

GARR-T Network Architecture *disaggregata ma troppo*

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Università Roma TRE, 8-10 ottobre 2019

WORKSHOP GARR 2019

Ottica

P.Bolletta
G.Vuagnin

SDN/NFV

F.Farina
G.Viola

Coordinamento

M.Campanella
M.Carboni

Packet

M.Valiante
M.Marletta
G.Viola

Automazione

F.Farina
P.Mandato
G.Marzulli
P.Velati

The GARR Network

IRU fiber footprint **16000+1500 km**

~**9.000 km** of backbone

~**7.000 km** of access links

+ **1500 km** of dedicated fibre for Metrology Application (INRIM)

About **1000 user sites** interconnected

> **1.5 Tbps** aggregated access capacity

~ **3.5 Tbps** Backbone Capacity

~ **90%** of the users via DF (limited xDWM)

DWDM/OTN/ROADM Network

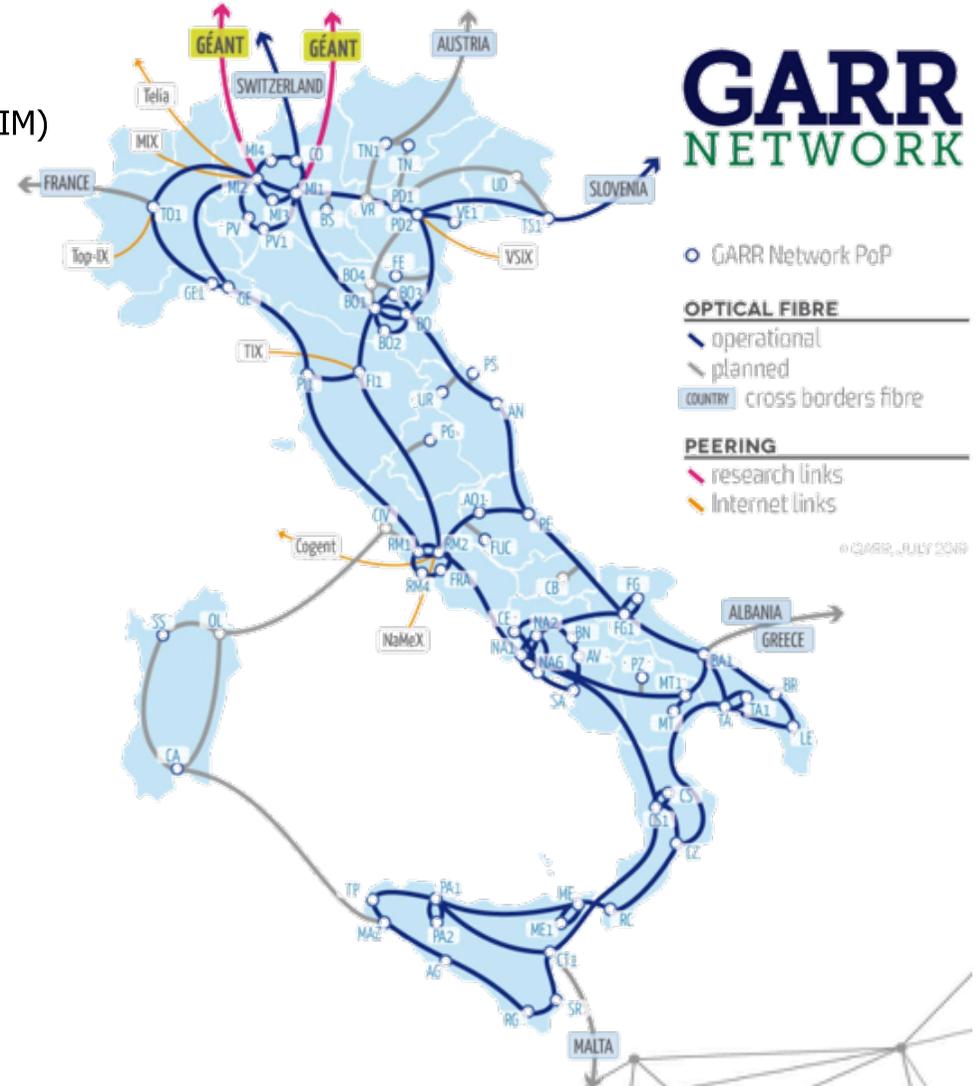
- (2011) Huawei 1/10 G
- (2015) Infinera 10/40/100 G
- (2017) Alien Waves 200G between Core PoPs
- (2018) **DCI 1.2T (5x100G active) CINECA – CNAF**

