NSATC
Futures Capability Workshop 2011
Future IV
(2016 and Beyond)
Final Report and Recommendations
Summary Overview

NDIA Armament Division
Joint Armaments Conference, Exhibition, and Demonstration

14-17 May 2012

Prepared for:

NSATC Executive Committee

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- **NSATC Futures IV Presentation Briefing Purpose:**
  - **Communicate NSATC Futures Vision and Capability Activities to NDIA Community**
  - **Demonstrate the Outcome Benefits of Future Capability Vision**
    - **Technology—Pull vs. Push**
    - **System Integration**
    - **Identify Key Priority Enabling Technologies**
  - **Outline How NSATC Futures Vision Provides Guidelines for Funded Programs and Funding**
  - **Address Follow-On Actions-- Futures Workshops—Topics—Participation**
    - **Futures Process Application Beyond Small Arms**
  - **Seek NDIA Attendee Comments and Involvement in Follow-On Futures Workshops**

Capturing "Industry Innovation Shapes Future Programs and Capability"

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Small Arms Systems 2016+
NSATC Futures IV
Future Technology and System Capability Vision

Futures Capability Workshop

- NSATC Futures Workshop Purpose/Objectives
- Workshop Process—Leverage "Disruptive Technology"—Innovation
- Workshop Outcomes—Technology—Systems—Barriers
- Go-Forward Plans—Future Workshops—
- Benefits
  - Government
  - Industry
  - Warfighter—National Security

Establish a "Dynamic Technology Driven Vision" for Future Warfighter Capability
Enable Annual Updates

Capturing "Industry Innovation Shapes Future Programs and Capability"

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Small Arms Systems 2016+
NSATC Futures IV
Future Technology and System Capability Vision

Futures Capability Workshop

- ***National Small Arms Technology Consortium (NSATC) Industry Only*** **Assessment of Technologies and System Capability Opportunities for 2016+**
- **Focused to *Revolutionary Opportunities* not Evolutionary Capability**
- ***Primarily Technology and System Integration Driven-*****---Not Linked to Capability GAPS, Requirements or Existing CONOPS**
- **Approximately 40 Industry and National Lab Participants (Government Observers)**
- **Established Basis for *Go-Forward Program and Budget Planning***
  - **System Integration—System Engineering Focused**
  - **Technology Priorities—System Demos—Priority Enabling Technology**
  - **Follow-On Futures Workshops—Rigorous Process—"Disruptive Technology**
- ***User Community Critique Key to Establishing Priorities, Resolving Concerns/Risk, and Establishing Path Forward Completed***
- ***Expanded Industry Participation Opportunities Complements Value and Benefits***

Future Conference IV Objectives

- **Establish Small Arms System and Technology Focused to *2016 and Beyond***
- ***Seek Innovative Visionary* Systems and Concepts and Applications:**
  - **Focused to Current Small Arms Systems and Operations**
  - **Visionary Small Arms Concepts and Operations**
- **Focus on Two Views of System Evolution**
  - **Capability/Requirements Driven**
  - **Systems/Technology Driven (PRIMARY EMPHASIS)**
- ***Seek Revolutionary Concepts* not Just Evolutionary or Incremental**
- **"Brainstorm" as *Open No Constraints* Groundrules**
- ***Industry Driven (Industry and Academia) Focus* as Independent of Government**

Ensures Systems and Technology with 2016 Beyond Vision

Future Workshop IV—Ensures Revolutionary Post 2016 Small Arms Systems and Technology Vision

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Futures Workshop
Why Futures IV Workshop 2011?

Futures Capability Workshop

- **Recognition of Need For Small Arms Technology and Systems Vision 2016+**
- **Significant R&D Progress In Advanced Technology and System Concepts**
  - **Rate of Technology and System Change**
  - **Revolutionary Enabling Technology Ready for Application Assessment**
- **Recognized Need to Match Superiority Capability to Evolving Threats and Missions**
  - **Changing Scenarios and Threat Demands New Warfighter Capability**
- **Need to Establish Technology Roadmap and Related Funding to Ensure Technology and System Readiness 2016+**
- **NSATC Industry and Academic Membership Focus on Leveraging Technology Driven Solutions**
- **Timely Opportunity to Present Future Capability Alternatives to User Community**
- ***Merger of Technology Driven Capability with User Identified Topics/GAPS or Requirements Ensures State of Art Capability Superiority***

Futures Workshop Structure Overview

Category	Team	Title	Focus/Objective
A—Future Systems and Technology for Current Operations	A1	Energy Usage	Innovative Energy Sources, Generation, and Energy/Power Integration and Management
	A2	Target Effectiveness	Innovative Mechanisms and System Integration to Achieve Efficient Defeat of Target Objectives
	A3	Target Engagement	Apply Smart Capabilities to Identify and Engage targets in LOS, BLOS, and NLOS
B—Revolutionary Future Systems and Technology for Visionary Capability	B1	Non-Traditional Weapons and Effectiveness Capability	Innovative Application of Non-Traditional Lethal, Non-Lethal and Scalable technology to Small Arms Systems
	B2	Evolving Revolutionary Small Arms Platform System Integration	Integrate Small Arms Systems with Unique Delivery Systems with Warfighter the primary interface
C-Emerging and Future Technologies Common to A and B	C1	Emerging Future Enabling Technologies	Innovative Emerging Enabling Technologies addressing categories A and B

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Futures IV Workshop
Focus Group Organization

Futures Capability Workshop

Focus Theme Group	Topic	Group Leader
	NSATC Futures IV Objectives—Approach—Outcomes Overview	Dave Broden
A1	Energy Usage	Eric Brisbon
A2	Target Effectiveness	George Kontis
A3	Target Engagement	Ray Pawlicki Hamid Hadim
B1	Non-Traditional Weapon Capability	Bryan Bockmon
B2	Revolutionary Non-Traditional System Integration	Andre Lovas
C1	Emerging Future Technologies	Ram Narayanan
	Summary Go-Forward Plans	Dave Broden
	NSAC/JSSAP Observations/Comments	Dr. Bart Halpern

Workshop Team Category A
Current Operational Concepts

- **Team A1—Energy Usage:**
  - Power Reception, Generation, Conservation, and Application
  - Characterized by Integration, Consolidation, and Miniaturization
  - Innovative Power Sources and Generation
  - Goal to Reduce Weight and Simplify Operation thru Integrated Power and/or Simplicity
  - Priority to Efficient Resupply and Logistics
  - Attention to Energy Management (Usage addresses Power Sources, Use Application Low Power Design (i.e. Power management), etc.)

- **Team A2—Target Effectiveness:**
  - Smart Weapon Systems with Programmable, Selectable, or Autonomous Capabilities
  - Characterized by Miniaturization
  - Improving Efficiency of Ordnance delivered to target by Achieving Ordnance Mechanism (lethal, non-lethal or scalable) efficiencies in design, energetic technology, mechanism focus on target etc.
  - Achieving Selective Target Effects
  - Achieving Improved Delivery Precision/Accuracy
  - Address Small Arms Concepts for Direct (LOS) and Beyond Line of Sight , and Fire (BLOS) and Non-line of Sight Fire (NLOS)

- **Team A3 –Target Engagement**
  - Full Range of Capabilities—Sensor type—Multimode Sensors—Multi spectrum Sensors—Sensor Fusion
  - Characterized by Integration and Miniaturization
  - Power Management (Link to Team A1)
  - Address Small Arms Engagement Methods for LOS, BLOS, and NLOS
  - Expand Situation Awareness Capability (Recon, Intel, Cyber etc.)
  - Networking Systems
  - “Smart Phone” Applications for Target Engagement and Networking

- **Team B1 ---Non-Traditional Weapons and Effectiveness Capability**
  - Focus on Emerging Future Non-Traditional Weapons and Related Capability
    - Lethal
    - Non-lethal
    - Scalable
  - ***Looks Beyond Current Small Arms Operational View to Potential New Capabilities to be Applied as Small Arms are in Current Operation (Visionary Concepts)----Key to Seeking and Defining Revolutionary Future Concepts***
  - Non-Traditional Candidate Systems and Technologies (Lethal and Non-Lethal)
    - Tunable/Scalable Systems
    - Directed Energy Systems
    - Laser Systems
    - E/M Systems
    - Acoustic Systems
    - See Thru Walls and Related Capabilities
    - Cyber Warfare Concepts
    - Recon, Communication, Intel etc. Capabilities
  - Team B1 Scope includes Outline of How Non-Traditional Future Capability Could be Used and Potential Operational Concept.

