



26 August 2008

ARO Computing and Information Sciences



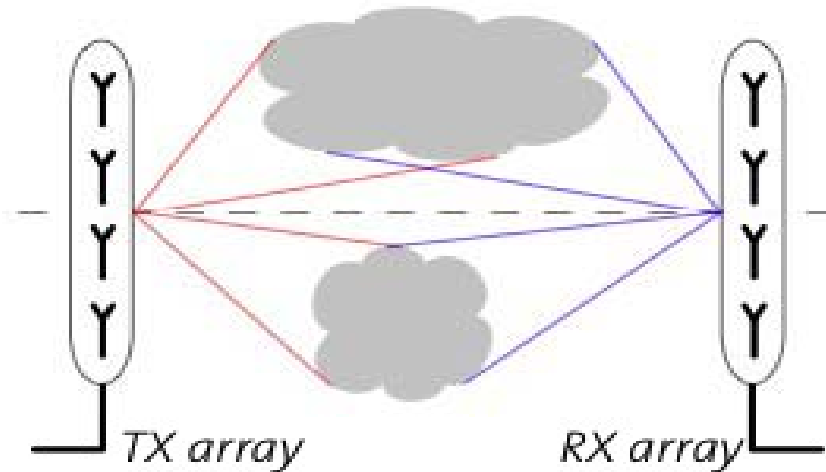
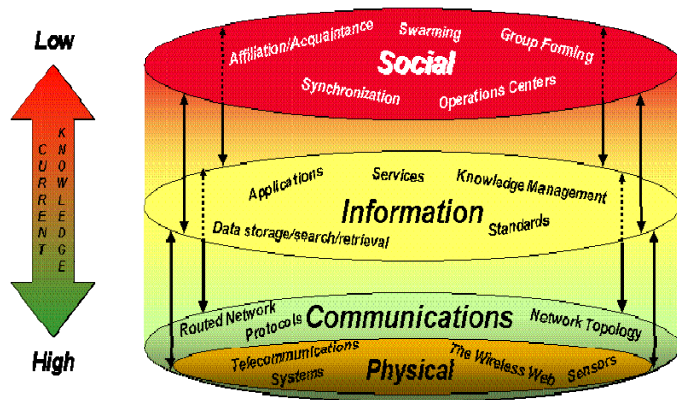
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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Command and Control ↔ Collaborate and Connect



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ARO Computing and Information Sciences Vision



To identify and enable basic research opportunities in the **Computing and Information sciences** that have the potential to transform Army capabilities and help maintain U.S. technological superiority

To lead the Army by embracing long-term, high-risk, high-payoff opportunities with special emphasis on **Communication and Networks, Information Assurance, Information and Signal Processing, Intelligent Systems, System and Control**



