Battlespace Awareness Program Overview

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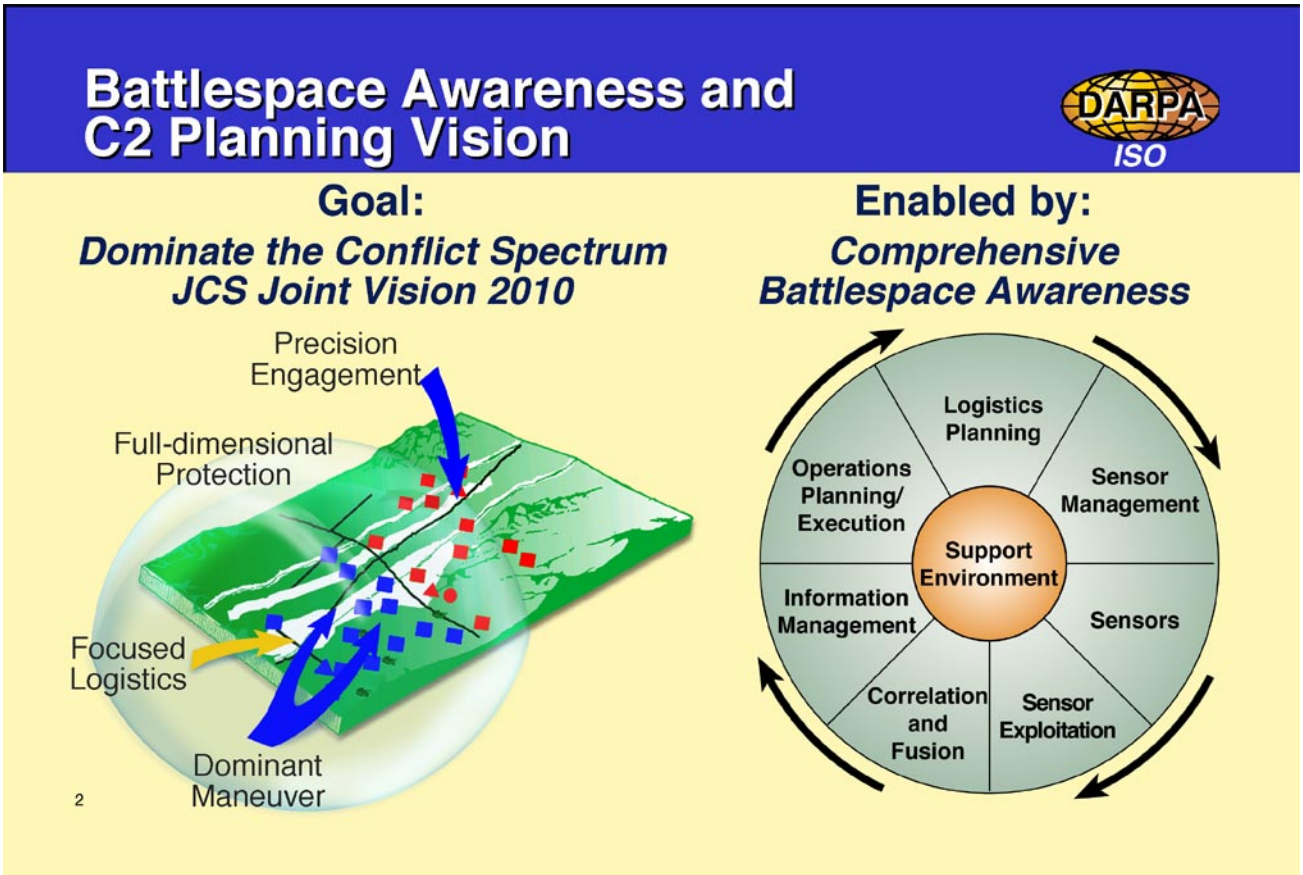
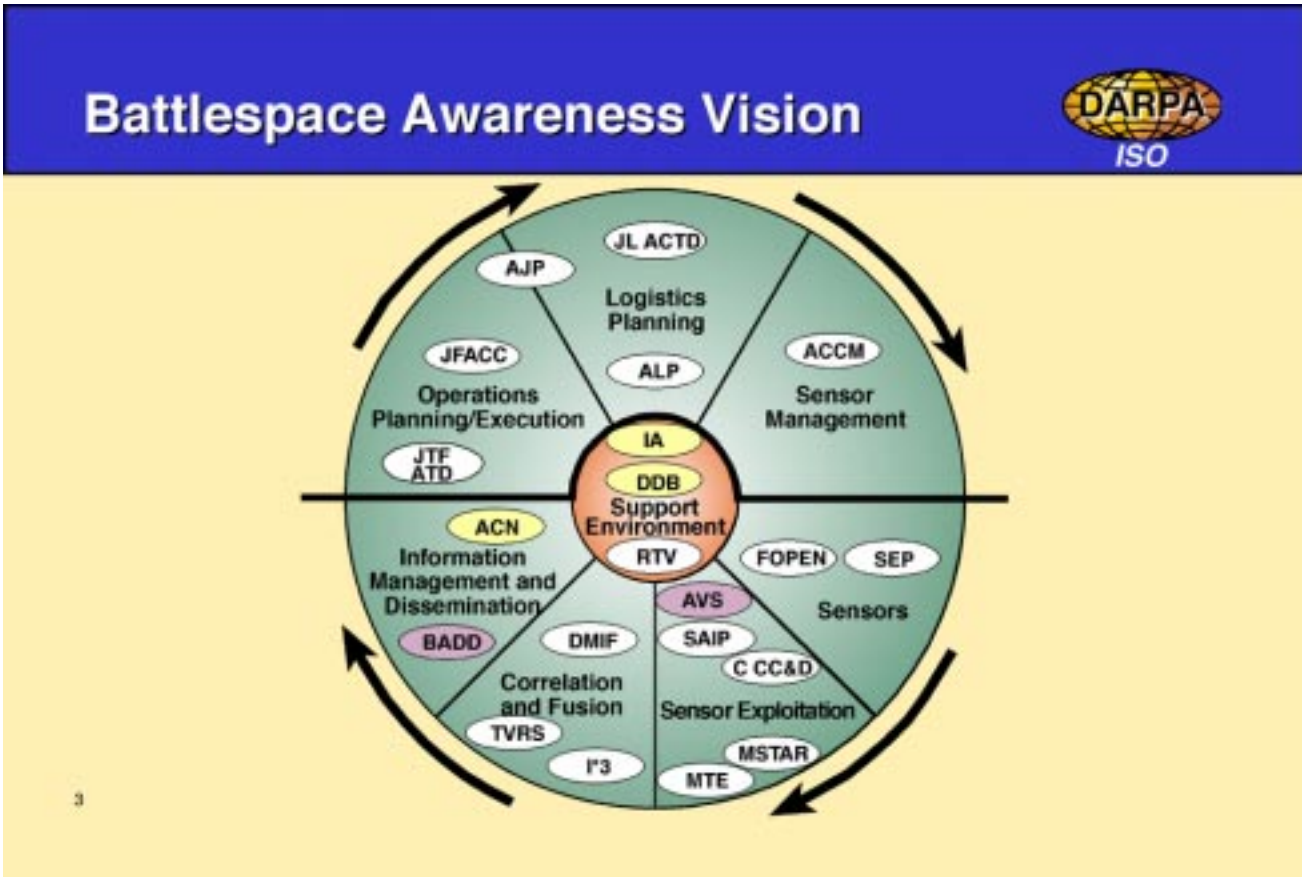


The goal of thrusts like Joint Vision 2010 is to dominate the conflict spectrum in four major areas: Precision Engagement, Dominant Maneuver, Focused Logistics, and Full-dimensional Protection.

This desired domination is built upon Information Dominance and enabled by Comprehensive Battlespace Awareness, as shown in the circular chart on the right hand side of the slide. This familiar intelligence, surveillance, and reconnaissance cycle involves the tasks of managing the sensors, sensing the desired targets and the environment, exploiting the collected data, correlating and fusing the information, and managing and disseminating the data with the aid of a dynamic support environment. These functions enable the warfighter to dominate the conflict spectrum through the Operations Planning and Execution and Logistics Planning C2 functions.



Mapped onto the Battlespace Awareness functions are a number of programs within the Information Systems Office. I will primarily focus my discussion on the lower half of the wheel. Those functions are grouped into comprehensive Battlespace Awareness within the Information Systems Office.

I will also also provide you with details of the Airborne Video Surveillance and Battlespace Awareness and Data Dissemination programs, shown as the purple shaded AVS and BADD ovals, respectively. Following my presentation will be briefings highlighting our new efforts in the Airborne Communications Node (ACN), Information Assurance (IA), and the Dynamic Data Base (DDB) programs, shown as yellow shaded ovals.

