EtherBone – A Network Layer for the Wishbone SoC Bus

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Overview

1. What is Wishbone?
2. Remote Wishbone
3. EtherBone vs The Establishment
4. EtherBone Applications
5. EtherBone Packet Layout
6. EtherBone Architecture
7. Conclusion
What is Wishbone?
What is Wishbone?

System-on-Chip (SoC) bus

- Connects modules inside an FPGA
- Simple Interface
- Ver. B4 supports pipelined streaming
- OpenSource, no royalties
What is Wishbone?

So it's ...

- Powerful
- Easy to use

- and confined to the chip
But why stop at the FPGA's borders?
Towards new shores

- Wishbone goes remote
Remote Wishbone

We want to talk to...

- FPGAs
- MCUs
- CPUs
- all of them, no matter what distance
Remote Wishbone

We want to be...

- as transparent as possible
- as fast as possible
- as versatile as possible
- low in protocol overhead
Remote Wishbone

What Interface and Protocol are suitable for those requirements?

- Network Interface
  - Routable Transport Protocol (no custom)
  - Streaming Protocol
  - WB Operation Protocol
Remote Wishbone

Wishbone
Remote Wishbone  

Wishbone + Ethernet
Remote Wishbone

Wishbone

+ Ethernet

+ IP
Remote Wishbone

Wishbone + Ethernet + IP + UDP
Remote Wishbone

- Wishbone
- + Ethernet
- + IP
- + UDP
- + A Packet format
Remote Wishbone

Wishbone
+ Ethernet
+ IP
+ UDP
+ A Packet format
+ Some Tricks
Remote Wishbone

Wishbone
+ Ethernet
+ IP
+ UDP
+ A Packet format
+ Some Tricks

EtherBone
The little differences

- EtherBone vs The Establishment
Established Protocols:

- CORBA
- SOAP
- RDMA
- Myrinet
EtherBone vs The Establishment

Established Protocols:

- CORBA
- SOAP
- RDMA
- Myrinet
EtherBone vs The Establishment

Established Protocols:

- **CORBA**
- **SOAP**
- **RDMA**
- **Myrinet**
EtherBone vs The Establishment

Established Protocols

- CORBA
- SOAP
- RDMA
So why not just use RDMA?
EtherBone vs RDMA

EtherBone:
- Any Ethernet hardware
- WB Bus
- Fidelity / Transparency
- Focus on latency
- Determinism

(fast) RDMA:
- Custom Hardware
- Any Bus
- Only Data, no bus syntax
- Focus on bandwidth
- Non-Deterministic
EtherBone vs RDMA

EtherBone:
• Any Ethernet hardware
• WB Bus
• Fidelity / Transparency
• Focus on latency
• Determinism

5,000 new FAIR & CERN timing nodes like this.
Where the bones are buried

- EtherBone Applications
EtherBone Applications

EtherBone is very close to hardware.
We could...
EtherBone Applications

... be very fast indeed

- Control Systems
- Timing Systems
EtherBone Applications

... make WB cores not even see it's there

- (almost) transparent bridges
- Easy Hardware to Hardware Connection
- Easier Software to Hardware Connection
EtherBone Applications

... build cool remote toys

• In-System-Programmer
• JTAG Debugger
• Logic Analyser
• Boundary Scan Interface
EtherBone Applications

Types of EtherBone nodes and their compatibility
Bone structure

- EtherBone Architecture
EtherBone Architecture

SW/HW EtherBone Nodes
EtherBone Architecture
EtherBone Architecture

Ethertype Architecture

EtherBone Hardware Slave
Wrapped up nicely

- EtherBone Packet Layout
# EtherBone Packet Layout

<table>
<thead>
<tr>
<th>Field</th>
<th>Offset (bits)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magic</td>
<td>0-23</td>
<td>0xE6F</td>
</tr>
<tr>
<td>Version</td>
<td>8-11</td>
<td>8-11</td>
</tr>
<tr>
<td>AddrSz</td>
<td>12-14</td>
<td>Address size</td>
</tr>
<tr>
<td>PortSz</td>
<td>15</td>
<td>Port size</td>
</tr>
</tbody>
</table>

- Potential padding to 64-bit alignment
# EtherBone Packet Layout

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Magic (0x4E6F)</td>
</tr>
<tr>
<td>12</td>
<td>Version</td>
</tr>
<tr>
<td>8</td>
<td>AddrSz</td>
</tr>
<tr>
<td>4</td>
<td>PortSz</td>
</tr>
<tr>
<td>0</td>
<td>Potential padding to 64-bit alignment</td>
</tr>
</tbody>
</table>

- **EB Packet Hdr**
  - EB CAF
  - EB RFP
  - EB WPE

- **EB Record Hdr**
  - EB CAF
  - EB RFP
  - EB WPE

- **EB CAF**
  - EB WCount
  - EB RCount

- **EB RFP**
  - EB WCount
  - EB RCount

- **EB WPE**
  - EB WCount
  - EB RCount
EtherBone Packet Layout

```
+-------+-------+-------+-------+-------+-------+-------+-------+
| Magic (0x4E6F) |     |     |     |     |     |     |     |
| Version | AddrSz | PortSz |     |     |     |     |     |
| WCount  | RCount |     |     |     |     |     |     |
| EB Hdr  |     |     |     |     |     |     |     |
| EB Record Hdr |     |     |     |     |     |     |     |
| WCount ≠ 0 |     |     |     |     |     |     |     |
+-------+-------+-------+-------+-------+-------+-------+-------+
|     |     |     |     |     |     |     |     |
| BaseWriteAddr |     |     |     |     |     |     |
| WriteVal 1 |     |     |     |     |     |     |
|     |     |     |     |     |     |     |     |
| WriteVal M |     |     |     |     |     |     |     |
```
EtherBone Packet Layout

- Magic (0x4E6F)
- Version
- AddrSz, PortSz
- Potential padding to 64-bit alignment
- EB PacketHdr
- EB RecordHdr
- WCount ≠ 0
- RCount ≠ 0
- WCount
- RCount
- BaseWriteAddr
- WriteVal 1
  ...
- WriteVal M
- BaseRetAddr
- ReadAddr 1
  ...
- ReadAddr N

EB Record (Repeats)
Playing tricks on packets

- EtherBone Transmission
EtherBone Transmission

Request
EtherBone Transmission

Request

*Magic (0x4E6F)*

*Version* 

*AddrSz*  

*PortSz*

*Potential padding to 64-bit alignment*

- BaseWriteAddr
- WriteVal 1
- ...
- WriteVal M
- BaseRetAddr
- ReadAddr 1
- ...
- ReadAddr N

*EB PacketHdr*

*EB RecordHdr*

*WCount ≠ 0*

*RCount ≠ 0*

---

Reply

*Magic (0x4E6F)*

*Version* 

*AddrSz*  

*PortSz*

*Potential padding to 64-bit alignment*

- BaseWriteAddr
- WriteVal 1
- ...
- WriteVal M

*EB PacketHdr*

*EB RecordHdr*

*WCount ≠ 0*

*RCount ≠ 0*
EtherBone Transmission

A salute to symmetry:
Know the length, know it all

✔ IP length field
✔ IP checksum
✔ UDP length field
✔ UDP checksum = 0
EtherBone in a nutshell

- Conclusion
Conclusion

EtherBone is ...

- low level
- an (almost) transparent bus bridge
- available in software and HDL
- good for time critical applications
- enabling remote embedded tools
Questions and Answers

Questions

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Thank you

For your time and attention