Implementation and Testing of a DWDM optical network based on PMA32s by Marconi-Ericsson

Relatori:

Prof. Stefano Giordano

Ing. Davide Adami

Prof. Michele Pagano

Candidato:

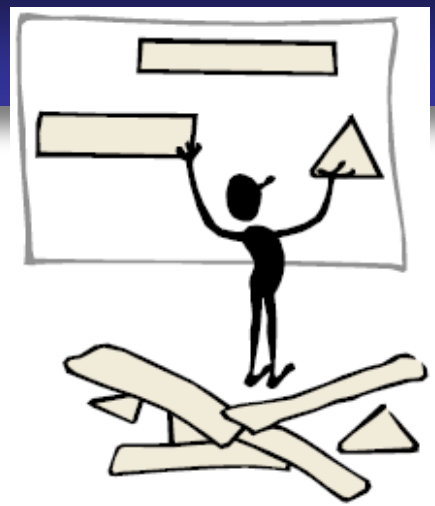
Nicola Azzaro

Gruppo RETI di TELECOMUNICAZIONI

Dipartimento di Ingegneria dell' Informazione - Università di Pisa

Pisa, 19 Dicembre 2008

Sommario



- DWDM Technology
- The PMA32 Optical Add Drop Multiplexer
- Implementazione di un core ottico con 3 PMA32
- Dal PMA32 alle nuove famiglie OMS Ericsson
- Evoluzione delle Backbone Networks

Introduzione

Per garantire l'accesso ad Internet ad un ampio e sempre crescente numero di utenti,o per avere un rapido aumento della capacità di una rete in ambito metro/long haul, è sicuramente molto costoso ricorrere a nuovi cavi in fibra ottica.

Marconi-Ericsson ha concepito una vantaggiosa alternativa:
un OADM (multiplexer ottico) in grado di aumentare fino a 32 volte la capacità di rete (32 CANALI OTTICI su UNA SOLA FIBRA).

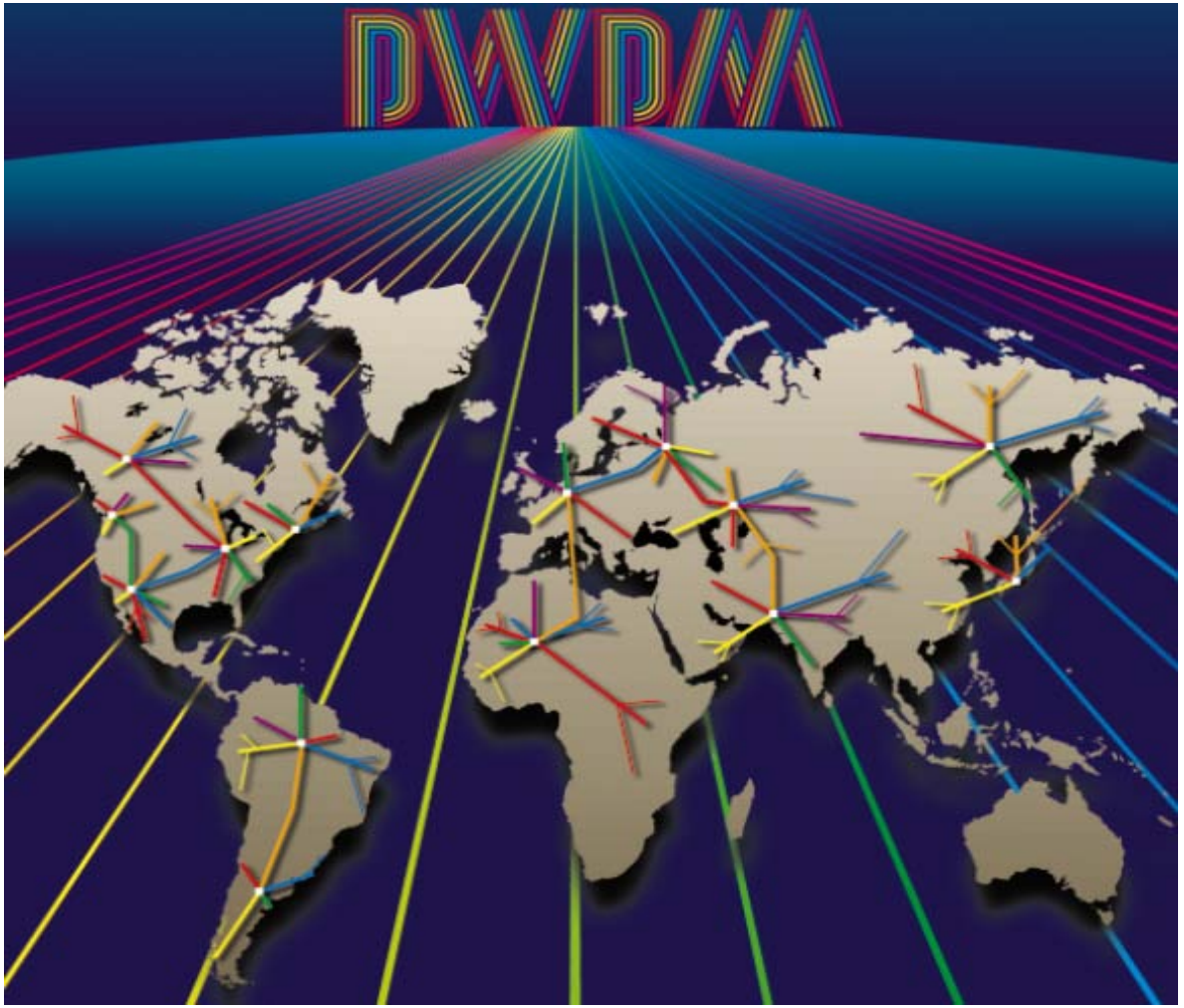
PMA32

La tesi si propone di analizzare l'Add-Drop Multiplexer PMA32 ed i prodotti successivi, focalizzando sulle tecnologie ottiche e sulla presenza di Ericsson nelle attuali dorsali Internet.

DWDM Technology

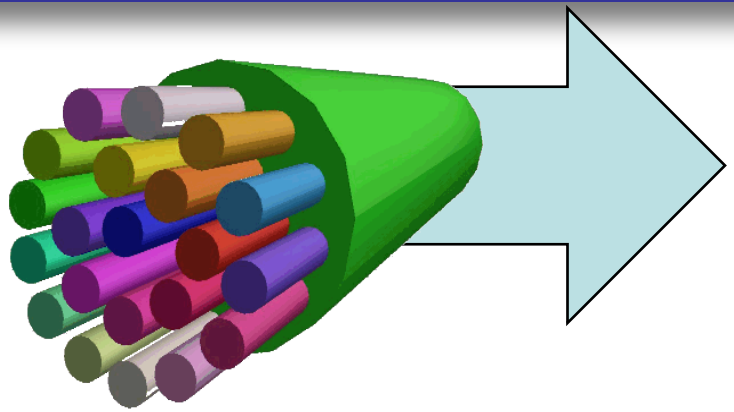
***D**ense*
***W**avelength*
***D**ivision*
***M**ultiplexing*

(Late-1990s)



DENSE, in quanto
16-160 canali,
spaziati da
200 a 25 GHZ
(piuttosto vicini fra loro)