- **Team B2—Evolving Revolutionary Small Arms Platform Systems Integration**
  - Focus on Revolution or Evolving Small Arms Platforms for Delivery of Non-Traditional Capability or Other Future Beyond 2016 Capability
  - Establishes Launch from Platform or Integration of Uniquely Designed Launcher/Weapon
  - Considers Warfighter as Primary Interface of Integrated System
  - System Platform may be Warfighter, Robotic, Advanced Turrets, UAV/UAS or Similar
  - Seeks to Identify Platform Unique Capability and Related Technologies
  - Capability is not limited to only Lethal or Non-Lethal—Does include Recon, Surveillance, Intel, etc.

- **Team C1 ---Emerging Future Enabling Technologies**
  - Emerging Future Enabling Technologies Applicable to Current and Evolving New Concepts of Operation--- ***Key Word is "Enabling"***
  - Addresses Technologies for Both Category A and B Teams
  - Establishes Roadmap of Technology Readiness—TRL Level
  - Defines Barrier to Application
  - Addresses Both Technology and Manufacturing Processes
  - Technology Categories (Examples—Team will add others)
    - Lethal Capability Technology (e.g. advanced warhead mechanisms and types)
    - Non-Lethal Capability Technology
    - Scalable Warhead Enabling Capability
    - Sensors
    - Fire Control
    - Communications (voice, video, Smart Phone Applications (APS) etc.
    - Location Devices (e.g. GPS)
    - Guidance and Control
    - Software
    - Advanced Energetics
    - Advanced Materials (metals, polymers, composites, memory)
    - Nano-Technologies (Materials, etc.)
    - Others TBD
  - Process Categories
    - Technology Manufacturing
    - Processes to Apply Emerging Future Technologies
    - Ensuring Emerging Technology and Application Quality Assurance
    - Emerging Future Technology Producibility/Affordability

Team C1

- Interacts with Category A and B Teams
- May form Subteams of common application, technology or process

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Futures IV Workshop Revolutionary—Visionary Considerations--Challenges

Futures Capability Workshop

Topics or Ideas for Focus Theme Groups Discussions—Not limited to this List

Capability Mechanisms: • Lethal • Non-Lethal----Less than Lethal • Scalable • Disruptive • Lasers, EM, Acoustic, HPM, etc. • Guided (Semi Autonomous, Autonomous, Other) • Sensors • Communication • Cyber and Cyber Jammers • C4ISR • Other	**Delivery/Platforms:** • Individual Devices (e.g. Like Weapons) • Robots • UAV etc. • Secondary Delivery (carried by Larger System—Deployed by Warfighter) • Hovering Searching Disrupting • Turrets or Equivalent in Future • Guided Systems • In Flight or Remote Control • Direct and Indirect Capability • Delayed Capability (Launch and Wait for Event)
Engagement: • Sensors • Sensor Fusion • Networks • Tracking • Identifying • Indirect Locations • Command and Control • Communication • Tagging and Following • Find Among Crowd • In Building/Cavity Detection (i.e. Through Wall Capability)	**Enablers:** • Power Sources and Technology • Nano-Technology (Metals, Polymers, Explosives, Propulsion, Signature Materials, Quantum Dots etc.) • Advanced Materials • MEM's • Smart Phones and Related Technologies • Digital/Software Radios • Miniaturization • Power Management • Artificial Intelligence • Manufacturing Capability (Long Term Vision)

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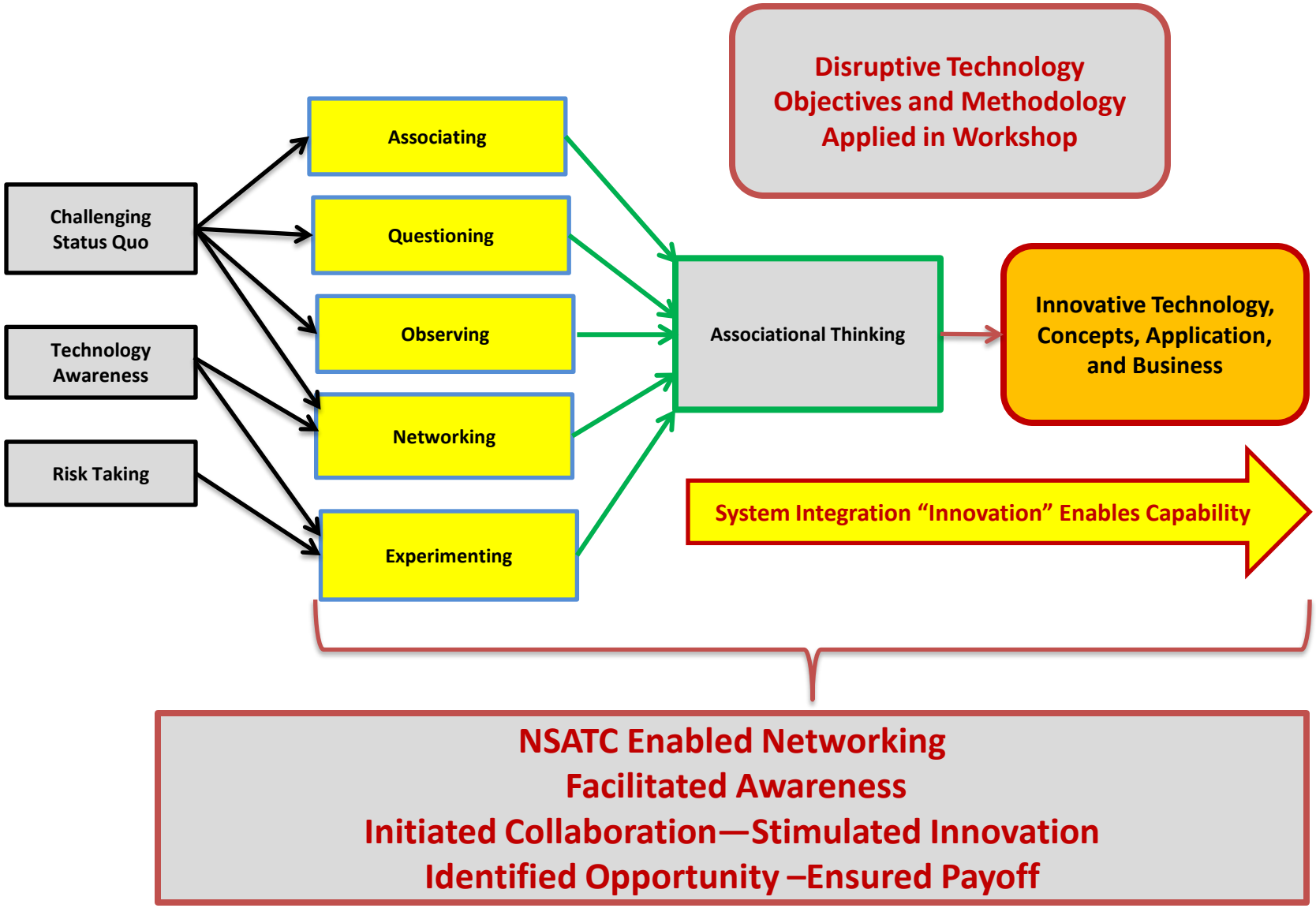
Futures IV Workshop Process Ensuring Revolutionary—Visionary Concepts

Futures Capability Workshop

- Focus ***on Technology Driven Innovation***
- ***Not Driven or Constrained by Requirements or GAPS etc.***
- Clean Sheet of Paper—Open Book---All Ideas Valid--- Focused Approach
  - ***Evolve Concepts and Approaches Through Rigorous Open Dialogue***
- ***Focus on What the Concept or Technology is not the How***
  - Protects Proprietary Information
  - Ensures Open Dialogue on All Subjects
- Focus Group Discussions Should ***Encourage Dialogue Among Members***
  - Ask Challenging Questions
  - Discuss and Debate Concepts and Ideas
  - Evolve Consensus where Possible

