

Mobile Ad Hoc Networks
Summary and Further
Reading

Part I of 13th and Last Week

18.07.2007



University of Freiburg
Computer Networks and Telematics
Prof. Christian Schindelhauer

Christian Schindelhauer
schindel@informatik.uni-freiburg.de



Summary I

➤ ISO/OSI Layers

➤ Physical Layer

- Fourier Transformations
- Frequency
- Modulation

➤ Theory

- Unit Disk Graphs, Random Placement, Data Flow, Min-Cut-Max-Flow, Multi-Commodity, Network Flow in Random Unit Disks

➤ MAC

- Aloha, Slotted Aloha, CSMA/CD, MACA, MACAW, Power-Aware MAC

➤ Measures

- Interference, Congestion, Energy Diversity

➤ Topology Control

- Spanner Graphs, Yao Graph Family, Hierarchical Layer Graph



Summary II

➤ Network Coding

- Theory, Practical Network Coding, XORs in the Air, COPE

➤ Routing

- Proactive, Reactive, Hybride
- Dijkstra, Distance Vector (Count-to-Infinity)
- Flooding, Dynamic Source Routing, Geographic Distance Routing
- AODV, Link Reversal, Partial Reversal, TORA, OLSR
- DSDV

➤ Mobility

- Mobility Patterns
- Mobility Models
- Random Waypoint (considered Harmful)
- Particle Based Mobility
- Mobility helps



Topics not covered by this lecture

University of Freiburg
Institute of Computer Science
Computer Networks and Telematics
Prof. Christian Schindelhauer

