Convergência de Redes ATM/FR & IP/MPLS

GTER18

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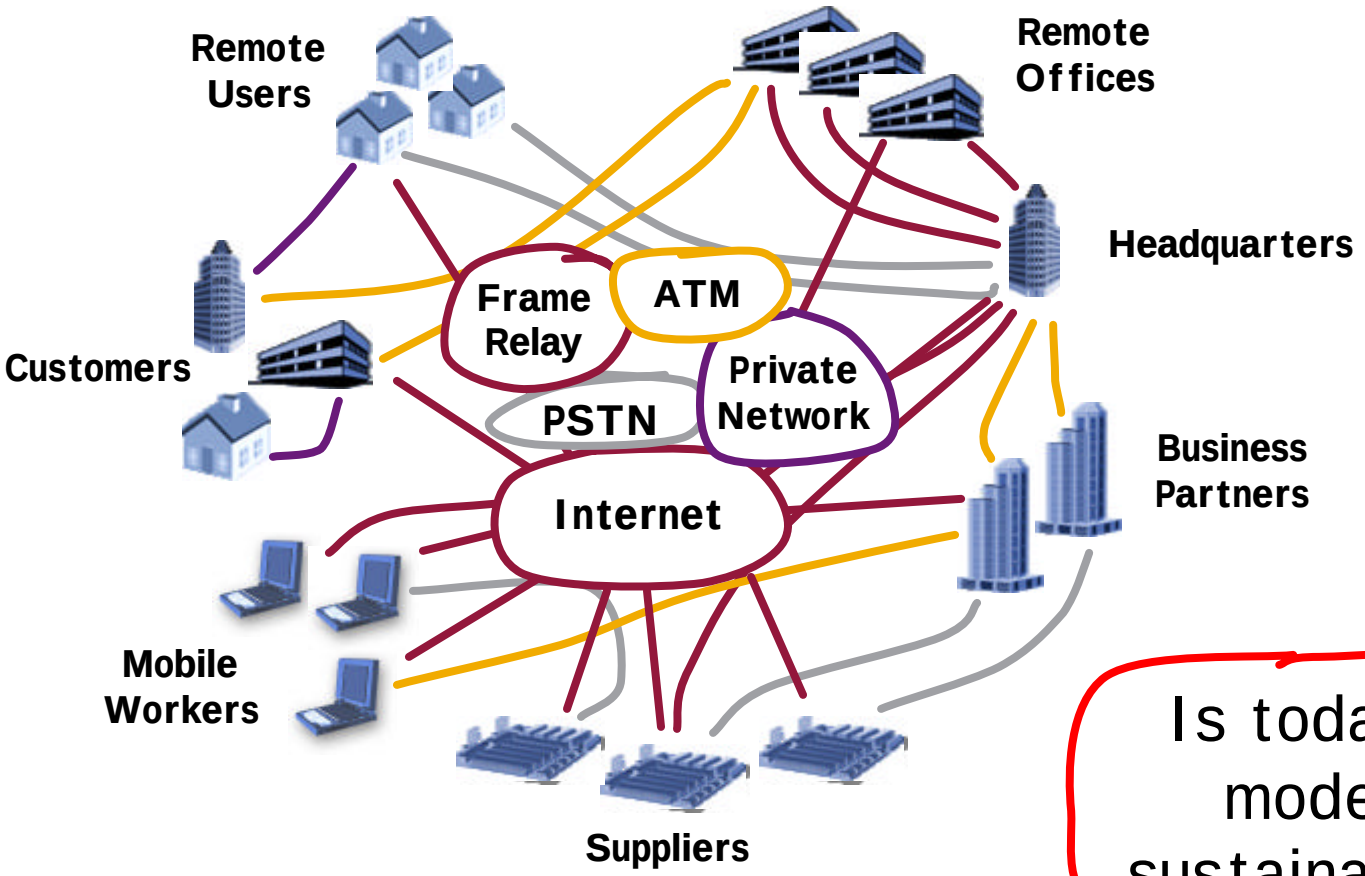
Juniper™ NETWORKS

Agenda

- Introdução
- *Building Blocks*
  - Modelos de Convergência
  - Mecanismos de Transporte
  - Qualidade de Serviço
- ATMoMPLS

Today's Increasingly Networked World



Is today's model sustainable?

The Industry Has Two Choices

Continue growing service-specific private networks & a commoditized Internet…

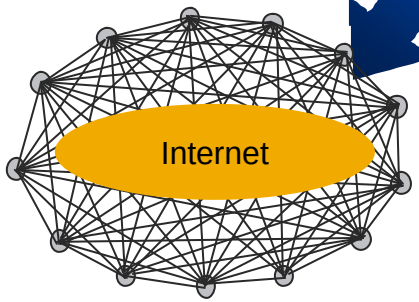
Voice

+

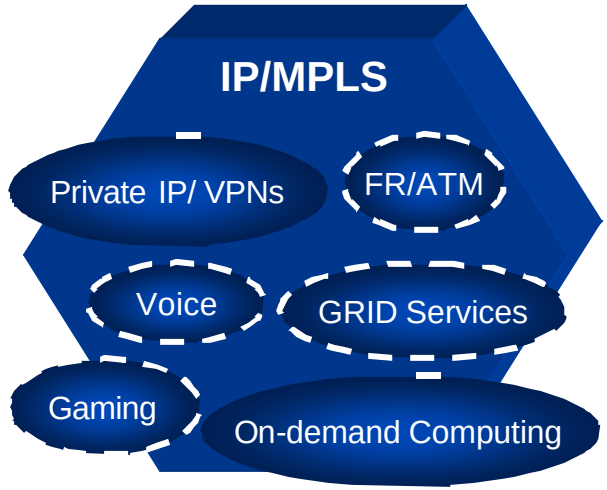
FR/ATM +

+

Private IP/ VPNs



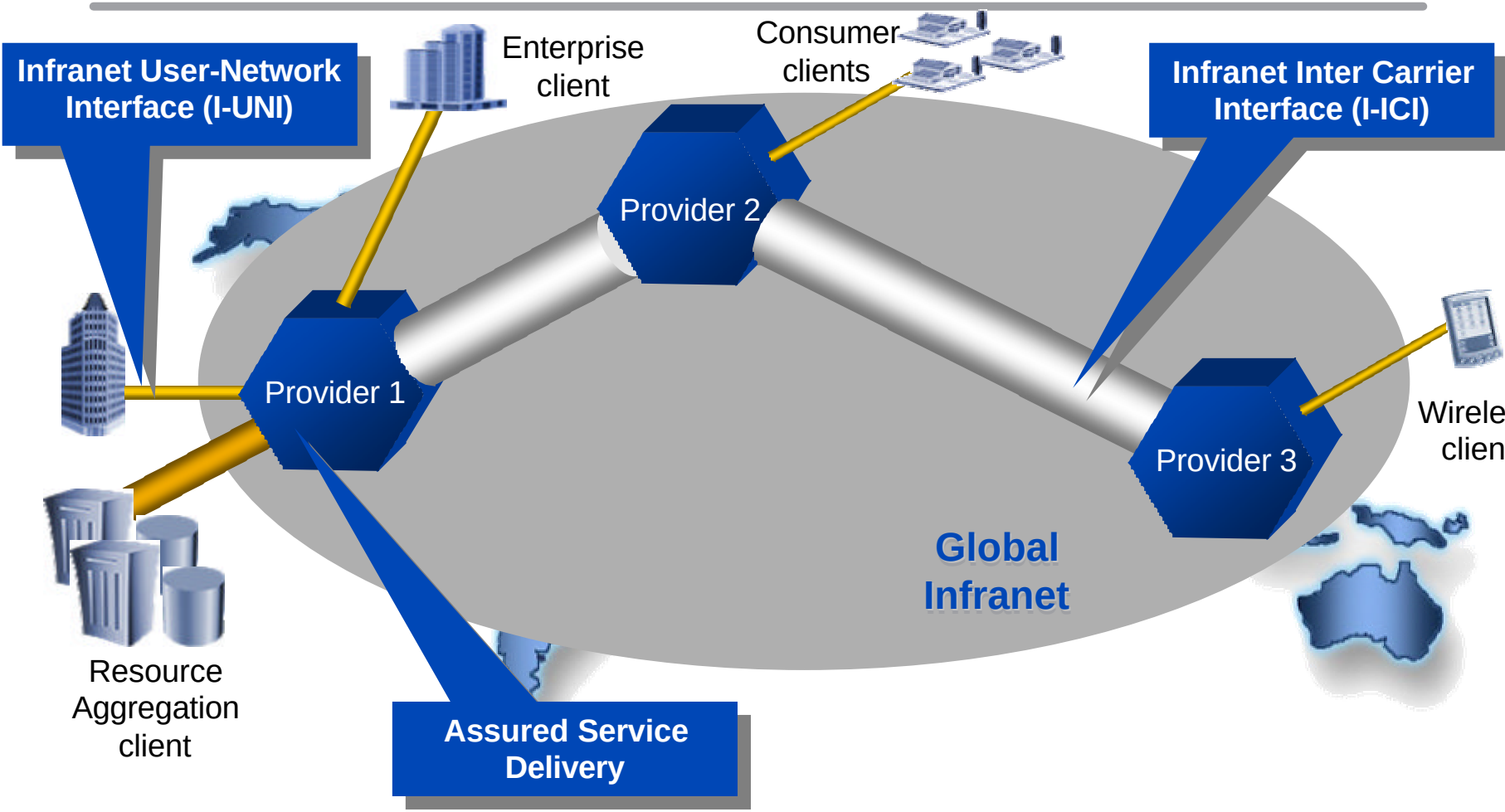
…OR migrate to a unifying infrastructure that delivers quality, security & reach



Optimized Service Environment

- Segregated, uniquely managed virtual networks
- Provides end-end assurances appropriate to application
- Dynamic service options increase revenues/ customer

The Infranet Standard Model (http://www.infranet.org)



