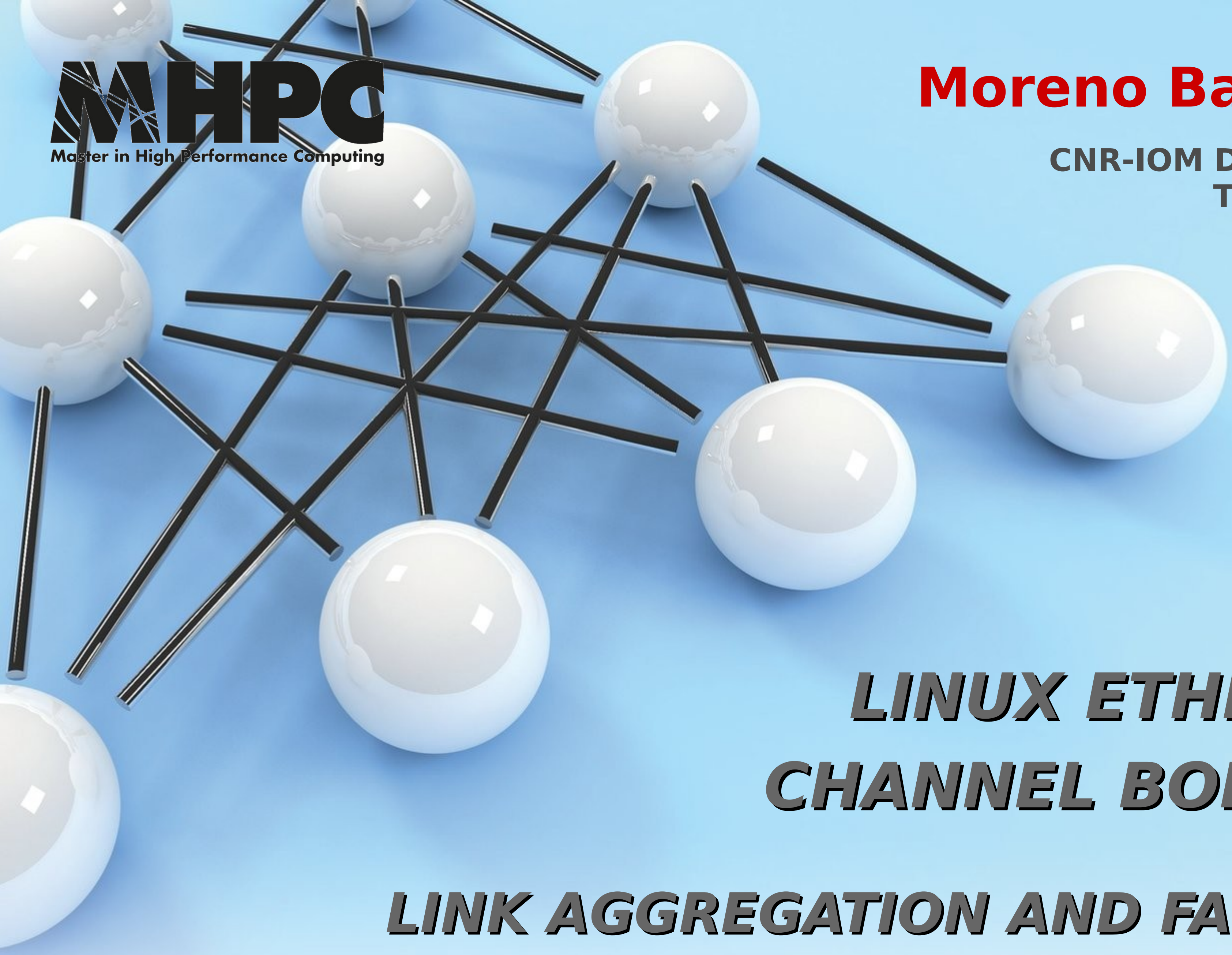


MHPC
Master in High Performance Computing

Moreno Baricevic

CNR-IOM DEMOCRITOS
Trieste, ITALY

iom Istituto Officina dei Materiali

LINUX ETHERNET CHANNEL BONDING

LINK AGGREGATION AND FAILOVER

ma per seguir virtute e canoscenza
SISSA
Scuola Internazionale Superiore di Studi Avanzati

ICTP
The Abdus Salam International Centre for Theoretical Physics

Agenda

- Port Trunking, Link Aggregation, NIC Teaming, Ethernet Channel Bonding, Etherchannel?
- About throughput, latency and high availability
- LINUX Ethernet Bonding Driver
- Bonding modes
- Link aggregation and LACP
- Failover
- LINUX commands (configuration, diagnostic, benchmarking)
- Switch configuration (Cisco and HP examples)

Port Trunking, Link Aggregation, NIC Teaming, Ethernet Channel Bonding, Etherchannel?

