A Fibre, WDM and Networking project
@
KTH/CSD master program
2009

Explore new ways for infrastructure

Motivation:

- Optical gear affordable
- New techniques like WDM
- Computers very powerful
- Need for communication

Project

Connect two campuses with dark fibre
Network and routing should also be setup
Use WDM if possible with budget

We don't have all optical instruments
Use what we got → PC's and skilled master Students.

Requirements

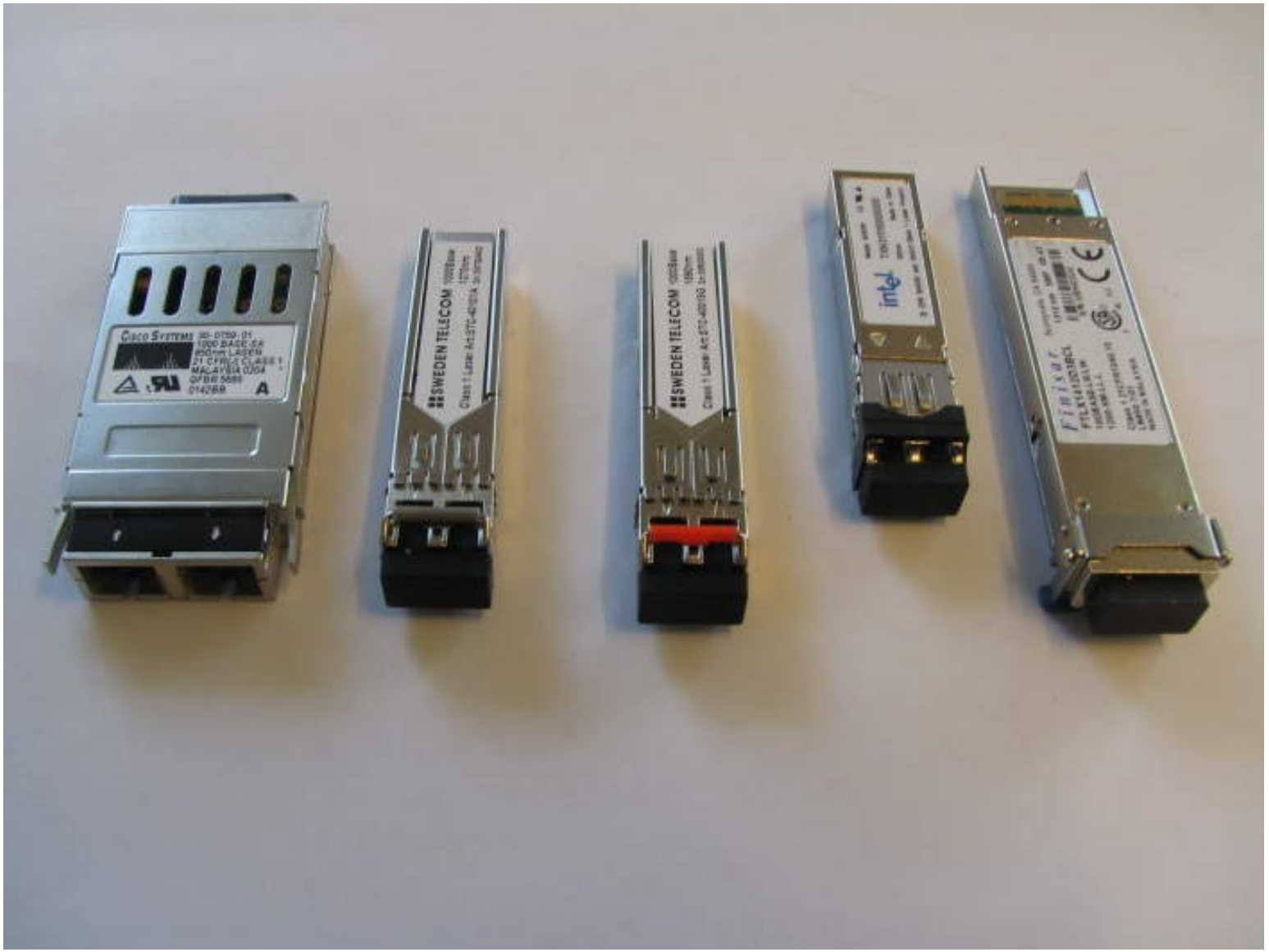
KTH campuses Kista-VV is 10km apart
Fiber distance is 20km
Research project need >1 Gbit/s → 10 Gbit/s
Other applications separate 1 Gbit/s links

Optical Modules

GBIC (older)
SFP Gigabit
SFP+ 10G
X2 10G (older)
XFP 10G

And even more form factors

Optical modules example



Optical Modules

Basic wavelengths 850, 1310, 1550 nm
Different ranges optical budget varies from 300 meter to 16 km

CWDM and DWDM versions available too

Optical Modules

Volume market
Look at ebay
Be aware...
 Some vendors only support their own brand

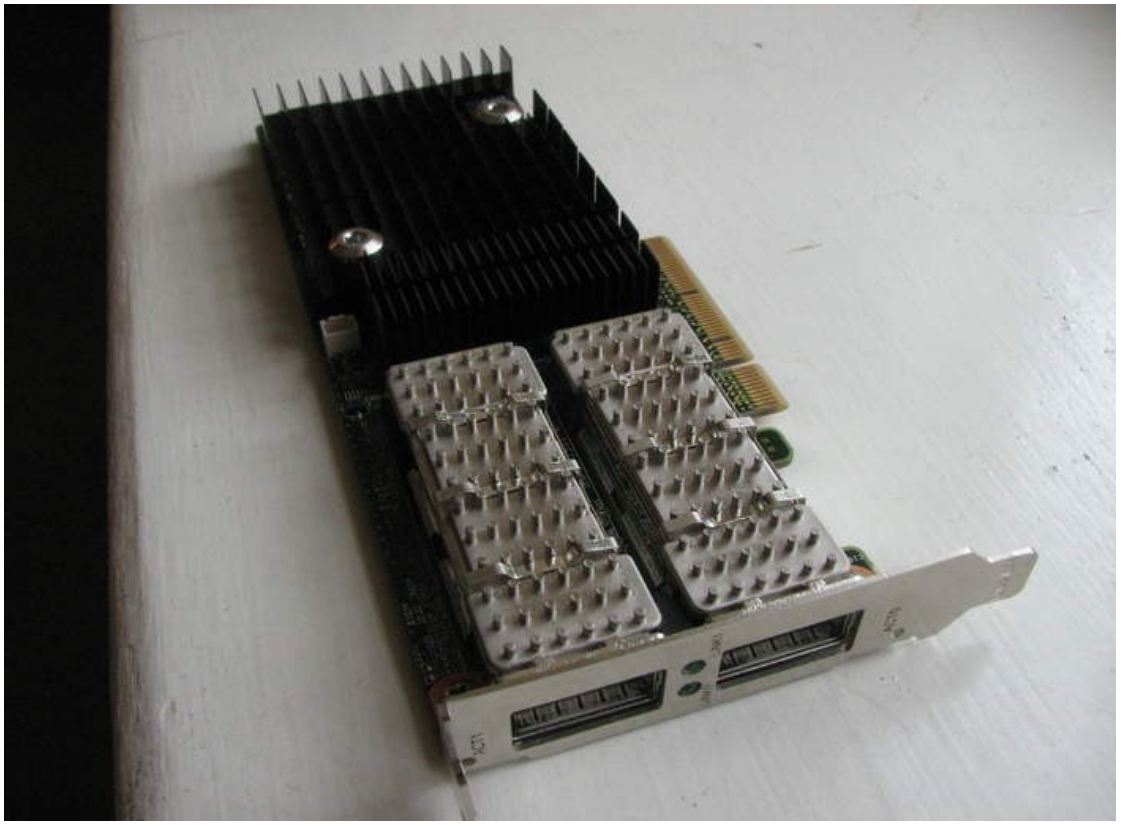
XFP Optical modules

XFP's are 10G and available for Long Range

XFP Optical modules

XFP's uses LC-connectors

XFP Interface Board



SUN Neptune 10g PCIe x8

Optical statistics

Optical related data from I2C bus
(2 pins in the connector)

