

Architecture and Prototyping of an 802.11-based Self-Organizing Hierarchical Ad-Hoc Wireless Network (SOHAN)

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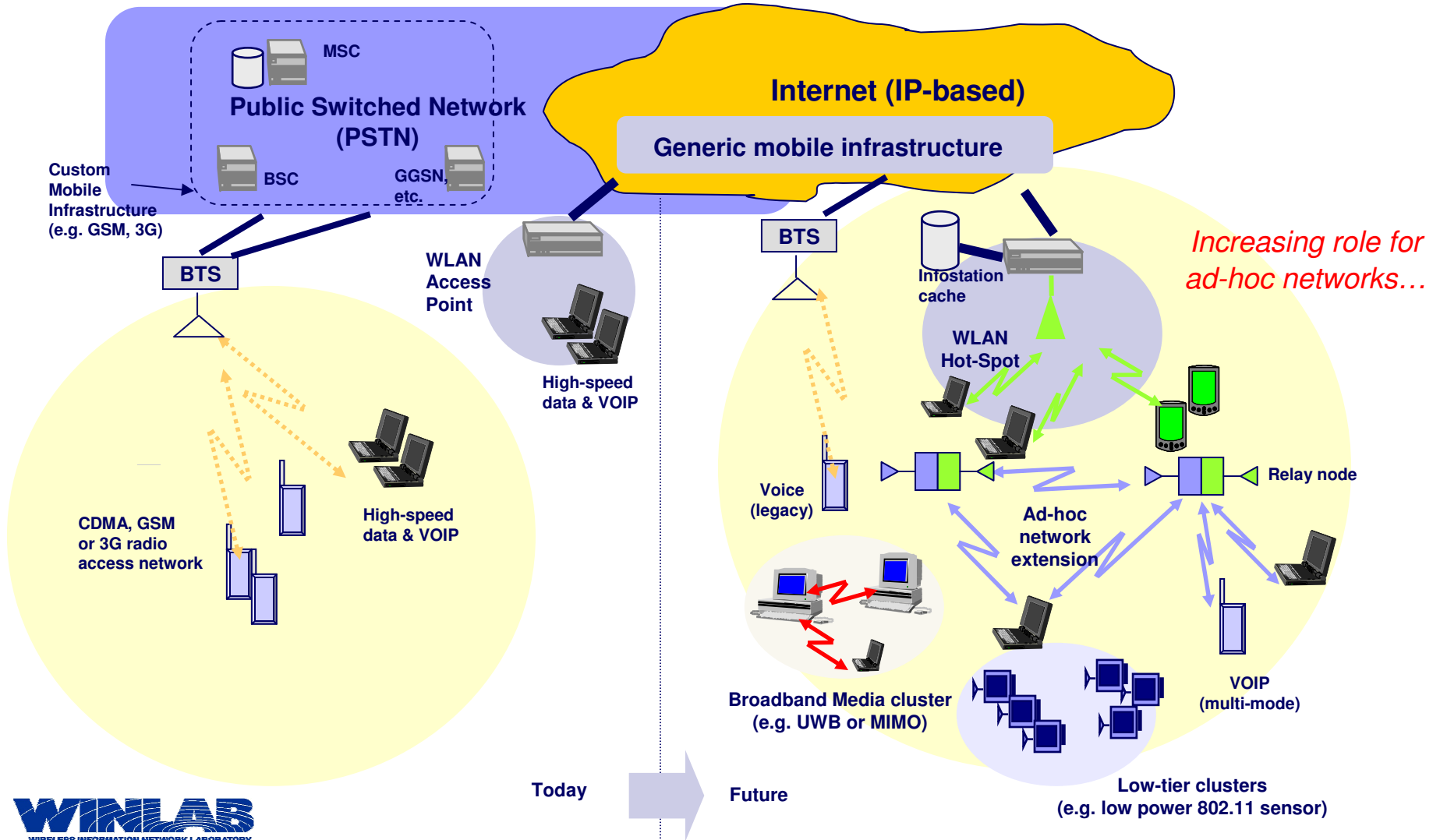
Rutgers, The State University of New Jersey