ARO CISD Program

Communication and Networks

Information Assurance

Information and Signal Processing

Intelligent System

System and Control

Program Manager

Dr. Robert Ulman

Dr. Cliff Wang

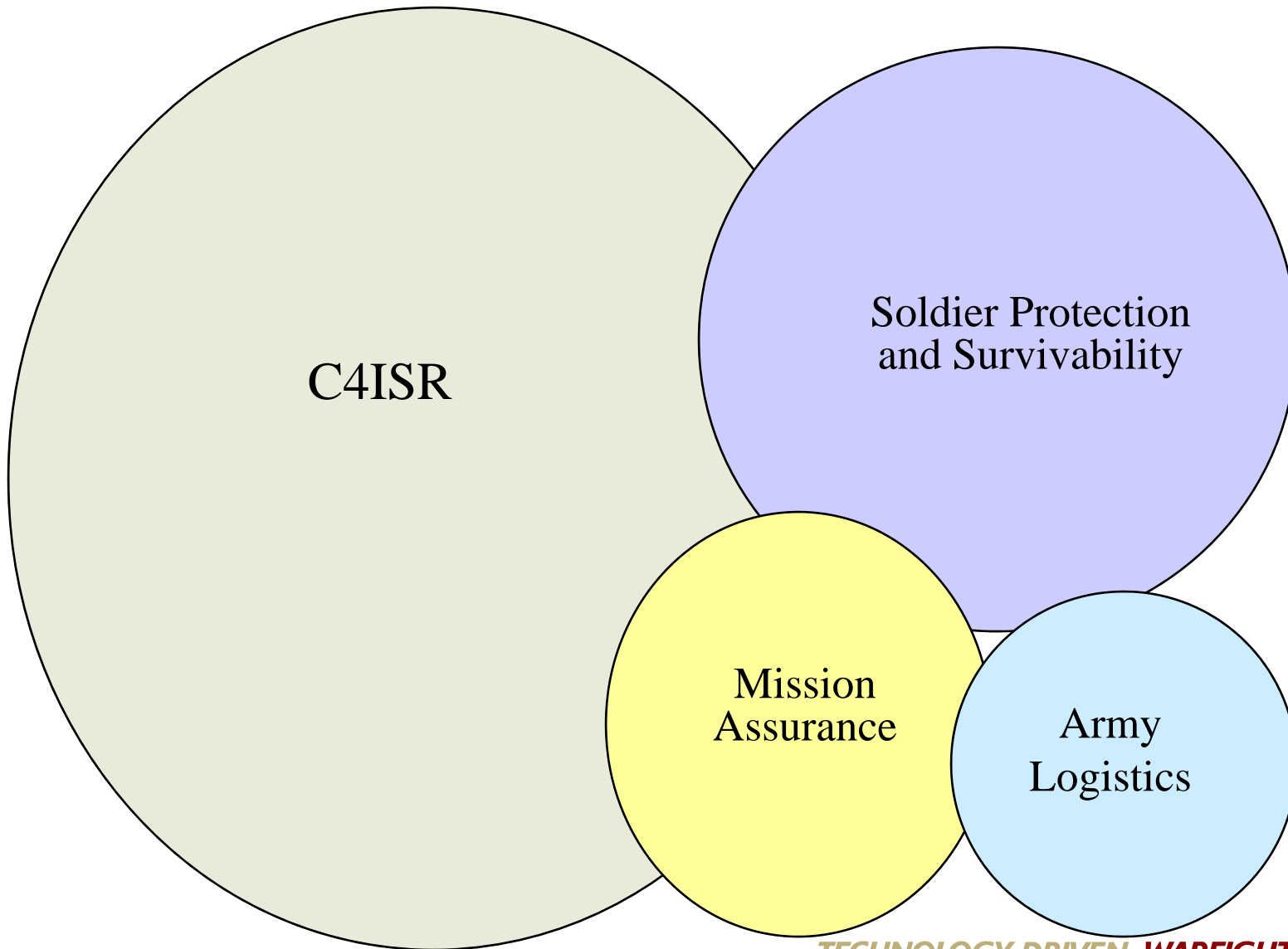
Dr. Liyi Dai

Dr. Purush Iyer

Dr. Randy Zachery



Computing and Information Sciences Army Impacts



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ARO Computing and Information Sciences Communication and Networks



Program Vision

Create technologies to facilitate the design and implementation of highly mobile ad-hoc wireless tactical and sensor communications networks needed by the Army. Concentrating on the brigade and below communications.

Key technology drivers:

- Multi-hop Wireless
- Low Energy
- Severe bandwidth constraints
- Mobility

Thrusts

- Wireless Network Science
- Exploitation of Spatial Domain of RF Using Array Antennas (Space Time Networking)
- Modulation and Coding



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Wireless Network Science

Understanding the theories that apply to tactical communications networks and applying them to Network Design

