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U.S. ARMY RESEARCH LABORATORY ARL 25 YEARS 1992-2017

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Information Sciences Campaign Overview

Dr. Alexander Kott
Information Sciences Campaign

Distribution A: Authorized for Public Release

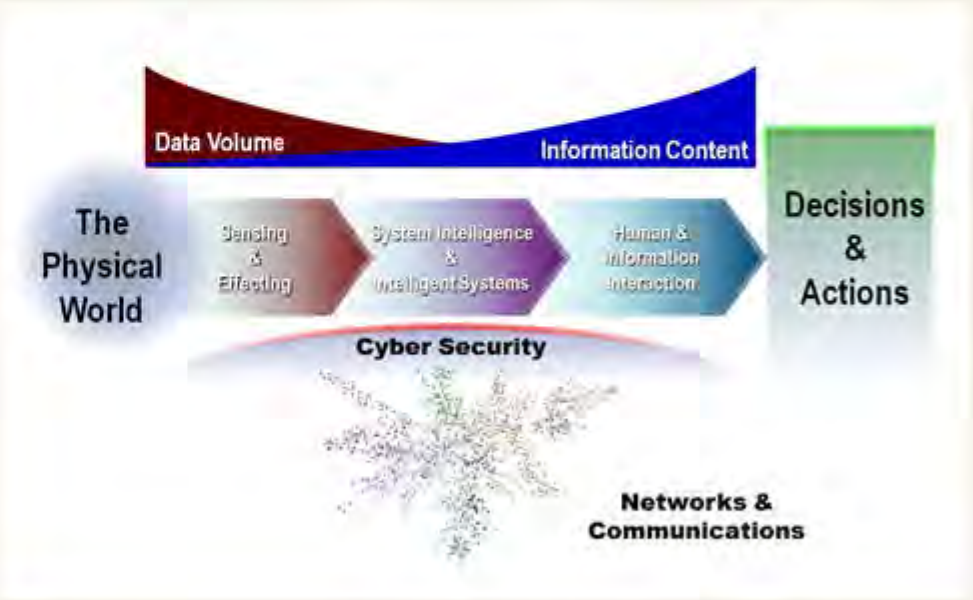
Vision:

Information supremacy to limit tactical surprise and improve situational awareness in complex, contested environments.

Mission:

Develop the scientific understanding to enable intelligent information systems for the Army, assuming:

- Decentralized and distributed information and systems to fully facilitate mission command
- Greater situational understanding and decision superiority
- Decisive offensive and defensive cyber domain operations at the tactical edge



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Information Sciences Campaign

Sensing & Information Fusion for Advanced Indications & Warning

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Sense and discover the presence of friendly and enemy assets and activities; predict future activities for situational understanding

We Have This:

We Need This:

Low & High Level Integrated Fusion

Distributed Analytics & Visualization

Enable situational understanding in complex operations

Fundamental research to enable distributed analytics and derive situational understanding **for forces operating at the tactical edge**

Optimize Human Performance; Maximize Demand Reduction and Improve Reliability; Maintain Overmatch

AWFC: 1, 3, 11, 13,16,19

CURRENT RESEARCH

- New sensors & processing for long range Indications & Warnings
- Technologies to mitigate environmental impacts
- Sensor information processing at the tactical edge

FUTURE TECHNOLOGY

- Truly autonomous conditional & adaptive modeling
- Optimize distributed data sources to relevant mission tasks
- Situational awareness involving multiple interacting info sources

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Sensors, Sensor Phenomenology and Algorithms