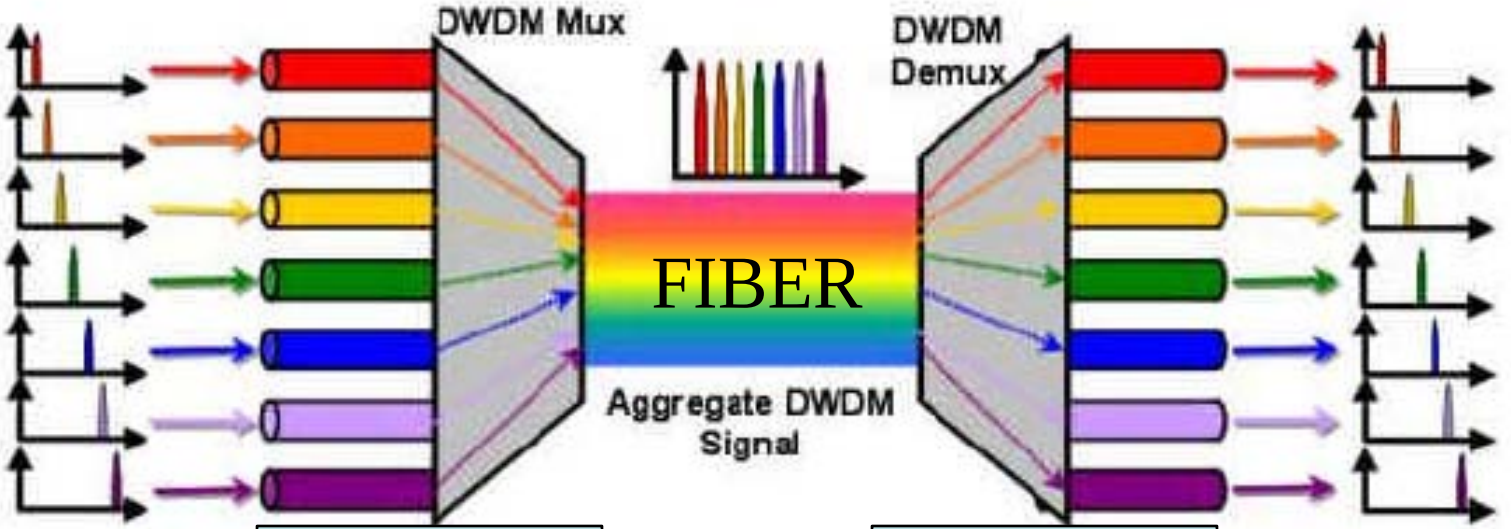
DWDM Technology



MANY OPTICAL CHANNELS
ONE FIBER CABLE

TRANSMITTERS

RECEIVERS



COMBINER

SPLITTER

The PMA32 OADM

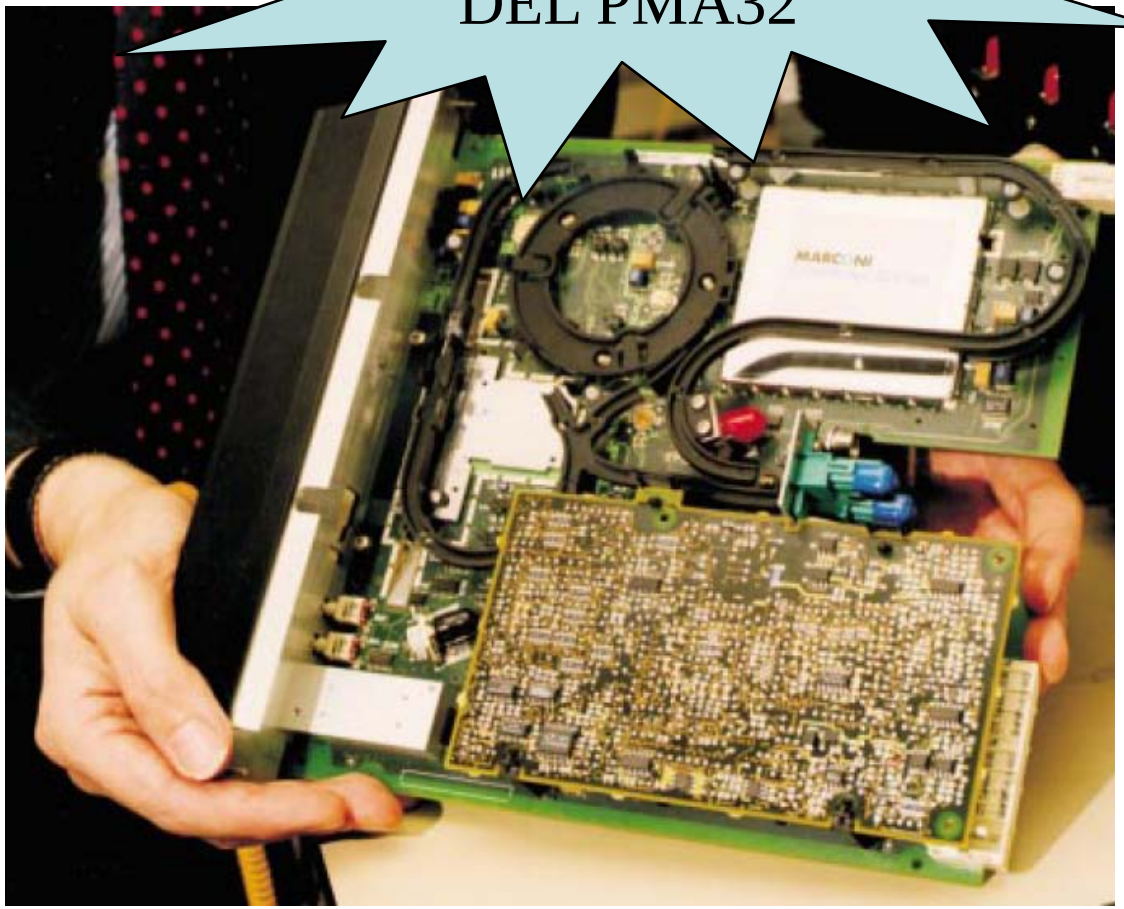
ERICSSON

- **Up to 32 optical <u>protected</u> channels (2,5 Gbps)**
- **Optical rings or Point-2-point links**
- **Fully and <u>remotely</u> reconfigurable**
- **Long-haul and metro-access**

The PMA32 OADM

ERICSSON

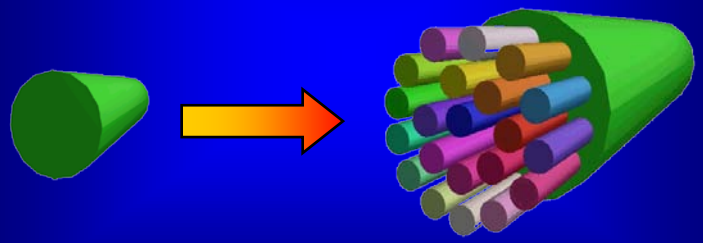
LE SCHEDE
DEL PMA32



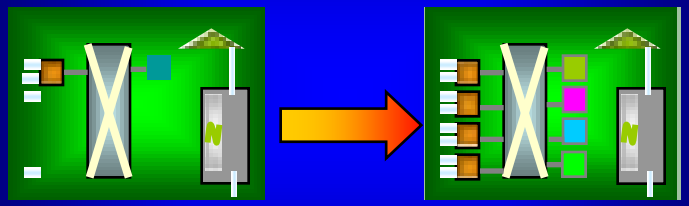
The PMA32 OADM

LE POTENZIALITA' DEL PMA32

Extends the Capacity of Existing Fiber (32 Times)



Scaleable Hardware

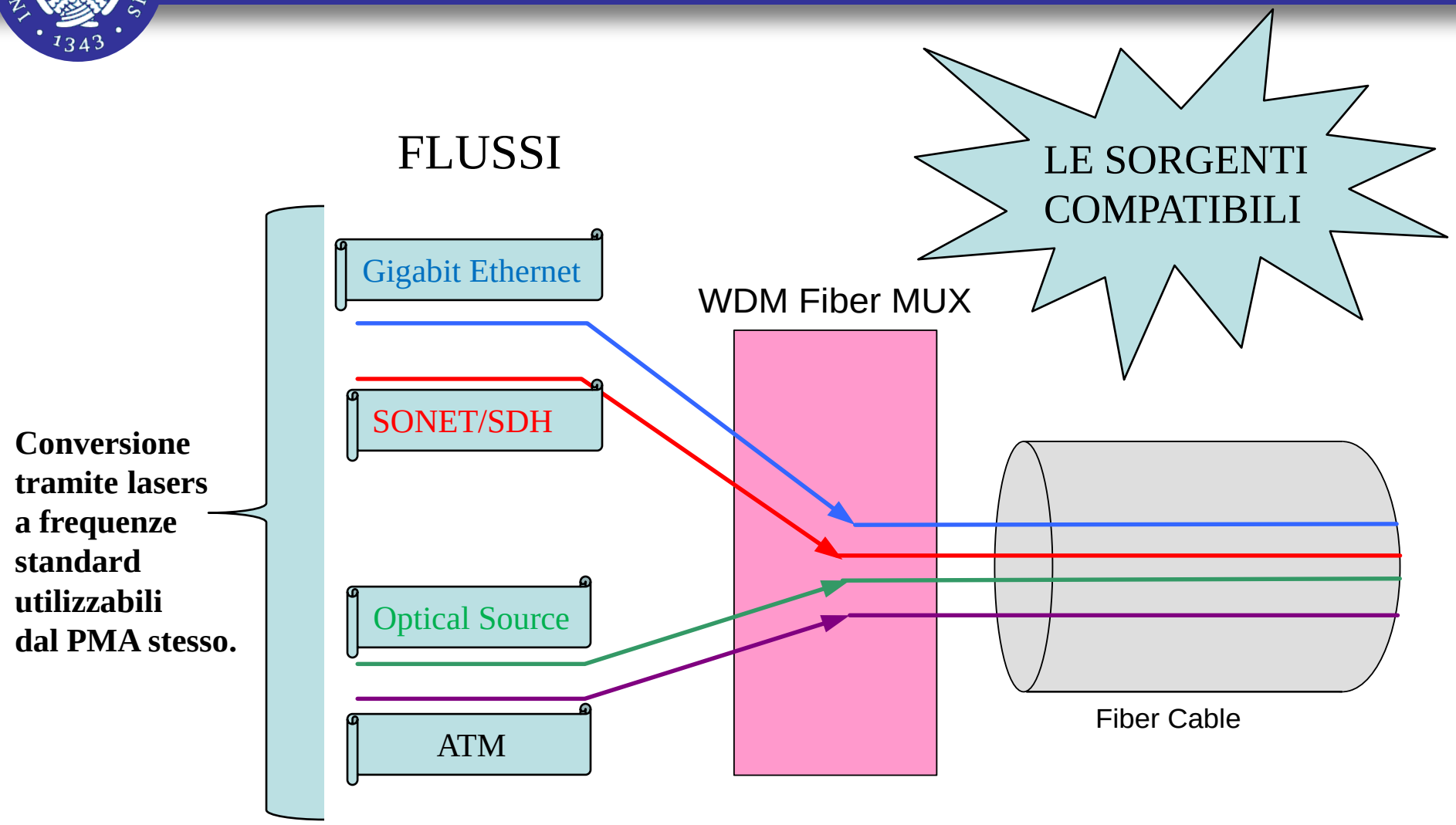


La Capacita' riduce i COSTI

Forecast-Tolerant Architecture

FUTURE NETWORKS

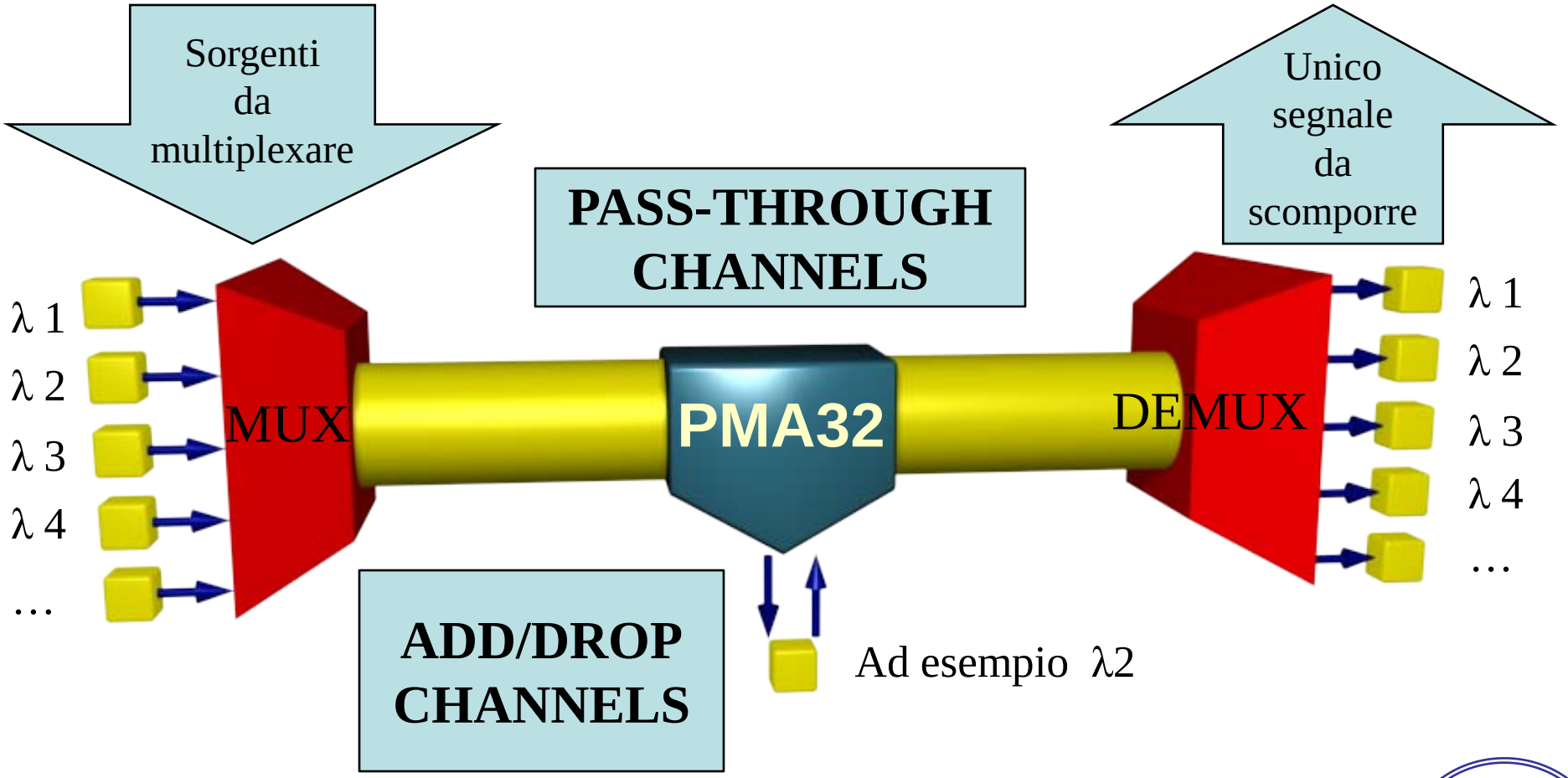
The PMA32 OADM



Conversione tramite lasers a frequenze standard utilizzabili dal PMA stesso.

