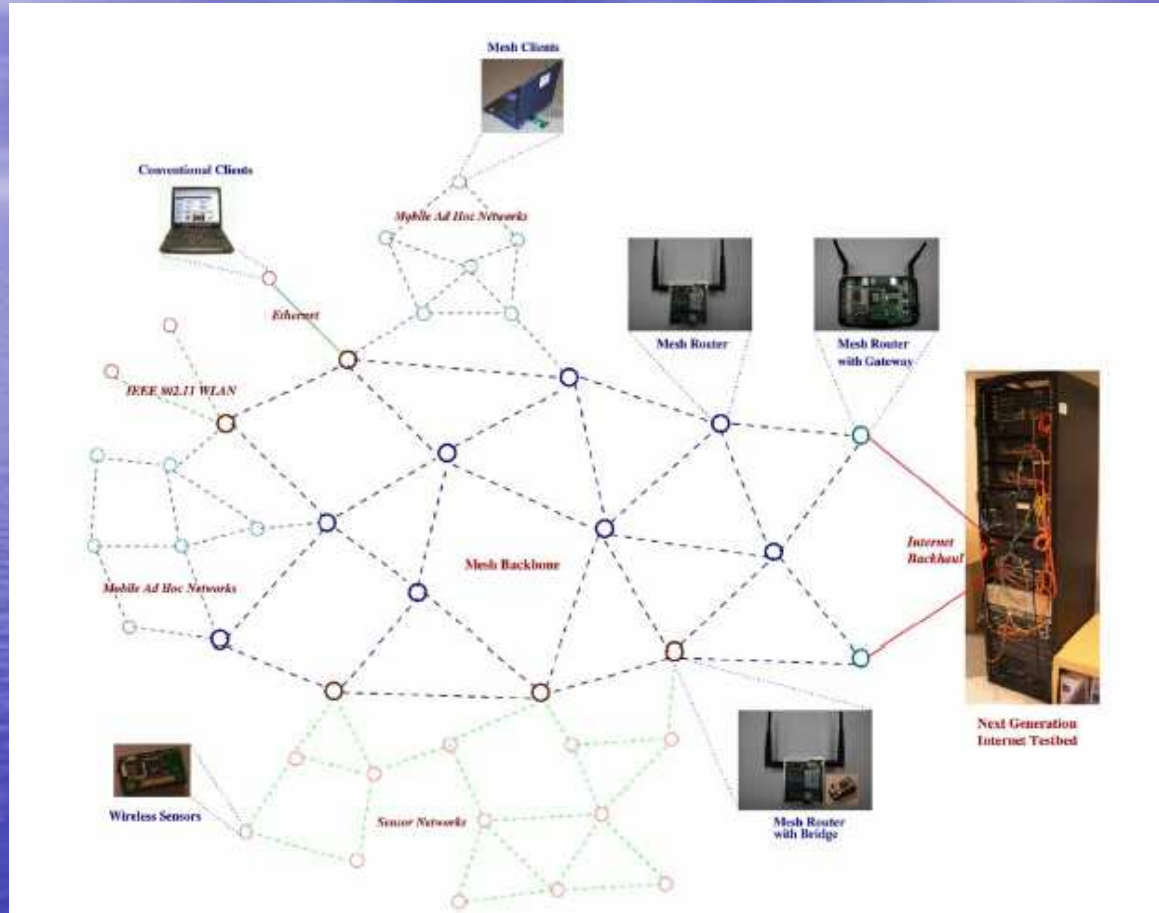
