



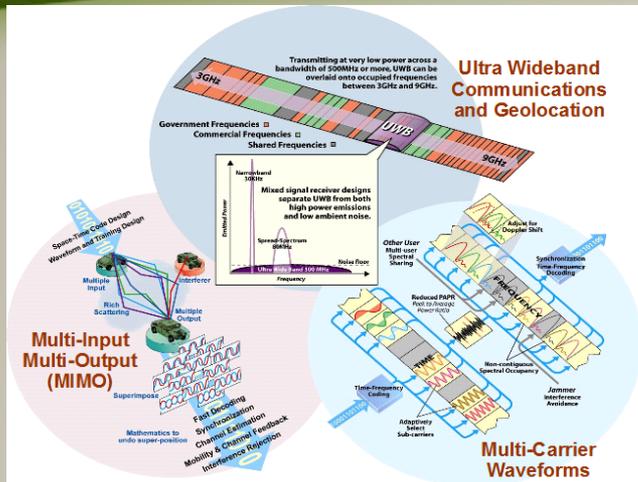
Communications & Networks CTA

Dr. Ken Young

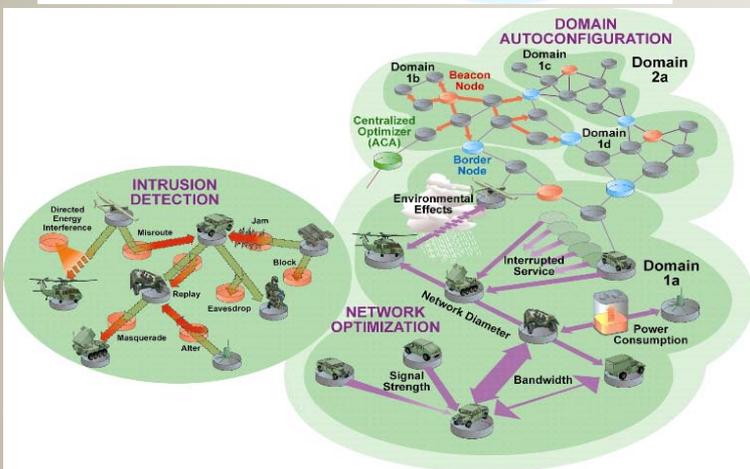
Network & Information Sciences ITA



Collaborative Technology Alliance (CTA)



Communications and Networks



Greg Cirincione
ARL Collaborative Alliance Manager



Telcordia *Ken Young*
Consortium Manager, Telcordia



Communications and Networks Collaborative Technology Alliance



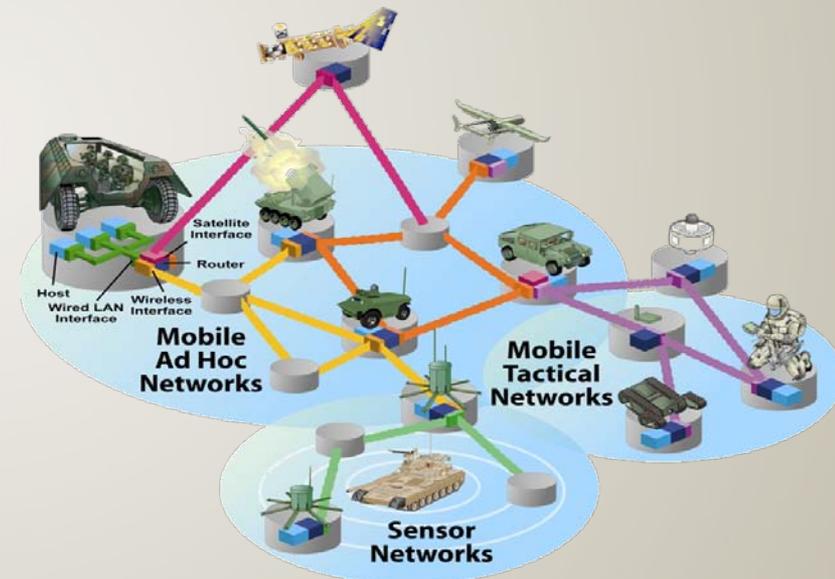
Vision: Enable a fully-mobile, agile, situation-aware, and survivable lightweight force with internetted C⁴I systems