RX power
TX power
Voltage
Temperature

Also some proprietary data...

Optical statistics

Be aware...

Not all modules supports statistics

Not all optical gear can read out the stats

Optical modules/our choice

XFP module 10 Gbit/s 1310 nm, 10 km Finisar
XFP module 10 Gbit/s 1550 nm, 40 km Finisar
SUN Neptune 10g NIC could host 2 XFP's

Still testing:
SFP cheap even up to 120 km and 160 km
SFP is affordable even for CWDM

WDM

Wavelength Division-Multiplexing

WDM → DWDM and CWDM
Different wavelengths can coexist
CDWM → Coarse WDM
normally 20 nm apart

Can be passive and very cheap

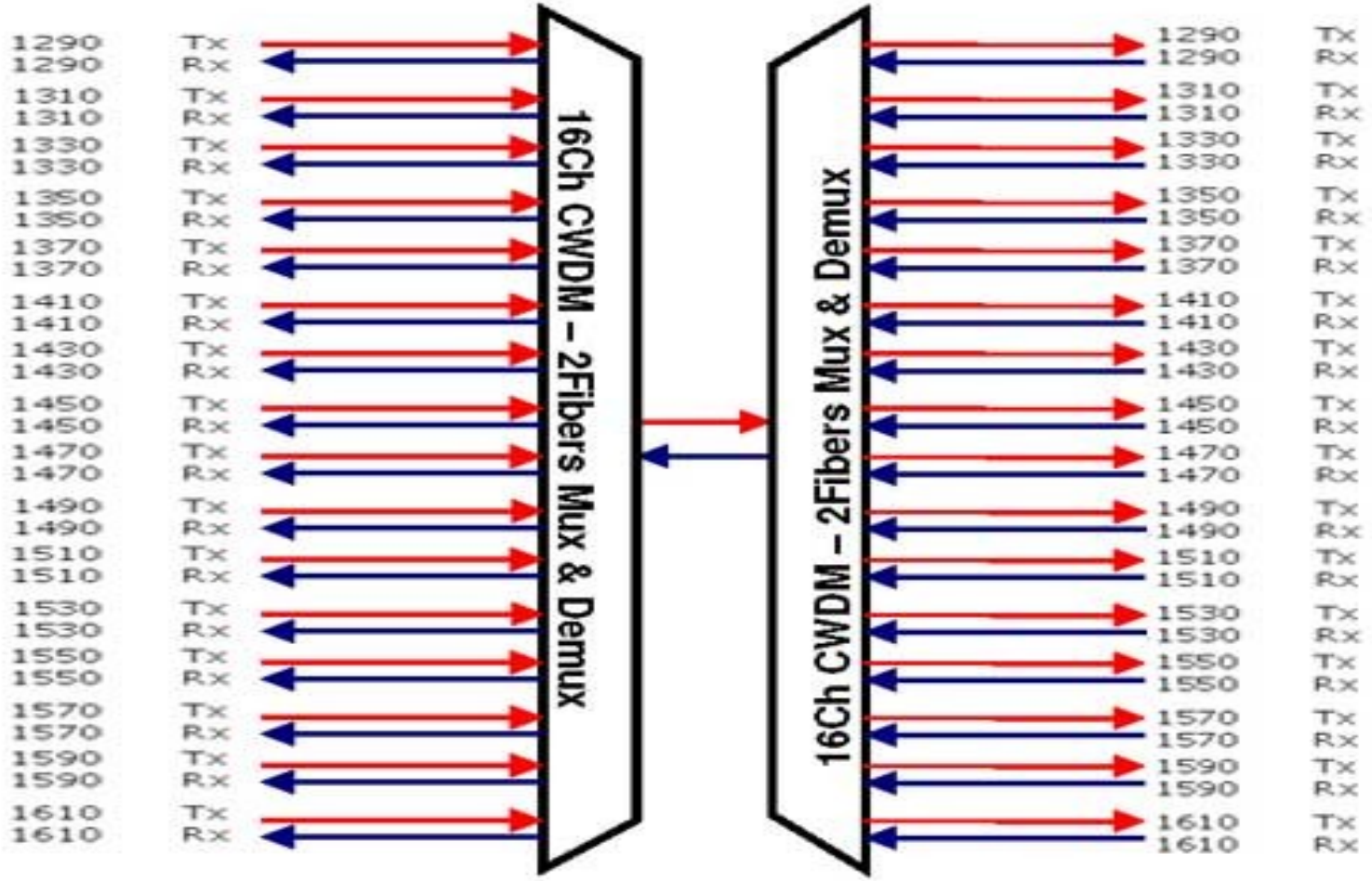