Different names for similar tecnologies.

Same purpose: provide fault tolerance and/or greater bandwidth.

Link Aggregation: general term that describes various methods of combining multiple network connections

LACP (Link Aggregation Control Protocol): IEEE 802.3ad, independent standard (became 802.1ax in 2008)

Ethernet Channel Bonding: LINUX main and historical software implementation (kernel-space)

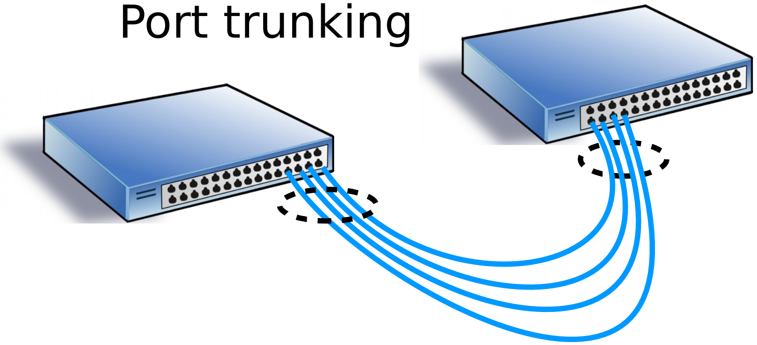
Linux Team Driver (libteam): new LINUX project implemented in user-space (*teamd* daemon)

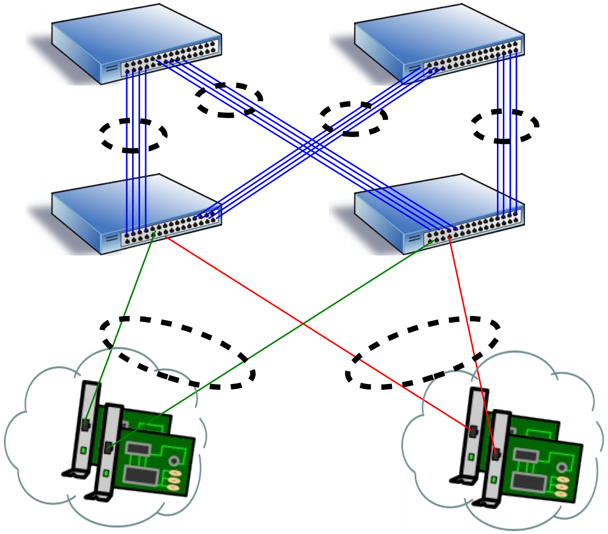
Port Trunking: (general term, switch configuration) method that combine more ports into a single virtual channel. Various protocols may define the (auto)configuration of the channel.

