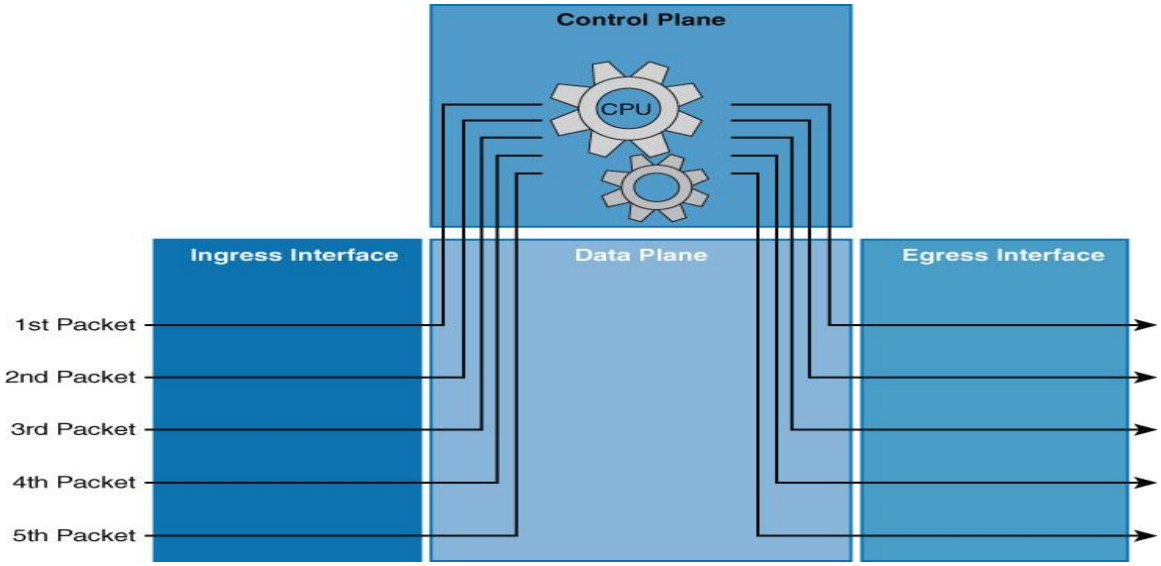
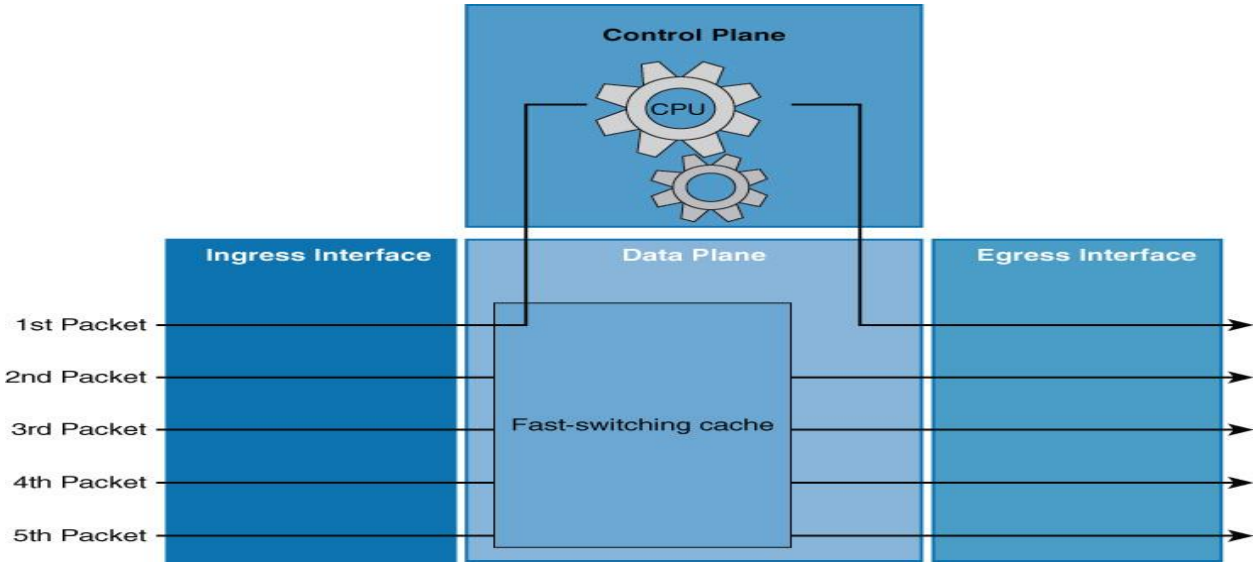
Process Switching:

