Network Edge Services

ONR BAA 10-018 Industry Day:
2010-May-21

Joseph Macker
Brian Adamson
Nathan Smith

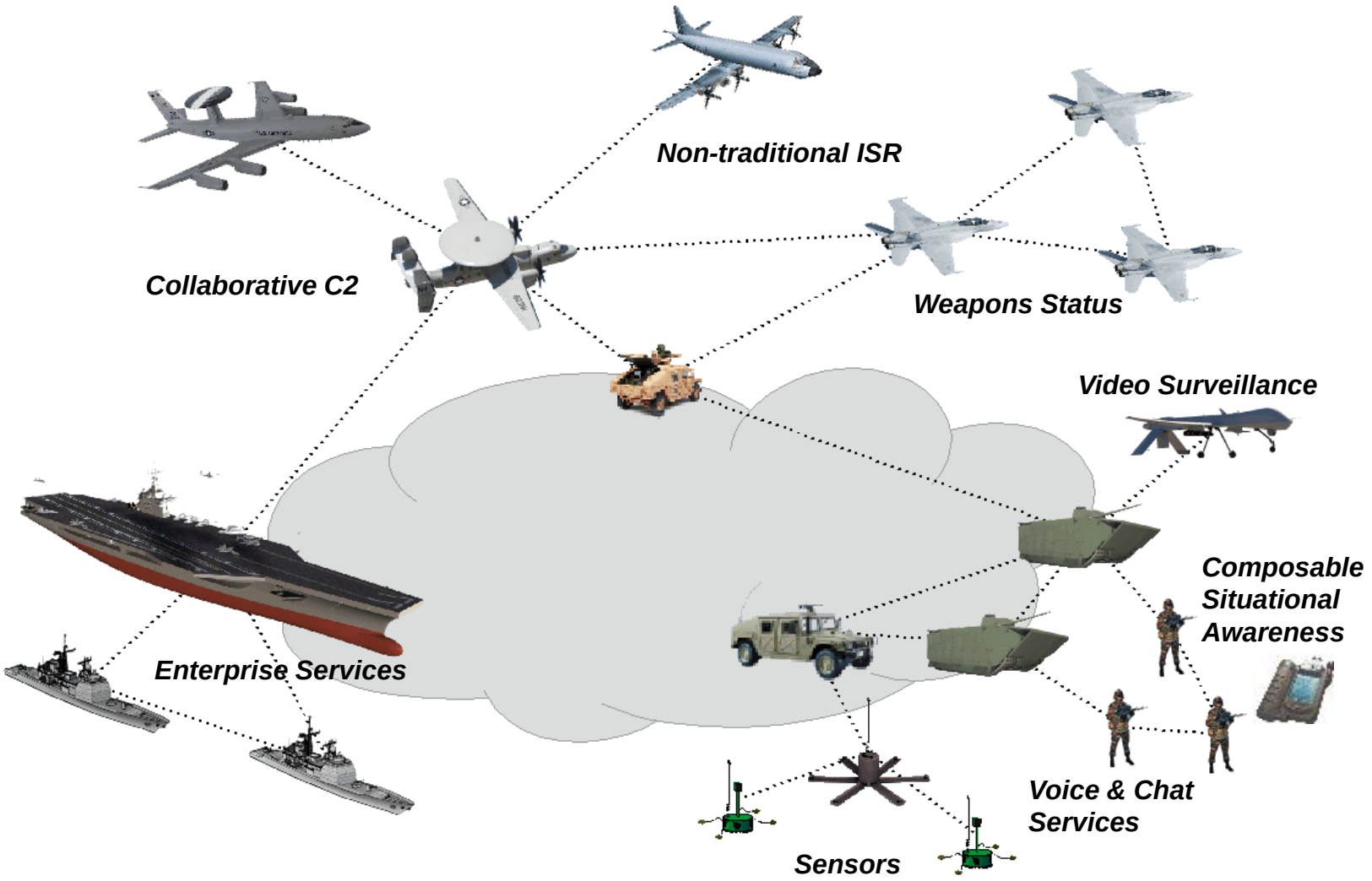
Naval Research Laboratory
Information Technology Division, Code 5522