EtherChannel: as above, for Cisco technologies

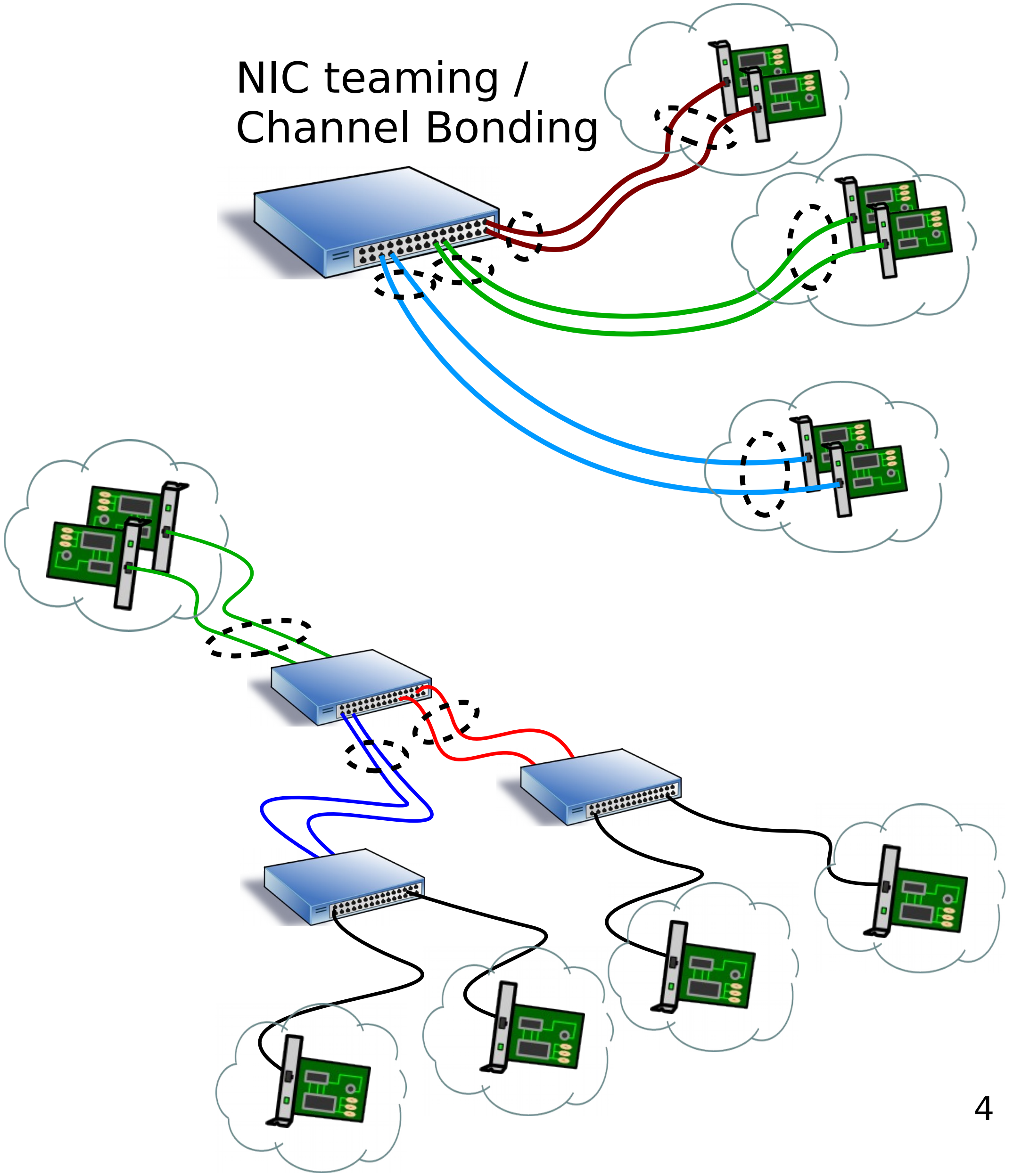
Port trunking and NIC teaming

Port trunking



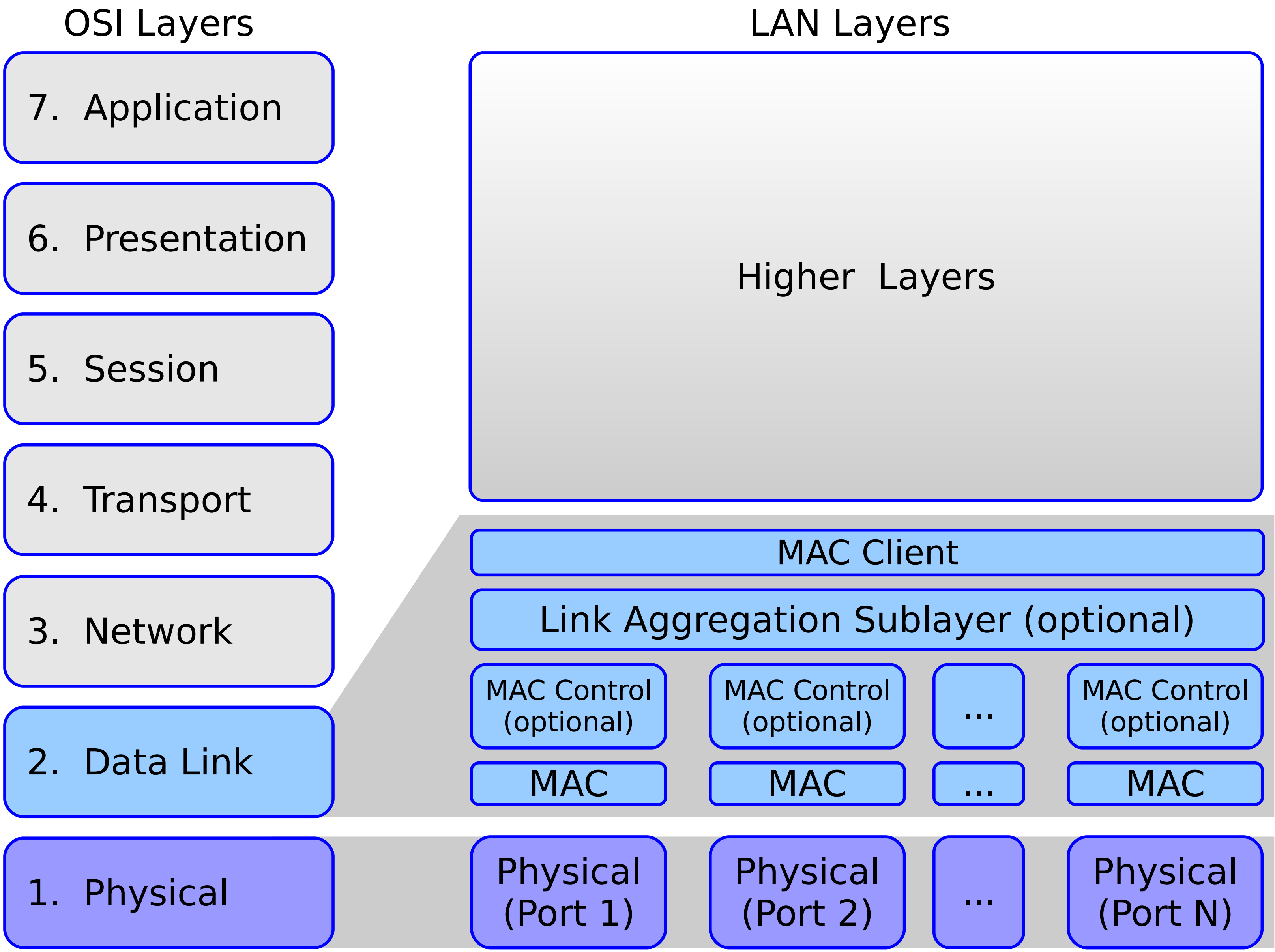


NIC teaming / Channel Bonding



LACP

IEEE Std 802.1AX-2008