Impact and Relevance:

- Enables the Soldier to operate while on-the-move with a highly mobile network infrastructure, and
- Under severe bandwidth and energy constraints
- Provides the soldier with jam-resistant comms in noisy hostile environments
- Enables dynamic spectrum, resource, and network management
- Provides efficient security services that protect wireless MANETs without reliance on strategic services

Technical Areas:

- Survivable Wireless Mobile Networks
- Signal Processing for Secure Comms and Networking
- Tactical Information Protection





C&N CTA Team Overview



ACADEMIA

1. Carnegie Mellon University
2. City College of New York
3. Cornell
4. Georgia Tech
5. Princeton
6. Morgan State University
7. Stanford
8. Texas A&M
9. University of California - Davis
10. University of California - Riverside
11. University of Delaware
12. University of Maryland
13. University of Michigan
14. University of Minnesota
15. University of Washington



INDUSTRY

16. Telcordia Technologies (LEAD)
17. SPARTA
18. BBN Technologies
19. General Dynamics

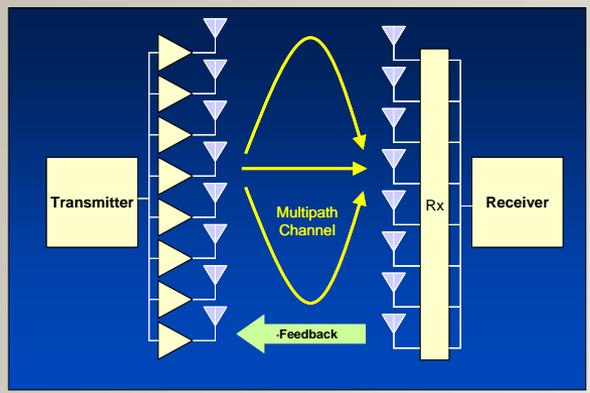
Blue = full Consortium members,
Black = non-member participants



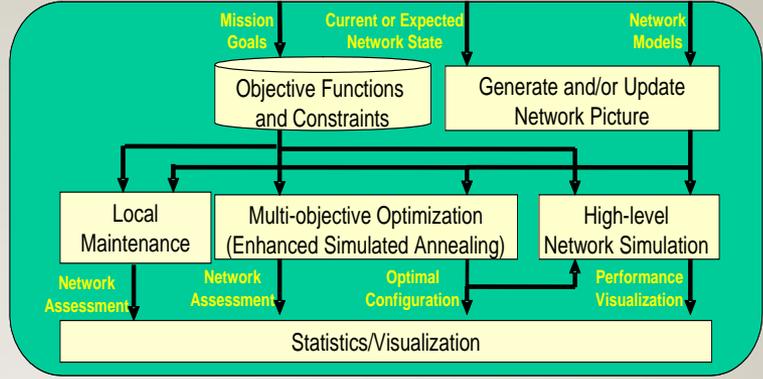
Significant Transitions



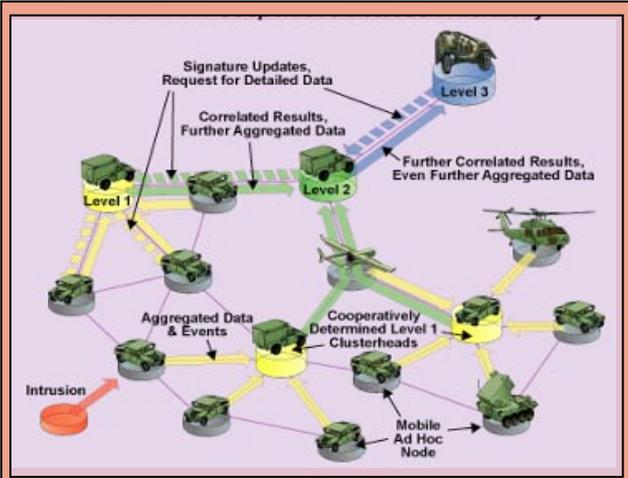
**MIMO to Classified CERDEC programs;
collaboration with ACIN**