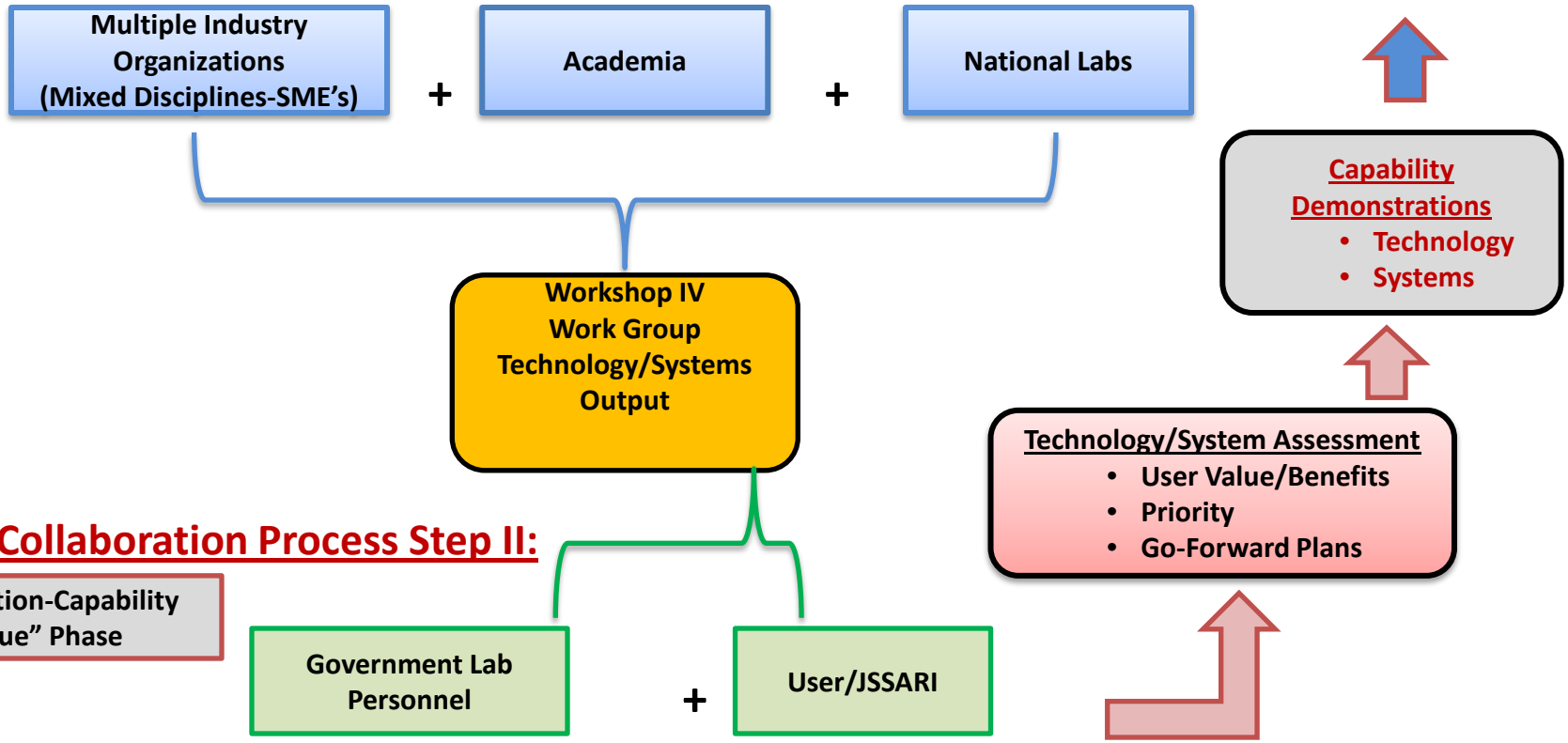
Disruptive Technology Thinking Enabling Innovation



Reference: The Innovators DNA—Dyer, Gregerson, Christensen 2011

- **Multi-Disciplined Collaboration Enabled:**
  - *Revolutionary Innovative Technology and Systems Future Warfighter Capability*

- **Collaboration Process Step I:** "Innovation—Creativity" Phase



- **Collaboration Process Step II:** "Validation-Capability Value" Phase

Focus Theme Group A1
Energy Usage

- **Focus/Objectives:**
  - Innovative Energy Sources and Integration for Small Arms Systems
    - Sources
    - Generation
    - Power Management
    - Recharge

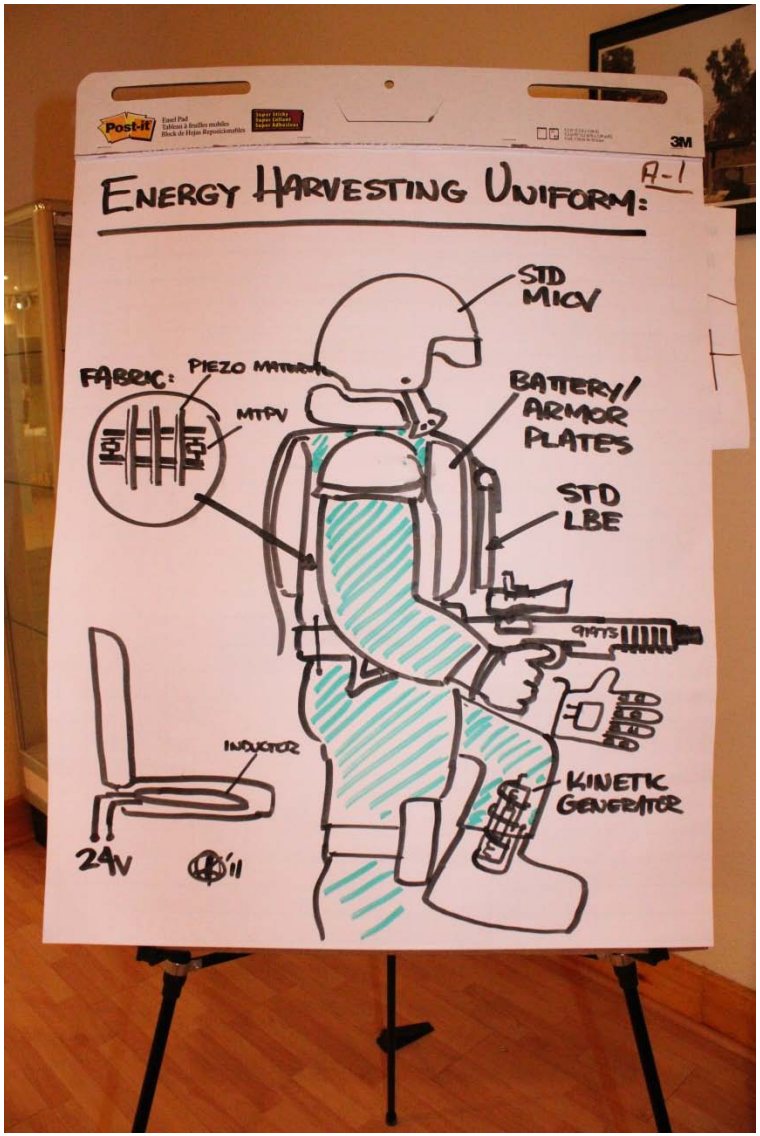
- **Key Requirements:**
  - High Energy Density
  - Recharge Capability
  - Storage Efficiency
  - Power Management
  - Conformal Shape
  - Low Weight
  - Simplicity
  - Availability
  - Environmental Performance Uniformity
  - “Green”

Focus Theme Group A1
Energy Usage

- **Technologies:**
  - Solar
  - Mechanical
  - Chemical
  - Nano-Materials
  - Wireless
  - Heat
  - Charging Concepts and Recharging

- **Barriers:**
  - Energy Density
  - Conformal Shape Generation and Storage (i.e. in uniform)
  - Efficiency
  - Lack of Cross Discipline Coordination Awareness
  - Lack of Focused Program and Coordinated Capability Objectives

Focus Theme Group C1
Emerging Future Technologies



Focus Theme Group A1
Energy Usage

- **Concepts Resulting:**
  - Nanite Cloud
  - Harvest Gas Via Turbine in Barrel
  - Wireless Energy Capture/Storage
  - Harvesting and Storage in Uniform (Integrated Suite)

- **Go-Forward Recommendations:**
  - Power Source Focused Coordination Across Multiple Activities
  - Outline Generic Small Arms Power Source Objectives
    - Power Capability
    - Conformal Criteria
    - Weight
    - Life/Recharge etc.
  - Establish Power Source Roadmap with TRL Milestones
  - Address Industrial Base Match to Technology

