

Ad-Hoc Networks

Mika Nupponen

S-72.333

Postgraduate Course in Radio
Communications

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 - past
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Introduction

- Ad-Hoc Networks:
 - Collection of communications devices (nodes)
 - no fixed infrastructure & rapid changes...
 - no pre-determined organization of available links
 - Nodes relay packets

Ad-Hoc Networks vs. Cellular Networks

Cellular network	Ad hoc network
Fixed, pre-located cell sites and base stations	No fixed base stations
Static backbone network topology	Highly dynamic network topologies with multi-hop
Relatively benign environment and stable connectivity	Hostile environment (losses, noise and sporadic connectivity).
Detailed planning before base stations can be installed	Ad hoc network automatically form and adapts to changes

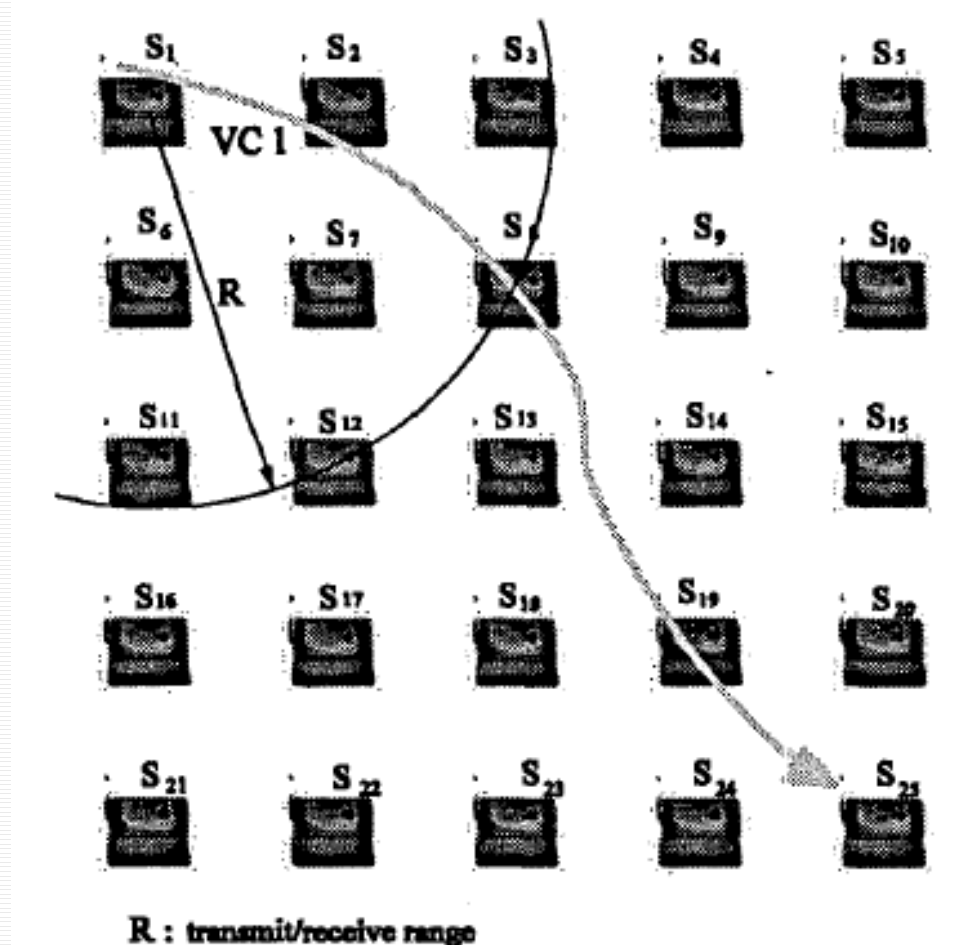
History

- History of Ad Hoc networking:
 - DoD sponsored Packet Radio Network (PRNET)
 - Survivable Adaptive Radio Networks (SURAN) (early 80's)
 - The goal was to provide packet switched networking to mobile battlefield
 - PRNET used a combination of ALOHA and CSMA for medium access and a kind of distance vector routing
 - SURAN's routing protocols were based on hierarchical link-state
- In the 90's:
 - Notebook computers, 802.11: term "ad hoc"
 - DoD: Global Mobile Information System (GloMo) and Near-term Digital Radio (NTDR)
 - IETF: Mobile Ad hoc Networkin (MANET) group
 - More about routing in Ad Hoc Networks can be found from "Routing in Mobile Ad-Hoc Networks" presentation

