essential near-term technology areas that should be emphasized to provide the firm foundation for the electronic advancement of the OFW include

- Energy storage
- Communications (robustness, security, NLOS)
- EMP hardening
- System software
- Miniaturization

For the year 2018 and beyond, enabling technologies that should be sufficiently advanced to provide additional, if not revolutionary capabilities, to soldiers who follow after the Objective Force Warrior include

- Nanotechnology
- Photonics
- Image Sensors and Processing
- Micro Electromechanical System (MEMS)
- Materials
- Energy Sources (Batteries, fuel cells, fuels from biomass)
- Servo Robotic Motion Control
- Biotechnology
- Signature Reduction
- Kinematics and Exoskeleton

Given the increasingly rapid pace of technology development, the panel recommends that intentional and considerable effort must be put forth by the Army to streamline its procurement and deployment processes because of the threat posed by advancing, off-the-shelf, commercial technologies being repurposed for war by our enemies. While such a sweeping change in the organizational process may seem unachievable, it is of fundamental importance to the goal of maintaining strategic overmatch in any engagement at any future time against a currently unknown enemy.

Introduction

Panel Three used Land Warrior as the baseline to make determinations as to where technology could have the largest impact on both Objective Force Warrior and Future Warrior. The periods used were 2004 for Land Warrior, 2010 for Objective Force Warrior, and 2018 for Future Warrior.

While there was parallel work done, a large initial effort focused on developing a meaningful vision for Objective Force Warrior. The main tenet of this vision is "overmatch." Research and Development and acquisition programs in the Air Force (F22 and Joint Strike Fighter), the Navy (Eisenhower Class Aircraft Carriers, Seawolf Attack Submarines and Joint Strike Fighter), and Army combat systems (Abrams, Bradley and Apache Longbow) clearly represent "overmatch" in their respective battle space domains. However, the dismounted U.S. soldier has not been supported with the similar programs to provide the same battlefield "overmatch." Additionally, the Objective Force Warrior will always fight as part of a unit of action and be linked to other battlefield systems including the Future Combat System. Thus, the vision embodies the concept that the Objective Force Warrior is the most lethal soldier in the world in any combat scenario and is fully linked to the unit of action and the Future Combat System. This ensures a unit of action capability greater than the sum of its parts. The seven capability areas underpinning this vision are collaboration; lethality; agility; synergy; communications; stealth and survivability.

The Panel Three divided into groups to develop metrics and technology areas. These groups worked in full coordination with each other in order to produce complimentary products. Simultaneously, the group worked with an illustrator to visualize the concept. The illustrations in the following briefing accurately represent the concept.

As Panel Three's concept evolved, much of the discussion centered on what technologies to apply to Objective Force Warrior and Future Warrior. The panel decided to focus their concept in four technology areas: situational understanding, weapons, power generation, and individual protective equipment. They looked at what technologies were available for application to Land Warrior, Objective Force Warrior, and Future Warrior. The presentation prepared for the out brief describes these technologies.

Objective Force Warrior "Another Look" - Panel Three Vision

The Panel felt that the Army could improve Land Warrior by the application of various Commercial Off-the-Shelf (COTS) technologies. There are some leap-ahead technologies available for Future Warrior. However, the greatest potential for leap-ahead capability is for Future Warrior. There is a potential for block upgrades in the intervening time between Objective Force Warrior and Future Warrior.

Panel Three Out Brief

The following PowerPoint slides were presented to Dr. Mike Andrews as the Panel Three out brief of the Objective Force Warrior "Another Look" Session Two on October 31, 2001.

Slide 1

The Mystics of Panel Three, the "Oak Ridge" Panel.

Slide 2

Slide 2 reflects the agenda for the Panel Three's briefing of their Objective Force Warrior concept.

Vision

The OFW is a warfighter in a unit of action whose aggregate capability far exceeds the sum of the individual soldiers' ability to fight and survive. This dismounted warrior represents a system of resources whose value is multiplied by a capability to perform duties across the full spectrum of military operations.

In the OFW, technology and training are combined to create a soldier-centric platform that embodies 21st century expectations compatible with and **maximizing the emerging Future Combat System.**

Individually, the OFW dominates opponents with respect to the seven primary capability focus areas. **As a unit**, the OFW unit of action represents an overmatch to opposing forces through its overpowering ability to:

- **collaborate among individuals and among units,**
- develop and maintain **unit focus and synergy** that dominates the battle space,
- perform with astonishing precision, agility, and speed, and
- adapt tactics and procedures to circumstances through **ubiquitous knowledge acquisition and communication.**

Slide 3

The Panel Three Objective Force Warrior vision . . .

Objective Force Warrior "Another Look" - Panel Three Vision

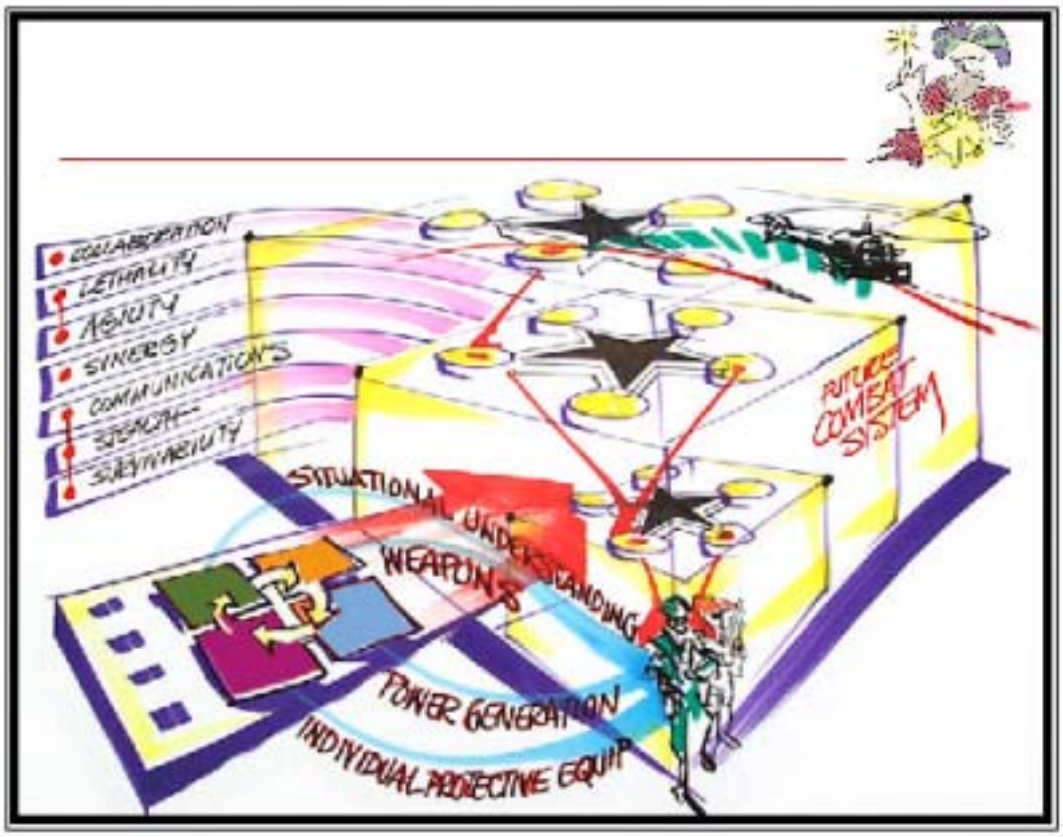
Slide 4

Situational understanding and collaboration is the competency that discriminates Objective Force Warrior from current technologies and capabilities. For example, today an Apache helicopter is an unprecedented killing machine. An Apache can move, detect, engage, and kill in ways expected of maneuver forces in the 21st century.

When integrated as a team of multiple Apaches, Apache Longbow, or Kiowa Warriors in a combined arms setting, the force becomes dominant on the battle space in ways and via means far in excess of the simple combination of the force's members and numbers. This team is capable of multiple sensing, collaborative planning, designating, handing-off, and engaging diverse, dynamic targets in a manner unparalleled in warfare. These teams not only fight with on-board weaponry but also can digitally direct remote fires and work with ground maneuver forces as a real-time member of the combined arms team.

Objective Force Warrior is the dismounted soldier application of this concept, integrating the capabilities of Objective Force Warrior across the battle space. Objective Force Warrior's power will expand the concept of collaboration, agility and lethality

by synchronously integrating and employing multiple components of the Future Combat Systems. Clearly, the Objective Force Warrior can operate in an infinite variety of settings and scenarios, bringing all the dominance and synergy of future systems to the full spectrum of future operations.



Slide 5

Slide 5 is a graphic depiction of the Objective Force Warrior concept. In the top left of the slide are the seven core capabilities of Objective Force Warrior: collaboration, lethality, agility, synergy, communications, stealth, and survivability.

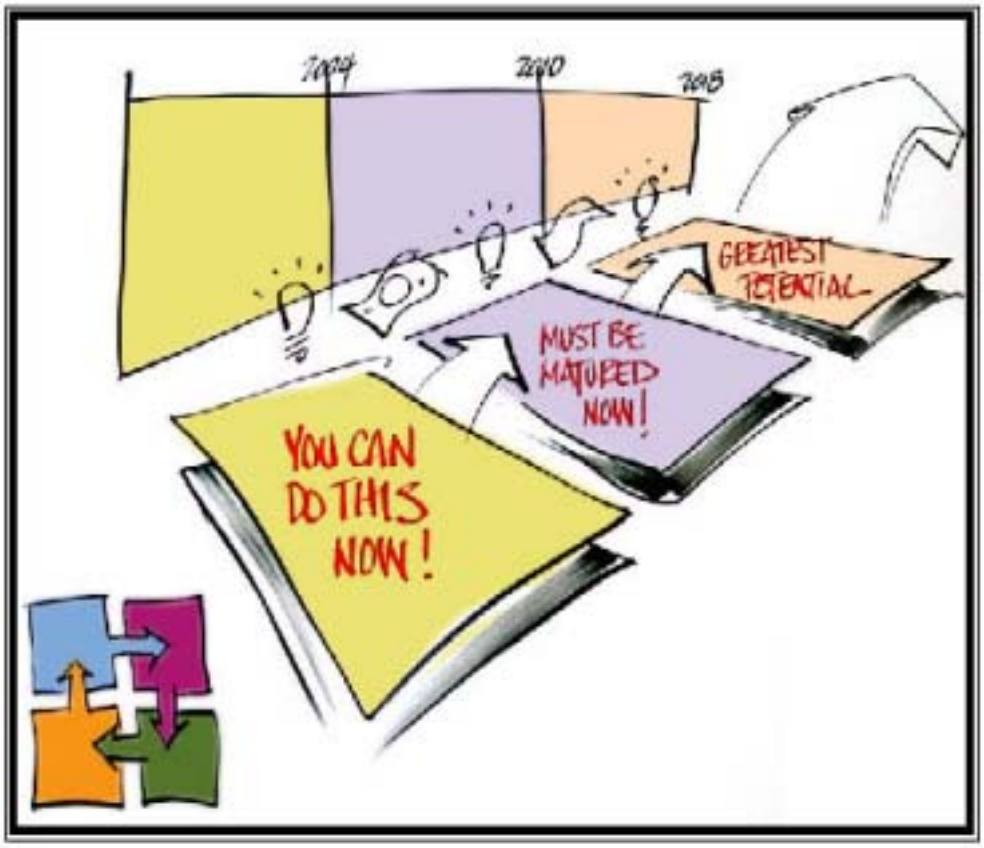
Collaboration means the ability to know the locations of all friendly forces, pass relevant combat information at the right time to the required level, and apply the correct fires to the right targets. Lethality comes in two parts. The first part is arming the Objective Force Warrior with individual and crew served weapons that overmatch anything on the battlefield. The second part is the ability of the Objective Force Warrior to apply the weapons systems of Future Combat System and air power at the time and place of decision.

Objective Force Warrior "Another Look" - Panel Three Vision

The Objective Force Warrior and unit of action must have the agility required to operate within the enemy's decision cycle. Synergy and Communications are inexorably linked to enable the Objective Force Warrior and the unit of action to have reliable, secure and long-range communications capability to prosecute all actions in total coordination.

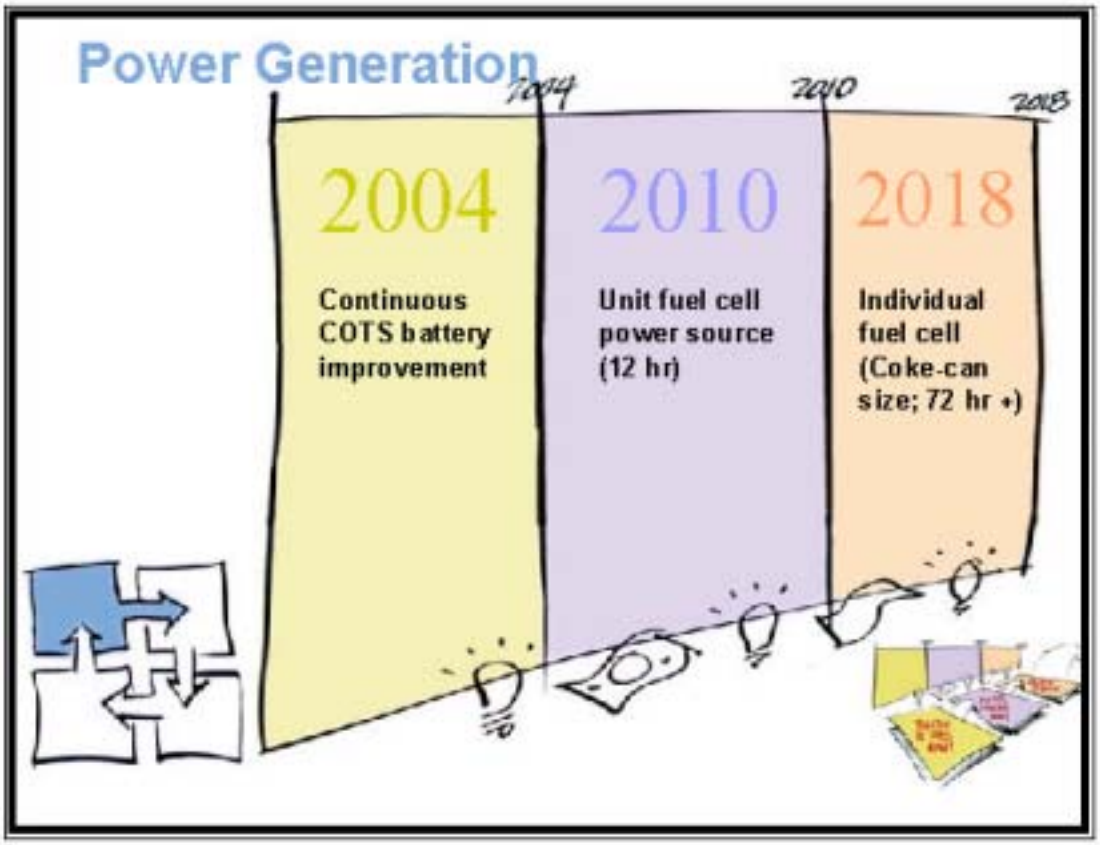
The Objective Force Warrior must be stealthy and survivable on tomorrow's battlefield. We must make him invisible in the thermal and infrared spectrum as well as endeavor to have adaptable camouflage. Survivability must include chemical, biological, and ballistic protection.

The lower left portion of the slide represents the four technology areas that this concept embraces: situational understanding, weapons, power generation, and individual protective equipment. The remainder of the slide shows the Objective Force Warrior and his linkage to the unit of action and the Future Combat System.



Slide 6

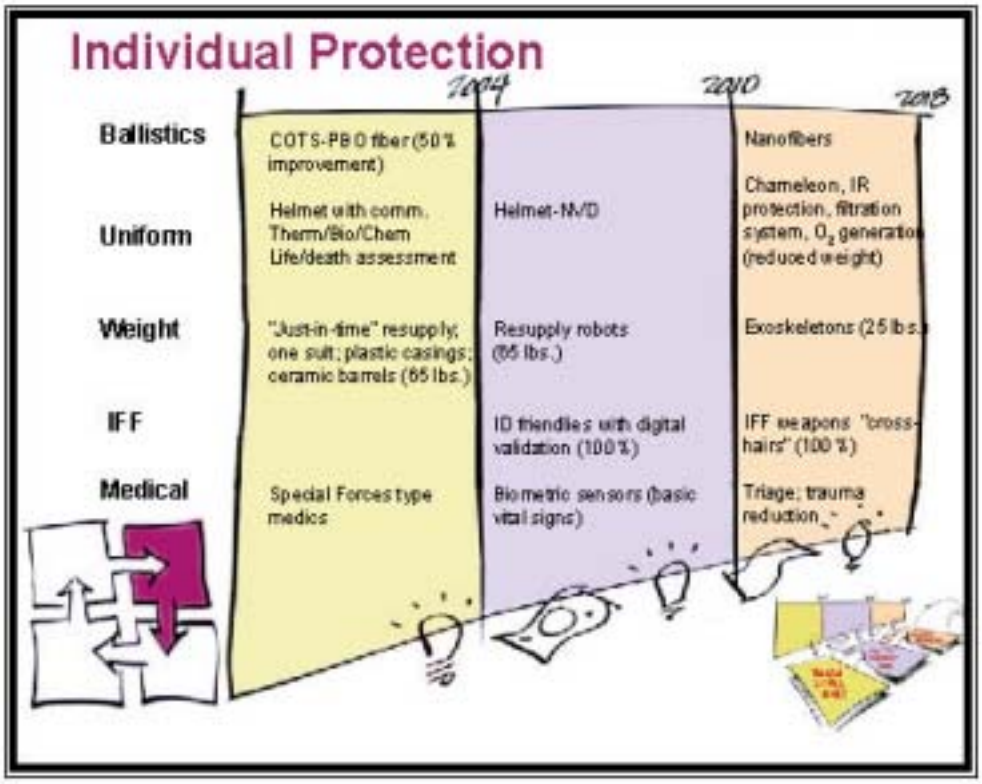
Objective Force Warrior "Another Look" - Panel Three Vision



Slide 7

In order to reduce weight and to provide the required power, the Army must move from batteries to fuel cells. Fuel cell power is the best "leap ahead" for power generation. Investing in deployment now can provide a unit fuel cell capable of "recharging" and/or "resupplying" electrical power no later than 2010. Continued development will provide individual fuel cells for the individual needs of the dismounted warrior that are small (soda-can size), lightweight, and operate for 72 hrs or longer. This capability could be available by no later than 2018.

