ATM – MPLS Network Interworking

The ATM Forum

ATM AMBASSADOR

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Topics

- Introduction to ATM–MPLS Interworking
- Encapsulation Formats
- Interworking Procedures
- Other Technical Issues
- Future Work
- Summary

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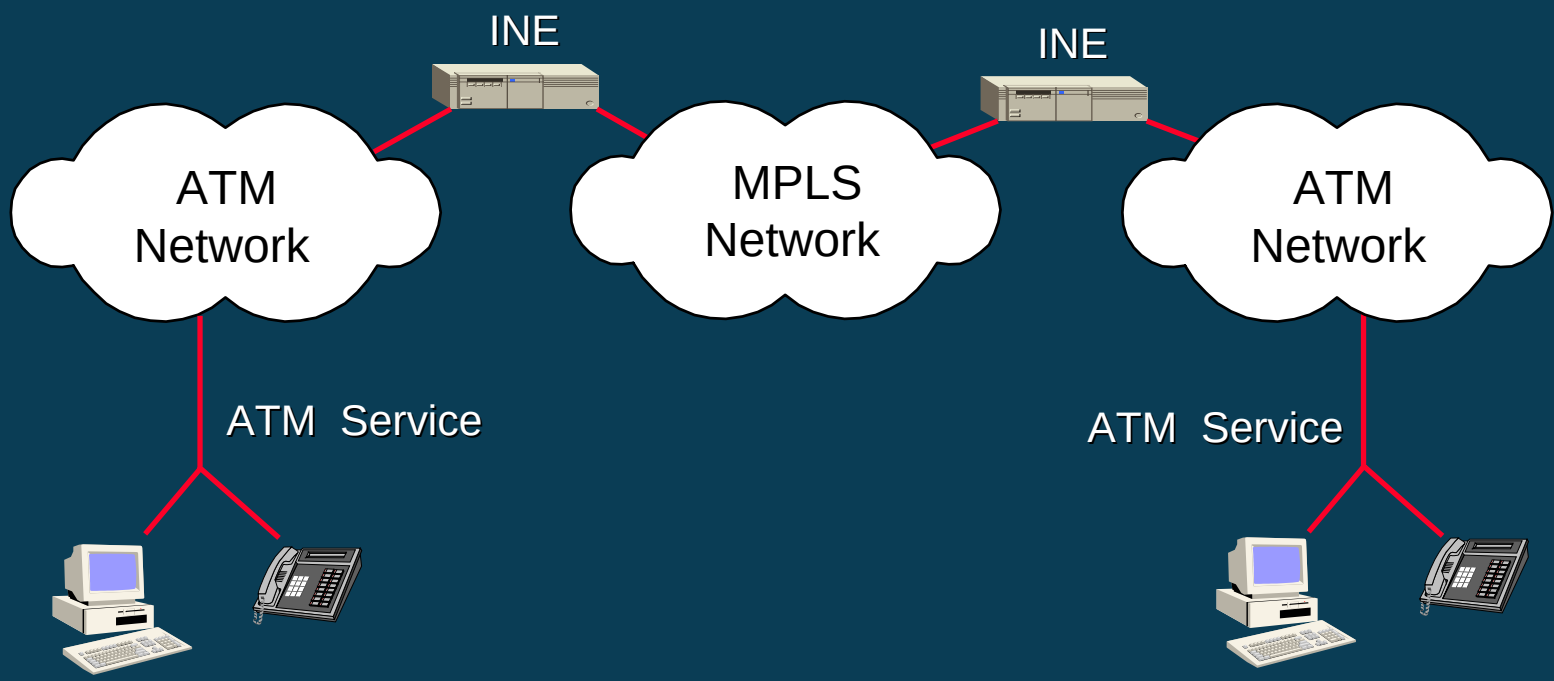
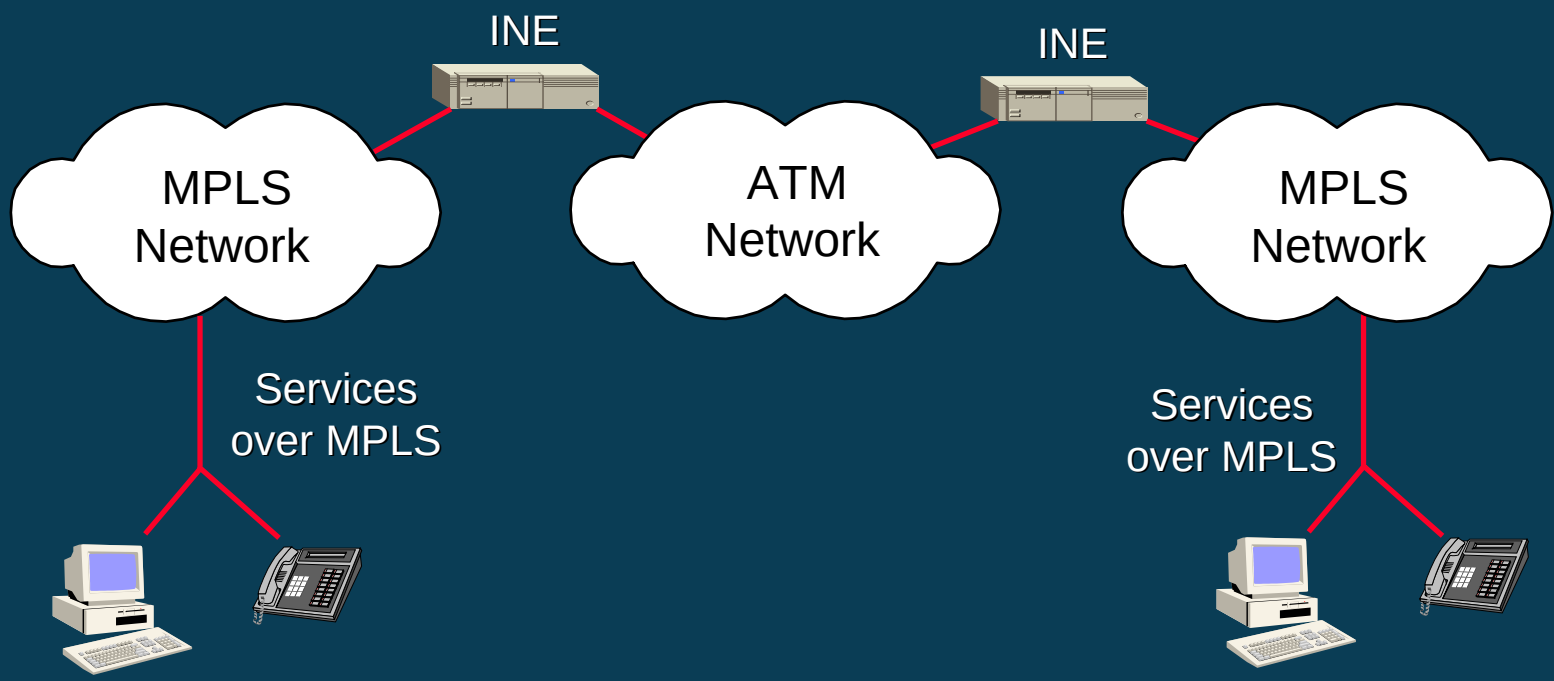
ATM–MPLS–ATM Reference Diagram (Network Interworking)



