Texas Instruments
Multi-core Processor with RapidIO

RapidIO Trade Association
4Q13
Agenda

- Popular past & present DSP interconnects
- KeyStone DSP RapidIO Features
- KeyStone DSP Interconnection with SRIO
- High performance SRIO DSP Processors in TI
- Q&A
Past interconnection based on TI DSP for Baseband application
Current Baseband Uplink Evolution

- Custom Interface
- Serial RapidIO Switch
- Base Band Processing
- RapidIO Link
- C66x W/ Serial RapidIO
- C66x W/ Serial RapidIO
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- C66x W/ Serial RapidIO
- C66x W/ Serial RapidIO
- Host
- To Network I/F Board (Backplane)
Keystone Architecture
The successful foundation for your next innovation

• **Best Low Power SoC Architecture**
  – State of the art SoC Infrastructure
  – Enable high performance applications
  – Twice the on chip memory with half the power consumption vs. alternatives

• **High Degree of Integration**
  – Accelerate from user interface to IP
  – On-Chip Ethernet switching
  – Unparallel High throughput IOs
  – Lowest total cost of ownership

• **Scalable and portable**
  – From consumer, industrial to infrastructure
  – SW design reuse, easy SW migration from Keystone I to Keystone II

• **Best return on Investment**
  – Reliable, best quality product
  – Field proven technology with rich ecosystem, speed time to market
KeyStone Serial RapidIO Overview

Serial RapidIO is a high-performance, packet-switched, interconnect technology that addresses the embedded industry's need for:

- **RELIABILITY**
- **INCREASED BANDWIDTH**
- **FASTER BUS SPEEDS**

- **KeyStone Serial RapidIO Support**
  - 1.25, 2.5, 3.125, 5G Baud/sec per link (1.0, 2.0 2.5 4 GBits/sec w/ 8B/10B encoding)
  - Up to four 1x links (each 1x link is bidirectional)
  - One 4x link (bi-directional pipe), which provides up to 20 GBaud/sec raw
    - Up to 10Gbps for 4x link with 8B/10B encoding
  - Also supports two 2x and two 1x + one 2x modes
    - Supports DSP to DSP on the same board, DSP to Switch, etc.

- Layered architecture to minimize impact on software
- Non-proprietary multi-vendor support
- Flexible and scalable
- Reduces chip count, board area and system cost
RapidIO Daisy Chain

- Connect 2 / 4 lanes from DSP to DSP or other devices with RapidIO Interface
- Ideal for applications where multiple hops is acceptable
- Can be used without switch
RapidIO Switch Interconnect

- Connect multiple DSPs to RapidIO switch via 1x or 4x lanes for DSP Farm
- For specific function where latency is critical or continuous data exchange is expected, local interconnection can be established
- Ideal where high bandwidth is needed to each device (vs daisy chain)
Direct Interconnected RapidIO

- Five DSPs are completely connected
- Provides direct connection from 1 device to any other device
- Reduces latency but limited to 1x lane bandwidth to each device
Mesh configuration with four 1x lanes

Can be used in different mesh configurations depending upon number of RapidIO lanes available
Combination Interconnect

- Use of any combination of options is possible
- Connectivity via RapidIO to back plane can also be used
KeyStone – Portfolio Highlights

Product range
• Processors for low/mid/high end applications

Reduces BOM cost
• Integrated ARM, accelerators, and I/O – smaller PCBs and fewer add-on chips

Solutions reduce time-to-market
• Mature tools, free software, excellent support and rich 3rd party ecosystem
• Existing customers protect investment: 100% backward compatible with C64x/C674x based TI DSPs

Reliable processor supplier
• 10+ years supply guarantee, strong roadmap and TI’s financial stability

Low cost EVM + free tools & software
KeyStone Processors Available Today

**C667x and 66AK2Hx**

**Best performance per Watt in the industry!**

- **C667x**
  - Up to 8 C66x cores @ 1GHz to 1.25GHz
  - 8 cores: 320GMACs/160GFLOPs @ ~10W
  - Network acceleration Pacs

- **66AK2HXX**
  - 4 A15 + 8 C66x: 352GMACs/198.4GFLOPs
  - 2 A15 + 4 C66x: 176GMACs/99.2GFLOPs
  - 13-16W depending upon DSP cores, speed, temp & other factors

**Power Optimized for Portable Applications**

- **C665x**
  - 1-2x C66x DSP cores

  - **C6657**
    - 2 C66x up to 1.25GHz
    - 64GMACs/32GFLOPs @3.5W

  - **C6655**
    - 1 C66x up to 1.25GHz
    - 32GMACs/16GFLOPs @2.5W

  - **C6654**
    - 1 C66x up to 850MHz
    - 27.2GMACs/13.6GFLOPs @<2W
# KeyStone Processors shipping in 1Q14