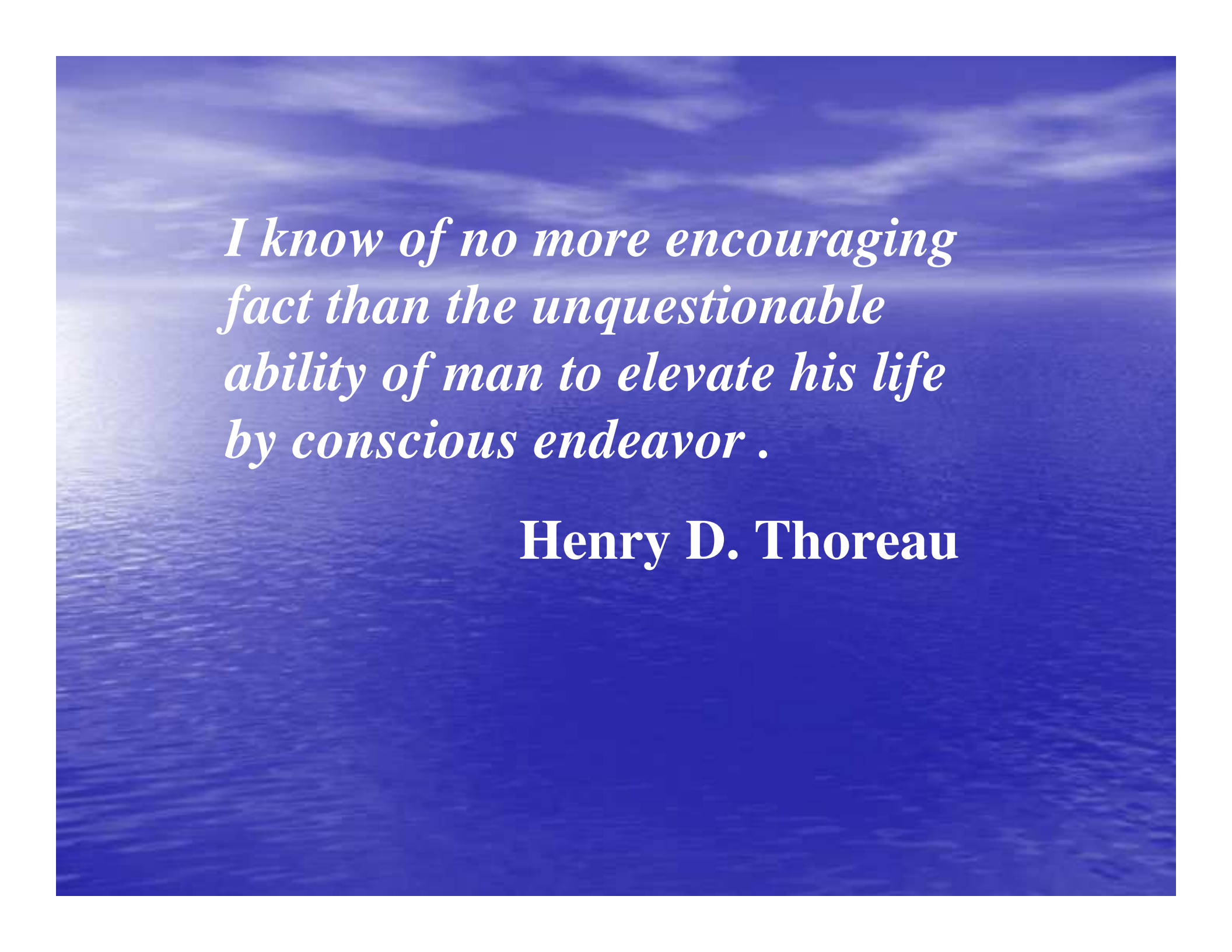