Joseph.Macker@nrl.navy.mil
Brian.Adamson@nrl.navy.mil
Nathan.Smith@nrl.navy.mil

Outline

- Technical Challenges and Opportunities
- Related Work
- Useful Tools and Methodologies

Tactical Application Services



Goal: Distributed Services in the Tactical Edge

Network Application Design and Issues

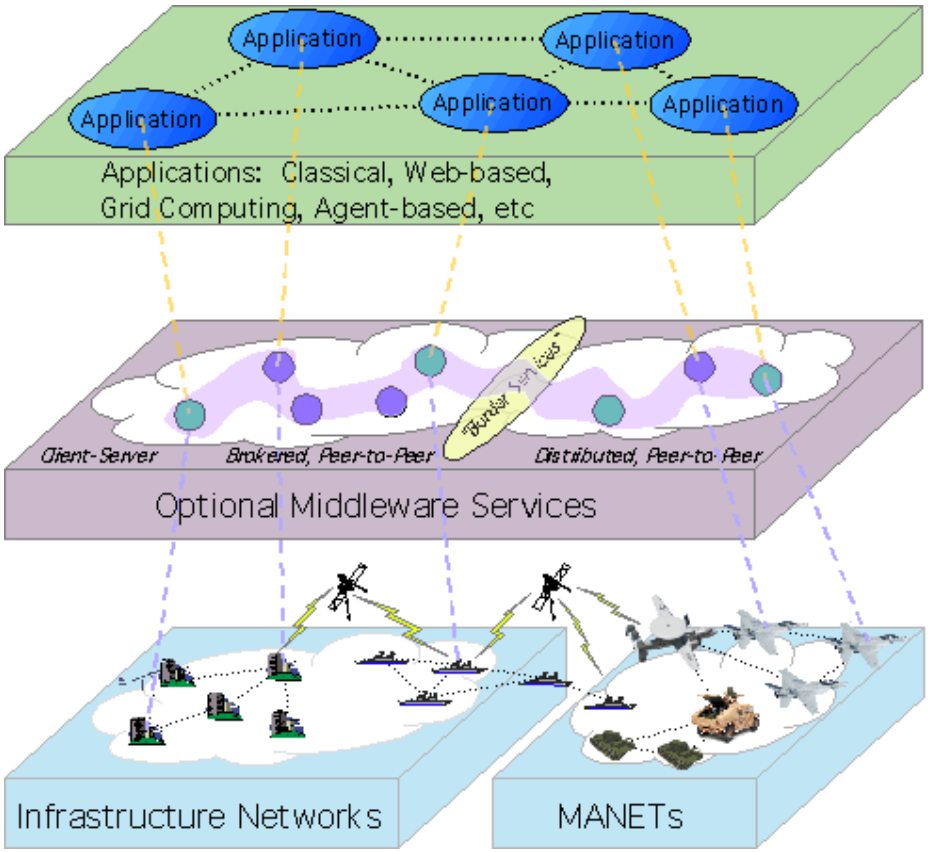
- *Different distributed application paradigms (Web Services, Grid Computing, Agent-based)*
- *Different service types and reliability Requirements*
- *Highly Distributed and Dynamic Inter-app communication design issues*
- *Effectiveness of designs in MANET environments*

Middleware Services Opportunities & Challenges

- *Publish/Subscribe*
- *Peer Discovery*
- *Service Discovery*
- *Persistent Data Transport*
- *Application Security Services*
- *Very immature in MANET environments*

Network Challenges

- *Infrastructure vs. Ad-hoc environments:*
  - *Tactical Edge networks and platforms may have intermittent connectivity to infrastructure.*
  - *Different network services ("underware" incl. transport, name resolution, auto-configuration, discovery, etc) may be needed for extreme environments.*
- *Cross-layer integration for better performance*