## 66AK2Exx

**Multicore ARM Processor with additional DSP**

- **4x ARM A15 + 1x C66x**

**66AK2E05**
- 4 ARM A15s up to 1.4GHz
- 1 C66x DSP up to 1.4GHz
- 89.6GMACs/67.2GFLOPs @ ~8.5W
- 2x 10Gb + 8x 1Gb Ethernet
- 7MB on-chip RAM

## AM5K2Exx

**Multicore ARM-Only Processors**

- **2x ARM A15 up to 1.4GHz**
- **4x ARM A15 up to 1.4GHz**

**AM5K2E04**
- 4 ARM A15s at 1.4GHz
- 2x 10Gb + 8x 1Gb Ethernet
- 6MB on-chip RAM
- 44.8GMACs/GFLOPs @ ~8W

**AM5K2E02**
- 2 ARM A15s up to 1.4GHz
- 22.4GMACs/GFLOPs
KeyStone I
TMS320C6671/2/4/8 Functional Diagram

- **Cores & Memory**
  - Up to 8 C66x DSP 1GHz-1.25GHz
  - 320 GMACs, 160 GFLOPS
  - 8MB on chip memory w/ECC

- **Multicore Infrastructure**
  - Navigator with 8k queues, 1600 MIPS
  - Non blocking Network on Chip
  - Multicore Shared Memory Controller reduce external memory access latency

- **Switches**
  - 1GbE: 2 external port switch

- **Network, Transport**
  - Crypto: IPsec, ESP, AH Tunneling, SRTP
  - Packet Acceleration – Multiple IP Addr, 1.5Mpps @ full wire-rate, QoS support

- **Connectivity – 82Gbps**
  - HyperLink(50), PCIe(10), SRIO(20), 1GbE(2)

- **Power Optimized**
  - <10W at 1GHz nominal temp
  - Advanced power optimization including Smart Reflex
TMS320C6670 Functional Diagram

- **Cores & Memory**
  - 4 C66x DSP 1GHz-1.2GHz
  - 153 GMACs, 76 GFLOPS
  - 6MB on chip memory w/ECC

- **Multicore Infrastructure**
  - Navigator with 8k queues, 1600 MIPS
  - Non blocking Network on Chip
  - Multicore Shared Memory Controller reduce external memory access latency

- **Switches**
  - 1GbE: 2 external port switch

- **Network, Transport**
  - Crypto: IPsec, ESP, AH Tunneling, SRTP
  - Packet Acceleration – Multiple IP Addr, 1.5Mpps @ full wire-rate, QoS support

- **Physical Layer Acceleration**
  - Accelerate 2G/3G/4G wireless communication signal chain

- **Connectivity – 118Gbps**
  - HyperLink(50), PCIe(10), SRIO(20), CPRI/OBSAI(36), 1GbE(2)

24mm x 24mm package
TMS320C6655/57

- **Cores & Memory**
  - 1 or 2 C66x DSP at 850MHz, 1GHz & 1.25GHz
  - 80 GMACs, 40 GFLOPS
  - 3MB on chip memory w/ECC

- **Multicore Infrastructure**
  - Navigator with 8k queues, 1600 MIPS
  - Non blocking Network on Chip
  - Multicore Shared Memory Controller reduce external memory access latency
  - 36bit DDR3 with ECC at 1333MHz, 8GB addressable external memory

- **Communication Acceleration**
  - 1xTCP3 – Turbo Decoder
  - 2xVCP2 – Viterbi Decoder

- **Connectivity – 81Gbps**
  - HyperLink(50), PCIe(10), SRIO(20), 1GbE(1)

- **Power Optimized**
  - 2.5W C6655 and 3.5W C6657 @ 1.0GHz at 85C case temperature
  - Advanced power optimization including Smart Reflex
  - -55C to 100C Extended temperature options

*21mm x 21mm package*
KeyStone II
66AK2H12/06

- **Cores & Memory**
  - 4x/8x C66x DSP up to 1.2GHz
  - 2x/4x ARM Cortex A15 up to 1.4GHz
  - 18MB on chip memory w/ECC
  - 2 x 72 bit DDR3 w/ECC, 10GB addressable memory

- **Multicore Infrastructure**
  - Navigator with 16k queues, 3200 MIPS
  - 2.2 Tbps Network on Chip
  - 2.8 Tbps Shared Memory Controller

