Software-Defined Networking and Internet of Things (IoT) with Power Architecture

FTF-SDS-F0016

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A P R . 2 0 1 4
Agenda

• Overview and Motivation – “Smart” Software-Defined Networking and Internet of Things (IoT) with Power Architecture
  - iOT connected intelligence needs Smart Networking
  - Efficient
  - Secure
  - Scalable
  - Virtualized
  - Open – OpenFlow, Openstack software platforms

• QorIQ devices - High performance/Watt

• Hands-on Demo:
  End-to-end Software-Defined Virtualized Network using QorIQ
  - Software Defined Data-Center, connected Branch Office, and customer premises
Utility Sub with QorIQ Qonverge (video of actual substation or lighted poster)

Server Rack with T4240 Data Center Demo

Sensor (Network/Car/Other?)

FSL IOT Gateway
On Demand Connections of 50B devices with 8B people, Edge nodes to IOT Gateways to WAN to Cloud
Networks Must Get Smarter, Fast!

The exponential demands of the network infrastructure require a networking architecture designed with software in mind:

- Flexible hardware approach
- Extreme programming flexibility
- Real-time, ‘soft’ control over the network
Realities of the New Virtualized Network

With the Evolving Physics of Networking Implementations …

**Next-Generation Networks Must Balance Changing Deployment Paradigms**

1. Deployment, configuration, management agility
2. Vendor neutral interoperability
3. Open Standards based

1. Power limitations dominate architectural decisions
2. IO scaling MUCH faster than CPU integration
3. Multicore scaling has reached limits (HW, SW)
Freescale Smart Networking Platform = SDN + IOT
Scalable, Secure, Virtualized, Fast & Open
Q Distributed Cloud for IoT: Fog Computing
Freescale QorIQ platforms: market-leading performance per Watt per Dollar
Leverage HW-accelerators – Systems Solutions Benchmark customer use case

Freescale QorIQ is SDN Ready and IOT Ready
Disruptive Networking Technologies
– Software Defined Networking (SDN)
& NFV – Network Function Virtualization

**Software Defined Networking (SDN)**

- SDN switch supporting OpenFlow V 1.3.x on QorIQ series of Multicore SoC
- L3-L7 switch extensions running Firewall, IPSec, QoS.
- SDN Controller supporting OpenFlow 1.3.x with IP Forward, Firewall, IPSec, QoS
- Scalable across broader QorIQ communication platforms.

**Network Functions Virtualization (NFV)**

- OpenStack cloud OS multi-tenant Data Center platform supporting NFV service chaining on QorIQ Multicore SoC
- IPTables/EB tables Firewall as a virtual service
- HA proxy server loadbalancing as a virtual service
OpenFlow Networks

- Open Networking Foundation
  - Google, Facebook, Microsoft, Yahoo, Verizon, Deutsche Telekom, and many other companies
- Commercial OpenFlow switches
  - HP, NEC, Quanta, Dell, IBM, Brocade, Juniper, …
- Network operating systems
  - NOX, Beacon, Nettle, ONIX, POX, Frenetic, Floodlight

- Rule-based packet processing
  - Pattern: match packet header bits
  - Actions: drop, forward, modify, send to controller
  - QoS Priority: disambiguate overlapping patterns
  - Counters: #bytes and #packets
Open Vswitch (OVS)

- Multi-Layer Virtual Switch (MLPS)
- Flexible Controller in User-Space
- Fast Datapath in Kernel
- OpenFlow driven

- A switch contains ports
- A port may have one or more interfaces
- LACP multi-port Bonding (Link Aggregation)
- Rule-based packet-forwarding, IGMP multi-cast, L2/L3 hybrid switch+routing