Related Technology Gaps

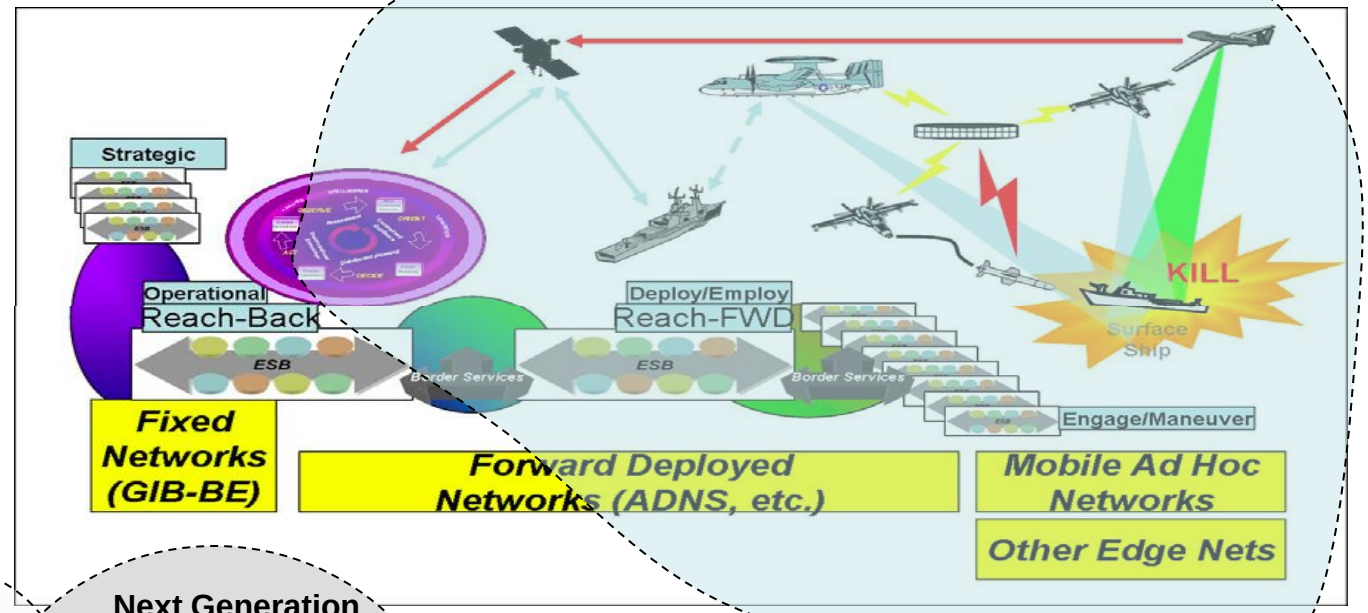
- Dynamic Routing (including multicast routing)
- Dynamic, Self-organization at all layers
- Group communications support
  - Wireless multicast
  - Middleware use of multicast in wireless
  - Group communication paradigms for applications
  - Reliable transport for group communications
- Performance optimization for constrained wireless systems
- Understanding of protocol trade-offs as network size, traffic trends (loading, one-to-many vs. many-to-many), etc scale up/down or change
- Standards! (interoperability, performance, etc)

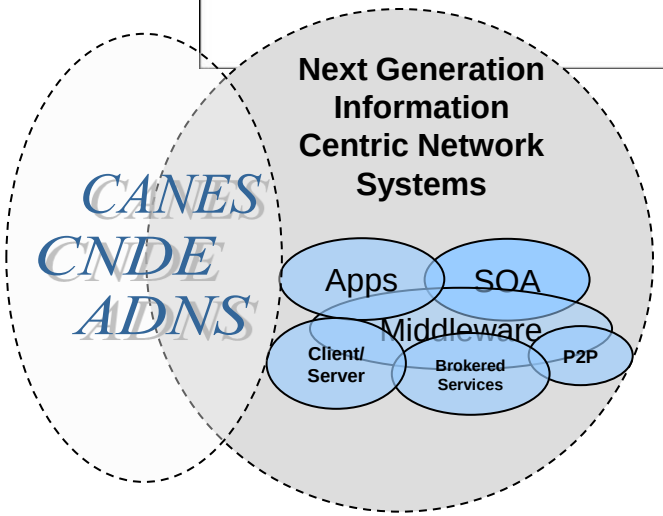
Dynamic Self-Organization

- Auto-configuration
- Application/ middleware
- Discovery and Pub/Sub Services
  - To support apps, security, management, etc
- Network-awareness
  - Organization matched to network topology and capabilities
  - Cross-layer metrics and triggers
- Security mechanisms to support self-organization

