Redes de Dados II

3º Ano

Licenciatura em Engenharia Informática

acunha@utad.pt

1

Protocolo EIGRP

Enhanced Interior Gateway Routing Protocol

2

EIGRP (protocolo proprietário Cisco)

- Desenvolvido em 1985 para
  - ultrapassar o limite de 15 hops do RIP (v1)
- Protocolo do tipo
  - Misto: distance vector / linkstate
- Métricas:
  - Largura de banda;
  - Atraso;
  - Grau de confiança;
  - Carga.
- Suporta autenticação e encriptação.
- Split Horizon and Poison Reverse.
- Usa algoritmo DUAL
  - **D**iffusing **U**pdate **AL**gorithm

EIGRP

- Reliable Transport Protocol (**RTP**)
  - O RTP é utilizado para enviar e receber os pacotes EIGRP
- Pode ser :
  - Na **Entrega confiável**
    - implica a confirmação por parte do destino;
  - Na **Entrega não confiável**,
    - não implica qualquer confirmação.

- Os pacotes podem ser enviados:
  - Por unicast;
  - Por multicast (224.0.0.10).

EIGRP - Cálculo da métrica

Default Composite Formula:
metric = [K1*bandwidth + K3*delay]

Complete Composite Formula:
metric = [K1*bandwidth + (K2*bandwidth)/(256 - load) + K3*delay] * [K5/(reliability + K4)]

(Not used if "K" values are 0)

Default values:
K1 (bandwidth) = 1
K2 (load) = 0
K3 (delay) = 1
K4 (reliability) = 0
K5 (reliability) = 0

"K" values can be changed with the **`metric weights`** command.

```
Router(config-router)#metric weights tos k1 k2 k3 k4 k5
```


EIGRP Vector Metrics

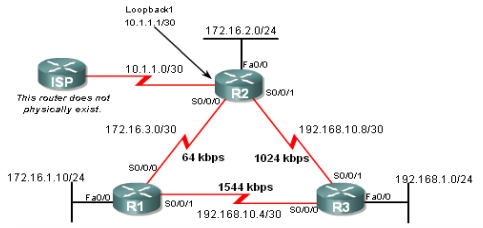
Vector Metric	Description
bandwidth	The minimum bandwidth (Bw) of the route, in kilobits per second. It can be 0 or any positive integer. The bandwidth for the formula is scaled and inverted by using the following formula: Scaled Bw = (10^7/minimum bandwidth (Bw) in kilobits per second)
delay	Route delay, in tens of microseconds. Scaled Delay = (Delay/10)
load	The effective load of the route, expressed as a number from 0 to 255 (255 is 100 percent loading).
reliability	The likelihood of successful packet transmission, expressed as a number between 0 and 255, where 255 means 100 percent reliability and 0 means no reliability.

https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/iproute_eigrp/configuration/15-sy/ire-15-sy-book/ire-wid-met.html

EIGRP – Cálculo da métrica

- Show interfaces
  - permite visualizar as métricas.
- Modificar a largura de banda da interface utiliza-se o comando:
  - Ruter(config-if)#bandwidth kilobits

  (Este comando não altera a velocidade da interface física).
- Verificar a largura de banda:
  - **show interface**