- Packet header of a flow is processed by Openflow controller (Floodlight)
- The controller programs the datapath’s actions for a flow
  - Usually one, but may be a list
  - Actions include:
    - Forward to a port or ports, mirror
    - Encapsulate and forward to controller
    - Drop ports
- And returns the packet to the datapath
- Packet transferred via the datapath
- Demo OVS switch with KVM virtualization, LACP link aggregation, VLAN/VXLAN, IGMP multicast
NFV – Network Function Virtualization (Virtual Appliance)
OpenStack Cloud Orchestration with OpenFlow, OpenVSwitch
Key drivers

“Smart” Software-Defined Networking (SDN) and Internet of Things (IoT) with Power Architecture

Efficient, Secure, Scalable, Virtualized and Open

- Efficient – Software based on Freescale QorIQ T4/T2/T1 and Layerscape communications processors, High Performance/Watt
- Secure – Deep Packet Inspection (DPI), OpenSSL for hardware acceleration, VPN/IPSEC encryption
- Scalable – Distributed Network Function Virtualization (NFV) with high availability auto-failover
- Virtualized – Extend SDN from Data-center to Edge to Enterprise
- Open – open source software platform
  - OpenDaylight, OpenFlow®, OpenVswitch, OpenStack software platforms
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  - Virtualized
  - Open – OpenFlow, Openstack software platforms

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Digital Networking Product Family Progression

- **QorIQ Layerscape**: Software Driven Core-agnostic
- **QorIQ Qonverge**: 2-14 Heterogeneous cores, Protocol acceleration
- **QorIQ T-Series**: Multi-thread 1-24 cores, 64-bit, Altivec
- **QorIQ P-series**: 1-8 cores, packet acceleration, security & pattern matching, hardware-assisted hypervisor
- **PowerQUICC**: Industry’s leading Communications Processor

**Platform In Execution**

- **4 family members / 2013**
- **6 family members 2013**
- **25 family members**
- **75 family members**
QorIQ Communications Processor Roadmap

**SDKs**

- **Biannual releases**
  - SDK 1.3
  - SDK 1.4
  - SDK 1.5
  - SDK 1.6
  - SDK 1.7

- **High Performance**
  - 25W+ TDP
    - P3041
    - P5040
    - T4240
    - T4160
    - P5020/10
    - P5021
    - P4080/40
    - Industry's Highest CoreMark™/W

- **Mid Performance**
  - 10-25W TDP
    - MPC8569
    - P2041/40
    - P2020/10
    - T2080
    - T2081

- **Value Performance**
  - <10W TDP
    - P1023/17
    - P1022/16
    - P1021/12
    - P1020/11
    - P1010/14
    - P1010/14
    - 1GHz P1010 Provides Drop in Performance Upgrade
    - Innovative solution with ARM® Cortex™-A7: Dual-Core with ECC

**Roadmap**

- Production 2013
- Production 2014
- Production 2015
- Production 2016

- LS1xxx
- LS10XXA
- LS104XA
- LS102XA
- LS3080A
- LS3240A
- LS2xxx
- LS2A
- LS3xxxA
- LS3xxx

- Power Upgrade Path
- Drop in Performance Upgrade
- + H/W Table-walk
- + AIOP Libraries
- USDPA for LS
- OpenSSL
- DPAA GSO/GRO

**Innovative solution with**

- ARM® Cortex™-A7: Dual-Core with ECC

**Powerful new T series**

- T1023 dual core delivers
- 11ac Power Upgrade Path

**Sample**

- Production
- Execution
- Planning
- Proposal

**Timeline**

- 2012
- 2013
- 2014
- 2015
- 2016
**QorIQ T4 Family: Introducing T4080**

*Now with Value, Mid, and High tier offerings*

**3x CPU Performance Scaling in One Package**

**Scalability** – Now the T4 family has a one-, two-, and three-cluster solutions. Choose the best fit for the performance requirement.

**Pin Compatibility** – All T4 family members are pin compatible. Enables customers to develop multiple SKUs from a single PCB.

**Accelerator Centric** – T4080 performance is weighted towards efficient accelerators (security, DPI, data compression), enabling better performance per watt per dollar.

**Upgrade from T2080** - choose T4080 for dual memory controllers, more I/O flexibility, higher performance security or Ethernet support, or Interlaken.