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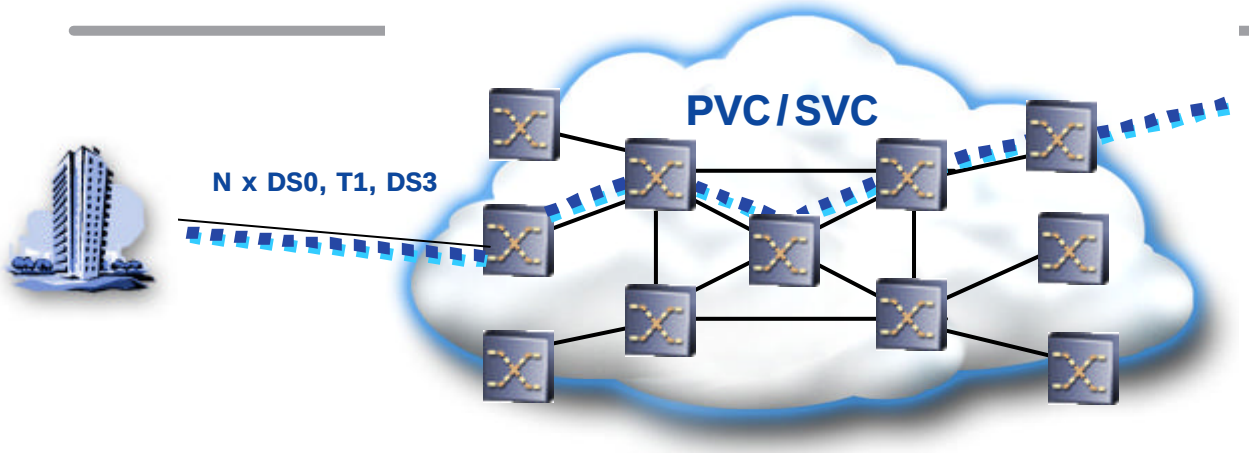
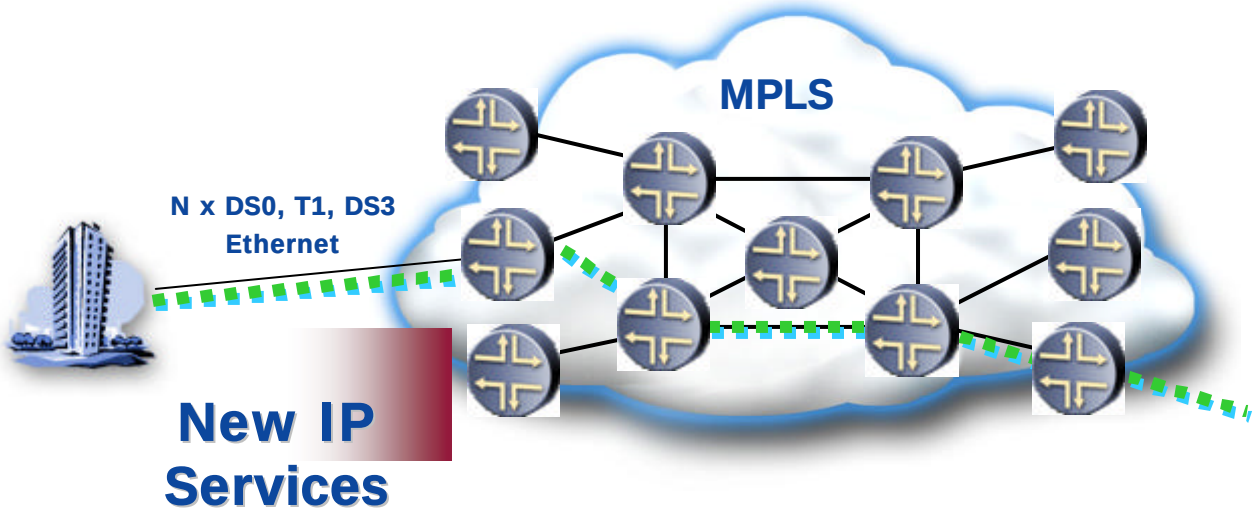
Parallel Cores at a glance



Current ATM:

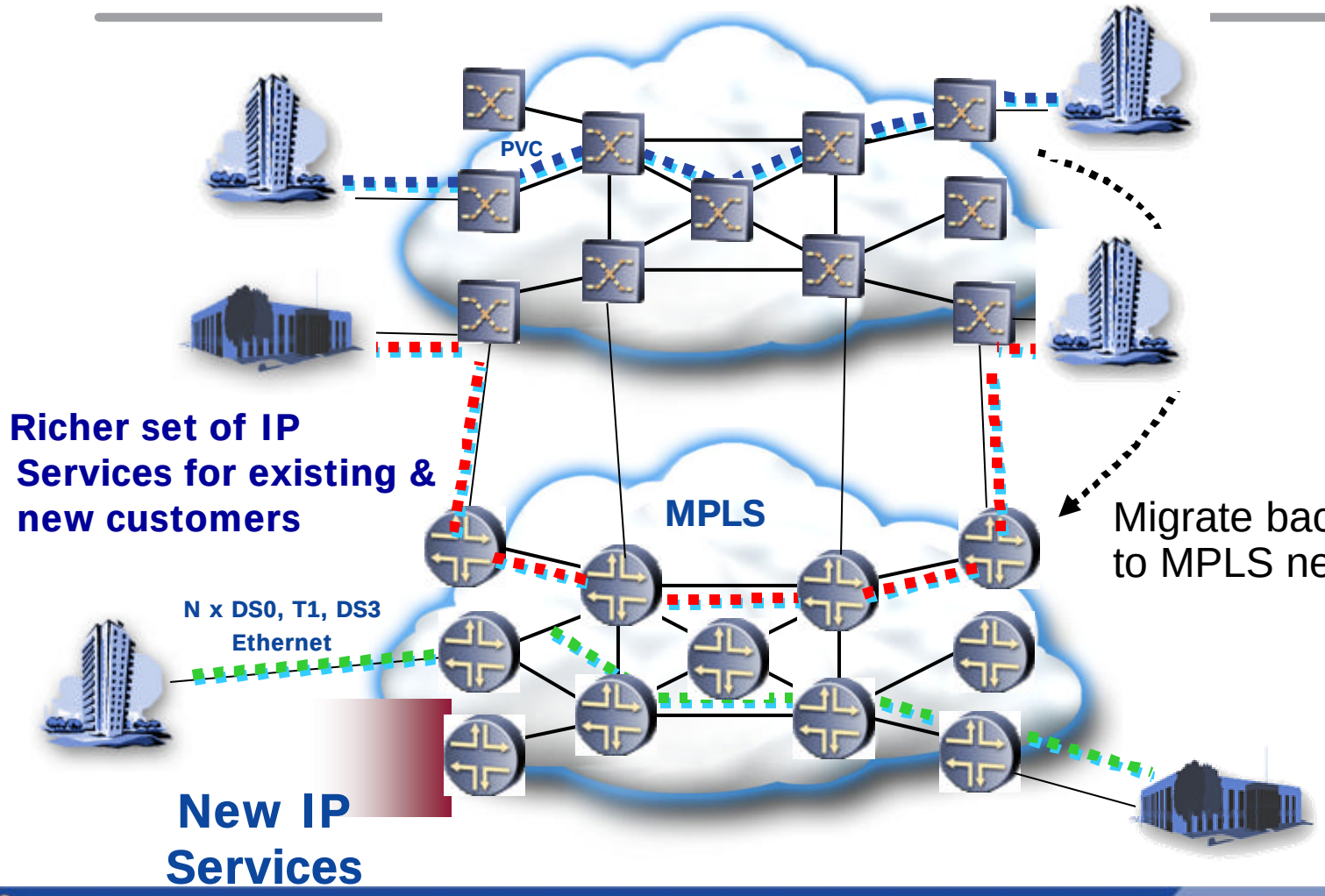
- Backhaul
- Aggregation



New IP Core:

- Layer 3 VPNS
- Layer 2 VPNs
- Layer 2.5 VPNs
- Managed Firewall
- Voice over IP
- Enhanced DSL

ATM Core Off-load at a glance



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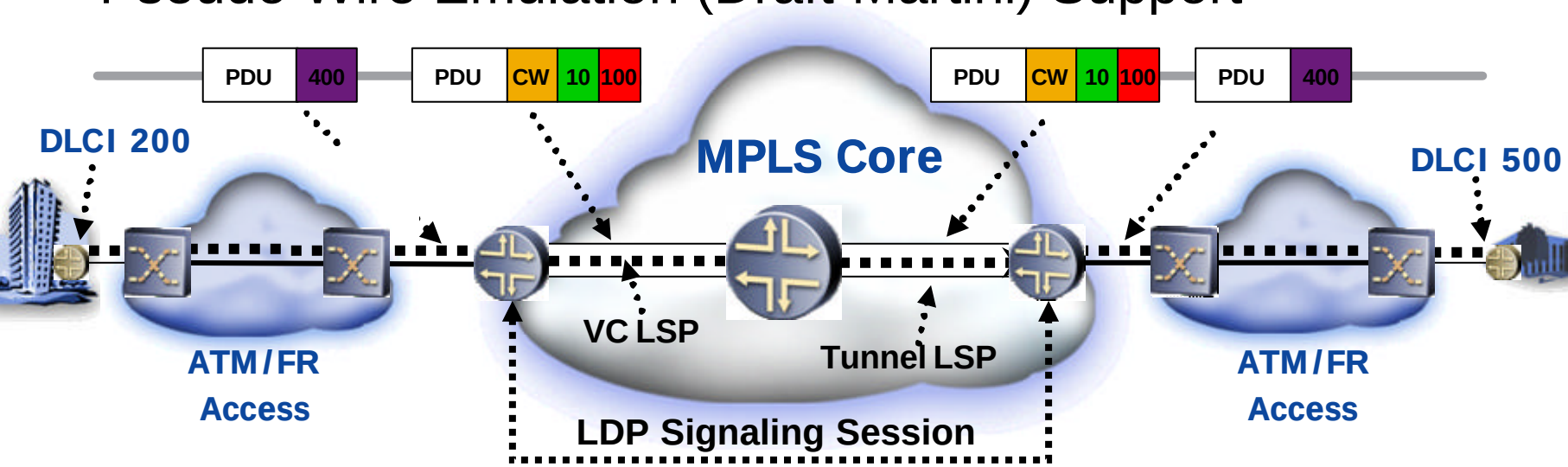
Mecanismos de Transporte

Pseudo Wire Emulation (Draft-Martini) Support



Application

- Allows Service Provider to build point to point circuits over MPLS core using LDP signaling

How it works?