Core IP/MPLS network

- Juniper MX960/480/80

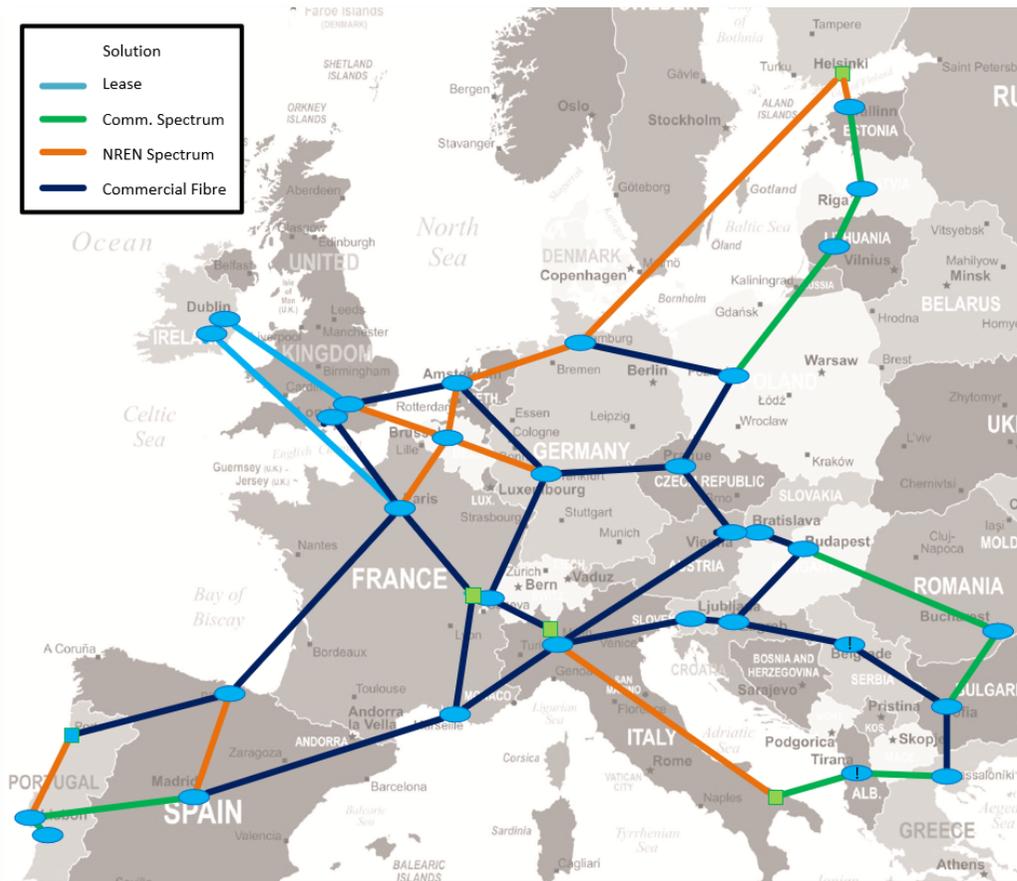
Metro/Aggregation

- Cisco ME3600/3400
- CPE Cisco 2900 series
- ISR-43xx, ISR-4451

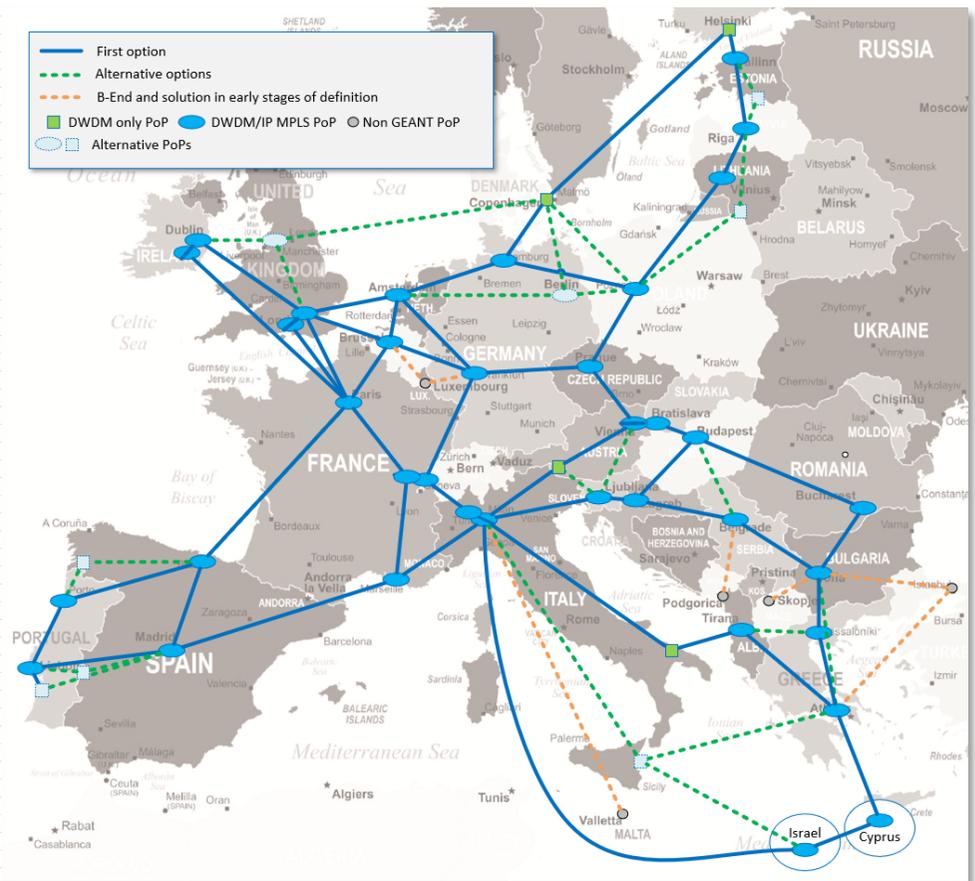


GEANT Network Footprint Evolution

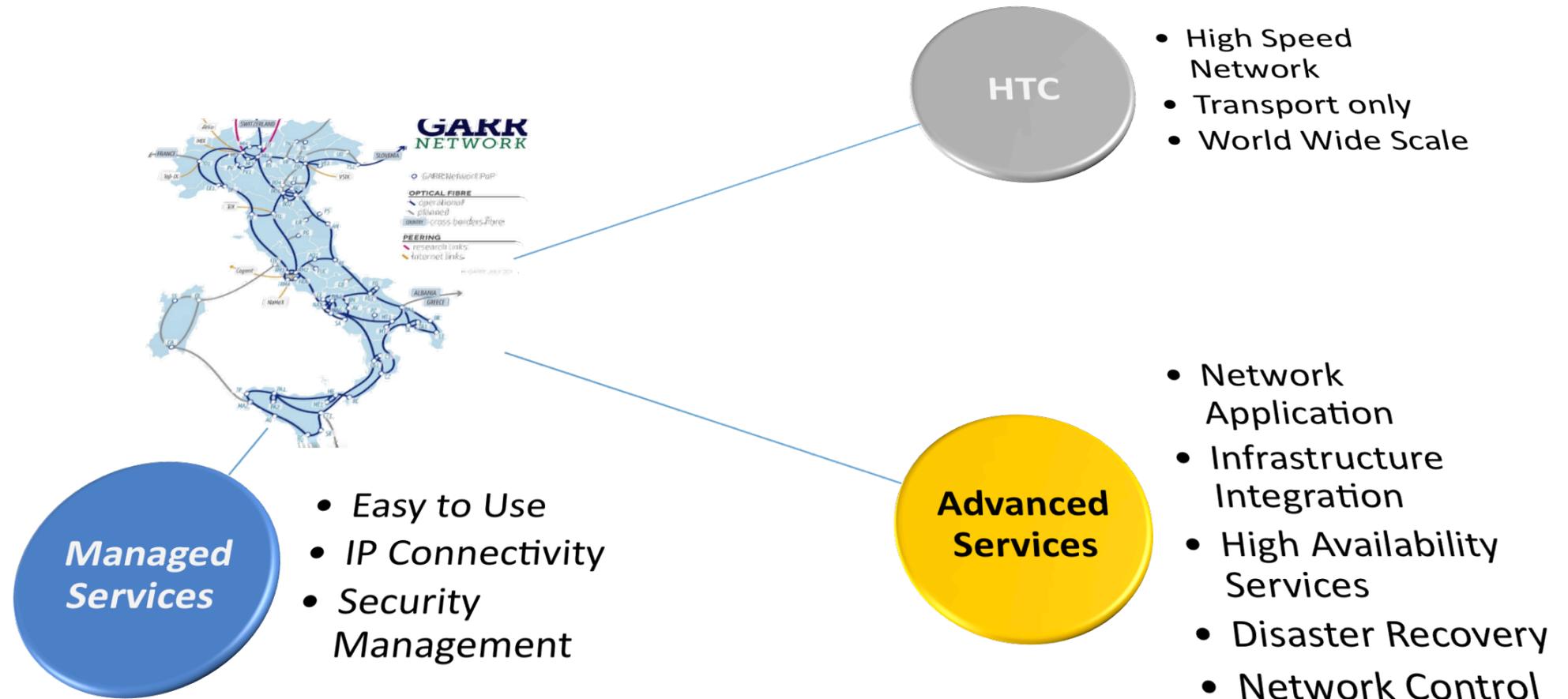
Reference 2019



The Full engagement



I requisiti della comunità GARR



Come Evolvere

Evoluzione Tecnologica

Fibre & Trasmission

1

2

Ethernet Roadmap

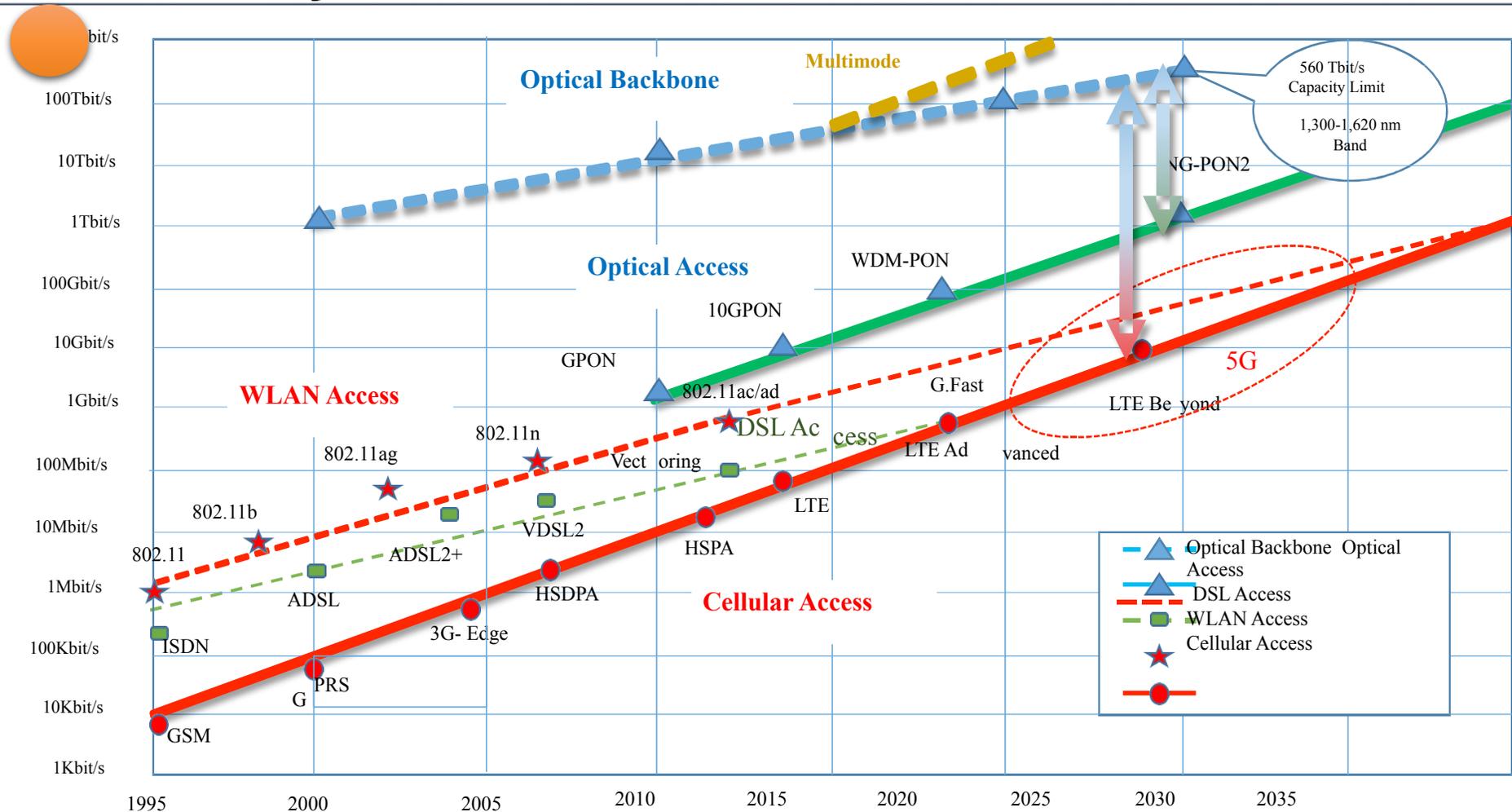
Packet

3

4

Software Glue

Benchmark of Wired and Wireless Technologies with Projections

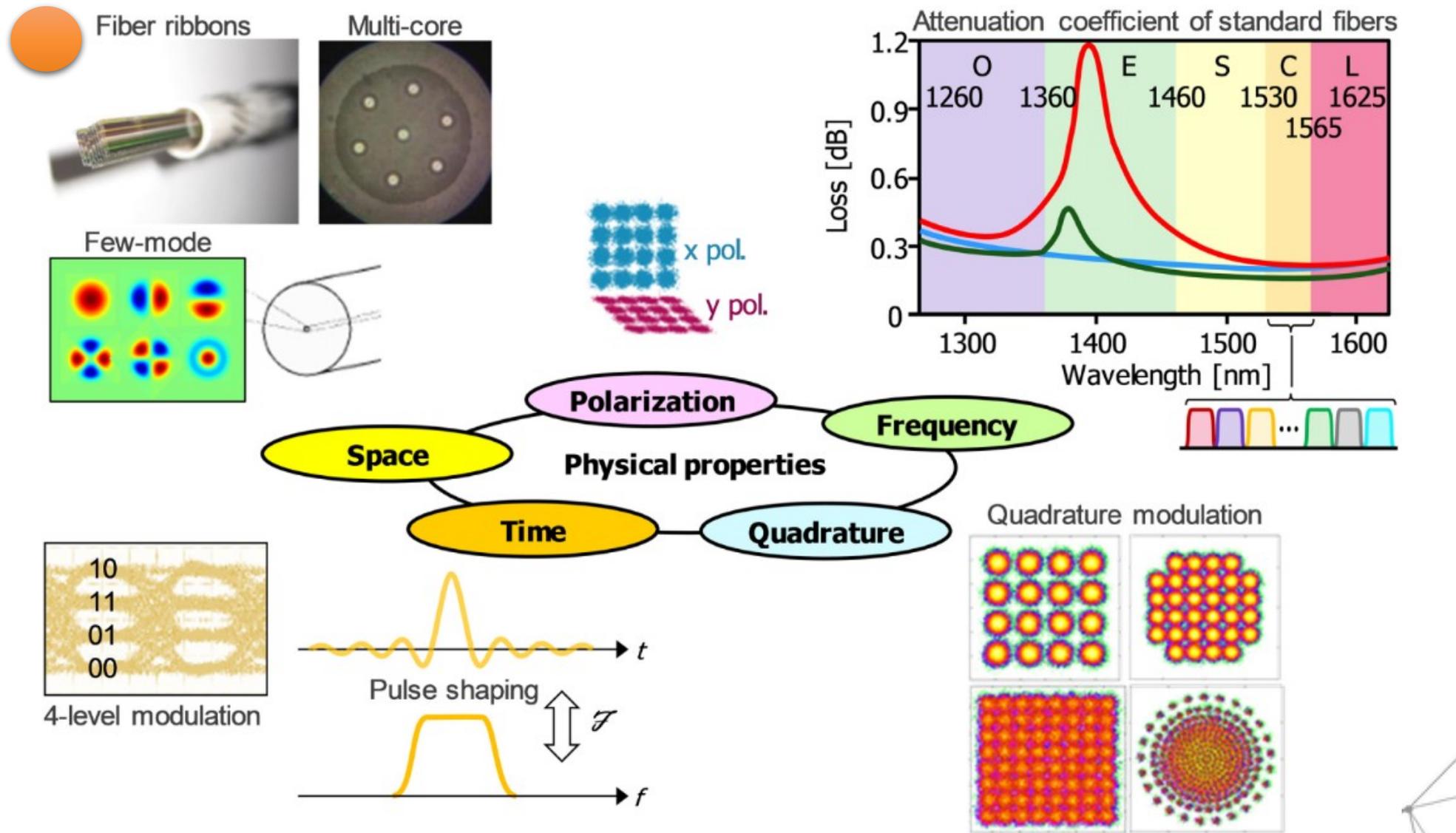


Source: M. Dècina, 2014, based on data by Bell Labs, G. Fettweis, and others

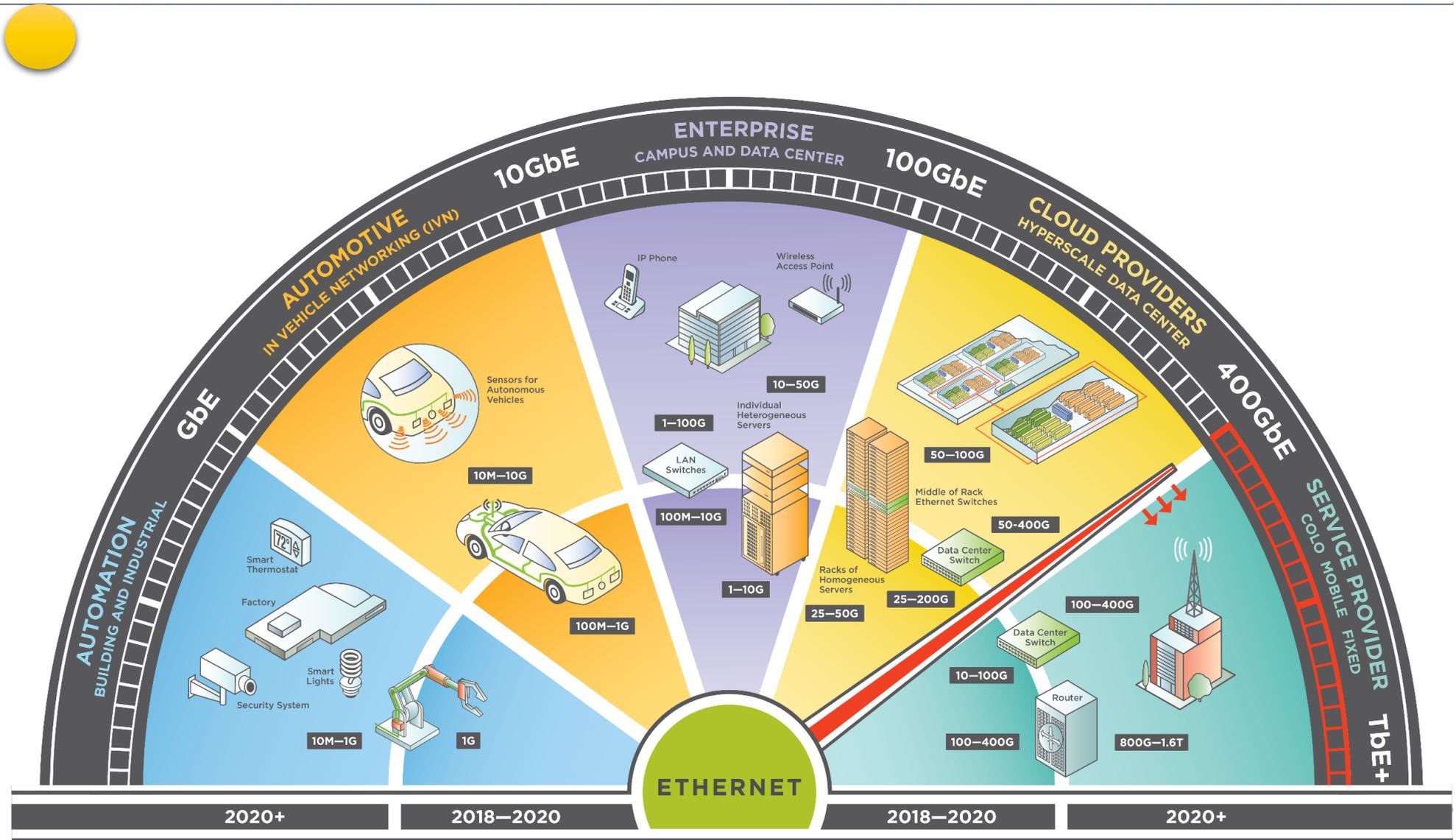
DEIB-Politecnico di Milano

Maurizio Dècina, 5G Italy, Rome, December 13th, 2018

Evoluzione della fibra ottica e dei sistemi di modulazione



Ethernet Road Map



Emerging Interfaces and nomenclature



EMERGING INTERFACES AND NOMENCLATURE

	Electrical Interface	Backplane	Twinax Cable	Twisted Pair (1 Pair)	Twisted Pair (4 Pair)	MMF	500m PSM4	2km SMF	10km SMF	40km SMF	80km SMF