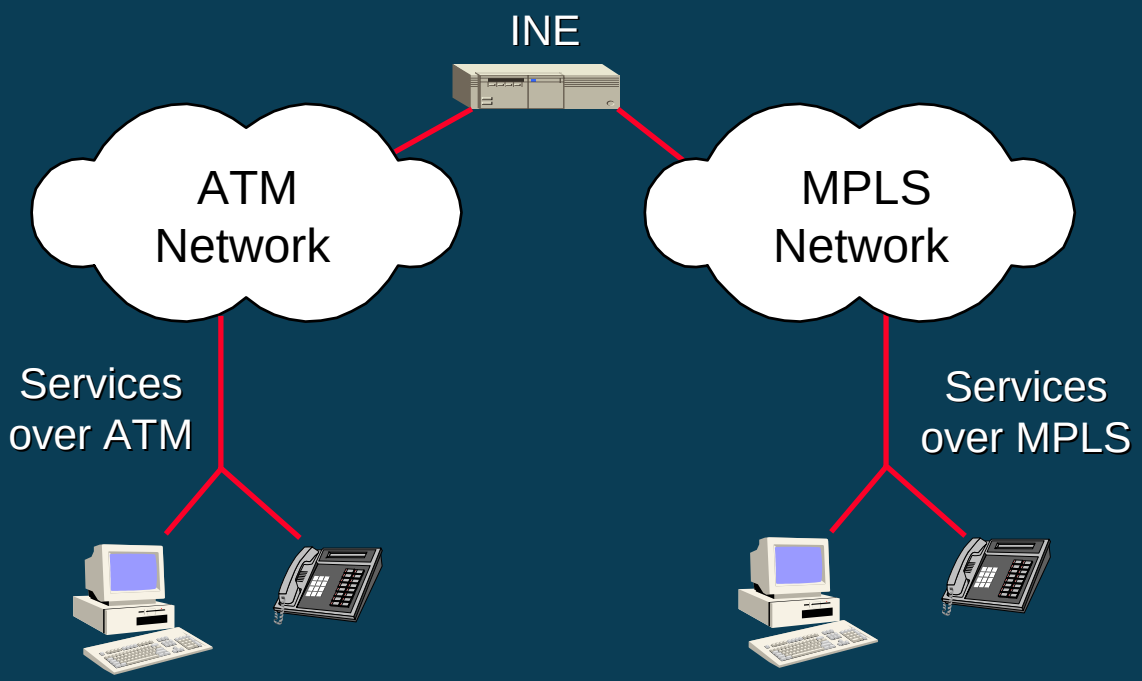
"INE" = Interworking Network Element

MPLS–ATM-MPLS Reference Diagram (Network Interworking)



"INE" = Interworking Network Element

ATM–MPLS Reference Diagram (Service Interworking)



"INE" = Interworking Network Element

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ATM Forum Specifications

- The ATM Forum is specifying methods for ATM-MPLS interworking:
  - Addresses future co-existence of ATM & MPLS technologies within networks.
  - First fruits: AF-AIC-0178.000 (ftp://ftp.atmforum.com/pub/approved-specs/af-aic-0178.000.pdf)
  - Ambitious follow-on plan

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Requirements

- Initial ATM Forum specification focuses on *user plane* aspects of ATM-MPLS-ATM network interworking:
  - Multiple ATM VCCs and/or VPCs within a MPLS LSP,
  - Support ATM traffic contracts and QoS,
  - Transport all AAL types,
  - Transport OAM and RM cells,
  - Transport single or multiple ATM cells within a single MPLS frame, and
  - Provide transparency to ATM cells.

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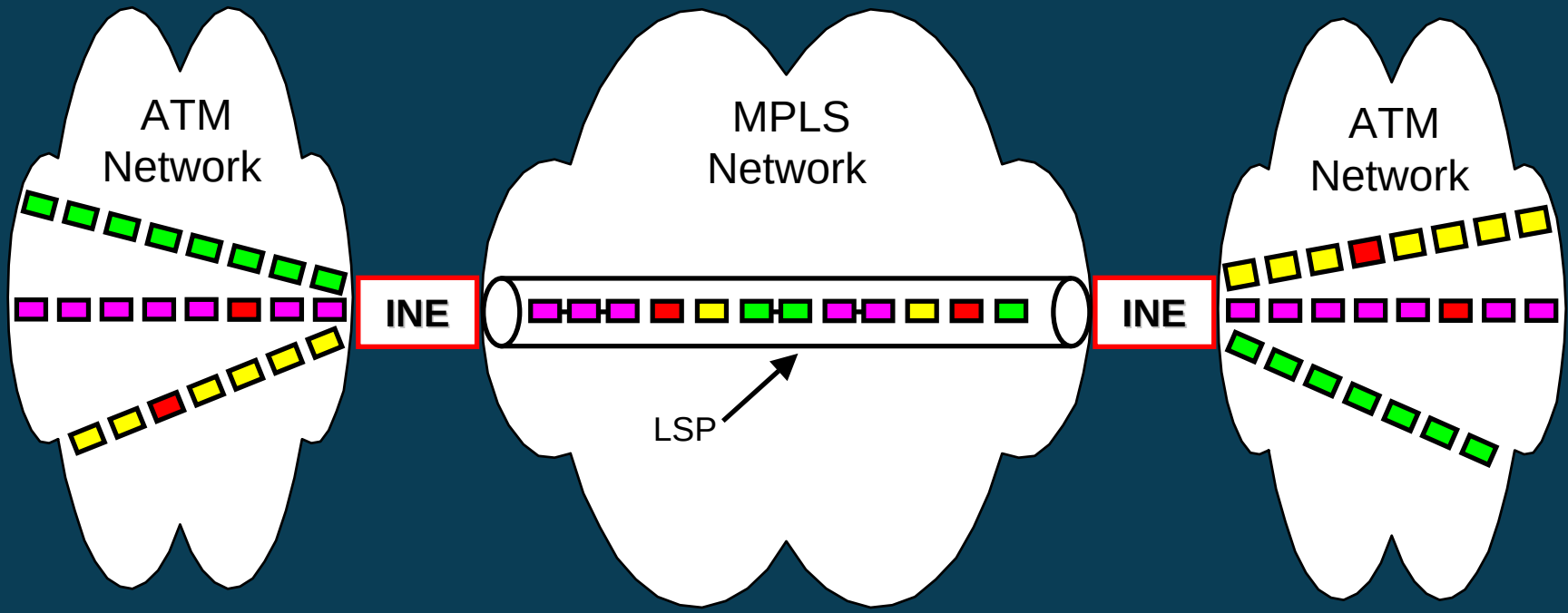
ATM Cells to/from MPLS Frames