CWDM MUX/DEMUX 4 Ports

Price idea 600 Euro

CWDM MUX/DEMUX 8 Ports

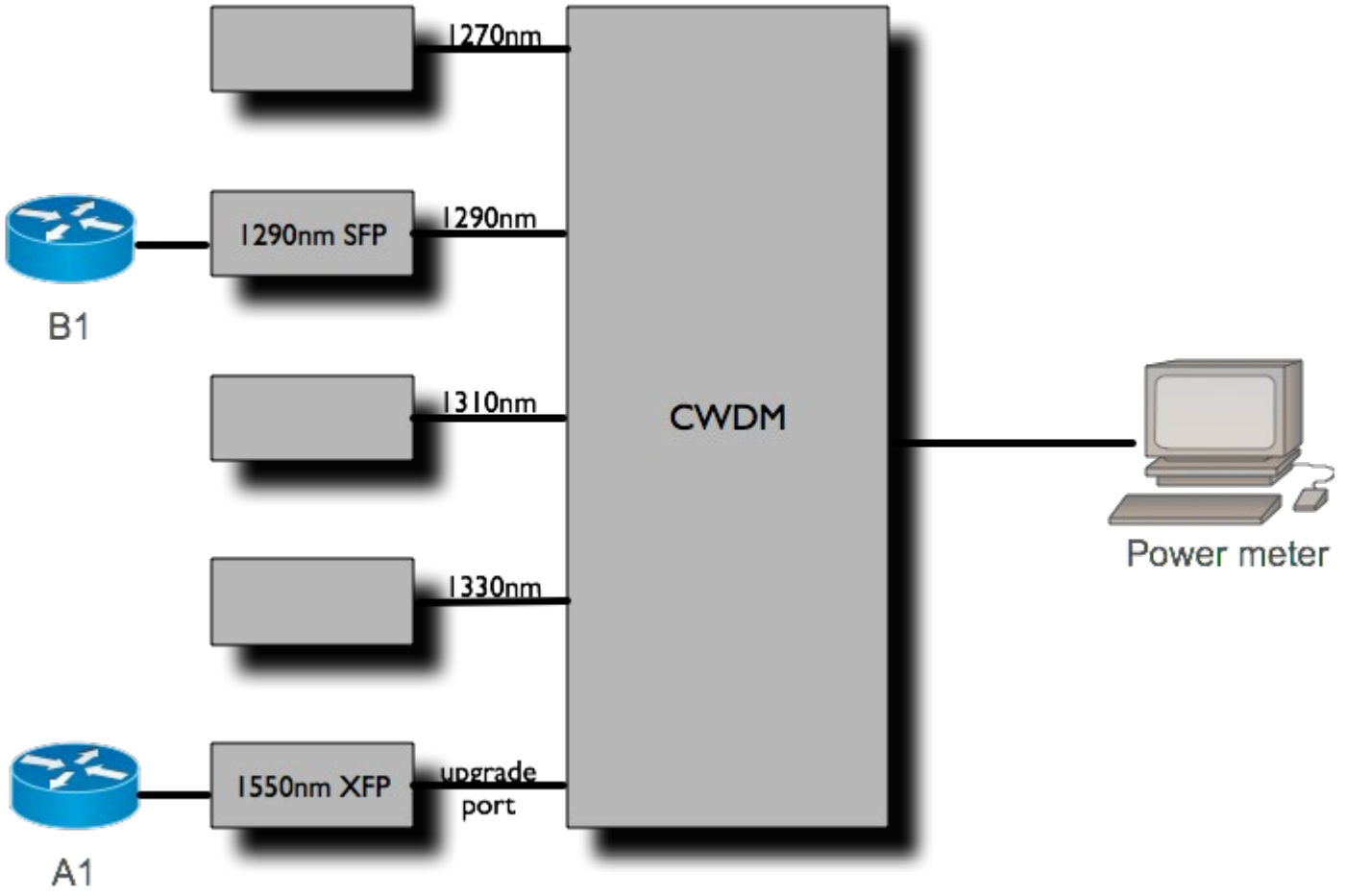
Can be stacked

CWDM MUX/DEMUX 16 Ports

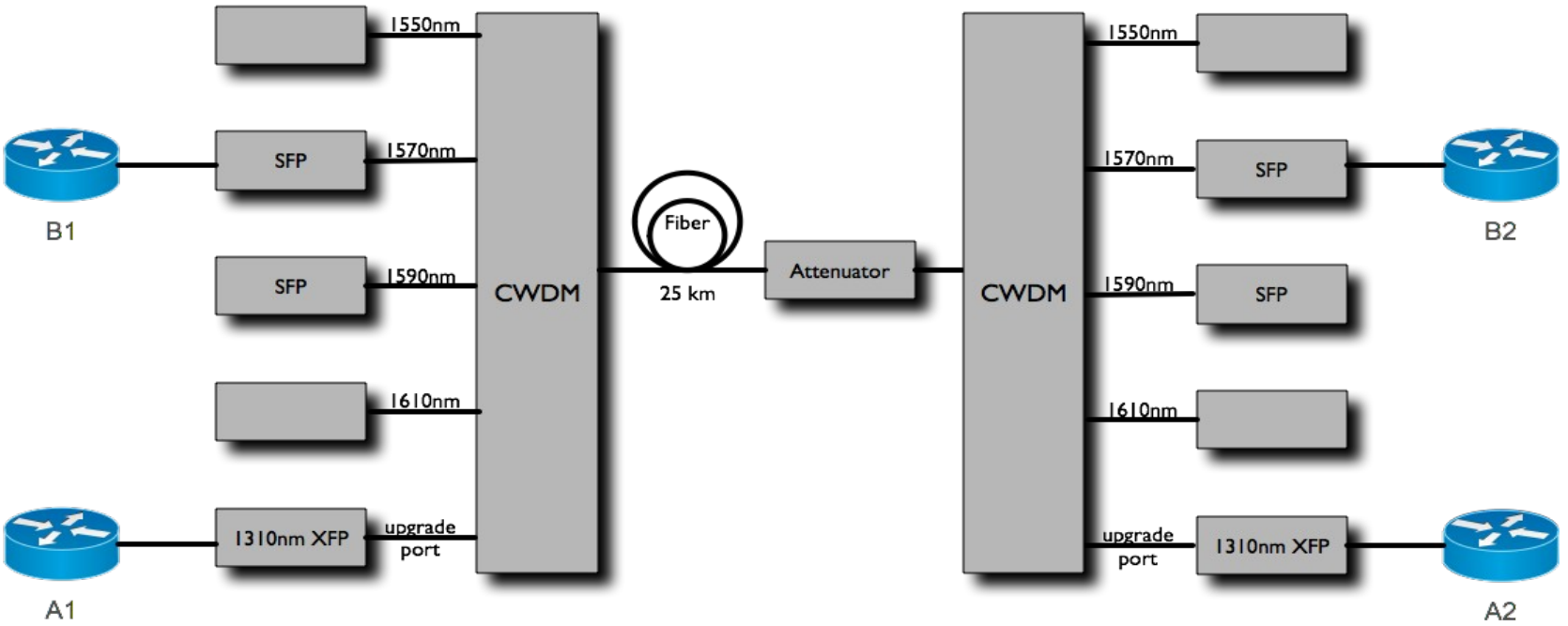


Up to 16 channels

Functional view 1300 nm CWDM



Lab setup and testing



Optical verification and budget by attenuation

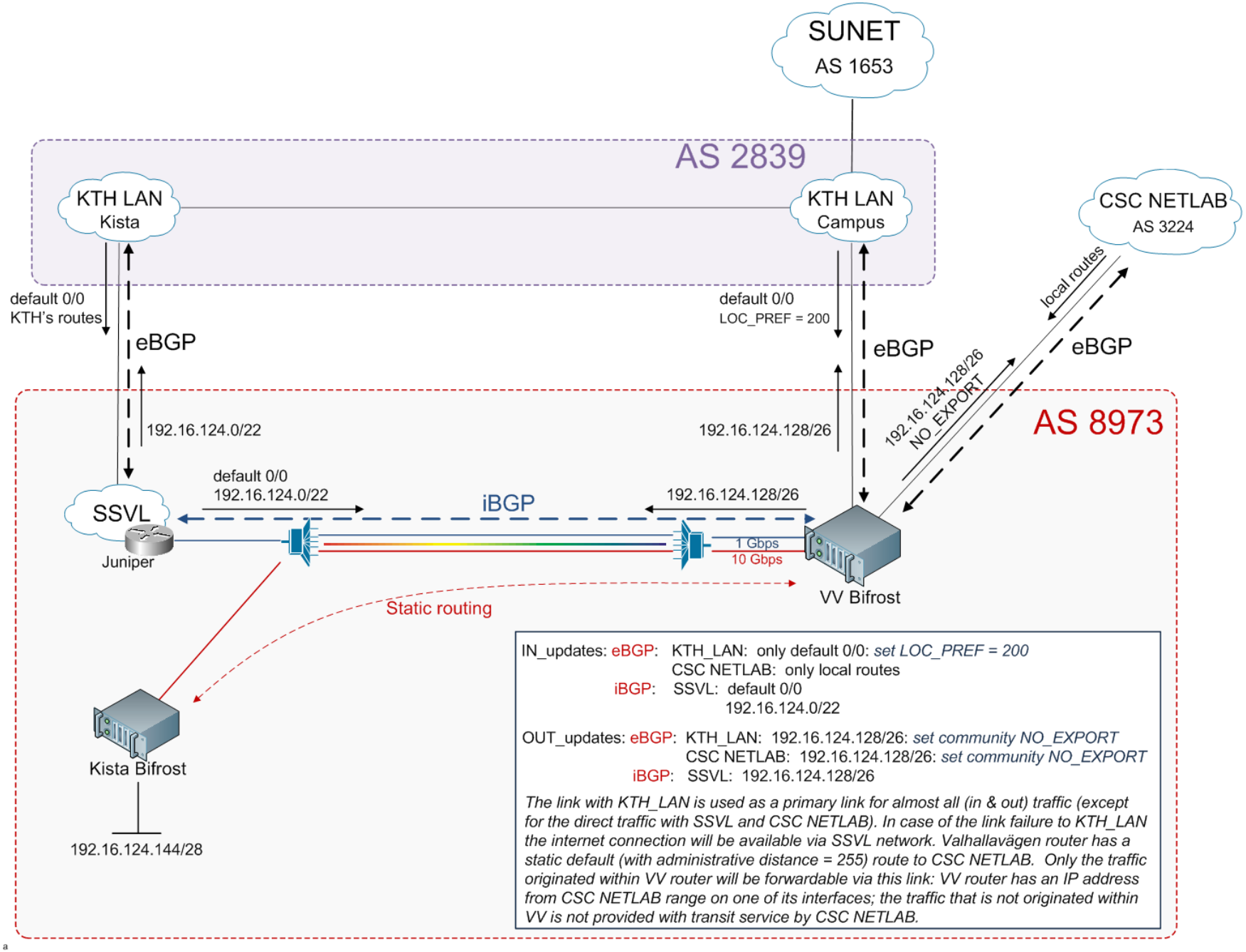
Test#	Attenuators	10Gb/s link Mb/s	10Gb/s link Packetloss	1Gb/s link Mb/s	1Gb/s link Packetloss
1	8dB–5dB	3040	0%	941	0%
2	10dB–11dB	3045	0%	941	0%
3	15dB–15dB	-	100%	941	0%
4	20dB–20dB	-	100%	925	0%
5	25dB–25dB	-	100%	-	100%
6	23dB-23dB	-	100%	-	100%