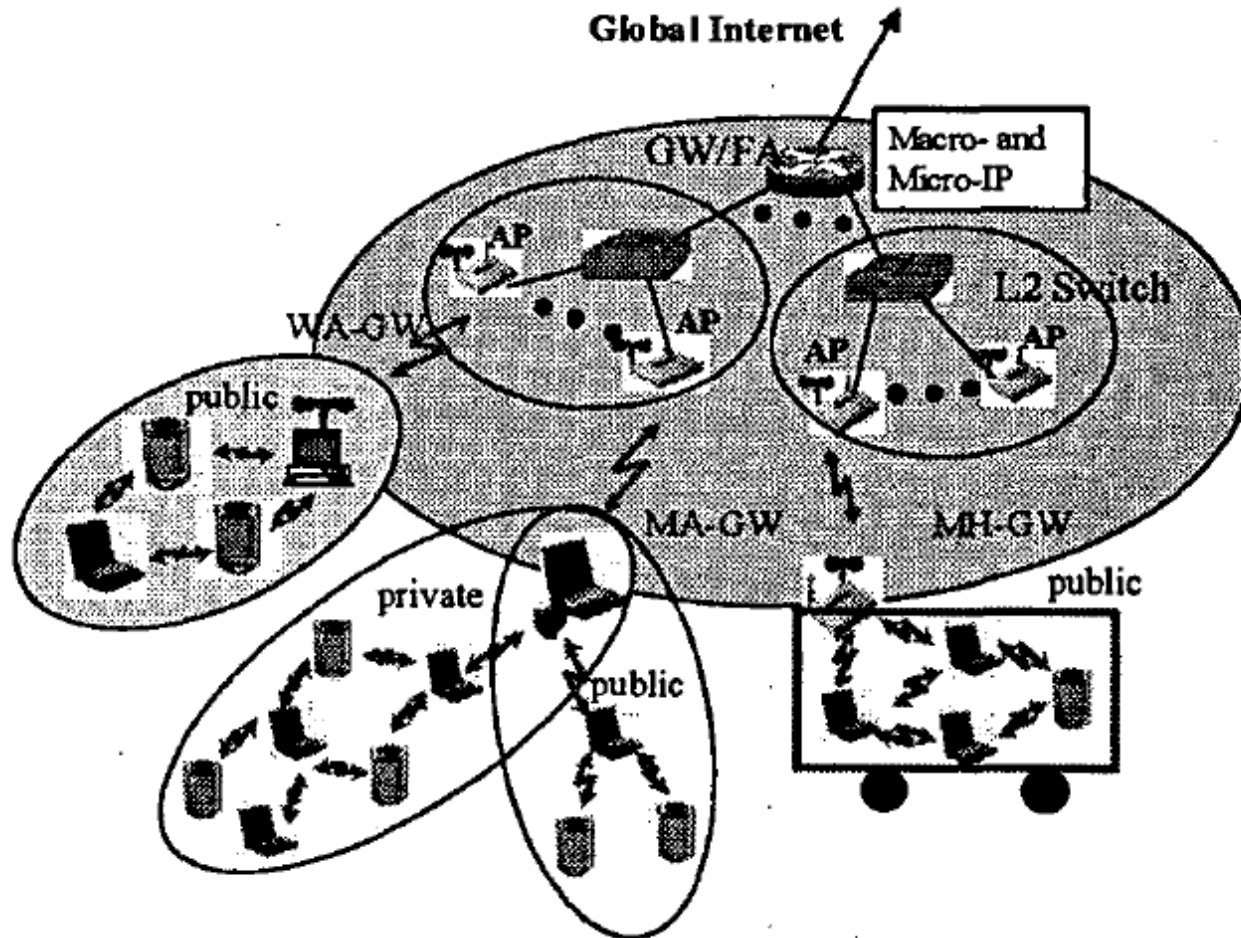
The Role of Ad hoc networking in Future

- Isolated Ad hoc networks
 - Large scale isolated networks
 - Security, Cost of routing packets, traffic performance
 - Small scale Isolated Ad hoc networks
 - Bluetooth, ...
- Integrated Ad hoc networks
 - Hotspot scenario
 - GPRS/UMTS scenario
- Cellular Ad hoc networks

