

# Tutorial

## Mobile 802.11 Extended Service Sets using the Dynamic Backbone Subnet Architecture (DBS/802.11)

Presented at the IEEE 802 Plenary Meeting, March 2003

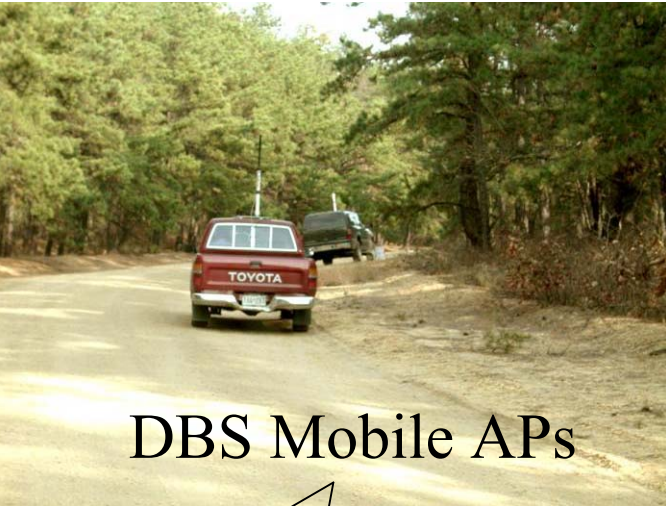
by

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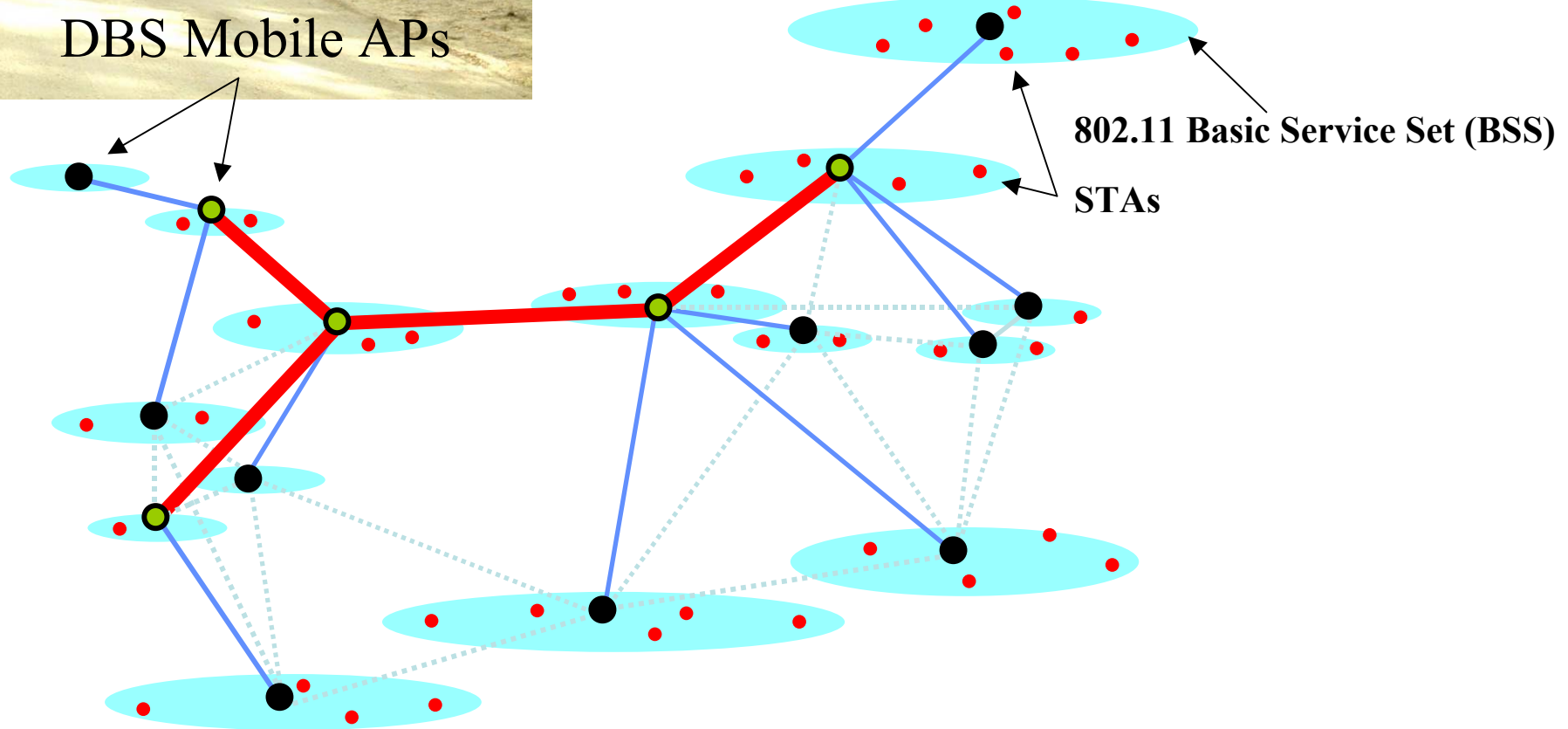
Naval Research Laboratory (NRL)

