SICS Center for
Networked Systems

Managing network resources and disturbances

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SICS

Network management

- Growing network issues
  - Increasing size
  - Complexity
  - Dynamism
  - Heterogeneity
- New approach to network management needed
- Manual intervention needs to be replaced by self-management

Managing network resources and disturbances

- One out of four projects within CNS 2010-2012; critical component of the centers *Reliable Internet* vision
- Addresses issues within the *Self-management of networks and systems* focus area
- Three general objectives,
  - Development of more efficient traffic measurements
  - Development of robust anomaly detection and disturbance management techniques
  - Creating methods for fully autonomous resource management

Issues in self-management

- Today's solutions are often centralized, configuration is not changed frequently
- Future management techniques must manage
  - Scalability (millions of elements)
  - Rapid configuration (highly dynamic state, adapt configuration continuously, respond to disturbances)
- Management solutions must be
  - Autonomous and self-adaptive
  - Robust
  - Highly controllable
  - Easily configured

General approach

- Decentralized, distributed, and self-organizing solutions (scalability and robustness)
  - Embedding management intelligence into the network
- Probabilistic, learning systems (adaptive, robust, and easily configured)
  - Manage uncertainty and noise, adapt to changing conditions
- Intelligent policy management (controllable, easily configured)
  - Translate high-level objectives to low level parameter settings

Monitoring and disturbance detection

- Detecting anomalous network entities
  - Amongst large numbers of alarms and notifications, which entities and event types stand out?
  - Probabilistic, adaptive approach
  - Anomaly detection on alarm logs from base stations
  - Scalability issues
- Distributed service monitoring
  - Detection and localization of network or service faults or disturbances
  - Distributed, localized statistical models, node cooperation
  - Scalable, robust, and easily configurable

Capacity and root-cause analysis

- Measuring available capacity
  - BART, our patented algorithm for measuring available capacity
  - Objective means of comparing capacity measurements
  - Is BART optimal? Are other methods better?
  - Scalability of active measurements
- Root cause analysis and causal structure
  - Event correlation for root-cause analysis
  - Correlate events on different (virtual) layers
  - SLA compliance monitoring

Resource management

- Robust routing optimization
  - Balance load, reliable and predictable services
  - Towards router settings distribution, realize routing optimization as a protocol
  - Scenario: Multiple peering-points in mobile access networks
- SLA management
  - Ensure consistent policies
  - Translate high-level policies to network parameters
  - Traffic prioritization in mesh networks
    - Mobile units, varying bandwidth, varying content
    - Prioritize between traffic using combination of SLAs, network level priorities, network optimization
    - SLA format, mapping SLAs to network settings

Self-configuration of cellular networks

- UE localization in cellular networks
  - Set up and manage cellular networks without manual configuration
  - Method using statistical models
  - Network self-organization
- Cellular networks will
  - Require much less manual configuration
  - Make more efficient use of network resources
  - Be possible to deploy rapidly in e.g. disaster areas

Summary

- Self-management is critical for the future Internet
- Working on problems selected together with industry
- Several of our solutions are being put to use in industry and are being patented
- We are now opening up new research areas