OSI Layers

7. Application
6. Presentation
5. Session
4. Transport
3. Network
2. Data Link
1. Physical

LAN Layers

Higher Layers

MAC Client

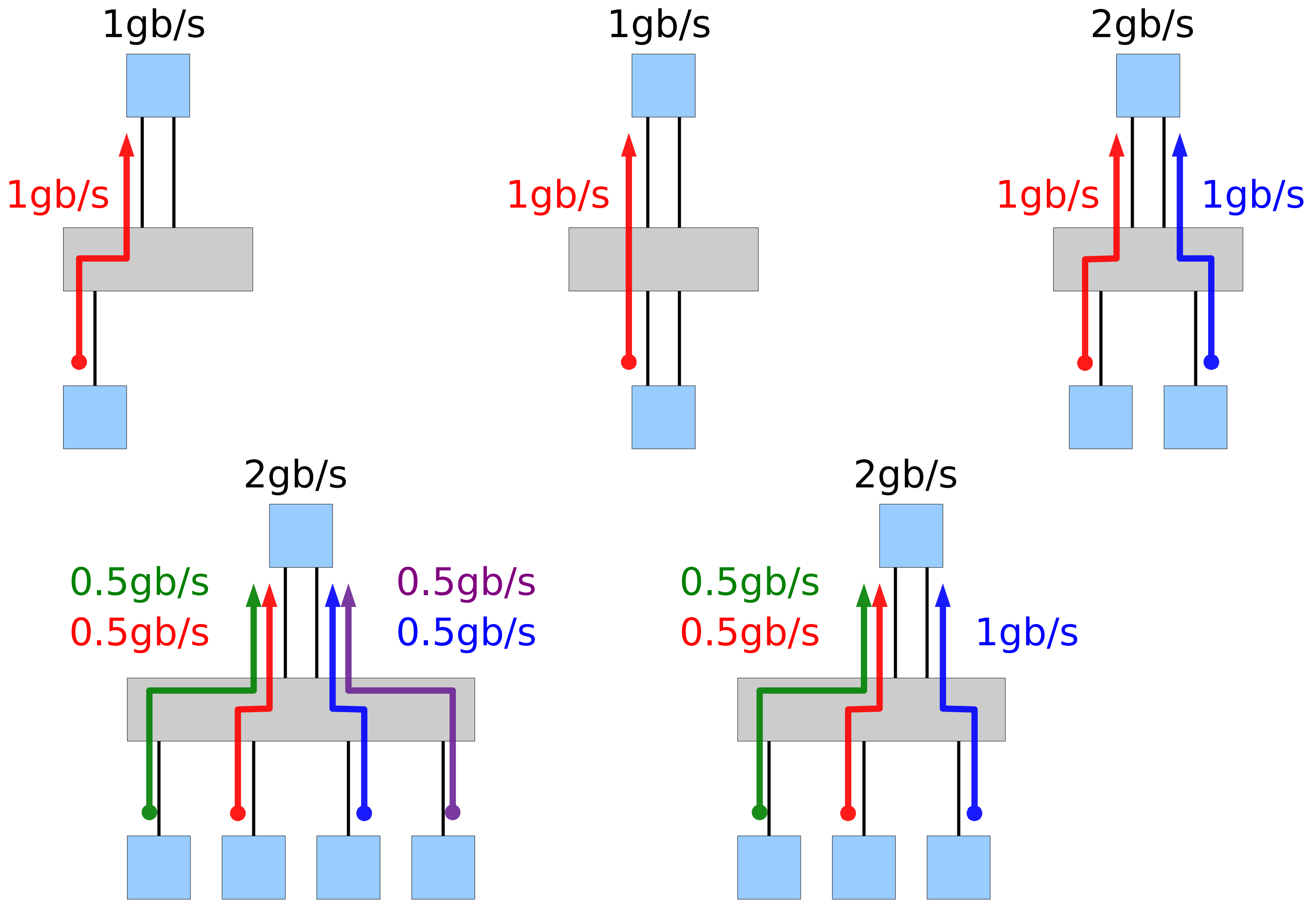
Link Aggregation Sublayer (optional)