Isolated ad hoc network



Hotspot Scenario



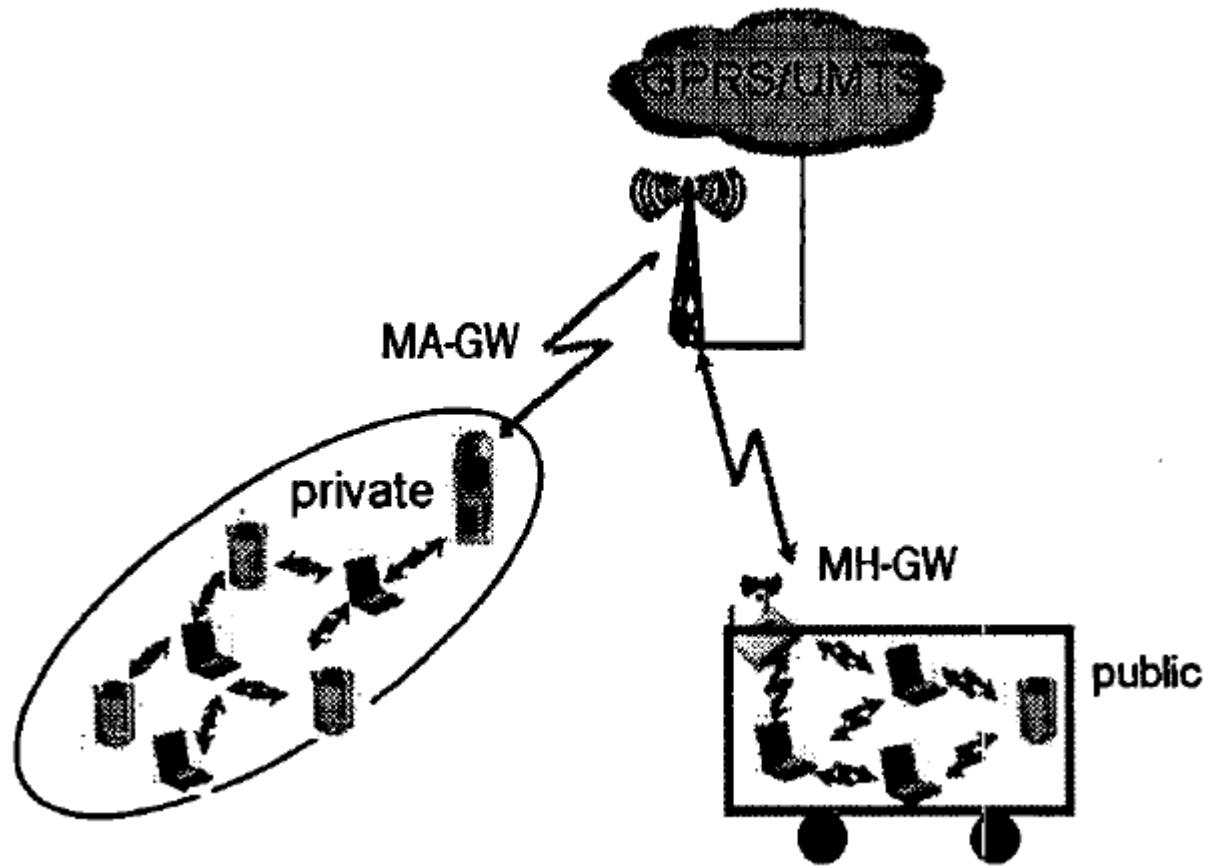
AP = Access point

WA-GW = Wireless Ad hoc gateway

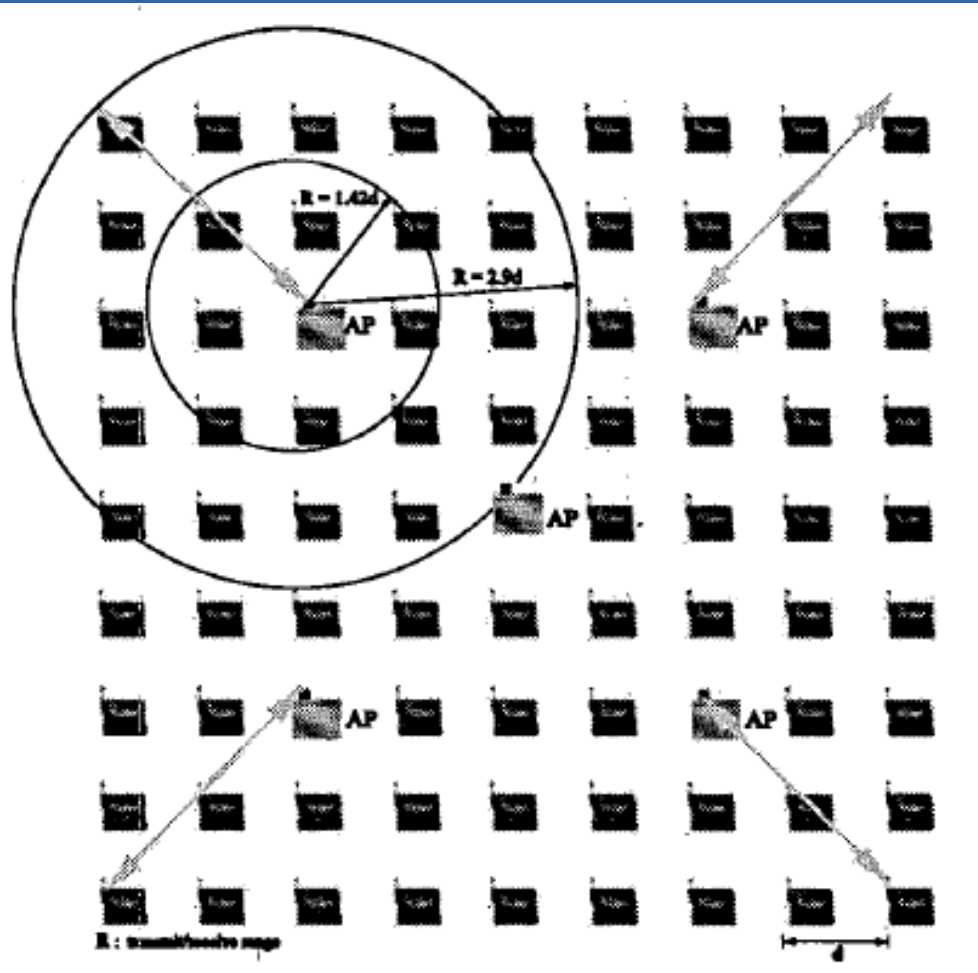
MA-GW = Mobile Ad hoc gateway

MH-GW = Mobile HotSpot Ad hoc gateway

GPRS/UMTS Scenario



Cellular Ad hoc network



- Cellular ad hoc networks are self-organizing multihop networks with multiple access points.
- Broadband core network
- Traffic to/from access points

Ad Hoc: Known Problems

- Scalability
- Energy efficiency
- QoS
- Security
- Design of Ad-Hoc Networks
- The lack of well defined and widely accepted models for path attenuation, mobility and traffic

Mobile IP with Ad hoc Networks – proposed solution

- The Internet Engineering Task Force's mobile Internet protocol is a widely accepted standard that uses mobile agents to support seamless handoffs, making it possible for mobile hosts to roam from subnet to subnet without changing IP addresses.
- Another emerging wireless architecture, mobile ad hoc networks (MANETs) can be flexibly deployed in most environments without the need for infrastructure.

