On Using Peer-to-Peer Technology for Decentralized Detection of Service Level Agreement Violations

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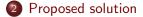**31st NMRG meeting (Zürich, Switzerland), October 2013**

Outline

Problem definition

- Service level requirements of critical networked services $\rightarrow$ critical concern for network administrators
  - Services expected to operate respecting associated Service Level Agreements (SLAs)
- Active measurement mechanisms (*e.g.*, Cisco IPSLA, IETF OWAMP/TWAMP) are the prime choice for SLA monitoring
  - Measurement probes distributed along the network to inject synthetic traffic and deliver the SLA metrics
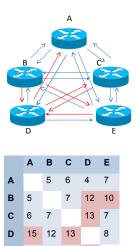
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- Active measurement mechanisms (*e.g.*, Cisco IPSLA, IETF OWAMP/TWAMP) are the prime choice for SLA monitoring
  - Measurement probes distributed along the network to inject synthetic traffic and deliver the SLA metrics
- Active measurement is expensive $\rightarrow$ CPU cycles, memory footprint, human resources
  - Monitor all connections is too **expensive** $\rightarrow$ combinatorial explosion
  - Fast reactions required to reconfigure probes if critical flows are too short in time and dynamic in terms of traversing network paths
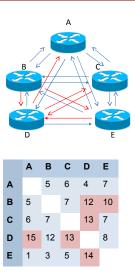
Problem definition

Best practice

- Distribution of the available measurement probes along the network considering available data (*e.g.*, NetFlow records)
- Collection of measurement and traffic information to infer which are the best locations to activate probes

	A	**B**	**C**	**D**	**E**
A		5	6	4	7
B	5		7	12	10
C	6	7		13	7
D	15	12	13		8
E	1	3	5	14	

Problem definition

- **Too difficult and labor intensive**
- **Inefficient considering fast changing network environments**
- **# of detections constrained by the # of available probes**

	A	B	C	D	E
A		5	6	4	7
B	5		7	12	10
C	6	7		13	7
D	15	12	13		8
E	1	3	5	14	

Our Approach

- Utilization of Peer-to-Peer (P2P) technology embedded in network devices to improve probe activation decisions.
  - Network device programmability (*e.g.*, Cisco onePK and EEM, Juniper Junos Script Automation)
- Inspiration $\rightarrow$ network administrators' common sense when using active mechanisms to detect SLA violations
- Solution goals
  - Adaptive to changes in network conditions
  - Independent of the underlying active measurement technology
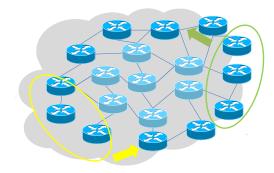 - Requires no human intervention.
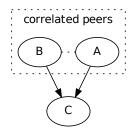
Proposed Solution

Principles

- Past service level measurement results to prioritize destinations
- Correlated peers to provision the management overlay
- Coordinated measurements to optimize resource consumption

- Principles materialized through **probe activation strategies**
  - Definition of how (local and remote) information is used to infer the destinations that are more likely to violate the SLA and, therefore, should be monitored
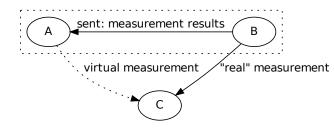
Correlated Peers → P2P Management Overlay Provisioning

- Two nodes considered as correlated peers (correlation is symmetrical) if their measurements for a given destination (or a set of destinations) are correlated
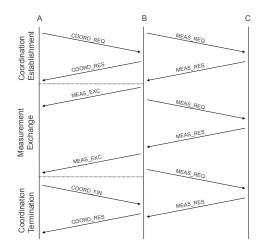
Coordination strategy and measurement probe placement

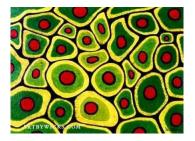# Coordination strategy and measurement probe placement

Coordination protocol

Probe Activation Strategies

- Random strategy
  - Only resource constraints (baseline)
- Local strategy
  - Locally-colected past service level measurement
- Local and remote strategy
  - Received and locally-colected past service level measurement
  - Correlated peers
- Coordinated strategy
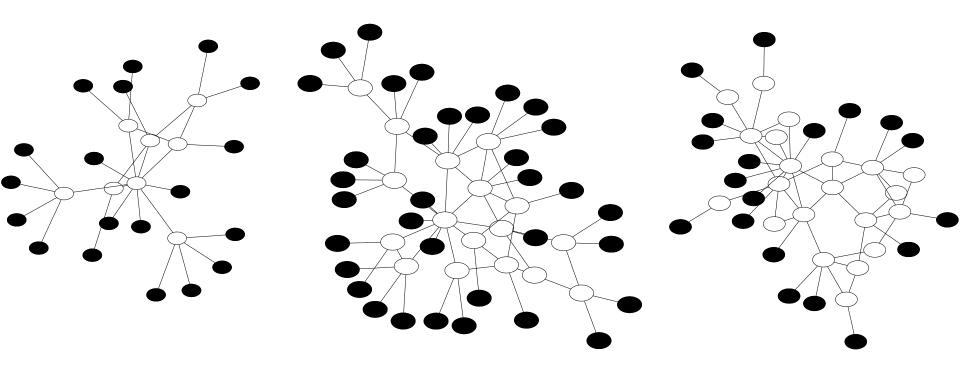 - Coordinated sharing of measurement results

