Network Functions Virtualisation

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+ Don Clarke, Pete Willis, Andy Reid, Paul Veitch (BT)
+ further acknowledgements within slides
Network Functions Virtualisation Approach

Independent Software Vendors

Orchestrated, automatic remote install

hypervisors

Generic High Volume Servers
Generic High Volume Storage
Generic High Volume Ethernet Switches

Classical Network Appliance Approach

Message Router
CDN
DPI
Firewall
Carrier Grade NAT
Tester/QoE monitor
WAN Acceleration
BRAS
Radio Network Controller
SGSN/GGSN
PE Router

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SGSN/GGSN
Radio Network Controller
BRAS
Tester/QoE monitor
WAN Acceleration
Carrier Grade NAT
DPI
Firewall
Deadpool
Message Router
If price-performance is good enough, rapid deployment gains come free

Mar’12: Proof of Concept testing

• Combined BRAS & CDN functions on Intel® Xeon® Processor 5600 Series HP c7000 BladeSystem using Intel® 82599 10 Gigabit Ethernet Controller sidecars
  – BRAS chosen as an “acid test”
  – CDN chosen as architecturally complements BRAS
• BRAS created from scratch so minimal functionality:
  – PPPoE; only PTA, priority queuing; no RADIUS, VRFs
• CDN COTS – fully functioning commercial product

Significant management stack:
1. Instantiation of BRAS & CDN modules on bare server
2. Configuration of BRAS & Ethernet switches via Tail-F
3. Configuration of CDN via VVue mgt. sys.
4. Trouble2Resolve via HP mgmt system
Mar’12: Proof of Concept Performance Test Results

- Average 3 Million Packets Per Second per Logical Core for PPPoE processing.
  - Equivalent to 94 M PPS/97 Gbps per Blade = 1.5 G PPS/1.5 Tbps per 10 U chassis\(^1\).
  - Test used 1024 PPP sessions & strict priority QoS
  - Test used an Intel® Xeon® E5655 @ 3.0 GHz, 8 physical cores, 16 logical cores (not all used).
- Scaled to 9K PPPoE sessions per vBRAS.
  - Can support 3 vBRAS per server.
- Subsequent research:
  - implemented & testing software Hierarchical QoS
  - results so far show processing is still not the bottleneck
  - (also tested vCDN performance & video quality)

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<table>
<thead>
<tr>
<th>Test Id</th>
<th>Description</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Management access</td>
<td>Pass</td>
</tr>
<tr>
<td>1.2.1</td>
<td>Command line configuration: add_sp_small</td>
<td>Pass</td>
</tr>
<tr>
<td>1.2.2</td>
<td>Command line configuration: add_sub_small</td>
<td>Pass</td>
</tr>
<tr>
<td>1.2.3</td>
<td>Command line configuration: del_sub_small</td>
<td>Pass</td>
</tr>
<tr>
<td>1.2.4</td>
<td>Command line configuration: del_sp_small</td>
<td>Pass</td>
</tr>
<tr>
<td>1.3.1</td>
<td>Establish PPPoE session</td>
<td>Pass</td>
</tr>
<tr>
<td>1.4.1</td>
<td>Block unauthorized access attempt: invalid password</td>
<td>Pass</td>
</tr>
<tr>
<td>1.4.2</td>
<td>Block unauthorized access attempt: invalid user</td>
<td>Pass</td>
</tr>
<tr>
<td>1.4.3</td>
<td>Block unauthorized access attempt: invalid VLAN</td>
<td>Pass</td>
</tr>
<tr>
<td>1.5.1</td>
<td>Time to restore 1 PPPoE session after BRAS reboot</td>
<td>Pass</td>
</tr>
<tr>
<td>1.6.1</td>
<td>Basic Forwarding</td>
<td>Pass</td>
</tr>
<tr>
<td>1.7.1</td>
<td>Basic QoS - Premium subscriber</td>
<td>Pass</td>
</tr>
<tr>
<td>1.7.2</td>
<td>Basic QoS - Economy subscriber</td>
<td>Pass</td>
</tr>
<tr>
<td>2.1.1</td>
<td>Command line configuration: add_sp_medium</td>
<td>Pass</td>
</tr>
<tr>
<td>2.1.2</td>
<td>Command line configuration: add_sub_medium</td>
<td>Pass</td>
</tr>
<tr>
<td>2.2.1</td>
<td>Establish 288 PPPoE sessions</td>
<td>Pass</td>
</tr>
<tr>
<td>2.3.1</td>
<td>Performance forwarding: downstream to 288 PPPoE clients</td>
<td>Pass</td>
</tr>
<tr>
<td>2.3.2</td>
<td>Performance forwarding: upstream from 288 PPPoE clients</td>
<td>Pass</td>
</tr>
<tr>
<td>2.3.3</td>
<td>Performance forwarding: upstream and downstream from/to 288 PPPoE clients</td>
<td>Pass</td>
</tr>
<tr>
<td>2.4.1</td>
<td>Time to restore 288 PPPoE sessions after BRAS reboot</td>
<td>Pass</td>
</tr>
<tr>
<td>2.5.1</td>
<td>Dynamic configuration: add a subscriber</td>
<td>Pass</td>
</tr>
<tr>
<td>2.5.2</td>
<td>Dynamic configuration: connect new subscribers to BRAS</td>
<td>Pass</td>
</tr>
<tr>
<td>2.5.3</td>
<td>Dynamic configuration: delete a subscriber</td>
<td>Pass</td>
</tr>
<tr>
<td>2.5.4</td>
<td>Dynamic configuration: delete service provider</td>
<td>Pass</td>
</tr>
<tr>
<td>2.6.1</td>
<td>QoS performance – medium configuration</td>
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<tr>
<td>3.1.1</td>
<td>Command line configuration: add_sp_large</td>
<td>Pass</td>
</tr>
<tr>
<td>3.1.2</td>
<td>Command line configuration: add_sub_large</td>
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</tr>
<tr>
<td>3.2.1</td>
<td>Establish 1024 PPPoE sessions</td>
<td>Pass</td>
</tr>
<tr>
<td>3.3.1</td>
<td>Performance forwarding: downstream to 1024 PPPoE clients</td>
<td>Pass</td>
</tr>
<tr>
<td>3.3.2</td>
<td>Performance forwarding: upstream from 1024 PPPoE clients</td>
<td>Pass</td>
</tr>
</tbody>
</table>