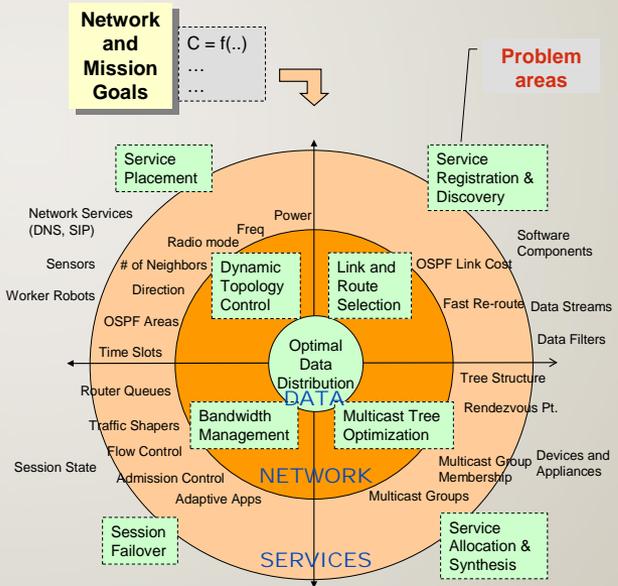
MONOPATI to CERDEC Net Design



DSRC-T to CERDEC PILSNER

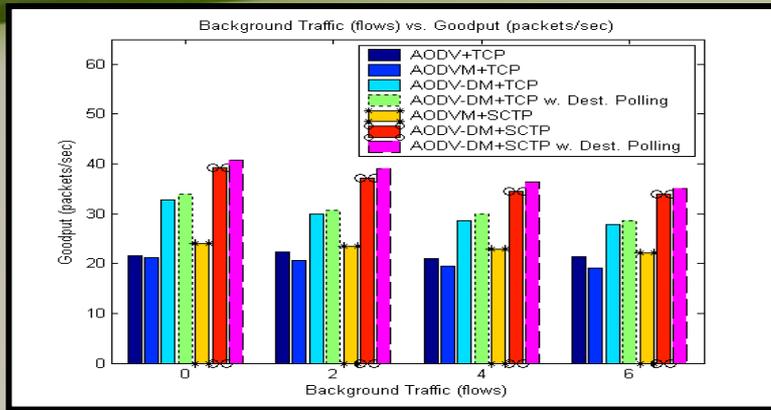


**MANET Intrusion Detection
Algorithms to TWNA ATO and FCS TTA**





Survivable Wireless Mobile Networks

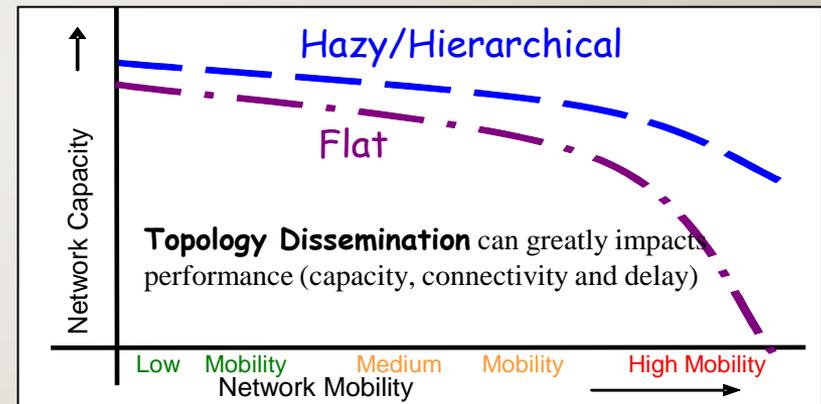


FY06-07

- Developed Controlled Dissemination Filter technology
- Developed MONOPATI network configuration toolset
- Characterized link lifetimes based on mobility
- Developed POMDP approach to optimal transmission scheduling