Wireless Mesh Network (WMN)



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*I know of no more encouraging
fact than the unquestionable
ability of man to elevate his life
by conscious endeavor .*

Henry D. Thoreau

Agenda

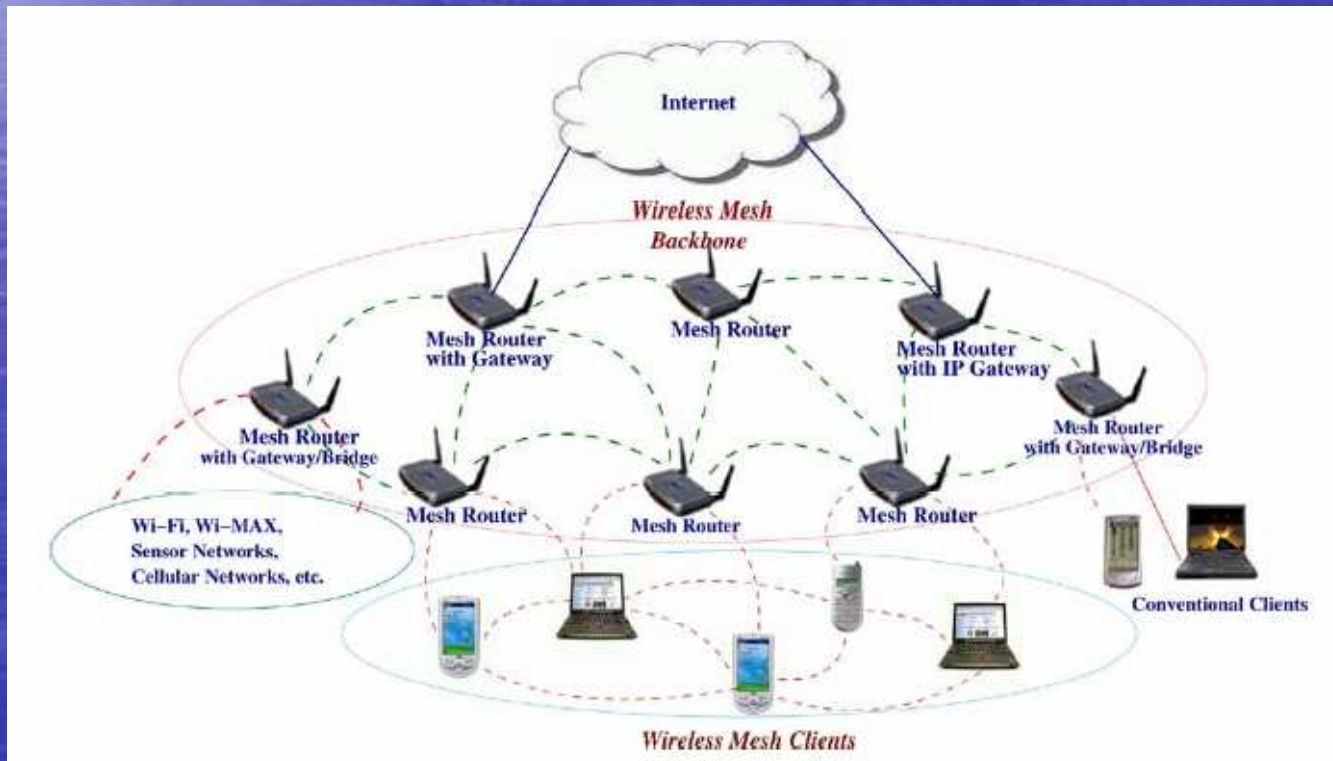
1. Introduction
2. Network Architecture
3. Characteristics
4. OSI model
5. Applications
6. Challenges
7. Standards
8. Conclusion

1. Introduction

- Starting? Carnegie-melon university, 2001
- Standard
- Advantages
 - Self organized
 - Self configured
 - Easy maintenance
 - Reliability & scalability (no of nodes)
- Usage
 - Fire fighters
 - Emergency personal
 - Wearable NTKs

2. NTK Architecture

- Types of arch.
 - Backbone WMN
 - Client WMN
 - Hybrid WMN



- Hardware

- Mesh router – backbone
- Mesh client – stationary, mobile
- Gateway



- Routing/repeating

- Multi-hop communication

- Low power
- Small range

- Other topologies communications

- 802.11, 15, 16
- Ad hoc, WPAN, Ethernet

3. characteristics

- Multihop – LOS, NLOS
- Support of ad hoc
 - self forming with more design complexity
- Multiple types of NTK access
- Power consumption constraints

WMN vs. Ad hoc

- Integration
- Wireless backbone/infrastructure
- End-user load decreased – power, cost
- Multiple radios – configuration, users
- Mobility of users

4. OSI model

Physical layer

- Improve TX rate and physical layer techniques
 - UWB – short distance
- Higher layer adaptation (MAC)
- Multiple-antenna systems

