# NDIA Ground Robotics Division: Discussion on Ad Hoc Mobility and other interesting technologies


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# Cisco Vision: Mobile Network of the Future

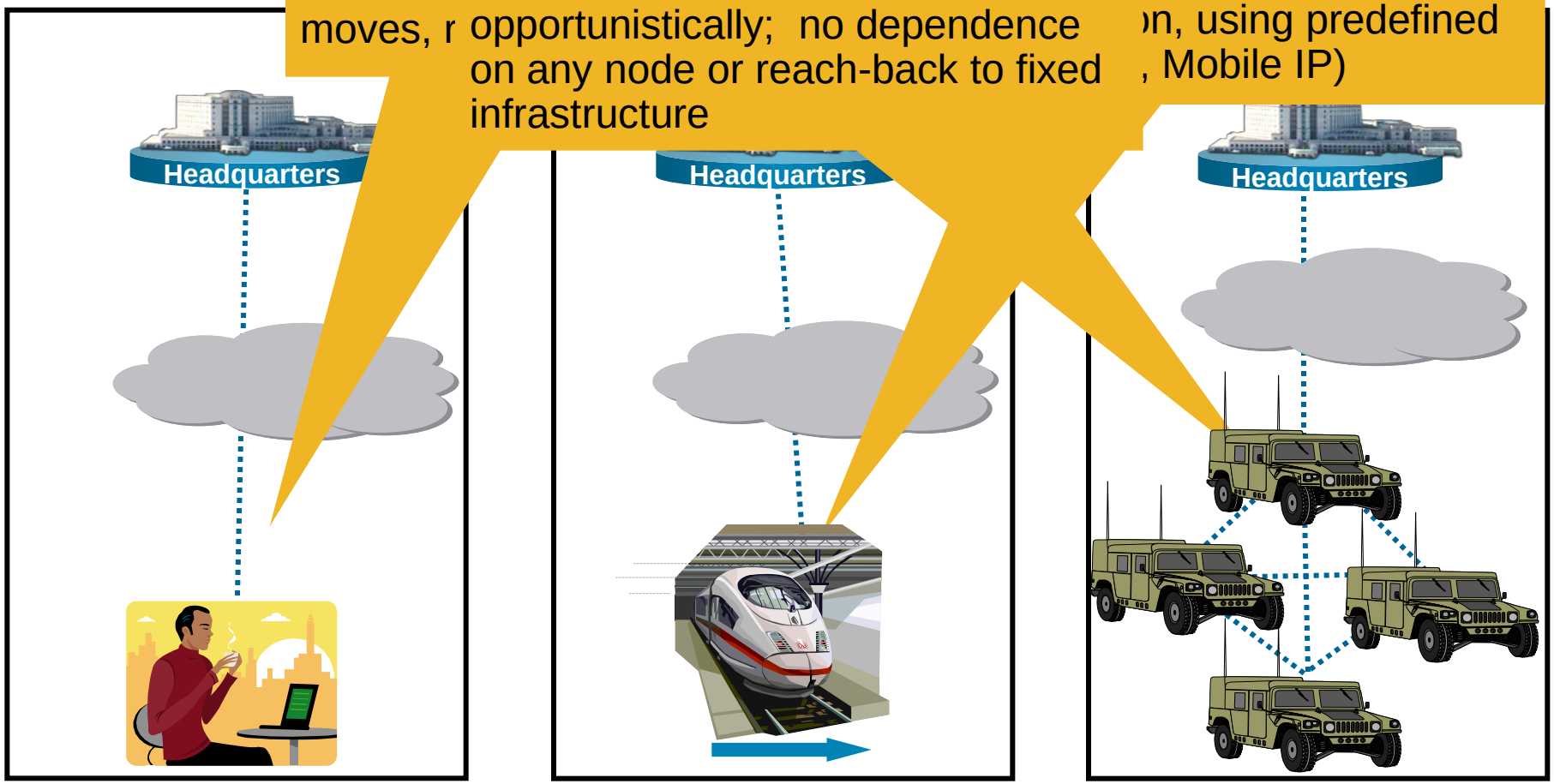
Enables people to connect and communicate how, when and where they want with no limitations on location, and continuously adapts to their needs – even where there is no pre-defined fixed infrastructure.

# Types of Mobile Networking

Node or
moves, r

Nodes or networks interconnect opportunistically; no dependence on any node or reach-back to fixed infrastructure

ork stays connected
on, using predefined
, Mobile IP)




