

End-to-End Lightpaths

...in the Smallest University of the Netherlands

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Contents

- Introduction
 - What is the Smallest University?
- Analysis
 - How is path configuring done now?
 - Is there a human problem?
- Solutions
 - How Policy Based Routing may help
 - How a generic switch configuration tool may help
- Conclusion

Smallest University?

- A customer of a NREN typically is a university
- The Smallest University of The Netherlands is the smallest “customer” of SURFnet
- We set up a path between two computer labs for System & Network Engineering in Amsterdam and Oslo
- What problems do you run into?
- How can we create an end-to-end path?

Ideal solution vs. reality

- Ideally there would be an Inter Domain Manager, Domain Manager and technology proxy for the university network, but...
- In reality there is no domain management software
- VLAN's with or without QoS over dedicated fiber/copper are used
- There are some SNMP-based configuration tools created by vendors, but CLI is favorite

Typical university network

- Not a single (administrative) domain
- LAN – MAN – NREN - NREN – MAN - LAN
- Centrally managed MAN between locations
- This MAN is homogeneous (e.g. Cisco only)
- Locally managed faculty and lab LAN's
- LAN's are heterogeneous (mixed brands)
- The Authentication, Authorization and Accounting protocol for paths is email

“got root?”: a human problem

- Network administrators have enable passwords
- There are a lot of domains in the university network and a lot of network administrators
- Network administrators want full control of the configuration of their network devices
- Network administrators do not see the need for a higher complexity of their network
- Network administration of the LAN's is done informal, no network maps, no documentation

Lightpaths or light paths?

- “Stitching” network technologies together
- Congestion free, low latency, point-to-point
- Can be on either layer 1, 2 or 3
- ... or no paths at all: over-provisioning

Solutions in the campus

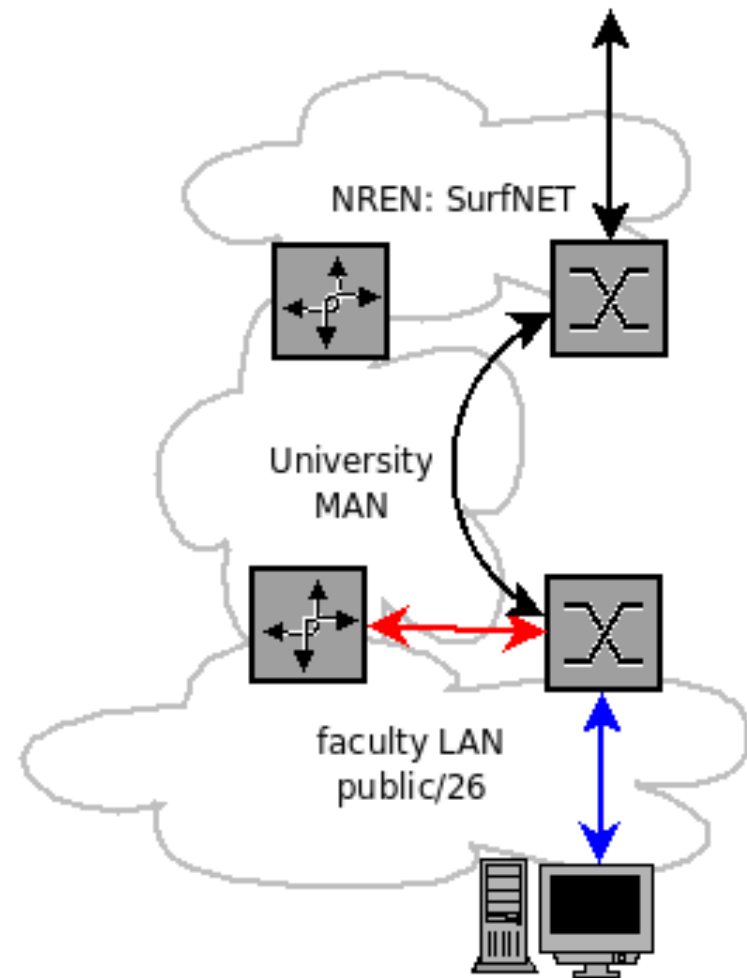
- Layer 1: SDH, SONET, optical interconnects
 - Not yet widely available in the campus
- Layer 2: VLAN's and Ethernet bridge routing
 - VLAN's and QoS are available
 - 802.1X may be set up
- Layer 3: IP source based routing and QoS
 - Policy based routing may be available