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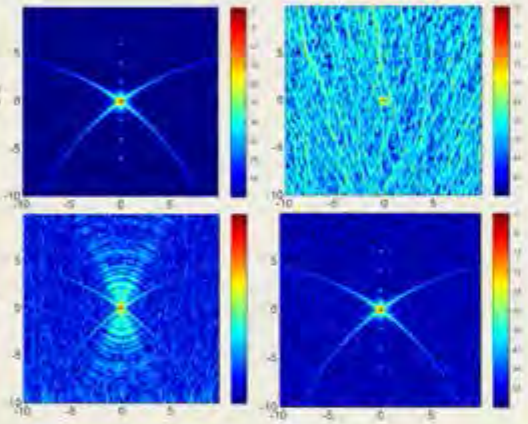
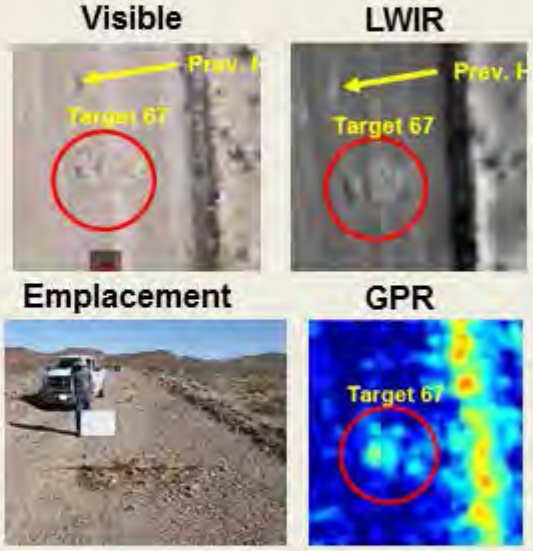
Develop underpinning technologies that will provide a high degree of situational understanding against ground and airborne threats.





Multi-Sensor Explosive Hazard Detection

Whistler, passive RF RCIED detection sensor

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Atmospheric Boundary Layer Exploitation

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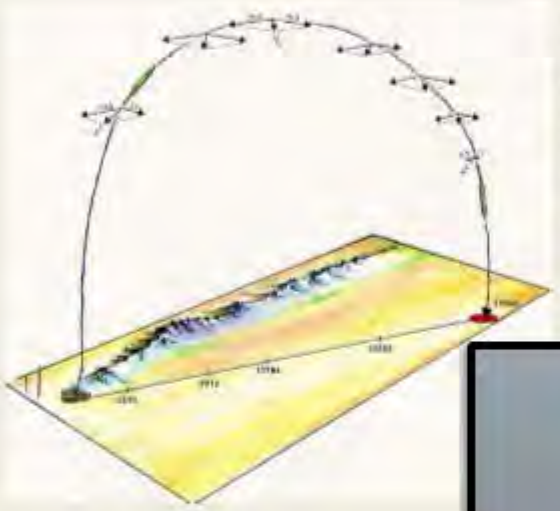
Advance the ability to accurately sense and forecast weather events and to mitigate their effects on Army personnel, systems, and operations.



Atmospheric modeling at multiple points along an artillery round's trajectory

- Increased accuracy of artillery fires
- Reduced collateral damage

Fine-scale meteorological sensor network at WSMR, NM

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ARL Open Campus Collaboration Opportunities

All Posters located in Network Science Research Laboratory – Building 204/2D Corridor

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Networks & Communications

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System Intelligence & Intelligent Systems

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Human & Information Interaction

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Sensing & Effecting

Atmospheric Characterization, Analysis and Effects	Dr. Robb Randall
Atmospheric Sensing	Mr. Chatt Williamson
Atmospheric Boundary Layer Modeling	Mr. David Knapp
Acoustic Sensing & Processing	Mr. Michael Scanlon
Radar Technology for Detection of Concealed Targets	Dr. Anders Sullivan
Technology for Multi-mission Radar	Dr. Abigail Hedden
Cross-modal & Extended Range Face Recognition	Dr. Raghu Rao
Human Detection "in the wild"	Dr. Raghu Rao
Sensing, Signal Processing & Fusion	Mr. Nassy Srour

Cyber Security

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Tours/Demo

Network Science Research Laboratory	Mr. Andrew Toth
Intelligent Systems Center (BLDG 307)	Dr. Stuart Young
3D Terrain Visualization (NSRL)	Dr. Damon Conover

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Information Sciences Campaign

