Cisco Connect

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Cisco Architectures

Fixed Mobile Convergence

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Contributors

Thanks must go to the following people without whose support this session would not be possible

Cisco SDU Team, specifically
Horia Miclea and Chris Lewis

Istvan Kakonyi for technical support

Our vision to run a fully converged network where all the fixed and mobile services run on the same IP network is being achieved through our fixed mobile convergence projects. By collaborating with Cisco will be able to continue to deploy state-of-the art technology to continue enhancing the level of service we are delivering to our customers

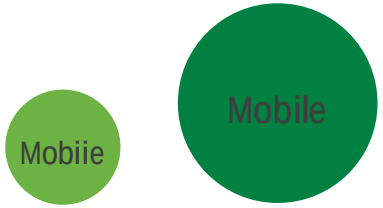
Hatem Bamatraf, SVP Network Development, Du

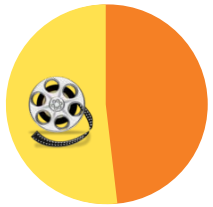
Agenda

- Introduction – Challenges ahead of Service Providers
- Subscriber Trends
- Cisco Vision & Architectures
- Technical Architectures
- FMC Service Models
- FMC Resiliency & Other Elements

Some Interesting Facts….

Mobile data traffic grew 159%



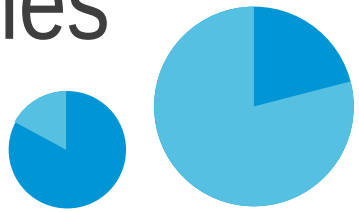


More than 50% is already video

Connection speeds Doubled

Smartphones

Only 13% of handsets



But 78% of Traffic

Tablets

& Smartphones represent highest growth category

=  x 5

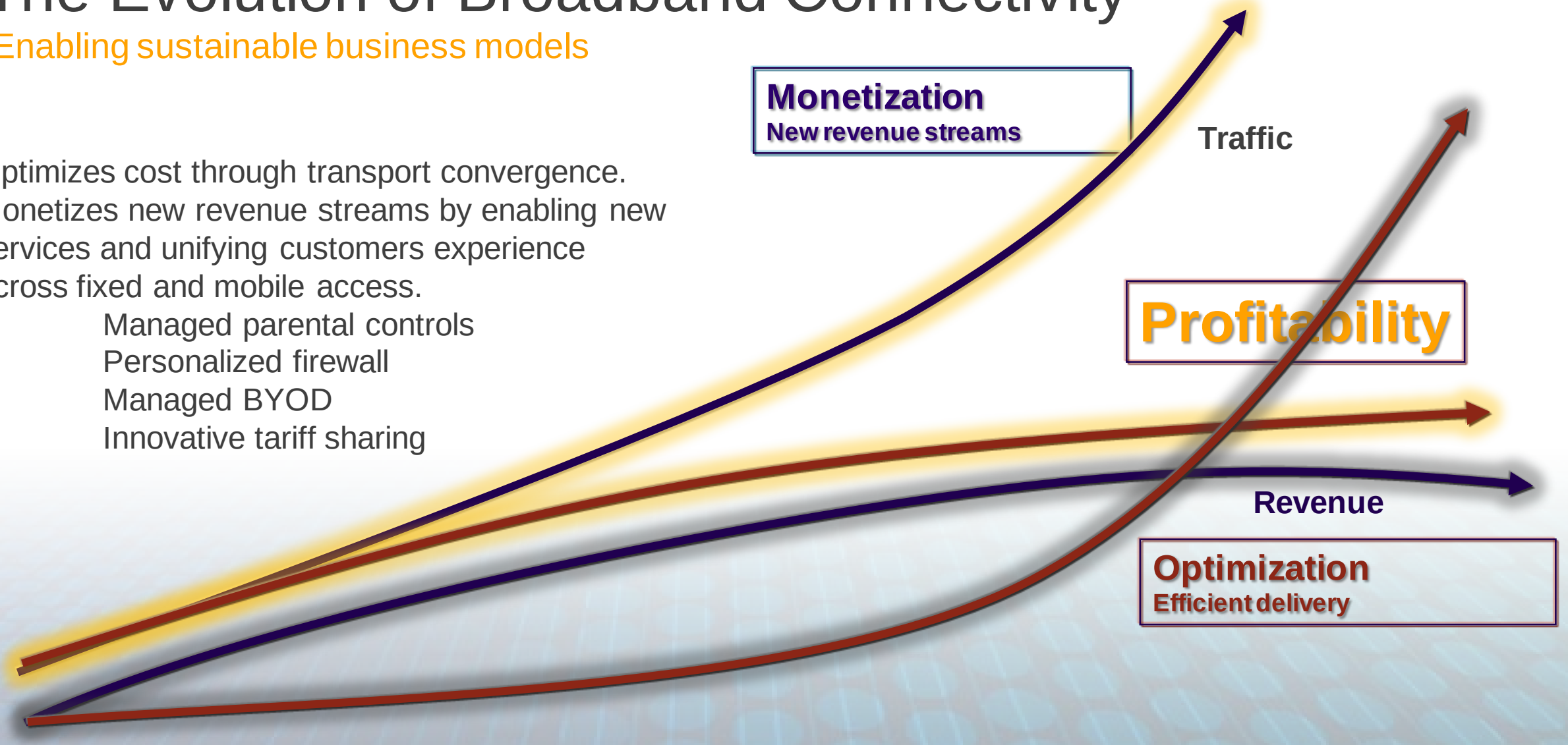
Source: Cisco Visual Networking Index 2012

The Evolution of Broadband Connectivity

Enabling sustainable business models

Optimizes cost through transport convergence.
Monetizes new revenue streams by enabling new services and unifying customers experience across fixed and mobile access.

- Managed parental controls
- Personalized firewall
- Managed BYOD
- Innovative tariff sharing



1 Zettabyte of Data within 24 months

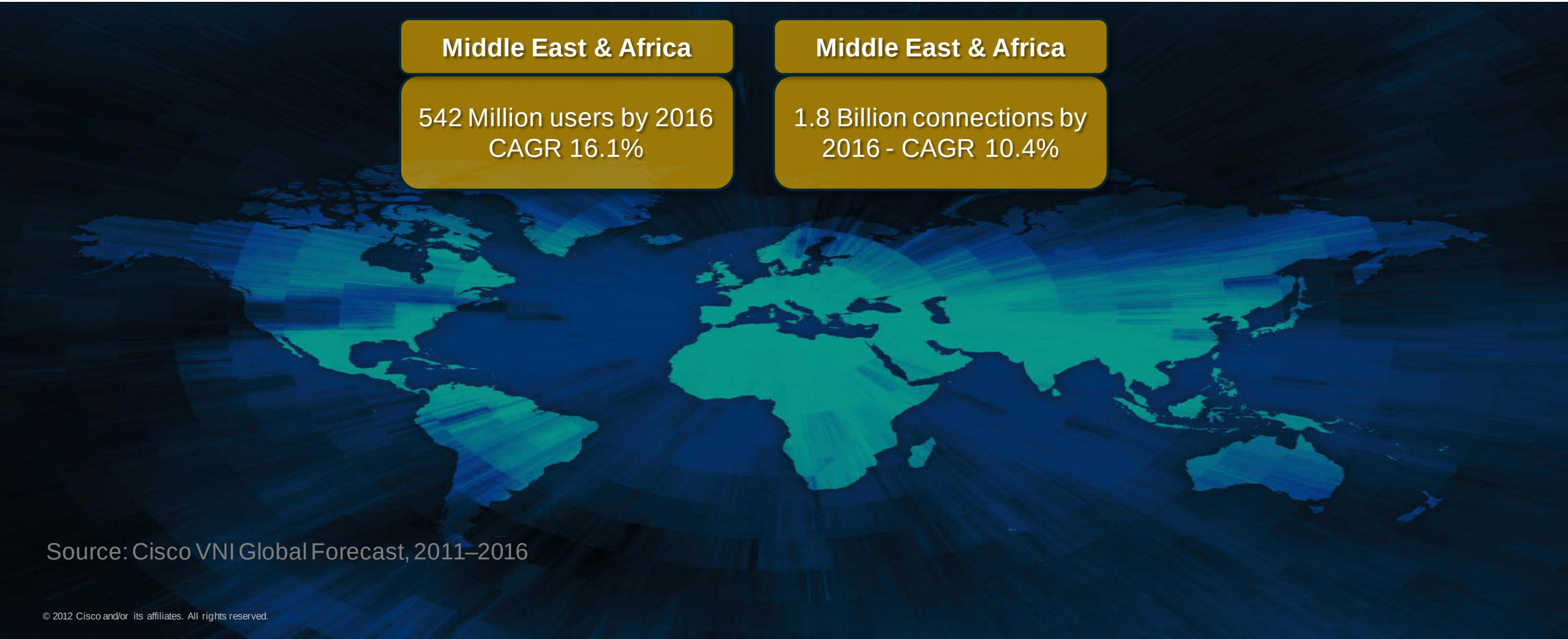
The difficulty with current architectures

- **One zettabyte=** stack of books from Earth to Pluto 20 times (72 billion miles)
- Increase of 540,000 times from 2003; more than 90% from video
- If an 11 oz. cup of coffee equals 1 gigabyte, then 1 zettabyte would have the same volume of the Great Wall of China

- How about Data for the Middle Eastern Region??

Global Internet Growth

3.4Billion Users by 2016



Source: Cisco VNI Global Forecast, 2011–2016

Questions asked today by SPs

- How do I innovate services delivered by my network?
- How do I lower cost in the face of exponential traffic growth?
- My network has grown over a long period of time to utilize multiple technologies and standards, how can I simplify operations while adding new services?
- How can I personalize services in an automated fashion without arduous operational procedures?
- My customers expect any service on any device at any location in a secure manner with consistent quality of experience, how can I achieve that?
- How can I monetize my network assets while enabling subscribers to use any device they want to access services?

Service Provider Network Challenges

The difficulty with current architectures

Complex legacy networks unprepared for ongoing convergence

Not Optimized to handle growth

Siloed networking and **business** paradigms

Technology Centric when you need business-centric

Subscriber / SP Challenge Summary

- Subscriber behaviour and consumption of Internet communications services is undergoing dramatic change – both for Fixed and especially for mobile access
- Consumers and business are expecting “information everywhere”, on “Any Device” via “Any Medium” and with a “Consistent Experience”
- Service providers facing massive with existing and legacy networks, Silos and technology centric organisations are slowing the ability to innovate and deliver cost-optimised solutions
- Cisco is committed to delivering proven, tested architectures with detailed design and implementation guides to demonstrate our commitment and strategy to both fixed and mobile service providers

Cisco's Vision

Deliver solutions that address SP challenges of network reach, network intelligence, and service velocity while enhancing overall profitability…

Simplicity is the key, but is it easy?

