An Overview of Mobile Ad hoc Networking

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Overview of Presentation

- Introduction to MANET
- Applications for MANET
- IP-based MANET Control Rationale
- IETF Standardization Work Status
MANET (1832-1883)

“Father of Impressionism”
whose work influenced

- Edgar Degas
- Claude Monet
- Auguste Renoir
- Alfred Sisley
- Camille Pissarro
- Paul Cézanne

Edouard Manet
Mobile Ad Hoc Networking

Technology also known as ...

- **Mobile Packet Radio Networking**
  - Term coined during early military research (70s, 80s)

- **Mobile Mesh Networking**
  - Term which appeared in an *Economist* article regarding the structure of future military networks

- **Mobile, Multihop, Wireless Networking**
  - Perhaps the most accurate term
Characteristics of MANET Technology

Mobile Ad hoc Networks (MANET)

- No wires or cabling (cheap installation)
- Mobile infrastructure possible (flexible)
- Autonomous operation possible (stand-alone)
- Relatively low capacity (Mbps)
Hybrid Communications Networks

- mobile ad hoc networks
- cellular/PCS/WLAN/networks
- high speed networks
- satellite overlay

No fixed infrastructure (fully mobile network)

fixed or static infrastructure
Likely Initial Usages

✧ Small-scale (few nodes)

✧ Usage in Diverse Applications

• Commercial
  – Industrial: factory, construction site, outdoors
  – Office/Home: personal networks

• Government-specific
  – Fire/Safety/Rescue/Disaster Recovery operations
  – Military

• Community/Urban Networks (HAM radio-type)
  – “covert” networks
Large-scale usage (many nodes)

- Commercial
  - Mobile Cellular-like Infrastructures
- Government
  - Large-scale Military Networks
- “Free” Community/Urban Networks
  - Unrestricted local communications
**MANET:** A network of highly mobile platforms that are not dependent on pre-existing or fixed communications infrastructure.

Router connects hardwired local net to multiple wireless interfaces.

Combined host/router with multiple wireless interfaces.

Airborne router provides asymmetric links to MANET.

Embedded host/router with single wireless interface.

Ad hoc networks form and disband as mobile nodes enter and exit net.

Maneuvers: A network of highly mobile platforms that are not dependent on pre-existing or fixed communications infrastructure.
Initial Architectures

- Low power sensor networks
  * “Surveillance” webs
- Small, relatively static, embedded ad hoc networks
  * “Bluetooth-type” networks
- Small-to-medium sized, mobile ad hoc networks
  * “802.11-style” networks
A Wireless LAN (WLAN) Standard

- 2.4 GHz, 1 to 11 Mbps WLAN technology capable of efficient multihop operation using peer-to-peer CSMA/CA mediated access
- Range: nominal 250 meters, but extendable with power amplification
- Suitable for in-building and outdoor usage
- Cost: $100’s per transceiver, possibly $10’s per transceiver in future
802.11 Uses

Campus-sized networks
  • people
  • vehicles

Voice over IP over MANET over 802.11
  • peer-to-peer
    – point-to-point
    – multi-hop
  • non-optimized---yet works good enough as long as network loading is low
A global specification for wireless connectivity created by an industry consortium

- “cable replacement” technology
- 2.4 GHz, 1 Mbps wireless LAN technology capable of multihop operation
- Short Range: 10m initial range (100m coming)
- Suitable for in-building and personal use
- Cost: $5 per transceiver chip targetted
Bluetooth Uses

☞ Personal Networks
  • cellphone to laptop (in briefcase ;-) , ...

☞ Desktop Networks
  • between laptop, desktop, printer, fax, network

☞ Spontaneous Networks
  • ad hoc meetings, laptop to laptop
  • conferences
Wireless technologies will continue to evolve

Multiple technologies can be used simultaneously—multi-mode radios

- There is need for a standards-based approach at the network layer
Mobile Ad hoc Networking and the Internet Engineering Task Force (IETF)


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Future Global Internet Architecture

Wireless Cloud (mobile Internet)

Fiber Optic Core (fixed Internet)
Characteristics

- Dynamic topologies
- Bandwidth-constrained, variable capacity, asymmetric links
- Energy-constrained operation
- Wireless vulnerabilities and limited physical security
Advantages of IP Routing for MANETs

**Traditional Mobile Packet Radio Design**
- Proprietary
- Single technology
- Technology-specific networking

**IP-Based Design**
- Standards-based
- Degree of physical media independence
- Routing flexibility, efficiency and robustness
- Eased interoperability with Internet
- Hardware economies of scale
- Future quality of service support
Why an Internet Layer Solution?

(... as opposed to subnet-based, link-level addressing and routing)

- The intent is the same as the original concept of the Internet:
  “... to develop a homogeneous networking capability over a heterogeneous networking infrastructure.”

Commercial Driver-> Cost Effectiveness

- In this case, the infrastructure is wireless rather than hardwired with
  - *Multiple* wireless platforms
  - *Multiple* link-layer technologies
**MANET:** An autonomous system of mobile nodes which may consist of separate networked devices or may be integrated into a single device
Logical Topology of Wireless Fabric for Routing at the IP Layer

Topologies of Wireless Technology A and B

Logical link
Logical node
Logical
Physical

Mobile node
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Host

Wired LAN Interface

Router

Satellite Interface

Wireless Interface
Application to Today’s Networking

**IP-based MANET can provide robust, low-capacity communications**

- Secondary form of information delivery
- Primary form when higher capacity options are unavailable

**Advantages include:**

- Cost effectiveness
- Flexibility
- Interoperability
- Physical media independence
“One size does not fit all...”

**Smaller Networks**
- Ad hoc On-demand Distance Vector (AODV)
- Dynamic Source Routing (DSR)
- Optimized Link State Routing (OLSR)
- Topology-Based Reverse Path Forwarding (TBRPF)

**Larger Networks**
- Temporally-Ordered Routing Algorithm (TORA)
- Zone Routing Protocol (ZRP)
- Landmark Router (LANMAR)
IETF Standards Snapshot

- AODV: completed second WG last call for comments on promotion to Experimental RFC status
- DSR: second last call coming
- OLSR and TBRPF: respective proponents are engaged in a debate within the WG for mindshare
- Large-scale MANETs: Near-term impracticality and lack of WG interest have put this work into question
- Flooding: work beginning on requirements definition
Questions???

For More Information...

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http://tonnant.itd.nrl.navy.mil/manet/manet_home.html