ACRONYM TABLE

ACCM - Advanced Cooperative Collection Management; ACN - Airborne Communications Node; AJP - Advanced Joint Planning Advanced Concept Technology Demonstration; ALP - Advanced Logistics Program; AVS - Airborne Video Surveillance; BADD - Battlefield Awareness and Data Dissemination; CCC&D - Counter Camouflage, Concealment & Detection; DDB - Dynamic Data Base; DMIF - Dynamic Multi-User Information Fusion; FOPEN - Foliage Penetration; I*3 - Intelligent Integration of Information; IA - Information Assurance; JFACC - Joint Force Air Component Commander; JL ACTD - Joint Logistics Advanced Concept Technology Demonstration; JTF ATD - Joint Task Force Advanced Technology Demonstration; MSTAR - Next Generation Automatic Target Recognition Technologies; MTE - Moving Target Exploitation; RTV - Rapid Terrain Visualization; SAIP - Semi-Automated Imagery Intelligence (IMINT) Processing; SEP - Sensor Emulation Platform; TVRS - Text, Radio, Video, Speech

Battlespace Awareness Strategy

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- Design, develop, demonstrate, and transition selected technologies to empower the warfighter with battlespace awareness
- Approach:
  - Distributed network of sensors
  - Sensor diversity to counter camouflage, concealment, and deception
  - Automated and semi-automated exploitation to detect, classify, and track stationary, moving, exposed, and hiding targets
  - Distributed, dynamic all-source correlation, and fusion
  - Wideband dissemination, dynamic information management, and tailored visualization

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The strategy of Battlespace Awareness is to design, develop, demonstrate, and very important, to transition technologies to empower the warfighter.

The approach is to take advantage of the ubiquitous distributed network of sensors and platforms having the diversity to counter camouflage, concealment, and deception techniques. Automated and semi-automated exploitation techniques will be used to detect, classify, and provide birth-to-death tracking of stationary, moving, exposed, and hiding individual targets and groups.

Distributed, dynamic all source correlation, and fusion are used to support situation awareness evidence accumulation. Wideband dissemination, coupled with tailored visualization, and dynamic collection management complete the Battlespace Awareness process.

Battlespace Awareness Thrusts

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Sensors

- Targets in open → Targets in natural hide or CC&D

Sensor Exploitation

- Single observable → Diverse observables
- Manual Interpretation and Classification → Automated interpretation and classification
- Template-based → Model-based

Correlation and Fusion

- Stylized forces → Non-stylized formations
- Single source correlation → Multisource correlation

Info. Mgmt. & Dissem.

- Text messages → Multimedia information
- Fixed stovepipes → Broadcast information on demand

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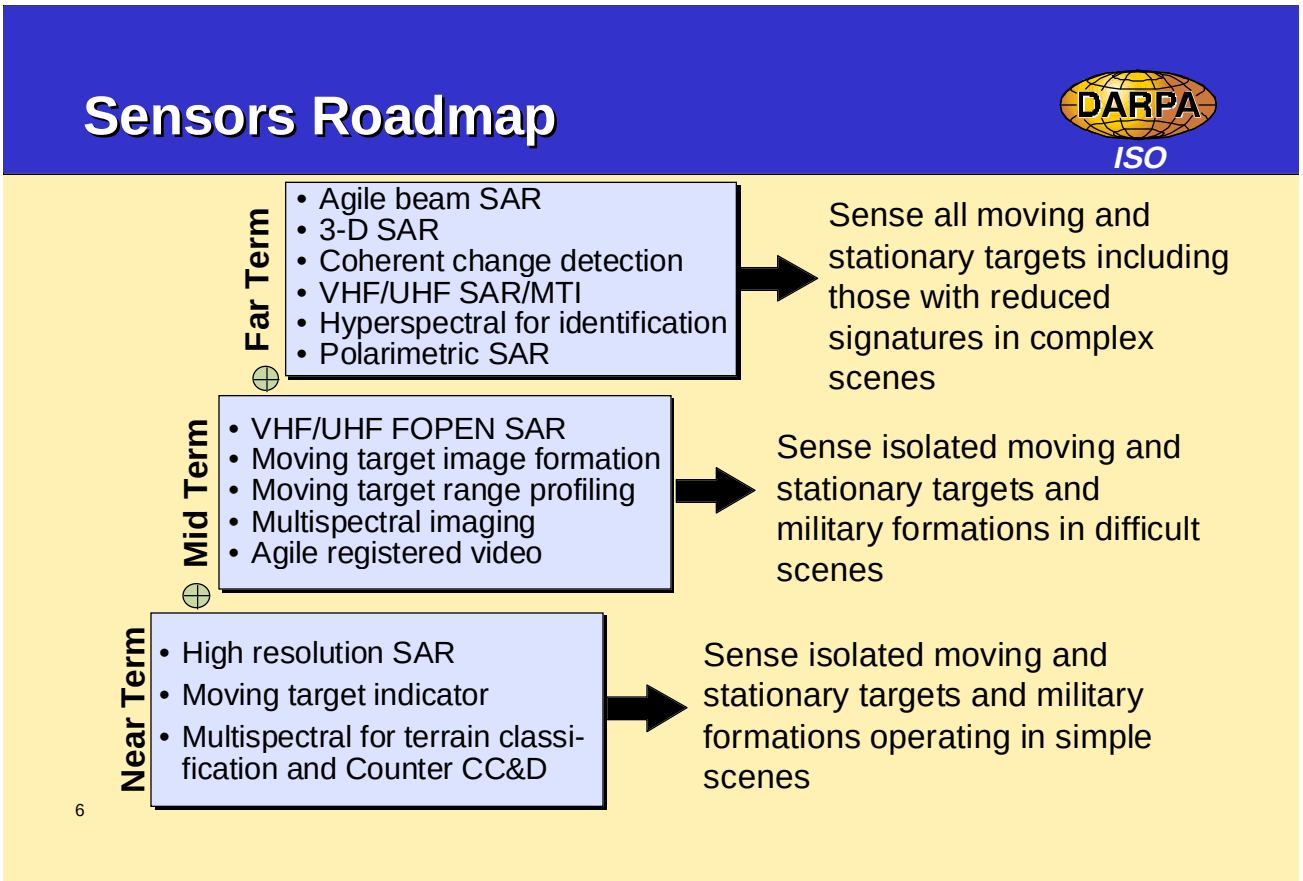
The Battlespace Awareness thrusts in the four major functions are shown in this slide.

The diverse set of sensors must collect against targets in the open and targets in natural hide or under artificial camouflage, concealment, and deception.

Exploitation techniques must take advantage of the diverse observables that support automated data interpretation and target classification using template and model based algorithms.

Correlation and fusion techniques must support evidence accumulation of non-stylized forces and multisource correlation as we move into the post cold war environment.

Information management and dissemination will be relied upon to make multimedia information available to all echelons via direct broadcast on demand, as well as enabling theater connectivity through airborne relays and nodes (e.g., ACN).

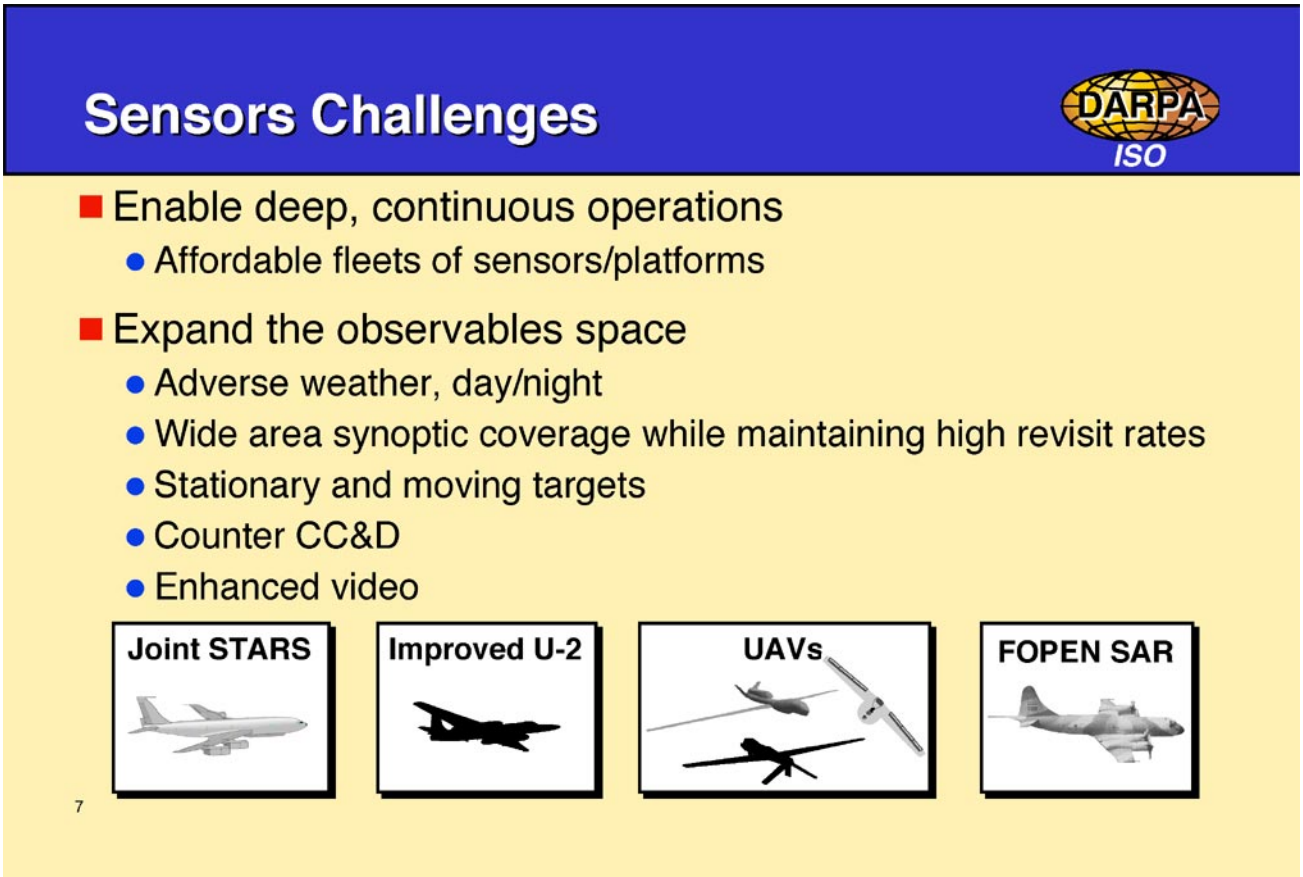


This chart shows the sensor roadmap moving from the near term to the far term. Current sensing capabilities including high resolution synthetic aperture radar or SAR, moving target indicator or MTI, and multispectral data for terrain classification and CC&D allows us to sense isolated moving and stationary targets and military formations operating in simple scenes.