Simple is a pre-requisite for reliability

Simple comes from Simplex, meaning single thread.
Opposite is Complex, meaning multi-threaded

Easy comes from adjacent, what is already known

Opposite is what is difficult or unknown

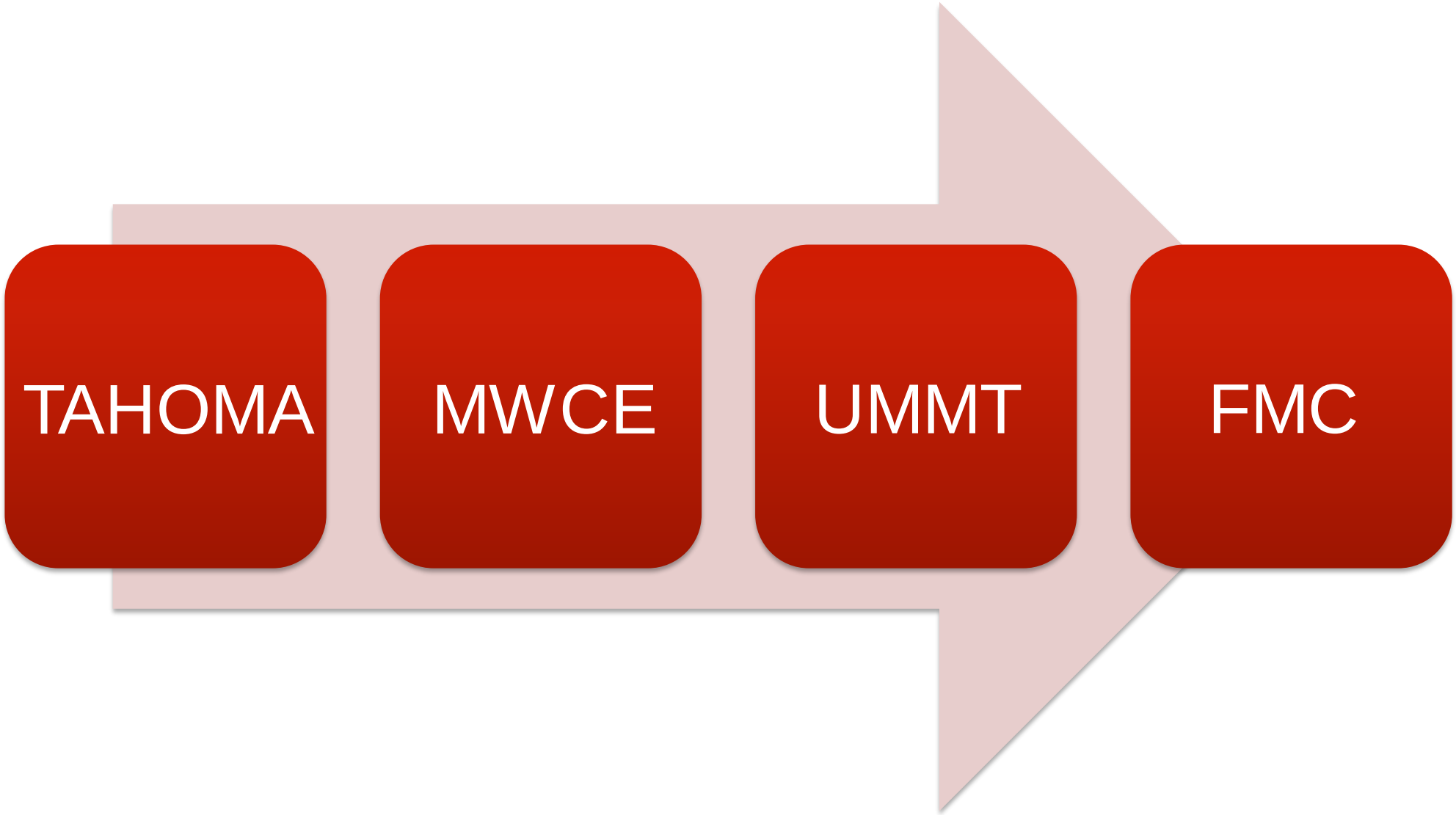
Each step by itself is simple in the figure, but the end result is complexity

To create simplicity is initially hard, takes planning and understanding of all aspects of business and technology

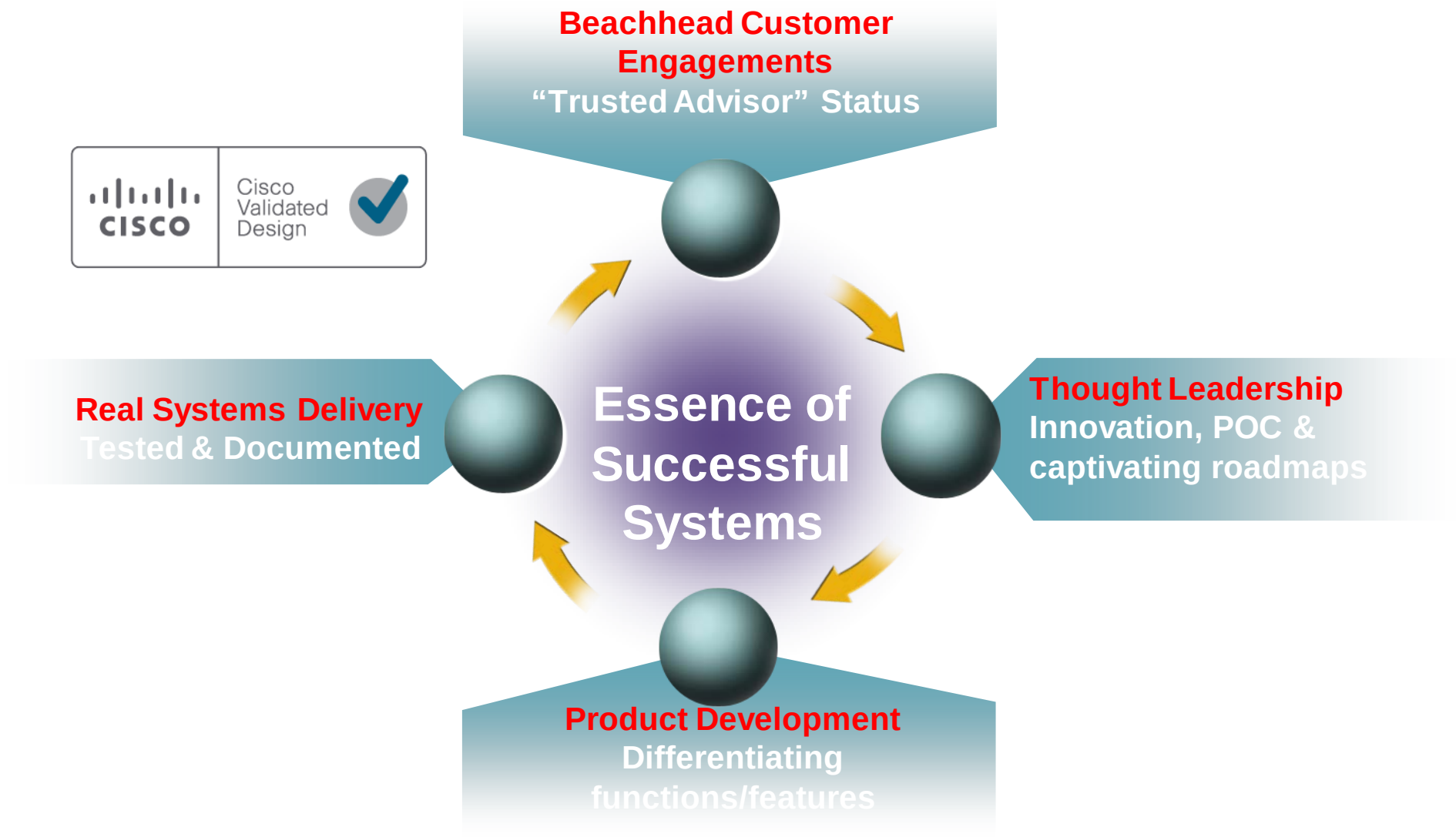
What does this concept look like in practice?

- We see the network equivalent of the knitted or woven castle. Each piece was added on fairly easily.
- Change to accommodate new services, acquisitions, operational simplification is compromised
- What we strive for is the network equivalent of the Lego castle. Easily changed, modular and a single skill set to master

