Security in Wireless Ad Hoc Networks

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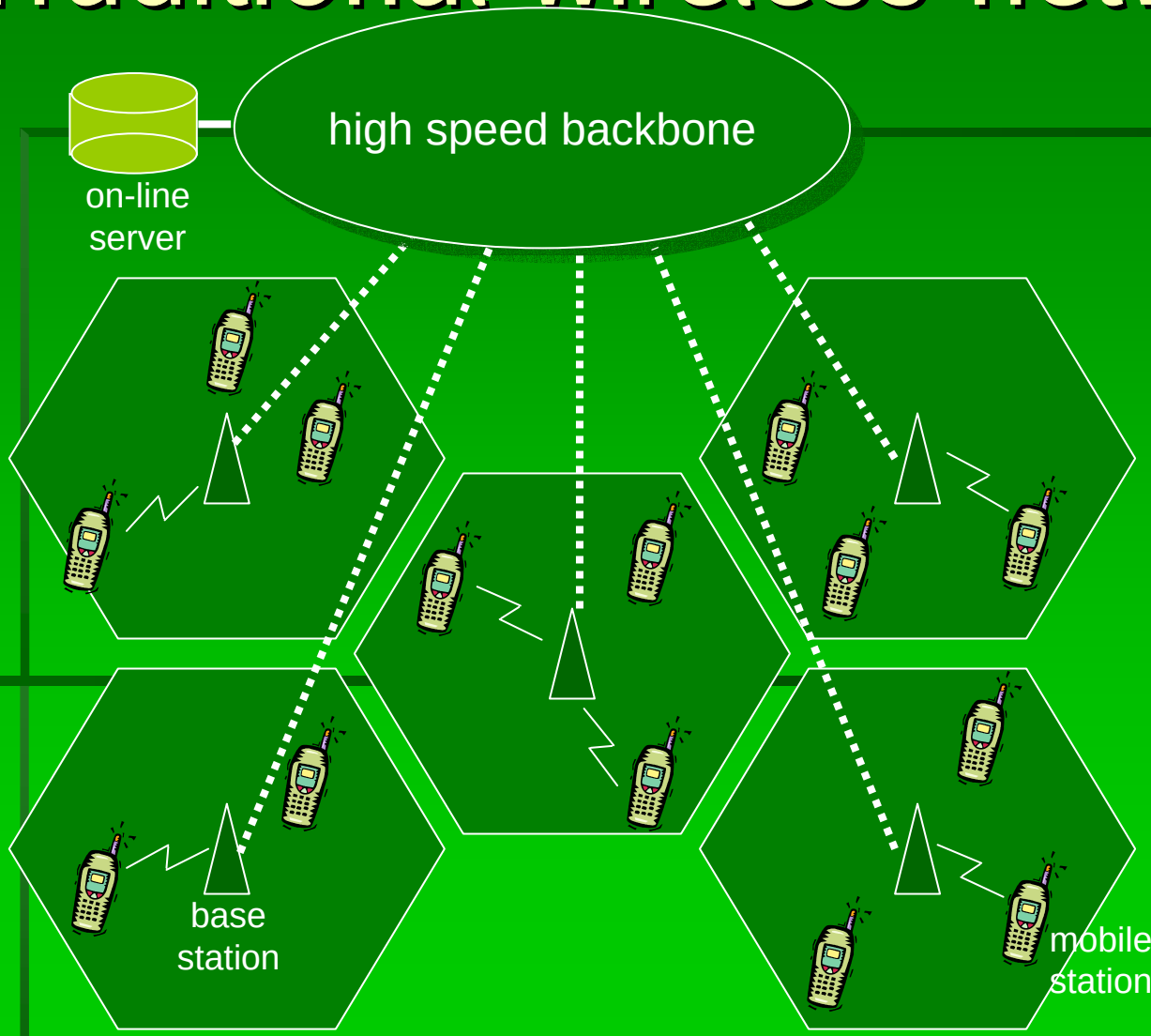
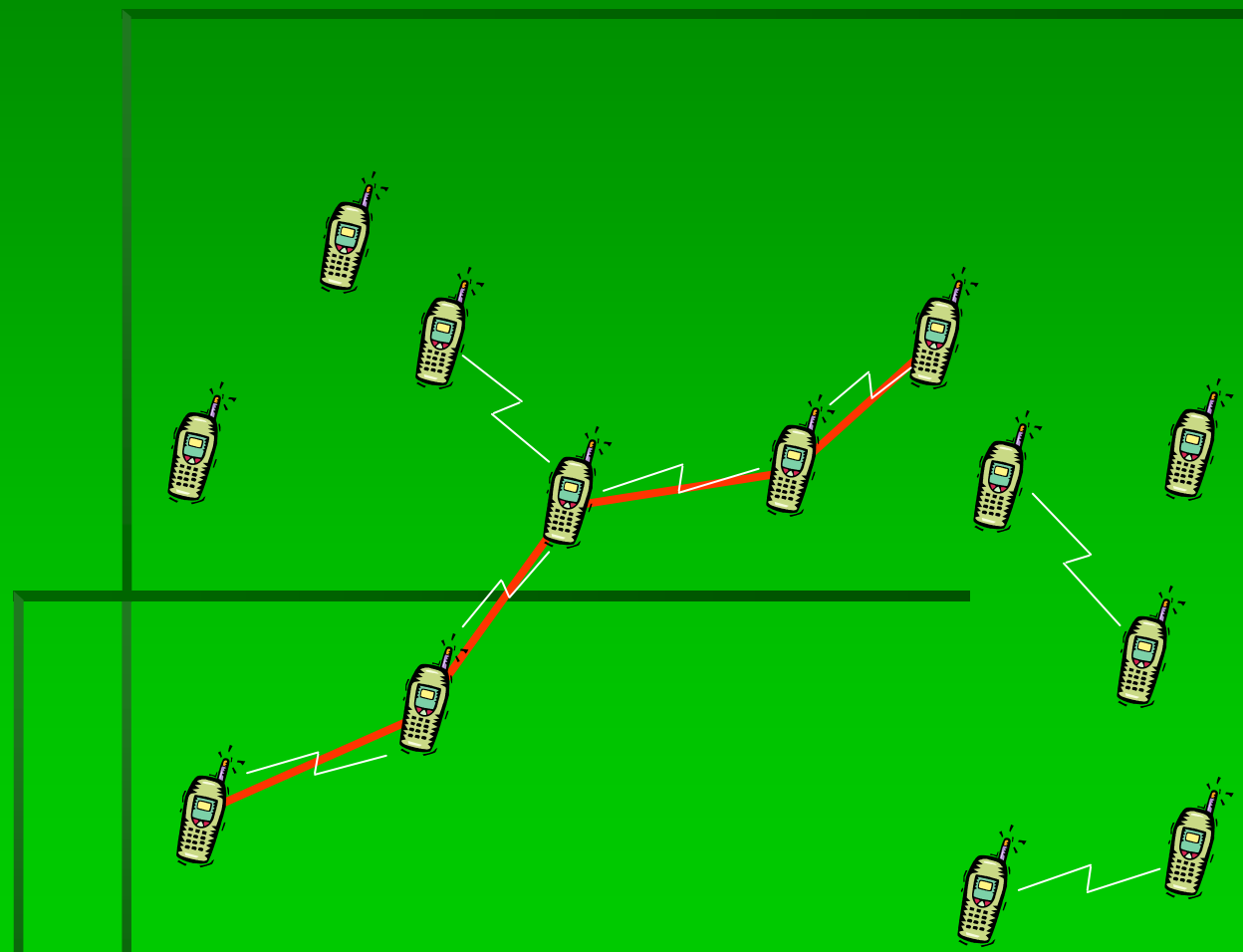
Traditional wireless networks