Disconnected

Connected

Ad Hoc

# Mobile Ad Hoc Networks (MANET)

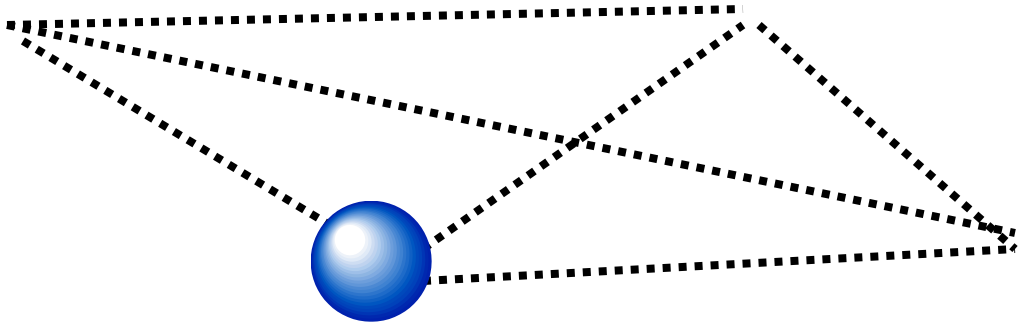
**Self Forming**

**Self Healing**

**Peer to Peer**

**Infrastructure-less**

**Highly Dynamic**



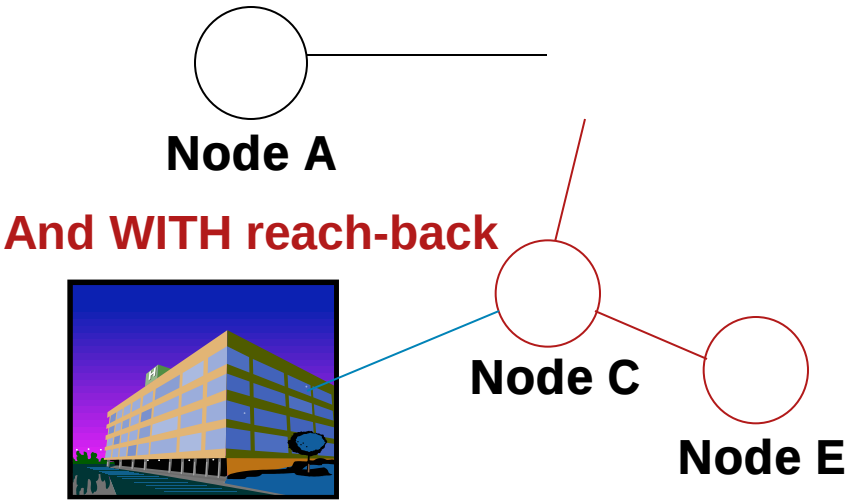
# Applications for MANET

- *Any application or environment characterized by*:
  - Highly mobile users/nodes
  - Compelling need to share IP-based voice, video, data
  - Fixed infrastructure inoperable, overloaded, or non-existent
- Medical
- Construction
- Mining
- Transportation
- Defense
- Disaster Recovery
- Special Events

# Simplified Problem Statement

**Basic Premise: Any two or more nodes should be able to communicate without "a priori" knowledge, and without reach-back.**

**Applications should just *work.***




**Step 7: Begin Applications interworking**

Typical Issues: database synchronization, peering

**Step 6: Begin services interworking**

Typical Issues: Connection vs Connectionless sessions, message protocols, directories, servers

**Step 5: Begin Data transfer**

Typical Issues: fragmentation? Packet loss vs latency trades? Delivery verification?

**Step 4: Set up Secure link**

Typical Issues: encryption? Trust? Identity?

**Step 3: Establish Routed data network**

Typical Issues: MANET? Address Domains?

**Node B**

**Step 2: Establish serial data link**

Typical Issues: framing? Sync?

**Step 1: establish RF link**

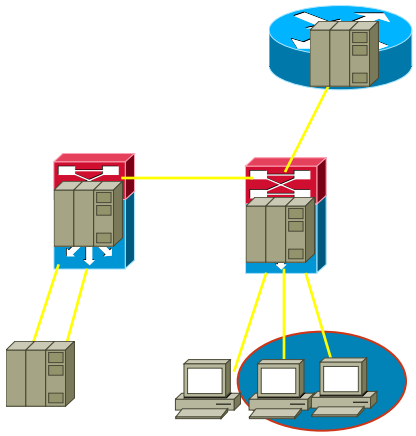
Typical Issues: Band? Full or half duplex?

**So how can we build this?**

**How can we scale this?**

# T-SONA Breakthrough Concepts

- SONA Approach: The network provides services.

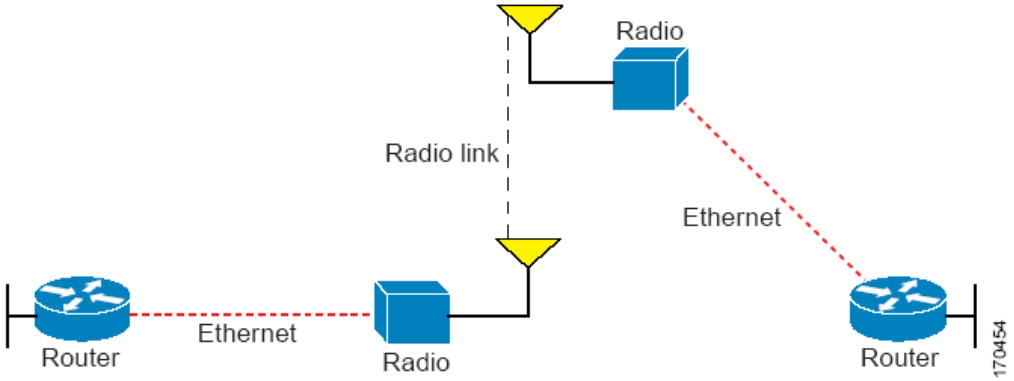


- T-SONA: Each mobile node is a self-contained, enterprise network.
- Therefore, each mobile node brings its own services with it
  - A node may have 0,1…n connections to other networks (nodes)
  - Each node is vertically integrated
  - Each node carries with it an entire suite of application servers (scaled appropriately)
  - Nodes do not use Peer-to-peer networking, but network-to-network connections at all layers

# Networking Thoughts

- Each node is a self-sufficient network- it brings its own resources. More nodes augment the whole.
- There is no communication hierarchy - the network is opportunistic.
- All nodes contain the same basic functionality- the only difference is size.
- There is no “end node”- any node can be a repeater.
- Application Integration is enabled by network services (SONA).

