# Security for Future Wireless and Decentralized Communication Networks

## Harnessing Cooperation, Space, and Time

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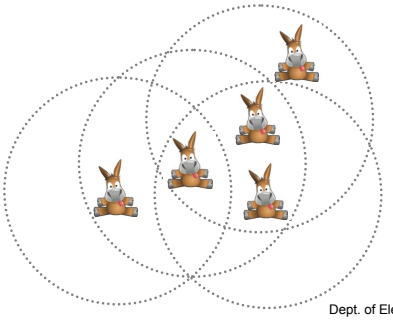

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3. Juli 2008



## Motivation

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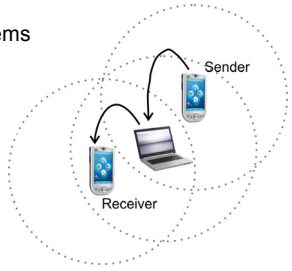
**Decentralized Systems**

- Enable communication beyond borderlines of 'traditional' systems
- Here: Mobile ad hoc networks and peer-to-peer systems




**But: Highly dynamic scenarios, wireless transmission**

→ No well defined network borders
→ Functionality based on cooperation
→ Devices from many administrative domains

**But: No constant availability of devices and services**

→ No central, trusted instances
→ No e.g. RADIUS, Kerberos

**→Decentralized Systems are beyond borderlines of 'traditional' security measures**

## Motivation (cont'd)

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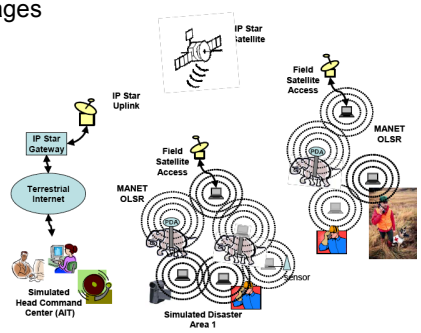
### DUMBO (Digital Ubiquitous Mobile Broadband OLSR)

- Research project of Thailand, France, and Japan
- Communication services for emergency response scenarios
- Designed for wide area deployment (natural disasters)
- Offers video streaming, VoIP, text messages

Source: [Kanchanasut2007a]




Source: [Kanchanasut2007b]



## Harnessing Cooperation

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### Idea: Counterbalance missing trusted instances

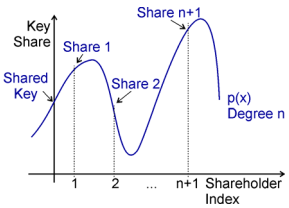
- Enforce cooperation for security relevant decisions
- Distribute required cryptographic operations


### Alternative: Threshold Cryptography

- Based on Shamir's secret sharing [Shamir1979a]
- One cryptographic key distributed among multiple peers
- Enables anonymous cooperation
- E.g. Shoup's threshold signatures [Shoup2000a]

### Alternative: Multisignatures

- Naïve approach: List of signatures and signers
- One cryptographic key per peer
- Enables detailed mapping of administrative structures
- E.g. Boldyreva's multisignatures [Boldyreva2003a]



## Harnessing Cooperation (cont'd)

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**Challenge: No predefined decision policies**

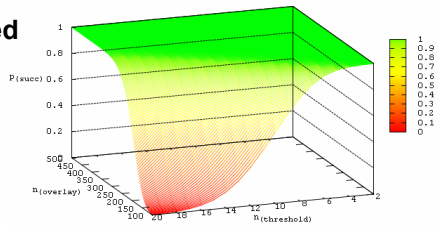
- All security relevant requests in spontaneous networks hard to foresee

**Thus: User interaction may be required**

- To decide on non-predefined requests

**But: Users may not reply in time**

- Sending redundant requests reasonable




**Our Approach: Models for overhead / performance trade-off**

- To offer runtime adaptation of relevant parameters

$$p_{succ} \geq \left( \frac{p_{reply}(n_{gossip} - n_{threshold} + 1)}{(1 - p_{reply})(n_{threshold} - 1)} \right)^{n_{threshold}-1} \cdot \left( \frac{(1 - p_{reply})(n_{threshold} - 1)}{n_{gossip} - n_{threshold} + 1} + (1 - p_{reply}) \right)^{n_{gossip}}$$



## Harnessing Space and Time

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**Challenge: No gateways, firewalls, …**

- Low-effort attacks on network possible

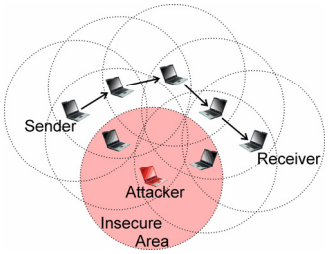
**Thus: Exclusion of misbehaving devices required**

- Reactive approach seems promising

**But: Devices from many administrative domains**

→ Changing addresses easily possible

→ How to identify misbehaving nodes?

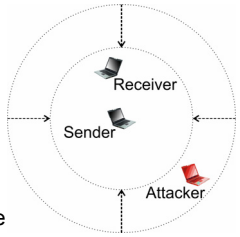



**Our Approach: Location-based intrusion response**

- Quarantine zones as temporal network borders

**Further Enhancements**

- Adaptive transmission power to reduce size of quarantine zones
- Harnessing delay tolerance
  - E-mail, SMS, ... may be delayed until node left quarantine zone



## Harnessing Space and Time (cont'd)

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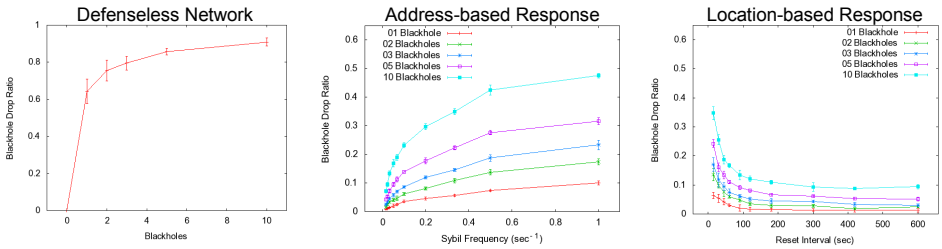
**Comparison of address-based and location-based intrusion response**

- When confronted with black hole and Sybil attack
- 1000 nodes, 7-8 neighbors, pedestrian speed, 1 hour simulated time
- Metric: Drop ratio caused exclusively by black hole nodes






## Thanks for Your Attention!

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**Further Information**

- www.kom.tu-darmstadt.de/en/research/security/overview
- www.kom.tu-darmstadt.de/en/people/staff/andre-koenig

## References


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