Objective Force Warrior "Another Look" - Panel Three Vision



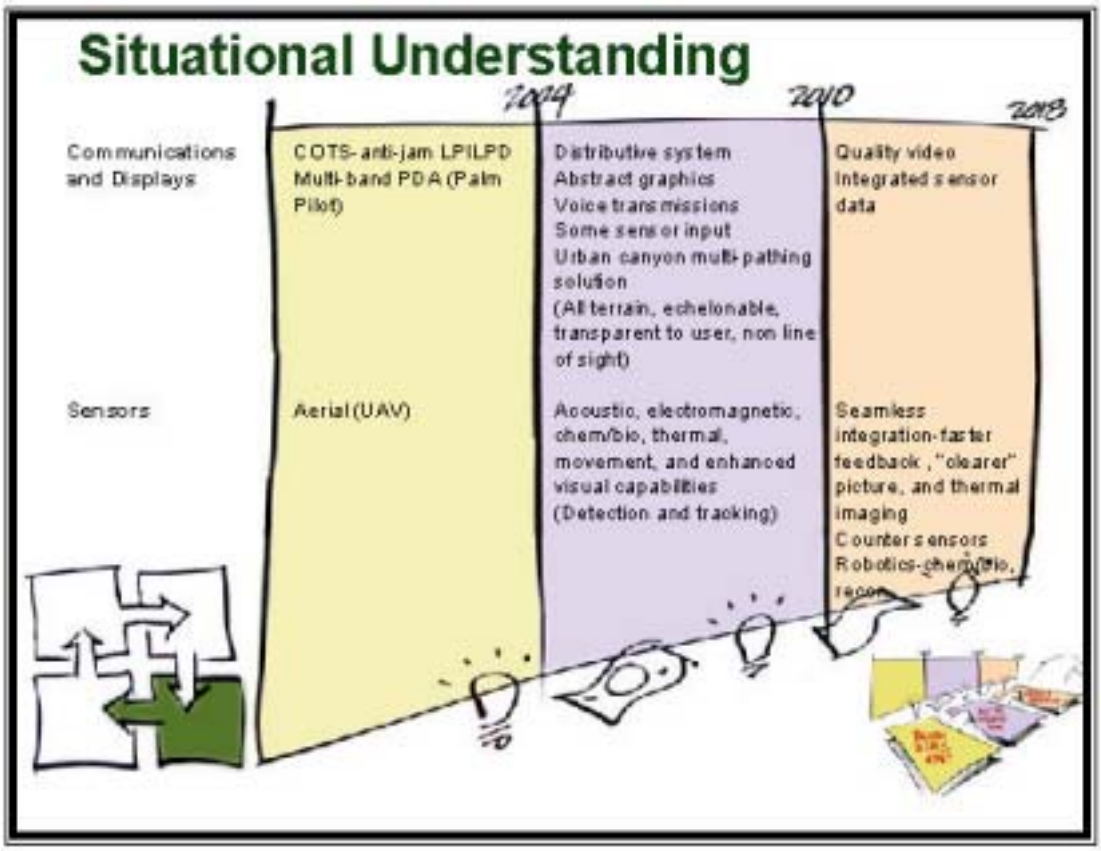
Slide 8

Rapid movement and agility are critical to the effectiveness of the Objective Force Warrior, but, presently, the fighter is burdened with too much weight. Reducing this weight by 25% by 2004 is likely attainable, with 50% reduction possible with aggressive redesign of equipment and reconceptualization of what the warfighter needs to carry and why. Some examples include the following:

- Rapid, reliable, "just-in-time" resupply can reduce the load of consumables.
- Changing to plastic case or caseless ammunition can reduce ammunition weight near-term. Far-term use of directed energy weapons could also reduce weight.
- Ballistic protection and thermal control might be integrated into the suit incorporating nanotube fibers by the year 2018.
- The multitude of batteries will be replaced with better performance (fuel cells or isotopic power).
- Immediate transition to plastic casings and ceramic barrels would reduce weight without adversely affecting performance.

Robotics can make weight almost irrelevant if employed as a powered "exoskeleton."

Objective Force Warrior "Another Look" - Panel Three Vision

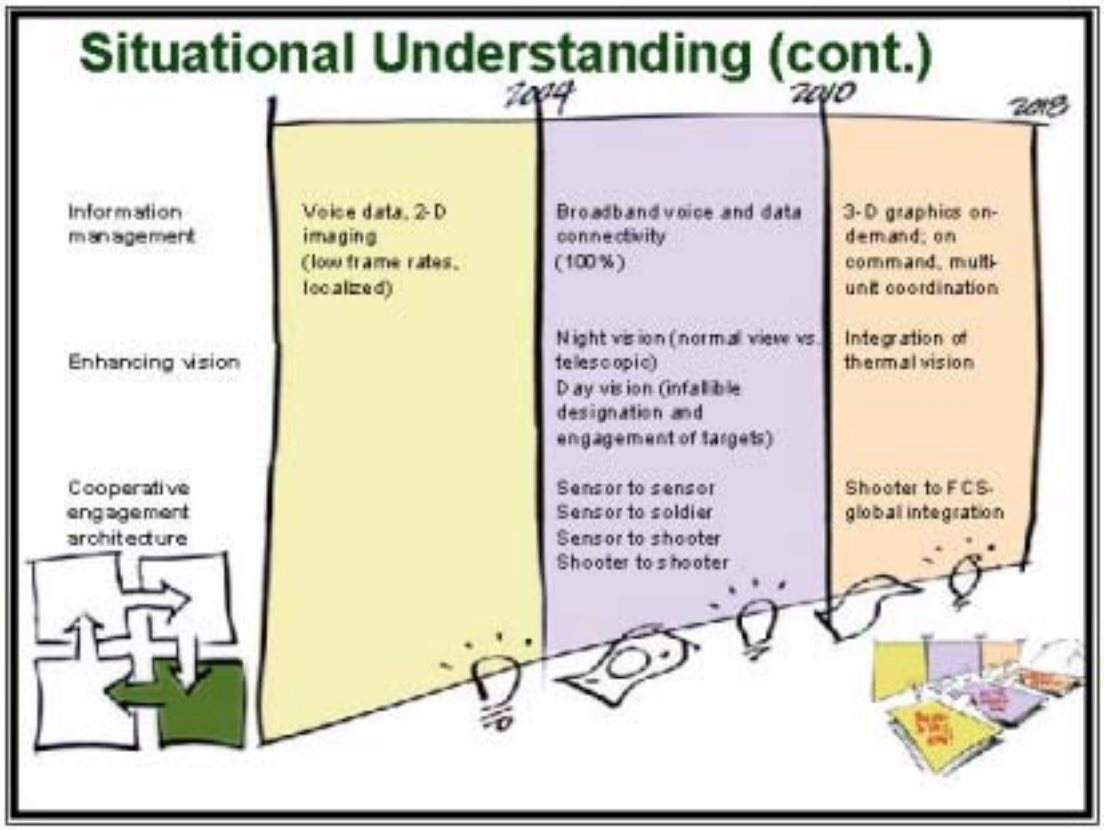


Slide 9

Situational understanding is an essential component for making the Objective Force Warrior dominant on the battlefield.

The next two slides discuss technological improvements for 2004 and 2010. In the 2004 timeframe, we can provide Commercial Off-the-Shelf, anti-jam, low probability of intercept and detection communications systems. Combined with a multi-band Personal Digital Assistant (PDA) type device, we can go a long way now to provide near-real time situational understanding of the battlefield. For the Objective Force Warrior, we can improve to non-line-of-sight communications using mobile ad hoc networks that move voice, data, and video. Regarding sensors, the Objective Force Warrior should have at his disposal a suite of sensors for detection, tracking, and targeting.

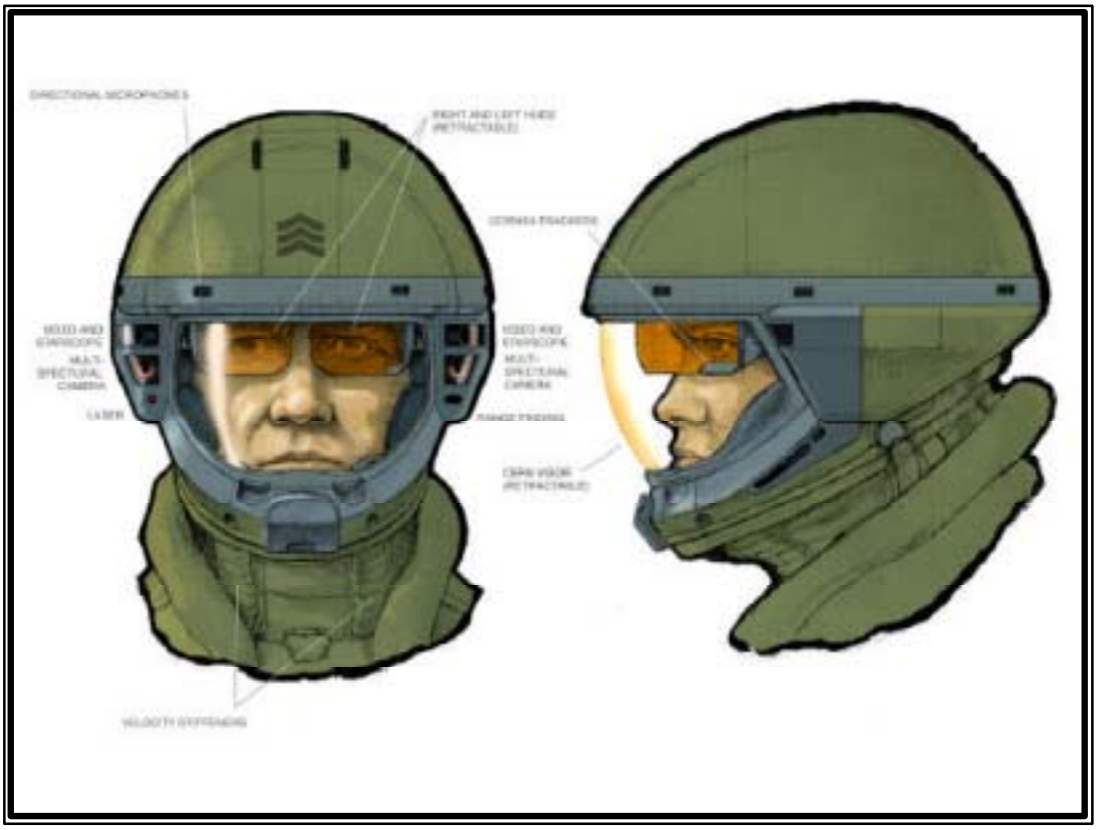
Objective Force Warrior "Another Look" - Panel Three Vision



Slide 10

In the areas of information management, enhancing vision, and cooperative engagement, there is little where technology can help in the short term. For Objective Force Warrior, we should be able to create broadband voice and data connectivity and enhance our ability to see multi-spectrally. Sensor advancements should be phenomenal. The next two slides represent concepts for the helmet and the heads-up display that should be the objective for Future Warrior.

Objective Force Warrior "Another Look" - Panel Three Vision

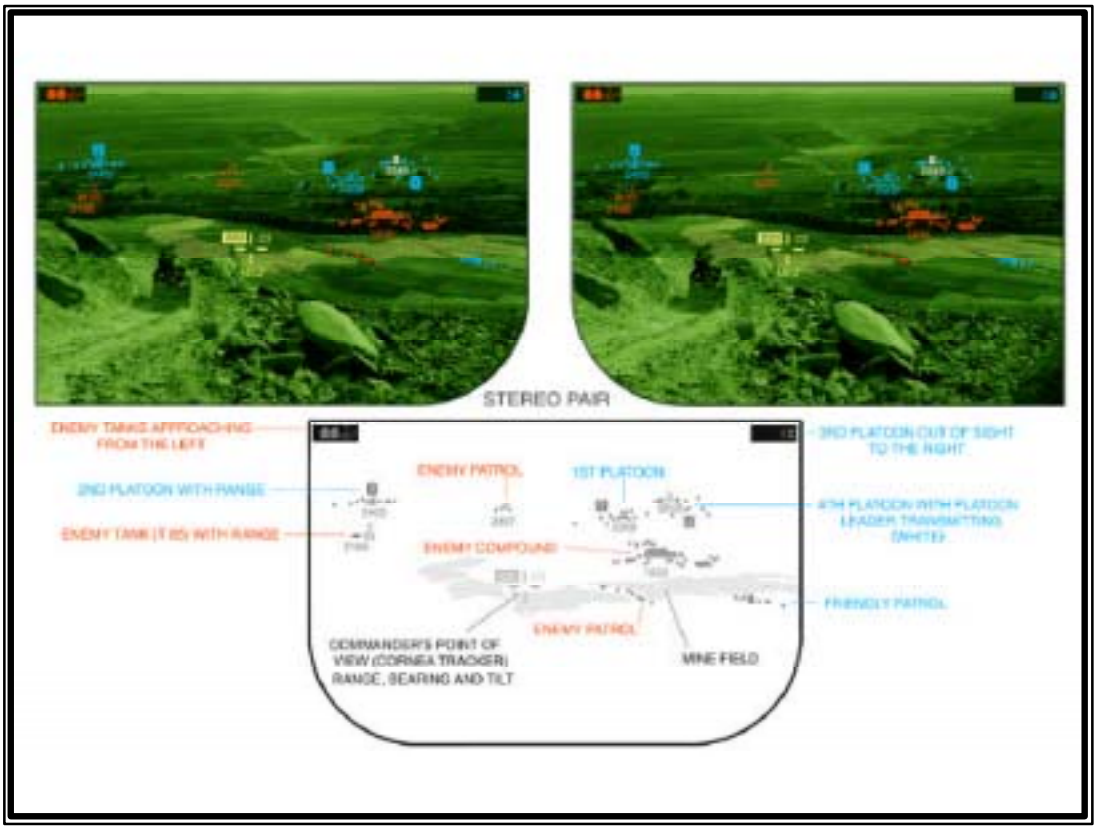


Slide 11

This represents a concept for how the Future Warrior helmet might look. This integrated, sealed helmet would contain communications, vision enhancements, laser for target ranging and designation as well as a heads-up display, shown on the next slide.

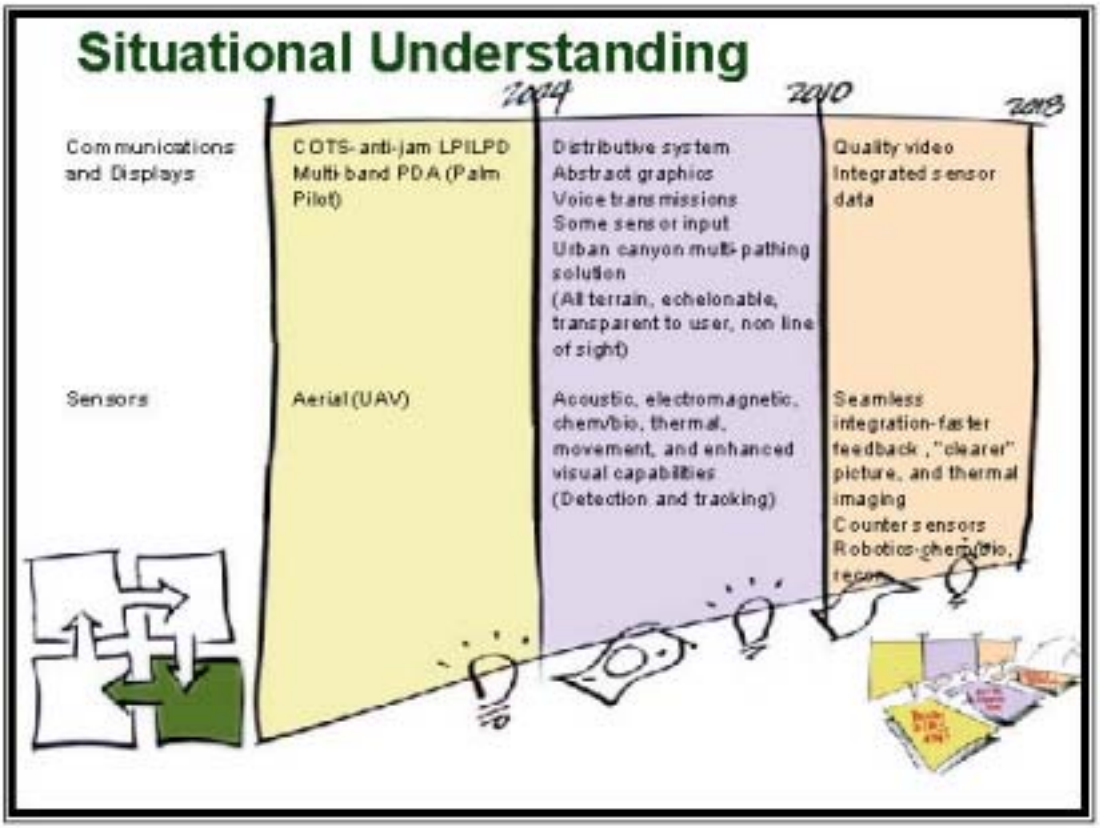
Objective Force Warrior "Another Look" - Panel Three Vision

This is an example of the information that could be displayed in a heads-up display. When coupled with the individual weapon or the systems of the Future Combat System of Systems, the Objective Force Warrior could have 100% hit capability and with state-of-the-art weapons systems – 100% kill.