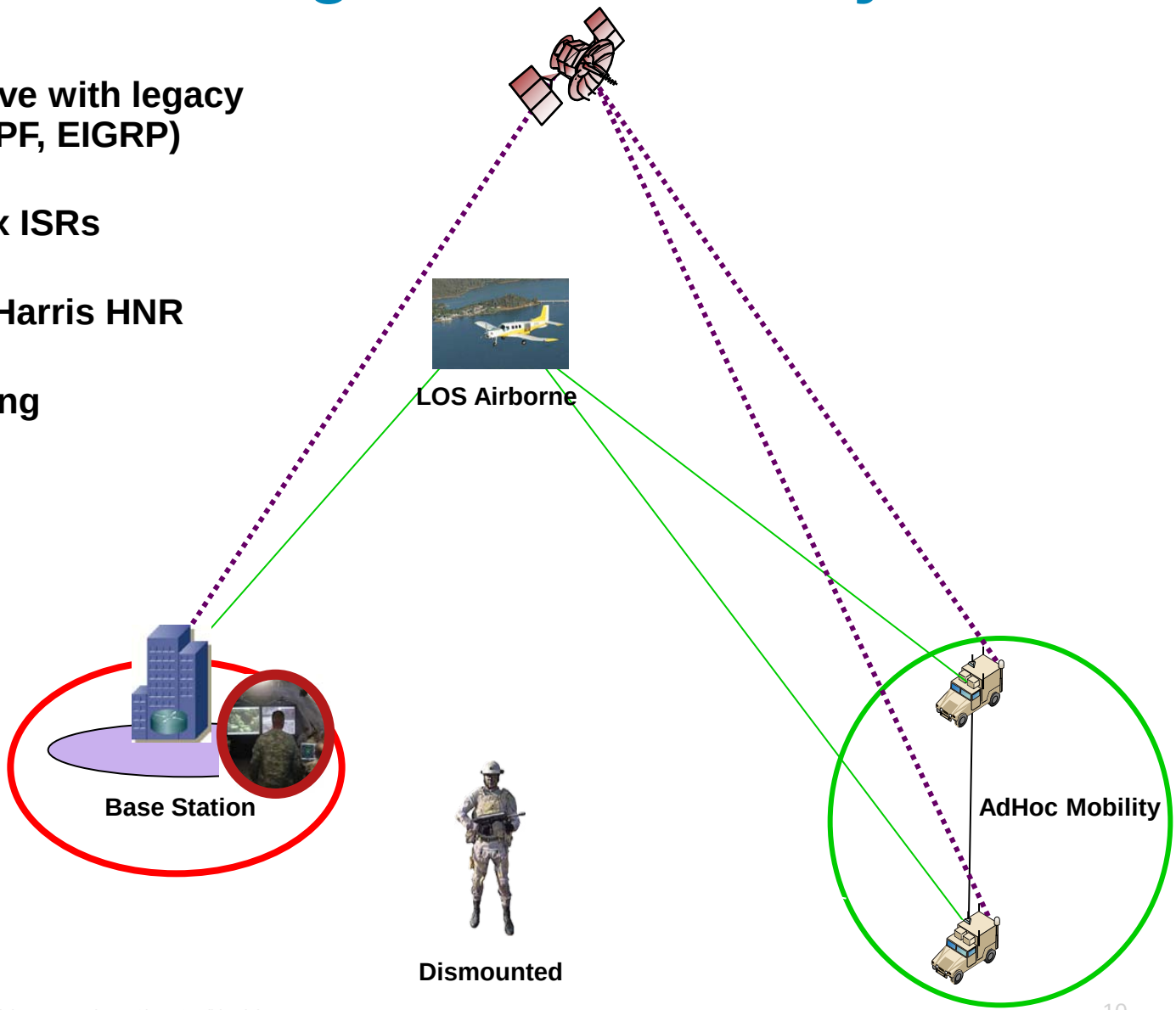
# MANET Extensions for Router-Radio Links




- Use Layer 2 feedback from the radio network to choose best paths for IP routing
- Speed network convergence through faster recognition of Joins and Leaves
- Implement a flow control mechanism between routers and radio

# Ad Hoc Networking Solution Today

- Networking on the Move with legacy routing protocols (OSPF, EIGRP)
- Cisco 32xx, 28xx, 38xx ISRs
- 32xx integration with Harris HNR
- Voice-over-IP, Streaming Video, IP Data, Chat
- Point to Point Radio
  - RFC 4938 Enabled
  - Ethernet-Attached
- Basic Multicast
- Scale to about 20 nodes



