A Framework to Quantify Network Resilience

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Introduction

- Network resilience
  - critical to meet service requirements
  - lack of rigorous and consistent evaluation methods
  - requires computational metrics
  - inherently complex problem
- Research objectives
  - characterize networks using fundamental properties
    - physical properties, data traffic, and service expectations
  - quantify operational and service aspects using metrics
  - compare resilience mechanisms
  - design and engineer networks with higher resilience

Network Characterisation

- Operational metrics $N$
  - quantify the operational state from network properties
  - probability distributions capture network dynamics
  - e.g. link connectivity, traffic load
- Service parameters $P$
  - quantify service using numerical functions
  - based on application/user requirements
  - e.g. response time, service request failures
- Network state $S$
  - discrete sets of oper. metrics and service parameters
  - aggregation limits number of states

Problem Formulation

- Network state is a tuple $(N, P)$ of
  - operational metrics
  - service parameters
- State transitions
  - due to challenges
  - local perturbations
  - inter and intra state
  - severity of events
- Multi-level approach
  - At any abstraction level
    - operations and service can be defined

Resilience Evaluation

- State-space framework
  - divide operational and service space in to regions
  - plot states based on
    - network design
    - experimentation
    - monitoring
- Resilience measures
  - time in acceptable region
  - graceful degradation
  - state recovery
  - transition trajectory
  - steady state resilience

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