ONR 6.2 SONOMA

Decentralized and Mobile Network Discovery Services





- Extend State-of-the-Art Network Service Discovery and Pub/Sub Approaches to Include Mobile Ad Hoc and Dynamic Operation with and without backhaul connections (Survivable, Decentralized)
-

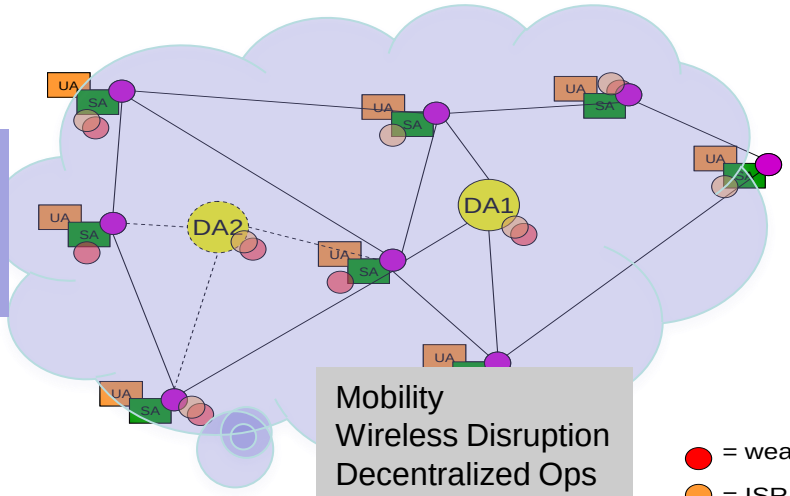
Provide novel design and analysis to improve edge operation without sacrificing backhaul and enterprise interoperability to conventional networked service methods

Progress: Service Discovery

- Developed mobile ad hoc service discovery prototype, called INDI (Independent Network Discovery Interface)
  - Goal: Research prototype in both simulation and real world system
  - More sophisticated/robust discovery than current practice
  - Flexible to extend and to apply different service models, brokering, and subscription/publication overlays for SONOMA related investigations
  - Recently interfaces extensions added, Proactive vs. Reactive Discovery, WS-Standard interfaces, multicast DNS interfaces.

Discovery Modalities:

Multicast, Unicast
Proactive, Reactive, Hybrid
Opportunistic Cacheing



UA = *User Agent (local cache)*

SA = *Service Agent*

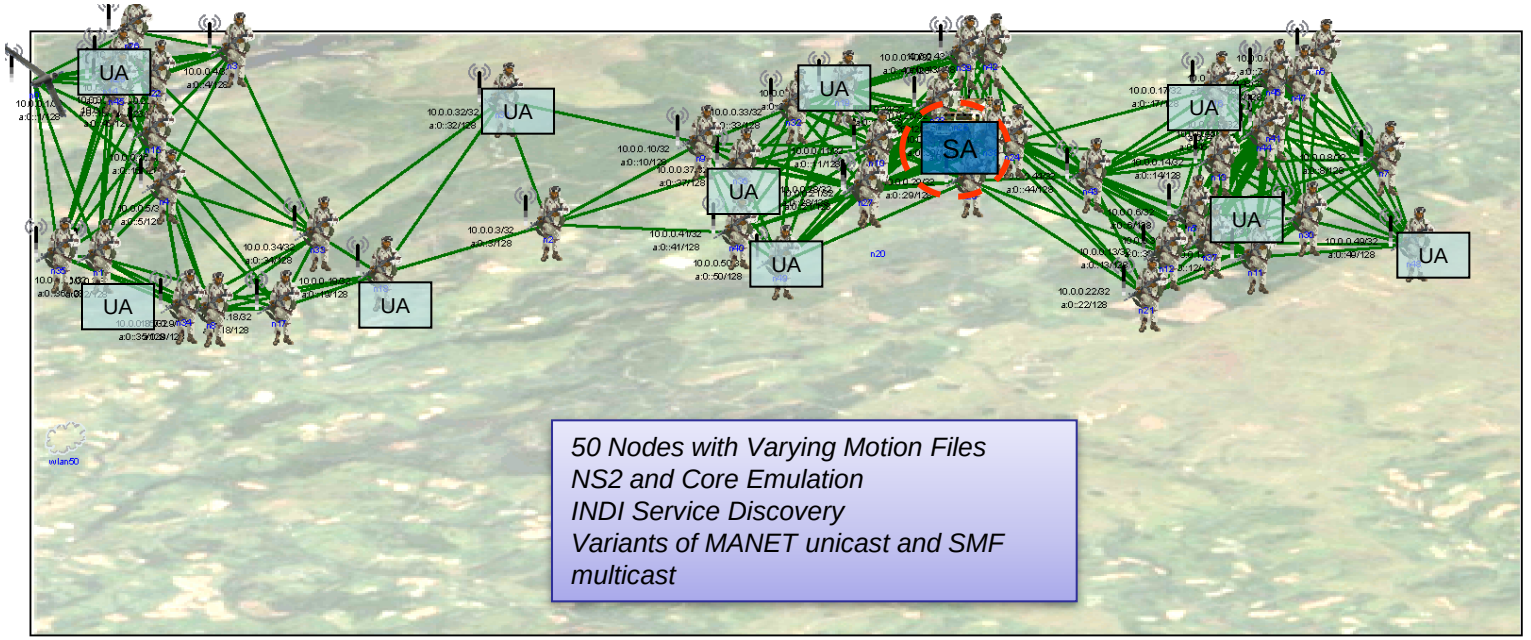
DA = *Discovery Agent (broker/cache)*

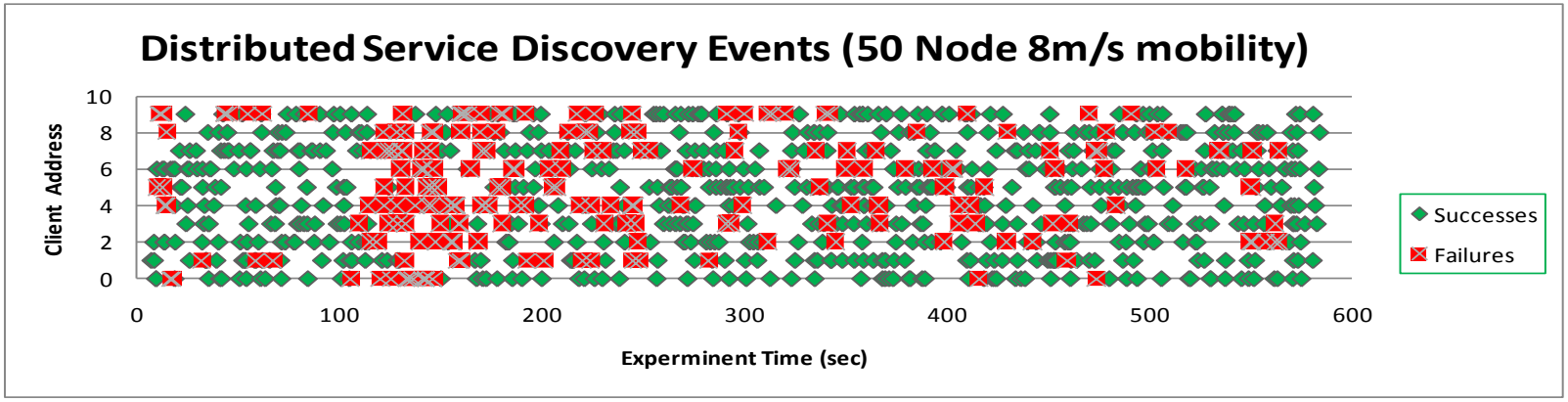
= *Representation of Scopes (Security or Roles)*