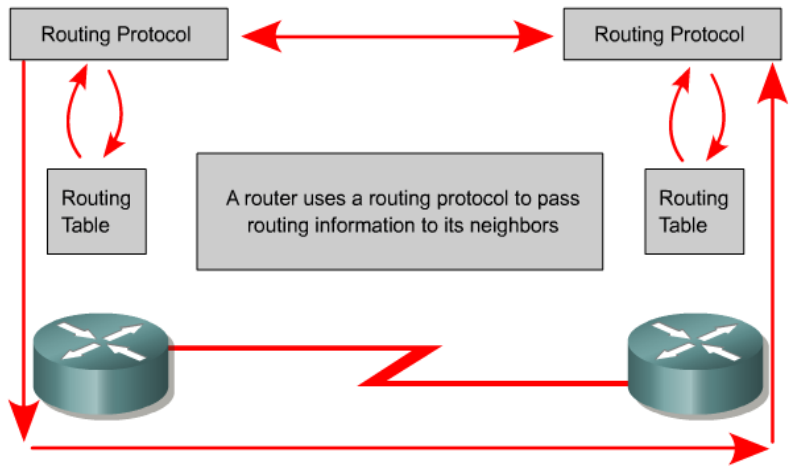



```
R1#show interface serial 0/0/0
Serial0/0/0 is up, line protocol is up
  Hardware is GT96K Serial
  Description: Link to R2
  Internet address is 172.16.3.1/30
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:00, output 00:00:01, output hang never
  Last clearing of "show interface" counters 3d22h
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     112522 packets input, 7303722 bytes, 0 no buffer
     Received 40016 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     112601 packets output, 7280131 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets
     0 output buffer failures, 0 output buffers swapped out
     12 carrier transitions
     DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

usec = microsecond or 1 millionth of a second

Resumo

Encaminhamento Dinâmico



Protocolos RIP

- Protocolo de encaminhamento
  - por Vector de Distância
- Métrica
  - A contagem de hops
- Nº Max de Hops 15,
  - se ultrapassado o pacote é descartado
- As atualizações
  - broadcast a cada 30 segundos

Protocolos - OSPF

- Protocolo de encaminhamento
  - por Link-State – Utiliza LSA
- Protocolo de encaminhamento de padrão aberto
- Usa um algoritmo SPF para calcular o menor custo até um destino
- Quando ocorrem alterações na topologia, há muitas actualizações de encaminhamento

Protocolos IGRP

retirado (protocolo proprietário Cisco)

- Protocolo de encaminhamento
  - por Vector de Distância
- Métrica composta
  - A largura de banda, carga, atraso e confiabilidade
- Actualizações de encaminhamento
  - Broadcast a cada 90 segundos

Protocolos – EIGRP (protocolo proprietário Cisco)

- Protocolo de encaminhamento
  - Por vetor de distância
  - Usa balanceamento de carga com custos desiguais
  - Usa características combinadas do vetor de distância e LSA
  - Usa o DUAL para calcular o caminho mais curto
- As atualizações de encaminhamento
  - *Multicast* usando 224.0.0.10
  - São disparadas por alterações de topologia

Protocolos de encaminhamento - BGP

- Protocolo de encaminhamento exterior
  - por vector de distância
- Usado entre ISP's ou entre ISP's e clientes
- Usado para encaminhar o tráfego de Internet entre Sistemas Autónomos

Encaminhamento

Dinâmico Vs Estático

	Dynamic routing	Static routing
Configuration Complexity	Generally independent of the network size	Increases with network size
Required administrator knowledge	Advanced knowledge required	No extra knowledge required
Topology changes	Automatically adapts to topology changes	Administrator intervention required
Scaling	Suitable for simple and complex topologies	Suitable for simple topologies
Security	Less secure	More secure
Resource usage	Uses CPU, memory, link bandwith	No extra resources needed
