



Center of Excellence for Integrated Transmission and Exploitation (CITE)

Director of CITE

<http://www.if.afrl.af.mil/tech/programs/CITE/index.htm>



Purpose



The Center for Integrated Transmission and Exploitation (CITE) provides:

- **a focus for basic and applied research in the science and engineering of integrated transmission and exploitation**
- **a systems approach toward the integration of transmission and exploitation**



Current Deficiencies of DoD

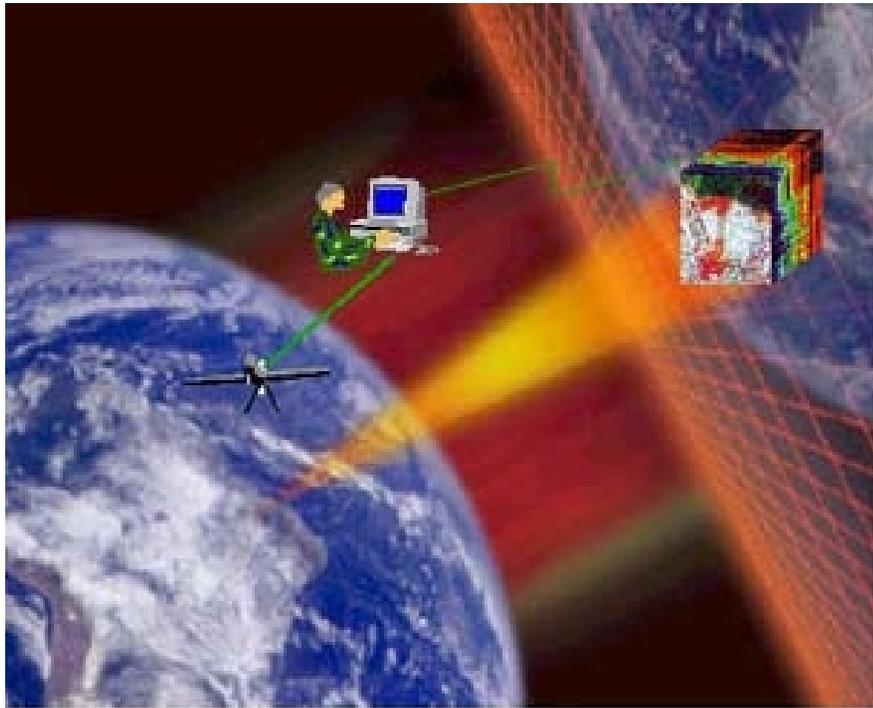


- **Can not form common operating picture**
- **Can not share information with coalition partners**
- **Limited performance against “difficult targets”**
- **Limited capability for combat identification**
- **Limited capability for “deep reach”**

Ref: DoD Report to Congress entitled “Kosovo/Operation Allied Force After-Action Report,” 31 January 2000



Future Vision of DoD



- **Interconnected and distributed Intelligence, Surveillance, and Reconnaissance (ISR) sensors and Command and Control (C2)**
- **Interoperability via Global Grid**

• **A paradigm shift for cooperative exploitation from “exploitation systems that passively receive sensor data and then extract desired information” to “exploitation systems that actively request information from sensors”**



Problems



Existing transmission and exploitation systems are:

- **Optimized for “local” performance, that is they are treated independently of each other**
- **Unable to reconfigure and adapt transmission and exploitation resources on demand**



