Introduction to Freescale 28nm e6500 Advanced 64bit Multi-threading Power Architecture for embedded space

*Dac Pham, Ph.D.*
Fellow, Director Freescale NMSG Cores, Platforms, and IP

CELEBRATING 21 YEARS OF POWER ARCHITECTURE ANNIVERSARY
History Of Accelerated Innovation
QorIQ AMP T4240
QorIQ Qonverge B4860

login[981]: root login on 'tyS0'

# #
# top

Mem: 34932K used, 3982312K free, 0K shrd, 116K buff, 1528K cached
CPU: 0.0% usr 0.0% sys 0.0% nic 99.9% idle 0.0% io 0.0% irq 0.0% siq
Load average: 0.00 0.00 0.00 1/106 990

PID PPID USER STAT Vsz %MEM CPU %CPU COMMAND
980 981 root R 2076 0.0 18 0.1 top
981 1 root S 2072 0.0 16 0.0 init
9 2 root SW 0 0.0 1 0.0 [ksoftirqd/1]
5 2 root SW 0 0.0 0 0.0 [kworker/u:0]
974 2 root SW 0 0.0 8 0.0 [kworker/0:0]
2 0 root SW 0 0.0 5 0.0 [kthreads]
3 2 root SW 0 0.0 0 0.0 [kworker/0:0]
4 2 root SW 0 0.0 0 0.0 [kworker/0:0]
6 2 root SW 0 0.0 0 0.0 [migration/0]
7 2 root SW 0 0.0 1 0.0 [migration/1]
9 2 root SW 0 0.0 1 0.0 [kworker/1:0]
10 2 root SW 0 0.0 0 0.0 [kworker/0:1]
11 2 root SW 0 0.0 2 0.0 [migration/2]
12 2 root SW 0 0.0 2 0.0 [kworker/0:0]
13 2 root SW 0 0.0 2 0.0 [kworker/0:0]
14 2 root SW 0 0.0 3 0.0 [migration/3]
15 2 root SW 0 0.0 3 0.0 [kworker/3:0]

T4240 Linux is up!

[Images of people working in a lab and technical equipment are shown.]
Industry’s highest CoreMark benchmark performance score ever recorded for an embedded processor!
Wide Adoption Of Power Architecture Based Multicore

**Networking**

**Drivers**
Performance / Watt, system cost & power, Increased bandwidth, increased number of subscribers, increased processing per packet, and software complexity

**Application Examples**
Cloud networking, Routing & switching; control plane + data plane consolidation, multimedia content processing, 4G wireless processing. Servers: Multiple users access similar service simultaneously

PowerQUICC
PowerQUICC II/Pro
PowerQUICC III

QorIQ QorIQ Qonverge

QorIQ AMP Series
4x Application Performance
4x Networking Bandwidth Improvement

QorIQ QorIQ Qonverge Platform
QorIQ AMP Series
QorIQ Layerscape Series
e6500 Core Complex

Core Performance: CoreMark™ / Watt Benchmark

High-Performance
- Industry’s highest CoreMark score
- Industry’s best CoreMark per Watt
- 64-bit Power Architecture® core
- Dual strong threads provide 1.7 times the performance of a single thread
- Clustered L2 cache allowing strict allocation or full sharing
- 128b AltiVec SIMD unit
  - 192 GFLOP aggregate

Large Memory Space
- 40-bit real address
- Terabyte physical address

Increase Productivity
- Core Virtualization
  - Hypervisor
  - Logical to Real Address Translation

Energy Efficiency
- 1.4 to 3 times more power efficient than the nearest competition
- Drowsy: core, cluster, AltiVec

Dual 6 core (12 thread) server processors @ 2.266GHz *
32 core processor @ 1.5GHz*
12 core (24 thread) T4240 @ 1.8GHz

T4240 - Industry’s Best
- CoreMark Score
- CoreMark per Watt

*Source: www.coremark.org

CoreNet Interface
40-bit Address Bus  256-bit Rd & Wr Data Busses

CoreNet Double Data Processor Port

2MB 16-way Shared L2 Cache, 4 Banks
T4240 Block Diagram

- **Core Complex**
  - Core Clusters: 3, 2
  - DDR Memory Controllers: 3, 2
  - 10G Serdes Lanes: 32, 24
  - 10GbE MAC: 4, 2
  - Typical Power (with IO): 30W, 25W

- **CoreNet™ Coherency Fabric**
  - DCE 1.0, Security 5.0, Queue Mgr.
  - FMAN, Parse, Classify, Distribute