Space-Time Networking

Multi-hop network design with MIMO and directional antennas

Modulation and Coding

Research in new breakthrough areas, such as UV Communications



UV Communications research, Daniel Xu, UC Riverside

Unique Channel Characteristics

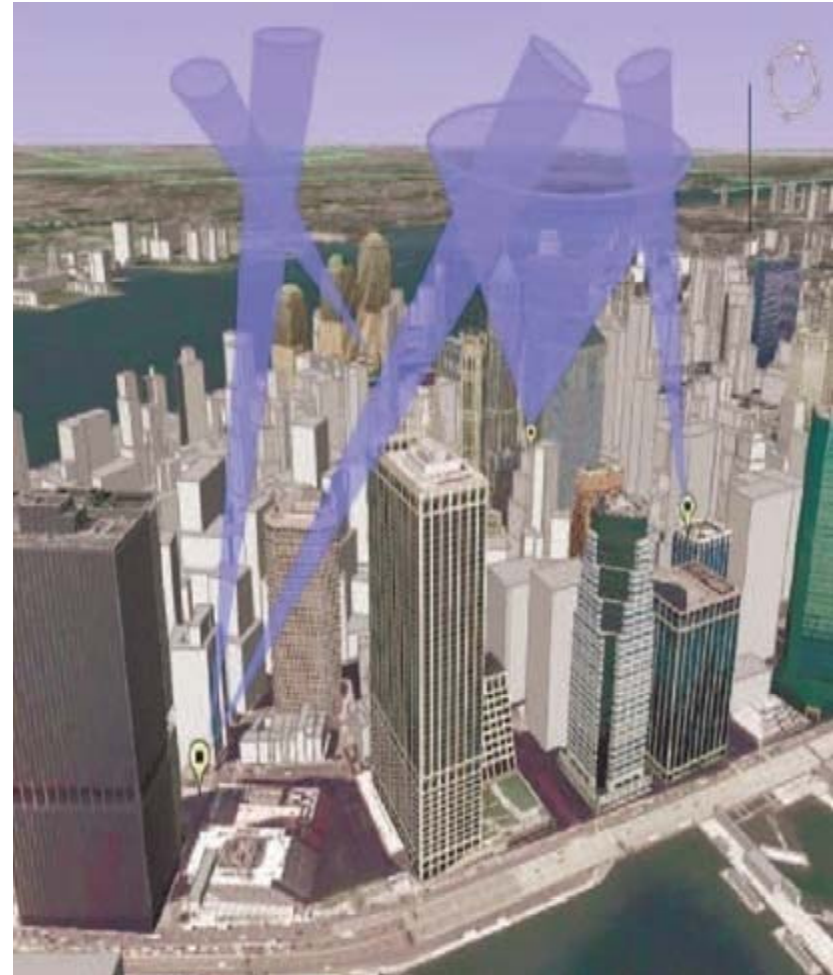
- Solar blind ($\lambda=200-280\text{nm}$) -> high SNR
- High scattering -> NLOS (relaxed PAT)
- High absorption -> covert and jamming-proof
- High bandwidth (potentially high rate)

Recent Enabling Technologies

- New devices: UV LEDs, High fidelity UV PMTs, UV APDs
- Solar blind filters

Active research

- Link component characterization
- Channel Modeling and characterization
- Link analysis of LOS and NLOS propagation





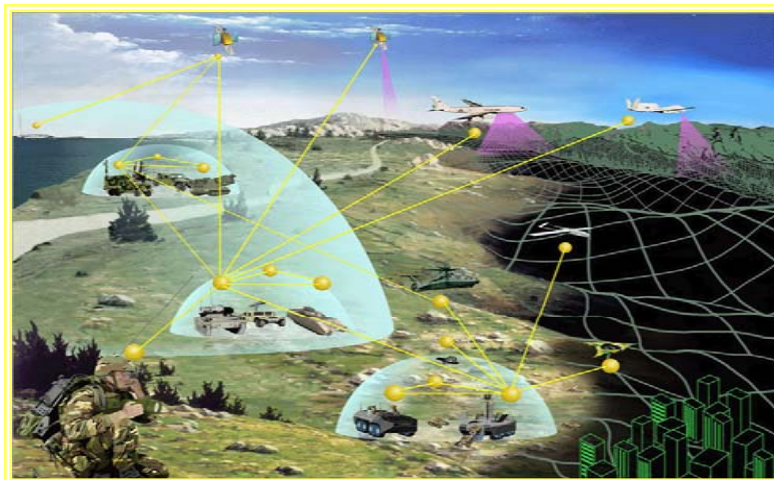
Program Vision

Research and development of robust and resilient information systems that address the processing and delivery of authentic, secure, reliable, and timely information, regardless of threat conditions.