# Example Application

- VoIP demonstrations

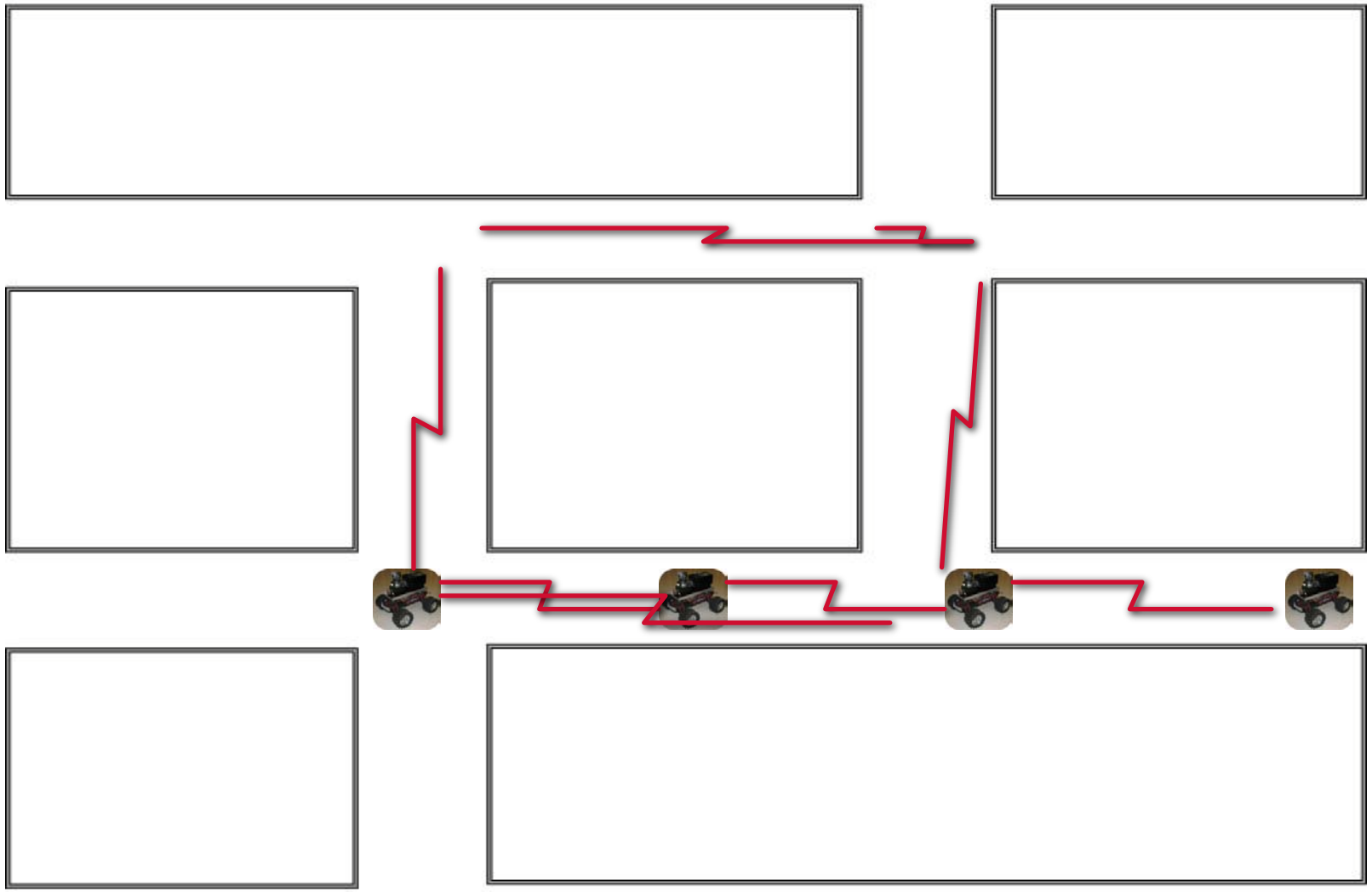
# Topology

# Small demo system

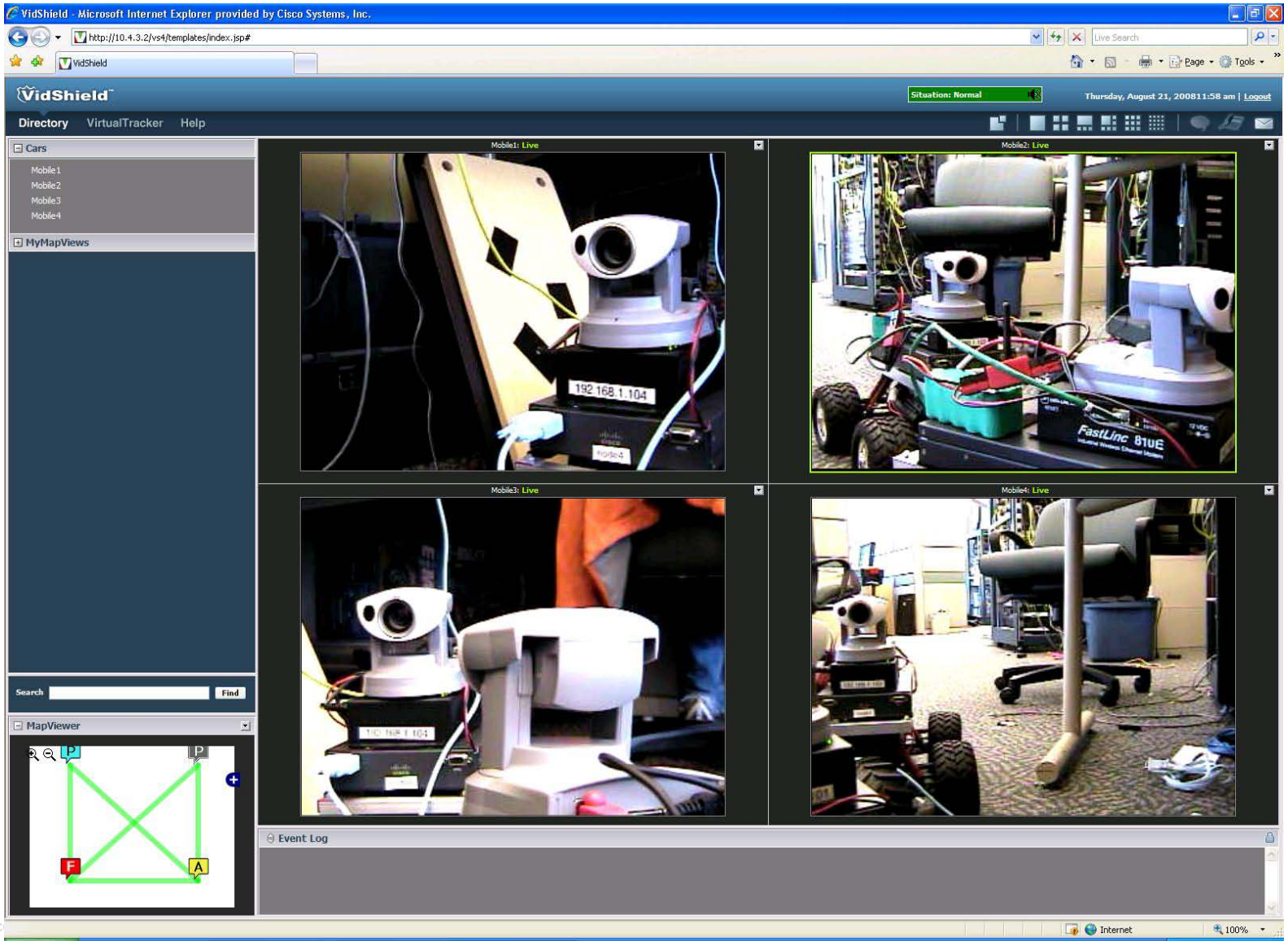
- We have assembled a demo system using 4 radio controlled cars.

