Fourth Gigabit Kits Workshop
January 10, 2001

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Agenda

Wednesday, January 10
8:30 Gigabit Kits Program Update -- Jon Turner, WashU
9:00 Adaptive Network Processing -- Bobby Bhattacharjee, Univ. of Maryland
9:40 Distributed Computing over APIC DMA -- Ron Srodawa, Oakland Univ.
10:10 Break
10:40 The CoE in ATM and Broadband Networks at the University of Cape Town -- Sven Shepstone, University of Cape Town
11:20 Design of a Multiservice Router -- Fred Kuhns, Washington University
12:00 Lunch and Demonstrations
1:15 Linux Driver Status & User-Mode Interface -- Berkley Shands, WashU
1:45 Network Management and Visualization -- Ken Wong, WashU
2:15 A WUGS-20 Monitoring Tool with a Graphical User Interface -- Wei Deng, WashU
2:45 Break
3:15 Smart Port Card Software -- John Dehart, WashU
3:45 The Field Programmable Port Extender -- John Lockwood, WashU
4:20 Mobility Support in Edge Routers -- Michael Eyrich, Tech. Univ. Berlin
APIC Status

- APIC Linux driver released and (apparently) working well.
- NetBSD driver continues to work well.
- Continuing development and use of user-level library.
- No new problems with APIC hardware.
- Known bugs.
  - wrong word order on receipt -- fix is software word-swapping in driver
  - interrupt register startup problem
    - fixed with external logic on APIC NIC
    - ignored on SPC
  - system crashes sometimes with very heavy input load

Smart Port Card Status

- Embedded Pentium module provides active processing.
  - 167 MHz, 64 MB DRAM
  - 32 bit PCI at 33 MHz
  - dual RS-232 ports for debugging
- System FPGA.
  - BIOS startup functions, interrupt controller, programmable timer
- SPC now fully operational.
  - bug in Intel module power circuit
  - new modules received from Intel and SPC now works well
  - have built 100 for kits users
  - expect to ship remainder soon
  - still looking at options for SPC 2
ATM Signalling Software

- Limited progress since last time.
  - staff turn-over
  - current focus on Jammer & Switch Controller to WUGS-160
- Leverages existing public domain software:
  - Naval Research Lab’s Proust for PNNI signalling and network-side processing of UNI signalling protocol
    - extended to provide WUGS switch control functions
    - have demonstrated operation in simple multi-switch configurations
    - planning to add general multicast features
  - Linux ATM software for end-system signalling
    - ATM support now part of standard kernel
    - Simple application completed to demonstrate usage
    - Works with ENI NIC and with APIC/Linux driver
    - need to add support for multicast
  - NRL’s SEAN package for end-system signalling
    - platform and OS independent, user-level library and daemon
    - running on NetBSD with ENI NICs and with APIC
    - need to add support for multicast

Field Programmable Port Extender (FPX)

- Network Interface Device (NID) provides access to cells.
- Reprogrammable Application Device (RAD):
  - large Xilinx/Virtex gate array, probably Virtex 2000E
  - ample, fast off-chip memory
  - can be reprogrammed for variety of functions
- Status
  - 5 boards have been built
  - testing underway - so far, so good
  - focus on design environment for supporting plugin development
  - IP address lookup and packet reassembler ready to test
  - SDRAM interface completed
- Partial reprogramming
  - allows independent modules to be loaded into RAD while system is running
- Plan to build 75 copies for distribution.
  - this spring

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Control Processor

- global coordination & control
- routing protocols
- builds routing tables and other SPCs

Active Packet Processing

Washington Univ. Multiservice Router

Smart Port Card
- 64 MB DRAM
- 64-bit Video
- Pentium Processor
- APIC

ATM Switch Core
- Embedded Processors
- Transmission Interfaces

Control Processor
- Switch Fabric
- SPC
- Smart Port Card
- Pentium
- Cache

Active Packet Processing

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Distributed Queue Management

- Rate adjustment frequency limited by reporting overhead.
  - For 64 port OC-48 router, 200 μs update period yields 5% overhead
  - Update period corresponds to 60 KB of data at 2.4 Gb/s

Distributed Queueing in Software

<table>
<thead>
<tr>
<th>User Space</th>
<th>SW Interrupt</th>
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<tbody>
<tr>
<td>HW Interrupt for APIC</td>
<td>SW Interrupt</td>
</tr>
</tbody>
</table>

Interrupt

Manage pacing and implement Distributed Queueing

Hardclock at 100 μs
Fast Path Throughput Results

![Graph showing Fast Path Throughput Results](image)

- **Input Rate (Kpackets/s)**
  - 0
  - 50
  - 100
  - 150
  - 200
  - 250

- **Forwarded Rate (Kpackets/s)**
  - 0
  - 50
  - 100
  - 150
  - 200
  - 250

- **NetBSD throughput**

Adding Programmable Hardware

![Adding Programmable Hardware](image)

- **Field Programmable Port Extenders**

Field Programmable Port Extenders
**“Vanilla” Packet Processing**

- Control Processor
- Field Programmable Port Ext.
- NID
- RAP
- TI
- SPC
- FPX
- OPP
- IPP

**Active Packet Processing**

- Control Processor
- Smart Port Card
- Sgs. FPGA
- APIC
- Pentium Cache
- TI
- SPC
- FPX
- OPP
- IPP
Scaling up

System chassis
- 8 IO modules
- 4 SE2 boards
- backplane

- Includes hardware assist for reliable multicast
- Convert line card to router by augmenting
  » embedded processor module
  » large FPGA

3 stage network
64 ports @ 2.4 Gb/s ea.
dynamic load balancing
binary replication &
range copy multicast

Recent Active Networks Demo

from Princeton

WV Plugin

Filter & Mon.

WU Routers
to GATech

WUStl video display

Princeton

WV Source

WV Plugin

Filter & Mon.

from Princeton

Xtraffic 1

Xtraffic 2,3

S/Abilene

1/11/01
Quo Vadis

- Are workshops useful?
  - limited “user” participation (talks, demos)
  - should we focus entirely on tutorials (MSR, “re-runs”)
  - how about coaching sessions?
  - should we drop to once a year?

- New hardware components
  - more SPCs (done that, could still do more)
  - SPC version 2
  - APIC NICs with OC-12 interfaces (possibly dual?)
  - switch line card with dual OC-12 interfaces
  - Switch line card with gig-Ethernet interface

- Need input from you guys!!!