# Our Vision of a DBS/802.11 Extended Service Set (ESS)



DBS Mobile APs

- ◆ ~30 APs, 100s of STAs
- ◆ Mobile, ad-hoc DS
- ◆ STAs can roam
- ◆ Hides mobility from IP layer
- ◆ ESS provides ethernet-like behavior
- ◆ Self-Organizing
- ◆ QoS extended to entire ESS
- ◆ Applications: Neighborhood/home/military/... networks



# Some Background on Early, Mobile Ad-hoc Network Research at NRL

- Started with design of a High Frequency Intra-Task Force Network (HF ITF Network) to use planned new HF Wideband Radios (ca. 1980)
- Linked Cluster Architecture (Baker, Ephremides, Wieselthier, IEEE Trans. on Comm., Vol. COM-29, No. 11, Nov. 1981) (“emulated” an ethernet subnet, supported broadcast, hid mobility from higher (IP) layers, self-organizing)
- Invited paper in special issue on packet radio (Proc. IEEE, Vol. 75, No. 1, Jan. 1987)

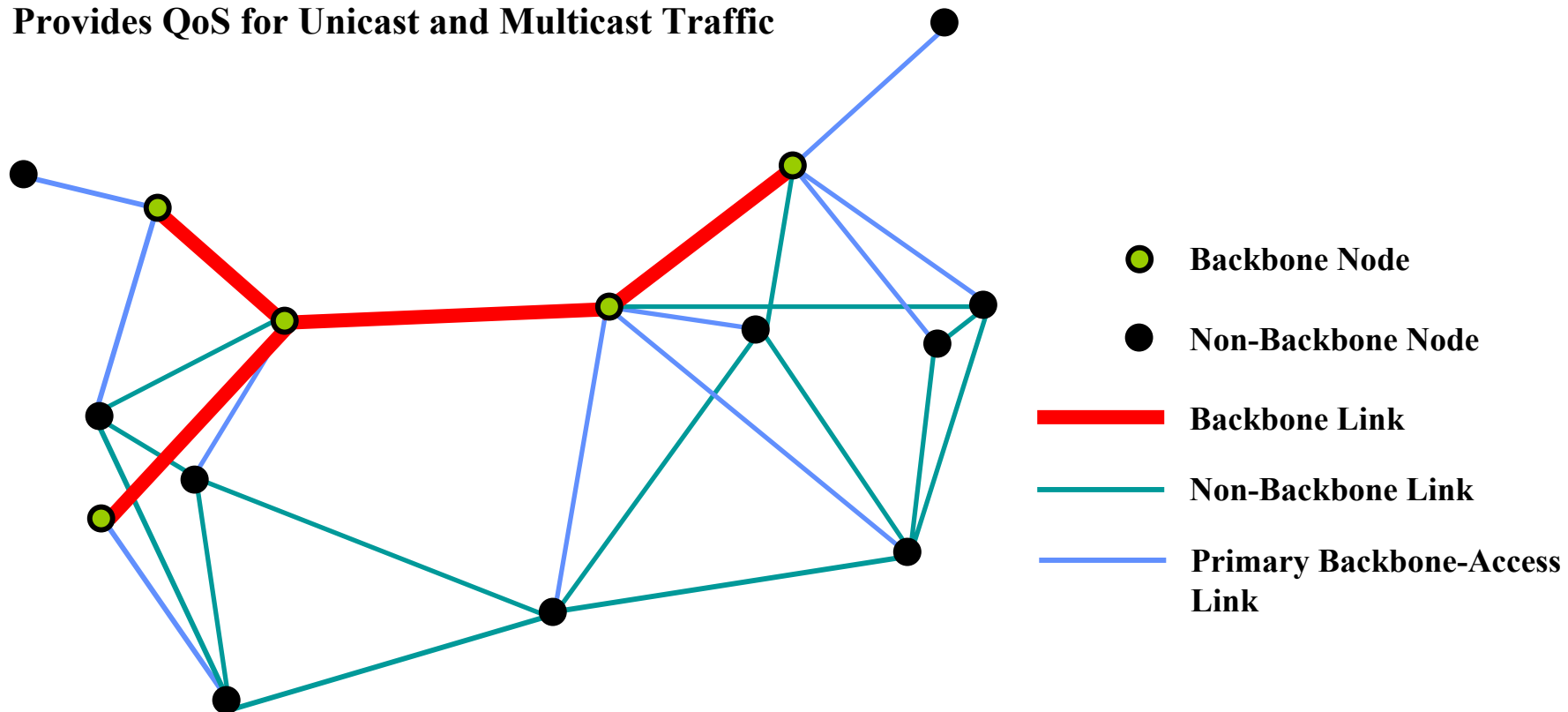
# Background con't.(after 1987)

- 3 Distinct Networking Research Groups Evolved
  - Basic Research (J. Wieselthier, A.Ephremides, ...)
  - IETF/MANET Research (J. Macker, B. Adamson, ...)
  - Dynamic Backbone Subnet (DBS) Research (D. Baker, J. Hauser, ...)

# Dynamic Backbone Subnets

## NRL's DBS Features:

- ◆ Automatic, Distributed, Self-organizing Network Architecture with Adaptive Reconfiguration
- ◆ Blends Packet Switching and Virtual Circuit (VC) Switching into a Single Subnet
- ◆ Fully Compatible with Standard IP Protocols (hides subnet dynamics from the IP layer)
- ◆ Dynamically Maintained Backbone Within Subnet
- ◆ Provides QoS for Unicast and Multicast Traffic