- **Benefits:**
  - Enables and Support Small Arms Revolutionary/Evolutionary Systems to Mature to Integrated Systems (TRL 6)

Focus Theme Group A2
Target Effectiveness

- **Focus/Objectives:**
  - **Innovative and Revolutionary Technology and System Integration Enabling Significant Improvement in Target Effectiveness**
    - **Technology**
    - **Systems**
    - **Engagement Enhancement**
    - **Target Defeat**

- **Key Requirements:**
  - **Defeat Mechanisms for Personnel, Vehicles, Tunnels and Infrastructure**
  - **Non-Traditional Defeat Mechanisms and Integration**
  - **Non-Lethal to Lethal**
  - **Range Increments, <25m; to 100m; ,1000m**
  - **Scalable**
  - **Precision**
  - **Robotic/UAV Mounted/Delivered**
  - **Improved Situation Awareness/Intelligence—C4ISR**

Focus Theme Group A2
Target Effectiveness

- **Technologies:**
  - Virtual Reality Simulations
  - Thought (neurological) Fire Control
  - Nanite Technology
  - Robotic/UAV Specific Weapons
  - Precision Systems
  - Hovering Systems
  - Non-Traditional Defeat Mechanisms (HPM, Cyber, Acoustic etc.)
  - Recoilless Technology
  - Small Efficient Electric Motors

- **Barriers:**
  - TRL Status
  - Expertise
  - Legal Assessment
  - Match of Concepts to User Interest/Support

Focus Theme Group A2
Target Effectiveness

- **Concepts Resulting:**
  - Multiple Concepts Identified –Matched to Range and Capability
  - Thought Directed Fire Control
  - Nanite Cloud (if technology exists)
  - Virtual Reality Simulation
  - Address State of Art For Robotic and UAV Weapons (e.g. Recoilless etc.)
  - Multiple Non-Traditional Mechanisms

- **Go-Forward Recommendations:**
  - Focus on Advance Defeat Mechanisms
  - Increase Interface with National Labs
  - Soldier User Scenario Futures Conference to Link
  - Integration with Other Futures IV Focus Groups
  - Increase Focus on Robotic and UAV Systems
  - Address Precision Integration

- **Benefits:**
  - Provides Multiple Advanced Defeat Mechanisms for Integration
  - Provides Concepts for New Platform Applications
  - Links Precision with Situation Awareness

Focus Theme Group A3
Target Engagement

- **Focus/Objectives:**
  - Innovation Systems Providing Revolutionary Capability Enabling Target Engagements
    - LOS
    - BLOS
    - NLOS

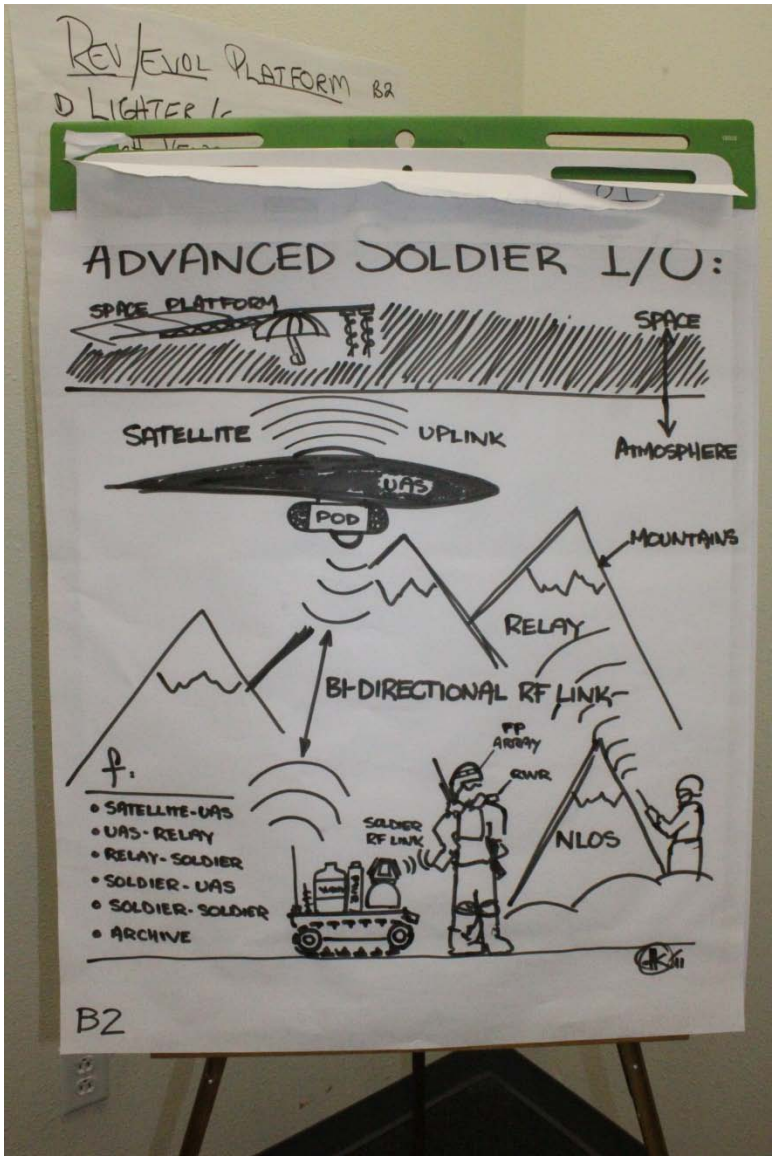
- **Key Requirements:**
  - Enhanced Situational Awareness in All Scenarios Situations
  - Threat Detection
  - Threat Location
  - Overall Situation Awareness
  - Support Networked Fires
  - Man Portable Deployable
  - Hovering Capability
  - All Weather Capability
  - Data Fusion
  - Real Time Data Transmission to Squad
  - Automated Response

Focus Theme Group A3
Target Engagement

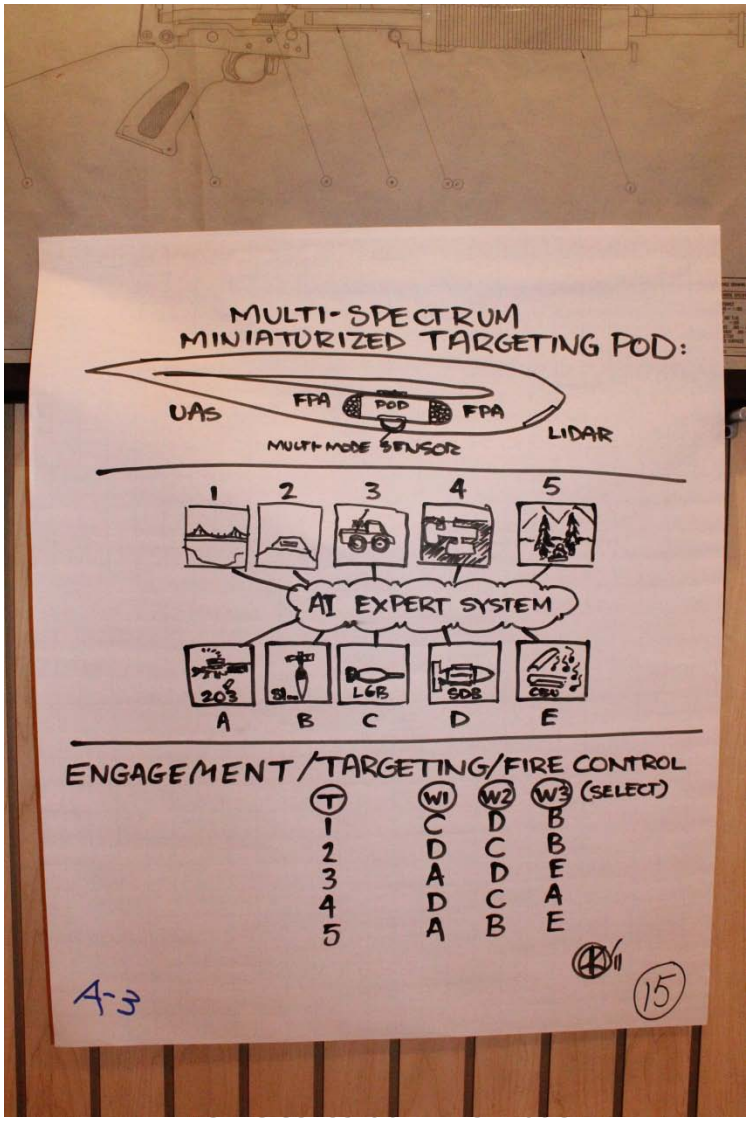
- **Technologies**
  - Sensors
  - Communication
  - Sensor Fusion (IR, Thermal, Radar, MMW etc.)
  - Artificial Intelligence (AI)
  - High Processing Speed
  - Power Management
  - Data Management
  - Innovative I/O Devices-User Friendly
  - Launch and Hovering Technology
  - Fire Control For BLOS and NLOS or Link to System