- Provider pre-provisions tunnel LSPs
- Provider provisions Virtual Circuit LSPs one per customer site
- Layer 2 frame encapsulated in MPLS

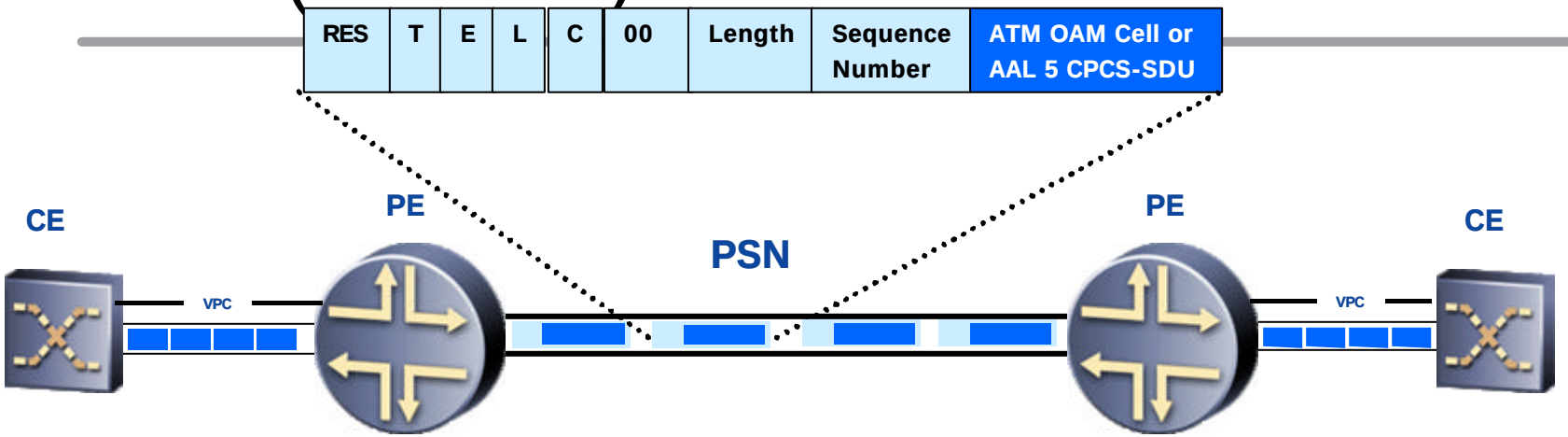
Encapsulations supported

- Ethernet VLAN & Port
- PPP, HDLC - Port to Port, DS0 to DS0
- Frame Relay - DLCI to DLCI, Port to Port
- ATM AAL5 – VC to VC, Port to Port
- ATM Cell Mode – VC to VC, Port to Port
- ATM Cell Relay Mode
- L2-interworking (any-any) supported for IP

ATM over PWE

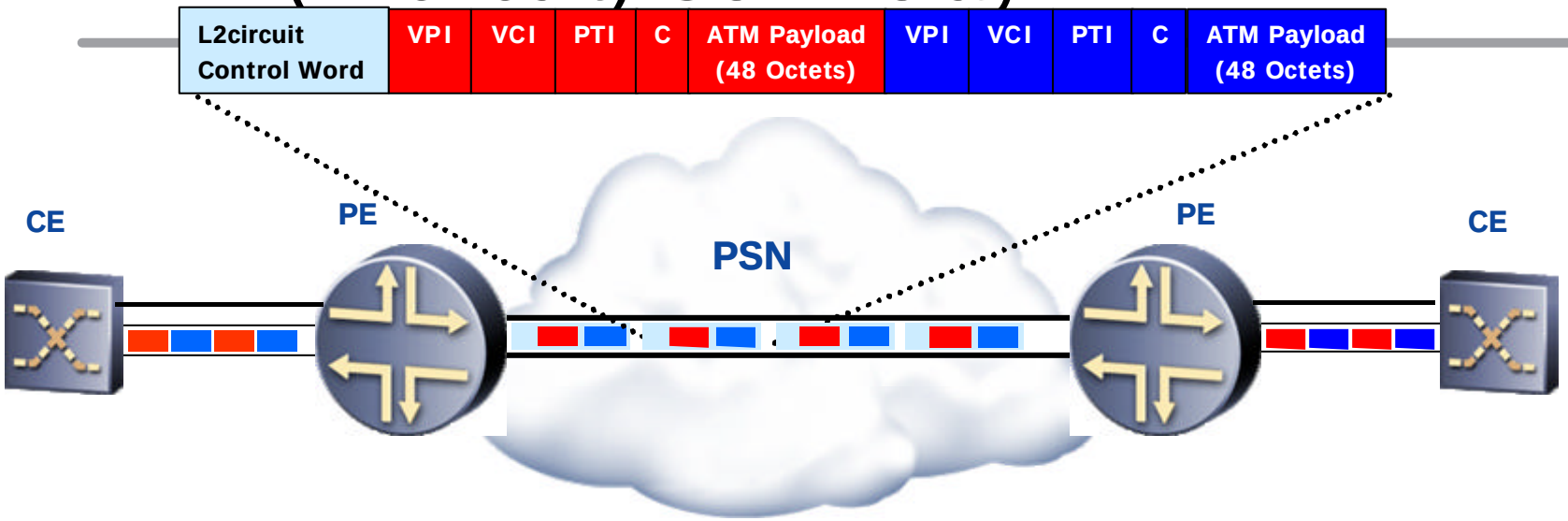
- There are currently two modes of carrying ATM traffic over Pseudo Wires:
  - AAL5 mode: ATM cells are SARed into AAL5 packets before transport over MPLS
  - Cell-Relay: ATM cells are carried directly into MPLS packets. Cell-relay can be done in different granularity:
    - VC mode
    - VP mode
    - Port mode
  - Cell-relay in Port mode and VP mode are best suited for convergence applications.

PWE (L2circuit) AAL5 Mode



- Martini (L2circuit) AAL5 Mode
  - Flag bits are used to indicate:
    - T: Packet contains an ATM Cell (OAM) or AAL5
    - E: EFCI for Explicit Forward Congestion Indication
    - L: CLP for cell loss priority
    - C: C/R for FRF 8.1 FR/ATM service interworking

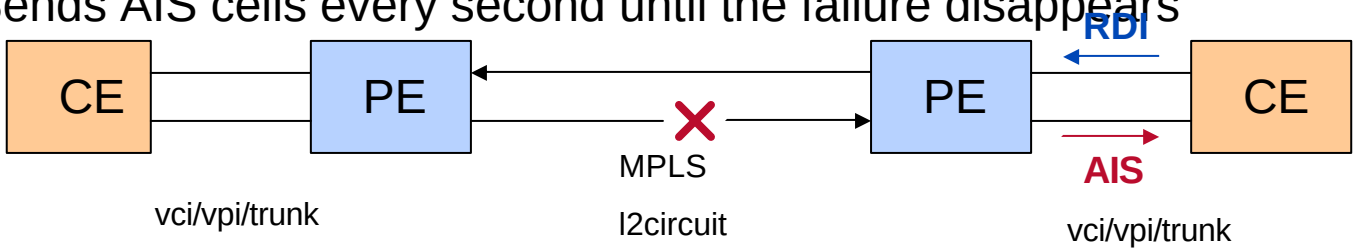
PWE (L2circuit) Cell-Relay



- One or more cells are concatenated
  - Maximum number of cells is limited by network MTU, and is optionally negotiated with far-end ingress router; the number of cells/bundle must not exceed far-end limit
  - Cells are bundled per VC, per VP or per Port
  - cell_bundle_size is a local configuration option

OAM in Cell-Relay mode

- In Cell-relay mode, OAM cells received by PE are transparently forwarded to LSP
- When LSP failure is detected , PE generates OAM AIS cell towards the CE
- For VC-mode Cell-relay, F5 OAM AIS is generated
- For VP-mode Cell-relay, F4 OAM AIS is generated on VPI.4
- For Trunk-mode Cell-relay, F4 OAM AIS is generated on Trunk.4
- For Port-mode Cell-relay, no OAM cell is generated
- Sends AIS cells every second until the failure disappears



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Qualidade de Serviço

MPLS QOS: How do we turn COS into QOS?

- Diffserv is usually associated with Class of Service or Differentiated Services
- ATM demands quality of service or assured experience (e.g, CBR traffic)
- This is attainable through smart combination of new MPLS features intended for ATM convergence:
  - E-LSPs, L-LSPs, Diffserv-Aware Traffic Engineering
  - Per LSP QOS enforcement
  - Per LSP Traffic Class Policing and Admission control at the ingress

DiffServ

- Give different forwarding treatment (per-hop-behavior, PHB) to traffic based on the “class-of-service” classification.
- From a practical point of view: assign traffic to different queues and partition the resources among the queues.
- For IP packets, the “class-of-service” is marked on the packet itself, in the 6-bit DSCP field.

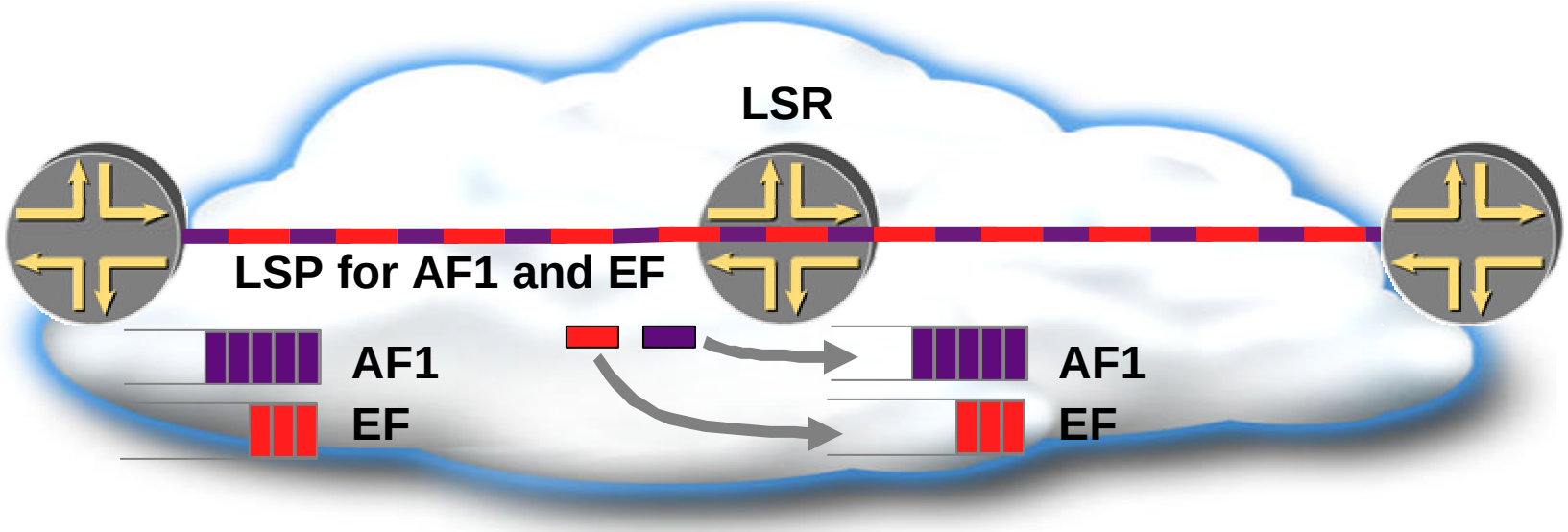
MPLS DiffServ

- For MPLS packets, the “class-of-service” needs to be encoded in the MPLS header.
- The only available field, 3-bit EXP field.