# Introduction

# Exercise Beta



# Information Delivery Visualization

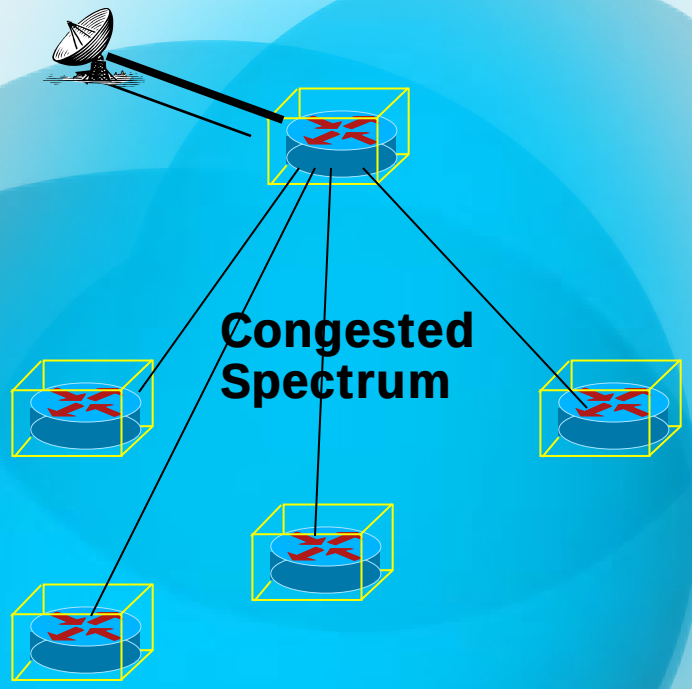


# Preview of Advanced Technologies

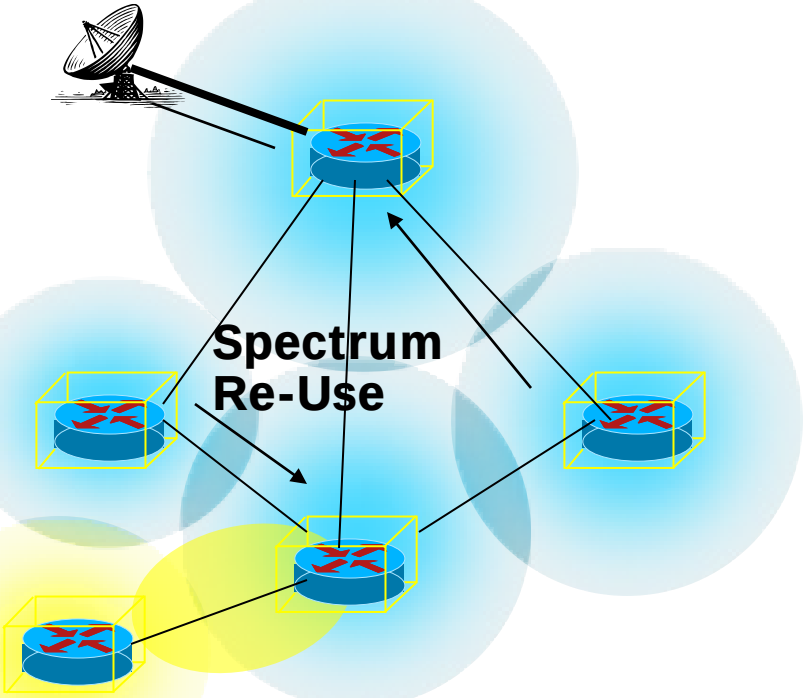
- Overview of technologies to apply to the problems of Ad Hoc networking
  - Multi-Hop Routing (MANet)
  - Trust Models
  - Geo-Spatial Routing