- **Barriers**
  - AI Algorithms and Criteria
  - Sensor Fusion Maturity
  - Integration for Operational Simplicity
  - Application to LOS, BLOS, NLOS
  - Power
  - Secure Bandwidth

Focus Theme Group C1
Emerging Future Technologies



Focus Theme Group C1
Emerging Future Technologies



Focus Theme Group A3
Target Engagement

- **Concepts Resulting:**
  - "God Eye" Situation Awareness Module—C4ISR Focused
  - Related Conformal Efficient Power Module

- **Go-Forward Recommendation:**
  - Establish Situation Awareness Module Notional Capability Requirements
  - Establish "God Eye" Concept Design Alternatives
  - Evolve Real Time Sensor Data Fusion Modules
    - Integrated
    - Mission Specific Payloads
  - Coordinate Operational Concepts with User
  - Define Technology, System Integration, and User Interface Roadmap

- **Benefit:**
  - Enables Scenario Situation Awareness Monitoring and Links with Related Data Sources
  - Enables LOS, BLOS, and NLOS Capability
  - Enables Remote Fires
  - Supports Networked Fires
  - Ensures Battle Damage Assessment

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Focus Theme Group B1
Non-Traditional Weapon Capability

Futures Capability Workshop

- **Focus/Objectives:**
  - Innovation in Technology and System Integration of Non-Traditional Defeat Mechanisms and System Capability
    - Non-KE Temporary or Permanent Incapacitation (Personnel or Materiel)
    - May Use KE for Non-Traditional Payloads
    - Spectrum of Scalable Effects
      - Dissuasion, Disrupt, Incapacitation, Delay, Lethal
    - Consideration of:
      - Directed Energy
      - Unique Mechanisms Not Applied Today
      - Advanced Technology Meeting Legal Criteria
        - (Included as a potential if Legal Assessment Supports)

- **Key Requirements:**
  - Legal Assessment Must Be Favorable or Plan for Approval
  - Size, Weight, and Power Compatible with Small Arms Systems
  - Threat Biometric Technology
  - Scalable
  - Holographs (False Targets)

Focus Theme Group B1
Non-Traditional Weapon Capability

- **Technologies:**
  - EMP Systems (Size, Scalable, Power)
  - Laser Systems
  - Acoustic Technology (size limits)
  - Power and Power Management
  - Biometric Sensors
  - Holography (False Targets)
  - Chameleon Capability
  - Nano-Technology
  - Advanced Approved Capability

Technologies Subject to Review and Application of:
- Treaties
- Agreements
- Operational Concepts
- Other Criteria

- **Barriers:**
  - Legal Assessment On-going and In Advance of Some Technology Considerations
  - Miniaturization
  - Power Management
  - Defeat Criteria
  - Biometric Measurement

Focus Theme Group B1
Non-Traditional Weapon Capability

- **Concepts Resulting:**
  - Advanced Non-Traditional Systems (Dependent on Legal Review)
  - Ray Gun (Directed Energy)—Acoustic Etc. (Scalable)
  - EMP (HPM) Emitter System
  - Agile Directed Energy Laser System
  - Holography (False Target Generator)
  - Enemy Combatant Biometric Sensors
  - Chameleon Systems

- **Go-Forward Recommendations:**
  - Establish On-Going Legal Assessment (Link with other Non-Traditional Systems)
  - Establish Non-Traditional System Roadmap for Approved Technology
    - (Focus on Adapting to Small Arms System Applications)
  - Prioritize Non-Traditional System Capability Evolution Ensuring Progress to TRL6

- **Benefits:**
  - Provides a Suite of Non-Traditional Mechanisms and Systems which can be Deployed in Asymmetric Warfare Scenarios

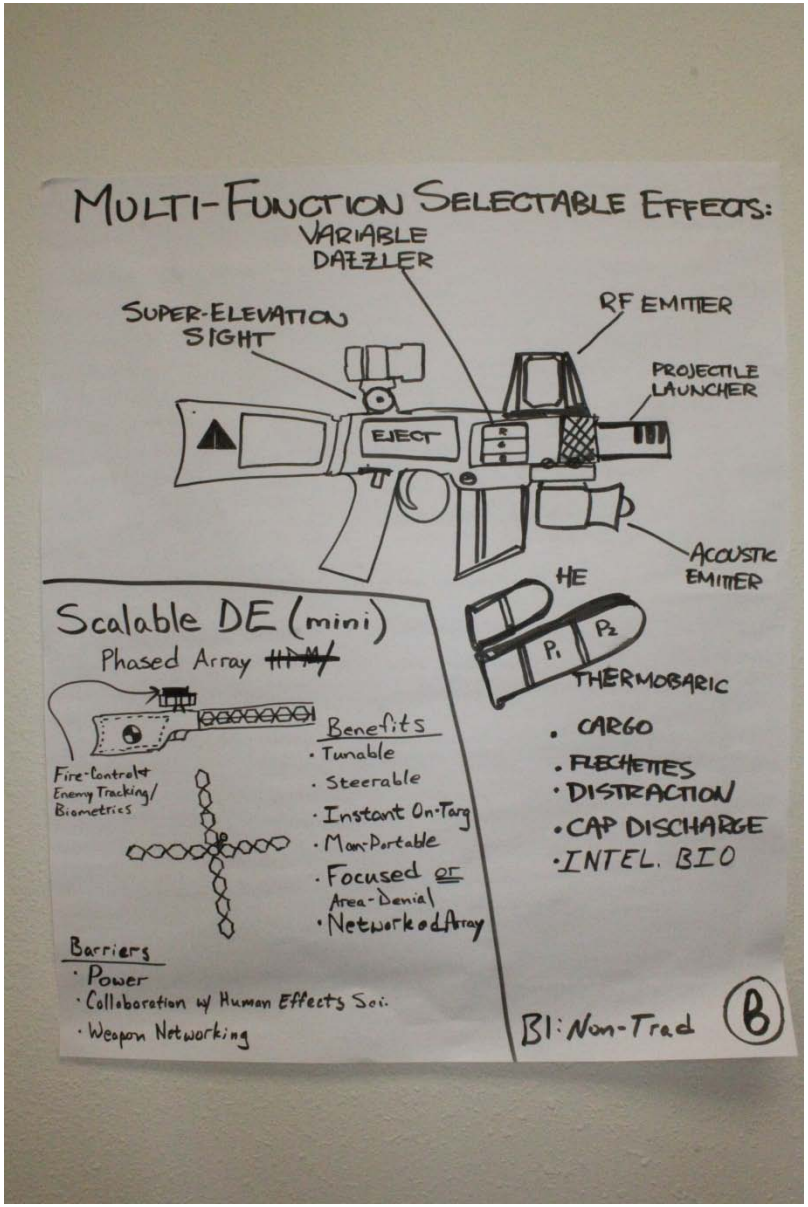
Focus Theme Group B2 Revolutionary Non-Traditional Systems Integration

- **Focus/Objectives:**
  - Innovation in System Integration to Achieve Superior Capability Using Traditional and/or Non-Traditional Armament Systems
    - Integration of Enabling Technologies
    - Leverage of Other Focus Group Technologies and Concepts
    - Attributes
      - Observe
      - Orient
      - Decide
      - Act

Functions:
- Detect
- Acquire
- Engage
- Access
- Re-Engage

- **Key Requirements:**
  - Integrated Situation Awareness—C4ISR
  - Secure Communications
  - High Speed Large Bandwidth Wireless
  - Miniature Sensors and Fusion
  - Power Sources and Management
  - Artificial Intelligence

Focus Theme Group C1
Emerging Future Technologies



Focus Theme Group B2 Revolutionary Non-Traditional Systems Integration

- **Technologies:**
  - Integration
  - Miniature Sensors and Fusion
  - Power Management
  - Artificial Intelligence
  - Wireless Secure Broadband Network
  - Defeat Mechanism Scalability
  - I/O Simplicity and Flexibility
  - Target Processing
  - Soldier Biometric Monitoring and Impact Assessment

