Convergence Behavior of the Enhanced Interior Gateway Routing Protocol (**EIGRP**)

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Website: http://come.to/ensc833

General Routing Concepts

Inter-Domain vs. Intra-Domain

Autonomous System = Under one roof

Inter-Domain

- Between AS
- Border Gateway Protocol version 4 (BGPv4)
- Apply policy routing

Intra-Domain

- Within AS
- different favors of Interior Gateway Protocol (IGP)
- Efficient routing

IGP - Two Types

Distance Vector (DV)

- use Bellman Ford Algorithm
- “gossiping”
- not CPU intensive ☺
- slow convergence ☹

Link State (LS)

- use Dijkstra Algorithm
- broadcast my “business card”
- fast convergence ☺
- CPU intensive, need more planning ☹

Routing Protocols

RIP

- Routing Info Protocol
- metric = hop-count
- easy to configure ☺
- classful,slow,inaccurate ☹

OSPF

- Open Shortest Path First
- metric related to BW
- classless, accurate, fast ☺
- need more engineering ☹

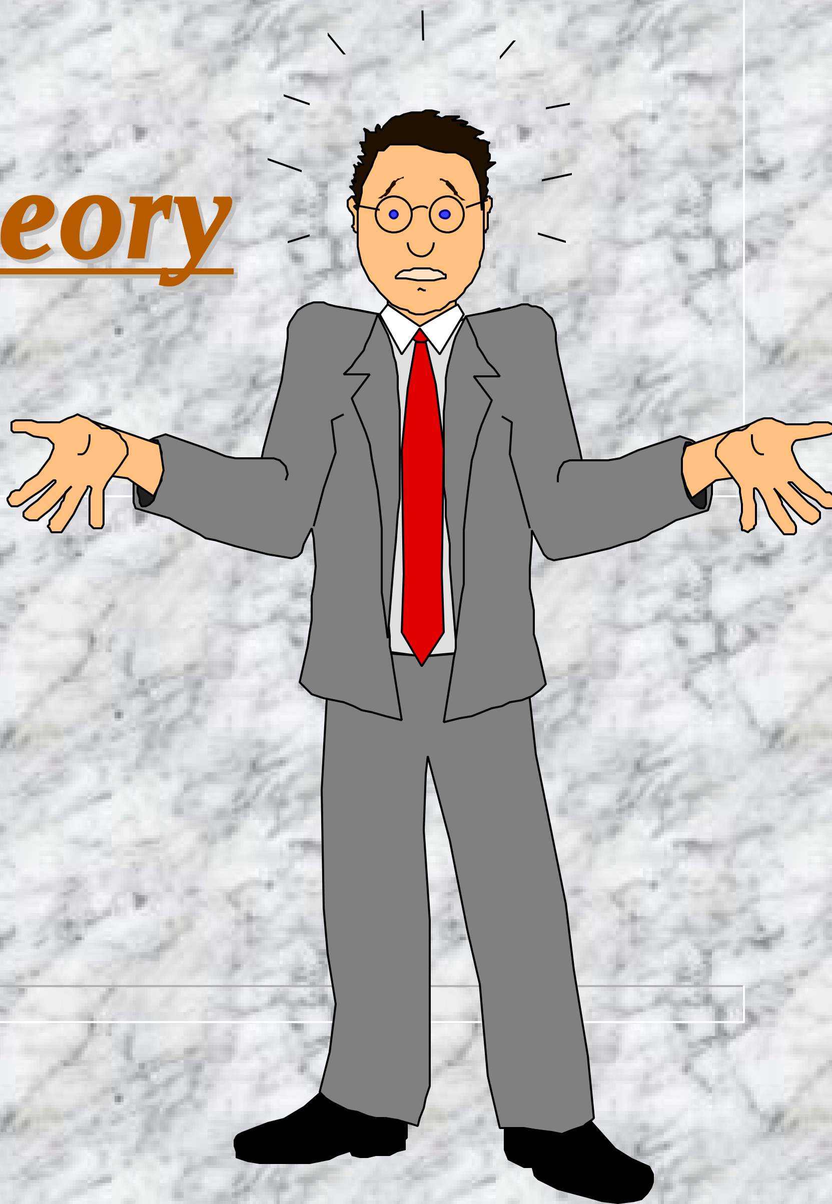
IGRP

- Interior GW Routing Protocol
- metric = complex
- easy to use, accurate ☺
- classful, slow, Cisco ☹

