Network Processor: Architecture and Applications

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Outline

- Overview of Network Processors
- Network Processor Architectures
- Applications
- Case Studies
  - Wireless Mesh Network
  - a Content-Aware Switch
- Conclusion
Packet Processing in the Future Internet

Future Internet

More packets & Complex packet processing

ASIC

General-Purpose Processors

- High processing power
- Support wire speed
- Programmable
- Scalable
- Optimized for network applications
- …
What is Network Processor?

- Programmable processors optimized for network and protocol processing
  - High performance
  - Programmable & Flexible
  - Optimized for packet processing
- Main players: AMCC, Intel, Hifn, Ezchip, Agere

## Commercial Network Processors

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Product</th>
<th>Line speed</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMCC</td>
<td>nP7510</td>
<td>OC-192/10 Gbps</td>
<td>Multi-core, customized ISA, multi-tasking</td>
</tr>
<tr>
<td>Intel</td>
<td>IXP2850</td>
<td>OC-192/10 Gbps</td>
<td>Multi-core, h/w multi-threaded, coprocessor, h/w accelerators</td>
</tr>
<tr>
<td>Hifn</td>
<td>5NP4G</td>
<td>OC-48/2.5 Gbps</td>
<td>Multi-threaded multiprocessor complex, h/w accelerators</td>
</tr>
<tr>
<td>EZchip</td>
<td>NP-2</td>
<td>OC-192/10 Gbps</td>
<td>Classification engines, traffic managers</td>
</tr>
<tr>
<td>Agere</td>
<td>PayloadPlus</td>
<td>OC-192/10 Gbps</td>
<td>Multi-threaded, on-chip traffic management</td>
</tr>
</tbody>
</table>
Typical Network Processor Architecture

Network Processor

SDRAM (e.g. packet buffer)  SRAM (e.g. routing table)

Co-processor  H/w accelerator

Network interfaces  Bus
Intel IXP2400 Network Processor
Snapshots of IXP2xxx Based Systems

ADI Roadrunner Platform
- IPv4 Forwarding/NAT
- Forwarding w/ QoS / DiffServ
- ATM RAN
- IP RAN
- IPv6/v4 dual stack forwarding

Radisys ENP2611 PCI Packet Processing Engine
- multiservice switches,
- routers, broadband access devices,
- intrusion detection and prevention (IDS/IPS)
- Voice over IP (VoIP) gateway
- Virtual Private Network gateway
- Content-aware switch
Intel IXP425 Network Processor

Media Independent Interface

HSS-0  HSS-1  UTOPIA 2

WAN/Voice NPE
UTOPIA (Max 24 xDSL PHYs)
AAL, HSS, HDLC

Ethernet
NPE A
 Ethernet MAC

Ethernet
NPE B
 Ethernet MAC
 SHA-1/MD5,
DES, 3DES, AES

133 MHz Advanced High-Performance Bus

Arbiter

Queue
Manager
8-KB SRAM

SDRAM
Controller
8 MB-256 MB

32-bit

32-bit

133 MHz Advanced High-Performance Bus

Bridge

Queue
Status
Bus

Arbiter

PCI
Controller

Exp. Bus
Controller

32-bit

16-bit

Intel XScale® Core
266/400/533 MHz
32-KB Data Cache
32-KB Instruction Cache
2-KB Mini-Data Cache

Intel XScale® Core
266/400/533 MHz
32-KB Data Cache
32-KB Instruction Cache
2-KB Mini-Data Cache

Test Logic
Unit

PMU
(AHB)

USB
Controller

GPIO
Controller

UART
921Kbaud

Interrupt
Controller

Timers

66 MHz
Advanced Peripheral Bus

UART
921Kbaud

16 Pins

JTAG

PCI
Controller

Exp. Bus
Controller

16-bit

32-bit

10/25/06
StarEast: IXP425 Based Multi-radio Platform
Applications of Network Processors

- DSL modem
- Wireless router
- VoIP terminal
- Printer server
- Core router
- Edge router
- VPN gateway
Case Study 1: Wireless Mesh Network
Software Stack on StarEast

**Customer Applications**

**Seamless Networking**

**Mesh**

**Cognitive Radio**

**Radio Network Middleware**

**ARA/RAL (Radio/MAC Abstraction Layer)**

**User**

**Kernel**

**Bootloader (Redboot)**

**Stareast Hardware Platform**

**XP425 Access Library**

**Cardbus**

**Intel (PCI-PCI)**

**miniPCI**

**loctl**

**HostAP**

**Driver**

**FW/unicode**

**Card**

**Intel PRO-100**

**NPE A**

**NPE B**

**USB Slave**

**Netgear WAG511**

**Intel PRO-100**

**Intel 2200L**

**NPE A**

**NPE B**

**UART**

**Intel PRO100**
Case Study 2: Content-aware Switch

- Front-end of a Web cluster, only one Virtual IP
- Route packets based on Layer 5 information
  - Examine application data in addition to IP & TCP
- Advantages over layer 4 switches
  - Better load balancing: distributed based on content type
  - Faster response: exploit cache affinity
  - Better resource utilization: partition database