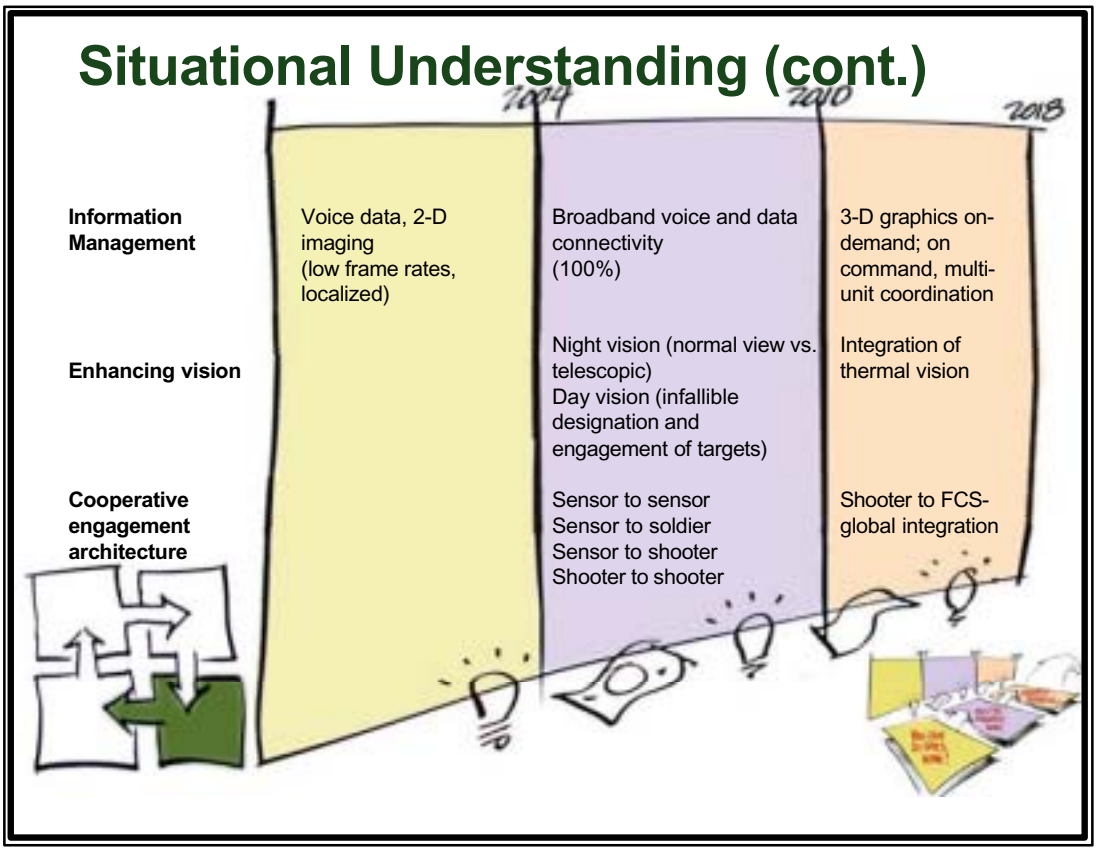
Slide 11

Objective Force Warrior "Another Look" - Panel Three Vision



Slide 13

For Future Warrior, there should be quality video and completely integrated suite of sensors as well as the integration of data from robots.



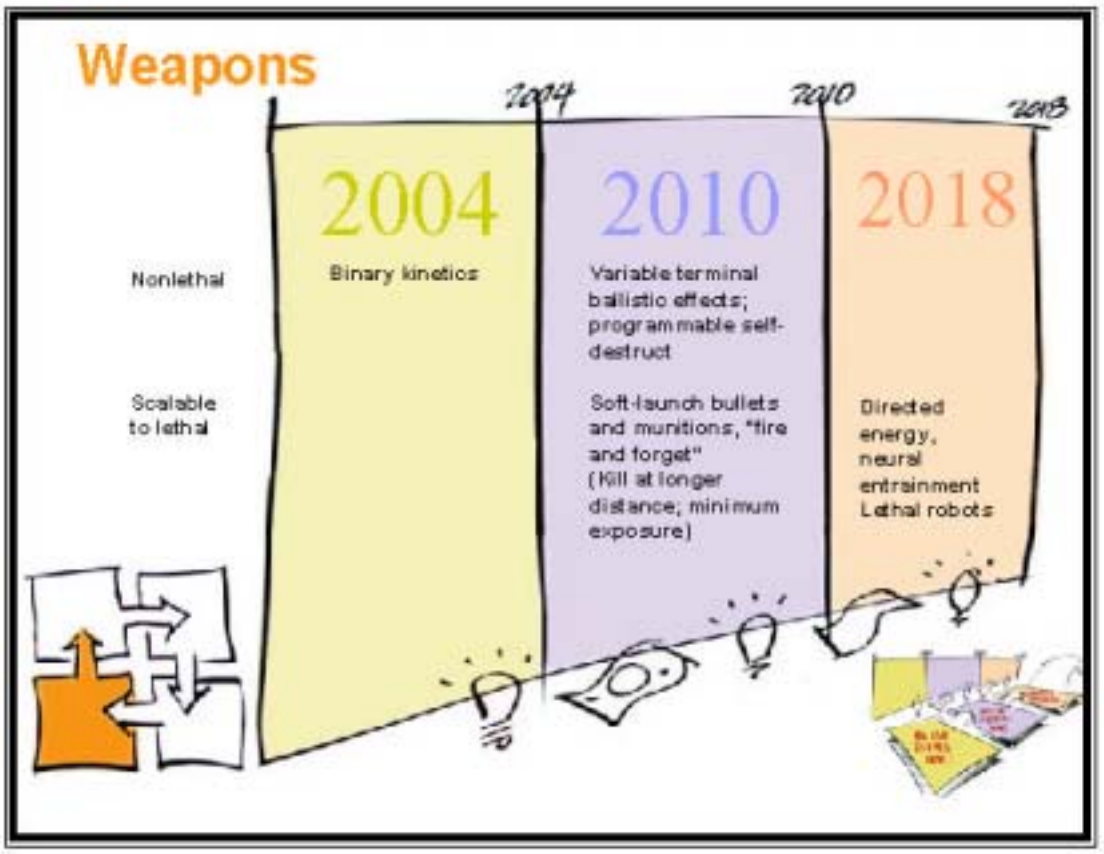
Slide 13

These capabilities will provide for revolutionary levels of tailored information/knowledge to be available to the Objective Force Warrior and the unit of action. This information can be delivered at the right time and in a manner that limits distractions. This approach also allows vital mission rehearsal when productive.

Communications – A ubiquitous communications capability is not currently available. This leap-ahead ability must support an overarching omnipresence system capable of maintaining all activity in the Area of Responsibility. The soldier is able to request any information from the system. The system will provide input if it views the individual or unit as intercepted. This allows the unit to act as one or combine firepower with the Future Combat System.

Identification Friend or Foe (IFF) – The capability of the communications network will ensure IFF. It is the goal to obtain 100% infallible fraternal identification within the Objective Force Warrior's immediate battle space by 2004.

Objective Force Warrior "Another Look" - Panel Three Vision

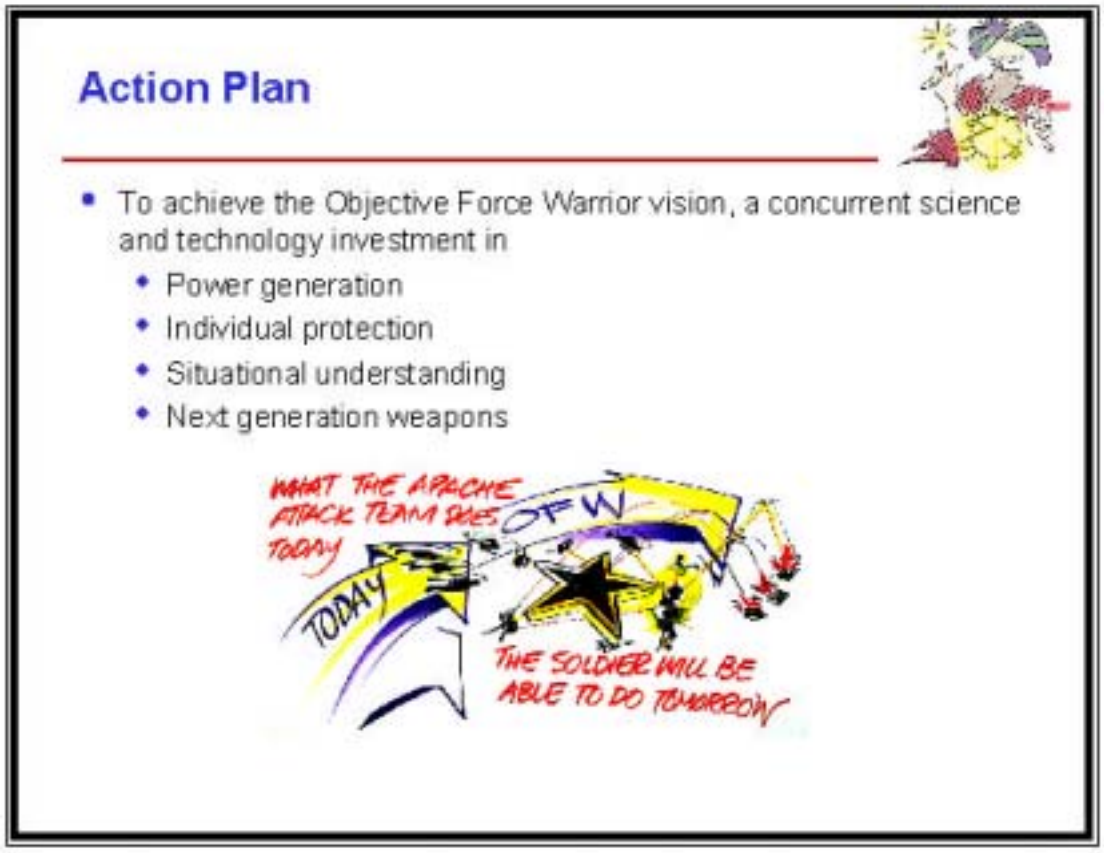


Slide 15

Development efforts should begin immediately toward soft-launch bullets and munitions to be delivered by no later than 2010. The development of directed energy munitions and neural entrainment "weapons" should be continued with fielding objective no later than 2018.

Research and Development investment in variable thrust cartridges, binary projectiles with controlled terminal effects, and programmable self-destruct ammunition must be initiated to provide operationally specific utility by 2010.

Expanded investment in directed energy will provide new generations of weapons beginning in 2018.



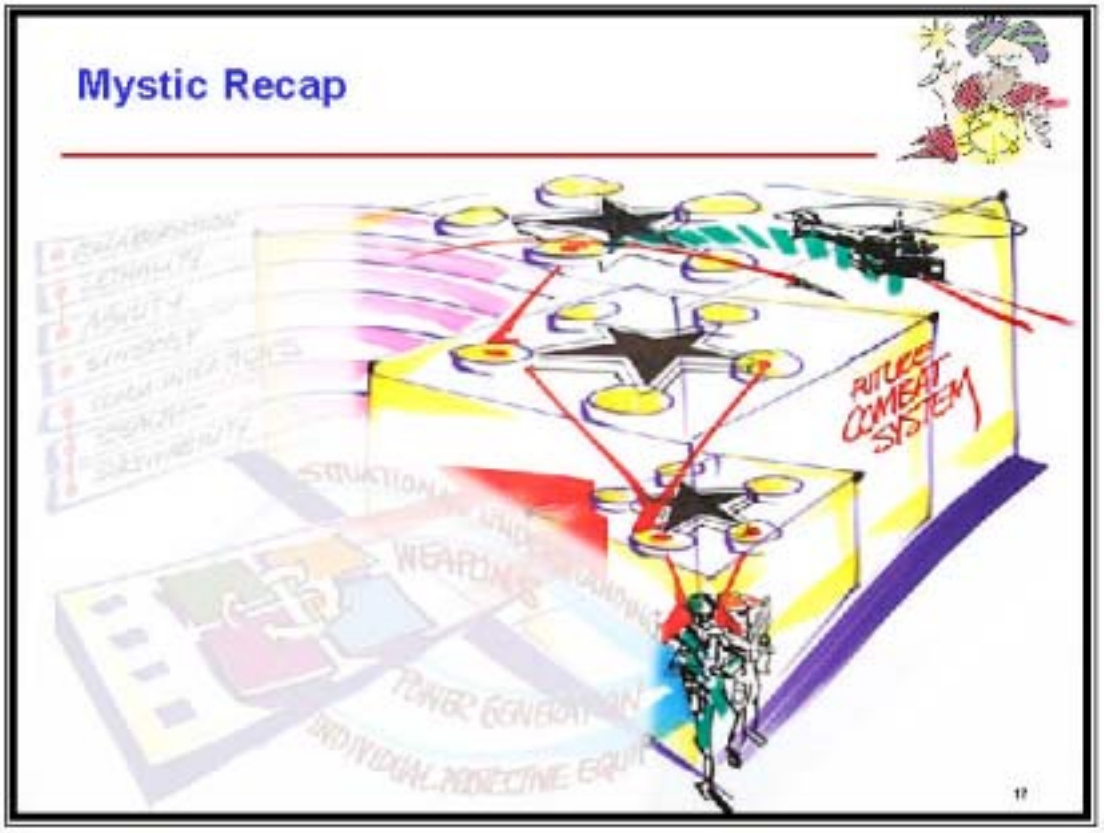
Slide 16

Our recommended Action Plan focuses on these four technology areas. In order to meet the power requirements of Objective Force Warrior and Future Warrior, we must develop fuel cells because batteries are too heavy and not capable of generating the required wattage.

Development of a soldier suit that provides thermal management and chemical/biological protection must be a high priority in the near to mid term.

Development of nanotube fibers for ballistic protection should be a focus for the long term. The most important capability area is in situational understanding and the systems that would make this a reality. Lastly, we must move from kinetic energy weapons to directed-energy weapons.

Objective Force Warrior "Another Look" - Panel Three Vision



Slide 16

In summary, the Objective Force Warrior represents an overmatch in capability on the battlefield or in the urban environment. The Objective Force Warrior fights as part of a unit of action that is the sum of its component parts and is able to leverage the components and capabilities of the Future Combat Systems of Systems in real time.

Objective Force Warrior "Another Look" - Panel Three Vision

Slide 18

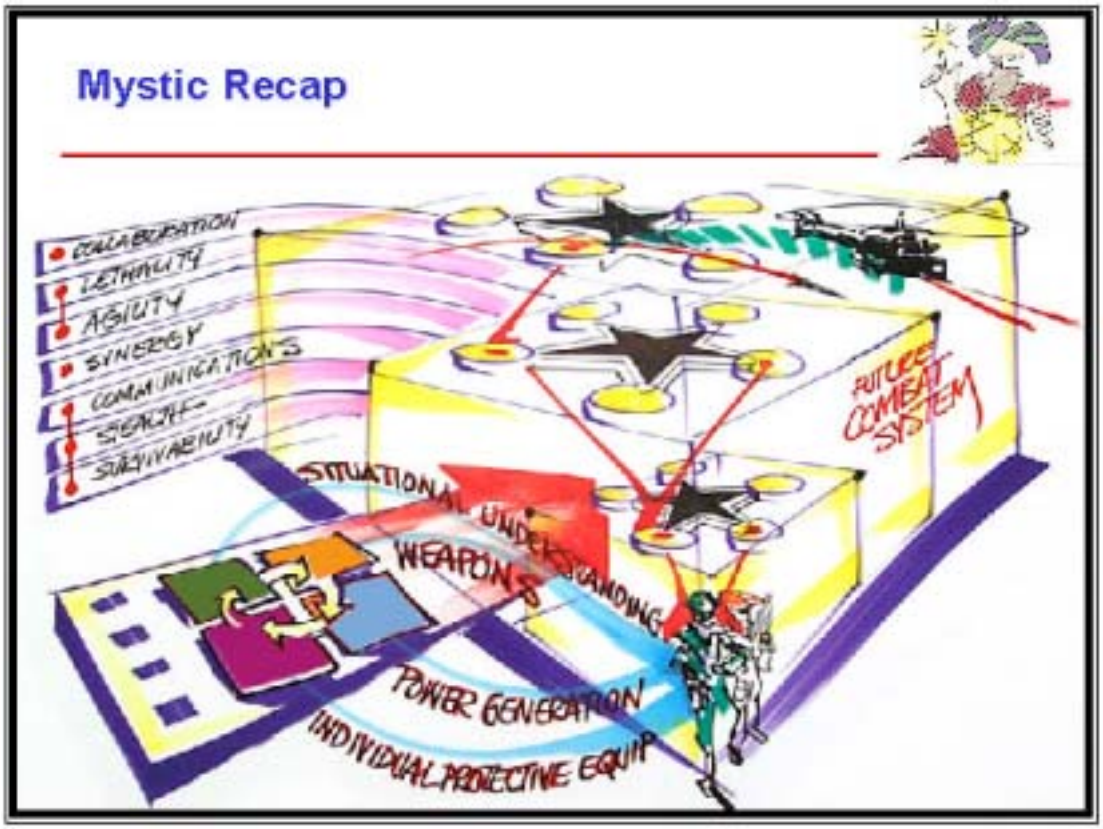
These seven capability areas are the foundation upon which the Objective Force Warrior is built. No single area represents a leap ahead in capability but the seven working in concert produces the most lethal dismounted soldier in the world.