In the mid term, UHF and VHF wideband foliage penetration SAR, moving target image formation and moving target range profiling, and improved multispectral sensors will support sensing isolated moving and stationary targets and formations in more difficult scenes, like targets against tree lines or partially obscured by foliage and camouflage.

In the far term, agile beam, 3-D, and polarimetric SAR, VHF and UHF MTI, and hyperspectral sensors combined with coherent change detection will allow commanders to sense all moving and stationary targets in the battlespace, including those employing reduced signatures or located in complex scenes.

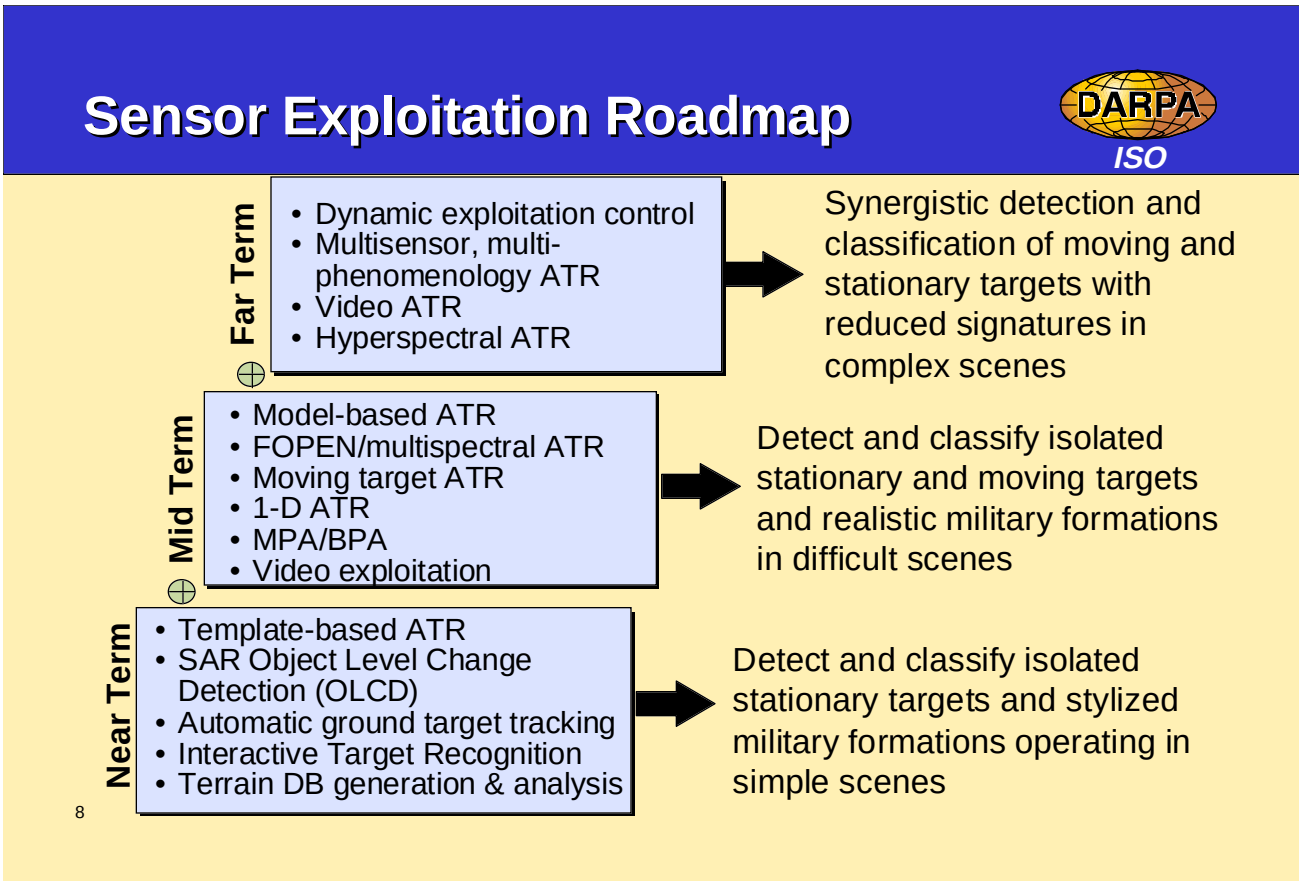
For purposes of this and subsequent roadmaps, near term is defined as “within 5 years,” mid term is “5 to 10 years,” and far term is “beyond 10 years.” While exact time scales for technology are always suspect, this provides a rough view of where we are focused and when we think we can have a military significant contribution.



The challenges for the sensor community are to enable continuous operations deep within enemy-controlled areas. These operations will be supported by an affordable fleet of diverse sensors and platforms.

The challenge is to expand the observables space to all weather, day/night operation, providing wide area synoptic coverage while maintaining high revisit rates of stationary and moving targets employing CC&D. Enhanced video sensors will support the need for real-time tactical imagery.

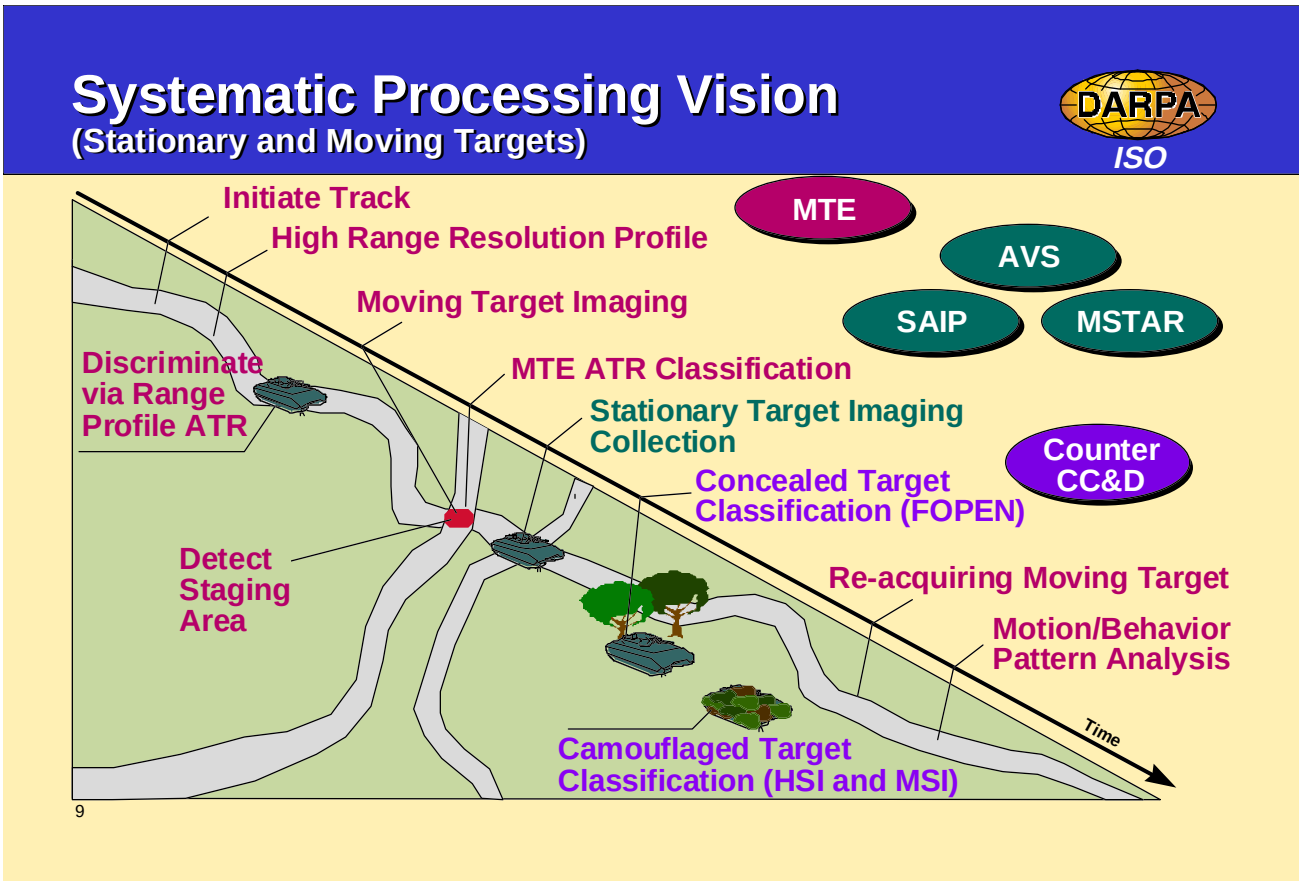
Our vision is not only to meet the stated military requirement “40,000 sq. nmi. every 24 hrs.,” but to exceed that so that the entire theater battlespace is under essentially constant surveillance. This provides drivers on sensor cost and capabilities, and impacts downstream exploitation and dissemination concepts, as will be seen in the following slides.