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1 - Using 128 byte packets. A single logical core handles traffic only in one direction so figures quoted are half-duplex.
3 Complementary but Independent Networking Developments

**Network Functions Virtualisation**
- Creates operational flexibility
- Reduces CapEx, OpEx, delivery time
- Reduces space & power consumption

**Open Innovation**
- Creates competitive supply of innovative applications by third parties

**Software Defined Networks**
- Creates control abstractions to foster innovation.
New NfV Industry Specification Group (ISG)

• First meeting mid-Jan 2013
  > 150 participants
  > 100 attendees from > 50 firms
• Engagement terms
  – under ETSI, but open to non-members
  – non-members sign participation agreement
    • essentially, must declare relevant IPR
      and offer it under fair & reasonable terms
  – only per-meeting fees to cover costs
• Deliverables
  – White papers identifying gaps and challenges
  – as input to relevant standardisation bodies
• ETSI NfV collaboration portal
  – white paper, published deliverables
  – how to sign up, join mail lists, etc
  http://portal.etsi.org/portal/server.pt/community/NFV/367
• Network-operator-driven ISG
  – Initiated by 13 carriers shown
  – Consensus in white paper
  – Network Operator Council offers requirements
  – grown to 23 members so far
gaps & challenges
examples

• management & orchestration
  – infrastructure management standards
  – multi-level identity standard
  – resource description language

• security
  – Topology Validation & Enforcement
  – Availability of Management Support Infrastructure
  – Secure Boot
  – Secure Crash
  – Performance Isolation
  – Tenant Service Accounting
Q&A

and spare slides
Domain Architecture

NfV Applications Domain

NfV Container Interface

Infrastructure Network Domain

Virtual Network Container Interface

Virtual Machine Container Interface

Hypervisor Domain

Compute Domain

Compute Container Interface

Orchestration and Management Domain

Carrier Management
NVF ISG Organisation Structure…
ISG Working Group Structure

Technical Steering Committee
Chair: Technical Manager: Don Clarke (BT)
Vice Chair/Assistant Technical Manager: Diego Lopez (TF)
Programme Manager: TBA
NOC Chair (ISG Vice Chair) + WG Chairs + Expert Group Leaders + Others

Working Group
Architecture of the Virtualisation Infrastructure
Steve Wright (AT&T) + Yun Chao Hu (HW)
Managing Editor: Andy Reid (BT)

Working Group
Management & Orchestration
Diego Lopez (TF) + Raquel Morera (VZ)

Working Group
Software Architecture
Fred Feisullin (Sprint) + Marie-Paule Odini (HP)

Working Group
Reliability & Availability
Chair: Naseem Khan (VZ)
Vice Chair: Markus Schoeller (NEC)

Expert Group
Performance & Portability
Francisco Javier Ramón Salguero (TF)

Expert Group
Security
Bob Briscoe (BT)

Additional Expert Groups can be convened at discretion of Technical Steering Committee

HW = Huawei
TF = Telefonica
VZ = Verizon
Hypervisor Domain

- General cloud hypervisor is designed for maximum application portability
  - Hypervisor creates
    - Virtual CPUs
    - Virtual NICs
  - Hypervisor provides
    - Virtual Ethernet switch
  - Hypervisor fully hides real CPUs and NICs
- NfV Hypervisor is aimed at removing packet bottlenecks
  - Direct binding of VM to core
  - Direct communication between VMs and between VMs and NIC
    - User mode polled drivers
    - DMA remapping
    - SR-IOV
- Many features already emerging in hypervisors
Orchestration and Infrastructure Ops Domain

- Automated deployment of NFV applications
  - Orchestration console
  - Higher level carrier OSS
- Tools exist for automated cloud deployment
  - vSphere
  - Openstack
  - Cloudstack
- NFV infrastructure profile for NFV application to
  - Select host
  - Configure host
  - Start VM(s)
- Application profile to specify
  - Service address assignment (mechanism)
  - Location specific configuration