Predictability	Route depends on the current topology	Route to destination is always the same

Comparação dos Protocolos

Vector Distância	Estado da Ligação
Visão da topologia de rede do ponto de vista dos vizinhos	Visão geral de toda a topologia de rede
Adição de vectores distância de router em router	Calcula os caminhos mais curtos para os outros routers
Actualizações frequentes e periódicas: Convergência lenta	Actualizações accionada por acontecimentos: Convergência rápida
São passadas cópia das tabelas de encaminhamento aos vizinhos	Passa actualizações do estado das ligações aos outros routers
Os routers calculam as melhores rotas distribuidamente (distâncias são propagadas para os destinos)	Cada router constrói um mapa da rede e calcula localmente a melhor rota através deste mapa

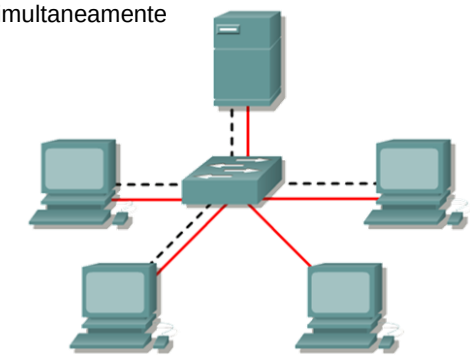
The Various Routing Protocols

Features	RIP v1	RIP v2	IGRP	OSPF	EIGRP
Classful / Classless	Classful	Classless	Classful	Classless	Classless
Metric	Hop	Hop	Composite (bw and delay)	Cost 100,000/BW	Composite (bw and delay)
Periodic Advertisement	30 seconds	30 seconds	90 seconds	none	30 seconds
Advertising Address	255.255.255.255 (broadcast)	224.0.0.9 (multicast)	255.255.255.255 (broadcast)	224.0.0.5 224.0.0.6 (multicast)	224.0.0.10 (multicast)
Administrative Cost	120	120	100	110	Internal: 90 External: 170
Category	Distance Vector	Distance Vector	Distance Vector	Link State	Hybrid

Operações de comutação

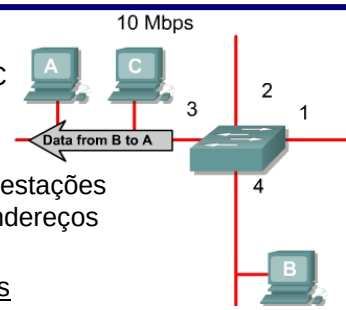
Operações de comutação

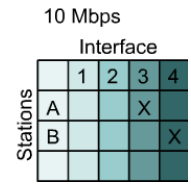
- Comutação numa LAN
  - Permite acesso dedicado
  - Elimina colisões e aumenta a LB disponível
  - Suporta conversas múltiplas simultaneamente



Operação Switch numa LAN

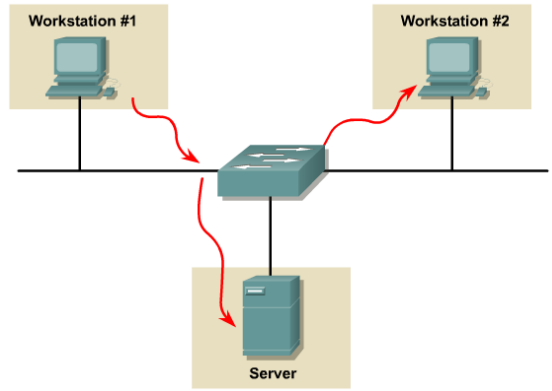
- Redireciona tramas com base nos endereços MAC
- Opera na camada 2 do modelo OSI
- Aprende a existência das estações de trabalho a parir dos endereços de **origem.**
- Envia para <u>todas as portas</u>
  - Broadcast
  - Multicast
  - Endereços desconhecidos
- Encaminha quando o destino se encontra noutro interface





Latency Switch Ethernet

- Tempo de Latência
  - Tempo desde que entra do switch até que sai.

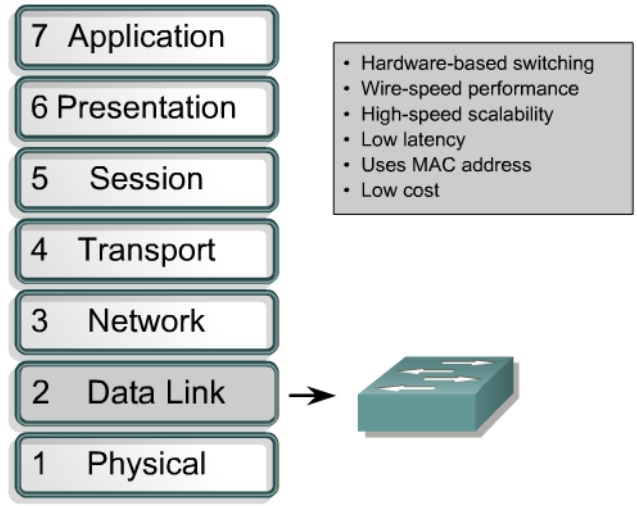


Layer 2 Switching UV Layer 3 Switching

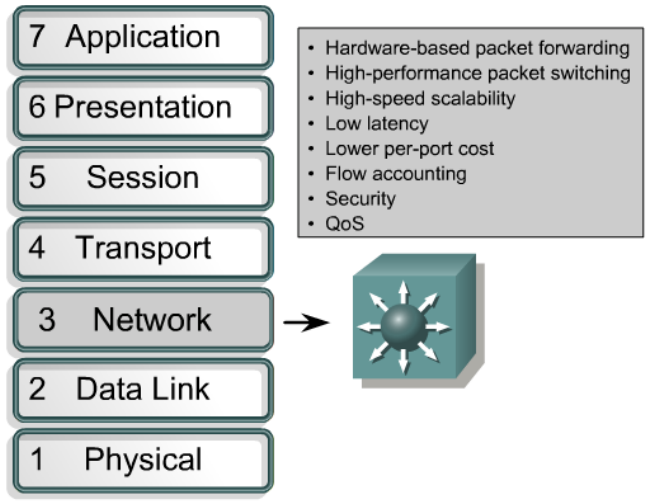
- A diferença está no endereço que é utilizado para determinar o interface correto de saída
  - Layer 2 switching – Endereço MAC
  - Layer 3 switching – Endereço IP

- Comparação
  Switching Layer 3 e Router Switching
  - Diferença está na implementação física, em hardware (ASIC) ou em Software a correr em microprocessadores

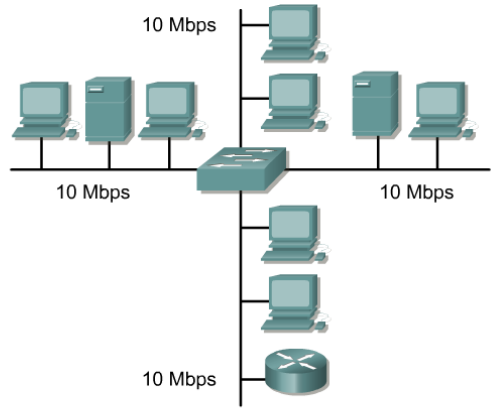
Layer 2 Switching



Layer 3 Switching



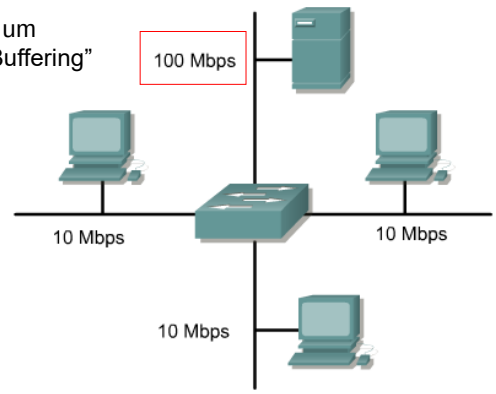
Switching - Simétrico