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Introduction

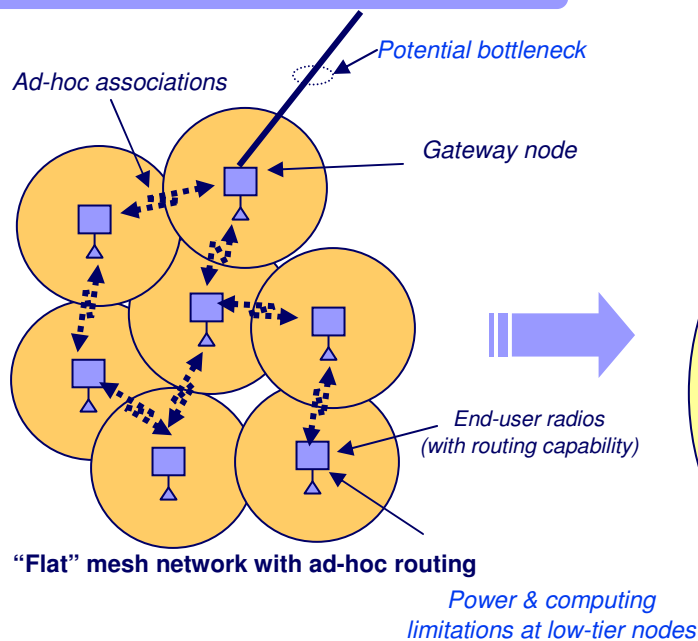
Introduction: Next Generation Wireless Network



Introduction: Flat vs. Hierarchical Ad-Hoc Nets

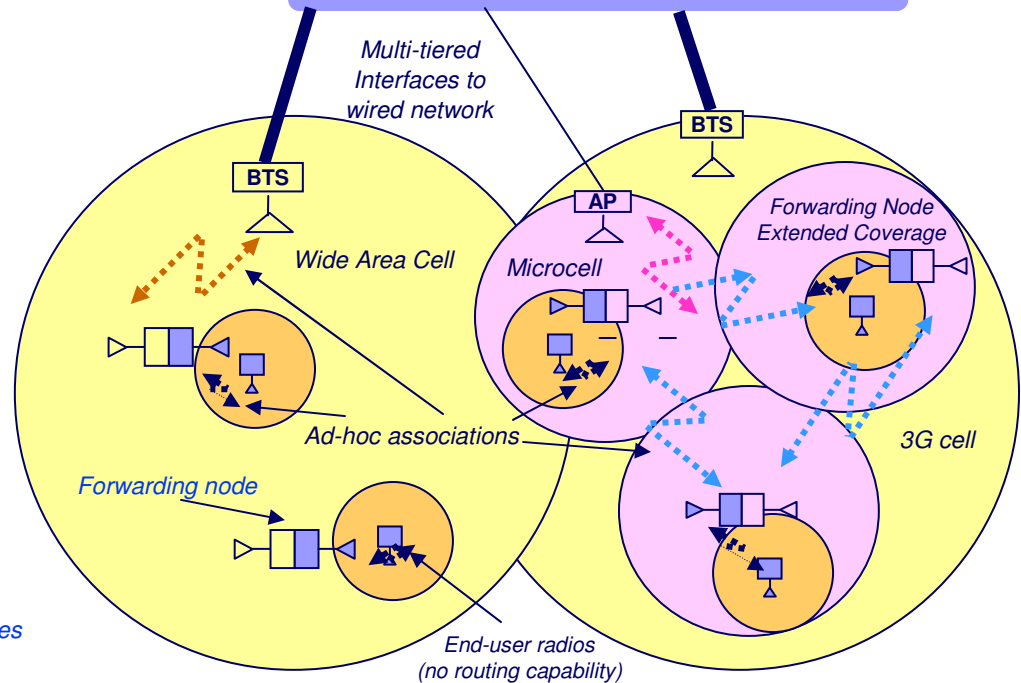
- Hierarchical structure is essential, and helps to achieve:
 - Scalability, i.e. improved max throughput and delay/QoS
 - Effective integration with 3G/4G, WLAN and Internet
 - Improved coverage & power consumption at subscriber radios