The PMA32 OADM

LA GESTIONE DEI CANALI

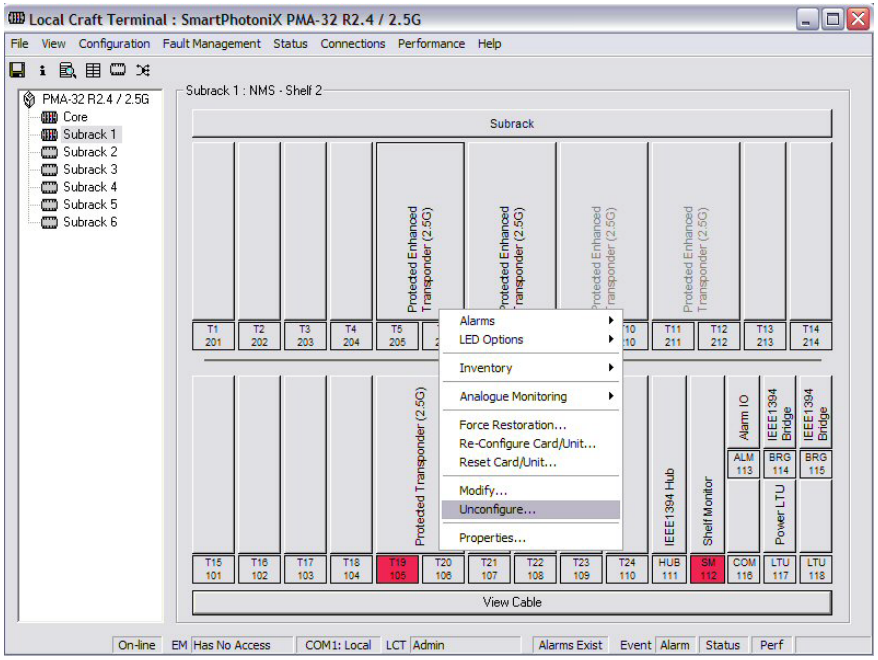


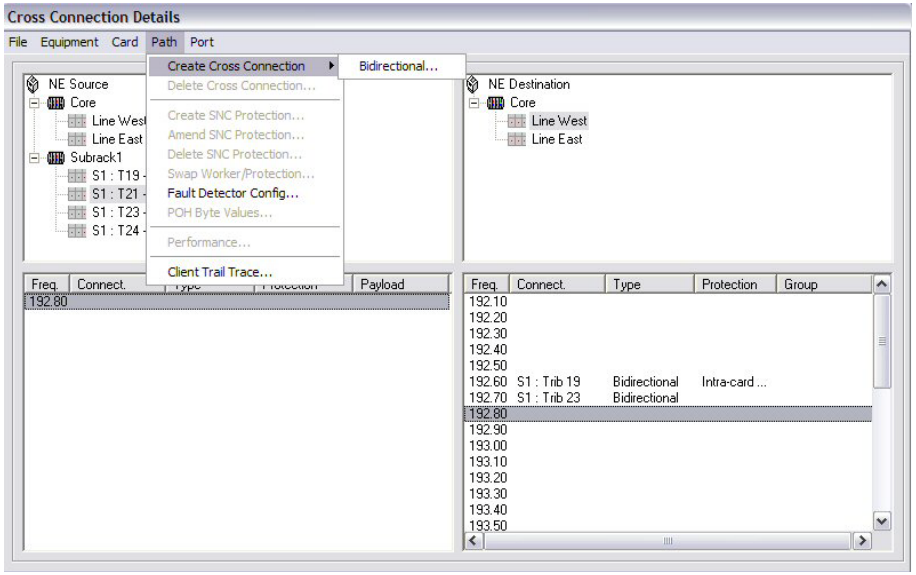
The PMA32 OADM

IL SOFTWARE

Local Craft Terminal (LCT)

Provided by ERICSSON





HARDWARE CONFIGURATION
(TXs/RXs/TRANSPONDERS/ADMs…)

CROSS CONNECTIONS /
PASS-THROUGH CONNECTIONS

The PMA32 OADM

GLI ALLARMI PIU' COMUNI

Real Time Alarms

Card Slot	Alarm Source	Alarm Type	Severity
LERx	OTS	TIM	Critical
MCF	Card	Distributed PSU Failure	Critical
MCF	Card	EM Comms Link Failure	Critical
S1 : T19	Card	ALS	Critical
S1 : T19	Rx OCh	Loss of Signal	Critical
S1 : T19	Client Input	Client Input Loss of Signal	Critical
S1 : T23	Rx OCh	Loss of Signal	Critical
S1 : T23	Client Input	Client Input Loss of Signal	Critical
S1 : T24	Client Input	Client Input Loss of Signal	Critical
S1 : MCF	Card	Distributed PSU Failure	Critical
MCF	Card	Real Time Clock Not Set	Major
MCF	OCh : 192.60 THz West	Connected Path Absent	Minor
MCF	OCh : 192.70 THz West	Connected Path Absent	Minor
MCF	OCh : 192.60 THz East	Connected Path Absent	Minor
MCF	OCh : 193.50 THz East	Connected Path Absent	Minor
LERx	OMS	SSF	Warning
LERx	OCh : 192.80 THz	SSF	Warning
SQM	Rx Line West 193.10THz	Monitored Wavelength LOW	Warning
SQM	Rx Line East 193.10THz	Monitored Wavelength LOW	Warning
MCF	Card	Fan Tray 1 Failure	Warning
MCF	Card	Fan Tray 2 Failure	Warning
MCF	Card	Fan Tray 1 Problem	Warning
MCF	Card	Fan Tray 2 problem	Warning
MCF	Card	Historic Alarm Log Threshold Exceedence	Warning
MCF	Card	LT Access Event Log Threshold Exceedence	Warning
S1 : T19	Rx OCh	East Loss of Signal	Warning
S1 : T19	Rx OCh	West Loss of Signal	Warning
S1 : MCF	Card	Fan Tray 2 Failure	Warning
S1 : MCF	Card	Fan Tray 2 problem	Warning
SQM	Tx Line West 193.10THz	Monitored Wavelength LOW	Warning
SQM	Tx Line East 193.10THz	Monitored Wavelength LOW	Warning

ADD CHANNEL FAILURE
(cablaggio)

LOSS OF SIGNAL
(perdita per card o cablaggio)

CONNECTED PATH ABSENT
(problemi fisici in PMA a monte)

PRESENT PATH UNCONNECTED
(config. del software incongruente)