- Process Switching is primary function of forwarding the packets to the destination.
- The Process switching, also referred to as Software Switching or called Slow Path.
- Process Switching is responsible for inspecting every single packet by the processor.
- Process switching requires CPU to be personally involved with every forwarding decision.
- The ip input process runs on general-purpose CPU for processing incoming IP packets.
- All packets examined by CPU & all forwarding decisions are made in software very slow.
- Software Switching is significantly slower than the switching done in the hardware.
- Process switching requires CPU to be personally involved with every forwarding decision.
- Router looks on destination IP address, compare it with routing table next hop address.



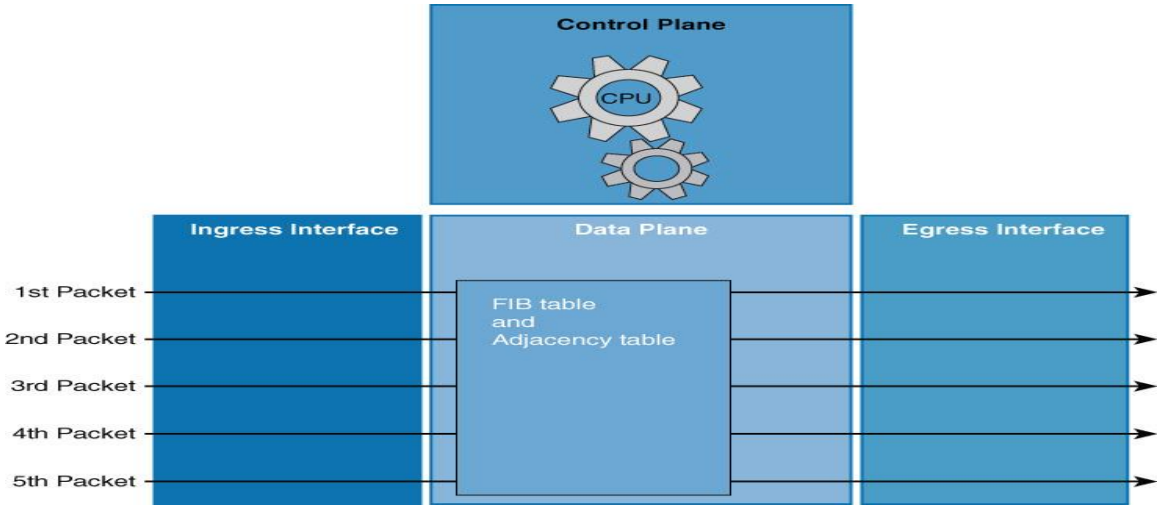
Fast Switching (Route Caching):

- Fast Switching improves on process switching by making use of a cache concept.
- In Fast Switching, the first packet to a destination is Process Switched method.
- But subsequent packets are forwarded using the information stored in fast cache.
- First packet in flow is examined by CPU; the forwarding decision is cached in hardware.
- When another packet going to same destination, next hop info can be reused from cache.
- So, the processor does not have to look up and assemble all the information again.



CEF (Cisco Express Forwarding):

- CEF is a Cisco term, which is stand for Cisco Express Forwarding (CEF).
- Router perform multiple steps before forward packet check routing table lookup.
- Router must perform multiple steps includes ARP table lookup, ACLs checkup, etc.
- If the Cisco Network Router do all of these in the software, process will be very slow.
- Cisco Express Forwarding is Packet-Switching technique used within the Cisco Routers.
- Purpose of CEF is to optimize forwarding of packets & increase packet switching speed.
- Prior to CEF there were 2 methods for packet-switching Process and Fast-Switching.
- The first method, Process-Switching is oldest and slowest method to process the packets.
- In short, in Process-Switching method, the CPU is involved in every forwarding decision.
- With fast-switching, CPU is still used to determine destination, but only for initial packet.
- The Info is stored with fast-switching cache, Subsequent packets are switched using cache.
- If router receiving high volume of traffic to destinations not yet in cache, CPU still consume.
- To overcome the problems with Process-Switching and Fast-Switching the CEF was created.
- CEF is built around 2 main components - Forwarding Information Base & Adjacency Table.
- CEF put all this info into single hardware table which allows very fast packet forwarding.
- CEF is a feature that allows a Router to very quickly and efficiently make a route lookup.
- Cisco Express Forwarding is enabled by default & CEF also called topology-based switching.
- Only Cisco Multilayer switches or Layer 3 switches and the Cisco routers use CEF method.