A method of finding out optical budget by just using fiber attenuators
We use PC/routers to send TCP data for this we use netperf program.

```
netperf -H 10.10.10.2
```

Were 10.10.10.2 is host on the other side of the link. (Which runs Netserver program)

The final result



Price idea

XFP	10G	10km	900 Euro	
XFP	10G	40km	1400 Euro	
SFP	1G	40km	200 Euro	
SFP	1G	80km	250 Euro	
SFP	1G	40km/WDM	250 Euro	
WDM	4-port		650 Euro	(CWDM)

Network Card	1G	4-SFP	PCIe	500 Euro	
Network Card	10G	2-XFP	PCIe	600 Euro	

Report

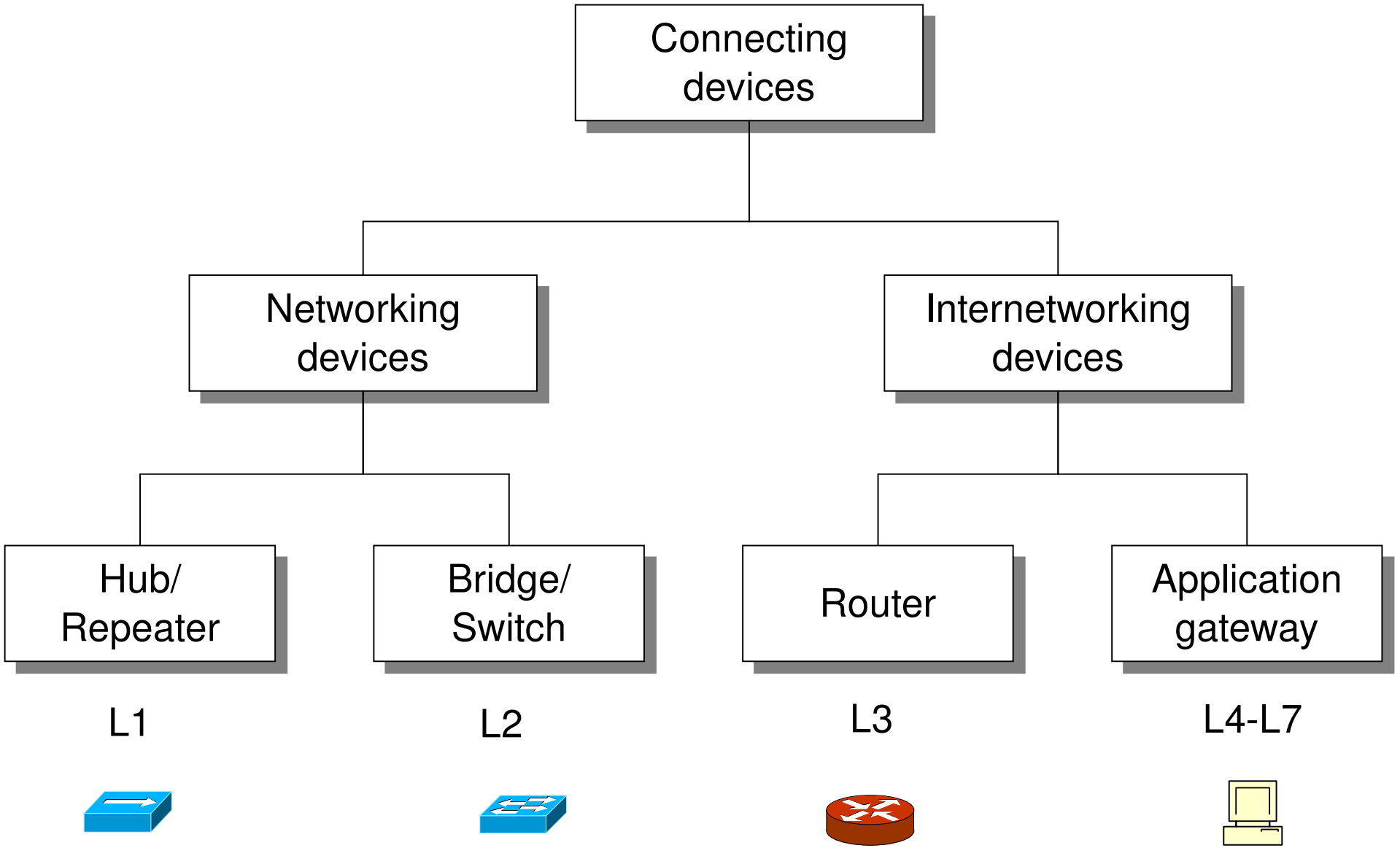
Full report:

http://www.tslab.ssvl.kth.se/csd/projects/0911130/sites/default/files/WDM%20Test%20report-v0.3.pdf