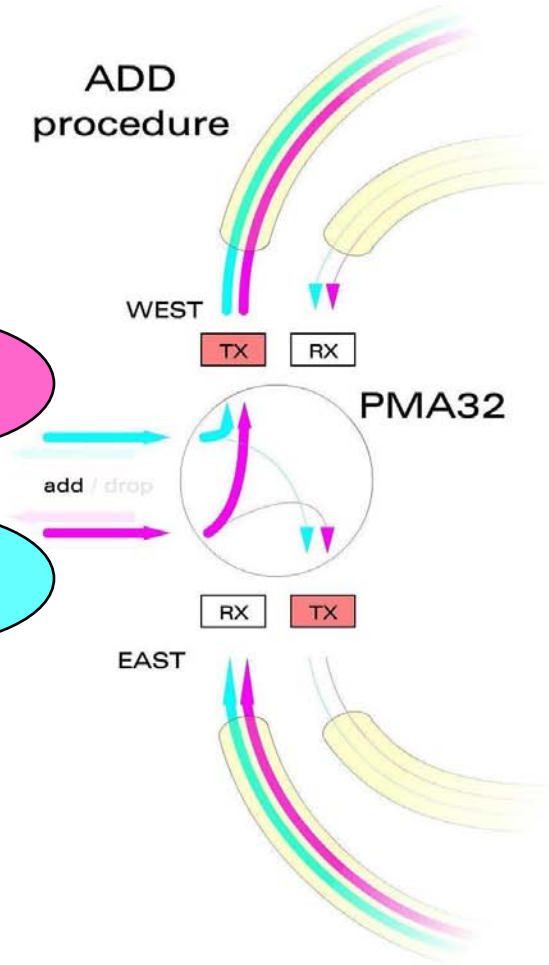
The PMA32 OADM

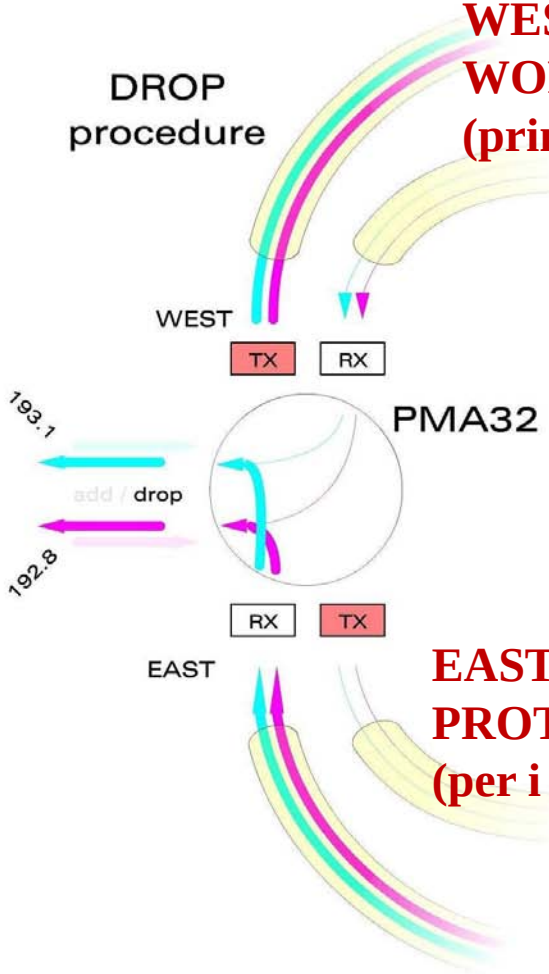
ADD/DROP MECHANISM

2 FREQUENZE

192,8 THZ

193,1 THZ





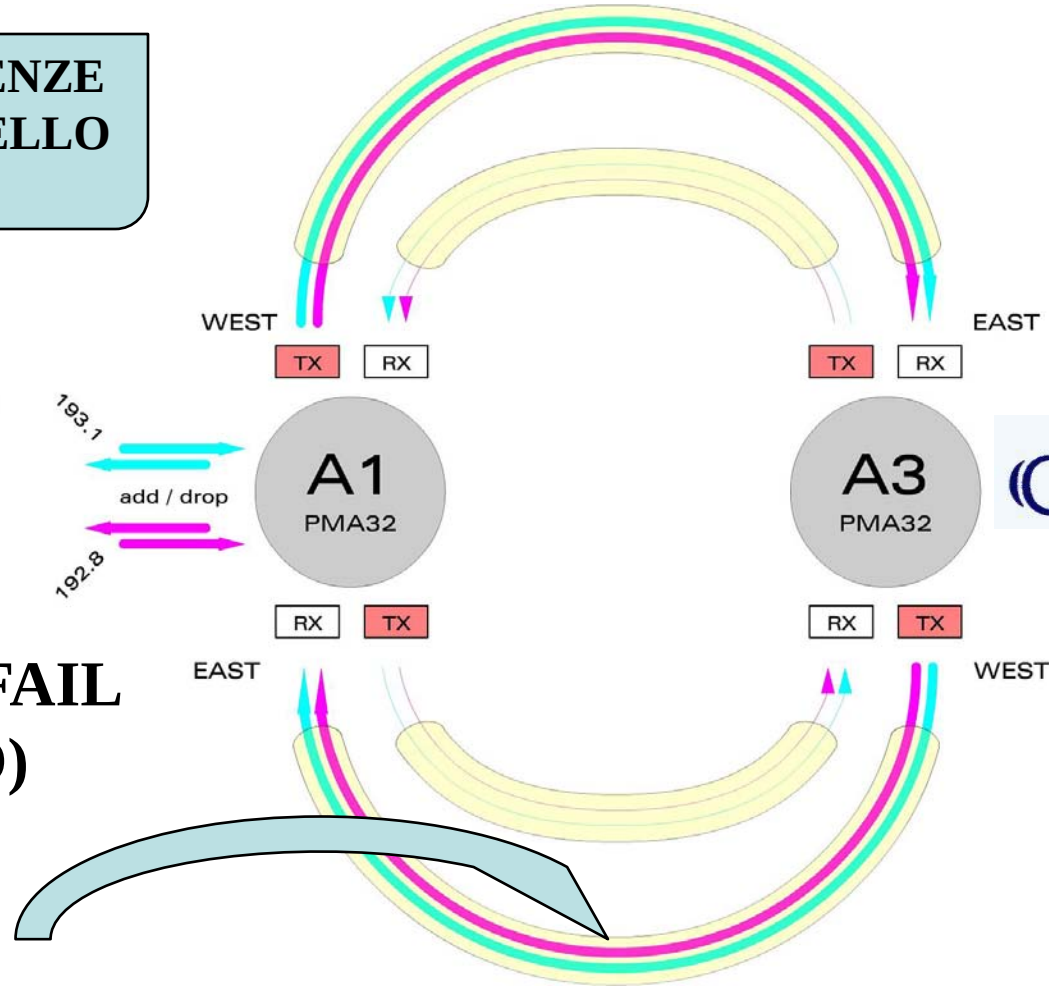
WEST = WORKING LINE (principale)

EAST = PROTECTION LINE (per i guasti)

The PMA32 OADM (Testing)

ANELLO CON DUE PMA32

2 FREQUENZE SULL'ANELLO OTTICO



TX OVEST sia nel PMA a INGEGNERIA, sia nel PMA al CNR.

Ingegneria

cnit

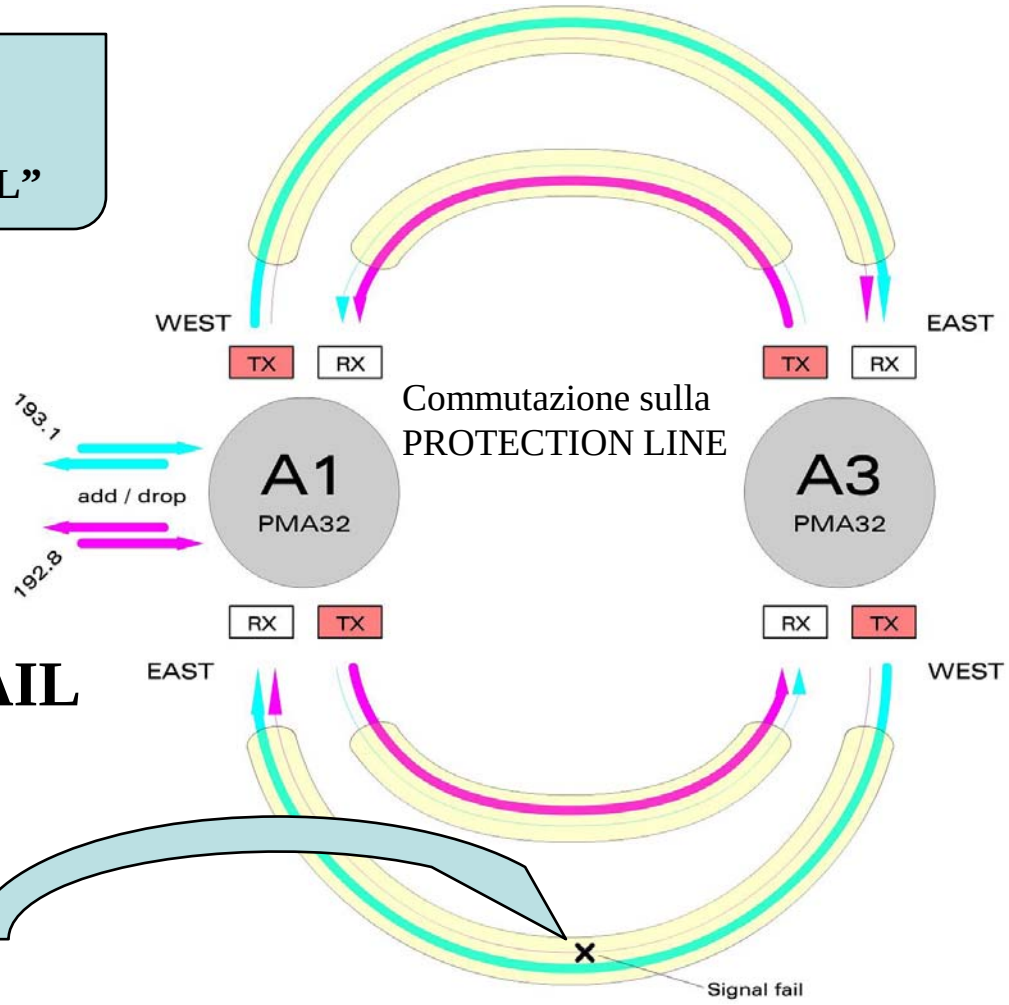
SIGNAL FAIL (GUASTO)

192,8 THZ

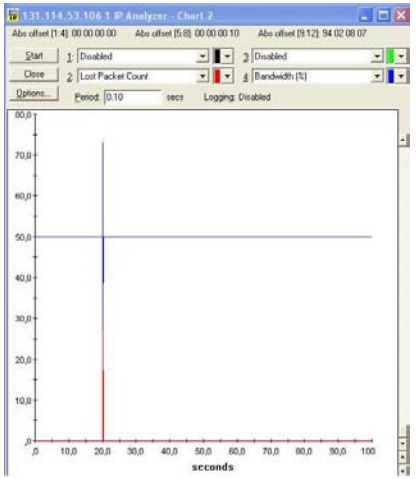
The PMA32 OADM (Testing)

ANELLO CON DUE PMA32

SWAPPING IN CASO DI "SIGNAL FAIL"



PERTURBAZIONE ISTANTANEA & SWAPPING IMMEDIATO



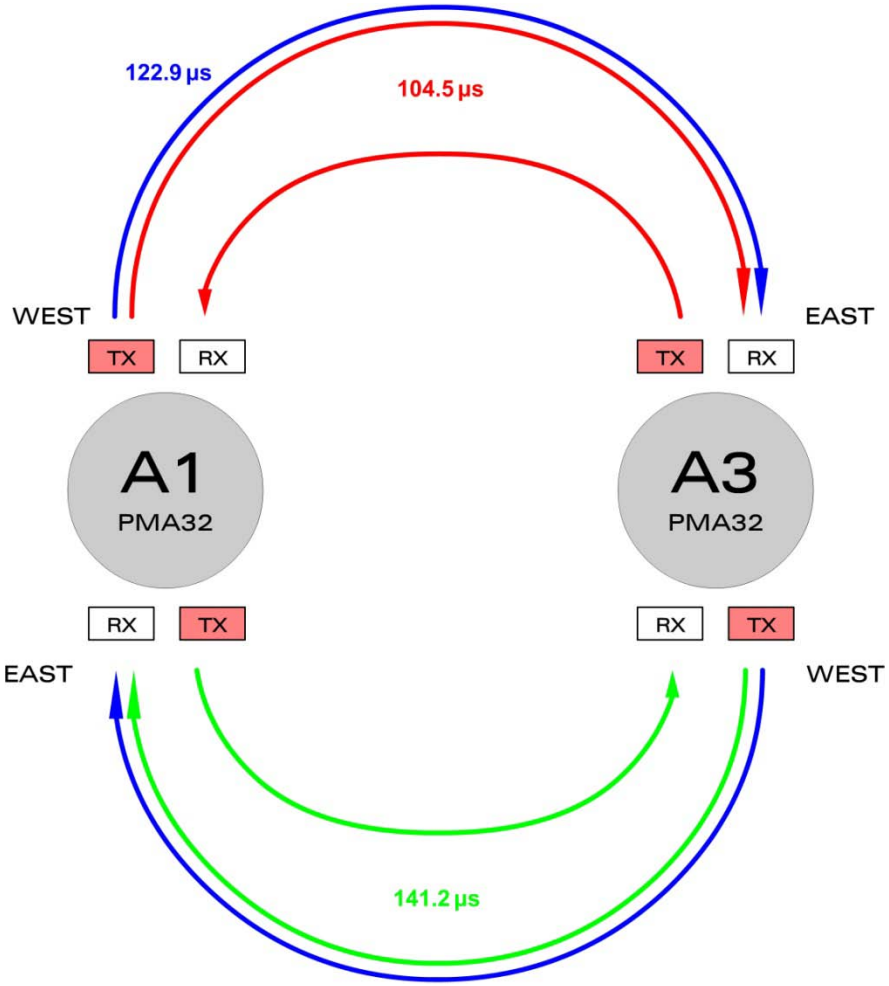
SIGNAL FAIL (GUASTO)

192,8 THZ

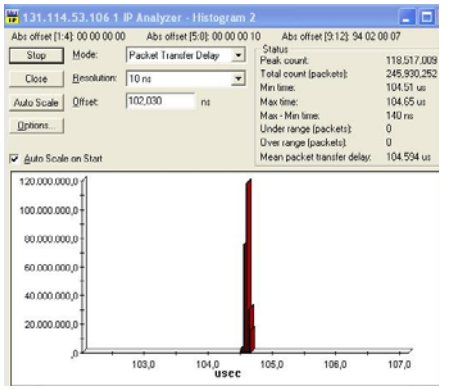
The PMA32 OADM (Testing)