Wired Internet Infrastructure



Throughput per node scales $\sim 1/\sqrt{n}$

Wired Internet Infrastructure



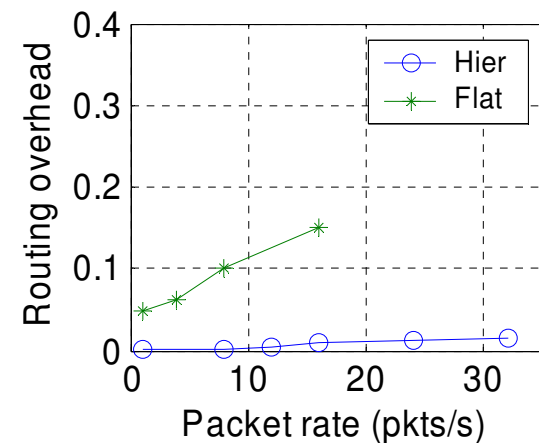
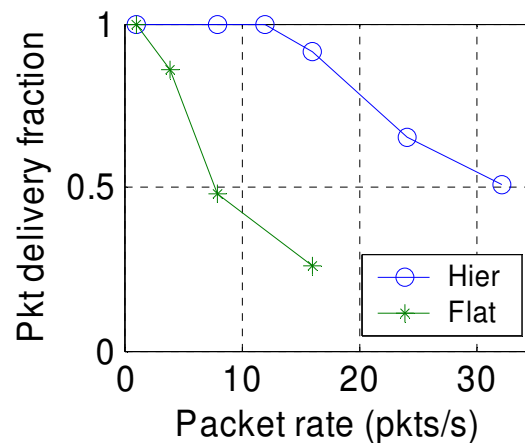
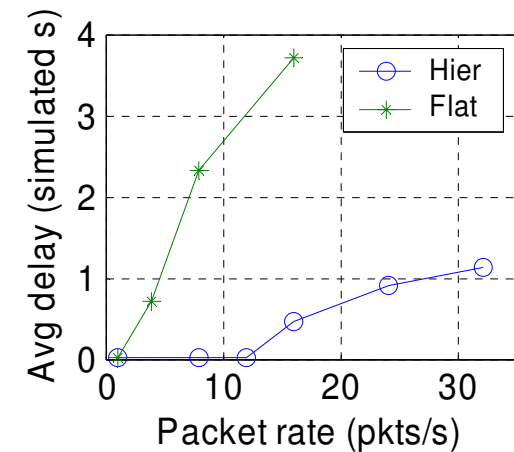
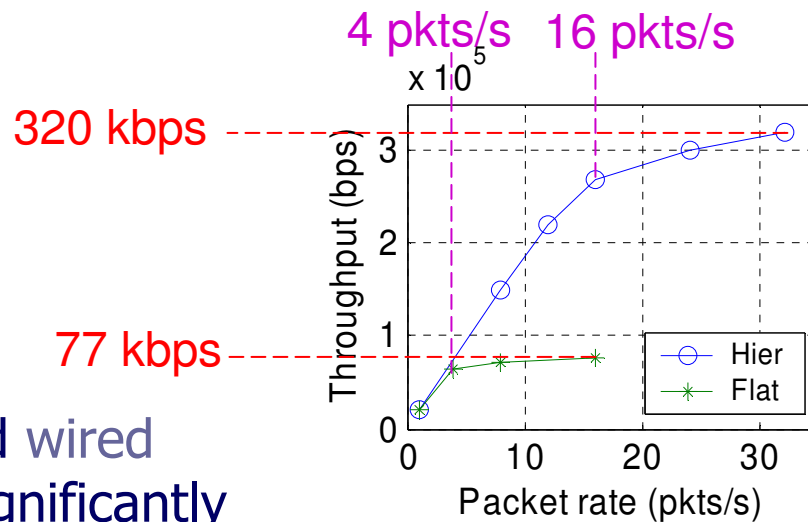
Throughput per node can scale ~ 1 with right ratio of FN's, AP's

Hierarchical architecture with radio forwarding nodes and AP's/BS's

Introduction: Hierarchical Ad-Hoc Net Capacity

Hierarchy and wired integration significantly improve network throughput, delay and packet loss.