**Migrate from P4080** - Same 8-thread, 2-FMan programming model, but higher frequency, upgraded I/O, accelerators, packet handling, and DDR controllers, and lower cost.
## Industry’s Most Scalable Processor Portfolio

<table>
<thead>
<tr>
<th></th>
<th>T2080</th>
<th>T4080</th>
<th>T4160</th>
<th>T4240</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CPU (64b)</strong></td>
<td></td>
<td></td>
<td>e6500</td>
<td></td>
</tr>
<tr>
<td># of CPU cores, threads</td>
<td>4, 8 threads</td>
<td>8, 16 threads</td>
<td>12, 24 threads</td>
<td></td>
</tr>
<tr>
<td><strong>Max frequency</strong></td>
<td>1.8GHz</td>
<td>1.67GHz</td>
<td>1.8GHz</td>
<td></td>
</tr>
<tr>
<td><strong>L2 Cache per core</strong></td>
<td>512KB</td>
<td></td>
<td></td>
<td>512KB</td>
</tr>
<tr>
<td><strong>Platform Cache</strong></td>
<td>512KB</td>
<td>1MB</td>
<td>1.5MB</td>
<td></td>
</tr>
<tr>
<td><strong>DRAM Interface</strong></td>
<td>1x DDR 64b 3/3L</td>
<td>2x DDR 64b 3/3L</td>
<td>3x DDR 64b 3/3L</td>
<td></td>
</tr>
<tr>
<td><strong>IPFwding perf (small pkt)</strong></td>
<td>24Gbps</td>
<td>24Gbps</td>
<td>36Gbps</td>
<td>48Gbps</td>
</tr>
<tr>
<td><strong>IPSec perf (large pkt)</strong></td>
<td>14Gbps</td>
<td></td>
<td>32Gbps</td>
<td>32Gbps</td>
</tr>
<tr>
<td><strong>Max # Ethernet</strong></td>
<td>4x 1/10GbE + 4x 1GbE</td>
<td>2x 1/10 GbE + 14x 1GbE</td>
<td>4x 1/10GbE + 12x 1GbE</td>
<td></td>
</tr>
<tr>
<td><strong>Other High Speed Serial</strong></td>
<td>4x PCIe: Gen 2.0/3.0</td>
<td>4x PCIe: Gen 2.0/3.0</td>
<td>4x PCIe: Gen 2.0/3.0</td>
<td></td>
</tr>
<tr>
<td><strong>Power (typ 65C) at Fmin</strong></td>
<td>11W-1.2GHz</td>
<td>19W-1.5GHz</td>
<td>25W-1.5GHz</td>
<td>30W-1.5GHz</td>
</tr>
<tr>
<td><strong>Pin Compatibility</strong></td>
<td>25x25 mm 896p FCBGA</td>
<td></td>
<td>42.5x42.5mm 1932-pin FCBGA</td>
<td></td>
</tr>
</tbody>
</table>
T4080 Upgrades Relative to T2080

- Both have the same one cluster, same CPU capability, and same L2, but:

<table>
<thead>
<tr>
<th></th>
<th>T2080</th>
<th>T4080</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDR Contrlr</td>
<td>One</td>
<td>Two</td>
<td>2x the bandwidth, and lower latency due to interleaving</td>
</tr>
<tr>
<td>Corenet Platform Cache</td>
<td>512kB</td>
<td>1MB</td>
<td>Lower latency access for DPAA, higher throughput</td>
</tr>
<tr>
<td>IPSec, 1442B pkt</td>
<td>14Gbps</td>
<td>32Gbps</td>
<td>Higher perf SEC block in T4</td>
</tr>
<tr>
<td>FMan</td>
<td>One</td>
<td>Two</td>
<td>Each Fman has 38Mpps packet handling capability</td>
</tr>
<tr>
<td>SerDes lanes</td>
<td>16</td>
<td>24</td>
<td>More I/O flexibility</td>
</tr>
<tr>
<td>Interlaken LA-1</td>
<td>No</td>
<td>Yes</td>
<td>Supports TCAM for high-perf classification</td>
</tr>
<tr>
<td>Pin compatible devices</td>
<td>T10x0 (T2081)</td>
<td>T4160, T4240</td>
<td>T2081 is pin compatible to lower cost devices, T4080 is pin compatible to higher performance devices</td>
</tr>
</tbody>
</table>
QorIQ T4240