ANELLO CON DUE PMA32

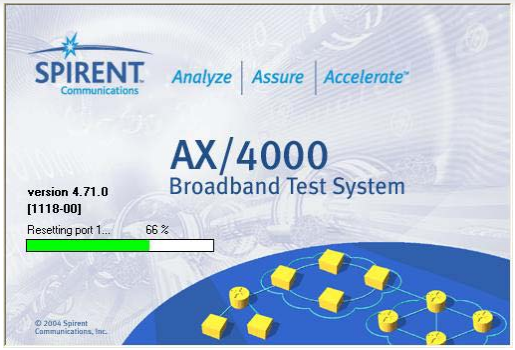
RITARDI MISURATI SULLA RETE



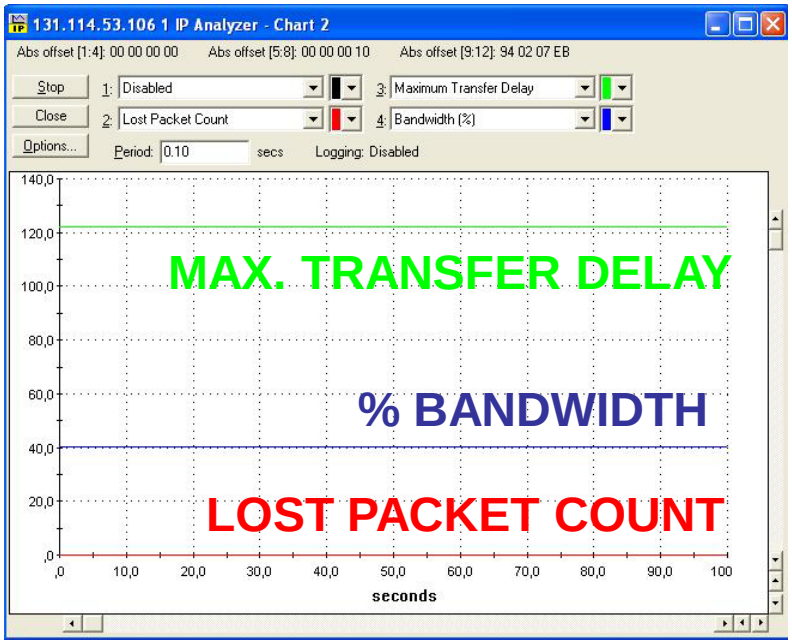
SHORTEST PATH
104,5 microseconds



The PMA32 OADM (Testing)



Testing con AX4000
Traffic Generator / Analyzer

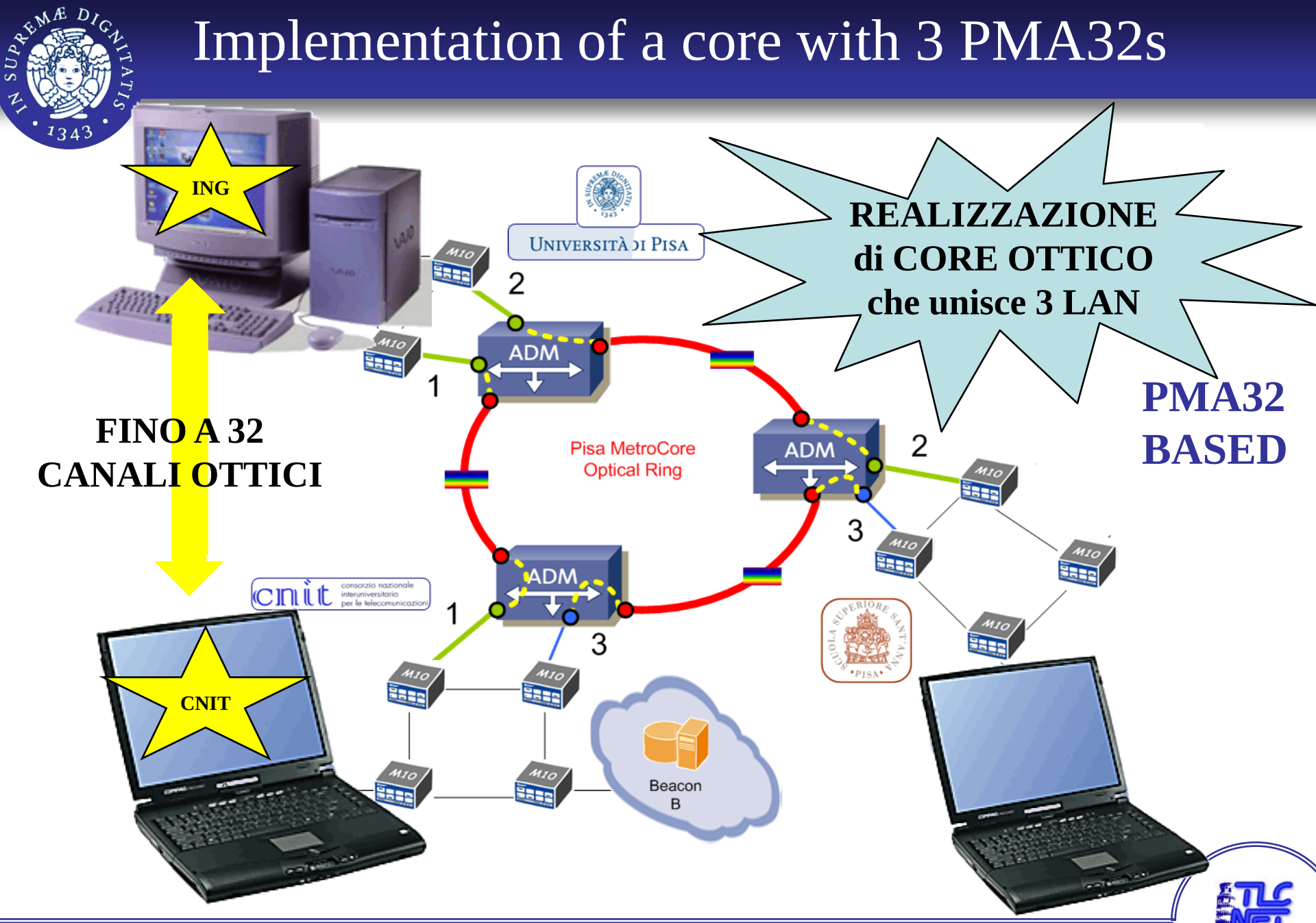


APPROACH:
Mode: IP packets
Distribution: periodic packets
Fixed datagram length: 64/128/512/1500 bytes
Max. load/fixed length: 25% to 100%

104 - 141 microsecondi di ritardo sull'anello

DI CUI 1 µsec dovuto a 1 PMA32 (nettamente trascurabile)

