



Dependability Modelling and Analysis for Network Evaluation – *An Example of Co- operations between Q2S and UNINETT*

Qitao Gan

qitao.gan@Q2S.ntnu.no

Centre for Quantifiable Quality of Service in Communication Networks,
Norwegian University of Science and Technology, Norway

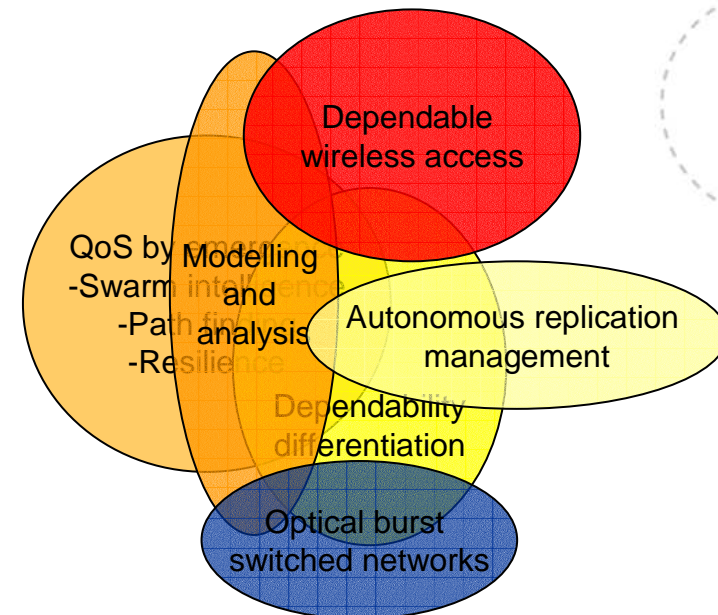


Outline

- Related research at Q2S
- Objectives of my research
- Cooperation with UNINETT
- Discussions

Related Research at Q2S

- Area, International co-operation:
 - Trustworthy Multiparty Interactions in Dynamic Networking Environments
 - EU FP6 Network of Excellence: EuroNGI, WP.JRA.3.3 / 2.3
- Dependability research activities:
 - QoS/network management by emergent techniques
 - Modelling and analysis
 - Dependable wireless access
 - Autonomous replication management
 - Burst switch optical networks



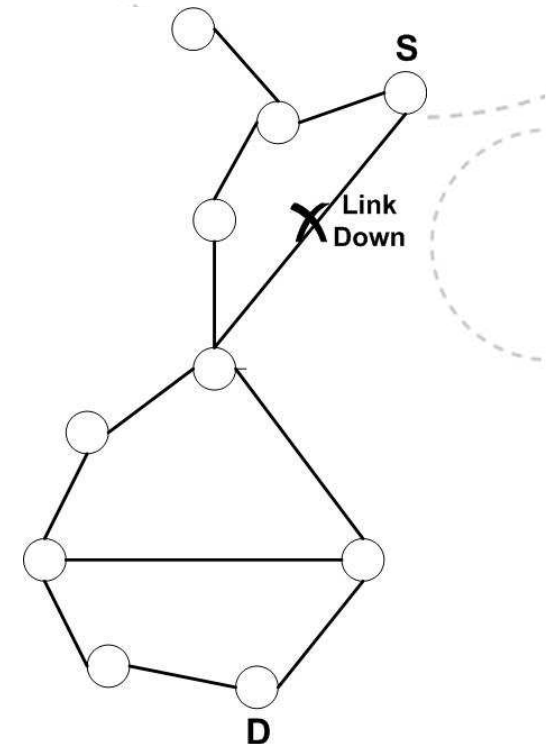
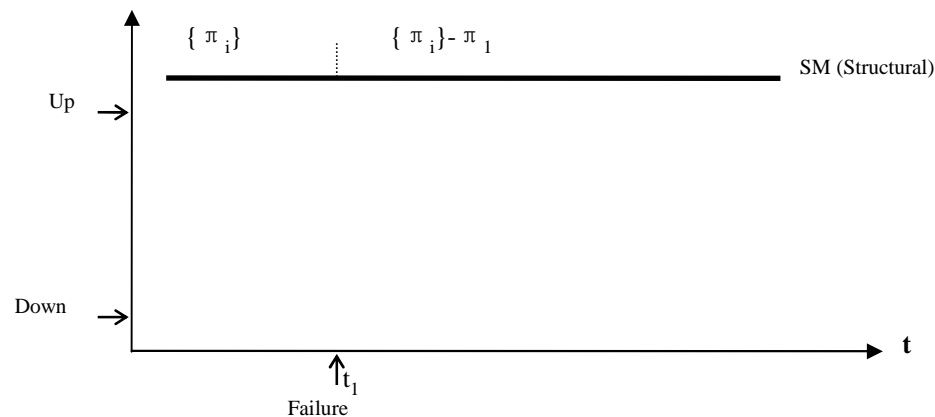
Objectives of My Research

