Robustness of Communications Infrastructures

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A single infrastructure of Failure
Recently, large scale infrastructure failures have disrupted vital services.
Assessing communication infrastructure robustness is an intricate task.
The Infrastructure is a black box

No information about the underlying topologies.
No information about peering points and SLAs between operators
No information about routing strategies
No information about shared dependencies between operators

…Information that we will unlikely ever have…
Robustness is a complex notion that encompasses several other concepts

**Resilience**

Ability to recover from failures

**Survivability**

Ability to continue functioning post outages and disasters

**Reliability**

Ability to provide a predictable service level
Source: Sterbenz et. al “Resilience and survivability in communication networks: Strategies, principles, and survey of disciplines”
We are no longer talking about a single infrastructure

Robustness properties of interdependent networks differ qualitatively from a single network

Source: Buldyrev et. al “Catastrophic cascade of failures in interdependent networks” Nature 2010
Where are we today?

- Lack of systemic approach: Regulators are left with post-incident reports submitted by the operators
- No consensus on metrics and measures
- Just started scratching the surface on assessing interdependent reliability
Measurements to understand the infrastructure

Test implementations to see how we can utilize that knowledge in practice
Three approaches for measuring communications infrastructures

Crowd sourcing

Operators’ logs

Dedicated measurement setup
- Over one hundred dedicated measurement nodes all over Norway

- connected to 4 UMTS and 1 CDMA networks in Norway
System overview

Measurement servers

Management and data repository

Measurement nodes

Visualization
NNE is characterized by a set of key features that make it suitable for assessing robustness.

Reproducible continuous measurements

Capture time evolution

Rich metadata
Robustness and reliability need to be assessed at multiple levels.

User experience

Performance (download speed)

Useful connection (can use VoIP)

Data connection (can send packets)

Registration in the network

Baltrunas, Elmokashfi, and Kvalbein “Measuring the reliability of mobile broadband networks” IMC 2014
Our framework identified sub-optimal configurations in one of the measured networks

Baltrunas, Elmokashfi, and Kvalbein “Dissecting packet loss in mobile broadband networks from the edge” Infocom 2015
The geographic spread of our nodes helps differentiating local, regional and global failures.

Baltrunas, Elmokashfi, and Kvalbein “Dissecting packet loss in mobile broadband networks from the edge” Infocom 2015
Measurements from the edge can sometimes reveal outages not seen by operators.
Leveraging multi-connectivity enhances connection-stability significantly

Baltrunas, Elmokashfi, and Kvalbein “Measuring the reliability of mobile broadband networks” IMC 2014
National infrastructure for experimental network research
A few takeaways

- Continuous end-to-end measurements are crucial for assessing the reliability and robustness of communication infrastructures.
- Measuring and reporting on live infrastructures and systems trigger a very dynamic process that eventually lead changing the properties and structure of these networks.
- More efforts are needed for standardizing measurement metrics and methodology.
MONROE is taking NorNet to the European stage

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Key next steps

Assessing interdependence between networks

Better metrics and coverage

Theoretical foundations?
Please help us increasing NNE’s footprint

Email me at ahmed@simula.no if you can host a node