= user cells from VC #1
= user cells from VC #2
= user cells from VC #3
= OAM cells

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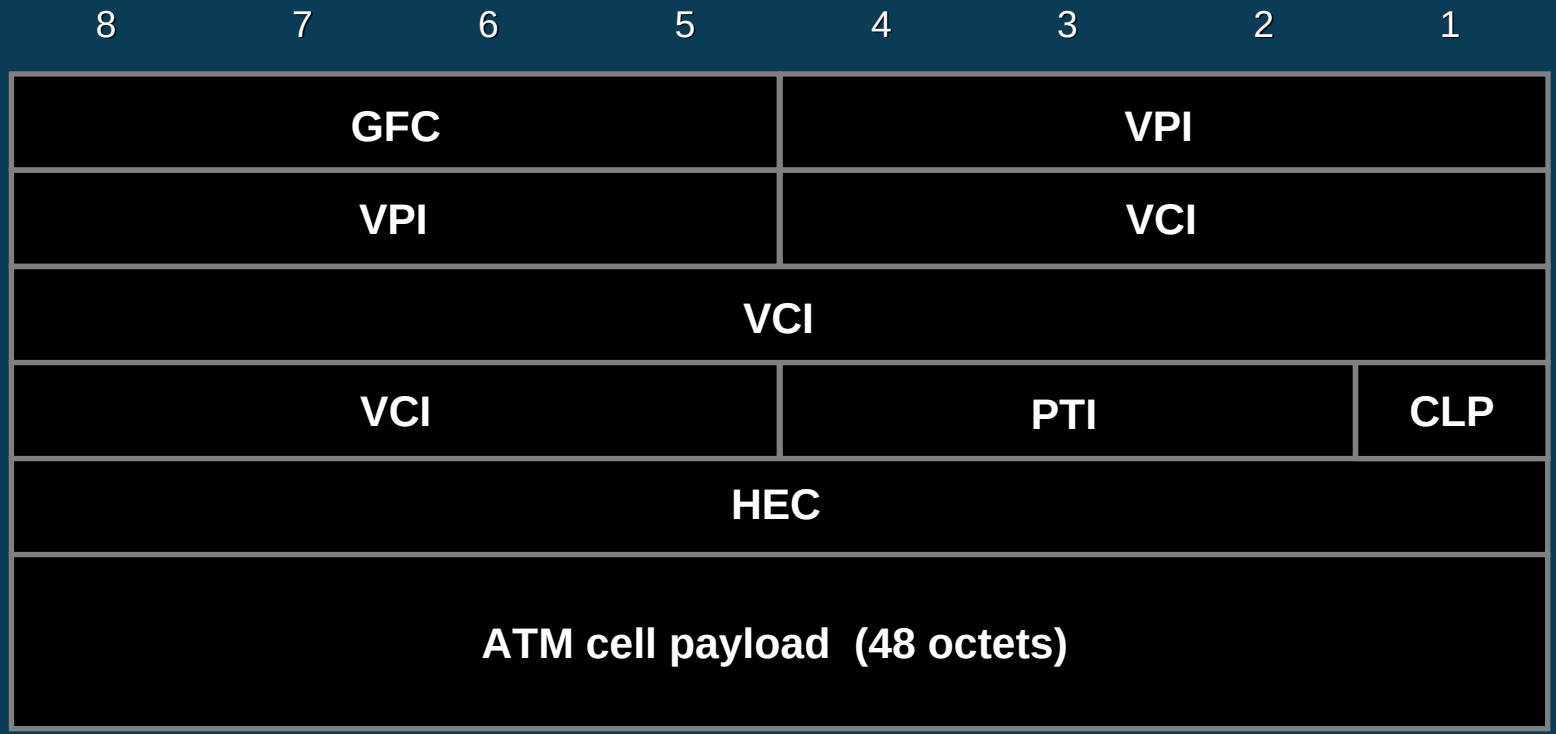
ATM Cell Format

Fixed-length cells are used to transport data, voice, and video inside ATM networks.



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AAL-5 PDU Frame Format

Variable-length AAL-5 frames are segmented into cells for transport across ATM networks.