= weather scope

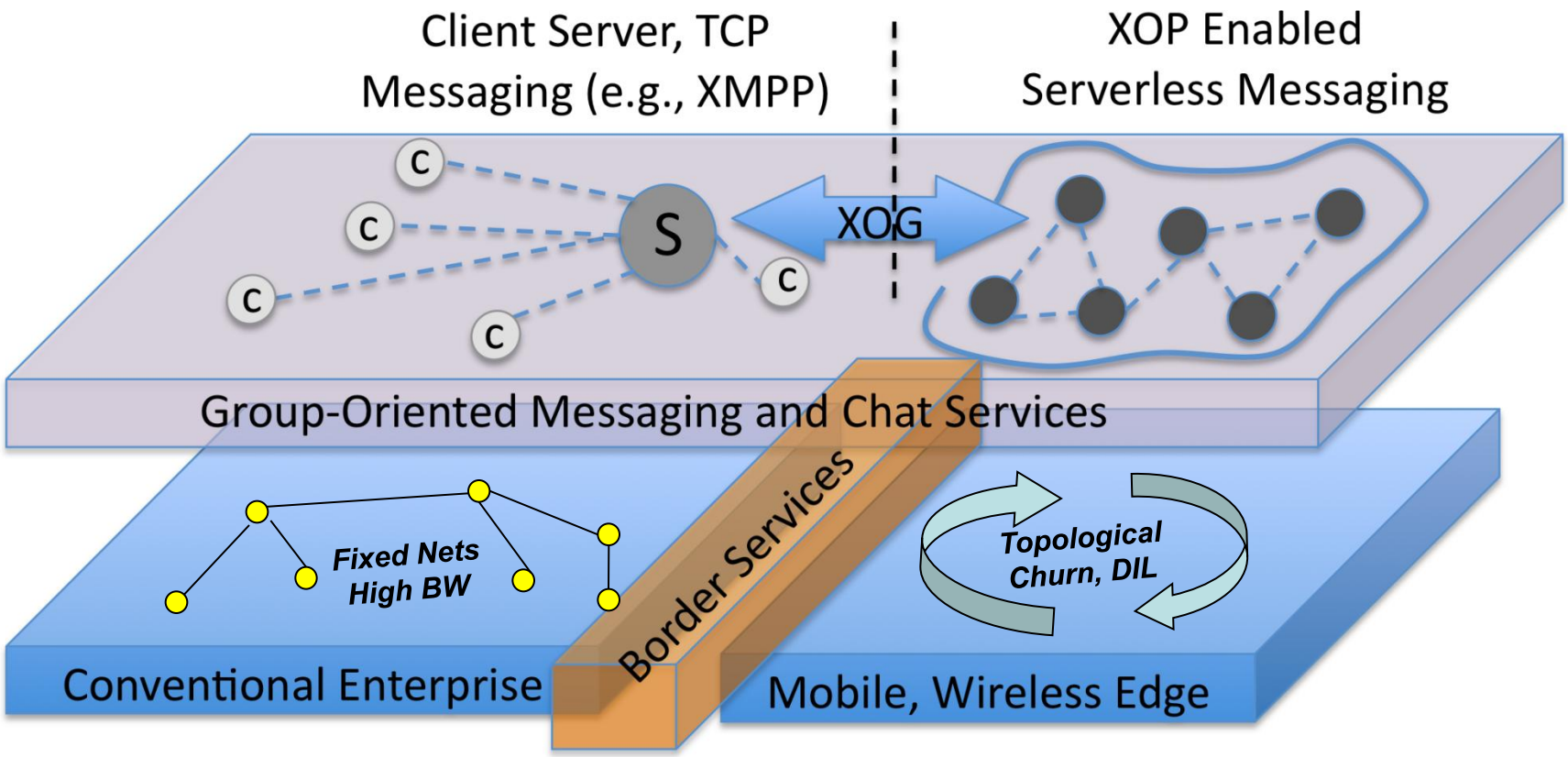
= ISR scope

Mobile Multicast Service Discovery Experiments

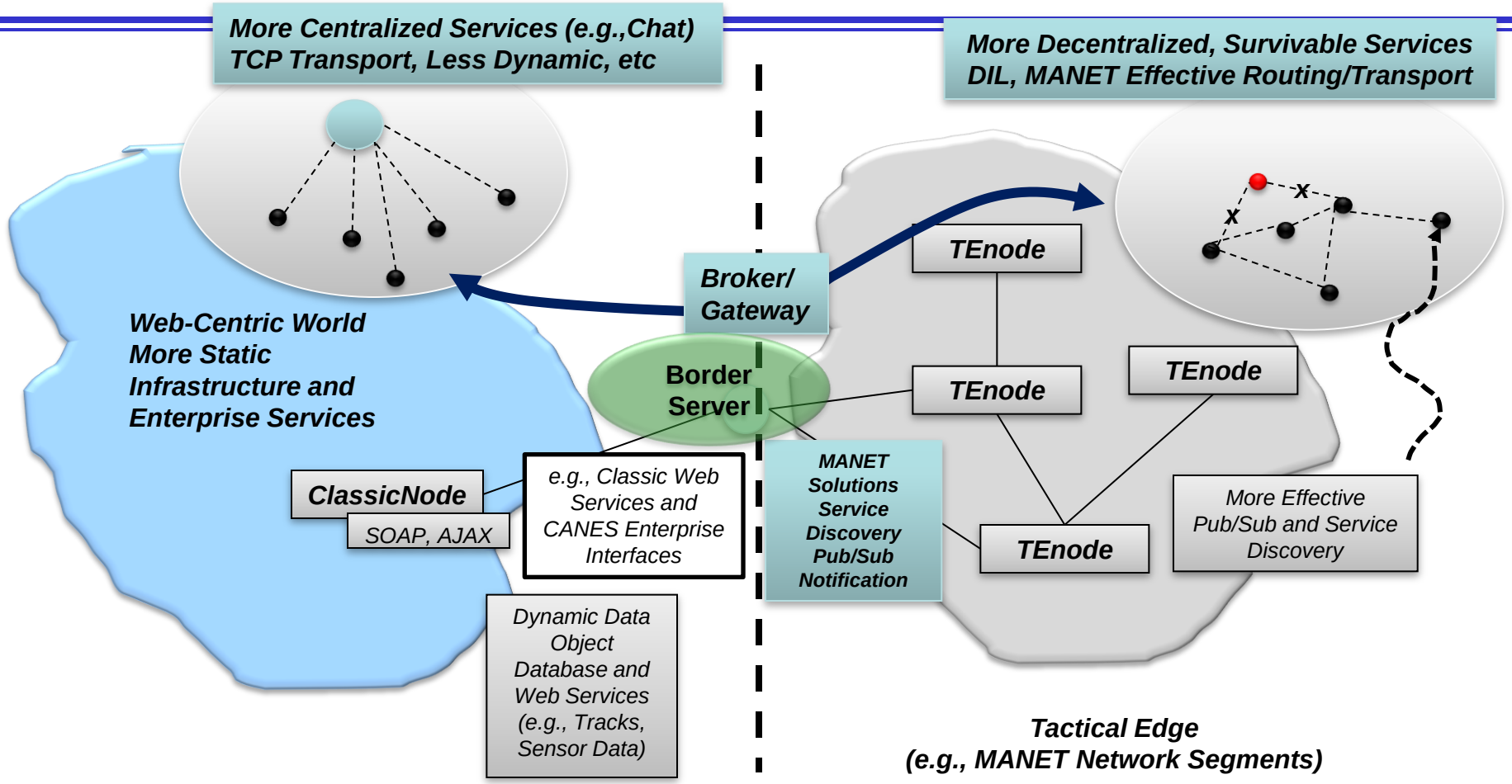




Serverless, Multicast Chat Messaging Proxy and Border Service



Further Work on Border Services



SONOMA goal is to develop, experiment, and demonstrate approaches for tactical use and tactical gateway interaction and interoperability