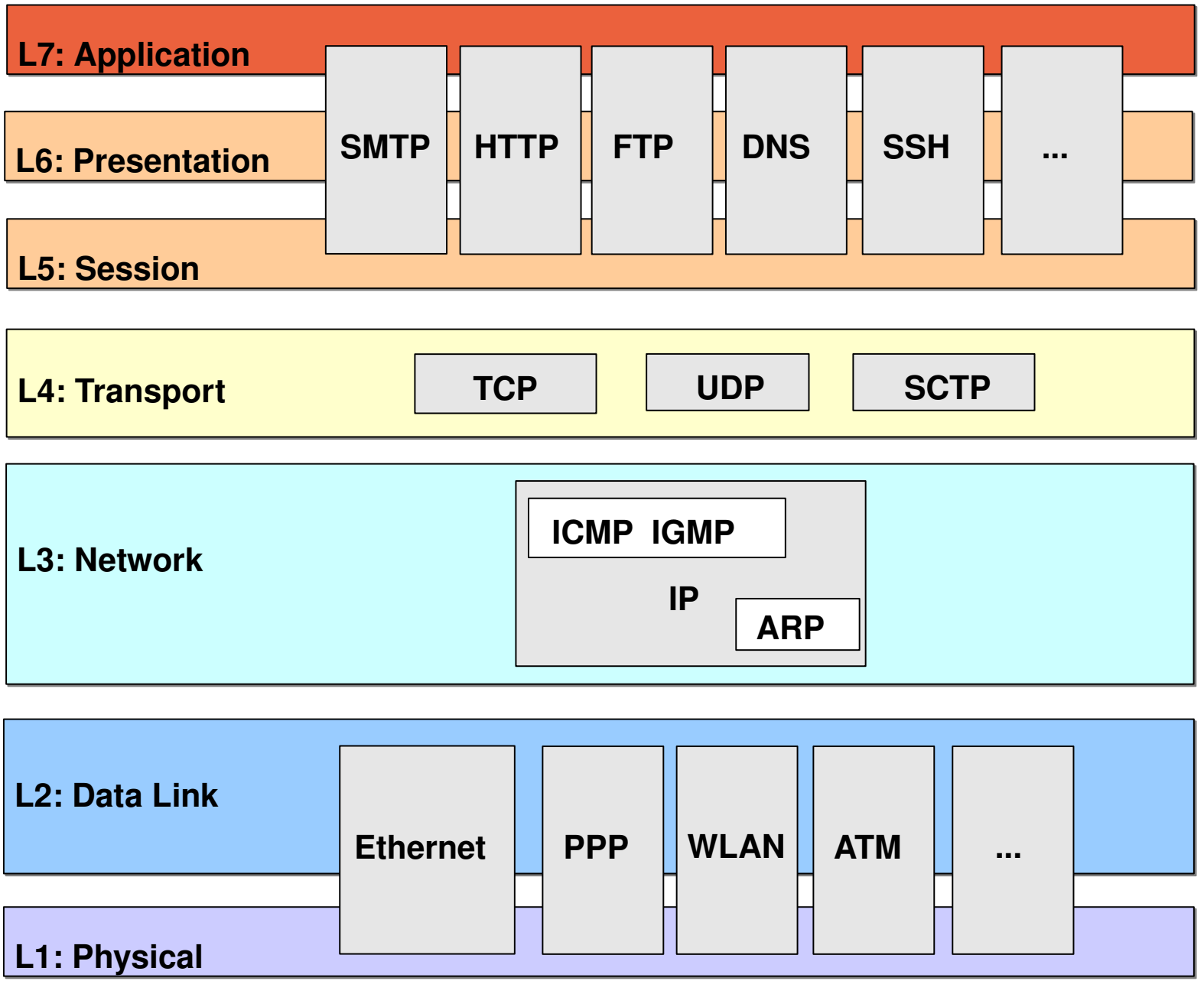
Web site:

http://www.tslab.ssvl.kth.se/csd/projects/0911130/

Network Building Blocks



Network layers (OSI)

