Achieving Reliable Communication in Dynamic Emergency Responses

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State-of-the-practice exhibits

- Communications using radios & paper
  - Error-prone and labor-intensive
  - Slow dissemination of information
- Electronic data may address these limitations
“Typical” disaster scenario

Golden Guardian drill, April 2010
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Golden Guardian drill, April 2010
Reliable communication is a key challenge

- Responders and commanders must communicate reliably

**Challenges:**

- limited infrastructure ➔ existence of network partitions
  - cannot rely on existing infrastructure
  - limited opportunities to deploy infrastructure during emergencies

- dynamic radio environment ➔ continuously changing topology
  - heavy equipment attenuates radio signals
  - external interference (e.g., video broadcasts)
  - mobile users
Initial approach: Client-server + Adhoc routing
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Failure to update end-to-end paths ⇒ low reliability
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Failure to update end-to-end paths \implies low reliability
Initial approach: Client-server + Adhoc routing

Failure to update end-to-end paths ⇒ low reliability

Network partitions ⇒ prevent clients from communicating
Peer-to-peer + Gossip
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Peers communicate locally $\Rightarrow$ tolerates topology changes
Peer-to-peer + Gossip

Peers communicate locally $\Rightarrow$ tolerates topology changes

Mobility $\Rightarrow$ bridges network partitions
Peer-to-peer + Gossip

Peers communicate locally ⇒ tolerates topology changes

Mobility ⇒ bridges network partitions

Infrastructure peers ⇒ augments communication
Impact of network partitions

client server

peer-to-peer
Impact of network partitions

Client server

Peer-to-peer
Impact of network partitions

Delivery from A to B without infrastructure
- client-server + routing: 0%
- peer-to-peer + gossip: 100%
Impact of mobility
Impact of mobility
Impact of mobility

Mobile node moving between A & B with infrastructure

- client-server + routing: 67.2%
- peer-to-peer + gossip: 100%
Conclusions

• Medical response in disasters creates unique challenges for rapid, effective, affordable response
  • IT solutions can help ⇒ robust communication a key challenge

• Standard client-server + routing solutions has poor reliability
  • difficult to maintain end-to-end routes in dynamic environments
  • network partitions prevent clients from communicating

• Peer-to-peer + gossip significantly improves performance
  • relies only on local information that is less susceptible to dynamics
  • tolerates network partitions