Message Signalled Interrupts in Mixed-Master Control

Wesley W. Terpstra
GSI, Germany
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What is FAIR?
Where is the ring?
What controls it?
What is inside it?

- This talk: the links between cores
What is Wishbone?

- Wishbone: synchronous parallel bus
- Simple master-slave connections only
What is Wishbone?

- Wishbone: synchronous parallel bus
- Simple master-slave connections only
WB bus is extended using crossbars

- A crossbar acts as a network switch
- Slave ports for masters and master ports for slaves
Big systems have multiple crossbars

- Our timing receivers contain ~50 WB components
- Nesting crossbars is a useful organizational tool
What's the problem?

- In Wishbone, all communication initiated by master
- Sometimes slaves must tell the master they have data
  - Help! I'm on fire!
Approach: Classic interrupts

- Slaves connected to a predetermined master
- Interrupt priorities fixed at design-time (shared line)
- Master must query all slaves to find source

⇒ Cheap, but ... Not composable
Approach: Message Signalled (MSI)

- Invert Wishbone bus
  - Slaves send messages to masters
  - Address selects master
Requirements for Using MSI

- MSI-enabled masters provide
  - A slave link to the MSI bus
  - A range of addresses to receive MSIs
    - potentially with different priority queues

- MSI-enabled slaves provide
  - A master link to the MSI bus
  - For each type of MSI message (burning / ready / full)
    - A register to select which address receives it
    - A register to enable the MSI
MSI is composable

- Masters set address in slave's MSI target address register
  - Slaves can notify any master which controls them

- Masters have thousands of “interrupt target addresses”
  - Can immediately distinguish source of MSI
  - Can prioritize MSIs by choosing destination queue

- Composable: plug crossbars together
Addressing and SDB

- To find slaves, masters recursively search SDB
- Slaves addresses differ as seen from different masters
- Addresses describe a path, not a destination
• In MSI bus, master address differs from slave PoV
• When masters scan bus, also scan backwards path
  → address slaves need to send master MSI
  → constructed bottom-up
WB+MSI well suited for complex buses

- Wishbone scales well, from 2- to 50-component systems
- MSI expands bus composability to interrupts
- SDB must be extended with master records