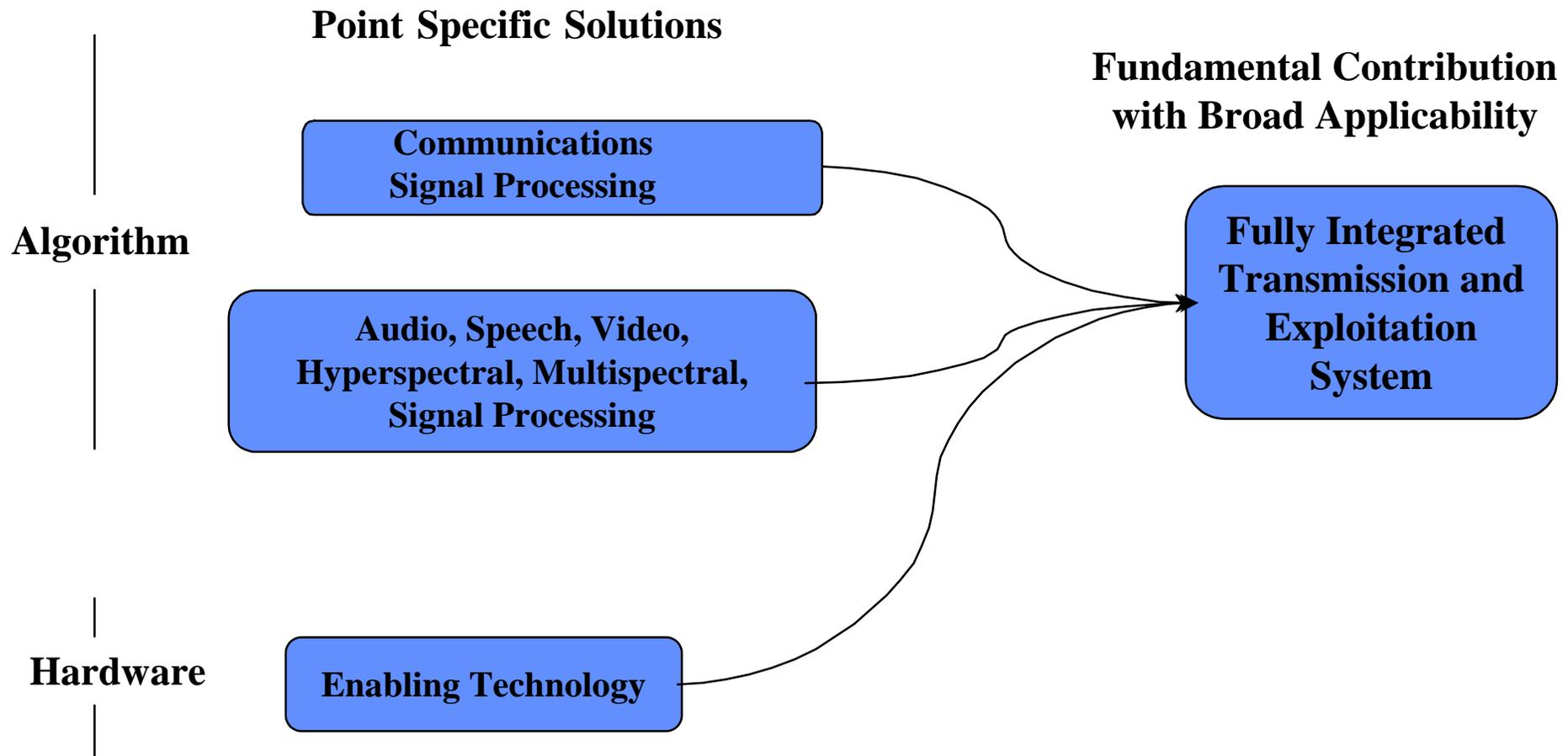
Objectives



- **Accessing and disseminating information in a timely manner over disadvantaged links**
- **Extracting, processing, and bandwidth matching, together with information assurance, for timely robust information dynamically tailored to the situation**



Vision





Science of Integrated Transmission and Exploitation



Study of overarching first principles of both transmission and exploitation

- *Scalability* – a principle concerned with enhancing information content of the transmitted signal by matching the bandwidths of transmitter, channel, and receiver
- *Adaptivity* – a principle concerned with minimizing the effects of interference, natural or man-made, on the collection and on the transmission of information
- *Nonstationarity* – a principle concerned with characterizing the statistics associated with the time-varying behavior of collection and transmission environments



Engineering of Integrated Transmission and Exploitation



Study of the fundamental principles to achieve the architectural vision for 21st century, where sensors and C2 become distributed across the battlespace and connected via the global grid

- **Dynamic allocation and control of transmission and exploitation resources**
- **Provide the timely dissemination of information**
- **Evaluate the impact of emerging hardware and software technologies for application to integrated transmission and exploitation systems**



Real-time Processing Requirements for Hyperspectral Imaging



	<u>Today</u>	<u>2007</u>
Image Resolution	1,000x1,000	10,000x10,000
Dynamic Range	10 bits/pixel	12 bits/pixel
Number of Wavelengths	200	1000
Frame Rate	30 frames/s	30 frames/s
Required Bandwidth	60 Gbits/s	36 Tbits/s



Scalable Video



***Problem:* Communication of Video Over Disadvantaged Pipes**

***Approach:* Scalable Video to enhance information content of transmitted video by matching the bandwidth of the transmitter and the receiver while preserving the essential characteristics of the data**

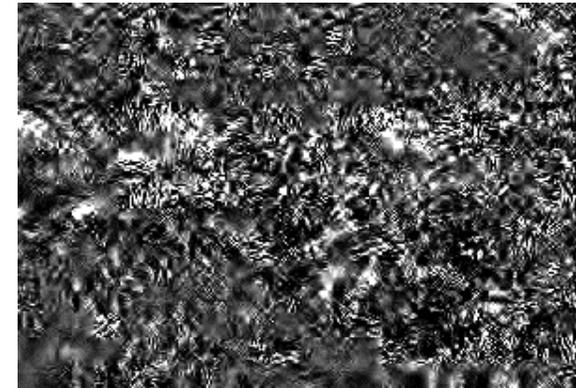


Scalable Video



Data rate for transmitted signal 2.5 Mbits/s.