Taming the Flash Floods of Networked Battlefield Information

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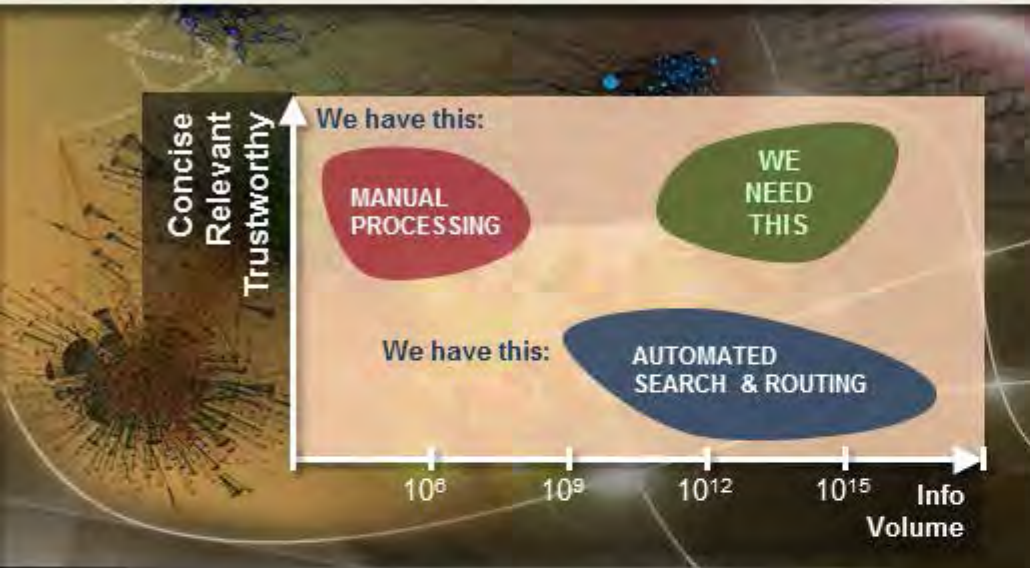
Warfighter dominance and control in the Cyber domain at the Tactical Edge



Network Attacks

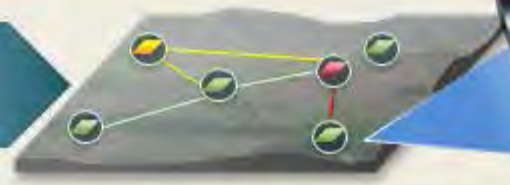
Controlling, channeling, directing, reshaping the dynamic, cluttered information field to provide **precise, timely, and mission context relevant information to the Soldier**

REDUCE DEMAND & IMPROVE RELIABILITY; CONTINUOUSLY UPGRADE THE NETWORK; ENHANCE EXPEDITIONARY CAPABILITIES; OPTIMIZE HUMAN PERFORMANCE — AWFC: 1, 3, 7, 11, 13, 16, 19

FUTURE TECHNOLOGY

CURRENT RESEARCH

- Trust Management Theory
- Heterogeneous Information Fusion
- Semantic Information Theory
- Information Quality Networking



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Text and Video Analytics

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Develops a deeper semantic representation of unstructured data, using real-world knowledge that can make it easy for human analysts to quickly recognize important factors and relationships.

Preliminary notion of joint problem space

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Networks & Communications

Quality of Information (QoI) for Semantically-Adaptive Networks	Dr. Kevin Chan
Group Structures in Composite Networks	Dr. Ananthram Swami
Tactical Optical Communications	Dr. Robert Drost
Cognitive Hybrid Networking	Dr. Brian Sadler

System Intelligence & Intelligent Systems

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Computational Intelligence	Dr. Stuart Young
Reasoning and Decision Making Under Uncertainty	Dr. Douglas Summers-Stay
Joint Text & Video Analytics	Dr. Heesung Kwon & Dr. Clare Voss

Human & Information Interaction

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Discovery Mechanisms for Engendering Creative Decision Making	Dr. Stephen Russell

Sensing & Effecting

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Cyber Security

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Tours/Demo

Network Science Research Laboratory	Mr. Andrew Toth
Intelligent Systems Center	Dr. Stuart Young
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Please refer to agenda for times and locations of scheduled tours & demos.

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Information Sciences Campaign

Acting Intelligently in a Dynamic Battlefield of Information, Agents, and Humans

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Optimize Human Performance; Maximize Demand Reduction and Improve Reliability; Maintain Overmatch; Enhance Expeditionary Capabilities; Accelerated Data to Decision; Human Performance Enhancement — AWFC 1, 11, 16, 19

CURRENT RESEARCH TOPICS

- Contextually-aware robot/agent interaction
- Localized computational scalability and information access
- Semantic interoperability between systems for teaming

FUTURE TECHNOLOGY

- Pervasive information availability
- Distributed cognitive computing
- Virtual staff

Information understanding to extract and combine data from disparate information sources transforming information into Soldier-useable formats.

Information fusion to integrate data from human and physical sensors by incorporating contextual and semantic information; providing Soldiers with trustworthy, high quality actionable intelligence.

Automated intelligence to support Soldier perception, reasoning, planning, collaboration, and decision making.

Provide the theory and techniques to synergistically integrate information with intelligent agents acting upon the world, augmenting the Soldier to accomplish tactical missions.

