Dynamic Virtual Network Embedding (Re-Embedding)

Andreas Blenk
andreas.blenk@tum.de
Motivation

- Users demand for different types of services and content, e.g., (Video, Office Applications, etc.)
- Data of different services still transmitted on best effort basis
- Current architecture called to be ossified
- Virtualization helped address myriad problems [1]

Motivation

• SP demands service specific topology
• SP manages virtual resources according to service demands
• Virtualization allows to innovate, e.g., wide area multicast IPTV [1]

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Virtual Network Embedding algorithms optimize resource allocation (Utilization, QoS)

Most embedding algorithms assume static virtual network demands

But VN demands should change over time → Re-Embedding
Re-embedding Problem Formulation

- InP has to re-embed VNs (Re-Embedding)
- Leads to Reconfigurations (Link migrations, Node migrations)
- Find an embedding that avoids reconfigurations
- Our solution: Assume knowledge about traffic patterns (future demands)
Sandvine – Global Internet Phenomena Report

Streaming for Gold
How the U.S. watched the 2012 Summer Olympics online

- Gymnastics: Women’s observations. Jordyn Wieber falls to make the final.
- Swimming: Men’s 400m individual medley. Ryan Lochte wins gold.
- Swimming: Women’s 100m butterfly. Missy Franklin wins 3rd of 4 golds.
- Swimming: Men’s 200m individual medley. Phelps and Lochte win gold and silver.
- Swimming: Men’s 100m butterfly. Anchor Phelps threepoints.
- Athletics: Men’s 4x100m relay. Michael Phelps’ last race.
- Athletics: Men’s 100m final. Usain Bolt wins gold in 9.63s.
- Beach Volleyball: Women’s gold medal match. USA1 vs. USA2.
- Athletics: Men’s 4x100m relay. Usain Bolt wins his 3rd gold of 2012.

What devices were being used to stream in the home?
- PCs: 71.8%
- Tablets: 23.6%
- Smartphones: 4.6%

The most popular sports were:
- Athletics
- Swimming
- Gymnastics

Closing Ceremonies: Were live streamed.

Traffic Pattern-based Virtual Network Embedding

• Traffic Patterns
  – Based on spatial and temporal user behavior
  – Periodically repeating
  – Partly predictable

• Impact of reconfigurations depends also on technology
  – Link migrations in MPLS Networks [1]
  – Controller migrations in OpenFlow based Networks

• Investigation of different embedding algorithms
  – Pure load balancing (PLB)
  – Load balancing + Considering reconfiguration (LR)
  – Load balancing + Considering reconfiguration + Knowledge about demand progress (TP)

Simulation Setup for a Proof of Concept

- Physical Network
  - 12 Nodes
  - 14 Links
  - Unlimited Link Capacity
  - Unlimited Node Capacity

- 6 Virtual Networks
  - 6 to 12 Virtual Nodes
  - No Node Demands
  - Link Demands vary randomly from 4 to 200

- 75 Runs

Optimization Objective: Balanced Link Load + Avoiding Link Migrations
First Simulation Results (1/2)

- Equal solution in terms of utilization
- TP and LR decrease link migrations

First Simulation Results (2/2)

- Setup: Accepting 5% higher link utilization
- Improves amount of reconfigurations
Summary and Outlook

- Virtualization offers more flexibility but may introduce additional reconfiguration overhead

- First re-embedding approach based on traffic patterns
  → Assume to have knowledge about future demands

- First simulation results
  - Minimize reconfigurations, i.e., virtual link migrations
  - Algorithm does not diminish network utilization
  → Potential for further improvements

- Outlook
  - Integrate missing constraints (Capacity, Real Patterns)
  - Integrate uncertainty into the patterns
  - Analyze reconfigurations according to use case/architecture (SDN)
  - Focus on control plane architectures considering reconfigurations
Questions?

Thank you!