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

Mobile World Congress 2017
Agenda

Challenges and Trends
Use Cases and Solutions
Products and Services
Proof Points
Juniper’s Mobile Cloud Architecture
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
Access
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

Industry Trends
IP Traffic Growth pushing envelope

- BB traffic increasing 50% a year. Mobile 90%

Access vs. Transport vs. Packet

- An atomic collision?
- Convergence is in vogue ...

Fiber in the Access

- FTTx: fiber to homes, cabinets, buildings and cell sites

Fixed Mobile Convergence

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

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Customer Challenges
Forcing a shift in Network Infrastructure

- **Lock-in**
  - Bookended Optical Line Systems

- **Manual Provisioning**
  - Manual Operations
  - 9 Months

- **Complexity & Lack of Visibility**
  - Silo & Fragmented Topology

- **Open**
  - ...Increased Interoperability
    - Open optical networking
    - Community development and innovation
  - ...Increased Efficiency
    - Open APIs & DevOps tools
    - Cloud-scale network ops
    - Multi-layer intelligence, control, optimization

- **Automated**
  - Minutes / Days

- **Simple**
  - IP/Ethernet
  - Optical
  - MBH & DCI

- **proNX**

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Juniper’s Packet-Optical Strategy
Towards truly integrated end-to-end architectures

- Packet-Optical is an area of growth
  - Focus on Metro / A&A and DCI
- Disrupt Metro/DCI optical transport
  - Develop open and interoperable solutions
  - Disaggregate the optical layer
- Junos-centric solutions:
  - Seamlessly integrate L0 to L3
  - Multi-layer management/control, JFusion, JTI analytics

OPEN: Interfaces and interworking on all network layers
AUTOMATED: Program the network for self-optimization across network layers
SIMPLE: Seamless choice between integration or disaggregation on all layers
Integration vs. Disaggregation
There’s no one-size-fits-all

**DWDM Transponder Disaggregation**
- Full logical integration
- DWDM and routing/switching in separate physical nodes
- Optimized for flexibility & scalability
- 10G: ACX, MX, PTX, BTI 7000/7800
- 100G: MX, PTX, QFX, BTI 7800

**DWDM Router Interface Integration**
- Physical and logical integration
- DWDM and routing/switching in 1 physical node for E2E packet-optical convergence (data, management & control)
- Optimized footprint for print, power & cost
- 10G: MX, PTX, BTI 7000/7800
- 100G: MX, PTX, BTI 7800

Different hardware architectures but same unified end-to-end software architecture
Use Case: Packet-Optical DCI

Architecture

DC to DC Pont to Point, Ring or Mesh

Peering Colocation & Cloud/Metro Connect

DC

Juniper MX

Juniper MX

Data Center A

QFX10k

QFX10k

Juniper Fabric

QFX

MX

BTI7800

Data Center B

200G DWDM

QFX

MX

BTI7800

Juniper Fabric

QFX

vRAN

vGi

vEPC

Gi-LAN

vRAN

vGi

vEPC

Gi-LAN

VIRTUALIZED

VIRTUALIZED

NETCONF/SNMP/YANG

NorthStar Controller

REST

proNX

Data Center A

Juniper QFX10k

Juniper QFX10k

Virtualized vEPC

vGi

LAN

vRAN

Data Center B

Juniper QFX10k

Juniper QFX10k

Virtualized vEPC

vGi

LAN

vRAN

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Use Case: Packet-Optical MBH

Architecture

MBH from Juniper includes:

- 10G/100G Packet-Optical Solution
- LTE-A Compliant: Integrated Timing and Synchronization
- Network Management, SDN, Service Control
- Proven solutions for Macro and Small Cells
- Hardened options for indoor and outdoor CSRs
- One Junos OS E2E
Solution: Integrated Packet-Optical
Complete Packet and Optical Solution

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

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

BTI 7000 / 7800 Series
- 10G/100G/200G Transponders
- Muxponders, ROADMs, 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
Solution: Integrated Timing

**LTE-A: Accurate Phase Sync & Low Latency Are Key**

- Accurate phase sync provided by integrated PTP on MX and ACX routers
- Enables network timing for demanding LTE-A features: eICIC, CoMP, intersite CA, Geolocation, eMBMS, NGFI/vRAN

**CoMP**
Feature of 3GPP Rel.11
Full Gains realized with R11 Ue

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Juniper Networks’ Timing Implementation Supports LTE-A CoMP & eICIC Requirements

- To achieve ≤5ms latency, X2 needs a SecGW at pre-aggregation sites: supported by MX-104
Solution: Personalized Subscriber Services

Monetization made possible with Gi-LAN solution
Products: Comprehensive Routing Portfolio
Integrated Packet, Optical & Timing Solutions

Access
- ACX500
- ACX1x00
- ACX4000
- MX40

Aggregation
- ACX2x00
- MX104
- MX80

Edge
- vMX

Core
- PTX5000
- PTX3000
- PTX1000

CAPACITY
- 100 Tbps
- 10 Tbps
- 1000 Gbps
- 100 Gbps
- 10 Gbps
- 1 Gbps
Services
Integrated Packet, Optical & Timing Solutions

Customer Lifecycle
- Plan
- Build
- Operate
  - Assessment
  - Deployment
  - Maintenance
  - Design
  - Migration
  - Optimization

Juniper Service Offerings
- Juniper Professional Services
  - Metro Network Design Service
  - Network Modernization Assessment Service
  - MPLS Assessment Service
  - Customer On-Boarding
- Juniper Care
- Juniper Care Plus
- Juniper Optimum Care

Juniper Education and Training
### Proof Points
**Integrated Packet, Optical & Timing 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**
- **#4 for service provider edge router deployments globally**
- **ACG Research - 3Q15**
- **IHS Research - CY2015**

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**Unique Integrated Timing**
Only vendor today that meets strict timing requirements (phase & freq.) of LTE-A & 5G

**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
# 1 of 5 Solutions within Juniper’s Mobile Cloud Architecture

## Integrated Packet, Optical & Timing Solutions

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## Products

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<th>ACX Series</th>
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<th>Network timing enabled</th>
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<td>NorthStar</td>
<td>Multi-Layer WAN SDN Controller</td>
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## Services

Metro Network Design Service, Network Modernization Assessment Service, MPLS Assessment Service

## Diagram

- **Enterprise Site**
- **Het-Net Sites (Macro & Small Cells)**
- **Distributed Compute Node**
- **Residential**
- **Business**
- **Access & Aggregation Network**
- **Distributed Data Center**
- **Regional Data Center**
- **NGCO**
- **Centralized Data Center**
- **Core Network**
- **Internet/ Roaming**
Juniper’s Mobile Cloud Architecture
E2E Offering for your Next-gen Secure Distributed Telco Cloud from the Industry’s Most Trusted Vendor

- **Automated Control & Orchestration**: Industry’s most deployed SDN solution for multi-vendor and multi-layer network automation.
- **Security Everywhere**: Industry’s most innovative and comprehensive platform to secure the distributed telco cloud.
- **Disaggregation & Virtualization**: Pioneer in utilizing an open framework to ensure a seamless migration to carrier-grade NFV.
- **Distributed Data Centers**: Complete, automated and secure solutions for mini DCs at the edge and large DCs in the core.
- **Integrated Packet, Optical & Timing Solutions**: Integrated solutions from a global leader and innovator in packet networking and optical DCI.

**Use Cases**

**Partners**

**Services**

**Key mobile use cases supported**

**Best-of-breed partner ecosystem**

**Best-in-class life-cycle service & support**
Thank you