Objective Force Warrior "Another Look" - Panel Three Vision

Slide 19

These are the four technology areas that research, development and acquisition programs can be applied against to produce the biggest payoff in capability for the Objective Force Warrior.

Objective Force Warrior "Another Look" - Panel Three Vision



Slide 20

The Objective Force Warrior concept discussed in the presentation applies the same overmatch principles used by the Navy in the development of its combatant vessels and aircraft technology, the Air Force in its development of the F22 and Joint Strike Fighter, and by the Army in its land maneuver dominance via the Abrams, the Bradley, and the Apache Longbow.

The Objective Force Warrior and Future Warrior dominate the dismounted battle space, using technology to overmatch their potential opponents. Objective Force Warrior and Future Warrior will collaborate with any echelon of the force and be lethal as an individual and as part of the Future Combat System. These warriors will have the agility to operate within the enemy's decision cycle, have synergy of effort through seamless, robust, secure communications, and be nearly invisible and extremely survivable.

Vision

The Objective Force Warrior is a warfighter in a unit of action whose aggregate capability far exceeds the sum of the individual soldiers' ability to fight and survive. This dismounted warrior represents a system of resources whose value is multiplied by a capability to perform duties across the full spectrum of military operations.

In the Objective Force Warrior, technology and training are combined to create a soldier-centric platform that embodies 21st century expectations compatible with and maximizing the emerging FCSS.

Individually, the Objective Force Warrior dominates opponents with respect to the seven primary capability areas. As a unit, the Objective Force Warrior unit of action represents an overmatch to opposing forces through its overpowering ability to

- Collaborate among individuals and among units
- Develop and maintain unit focus and synergy that dominates the battle space
- Perform with astonishing precision, agility, and speed
- Adapt tactics and procedures to circumstances through ubiquitous knowledge acquisition and communications

Metrics

- **Power Generation**
  - 2004: COTS Battery Improvement
  - 2010: 12 hr Fuel Cell
  - 2018: 72 hr Fuel Cell
- **Individual Protection**
  - Ballistic Protection
    - 2004: COTS PBO Fiber; 50% improvement
  - Uniform
    - 2004: Integrated chem./bio/thermal mgmt in one suit
    - 2018: Chem/bio, no Thermal/IR signature, chameleon

- Weight
  - 2004: Load reduced to 65 lbs
  - 2010: Weight reduced by use of resupply robot
  - 2018: Weight reduced to 25 lbs (use of exoskeletons)
- Identification Friend or Foe (IFF)
  - 2010: 100% identification of friendly forces
  - 2018: IFF integrated into weapons sights with 100% accuracy
- Medical
  - 2004: Train Army medics to Special Forces "standard"
  - 2010: Biometric sensors in suit for basic vital signs
  - 2018: Full sensing of vital signs, basic triage, and trauma reduction in suit

- **Situational Understanding**
  - Communications and Displays
    - 2004:
      - Commercial Off-the-Shelf anti-jam Low Probability of Intercept (LPI) Low Probability of Detection (LPD) Communications
      - Multi-band Personal Digital Assistant (PDA) for information
    - 2010:
      - Distributed, NLOS, multi-path
      - Abstract graphics
      - Integrated Helmet w/ display
      - Helmet with like-HUD
      - Day/multi-spectral vision enhancement
      - Quality video
  - Sensors
    - 2010:
      - Integrated sensor architecture
      - Acoustic, electromagnetic, Chem/bio, thermal, visual

  - 2018:
    - Seamless, integrated architecture
    - Counter sensors

- **Information Management**
  - 2004: Two dimensional imaging
  - 2010: 100% voice and data connectivity
  - 2018: Three dimensional graphics, multi-unit collaboration

- **Enhanced Vision**
  - 2010:
    - Day/Night enhancement
    - 100% target designation
  - 2018:
    - Full multi-spectral capabilities

- **Cooperative Engagement Architecture:**
  - 2010:
    - Sensor to sensor
    - Sensor to soldier
    - Sensor to shooter
    - Shooter to shooter
  - 2018:
    - Shooter to FCS

- **Weapons**
  - 2010:
    - Variable lethality
    - "Fire and forget" munitions
  - 2018:
    - Directed energy
    - Neural entrainment
    - Lethal robotics

Key Components

- Collaboration
- Lethality
- Agility
- Synergy
- Communications
- Stealth
- Survivability

Enabling Technologies
(Priority)

- Situational Understanding
- Individual Protective Equipment
- Weapons
- Power Generation

Breakthrough Technologies for 2018

- Individual Fuel Cell with 72-hour capability
- Nanotechnology for material development
- Exoskeletons
- Development of soldier suit and integrated helmet
- Multi-path, NLOS, broadband, distributed communications architecture
- Semi-autonomous sensor and lethal robotics
- Directed energy weapons – both lethal and non-lethal

Recommendations

Focus research, development, and acquisition efforts on

(1) Situational Understanding

(2) Weapons,

(3) Power Generation

(4) Individual Protective Equipment.

Other Issues

The Army acquisition cycle is too cumbersome; "Moore's Law" means the Army will always field outdated technology unless changes are made.

C^4ISR architecture that overreaches Objective Force Warrior and Future Warrior and the Future Combat System of Systems requires much work to ensure total integration.

Summary

October 30, 2007

Dear Mom & Dad,

Yesterday I finished my last technical school and was fitted for my new uniform. It's an OFW mark 3, that's Army lingo for an Objective Force Warrior Battle Dress, third version. They won't let me send you a picture of it for some security reasons, but I can tell you what it looks like and the many things it does. I know you were hurt when I joined the Army, especially after you told me about my great uncle Jack who died on the beach at Normandy, and my uncle Fred who died in a rice paddy in Vietnam, and my older brother Bill who was injured in Afghanistan. But they didn't have technology working for them like I do. I understand the risks I'm taking, a soldier is supposed to get in harm's way, and many soldiers will still be injured and killed protecting our freedoms. But with the OFW Mark 3, I will have lots of advantages that Jack, Fred, and Bill didn't have.

My suit has the ability to stop a rifle bullet. It is made of a material that is as flexible as my football jersey, but gets hard as steel when a bullet or knife is pushed into it. The material has some kind of chemical in it that lets fresh air pass through it, but stops and destroys chemical warfare agents. The material is also filled with some kind of foam that cools me on hot days and warms me on cold nights. If I do get injured the suit automatically inflates over the wound, stopping the bleeding and applying medicine to the injury until our medic can come help me.

The medicine and medical care provided by the medic is part of the OFM Mark 3 too. It somehow measures my health and notifies my squad leader when I need to take a rest or get a drink. Remember when I got all those muscle cramps in the 3rd quarter or each football game? That doesn't happen now because the suit and my leaders look out for my electrolytes.

Remember how you used to tell me that playing all those video games wouldn't get me anywhere in life? You have to see my helmet to believe it, it's like an IMAX movie right before my eyes. All I have to do is whisper "show me my battery reserves" and a little gas gauge is projected in front of me and I can see that my power pack has 2 more days of energy in it. I can ask how much ammo I have and the number of rounds I projected on my vision. If I see the enemy my visor tells me how far away the

target is and the probability that my first shot will kill him. There are special modules that I plug into the side of my helmet that gives me other capabilities. A laser can shine on the enemy and if he has chemical weapons protective clothes on he shows up in my visor with a green glow around him. Remember the depression Bill had when he had to kill the women in Afghanistan because they all looked alike, but under their long dresses and hoods they had RPGs? Well, mistakes like that can still happen, but my visor outlines anyone who has gun cleaning oil or CWM clothing on and it gives me a chance to sort out the refugees from the terrorists. If Bill had this technology, he would know if those women were terrorists or friendlies in the wrong place.

When Bill was faced with danger he didn't have any options, he had to shoot to kill and he had to shoot a bunch of rounds because with little time to aim he had to just cover the vicinity with lead. My OFW Mark 3 rifle has steerable bullets which means any target I look at I hit the first time, even if it's moving. And, I have the option of using nonlethal bullets. I just ask my helmet, "What is the probability that the person in my sights wants to kill me?" The battle computer compares the images from the video, laser, microwave and acoustic sensors and recommends the safest action for me. Some of the microwave sensors on my helmet can see guns and knives under someone's clothes, and the laser can measure the gun cleaning fluids and gunpowder that gets on your clothes when you shoot a gun. If these are present, my visor recommends that a lethal round be chambered. If I Say "Yes" my rifle is loaded and the target range and velocity is downloaded into the bullet.

Remember the GPS unit I used in Boy Scouts? My OFW Mark 3 has a much better one built in. The GPS doesn't have the same accuracy as the locator on my mark 3 because it locates you by triangulating 3 satellites. We still use the GPS when we first get to the battle zone, but very quickly our UAVs (that is a little model airplane that flies over us) takes a special multispectral picture of the earth and continually updates the battle computer. The computer can see exactly where I am when I'm outside and can sense my IFF transponder when I'm under a tree or in a building. I can talk to the soldiers running the battle computer, and they can tell me what they are seeing from the sky and the other sensors we drop into the city or fields. The location of all of the people is displayed on my visor. In the city, it looks confusing, but with my training and practice I've been able to stay focused on finding the potential evil doers.

Objective Force Warrior "Another Look" - Panel Three Vision

Most important to me is to know where I am and where my buddies are. All I have to do is ask "Where am I?" and immediately a map of the area is visible on my visor, and I can see a green dot where I am. I can ask, "Where is my squad leader?" A leader symbol blinks on my visor. Or, I can ask "Where is the medic?" A little red cross lights up on the map where he is. If I say "take me to him," the helmet tells me how to get to him, just like the navigation feature on Dad's car, the one that tells him where to turn to get to the next gas station or hotel. If I start to get lost on the way to the medic, the helmet gives me new instructions. If I keep getting lost the helmet tells me to stop, and somehow the medic is alerted to come to me! His visor shows my location and his helmet tells him where to go. This is real handy when it's a dark night, or we are using smoke to conceal our location and strength.

My helmet has night vision enhancement, on a totally dark night I can see by star light just as well as if it was mid-day. The infrared detector makes the animals and people and machines all show up as white outlines because they give off heat. It's like the heads up display on Dad's car, except I can look at anything and ask my helmet "What is this thing?" and the battle computer will display what the image most likely is. It can actually tell me, in total darkness if it is a Toyota pickup truck or a Ford F-150. This could be important information if our spies have told us that the terrorists have been seen in a Toyota pickup, and the nuns drive an old F-150.

I have lots of neat gizmos in my backpack, and on my mechanical mule that carries my extra food, water, bullets, fuel and sleeping bag. Whenever I get low on food, water, and fuel for my fuel cell that generates my suit's power, I just check off the items I need on my palm pilot. Sometime during the night, a robotic resupply airplane precisely drops supplies to our unit. This has been a real improvement to my life because I don't have to carry everything I need on my back. They tell me that before this resupply system was perfected, soldiers had to carry over 100 pounds of gear! I have a tiny remote control airplane that flies silently and looks down on the land around me. It's really smart, it flies a pattern about 1000 feet in front of me and if it sees something move, or give off heat it asks me if I want to see. If I say yes, a map of the area ahead of me is visible on my visor with symbols of what the airplane sees. I can switch to video and actually see what's ahead of me. If the enemy is too far away from me to have a good chance to hit with my first shot, my helmet will instruct the airplane to illuminate the target with a laser. My rifle is automatically

loaded with a high velocity laser guided round and just like magic my first shot is a kill. Tsgt Smith has the long distance record for our unit, he hit a target on a dark night on our practice range with his UAV (that's what we call the little airplane) at 1 ¼ miles.

Next year they will issue me an OFW Mark 4. It's supposed to have some mechanical assist machine built in that will let me jump 7 feet up, run at 20 mph and carry over 200 pounds of equipment. It will be an improvement because as nifty as the Mark 3 is, it is a little cumbersome, and it's impossible to lift a wounded soldier because he weighs too much in the Mark 3. The Mark 4 will have a better fuel cell power pack, making more electricity and weighing less. The suit is supposed to have some elementary camouflage capability. I saw one in Tech School. The suit looks behind you and then changes the fabric colors on your front side to look like what's behind you. From a distance if you don't move, you really disappear into the weeds. It's like the rope oversuits the snipers wear, up close looks like a person in a rope suit, but at 50 yards you totally miss the sniper and only see the leaves and weeds. The camouflage suit takes a lot of power which is why it isn't on my Mark 3, my power unit is too small. The new OFW Mark 4 also sends and receives battle information to the officers who are watching the battle and changing the strategy. The Mark 4 also has special "TAGS" on it so the artillery guys won't target us—if the incoming round sees our TAG, it won't arm itself. This should reduce the number of "friendly fire" accidents we used to have! I've heard that the Mark 4 can also support the new directed energy weapons that fire laser bursts and microwaves to disable or kill the enemy. It's sort of like a Star Trek phaser on "stun;" it makes your brain stop working. The new directed energy weapons make it possible to engage the enemy further away with more accuracy.

Well, I have to go to dinner now. We get special meals for several days before a mission so we will have the stamina to wear the Mark 3 for 2 or 3 days straight. I'll call when I get back from wherever we're going.

Give my love to my sister and grandma.

Love,

Bob

Objective Force Warrior “Another Look” - Panel Three Vision

Introduction

The vast majority of Panel Four, the U.S. Army Panel, are, or have been, working the integrated system design/revolutionary capabilities for an ultra-lightweight, multi-functional, protective combat ensemble for the U.S. Army soldier. Mike Lesnick (Meridian Institute), Tim Mealey (Meridian Institute), and James Kievit (U.S. Army War College) facilitated Panel Four.

Panel Four exerted considerable effort between Session I and II on how best to structure a presentation that is innovative while intellectually delivering a clear actionable Objective Force Warrior vision. Session I provided several new perspectives; however, for this group it provided more confidence in those technological solutions on which they had already decided would probably provide the best return on investment.

GEN (R) Gorman provided the catalyst required, ensuring our components were well thought out and properly addressed. All the experienced members discussed how to be compelling, charismatic, and focused while making the vision real and actionable. The group achieved consensus after much spirited deliberation. Overall, the working effort could be termed as thoughtful, collegial, and professional.

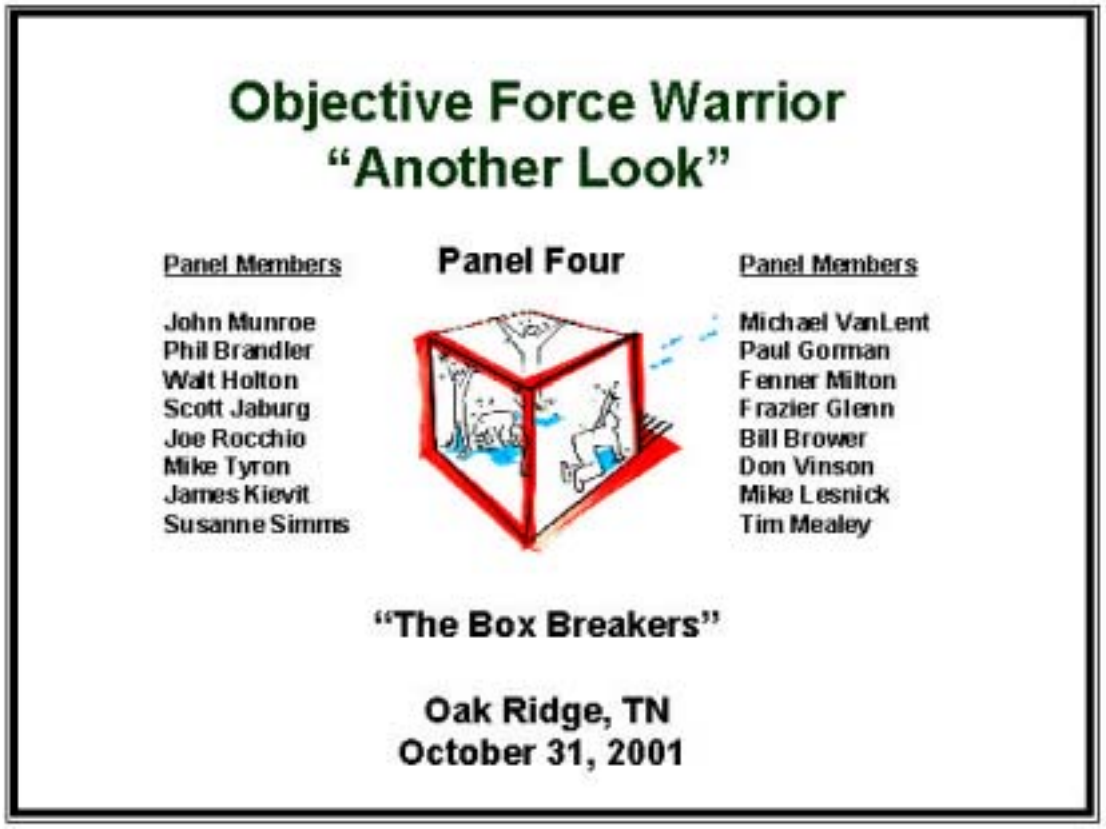
The overarching vision for Objective Force Warrior developed by Panel Four is to change the way we fight! Objective Force Warrior will be able to conduct overmatching decisive operations in all environments exploiting the power of a networked three-dimensional (3-D) force through the ability to *See First*, *Understand* and *Act First*, *Finish Decisively*, *Survive* and *Endure*. In short, Objective Force Warrior must exploit the power of the entire force!

