The Benefit of Information Centric Networking for Enabling Communications in Disaster Scenarios

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Scenario and Use Cases

Disaster Scenario

- The aftermath of a disaster (hurricane, earthquake, tsunami, or a human-generated network breakdown)
- E.g. the enormous earthquake which hit Northeastern Japan on March 11, 2011 (causing extensive damages including blackouts, fires, tsunamis and a nuclear crisis)

Key Use Cases (High-Level)

- Authorities would like to inform citizens of possible shelters, food, or of impending danger
- Relatives would like to communicate with each other and be informed about their wellbeing
- Affected citizens would like to make enquiries of food distribution centres, shelters or report trapped, missing people to the authorities
Key Research Challenges

- **Communication in Fragmented Networks** (using disconnected but functional parts of the infrastructure)
- **Security** (access control, message authentication)
- **Traffic Prioritization / Handling Congestion** (overall capacity is reduced)
- **Delay/Disruption Tolerant Approach**
- **Energy Efficiency** (devices run on battery)

Support Routing and caching in fragmented networks
Investigating energy efficient information delivery mechanisms for fragmented mobile networks.

Access Control and Management in fragmented networks
Designing access control and information management in fragmented networks.

Implementation and validation of applications for Disaster and Rescue Management
Extending/adapting essential functions to support fragmented networks in disaster stricken areas and design applications exploiting such functionality.
How ICN can be Beneficial\textsuperscript{[1]}\textsuperscript{[2]}

**Routing-by-Name**
- In fragmented networks, references to location-based, fixed addresses may not work as a consequence of disruptions (e.g. reachability of DNS servers)

**Content-based Access Control**
- ICN security model can regulate access to data objects (e.g. only to a specific user or class of users) by means of content-based security

**Authentication of Named Data Objects**
- With 'self-certifying data' approaches, the origin of data retrieved from the network can be authenticated without relying on a trusted third party or PKI

**Caching**
- Caching can help to avoid congestion in the network (e.g. congestion in backhaul links can be avoided by delivering content from caches at access nodes)

**Sessionless Communication**
- ICN does not require full end-to-end connectivity (facilitating a seamless aggregation between normal operations and a disaster)

\textsuperscript{[1]} J. Seedorf et al.: “Using ICN in disaster scenarios”, draft-seedorf-icn-disaster-04, IRTF ICNRG, Oct. 2015
Research Gap

Quite some work in the DTN community, however most DTN work lacks key features which are needed in the disaster scenarios we consider, such as:

- publish/subscribe (pub/sub) capabilities, caching, multicast delivery, message prioritisation based on content types, …

Could enhance existing DTN approaches with these features – we argue that ICN makes a better starting point for building a communication architecture that works well before & after a disaster.

Vision / Rationale: Start with existing ICN approaches and extend them with the necessary features needed in disaster scenarios
Selected Results & Ongoing Research

ICN ’Data Mules’ [3] [4]
- Logical interface, multipath support

ICN Data Mules in a Disaster Scenario

Selected Results & Ongoing Research

ICN ‘Data Mules’

Priority dependent Name-based Replication (NREP) [5]
- Routing/forwarding decisions based on name/attributes


More Replications till Expiry for High Priority Messages
Selected Results & Ongoing Research

ICN ‘Data Mules’

Priority dependent Name-based Replication (NREP)

Information Resilience [6]
- NDN Extension “Satisfied Interest Table (SIT)”

Information Resilience: Router Design with Satisfied Interest Table (SIT)

Results / Ongoing Research

ICN ‘Data Mules’

Priority dependent Name-based Replication (NREP)

Information Resilience

Data-centric Confidentiality, Access Control & Authentication [7] [8]
- Identity Based Encryption, Attribute Based Encryption, Web-of-Trust

Moderator-controlled Information Sharing by Identity-based Aggregate Signatures

[8] https://github.com/byambajav/ndn-ibas
Conclusion

ICN brings many features that are very useful for enabling communications after a disaster happened

Main Achievement: Extended existing ICN approaches with the necessary features needed in disaster scenarios
- Developed and evaluated key mechanisms for
  - Decentralized Forwarding
  - Message Prioritization
  - Security (Access Control and Authentication)
- Integration into overall architecture ongoing

Outlook: Bigger Picture
- Ongoing discussion with DTN Community on ICN / DTN Intersection
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