Power Aware Networks (PANET): problem statement and requirements

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The Problem

- Increasing energy consumption of network infrastructures
  - More network devices: routers, switches, …
  - Devices are more power-hungry.
- Impacts
  - Power delivery, Cooling
  - Financial and environmental
  - Limiting system performance and future growth
- In ISPs, IXPs, data centers, enterprises, …

The Opportunity

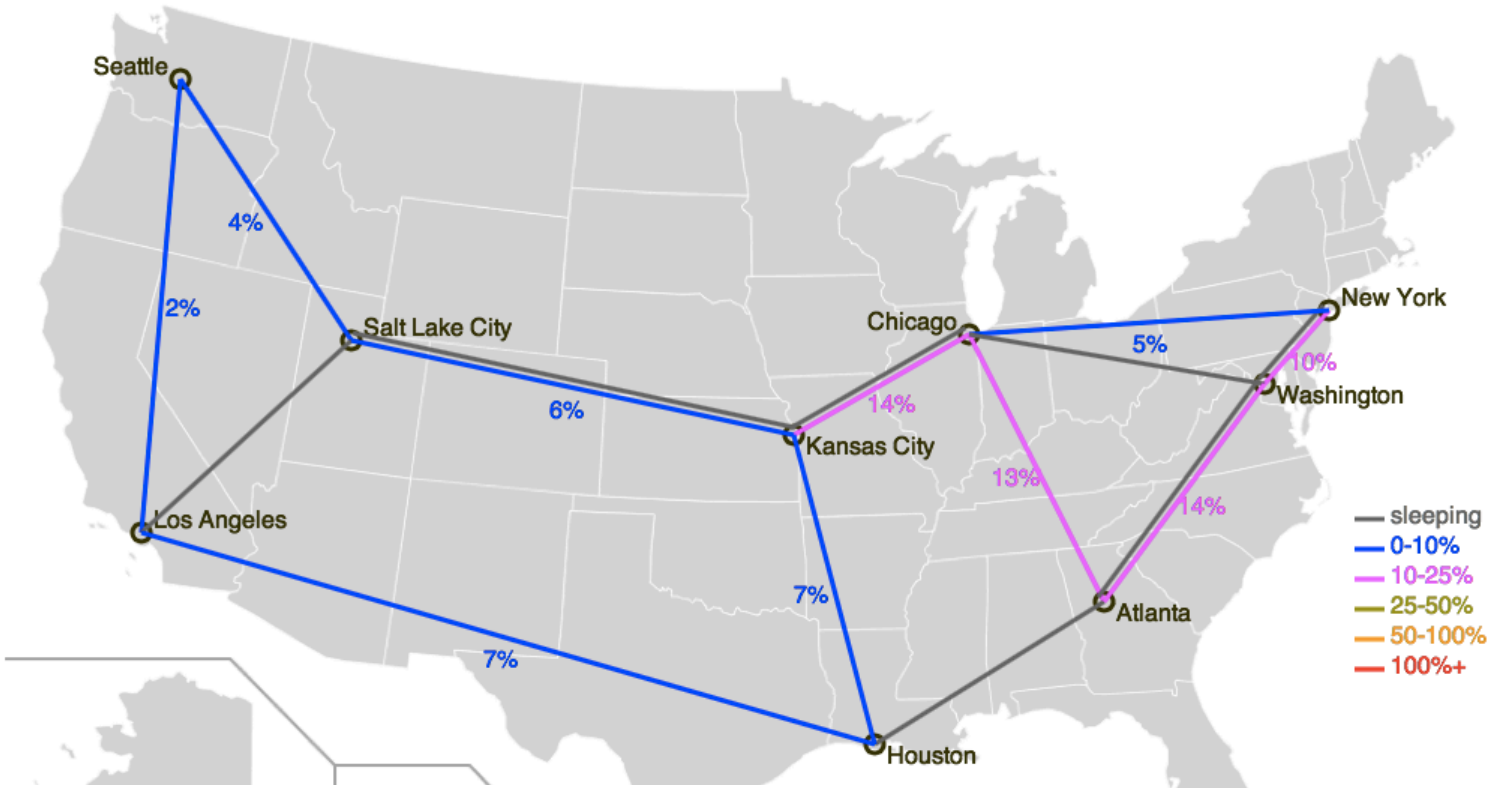
- Networks have lots of redundancy
  - Redundant links and nodes
  - Overprovisioned link capacity
  - Load-balancing traffic engineering
- Average link utilization is low but all devices are running at full capacity all the time.
  - High resiliency, low energy efficiency.
- Need a better tradeoff between the two.

Solutions

- More energy-efficient hardware components
- Better energy management mechanisms
  - E.g., Energy Efficient Ethernet (IEEE 802.3az)
    - Allow a link to go Low Power Idle or even deeper sleep.
    - Keep the link alive and remain the same speed.
- At Layer-3
  - Coordinate forwarding workload to give lower layers more chance of saving power network-wide.
    - E.g., aggregate traffic onto fewer links, to save standby power of others.
    - GreenTE web demo: http://greente.65536.cn

GreenTE Web Demo

GreenTE demo



optimize | opt | read TM | TM 1 | TM 2 | TM 3

from \ to	Seattle	New York	Chicago	Atlanta	Washington	Los Angeles	Houston	Kansas City	Salt Lake City
Seattle		23021	34985	23550	37237	101388	14438	15810	17162
New York	0		41611	59480	59942	44426	16893	46917	7587
Chicago	0	77570		58857	647666	47046	25419	212506	109936
Atlanta	0	107539	14181		66905	150941	39251	17232	4162
Washington	0	334980	211549	134210		131438	31506	136355	101092
Los Angeles	24080	46791	132406	15896	37328		20761	15586	51219
Houston	0	51716	142463	21616	44745	244136		49326	52413
Kansas City	0	55825	244190	32388	287676	81569	117227		159809
Salt Lake City	153386	46486	66960	26022	47109	7420	31628	32846	

Seattle -> Atlanta

0%	Seattle-Salt Lake City-Kansas City-Chicago-Atlanta
0%	Seattle-Los Angeles-Houston-Atlanta
0%	Seattle-Salt Lake City-Kansas City-Houston-Atlanta
0%	Seattle-Salt Lake City-Kansas City-Chicago-Washington-Atlanta
100%	Seattle-Salt Lake City-Kansas City-Chicago-New York-Washington-Atlanta

Proposed PANET Problem Statement

- Develop power-aware layer-3 mechanisms to improve network energy efficiency.
  - Fully realize lower-layer's energy-saving potential.
  - Satisfy upper-layer's performance requirements.
  - Compatible with other protocols at the same layer.
- Scope
  - Focus on a single domain.
  - What type of networks?
- First steps:
  - Understand router's power consumption model
  - Understand the technology and trends
  - Problem statement, framework, low-hanging fruit.

Dependency/Assumption

- Lower layer's energy-saving mechanisms and parameters
  - E.g., wakeup time, shutdown time, transition cost, link alive or not, durability, granularity of power control, etc.
- Power status of network elements.
  - E.g., EMAN.

Requirements

- Maintain network resiliency
  - Node/link failures, congestion, etc.
  - FRR mechanisms?
- Satisfy QoS
  - Delay, jitter, etc.
- Compatible with other protocols.
  - Work properly when only a subset of network elements are in power-saving mode.
- Support operational policies.
- Understand the impacts on network operation and management.

Comments?