MAC layer

- Multihop communications vs. classical
 - Depends on routing protocols
- Multipoint-to-multipoint – no centralization
- Mobility effect
- multiple access techniques
 - TDMA – synchronization
 - CDMA - code control
 - CSMA/CA

NTK layer

- Performance metrics
 - No of hops
 - Link utilization
 - RTT
- Load balancing – congestion
- Scalability – routing path
- Adaptive support for routers/clients
 - Power consumption

Transport Layer

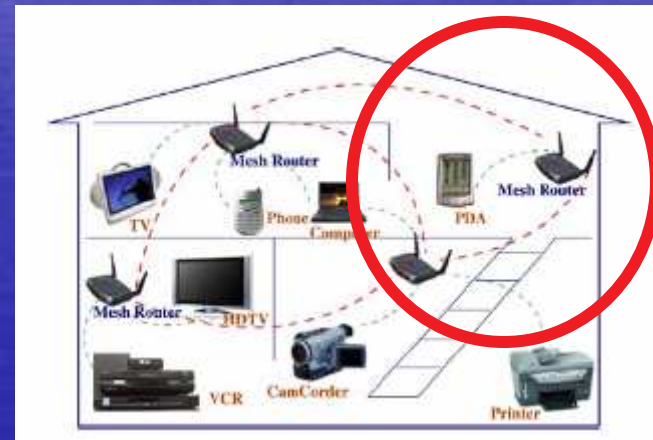
- No protocol specifically for WMN until now !!
- TCP
 - Congestion/non-congestion losses
 - Acknowledgment.
- UDP
 - Real time end-to-end delivery not guaranteed
- Dependence on other layers
 - MAC – asymmetry
 - NTK - routing

5. Applications

a) Home Networks

- 802.11 AP locations ??
- AP connections – Hub
- Dead zones

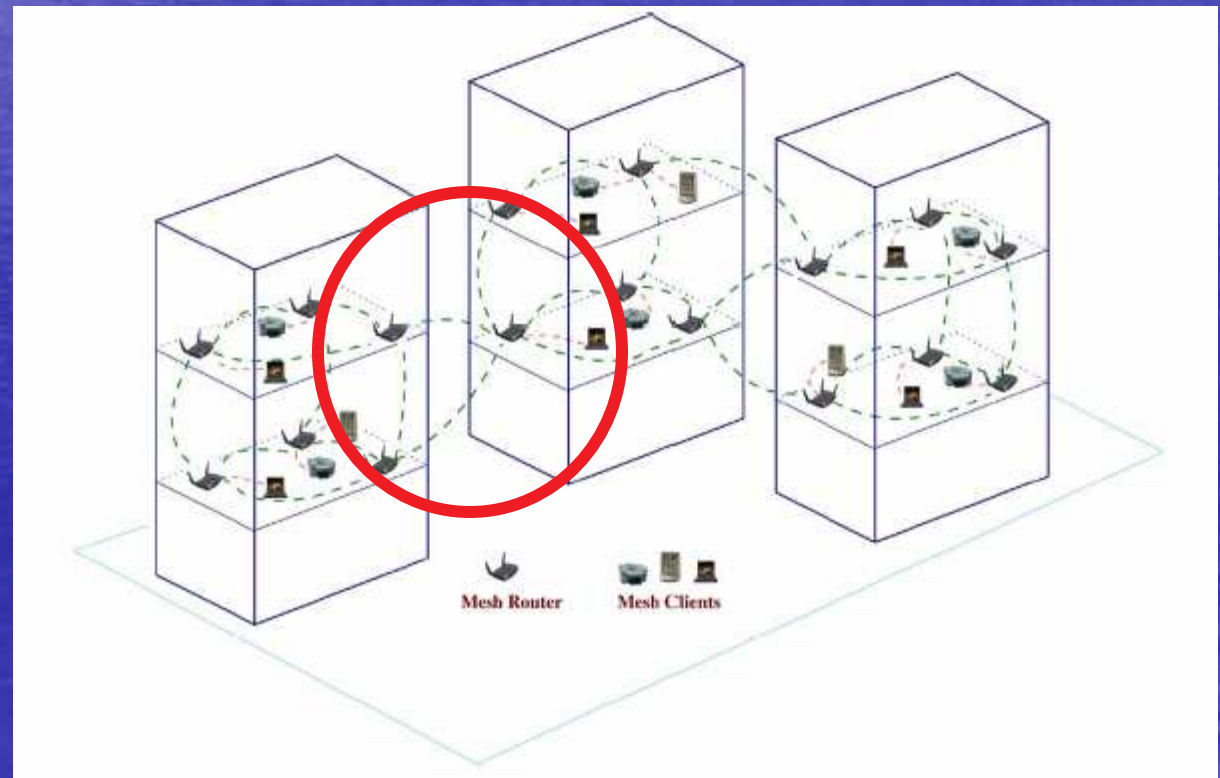
- Multiple mesh routers
- Power level
- Mobile Ad hoc NTK, WSN