➤ **General**

- Self-Organization
- Pricing Scheme

➤ **Physical Layer**

➤ **Quality of Service**

➤ **Wireless Internet**

➤ **Security**

➤ **Energy Management**

➤ **Related Wireless Networks**

➤ **MAC**

➤ **Network Layer**

➤ **Transport Layer**

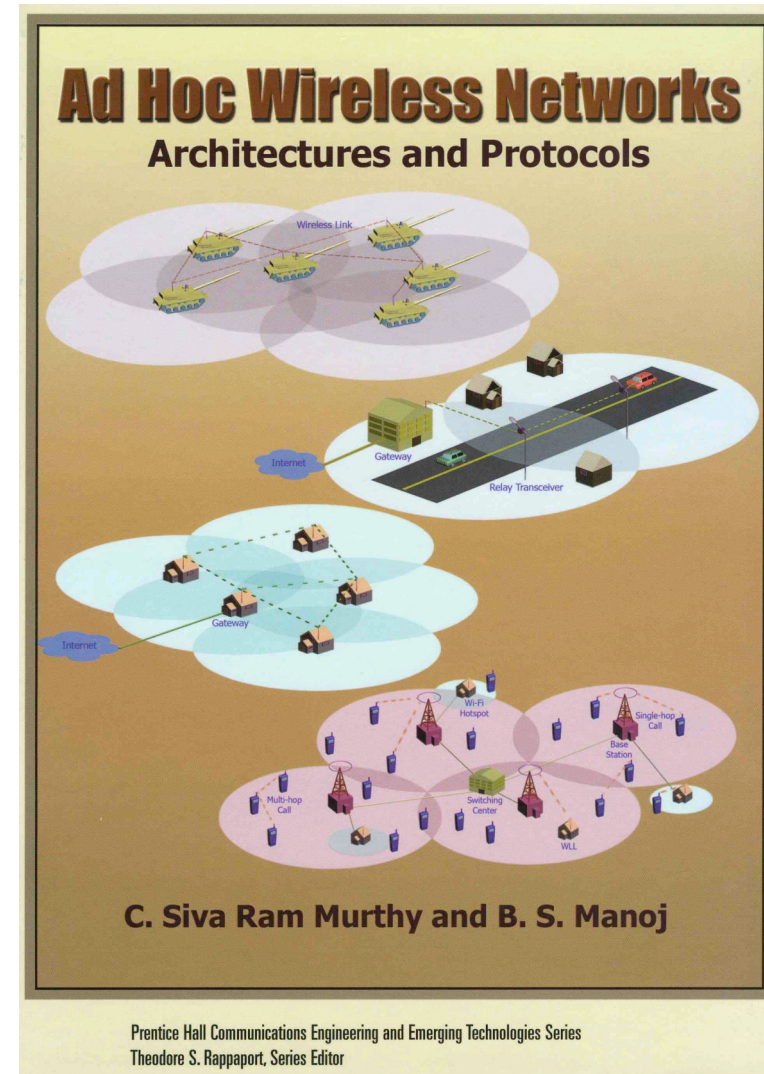


Further Reading

The following pictures are from this book

University of Freiburg
Institute of Computer Science
Computer Networks and Telematics
Prof. Christian Schindelbauer

- **Murthy and Manoj**
 - *Ad Hoc Wireless Networks, Architectures and Protocols*
 - Pearson/Prentice Hall, 2004
- **Comprehensive Monography on Ad hoc Wireless Networking**
- **Recommended as one book covering early all aspects of wireless communication**
 - 802.3, 802.11, HiperLAN, GSM, ATM, WATM, MobileIP, MANET, MAC for Wireless, Routing and Multicast Routing in MANETs, Transport layer, QoS, Energy Management, Sensor Networks, Hybrid Networks





Self-Organization

- **No central control**
- **Participants may change their own protocols**
- **Incentives needed for cooperation?**
 - What makes my neighbor route my message
- **or completely self-organization**
 - Tit for tat
 - If the other does not cooperate I punish him
- **Game theoretic approach**
 - prisoner's dilemma, etc.
- **Pricing Schemes**
 - Auction system
 - How to pay?



Physical Layer

➤ Voice Coding

- most prevalent usage of mobile devices: telephone
- mp3
- Pulse Code Modulation
- Vocoders

➤ Error Control: Coding

- Hamming Code
- CRC
- Convolutional Codes
- Turbo Codes



Energy Management

➤ **Battery Management**

- Mobile nodes rely on batteries

➤ **Transmission Power Management**

- Besides CPU and screen mobile communication is a major energy drain

➤ **System Power Management**

- Balance energy usage (computation versus communication)