- **Barriers:**
  - Bandwidth Capability Limitations
  - Processing Speed
  - Decision Process and Algorithms
  - Low Power Consumption
  - Sensor Fusion State of Art
  - Operation Concept Assessment

Focus Theme Group B2 Revolutionary Non-Traditional Systems Integration

- **Concepts Resulting:**
  - Advanced Soldier I/O System (Communicates Soldier Situation Awareness)
  - Targeting Marksmanship Augmentation (Biometric Effects of Soldier etc.)
  - (Note items above are linked to Concepts of A3)
  - Universal Multi-Gun Integrated Weapon System (Scalable) (Linked to Situation Awareness Modules)

- **Go Forward Recommendations:**
  - Establish Integrated System Concept—Outline System/Subsystem Requirements
  - Establish State of Art and TRL Level of Subsystems—Prioritize
  - Establish Rigorous Situation Awareness Scenarios and Decision Processes
  - Assess Biometrics of User—Identify Sensors and Measures of Effects/Metrics
  - Establish System Demo Roadmap

- **Benefits:**
  - Applies Situation Awareness Data Base and Decisions in All Target Engagements
  - Potential to Reduce Warfighter Operation Decisions

Focus Theme Group C1
Emerging Future Technologies

- **Focus/Objectives:**
  - Identify Innovative Emerging Technologies which Enable Revolutionary Change in Small Arms Systems when Integrated as a Total System
    - Materials
    - Energetics
    - Sensors
    - Software
    - Communication and Related RF, Wireless

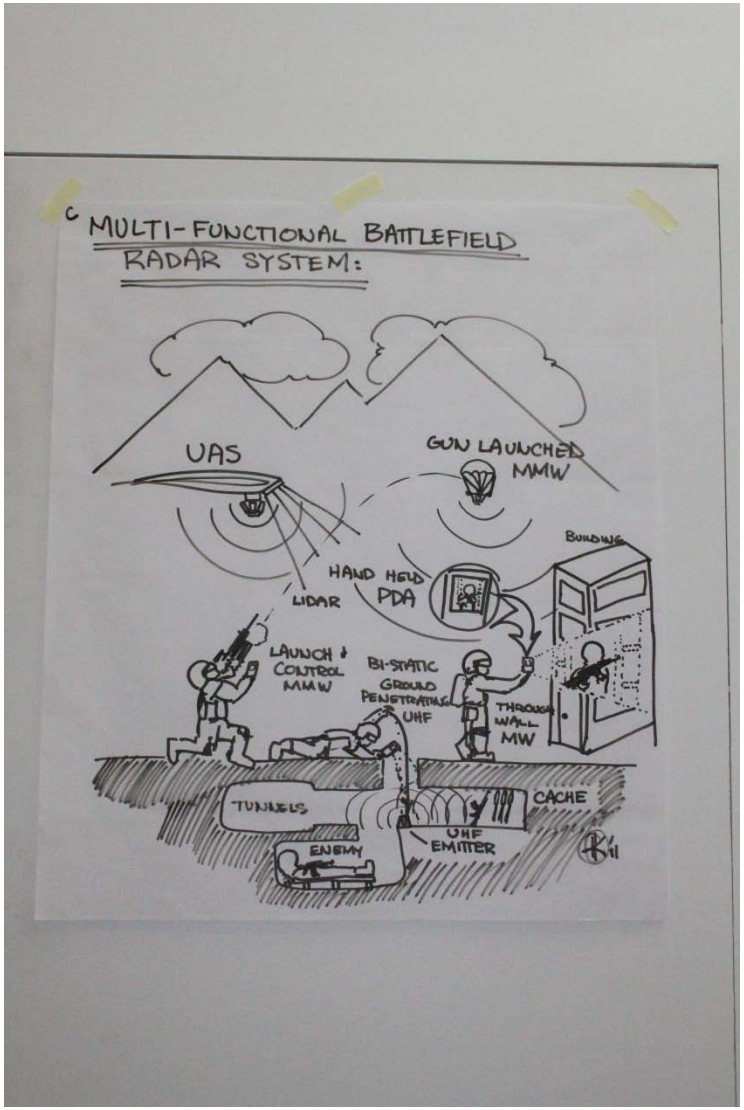
- **Key Requirements:**
  - Unique Material Properties
    - Lightweight—High Strength
    - Adaptive Materials
  - Unique Energetics (Explosives, Detonators, Propulsion)
  - Sensor Performance Enabling Target Detection in Real Time
  - Efficient and Effective Sensor Fusion
  - Multi-Functional Wireless MMW Radar

Focus Theme Group C1
Emerging Future Technologies

- **Technologies:**
  - Nano-Materials
  - Nano-Energetics
  - Hybrid Materials
  - Millimeter Wave Sensors and Radar Systems
  - MMW Wideband Components and Antennas (Focus on Miniaturization)
  - Wireless Technology
  - Sensor Miniaturization
  - Sensor Fusion
  - High Speed Signal Processing
  - State of Art CFD and Related Simulations

- **Barriers:**
  - State of Art—TRL Level
  - Material Characterization
  - Millimeter Wave Technology Miniaturization
  - MMW System Fusion

Focus Theme Group C1
Emerging Future Technologies



Focus Theme Group C1
Emerging Future Technologies

- **Concepts Resulting:**
  - Multiple Established—4 Selected
    - 1. Hyper-Velocity Anti-Material KE Penetrator
    - 2. Bio-Inspired, Multi-Functional Material Armor/Armor System
    - 3. Multifunctional Wireless Radar/Ladar Camera—Situation Awareness
    - 4. Tagging Round

- **Go-Forward Recommendations:**
  - Establish Multifunctional Wireless Radar Roadmap
  - Evolve MMW Sensor Data Base
  - Track and Communicate Advanced Material Status to NSATC
    - Conduct Advanced Materials Workshop (Structural and Energetics)
  - Discuss Selected Concept with User Community

- **Benefits:**
  - Specific Emerging Technologies Which Will Enable Revolutionary Small Arms Capability Have Been Identified and Status Defined and Coordinated

Key NSATC Futures IV Observations

- ***Innovation Vision for 2016+*** **Was the Focus of All Participants**
- **Strong Focus on** ***Technology Driven Innovation*** **Linked to Warfighter Capability**
  - **Little Attention to "Requirements Driven"**
- **Discussions Focused on** ***"What" Not "How"*** **Enabled Openness and Innovation**
- **Industry/Academia Participants Were** ***Not Constrained in Open Discussion***
  - **Proprietary Data and Information Issues Were Not a Concern**
- **Focus Work Group** ***Interaction Was Excellent*** **—Process and Facilitator Enabled**
- **Each Focus Work Group Established** ***Prioritized Innovative*** **Concepts/Technology**
- **Definite Interest in** ***Follow On NASTC Futures Workshop***

- **Futures IV Met Objectives/Outcomes**
- **Effectiveness of Industry/Academia Participants Only Confirmed**
- **Outcomes Provide Input for Visionary 2016+ Warfighter Capability**

Small Arms 2016+ Technology Innovation Drivers

1. Advanced Energy Sources
   - High Energy Density
   - Power Efficiencies
   - Miniaturization
   - Integration Ease/Conformal
   - Rapid Recharge Recovery
   - Lightweight
   - Environmentally Rugged (temperature, shock, vibration etc.)

- System Engineering/System Integration Focus is Critical
- Application Concepts
- Design/Performance Guidelines
- TRL Criteria/Status
- Manufacturing Readiness

2. State of Art Virtual Simulations

3. Integrated Situation Awareness Capability
   - User Adaptable
   - Video (Still and Live)
   - IR/Fusion etc.
   - Communication
   - GPS
   - Hovering
   - Networked Fires Capability
   - Cognitive Decision Making

4. Expanded Non-Traditional Armament Capabilities

- **Legal Assessment On-Going**
- **Innovation in Defeat Mechanisms using New Technologies**
- **Energy Sources Suitable for Man portable Non-Traditional Mechanism**
- **Consideration of Selected New Capabilities**
  - ***(Requires Detailed Review of Acceptance for Consideration)***
  - ***(Proceed with Appropriate Review and Caution)***
- **Application of Scalable Mechanisms**

5. Evolution of Hypervelocity Mechanisms

6. Unique Expansion of Radar and MMW Technology for Target Detection and Location—Linked to Situation Awareness Mechanisms/Capability

7. Attention to Sensor Fusion—Effectiveness, Integration, Power, Size, Capability

8. Nano—Technology Applications—As Nano-technology evolves and matures the use of these materials will be key enablers for Advancements in the Small Arms and supporting areas.