Wireless-Ready Reliable Transport

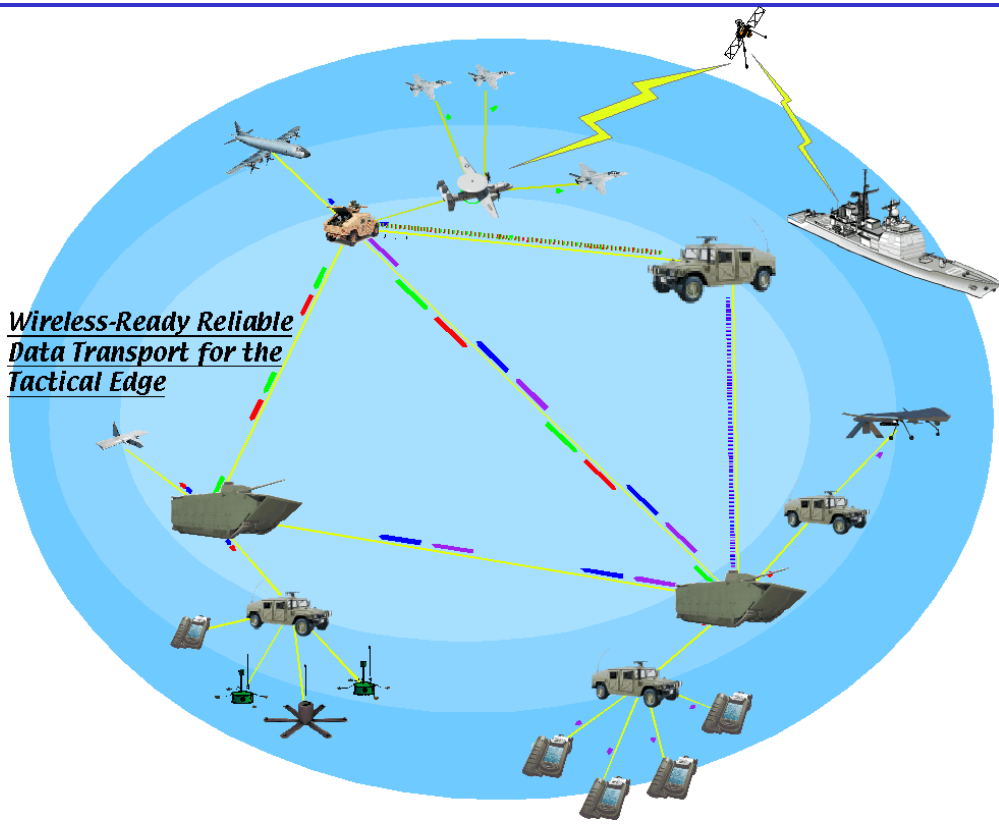
***Objective**: Develop wireless-ready, reliable data transport technologies suitable for tactical-edge and afloat networks.*

***Payoff**: Networks protocols supporting robust, efficient <u>group</u> (multicast) and point-to-point communications for:*

- *Distributed, composite computing in weapons systems,*
- *Sensor network systems, and*
- *C4ISR in the tactical edge.*

Approach:

- *Leverage existing NACK-Oriented Reliable Multicast (NORM) protocol with enhancements for:*
  - *Wireless-ready congestion control,*
  - *Advanced packet-based erasure (FEC) codes, and*
  - *Hybrid end-to-end and hop-by-hop mechanisms.*
- *Conduct extensive simulation-based studies.*
- *Integrate into Navy and Marine Corps tactical edge networking demonstrations.*
- *Actively transition into appropriate standards bodies.*



Planned Products:

- *Simulation and working implementation code*
- *Experimentation and test reports and papers*
- *Demonstrate the algorithms developed in live wireless networks and testbeds.*

Scenario/ Mission-Driven Performance Evaluation

- The complexity of network-based communication systems requires thorough, detailed performance evaluation and characterization to determine suitability for critical, tactical systems.
  - *Subtle protocol interactions can lead to pathological conditions in dynamic, often stressed tactical communication environments.*
- Tactical Edge Networks (TEN) built emerging network radio technologies offer new opportunities for improved capability, but system performance needs to be carefully studied to to achieve successful system integration.
  - *System will be an amalgam of different protocols and vendor technologies.*
  - *New technologies offer new capabilities that merit further study in context of network systems.*
- Test tools, methodologies, and detailed simulation models are needed for tactical and wireless network performance evaluation. Some are available and can be leveraged for design and system integration trade-off studies.

Wireless Network Emulation