➤ **Network Power Management**



MAC

➤ Synchronization

➤ Directional Antennae

➤ Multi-channel MAC Protocols

- Control channels
- Preferenced channels

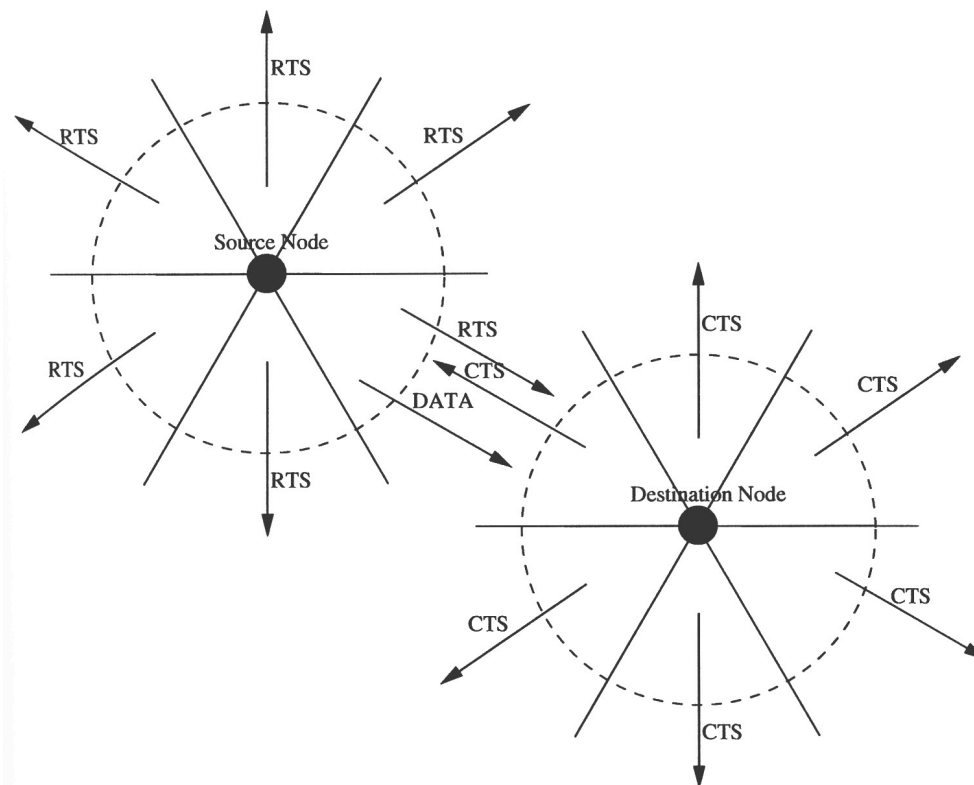


Figure 6.29. Packet transmission.



Network Layer

- **Addressing and Service Discovery**
 - IP address carry routing information
 - Locator and Identifier should be treated separately
- **Numerous Routing Protocols**
 - Fisheye State Routing
 - Hierarchical State Routing
 - DYMO Routing
- **Multicast Routing**
 - ...



Transport Layer

- **TCP over Ad Hoc Networks**
 - TCP's AIMD mechanism is not working well in wireless connections

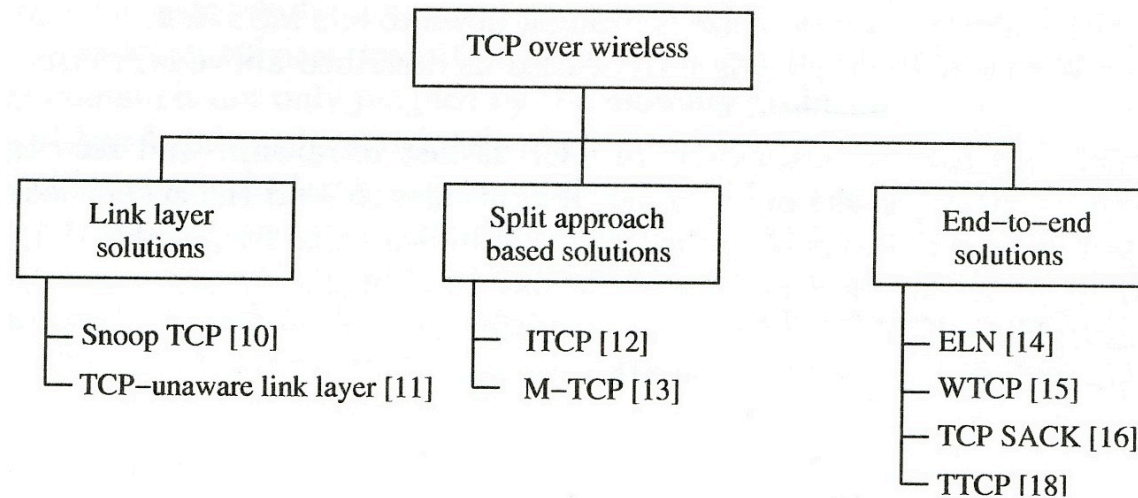


Figure 4.6. Classification of approaches for TCP over wireless.