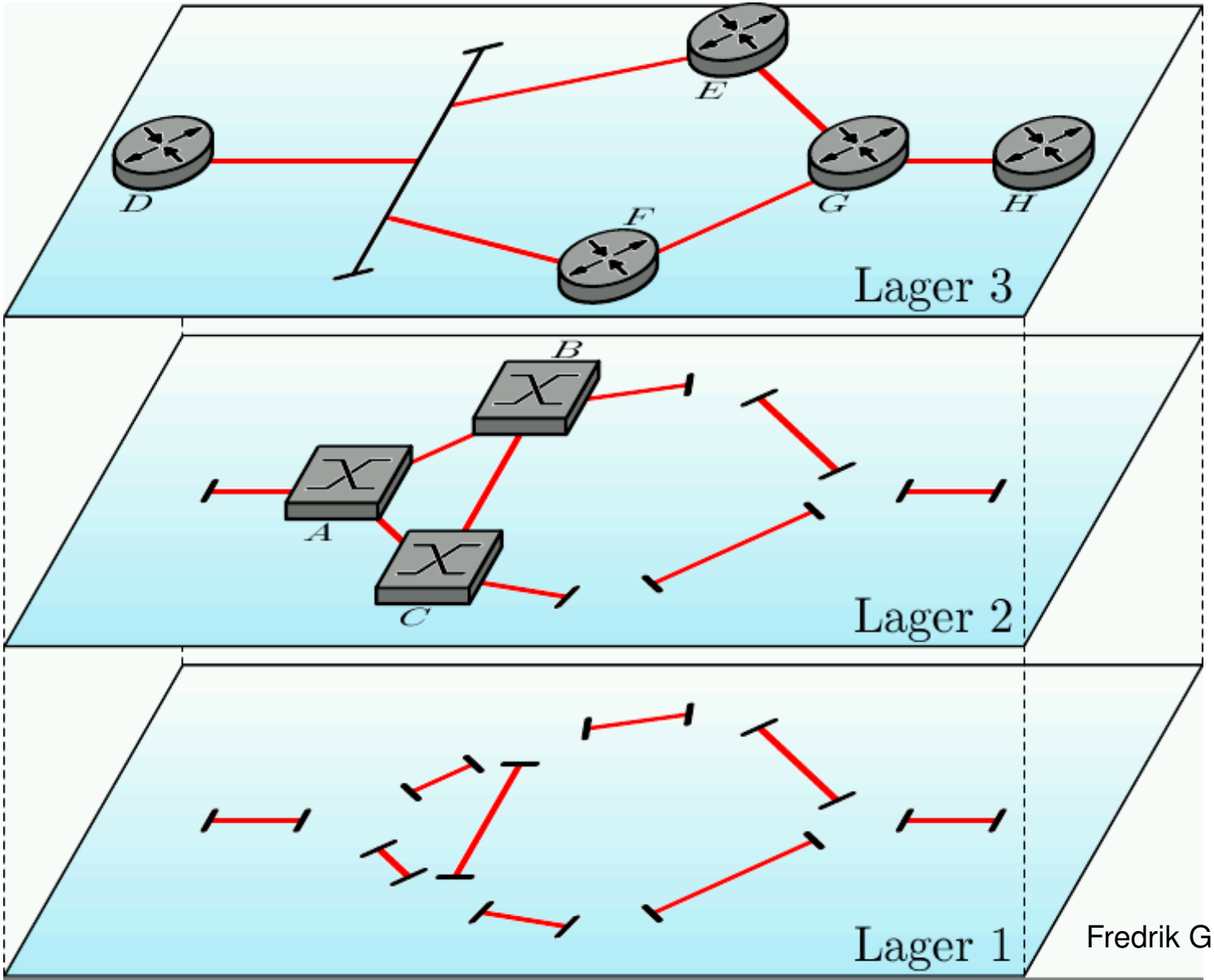


Switching and Routing is based on destination address

Network
Routers

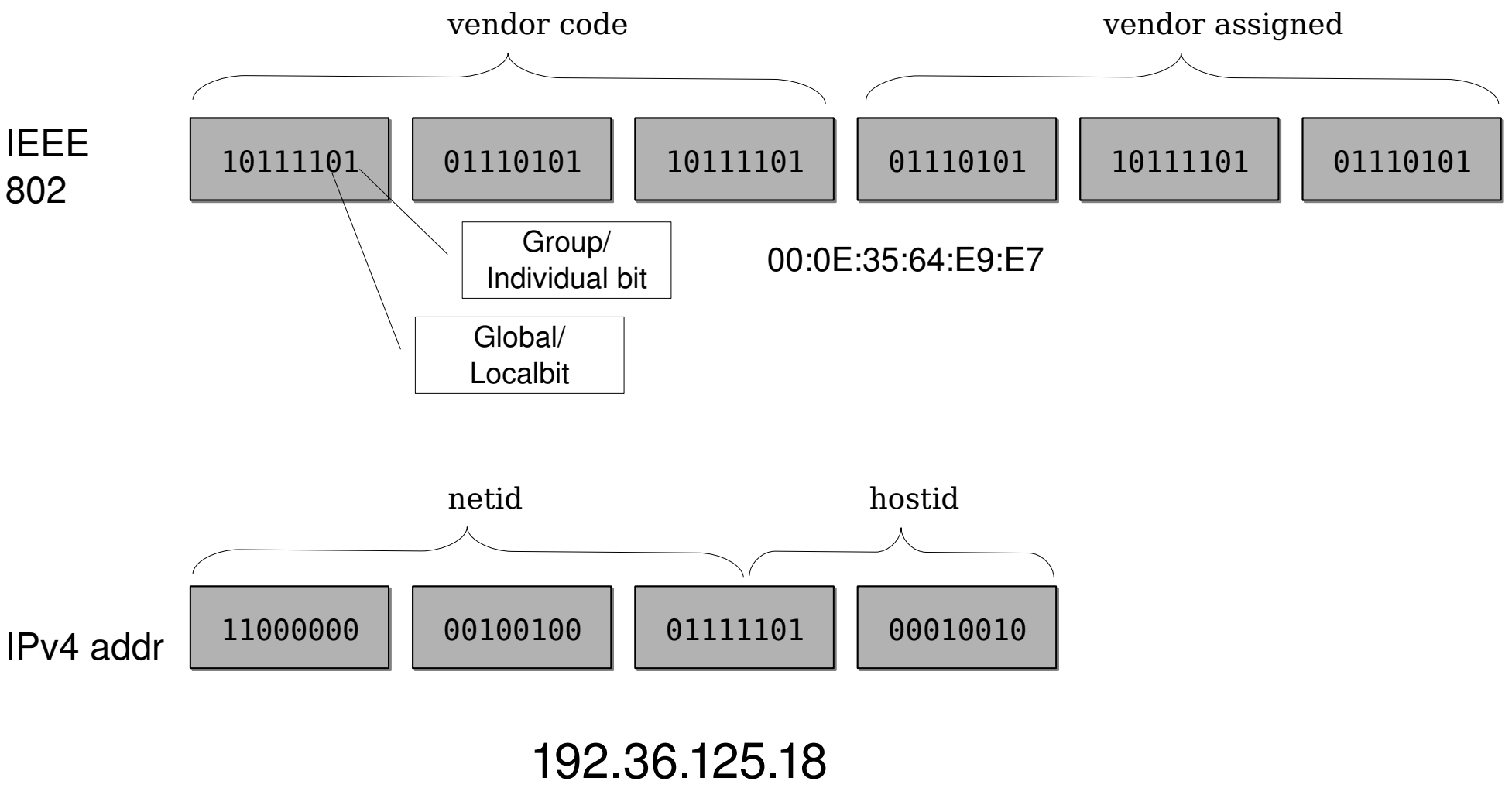
Data Link
Switches

Physical
Optical etc?



Fredrik Gunger

Ethernet vs IPv4 addresses



Address assignment

For Ethernet there is no need

IP

- Manual
- DHCP (Dynamic Host Configuration Protocol,)

IP-numbers (private)

3. Private Address Space. (RFC1918)

The Internet Assigned Numbers Authority (IANA) has reserved:

10.0.0.0	-	10.255.255.255	(10/8 prefix)
172.16.0.0	-	172.31.255.255	(172.16/12 prefix)
192.168.0.0	-	192.168.255.255	(192.168/16 prefix)

