Integrated Packet, Optical Solutions
Within Juniper Networks’ Mobile Cloud Architecture

June, 2017
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Agenda

Trends and Challenges
Packet Optical Strategy
Product Solution
Summaries
Industry Trends
Forcing a shift in Network Infrastructure

1. IP Traffic Growth pushing envelope
   BB traffic increasing 50% a year. Mobile 90%

2. Access vs. Transport vs. Packet
   An atomic collision?
   Transport
   Packet
   Convergence is in vogue ...

3. Fiber in the Access
   FTTx: fiber to homes, cabinets, buildings and cell sites

4. Fixed Mobile Convergence
   Internet & VPN Services
   Metro Aggregation Networks
   Organizations?
   Spectrum and backhaul pressure => small cells => mm-wave, fiber aggregation

Mega-trends
5G & IoT
Video
4K & beyond
Social Networking
Mega Cloud Builds
M2M traffic
100Tbps inter-DC

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But, There are…… Industry Initiatives towards Openness

**TERASTREAM**
- Zero touch, simple, effective operation
- IP + Optical
- Coherent LH interoperability
- Multivendor

**Open ROADM**
- Network disaggregation, software control
- Controller Lead
- Interoperability
- Multivendor

**TIP**
- Open ecosystem, developer communities
- Open line system
- No locks-in solution

**TIP Membership Momentum**
Juniper Packet Optical Strategy

OPEN
- Open Line System
- Open Transponder

PROGRAMMABLE
- Open Models
- Telemetry
- Device level API

AUTOMATED
- Controller driven or Router
- Port Extension
- Multi layer
- Flexible Service Placement

OPEN PROGRAMMABLE AUTOMATED
What’s happening in the Infrastructure?
The packet-optical Architecture (R)evolution

Technology is evolving, creating a true opportunity to simply the network!

Packet demands

Edge router

Core router

DWDM transponder shelf

ROADM node

Lower CAPEX, Power & Footprint
Improved Reliability & Manageability

Packet demands

Edge router

IP/MPLS core router with DWDM transponders

ROADM node
Simplicity for Network Efficiency
Deployment Scenarios

Use case 1 - Point to Point
- IPLC and Malaga/Cordoba PICs integrated topology
- Provisioning/Monitoring through CLI/CSD
- Automation of solution

Use case 2 – Multispan
- ILA HW integrated into Use case 1
- Provisioning/Monitoring through CLI/CSD

Use case 3 - Optical Rings
- Optical bypass, Ring infrastructure
- End to End provisioning/monitoring through CLI/CSD
- Automation of end to end solution
Industry’s Traditional Mode Of Operation

Minimal communication between different departments (competition, defense of ‘own’ technology) often results in in-efficient network utilization and defensive network evolution.
The new packet-optical network
Based on open standards!

Packet and optical transport layers need a common control plane and NMS approach:
- Truly simplify the network architecture.
- Simply and speed-up service provisioning.

... So an OPEN STANDARD BASED approach and not with a closed and proprietary architecture is a Key.
MPLS Transport Service creation
Merging the Benefits of the Packet & Transport Domains

Northstar: Use-cases

- LSP Control, Creation, & Path Optimization
- Path Diversity (Link, Node, Facility)
- Bandwidth Scheduling & Calendaring
- Fast Reroute Planning
- Programmable Path Cost Functions
- Optimized Exit Control
- Global Concurrent Optimization
- Container LSP association (Auto-B/W & LSP multi-path/load-balancing)
Components of A Multi-layer PCE
A Multi-Layer Path Computation Element (PCE)

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<td>LSP Control/Modification/Optimization</td>
<td>Exhaustive Failure Analysis</td>
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**REAL-TIME NETWORK FUNCTIONS**
- Dynamic Topology updates via BGP-LS / IGP-TE
- Dynamic LSP state updates via PCEP
- Real-time modification of LSP attributes via PCEP (ERO, B/W, pre-emption, …)

**MPLS LSP PLANNING & DESIGN**
- Exhaustive failure analysis & capacity planning for MPLS LSPs
- MPLS LSP design:
  - P2MP, Diverse-path
  - FRR (bypass, path, opt.)
  - JUNOS config or PCEP

**MULTI-LAYER IP NETWORK DESIGN**
- Create the optimal IP/MPLS (client-layer) design Given the PE-to-PE traffic matrix
- Optimum solution is obtained by selectively pruning the IP topology from the set of possible links obtained from the transport layer
Mapping the Physical-Layer to the Service-Layer

- Learned from the optical/transport client, Learned/imputed statically, learned via API and IP/MPLS network

![Diagram showing connectivity matrix via RESTconf](image)
Solution: Integrated Packet-Optical
Complete Packet and Optical Solution

PTX Series
- Metro
  - < 400 km
  - 24 x 10G DWDM PIC
- Long Haul
  - 2000+ km
  - 2 x 100G DWDM PIC
- Regional/LH
  - 1500+ km
  - 5 x 100G DWDM PIC
- IPLC
- Integrated Photonics Line Card
- ILA
- Inline Optical Amplifier

MX Series
- Metro
  - < 80 km
  - 24 x 10G DWDM MIC/MPC
- Regional/LH
  - 2000+ km
  - 1 x 100G DWDM MIC

BTI 7000 / 7800 Series
- 10G/100G/200G Transponders
  - Muxponders, ROADM, Amplifiers
  - Passive Multiplexers

CSD
- Network Management
- Optical Provisioning
- Comprehensive System

Northstar
- Complete Multi-Layer SDN
- Full Optimization
- Constant Evaluation

proNX
- Centralized Visibility
- Network Design
- Service Management

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Summaries
Integrated Packet, Optical Solutions

Analyst reaction to Juniper acquisition of BTI Systems - Jan. 2016
“…the acquisition will allow [Juniper] to deliver best-of-breed, open, automated and more efficient packet optical transport solutions to customers.”
Michael Cusanelli, Talkin Cloud

“Juniper Networks is looking to expand its software-defined networking ambitions and its offerings for cloud and services providers with the acquisition of BTI Systems.”
Jeffrey Burt, eWEEK

#2 for metro optical DCI deployments globally
ACG Research - 3Q15

#2 for service provider core router deployments globally

#4 for service provider edge router deployments globally

IHS Research - CY2015

Industry Leader
Leader in optical DCI and router performance, throughput, scale, slot density & power efficiency

Flexible Solution
Small cell, hardened and disaggregated cell site router options

Monetization
Add SW to router to personalize Gi-LAN subscriber services and enable new revenue

Zero-touch
Seamless and automated end-to-end service provisioning, monitoring & FCAPS support
提醒填寫本場議程問卷！
利用電子票卡進行線上填寫並請保留完成後的QRcode畫面，至該場次入口服務處兌換問卷禮，謝謝！