The MPLS DiffServ problem

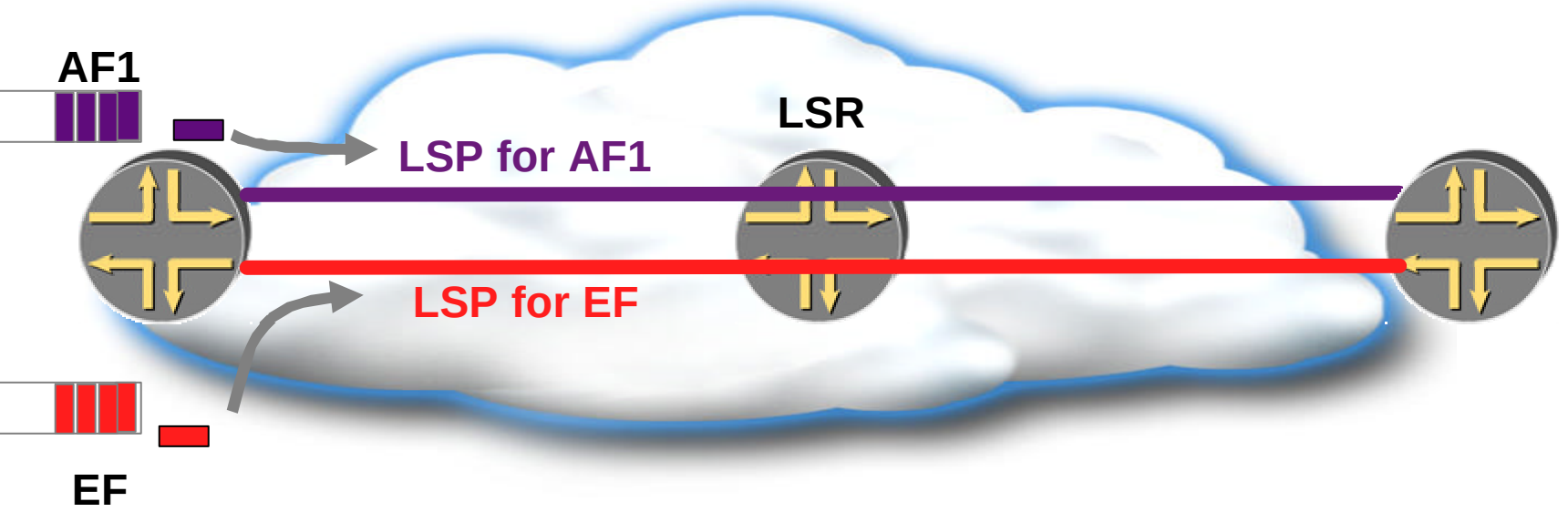
- How to map between 6-bit IP DSCP field (64 values) and 3-bit MPLS EXP field (8 values)?
- Solution:
  - If only 8 values are used, they can be encoded in the EXP bits -> E-LSPs (E stands for EXP)
  - If more than 8 values are used, use the label and the EXP bits to convey the info -> L-LSPs (L stands for label) – requires extra signaling

MPLS DiffServ - E-LSPs



- Support of EF and AF1 on an E-LSP
  - EF and AF1 packets travel on single LSP (single label)
  - Packets have different MPLS EXP values and are placed into different queues

MPLS DiffServ - L-LSPs



- Support of EF and AF1 on L-LSPs
  - EF and AF1 packets travel on different LSPs (different labels)
  - Packets are placed into different queues based on the label

The “TE” in DiffServ-TE

- Constraint-based routing – enforce different bandwidth constraints for different classes of traffic.
- Admission control per-class (at the time the LSP is established).
- Requires extensions to RSVP and the IGPs

Terminology – Class-type (CT)

- Class-Type (CT or traffic class): collection of traffic flows that will be treated equivalently from a DS-TE perspective.
- Maps to a queue, equivalent to the class-of-service “forwarding-class” concept.
  - CT0: Best effort
  - CT1: Expedited forwarding
  - CT2: Assured forwarding
  - CT3: Network control

Priorities and preemption

- The idea: some LSPs are more important than others, and can “kick out” the less important ones, when resource contention occurs.
- Happens at setup time, not at forwarding time.
- Eight priority levels:
  - Priority 0 (best)
  - Priority 7 (worst)

How is bandwidth accounted?

- The IETF defined bandwidth models.
- They determine the partitioning of BW among the different CTs

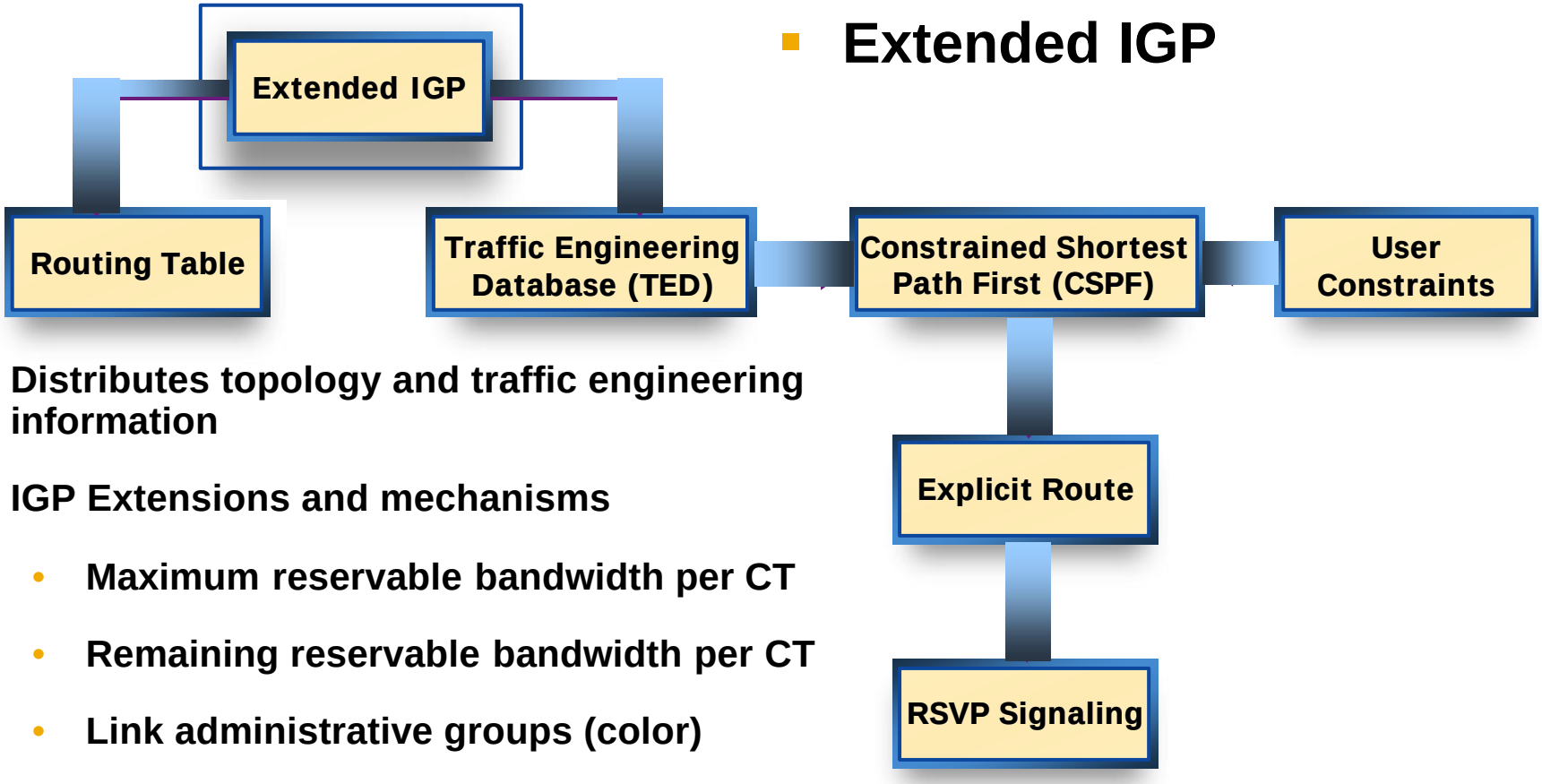
BW model MAM (maximum allocation)

- The available bandwidth is partitioned between the CTs
- No sharing is allowed.
- Unused resources cannot be used by other CTs. Good or bad? Both…

BW model RDM (Russian dolls)

- The available bandwidth is partitioned between the CTs.
- Sharing is allowed.
- Requires using preemption to ensure bandwidth guarantees to CTs.

