Programmable Networking is SFW

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CTO & Chief Architect
Platform Systems Division, Juniper Networks
The Developer and The Network

We should care about each other

YOU ARE DEVELOPERS

Experience

WE ARE THE NETWORK

Connecting everybody to everything

Programmable Networking is SFW
The Developer and The Network
Improving user experience by programming the network

Real Problems. Real Revenue. Real Attention.

Application World -> Network World
Beyond ferreting the information
Current approximation techniques are barely sufficient and inefficient

<table>
<thead>
<tr>
<th>APPLICATION WORLD: GUESSING</th>
<th>NETWORK WORLD: DERIVING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applications blindly probe the network to understand what it can deliver</strong></td>
<td><strong>Networks spy on traffic to try to understand applications</strong></td>
</tr>
</tbody>
</table>

**? Network Aware Applications ?**
- Game ping-stats, doppler, geo-location, whois
- Proprietary codecs
- Approximate topology/location

**? Application Aware Networking ?**
- Deep Packet Inspection
- Stateful flow analysis
- Application fingerprinting
- Service specific overlay topologies

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How to ensure the best experience?

Bringing together the important elements … … enabled via real-time interaction to influence the experience of the end user

**Application:**
Knows end-device capabilities. Proximity of end-user to content. Controls resources.

**Content:**
Adjusts placement, selection & insertion of content from analytics.

**End-User:**
Knows what it wants and is directed there

**Network:**
Real-time interaction between application, content and end-users.

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Let’s talk about why networks & applications need to work together
What brings the two together?

Bi-directional interaction and programmability
Interaction at multiple touch points

Inform network of desired behavior

Inform application of data intrinsically in the network

User service profile
Enterprise edge
Hypervisor stack
CDN
Billing profile
Business edge service profile
VPN/mobile/security gateways

Extract information or program desired behavior
What is possible in this new world?

Applications made better by information from network
- Understanding of end-device capabilities
- Real location / topology
- Adjust behavior to real-time usage
- Billing granularity

Flexibility of service placement

Networks made better by information from application
- Bandwidth and resource optimization
- New service topologies
- Security identification
- Service-specific packet treatment

Control of resources from applications
How do networks & applications work together?
There’s more than what you are hearing

Software Defined Networks
- Separation of existing protocols from forwarding plane for network devices
- Programming of forwarding plane via centralized orchestration platforms

No interaction with existing routing/signaling protocols of the Internet
- Augment what’s already on the internet
- Integration with routing, signaling and policy logic
- Modular, programmable touchpoints
- Seamless service model via collaborative inputs
- Standards-based approach

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Application and network interaction

As a developer you will have many ways to influence the network or application.
Choices depend on your touch point to the network.

<table>
<thead>
<tr>
<th>Intuiting Info</th>
<th>Communicating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Application deriving network</strong></td>
<td><strong>Application programming network</strong></td>
</tr>
<tr>
<td>Proprietary control channels, pingstats, GSM, check-ins, traceroute</td>
<td>OpenStack, CloudStack, OpenFlow, PCE, GenApp, Provider-based development platforms</td>
</tr>
<tr>
<td><strong>Network spying on application</strong></td>
<td><strong>Network informing application</strong></td>
</tr>
<tr>
<td>DPI, Netflow, IPDR, IDS</td>
<td>ALTO, BGP-TE, BGP-CDNI</td>
</tr>
</tbody>
</table>

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How do we make this happen?
Without breaking everything …

Real-time topology understanding (ALTO, BGP-TE)

Steering traffic through optimal paths (PCE)

Selecting specific traffic (OpenFlow)

New touch points: gateways, billing collectors, service appliances, CDN, DPI

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### The protocols

<table>
<thead>
<tr>
<th>Function</th>
<th>Delivery Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Intelligence Query Point</td>
<td>ALTO</td>
</tr>
<tr>
<td>Path Computation</td>
<td>PCE</td>
</tr>
<tr>
<td>Policy Enforcement / Provisioning</td>
<td>OpenFlow</td>
</tr>
<tr>
<td>Service Location</td>
<td>Services Registry</td>
</tr>
</tbody>
</table>

#### Network intelligence query point

- Where is “it” in the network

#### Path computation and establishment

- Path Computation Element (PCE) for determining traffic path and setup

#### Policy enforcement

- Permit/Deny policy enforcement through programmable flow filters (OpenFlow) / SMI

#### Service location

- Centralize/Distributed registration for services, application resources and content cache locations

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Orchestration and Development Platforms

- **Traditional IT:**
  - Operation, Billing
  - COPS, Radius, Diameter, netconf, DHCP, CAPWAP, GSMP

- **Emerging Network Function Specific:**
  - SLA monitoring, OTT virtualization, Path management, Unified Communication

- **Emerging Service Specific:**
  - Flow intelligence, user telemetry information, sensor networking, service profile updates, network appliance and CDN control

- **New Provider-Based Development Platforms:**
  - Specific functionality for a specific customer set: mobile phone, STB

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Network Operators Building Development Platforms

Network operator innovation centers around the world

Platform potential: Reaching ~53% of world population; Equals ~64% of world GDP

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Networked application examples

- **Content / Service Routing**
  - Locate best copy of content for the end user, using customer rules

- **Managed content distribution**
  - Content prepositioning to caches
  - Live events

- **Map-Reduce class of applications**
  - High-end distributed computing

- **Cloud OS network operations**
  - Move VMs / Apps / Storage between locations

- **Cloudburst**
  - Flexibly, on-demand allocate cloud & network capacity to customers

- **Security**
  - DDoS attack prevention
What is a Service Engineered Path?

