Multi-Computing
PC Card

Architectural Decisions
Part 1 Controller Selection

Janicki Tomasz
Agenda

1. MCPCC General Idea(s)
2. Controller Selection Criteria(s)
3. Controller Selection Summary
4. OMAP – L138
5. Future Plans – What's next
1. MCPCC General Idea(s)

- To work as stand-alone board or as a PC card (PCI Express)
- As low-cost as possible (thus not super-computing)
- To communicate over (various) digital interfaces
- Functional–educational platform
  - HDL implementations
  - Embedded programs (systems) implementations
  - Digital Signal Processing
- If possible – Not one high speed controller but Cluster
## 2. Controller Selection – table

### Taken into consideration

<table>
<thead>
<tr>
<th>Freescale</th>
<th>Analog Devices</th>
<th>Texas Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ColdFire</td>
<td>AduC*</td>
<td>MSP430</td>
</tr>
<tr>
<td>i.MX</td>
<td>Blackfin</td>
<td>C2000</td>
</tr>
<tr>
<td>PowerQUICC</td>
<td>SHARC</td>
<td>Stellaris</td>
</tr>
<tr>
<td>QorIQ</td>
<td>SigmaDSP</td>
<td>TMS570LS</td>
</tr>
<tr>
<td>8xxx,7xxx,7xx,6xx</td>
<td>TigerSHARC</td>
<td>Sitara</td>
</tr>
<tr>
<td>5xx/5xxx</td>
<td>ADSP-21xx</td>
<td>C6000</td>
</tr>
<tr>
<td>StarCore</td>
<td></td>
<td>DaVinci</td>
</tr>
<tr>
<td>Symphony</td>
<td></td>
<td>OMAP</td>
</tr>
<tr>
<td>Onyx</td>
<td></td>
<td>C5000</td>
</tr>
<tr>
<td>DSC*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2. Controller Selection – criteria 1/7

- **Efficient 32-bit computing (only)**
- **Free (Integrated) Development Environment**
- **Low-cost ICE (OCD)**
- **Effective Cluster Connection**
- **Available documentation**
- **Interfaces**
- **Price**
- **Availability**

### Assumption of (32-bit) digital computing and processing
- No need for analog interfaces
- Efficient architecture (DSP, but lacks interfaces)
- Interesting digital interfaces (PCI, Eth, USB, ...)

### GNU Toolchain (at present GCC 4.4.4)
- ARM (exclude M4, M0, A5, 1156t2f-s)
- Power (every may work as generic)
- ColdFire
- Blackfin (exclude bf; 561, 504, 506, 535)

### Code Composer Studio (with XDS100)
- TMS320C; 28xx, 54xx, 55xx, 674x, 64x+, ARM; 9, Cortex A8, Cortex R4
- TI web site says also: OMAP and DaVinci

<table>
<thead>
<tr>
<th>Freescale</th>
<th>Analog Devices</th>
<th>Texas Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ColdFire (V4, ex. 5445x)</td>
<td>Blackfin (ex: 561, 504, 506, 535)</td>
<td>Sitara</td>
</tr>
<tr>
<td>i.MX</td>
<td></td>
<td>C6000</td>
</tr>
<tr>
<td>PowerQUICC</td>
<td></td>
<td>DaVinci</td>
</tr>
<tr>
<td>QorIQ</td>
<td></td>
<td>OMAP</td>
</tr>
<tr>
<td>8xxx,7xxx,7xx,6xx,5xx,5xxx</td>
<td></td>
<td>C5000</td>
</tr>
</tbody>
</table>
Efficient 32-bit computing (only)

Free (Integrated) Development Environment

Effective Cluster Connection

Available documentation

Interaces

Computing Power

Price

Availibility

Low-cost ICE (OCD)

Efficient ICE (OCD)

Efficient 32-bit computing (only)

Free (Integrated) Development Environment

Effective Cluster Connection

Available documentation

Interaces

Computing Power

Price

Availibility

Low-cost ICE (OCD)

• ColdFire
  – Turbo BDM Light Coldfire (TBLCF)
  – CodeSource support (GNU toolchain)