10BASE-		TIS?		TIS/TIL							
100BASE-				T1							
1000BASE-				T1	T						
2.5GBASE-		KX		TIS?	T						
5GBASE-		KR		TIS?	T						
10GBASE-				TIS?	T						
25GBASE-	25GAUI	KR	CR/CR-S		T	SR			LR	ER	
40GBASE-	XLAUI	KR4	CR4		T	SR4/eSR4	PSM4	FR	LR4	ER4	
50GBASE-	LAUI-2/50GAUI-2 50GAUI-1	KR	CR			SR		FR	LR	ER	
100GBASE-	CAUI/10 CAUI-4/100GAUI-4 100GAUI-2 100GAUI-1	KR4 KR2 KR1	CR10 CR4 CR2 CR1			SR10 SR4 SR2	PSM4 DR	10X10 CWDM4 CLR4 100G-FR	LR4 4WDM-10 100G-LR	ER4 4WDM-40 ?	?
200GBASE-	200GAUI-4 200GAUI-2	KR4 KR2	CR4 CR2			SR4	DR4	FR4	LR4	?	?
400GBASE-	400GAUI-16 400GAUI-8 400GAUI-4	KR4	CR4			SR16	DR4	FR8 400G-FR4	LR8 ?	?	?

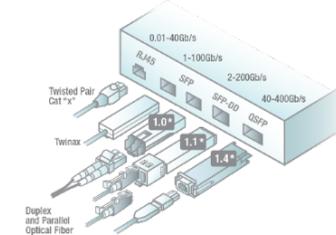
Gray Text = IEEE Standard Red Text = In Standardization Green Text = In Study Group
Blue Text = Non-IEEE standard but complies to IEEE electrical interfaces



FORM FACTORS

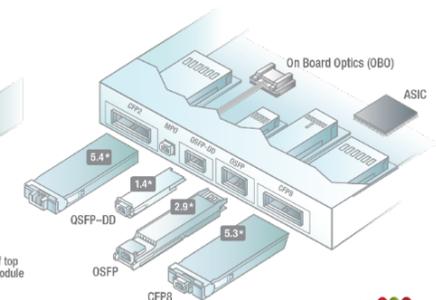
This diagram shows the most common form factors used in Ethernet ports. Hundreds of millions of RJ45 ports are sold a year while tens of millions of SFP and millions of QSFP ports ship a year.