Major Thrusts

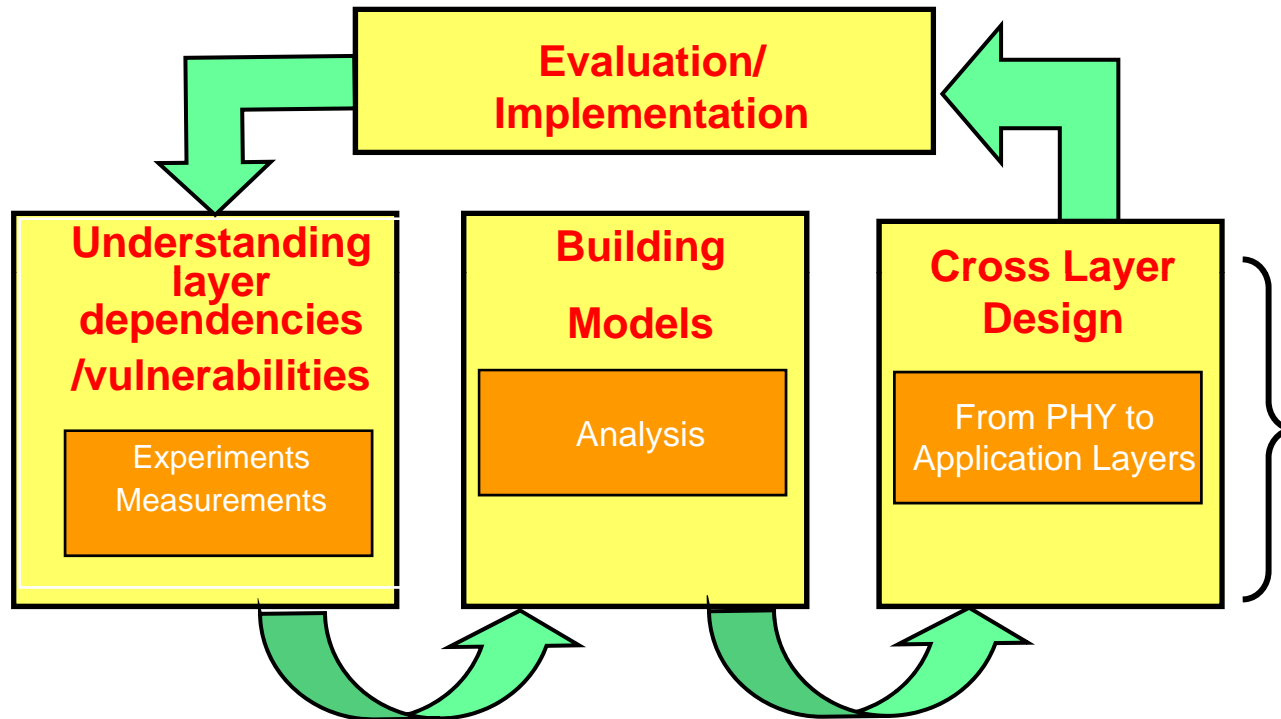
- Highly Assured Tactical Information
- Resilient and Robust Information Infrastructure

- Leveraging advances in information fusion and decision sciences to establish Cyber Situation Awareness which ultimately combines intrusion prevention, detection, response, and recovery together
- New theory/methods for secure and trustworthy information delivery and fundamental design principles for robust and resilient tactical communication systems
- New resilient system principles and concept (such as virtualization) for mission sustaining information infrastructures
- Information assurance metrics in the tactical environment