- Provides switching between like bandwidths (10/10 or 100/100 Mbps)
- Multiple simultaneous conversations increase throughput

Switching - Assimétrico

Requer a utilização de um Switch com “Memory Buffering”



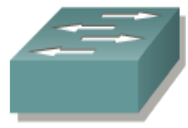
- Provides switching between unlike bandwidths (10/100 Mbps)
- Requires the switch to use memory buffering

Buffer de Memória

- Port-based memory buffering
  - As tramas são guardados em filas que são ligadas a portas de entrada específicas.
  - É possível que **uma só trama bloqueie todas as outras** pacotes porque a sua porta de destino está ocupada (mesmo que os outro pacotes pudessem ser entregues).
- Shared-memory buffering
  - Todas as tramas utilizam uma buffer comum de memória.
  - As tramas na buffer então ligados (mapeados) de forma dinâmica aos portos apropriados de destino.
  - Ajuda o balanço entre portas 10Mbps e 100Mbps.

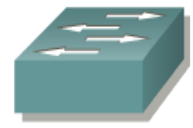
Two Switching Methods

Cut-through



The frame is forwarded through the switch before the entire frame is received.

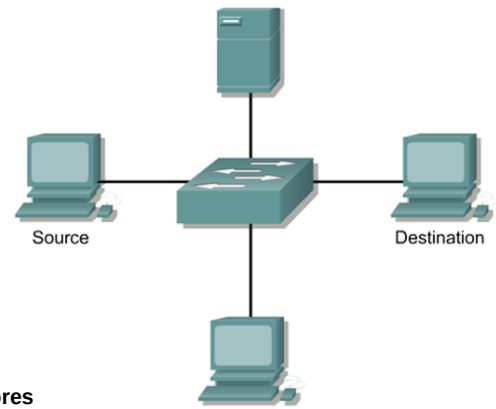
Store-and-forward



Complete frame is received before forwarding.

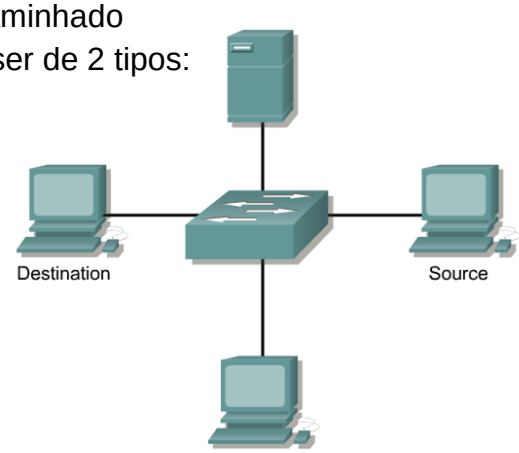
Store-and-forward

- Recebe todo o frame e verifica o CRC
- Se o CRC e o comprimento estão ok, encaminha o frame para o interface de saída.

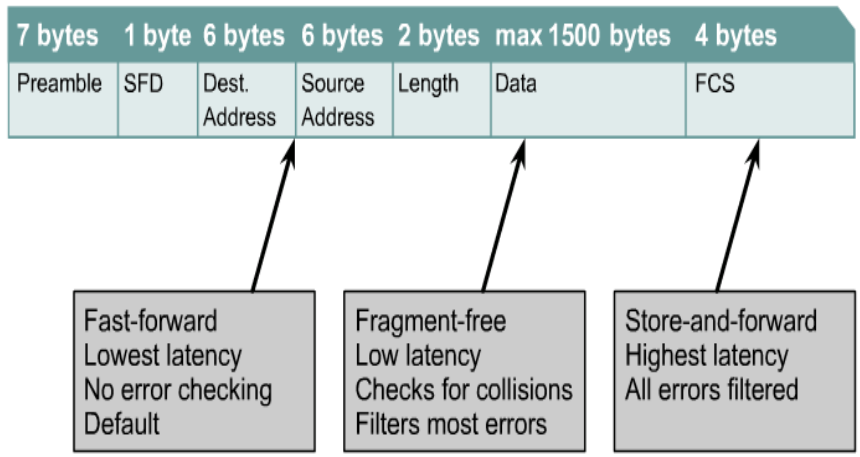


Cut-through

- Encaminha o frame antes de este ser todo recebido
- Pelo menos o endereço de destino tem de ser lido antes do frame ser encaminhado
- Cut-though pode ser de 2 tipos:
  - Fast-forward
  - Fregment-free

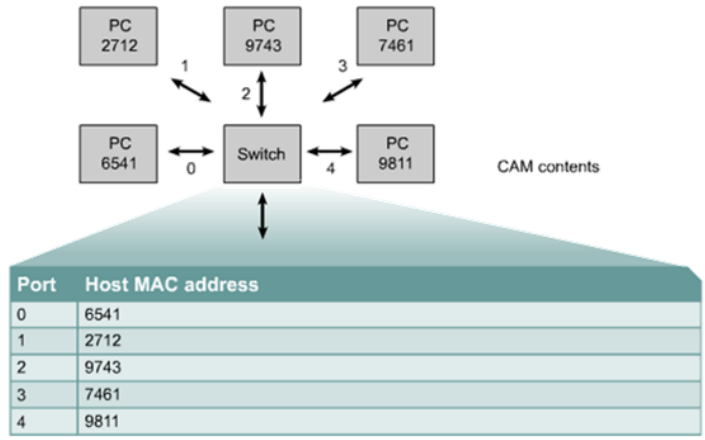


Frame Transmission Modes

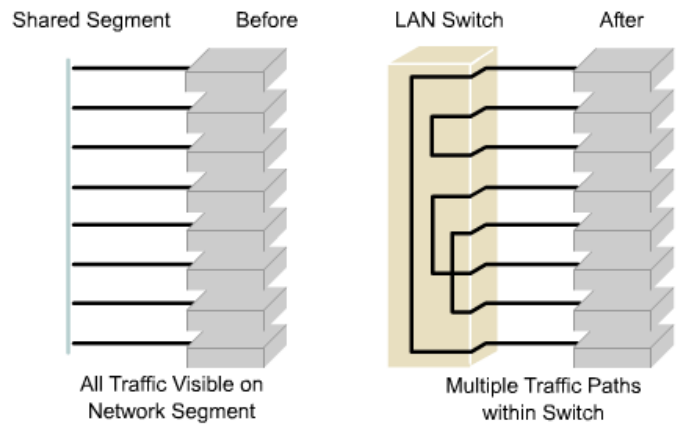


Network Switch Using CAM

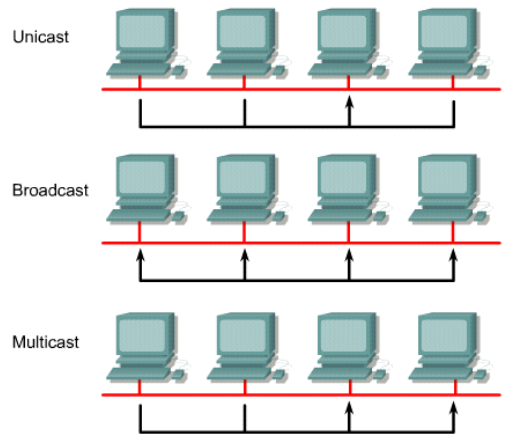
- **CAM** (Content Addressable Memory)
  ou **Mac Address table**



Microsegmentação da Rede



Three Methods of Communication

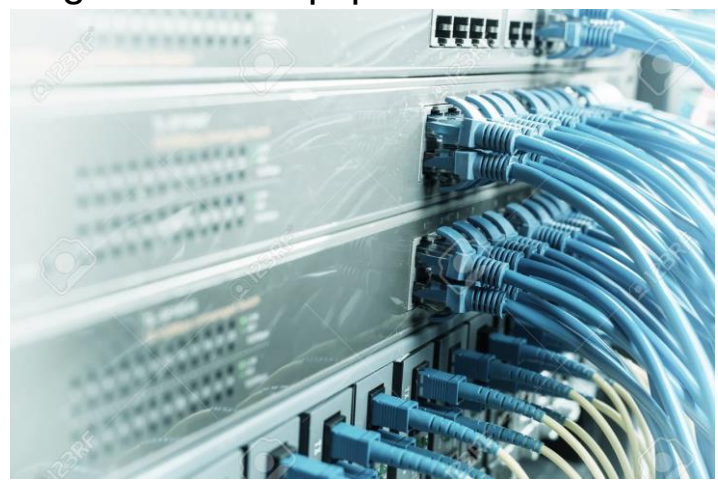


Protocolo de descoberta de vizinhos CDP

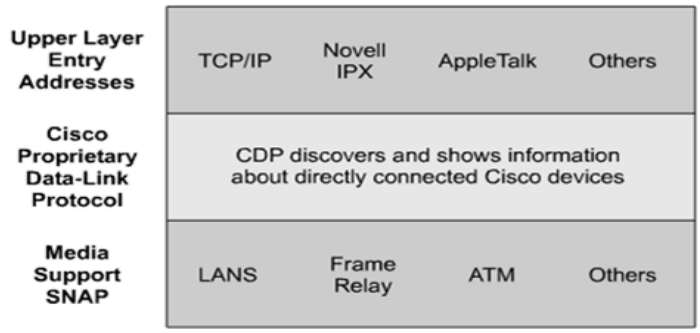
35

Problema:

- A onde ligam estes equipamentos?



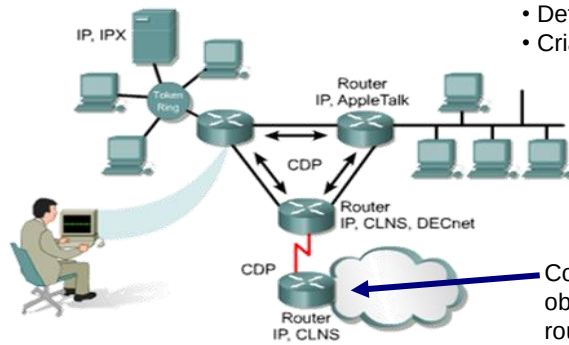
Cisco Discovery Protocol (CDP)



- O CDP é independente do meio e do protocolo
- Corre sobre o protocolo SNAP (*Subnetwork Access Protocol)* em todos os equipamentos Cisco

CDP mostra os vizinhos

Utilizado para:
- Detecção de erros
- Criar documentação da rede



Como é que o utilizador pode obter informação deste router?

Single command summarizes protocols and addresses on target (for example, neighboring Cisco router)

CDP - Funcionamento

- Durante o processo de BOOT,
  - cada dispositivo envia um **CDP advertisements** para um endereço multicast para recolher informação dos seus vizinhos
