# Router Architectures

An overview of router architectures.

## Introduction

***What is a Packet Switch?***

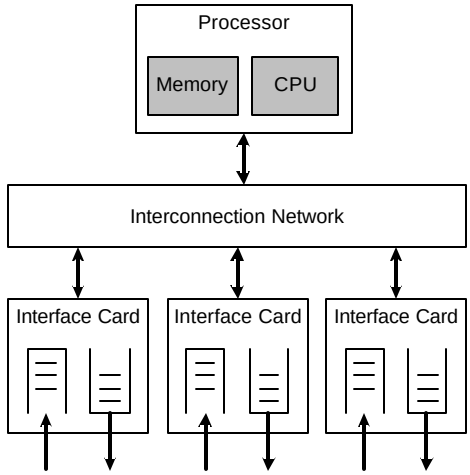
- Basic Architectural Components
- Some Example Packet Switches
- The Evolution of IP Routers

# Router Components

- Hardware components of a router:
  - Network interfaces
  - Interconnection network
  - Processor with a memory and CPU

- **PC router:**
  - interconnection network is the (PCI) bus and interface cards are NICs
  - All forwarding and routing is done on central processor

- **Commercial routers:**
  - Interconnection network and interface cards are sophisticated
  - Processor is only responsible for control functions **(route processor)**
  - Almost all forwarding is done on interface cards

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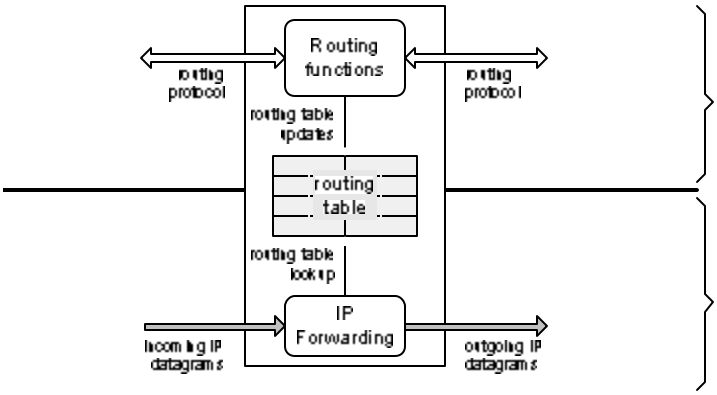
# Functional Components




**Control**

**Datapath:** per-packet processing

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## Routing and Forwarding

Routing functions include:

- route calculation
- maintenance of the routing table
- execution of routing protocols

- On commercial routers handled by a single general purpose processor, called *route processor*

IP forwarding is per-packet processing

- On high-end commercial routers, IP forwarding is distributed
- Most work is done on the interface cards

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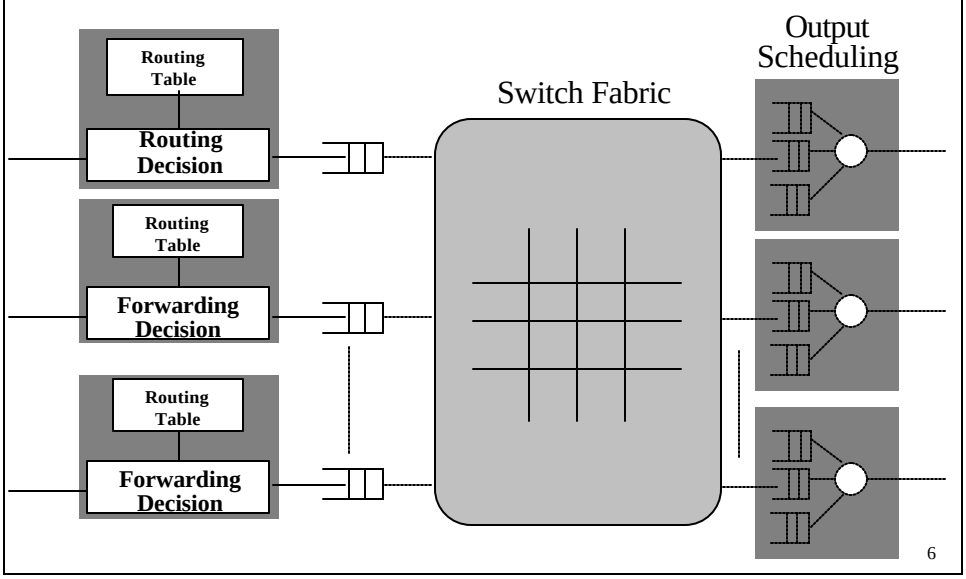
## Basic Architectural Components

***Per-packet processing***

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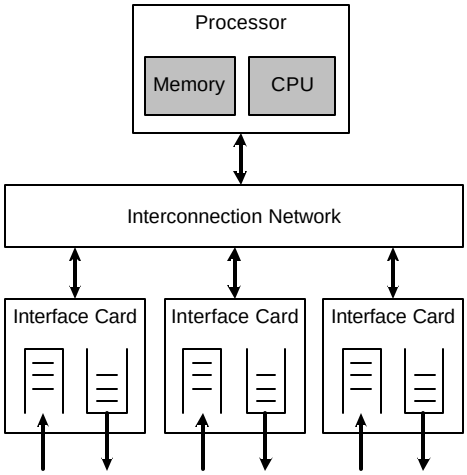
# Router Components