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Natural Language Processing/ Multi-Lingual Computing

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Addresses underpinning science for information gathering and management, human-intelligent system interactions and intelligence and mission support tools.

Special medical domain English-Pashto translation software saves time and money.

Machine Translation

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Networks & Communications

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System Intelligence & Intelligent Systems

Intelligent Information Management for the Battlefield	Dr. Niranjan Suri
Social Computing	Dr. Judith Klavans
Computational Intelligence	Dr. Stuart Young
Reasoning and Decision Making Under Uncertainty	Dr. Douglas Summers-Stay
Joint Text & Video Analytics	Dr. Heesung Kwon & Dr. Clare Voss

Human & Information Interaction

Investigating Social Biases in Social Media Information Transmission	Dr. Sue Kase
Discovery Mechanisms for Engendering Creative Decision Making	Dr. Stephen Russell

Sensing & Effecting

	[illegible]
	Mr. Chett Williamson
	Mr. [illegible]
	Mr. Michael Scanlon
	Dr. Anders Sullivan
	Dr. Abigail Hedden
	Dr. Raghu Rao
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Cyber Security

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Information Sciences Campaign
Cyber Fire and Maneuver in Tactical Battle

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Degrade, disrupt, deny, deceive, and destroy adversary cyber capabilities

Actionable Cyber Intel for Real-time situational awareness

Rapidly transform friendly cyber resources to deny adversary cyber actions

MAXIMIZE DEMAND REDUCTION AND IMPROVE RELIABILITY; MAINTAIN OVERMATCH; CONTINOUSLY UPGRADE, PROTECT AND SIMPLIFY THE NETWORK
AWFC 1, 3, 7, 11, 13, 16, 19

FUTURE TECHNOLOGY

CURRENT RESEARCH

- Techniques for detection and identification
- Methods for active responses
- Approaches to characterizing risks
- Quantifying effects of cyber maneuvers
- Autonomous and covert collection and analysis
- Methods to destroy enemy cyber assets
- Agent-based integrated collaborative planning
- Autonomously update and replace cyber agents

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Networking and Communications in Contested or Austere Environments

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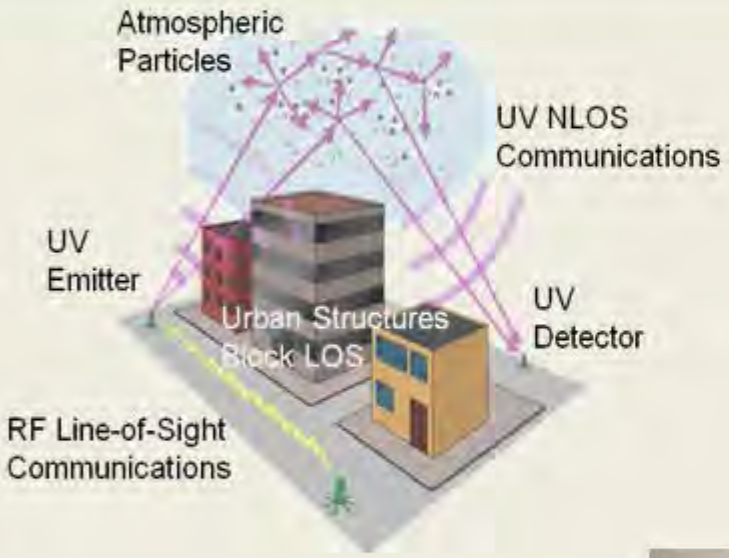
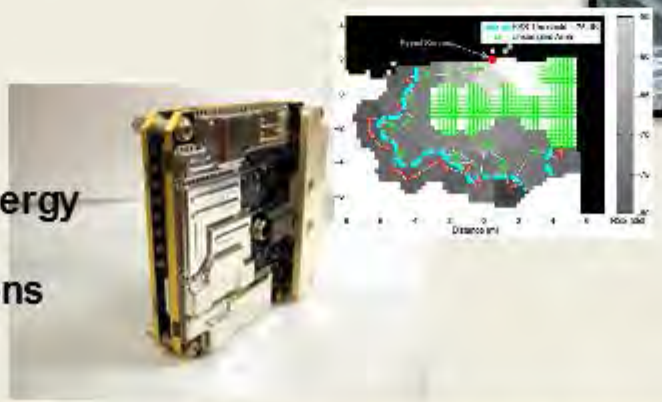
Provide underpinning technology for Key Campaign Initiatives where it is critical to ensure communications remain reliable, robust and resilient in the face of disruptive effects.