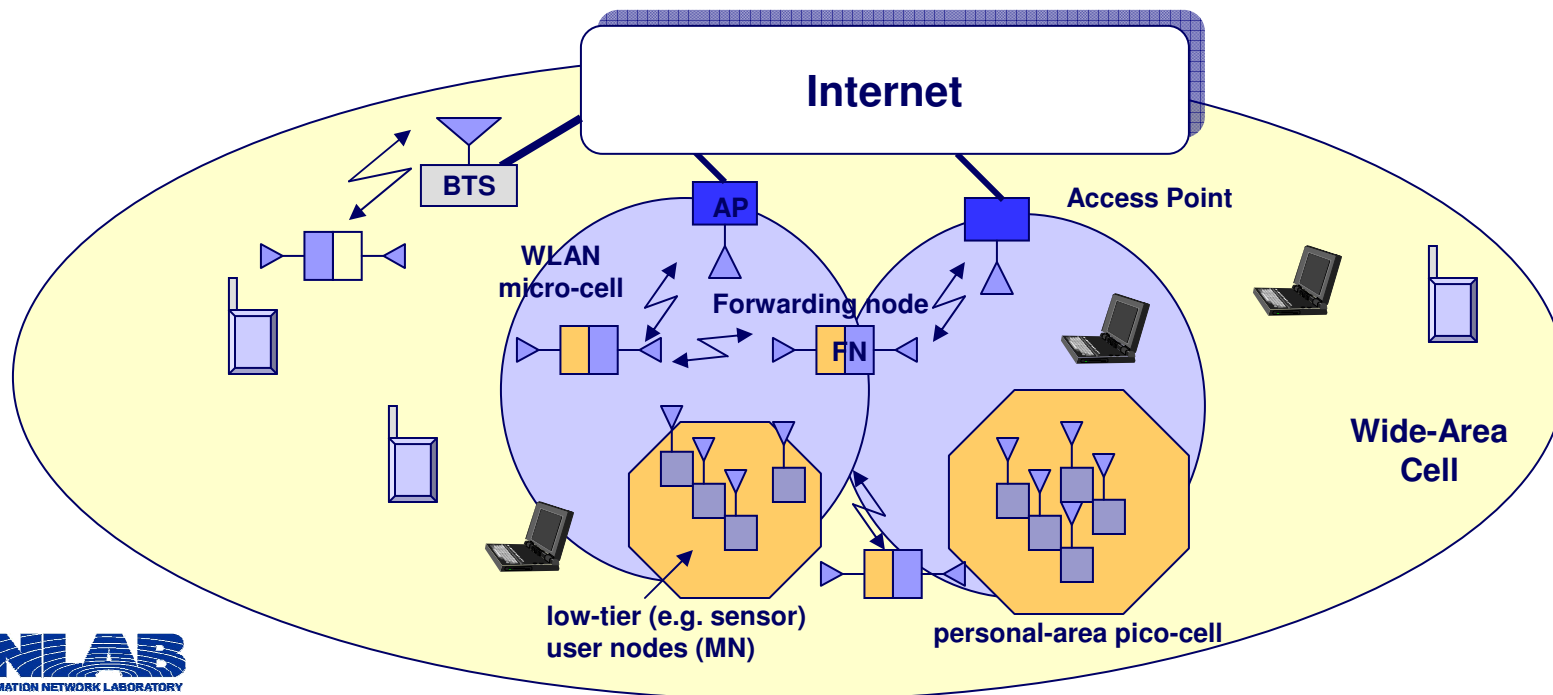
Routing overhead decreased as well.