8	7	6	5	4	3	2	1
Payload (1 – 65,535 octets)							
Pad (0 - 47 octets)							
UU (1 octet)							
CPI (1 octet)							
Length (2 octets)							
CRC (4 octets)							

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MPLS Frame Format

Variable-length frames are used to transport data, voice, and video inside MPLS networks.

Label (20 bits)	**Exp (3 bits)**	**Stack (1 bit)**	**TTL (8 bits)**
Label (20 bits)	**Exp (3 bits)**	**Stack (1 bit)**	**TTL (8 bits)**
Payload			

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ATM-MPLS-ATM Encapsulation Modes

- Single Cell Mode - mandatory
  - Each MPLS frame contains a single ATM cell
- Concatenated Cell Mode - optional
  - More efficient than single cell mode
- Frame Mode - optional
  - Most efficient of all modes
  - No support for AAL types 1, 2, 3, and 4
  - Loss of ATM cell header transparency

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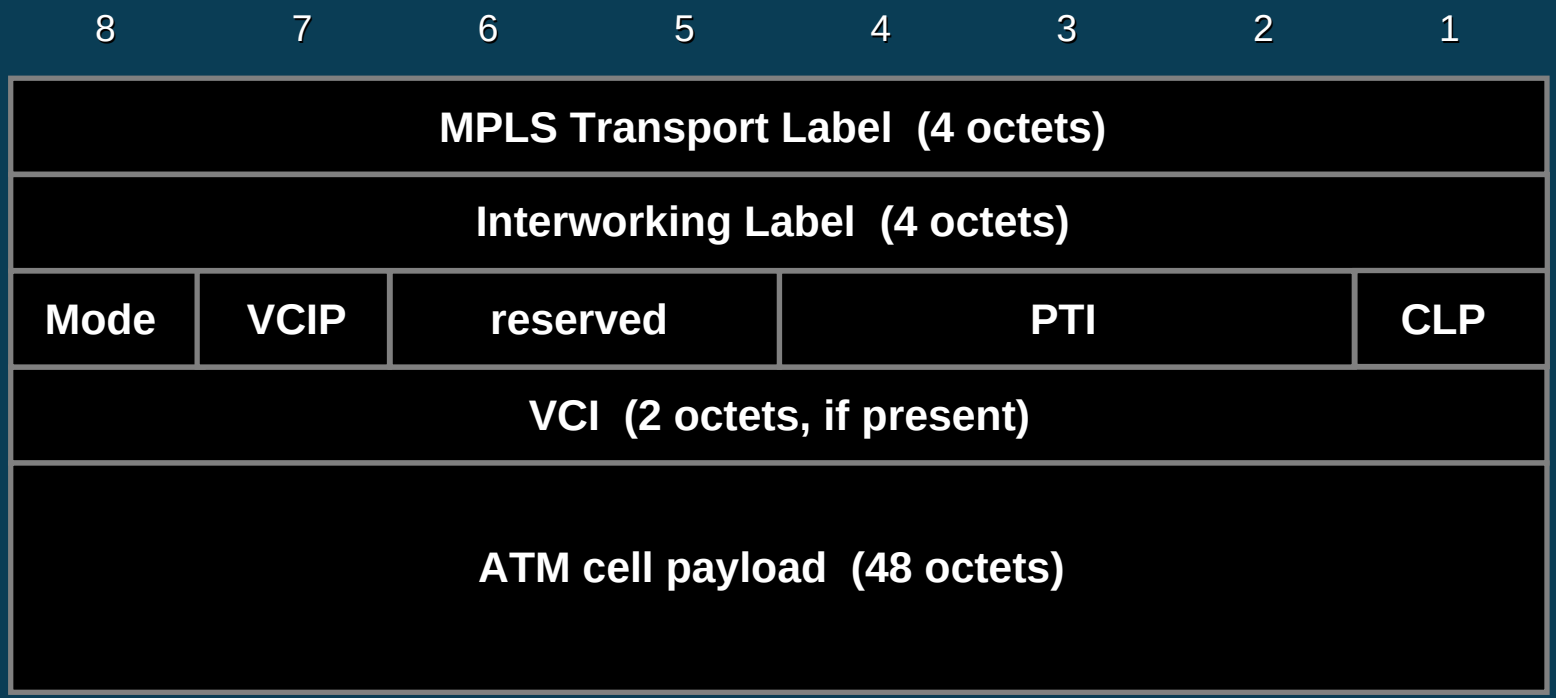
Single Cell Mode



