SDN seminar 2018
Traffic engineering
You own this.
It runs here.
A data centre is ...
The network system
The network

• Set of network devices connecting compute and storage

• Purpose: move traffic from A to B according to management policies
The network

- A real deployment
What functionality do we need to move data around?
Traffic forwarding: the Data plane

Packet processing

• Classify incoming traffic
• Look up forwarding instruction
• Send packet to outgoing port
Traffic forwarding: conventional switch

- Use mac address to decide on forwarding
- Learns its attached clients (mac address)
- Simply forwards packets
Traffic forwarding: conventional switch

- Crossbar switching
Traffic forwarding: conventional router

- Use IP address to decide on forwarding
- Learns interfaces (IP address-to-port) during configuration
- Modifies packet header
Traffic forwarding: SDN switch

- SDN separates the data and control plane
- Routing is an application
- Simplified (cheaper) switch design
- More flexible control (per-flow decisions)
Forwarding decisions: the Control plane

• How to classify packets
  • Which header fields to use?

• Which path to take in the network (routing criteria)
  • Quality of Service routing
  • e.g. shortest path, fastest path, with most bandwidth

• Higher-level policies
  • Policy-based routing
  • e.g., pass through a firewall, pass server S first, spread traffic
Control plane: routing criteria

• Shortest path based on link cost (OSPF protocol)
  • A link has a cost $C_i$
  • A path has a cost equal to $\Sigma C_i$ over all links belonging to the path
  • Typical costs in distributed protocols: 1 (hop count), link capacity
Control plane: routing criteria

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- Pro’s:
  - Simple to implement

- Con’s:
  - Static (does not adapt to traffic needs)
  - Disbalanced use of link capacity (no multipath)
Traffic engineering

A method of optimizing the performance of a network by dynamically analysing, predicting and regulating the behaviour of data transmitted over that network.
Control plane: routing criteria

• Link cost in SDN can represent
  • Hop count: link cost of 1
  • Delay: propagation delay (or round trip time)
  • Error: bit error rate experienced on the link
  • Bandwidth: total link capacity, occupied bandwidth or residual bandwidth

• Topic: Bandwidth-constraint routing
Control plane: traffic policy

- Different categories of traffic need different treatment
  - security policies through firewalls and deep packet inspection (DPI)
  - address mapping through network address translation (NAT)
  - processing policies for content delivery, e.g., image recolouring, parental control

- Steering based on traffic classification
  - Waypointing: go through node X
  - Isolation: omit passing node Y
  - Redundancy: use multiple paths
Path redundancy

- Physical topology offers multiple paths between a source and a destination
- Shortest path is inefficient in network resource
Path redundancy

- Routing with load balancing
  - Uses multiple paths
  - Increases processing capacity

- Example:
  - Four paths between s and x
  - Spread traffic via hashing on headers

- Topic: Load balancing
Control plane: congestion management

• A link can belong to multiple paths
  • Capacity is shared among paths
  • Congestion may occur

• Possible solutions
  • Congestion prevention: explicit admission control
  • Congestion prevention: monitor traffic and rate limit sources
  • Congestion mitigation: monitor traffic and drop excess

• Topics: Congestion control, Heavy hitters, Traffic shaping
Data collection

• Network control is based on data on actual traffic and on administrator defined policies.
• How to collect data?

• Control plane statistics: at control applications
• Data plane measurements: at switches
• Edge measurements: at end hosts

• Topics: Monitoring
Other important aspects

- **Correctness**: does the network operate as expected
- **Pricing strategies**: who to bill and how to bill?