1-4 Lane Interfaces



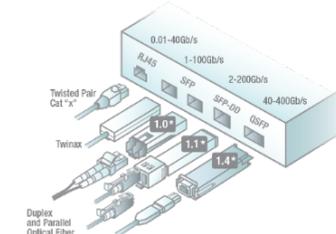
*Square inches of top surface of the module

4-16 Lane Interfaces



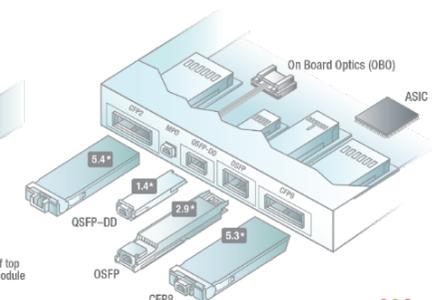
FORM FACTORS

1-4 Lane Interfaces



*Square inches of top surface of the module

4-16 Lane Interfaces



Many Technologies Support Carrier Ethernet



Transport Encapsulation



L0/L1 Transport
(EoSONET/SDH, OTN, DWDM)



L2 Bridging
(QinQ, 802.1ad, PBB)



MPLS Switching
(MPLS-TP, PW, VPLS, EVPN)

Control Plane

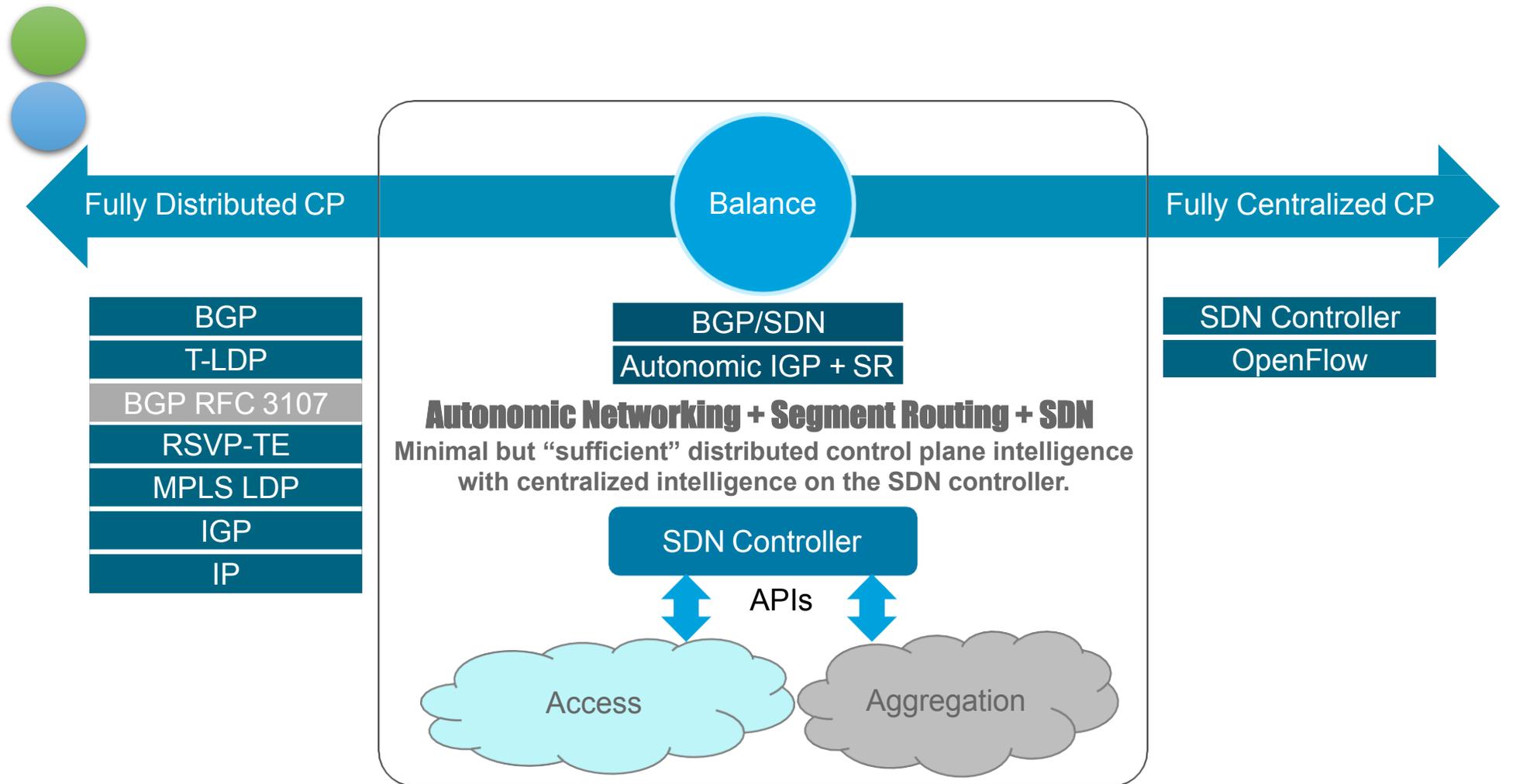
EMS/NMS + SNCP/MS-SPRing
ASON/WSON, GMPLS

xSTP, REP, others
G.8031, G.8032

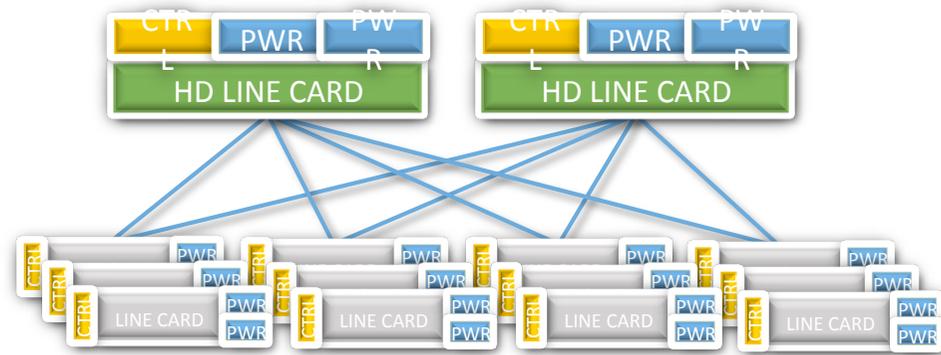
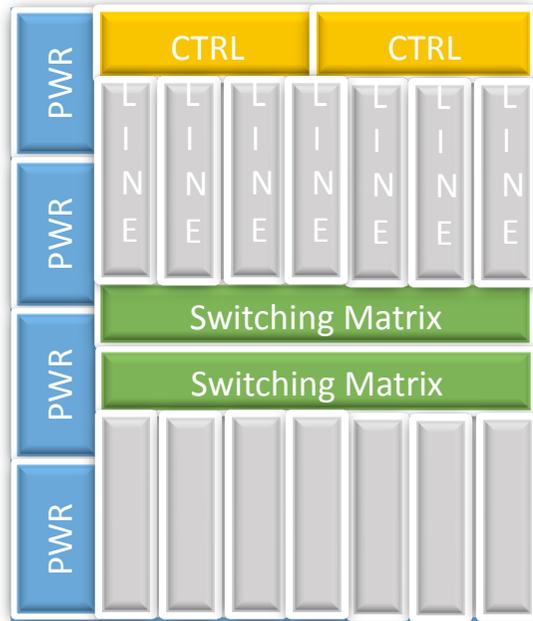
IP/MPLS (IGP, LDP, RSVP, BGP)
SR, GMPLS, EMS/NMS

+ various access (wireless, wireline, cable) and tunneling technologies.

Agile Carrier Ethernet Networks



Disaggregated Network Components



Vantaggi:

- costi minori
- maggiore resilienza ai guasti-aggiornamenti
- Affidabilità architetturale
- ciclo di vita definito

Svantaggi:

- Maggiore complessità

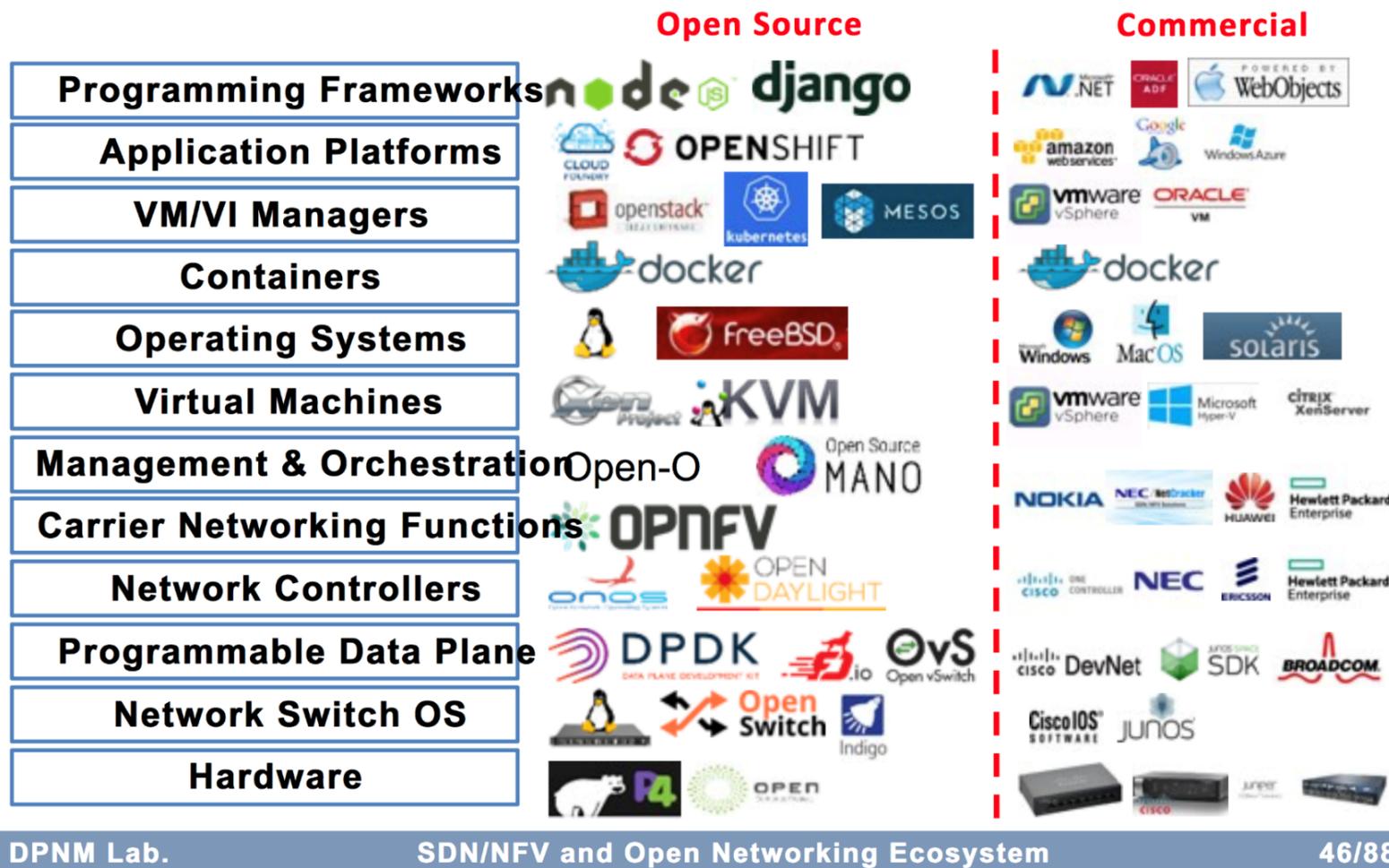
The Evolving Technologies



Open Networking Ecosystem



❖ Open Source vs. Commercial Solutions



DPNM Lab.

SDN/NFV and Open Networking Ecosystem

46/88

Evoluzione Tecnologica a supporto dell'evoluzione

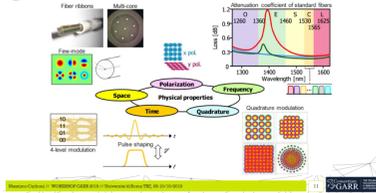
Fibre & Trasmissione

1

Benchmark of Wired and Wireless Technologies with Projections



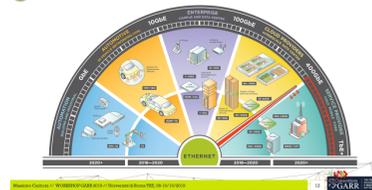
Evoluzione della fibra ottica e dei sistemi di modulazione



Emerging Interfaces and nomenclature

EMERGING INTERFACES AND NOMENCLATURE	FORM FACTORS				
<table border="1"> <tr><th>Interface</th><th>Form Factor</th></tr> <tr><td>...</td><td>...</td></tr> </table>	Interface	Form Factor	
Interface	Form Factor				
...	...				

Ethernet Road Map



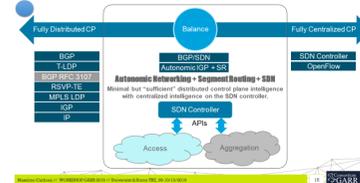
2

Ethernet Roadmap

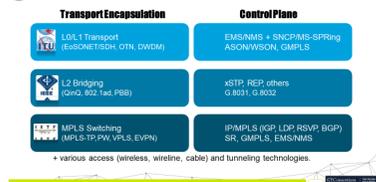
Packet

3

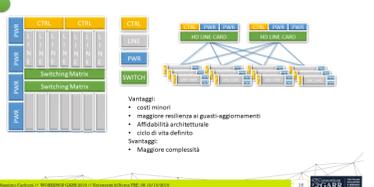
Agile Carrier Ethernet Networks



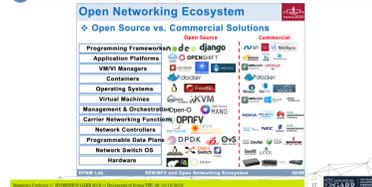
Many Technologies Support Carrier Ethernet