- Estes *Avisos* são enviados periodicamente de forma a que a informação recolhida seja atualizada.
- A informação só é trocada entre dispositivos diretamente ligados

Informações recebidas

TLVs - Type Length Values

TLV	Definition
Device-ID TLV	Identifies the device name in the form of a character string
Address TLV	Contains a list of network address of both receiving and transmitting devices
Port-ID TLV	Identifies the port on which the CDP packet is sent
Capabilities TLV	Describes the functional capabilities of a device in the form of a device type such as a switch
Version TLV	Contains information about the software release version on which the device is running
Platform TLV	Describes the hardware platform name of the device
IP Network Prefix TLV CDPv2	Contains a list of network prefixes to which the sending device can forward IP packets. This information is in the form of the interface protocol and port number such as Eth 0/1
VTP Management Domain TLV CDPv2	Advertises the configured VTP management domain name string of a network and is used by network operators to verify VTP domain configuration in adjacent network nodes
Native VLAN TLV CDPv2	Indicates the assumed VLAN for untagged packets on each interface and is implemented only for interfaces the support the IEEE 802.1Q protocol
Full or Half Duplex TLV	Indicates the status duplex configuration of a CDP broadcast interface and is used by network administrators to diagnose connectivity problems between adjacent network devices

Comandos CDP

Command	Mode	Purpose
`cdp run`	Global configuration mode	Enables CDP globally on the router.
`cdp enable`	Interface configuration mode	Enables CDP on an interface.
`clear cdp counters`	Privileged EXEC mode	Resets the traffic counters to zero.
`show cdp`	User or privileged EXEC mode	Displays the interval between transmissions of CDP advertisements, the number of seconds the CDP advertisement is valid for a given port, and the version of the advertisement.
`show cdp entry {* | device-name [*] [protocol | version]}`	User or privileged EXEC mode	Displays information about a specific neighbor. Display can be limited to protocol or version information.
`show cdp interface [type number]`	User or privileged EXEC mode	Displays information about interfaces on which CDP is enabled.
`show cdp neighbors [type number] [detail]`	Privileged EXEC mode	Displays the type of device that has been discovered, the name of the device, the number and type of the local interface (port), the number of seconds the CDP advertisement is valid for the port, the device type, the device product number, and the port ID. Issuing the detail keyword displays information on the native VLAN ID, the duplex mode, and the VTP domain name associated with neighbor devices.

O Comando `show cdp interface`

Router