FY08-09

- Domain auto-configuration with social networking
- Component-based routing analysis and design
- Network modeling; capacity and scalability analysis techniques
- Dynamic and survivable network resource control for multicast flows



Objective: Develop networking capabilities to enable Army's Vision of information dominance



Survivable Wireless Networks: Advanced Structures for MANET

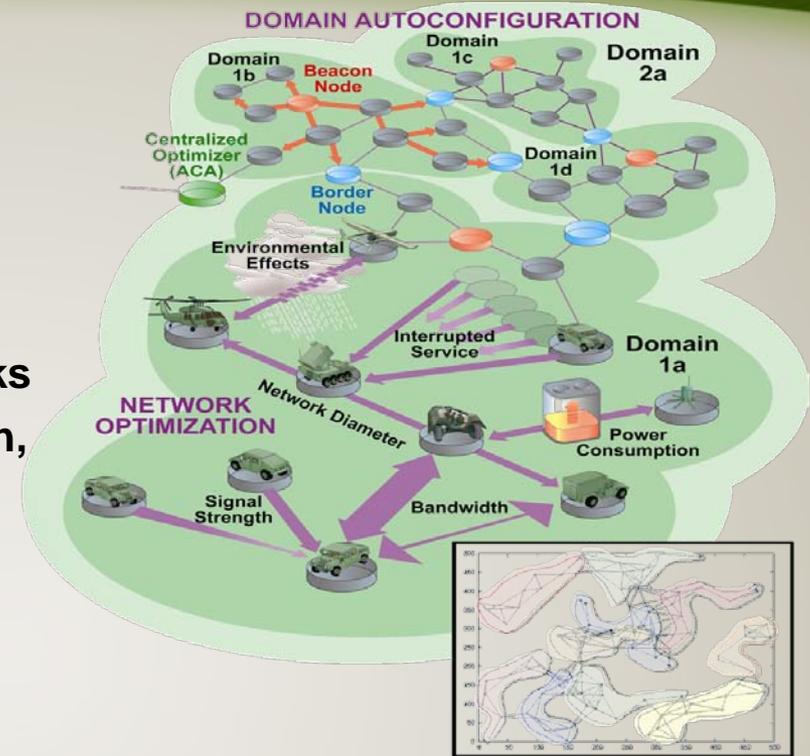


Overall Plans

- Form advanced structures that improve key aspects of the underlying network.
- Develop a formal, versatile and efficient framework for diverse networks
 - Physical and logical network
 - Social, knowledge & resource networks
- Dynamically adapt structures as the mission, network and requirements evolve

Social Networking Extensions

- Task assignment for efficient resource utilization and robust real time organizational adaptation.
- Dynamic network analysis based on real data collected from military installations
- Structures' optimality vs. adaptability



Intrusion Detection Extensions

- Requirements for efficient and Byzantine attack-resistant network structures

Objective: Design of a common, versatile, formal and algorithmic framework for efficient network configuration and assessment