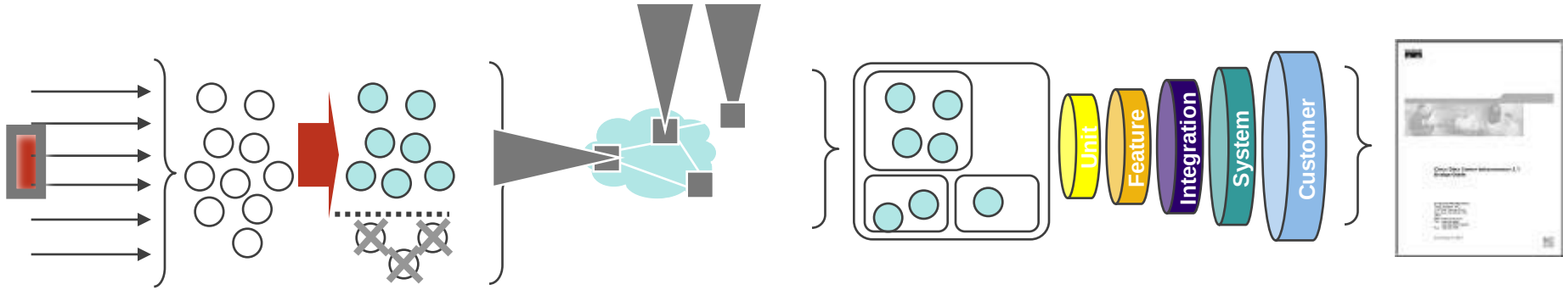
Evolution of Cisco SP NGN Architectures



Cisco – Systems Development Unit



Cisco Validated Designs -> FMC

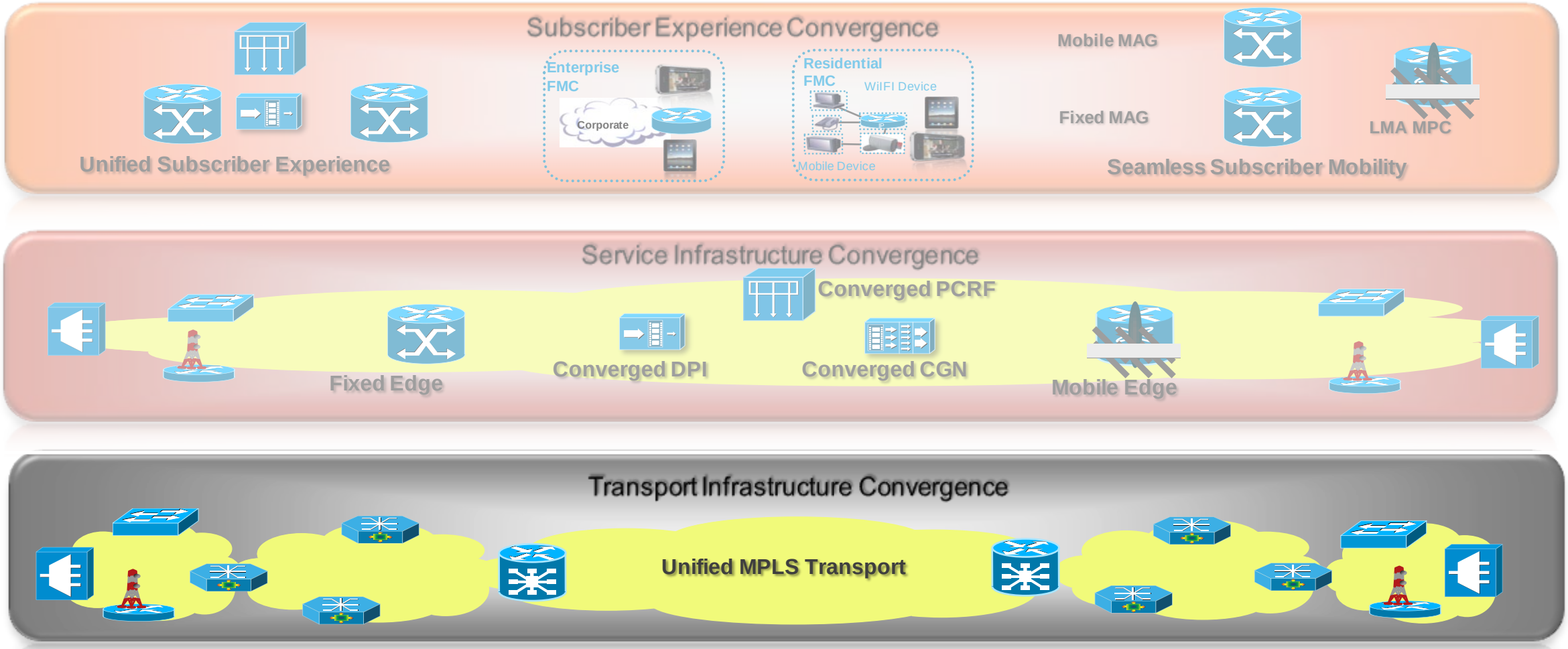


Planning	Systems Design	Systems End-to-End Verification	Customer Documentation
Customer Require-ments	Compile Requirements Define Common Service Definitions Prioritize Requirements/ Services	Requirements Documentation Architecture Roles Interfaces Proof of Concept Test plans	Validation: Feature Integration System Funcational roles based testing automation and reporting System level test: Performance, scalability, reliability	DIGs—Design Guides Network Integration Services Deployment with reduced risk

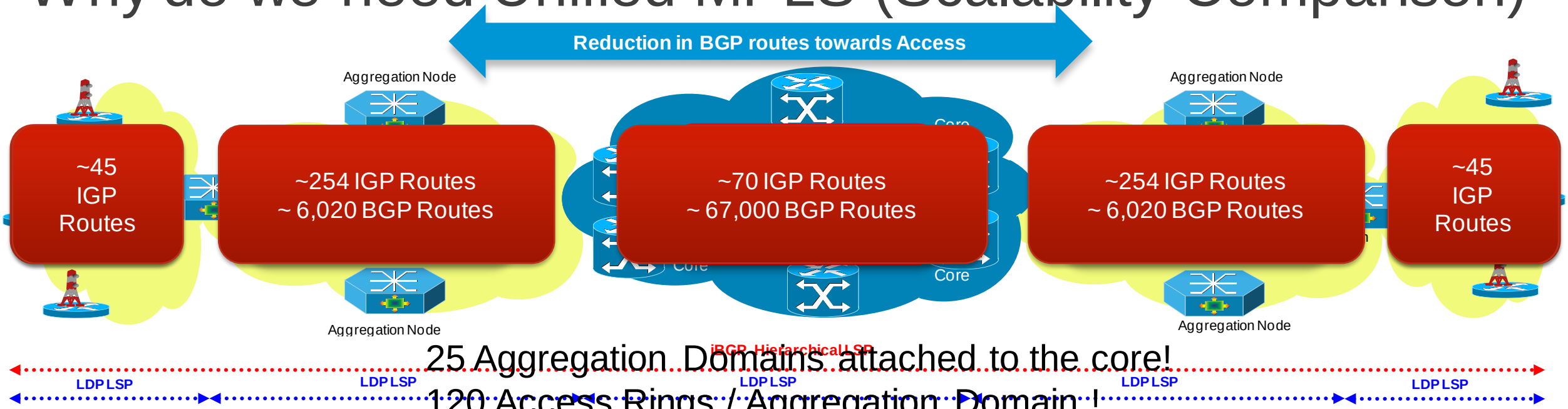
System Reference Designs

FMC: Technical Architectures

FMC System Overview



Why do we need Unified MPLS (Scalability Comparison)

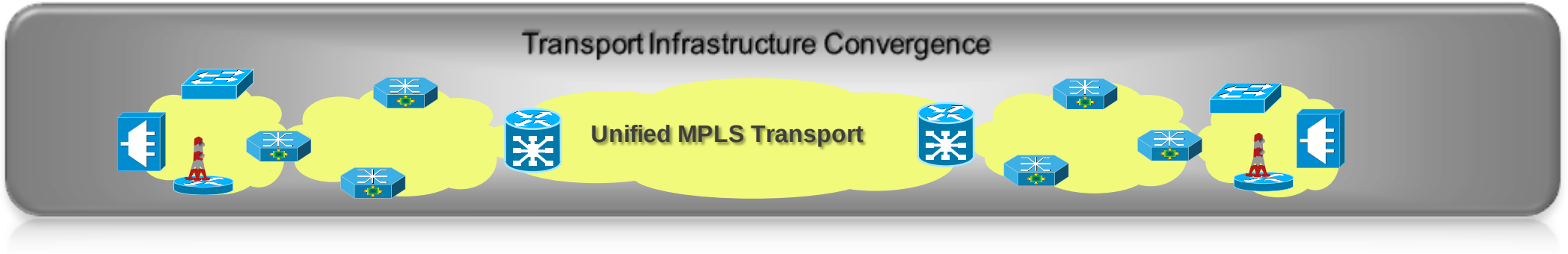


25 Aggregation Domains attached to the core!
120 Access Rings / Aggregation Domain !

Node	Access Domain	Aggregation Domain	Network Wide
Cell Site Gateways	20	2,400	60,000
Pre-Aggregation Nodes	2	240	6,000
Aggregation Nodes	NA	12	300
Core ABRs	NA	2	50
Mobile transport Gateways	NA	NA	20

Transport Convergence

- Enabled by **Unified MPLS** technology
- Evolving the UMMT system by adding wireline services
- Optimizing the scalability control with new automation models
- Introducing multicast support for IPTV fixed and mobile applications
- Simplifying the operations by enabling SON MPLS VPNs for LTE and Autonomic Access Networks
- Concluding the carrier class capability by completing the HA, OAM and PM support.
- Optimise Microwave integration by using Microwave ACM correlation.

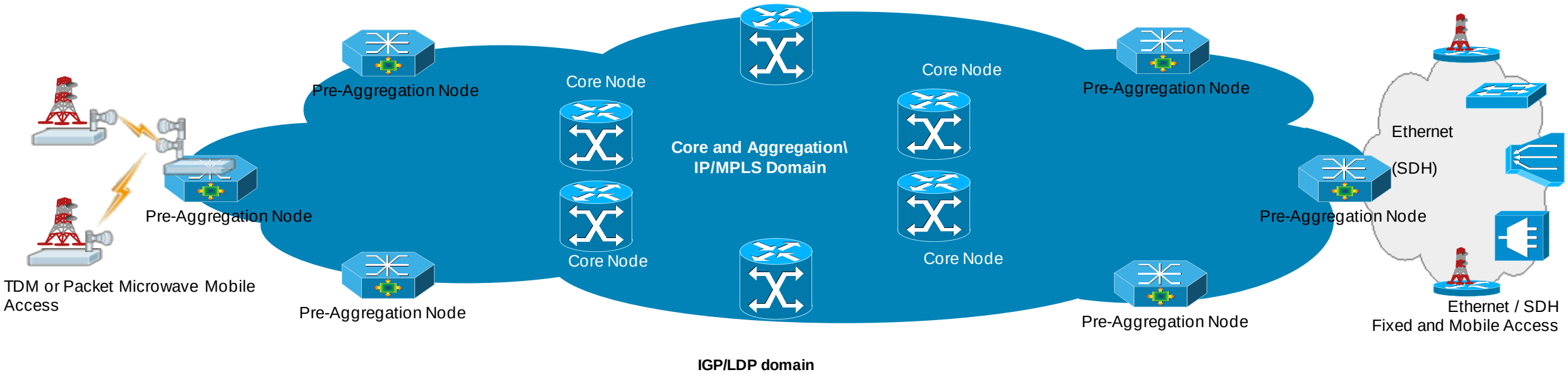


FMC / UMMT Transport Models

The Unified MPLS Transport Network is structured based on Network Size and Access Network Model.