Used for NAT and experiments

IP resources

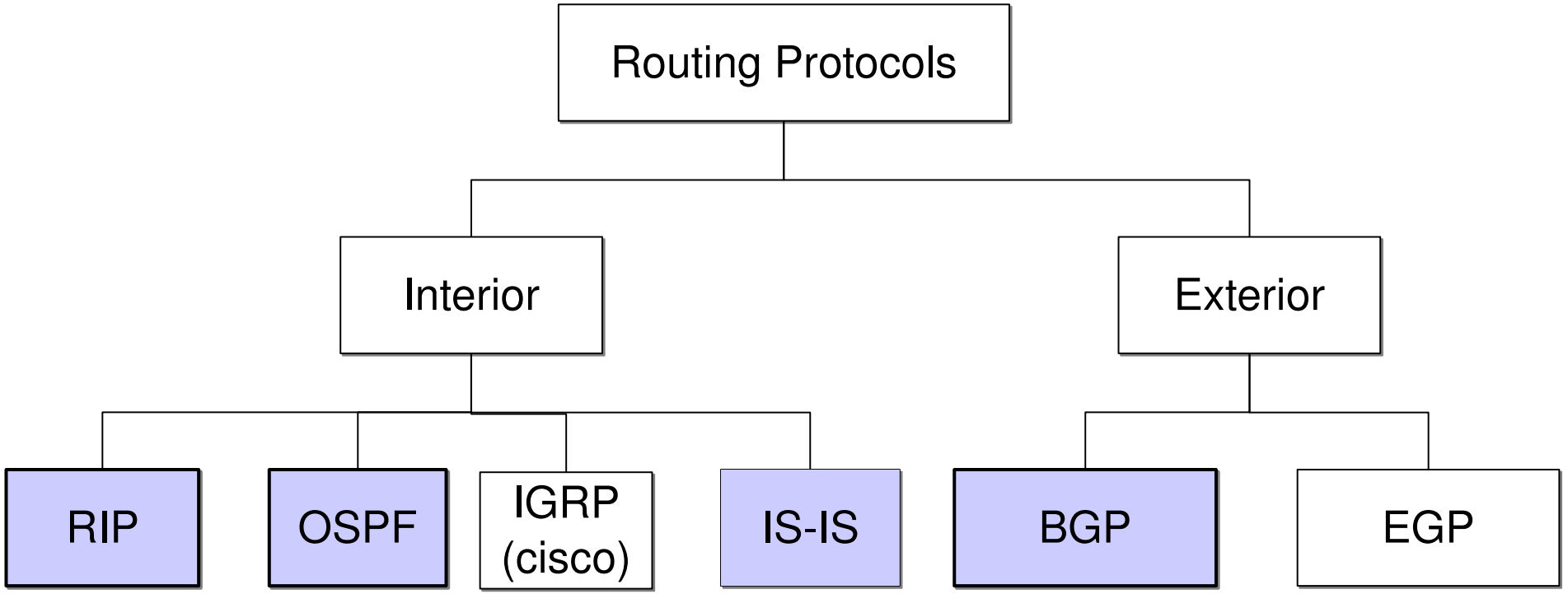
- IP numbers Ipv4 (exhausted when?)
- IP numbers IPv6
- AS-numbers 16 vs 32 bit

  - LIR, AfriNIC or through provider.

IPv6: What drives deployment?

- Asia and Europe
  - Smaller pools of IPv4 addresses
  - Faster at adopting new technology
  - Government-driven (ASIA)
  - Wireless (3G in Europe)
- U.S.
  - DoD announced that it will move to IPv6 by 2008
    - Public address assignment simplifies end-to-end security
- IPv6 has been added to DNS root servers
- SUNET and NorduNET runs IPv6 in core

Popular Unicast Routing Protocols



What is BGP?

Border Gateway Protocol version 4. RFC 4271

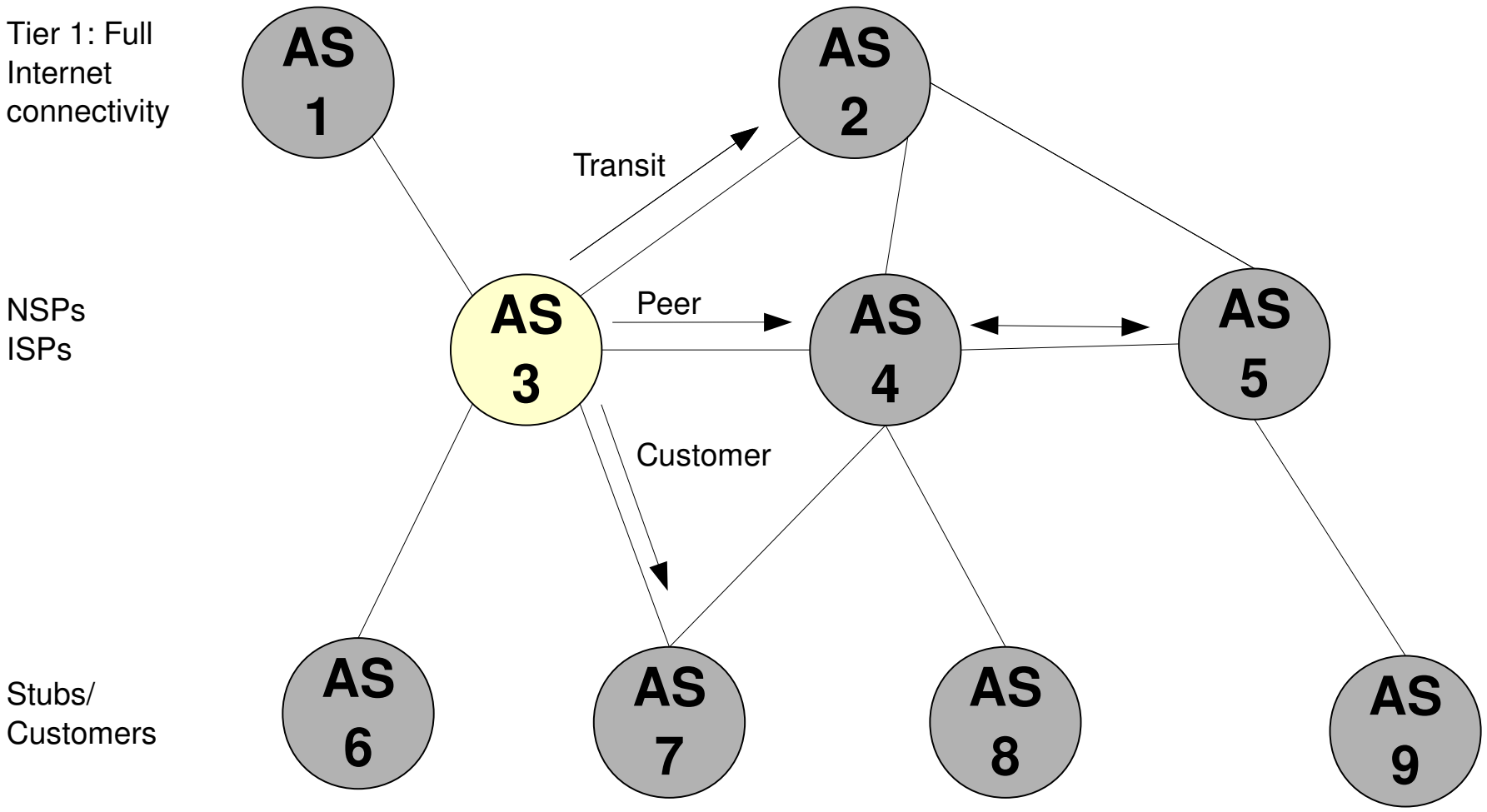
An inter-domain routing protocol for Internet