The sensor exploitation roadmap shows that current exploitation capabilities include template-based automatic target recognition, or ATR, SAR-based object level change detection, or OLCD, to help reduce the number of false targets detected, and automatic ground target tracking of moving targets. Interactive target recognition and terrain database generation further support the detection and classification of isolated stationary targets and some military formations operating in simple scenes.

In the mid term, model-based ATR, moving target 1-D and 2-D ATR and force structure analysis, and FOPEN ATR and OLCD techniques will be combined with improved video exploitation, multispectral, and EO site monitoring techniques to detect and classify isolated stationary and moving targets and realistic military formations operating in difficult scenes.

In the far term, dynamic exploitation control and multisensor, multi-phenomenology ATR will exploit all available observables. Interferometric SAR, improved video ATR, and hyperspectral ATR will help exploit currently unexploited information to provide the synergistic detection and classification of moving and stationary targets having reduced signatures operating in complex scenes.



Stationary target exploitation technologies (for example, those developed in the SAIP ACTD) and moving target exploitation technologies (for example, those developed in the Moving Target Exploitation and Airborne Video Surveillance programs) may be synergistically combined to support target identification and birth-to-death target tracking.

As the target enters the battlespace, MTI radar tracks the target. High range resolution MTI radar and 1-dimensional ATR are then used to perform bulk target classification. As the vehicle continues on the road, moving target imaging produces a 2-dimensional image, and ATR is then used to identify the vehicle. Stationary target SAR collections and exploitation are then scheduled when the vehicle stops, for example, in a staging area. If the vehicle moves to a hide site containing foliage, cover, or camouflage, foliage penetrating (FOPEN) radar or spectral sensing (elements of the Counter CC&D program) are used to detect and classify the vehicle. When the target leaves the staging area, MTI radar produces new track and vehicle motion and behavior pattern analysis support proper vehicle identification. The vehicle's identity is maintained throughout the process through moving and stationary target exploitation. The result is the vehicle has no place to hide from the combination of advanced sensors and exploitation techniques. The Dynamic Database, a program you will hear more about later, is a key component of maintaining this level of birth-to-death tracking and identification of theater targets.

Sensor Exploitation Challenges

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- Expanded observables space
  - Diversity of observables (phenomenology)
  - Achieving synergistic interplay
- High volume of data
  - SAR imagery: 40,000 (n.mi.)^2 or 137 billion pixels (at 1 m) per day per Global Hawk
  - MTI primitives (green worms): 2,000 to 4,000 in field of view
- Uncertain targets and scenarios
  - Countering the evolving means to deliver weapons of mass destruction
  - Rag tag, ad hoc maneuver forces that challenge force structure models
  - Operations in high clutter urban environments

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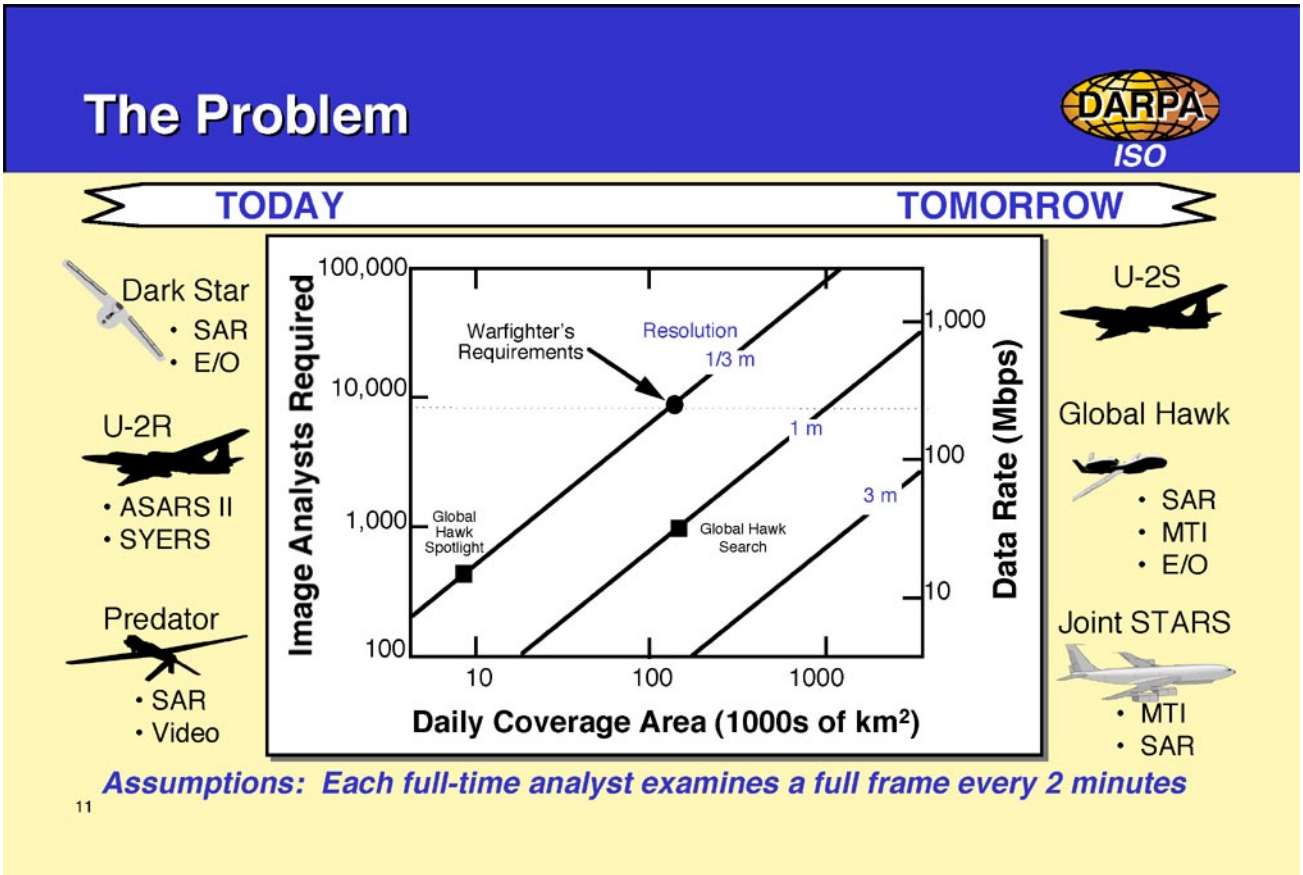
An important challenge for the exploitation and ATR communities is to expand the observables space, capture the available diversity of observables, and achieve a synergistic interplay.

The high volume of data available for exploitation means that automated and semi-automated techniques are very important. The high altitude endurance UAVs and the U-2 will provide vast amounts of stationary SAR and MTI data.

The world environment increases the likelihood of facing uncertain targets and scenarios. Future opponents composed of rag tag maneuver forces may possess weapons of mass destruction and operate in high clutter urban environments. These issues mean that future exploitation systems will likely be based on a good understanding of the underlying phenomenology and operate in multisensor environments.



This familiar chart demonstrates the need for automated systems. The graph shows the number of image analysts required as a function of the daily area coverage for a family of sensor resolutions given the set of accompanying assumptions.

A warfighter's requirement of a sensor with a 1/3 meter resolution that can cover 100,000 square kilometers per day would require nearly 10,000 image analysts, an unachievable number. This throughput can only be achieved through automating the exploitation. Future, more advanced collection systems will collect even more data, which moves the bottleneck from sensing to exploiting.

Airborne Video Surveillance (AVS) — Why Video?

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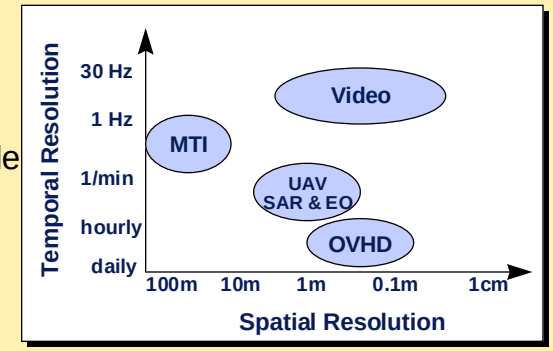
Video: any EO or IR sensor > 1 Hz
Only sensor to provide *high resolution* and *rapid revisit*

Advantages

- Immediacy
- Human understandable
- Continuous coverage
- Multiple looks
- Plentiful



Limitations

- Narrow field of view
- Weather
- Cumbersome data volumes
- Tedious to exploit
- Content is perishable

Difficult operational questions become simple

- Will the bridge support a vehicle?
- Did a missile test fire occur?