- **On a PC router:**
  - interconnection network is the (PCI) bus
  - Interface cards are NICs (e.g., Ethernet cards)
  - All forwarding and routing is done on central processor
- **On Commercial routers:**
  - Interconnection network and interface cards can be sophisticated
  - Central processor is the route processor (only responsible for **control functions**)

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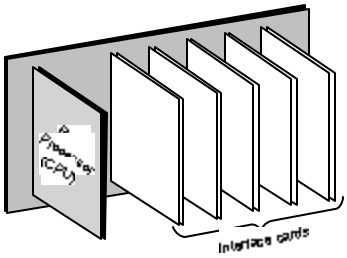
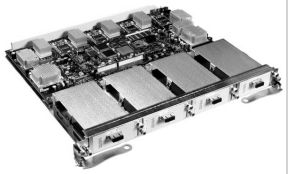
# Slotted Chassis



- Large routers are built as a slotted chassis
  - Interface cards are inserted in the slots
  - Route processor is also inserted as a slot
- This simplifies repairs and upgrades of components

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## Evolution of Router Architectures

- Early routers were essentially general purpose computers
- Today, high-performance routers resemble supercomputers
  - Exploit parallelism
  - Special hardware components

- Until 1980s (1st generation): standard computer
- Early 1990s (2nd generation): delegate to interfaces
- Late 1990s (3rd generation): Distributed architecture
- Today: Distributed over multiple racks

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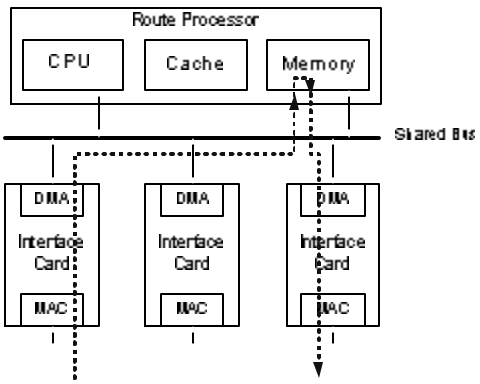
## 1st Generation Routers

- This architecture is still used in low end routers

- Arriving packets are copied to main memory via direct memory access (DMA)
- Interconnection network is a backplane (shared bus)
- All IP forwarding functions are performed in the central processor.
- Routing cache at processor can accelerate the routing table lookup.

- Drawbacks:
  - Forwarding Performance is limited by CPU
  - Capacity of shared bus limits the number of interface cards that can be connected

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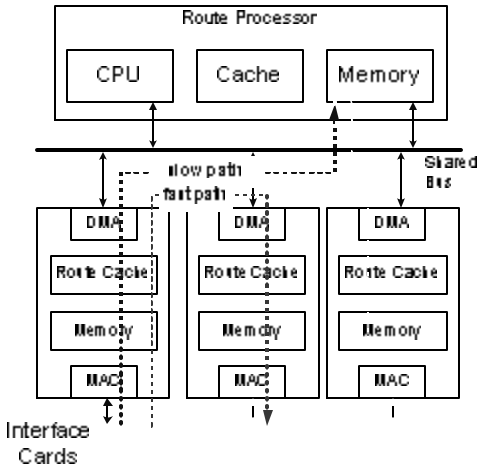
Route Processor
CPU
Cache
Memory
Shared Bus
slow path
fast path
DMA
DMA
DMA
Route Cache
Route Cache
Route Cache
Memory
Memory
Memory
MAC
MAC
MAC
Interface Cards

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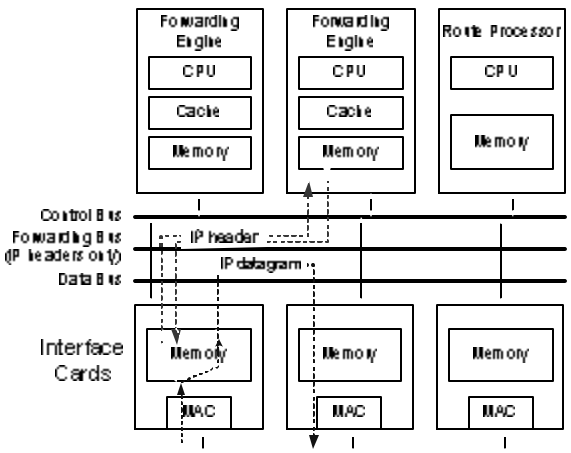
Forwarding Engine
Forwarding Engine
Route Processor
CPU
CPU
CPU
Cache
Cache
Memory
Memory
Memory
Control Bus
Forwarding Bus (IP headers only)
Data Bus
IP header
IP datagram
Interface Cards
Memory
Memory
Memory
MAC
MAC
MAC

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# 3rd Generation Architecture

- Interconnection network is a switch fabric (e.g., a crossbar switch)
- **Distributed architecture:**
  - Interface cards operate independent of each other
  - No centralized processing for IP forwarding
- These routers can be scaled to many hundred interface cards and to aggregate capacity of > 1 Terabit per second