An FPGA-based Prototyping Platform for Research in High-Speed Interprocessor Communication


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Key Features (First System)

• Remote DMA (RDMA) based operation
• Notifications: departure and/or arrival, interrupt or enqueue
• Remote Enqueue for short messages, multiple senders
• Credit-based flow control: lossless communication
• Per-destination Virtual Output Queues (VOQ’s): flow isolation
• Extensive event logging, debugging & performance counters
• Switch:
  – 8x8 implementation – 32-bit datapath @78.125 MHz
  – achieved up to 16x16 – 16-bit dpth @156.25MHz to fit in FPGA
• Linux already adapted for this platform (kernel-mode comm.)
• MPI port for this platform under way
Hardware Development Cost (1st System, 2 versions)

- Buf. Crossbar Switch (6pm)
- Multipath Routing (10pm)
- RocketIO Links (10pm)
- Second Version PCI-X (12pm)
- Multiple VOQs (6pm)
- Demo Evaluation
- First Version (plain PCI) (20pm)

2004 2005 2006

pm = person-months
NI Photo, with 4 RocketIO links
NI Architecture

- 64-bit PCI-X @100MHz to Host
- Per-dest. DMA request Q’s
- Per-destination VOQ’s
- DMA segmentation into packets
- Link bundling: $4 \times 2.5 = 10$ Gb/s
  - inverse multiplexing
  - multipath routing
- Out-of-order packet arrivals:
  - DMA body immediately written into memory
  - headers wait in resequ. Q’s
  - nxt sys: just count # bytes
  - notify completion after resequ. / count complete
  - resequ. tolerates 1-pck loss
PowerPC

On-chip, @ 266MHz

DRAM

On-chip, (fast, on-chip, up to 306 KB)

NI must be simple and small compared to CPU and its local memory

BRAM

Network

10 Gb/s

10 Gb/s

NI

OCM

PLB

128b @ 156 MHz

128b @ 133 Mhz

32b x 2 @ 133 MHz

3 × SATA running @ 2.5 Gbps + 1 × SMA @ 2.5 Gbps
Next-Generation System Node (Xilinx Univ.Pr.)

- Three high current power supplies with continuous monitoring
- Platform Flash for storing FPGA configurations
- USB2 port for FPGA configurations
- Compact flash card port for FPGA config and removable storage
- PS/2 mouse and keyboard port
- RS-232 serial port
- Additional I/O via four 60-pin headers
- Power connector and switch
- XSGA Video Port
- SATA connectors for Gigabit serial I/O
- 10/100 Ethernet MACPHY
- Stereo audio via AC97 codec
- High-speed expansion connector compatible with Digilent boards
- Buttons, switches, and LEDs
- Low-speed expansion connector compatible with Digilent boards
- DDR SDRAM DIMM slot holds up to 2GBBytes
- Virtex-II Pro XC2VP30 FPGA
- SystemACE chip for Compact Flash I/O