MAC Control (optional) | MAC Control (optional) | ... | MAC Control (optional)

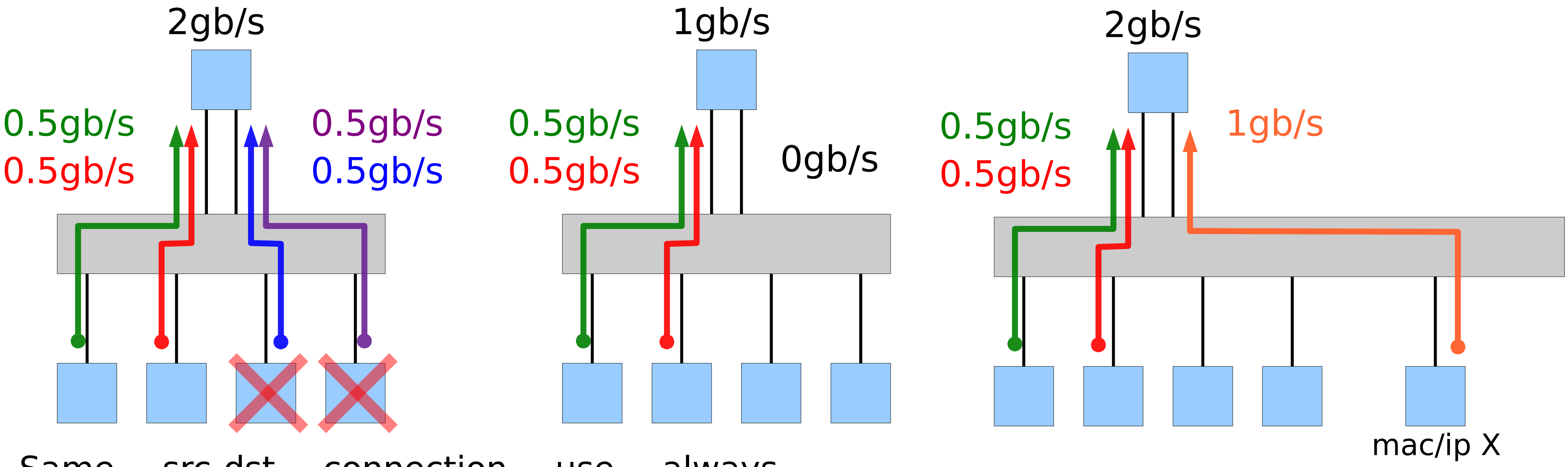
MAC | MAC | ... | MAC

Physical (Port 1) | Physical (Port 2) | ... | Physical (Port N)