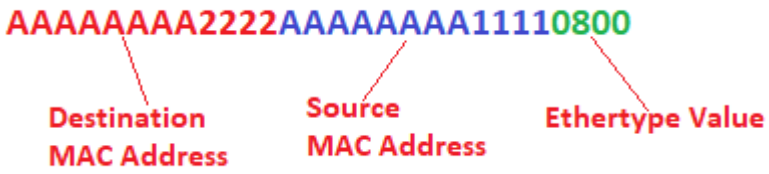


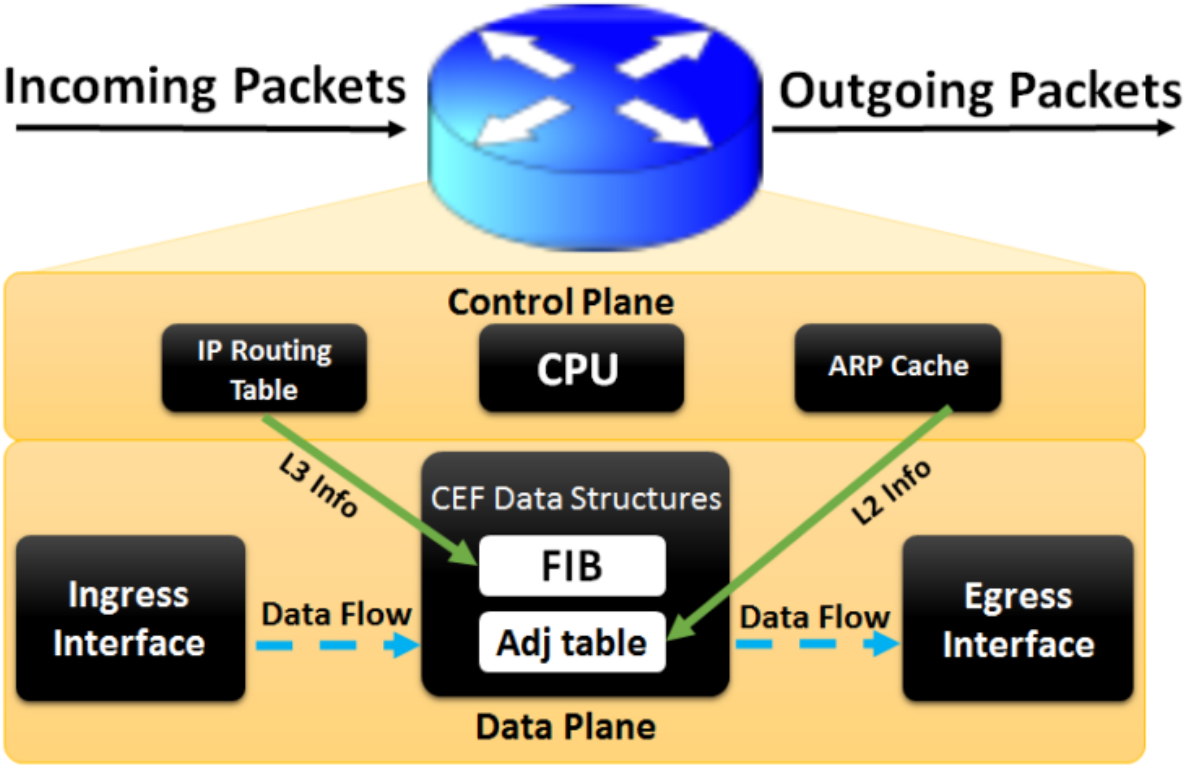
FIB:

- Forwarding Information Base (FIB) maintains Layer 3 forwarding information.
- It maintains mirror image of forwarding information contained in the IP routing table.
- Forwarding Info Base is used to make IP destination prefix-based switching decisions.
- FIB maintains next-hop address information based on information in the IP routing table.
- FIB table contains destination reachability information as well as the next hop information.
- This FIB information is then used by the Cisco Network router to make forwarding decisions.
- FIB contains interface identifier & next hop info for each reachable destination network.
- The FIB contains destination reachability information as well as next hop information.
- FIB contains necessary info from the routing table, stripping out unneeded information.
- FIB remove unnecessary stuff like Administrative Distances, Metrics, Age of Routes, Tags.
- In addition, known /32 next hop and /32 local interfaces are stored in the FIB tables.