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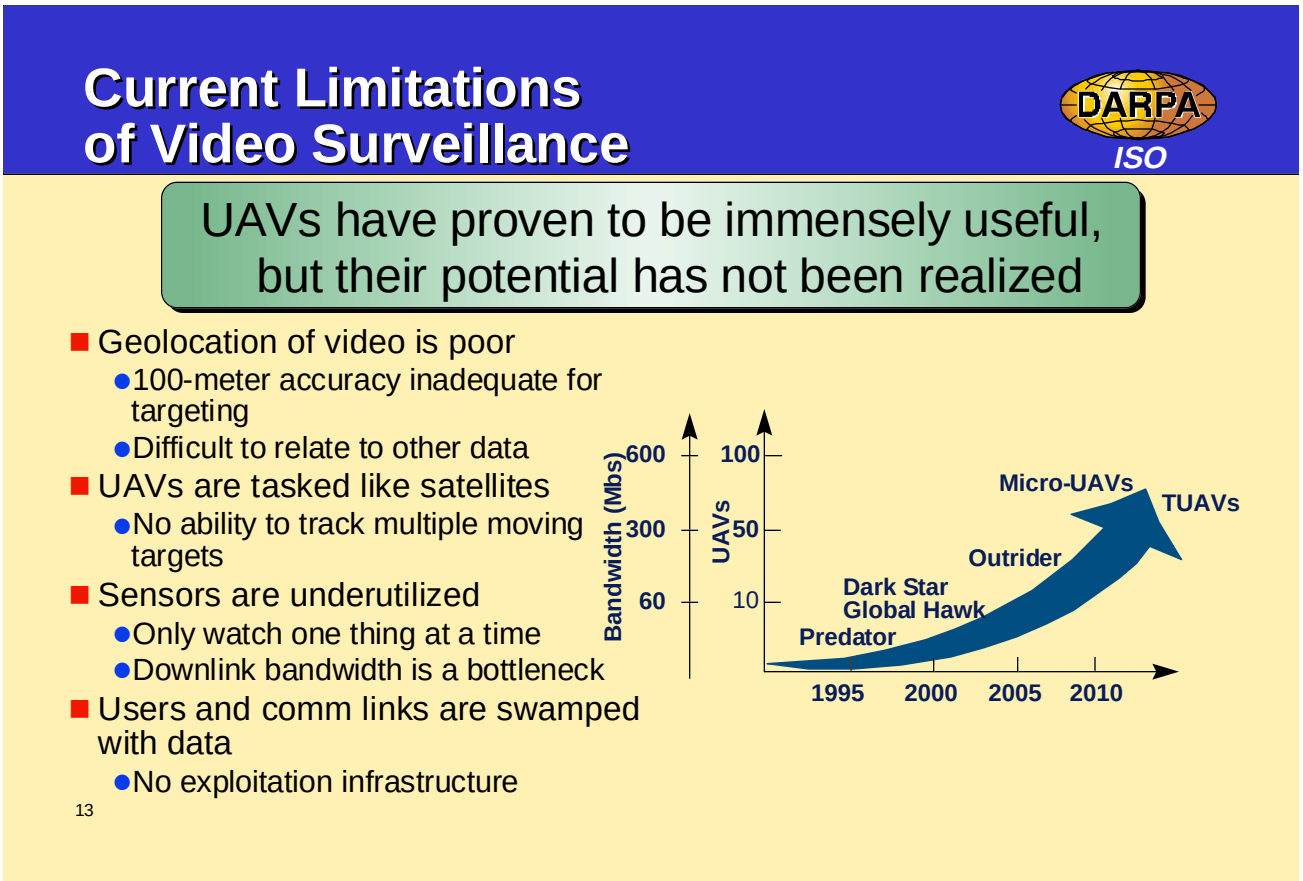
Video (defined for AVS as any EO or IR sensor operating at greater than 1 Hz) is currently the only tactical sensor capable of providing both the high spatial resolution and rapid revisit rates required for comprehensive battlespace awareness.

Video sensors possess a number of advantages for tactical exploitation: video data is human understandable, provides continuous coverage, can track non- radar scattering targets, provides motion information, and is currently produced in large volumes (making it very available for AVS system development).

Bounding these advantages are a number of limitations, including the narrow field-of-view (FOV) of existing video sensors, the impacts of weather on video collection quality and availability, the tedious nature of manual video exploitation, the cumbersome data volumes, and the content perishable nature of the targets being exploited.

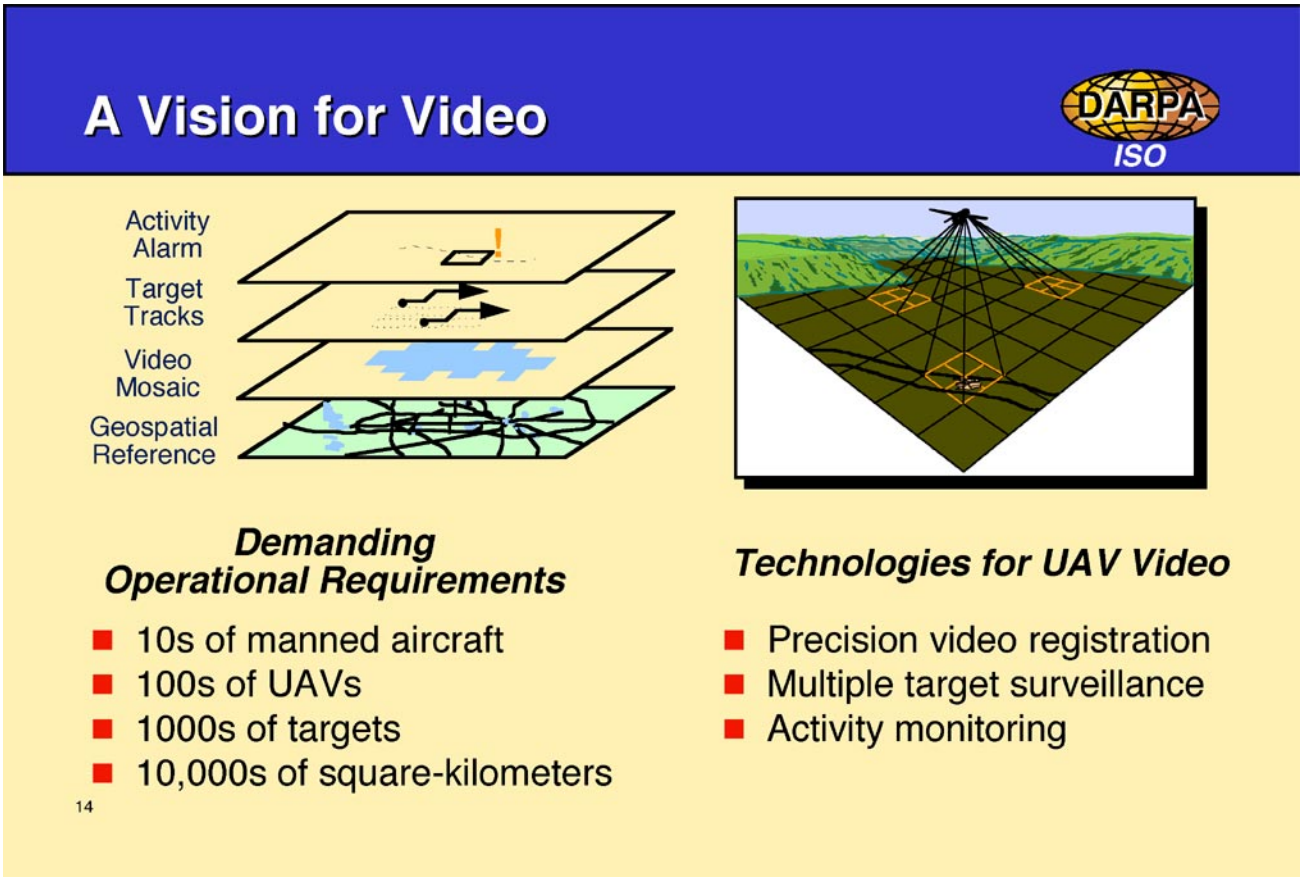


UAVs have been very useful in operational environments, but their full potential has not been realized. Operational limitations of current video surveillance systems provide a number of technology challenges that the AVS program is addressing.

The ability to deliver weapons to a target is dependent upon accurate target geolocation, but many of today's systems fall short of the 10 meter or less accuracy requirement of the warfighter. Mapping of video imagery to other data sources (such as digital terrain maps) is still a difficult and largely manual field process.

UAVs continue to be tasked like satellites and there is no ability to compensate for their narrow FOVs and to track multiple moving targets. Video sensors are then underutilized and image analysts or IAs are only able to watch a single object or area at a time.