Following figures & ideas from

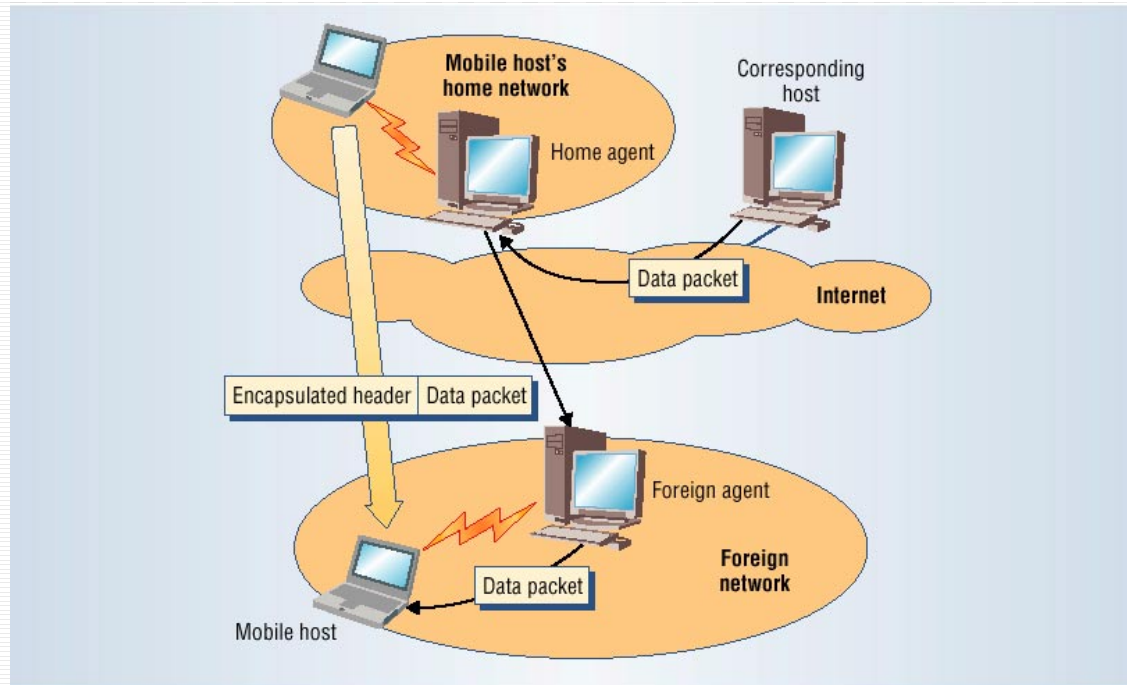
Integrating mobile IP with ad hoc networks

Yu-Chee Tseng; Chia-Ching Shen; Wen-Tsuen Chen;
Computer , Volume: 36 , Issue: 5 , May 2003
Pages:48 - 55

Mobile IP, Cellular IP & Hawaii

- Mobile IP
 - Designed originally support macro mobility
- Cellular IP
 - It separates local and wide area mobility and uses Mobile IP for inter domain mobility
 - Uses hierarchical approach to minimize registrations
 - One foreign agent can provide services to multiple base stations
- HAWAII
 - Handoff-aware wireless access Internet infrastructure
 - HAWAII segregates the network into a hierarchy of domains. Each domain has a domain root router.
 - base stations can be connected as a tree
- MIP-LR (Mobile IP with Location Registers) etc. etc.
 - Cellular IP & Hawaii: one base station, one wireless hop

Mobile IP



Mobile IP transmission: A corresponding hosts sends an IP data packet to a mobile host. Packet is tunneled from the mobile host's home network to its current foreign network.