- Investigate the effects of operational dynamics of the network to dependability, e.g.
 - Dynamics: routing, traffic load, resilience mechanisms, user requirements, ..., etc.
 - Measures (beyond connectivity): capacity, time delays, constraints, ..., etc.
- Propose a systematic methodology for quantitative dependability evaluation
 - For modelling, analysis, and tradeoffs
- Validate the applicability of the methodology for making realistic evaluations
 - Case studies

Investigation of Dynamics (1/4)

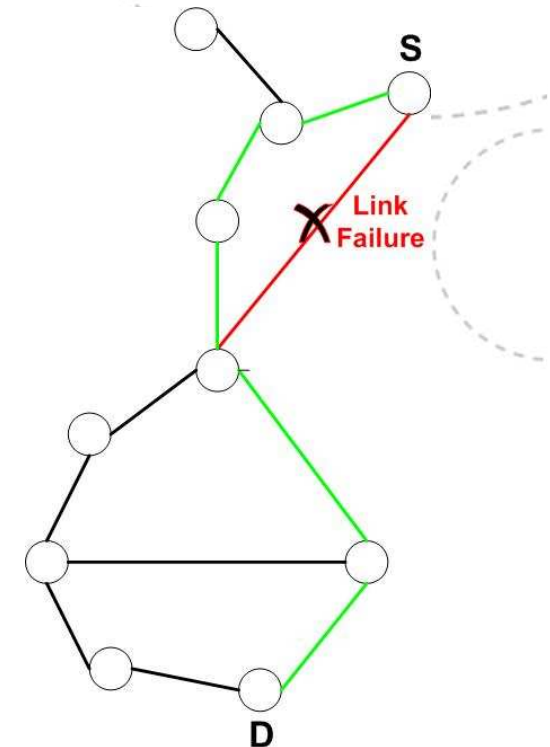
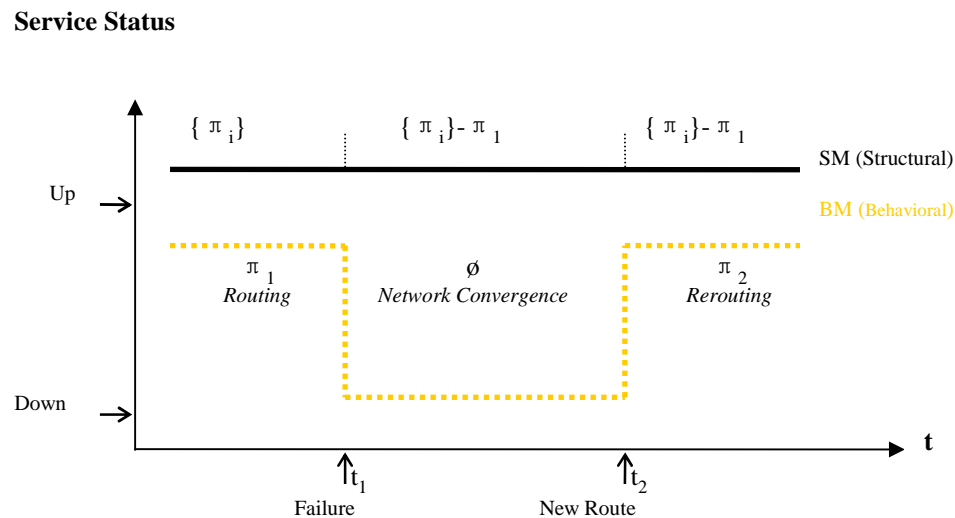
- Component failures/repairs
 - Network topological changes
 - Connectivity changes
 - Route/path changes
 - Unavailability ← “ *no connectivity* ”

Service Status



Investigation of Dynamics (2/4)