QoS vs. over-provisioning

- “It isn't clear to me that it is more expensive to over-provision bandwidth in a backbone than to deploy QoS in that backbone. Some folks here seem to be asserting that it is generally cheaper to deploy QoS.” -- RJ Atkinson
 -
 - (April 2001 on the end2end mailing list)

Network topology

- Arrows are VLAN's (with enough bandwidth or QoS)
- Blue scenario VLAN to the desktop
- Red scenario Source based routing combined with VLAN's



Policy based routing

- Policy based routing can provide QoS
- Source based routing can blend paths in
- Source based routing is just policy based routing with “source” as a policy
- Traditional routing protocols do not configure source based routes
- Label switching may not be available in the universities LAN's
- Static source based routing can be improved

Route Selection Algorithm

```
if packet.routeCacheLookupKey in routeCache :  
    route = routeCache[ packet.routeCacheLookupKey ]  
else  
    for rule in rpdb :  
        if packet.rpdbLookupKey in rule :  
            routeTable = rule[ lookupTable ]  
            if packet.routeLookupKey in routeTable :  
                route = route_table[ packet.routeLookup_key ]
```

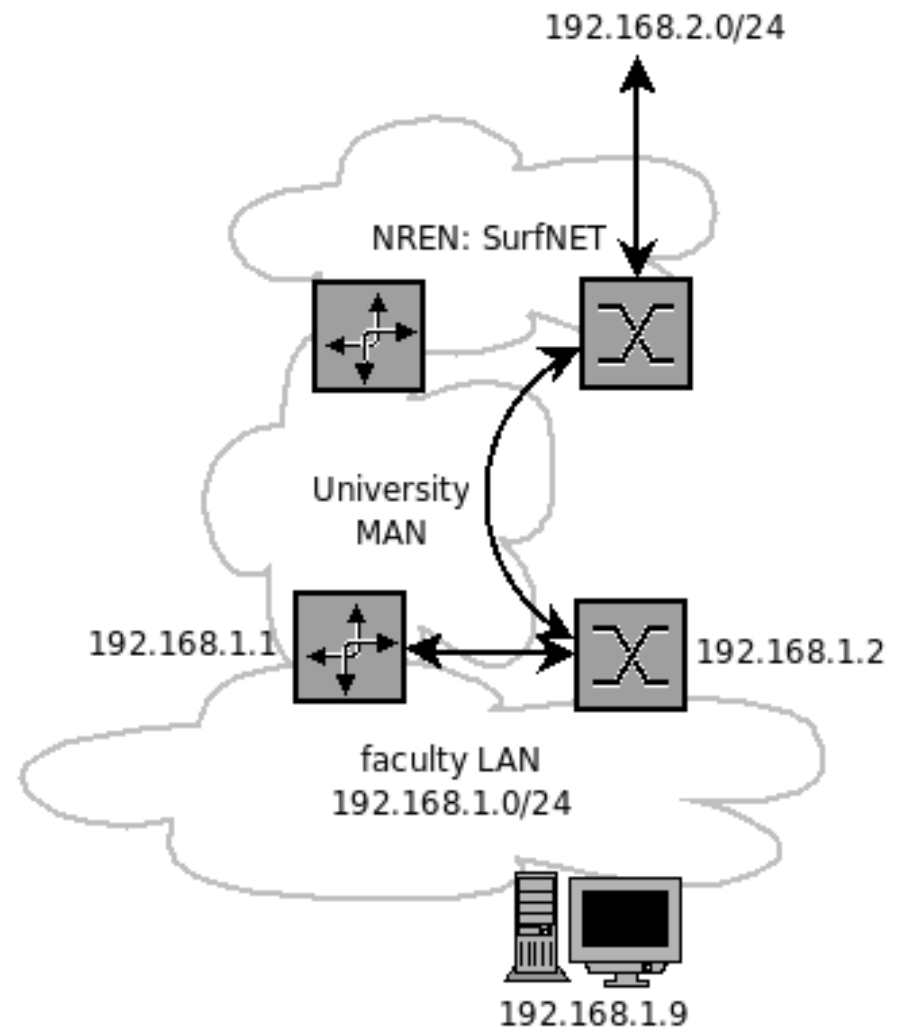
(Example 4.4 - <http://linux-ip.net/html/routing-selection.html#id2550232>)