Evaluation

Simulation Experiments
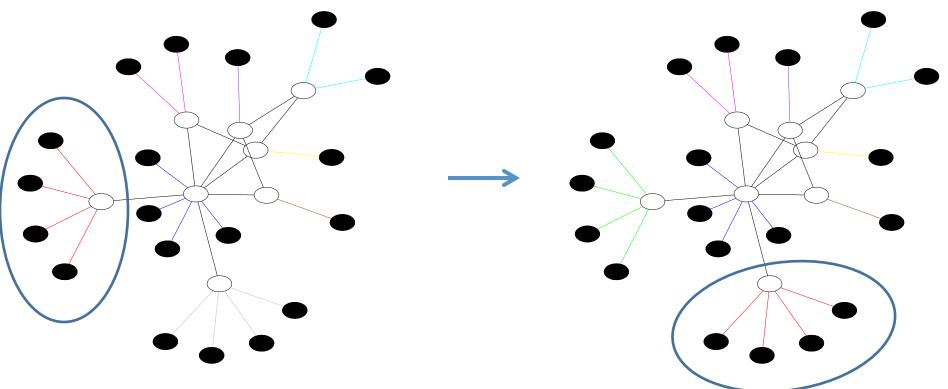
- PeerSim - open source P2P event-based simulator
- Synthetic and infered topologies
- # of detected SLA violations vs. changes on violating links $\rightarrow$ adaptivity

- CNSM'12 - local strategy, local and remote strategy
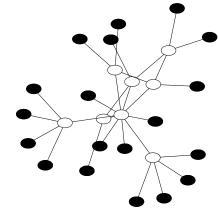- ICC'13 - coordinated strategy

Selected Topologies

Hot A   Hot B   Rocket A
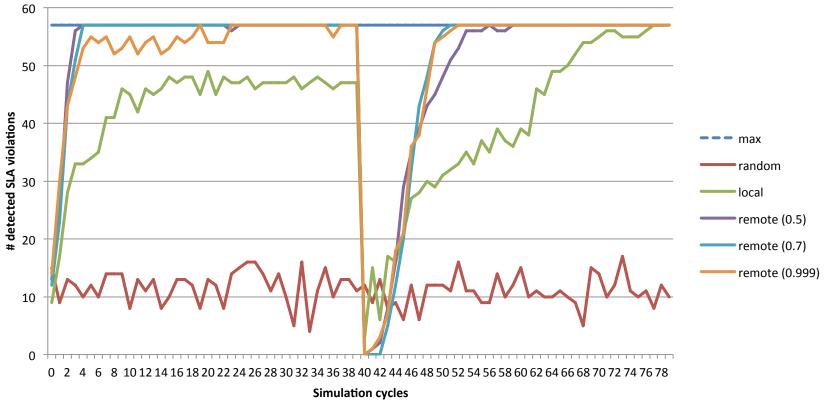
Different delays for different branches
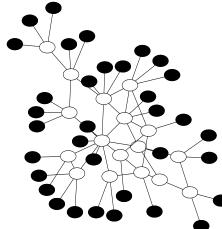

* Red links are the ones that violate the SLO

Hot A

Number of detected SLA violations

Legend:
- **max** (dashed blue)
- **random** (red)
- **local** (green)
- **remote (0.5)** (purple)
- **remote (0.7)** (teal)
- **remote (0.999)** (orange)

X-axis: **Simulation cycles**
Y-axis: **# detected SLA violations**

Hot B

Detected SLA Violations - Topology Hot B

Legend:
- ······ max
- ——— random
- ——— local
- ——— remote (0.5)
- ——— remote (0.7)
- ——— remote (0.999)

X-axis: **Simulation cycles**
Y-axis: **# detrected SLA violations**

Rocket A

Detected SLA Violations - Topology Rocket A

Legend:
- ...... max
- — random
- — local
- — remote (0.5)
- — remote (0.7)
- — remote (0.999)

X-axis: Simulation cycles
Y-axis: # detetec SLA violations

Outlook

Ongoing Work

Use of traffic information $\rightarrow$ destination relevance

- Selection of candidate nodes
    - Improve the bootstrapping of P2P management overlay
- Prioritization
    - Detect SLA violations that impact more users and/or heavy ones

Future Work

- Different topologies and network conditions
- Composite measurement tasks through cooperation
- Prototype implementation using Software-Defined Networking (SDN) equipment

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Thanks for your attention! Questions?