Aggregated bandwidth and (not-so-intuitive) balancing 1/2



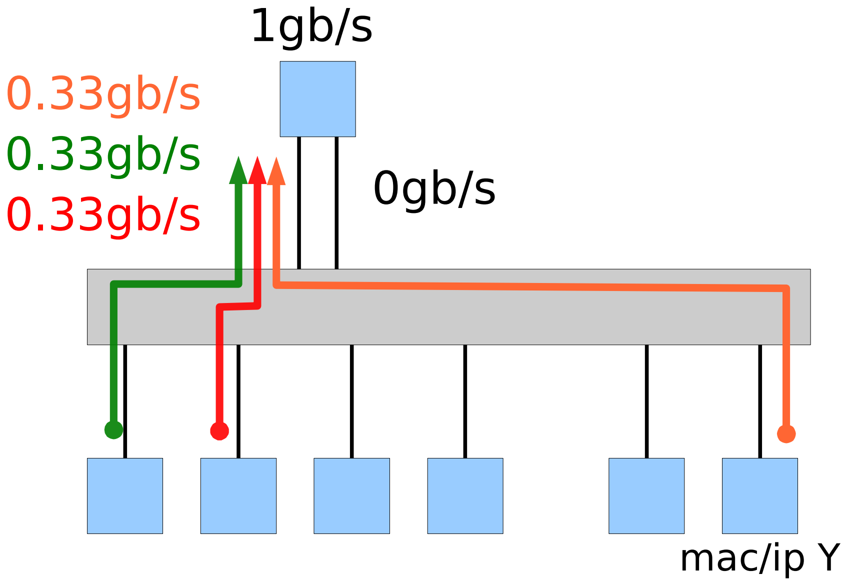
Aggregated bandwidth and (not-so-intuitive) balancing 2/2



Same src-dst connection use always the same link in order to avoid retransmissions (due to out-of-order packets) and the consequent impact on performance.

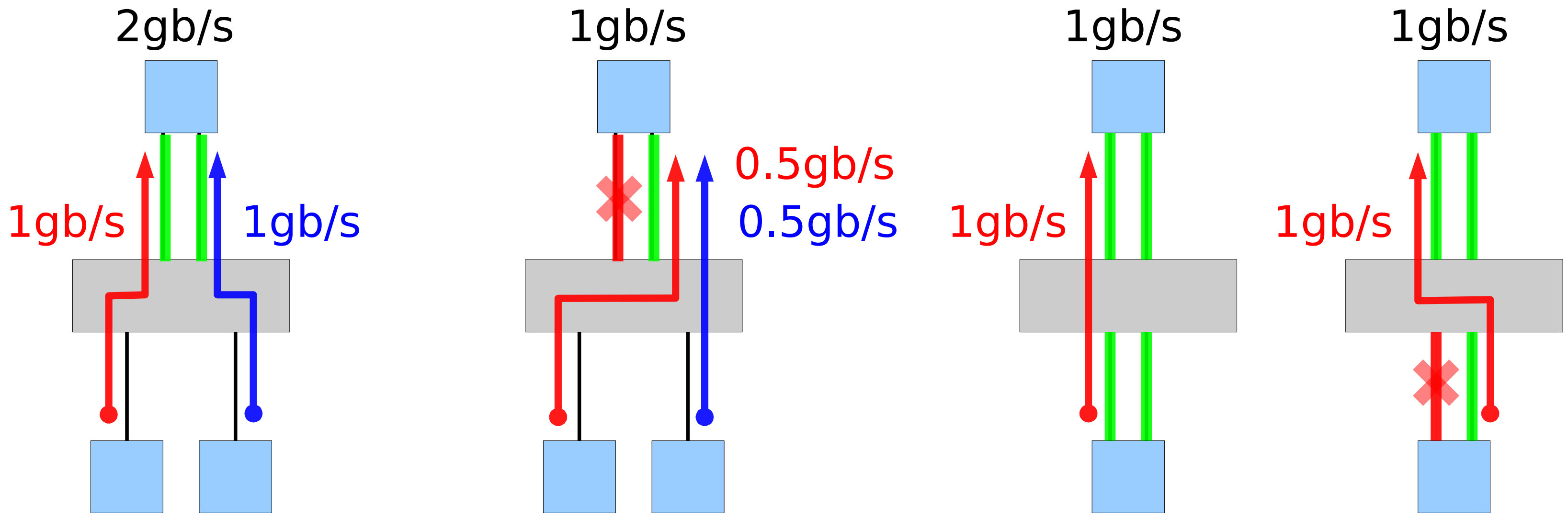
The balancing is usually based on src/dst MAC (L2) or src/dst IP (L3) addresses, or various combinations of both. (L4 balancing is also implemented on some high-end devices virtually reaching 50/50)

(cisco: show etherchannel load-balance)