- ***NSATC Futures IV Workshop Addressed Barriers To Addressed and Approaches to Resolution***

- **Key Barrier Categories:**
  - Linking Workshop Output to User Evolving Future Capability Vision
  - Selected Technology Availability and Readiness
  - System Integration of Advanced Concepts—Early Systems Engineering is Priority
  - Effective Collaboration with Relevant "Subject Matter Expertise"

- **Examples of Technology Barriers:**
  - Power Source Technology and Integration
  - Sensor Fusion Maturity and Related Size, Power and Integration
  - Advanced Defeat Mechanisms (Warheads and Other Mechanisms) Readiness
  - Evolving Maturity of NanoTechnology
  - Treaty and Agreements Re: Advanced Technologies

Barrier Resolution: 1)Systems Engineering 1) On-Going NASTC Actions; 2) Futures IV Follow-Up; 3) Planning for Futures V etc.; 4) NSAC Projects; 5) Industry Activity

Futures IV
Enabling Resources
Complementing Small Arms Scope

- **Futures IV Innovative Visionary Capability Requires Resources and Coordination Outside Scope of Small Arms Systems**

- **Establishing Links with Relevant Technologies and Systems Is Key to Realize Future Visionary Systems**
  - **Enabling Technologies**
  - **Joint Programs**
  - **System/Subsystem Interfaces**
  - **User Operational Considerations**

- **Complementary Resources and Centers (Industry, Academia, Government)**
  - **Communications/Networking/Situation Awareness (C4ISR)**
  - **Sensors and Sensor Fusion**
  - **Materials Technology**
  - **Robotics/UAV's—Emerging Platforms etc.**

Actions to Link to Complementary Resources

1. **Futures IV Output Identifies Needed Capability/Links**
2. **Links Across Related Consortiums**
3. **Government Interface with Other Agencies/Departments**
4. **Industry/Academia Initiatives**

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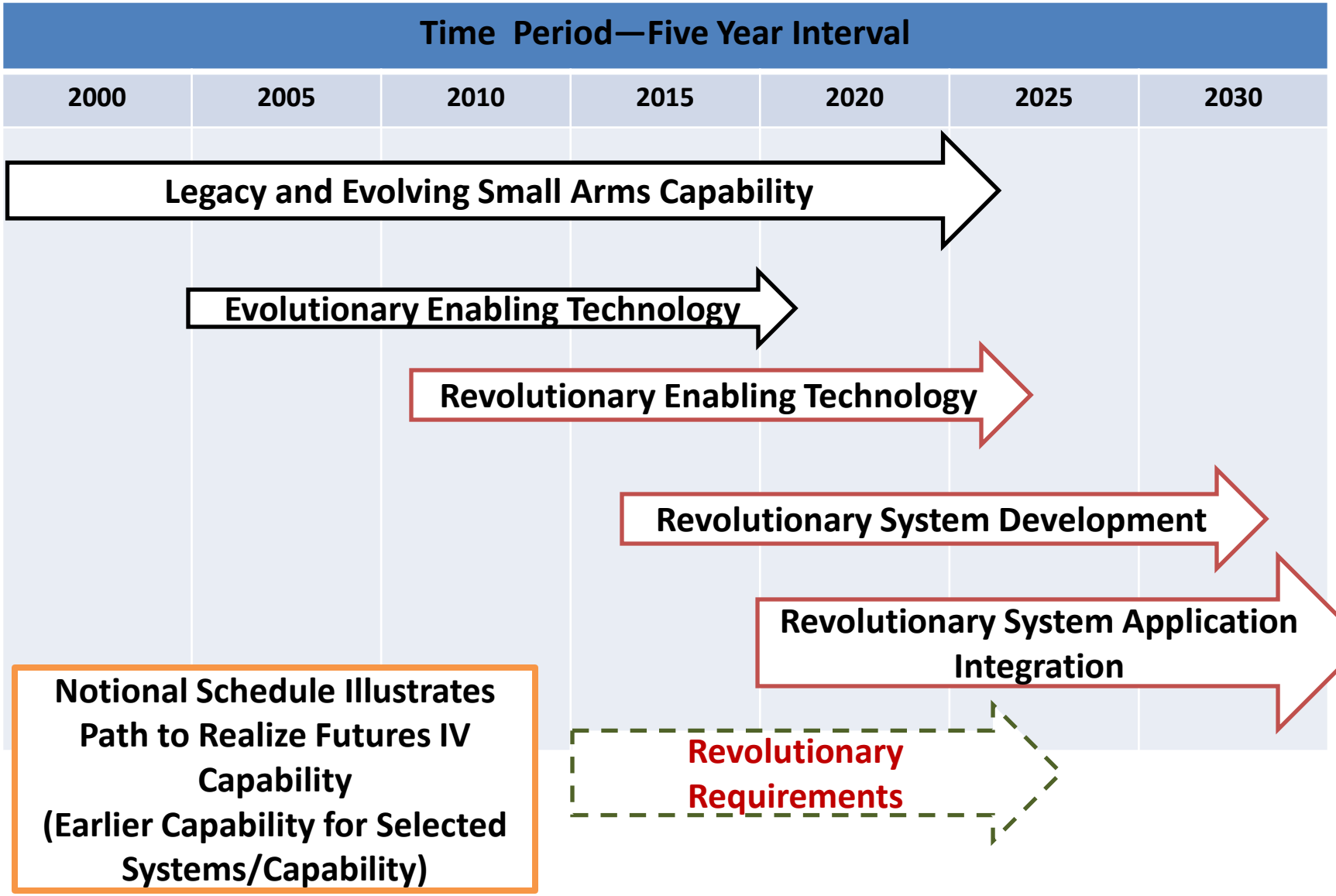
Futures IV Workshop
Integrated Visionary Schedule

Futures Capability Workshop



Futures IV Workshop
Revolutionary 2016+
Small Arms Capability Vision

Small Arms Capability—2012

- Individual Weapons
- Crew Served Weapons
- Turreted System
- Air Burst Systems
- Non-Lethal Capability
- (Short Range)
- Fire Control Systems

2016+ Vision Evolved From Futures IV Revolutionary Innovative Concepts

Small Arms Capability 2025 (Enabled by 2016+Vision)

- 2012 Capability Evolved and Integrated with Revolutionary Systems
- Power Source Efficiencies and Conformal Packing
- Expanded Situation Awareness Capability
- Networked Systems
- Precision System Capability
- Scalable Weapon Capability
- Non-Traditional Weapon Capability
- Non-Lethal Advanced Mechanisms and Extended Range
- Multiple Platforms
  - Warfighter
  - Robotics
  - UAV

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Small Arms 2016+ Visionary Technology and System Integration Changes Government and Industry Readiness Response

Futures Capability Workshop

- **Innovative Revolutionary Technologies and Systems Reach Beyond Traditional Scope of Small Arms Resources**

- **Realizing Revolutionary Systems Capability Will Require Expanded Collaboration Among Government (including National Labs), Industry, and Academia**

- **Key Priority Topics Benefiting from Collaboration;**
  - **1. Power Source and Power Management**
  - **2. Sensors and Sensor Fusion**
  - **3. Advanced Materials including Nano-Materials(Metallic, Polymers, Composites, Energetics etc.)**
  - **4. Millimeter Wave Technology**
  - **5. Artificial Intelligence**
  - **6. Non-Traditional Defeat Mechanisms and Weapons**
  - **7. Situation Awareness and Cognitive Technology**
  - **8. Networked Systems**
  - **9. Others TBD**

Small Arms Systems 2016+
Expanded Interface Involvement
Enabling
Revolutionary System Applications

- Links Across Government Agency Technology and System Expertise Centers
- Links and Interface with Other DOD Consortiums
- Expand Dialogue with National Laboratories
- Expand Network and Interfaces with Academia
- Connect with Specialty Business Association or Technology Groups
- Ensure Involvement of Industrial Base When Applying New Technology and Systems—Industrial Base Must Evolve Concurrently with New Technology