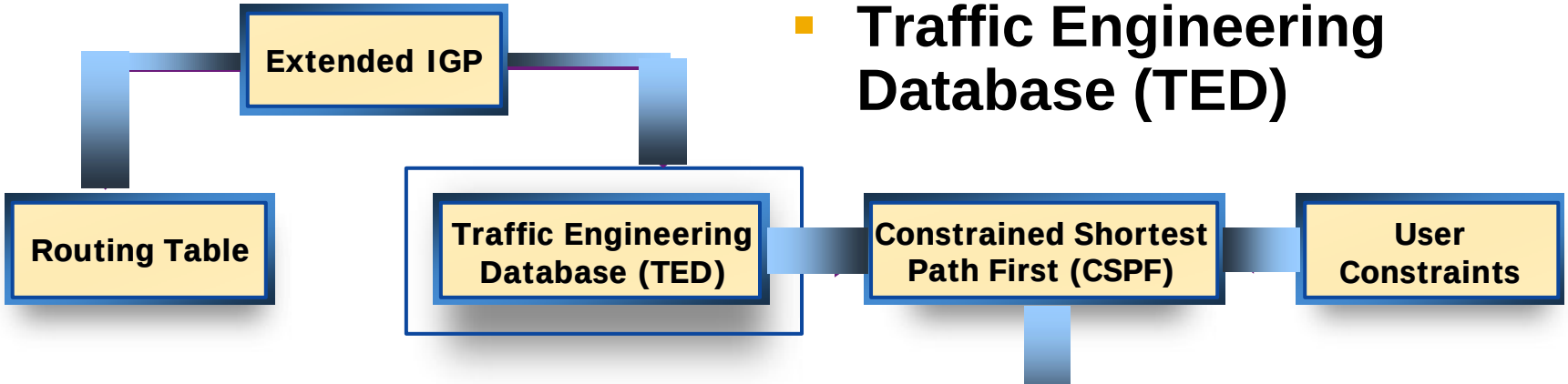
How DS-TE operates



- **Extended IGP**

- **Distributes topology and traffic engineering information**
- **IGP Extensions and mechanisms**
  - **Maximum reservable bandwidth per CT**
  - **Remaining reservable bandwidth per CT**
  - **Link administrative groups (color)**
  - **Opaque LSAs for OSPF, New TLVs for IS-IS**

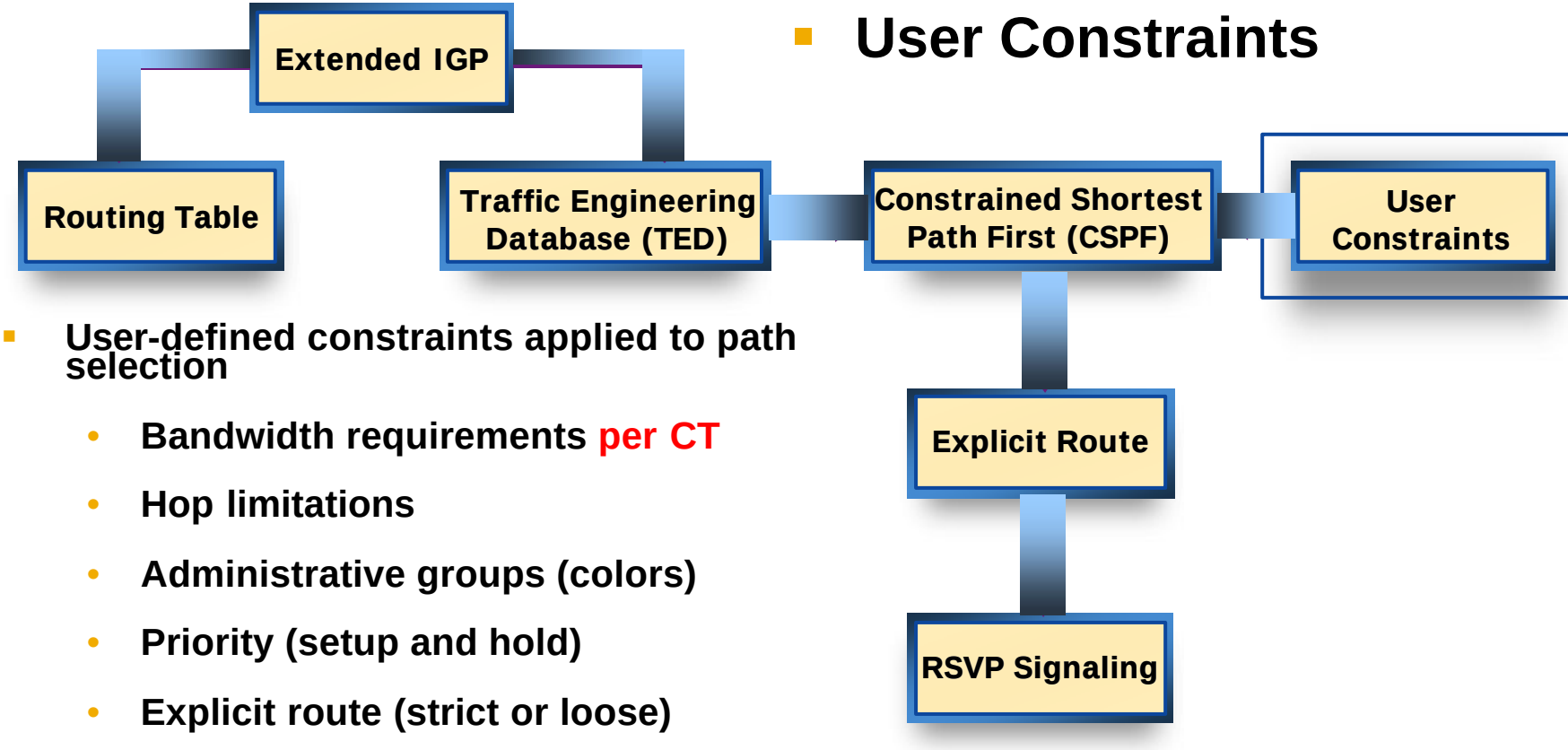
How DS-TE operates



- **Traffic Engineering Database (TED)**

- Maintains traffic engineering information learned from the extended IGP & contains:
  - Up-to-date network topology information
  - Current reservable bandwidth of links per CT
  - Link administrative groups (colors)

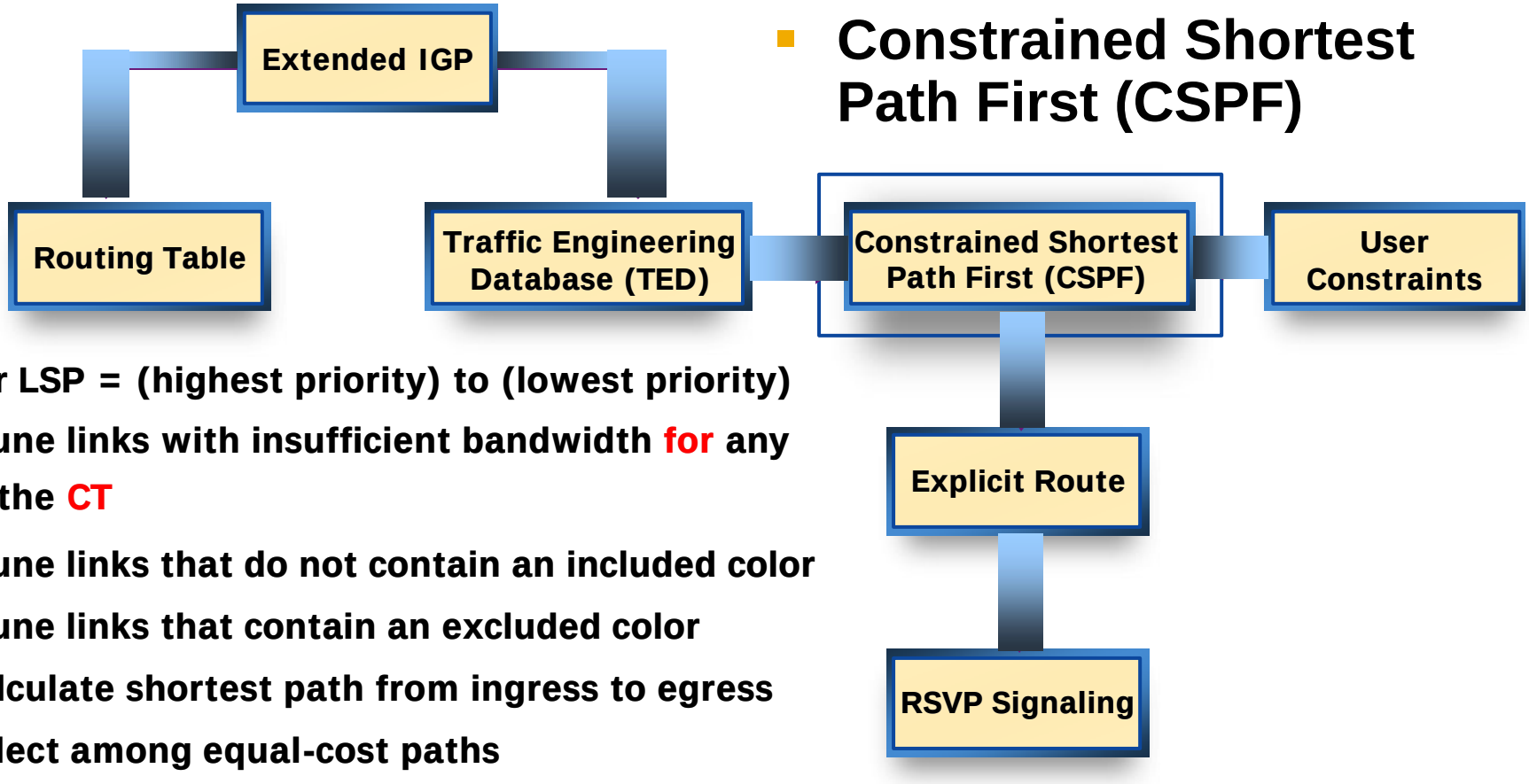
How DS-TE operates



- **User Constraints**

- **User-defined constraints applied to path selection**
  - **Bandwidth requirements per CT**
  - **Hop limitations**
  - **Administrative groups (colors)**
  - **Priority (setup and hold)**
  - **Explicit route (strict or loose)**

How DS-TE operates



- **Constrained Shortest Path First (CSPF)**

For LSP = (highest priority) to (lowest priority)