- **Interconnect Fabric**
  - 64-bit DDR3 Memory Controller
  - 512KB CoreNet Platform Cache

- **High Performance I/O**
  - 50Gbps Networking and HW Acceleration

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Performance and Power Challenges of Datacenter Application and Network Computing

Data Center application and network processing

- Processing density
- Power & energy efficiency
- Virtualization

### CoreMark™

<table>
<thead>
<tr>
<th>Processor</th>
<th>AKA</th>
<th>Threads</th>
<th>Freq (GHz)</th>
<th>Temp range</th>
<th>Compiler</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>T4240</td>
<td>QorIQ AMP</td>
<td>24:Threads</td>
<td>1.8</td>
<td>105°C</td>
<td>GCC4.6.0</td>
<td>emulation</td>
</tr>
<tr>
<td>T4240</td>
<td>QorIQ AMP</td>
<td>24:Threads</td>
<td>1.8</td>
<td>75°C</td>
<td>GCC4.6.0</td>
<td>emulation</td>
</tr>
<tr>
<td>Core i7-3930**</td>
<td>Sandy Bridge</td>
<td>12:Threads</td>
<td>3.2</td>
<td>66°C case</td>
<td>GCC4.4.6</td>
<td>silicon</td>
</tr>
<tr>
<td>Core i5-2400**</td>
<td>Sandy Bridge</td>
<td>4:Threads</td>
<td>3.1</td>
<td>72°C case</td>
<td>GCC4.4.5</td>
<td>silicon</td>
</tr>
</tbody>
</table>

QorIQ Processors implement more than just General purpose processing

- Integrated networking datapath
- Hardware acceleration
  - Crypto
  - Reg-ex
  - Compression

### 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 105°C =&gt; ~700K Coremark</td>
<td>T4s 234W** Tj 75°C =&gt; ~1040K Coremark</td>
</tr>
</tbody>
</table>

* CoreMark score from coremark.org
** T4240 power are estimates
Wireless Access SoC Multicore Solution

QorIQ Qonverge

DSP Core

Power Architecture ®

64-bit DDR-3/3L Memory Controller

Multicore Fabric

Multi standard Protocol Acceleration

Security Engine

USB 2.0

JESD207 / ADI / MAXPHY

Ethernet RGMII

Ethernet RGMII

Multi-standard support, including LTE, WCDMA & CDMAx;
common software architecture for Femto, Pico and large cells (Macro & Metro)
QorIQ Qonverge B4860 – Benefits

- Next generation, e6500 Dual-Thread Power Architecture® cores offer highest CoreMark/Watt with AltiVec technology for dramatic L2 scheduling acceleration
- Next generation, SC3900 StarCore™ provides 2x DSP performance compared to competitive offerings
- Above 21GHz of Programmable Performance
- Smart hardware acceleration for Layer 1, 2, Control and Transport allows for best in class performance, power and cost
- Large scale SoC integration allows for simpler programming models and easier load balancing
- Integrated, Rich I/O including backhaul & antenna interfaces provides flexibility, interoperability and reduces overall system cost
Benefit of Intelligent Integration

3 sector, 20 MHz LTE with 5 major components

3 sectors, 20 MHz LTE, or Single sector 60MHz LTE-A on a single SoC

4X Cost Reduction
3X Power Reduction
Freescale the Industry’s only “Air-to-Core” Provider

QorIQ Qonverge™ and AMP™:
- Discrete & Integrated SoC Offerings
- L1 DSP, L2 & L3 → Network Processing
- **FSL STRENGTHS**: Market Leader, SoC Expertise, Multicore Performance, Core & DSP IP

Airfast™ RF PA:
- Diverse Technology Offerings (12 – 48V LDMOS, 5 – 12V GaAs & GaN)
- Broad system focus targeting multi-standard / multi-band performance leadership
- **FSL STRENGTHS**: Market-Leading Performance, Cost & RFIC Integration, Strong Investment in Technology

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Migrates customers to the next level with 4x performance and 2x power efficiency with T4240, intelligence integration, industry first “air-to-core” B4860

Industry’s highest CoreMark benchmark performance score ever recorded for an embedded processor

Freescale’s T4 and B4 families of processors are the ideal building block to evolve the world’s data center and intelligence networks

- Reduce power
- Lower deployment cost
- Expand bandwidth
THINK POWER CHOOSE POWER

INNOVATION    COLLABORATION    GROWTH

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