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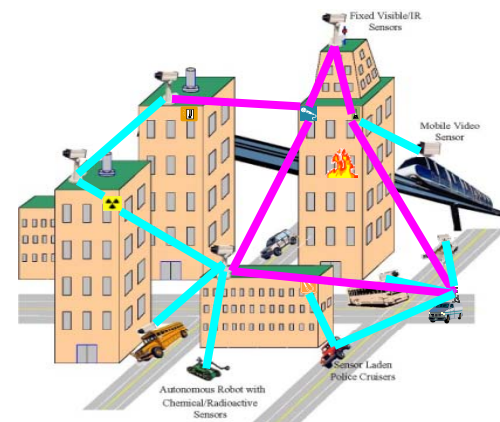
A Cross-Layer Architecture for Secure Resilient Tactical MANET



- Experimentally validated physical and higher layer characterization and dependencies
- Account for physical layer effects in the cross-layer designs to provide better security and resiliency
- Modeling of a comprehensive set of attacks and fault-management issues

Program Vision

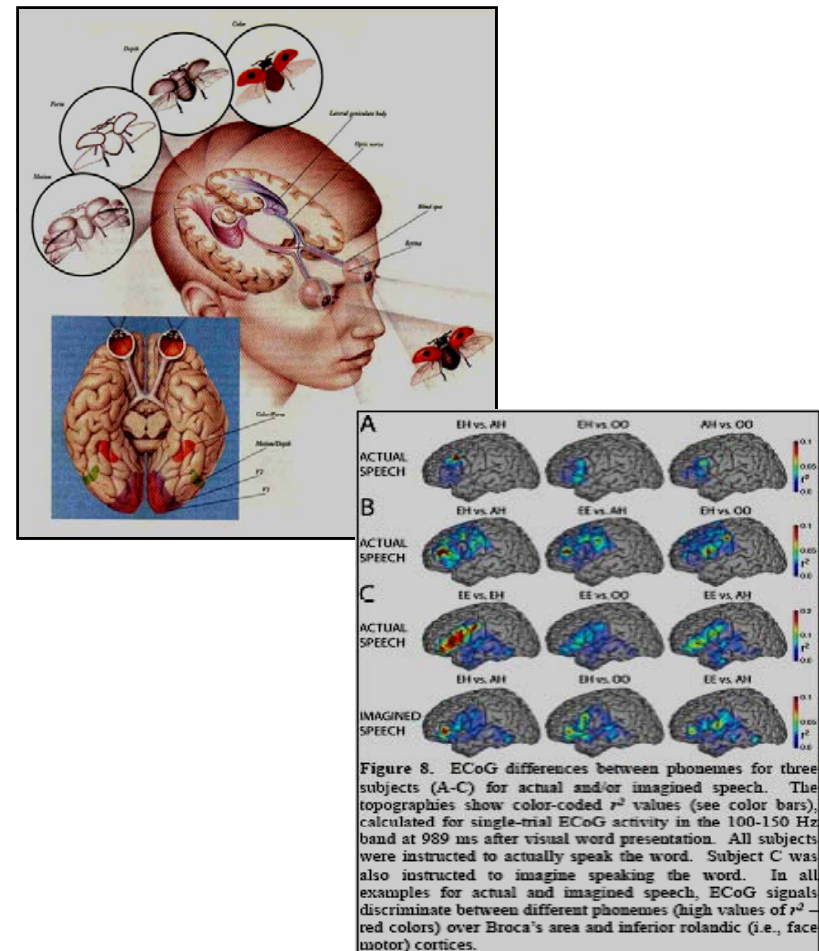
Provide increased performance and capability for processing signals, data, and information to enhance warfighters' decision-making and to improve targeting capability of weapon systems



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Brain Network Analysis and Modeling for Communication and Orientation