Prune links with insufficient bandwidth for any of the CT

Prune links that do not contain an included color

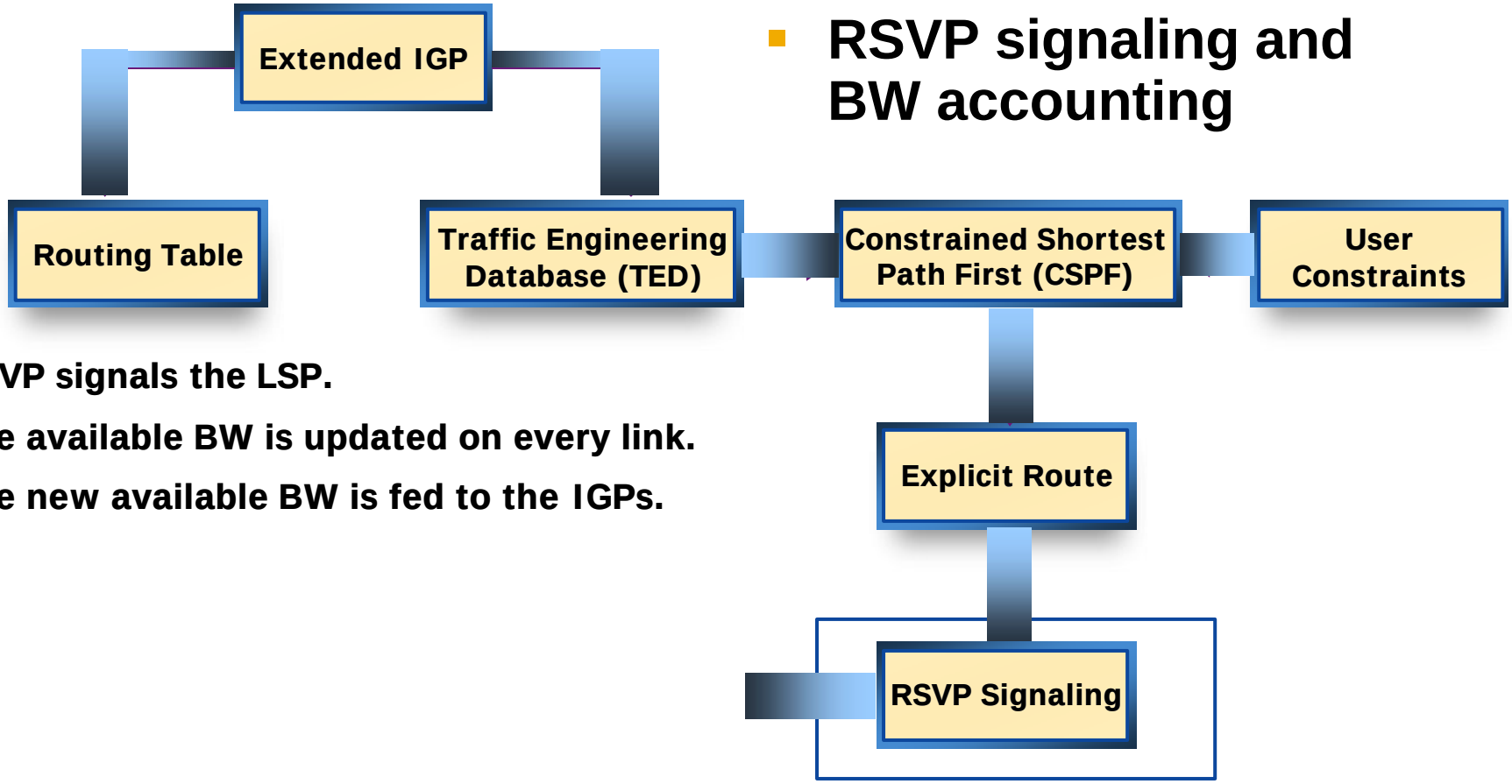
Prune links that contain an excluded color

Calculate shortest path from ingress to egress

Select among equal-cost paths

Pass explicit route to RSVP

How DS-TE operates



- **RSVP signaling and BW accounting**

RSVP signals the LSP.

The available BW is updated on every link.

The new available BW is fed to the IGPs.

Multiclass E-LSPs Advantages

- Multiple classes per LSP means fewer LSPs in the core
- The bandwidth reservation is made for several classes at the same time reducing resource consumption and set up time
- Emulates ATM trunks better due to fate-sharing among different classes
  - ATM trunk has multiple classes CBR, VBR-rt, etc.
  - If one fails and reroutes, all should fail and reroute like ATM

LSP Input Policing

- All the hard work of establishing LSPs and marking the traffic is for nothing if more traffic is pushed on the LSPs than what we reserved.
- LSP policers ensure that traffic stays in profile.
- The policing is done per CT. The policers are configured in a filter that is attached to the LSP.

L2circuit CAC

- Don’t bring up the layer 2 circuit unless there is enough bandwidth available on the underlying LSP.
- Avoids overloading the underlying LSPs, ensuring service quality for all circuits using it.

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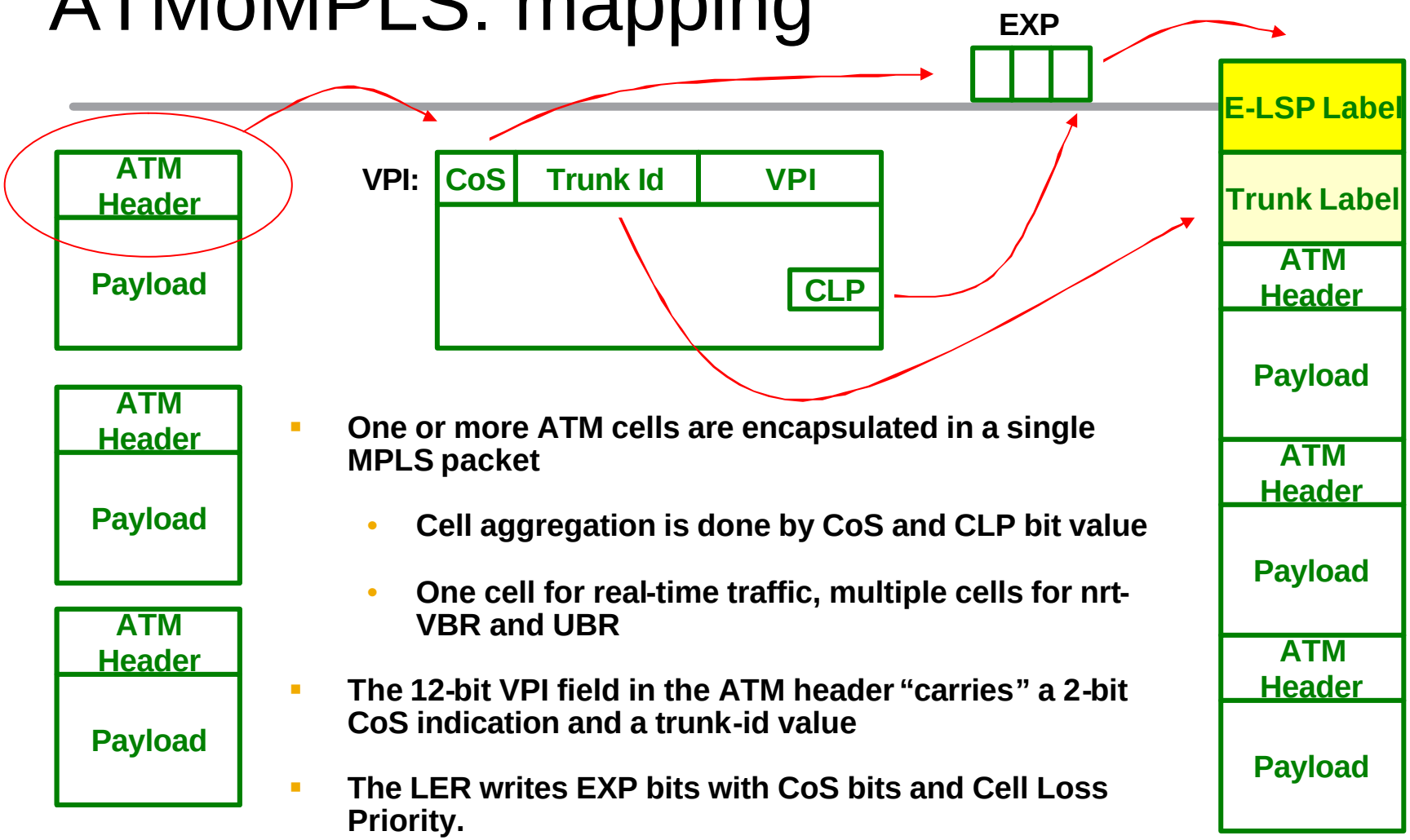
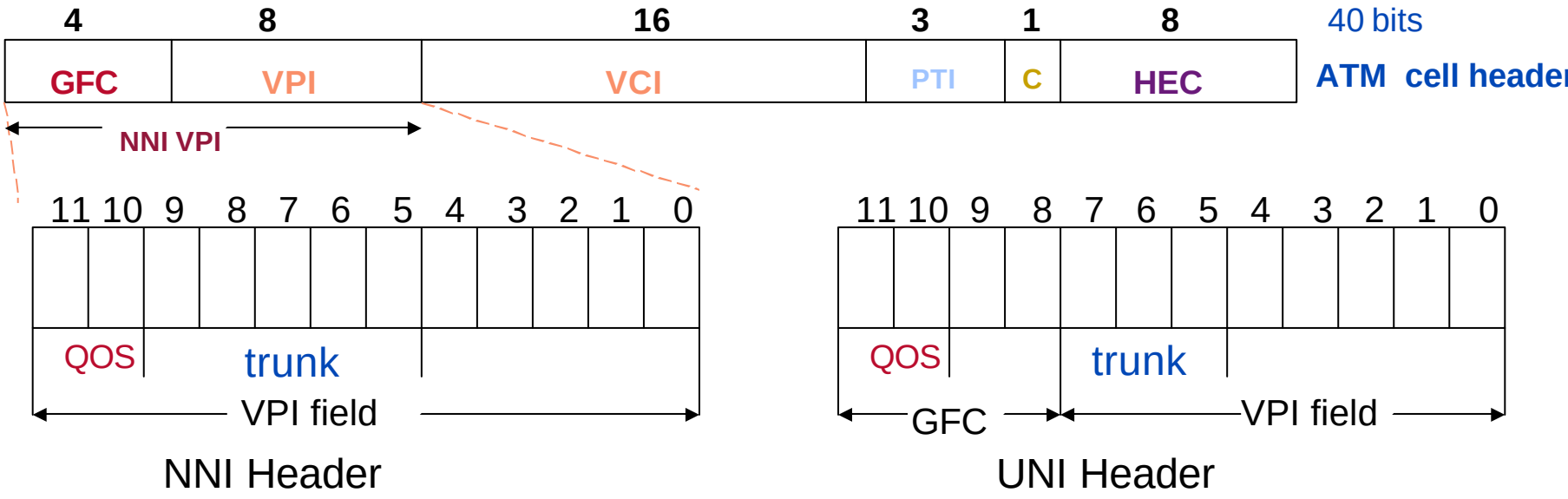
ATMoMPLS: mapping