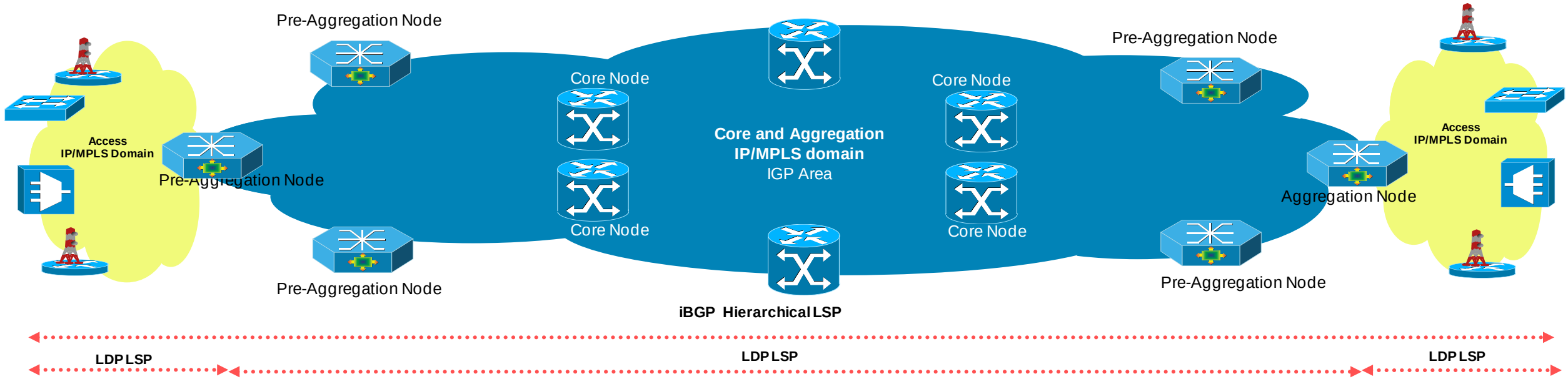
	1. Small Network	2. Large Network
MPLS-TP or TDM/Ethernet Access Service	**Model 1.1** Flat LDP Core and Aggregation Network	**Model 2.1** Hierarchical Labeled BGP Core and Aggregation Network
IP/MP Access Network	**Model 1.2** Hierarchical Labeled BGP LSP Access Network	**Model 2.2** Hierarchical Labeled BGP Access Network
	Model 1.3 Labeled BGP Redistribution into Access IGP/LDP (optional LDP DoD)	**Model 2.3** Labeled BGP Redistribution into Access IGP/LDP (optional LDP DoD)+2.1

1.1 – Flat LDP LSP across Core/Agg networks



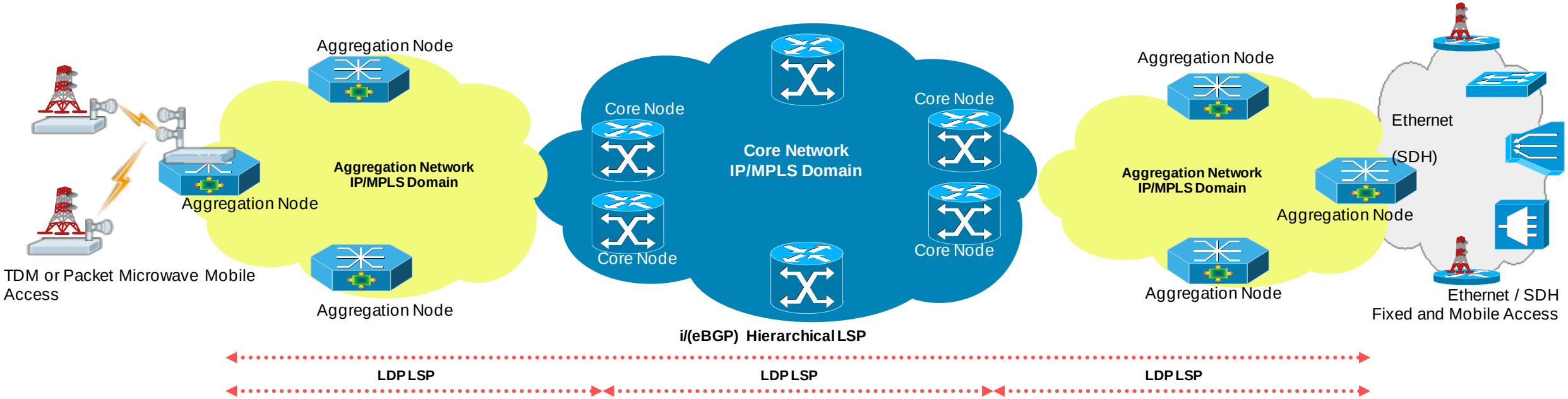
- Core and Aggregation Networks form one IGP and LDP domain.
  - For small aggregation platforms scale target is less than 1000 IGP/LDP nodes.
- All Mobile and Wireline services are enabled by the Aggregation Nodes. The Mobile and Fixed Access is based on Ethernet, SDH or Packet/TDM Microwave links aggregated in Aggregation Nodes enabling TDM/ATM/Ethernet/IP interworking VPWS and MPLS VPN transport

1.2 – Hierarchical BGP LSP across Core/Agg/Acc networks



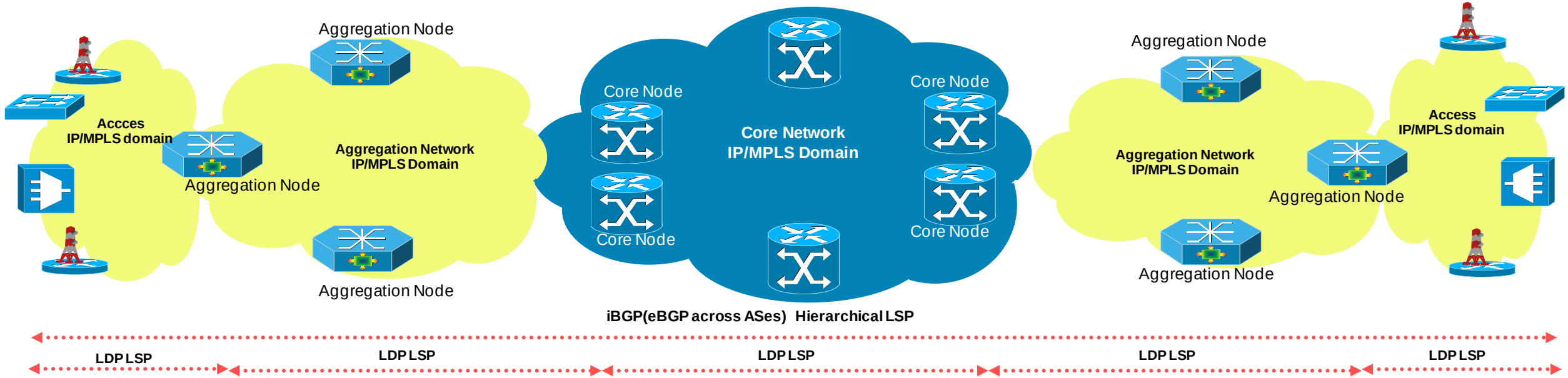
- The Core and Aggregation form a relatively small IGP/LDP domain (1000 nodes)
- The Access is MPLS enabled. Each Access Network forms a different IGP/LDP domain
- The Core/Aggregation and RAN Access Networks are integrated with labelled BGP LSP
- The Access Network Nodes learns only the required service destinations based on inbound or outbound labelled BGP filtering done in Access Node or the Unified MPLS ABR (the Pre-Aggregation Node)

2.1 – Hierarchical BGP LSP across Core/Agg Domains



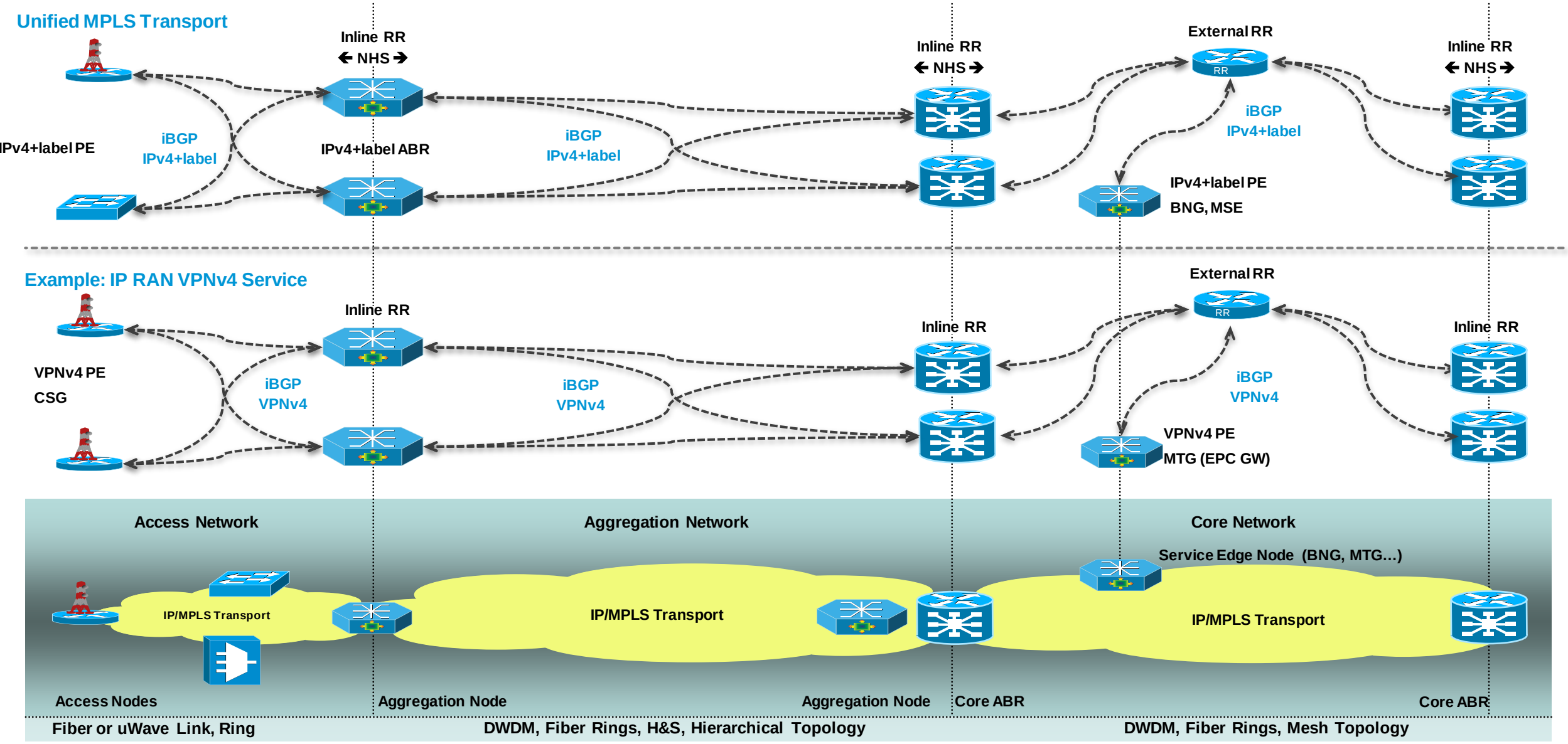
- The Core and Aggregation Networks enable Unified MPLS Transport
- The Core and Aggregation Networks are organized as independent IGP/LDP domains
- The network domains are interconnected with hierarchical LSPs based on RFC 3107, BGP IPv4+labels. Intra domain connectivity is based on LDP LSPs
- The Aggregation Node enable Mobile and Wireline Services. The Fixed and Mobile Access Network may be Ethernet, SDH, Packet/TDM Microwave