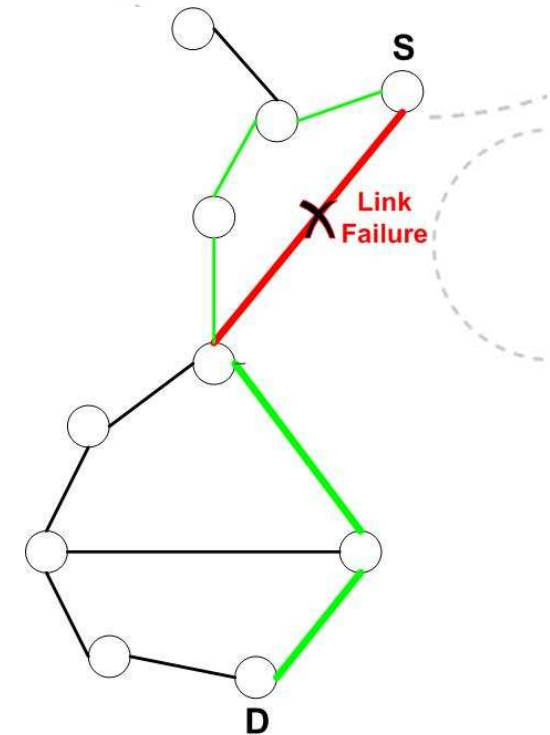
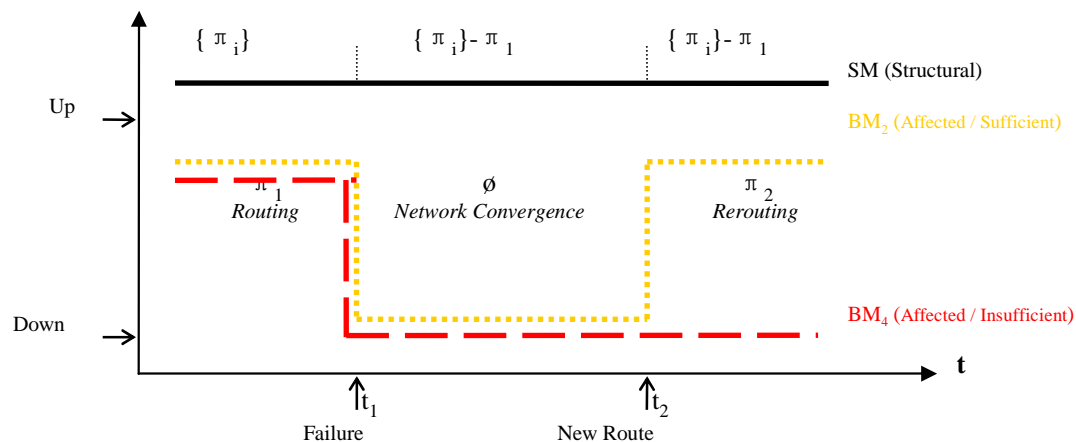
- Recovery techniques
 - e.g. Rerouting, protection schemes
 - Network convergence time
 - Unavailability ← “*recovery time delay*”



Investigation of Dynamics (3/4)

- Resource management
 - Routing (patterns)
 - Using dedicated/shared resource for recovery
 - Capacity constraints: limited
 - Unavailability \leftarrow “insufficient resource”