Enhanced robust communication devices and protocols for hostile environments

Adaptive and energy efficient communications



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Human & Information Interaction

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Sensing & Effecting

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Cyber Security

Networked Trust and Its Impact on Security	Dr. Ananthram Swami, Dr. Jin-Hee Cho & Dr. Kevin Chan
Learning and Detection	Dr. Richard Harang
Risk Modeling	Dr. Hasan Cam

Tours/Demo

Network Science Research Laboratory	Mr. Andrew Toth
Intelligent Systems Center	Dr. Stuart Young
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Supporting Infrastructure and Facilities

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- Network Science Research Lab (NSRL)
- Cognitive Networking, Communications & Protocols Laboratory (CNCPL)
- Quantum Network Protocols and Algorithms Laboratory (QNPAL)
- Army Cyber Research & Analytics Lab (ACAL)

- Cyber Virtual Assured Network (CyberVan)
- Electromagnetic vulnerability assessment facility (EMVAF)
- Multilingual Computing Laboratory
- Intelligent Systems Research Center
- Aerosol Research Facility
- Data to Decisions Test Bed
- Mobile Network Modeling Institute
- Open Standards for Unattended Sensors (OSUS) Systems Integration Laboratory (SIL)
- Sensor Information Test Bed Collaborative Research Environment
- Atmospheric Sciences Center
- Buried Threat Experimentation Facility
- Acoustic Measurement Facility
- E-field Cage

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Benefits of Open Campus

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Benefits to Academic and Industrial Partners

- Insights into real-world domain
- New and exciting problems
- Contributions from experienced, capable collaborators
- Access to ARL technology
- Use of facilities and data
- Evidence of relevance to real-world challenges
- Opportunity for transitions
- More publications
- Better-grounded publications
- Credibility for future proposals
- Insights for future proposals
- Broadening of the professional network
- Collaborations in proposals

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Select ARL-Wide OCOH Successes

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Establishment of New CRADAs & MOUs:

- Computational Fluid Dynamics Research Corporation establishing a new CRADA addressing atmospheric impacts on hypersonic munition projectiles.
- CRADAs for Applied Anomaly Detection Tool research initiated with University of Texas - San Antonio to focus on big data analytical techniques that require developing approaches for uncertainty quantification implemented as novel statistical and classification-based methods, and with Johns Hopkins University to investigate new computational methods for scene understanding that can identify and classify human activities in real-time video.
- ARL and Lockheed Martin finalize CRADA on Information Exploitation Research under the Open Campus Business Model. Through collaboration with Lockheed Martin's ATL, ARL has the unique opportunity to collaborate on the design, development, and implementation of advanced information science and knowledge processing frameworks and architectures to meet defined Army objectives.
- Memorandum of Understanding initiated with US Department of Agriculture's Agricultural Research Service, Jornada Experimental Range, benefiting ARL, USDA and their supporting research connections with New Mexico State University and the University of Texas at El Paso.

Advances in the Sciences:

- ARL researchers, with Open Campus collaborator Jihun Choi (UMICH) demonstrated their low frequency communications system at a four-day event organized by SOCOM.
- Open Campus Student Tong Wu won the Best Student Paper Award at the IEEE Image Video and Multidimensional Signal Processing Workshop held in Bordeaux, France 11-12 July 2016

Establishment of New Facilities:

- The Honorable Katherine Hammack, Assistant Secretary of the Army for Installations, Energy and the Environment, formally opened the Network Science Research Laboratory, the first major laboratory space to be designed specifically to support the Open Campus initiative, on 25 March.

New Hires:

- Under the Open Campus concept, the first two graduate students working at ARL under the Pathways Program have transitioned to employment at ARL while continuing their studies.

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ARL People and Expertise

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ARL has over 200 Scientists and engineers engaged in Information Sciences, including nationally recognized leaders in:

- Sensing, networking, and autonomous systems
- Sensing and information fusion
- Signal and image processing
- Microscale meteorology
- Energy efficient communications and networks
- Machine translation
- Social network analysis and field experimentation
- Information-based decision and trust in networks
- Machine learning in cyber defense

Collaboration Opportunities:

Intelligent Sensing
Autonomous Systems
Natural Language Processing
Signal and Information Processing
User Adaptive Info Architectures
Advanced Communications
Cyber Defense

Questions?