- infrastructure
  - base stations
  - high speed backbone
  - on-line servers
- network operators
  - operate and maintain the system
  - determine policies
- single-hop wireless communication

Wireless ad hoc networks

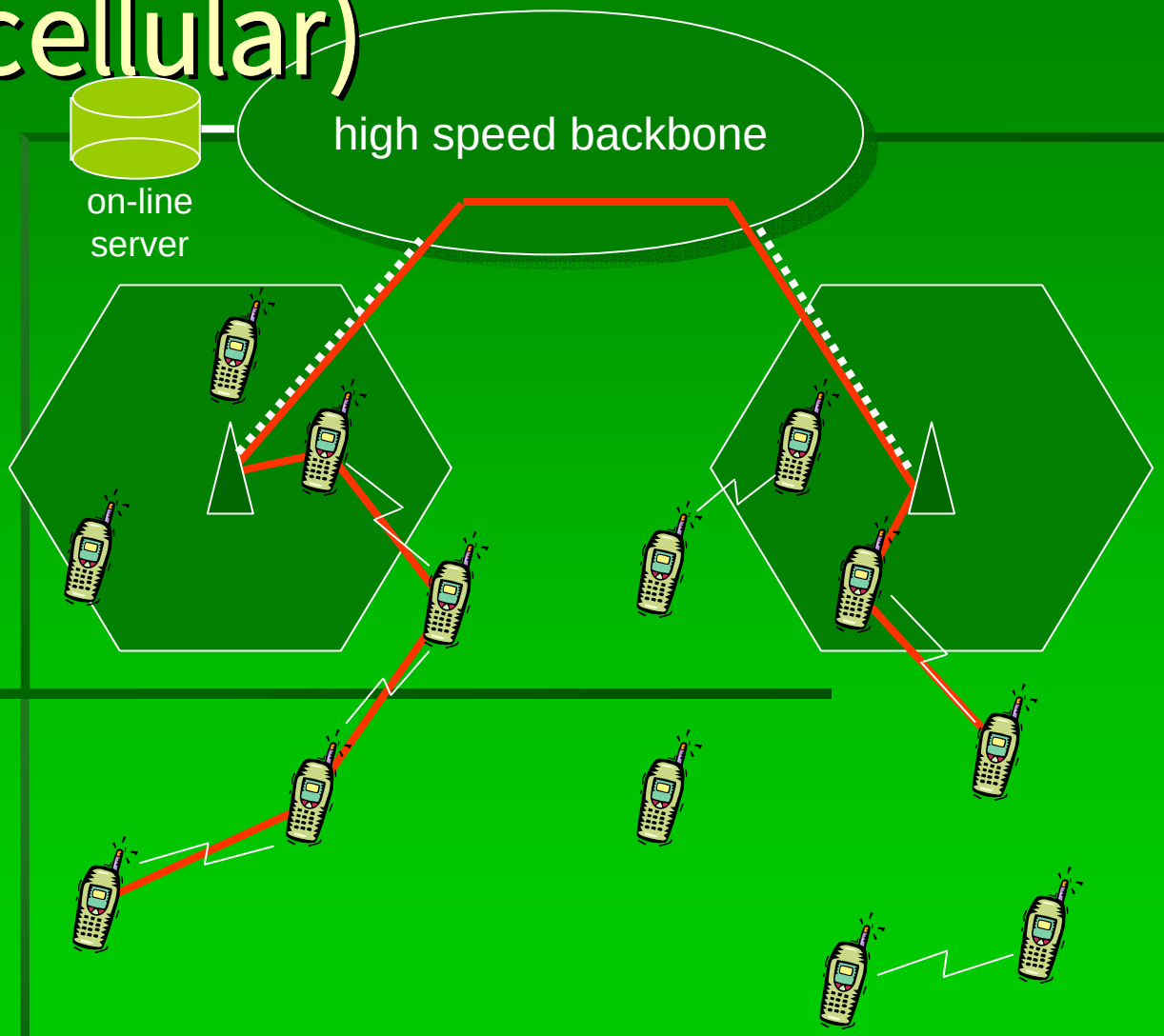


- no infrastructure
  - no base stations
  - no backbone
  - no servers (→ P2P)
- no network operators
  - self-organization
  - self-configuration
  - self-healing
- multi-hop wireless communication

Applications of ad hoc networking technology

- battlefield
- rescue operations
- sensor networks
- spontaneous networks of personal devices
  - e.g., conferences, meetings
- car networks
- pervasive computing
  - connecting embedded computers
  - e.g., connecting personal gadgets or household devices

Hybrid networks (multi-hop cellular)



- advantages
  - fewer base stations / larger coverage
  - reduced total energy consumption of mobile stations
  - reduced interference
- disadvantages
  - synchronization?
  - routing?
  - QoS?