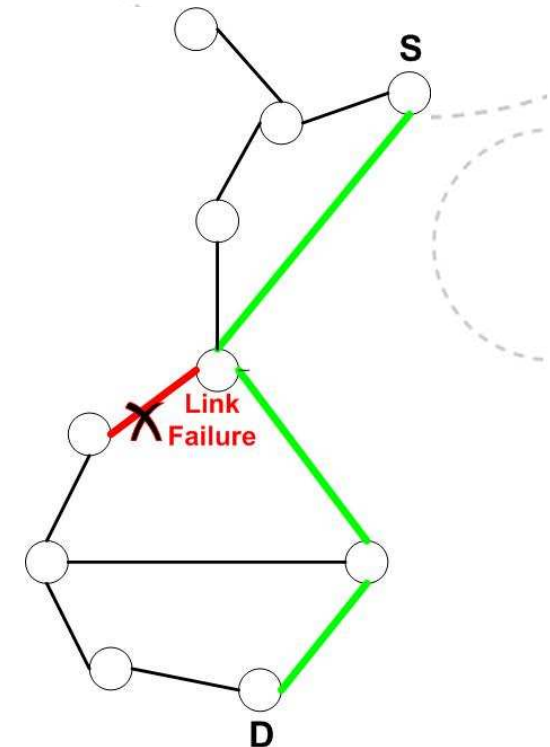
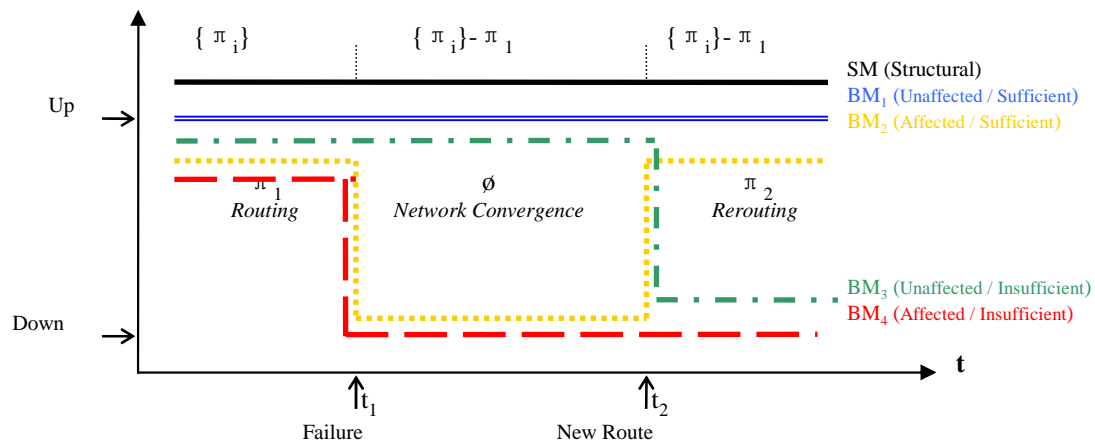
Service Status



Investigation of Dynamics (4/4)

- Quality of Service (QoS) tolerance
 - User/service specific traffic requirements (SLA)
 - Differentiated QoS/dependability
 - Different tolerance: packet loss, delay, etc.
 - Unavailability \leftarrow “insufficient QoS”