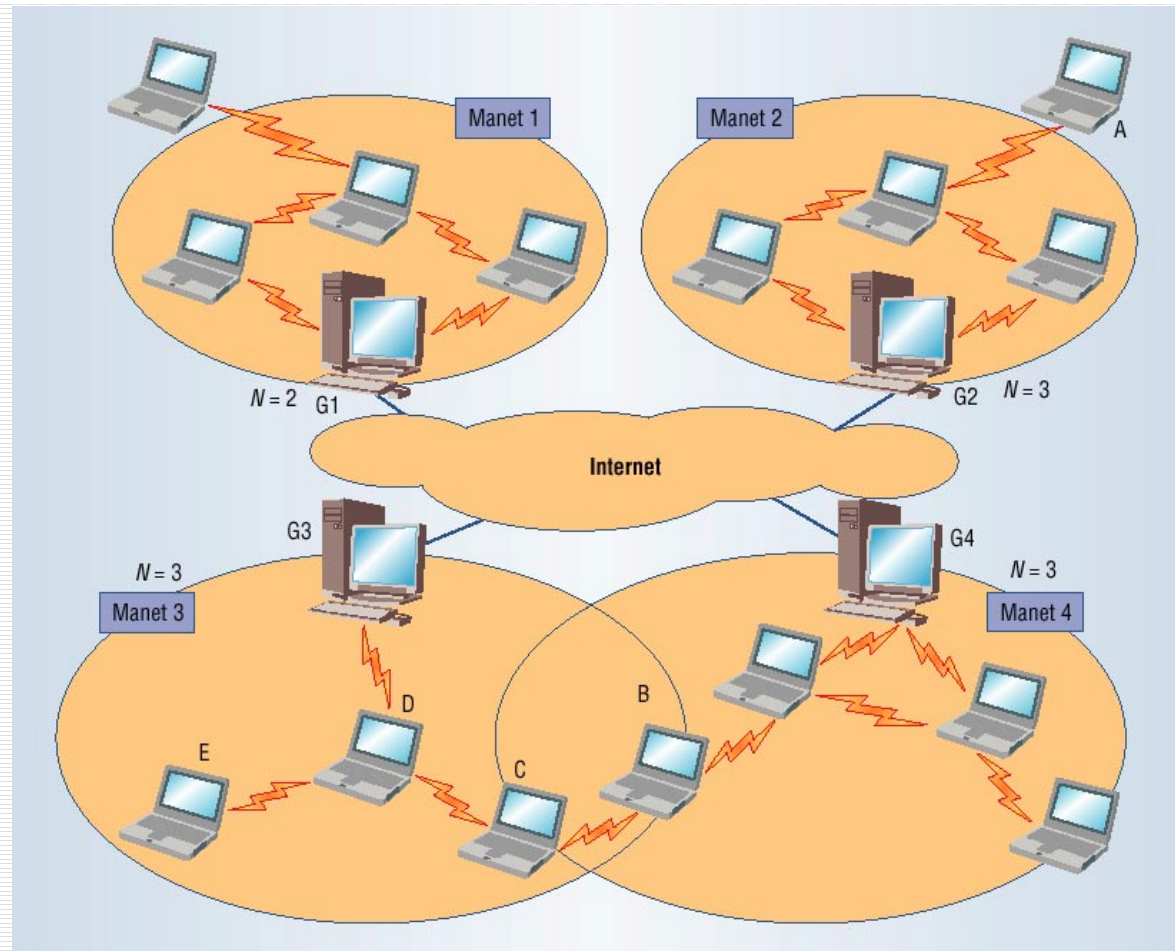
Integration & Implementation

- TTL in IP Packets
 - dynamically tuned TTL to control Agent_Advertisement, Agent_Solicitation and broadcast packets
- Routing inside Manets
 - Based on DSDV protocol (Destination-sequenced-distance vector - more about routing: NEXT PRESENTATION!)
- Agent advertisement_messages
 - Normal case TTL = 1, in MANET; TTL = N
- Agent solicitation
 - A Mobile host can multicast an Agent_Solicitation message to locate a nearby mobile agent
 - If this fails TTL can be doubled
 - Original TTL value should be recorded in the packet payload (Gateway can compare it to the N)