Disaggregated Network Components



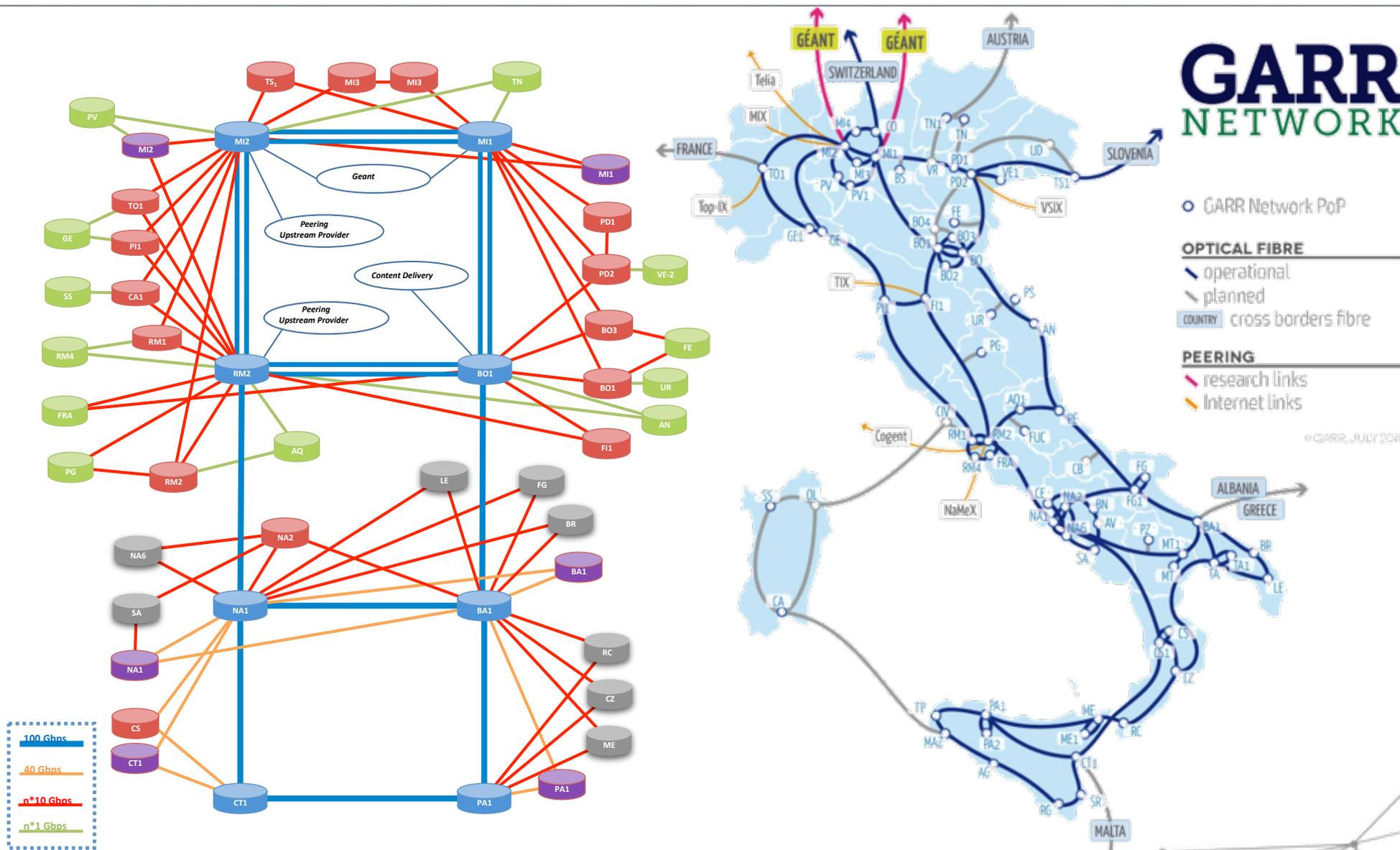
The Evolving Technologies



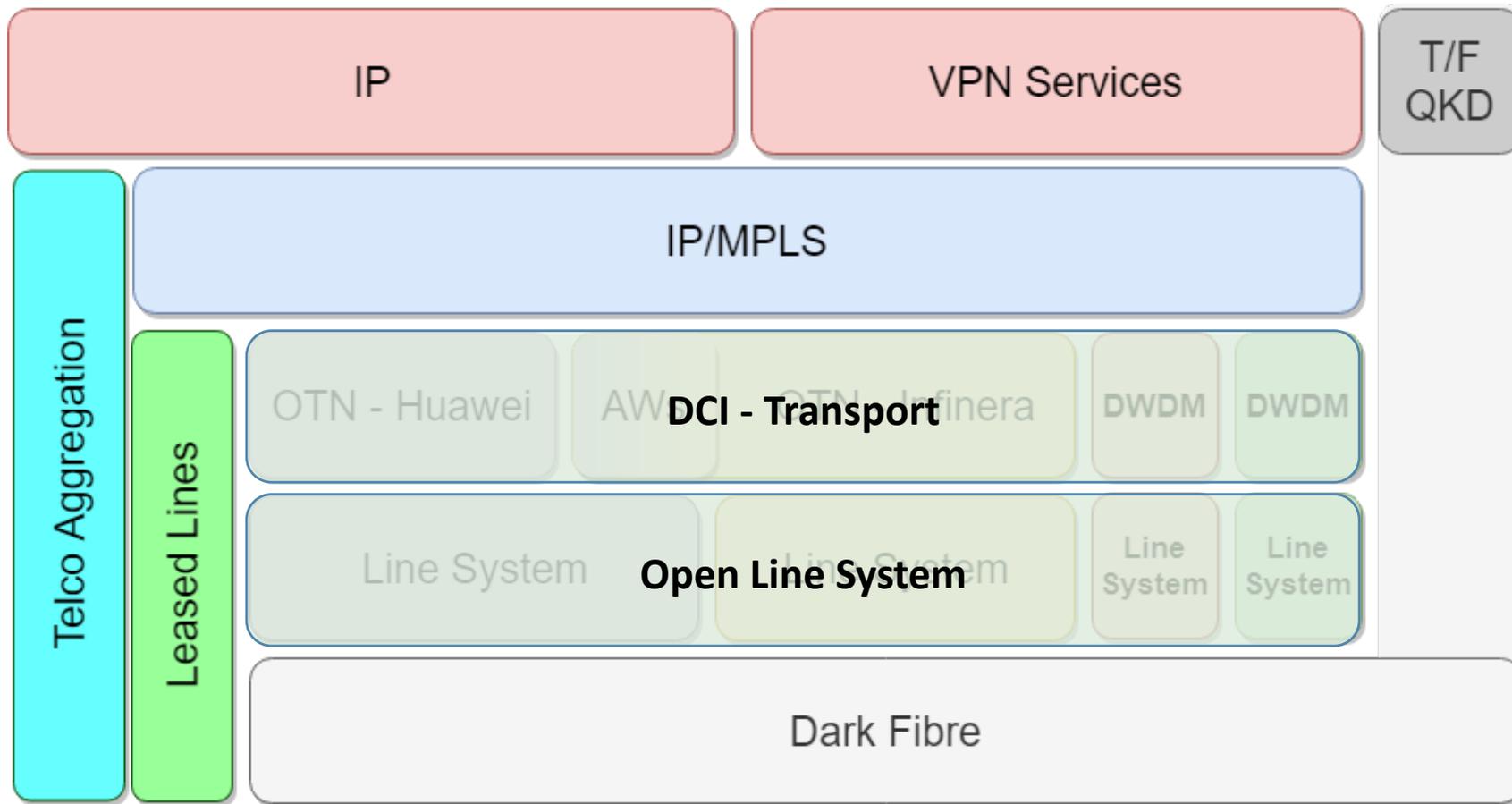
4

Software Glue

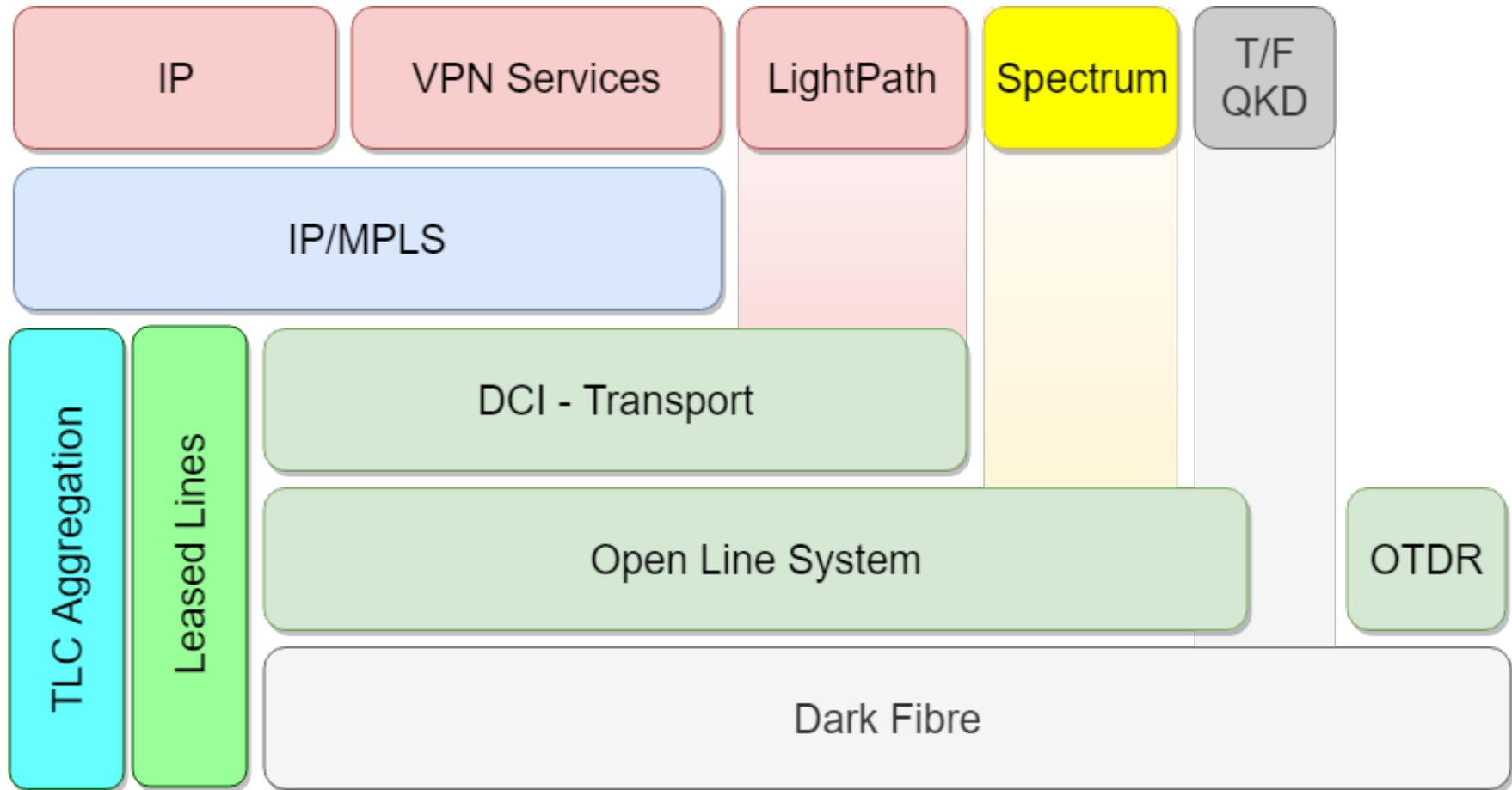
La Rete Attuale



GARR-X Network Architecture



GARR-T High Level Network Architecture v-1.0



L'evoluzione di rete in pillole

- Il disegno di rete pensato come “greenfield”

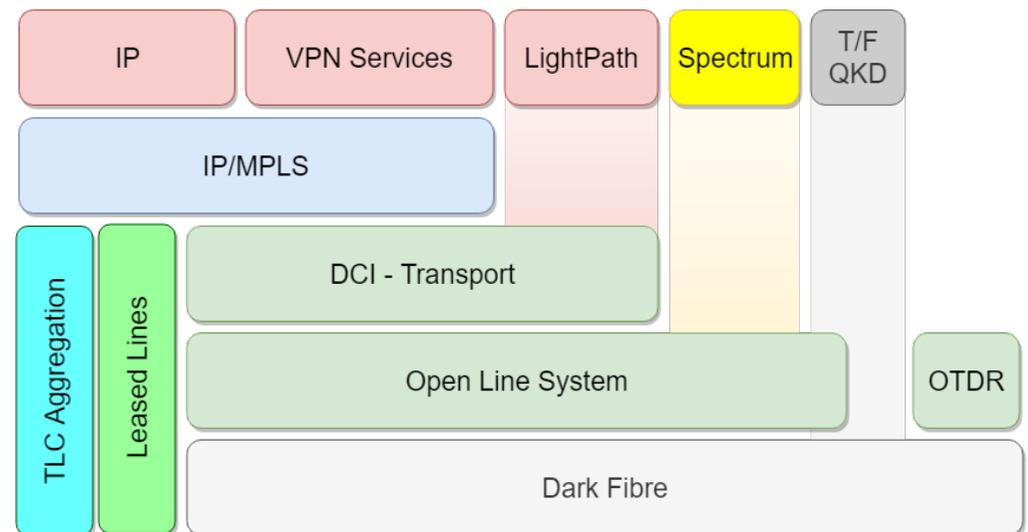
- Fibra ottica di lunga distanza, sistemi ottici e apparati completamente nuovi
- Introduzione della automazione su IP/MPLS network