- Industry’s highest CoreMark score for an embedded SOC
- Performance-per-watt leadership
  - 12 dual threaded e6500 cores, 64b
  - 1.8GHz
  - AltiVec
  - Inverted cache hierarchy
- Advanced Power Management
  - Thermal Management Unit
  - Drowsy power modes
- Improved Dataplane
  - 40Gb/s Pkt handling with 64B packets
  - 4x 10GE ports incl XFI/10GBase-KR
  - Datacenter Bridging, Interlaken, HiGig
- Upgraded Acceleration
  - Crypto upgraded to 40Gb/s
  - Data Compression Engine to 20Gb/s
  - Pattern matching to 10Gb/s
## QorIQ T4 Series Key Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>High perf/watt</td>
<td>• 188k CoreMark in 55W = 3.4 CM/W&lt;br&gt;• Compare to Intel E5-2650: 146k CM in 95W = 1.5 CW/W;&lt;br&gt;• Or: Intel E5-2687W: 200k MC in 150W = 1.3 CM/W&lt;br&gt;• T4 is more than 2x better than E5&lt;br&gt;• 2x perf/watt compared to P4080, FSL’s previous flagship</td>
</tr>
<tr>
<td>Highly integrated SOC</td>
<td>Integration of 4x 10GE interfaces, local bus, Interlaken, SRIO mean that few chips (takes at least four chips with Intel) and higher performance density</td>
</tr>
<tr>
<td>Sophisticated PCIe capability</td>
<td>• SR-IOV for showing VMs a virtual NIC, 128 VFIs (Virtual Functions)&lt;br&gt;• Four ports with ability to be root complex or endpoint for flexible configurations</td>
</tr>
<tr>
<td>Advanced Ethernet</td>
<td>• Data Center Bridging for lossless Ethernet and QoS&lt;br&gt;• 10GBase-KR for backplane connections</td>
</tr>
<tr>
<td>Secure Boot</td>
<td>Prevents code theft, system hacking, and reverse engineering</td>
</tr>
<tr>
<td>Altivec</td>
<td>On-board SIMD engine – sonar/radar and imaging</td>
</tr>
<tr>
<td>Power Management</td>
<td>• Thread, core, and cluster deep sleep modes&lt;br&gt;• Automatic deep sleep of unused resources</td>
</tr>
<tr>
<td>Advanced virtualization</td>
<td>• Hypervisor privilege level enables safe guest OS at high performance&lt;br&gt;• IOMMU ensures memory accesses are restricted to correct area&lt;br&gt;• Virtualization of I/O blocks</td>
</tr>
<tr>
<td>Hardware offload</td>
<td>• Packet handling to 50Gb/s&lt;br&gt;• Security engine to 40Gb/s&lt;br&gt;• Data compression and decompression to 20Gb/s&lt;br&gt;• Pattern matching to 10Gb/s</td>
</tr>
<tr>
<td>3x Scalability</td>
<td>• 1-, 2-, and 3- cluster solution is 3x performance range over T4080 – T4240&lt;br&gt;• Enables customer to develop multiple SKUs from on PCB</td>
</tr>
</tbody>
</table>
# QorIQ T4 Series Target Applications