```
Rtl#show cdp interface serial0/0
Serial0/0 is up, line protocol is up
   Encapsulation HDLC
   Sending CDP packets every 60 seconds
   Holdtime is 180 seconds

Rtl#show cdp interface fastethernet0/0
FastEthernet0/0 is up, line protocol is up
   Encapsulation ARPA
   Sending CDP packets every 60 seconds
   Holdtime is 180 seconds
Rtl#
```

O Comando `show cdp neighbors`

Router

```
Rt2#show cdp neighbors
Capability Codes: R-Router, T-Trans Bridge, B-Source
Route Bridge, S-Switch, H-Host, I-IGMP, r-Repeater

DeviceID Local Intrfce Holdtme Capablty Platform  Port ID
Rt3      Ser0/1        152     R        2500      Ser1
Rt1      Ser0/0        121     R        2620      Ser0/0
Rt2#
```


Mapa da Rede

- O comando `show cdp neighbors [`*`type number`*`] [detail]` pode ser usado para obter as seguintes informações:
  - Device ID — Address
  - Port ID — Capabilities
  - Version — Platform
  - IP network prefix
  - VTP management domain name (CDPv2 only)
  - Native VLAN (CDPv2 only)
  - Full/Half duplex (CDPv2)

Desabilitar o CDP

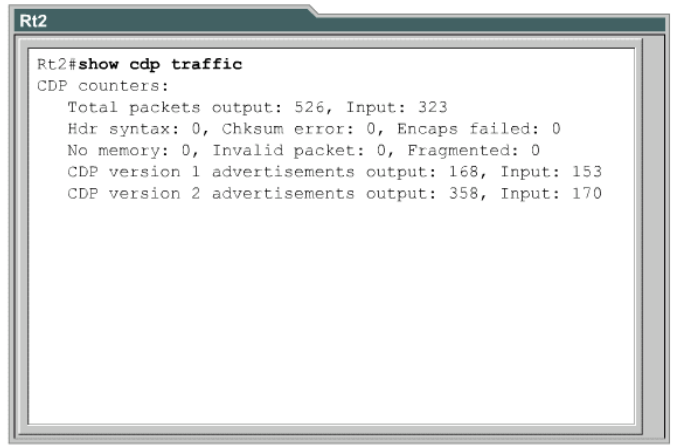
Rt1