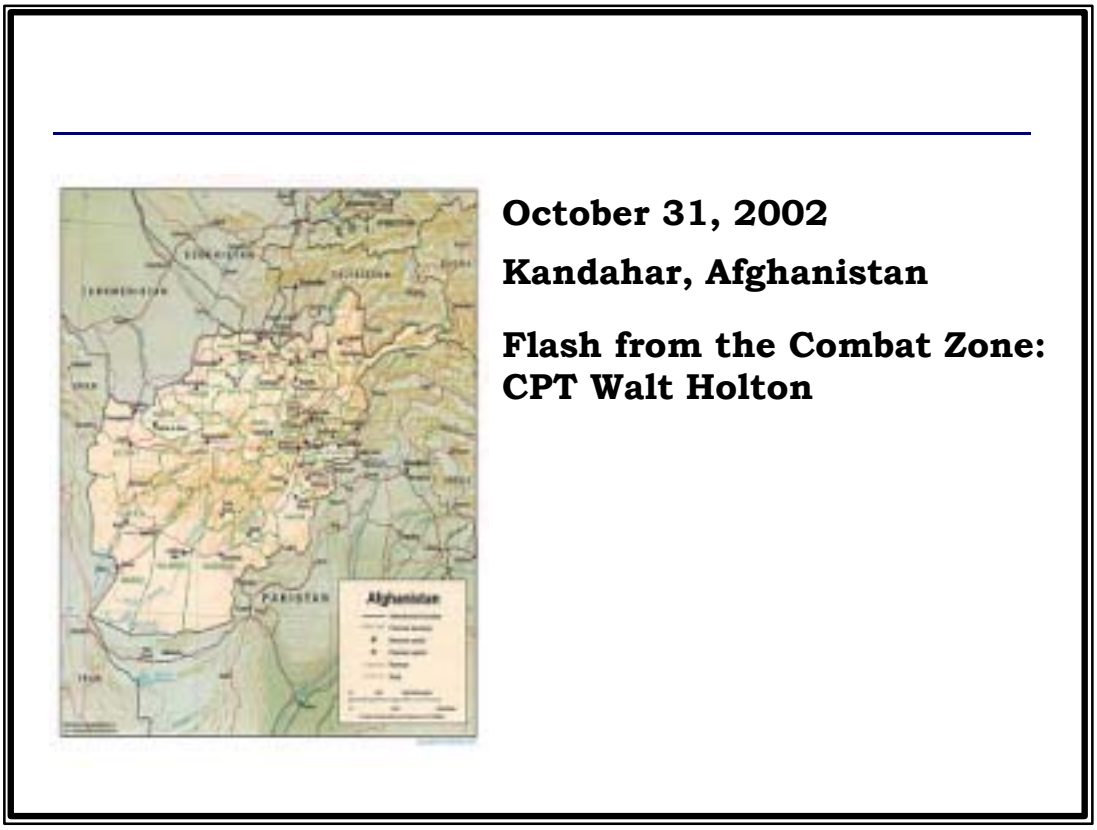
Panel Four chose these six Operational Imperatives to communicate the Objective Force Warrior vision.

- See First: Amplify and Extend the Senses
- Understand and Act First: Know, Decide And Adjust On The Move
- Finish Decisively: Overmatch and Mass Lethal and Non-lethal Effects
- Survive and Endure: Maintain High Operational Tempo
- Human Performance-Centric Design Paradigm
- Lighten Individual Burden and Reduce Weight and Cube of the Team

Panel Four Out Brief

The following PowerPoint slides were presented to Dr. Mike Andrews as the Panel Four out brief of the Objective Force Warrior “Another Look” Session Two on October 31, 2001.





Slide 3

CPT Holton delivers a telephonic situation report to TSM-Soldier with a map behind him. The year is 2002, and CPT Holton keeps his promise to provide leader feedback from the combat zone. His commentary follows:

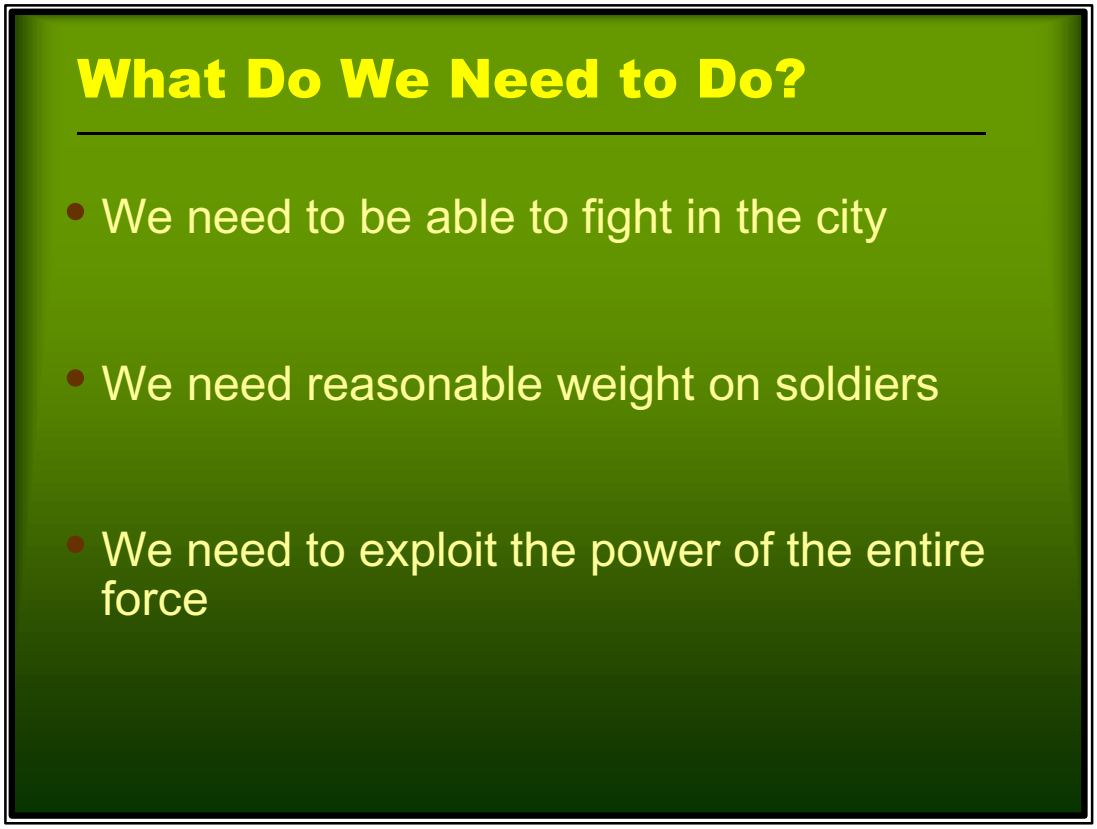
> Sir, Bottom Line Up Front. We’re having problems over here!
>
> My access to critical intelligence and other information is often untimely and disjointed because it flows through multiple levels and layers. My actions are limited due to responding to enemy attacks vice setting the conditions for success. The enemy situation is often vague because of sluggish and unsynchronized information flow. The soldier intercom radio doesn’t work in the city. Without a clear picture of our forces, the bad guy, and non-combatants within the city, I can’t maneuver my force into positions of advantage.
>
> Non-organic fire support is virtually non-responsive. I have difficulty getting clearance of fires. OPTEMPO

prevents me from maintaining a synchronized picture of friendly forces.

My soldiers look like overburdened “Christmas Trees.” Their weapons, body armor, squad equipment and distributed loads are too darn heavy and bulky. Their mobility is hampered by the bulk and weight of their equipment and the mission is at risk. It’s really frustrating to lose guys because they bled out before I can get them out of the battle area.

CPT Holton abruptly terminates his phone call with a report of unexpected contact; however, he succinctly lays out those shortcomings with the current battle uniform and the compelling need for the next generation ensemble.

To be compelling, Panel Four feels any Objective Force Warrior concept must solve these three issues!

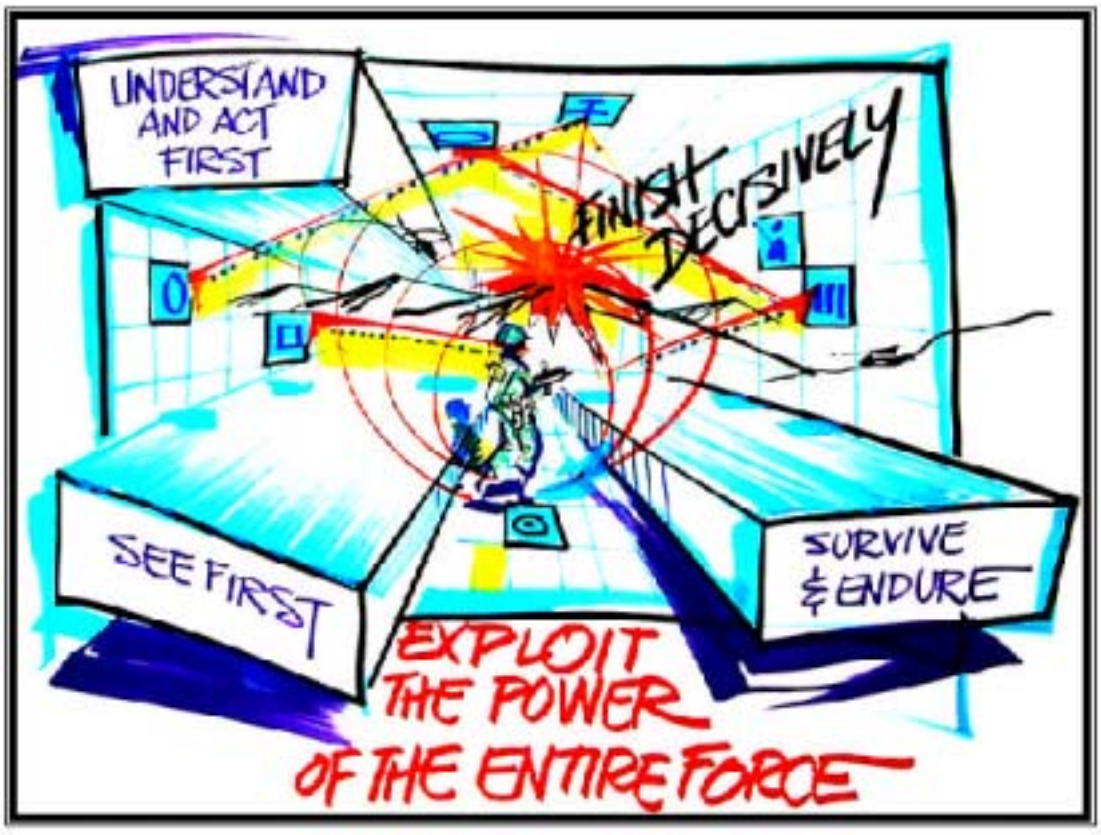


Slide 4

The growing urbanization of the world means that Objective Force Warrior must not only be able to cope with this problem but excel.

The daunting problem of almost unbearable loads for the American soldier must be eliminated. The true power is the power of one – where the Objective Force Warrior is absolutely integral to the Objective Force and is able to apply its full capabilities. The last bullet was carefully crafted as a transition accentuation on the Objective Force and all its collective qualities.

Now, What is the overarching goal of our Objective Force Warrior concept? **IT IS TO CHANGE THE WAY WE FIGHT!**



Slide 5

The Objective Force Warrior will be able to conduct overmatching decisive operations in all environments exploiting the power of a networked 3-Dimensional force through the ability to

- See First
- Understand and Act First
- Finish Decisively
- Survive and Endure

In short, our Objective Force Warrior will exploit the power of the entire force.

Slide6

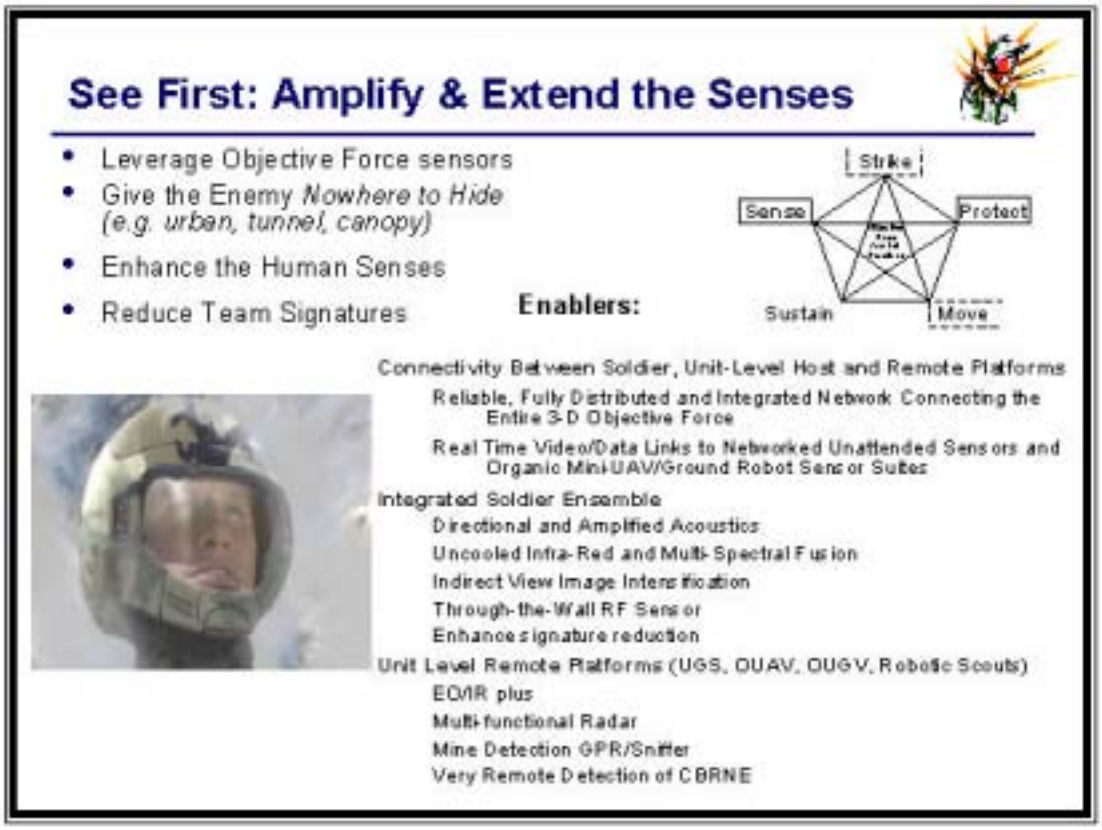
The human is central to our vision. We will place emphasis on reducing the weight and volume burden he must carry. But, most importantly, we will shift the design paradigm to a human performance-centric approach.

When our vision is realized, the Objective Force Warrior

- Will never be alone
- Will never be disconnected
- Will always feel at home
- Will always be protected

Slide 7

Panel Four chose these six Operational Imperatives to communicate the Objective Force Warrior vision to Dr. Andrews. Panel Four spent over two hours selecting the words for this methodology. Once the group achieved consensus on these imperatives, the evaluation criteria and enabling technologies flowed naturally for each.



Slide 8

This initial imperative chart orients the audience and explains the methodology to communicate the Objective Force Warrior message. For each Operational Imperative, we present an icon of the five Objective Force Combat Functions that are addressed by this Imperative (upper right hand corner). An Imperative may address multiple functions but the principal function is highlighted. Here we present the Key Performance Issues that must be addressed (upper left-hand quadrant) and the technological enablers to be incorporated in the Objective Force Warrior (lower right-hand quadrant).

