Architectural Framework For Automatic Protection Provisioning in Dynamic Optical Rings

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Outline

- Background and Motivation
- Optical Ring Architectures
- Dynamic Provisioning
- Future Work
- References

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Background and Motivation

- **SONET/SDH represent traditional ring solutions**
  - Rigid TDM-framing formats (125 μs frame)
  - Two- and four-fiber rings (UPSR, BLSR)
  - 50 ms protection switching (1+1,1:1,1:N)
  - Well-defined K1-K2 byte APS protocol

- **Limitations and restrictions of TDM rings**
  - TDM channels difficult to scale beyond 10 Gb/s
  - Non-transparency limitations (mappings required)
  - Unscalable, costly for large fiber/lambda counts
  - Complex, lengthy service provisioning procedures

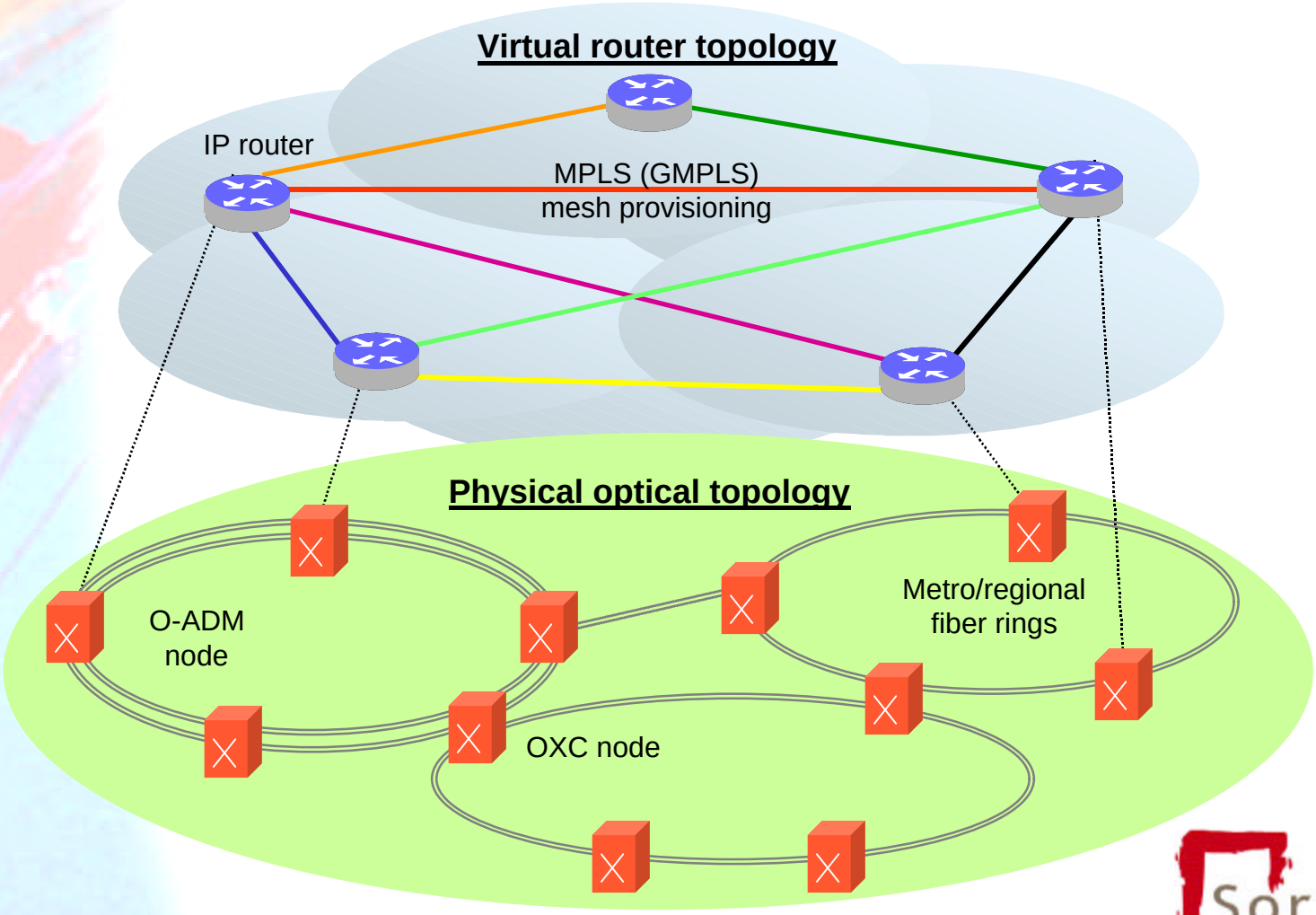
Background and Motivation

- **Architectural significance of rings will remain**
  - Ring architectures still dominate fiber plants:
    E.g., Access, metro/regional, even long-haul
  - Extensive operator experience (TDM rings)
  - Ubiquitous fast protection switching concepts