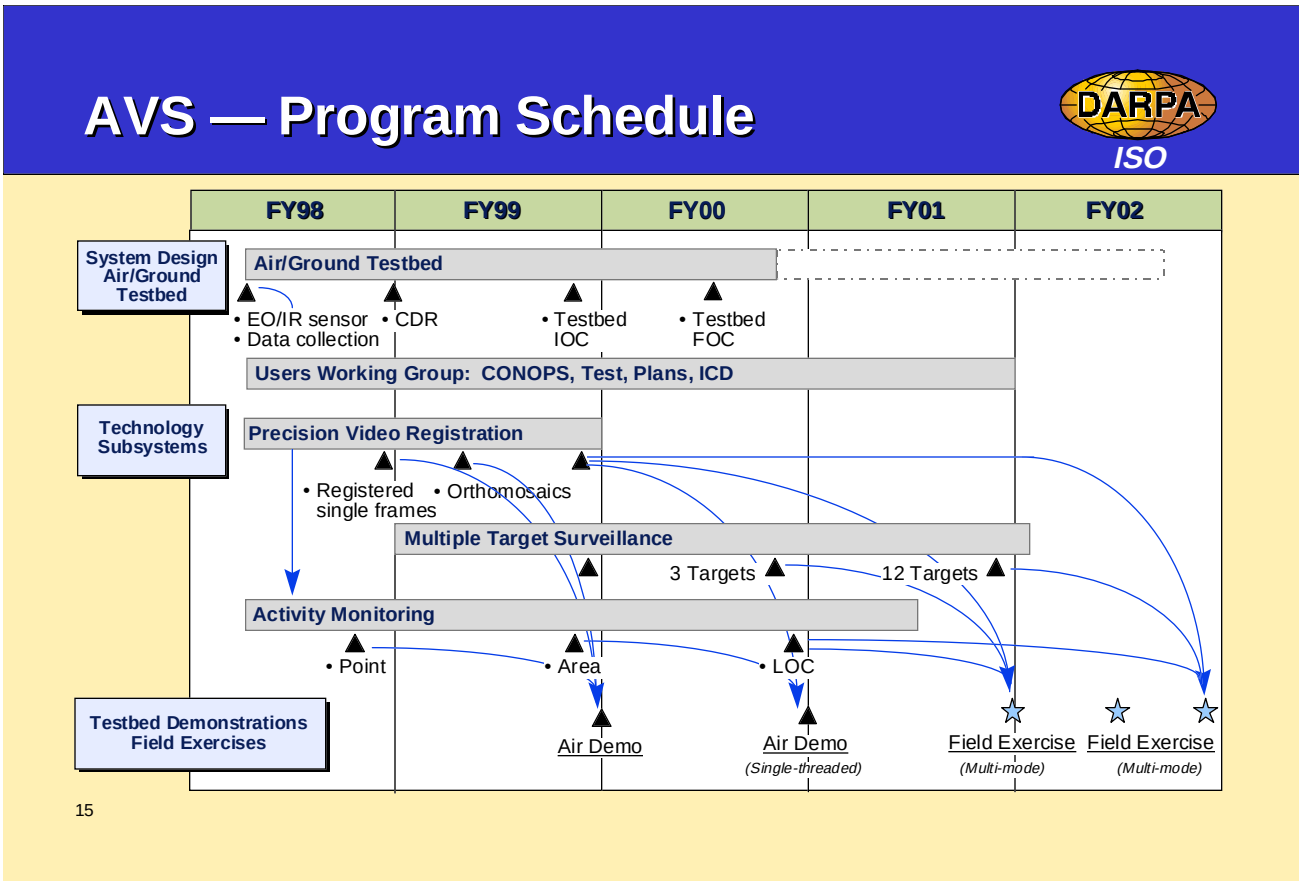
Finally, the volume of video data being collected swamps both the user and the communication links. The large amount of data, combined with the lack of an exploitation infrastructure to support video processing, results in video exploitation that exceeds the video collection time cycle.



Automated video exploitation techniques developed in the AVS program will support the future battlespace where 100s of UAVs collect imagery of 1000s of targets operating in 10,000s of square kilometers.

Three technologies form the core of the AVS technology program.

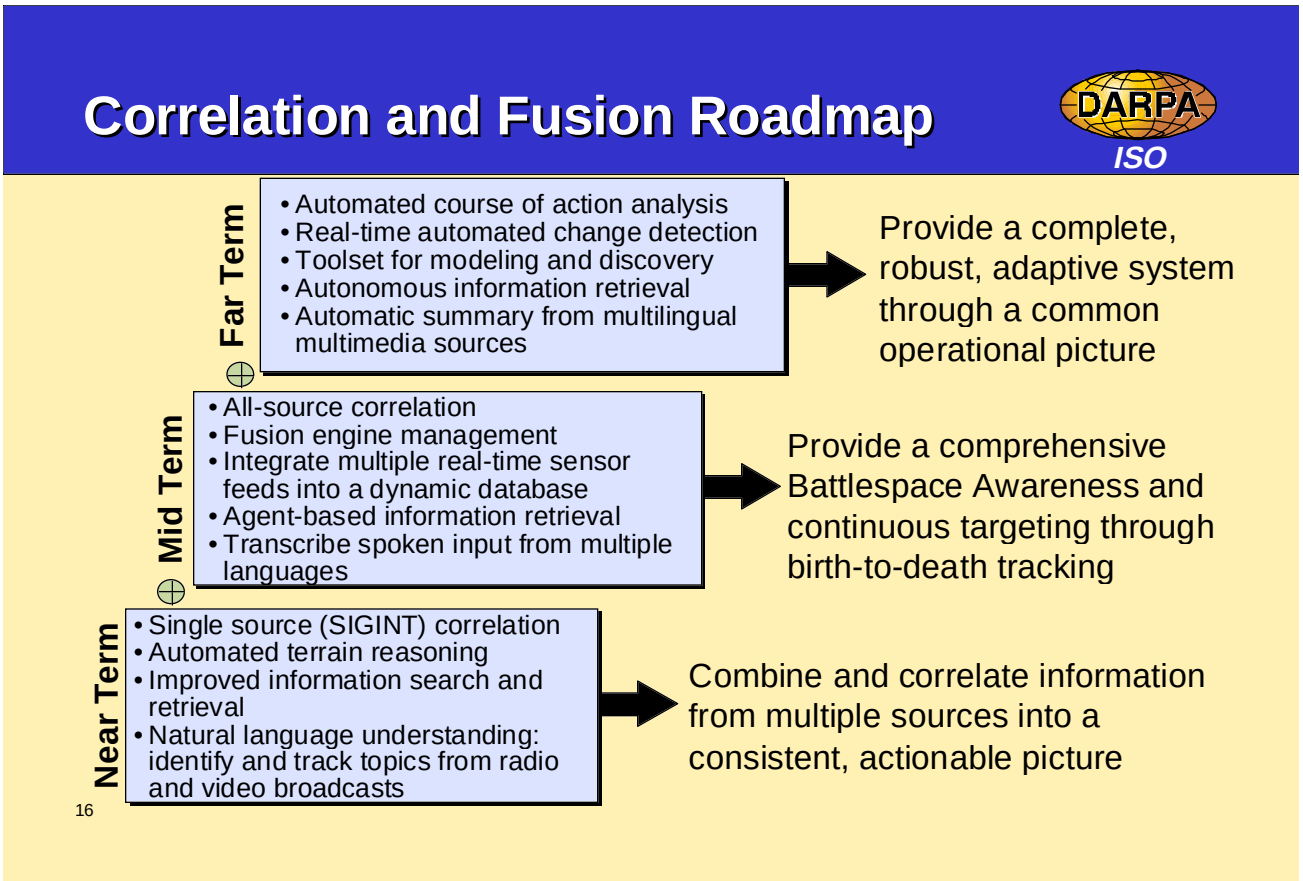
- Precision video registration uses geo-registration and orthomosaics, which have the potential of providing targeting locations with 2-meter accuracy.
- Multiple target surveillance is supported through the development of a multiplex video sensor controller capable of producing virtual video streams of multiple targets being tracked in a virtual field of view.
- Activity monitoring supporting point reconnaissance, lines-of-communication (LOC) monitoring, and intrusion detection through automated video monitoring techniques offers a method of focusing IA attention to active sites when activity is detected.



Major testbed hardware procurements are scheduled for early FY98 (sensor and gimbal) and FY99 (airborne/ground processing and communications) with refinements scheduled through FY00. The testbed will be available for data collections on a quarterly basis for the duration of the program.

The technology subsystems are broken up into three work packages, with incremental progress proposed as follows:

- Precision Video Registration
  - – georegistration of single video frames
  - – orthomosaics comprising multiple frames
  - – progressive refinements to orthomosaicing capability
- Multiple Target Surveillance
  - – track and re-acquire individual targets
  - – simultaneously track 3 targets not in a single FOV
  - – track 12 separate targets
- Activity Monitoring
  - – monitoring of multiple discrete points outside a single FOV
  - – monitoring of multiple areas
  - – monitoring along LOCs
  - – refinement of “activity” detectable at each site



Near term correlation and fusion capabilities support single source SIGINT correlation, automated terrain reasoning, improved search engines, and natural language processing to identify spoken language in radio broadcasts. These capabilities allow the users to combine and correlate information from multiple sources to form a consistent actionable operational picture.

In the mid term, correlation capabilities will be enhanced to support all-source correlation and fusion. Adaptive models will support force-level reasoning and integrate multiple real-time sensor feeds into a dynamic database. Intelligent agents will retrieve information from disparate systems and transcription systems will support input from multiple languages. These systems will support a major goal of Battlespace Awareness: continuous target targeting through birth-to-death tracking.

In the far term, a complete robust adaptive correlation and fusion system will support a common operational picture. Automated enemy and friendly course of action analyses, real-time change detection, and autonomous information retrieval systems will provide users with required information before they know they need it.