2.2 – Hierarchical BGP LSP across Core/Agg/Acc networks



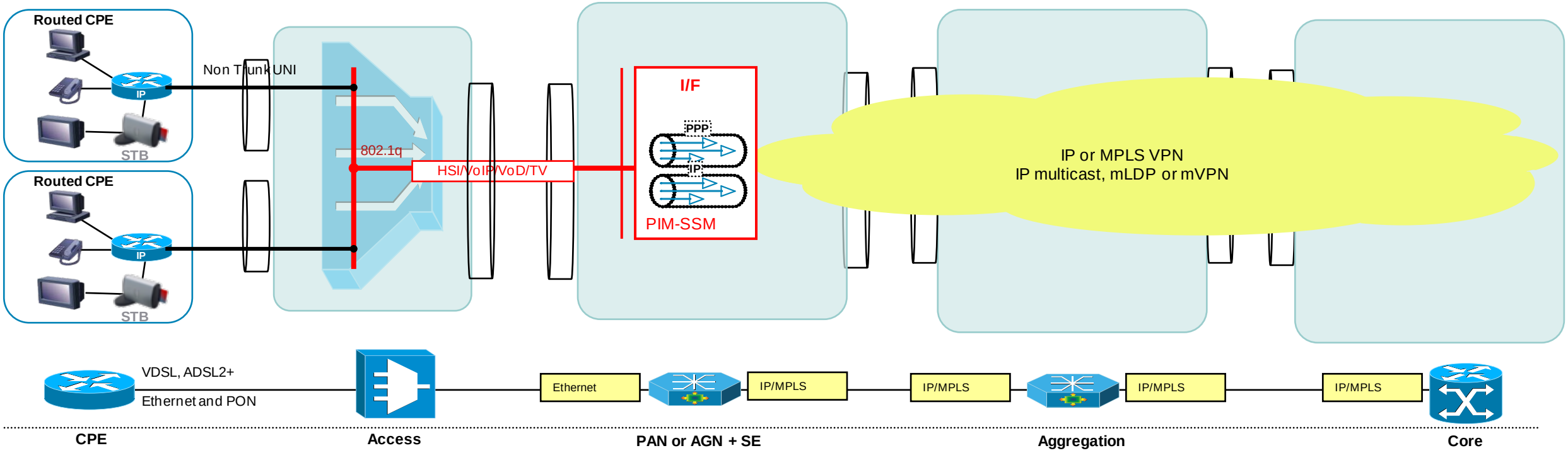
- The Core, Aggregation, Access Network enable Unified MPLS Transport
- The Core, Aggregation, Access are organized as independent IGP/LDP domains
- Core and Aggregation Networks may be in different Autonomous Systems, in which case the inter-domain LSP is enabled by labeled eBGP in between ASes
- The network domains are interconnected with hierarchical LSPs based on RFC 3107, BGP IPv4+labels. Intra domain connectivity is based on LDP LSPs
- The Access Network Nodes learns only the required labelled BGP FECs based on inbound or outbound service specific filtering. It can support Wireline and Mobile services.

BGP CP – Single AS, Multi-Area IGP, Labeled BGP Access

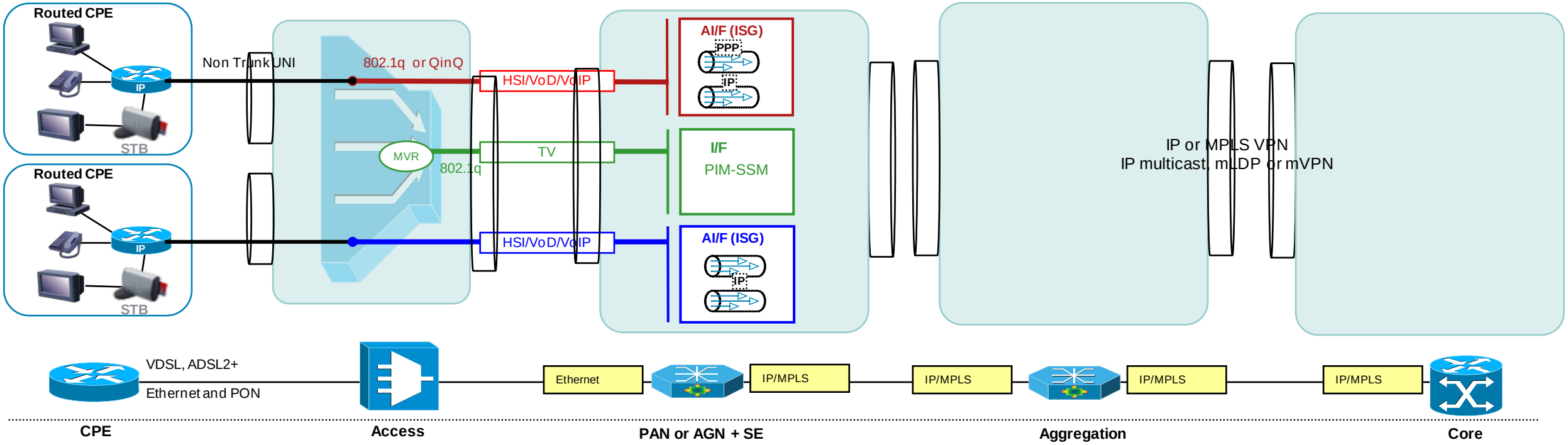


FMC: Service Models

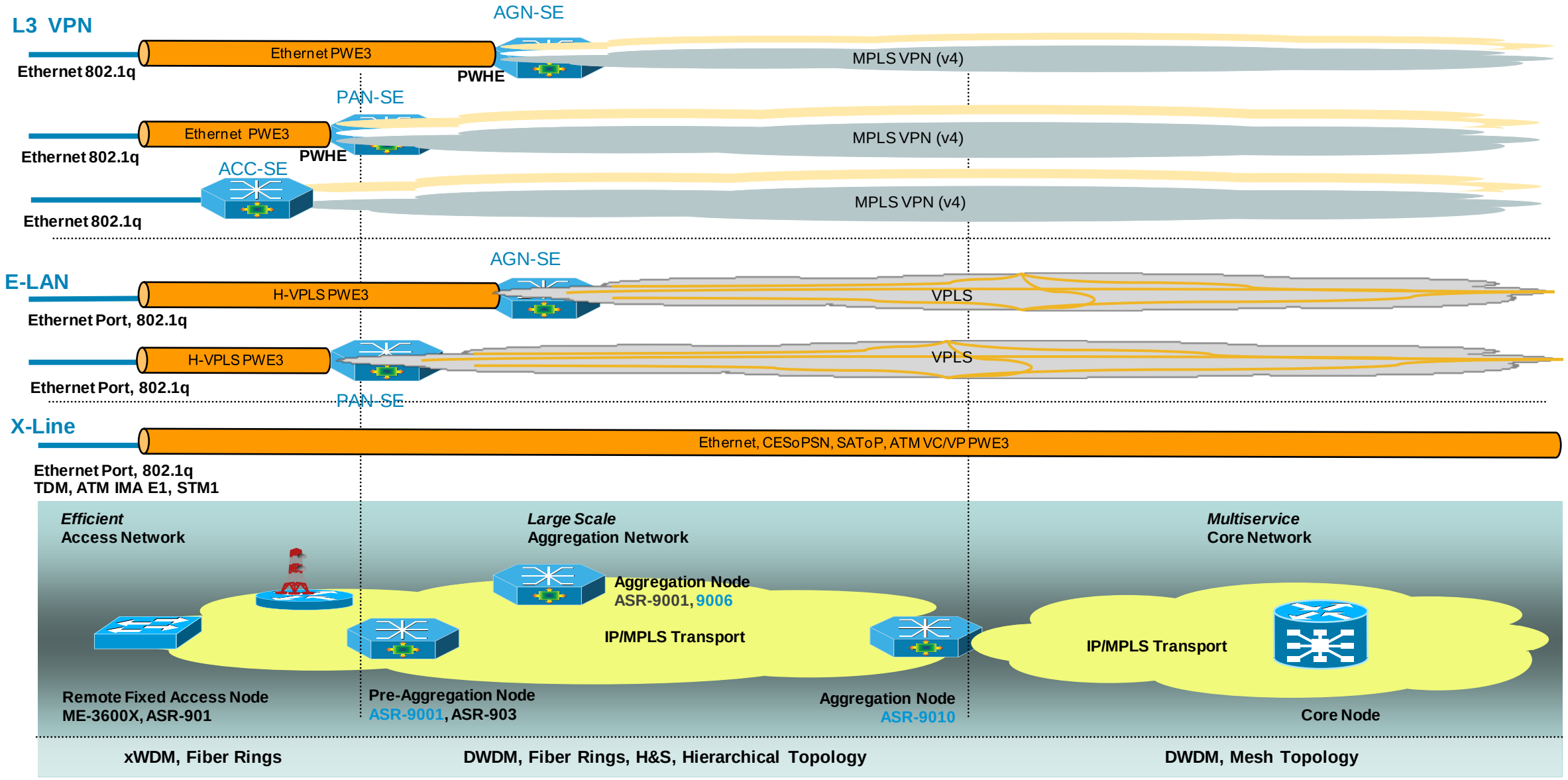
Residential Services- Non Trunk UNI, N:1 VLAN