IS-IS

- Intermediate System - Intermediate System
- not common

EIGRP Theory



Some Theory

- "Hybrid" Protocol → (DV + LS)/2

Diffusing Update Algorithm (DUAL)

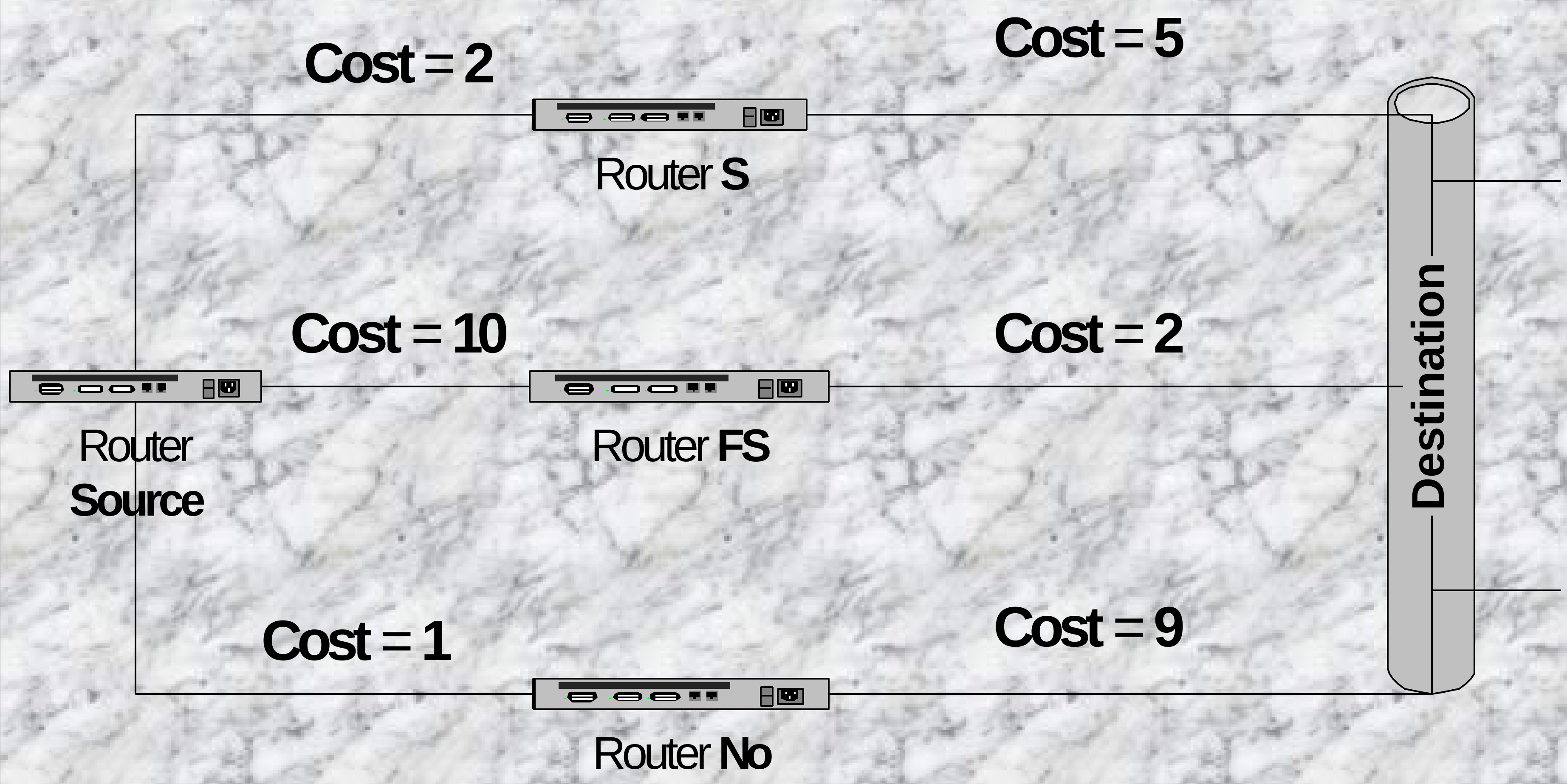
- I will travel a shorter road to destination than someone who goes through me.