Wireless Internet

- Addressing
- Mobile IP
- Handoffs
- WAP

– Wireless Application Protocol Stack

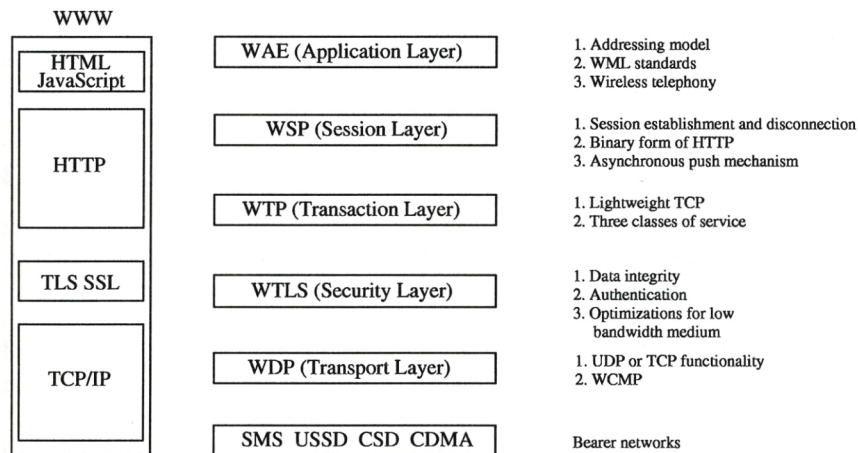


Figure 4.9. The WAP protocol stack.

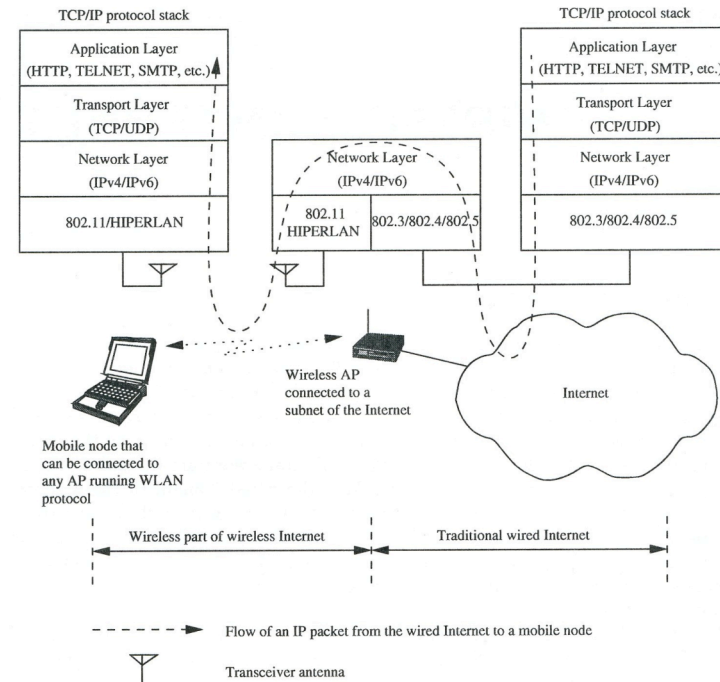


Figure 4.1. An illustration of wireless Internet.



Quality of Service

➤ Real-Time Traffic

- control of delay and throughput

➤ Challenges

- dynamics
- Inaccurate state information
- lack of central coordination
- error-prone radio channel
- limited resources
 - batteries, bandwidth, storage space

➤ MAC-Layer

➤ Network Layer

➤ Application Layer

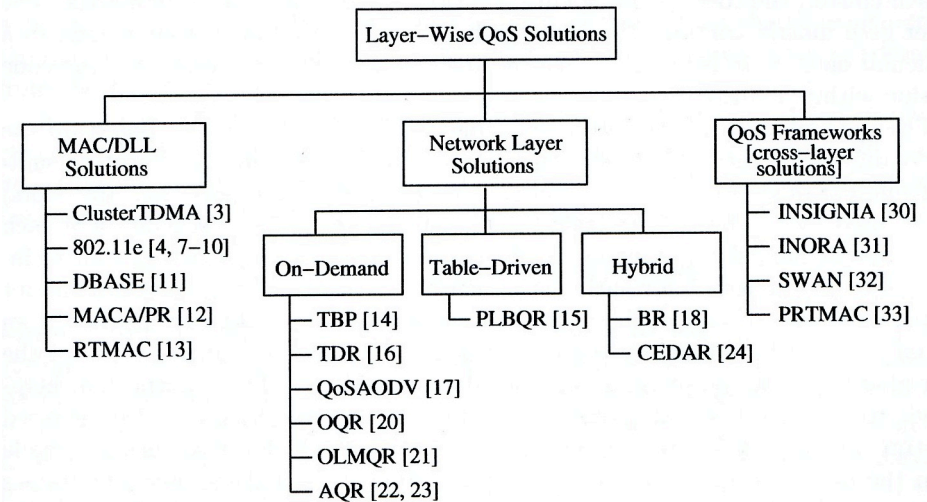


Figure 10.3. Layer-wise classification of QoS solutions.