Adjacency Table:

- The adjacency table, also known as the Adjacency Information Base (AIB) table.
- The Adjacency table maintains Layer 2 information for next hops listed in the FIB table.
- To avoid need for an Address Resolution Protocol (ARP) request for each table lookup.
- The adjacency table is tasked with maintaining the layer 2 next-hop information for the FIB.
- Adjacency table maintains layer 2 or switching information linked to a particular FIB entry.





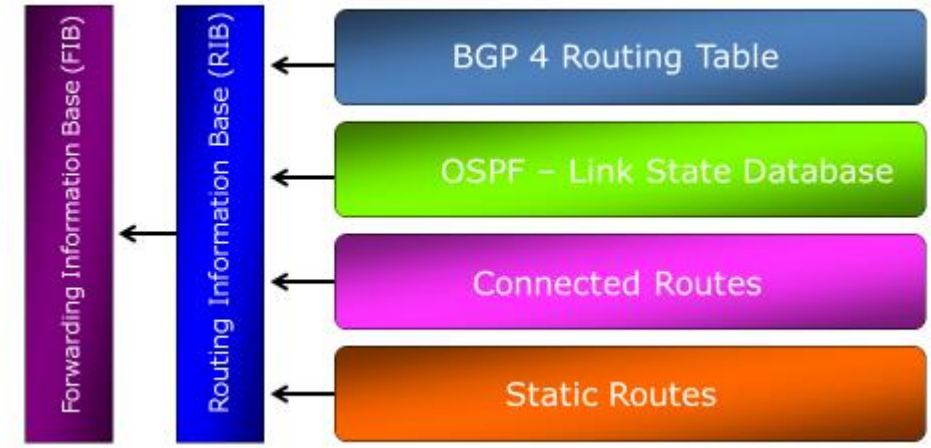
Step by step procedure of how CEF handles packets that enter the Router.

1. Once the packets arrives at the Router, its layer 2 information is stripped off.
2. This is normal procedure that happens whenever a frame is accepted to layer 3 device.
3. Router looks up destination using CEF table, even 1st packet router does not reach CPU.
4. Cisco Express Forwarding (CEF) handles all the packets as they enter the interface.
5. Cisco Network Router finds the corresponding adjacency table entry for Layer 2 info.
6. Router then adds corresponding Layer 2 info back to the packet & forwards the packets.

Commands	Description
R1(config)# ip cef	Globally enables CEF
R1(config)# interface f0/0 R1(config-if)# ip route-cache cef	Enter Interface mode Enables CEF on an interface
R1(config)# interface f0/0 R1(config-if)# ip route-cache	Enter Interface mode Enable Fast-Switching on an interface
R1(config)# interface f0/0 R1(config-if)# no ip route-cache	Enter interface mode Enable Process Switching on an interface
R1# show ip interface interface-id	Interface info include packet switching mode
R1# show ip cef	Displays the contents of a router's FIB
R1# show adjacency [detail]	information contained in the adjacency table
R1# show adjacency summary	Check how many adjacencies we have
R1# debug ip packet [detail]	Check real time IP packet details

RIB:

- The Routing Information Base RIB is where all IP Routing information is stored.
- The routing table, also known as the Routing Information Base (RIB) table.
- RIB built from dynamic routing protocols & directly connected & static routes.
- RIB is the repository where all the routing protocols place all of their routes.
- Routes are insert into RIB when routing protocol running on router learns route.
- Routing Information Base (RIB), Where routing table is built- in Control Plane.




```
R1#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set                    RIB (Routing Information Base )

      1.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        1.1.1.0/24 is directly connected, Loopback1
L        1.1.1.1/32 is directly connected, Loopback1
      11.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        11.11.11.0/24 is directly connected, Loopback2
L        11.11.11.11/32 is directly connected, Loopback2
      192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.12.0/24 is directly connected, FastEthernet0/0
L        192.168.12.1/32 is directly connected, FastEthernet0/0
```

```
R1#show ip cef
Prefix              Next Hop            Interface
0.0.0.0/0           no route
0.0.0.0/8           drop
0.0.0.0/32          receive
1.1.1.0/24          attached            Loopback1
1.1.1.0/32          receive             Loopback1
1.1.1.1/32          receive             Loopback1
1.1.1.255/32        receive             Loopback1
11.11.11.0/24       attached            Loopback2
11.11.11.0/32       receive             Loopback2
11.11.11.11/32      receive             Loopback2
11.11.11.255/32     receive             Loopback2
127.0.0.0/8         drop
192.168.12.0/24     attached            FastEthernet0/0
192.168.12.0/32     receive             FastEthernet0/0
192.168.12.1/32     receive             FastEthernet0/0
192.168.12.2/32     attached            FastEthernet0/0
192.168.12.255/32   receive             FastEthernet0/0
224.0.0.0/4         drop
224.0.0.0/24        receive
240.0.0.0/4         drop
255.255.255.255/32  receive
```