Reference: S. Zhao, I. Seskar and D. Raychaudhuri, "Performance and Scalability of Self-Organizing Hierarchical Ad Hoc Wireless Networks", *Proceedings of the IEEE Wireless Communications and Networking Conference (WCNC 2004)*, March 21-24, 2004, Atlanta

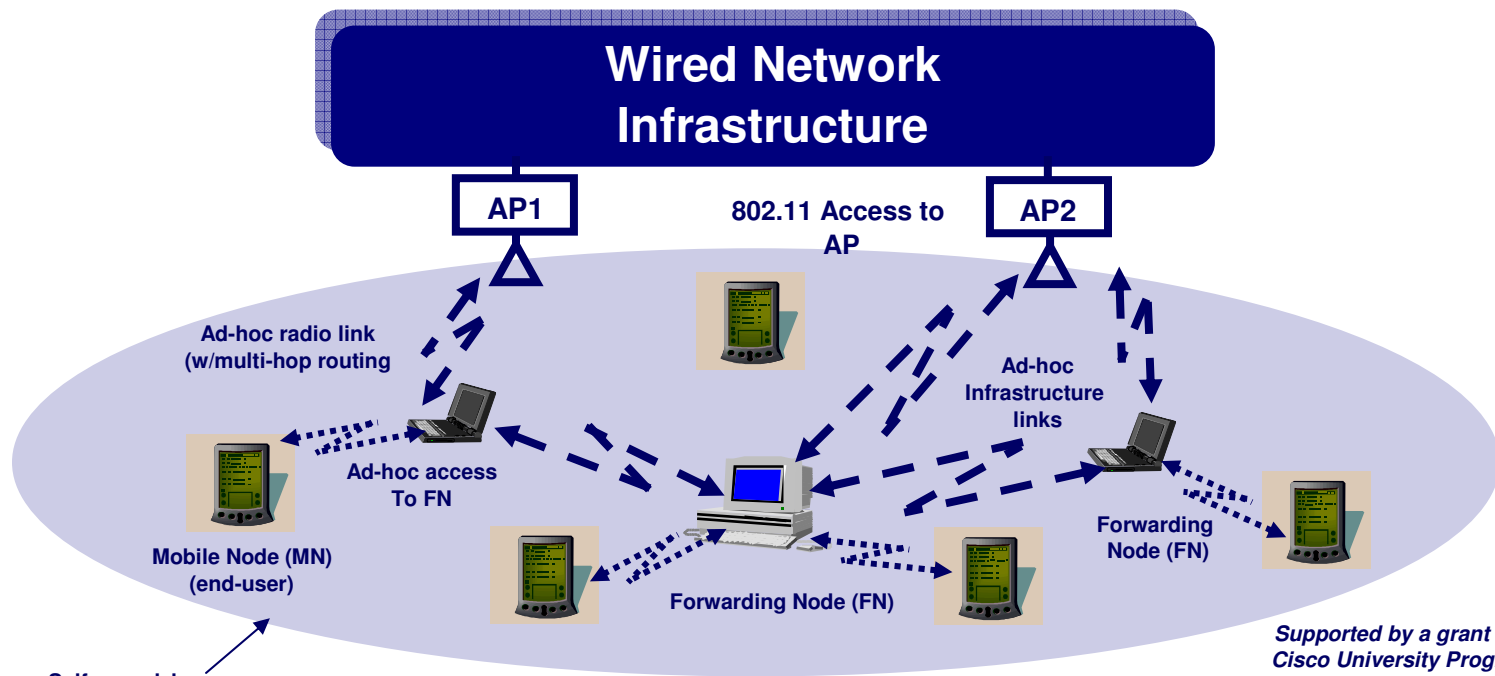
Introduction: 3-tier ad-hoc hierarchy

- Self-organizing hierarchical ad-hoc wireless network (SOHAN) under consideration at WINLAB
 - **Tier 1:** low-tier mobile nodes, e.g. low-power PDA's, sensors, etc. (MN)
 - **Tier 2:** forwarding nodes (FN) with multiple radio interfaces (UWB, WLAN, cellular...)
 - **Tier 3:** wired base stations and access points (BS or AP)
 - Research on new protocols for: ad-hoc discovery, MAC and routing