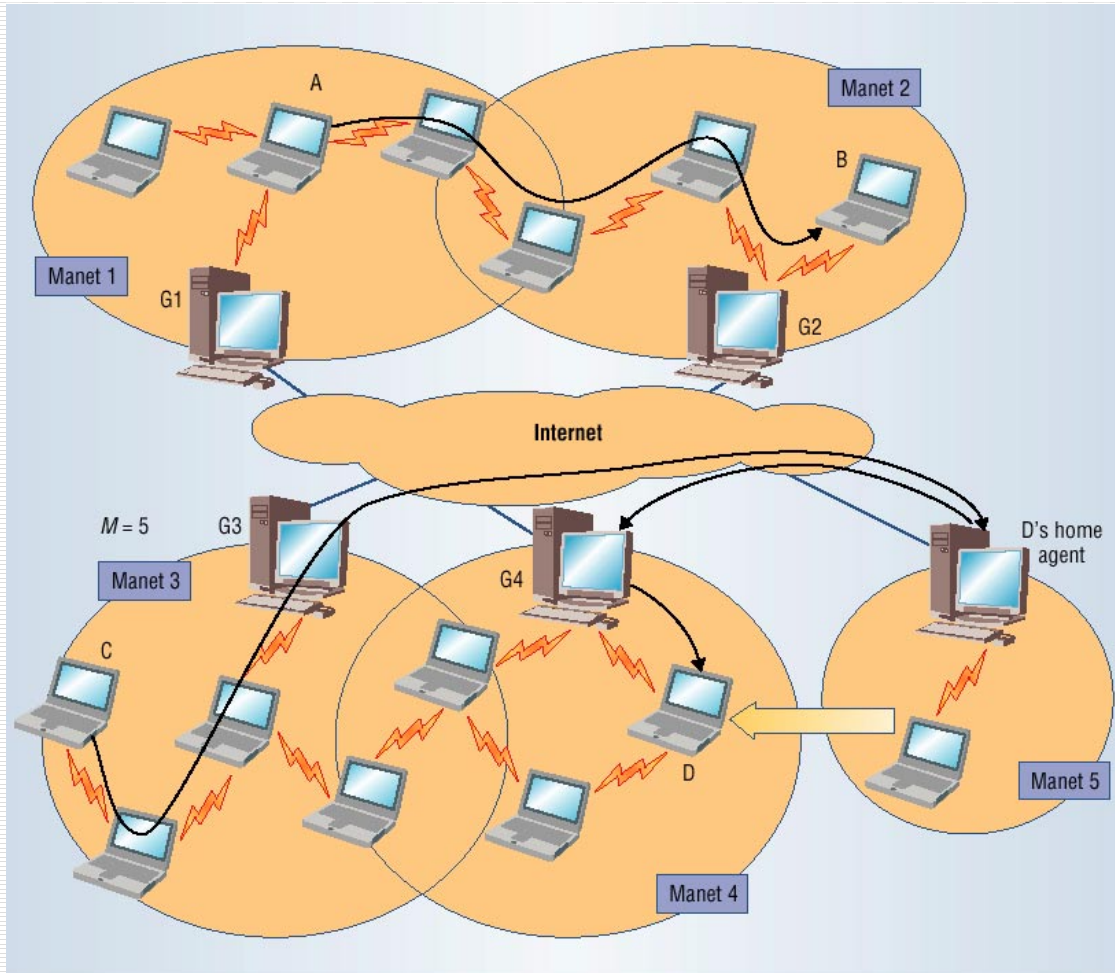
Integration & Implementation

- ARP
 - ARP should be disabled when mobile host visits foreign network
 - Host registers the MAC-to-IP address mapping when it receives an Agent_Advertisement message
- Broadcast
 - Broadcast daemon to support the broadcast routing
- Destination address and TTL
 - Mobile host always collects and propagates routing information for mobile hosts within M wireless hops from itself.
 - Parameter M is service range, recommended $M=2*N$
- IEEE 802.11b NICs
 - Network interface cards peer-to-peer (ad hoc) mode
 - Same extended service set identifier and channel number