Signal Processing for Secure Communications and Networks



MIMO Transmitter



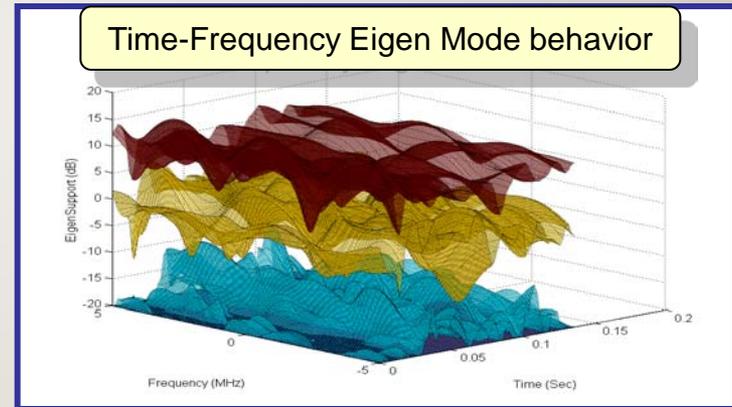
MIMO Node

FY06-07

- Turbo-MIMO algorithms and adaptive coding schemes for low-complexity spectrally efficient comms
- Developed & tested efficient OFDM channel estimation, and synch algorithms
- Error-exponent characterization of distributed inference in sensor nets

FY08-09

- MACs for MIMO, multi-packet reception and spectral agility
- Cross-layer design of MANETs and sensor networks
- UV and UWB communications
- Adaptive Cognitive MIMO Testbed experimentation



Objective: Signal processing foundations for advanced communications for tactical MANETs & sensor networks



SP for Secure C&N Multiple-Input Multiple-Output (MIMO)

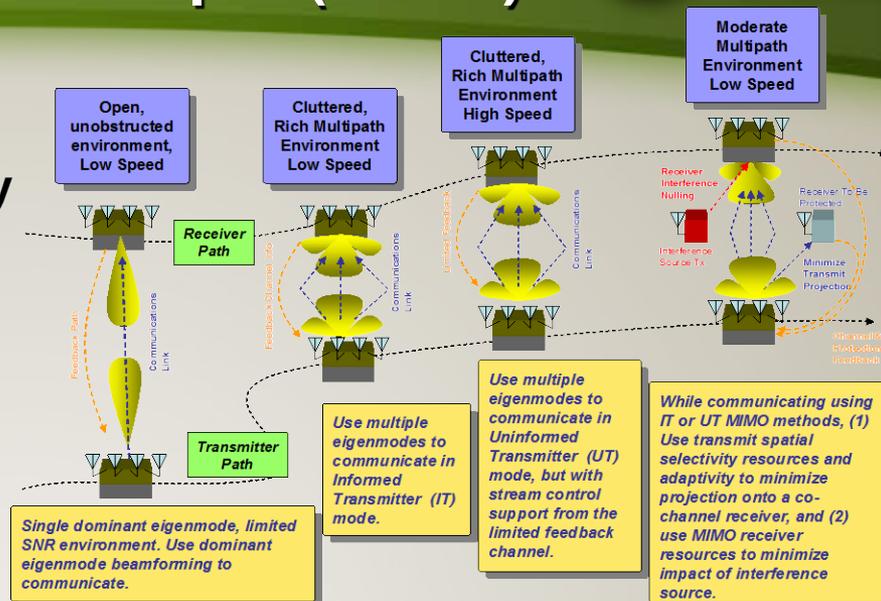


Research Challenges

- Best possible trade-offs between energy and spectral efficiency at manageable complexity
- Adaptivity to switch between high-rate and high-efficiency modes

Approach

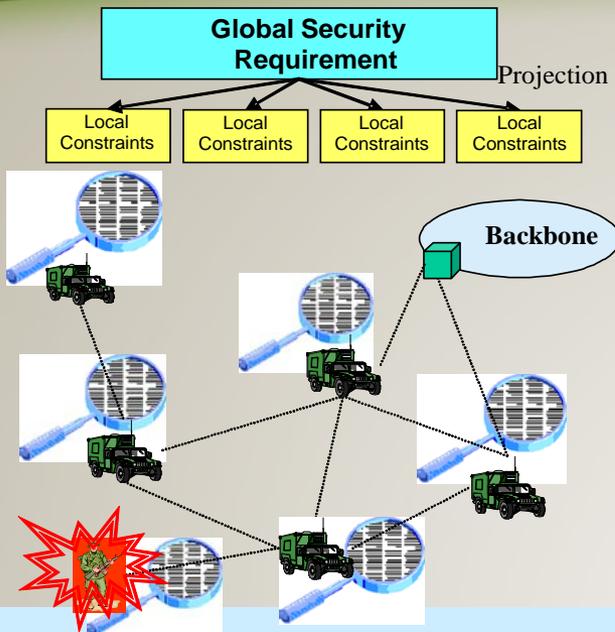
- Adaptive MIMO signal processing, waveform design and experiments
- Distributed and co-located energy-efficient MIMO systems for anti-jam
- Distributed robust OFDM communications
- Detection and estimation in unknown MAI
- Wireless channel modeling and channel state information dissemination