Security

➤ Network Layer Attacks

- Denial of Service
- Host impersonation
- Information disclosure
- Resource consumption

➤ Key Management

- How to distributed public keys and prove identity without contact to a central server

➤ Secure Routing



Related Wireless Networks

➤ Cellular Networks

➤ Wireless Sensor Networks

- Lecture of its own (see last winter semester)

➤ Hybrid Wireless Networks

- combine cellular networks and ad hoc networks

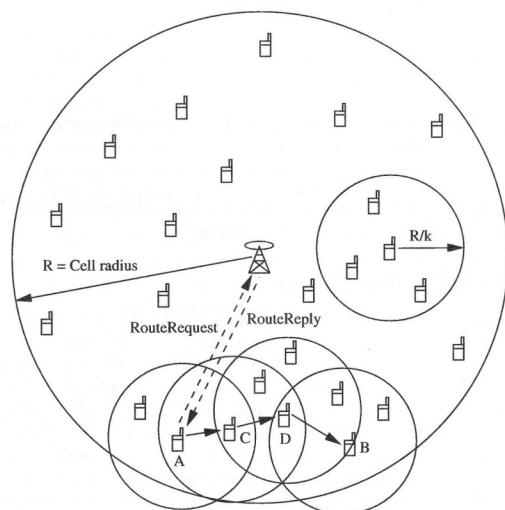


Figure 13.2. MCN best-effort architecture. Reproduced with permission from [16], © Elsevier, 2004.

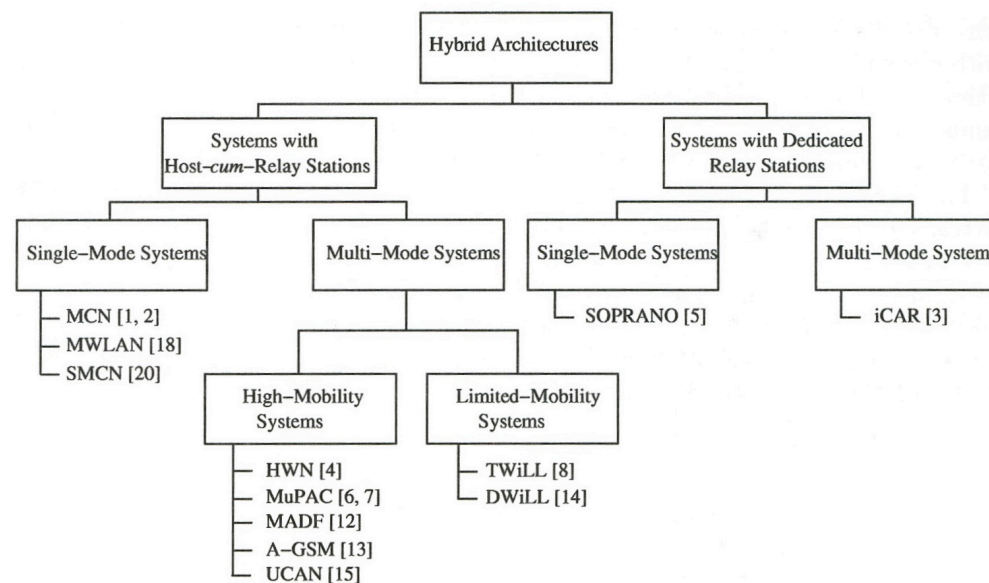


Figure 13.1. Classification of hybrid architectures.

Thank you!



University of Freiburg
Computer Networks and Telematics
Prof. Christian Schindelhauer

Mobile Ad Hoc Networks
Christian Schindelhauer
schindel@informatik.uni-freiburg.de

13th Week
18.07.2007