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Concatenated Cell Mode

8	7	6	5	4	3	2	1
MPLS Transport Label (4 octets)							
Interworking Label (4 octets)							
Mode	VCIP	reserved		PTI			CLP
VCI (2 octets, if present)							
ATM cell payload (48 octets)							
Mode	VCIP	reserved		PTI			CLP
VCI (2 octets, if present)							
ATM cell payload (48 octets)							

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Frame Mode

8	7	6	5	4	3	2	1
MPLS Transport Label (4 octets)							
Interworking Label (4 octets)							
Mode	VCIP	reserved		FRAG		EFCI	CLP
VCI (2 octets, if present)							
AAL-5 PDU fragment (multiple of 48 octets)							

Fragment Options:

1. Complete AAL-5 PDU
2. Start of AAL-5 PDU
3. Middle of AAL-5 PDU
4. End of AAL-5 PDU

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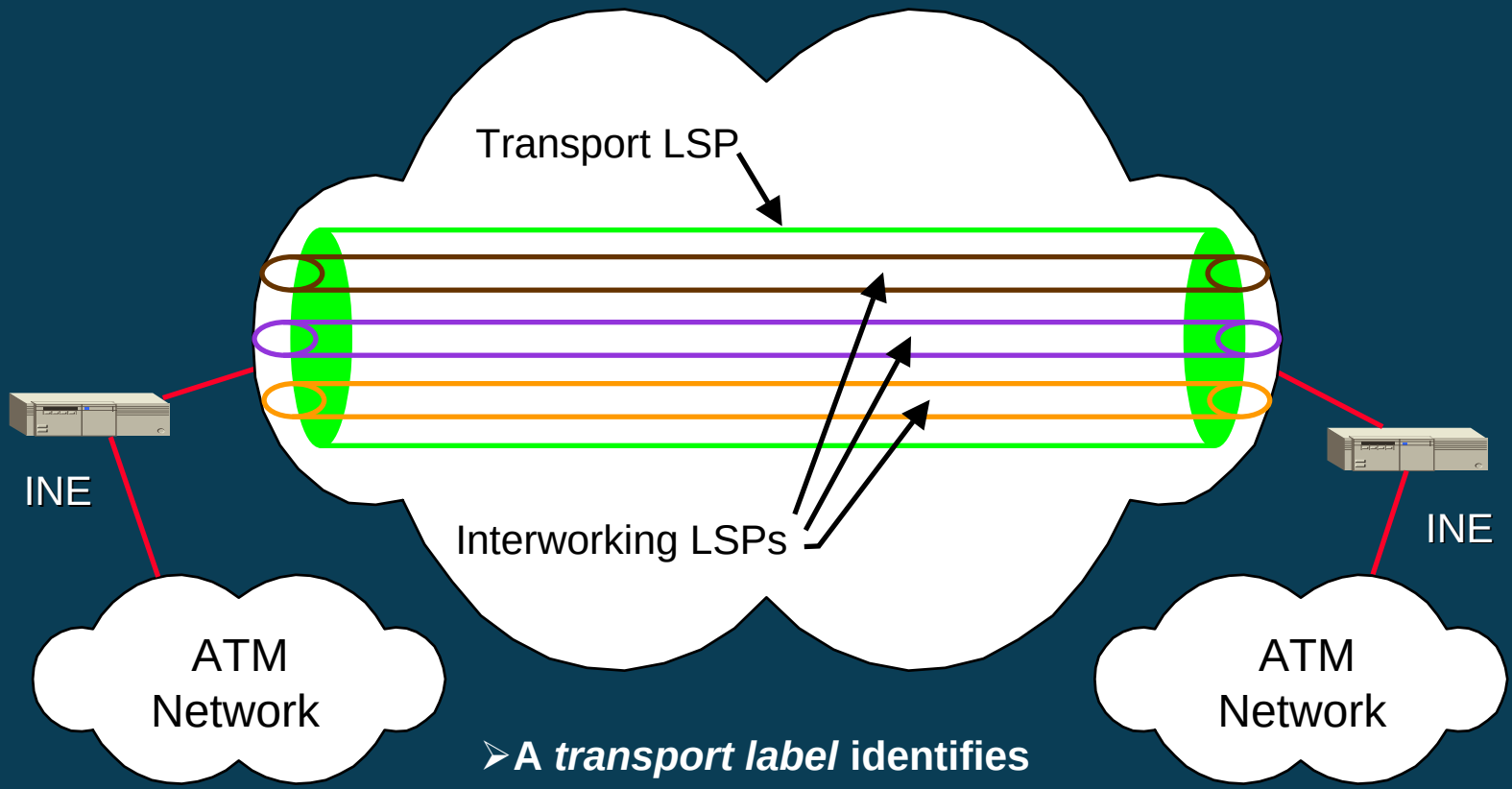
“Transport” & “Interworking” Labels



- **A *transport label* identifies an MPLS *transport LSP*.**
- **An *interworking label* identifies an *interworking LSP*.**

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Interworking Label Context

- An interworking label is associated with the following ATM connection parameters:
  - Connection type (i.e. VCC or VPC),
  - VPI of the ATM cell header,
  - VCI of the ATM cell header (VCC only), and
  - Perhaps other parameters.