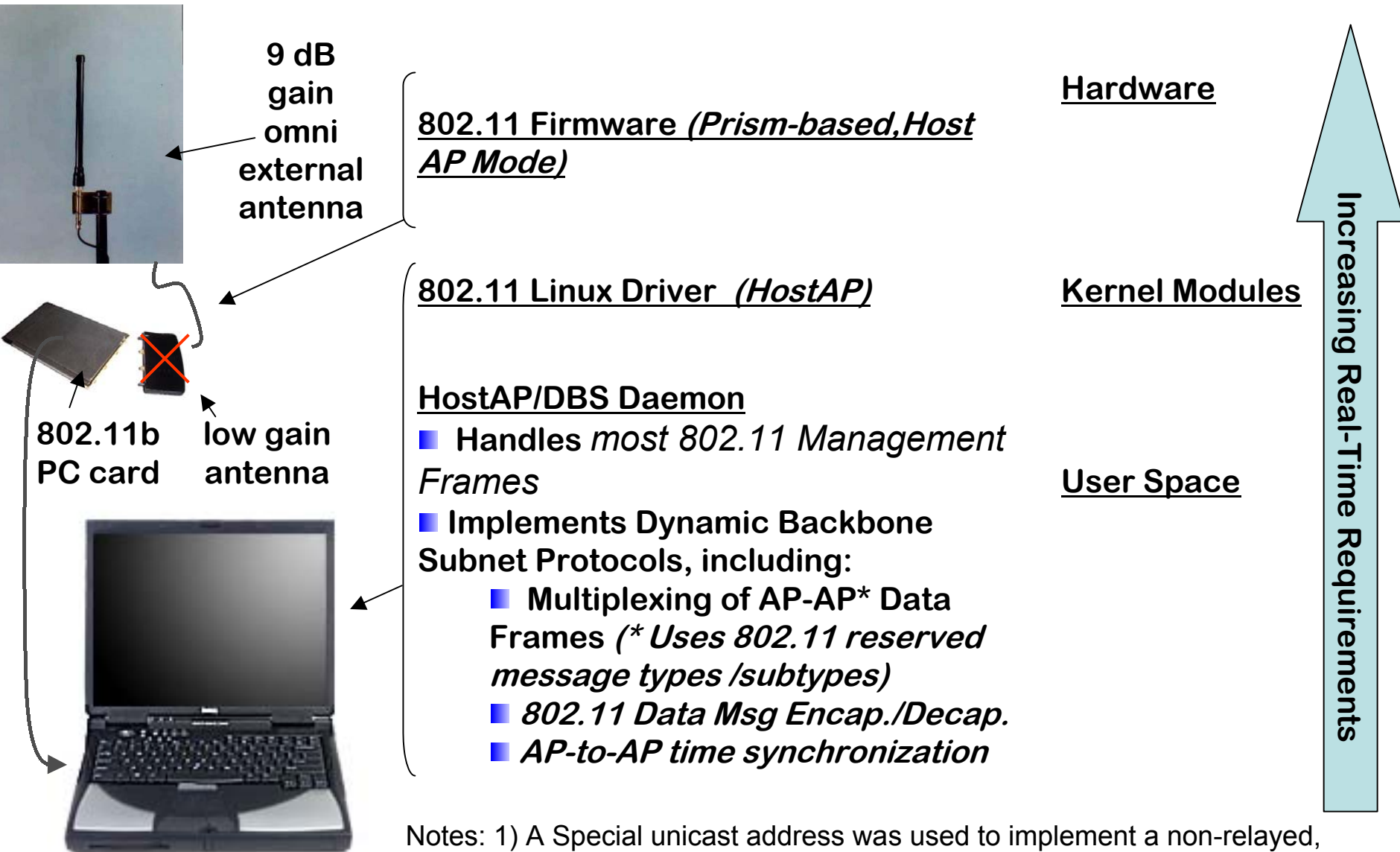
# MCA Demo

- Reorganization Protocol

# MANET/IETF & DBS/802.11 Comparison

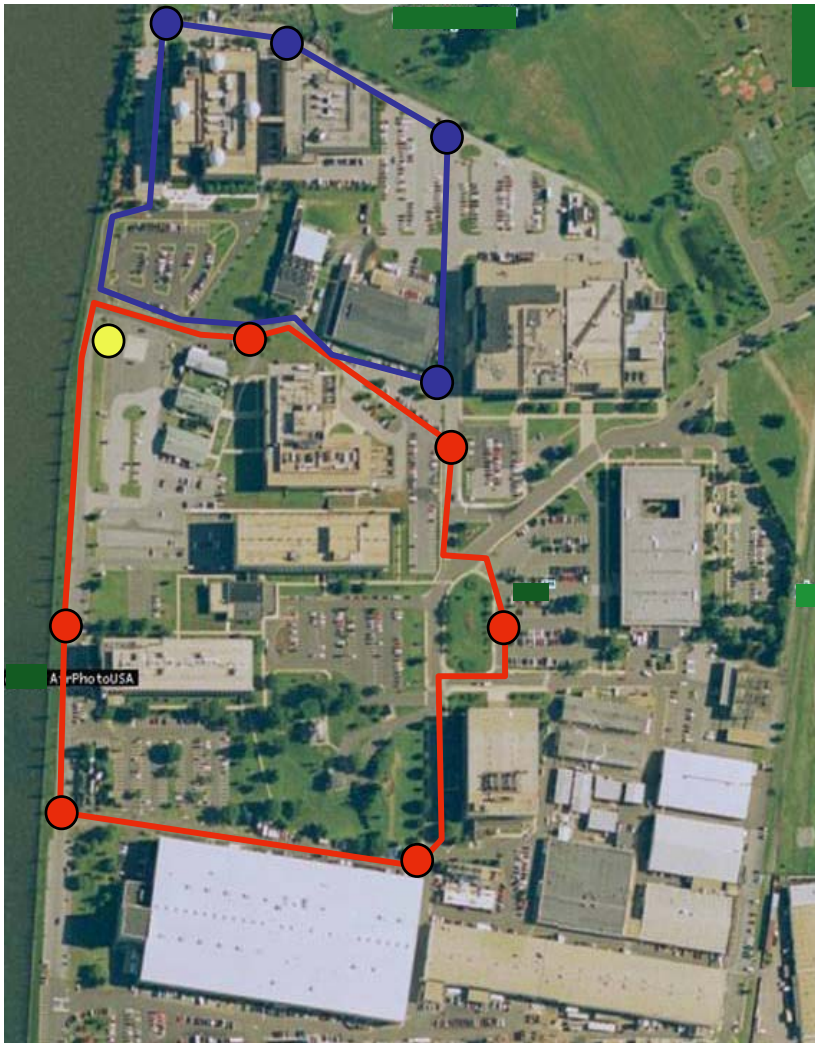
- MANET/IETF
  - IP-layer routing
  - Heterogeneous links
  - All 1's broadcast is problematic
  - IBSS (802.11)(i.e., no DS)
  - DCF, EDCF (802.11)
  - Asynchronous protocols
  - Routing and MAC are decoupled
- DBS/802.11
  - Subnet-layer routing
  - Homogeneous links
  - All 1's broadcast is supported
  - ESS (802.11)(i.e., with DS)
  - DCF/PCF/EDCF/HCF (802.11)
  - Synchronous & asynchronous protocols
  - Routing and MAC may be integrated

# DBS/802.11 Implementation (Current)



Notes: 1) A Special unicast address was used to implement a non-relayed, non-buffered, local broadcast from APs  
2) Single-channel implementation

# DBS/802.11 Afternoon Experiment of 9/11/02



- Xcom (stationary)
- Way Pt South Loop (counter-clockwise rotation)
- Way Pt North Loop (clockwise rotation)

- Xcom sends relayed broadcast traffic to 10 mobile nodes (7 pkts/s – 328 bytes/pkt)
- Each mobile sends relayed point-to-point PLI traffic to Xcom (1 pkt/s – 100 bytes/pkt)
  - ✓ PLI includes the mobile node's current position and traffic stats
- 5 minute rotation period
- ~ 191 Kbps aggregate network load
  - ✓ Broadcast load per node: 18,368 b/s
  - ✓ Point-to-point load per node: 800 b/s
  - ✓ Aggregate for 10 nodes: 191,368 b/s
- ~ 174 Kbps aggregate network throughput
  - ✓ PLI: 74.08%
  - ✓ Bcast: 90.67%
- No DBS daemon failures during full day of experimentation on 9/11/02
- Node 16 had faulty antenna connection

# JMAP Demo

# Lessons Learned

- The hierarchical approach to hiding node mobility under an interface that appears as a static ethernet interface provides a powerful mechanism for integrating mobility management with a standard IP architecture
- There is a common misconception that subnet protocols are **necessarily** proprietary rather than based on standards
- Subnet protocols have the **very desirable feature** that they allow solutions that **jointly** consider routing, MAC, power control, and QoS
- It is very difficult to achieve rapid convergence of routing protocols in a dynamic environment without the use of synchronous protocols

# Recommendations

- Begin process of creating an AP-to-AP subnet standard for a mobile, ad-hoc Distribution System
- Use dynamic backbone subnet technology as the basis for AP-to-AP subnet standard