Dominant information exploitation is key to the success of the Objective Force:

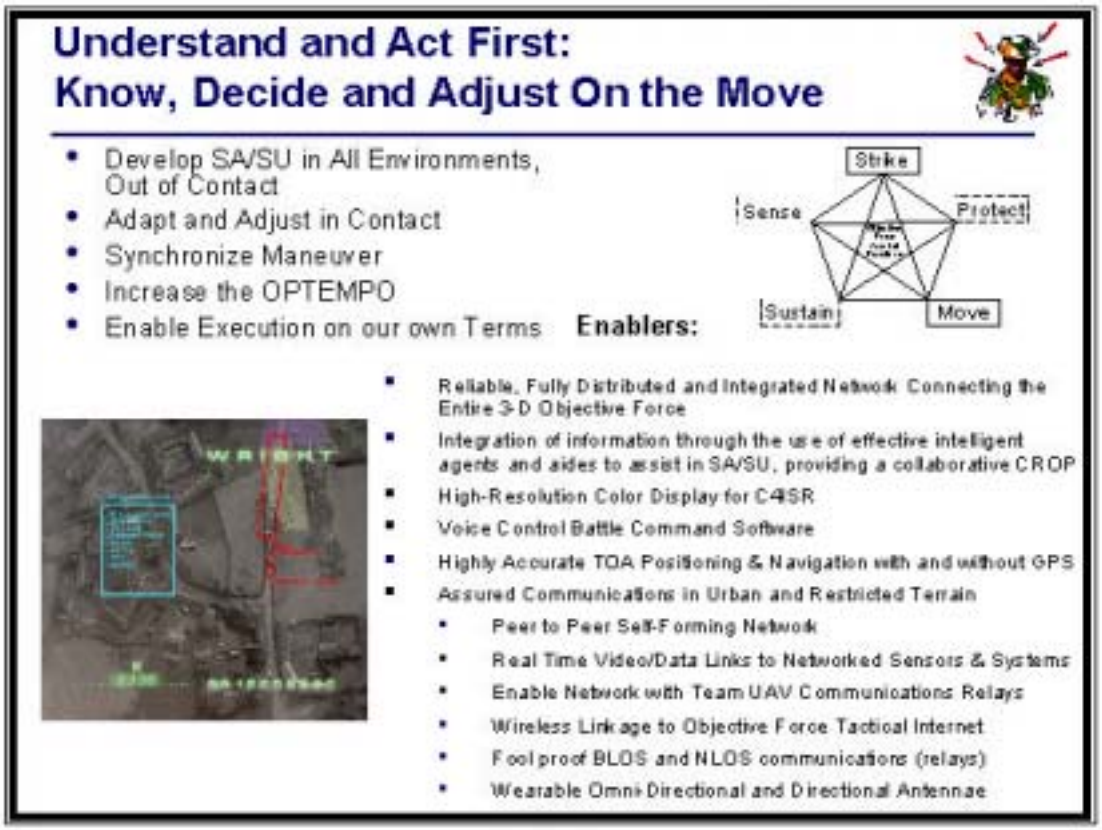
- The seamless C4ISR network is fundamental to the Objective Force Warrior.
- Objective Force Warrior teams are high fidelity, intelligent sensor grids that amplify the senses of the Objective Force – there will be nowhere for the enemy to hide.

Key enablers are

Pervasive multi-spectral sensors – on the soldier, weapon, sensors, etc – enabled by low cost uncooled IR devices.

- The integrated soldier equipment ensemble.
- The Objective Force Warrior will exploit team-level semi-autonomous platforms.

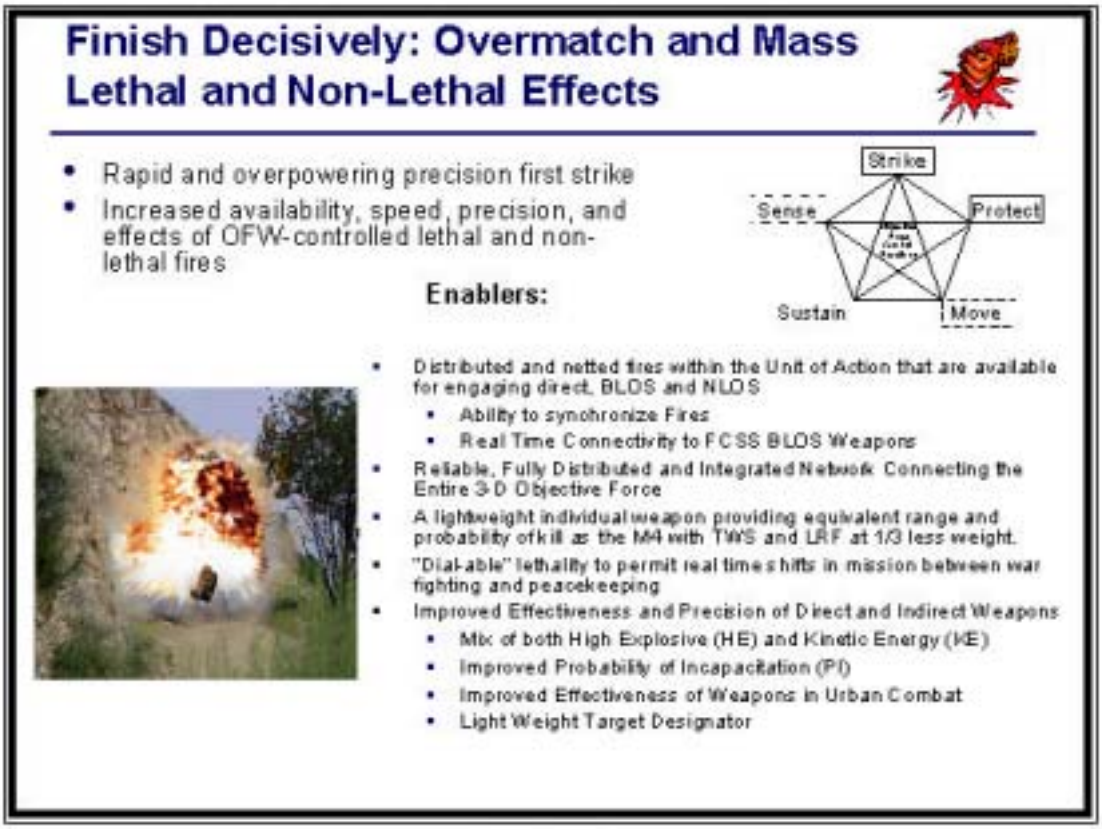
Our ability to see first will enable our ability to act on this information first – to seize, exploit, and maintain the initiative. Seamless situational awareness and situational understanding of friendly and enemy forces and non-combatants is the foremost key performance issue.



Slide 9

The key enabler is assured communications in difficult terrain, including

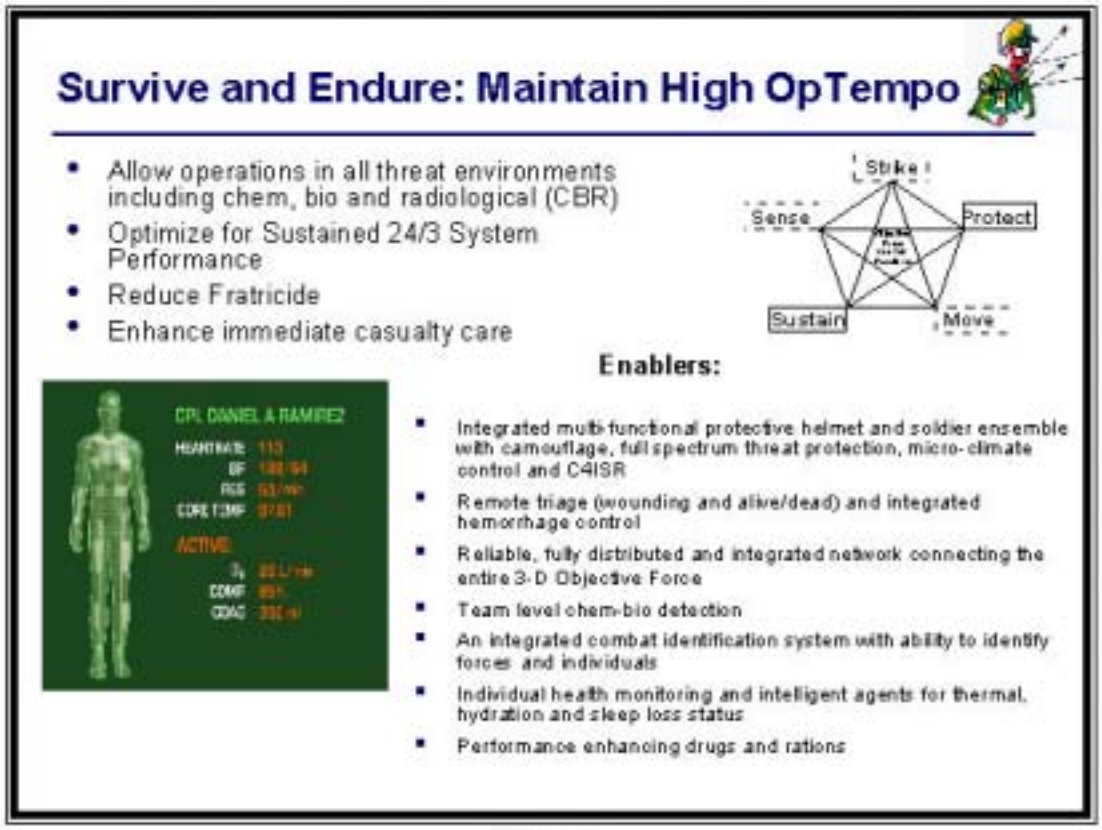
- Peer-to-peer, self-forming networks
- Fool-proof BLOS / NLOS communications



Slide 10

The purpose of being first to act is to finish decisively. The essential performance issue is the ability to rapidly synchronize devastating fires and decisive maneuver. Three of the key enablers depicted on the chart, to only mention a few, include

- Distributed and networked fires with effectively zero latency at the Objective Force Warrior unit of action level.
- “Dialable” lethality to enable rapid transition between combat, stabilization, and support operations.
- Peer to peer self-organizing ad hoc communications network.



Slide 11

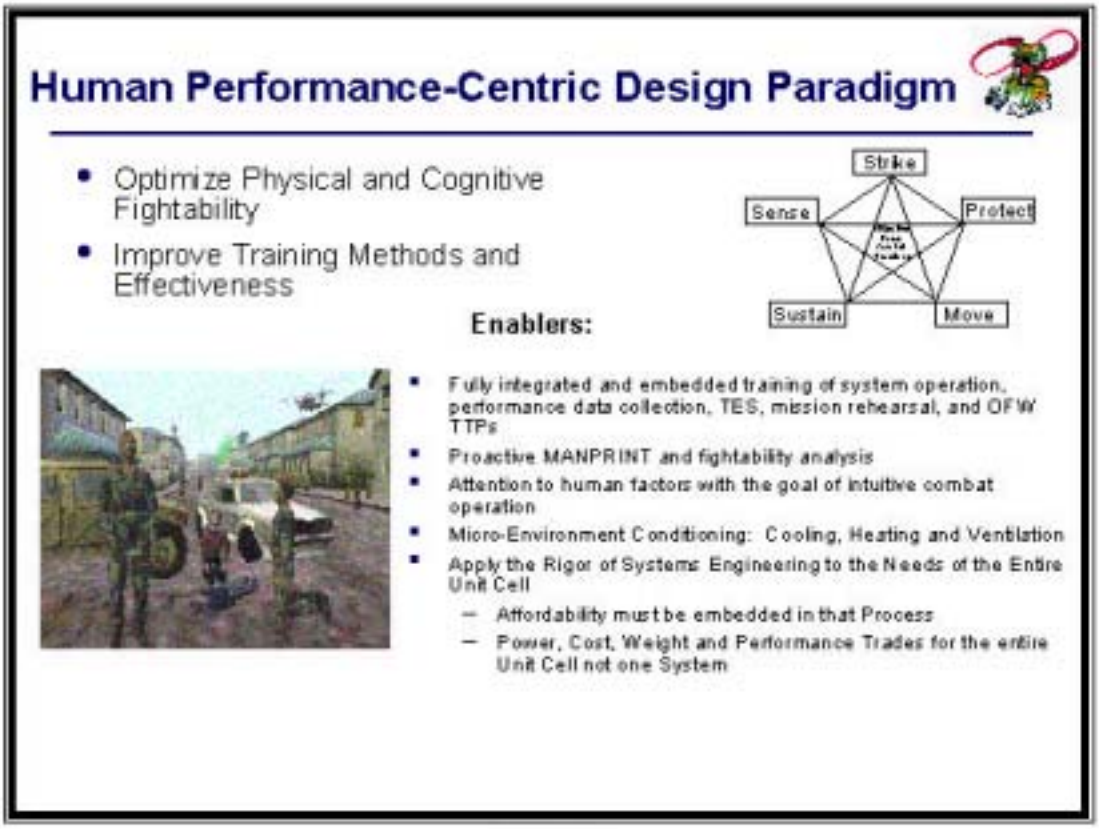
Objective Force Warrior will survive and endure in the battle space of the future. Key performance issues are

- The ability to conduct operations in all threat environments
- Sustain the force 24 hours a day for at least three days

The key enablers are

- The integrated multifunctional helmet and equipment ensemble
- Remote triage
- Immediate hemorrhage control.

Hemorrhage control is thought to be uniquely important to Objective Force Warrior. Historical data tell us 50% of soldiers killed in action die because they bleed out within 15 minutes after being wounded.



Slide 12

The Army has always prided itself on its focus on the soldier – on equipping the man vs manning the equipment – although it has fallen considerably short of this goal in many cases. With Objective Force Warrior, Human Performance-Centric Design must be more than a slogan and a goal – <u>it is the controlling, bedrock principle</u>.

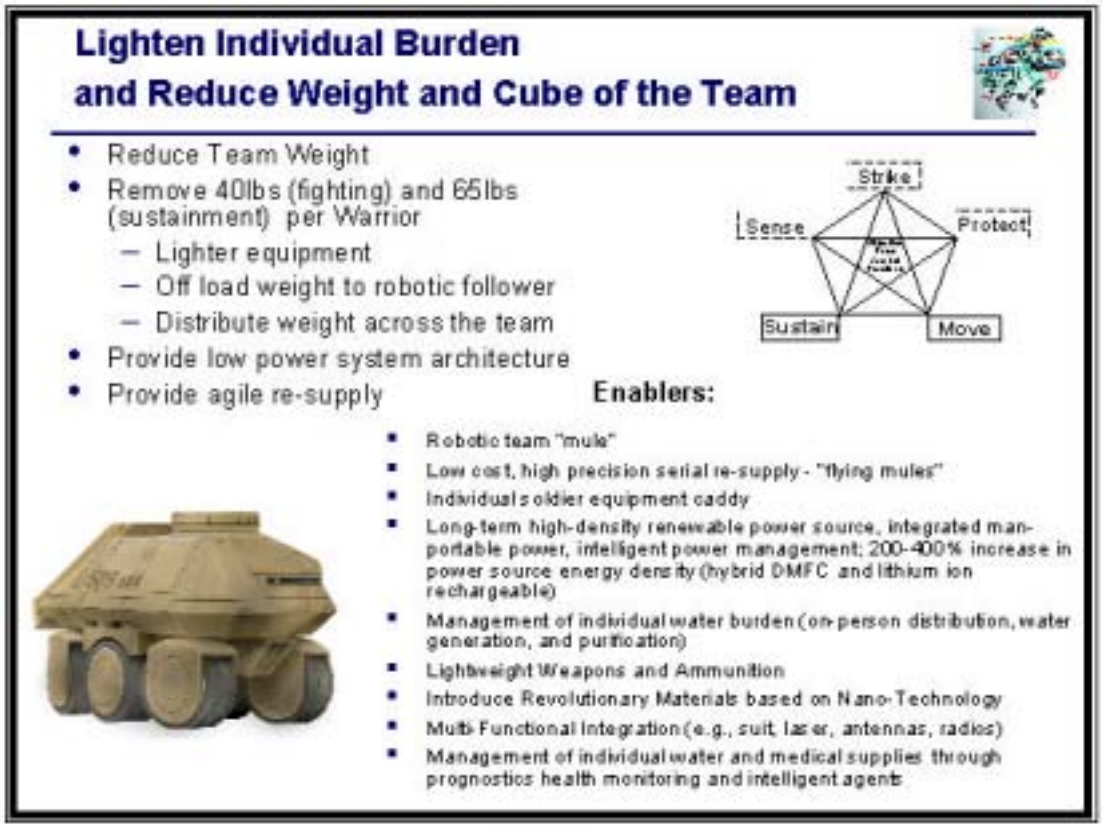
The key performance issues are

- Optimal human cognition
- Physical fightability
- Embedded systems

The key enablers are

- Full integrated and embedded training
- Proactive MANPRINT and fightability analysis
- Attention to human factors for intuitive operation

The bottom line is an Objective Force Warrior system that has lightened the burden of the individual and reduced the overall cube (volume) and total weight of the entire team.



Slide 13

Key performance issues are

- Reduce weight of individual components
- BUT the desired burden reduction can only be achieved by off-loading equipment to a team-level robotic follower

Key enablers are

- The robotic mule at team-level to carry the off-loaded equipment and supplies
- High-density renewable power sources
- Multi-functional integration of system capabilities

The robotic mule was a consensus favorite throughout both sessions. Lively debates were held about what it should be, level of complexity, and how multi-functional. Clearly, some form must be developed and introduced soon in an evolutionary fashion so it may evolve over time into the Objective Force Warrior solutions repertoire.

Slide 14

Our Objective Force Warrior concept achieves a true leap ahead over Land Warrior. To illustrate this, let us look at the three compelling issues we drew from CPT Holton’s situation report back in October 2002.

To fight in urban, complex, and restrictive terrain, we have exploited 3-D situational awareness and situational understanding enabled by robust networked communications and ubiquitous low cost sensors.

The essence of this graphic depiction reveals how an Objective Force Warrior soldier along with his/her parent organizations will look at urban and complex terrain as just another mission. The requisite Objective Force Warrior tools make it no more difficult than any other task.