Implementation of a core with 3 PMA32s



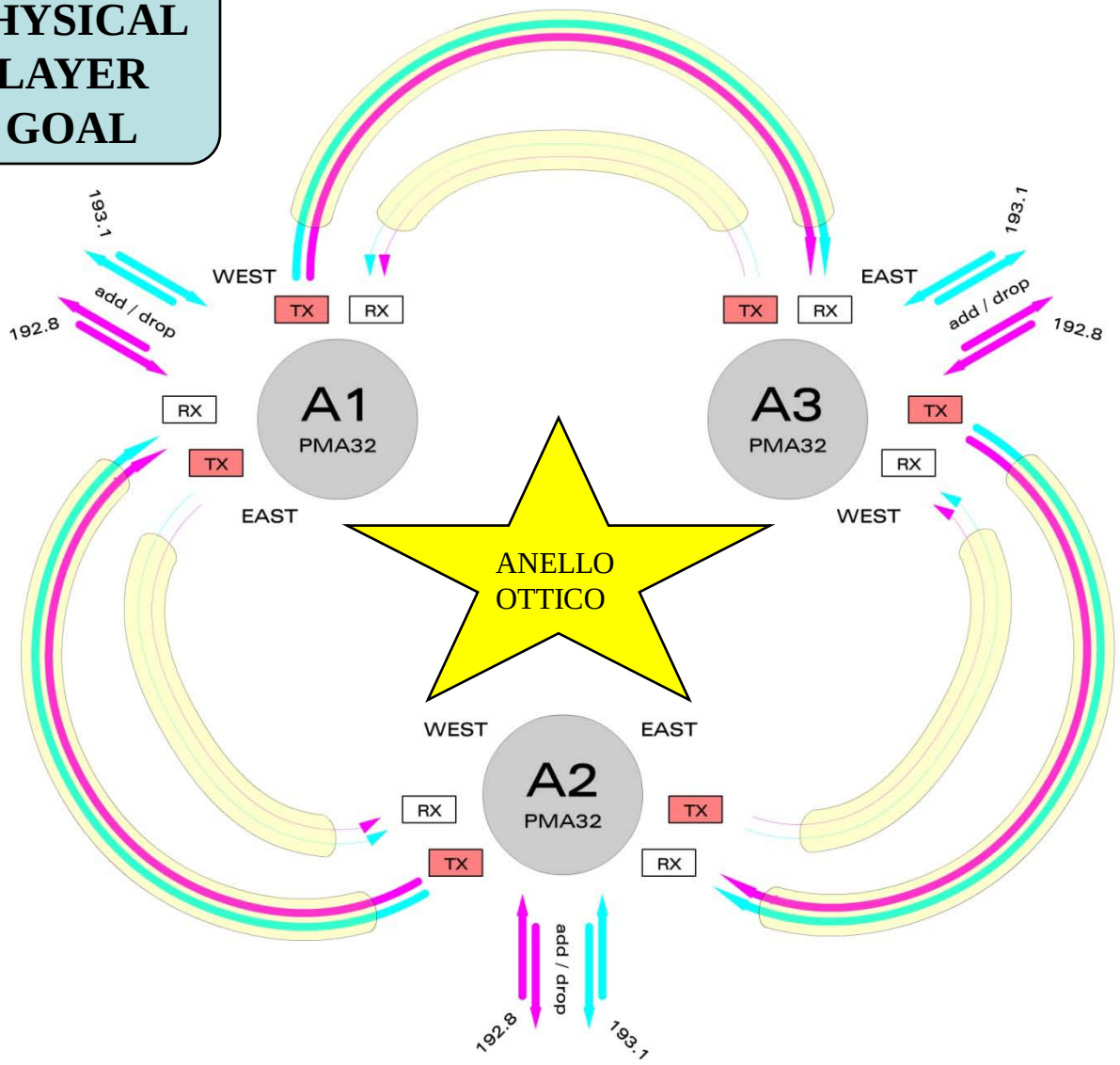
Implementation of a core with 3 PMA32s

PHYSICAL LAYER GOAL

193,1 THZ

192,8 THZ

GIGABIT ETHERNET



WORKING CHANNEL = TX WEST in ogni PMA32

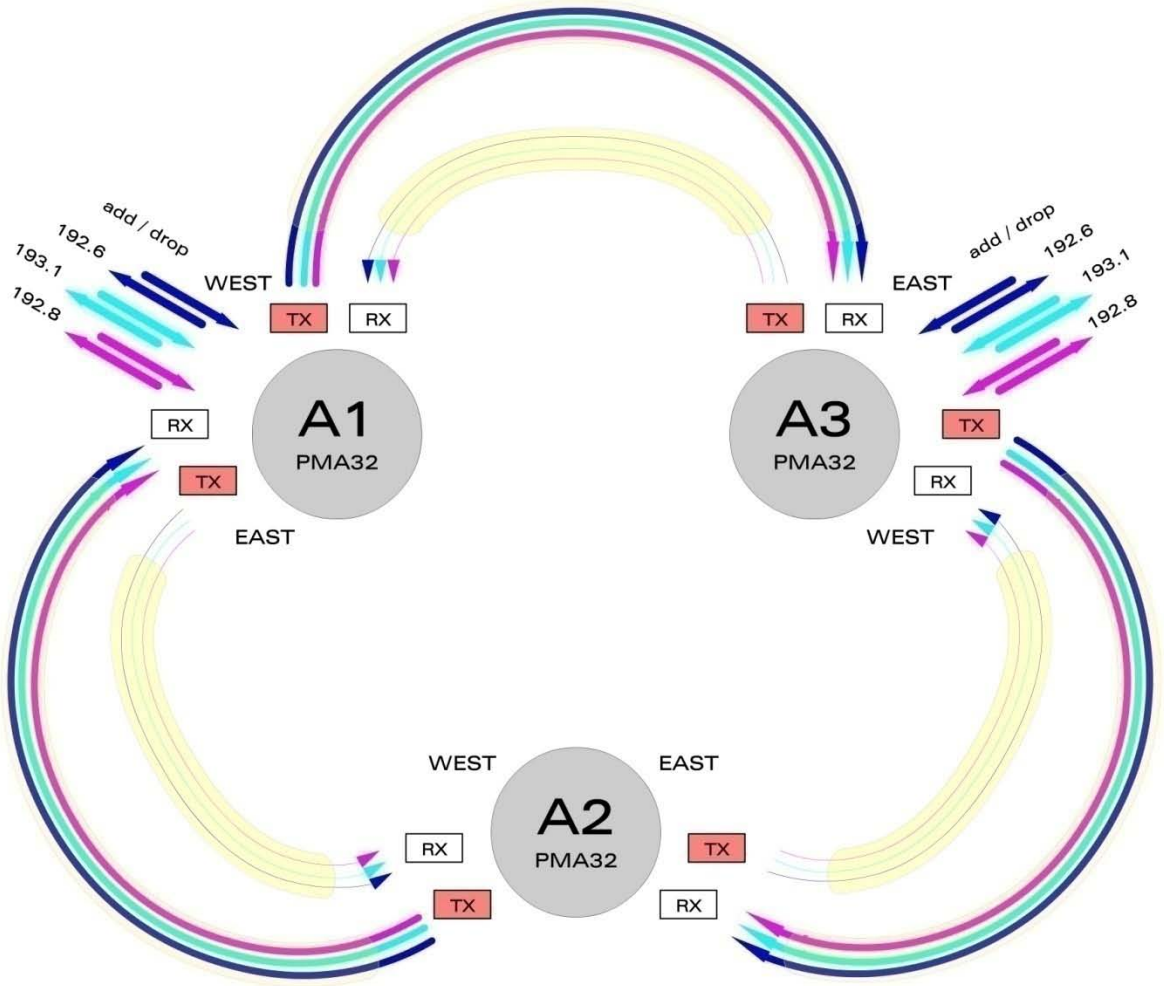
PROTECTION CHANNEL = TX EAST in ogni PMA32

Implementation of a core with 3 PMA32s

193,1 THZ

192,8 THZ

192,6 THZ

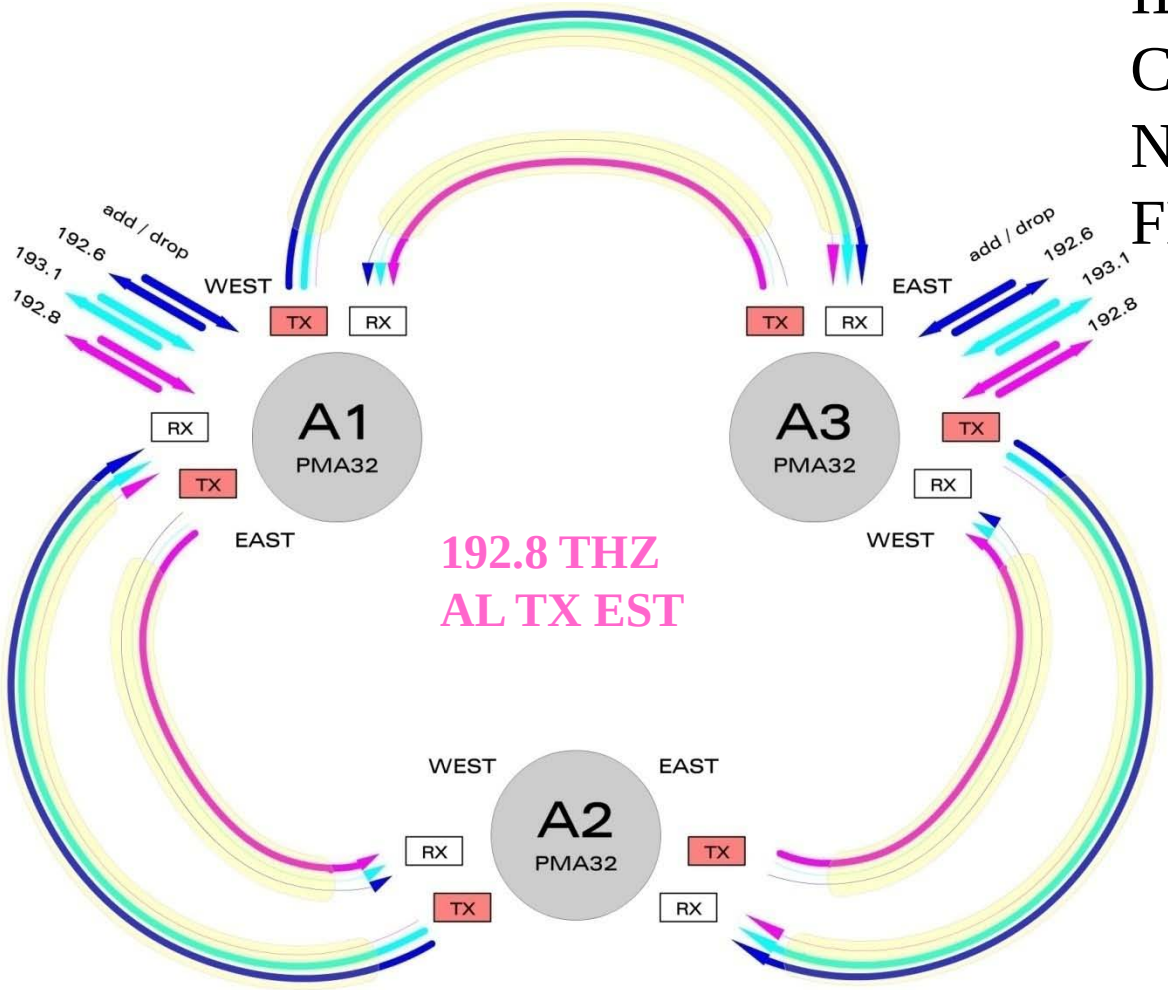


Alle due GIGABIT ETHERNET

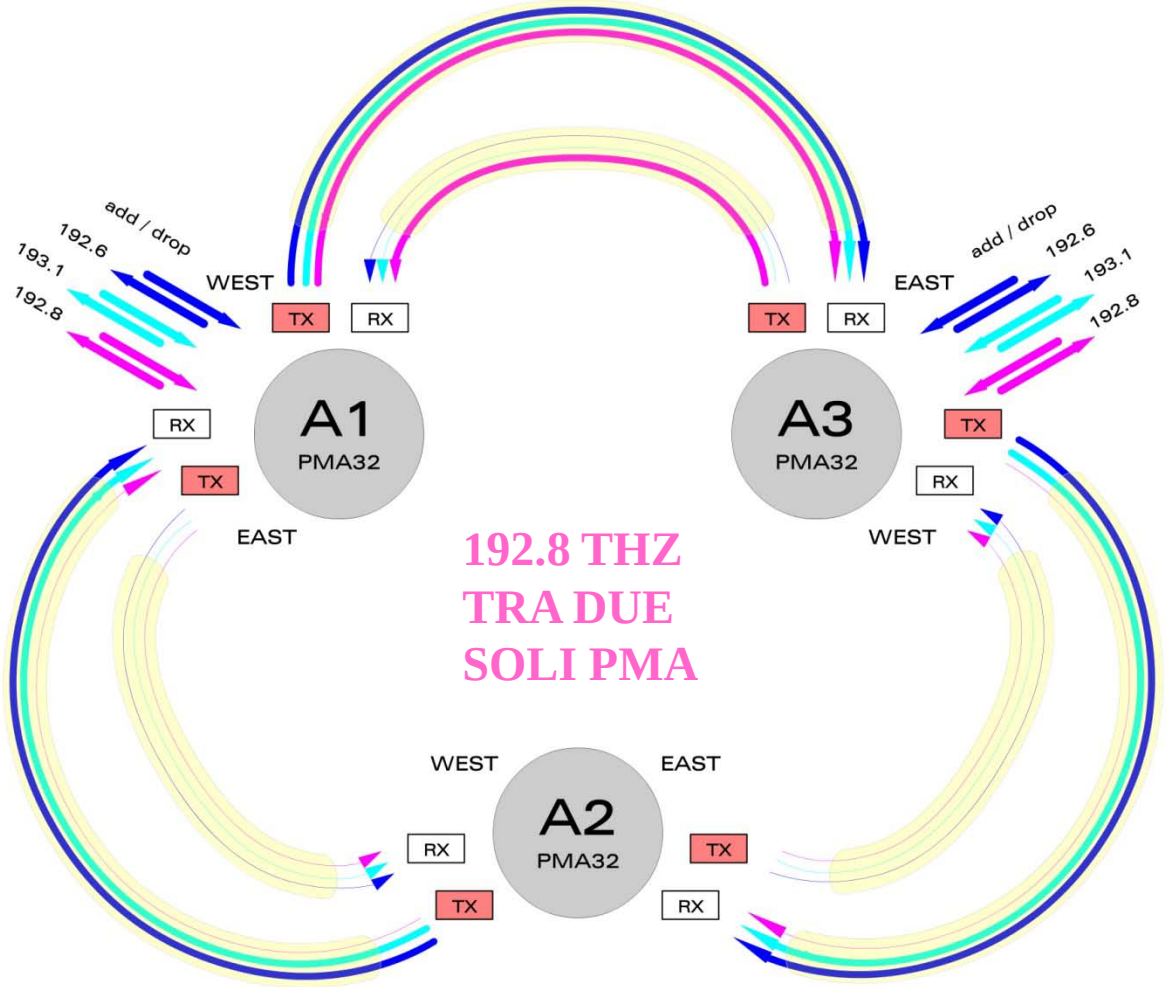
ABBIAMO AGGIUNTO un flusso ATM

Implementation of a core with 3 PMA32s

IL PMA32 CONSENTE NOTEVOLE FLESSIBILITA'