<table>
<thead>
<tr>
<th>Application</th>
<th>Key Features</th>
</tr>
</thead>
</table>
| Storage           | • High performance networking  
                    • Single-chip SOC solution                                                                                                                |
| Wireless Infrastructure | • Power architecture for legacy code migration  
                    • High performance density  
                    • Kasumi at 20Gb/s  
                    • Dual x4 SRIO at 5GHz for DSP and backplane                                                                                     |
| Micro server      | • High perf/watt  
                    • Integration leads to higher processing per rack unit  
                    • Ethernet integration eliminates the NIC  
                    • Data Center Bridging for rack-to-rack cabling  
                    • 10Gbase-KR for backplane                                                                                                         |
| iNIC or PCIe offload | • SR-IOV for support of 128 VMs  
                    • Compression and decompression to 20Gb/s for ADC                                                                                   |
| Mil/Aero          | • Altivec for legacy code support, > 6x the Altivec performance of 8641D.                                                                    |
| UTM               | • 40Gb/s IPSEC  
                    • Deep Packet Inspection offload to 10Gb/s                                                                                             |
| Data Plane        | • 48Gb/s 64B packet handling  
                    • Interlaken Lookaside for TCAM connectivity                                                                                           |
# Smart NIC: T2080 and T4240

<table>
<thead>
<tr>
<th>Device</th>
<th>Smart NIC – Value</th>
<th>Smart NIC - Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>1.8GHz</td>
<td>1.8GHz</td>
</tr>
<tr>
<td>Virtual Cores</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>L2 + L3 Cache</td>
<td>2.5MB</td>
<td>7.5MB</td>
</tr>
<tr>
<td>Memory Controllers</td>
<td>1x DDR3/3L to 2133MT/s</td>
<td>3x DDR3/3L to 1867MT/s</td>
</tr>
<tr>
<td>PCIe</td>
<td>4x PCIe</td>
<td>4x PCIe</td>
</tr>
<tr>
<td>Ethernet</td>
<td>4x 10GE + 4x GE</td>
<td>4x 10GE + 10x GE</td>
</tr>
<tr>
<td>64B IP Fwding</td>
<td>17Gb/s</td>
<td>40Gb/s</td>
</tr>
<tr>
<td>Bulk encryption</td>
<td>15Gb/s</td>
<td>40Gb/s</td>
</tr>
<tr>
<td>De/compression</td>
<td>18Gb/s</td>
<td>20Gb/s</td>
</tr>
<tr>
<td>Pattern Matching</td>
<td>10Gb/s</td>
<td>10Gb/s</td>
</tr>
</tbody>
</table>

- NIC capabilities (vNIC, NFV …)
  - TCP termination
  - Security offload
  - WAN optimization
  - Deep packet inspection
  - Data Compression (DCE)

- PCIe Capabilities
  - Up to x8 Gen2 or x4 Gen3
  - SR-IOV with 2 PF and 64 VF per PF
  - Full endpoint capability including customization of Device ID, Class Code, and Vendor ID. Driver can be stored in Expansion ROM.
T2080/LS2085A Smart NIC Reference Designs

- PCIe cards providing enhanced L3/L4+ functionality
  - IPSEC
  - Katsumi
  - TCP offload
  - Compression/decompression
  - Security (SSL/IPsec, SRTP),
  - SDN
  - Software switch
  - SR-IOV I/O virtualization

<table>
<thead>
<tr>
<th>Feature</th>
<th>T2080</th>
<th>LS2085A</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU Cores</td>
<td>4 (8 threads)</td>
<td>8 A57s</td>
</tr>
<tr>
<td>Frequency</td>
<td>1.2 to 1.8GHz</td>
<td>Up to 2.0GHz</td>
</tr>
<tr>
<td>Worst Case Power</td>
<td>15W-28W</td>
<td>30W TYP</td>
</tr>
<tr>
<td>64 bit DDR cntr</td>
<td>1 DDR3</td>
<td>2 DDR4</td>
</tr>
<tr>
<td>10G Enet I/Fs</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>IPv4fwd</td>
<td>24Gbps</td>
<td>80Gbps</td>
</tr>
<tr>
<td>IPSec</td>
<td>10Gbps</td>
<td>20Gbps</td>
</tr>
<tr>
<td>Data Compression</td>
<td>17.5Gbps</td>
<td>17.5Gbps</td>
</tr>
<tr>
<td>Pattern Matching</td>
<td>10Gbps</td>
<td>10Gbps</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>128 VF</td>
<td>128 VF</td>
</tr>
</tbody>
</table>
T1023: WLAN AP Power Architecture