Uses the *destination-based* forwarding paradigm

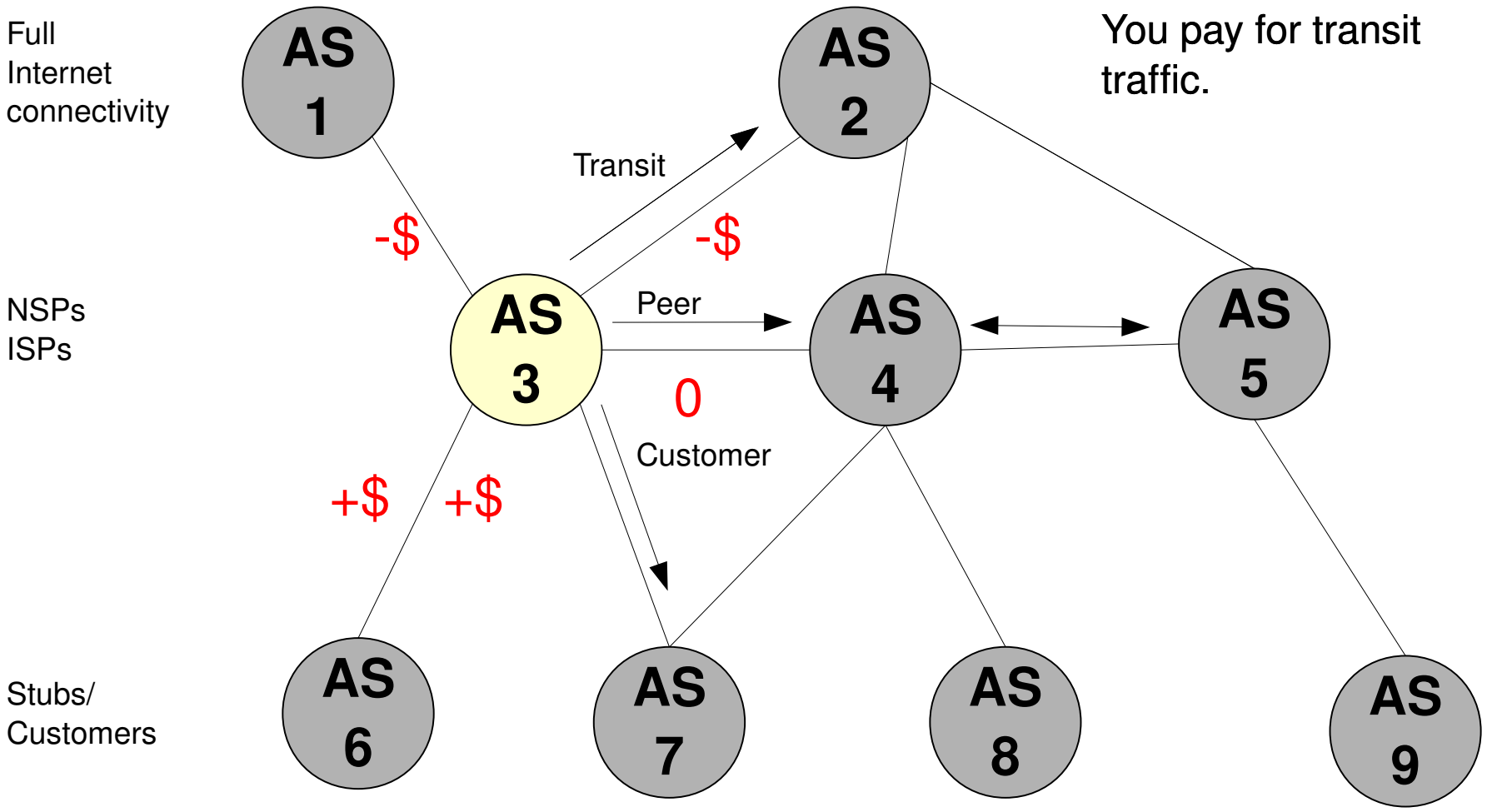
Views the Internet as a collection autonomous systems. AS-numbers.

Uses TCP between *peers*

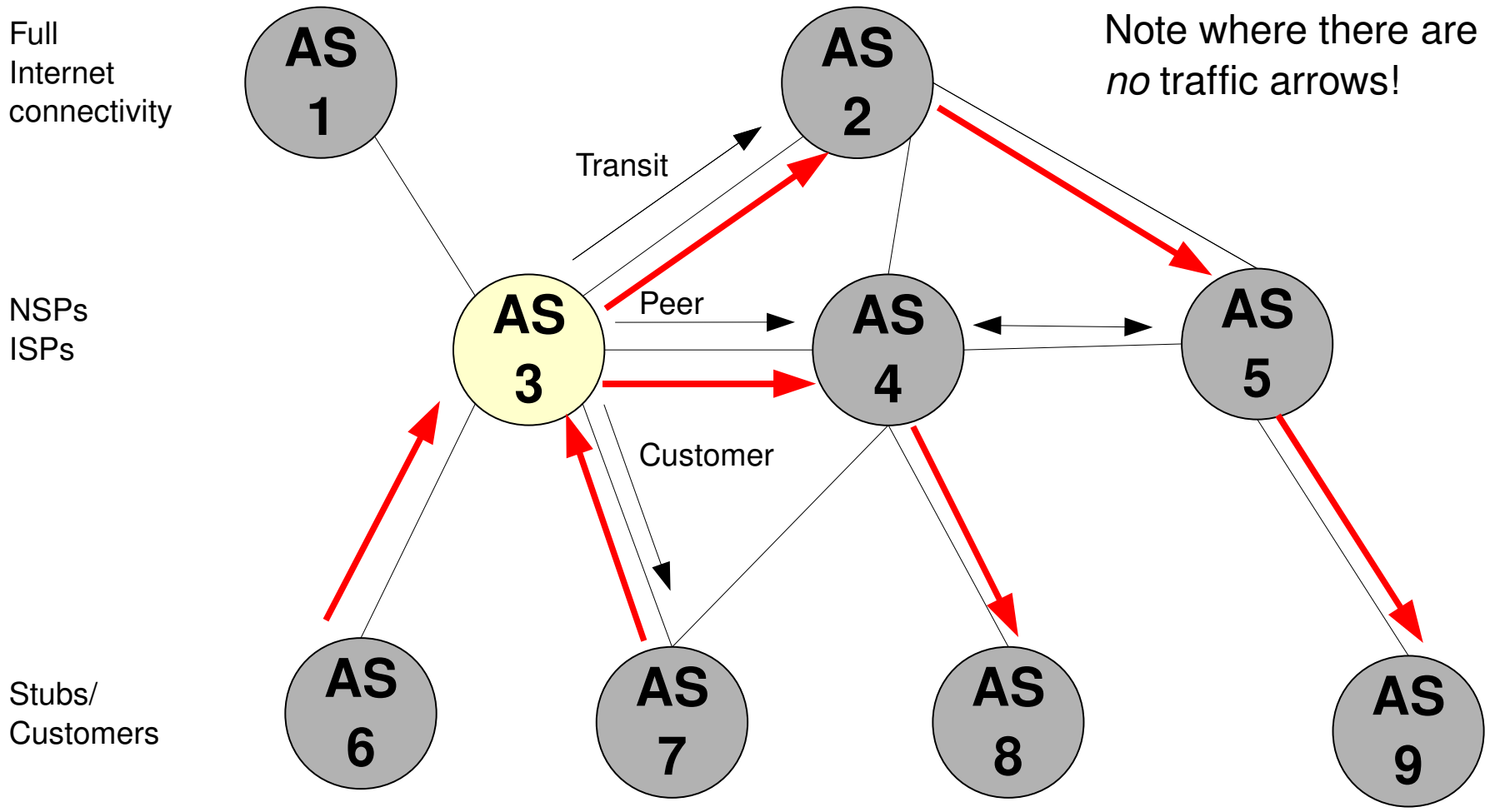
AS graph and peering relations



Cost and peering relations



Traffic patterns



That's all

Questions?