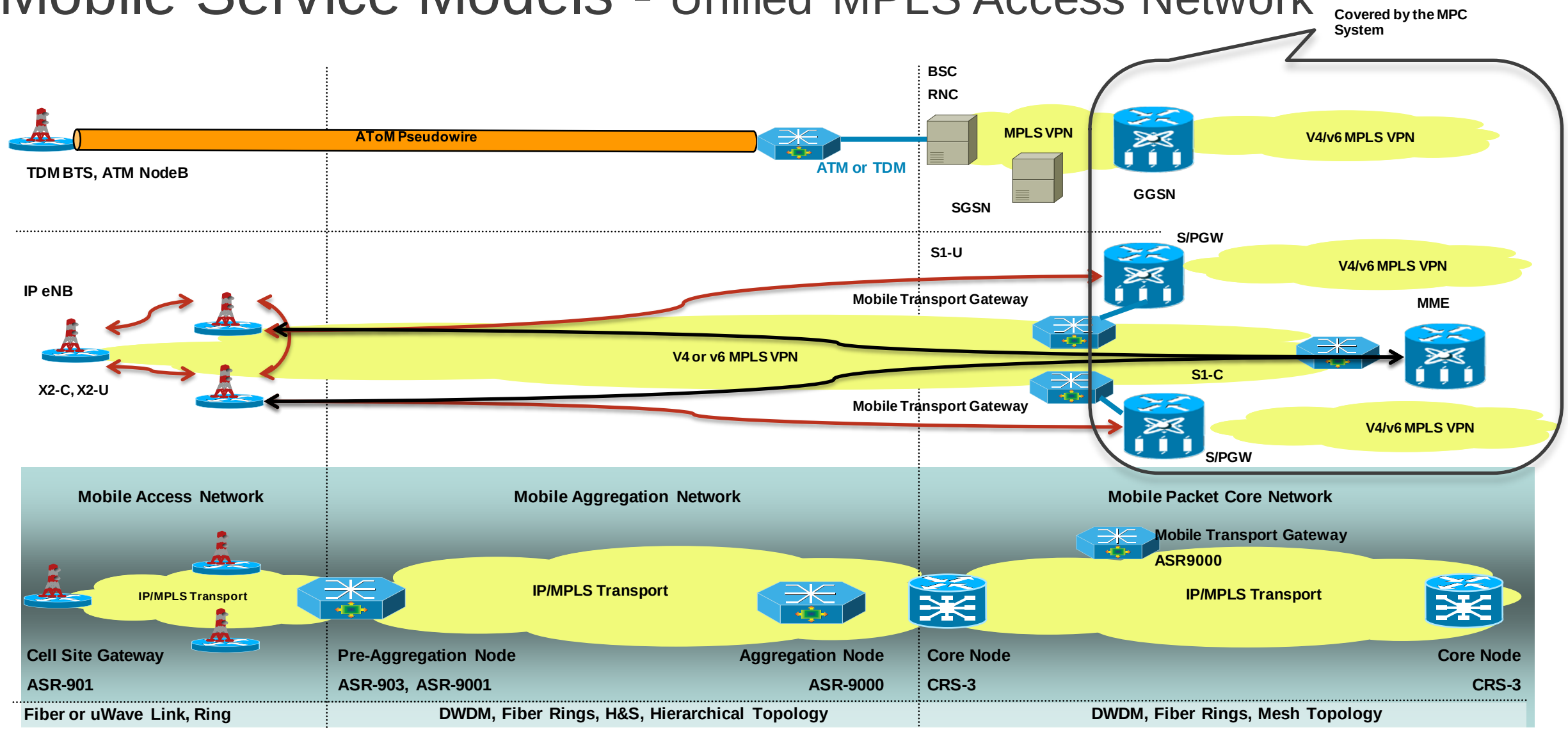
Residential Services - Non Trunk UNI, 1:1 VLAN



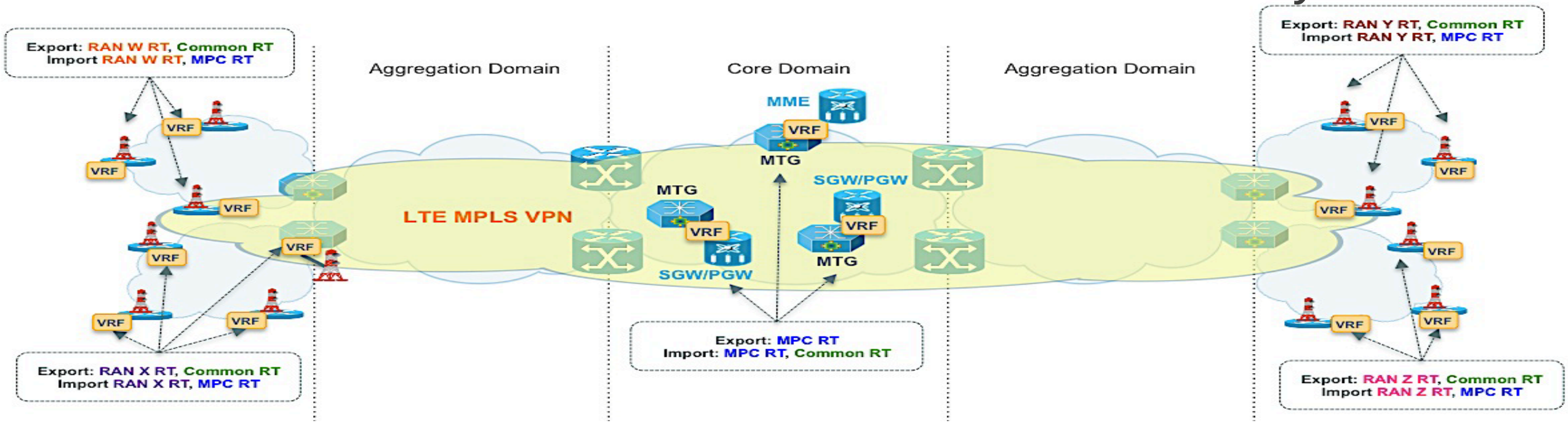
Business Service Models - Unified MPLS Access Network



Mobile Service Models - Unified MPLS Access Network



LTE S1 and X2 - MPLS VPN Service and Scalability Control

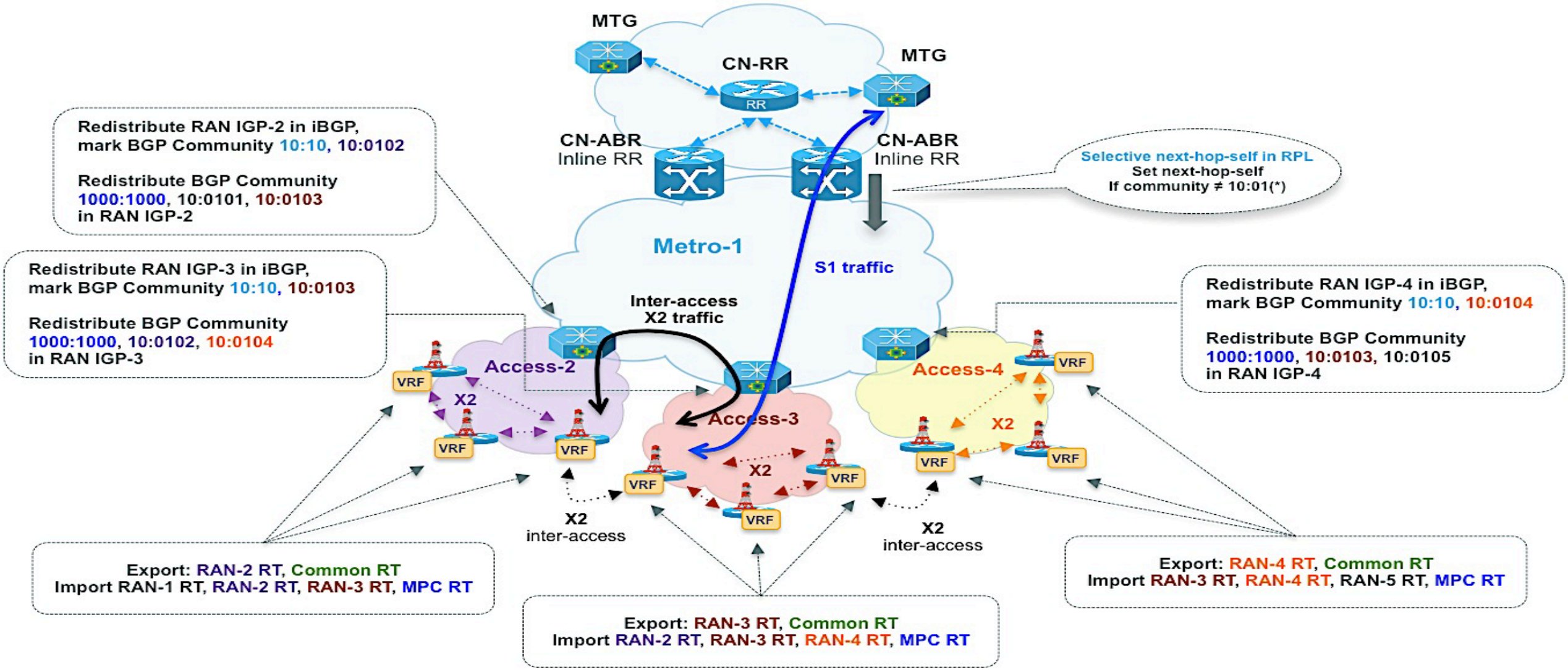


- Unified MPLS transport with a common MPLS VPN for LTE S1 from all CSGs and X2 per LTE region.
- Mobile Transport GWs import all RAN & MPC Route Targets, and export prefixes with MPC Route Target
- CSGs (and/or Pre-Aggregation Node) in a RAN region import the MPC and regional RAN Route Targets:
  - Enables S1 control and user plane with any MPC locations in the core, X2 between CSGs

- MPLS VPN availability based on BGP PIC Edge and infrastructure LSP based LFA FRR