Metric

$$metric = [k_1 \times BW_{IGRP(\min)} + \frac{k_2 \times BW_{IGRP(\min)}}{256 - LOAD} + k_3 \times DLY_{IGRP(sum)}] \times \frac{k_5}{RELI + k_4} \times 256$$

$$metric = BW_{IGRP(\min)} + DLY_{IGRP(sum)}$$

Easy Example



Terminology

- Successor = Next Hop
- Feasible Successor (FS) = Back-up Next Hop
- Feasible Distance (FD) = Distance to dest.
- Advertising Distance (AD) = FD of next hop

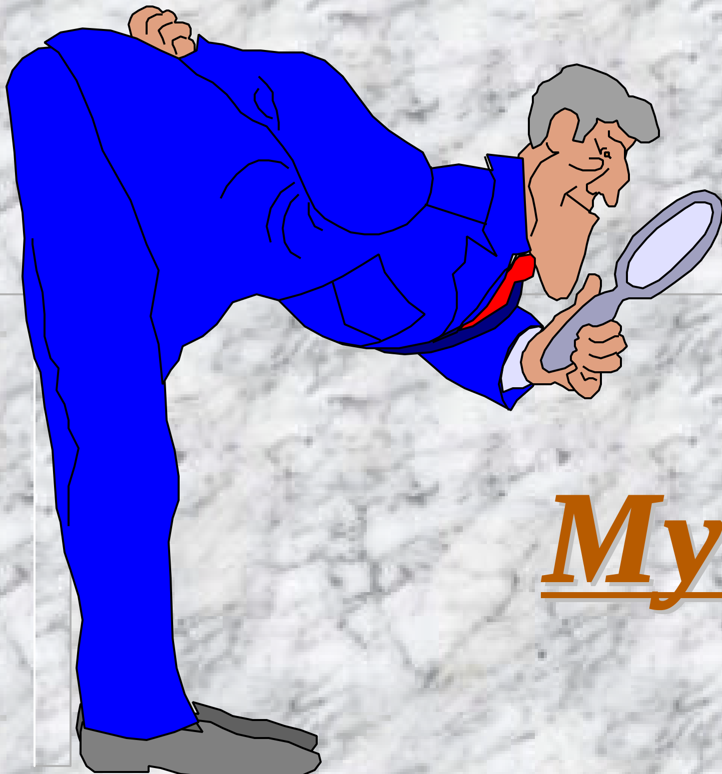
Pros and Cons

☺ **Pros** ☺

- Support IP, IPX, AppleTalk
- Fast convergence
- Support Variable Length Subnet Mask (VLSM)