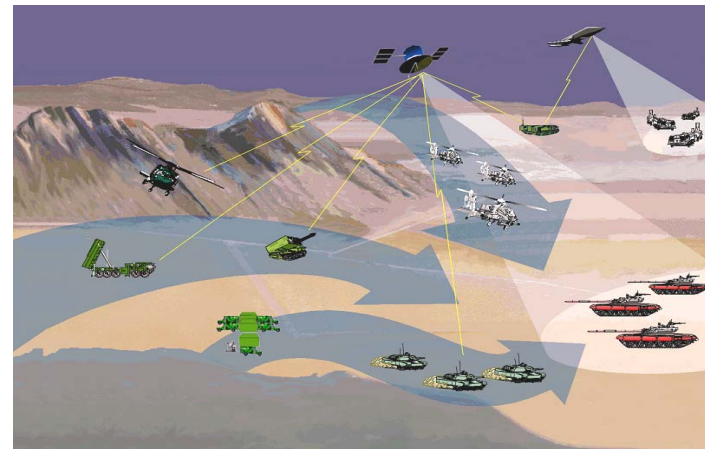
- Modeling and analysis of dynamic relationship between visual and auditory knowledge, intent, associated brain activities and command instructions
- Understand biological recognition capability and fusion mechanism





Program Vision

To understand principles for making a soldier omniscient.
To understand and develop principles that would allow command and control to plan for the future. To understand principles of self-monitoring infrastructures to help soldiers concentrate on higher level concerns.



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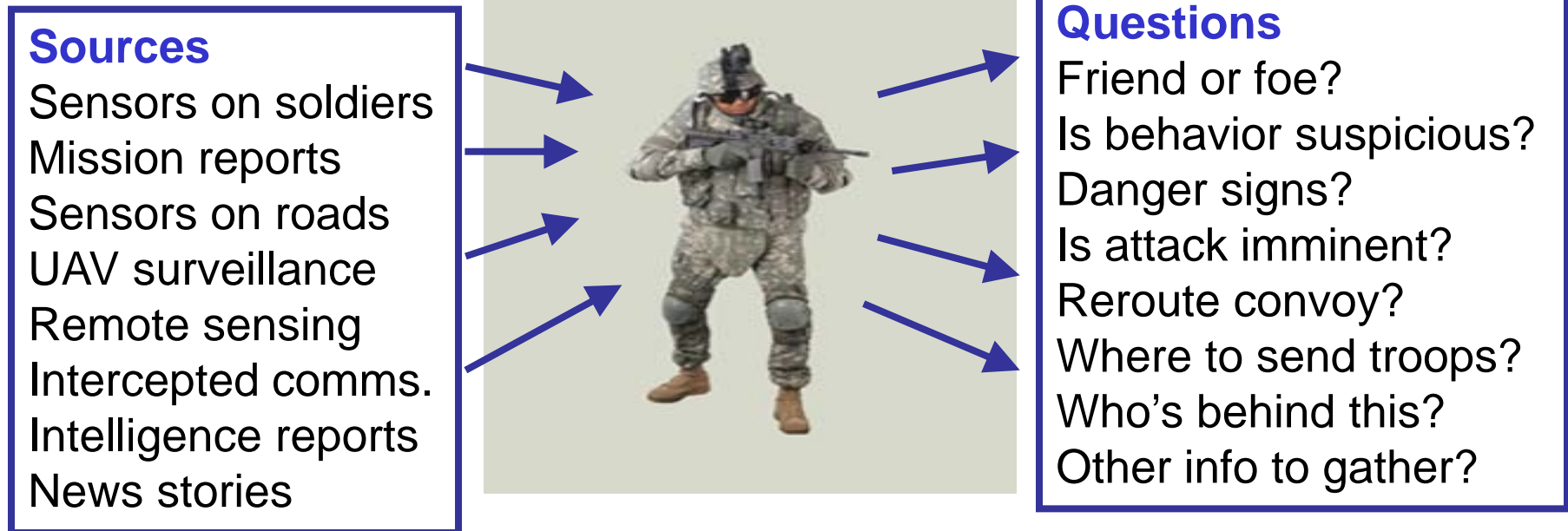
- Reason about (possibly uncertain or corrupted) data from sensors.
- Plan in adversarial situations with incomplete knowledge.
- Architectures for intelligent sensors.
- Formalize, automate and monitor mundane tasks.