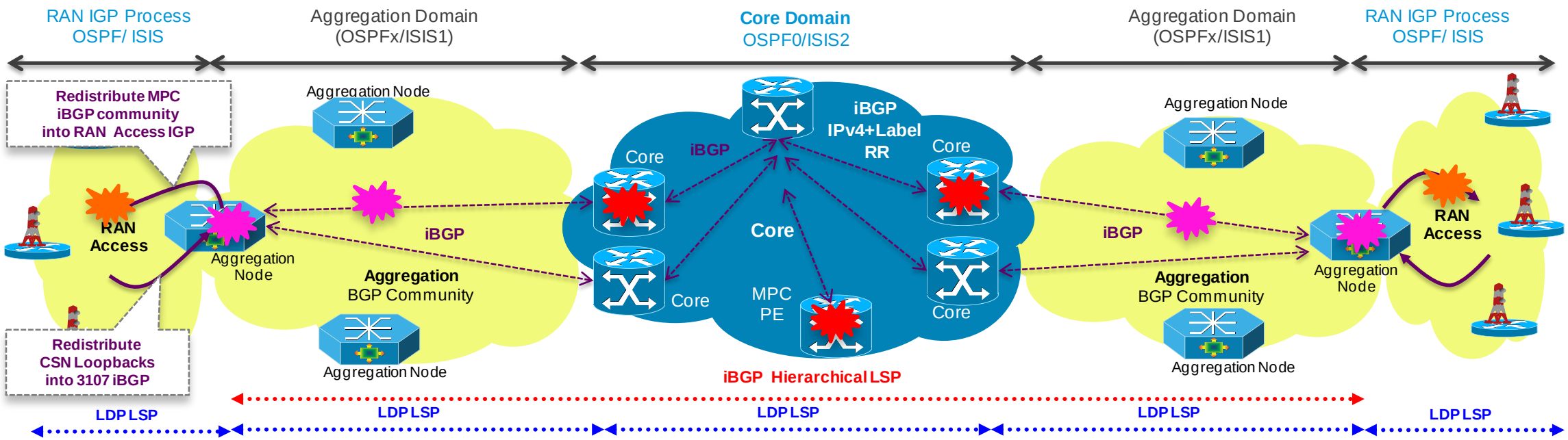
- Pre-Aggregation Nodes and Core POP Nodes form inline RR hierarchy for the MPLS VPN service
  - Core ABRs perform BGP community based Egress filtering to drop unwanted remote RAN VPNv4 prefixes
  - Pre-Aggregation Nodes implement RT Constrained Route Distribution towards CSR VPNv4 clients

LTE X2 Inter Access Network



FMC: Resiliency

High Availability Overview



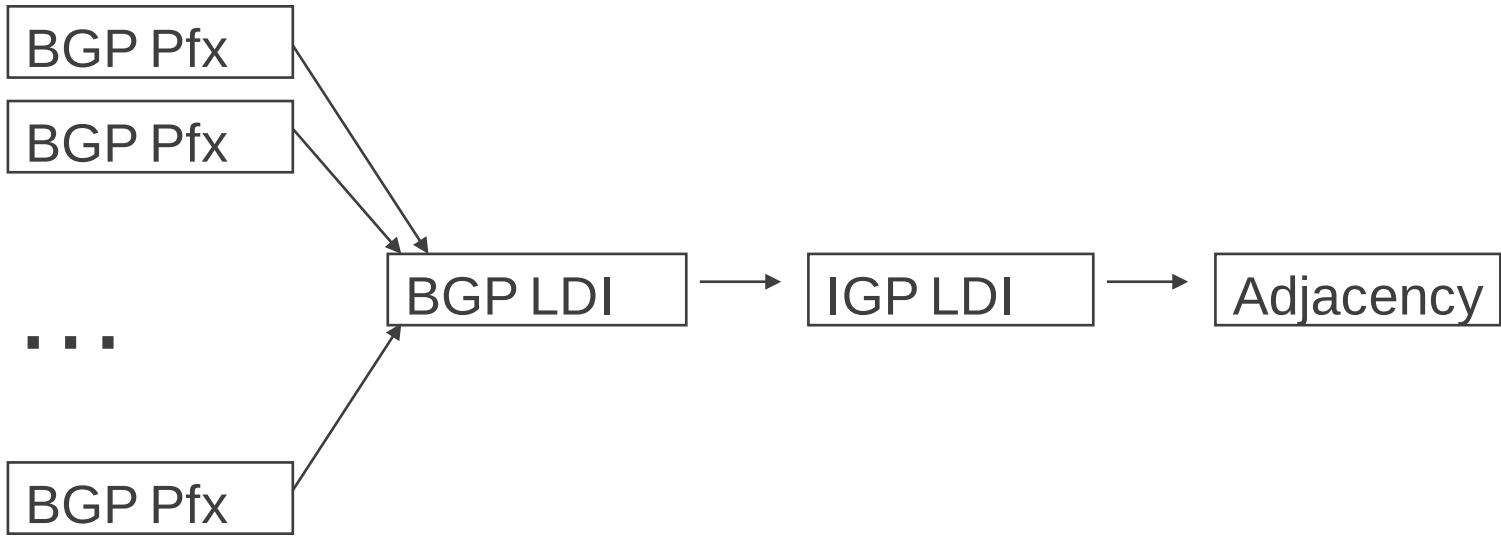
LFA L3 convergence < 50ms

BGP PIC Core L3 convergence < 100ms

BGP PIC Edge L3 convergence < 100ms

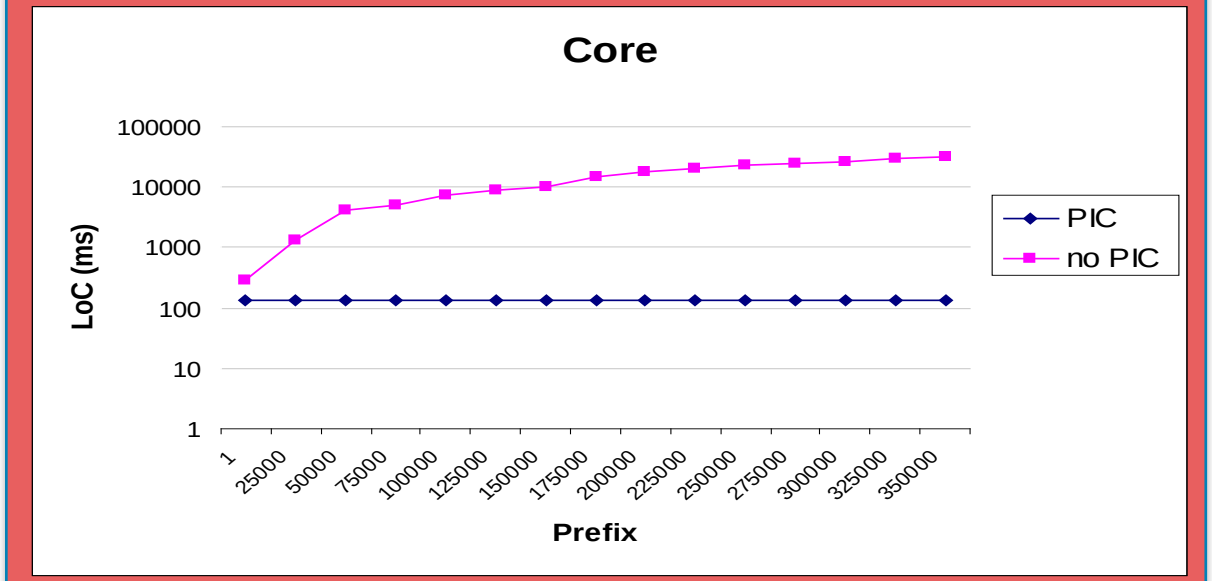
BGP PIC / BGP FRR

- **BGP Fast Reroute** (BGP FRR)—enables BGP to use alternate paths within sub-seconds after a failure of the primary or active paths
- PIC or FRR dependent routing protocols (e.g. BGP) install backup paths
- Without backup paths
  - •Convergence is driven from the routing protocols updating the RIB and FIB one prefix at a time - Convergence times directly proportional to the number of affected prefixes
- With backup paths
  - •Paths in RIB/FIB available for immediate use
  - •Predictable and constant convergence time independent of number of prefixes



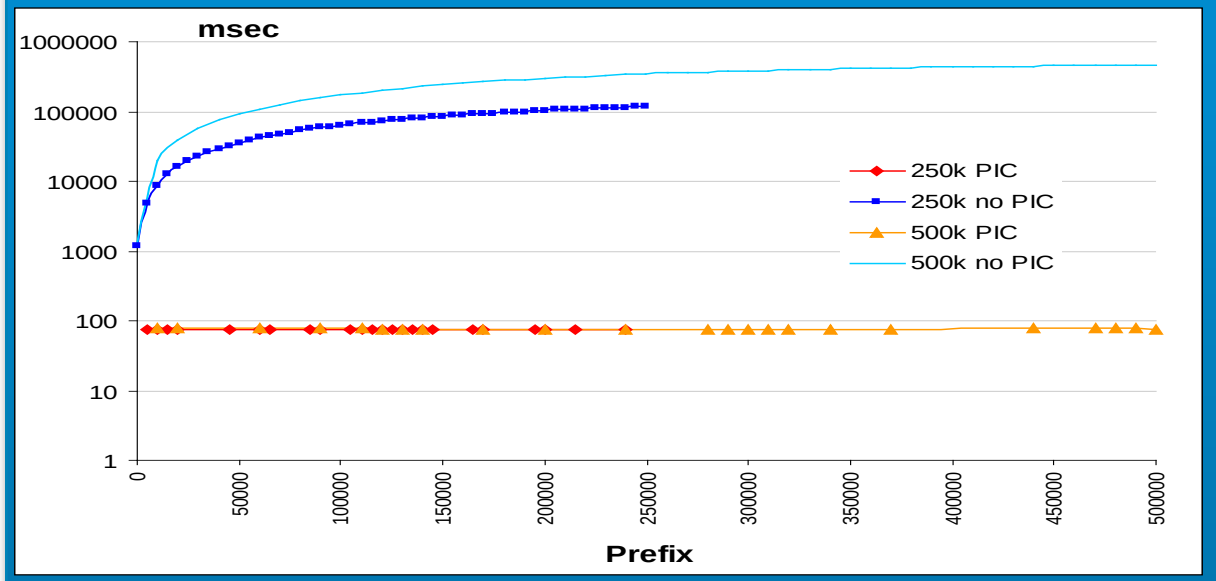
BGP PIC / BGP FRR

PIC Core



- **Upon failure in the core (uplink failure), without Core PIC, convergence function of number of affected prefixes**
- **With PIC, convergence predictable and remains constant independent of the number of prefixes**

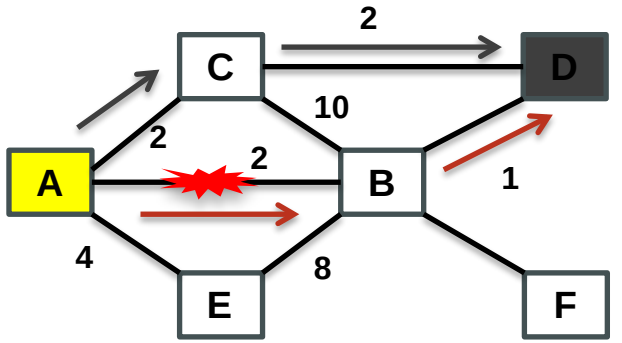
PIC Edge



- **Upon failure at the edge/core node, without edge PIC, convergence function of number of affected prefixes**
- **With PIC, convergence predictable and remains constant irrespective of the number of prefixes**