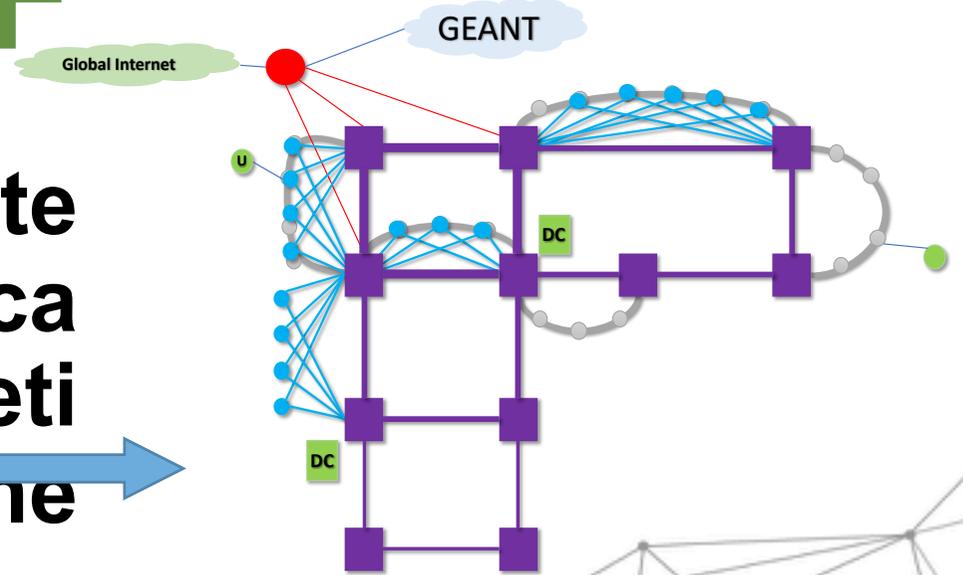
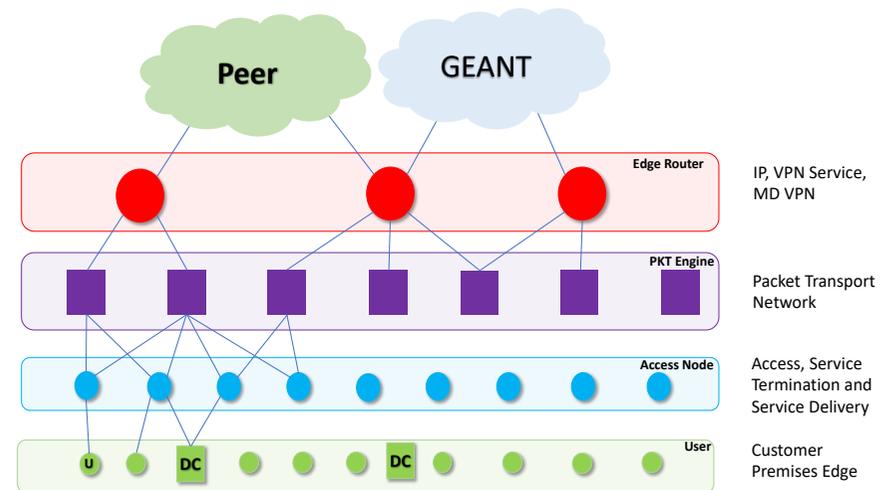
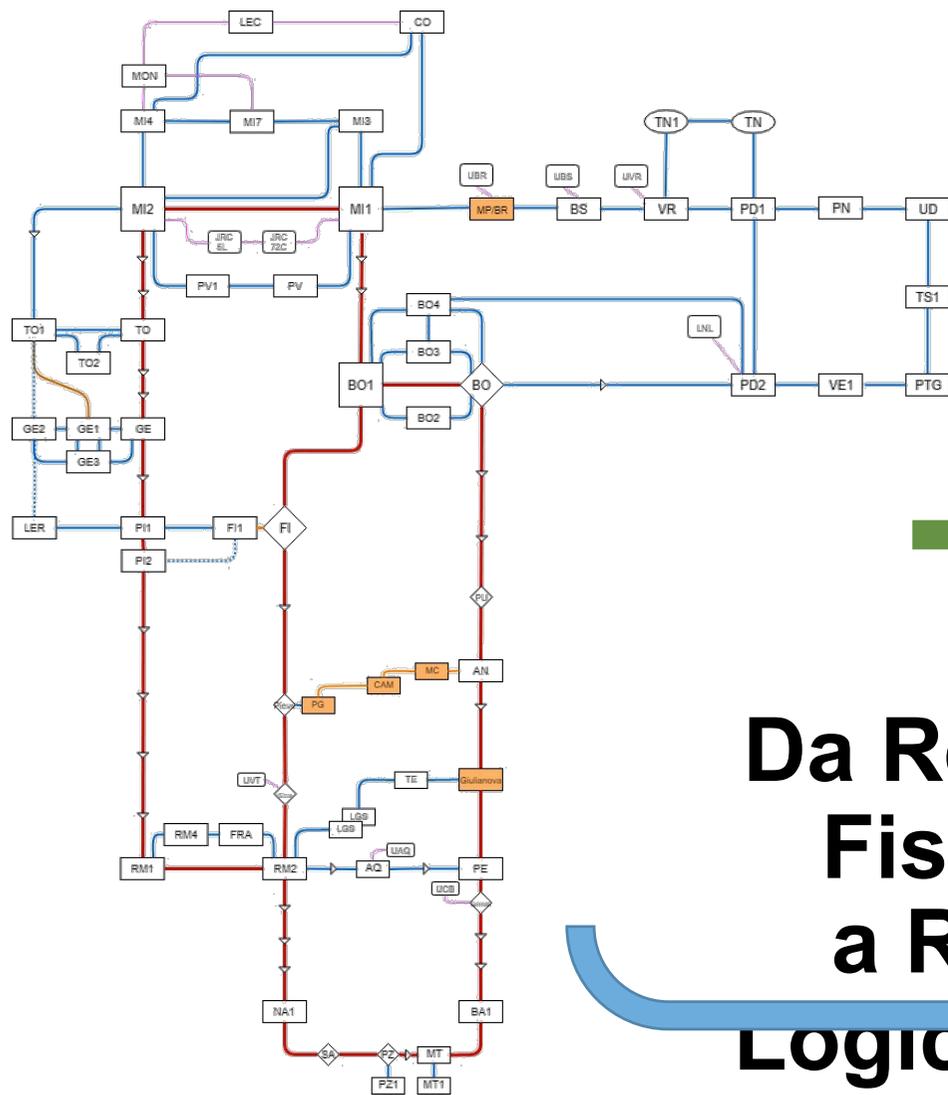
- Packet layer

- Servizi (IP, L2VPNs, L3VPNs, MDVPN etc.)
- Fast rerouting and restoration

- Optical layer

- Mette in comunicazione gli apparati di rete
- Spectrum e cammini ottici p-t-p (100 Gbps+)
- Nuovi Servizi: Time and frequency transfer
- Migrazione in service