Processor
- 2x e5501, 32/64b, up to 1.4GHz
- Each with 256 KB backside L2 cache
- 256KB Shared Platform Cache w/ECC
- Supports up to 64GB addressability (36 bit physical addressing)

Memory Sub System
- 32b DDR3L/4 1333MT/s commit

Corenet Switch Fabric

High Speed Serial IO
- 3x PCIe Gen2 Controllers
- 1x USB 2.0 with PHY

Network IO
- v3 FMan packet Parse/Classify/Distribute
  - Data path supporting up to 2.5Gbps of CAPWAP / DTLS & IPv6 offload
- MACsec, IEEE 1588
  - 1x 1GbE
  - 1x 10GbE or 1GbE
- Availability
  - Samples (T1040) Q4’13
  - Samples (T1023) 1H’14

Device
- 28HPM Process

Datapath Acceleration
- Fman:
  - CAPWAP PCD
  - Reassembly
  - IPv6
  - SEC:
  - DTLS
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  - Scalable
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• Performance Results
  - Freescale delivers high performance/Watt

• Hands-on Demo:
  End-to-end Software-Defined Virtualized Network using QorIQ
  - Software Defined Data-Center, connected Branch Office, and customer premises
Performance Results of Openflow and OpenvSwitch on T4/T2/T1 T4240/T2080/T10xx delivers high performance/Watt
Freescale T4 Advantage: Max. Performance/Watt/$$

- Application and network processing
  - Processing density
  - Power and energy efficiency
  - Virtualization

<table>
<thead>
<tr>
<th></th>
<th>AKA</th>
<th>Threads</th>
<th>Frequency (GHz)</th>
<th>Aggregate CoreMark™</th>
<th>TPD Power</th>
<th>Temp</th>
<th>Coremark/W ratio to T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>T4240</td>
<td>QorIQ AMP</td>
<td>24:PThreads</td>
<td>1.8</td>
<td>173,488</td>
<td>60</td>
<td>105C Tj</td>
<td>100%</td>
</tr>
<tr>
<td>T4240</td>
<td>QorIQ AMP</td>
<td>24:PThreads</td>
<td>1.8</td>
<td>173,488</td>
<td>39</td>
<td>75C Tj</td>
<td>100%</td>
</tr>
<tr>
<td>Core i7-3930K Sandy Bridge</td>
<td>12:Pthreads</td>
<td>3.2</td>
<td>150,962</td>
<td></td>
<td>130</td>
<td>66C case</td>
<td>40%</td>
</tr>
<tr>
<td>CN6880</td>
<td>Octeon II</td>
<td>32: cores</td>
<td>1.5</td>
<td>153,477</td>
<td>65</td>
<td>105Tj</td>
<td>82%</td>
</tr>
</tbody>
</table>

* CoreMark score from coremark.org
^ TPD From http://ark.intel.com/
** T4240 power are estimates

Compute density per blade at equivalent power

<table>
<thead>
<tr>
<th>Dual Socket Server</th>
<th>T4240 Quad</th>
<th>T4240 Sexuple</th>
</tr>
</thead>
<tbody>
<tr>
<td>I7 CPUs 260W =&gt; ~300K Coremark</td>
<td>T4s 240W** Tj 105C =&gt; ~700K Coremark</td>
<td>T4s 234W** T j75C=&gt; ~1040K Coremark</td>
</tr>
</tbody>
</table>
Software-Defined Virtualized Network with QorIQ and Layerscape

Scalable, Smart, Secure, Virtualized

T4240
- Highest CoreMark of any embedded SOC
- 24 virtual cores
- 50Gb/s packet handling
- Hardware virtualization
- Advanced power management

