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
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”

Virtual router topology

IP router

MPLS (GMPLS)

mesh provisioning

Physical optical topology

O-ADM node

Metro/regional fiber rings

OXC node

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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 (MP\text{\lambda}S)
  - 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
Sample Overview of Optical Add-Drop Multiplexer (O-ADM) Node (2-fiber)
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**
Dynamic Provisioning

新兴的“GMPLS-based”光控制
- CR-LDP/RSVP-TE用于路径设置信号
- 增强的IGP用于信息扩散
- 新的“UNI”定义（O-UNI, ODSI, 等）

扩展框架以包括光环
- 提供单一，统一的框架/架构
- 在每个（以上）区域都需要仔细考虑
- 目前尚未考虑“APS-like”信号
- 首先，初步讨论在草案提交中：
  OIF 2001.041, draft-ghani-optical-rings-00.txt

旁注：IETF正在研究IP在RPR上的应用
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**

- IGP re-routing (Packet level)
- RSVP-TE/CR-LDP (LSP flow level)
- RSVP-TE/CR-LDP O-APS Protocol (Lightpath level)

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

- Working LSP (A-B-C-D-E)
- Protection (PMTG) (A-B-F-G-D-E)
- Fault messaging (FIS messages)

Protected working LSP group sub-path (between PSL-PML pair)
**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)?
References