Security challenges

- well-known security problems (authentication, session key establishment, ...) must be solved under new assumptions
  - set of assumptions depends on the envisaged application of the network, but usually...
  - no central authority can be assumed
  - no access to on-line servers can be assumed
  - network may be very dynamic (mobility, link failures, broken routes, ...)
  - network lifetime may be short (transient associations)
  - capacity of nodes may be limited (energy constraints, peanut CPU, small memory, limited communication in space and in time)
  - nodes can be captured and compromised (no tamper resistance)

Security challenges

- new security problems specific to ad hoc networks
  - selfishness, non-cooperative behavior
  - new forms of DoS attacks (e.g., battery exhaustion)

Securing wireless Ad hoc networks

- Vulnerability of channels
- Vulnerability of nodes
- Absence of infrastructure
- Dynamically changing topology

Four session

- Trust and key management
- Secure routing and intrusion detection
- Availability
- Cryptographic protocols

Trust and key management

- Distributed Trust in Ah Hoc Networks
- Network Performance Centric Security Design in MANET
- Self-Organized Public Key Management for Mobile Ad Hoc Networks
- Admission Control in Collaborative Groups

“Distributed Trust in Ah Hoc Networks” Lidong Zhou, Microsoft 2002

- Distributed trust
- Distributed secure services
- Threshold cryptography
- Share refreshing
- Secure routing

“Network Performance Centric Security Design in MANET”, Hao Yang, UCLA, 2002

- Network performance centric

Scheme	Centralized	Peer-to-Peer	Localized
Scalability	Bad	Good	Good
Availability	Bad	Uncertain	Good
Robustness	Bad	Uncertain	Good
Communication	Centralized	Distributed	Localized
Computation	Undertaken solely by the servers	Shared by the nodes	Shared by the nodes

“Self-Organized Public Key Management for Mobile Ad Hoc Networks”, Srdjan Capkun, EPFL , 2002

- Fully self-organized
- Local certificate repository
- Certificate graph
- Maximum degree algorithm
- Shortcut certificates
- Shortcut Hunter Algorithms

“Admission Control in Collaborative Groups”, Yongdae Kim, University of Minnesota, 2002

- Peer group
- Group charter
- Group authority
- Group lifetime
- Group admission control
- Voting process

Secure routing and intrusion detection(1/2)

- Secure Routing for Mobile Ad Hoc Networks
- Packet Leashes: A Defense against Wormhole Attacks in Wireless Ad Hoc Networks
- Secure Efficient Distance Vector Routing in Mobile Wireless Ad Hoc Networks

Secure routing and intrusion detection(2/2)

- Ariadne: A Secure On-Demand Routing Protocol for Ad Hoc Networks
- Authenticated Routing for Ad Hoc Networks
- Dynamic and Secure Group Membership in Ad Hoc and Peer-to-Peer Networks
- Intrusion Detection

“Secure Routing for Mobile Ad Hoc Networks”, Panagiotis Papadimitratos, Cornell University, 2002

- SRP : Secure Routing Protocol
- IP header + basic routing protocol packet + SRP header
- SRP header = type + Reserved + Query Identifier + Query Sequence Number + SRP MAC
- Geometry
- Tunnel

“Packet Leashes: A Defense against Wormhole Attacks in Wireless Ad Hoc Networks”, Yih-Chun Hu, Rice University, 2002

- Wormhole attack
- Packet leashes
- Temporal leashes
- Geographical leashes

“Secure Efficient Distance Vector Routing in Mobile Wireless Ad Hoc Networks”, Yih-Chun Hu, Rice University, 2002

- Sequence number
- One-way hash function
- Distance Vector Routing
- Hash chains
- Authenticating Routing Update

“Ariadne: A Secure On-Demand Routing Protocol for Ad Hoc Networks”, Yih-Chun Hu, Rice University, 2002

- Symmetric cryptography
- Basic Ariadne Route Discovery
- Target authenticate ROUTE REQUESTs
- Per-hop hashing
- Basic Ariadne Route Maintenance
- Avoiding Routing Misbehavior

“Authenticated Routing for Ad Hoc Networks”, Kimaya Sanzgiri, UCSB, 2002

- Managed-open environment
- RDP : Route Discovery Packet
- S -> broadcast : [RDP, IP_D, $cert_S$, N_S, t]K_S

“Dynamic and Secure Group Membership in Ad Hoc and Peer-to-Peer Networks”, Claude Castelluccia, INRIA Rhone-Alpes, 2002

- Secure Node identity
- CBID : Crypto-Based Identifier

Current research directions

- decentralized public-key management schemes
  - using threshold cryptography
  - PGP-like approach*
  - exploiting mobility and secure side channels*
- secure ad hoc routing
  - various schemes for authenticating routing information that is distributed or exchanged among the nodes

Current research directions

- incentives for cooperation
  - micro-payment based schemes*
  - reputation based schemes
- low cost cryptographic primitives (algorithms and protocols)*
- anonymity, intrusion detection, ...