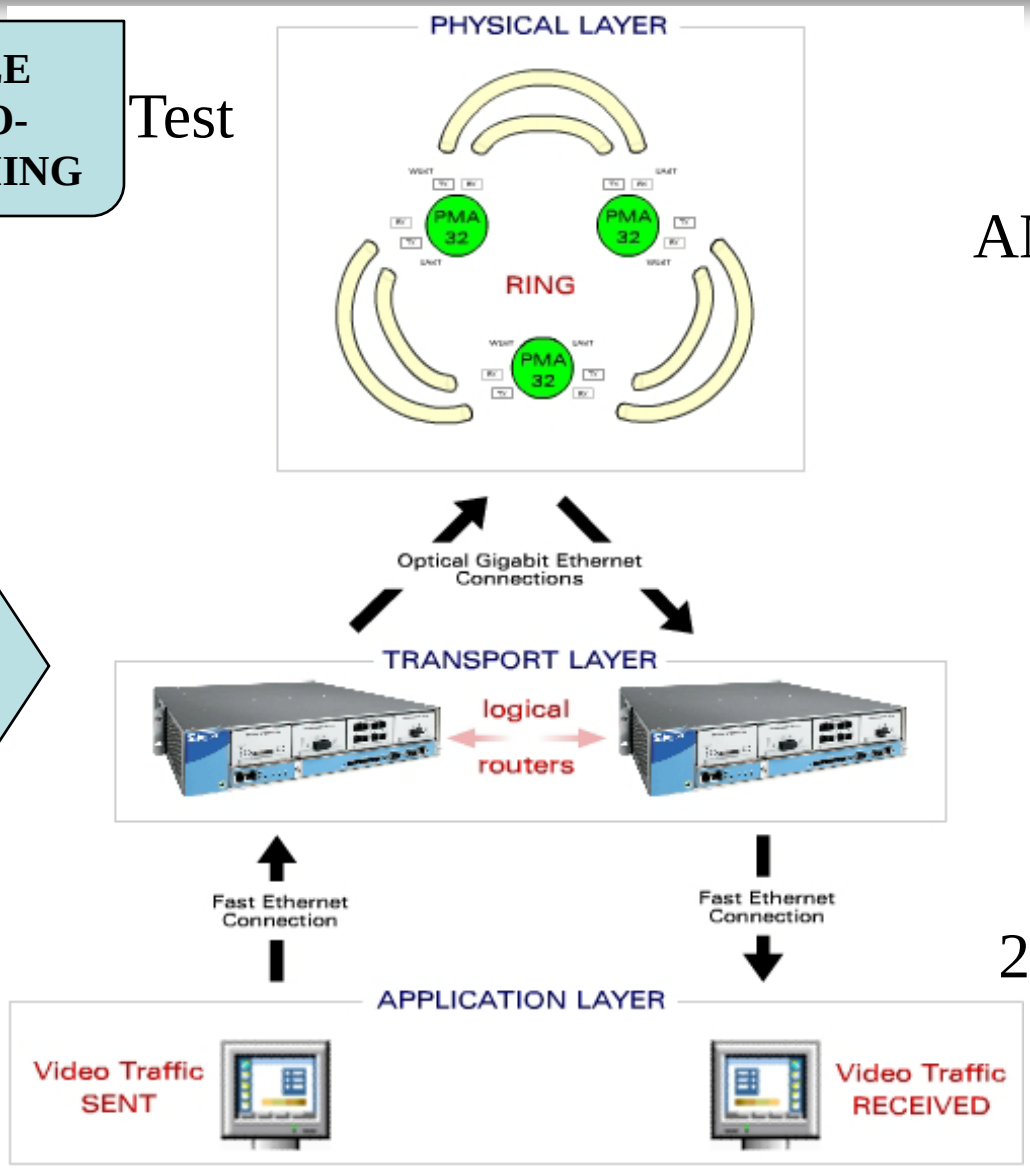
Implementation of a core with 3 PMA32s



Implementation of a core with 3 PMA32s

SINGLE VIDEO-STREAMING Test

RITARDO DEL PMA32 = ININFLUENTE



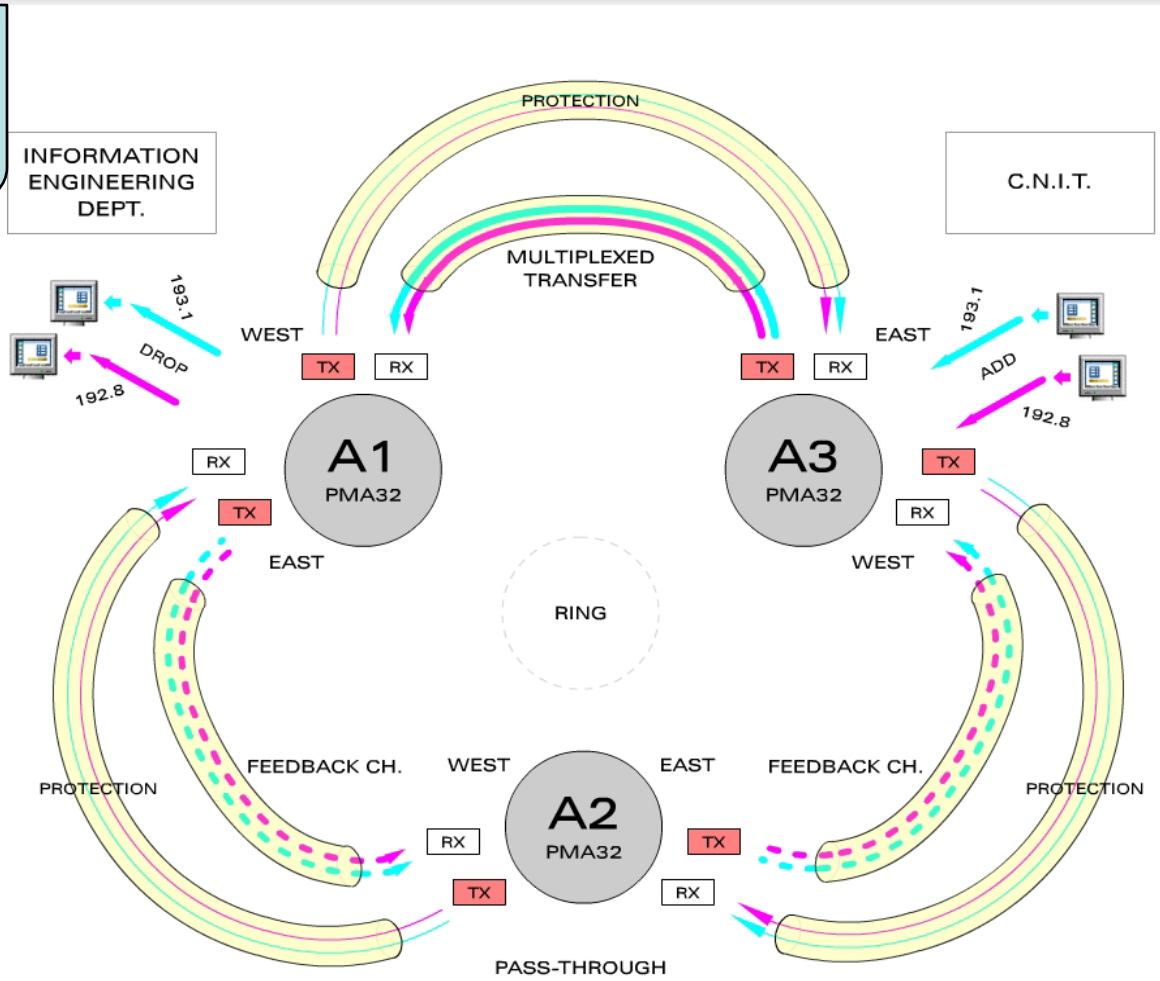
ANELLO OTTICO

ROUTERS

2 CALCOLATORI

Implementation of a core with 3 PMA32s

DOUBLE VIDEO-STREAMING



ABBIAMO
INFINE
INVIATO
2 FLUSSI
VIDEO

CNIT → ING

ANCHE QUI OTTIMA QUALITA' DEL TRASFER

From the PMA32 to the New OMS Families

MHL3000

OMS3200

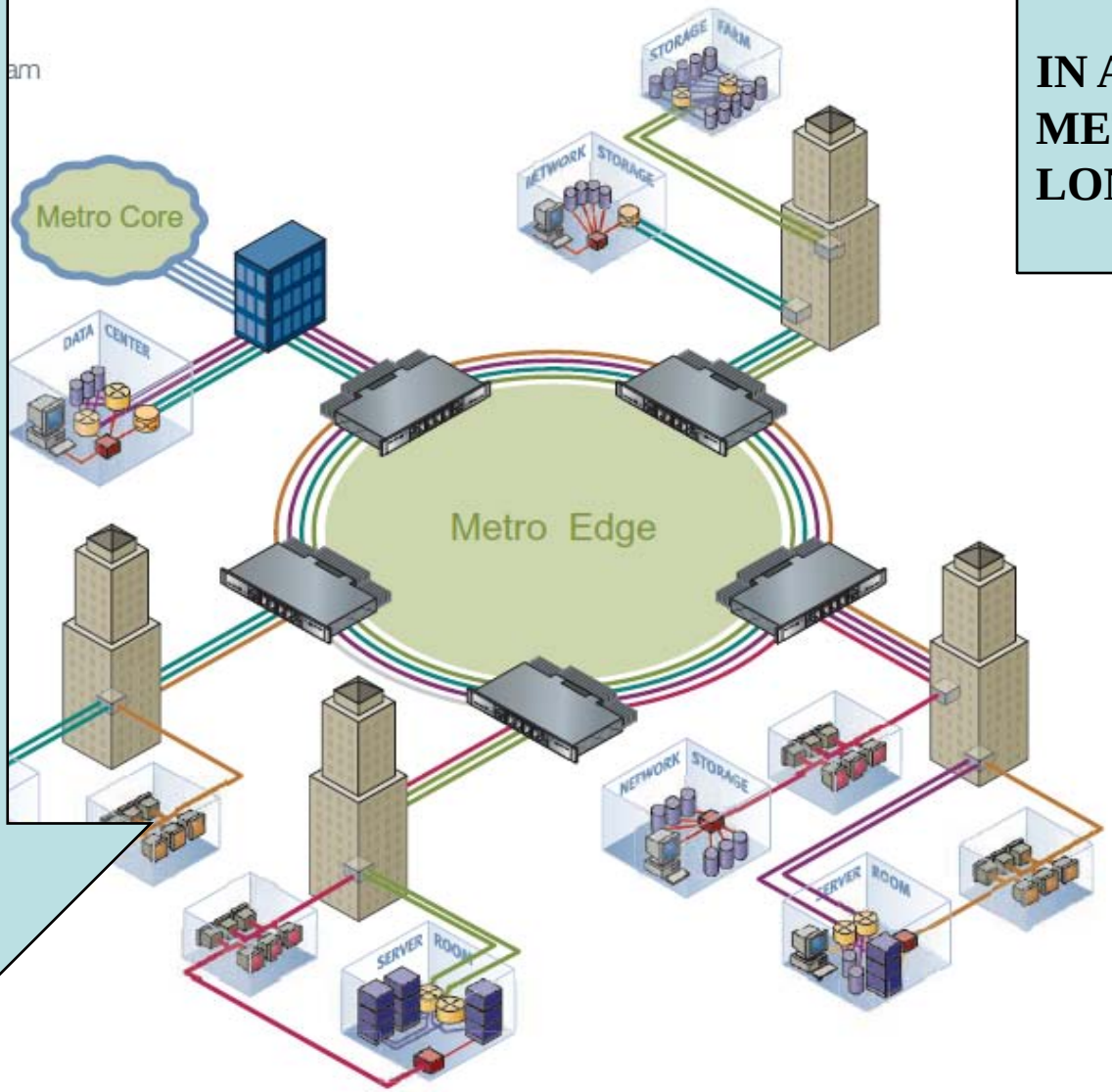
OMS MULTIHAUL

OMS2400

OMS1200

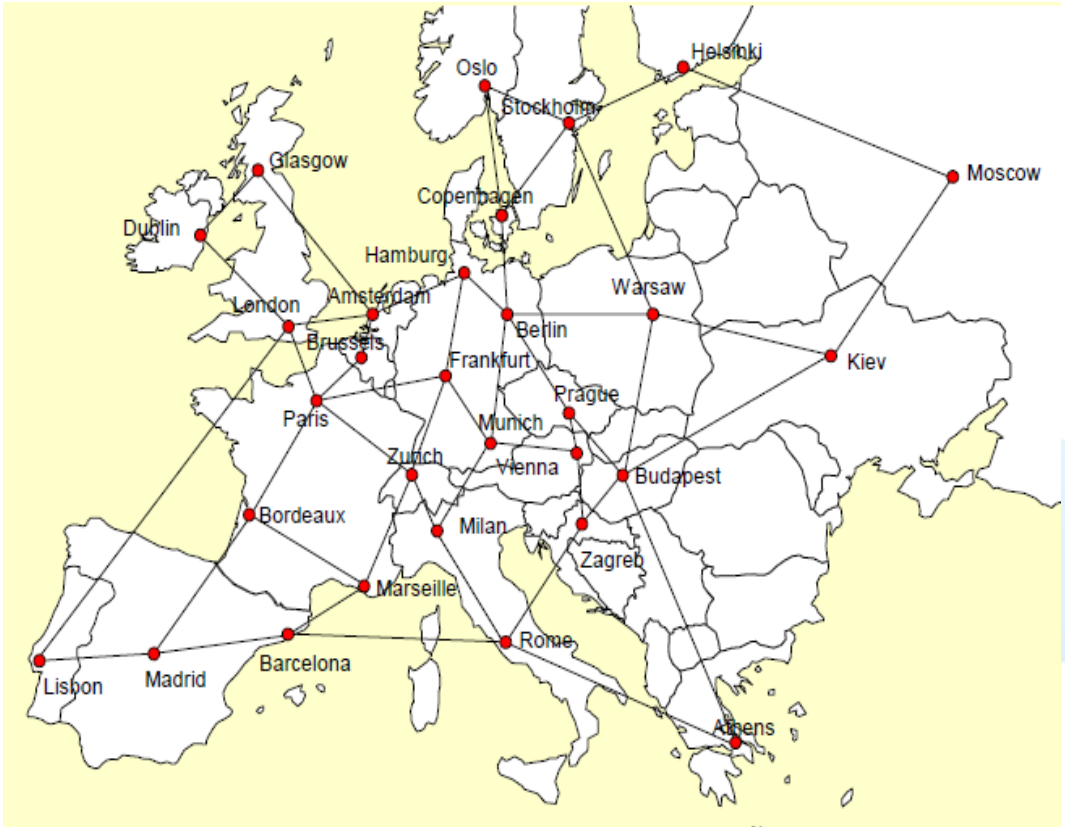
OMS1664

OMS1400
(molto recente)



IN AMBITO METRO/ LONG HAUL

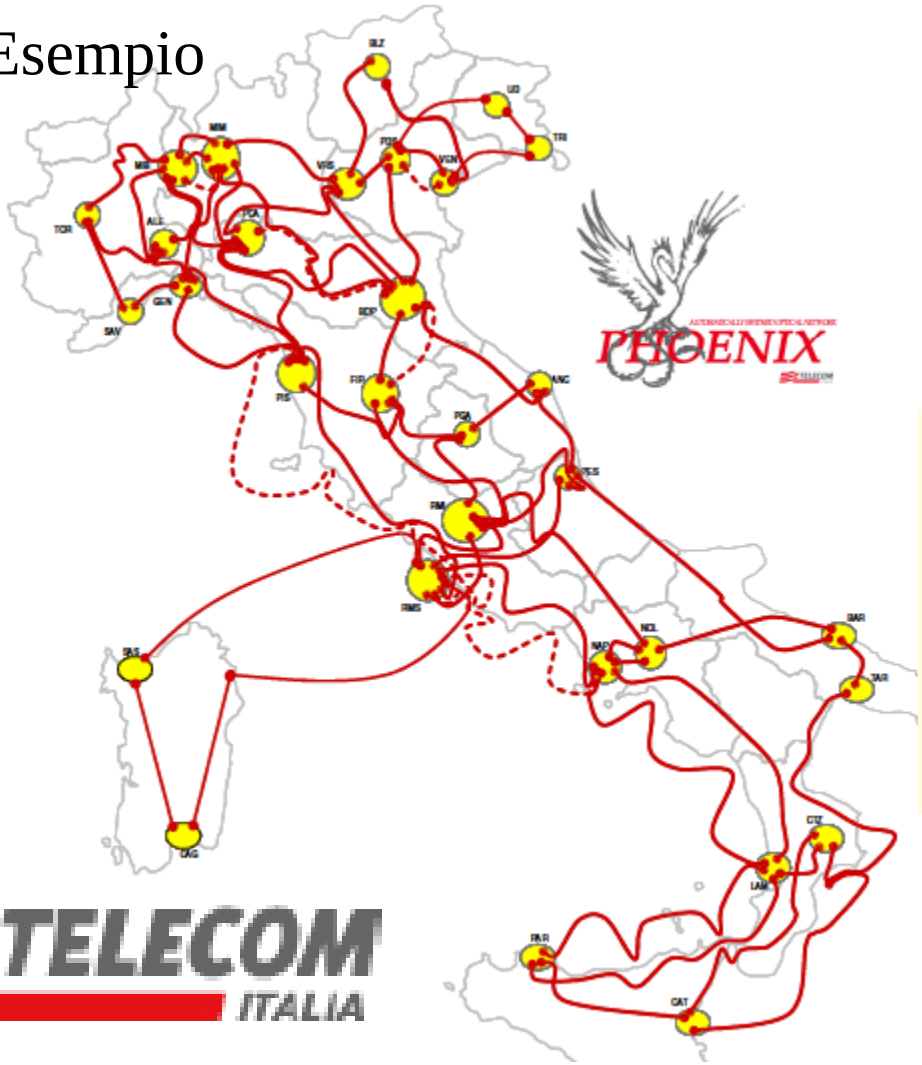