- **Must extend ring concepts to optical domain**
  - Timely, natural analogs to TDM rings
  - Very strong operator interest (esp. metro area)
  - Leverage existing plants (low transition costs)
  - Improved service delivery timescales

Background and Motivation

"Mesh Over Rings"



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Background and Motivation

- **Current focus largely on mesh architectures**
  - Evolve from IP protocols, themselves mesh-based
  - Early target of intelligent optics was “long-haul mesh”
  - Architecture, signaling definitions (IETF, OIF):
    - Multi-protocol lambda switching (MPλS)
    - Generalized MPLS (GMPLS)

- **Need to formalize work activities on optical rings**
  - Not just special case of mesh (many specifics)
  - T1X1 has started looking at rings (early stage)
  - Need proper integration w. MPLS–based concepts:
    Unify architecture, signaling, OAM&P, etc

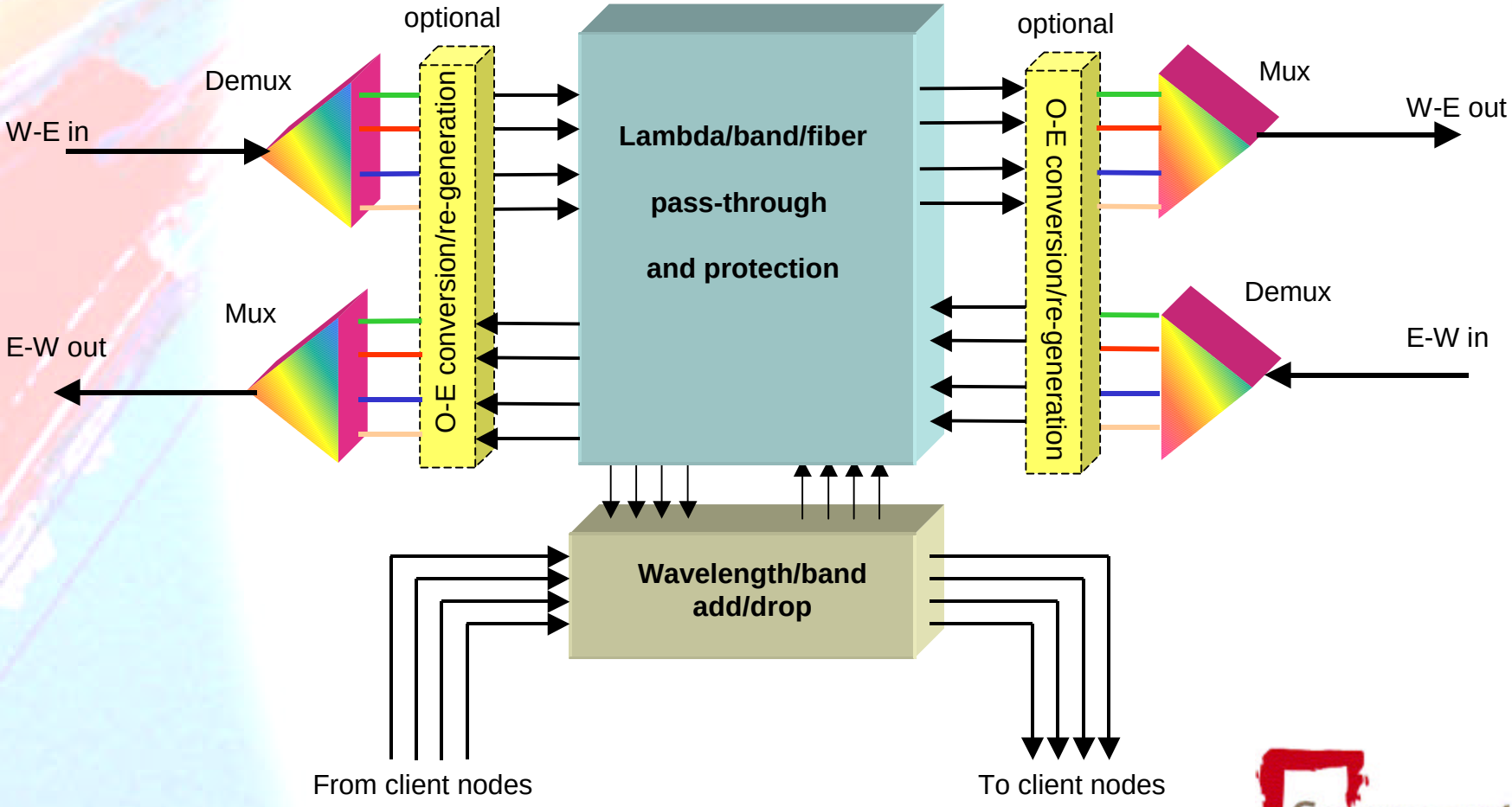
Optical Rings Overview

- **Extend existing TDM ring concepts**
  - Wavelength path replaces TDM timeslot channel
  - Optical add-drop multiplexer (O-ADM) nodes: Wavelength bypass, add, drop, protection stages
  - Translucent (O-E) or transparent O-ADM designs: In-band or out-band signaling/monitoring

- **Various protection concepts researched**
  - Optical channel (OCh) UPSR schemes
  - Optical multiplex section (OMS) BLSR schemes
  - Optical channel (OCh) BPSR schemes

Optical Ring Architectures

Sample Overview of Optical Add-Drop Multiplexer (O-ADM) Node (2-fiber)



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Optical Ring Architectures

- **Dedicated Path Protection Rings (DPRING)**