b) Enterprise Networks

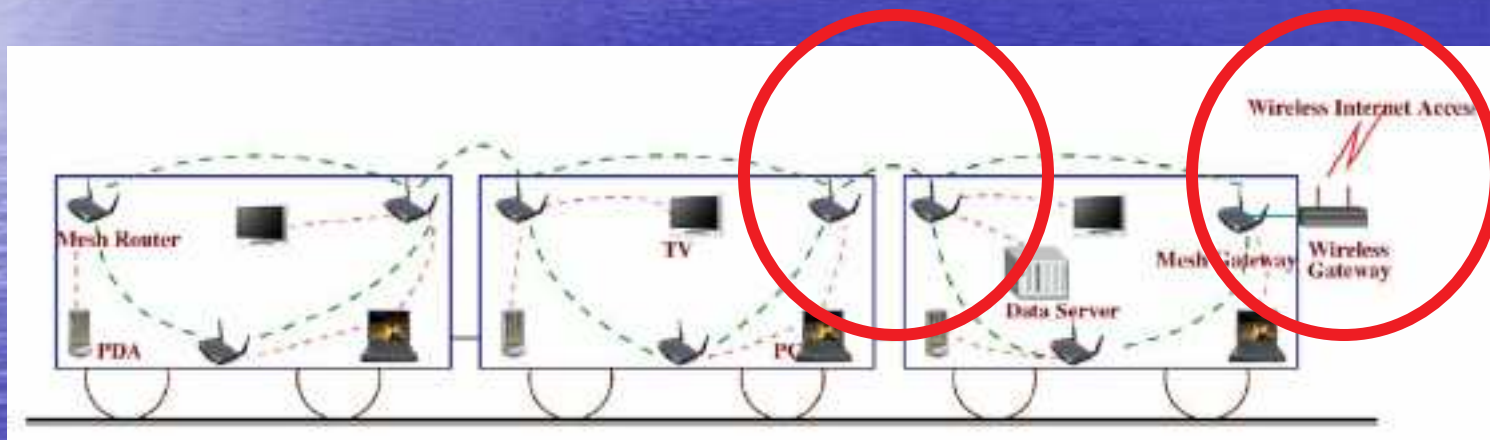
- Wired Connections
- Redundancy – cost
- Congestion