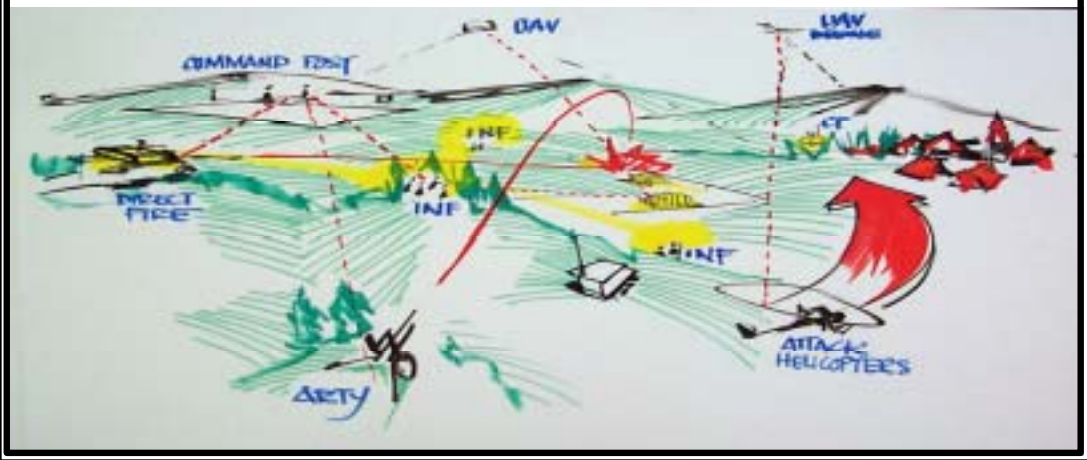
Embedded capabilities allow for mission rehearsals while sustaining critical readiness for all mission profiles and level of difficulty.

Slide 15

We have achieved an acceptable burden on the soldier by off-loading materiel to a robotic platform organic to the Team and hybrid power sources.

What Makes this Vision a Leap Ahead of LW?

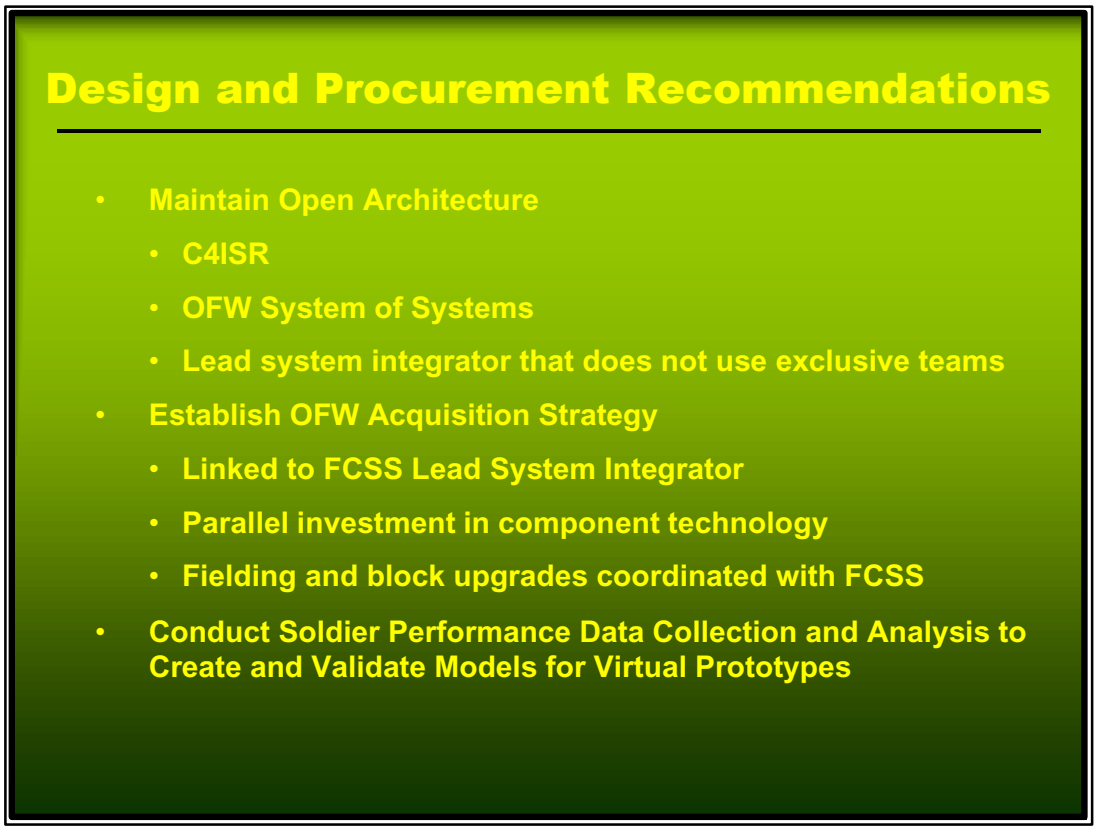
- **Exploits the Power of the Entire Objective Force**
  - Sensors (including pervasive overhead GMTI, RF tags, team OAV, UGS…)
  - Proactive counterfire
  - Airborne radio relays



Slide 16

We exploit the power of the entire Objective Force using the sensor net, enabling proactive counterfire. The essence of the foregoing three graphic depictions reveals an Objective Force Warrior along with his unit of action looking at urban and complex terrain as “just another mission.” The requisite Objective Force Warrior tools make it no more difficult than any other battlefield task. Embedded capabilities allow for mission rehearsals while sustaining critical training readiness for all mission profiles and level of difficulty.

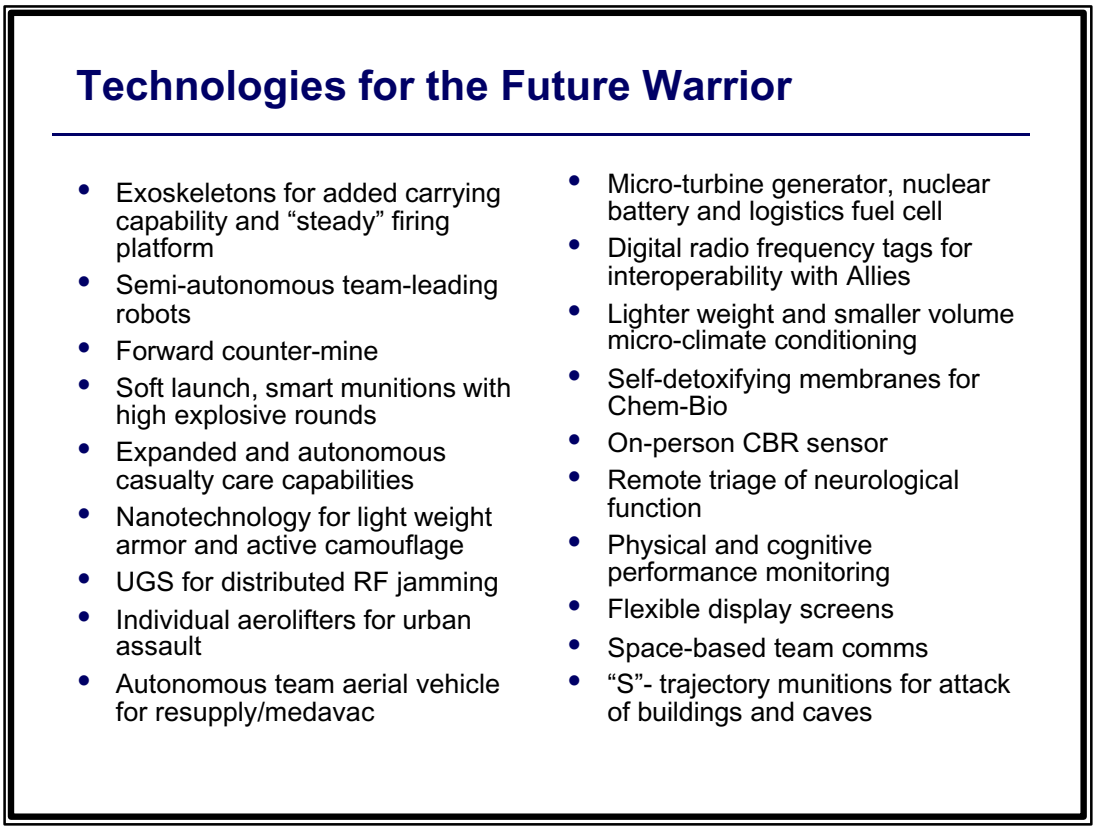
Our vision for Objective Force Warrior is compelling. However, to achieve it, several overarching design and procurement issues must be addressed.



Slide 17

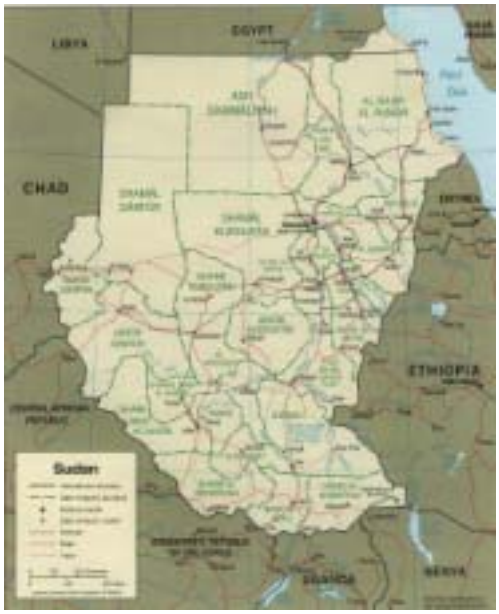
It is critical that the Army gets the C4ISR for both Objective Force Warrior and the Future Combat System architecture right. This architecture must remain completely integrated and compatible with the Future Combat System. The system integrators must work cooperatively and create an open system architecture that does not lead to proprietary equipment and software incompatible with other elements of the systems.

The Objective Force Warrior must be considered a single system of systems just as with the Future Combat System. The Objective Force Warrior system must be fielded and upgraded in concert with the Future Combat System.



Slide 18

We described the Objective Force Warrior with enabling technologies that can be transitioned at Technology Readiness Level 6 in 2006 and fielded in 2010. The technologies depicted here will continue to mature and we foresee Future Warrior embodying several of these advanced capabilities.



October 31, 2012
Khartoum, Sudan
Flash from the Combat Zone:
COL Walt Holton

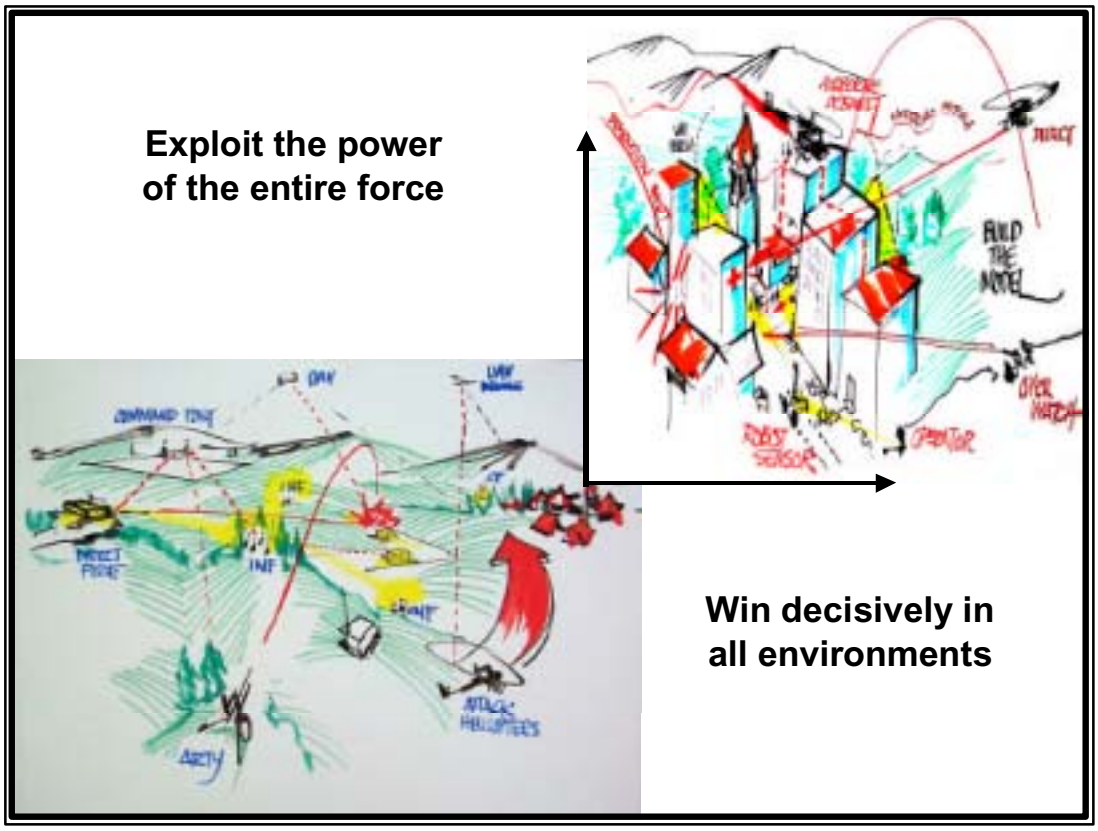
Slide 19

Fast-forward to 2012. Remember CPT Holton? Well, he now is COL Holton and Commander of an Objective Force Warrior Unit of Action. We have just been alerted to a video teleconference briefing he is about to give and hear his comments from ten years in the future.

Good morning Sir, I am COL Walt Holton, Commander of 6-502D Unit of Action. The purpose of the conference is to pass on some comments from my soldiers in the operational area.

Because of improvements to our force structure and advances in technology, I can command and control my Unit of Action far better than I could command my company ten years ago. I can now prearrange the conditions of the fight and strike the enemy with netted fires and decisive maneuver at the time and place of my choosing.

The enemy seldom surprises us any more. However, when we make contact, we now have immediate and responsive precision fires from any netted direct or indirect fire systems available.



Slide 20

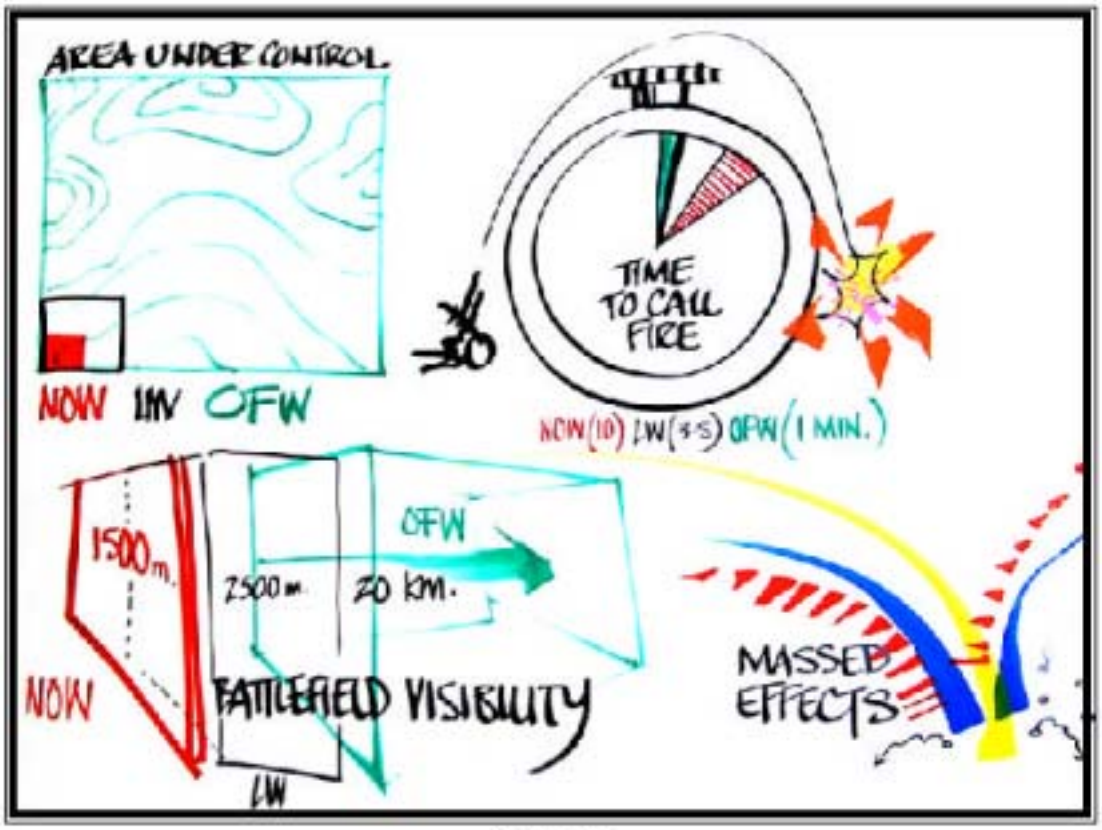
COL Holton continues by describing synchronized indirect and direct fires, aviation, and ground maneuver.

Through a distributed network of soldiers, sensors, and remote platforms, I can now better command and control my forces throughout the battle area.

The city has become another operational area rather than a debilitating obstacle to our force.

By netting our soldiers to sensors, remote platforms, and distributed fire systems, I am able to develop the situation, choose the decisive engagement, and continue the attack from positions of advantage.

When non-combatants are encountered, our ammunition now allows us to dial-in the appropriate level of response without reloading the weapons.



Slide 21

COL Holton continues.

Sir, I am going to use this chart to summarize what I just briefed.