Correlation and Fusion Challenges

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- Ever-increasing quantity of data; users still lack some required information
  - Stovepipe systems limit operators' access to multiple, simultaneous data sources
  - Data volume exceeds current exploitation capabilities
- Lack of C4ISR interconnectivity limits distributed, collaborative operations
  - Double-counting of messages from uncoordinated multiple sources leads to false intelligence confirmation
- Lack of a common operational picture that limits
  - Operations/intelligence integration
  - Continuous planning

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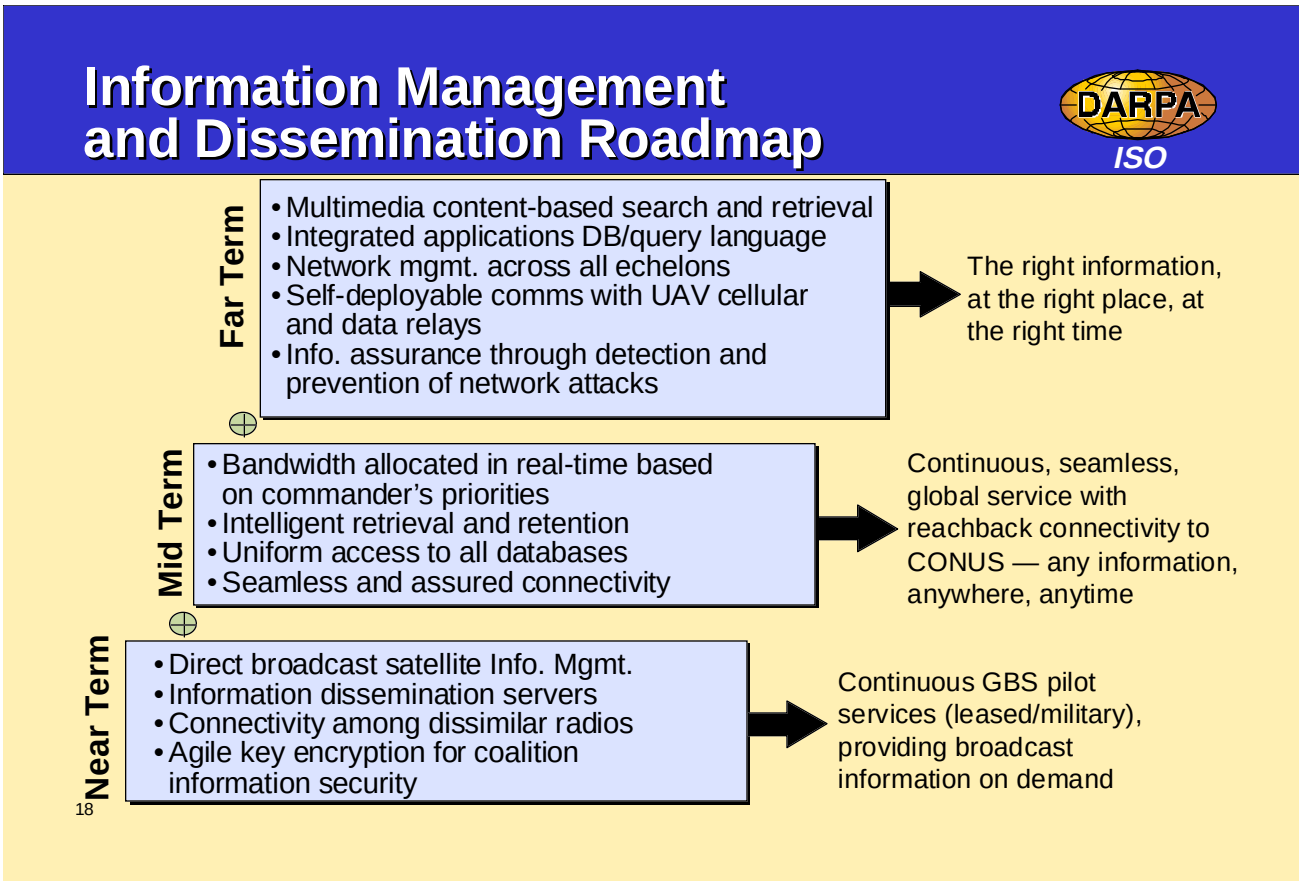
Correlation and fusion systems suffer the same fate as exploitation systems—they must filter and analyze the ever-increasing quantity of data to find the information the users need. Stovepipe systems limit the operators' access to simultaneous data sources.

The lack of C4ISR interconnectivity limits desired, distributed, collaborative operations, and messages may be double counted, leading to false intelligence confirmation.

Lack of a common operational picture may limit operations and intelligence integration and continuous planning, goals that must be achieved to keep pace with the rapidly changing battlespace.



Near term information management and dissemination systems will rely on leased broadcast satellites, information servers, and large data libraries to provide T-1 bandwidth to the warfighters for a variety of systems.

In the mid term, bandwidth will be allocated based on commanders' priorities. Intelligent retrieval systems will support uniform access to heterogeneous, multimedia databases. Near real-time seamless connectivity of isolated deployment forces will combine GBS, DISN tactical communications, and airborne relays. These systems will support continuous service in one OCONUS region with reach back connectivity to the CONUS.

Far term systems will optimize information management over dedicated military systems that integrate GBS with DISN and tactical networks. Multimedia content-based information retrieval systems will access integrated applications databases. Network management at all echelons will adapt to mission needs. Self-deployable communication systems will support all conflict phases with UAV-based cellular and data relays. Total information assurance will be achieved through the detection and prevention of network attacks. This future information management system will provide the warfighter with continuous multimedia service through a network of global broadcast communications and tactical internets.

Information Management and Dissemination Challenges

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- Need to connect isolated, rapid deployment forces
  - Current communications require large-scale theater assets
- Stovepipe communications systems limit connectivity
  - Support to the Joint Forces Commander and Component Commanders requires seamless tactical networking
- Ever increasing volume and availability of multimedia data
  - Current communications systems have limited bandwidth
  - Lack of common multimedia dissemination channels

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The information management and dissemination systems just described must have the ability to connect isolated rapid deployment forces. Current stovepipe systems limit seamless tactical connectivity vital to the Joint Forces Commander and the Component Commands.

Again, the increasing volume and availability of multimedia data means the need for more bandwidth is also increasing. Common multimedia dissemination channels will be required to support the flow of information.

Battlefield Awareness and Data Dissemination (BADD) Objectives

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- ***Wideband Information Delivery:***
  Expand the information flow to the battlespace (100 to 1000 times) reliably, timely, affordably, and efficiently
- ***Information Management Services:***
  Provide tools that enable the warfighter to manage and tailor his own information environment
- ***Battlefield Awareness Services:***
  Provide the warfighter with a comprehensive and intuitive awareness of the battlespace
- ***DII/COE Compliance:***
  Deliver as shrink-wrapped, DII/COE compliant software modules

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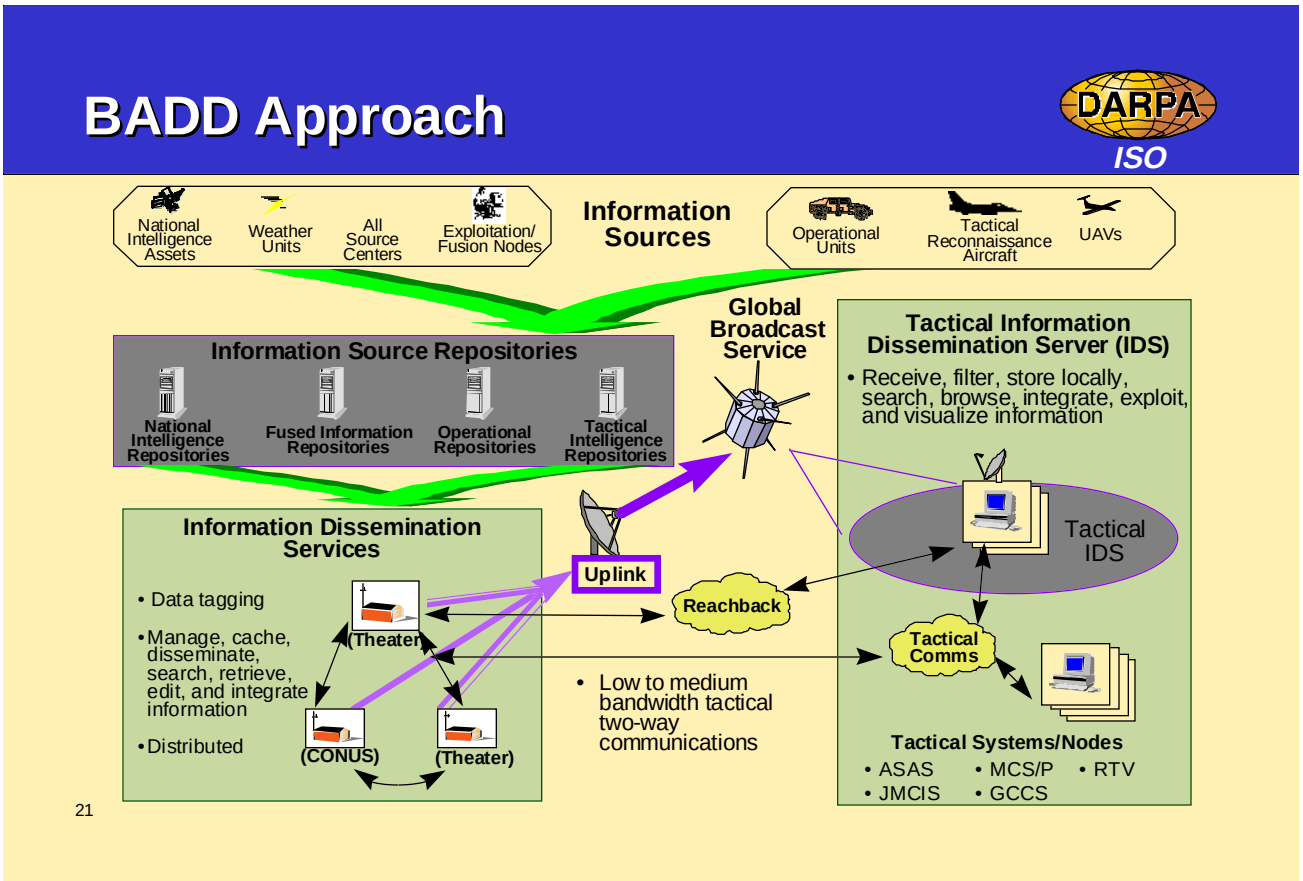
The Battlefield Awareness and Data Dissemination Advanced Concept Technology Demonstration provides the warfighter with the information he needs when he needs it in a useable and cost effective manner.