# Network Wireless Capacity Implementation Idea

**Traditional Hierarchical model**




- Multi-Hop Routing

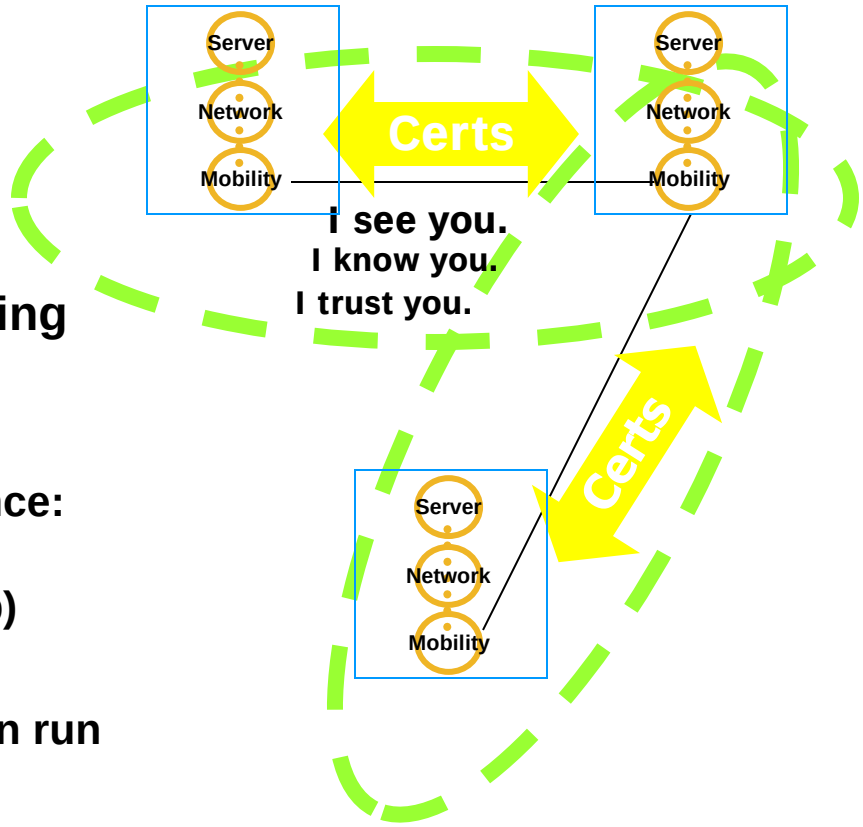



**Benefits:**
- **Network Capacity scales with the network**
- **Lower Power, Frequency re-use**
- **Support different "flavor" radios**

EIGRP is a good MANET protocol
Enabled by PPPoE/VMI

# Network Based Trust Model Implementation Idea

**Transportable Network-based Trust Service**

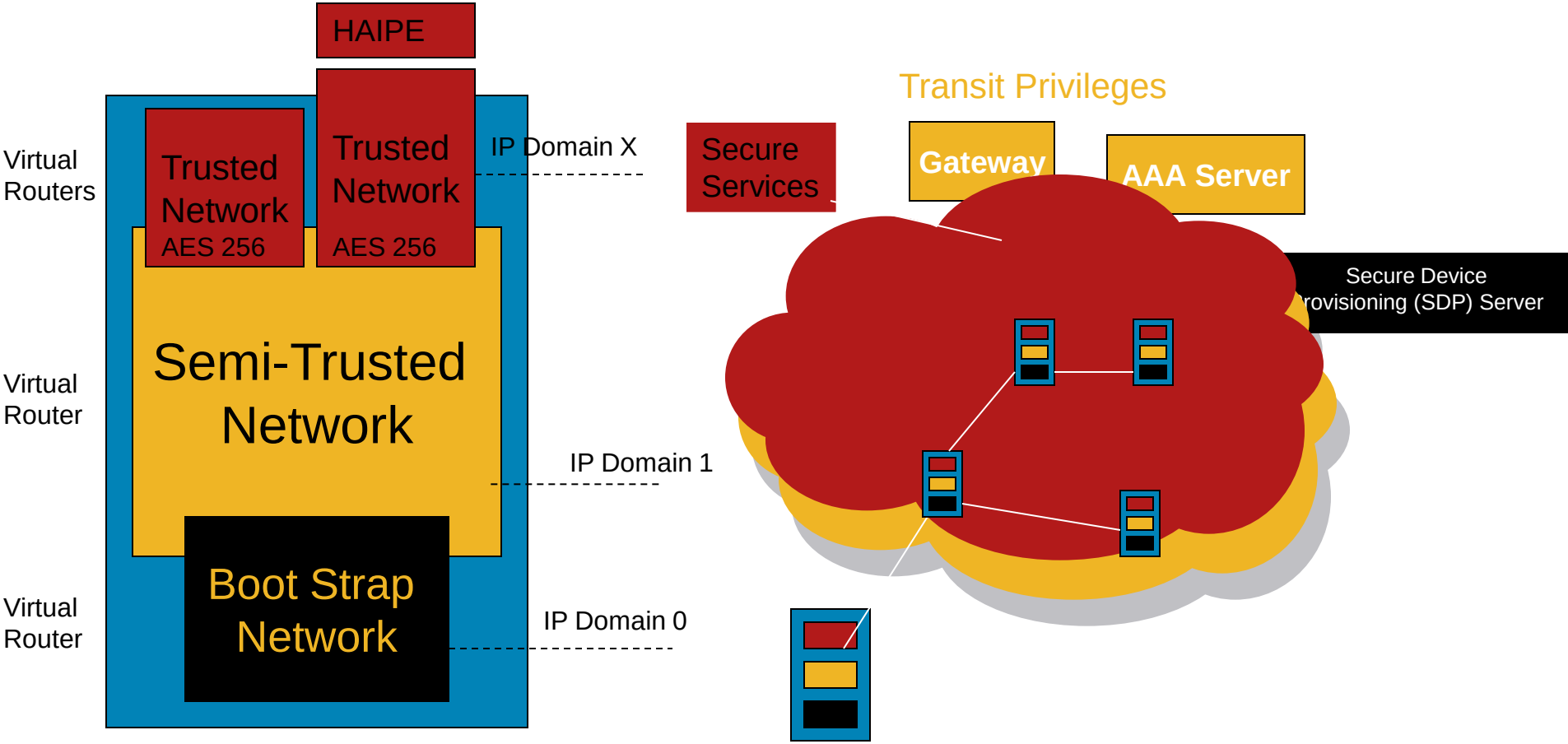



- **Advanced Technology: Trusted Networking**
  - Built-in AAA, preloaded with certificates
  - Certificate exchange determines trust level
  - Security Tags maintain Information Assurance: authentication, basic encryption
  - Tag establishes identity (group membership)
  - Per-hop trust model approach scales better
  - HAIPE and traditional encryption models can run in layers above this.