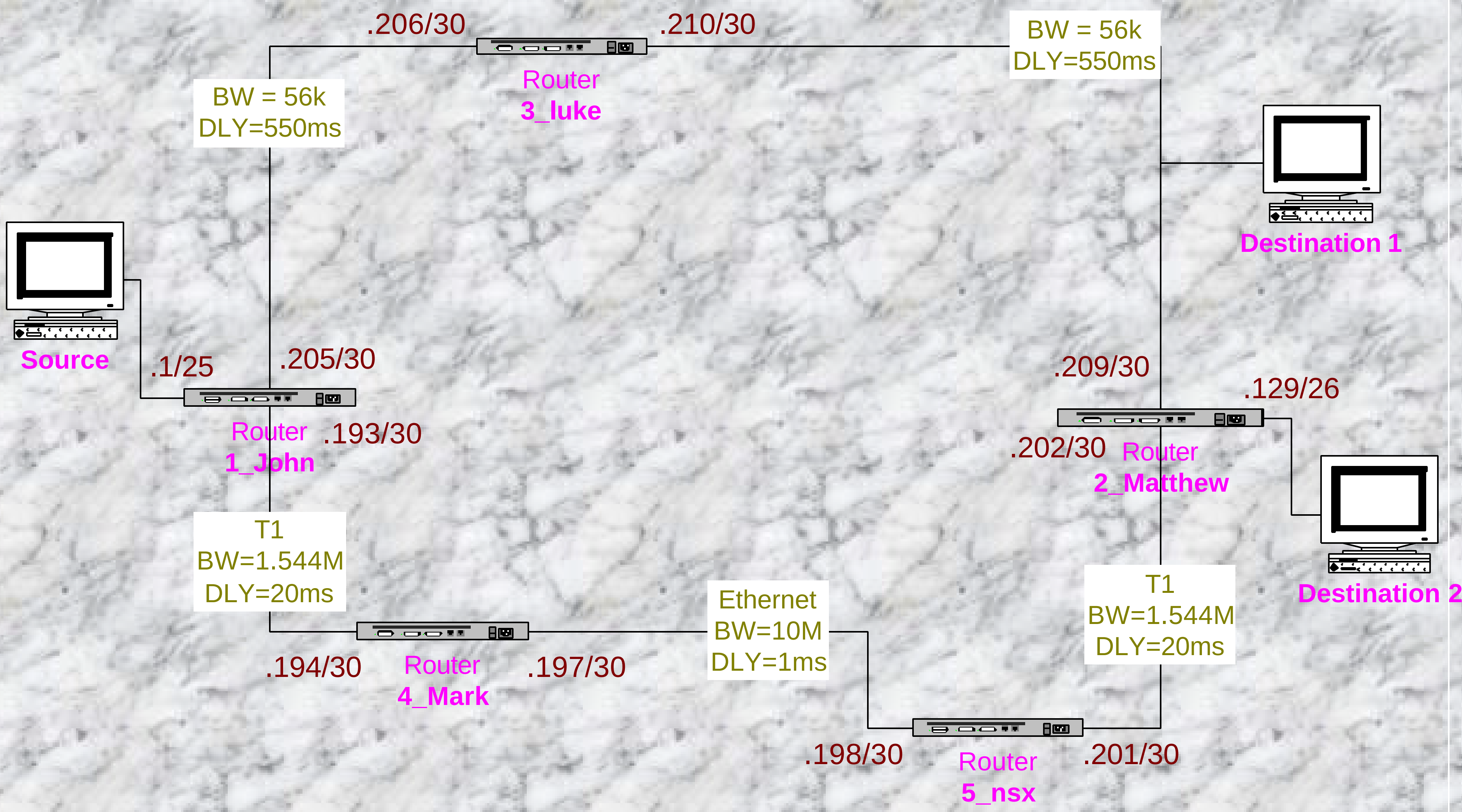
☹ **Cons** ☹

- Cisco Proprietary
- May use up a lot of bandwidth (but can be fixed)



My Experiments

Experiment Setup



"show ip eigrp topology"

```
1_John# show ip eigrp topology
IP-EIGRP Topology Table for process 7

Codes:      P - Passive, A - Active, U - Update, Q - Query, R - Reply,
            r - Reply status

P 10.1.1.0/25, 1 successors, FD is 281600
      via Connected, Ethernet0
P 10.1.1.128/26, 1 successors, FD is 2733056 ← Destination 2 (without FS)
      via 10.1.1.194 (2733056/2221056), Serial1       ← Successor
P 10.1.1.200/30, 1 successors, FD is 2707456
      via 10.1.1.194 (2707456/2195456), Serial1
P 10.1.1.204/30, 1 successors, FD is 59794176
      via Connected, Serial0
P 10.1.1.192/30, 1 successors, FD is 2169856
      via Connected, Serial1
P 10.1.1.196/30, 1 successors, FD is 2195456
      via 10.1.1.194 (2195456/281600), Serial1
P 10.1.1.208/30, 1 successors, FD is 60843776         ← Destination 1 (with FS)
      via 10.1.1.194 (60843776/60331776), Serial1     ← Successor
      via 10.1.1.206 (73874176/59794176), Serial0     ← Feasible Successor
```

Ping Result

With FS

1_John# ping ← ping cmd.
Protocol [ip]:
Target IP address: 10.1.1.209 ←Destination 1
Repeat count [5]: 20 ←20 ping pkts
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 10.1.1.1 ←from source
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 20, 100-byte ICMP Echos to 10.1.1.209, timeout is 2 seconds:
!!!!!!!!!!.!!!!!!!!! ← only 1 loss
Success rate is 95 percent (19/20), round-trip min/avg/max = 56/60/68 ms

Without FS

1_John# ping ← ping cmd.
Protocol [ip]:
Target IP address: 10.1.1.129 ←Destination 2
Repeat count [5]: 20 ←20 ping pkts
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 10.1.1.1 ←from source
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 20, 100-byte ICMP Echos to 10.1.1.129, timeout is 2 seconds:
!!!!!!!!!...!!!!!!!! ← 3 losses
Success rate is 85 percent (17/20), round-trip min/avg/max = 56/59/68 ms

K_3=3 – Delay Sensitive Traffic

$$metric = BW_{IGRP(\min)} + 3 \cdot DLY_{IGRP(sum)}$$

With FS

1_John# ping ← ping cmd.
Protocol [ip]:
Target IP address: 10.1.1.209 ←Destination 1
Repeat count [5]: 20 ←20 ping pkts
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 10.1.1.1 ←from source
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 20, 100-byte ICMP Echos to 10.1.1.209, timeout is 2 seconds:
!!!!!!!!...!!!!!!!!! ←3 loss
Success rate is 85 percent (17/20), round-trip min/avg/max = 56/60/68 ms