Industrial Base Companies Links and Involvement are Critical to Moving Innovative Futuristic Capability Forward

- **Technology, Systems Engineering, Manufacturing, Investments**

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Small Arms Systems 2016+ User Interface Vision

Futures Capability Workshop

- Establish a Rigorous On-Going Working Discussion Plan and Format
  - Proactive View of Future Threats and Capability Needs
  - Understand Evolving Threats and Operational Concepts etc.
  - MCOE Interface
  - All Services (JSSARI etc.)
  - Other Agencies
  - Expand Beyond JSSAP Coordination
- Address Requirements and Technology
  - Requirements Driven and Technology Driven Focus
  - Achieve Early Potential Value of Evolving/Revolutionary Technology/Capability
- Understand User Priorities and Focus (Current and Future Vision)
- Consider How User Interface can Impact Futures Visions and Technology/System Roadmap
- Seek User Expression (endorsement and priorities) of NSATC Technology Initiatives

Establish Industry Leadership Interface to Complement Government Interface

- **Objectives:**
  - Evolve Integrated Plan for NSATC Futures Workshop Continuing Series of Visionary Events
  - Confirm Plans for Futures V and Futures VI (Initiate 2012 and 2013)
  - Expand Industry Participation and Expertise Input
  - Ensure Attention to Priorities
    - Systems Engineering
    - Enabling Technologies
  - Address Transitioning Futures Output to Funded Projects
  - Communicate to NSATC and Related Participants

- **Approach:**
  - Obtain Industry, NSATC, Government Input for Futures V and VI Themes, Scope, and Participants
  - Select Themes and Topics Viewed as Offering Payoff If Addressed in Futures Workshop Format
  - Involve Subject Matter Experts (SME's) and Specialists (e.g. Gamers etc.)

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Futures IV Workshop
Follow On Future V and VI Workshop Content

Futures Capability Workshop

Workshop Topic(s)
Update Futures IV
Update and Expand Futures IV
User Dialogue and Update/Expand IV, Add User Preferred Topics
Manufacturing Emphasis (4-6 categories of Mfg)
Advanced Materials Focus (invite material specialists from industry, academia, and government Labs
Modeling and Simulation Focus
Advanced Energetics Focus
Power Focus
Sensor Focused
Electronics (low power and packaging)
Open Architecture Application to Small Arms Systems
Unconventional Armament Technology
Integration of Up to 6 Topics per Format of Futures IV
Other Suggested Topics

- 1. User Topics of Interest—Topics Suggested by User Community
- 2. Manufacturing Technology and Systems for the Future(Forming, Automation, Inspection etc.)
- 3. Advanced Materials and Material Protective/Finishes
- 4. Advanced Modeling and Simulation
- 5. Situation Awareness and Cognitive Technology
- 6. Power and Power Management
- 7. Advanced Energetics
- 8. Electronic (Low Power and Packaging)
- 9. Advanced Sensors
- 10. Miniature G&C
- 11. Unconventional Armaments
- 12. Networked Systems
- 13. Application of Open Architecture System Design for Small Arms Systems
- 14. Update and Expand Future IV Topics
- 15. Soldier Systems Utilzing Robotics and UAV/UAS etc.
- 16. Achieving Precision—Minimizing Collateral Damage
- 17. Command and Control Links for “Smart Muntions”
- 18. Other Suggestions by Government and Industry etc.

- 1. Game Experts
- 2. Advanced Material Expertise (Academia, Industry, Govnt labs, National labs)
- 3. Cognitive and Situation Awareness Technology
- 4. Virtual Simulations
- 5. Nanotechnology
- 6. Manufacturing Technology (Advanced machine tools, robotics, 3-D printing, other TBD)
- 7. Unconventional Weapons Technology
- 8. Evolving User Approach to Unconventional Weapons
- 9. Networked Systems
- 10. Open Architecture Application
- 11. Information Capture, Exchange, and Utilization (e.g. Smart Phone Technology etc.)
- 12. Other Special Experts
- 13. User Community Perspective of Future Capability Visions

- ***Experts (SME's) Would Provide Briefing of State of Art Technology and Work with Theme Focus Groups to Evolve Futures Concepts***

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Futures IV Workshop General Membership Participation Go Forward Actions

Futures Capability Workshop

- NSATC Futures Workshop Process Is Open to NSATC General Membership
- Futures IV Workshop Theme Focus Groups Are Open to Critique and Comments to Complement the Output/Outcomes
  - "Open On-Going Process" Will be Treated as Report Addendums

Input Encouraged

- Suggestions for Future Workshop Topics and Approaches are Encouraged
- Workshop Output/Outcome Shapes NSATC Programs, Budget, and Opportunities
- Small Arms System Capability Revolutionary Capability Change Opportunities Will Evolve Through Links with "User Community"
  - Links to Requirements Process
- Industry/Academia etc. On Going Investment and Innovation is Critical to the Path Forward

Industry/Academia Leadership in Technology and Concept Innovation Is Central to Realizing Revolutionary Capability
NSATC and Specific Programs Must Evolve with Clarity—Ensuring Opportunity

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Futures Workshop
Transitioning Workshop Output
To Funded Multi-Year Programs

Futures Capability Workshop

- **Objectives:** Establish NSATC Integrated Approach that Will Transition Future Workshop Outcomes to Funded Projects

- **Approach:**
  - Recognize that NSATC Futures Workshop Outcomes are Focused to "Technology Driven Innovation" not only "Requirements Driven" Capabilities
    - Focus on Innovation and Visions of "New Technologies"
    - Establish System Integration/Application
    - Assure TRL and Manufacturing Readiness Roadmaps
    - "Package the Information to Gain DA and DOD Acceptance
  - Establish Outcomes Focus to Specific Project Objectives and Benefits
    - Link to Warfighter Benefits and New Capability Multi Applications
  - Focused Team of NSATC, Industry and Government to Formulate the Plans
    - Roadmaps
    - Specific Projects
    - Applications
    - TRL/MRL
    - Milestone Plan—Demo---Maturity
    - Funding

Futures IV Workshop Out-Brief Re-Cap

- **NSATC Futures IV Workshop Provide Unique "Industry Focus" Format For Future Technology and System Capability for the Warfighter**
  - **Format Enabled Open and Not Constrained Identification of Innovative Technology/Systems**
  - **Out-Comes and Recommendations Have "Value" to Industry, Government Labs,and Warfighter in Planning Future Small Arms and Related Capabilities**
    - **Technology and System Roadmaps Baselines and Visions**

- **Format Utilized Established Structure and Process for Follow-On Workshops**
  - **Apply Similar Format and Process**
  - **Tailor to Specific Topics and Participants**

- **Workshop Critique and Comments from Non-Participants (i.e. Labs, JSSARI etc.) is Critical and Key to the Utilization of Workshop Output to Shape Future Requirements, Programs, and Capabilities**

- **Realizing Future Small Arms Potential Capability will be Impacted by:**
  - **Attention to Compliance with Treaties and Agreements**
  - **Linking of Small Arms System Technology Scope with Complementary Technology and System Integration**
  - **User Interface and Critique of Technology Driven Opportunities (Timely and Focused)**

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Futures IV Workshop Out-Brief Re-Cap

Futures Capability Workshop

- Futures Workshop Objective and Outcomes Completed
- "Disruptive Technology" Innovation Process Established
- Technology and Systems Roadmap for Post 2016 Initiated
- Priority Technologies and Enablers Established
- Focus on Systems Engineering Emphasized To Ensure Demonstration and Maturity
- Links to User Community Established
- Barriers and Challenges Identified
- Roadmap for Opportunities Evolving
- Expanded Industry Participation and Interface Adds to Innovation and Applications

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Futures Workshop Series Go-Forward Bottom Line Vision

Futures Capability Workshop

- NSATC Futures Workshop Series Value Confirmed
- Workshop Process Enables/Captures "Innovation"
- Process Application Applicable Beyond NSATC
- "Technology Driven" Priority Enablers Identified
- Systems Engineering Focus Critical to "Innovation"
- Barriers and Risks Established
- Application Roadmap Process Established

- Futures Process and Outcomes Provide Value/Benefits
  - Government
  - Industry
  - Academia
  - National Labs
  - Warfighter

- Key Process Drivers Ensuring Success:
- Disruptive Technology; Collaboration; Expertise