Demo - Scalable, Smart, Secure, Virtualized
- SDN Virtualized network (Openflow controller - ONF, OpenVswitch - OVS)
- OpenStack Data-center Orchestartion
- SSL acceleration (C29x)
- Demonstrate high performance per watt
Demo Topology (Before Fail-over, traffic flow through Yellow path)
Demo

Smart Virtualized Network - Efficient, Secure, Scalable

1. Gateways initially connect to Building-H Switch (Yellow path)

2. Building-H Switch connections disabled.

3. Demo Scalability, Smart: Resiliency, Virtualized network
   a. Switch Failover: Flow controller redirects gateway connection to Building-J Switch (Blue path)
   b. Demo Controller Fail-over

4. Demo Secured GRE over IPSEC tunnel

5. Show High Performance per Watt
Demo Topology (After Fail-over, traffic switch to Blue paths)
Summary

- **Overview and Motivation** – “Smart” Software-Defined Networking and Internet of Things (IoT) with Power Architecture
  - IoT connected intelligence needs Smart Networking
  - Efficient
  - Secure
  - Scalable
  - Virtualized
  - Open – OpenFlow, Openstack software platforms

- **Performance Results**
  - Freescale delivers high performance/Watt

- **Software-Defined Virtualized Network**
  - Freescale differentiation with QorIQ, and Layerscape
  - Software Defined Data-Center, connected Branch Office, and customer premises
Digital Networking Software and Services

- **World-Class Technology**
  - Freescale **Silicon** - Used in Leading Products
  - Freescale **Enablement** – Innovative Investment
    - Device Drivers – Optimized and Portable
    - Linux – Commercial-grade, Available
    - Solutions References – Near-market Ready
    - CodeWarrior – Commercial Tools

- **World-Class Ecosystem**

- Complemented by **Commercial Capability**
  - Freescale Networking Software and Services
    - Commercial Software – VortiQa Applications
    - Commercial Services – Linux Support and Services
Introducing The QorIQ LS2 Family

Breakthrough, software-defined approach to advance the world’s new virtualized networks

New, high-performance architecture built with ease-of-use in mind
Groundbreaking, flexible architecture that abstracts hardware complexity and enables customers to focus their resources on innovation at the application level.

Optimized for software-defined networking applications
Balanced integration of CPU performance with network I/O and C-programmable datapath acceleration that is right-sized (power/performance/cost) to deliver advanced SoC technology for the SDN era.

Extending the industry’s broadest portfolio of 64-bit multicore SoCs
Built on the ARM® Cortex®-A57 architecture with integrated L2 switch enabling interconnect and peripherals to provide a complete system-on-chip solution.
QorIQ LS2 Family

Key Features

SDN/NFV Switching

Data Center

Wireless Access

Unprecedented performance and ease of use for smarter, more capable networks

High performance cores with leading interconnect and memory bandwidth
- 8x ARM Cortex-A57 cores, 2.0GHz, 4MB L2 cache, w Neon SIMD
- 1MB L3 platform cache w/ECC
- 2x 64b DDR4 up to 2.4GT/s

A high performance datapath designed with software developers in mind
- New datapath hardware and abstracted acceleration that is called via standard Linux objects
- 40 Gbps Packet processing performance with 20Gbps acceleration (crypto, Pattern Match/RegEx, Data Compression)
- Management complex provides all init/setup/teardown tasks

Leading network I/O integration
- 8x1/10GbE + 8x1G, MACSec on up to 4x 1/10GbE
- Integrated L2 switching capability for cost savings
- 4 PCIe Gen3 controllers, 1 with SR-IOV support
- 2 x SATA 3.0, 2 x USB 3.0 with PHY
See the LS2 Family First in the Tech Lab!

4 new demos built on QorIQ LS2 processors:

- Performance Analysis Made Easy
- Leave the Packet Processing To Us
- Combining Ease of Use with Performance
- Tools for Every Step of Your Design