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Abductive Inference MURI

- Abduction = Inference to the best explanation
 - E.g.: Medical diagnosis, detective work
- Goal: Unify Logical approach (good at finding assumptions sufficient to deduce observations) and Probabilistic approach (can compute probability of explanations given observations) to drawing inferences.





Program Vision

Developing the theory and tools, through appropriate application and creation of the relevant mathematics, to the modeling, analysis, design, and robust control of complex real-time physical and information-based systems; including distributed and embedded, networked autonomous and semi-autonomous, non-linear, smart structures, and decentralized systems.



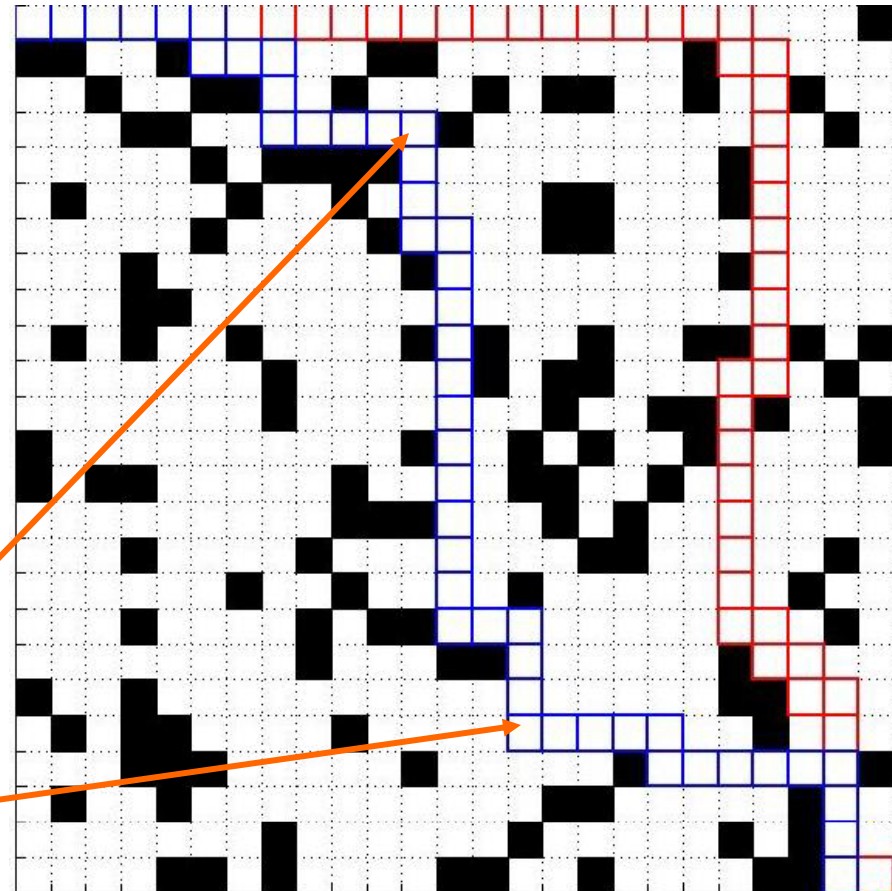
- A recognition that conventional mathematics of control and computing can be applied to new control structures (teams, etc.)
- Ubiquitous computation, communications, sensing, substantial (but incremental) progress in computer vision
- New mathematical understanding of how some biological systems work (multidisciplinary need)



Path planning including dynamics, Georgia Tech

Modify cost to incorporate history of cells visited (path “curvature” information)

Red path given by new method does not have sharp turns like these





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Complementary RDECOM
ARO Computing and Information Sciences



Communications and Network

- ARL CISD
- CERDEC

Information Assurance

- ARO Math Division
- ARL CISD
- ARL SLAD
- CERDEC

Information and Signal Processing

- ARO Life Sciences Division
- ARL CISD
- ARL SEDD
- CERDEC
- AMRDEC

Intelligent System

- ARL CISD
- ARL SLAD
- CERDEC

System and Control

- ARL VTD
- TARDEC
- ARDEC
- AMRDEC

<http://www.aro.army.mil>



Communications and Networks

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