Evolution of Backbone Networks



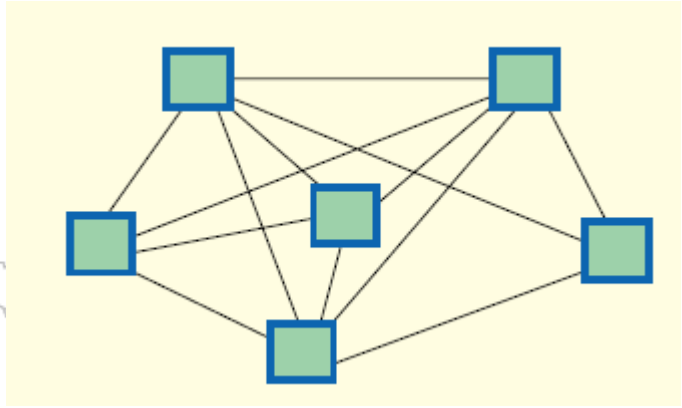
OGNI IMPORTANTE PROVIDER
= PROPRIA RETE OTTICA DI TRASPORTO DATI

Evolution of Backbone Networks

Esempio



FORTE AUMENTO COMPLESSITA' DELLA RETE



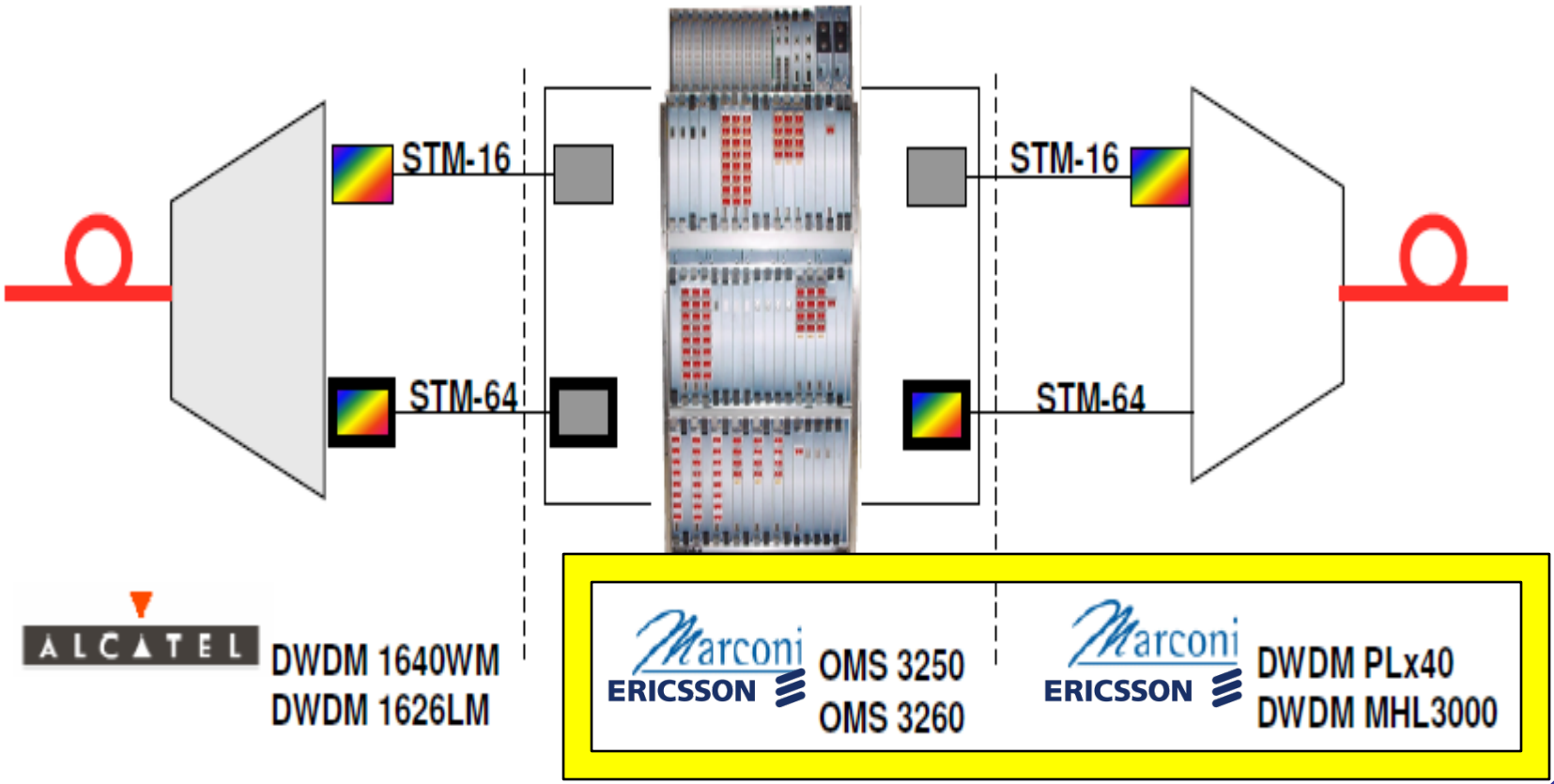
MESH TOPOLOGY (Maglia)

+

BETTER QoS

Evolution of Backbone Networks

ERICSSON's PORTFOLIO in PHOENIX by TELECOM ITALIA



Conclusioni

Questa tesi ha permesso di:

- Testare a fondo l'Oadm PMA32 Ericsson
- Realizzare un core ottico tra ING. e il CNR di Pisa
- Valutare la performance (rivelatasi ottima) di più flussi video attraverso l'anello ottico implementato

GRAZIE DELL' ATTENZIONE

Nicola Azzaro 19 Dicembre 2008