FIB - Forward Information base

In first column there are IP address and subnet mask combinations, that exist in our topology, and there are some additional prefixes that provide default functionality.

The second column contains the “Next Hop” value. The most familiar of these may be where the next hop is an IP address.

Drop means that any packet that match destination ip address or subnet entry will be dropped.

Attached simply means that the ip address or subnet in that entry is locally connected.

Receive means that any packet that match the destination ip address or subnet in that entry will be forwarded to the supervisor engine for processing.

Prefix: 0.0.0.0/0 | Next Hop: no route

This means that R1 has no route to 0.0.0.0/0, In other words, R1 doesn't have a default route.

Prefix: 0.0.0.0/8 , 127.0.0.0/8 , 224.0.0.0/4 , 240.0.0.0/4 | Next Hop: drop

Any packet destined to 0.x.x.x , 127.x.x.x or packets destined to any address ranging from 224.0.0.0 to 239.255.255.255 (multicast) and 240.0.0.0 to 255.255.255.254 (reserved) will be dropped. Prefix 224.0.0.0/4 will change from drop to multicast once enable multicast routing.

Prefixes with a Next Hop of "receive"

Any packet matched with receive entry will be considered by the receiving router to be destined locally (to itself) and it will not route the packet elsewhere.

Prefix: 1.1.1.0/24 , 11.11.11.0/24 , 192.168.12.0/24 , 192.168.12.2 | Next Hop: attached

This simply means that the networks 1.1.1.0/24 , 11.11.11.0/24 , 192.168.12.0/24 , and the address of 192.168.12.2 is directly connected.

```
R1#show adjacency detail
Protocol  Interface                 Address
IP        FastEthernet0/0           192.168.12.2(7)
                                    0 packets, 0 bytes
                                    epoch 0
                                    sourced in sev-epoch 0
                                    Encap length 14
AAAAAAAA2222AAAAAAAA11110800        AAAAAAAA2222AAAAAAAA11110800
                                    L2 destination address byte offset 0
                                    L2 destination address byte length 6
                                    Link-type after encap: ip
                                    ARP
```

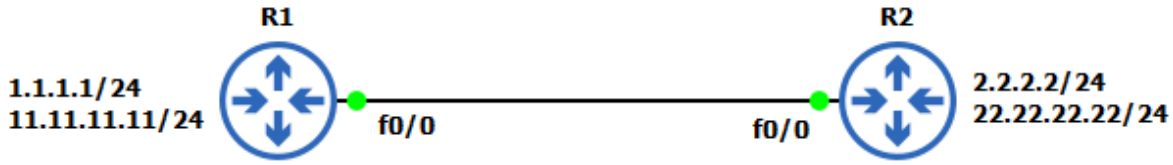
Destination MAC Address

Source MAC Address

Ethertype Value

Only have one next hop – 192.168.12.2 – the R2 end of the shared link.

The long alphanumeric in the middle starting AAAA, this string contains the destination and source MAC addresses, and finally an ethertype of 0800 which is tagged on the end. if using IPv4 then it will always 0800.



Commands	Description
R2#show proc cpu | inc IP Input	Verify CPU load for IP Input Fast Switching
R2#show ip cache	Display fast Switching table
R2#show ip int f0/0	Display fastethernet 0/0 details
R2(config)#interface f0/0 R2(config-if)#no ip route-cache	Enter Interface mode Disable fast switching also CEF on given interface
R2(config)#ip multicast-routing	Enable Multicasting on router
R2#debug ip cef receive	Enable debugging for CEF receive packets