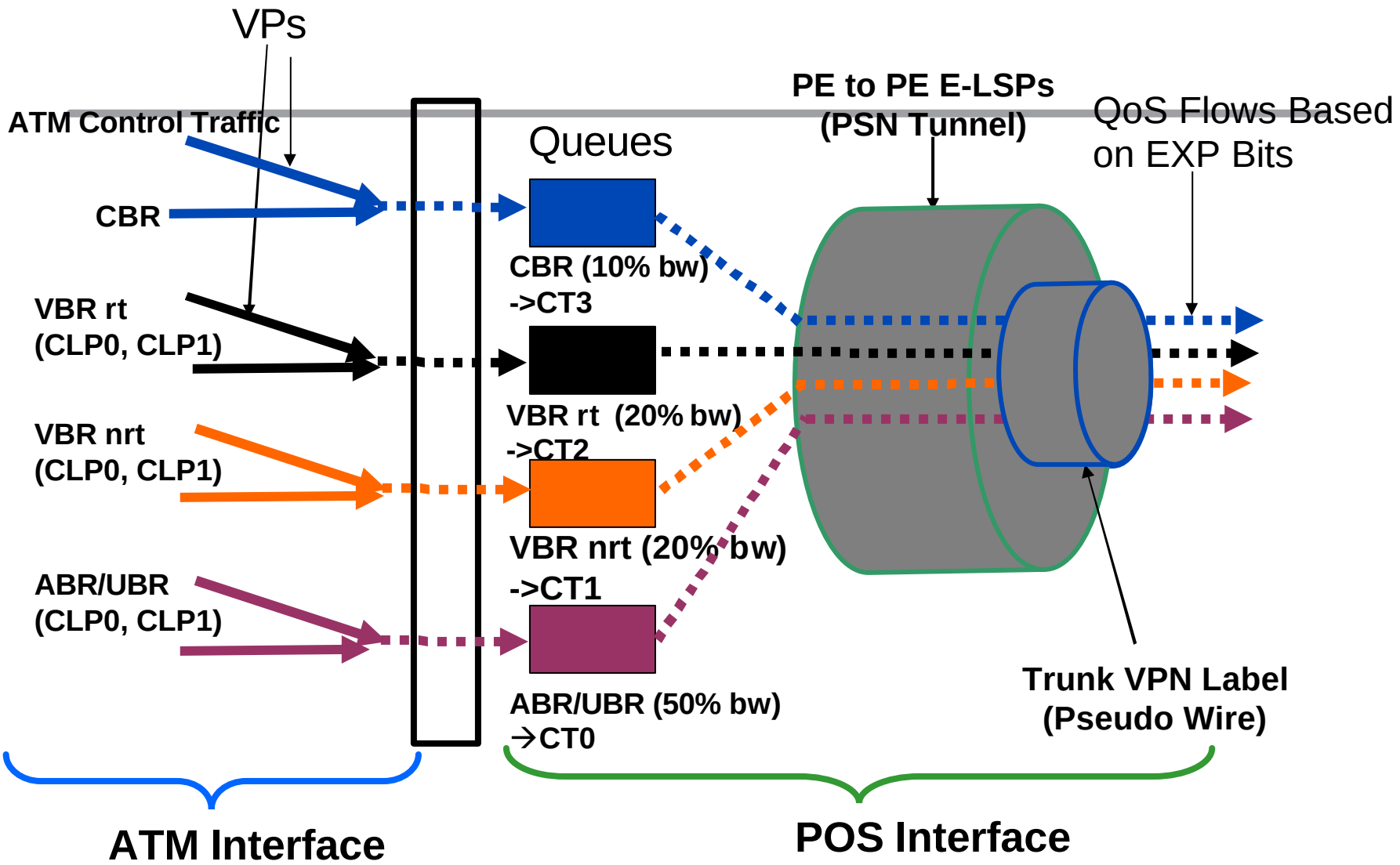
- One or more ATM cells are encapsulated in a single MPLS packet
  - Cell aggregation is done by CoS and CLP bit value
  - One cell for real-time traffic, multiple cells for nrt-VBR and UBR
- The 12-bit VPI field in the ATM header "carries" a 2-bit CoS indication and a trunk-id value
- The LER writes EXP bits with CoS bits and Cell Loss Priority.
- LER translates Trunk Id to Trunk (PW) Label

ATM over MPLS Trunk

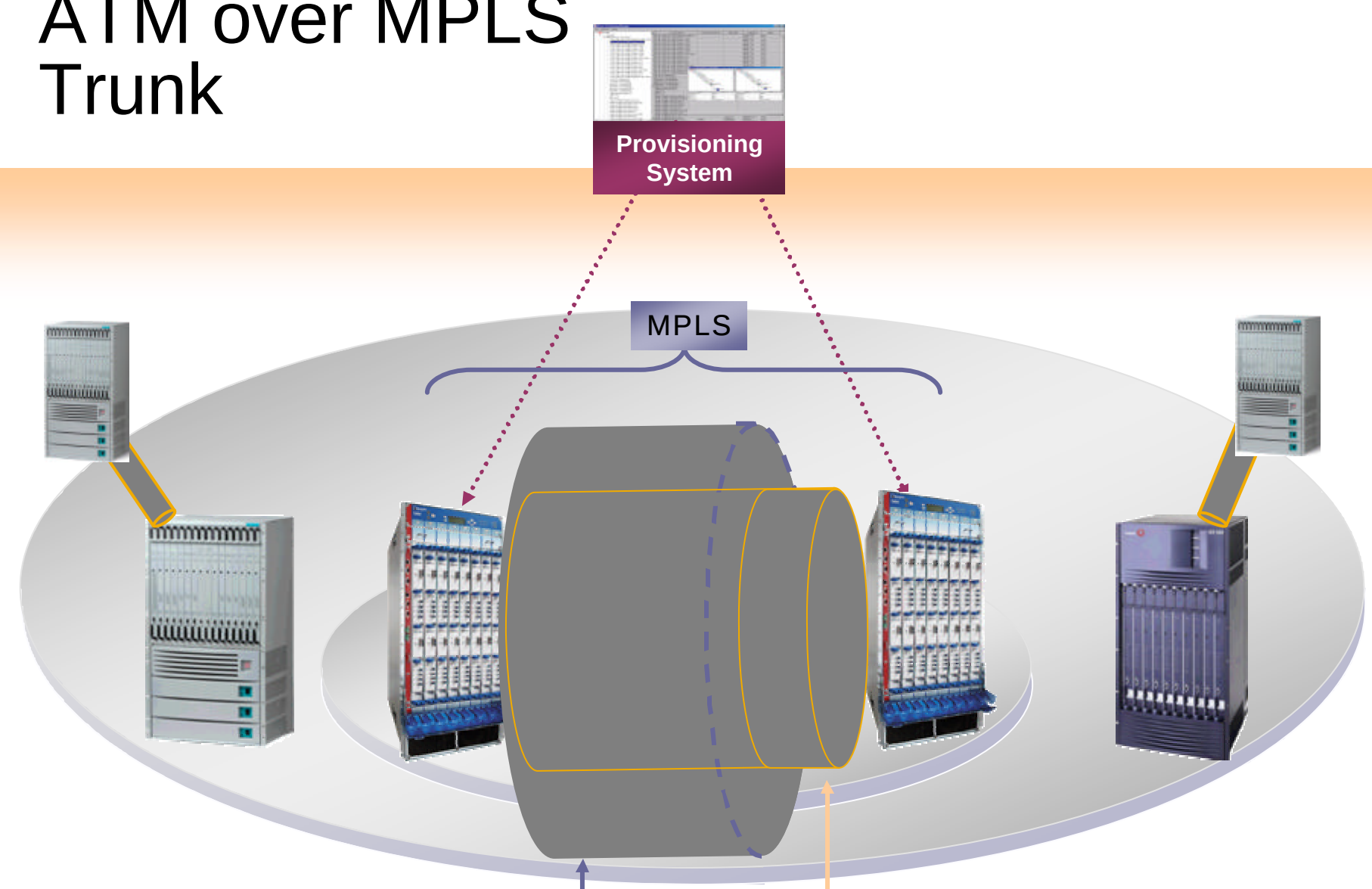
- Trunk consists of 32 VPIs
- 32 NNI trunks and 7 UNI trunks
- Customized ATM cell header
- Each trunk corresponds to a PWE3/Martini L2 Circuit



VC to MPLS QoS Mapping



ATM over MPLS Trunk



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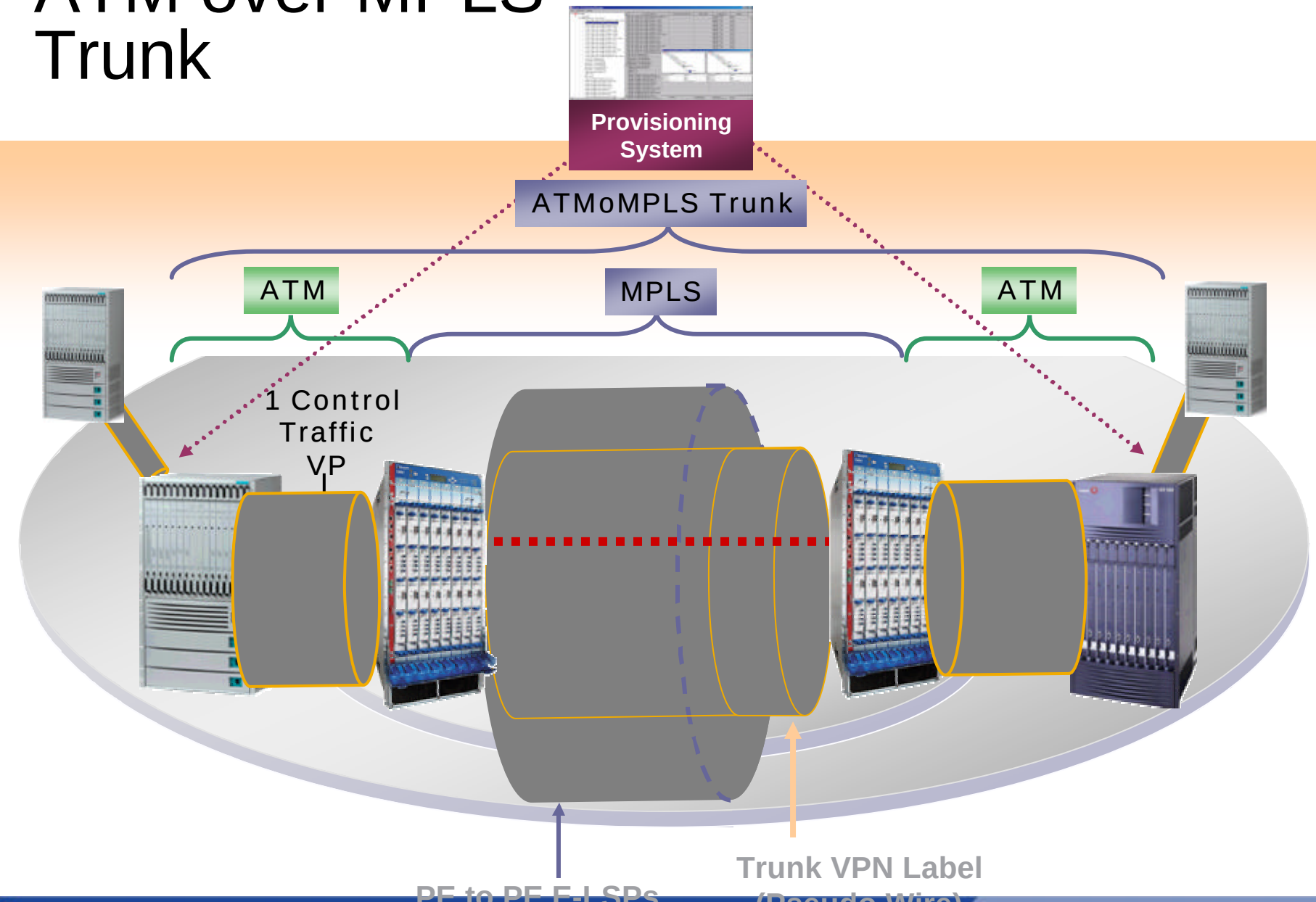