- Packet tunneling/switching technology that provides a pre-established forwarding path to specific service functions
- Technology enables selective traffic redirection based upon ephemeral classifiers
- Signaled paths requested via PCE – Path Computation Element
  - Standardized API

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Example: service appliance pooling

Pre-SEP Service Appliance Topology

Local Appliance Pooling

Centralized Appliance Pooling

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Example: service specific topology

- Subscriber traffic flows may be forced across specific service topologies as dictated by policy
  - Video traffic for one set of subscribers follows a specific path that is engineered to provide the optimal video experience
    - Path enabled using Service Engineered Path technology
  - Non-subscribing enhanced video traffic follows the normal routed path
Example: Content Request Routing

From where the user is connected…

… to where the content is best served

Based on:
- Network proximity
- Network availability
- Network congestion
- Content availability
- Content load
- Content capacity

This is new because:
- Uses information of the network infrastructure
- Runs across multiple service providers
- Mobile & broadband subscribers

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Example: Content Request Routing

- Per-network response times and site availability
- Network Proximity
- Network Availability
- Network Congestion
- Network Proximity
- Network Availability
- Network Congestion

- Server Availability
- Server Load
- Server Capacity

Where do I get my content?
- Network Proximity
- Network Availability
- Network Congestion

Answer: Chicago!
**Demo Scoreboard – Alto directs traffic based on network Proximity & conditions**

<table>
<thead>
<tr>
<th>Subscriber Location</th>
<th>Service Requested</th>
<th>ALTO Based Network Cost Maps:</th>
<th>Cedexis ADNS Resolves to Location:</th>
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<tbody>
<tr>
<td>Mobile</td>
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<td>Chicago - 10</td>
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**Metrics Per Regional POP**

- **ORD**
- **AMS**
- **LHR**

Datacenters are under normal load
Demo Scoreboard – Alternate datacenter chosen based on Media Flow load metrics

London and Amsterdam have exceeded the load threshold: Traffic is diverted to Chicago.
Mapping The Traffic Delivery

ALTO directs traffic to best POP based on network conditions

With London and Amsterdam MFCs overloaded, traffic is diverted to Chicago
Example: Bandwidth Calendaring

Schedule a reserved path for your session...

... without having to know the network

Technology used:
- Real-time topology understanding (ALTO, BGP-TE)
- Steering traffic through optimal paths (PCE)
- Reservation transaction (WebServices API)
- Selecting specific traffic (OpenFlow)

What would I use this for?
- Flexibility of service placement
- Scheduled data center backups
- Managed content distribution
- Cloud orchestration

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Example: Cloud Bursting

Enterprise A
Programmable Router A
Switch A
Uplink a
Port: a

Enterprise B
Programmable Router B
Switch B
Uplink b
Port: b

SP Cloud Data Center
Programmable Router C
SDK

Space (VM)
Cburst App

BSN (VM)

Port: ta
vPort: ta
Tunnel A
L3 cloud

Port: tb
vPort: tb
Tunnel B

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Example: Social Networking

Today’s wheel of missed fortune

- Untapped mine of information
  - Access technology and capability
    - Mobility events
    - Bandwidth, utilization
  - Capabilities of device and network
  - Network location
  - Proximity to caches / servers
  - Bandwidth / billing / usage caps
  - Security profile
Tune in - turn on: Be “in the topology”

<table>
<thead>
<tr>
<th>Weak architecture = one-legged tap dancing</th>
<th>Continuous, real-time streaming of surrounding content, resources, places, people</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Above the topology”</td>
<td>You’re here! &lt;access&gt; &lt;capability&gt; &lt;BW&gt; &lt;profile&gt;</td>
</tr>
<tr>
<td>“Visualize the topology”</td>
<td>And this is around you: &lt;content&gt; &lt;resources&gt; &lt;places&gt; &lt;people&gt; …</td>
</tr>
<tr>
<td>“Below the topology”</td>
<td>“In the topology”</td>
</tr>
</tbody>
</table>

Low value in navigational coordinates
What did he just say?

**UNLEASH THE POTENTIAL!**
Today the two worlds are not interlocked

**PROGRAMMABLE NETWORKING**

**DEVELOPMENT PLATFORMS EMERGING AND GETTING A LOT OF VC**

Enables:
- Flexibility of service placement
- Fungibility of assets
- Control of resources
- Derivation of telemetry and proximity

Decisions that impact your applications are being made by:
- IT departments
- Network equipment vendors
- Providers delivering your application
- Application developers

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Network Programmability

This is not a lottery

This is a game of skill

Enhance your skills

Enhance your applications

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JOIN THE REVOLUTION
CREATE. CODE. DEPLOY. EVERYWHERE THE NETWORK WORKS.