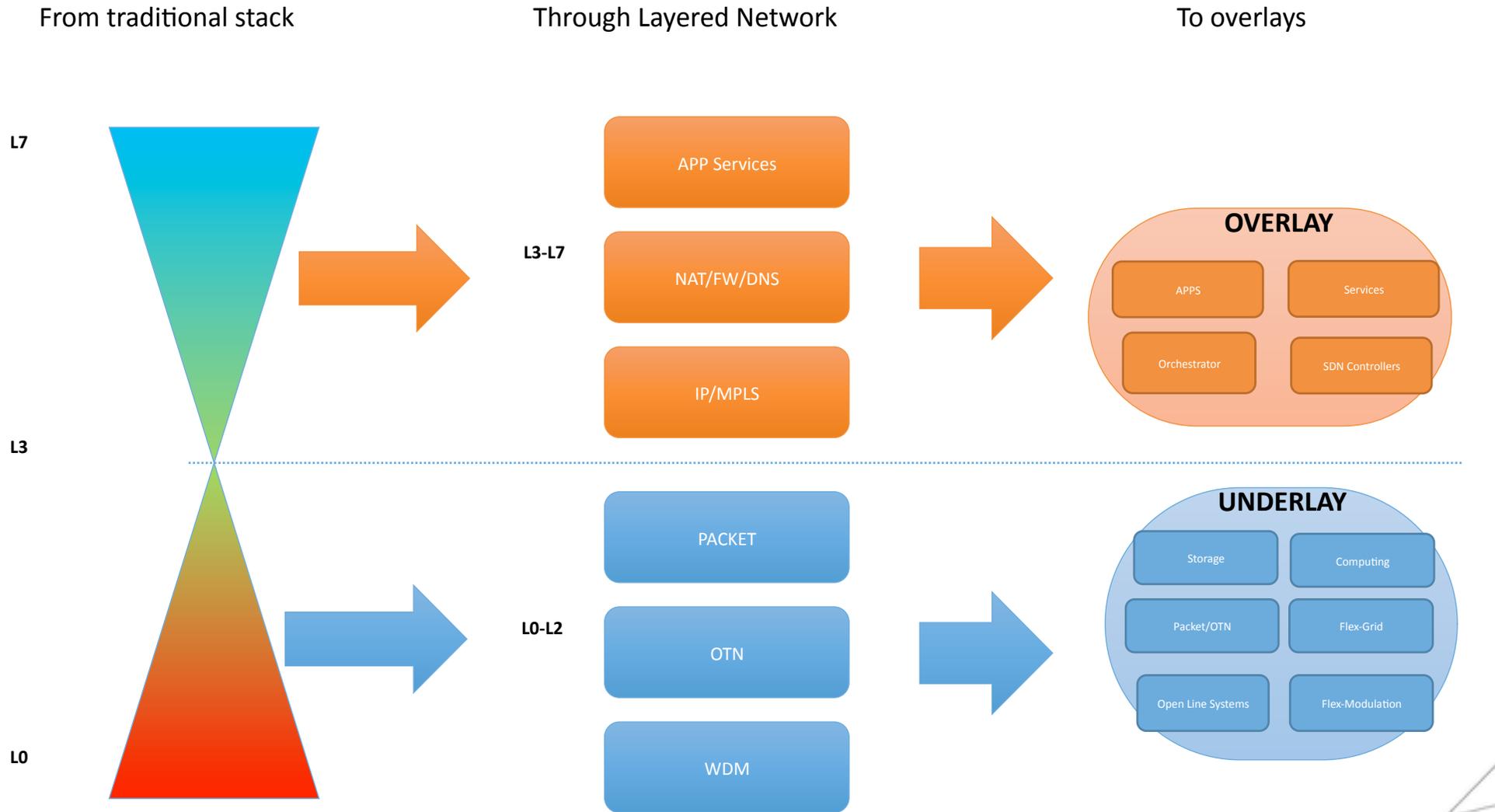




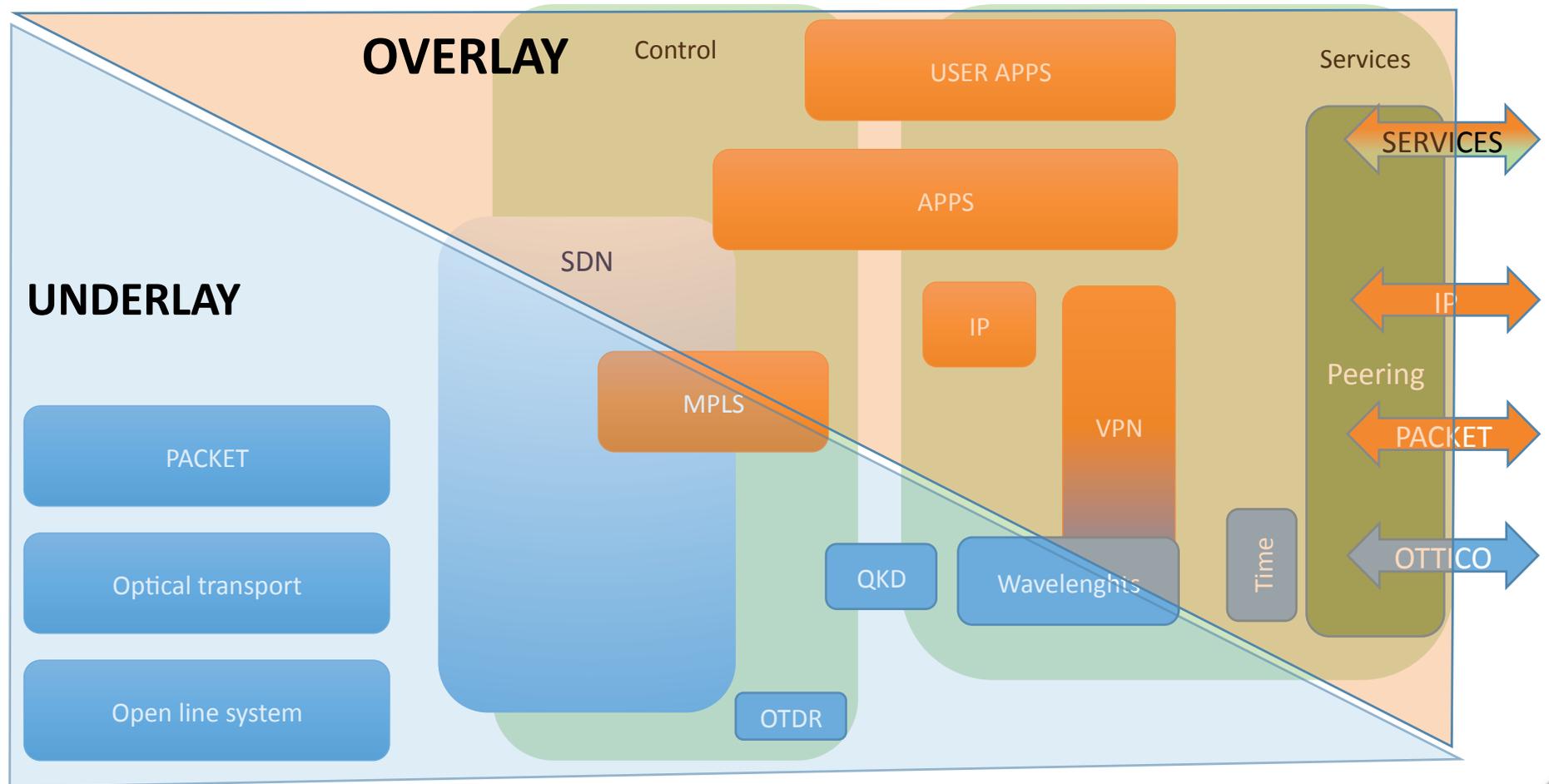
**Da Rete
Fisica
a Reti
Logiche**

Come procediamo

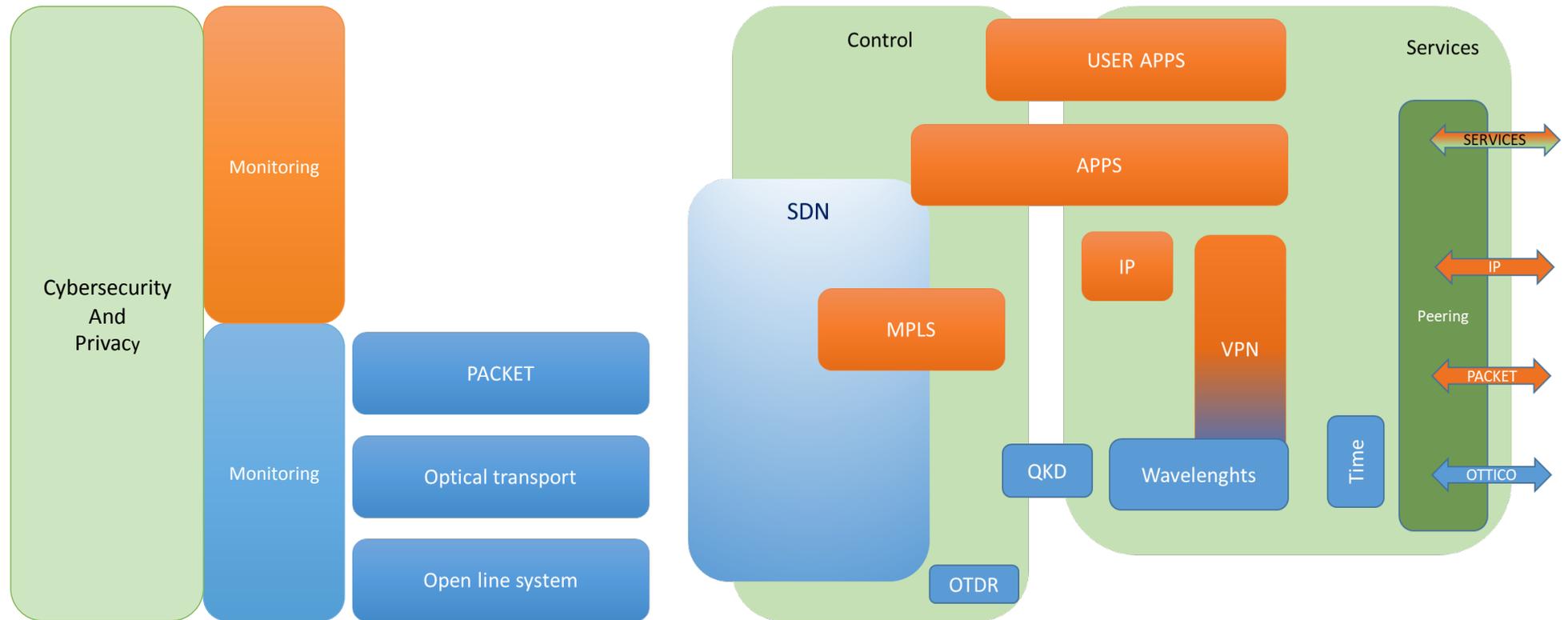
Network (and ICT) Evolution Trends



High Level Architecture + control + services



High Level Architecture + control + services + monitoring + Security



Conclusioni

Dobbiamo rispondere a **nuove sfide** che coinvolgono l'intero sistema di rete **GARR** come parte di un **network globale** via **GEANT**

Non solo **IP**

Elementi chiave **Infrastrutture fisiche** magliate, capillari e **condivisione di spettro**

La **disaggregazione** come building block per ridisegnare l'intero sistema

La **maggiore complessità** richiede una metodologia **devops** con le quali si «**disegnano**» le applicazioni **Infrastructure as a Code**

Sviluppare competenze nella capacità di vedere quello che accade in modo dinamico con **tempi di reazione** non confrontabili con i processi «umani»

Superamento di SS7/SMTP: servono nuovi protocolli di comunicazione, certamente condivisi

Dobbiamo semplificare, collaborare, riusare, aggiornarsi e condividere

Rimandi a presentazioni che seguono HL Architecture

Optical transport

Gloria Vuagnin, GARR
Evoluzione dell'infrastruttura in fibra: esercizi di equilibrio sulla rete

Open line system

Paolo Bolletta, GARR
Rete ottica parzialmente disaggregata: un'infrastruttura a lunga conservazione

SDN

Giancalo Viola, GARR
The SD-WAN story. Un approccio alternativo per la rete d'accesso

PACKET

Marco Marletta GARR
Nuovi scenari della rete IP: come cambiare la rete e vivere felici

USER APPS

Fabio Farina, GARR - SCRUM e scrum, o come massimizzare la spinta verso il futuro senza farsi (troppo) male

Paolo Velati, GARR - Filesender
Gianni Marzulli, GARR - WebMeeting
Gianni Marzulli, GARR - SCARR

APPS

Pasquale Mandato, GARR - Eduroam as a (Self) Service
Lorenzo Chiarelli, GARR - VConf: Migrazione e sviluppi futuri
Silvia d'Ambrosio, GARR - Aggregazione e analisi centralizzate dei log di dorsale
Nino Ciurleo, GARR - Mitigazione dei DDoS in GARR: aggiornamento sulle attività
Federico Dossena, Università di Milano - LibreSpeed