LFA FRR / IP FRR (Loop Free Alternate Fast Reroute)

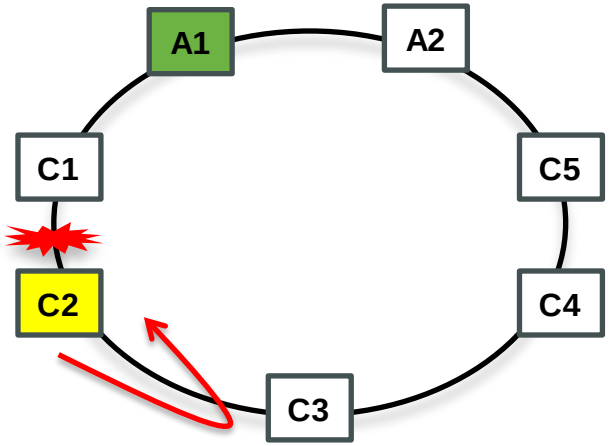
- What is LFA FRR?
  - Well known (RFC 5286) basic fast re-route mechanism to provide local protection for unicast traffic in pure IP and MPLS/LDP networks
  - Path computation done only at "source" node
  - Backup is Loop Free Alternate (C is an LFA, E is not)



- No directly connected Loop Free Alternates (LFA) in some topologies

- Ring topologies for example:
  - Consider C1-C2 link failure
  - If C2 sends a A1-destined packet to C3, C3 will send it back to C2

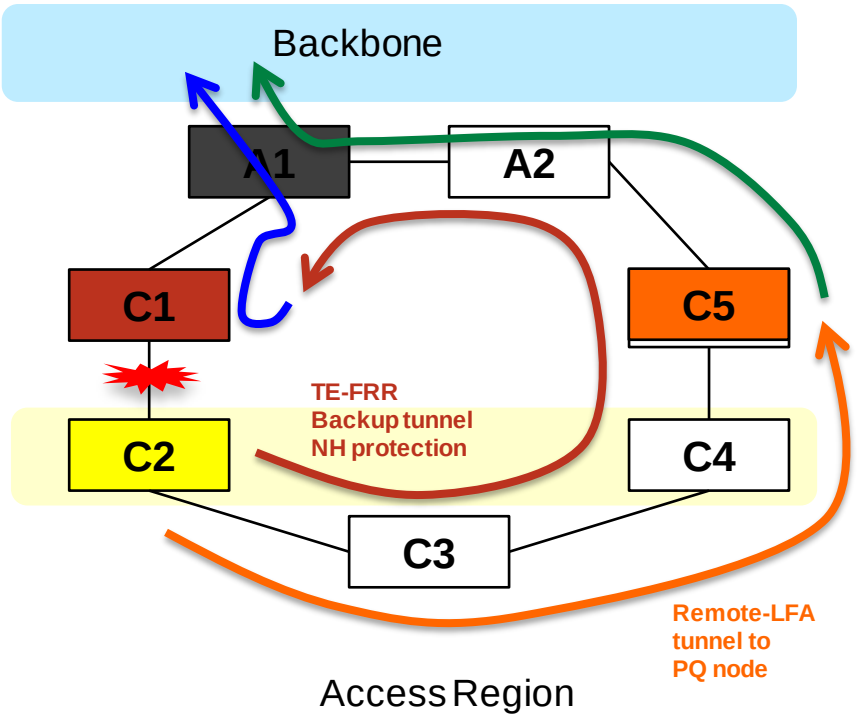
- However, a non-directly connected loop free alternate node (C5) exits



Remote LFA FRR Benefits

http://tools.ietf.org/html/draft-shand-remote-lfa

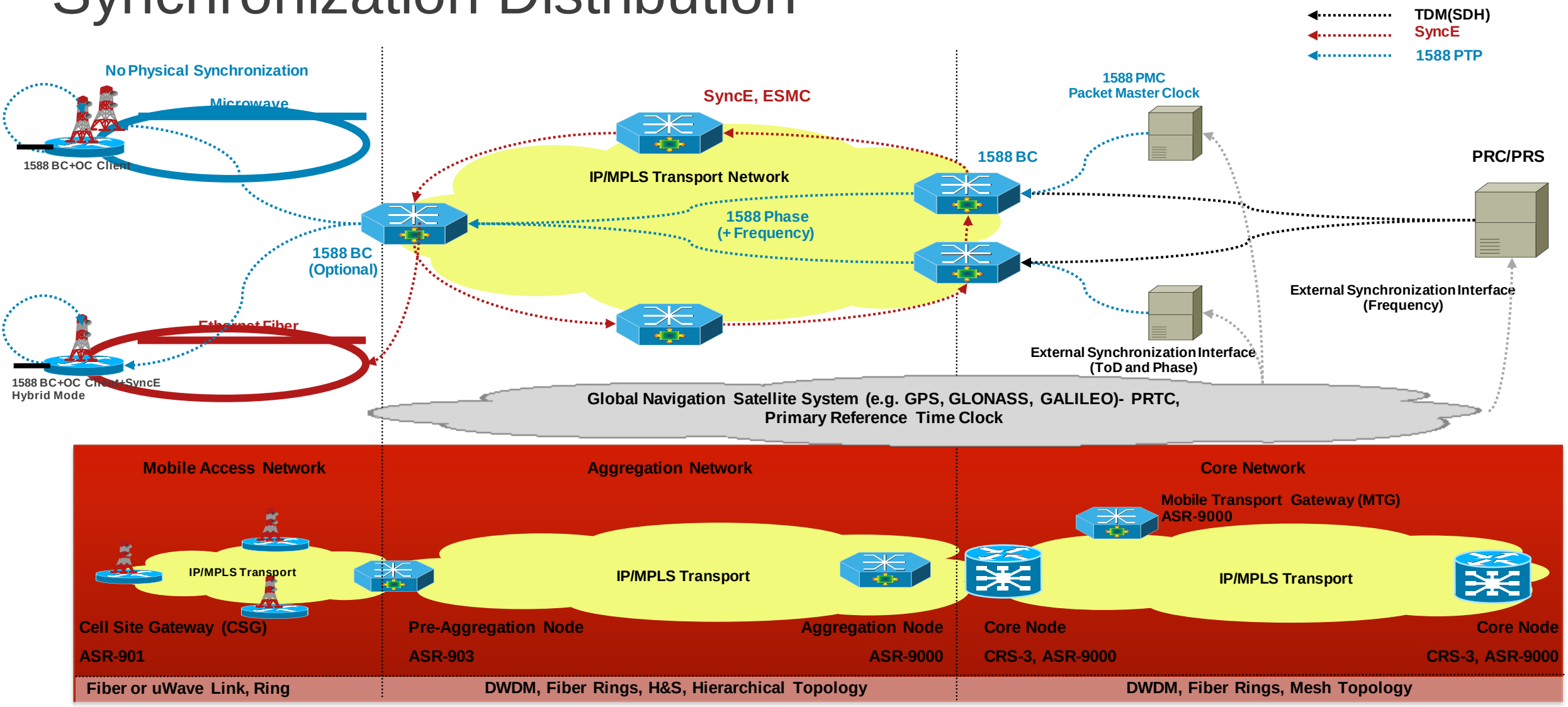
- Simple operation with minimal configuration (one line in OSPF)
- No need to run an additional protocol (like RSVP-TE) in a IGP/LDP network just for FRR capability
  - Automated computation of PQ node and directed LDP session setup
  - Minimal signalling overhead
- Simpler capacity planning than TE-FRR
  - TE-FRR protected traffic hairpins through NH or NNH before being forwarded to the destination
  - Need to account for the doubling of traffic on links due to hairpinning during capacity planning
  - Remote-LFA traffic is forwarded on per-destination shortest-paths from PQ node



If you need Traffic Engineering then TE is the way to go.
But, if all you need is fast convergence, consider simpler options!

FMC: Other Services

Synchronization Distribution



Differentiated Services QOS Domain

Traffic Class	PHB	Unified MPLS Transport		Service Edge			Fixed/Mobile Access Ethernet/TDM/ATM UNI		
		Core, Aggregation, Access		Business PWHE		Res/Bus Ethernet	M	R, B, M	M, B
		DSCP	EXP	DSCP	EXP	802.1P	DSCP	802.1P	ATM
Network Management	AF	56	7	56	7	7	56	(7)	VBR-nrt
Network Control Protocols	AF	48	6	48	6	6	48	(6)	VBR-nrt
Residential Voice Business Real-time Network Sync (1588 PTP) Mobility & Signaling traffic Mobile Conversation/Streaming	EF	46	5	46	5	5	46	5	CBR
Residential TV and Video Distribution	AF	32	4	32	4	NA	NA	4	NA
Business Telepresence	AF	24	3	NA	3	3	NA	3	NA
Business Critical In Contract Out of Contract	AF	16 8	2 1	16 8	2 1	NA	16 8	2 1	NA
Residential HSI Business Best Effort Mobile Background VQE Fast Channel Change, Repair	BE	0	0	0	0	0	0	0	UBR

FMC Overview

FMC – Managing Risk

- Built on tried and tested technologies
  - Risk reduced by reusing existing protocols
- Common platform used for mobile and fixed network
  - Hardware reliability
  - Software reliability (aka Bugs)
- Operational procedures
  - Minimise risk by implementing proper provisioning processes
  - Reduce risk and expose over CLI-Based provisioning.
- Lab Lab Lab…..
  - Have the right test environment to validate new feature deployment on the network
  - Ability to test in realistic environment impact on the network
  - Quality Control process for Method Of Procedure (MOP) planning and execution

FMC Overview Points

- Enables CSCO to differentiate by enabling fixed, mobile and enterprise convergence.
- Optimizes network costs by enabling the transport convergence with Unified MPLS and fixed and mobile service infrastructure integration
- Improves ARPU and customer retention by unifying the service experience across fixed and mobile access, by personalizing it per device and by making it seamless during roaming
- Brings new revenues to the Service Provider enabling it to offer SP managed BYOD services to Enterprise customers and unify BYOD and public subscriber experiences

Thank you.