• ARM (JTAG)
  – Simple LPT ↔ JTAG (circa 20euro)
  – OpenOCD + CodeSourcery (Open Source)

• ARM (via USB or UART if bootloader)
  – CodeSourcery

• Blackfin
  – gnICE, gnICE+, IGLOO (60euro)
  – Analog Open Source Koop (GNU toolchain)

• Code Composer Studio !!!
  – with XDS100 (60euro)
2. Controller Selection – criteria 3/7

- **ColdFire**
  - 10/100 (Fast Ethernet) x2

- **i.MX**
  - 10/100 (Fast Ethernet)

- **Blackfin**
  - SPORT (100Mbps), 10/100 Ethernet, Host DMA Port

- **Texas Instruments**
  - Ethernet 10/100 (/1000), Host Port Interface, uPP

## Interfaces
- ColdFire (V4, ex. 5445x)
- i.MX

## Price
- Blackfin (ex: 561, 504, 506, 535)

## Availability
- Sitara
- C6000
- DaVinci
- OMAP
- C5000
2. Controller Selection – criteria 4/7

- **ColdFire (27$ max)**  
  - FPU
  - 2x 10/100 Ethernet, PCI v2.2, 99 GPIO
  - 32-bit 133 MHz DDR/SDR-SDRAM Controller

- **i.MX (25$ max)**  
  - FLASH boot
  - 10/100 Ethernet, PATA, USB, LCD controller, 2D 3D graphics accelerator (up to WXGA)
  - mDDR and DDR2 SDRAM, 16/32-bit, 200MHz, SLC/MLC NAND flash, 8/16-bit

- **Blackfin (24$ max)**  
  - Possible flash integration
  - Ethernet, USB, Host DMA port
  - Async, SDRAM, Mobile SDRAM, NAND Flash
  - SDIO, ATAPI, USB, Host DMA port (no Ethernet)
  - Async, DDR, Mobile DDR, NAND Flash

---

<table>
<thead>
<tr>
<th>Freescale</th>
<th>Analog Devices</th>
<th>Texas Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ColdFire (547x, 548x)</td>
<td>Blackfin (ex: 561, 504,506,535)</td>
<td>Sitara</td>
</tr>
<tr>
<td>i.MX (27x,35x,37x,51x)</td>
<td></td>
<td>C6000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DaVinci</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OMAP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C5000</td>
</tr>
</tbody>
</table>
2. Controller Selection – criteria 5/7

- **Efficient 32-bit computing (only)**
- **Free (Integrated) Development Environment**
- **Effective Cluster Connection**
- **Availible documentation**
- **Interfaces**
- **Price**
- **Availibility**
- **Low–cost ICE (OCD)**

### Sitara (AM1808 9$ max :D)
- USB 2.0, EMAC, HPI, SATA, LCD Controller, VPIH, uPP, McBSP
- Async SRAM, DDR2, NAND Flash, NOR, SDRAM

### C6000
- TMS320C6424 35$ max :D
  - Ethernet, PCI, HPI,
  - Async SRAM, DDR2 SDRAM, NAND Flash
- TMS320C6748 19$ max :D
  - Ethernet, USB, SATA, HPI, VPIF, upp
  - Async SRAM, DDR2 NAND Flash, NOR, SDRAM

### OMAP (L138 C674x + ARM9 max 20$ :D)
- Ethernet, HPI, LCD controller, uPP, VPIF, SATA, USB
- Async SRAM, SDRAM, DDR2, NAND Flash, NOR

### Interfaces
- **Freescale**
  - ColdFire (547x, 548x)
  - i.MX (27x, 35x, 37x, 51x)
- **Analog Devices**
  - Blackfin (ex: 561, 504, 506, 535)
- **Texas Instruments**
  - Sitara (AM1808)
  - C6000 (C6424, C6748)
  - DaVinci
  - OMAP (L138)
2. Controller Selection – criteria 6/7

- **Effective Cluster Connection**
- **Available documentation**
- **Efficient 32-bit computing (only)**
- **Free (Integrated) Development Environment**
- **Low-cost ICE (OCD)**
- **Interfaces**
- **Price**
- **Availibility**