Introduction: Application to WLAN Mesh

- Hierarchical ad-hoc concept can be applied to extend coverage and QoS of 802.11 WLAN's...
 - Useful for WLAN's with coverage problems, home networks with QoS and/or coverage needs, outdoor community networks, etc.
 - Some nodes (either network elements or terminals without power constraints) serve as FN's
 - Requires extended discovery protocols (via beacons) and multi-hop routing
 - Optional upgrade of 802.11 MAC for efficient multihop operation



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Hierarchical Ad-Hoc Network Protocols

SOHAN Protocols: Components

■ Bootstrapping Mechanism

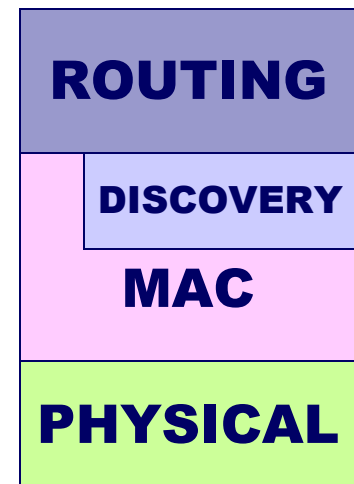
- Involves the configuration of the different devices in terms of channel assignments and initial transmit power level settings – for now, manual configurations using scripts

■ Discovery Mechanism

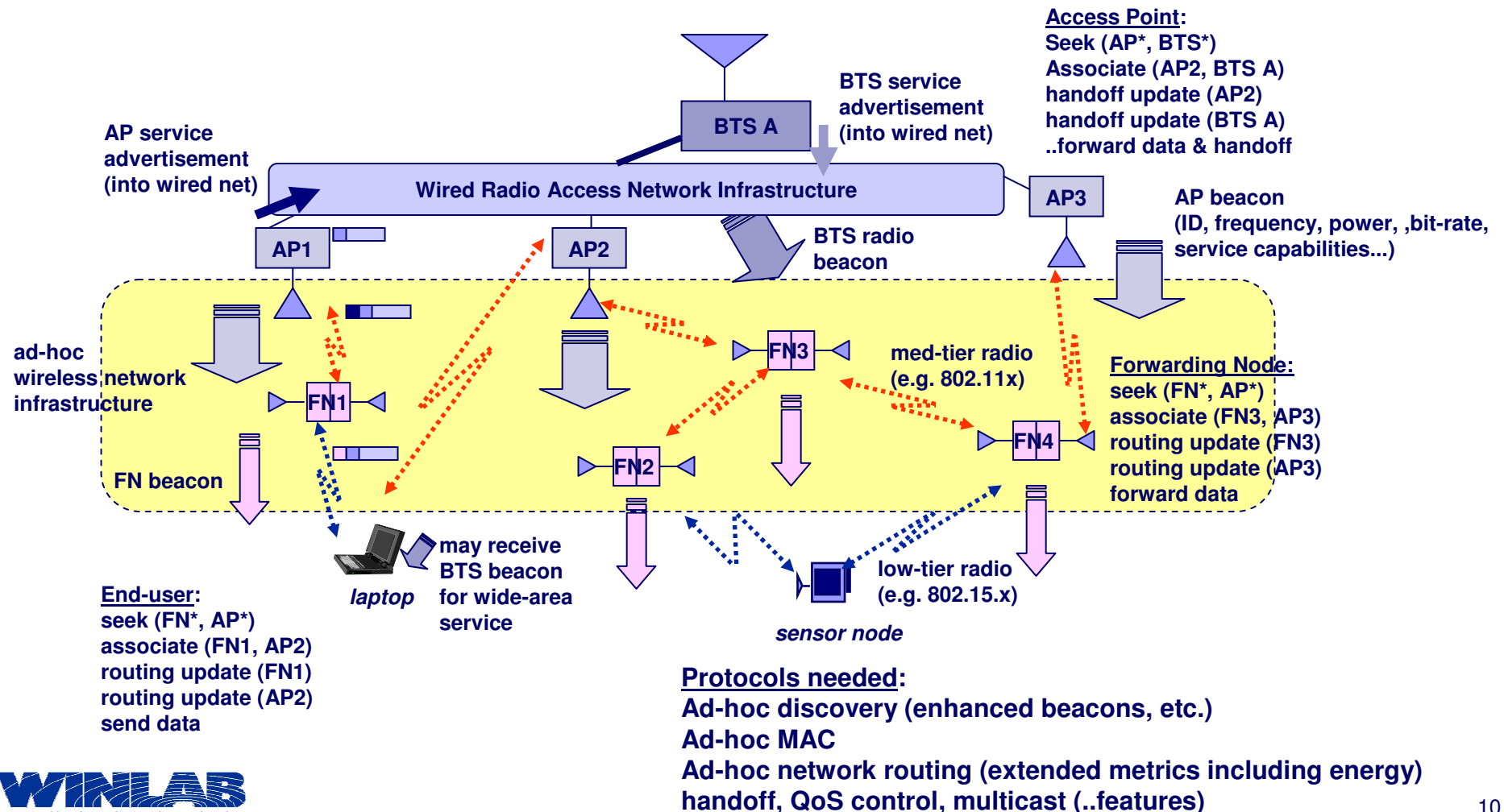
- Filters links made available to the routing protocol based on desired objective function – reduces routing overhead
- Allows each node to apply a different objective depending on the role it plays
- Supports multi-channel operation of network