```
Rt1#show cdp
Global CDP information
   Sending CDP packets every 60 seconds
   Sending a holdtime value of 180 seconds
   Sending CDPv2 advertisements is enabled
Rt1#configure terminal
Enter configuration commands, one per line. End with
 CNTL/Z
Rt1(config)#no cdp run
Rt1(config)#^Z
Rt1#show cdp
%CDP is not enabled
Rt1#configure terminal
Enter configuration commands, one per line. End with
 CNTL/Z
Rt1(config)#cdp run
Rt1(config)#^Z
```


Comandos para *Troubleshooting* CDP

Command	Description
`clear cdp table`	Deletes the CDP table of information about neighbors.
`clear cdp counters`	Resets the traffic counters to zero.
`show cdp traffic`	Displays CDP counters, including the number of packets sent and received and checksum errors.
`show debugging`	Displays information about the types of debugging that are enabled.
`debug cdp adjacency`	CDP neighbor information
`debug cdp events`	CDP events
`debug cdp ip`	CDP IP information
`debug cdp packets`	CDP packet-related information
`cdp timer`	Specifies how often the Cisco IOS software sends CDP updates.
`cdp holdtime`	Specifies the hold time to be sent in the CDP update packet.
`show cdp`	Displays global CDP information, including timer and hold-time information.

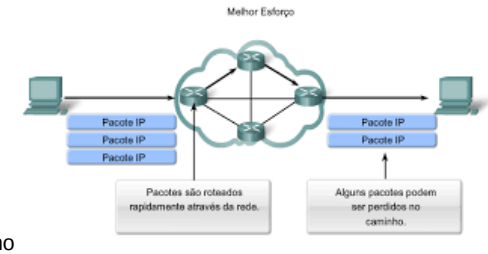
O Comando `show cdp traffic`



ICMP e ICMPv6

ICMP - **Internet** Control Message Protocol (Camada 3)

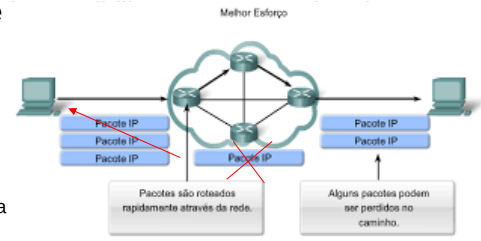
- Necessidade do ICMP:
  - O IP é um protocolo não "confiável" do tipo ***best effort***,
    - não havendo portanto qualquer garantia que os pacotes são entregues ao destino no caso de ocorrerem problemas na rede



  - *Em caso de falha*,
    - o IP não permite a notificação do emissor;
  - **Solução:**
    - O ICMP é o componente da pilha TCP/IP que lida com estas limitações do IP, exceto a "confiança", que têm de ser as camadas superiores a fornecer.

ICMP - Internet Control Message Protocol

- Quando existem erros que
  - O ICMP é utilizado
    - para reportar essa impossibilidade ao emissor
  - O ICMP não corrige
    - qualquer problema, apenas reporta a existência do erro

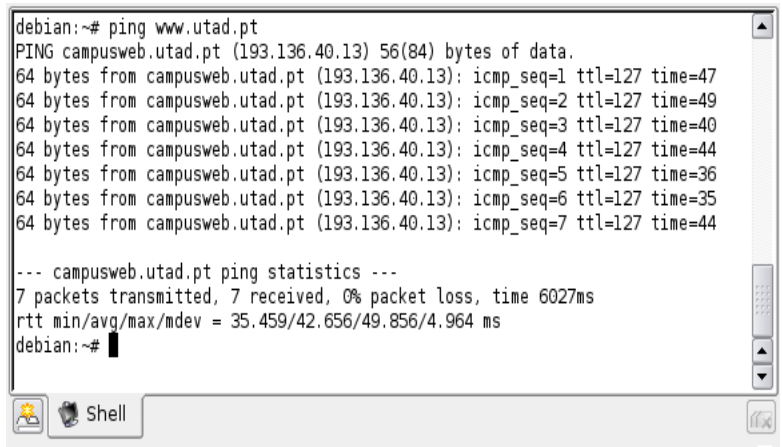


  - Qualquer erro que ocorra
    - é reportado apenas ao emissor dos datagramas e não aos routers por onde estes passaram, pois o TCP/IP não transporta qualquer informação acerca do caminho percorrido

- Quando uma mensagem de ICMP não pode ser entregue,
  - não podem ser enviadas mensagens de ICMP a reportar esse erro!

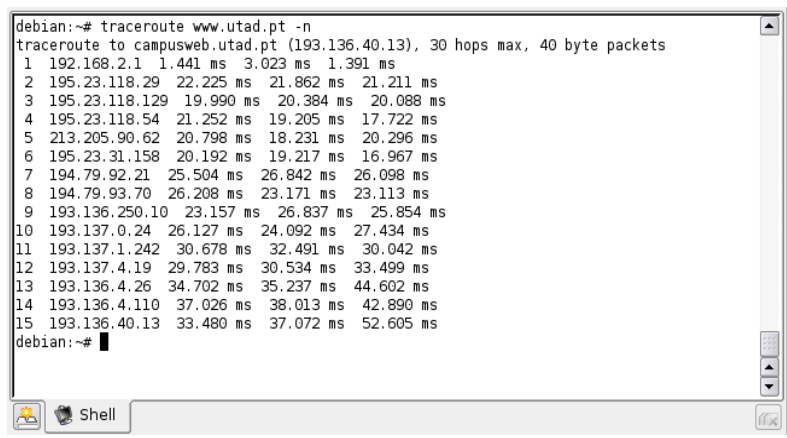
ICMP - Internet Control Message Protocol

- ICMP echo request/echo reply
  - Utilizando o comando *ping* para testar a conectividade



ICMP - Internet Control Message Protocol

- ICMP echo request/recho reply
  - Utilizando o *traceroute* Linux / *tracert* no windows



ICMP - Internet Control Message Protocol

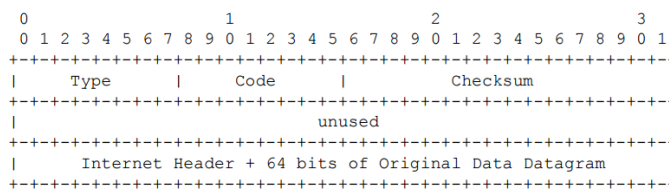
- **Formato das Mensagens ICMP – RFC792**

- As mensagens ICMP têm um formato próprio, mas todas começam com os mesmos três campos
  - **Type**: Indica o tipo de mensagem a ser enviada
  - **Code**: Contém informações específicas de cada tipo de mensagem
  - **Checksum**: Para verificar a integridade dos dados

ICMP - Internet Control Message Protocol

- **Formato das Mensagens ICMP – RFC792**

  Destination Unreachable
  - **Type: 3**
  - **Code:**
    - 0 = net unreachable;
    - 1 = host unreachable;
    - 2 = protocol unreachable;
    - 3 = port unreachable;
    - 4 = fragmentation needed and DF set;
    - 5 = source route failed.

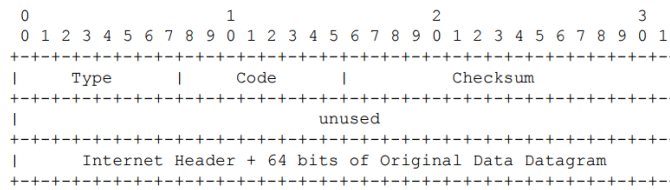


ICMP - Internet Control Message Protocol

- **Formato das Mensagens ICMP – RFC792**

  Time Exceeded

  - **Type: 11**
  - **Code:**