Simplify Source Based Routing

- Default routing table is for all source networks
- Different routing tables can be defined for more specific networks
- Representation is possible in a single table with an extra column for source network
- Precedence can be on source, destination network instead of only destination network
- Routing cache in Linux (and most routers) already have source address in their tuple

Source Based Routing

- Traffic from host 192.168.1.9 for network 192.168.2.0/24 goes over the path
- Traffic from other hosts for network 192.168.2.0/24 takes the default route



Single routing table

<u>Destination</u>	<u>Gateway</u>	<u>Iface</u>
192.168.1.0/24	*	eth0
0.0.0.0/0	192.168.1.1	eth0

<u>Source</u>	<u>Destination</u>	<u>Gateway</u>	<u>Iface</u>
192.168.1.9/32	192.168.2.0/24	192.168.1.2	eth0
0.0.0.0/0	192.168.1.0/24	*	eth0
0.0.0.0/0	0.0.0.0/0	192.168.1.1	eth0

Generic switch configuration tool

- Software that runs on a server in the network
- Requires managed switches that support SNMP, SSH or Web protocol
- Requires support of port-based VLAN's, trunks and bonds; QoS may help to guarantee bandwidth
- Different brands have different commands for configuration, it should use an abstract configuration language

Requirements

- Aware of network layout
- Can detect network changes
- Trunk reserved / available bandwidth aware
- Can create a graphical network map
- Has a graphical (web) interface to configure it
- May support bridge routers (eatables)
- Manual configuration should be supported

Acceptation requirements

- Must be able work with every brand of switch
- No loss of control, should only propose new configurations, with explanation, and should not execute them by default
- It should help the network administrator to document, map and monitor the network
- It must respect the running configuration, because network administrators must trust this tool

Tasks

- Network description and mapping (using NDL)
- Network connection database (current state)
- Network monitoring (detect network changes)
- Path request database (requested paths)
- Path request server (calculate configuration)
- Provisioning server (effectuate configuration)
- Inter domain controller (handling multi domain requests)

First version

- The system should be build with it's (future) tasks in mind
- Can be released as soon as it complies to all the acceptation requirements
- This system is being build with Virtual Square's VDE: Virtual Distributed Ethernet as a model and test environment (see: virtualsquare.org)
- Next slide is a screen-shot of the web interface of this system (still in production)

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View ▾

- ▶ Routerseiland
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 - ▶ Virtual switch #1
 - ▶ eth0
 - 0
 - eth1

Edit Device

Name:

Location: ▾

IP address:

Administrator: ▾

Device type: ▾

Description:

Save

Cancel

Conclusion

- Simplifying Source Based Routing may help administrators to set up end-to-end lightpaths
- A generic switch configuration tool may help the network administrator to bring the network administration to an acceptable level. This is necessary before we can start to implement automatic configuration
- It is important to gain the trust of the network administrator for automatic configuration to succeed