Objective: Jam-resistant links that are reliable in harsh propagation environments, capable of high throughputs in bursty channels



Tactical Information Protection

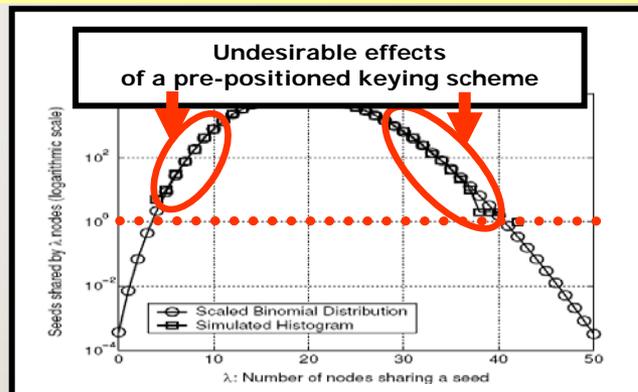


FY06-07

- Distributed cooperative detection and localization of in-band wormhole attacks in MANETS
- Byzantine-resistant routing attack detection
- Efficient group key management
- Threat models for cross-domain information flows

FY08-09

- Distributed dynamic trust management
- Efficient group key management
- Dynamic intrusion detection hierarchies
- Specification-based intrusion detection



Objective: Automated detection of vulnerabilities and efficient security services to prevent attacks, without compromising agility



Byzantine-Resistant Routing Attack Detection



Research Challenges

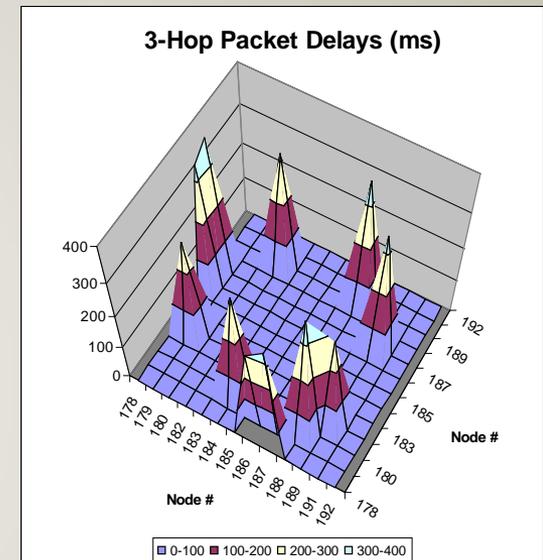
- Detecting attacks in which knowledgeable attacker controls subset of detection components
- Assessing susceptibility/resistance of detection techniques to subversion

Approach

- Localizing in-band wormholes and other covert tunnels
- Stealthy path probing/detection of data plane attacks
- Resilient cooperative detection systems
- Characterizing effectiveness, costs, resilience, tradeoffs

Research Team

- SPARTA, U Maryland, U Delaware, Georgia Tech, ARL



Paths across in-band wormhole link incur longer round trip delays

Objective: Develop and model techniques to detect insider attacks on MANET routing and distributed intrusion detection systems