Without FS

1_John# ping ← ping cmd.
Protocol [ip]:
Target IP address: 10.1.1.129 ←Destination 2
Repeat count [5]: 20 ←20 ping pkts
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 10.1.1.1 ←from source
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 20, 100-byte ICMP Echos to 10.1.1.129, timeout is 2 seconds:
!!!!!!!!!..!!!!!!!!! ← 2 loss
Success rate is 90 percent (18/20), round-trip min/avg/max = 56/59/68 ms

$K_1=0, K_2=255$ – "Effective" BW

$$metric = \left(\frac{255}{256 - LOAD}\right) \times BW_{IGRP(\min)} + DLY_{IGRP(sum)}$$

With FS

1_John# ping ← ping cmd.
Protocol [ip]:
Target IP address: 10.1.1.209 ←Destination 1
Repeat count [5]: 20 ←20 ping pkts
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 10.1.1.1 ←from source
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 20, 100-byte ICMP Echos to 10.1.1.209, timeout is 2 seconds:
!!!!!!!!!!.!!!!!!!!! ← only 1 loss
Success rate is 95 percent (19/20), round-trip min/avg/max = 416/1050/1348 ms

Without FS

1_John# ping ← ping cmd.
Protocol [ip]:
Target IP address: 10.1.1.129 ←Destination 2
Repeat count [5]: 20 ←20 ping pkts
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 10.1.1.1 ←from source
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 20, 100-byte ICMP Echos to 10.1.1.129, timeout is 2 seconds:
!!!.!..!!!.....!!!!! ← 1 or 5 losses
Success rate is 60 percent (12/20), round-trip min/avg/max = 1720/1934/2000 ms

Further Study

- Change k-value does not improve convergence time significantly
- Use the default k-value
- Should focus on the topology structure and IP addressing scheme

Conclusion

- Have all the advantages that OSPF has
  - Fast
  - Support VLSM
  - Plus it supports multi-network layer protocols (IP, IPX, AppleTalk)
- However, Cisco proprietary is a big “cons” ☹
- Therefore, it may be the best (technology-wise), but it is not the best (market-wise).

- Changing “k” would not have a significant impact

References

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[3] **Andrew Caslow**, *Cisco Certification: Bridges, Routers & Switches for CCIEs,* Prentice-Hall Of Canada Ltd, December 1998

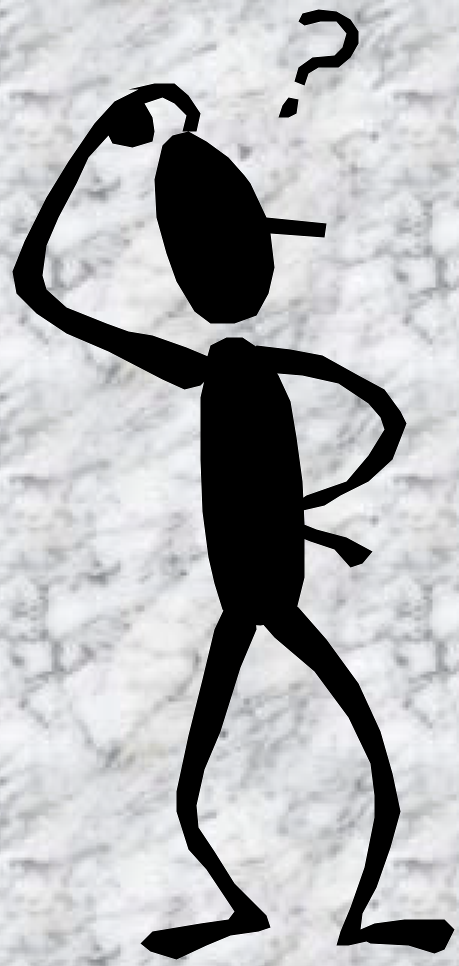
[4] **Enhanced Interior Gateway Routing Protocol –** http://www.cisco.com/univercd/cc/td/doc/cisintwk/ito_doc/en_igrp.htm

[5] **Introduction to Enhanced IGRP** – http://www.cisco.com/warp/public/103/1.html

[6] **Certification Zone** – http://www.certificationzone.com (need log-in ID)

[7] **Laura Chappell**, *Advanced Cisco Router Configuration*, Cisco Press, 1999

Any Questions?



Thank You :-)