**Benefits:**
- **Identity management and presence become network services.**
- **Supports Role-based networking**
- **Different levels of trust can be supported: Transit services**

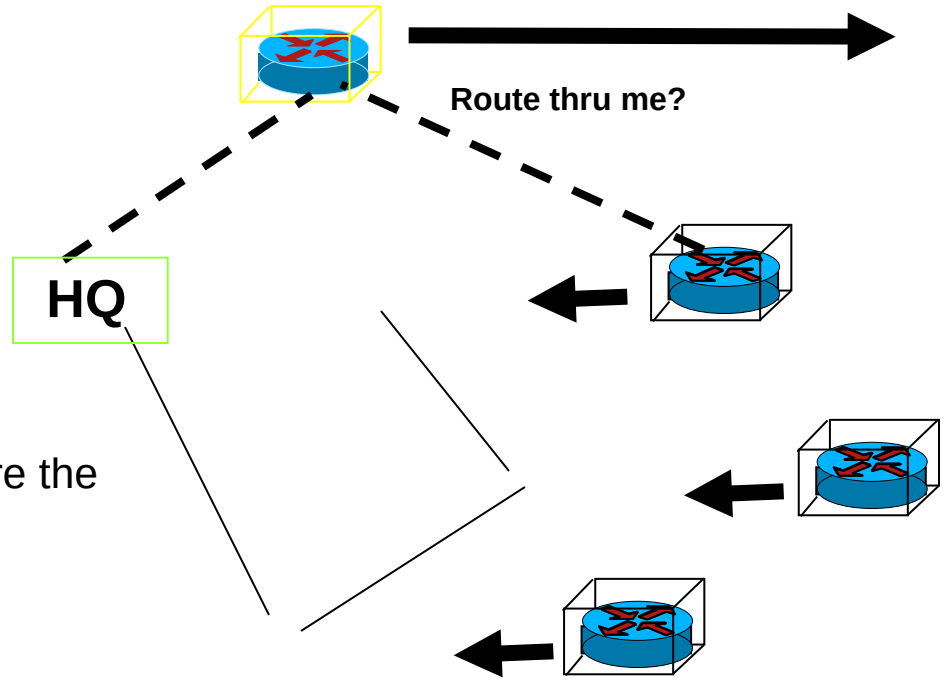
# Notional view

- Layered architecture



# Predictive Routing Implementation Idea

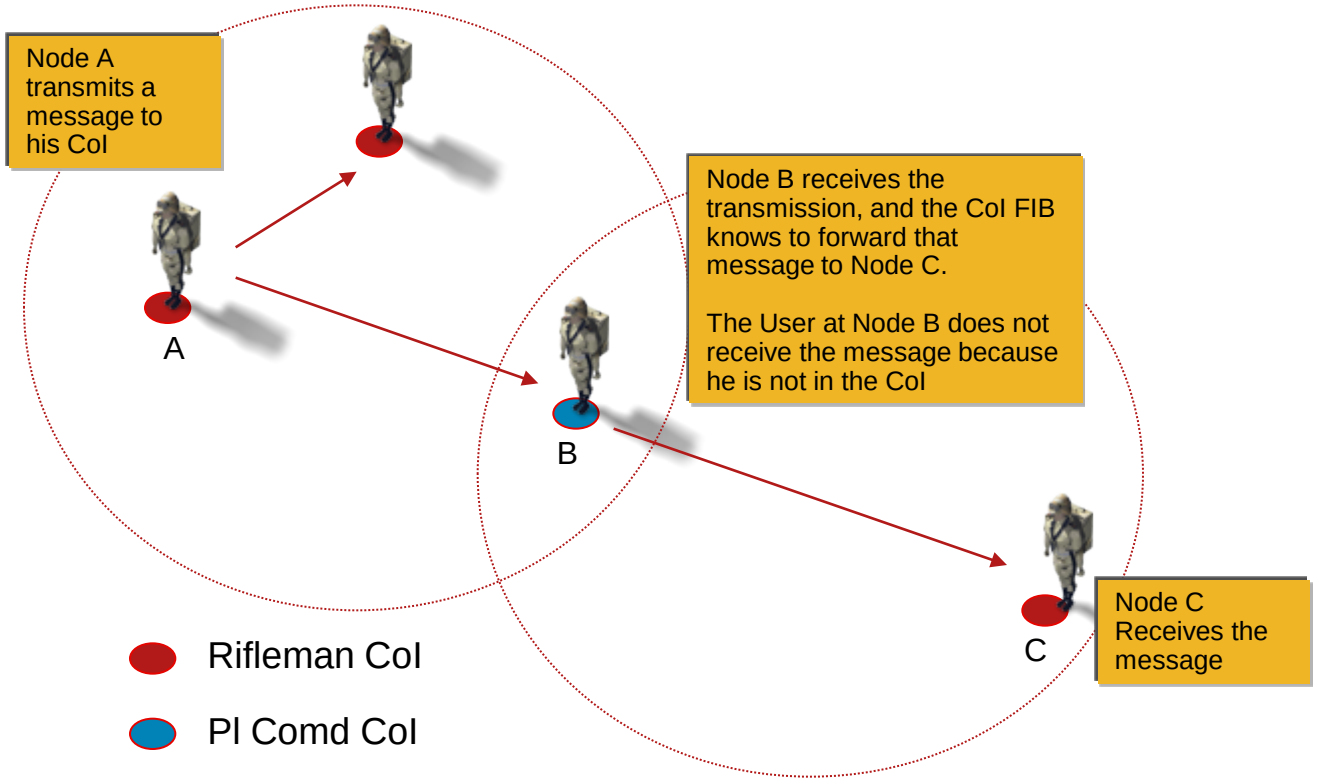
- Geospatial Routing
  - *Predictive* Routing model
  - Tracks information for each node:
    - Position
    - Velocity
    - Acceleration
    - Orientation
    - Other
  - Bases routing decisions based on where the node will be