■ Routing Mechanism

- Uses the “logical” topology information presented by the discovery mechanism in order to create and maintain local neighbor
- Used to route data from the MN's into the infrastructure network through FN's and AP's

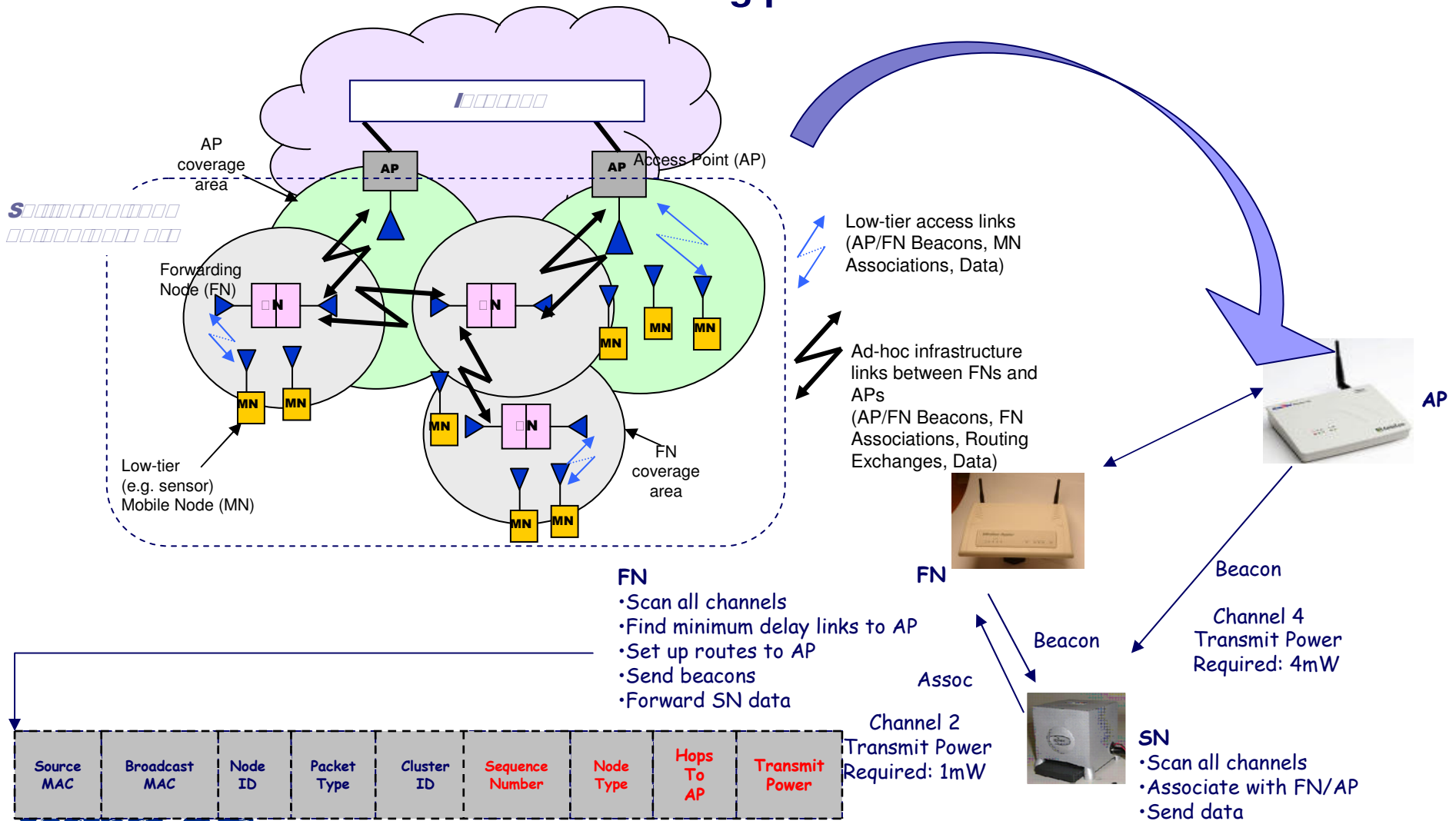


SOHAN Protocols: Conceptual Overview



SOHAN Protocols: Discovery Concepts

- Creates efficient ad-hoc network topology just above MAC layer in order to reduce burden on routing protocol...