- **Switches**
  - 1GbE: 4 external port switch

- **Network, Transport**
  - 1.5 Mpps @ full wire-rate
  - Crypto: 6.4 Gbps, IPsec, SRTP
  - Accelerate layer 2,3 and transport

- **Connectivity – 134Gbps**
  - HyperLink(100), PCIe(10), SRIO(20), 1GbE(4)
AM5K2E04/02

- **Cores & Memory**
  - 4x/2x Cortex A15 1.25GHz – 1.4GHz
  - 6MB on chip memory w/ECC
  - 72 bit DDR3/3L w/ECC, 8GB addressable memory

- **Multicore Infrastructure**
  - Navigator with 16k queues, 3200 MIPS
  - 2.2 Tbps Network on Chip
  - 2.8 Tbps Shared Memory Controller

- **Switches**
  - 1GbE: 8 external port switch
  - 10GbE: 2 external port switch

- **Network, Transport**
  - 1.5 Mpps @ full wire-rate
  - Crypto: 6.4 Gbps, IPsec, SRTP
  - Accelerate layer 2,3 and transport

- **Connectivity – 94Gbps**
  - HyperLink(50), PCIe(20), 10GbE(20), 1GbE(4)

- **Power Optimized**
  - 8.1W typical use case at 55C for K2E04
66AK2E02/05

• **Cores & Memory**
  – 1x C66x DSP up to 1.2GHz
  – 1x/4x ARM Cortex A15 up to 1.4GHz
  – 6MB on chip memory w/ECC
  – 72 bit DDR3/3L w/ECC, 8GB addressable memory

• **Multicore Infrastructure**
  – Navigator with 16k queues, 3200 MIPS
  – 2.2 Tbps Network on Chip
  – 2.8 Tbps Shared Memory Controller

• **Switches**
  – 1GbE: 8 external port switch
  – 10GbE: 2 external port switch

• **Network, Transport**
  – 1.5 Mpps @ full wire-rate
  – Crypto: 6.4 Gbps, IPsec, SRTP
  – Accelerate layer 2,3 and transport

• **Connectivity – 98Gbps**
  – HyperLink(50), PCIe(20), 10GbE(20), 1GbE(8)

• **Power Optimized**
  – 8.6W typical use case at 55C for K2E05
# High Performance DSP Roadmap

## Performance, Scalable Solutions

<table>
<thead>
<tr>
<th>Processor</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6678/4/2/1</td>
<td>1x/2x/4x/8x C66x 1.25GHz, 8MB of L2 PCIe, GbE, SRIO 24 x 24mm</td>
</tr>
<tr>
<td>C6657</td>
<td>1x/2x C66x 1.25 GHz, 3MB L2 PCIe, USB, GbE, SRIO 21 x 21mm</td>
</tr>
<tr>
<td>OMAP L138</td>
<td>1x ARM A9, 456 MHz 1xC674x, 456 MHz EMAC, USB2, TDM 13mm², 16mm²</td>
</tr>
<tr>
<td>C6748</td>
<td>1xC674x, 456 MHz EMAC, USB2, McASP 13mm², 16mm²</td>
</tr>
</tbody>
</table>

## Next Mid-Range Processor
- Multicore ARM and DSP
- Industrial control and communications

## Next High End Multicore
- High performance Multicore ARM + DSP
- Large L2, 2x DDR4
- High speed serial I/O

## Next High End Multicore
- Small-form factor
- High performance

## Next DSP Low
- Multicore ARM and DSP devices
- Industrial, Audio and Communications

## Future DSP Low
- Low Power DSP only
- Industrial comms, Audio
High Performance ARM Roadmap

Next High End Multicore
- High performance Multicore ARM + DSP
- Large L2, 2x DDR4
- High speed serial I/O

Next Mid-Range Processor
- Multicore ARM and DSP
- Industrial control and communications

66AK2H12/06
- 2x/4x ARM A15, 1.4 GHz
- 4x/8x C66x, 1.2GHz
- 18MB on chip memory
- PCIe, USB, GbE, SRIO

66AK2E05
- 4 ARM A15, 1.4 GHz
- 1 C66x, 1.2 GHz
- PCIe USB, 10GbE

AM5K2E 04/02
- 2x/4x ARM A15 cores
- 1.4 GHz, 4MB of L2
- PCIe, USB, 10GbE

Next ARM uP - Low
- ARM Cortex A15 device
- Industrial, Audio and Communications

Performance, Scalable Solutions

2013 2014 Future
Improved DSP Interface with RapidIO

- Direct DSP-to-DSP interconnect with optional local Host / ASIC communication
- Used in complete baseband processor card
- ASIC used for custom applications
- Based upon MAC processing needed optional HOST processor is used