**Benefits:**
- **Presence and Location become a network services. (Asset tracking)**
- **Network service supports applications: point-to-talk**
- **Routing Logic also supports reposition of nodes to enhance coverage.**
- **Better application performance (make-before-break), domain partitions**

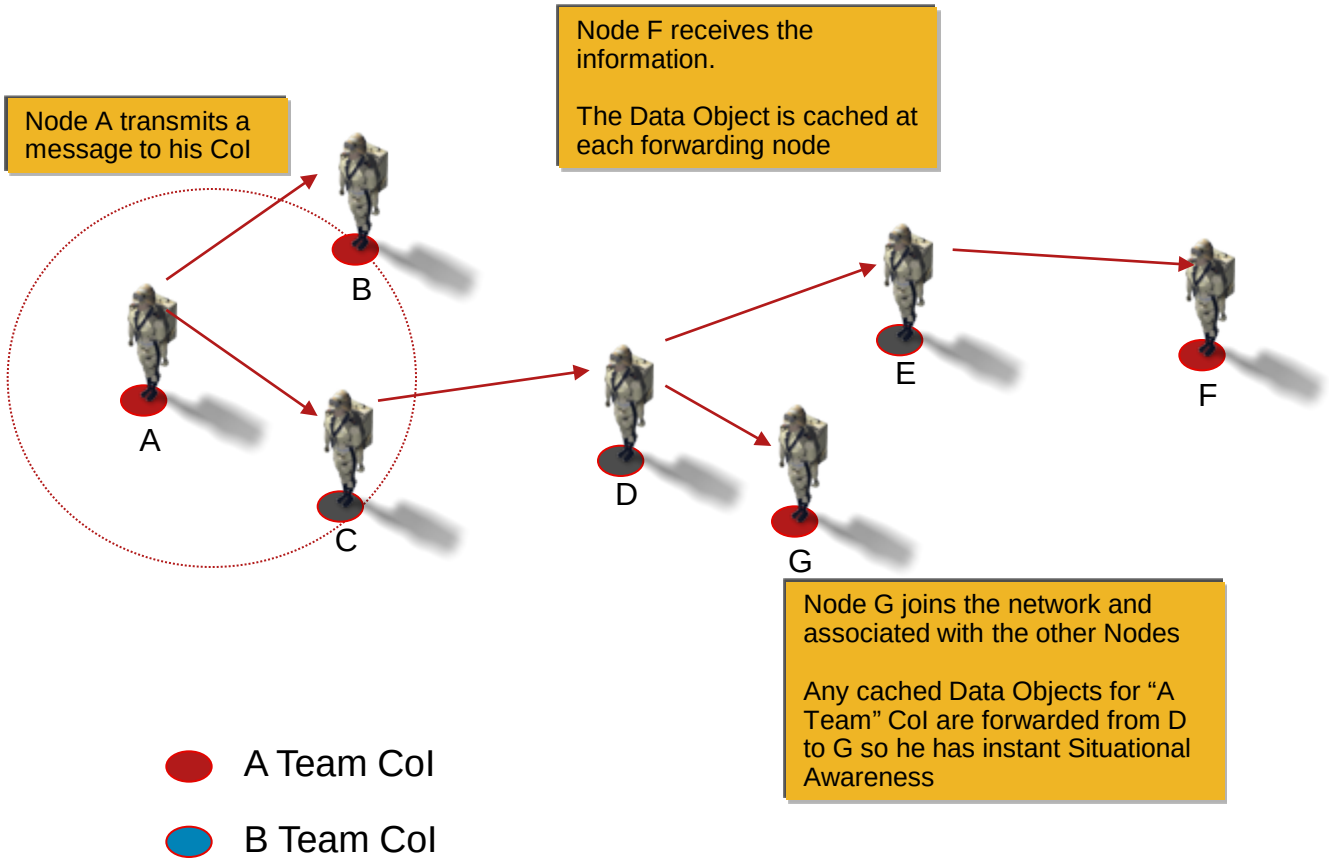
# Disruption Tolerant Networking (DTN)

Community of Interest (CoI) Information Routing



# DTN – Demonstrated in Phase 1

Disruption Tolerant Networking



# Other Promising Enabling Technologies

- T-Engine and the GeoSpace
- Service Provider video architectures (IMF)

# Summary

- Loose integration between routers and radios- Routers will evolve at a much faster rate than radios.
- We must break tradition and “leak” information between layers. MANET protocols alone are not the answer. Routers need to know what the radio sees, and Applications need to know what is happening in the network.
- We want to encourage peer-to-peer application models rather than client server. They are much more robust over intermittent links.
- The Network is a platform for innovation to drive change
- The Future is bright

# Questions?