  - Two-fiber UPSR scheme, non-signaled (1+1)
  - Low spatial re-use, good for hubbed traffic demands
- **OMS Shared Protection Ring (OMS-SPRING)****
  - Designed for fiber cut events, scalable protection
  - Two- and four-fiber schemes
- **OCh Shared Protection Ring (OCh-SPRING)****
  - Extend BLSR concepts to OCh level (i.e., BPSR)
  - Resource efficient, good for distributed demands

*** Require APS signaling protocol***

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Dynamic Provisioning

- **Emerging "GMPLS-based" optical control**
  - CR-LDP/RSVP-TE for path setup signaling
  - Augmented IGP's for information dissemination
  - New "UNI" definitions (O-UNI, ODSI, etc)
- **Extend framework to include optical rings**
  - Provide single, unified framework/architecture
  - Require careful provisions in each (above) areas
  - No considerations for "APS-like" signaling yet
  - First, initial discussions in draft submission:
    OIF 2001.041, draft-ghani-optical-rings-00.txt

Aside: IETF working on IP over RPR

Dynamic Provisioning

- **Channel signaling considerations:**
  - O-UNI (or other) interfaces define “attributes”:
    Need mappings on to underlying rings
  - CR-LDP/RSVP-TE (working/protection path setup):
    Any “ring-specific” extensions required?
  - Multi-domain ring provisioning (NNI implications?):
    E.g., protection coordination issues

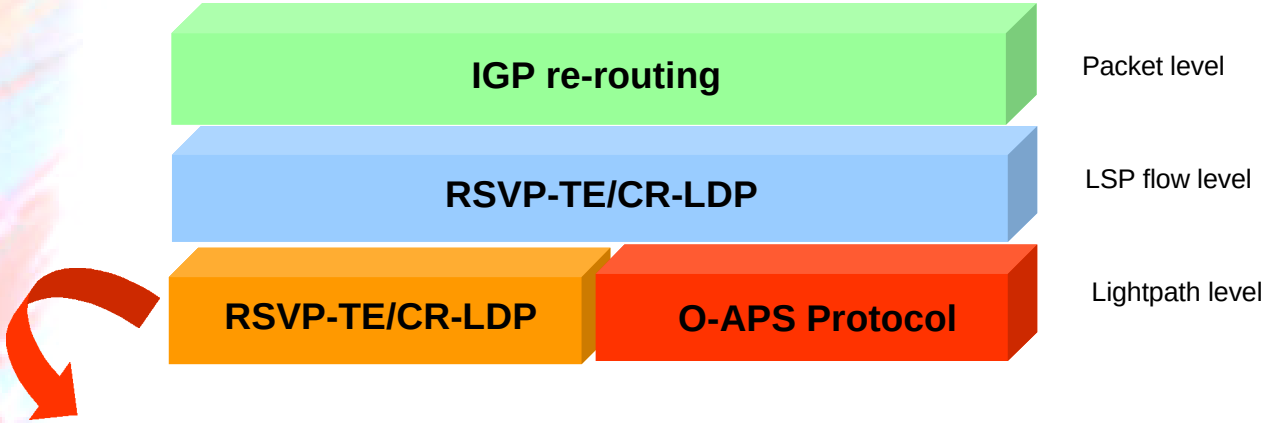
- **Resource and state information dissemination**
  - Many provisions already for mesh architectures:
    Fiber type, connectivity, transparency, SRLG, etc.
  - Other possible additions for optical rings:
    E.g., Define opaque LSA’s of area scope?