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ATM to MPLS Cell Mode Procedures

- An INE performs the following to convert ATM cells to MPLS frames (cell mode only):
  - The VPI and VCI are translated into an interworking label (VPC case uses only VPI).
  - For a VPC, the VCI is carried within the frame.
  - The PTI and CLP are carried within the frame.

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MPLS to ATM Cell Mode Procedures

- An INE performs the following to convert MPLS frames to ATM cells (cell mode only):
  - The interworking label is translated to the VPI and VCI (VPC case results in only VPI).
  - For a VPC, the VCI is copied from the frame.
  - The PTI and CLP are copied from the frame.

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ATM to MPLS Frame Mode Procedures

- An INE performs the following to convert ATM cells to MPLS frames (frame mode):
  - As ATM cells are received, they are reassembled into an AAL-5 PDU.
  - The VPI and VCI fields are handled in the same manner as cell mode.
  - The EFCI field (within frame) is set according to the most recently received ATM cell.
  - The CLP field (within frame) is set if any constituent ATM cells had their CLP field set.
  - The AAL-5 PDU may be fragmented.

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MPLS to ATM Frame Mode Procedures

- An INE performs the following to convert MPLS frames to ATM cells (frame mode):
  - The AAL-5 PDU may arrive in several fragments.
  - The VPI and VCI fields are handled in the same manner as cell mode.
  - The EFCI field (within frame) is copied to all ATM cells.
  - The CLP field (within frame) is copied to all ATM cells.
  - The AAL-5 PDU is segmented into ATM cells.

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Fragmentation

- Fragmentation applies only to frame mode.
- Common reasons for fragmentation:
  - An OAM cell arrives while an AAL-5 PDU is being reassembled
  - The AAL-5 PDU exceeds the MPLS MTU
  - To bound ATM cell delay
- Fragmentation is always performed on 48-octet boundaries of the AAL-5 PDU.

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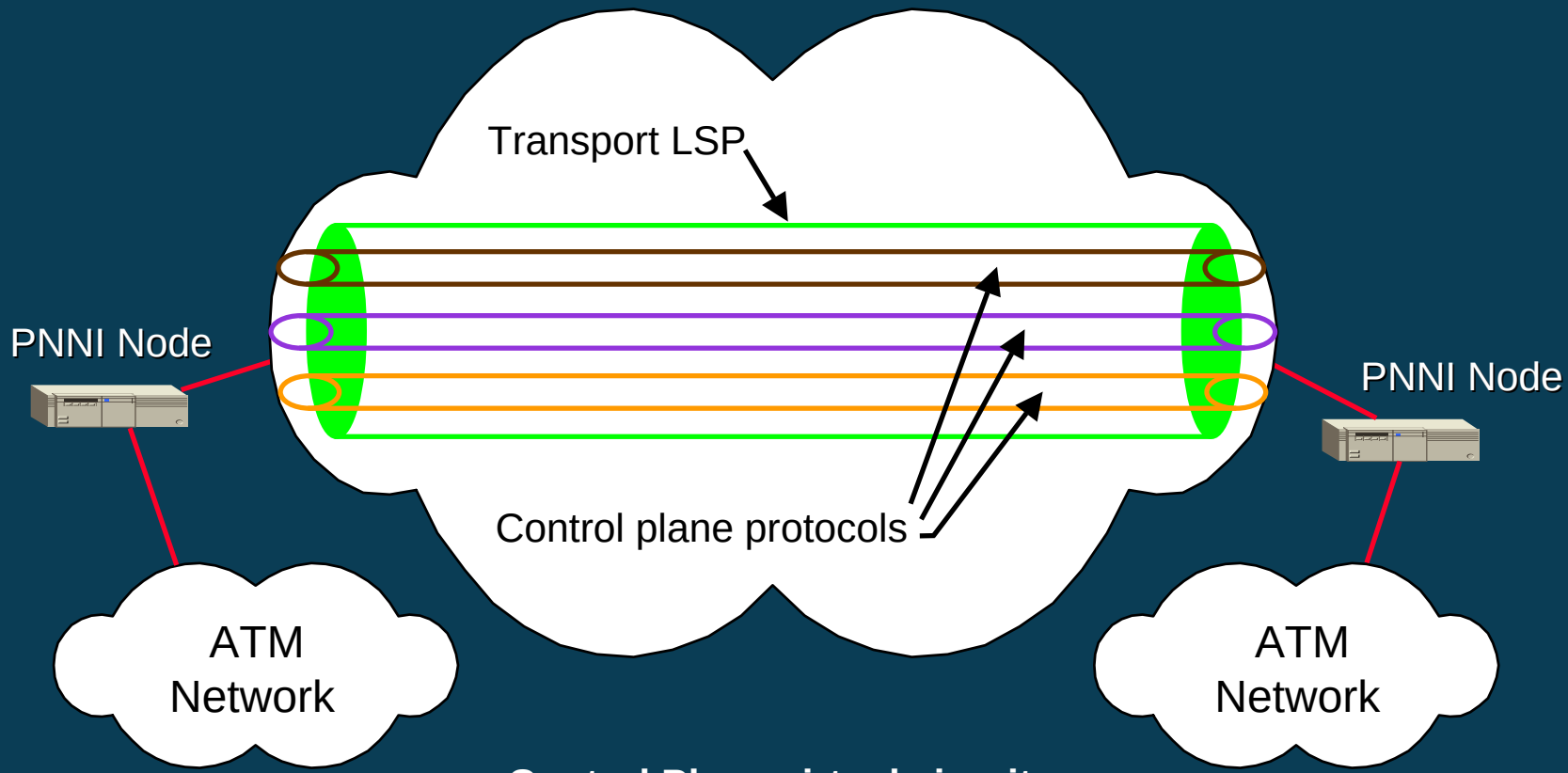
Transport of Control Plane Protocols