    - 0 = time to live exceeded in transit;
    - 1 = fragment reassembly time exceeded



ICMP - Internet Control Message Protocol

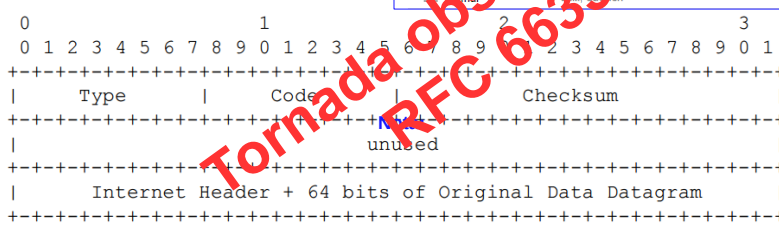
- **Formato das Mensagens ICMP – RFC792**

  Source Quench

  Pede à origem para diminuir o fluxo de pacotes enviado
  Controlo de fluxo.

  - **Type : 4**
  - **Code : 0**

Tornada obsoleta pela RFC 6633

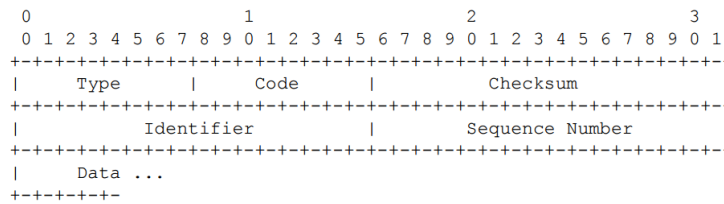


ICMP - Internet Control Message Protocol

- **Formato das Mensagens ICMP – RFC792**

  Echo & Echo Reply

  - Type:
    - 8 for **echo message**
    - 0 for **echo reply message**
  - Code: 0

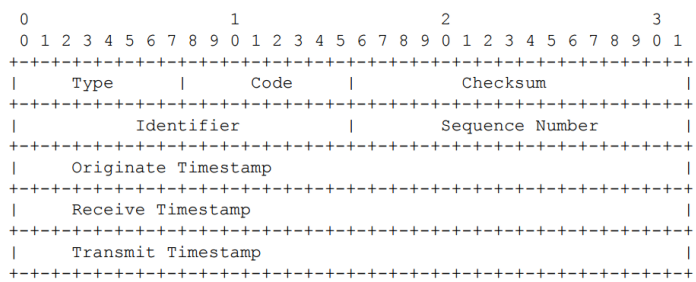


ICMP - Internet Control Message Protocol

- **Formato das Mensagens ICMP – RFC792**

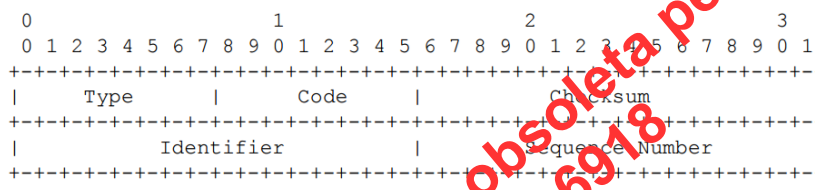
  Timestamp & Timestamp Reply

  - Type:
    - 13 for timestamp message
    - 14 for timestamp reply message
  - Code: 0



ICMP - Internet Control Message Protocol

- **Formato das Mensagens ICMP – RFC792**
  - **Information Request & Information Reply Message**

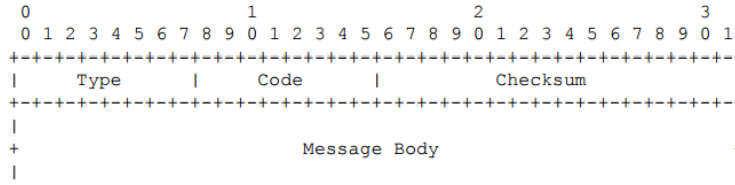


- Type :
  - 15 for information request message;
  - 16 for information reply message.
- Code : 0

Usado em máquinas sem disco
- para obter automaticamente sua configuração de rede
- Substituído por DHCP

ICMPv6 - Internet Control Message Protocol for IPv6

- **Formato das Mensagens ICMPv6 – RFC792**
  - **Formato Geral:**

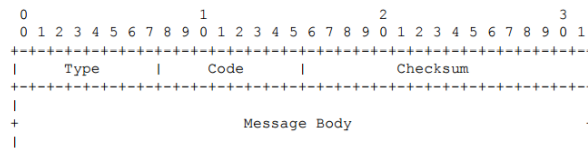


ICMPv6 - Internet Control Message Protocol for IPv6

- **Formato das Mensagens ICMPv6 – RFC792**

  Destination Unreachable

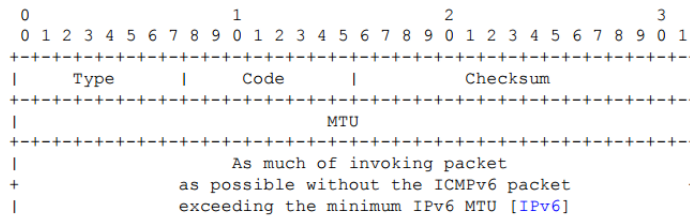
  - Type : 1
  - Code :
    - 0 - No route to destination
    - 1 - Communication with destination administratively prohibited
    - 2 - Beyond scope of source address
    - 3 - Address unreachable
    - 4 - Port unreachable
    - 5 - Source address failed ingress/egress policy
    - 6 - Reject route to destination



ICMPv6 - Internet Control Message Protocol for IPv6

- **Formato das Mensagens ICMPv6 – RFC792**

  Packet Too Big



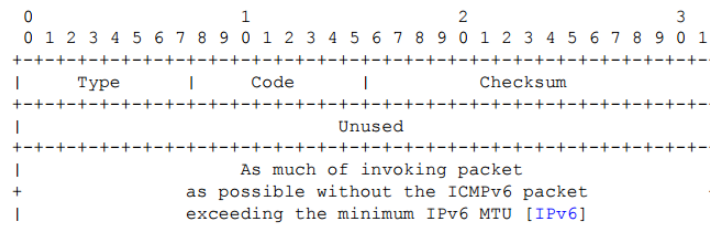
- **Type : 2**
- **Code : 0**
- **MTU:** The Maximum Transmission Unit of the next-hop link.

It is inefficient for routers to spend time doing fragmentation!

In IPv6 the decision was made to not allow routers to fragment datagrams.
This puts the responsibility on each host to ensure that datagrams they send out are small enough to fit over every physical network between itself and any destination.

ICMPv6 - Internet Control Message Protocol for IPv6

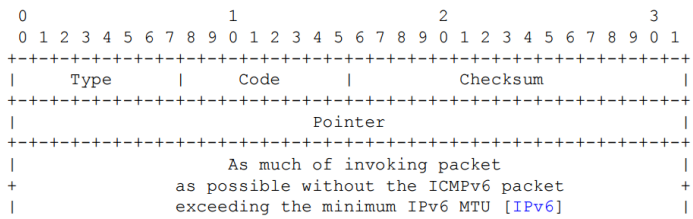
- **Formato das Mensagens ICMPv6 – RFC792**
  - **Time Exceeded**



- Type : 3
- Code :
  - 0 - Hop limit exceeded in transit
  - 1 - Fragment reassembly time exceeded

ICMPv6 - Internet Control Message Protocol for IPv6

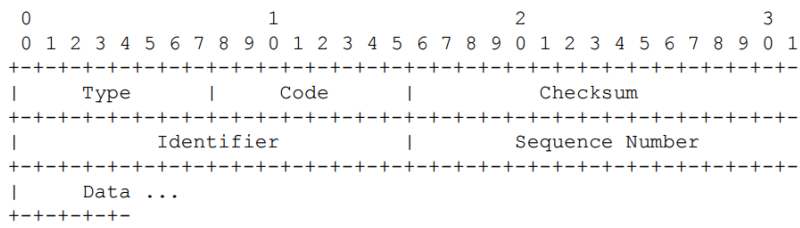
- **Formato das Mensagens ICMPv6 – RFC792**
  - **Parameter Problem**



- Type : 4
- Code :
  - 0 - Erroneous header field encountered
  - 1 - Unrecognized Next Header type encountered
  - 2 - Unrecognized IPv6 option encountered

ICMPv6 - Internet Control Message Protocol for IPv6

- **Formato das Mensagens ICMPv6 – RFC792**
  - **Echo Request and Response**



- Type :
  - 128 – Echo Request
  - 129 – Echo Response
- Code : 0

Para saber mais:

- RFC792, Internet Control Message Protocol, https://tools.ietf.org/pdf/rfc792.pdf
- RFC4443, Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification, https://tools.ietf.org/pdf/rfc4443.pdf

Bibliografia

- Computer Networking with Internet Protocols and Technology, William Stallings
- RFC 7868 - Routing Information Protocol
- CAP 10 - CCNA: Switching, Routing e Wireless Essentials