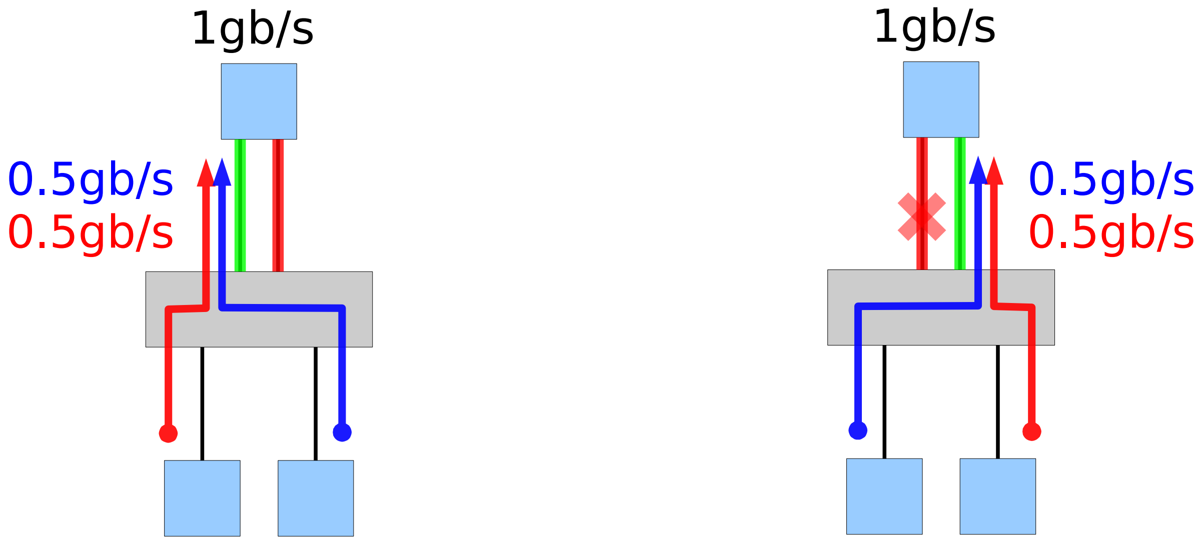


Fault tolerance

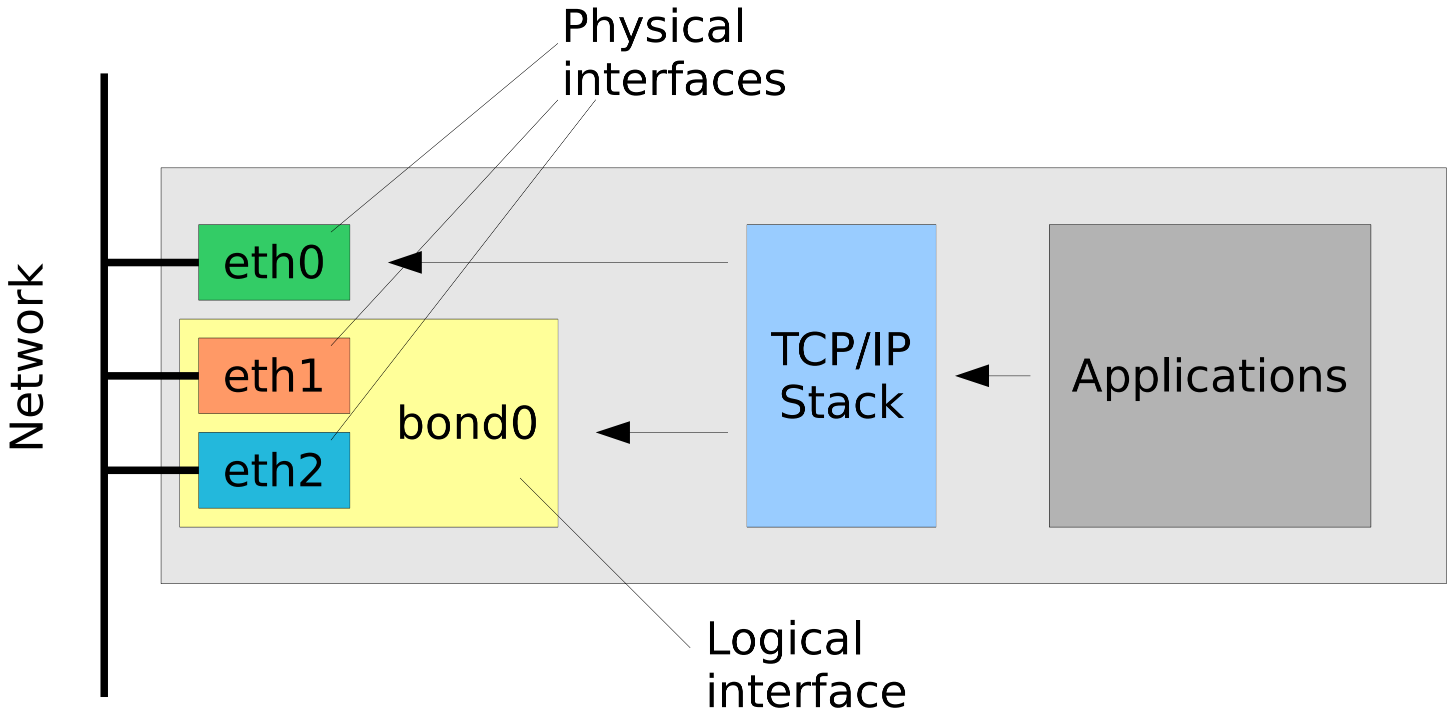
Active-active / Link Aggregation



Active-passive / Fault Tolerance



LINUX Ethernet Channel Bonding



eth0: has it's own MAC and IP address, configured as usual

bond0:
- forces the **same** MAC address on both the slaves (**eth1** and **eth2**);
- the MAC address used is the one of the first interface enslaved;
- the IP address belongs to bond0, not eth* (ifconfig bond0 ...);
- depending on the bonding mode adopted, addictional configuration may be required on the switch.

Bonding modes on LINUX

balance-rr / 0 (Round-robin)
load balancing and failover

active-backup / 1
fault tolerance

DOES NOT REQUIRE ANY SPECIAL SWITCH SUPPORT OR CONFIGURATION

balance-xor / 2
load balancing and failover

broadcast / 3
fault-tolerance

REQUIRES A SWITCH THAT SUPPORT LACP AND A SPECIAL CONFIGURATION IS NEEDED

802.3ad / 4
IEEE 802.3ad Dynamic link aggregation (LACP)

balance-tlb / 5 (adaptive transmit load balancing)
load balancing and failover

balance-alb / 6 (adaptive load balancing)
load balancing and failover

LINUX COMMANDS
command line, using std. utilities

Configuration:

```
# modprobe bonding mode=4 miimon=100
# ifconfig bond0 10.1.0.1 netmask 255.255.0.0 up
# ifenslave bond0 eth1 eth2
```

De-configuration:

```
# ifenslave -d bond0 eth1 eth2
# ifconfig bond0 down
# modprobe -r bonding
```

LACP: `mode=4` or `mode=802.3ad`
FAILOVER: `mode=1` or `mode=active-backup`

LINUX COMMANDS
command line, using sysfs+iputils

```