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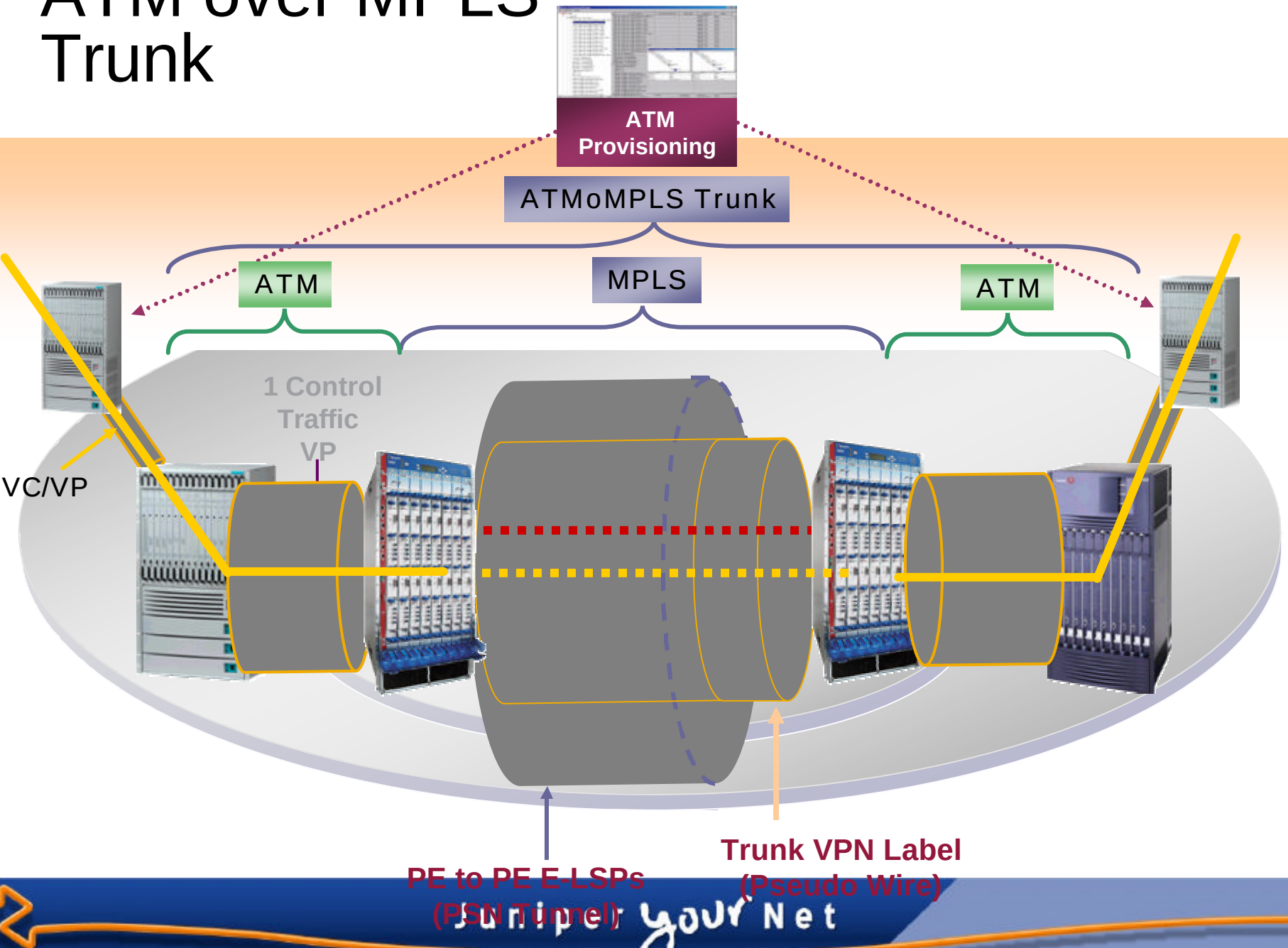

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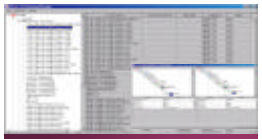
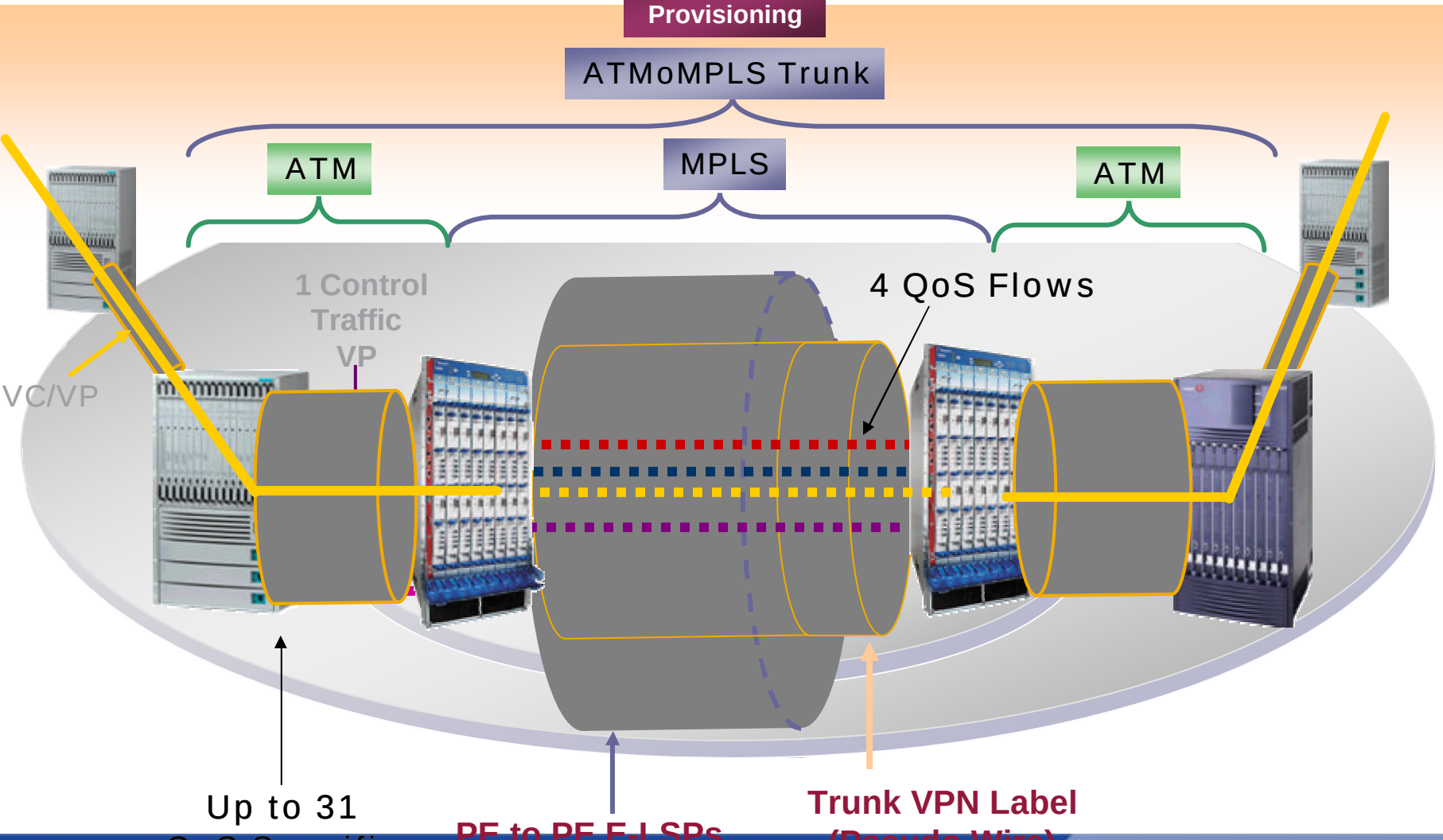


ATM Provisioning



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MPLS Diffserv-Aware Traffic Engineering

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Inter-Carrier Capabilities for IP/MPLS Networks

http://www.infranet.org/learn/literature/inter-carrier.pdf

Migration Strategies for IP Sevice Growth: Cell-Switched MPLS or IP-routed MPLS

http://www.juniper.net/solutions/literature/white_papers/200026.pdf

Transport of Layer 2 Frames Over MPLS

draft-martini-l2circuit-trans-mpls-09.txt

Encapsulation Methods for Transport of ATM Cells/Frame Over IP and MPLS Networks

draft-martini-atm-encap-mpls-00.txt

Referências

MPLS Support of Differentiated Services

`rfc3270`

Requirements for support of DS-aware MPLS TE

`Rfc3564`

Protocol extensions for support of DS-aware MPLS TE

`draft-ietf-tewg-diff-te-proto-05.txt`

Russian Dolls Bandwidth Constraints Model for DS-aware MPLS TE

`draft-ietf-tewg-diff-te-russian-03.txt`

Max Allocation Bandwidth Constraints Model for DS-aware MPLS TE

`draft-ietf-tewg-diff-te-mam-00.txt`

Dúvidas ?