BADD accomplishes this objective by supplying the information management technology to support intelligent search, retrieval, storage, and dissemination drawn from across the Defense Information infrastructure from national and theater sources. BADD uses the Global Broadcast Service, broadband DISN and selected tactical networks to ensure timely, accurate, useable, and affordable dissemination of the integrated view of the battlespace at all levels of command down to battalion, ship, or squadron. The BADD ACTD operational user sponsor is the US Atlantic Command.



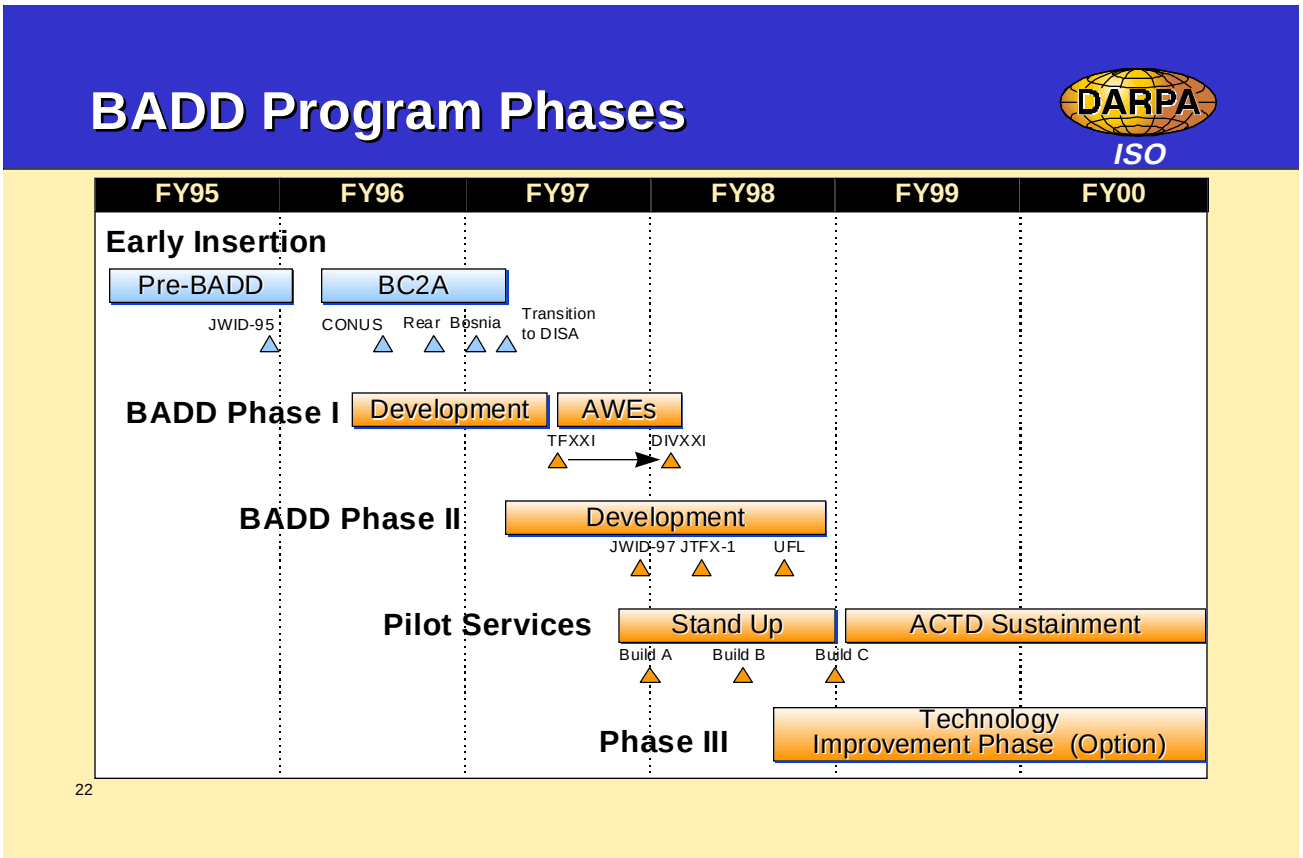
BADD's approach has four key technologies it must address to meet its goals:

The first: Commanders Information Policy. Provide the commanders with the means to specify and assess the impact of that policy on the outcome of their operation.

The second: Optimized Information Flow Management. Given a dynamically changing battlefield information infrastructure, optimize the dissemination of information throughout the battlefield in a manner that provides maximum operational utility as defined by the commander's policy.

The third: Multilevel Security/Coalition Information Management. Develop information management services with built-in MLS/Coalition releasable capabilities to optimize delivery of information to our coalition partners.

The fourth: Battlefield Awareness. Facilitate the real-time distillation, filtering, and presentation of information to the warfighter to guarantee he receives the right information in the right form at the right time.



Building on the experiences of the Bosnia Command and Control Augmentation initiative, the BADD Phase I effort concentrated on providing wideband broadcast services at the tactical level, within the USA digitized division efforts that culminated in the AWE TF XXI and continues in the AWE Division XXI in November.

Phase I provided the tactical utility of in theater C2I data down to battalion level. The Phase II development efforts are focused on three services.

- The Communication services and communication management services that were demonstrated in JWID 97 provide a seamless communication service for the users over the GBS broadcast.
- The Information Dissemination Management services are designed to enable the warfighter to manage the information available to ensure timely search and retrieval capability. This will be demonstrated in JTFX 98-1 (January 98).
- The Battlefield Awareness services will enable the warfighter to view his required information that will assist in specific decision making processes. It will concentrate in providing the warfighter faster response times, fewer information mistakes, and more cycles for thinking and less for monitoring. This will be demonstrated in Ulchi Focus Lens 98.

Pilot service of these capabilities and communication services will be stood up with the AITS-JPO beginning in September 97. Additional incremental enhancements to the pilot service will occur after each demonstration on 1998. Phase III will be the technical enhancements to the services developed in Phase II. There is a sustainment period for two years in the ACTD beginning in October 98.

Goal: Consistent Battlespace Awareness

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- Diverse, complete, distributed sensing
- Near real-time, semi-automatic exploitation of wide-area, moderate (and high) resolution imagery
- Automatic identification and birth-to-death tracking of all stationary and moving targets
- Distributed, dynamic, continuous, all-source correlation and fusion
- Integrated enemy and terrain database/knowledge-base population and maintenance
- Wideband data management and dissemination
- Near real-time seamless connectivity of rapid deployment forces

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The goal of the systems and programs described in this briefing takes advantage of the diverse, complete, distributed sensing. The technologies being developed support near real-time semi-automatic exploitation of wide-area imagery to provide automatic identification and birth-to-death tracking of all stationary and moving targets.

Distributed continuous all-source correlation and fusion and an integrated enemy and terrain database support the development and maintenance of a common operational picture. Data management and dissemination needs are supported by wideband communications down to rapid deployment forces.

Future Requirements/Missions

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- Our adversaries have studied our success in Desert Storm
  - Expect future targets to have
    - More concealment — natural and man-made camouflage
    - More realistic decoys/signature reduction
- The cruise missile is emerging as a key target
  - SCUDs are hard, but cruise missiles are harder
  - Small mobile target/easy to hide
- Lesser regional conflict scenarios present a new set of problems
  - Collateral damage is prohibited
  - Lack of prior target knowledge
  - Urban environments

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Although there are many exciting technologies being developed, there is still room for more improvements and breakthroughs. Our adversaries have studied our successes in Desert Storm. Future engagements will likely have more use of camouflage, concealment, and deception techniques, more realistic decoys and use of signature reduction techniques.

The cruise missile is emerging as a new threat. SCUDs are difficult to counter, but cruise missiles are harder. These small mobile targets operate with simple launch scenarios and are easy to hide.

Regional conflicts mean that precise target identification and ultra-low false alarm rates will be required to limit possible collateral damage. Targets will likely appear the first time during a battle, and new ATR templates or models will need to be created. Lack of a strict enemy doctrine and structure will challenge our previous models and assumptions.

Summary

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- DARPA is developing and inserting technology to improve our surveillance and exploitation systems via
  - Semi-automated IMINT ACTD for Stationary Target Exploitation (STE)
  - Moving Target Exploitation (MTE)
  - Airborne Video Surveillance (AVS)
  - Counter CC&D sensors and exploitation techniques
- But, there are serious outstanding needs:
  - Insert new targets into ATR rapidly during ad hoc conflicts
  - ATR theory
  - Integrated SIGINT/IMINT/MTE fusion
  - Dynamic database generation and inference
  - Continuous worldwide high bandwidth seamless network services

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DARPA is developing in inserting technology into many current and planned sensor and exploitation systems. The SAIP ACTD supports SAR-based stationary target exploitation, the Moving Target Exploitation program supports moving target exploitation. Much synergy can be achieved by combining the components from the two program to hold all targets at risk. Counter CC&D sensors and exploitation techniques support finding hard targets.

As mentioned, though, there are outstanding needs. ATR rapid target insertion capabilities will be needed to support ad hoc conflicts. New ATR physics-based theory will support the exploitation of additional observables. Techniques to exploit the vast number of degrees of freedom in multispectral and hyperspectral imagery and ladar must be developed. Improved techniques for SIGINT, imagery, and MTI fusion for stationary and moving targets are required to achieve multisensor integrated exploitation. The dynamic database which maintains the diverse set of raw data and models must be supported with new ideas. Finally the information must be managed and disseminated in a continuous, worldwide, high bandwidth network.