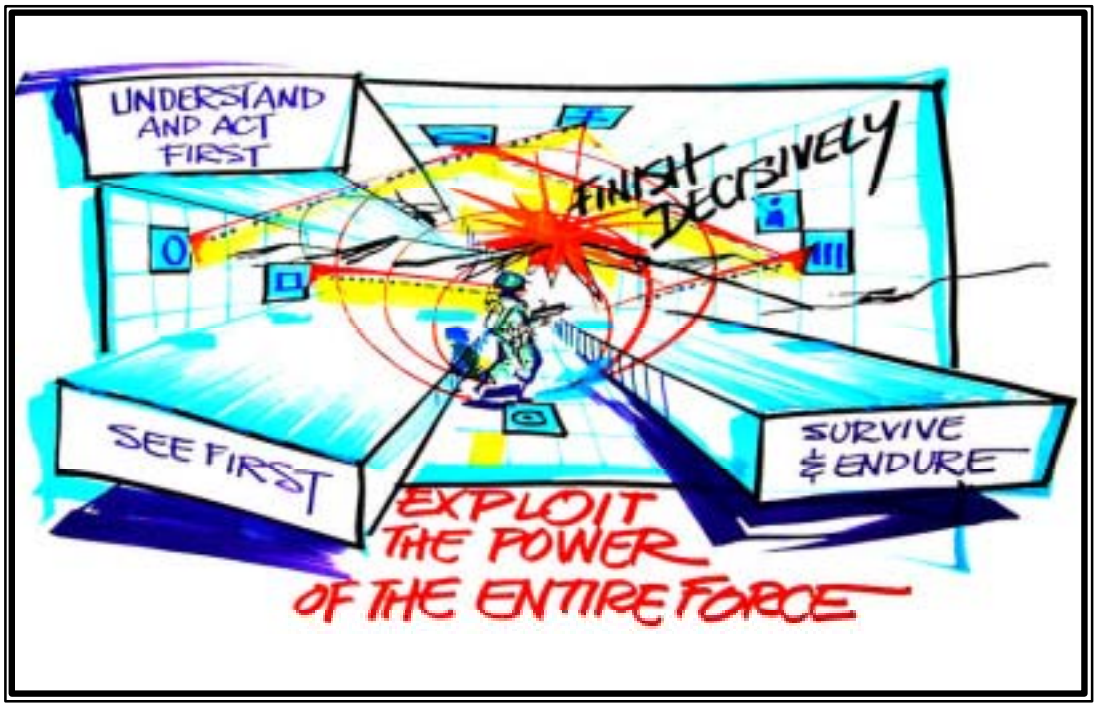
Battle space - Ten years ago, I could control only 1 km of battle space. Eight years ago Land Warrior increased my control to 3 km. Today, the Objective Force Warrior allows me to control up to 30 km with a 3-D perspective.

Visibility - Ten years ago, my visibility extended out to 1500 meters, terrain dependent during daylight. Land Warrior increased this distance up to 2500 meters, day and night. The Objective Force Warrior allows 3-D visibility out to 20 km.

Call for Fires - Ten years ago a call for fires took 10 to 15 min. Land Warrior reduced this task to 3 to 5 minutes. Today, the Objective Force Warrior allows us to call for fires in near real time.

Massed Effects - Today, the Objective Force allows us to mass lethal and/or non-lethal effects. A new capability that did not exist before the Objective Force!

GEN (R) Gorman was encouraged to encapsulate the emotion and commitment that Panel Four has for the Objective Force Warrior effort. Most of the members of this group are senior U.S. Army professionals who have been working these complex issues for months. The words provided by this quintessential officer who has commanded combat forces at every level says it all. It embraces the collective energy, capabilities, and synergy of the collective Objective Force. Truly, it is a force of one . . . an Army of One!



Slide 22

General Gorman’s Monologue:

The infantryman of today is thrust far forward.

He is the point of the army spear.

It is very lethal and very lonely out there.

The infantrymen of tomorrow will never be alone and he will advance on his enemy shielded by dominant information.

His leaders will be able to say this to him,

Soldier, you are the master of your battlespace. You will shape the fight. The network will enable you to see all that can be seen. You will out think, out maneuver, and out shoot your enemy.

The force is with you.

You are one with the force.

Vision

The overarching actionable vision is to change the way we fight! Objective Force Warrior will be able to conduct overmatching decisive operations in all environments exploiting the power of a networked three-dimensional (3-D) force through the ability to

- See First
- Understand and Act First
- Finish Decisively
- Survive and Endure

In short, Objective Force Warrior must exploit the power of the entire force!

Key Components

- See First: Amplify and Extend the Senses
- Understand and Act First: Know, Decide & Adjust On the Move
- Finish Decisively: Overmatch and Mass Lethal and Non-lethal Effects
- Survive and Endure: Maintain High Operation Tempo
- Human Performance-centric Design Paradigm
- Lighten Individual Burden and Reduce Weight and Cube of the Team

Metrics

- **See First**
  - Leverage Objective Force sensors
  - Give the Enemy *Nowhere to Hide (e.g. urban, tunnel, canopy)*
  - Enhance the Human Senses
  - Reduce Team Signatures
- **Understand and Act First**
  - Develop Situational Awareness and Understanding in All Environments, Out of Contact
  - Adapt and Adjust in Contact
  - Synchronize Maneuver
  - Increase the Operational Tempo
  - Enable Execution on our own Terms
- **Finish Decisively**
  - Rapid and overpowering precision first strike
  - Increased availability, speed, precision, and effects of Objective Force Warrior controlled lethal and non-lethal fires
- **Survive and Endure**
  - Allow operations in all threat environments including chem, bio and radiological (CBR)
  - Optimize for Sustained 24/3 System Performance
  - Reduce Fratricide
  - Enhance immediate casualty care
- **Human Performance-Centric Design Paradigm**
  - Optimize Physical and Cognitive Fightability
  - Improve Training Methods and Effectiveness

- **Lighten Individual Burden and Reduce Weight and Volume of the Team**
  - Reduce Team Weight
  - Remove 40 lbs (fighting) and 65 lbs (sustainment) per Warrior
  - Lighter equipment
  - Off load weight to a robotic follower
  - Distribute weight across the team
  - Provide lighter power system architecture
  - Provide agile re-supply while reducing logistics footprint

Enabling Technologies

See First

- **Connectivity Between Soldier, Unit-Level Host and Remote Platforms**
  - Reliable, Fully Distributed and Integrated Network Connecting the Entire 3-D Objective Force
  - Real Time Video/Data Links to Networked Unattended Sensors and Organic Mini-UAV/Ground Robot Sensor Suites
- **Integrated Soldier Ensemble**
  - Directional and Amplified Acoustics
  - Uncooled Infra-Red and Multi-Spectral Fusion
  - Indirect View Image Intensification
  - Through-the-Wall RF Sensor
  - Enhance signature reduction
- **Unit Level Remote Platforms** (UGS, OUAV, OUGV, Robotic Scouts)
  - EO/IR plus
  - Multi-functional Radar
  - Mine Detection GPR/Sniffer
  - Very Remote Detection of CBRNE

Finish Decisively

- Distributed and netted fires within the Unit of Action that are available for engaging direct, BLOS and NLOS
  - Ability to synchronize Fires
  - Real Time Connectivity to FCSS BLOS Weapons
- Reliable, Fully Distributed and Integrated Network Connecting the Entire 3-D Objective Force
- A lightweight individual weapon providing equivalent range and probability of kill as the M4 with TWS and LRF at 1/3 less weight.
- "Dial-able" lethality to permit real time shifts in mission between war fighting and peacekeeping
- Improved Effectiveness and Precision of Direct and Indirect Weapons
  - Mix of both High Explosive (HE) and Kinetic Energy (KE)
  - Improved Probability of Incapacitation (PI)
  - Improved Effectiveness of Weapons in Urban Combat
  - Light Weight Target Designator

Survive and Endure

- Integrated multi-functional protective helmet and soldier ensemble with camouflage, full spectrum threat protection, microclimate control and C4ISR
- Remote triage (wounding and alive/dead) and integrated hemorrhage control
- Reliable, fully distributed and integrated network connecting the entire 3-D Objective Force
- Team level chem-bio detection
- An integrated combat identification system with ability to identify forces and individuals
- Individual health monitoring and intelligent agents for thermal, hydration and sleep loss status
- Performance enhancing drugs and rations

Human Performance-Centric Design Paradigm

- Fully integrated and embedded training of system operation, performance data collection, TES, mission rehearsal, and Objective Force Warrior Tactics, Techniques and Procedures
- Proactive MANPRINT and fightability analysis
- Attention to human factors with the goal of intuitive combat operation
- Micro-Environment Conditioning: Cooling, Heating and Ventilation
- Apply the Rigor of Systems Engineering to the Needs of the Entire Unit Cell
    - Affordability must be embedded in that Process
    - Power, Cost, Weight and Performance Trades for the entire Unit Cell not one System

Comparison to Land Warrior 2004

Our Objective Force Warrior concept achieves a true leap ahead over Land Warrior.

- **Wins Decisively in Urban, Complex and Restrictive Terrain**
    - Robust communications networked with 3D Situation Awareness
    - IR everywhere
    - Hemorrhage control
    - Integrated protective ensemble

To fight in urban, complex, and restrictive terrain, Objective Force Warrior exploited 3-D situational awareness and situational understanding enabled by robust networked communications and ubiquitous low cost sensors.

The Objective Force Warrior soldier along with his/her parent organizations will look at urban and complex terrain as just another mission. The requisite Objective Force Warrior tools make it no more difficult than any other task.

Embedded capabilities allow for mission rehearsals while sustaining critical readiness for all mission profiles and level of difficulty.

- **Achieves Reasonable Weight on the Soldier**
  - Follower load bearing robot tailored to needs of soldier
  - New Hybrid power source

Objective Force Warrior achieves an acceptable burden on the soldier by off-loading materiel to a robotic platform organic to the Team and hybrid power sources.

- **Exploits the Power of the Entire Objective Force**
  - Sensors (including pervasive overhead GMTI, RF tags, team OAV, UGS…)
  - Proactive counterfire
  - Airborne radio relays

Objective Force Warrior exploits the power of the entire Objective Force using the sensor net, enabling proactive counterfire. The Objective Force Warrior along with his unit of action looks at urban and complex terrain as “just another mission.” The requisite Objective Force Warrior tools make it no more difficult than any other battlefield task.

Embedded capabilities allow for mission rehearsals while sustaining critical training readiness for all mission profiles and level of difficulty.

Breakthrough Technologies for 2018

The technologies listed below will continue to mature. Panel Four foresees Future Warrior embodying several of these advanced capabilities.

- Exoskeletons for added carrying capability and “steady” firing platform
- Semi-autonomous team-leading robots
- Forward counter-mine
- Soft launch, smart munitions with high explosive rounds
- Expanded and autonomous casualty care capabilities
- Nanotechnologies for light weight armor and active camouflage
- Unattended Ground Sensors (UGS) for distributed RF jamming

- Individual aerolifters for urban assault
- Autonomous team aerial vehicle for resupply and medical evacuation
- Micro-turbine generator, nuclear battery and logistics fuel cell for power generation
- Digital radio frequency tags for interoperability with Allies
- Lighter weight and smaller volume microclimate conditioning
- Self-detoxifying membranes for Chem-Bio protection
- On-person CBR sensor
- Remote triage of neurological function
- Physical and cognitive performance monitoring
- Flexible display screens
- Space-based team communications
- “S”- trajectory munitions for attack of buildings and caves

Recommendations/Summary

There are several recommendations that are necessities for a successful Objective Force Warrior endeavor:

- The seamless C4ISR network is fundamental to the Objective Force Warrior. Said another way, we must achieve a reliable, fully distributed and integrated network connecting the entire 3-D Objective Force, which includes real time video/data links to unattended sensors and organic mini-UAV/ground robot sensor suites.
- Must have a totally integrated helmet that provides a totally collaborative CROP, high-resolution color symbology display, multi-spectral fusion, directional/amplified acoustics and indirect view image intensification.
- Agile re-supply through robotic mules and individual soldier caddies are examples of enabling technologies and principals that have early “payoff”. The need is now and these devices can help today’s soldier while providing evolutionary developments for Land Warrior and Objective Force Warrior.
- Make the investment early for long-term high density renewable power sources (hybrid DMFC and lithium ion) and be ready to capitalize early on fuel cell development
- Establish an open architecture road-map now for
  - C4ISR
  - Objective Force Warrior system of systems
  - System Integrators . . . preclude exclusive franchise systems and methodology
- Do the homework now for a linked acquisition strategy with FCSS, parallel investment in best technologies, and field according to coordinated upgrades with FCSS
- Plan data performance collection and to accomplish superb program analysis creating the best virtual prototyping and early production models

Objective Force Warrior
"Another Look"

Panel Members

Panel 1

MG (RET) David Grange	Executive Vice President, Robert R. McCormick Tribune Foundation
LTC Plaudy Meadows	School of Advanced Military Studies
Dr. Robert Griffin	Deputy Director, Blue Cross, Blue Shield, VT
Mr. Otis Port	Technical Editor, "*Business Week*"
Mr. Tom Kelley	Vice President of Strategic Planning and Business Development, TPL
Mr. Larry Morgan	Vice President, Technology Development, Battelle Memorial Institute
Mr. Rich Adams	Technology Development, Battelle Memorial Institute
Dr. Daniel Schrage	Professor, Aerospace Engineering, Georgia Institute of Technology
Mr. David Hendrie	Project Manager, Institute for Creative Technologies
Mr. Forrest Arnold	Axis Solutions
Mr. Jerry Schmidt	Inside Moves LLC. (Facilitator)
Mr. Dennis Murphy	Center for Strategic Leadership/Army War College (Facilitator Session 2)
COL (RET) Gary Steimer	National Security Directorate, Oak Ridge National Laboratory

Panel 2

LTG (RET) Jack Nix	Former CoS, NATO Headquarters
LTC Jeff Witsken	School of Advanced Military Studies
Dr. Rick Satava	Professor of Surgery, Yale University; Consultant to DARPA
Mr. George Friedman	Author, *Future of War*
Dr. Dennis Bushnell	Chief Scientist, NASA Langley Research Center
MG (RET) Ross Pickus	Vice President, Computer Associates
LTC Eric Zimmerman	Director, Mech Eng Research Center, Dept of Civil and Mechanical Engineering, United States Military Academy
Mr. Robert Sears	Production Manager, Institute for Creative Technology
Mr. John Strand	Axis Solutions
Mr. Lee Martin	Director, Clarity Resources, LLC (Facilitator)
Mr. Tom Sweeney	Center for Strategic Leadership Army War College
LTC (RET) Tim Vane	National Security Directorate, Oak Ridge National Laboratory
COL (RET) Bob Leicht	National Security Directorate, Oak Ridge National Laboratory

Oak Ridge Panel

LTG (RET) George Crocker	Army Senior Mentor, 1st and 5th Army Units
CSM (RET) Bob Dare	Former FORSCOM Command Sergeant Major
COL (RET) Nancy Johnson	Director, Advanced Computing Technologies
Mr. Joe Dooley	Y12 National Security Complex
CDR (RET) Mike Maston	Y12 National Security Complex
Dr. Andy Loebl	Oak Ridge National Laboratory
Dr. Bill Hamel	Oak Ridge National Laboratory
Dr. Joe Herndon	Oak Ridge National Laboratory
Dr. Harvey Gray	Oak Ridge National Laboratory
Dr. Al Akerman	Oak Ridge National Laboratory
Mr. Bob Riepe	Y12 National Security Complex
Mr. Bob Wood	Y12 National Security Complex
Mr. Kevin Finney	Y12 National Security Complex
Mr. Ron Cobb	Concept Designer, Institute for Creative Technology
Mr. Mike Sobel	Axis Solutions
Mr. Doug Stewart	President/CEO Inside Moves, LLC (Facilitator)
Mr. Art Bradshaw	Center for Strategic Leadership Army War College (Facilitator Session 2)
COL (RET) Rich Stouder	National Security Directorate, Oak Ridge National Laboratory

Army Panel

GEN (RET) Paul Gorman	Institute for Defense Analysis and the Defense Science Board
Dr. Phil Brandler	Director, Natick Soldier Center
Mr. John Munroe	Warrior Systems Integration Team
Mr. John Hedderich	Associate Technical Dir., Picatinny Arsenal
Mr. Don Reago	Director, Science and Technology, CECOM
Mr. Fenner Milton	Director, CECOM Night Vision and Electronic Sensors, CECOM
COL Frazier Glenn	Deputy, Medical Research and Material Command
COL Walt Holton	TRADOC Systems Manager-Soldier
Mr. Mike Tryon	Deputy, TSM-Soldier
Mr. Bill Brower	PM-Soldier Systems
Mr. Joe Rocchio	Sensors, Electronic Device Directorate, Army Research Lab
Mr. Scott Jaburg	U. S. Armor Center, Fort Knox
Dr. Michael VanLent	Computer Scientist, Institute for Creative Technology
Ms. Susanne Sims	Axis Solutions
Mr. Mike Lesnick	Senior Partner, Meridian, LLC (Facilitator)
Mr. Tim Mealey	Meridian, LLC (Facilitator)
LTC (RET) Jim Kievit	Center for Strategic Leadership Army War College (Facilitator Session 2)
COL (RET) Don Vinson	Y12 National Security Complex

Composite Vision Team

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COL (RET) Pat Thomas	Y12 National Security Complex
COL (RET) Gary Steimer	National Security Directorate, Oak Ridge National Laboratory
LTC (RET) George Singleton	Y12 National Security Complex
Mr. Doug Stewart	President/CEO Inside Moves, LLC (Facilitator)

Mr. Jim Channon	Illustrator - Supported each panel