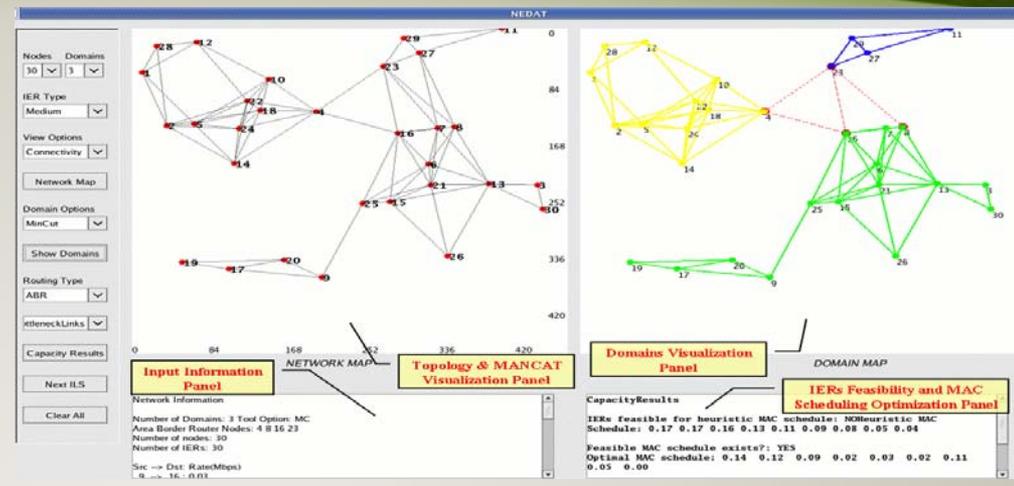


Transitions to CERDEC Network Design



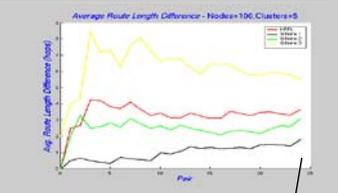
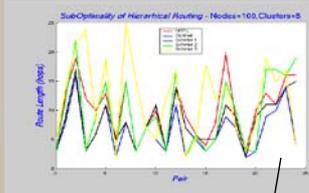
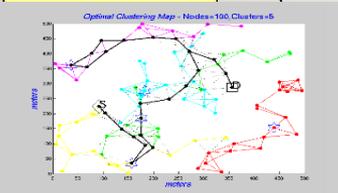
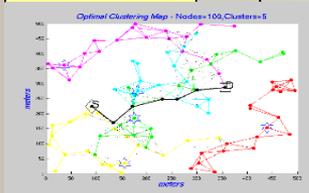
Research Challenges

- Lack of analytic methods and heuristics to understand impact of network design options and trade-offs
- Limitations of large-scale discrete-time, event-driven simulations



Optimal Path in Real Time

Hierarchical Path in Real Time



Path Length Per Flow Per Scheme

Average Path Length Per Scheme

Transitions from C&N CTA

- Network routing analysis & synthesis tools
- Domain formation analysis & synthesis tools
- Network resource optimization heuristics
- Network capacity and scalability analysis techniques
- Routing overhead analysis

Objective: Develop capabilities to assess and analyze mobile *ad hoc* network designs for large networks, such as WIN-T and FCS



Communications & Networks CTA Summary



- Significant research results
- Highly collaborative
- Results transitioning to key programs and standards
 - CERDEC MOSAIC, PILSNER, TWNA, Network Design, I2WD programs
 - DARPA CN, XGEN programs
 - FCS LSI, FCS System Design and Development (Net Mgmt), TMOS
 - JTRS Cluster 5 and Navy Digital Modular Radio
 - IETF and IEEE 802.16

Metrics through 1st Qtr FY07

Publications

- Journals 314
- Conferences 546

Disclosures/Patents

- Invention disclosures 39
- Patent applications 15
- Patent awards 10

Student Support

- PhDs graduated 48
- Masters 21

Lectures

- Lectures 38
- Workshops 5

Staff Rotation

- Staff rotations 53