Control Plane virtual circuits include ILMI, Signaling, & PNNI RCC.

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Control Plane Aspects

- An INE contains PNNI functionality.
- The MPLS Transport LSP appears as a physical link between two adjacent PNNI nodes.
  - Single hop, as viewed by PNNI routing algorithms
  - Role of PNNI routing remains the same as in a traditional ATM network.
  - MPLS LSRs ignorant of ILMI, Signaling, and PNNI protocols.
- During SVC setup, an interworking label is negotiated for each direction and bound to the VPI/VCI values.

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Transparency Concerns

- MPLS does not guarantee FIFO delivery!
  - Version 1 of the ATM Forum spec assumes a “well designed” MPLS network.
  - Next version will add sequence numbers.
- MPLS QoS mechanisms are still evolving!
- MPLS frames can degrade cell loss ratio!
  - A single link bit error has a greater chance of corrupting an MPLS frame versus an ATM cell header.
- Both concatenated cell mode & frame mode increase cell delay!
- Frame mode does not preserve EFCI state & the CLP field for every ATM cell.

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Remaining Work Items

- ATM-MPLS-ATM Network Interworking:
  - Sequence numbers to preserve FIFO ordering
  - Control plane details
  - Management plane details
  - Mapping of ATM traffic classes & QoS requirements to MPLS mechanisms.
- MPLS-ATM-MPLS Network Interworking
- ATM-MPLS Service Interworking

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Joint Work Effort with MPLS Forum

- ATM Forum and MPLS Forum are working together on ATM-MPLS interworking.
  - Joint Email exploder
  - Monthly teleconference calls
  - Invitations to each other's meetings
- The goal is to produce identical technical specs for ATM-MPLS interworking.

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Related Activities in Other Groups

- ITU-T (Q8/11)
- ITU-T (Q5/13)
- IETF PWE3 Working Group:
  - “Fischer Draft” is aligned with ATM Forum.
  - “Brayley Draft” is an evolution from the earlier “Martini Draft”.

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Summary

- The ATM Forum is engaged upon the task of specifying ATM-MPLS interworking.
- AF-AIC-0178.000 addresses user plane aspects of ATM-MPLS-ATM network interworking.
- Multiple ATM connections are carried over an MPLS LSP.
- Three encapsulation modes have been defined, providing trade-offs of efficiency versus complexity.
- Maintaining ATM cell transparency over an MPLS network is challenging.
- Other bodies (e.g. MPLS Forum, ITU-T, IETF) are also engaged in related work items.
- This tutorial is available at the ATM Forum's web site (www.atmforum.com); click "Library", then "Presentations".

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This concludes the presentation provided by The ATM Forum

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