- Public NTKs



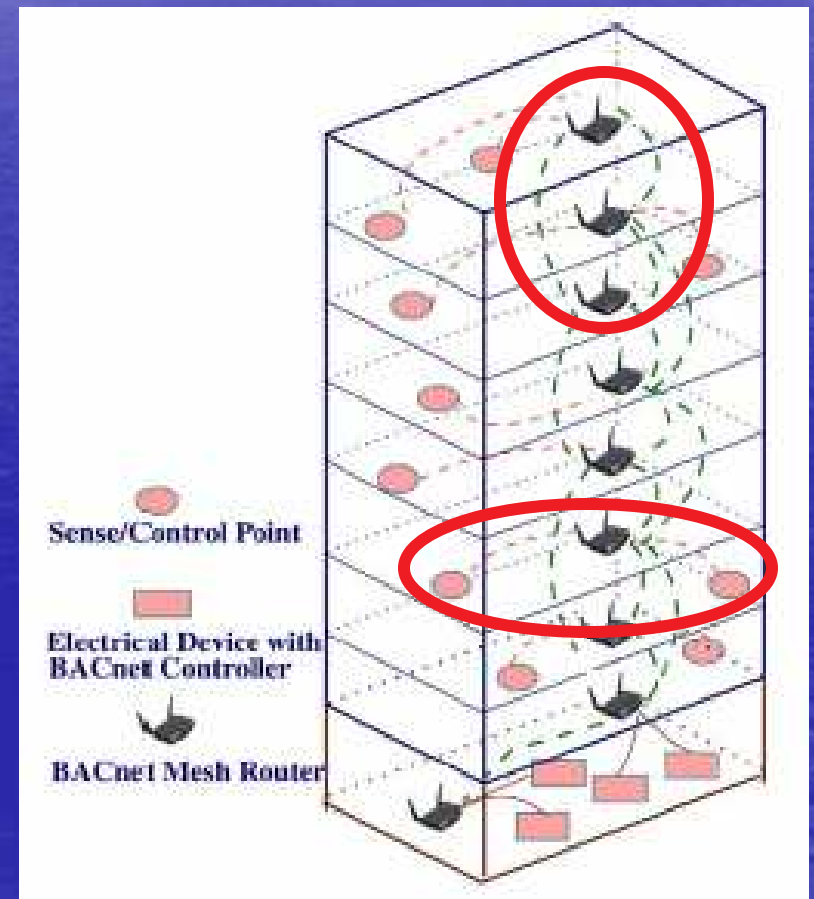
c) Transportation Systems

- High Speed Mobile Backhaul to Internet
- Mobile mesh NTKs



d) Building Automation

- BAC net (Building automation & control)
 - Elec. Devices power
 - Light
 - Elevators
 - A/C
- Connection and Wi Fi
 - cost



6. Challenges

- Radio Techniques
 - directional antennas
 - Mutli-radio/multi channel
 - MIMO - 802.11n high speed Wi Fi
 - dynamical control units
- QoS
 - compatibility and inter-operability
 - integration
 - end-to-end QoS constraints
 - delay, throughput, packet loss ratio, ...

- Scalability
 - Multihop
 - size vs. performance, routing protocol
 - 802.11 share BW
 - multiple access techniques
 - TDMA – synchronization
 - CDMA - code control
 - CSMA/CA
- security wireless
 - AAA – centralization
 - WLAN schemes
 - speed
 - Ad hoc schemes
 - not practical for WMN, ad hoc is like a subset

7. Standards

802.11

- 802.11s ESS (extended service set)
 - define MAC & PHY layers
- 802.11n - 1Gbps
- two models
 - Infrastructure, ESS
 - Clients, Layer 3 ad hoc
 - IBSS (independent basic SS)
 - flat IP – no distinction between AP & clients
 - Peer-to-peer

802.15

- 802.15.3a UWB
 - DS-UWB - PAN, 1.3 Gbps, 10 m or less
 - Advantages
 - low power and cost
 - accurate location information
 - high BW
- 802.15.4 Zigbee
 - support mesh topology
 - coordinator to start the NTK, NTK parameters, request-response routing algorithm
- 802.15.5 WPAN
 - Recently
 - MAC & PHY

802.16

- point-to-multipoint connection-oriented QoS
- freq. 10-66 GHZ with LOS

- 802.16a
 - freq. 2-11 GHZ with NLOS

- 802.16 mesh limitation
 - 100 subscribers - centralized scheduling message structure
 - connectionless –QoS
 - no-interference assumption - 2 hops away

8. Conclusion

- Promising
 - self organizing
 - reducing the complexity of deployment and maintenance
- variety of application
- integration with multiple wireless NTKs
- hot topic for research
 - academic and industrial

Success is a lousy teacher. It seduces smart people into thinking they can't lose ,and it's an unreliable guide to the future .

Bill Gates

The Road Ahead ,1996



Questions ?

Thank you