Network Architecture

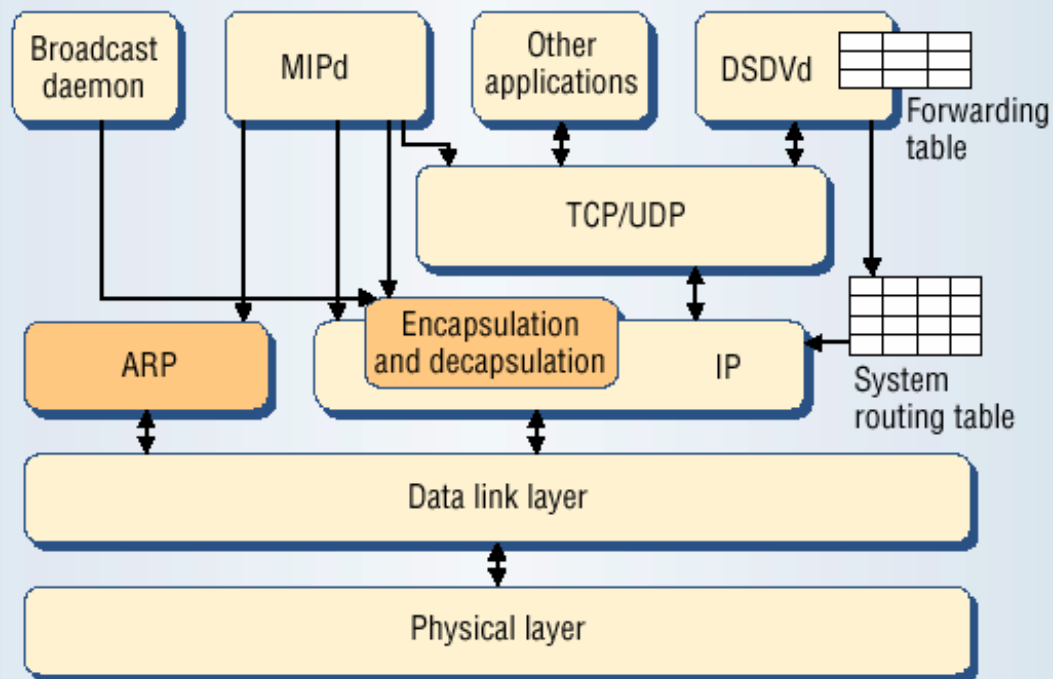


Inter-Manet routing



13/05/2004

System architecture



Conclusions

- A lot of problems
 - Ad-Hoc networking is a multilayer problem
- A lot of possibilities
- By supporting greater roaming flexibility, mobile IP with MANET would realize the dream of broadband wireless Internet access

References

- 1. The role of ad hoc networking in future wireless communications** *Bangnan Xu; Hischke, S.; Walke, B.*; Communication Technology Proceedings, 2003. ICCT 2003. International Conference on , Volume: 2 , 9-11 April 2003, Pages:1353 - 1358 vol.2
- 2. A Brief Overview of Ad Hoc Networks: Challenges and Directions** *Ramanathan R.; Redi J*; IEEE Communications Magazine, May 2002, Pages 20-22.
- 3. Integrating mobile IP with ad hoc networks** *Yu-Chee Tseng; Chia-Ching Shen; Wen-Tsuen Chen*; Computer , Volume: 36 , Issue: 5 , May 2003 Pages:48 - 55

HOMEWORK

1. List (and explain) 5 pros and cons related to ad hoc networks