Adaptive Service Provisioning for Emergency Communications using DTNs

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Communication in emergencies using DTNs

- Communication in emergency or harsh environment
  - Non “end-to-end” connection
  - Heterogeneous network
- It is not meant to replace current emergency services (Tetra) but augment it with a system that requires minimal infrastructure
- Increase probability of communication when the cellular infrastructure is not (or partially) operational.
- Dependence of infrastructure removed by using Delay Tolerant Network (DTN): “store-and-forward” feature
– Service provision: *Broadcast* and *Point to Point*
  - SMS, multimedia messaging and walkie-talkie communication
  - Tested on HTC Tattoo (Android) and Nokia N810 (Symbian)
Typical DTN transmission

Application-A
- Bundle
- Transport-A
- Network-A
- Link-A
- Physical-A

Application-B
- Bundle
- Transport-B
- Network-B
- Link-B
- Physical-B

Adaptive service
- DTN Bundle
- Bundles
- Bytes

Convergence layer

Physical-A

Physical-B
Proof of Concept

HTC tattoo

• Text
• Image
• Voice

Wi-Fi

Nokia N810

Bluetooth

Wi-Fi
System level simulation

- Using the Opportunistic Network Environment (ONE) simulator
- QMUL campus scenario
- 50% civilians use the Bluetooth connection and the others will adoptive change between WiFi and Bluetooth connections.
Message delivery probability

- Every civilian will send 5 messages to the rescue teams and rescue team will broadcast 5 messages to all civilians in 15 minutes
- Message size is between 10KB and 50KB
Message delivery latency

- Average message latency between the source and destination on different user density
- Because the rescue teams have both WiFi and Bluetooth connections, the message can be more easily broadcasted and the downlink message latency is always smaller than the uplink
Routing algorithm comparison

- Epidemic
- Binary Spray and Wait
- Probabilistic Routing Protocol using History of Encounters and Transitivity (PRoPHET)
- Epidemic will be better at the emergency beginning and the PRoPHET will be nice for the long term communication for the energy efficiency
Analysis of energy consumption on DTNs

- The energy consumption in a DTN is based on the
  - radio access method used
  - mobile App active time
  - the amount of messages transferred

- Energy behavior of the DTN node:
  - standby processes using power
  - the message transmission costs

- Objective:
  - Long time service provision
  - Message delivery probability and latency
Battery consumption

Simulation Time (minutes)

Battery Consumed (mAh)

- Epidemic
- PRoPHET
- Spray and Wait (4)
- Spray and Wait (12)
Message Delivery Probability

![Graph showing message delivery probability over simulation time. The graph compares Epidemic, PRoPHET, Spray and Wait (4), and Spray and Wait (12) methods. The x-axis represents simulation time in minutes (0 to 120), and the y-axis represents the probability of message delivery in percentage (%). Different lines and markers are used to distinguish between the methods.](image)
Future Work

- Energy efficiency: a three layer adaption
  - Application layer by contextual sleep management
  - Bundle layer by routing algorithm selection
  - the selection of different transport methods
- Security is a concern in DTN and still an open research issue, although research has shown that DTNs are quite resilient to attacks
  - Some studies reported that even when an attacker has corrupts 20% of the nodes, 45% of the packets are still delivered, compared to 70% delivery with no attack
- Other routing protocols to be investigated and proposed
- Investigation on the resilience of the system under different types of attacks
Thank you