*Received Signal: Scalable Video without
Error Resilience (a COTS solution)
[BER=.0001]*

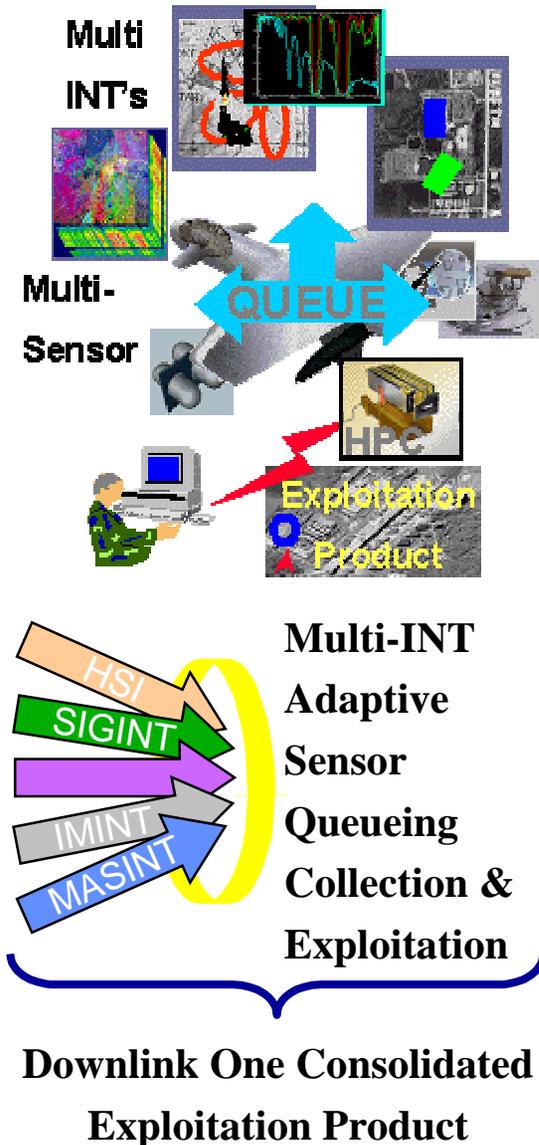


*Received Signal: Scalable Video with
Resilience [BER=.01]*





Multi-INT Collection & Exploitation



Technology Area Payoff

- Ability to Queue between sensors to optimize collection, reduce data collection (by adaptive collection) and provide a single consolidated relevant Exploitation Product to the Warfighter
- Adaptive Conformal Signal/Image Collection based on the Final Intelligence Product
- Moves exploitation algorithms & tools from the ground to the collection platform reducing:
 - Magnitude of downlink data
 - Processing Time & number of analysts
 - Time required to produce Multi-Sensor correlated Exploitation Products
- Allocate Computing responsibilities more intelligently
- Increased accuracy of Exploitation Products



CITE Interactions



- **Principal Players**
 - AFRL/IFG
 - AFRL/IFE
 - AFOSR/NM
- **Scholarly Interactions**
 - Journal and Conference Publications
 - Annual CITE Research Workshop



Current Areas of Research



- **CITE Research Themes**
 - **Compression and Information Assurance**
 - **Cooperative and Uncooperative Interference Mitigation**
 - **Metrics and Phenomenology of Nonstationarity**
- **X-CITE Research Themes**
 - **Joint Optimization of Motion Imagery and Its Communication**
 - **Wireless Information Assurance**



Current Achievements and Upcoming Milestones



- **FY01 Achievements**
 - 3 journal articles and 8 conference papers
 - General Chair of *IEEE International Conference on Multirate Systems and Wavelet Analysis*
 - Session Chairs at numerous meetings

- **FY01 Milestones**
 - **1 May 2001 -- Kickoff of CITE**
 - 31 May 2001 -- Demonstration: Jointly Optimized Wireless Transmission of Motion Imagery
 - Sept 2001 -- First Annual CITE Research Workshop



Payoffs



- **A World Class Basic Research Center designed to expedite the evolution of warfighter technology**
 - **An In-House Team of Government and Contractor Staff supplemented by Post-Docs and Visiting Scientists**
 - **Collaboration with Academic and Industrial Centers of Excellence in Supporting Technologies**
- **New and Exciting Research Initiatives enabling optimal end-to-end warfighter system performance**
 - **Accessing and disseminating information in a timely manner**
 - **Extracting, processing, and bandwidth matching for timely robust information dynamically tailored to the situation**
- **X-CITE - A World-Class/Unique Test Bed Available to Center Staff and Partners to Evaluate New Technologies and Showcase Ideas to Customers**