Service Status

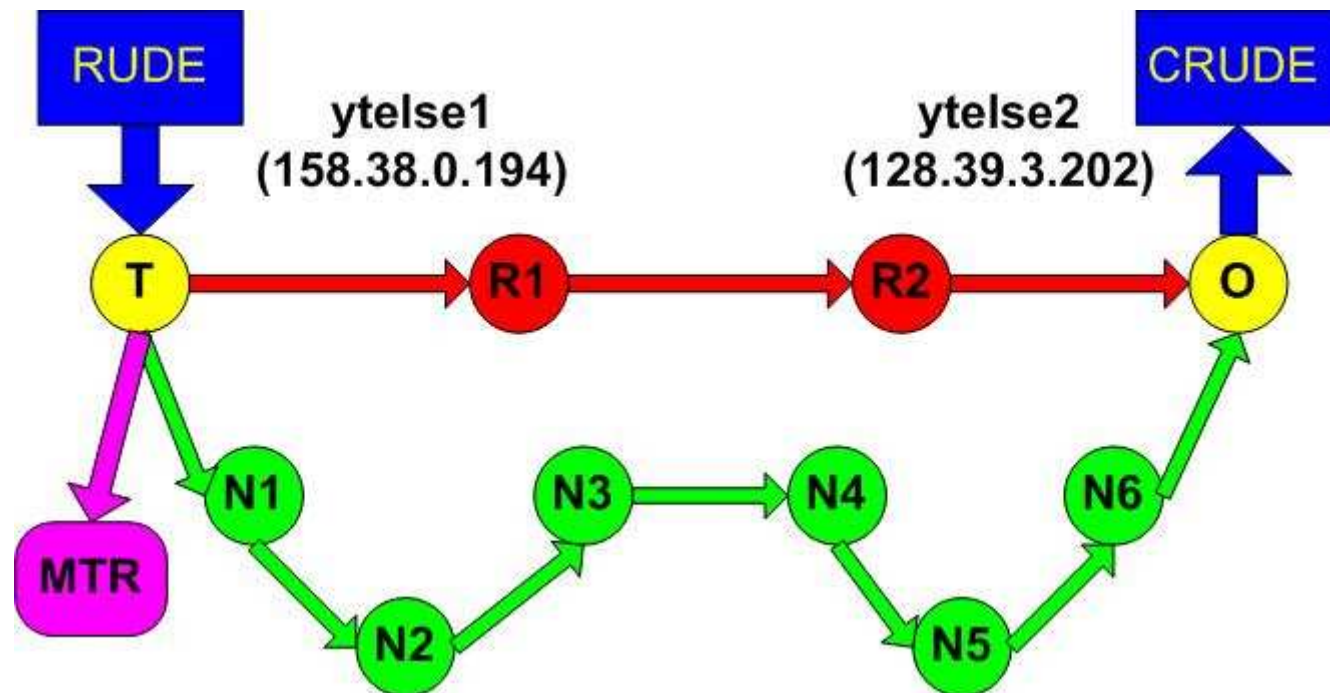


Cooperation with UNINETT

- Operational data support
 - Statistics: component failure/repair, traffic flow
 - Network configuration data: routing, capacity
- Routing measurement
 - Network convergence time
- Network dependability evaluation
 - Real case: UNINETT IP backbone, with IS-IS/OSPF rerouting
 - Fictitious scenario: UNINETT IP backbone, with *swarm based PBP protection*
 - A comprehensive case study: inclusion of node failures in a multi-layer network environment
- Future plan
 - Monitoring of fault handling

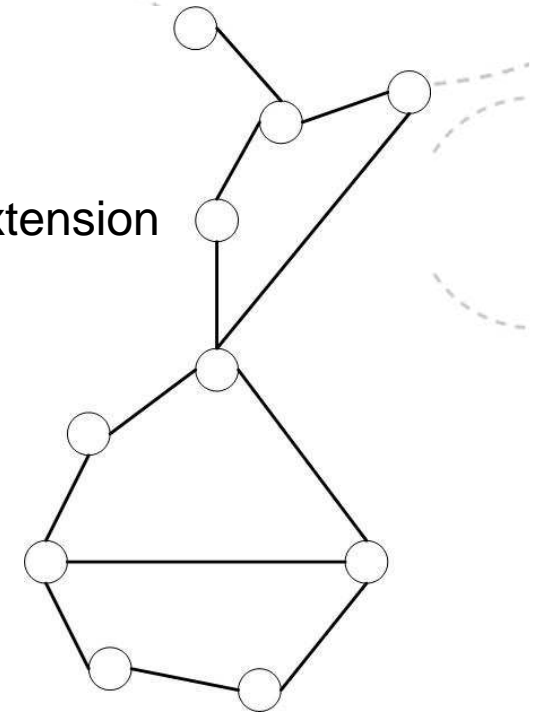
(1) Routing Measurement

- *A first trial to obtain network convergence characteristics (with simple efforts)*



(2) Network Dependability Evaluation

- Norwegian Univ. IP Backbone network
 - Real data used
- Modelling
 - Stochastic Activity Networks (SAN): Petri Nets extension
 - Dynamics: (re)routing, traffic handling, recovery
 - Results: by state limiting, bounding method
- Dependability Evaluation
 - End-to-end service availability measure
 - Fast converged results
 - Compared to connectivity measure



For more details/references, please contact me.

Discussions

- *For a better co-op between academic research (univ.) and industry (net. operator)*
- To abridge the gap {ideal (model) $\Leftarrow \dots \Rightarrow$ reality},
→ tradeoffs:
 - Model representation vs. complexity
 - Result accuracy vs. computation efforts
- Insights gained from the investigation of dynamics:
 - Understand effects of network operational dynamics
 - Discover more hiding (unavailabilities) in reality
 - Make realistic assumptions in modelling
- Network Dependability Evaluation
 - Different perspectives
 - Quantitative analysis for tradeoff-making
- Monitoring of Fault Handling
 - For better understandings/insights of the networks



The End

Any Questions or Comments?

References:

- Limiting state space explosion: NNRS'05 talk
 - Norwegian Network Research Seminar
- Modelling with routing and traffic: NGI'06 paper
 - EuroNGI Conference on Next Generation Internet
- Primary-backup paths protection: Draft paper
 - 1 paper submitted
- Reliability models of resilient networks: D.WP.JRA.3.3.3
 - EuroNGI technical deliverable
- Routing Measurement: No. 2005-01-R
 - Q2S technical report

See also: annual reports at

<http://www.q2s.ntnu.no/>