# modprobe bonding

# echo +bond-lacp > /sys/class/net/bonding_masters

# ip link set dev bond-lacp down

# echo '4' > /sys/class/net/bond-lacp/bonding/mode

# echo '100' > /sys/class/net/bond-lacp/bonding/miimon

# ip link set dev bond-lacp up

# echo +eth1 > /sys/class/net/bond-lacp/bonding/slaves

# echo +eth2 > /sys/class/net/bond-lacp/bonding/slaves

# ip addr add 10.1.0.1/16 brd 10.1.255.255 dev bond-lacp
  label bond-lacp
```

LINUX COMMANDS
permanent configuration

```
# /etc/modprobe.d/bonding.conf
alias bond0 bonding
```

```
# /etc/sysconfig/network-scripts/ifcfg-bond-lacp
DEVICE=bond-lacp
NM_CONTROLLED=no
ONBOOT=yes
USERCTL=no
BOOTPROTO=dhcp
LINKDELAY=10
BONDING_OPTS="mode=X miimon=100"
IPADDR=A.B.C.D
...
```

```
# /etc/sysconfig/network-scripts/ifcfg-eth[12]
DEVICE=eth[12]
HWADDR=AA:BB:CC:DD:EE:FF
NM_CONTROLLED=no
ONBOOT=yes
USERCTL=no
SLAVE=yes
MASTER=bond-lacp
```

LINUX COMMANDS
check running configuration

```
# lsmod | grep bonding

# ip addr

# ip addr ls DEVICE

# ifconfig

# ifconfig DEVICE

# ifenslave -a

# cat /proc/net/bonding/DEVICE

# grep . /sys/devices/virtual/net/DEVICE/bonding/*
```

Final remarks

- Link aggregation:
  - increases the bandwidth for servers/nodes that must be accessed by multiple clients, useless otherwise
  - requires high-end switch ($$$)
  - fault-tolerance/failover is provided too
- Active-backup:
  - no particular requirements about the switch
  - fault-tolerance/failover is native
- What to use, then?
  - consider the needs AND the cost
  - fault-tolerance using active-backup comes free (just one more cable and a switch port), so why not?
  - sometimes, upgrading to NICs and switch with higher base-operating speed may be a better option

That's All Folks!

www.mikeshapirocartoons.com

"In case you need the network administrator, he's
hiding under his desk in the fetal position."

```
( questions ; comments ) | mail -s uheilaaa baro@democritos.it

( complaints ; insults ) &>/dev/null
```