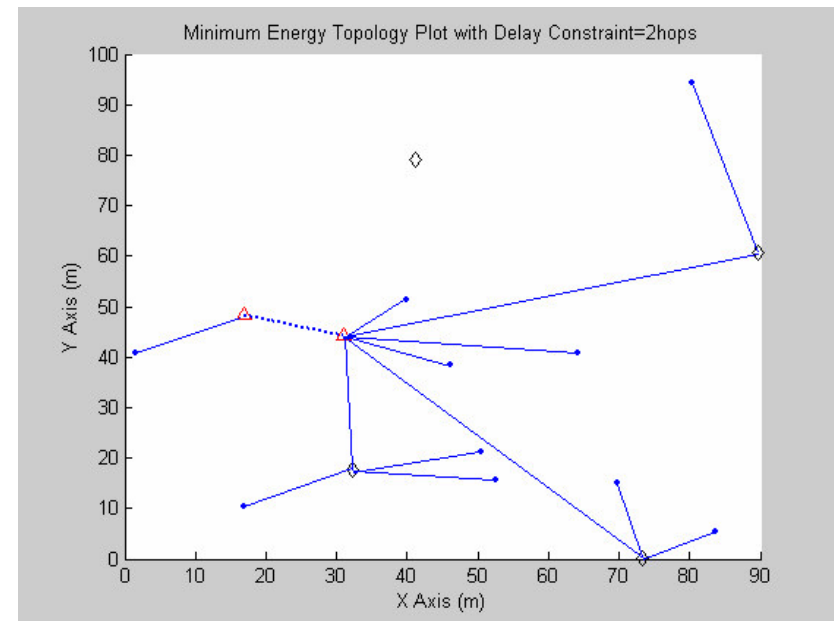
| Source MAC | Broadcast MAC | Node ID | Packet Type | Cluster ID | Sequence Number | Node Type | Hops To AP | Transmit Power |
|------------|---------------|---------|-------------|------------|-----------------|-----------|------------|----------------|
| | | | | | | | | |



Beacon Frame Format

SOHAN Protocols: Topology Discovery

Delay Constrained Energy Minimization:



ERROR: invalidstore
OFFENDING COMMAND: restore

STACK:

-savelevel-
-savelevel-