Dynamic Provisioning

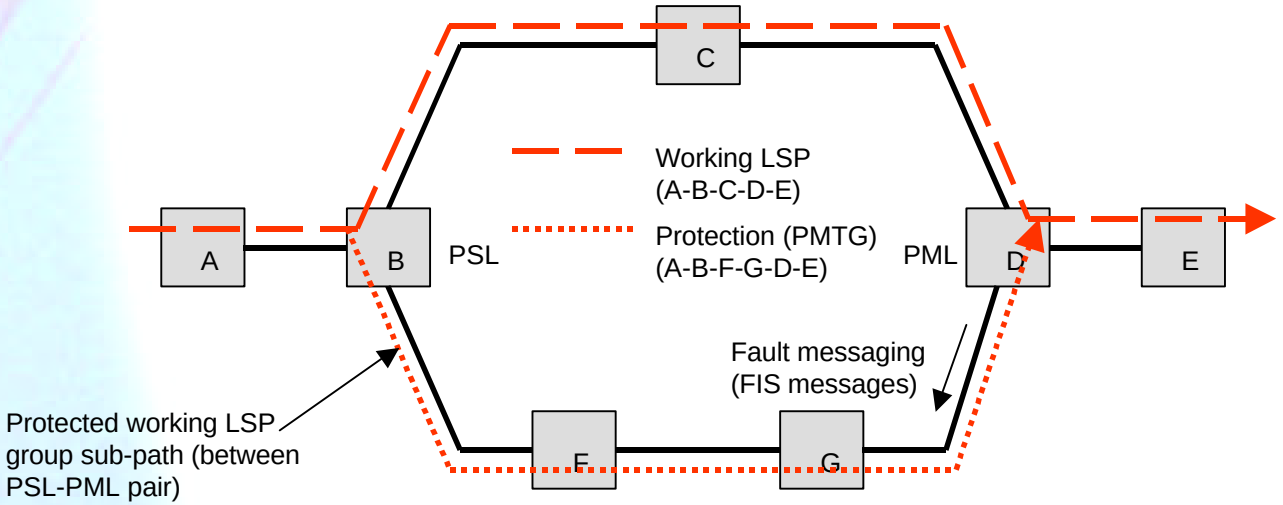
- **Protection signaling requirements**
  - "O-APS" for protection switching (BLSR, BPSR):
    Fast messaging, *guaranteed* latency
  - Operators will demand "SONET-like feel"
  - Added considerations for "operation modes":
    E.g., lockouts, forced switches, manual switches
- **Various APS alternatives possible**
  - "Direct approach": Extend LSP protection signaling
    - MPLS PSL/PML LSR nodes, RNT signaling
    - Many implementation issues, speed concerns
  - Develop new *packetized* "APS" protocol:
    - Generalize SONET K1-K2 byte protocol?

Dynamic Provisioning

Protection Signaling Interworkings



E.g., MPLS LSP path protection framework/proposal



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Dynamic Provisioning

- **Additional considerations possible**
  - Multi-layer (protection) escalation strategies:
    Inter-layer (level) hold-off or signaling needed
  - Mesh-ring interworkings:
    - Overlay: Leverage for mesh ("virtual rings")
    - Hybrid: Inter-topology provisioning (for migration)

    D. Guo, *et al, draft-guo-mesh-ring-optical-01.txt*

    D. Papadimitriou,*draft-papadimitriou-optical-rings-00.txt*

- **Recommendations/proposals**
  - Accept ring framework as a working group item
  - Explore synergies with packet rings (RPR)?

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