### DaVinci
- **Hard. (video and image) accelerators**
  - DM3x (ARM) DM368 DM365 (35$ max)
    - HPI, Ethernet, (however ADC)
  - DM643x (DSP) max 29$
    - PCI, Ethernet, HPI
  - DM644x (ARM9 + C64x+) 37$ max
    - HPI, Ethernet, ATA
  - DM64x (DSP) DM647 (55$) DM648 (75$)
    - Ethernet 1000, PCI, HPI 32-bit, SGMII
  - DM646x (ARM9 + C64x+) 117$ (T) (max 94$)
    - ATA, Ethernet 1000, HPI 32–bit, PCI, video interfaces

*All support DDR2 and more...*

<table>
<thead>
<tr>
<th>Freescale</th>
<th>Analog Devices</th>
<th>Texas Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ColdFire (547x, 548x)</td>
<td>Blackfin (ex: 561, 504, 506, 535)</td>
<td>Sitara (AM1808)</td>
</tr>
<tr>
<td>i.MX (27x,35x, 37x,51x)</td>
<td></td>
<td>DaVinci</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OMAP (L138)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## 2. Controller Selection – criteria 7/7

<table>
<thead>
<tr>
<th>CPU</th>
<th>$</th>
<th>Freq.</th>
<th>MMAC</th>
<th>MEM [kB] DSP, RISC</th>
</tr>
</thead>
<tbody>
<tr>
<td>547x</td>
<td>27</td>
<td>266</td>
<td>------</td>
<td>(L1) 32, (L2) 32 (SRAM) 32</td>
</tr>
<tr>
<td>i.mx</td>
<td>25</td>
<td>800</td>
<td>------</td>
<td>(L1) 32, (L2) 32 (SRAM) 128</td>
</tr>
<tr>
<td>Blackfin</td>
<td>24</td>
<td>600</td>
<td>1200</td>
<td>(L1) 148, (L2) 256, poss. Flash</td>
</tr>
<tr>
<td>AM1808</td>
<td>9</td>
<td>456</td>
<td>------</td>
<td>(L1) 32, (L2) 128, (ROM) 64</td>
</tr>
<tr>
<td>C6424</td>
<td>35</td>
<td>700</td>
<td>5600</td>
<td>(L1) 112, (L2) 128</td>
</tr>
<tr>
<td>C6748</td>
<td>19</td>
<td>300</td>
<td>2400</td>
<td>(L1) 64, (L2) 256, (ROM) 1024</td>
</tr>
<tr>
<td>L138</td>
<td>20</td>
<td>300 - 300</td>
<td>2400</td>
<td>(L1) 64, (L2) 256, (ROM) 1024</td>
</tr>
<tr>
<td>DM643x</td>
<td>29</td>
<td>700</td>
<td>5600</td>
<td>(L1) 112, (L2) 128, (ROM) 64</td>
</tr>
<tr>
<td>DM644x</td>
<td>37</td>
<td>594 - 297</td>
<td>4752</td>
<td>(L1) 112, 40, (L2) 64, (ROM) 0, 16</td>
</tr>
<tr>
<td>DM64x</td>
<td>75</td>
<td>900</td>
<td>7200</td>
<td>(L1) 64, (L2) 512, (ROM) 64</td>
</tr>
<tr>
<td>DM646x</td>
<td>94</td>
<td>1000 - 500</td>
<td>8000</td>
<td>(L1) 64,56 (L2) 128 (ROM) 0, 8</td>
</tr>
</tbody>
</table>
3. Controller Selection Summary

- Maximum functionality – DaVinci Family
- Maximum computing power – DaVinci Family
- Middle Solution in functionality – OMAP Family
- Middle Solution DSP – DM643x Family
- Low cost and functional – AM18x Family
- Low cost DSP – TMS320C674x Family

For those that were taken into consideration
(1) Note: Not all peripherals are available at the same time due to multiplexing.
5. Future Plans – What's next

- More detailed research on OMAP – L138
  - application notes, user guides, online trainings

- Research on USB, PCI express, SATA interfaces
  - electrical layer, layout guidelines

- Determining the architecture of MCPCC
  - selection of Peripherals and FPGA
  - efficient cluster connection
Thank you

tomasz.janicki.tj@gmail.com