

EIGRP

Enhanced (but still) Distance Vector

Enhanced IGRP



- **What remained**
 - ◆ Distance Vector
 - ◆ Same composite metric ($\times 256$)
- **New**
 - ◆ Link state behavior
 - ◆ Diffusing computations
 - ◆ Non-periodic, partial (incremental), and bounded updates
 - ◆ For IP, IPX, and AppleTalk

Facts



- Support of multiple unequal-metric paths
- Classless
- Fast convergence

Metric



Practical (default) EIGRP metric:

$$\left(\frac{10^7}{\text{minimum BW in Kbit/s}} + \text{sum of delays in 10 usecs} \right) \times 256$$

Complete EIGRP metric definition:

$$\text{Metric} = \left(K_1 \cdot BW + \frac{K_2 \cdot BW}{256 - \text{Load}} + K_3 \cdot \text{Delay} \right) \cdot \frac{K_5}{\text{Reliability} + K_4}$$

The default values for K are:
K1 = 1, K2 = 0, K3 = 1, K4 = 0, K5 = 0

Routing Traffic



- **IP Protocol 88, Multicast 224.0.0.10**
- **Reliable Delivery**
 - ◆ Unicast acknowledgement by each neighbor
 - ◆ 2 SeqNrs (Sender and Receiver)
 - ◆ Used for Updates, Queries, and Replies
- **Unreliable delivery**
 - ◆ Multicast without SeqNrs and ACKs
 - ◆ Used for Hellos and ACKs

DUAL



- **Diffusing Update ALgorithm**
 - ◆ Diffusing computations
 - ◆ Distributed shortest path routing
 - ◆ All time loop free
- **Step 1: Adjacency with neighbors**
 - ◆ K's and AS number must match
- **Step 2: Exchange all known routes**
- **Step 3: Calculate distances for each route including cost of link to advertizing neighbor**
 - ◆ "Feasible Distance (FD)" = lowest metric

Step 3 Details



- **Feasibility condition (FC)**
 - ♦ Is met if a neighbor's advertized distance to a destination is lower than the local router's FD
 - ♦ Then, neighbor becomes a **feasible successor** for that destination
- **FC guarantees loop avoidance**
 - ♦ Because feasible successor always downstream (to destination)

Topology Table



- **Contains all destinations and their FD**
 - ♦ Plus all associated feasible successors
 - ♦ Plus *their* advertized distance to the destination
 - ♦ Plus the locally calculated distances via each feasible successor
 - ♦ Plus associated interfaces
- **Best route is chosen for routing table**
 - ♦ Next-hop is simply the **successor**

Topology Table

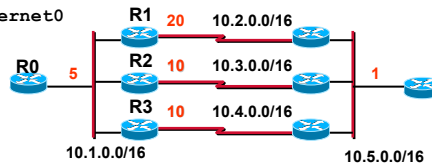


```

R0# show ip eigrp topology
IP-EIGRP Topology Table for process 1

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

P 10.1.0.0/16, 1 successors, FD is 1280
   via Connected, Ethernet0
P 10.4.0.0/16, 1 successors, FD is 3840
   via 10.1.0.3 (3840/2560), Ethernet0
P 10.3.0.0/16, 1 successors, FD is 3840
   via 10.1.0.2 (3840/2560), Ethernet0
P 10.2.0.0/16, 1 successors, FD is 6400
   via 10.1.0.1 (6400/5120), Ethernet0
P 10.5.0.0/16, 2 successors, FD is 4096
   via 10.1.0.2 (4096/2816), Ethernet0
   via 10.1.0.3 (4096/2816), Ethernet0
R0#
    
```



Feasible Successor

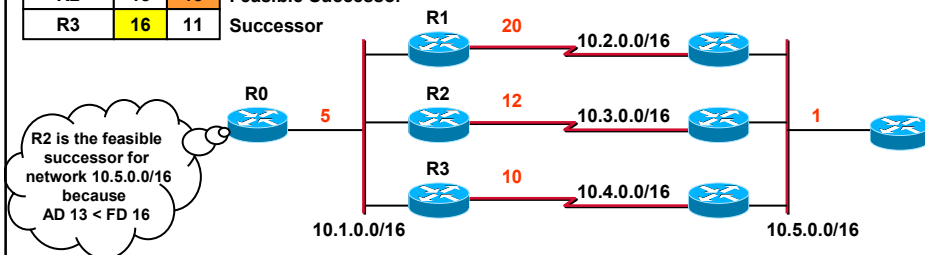


For a given destination, the advertized distance of a feasible successor must be lower than the local feasible distance !

Next-hop	FD	AD
R1	26	21
R2	18	13
R3	16	11

R2 is a Feasible Successor because AD 13 < FD 16

For simplicity let's consider delay as only metric (K1=0, K3=1)



Adjacency



- Hello – Neighbor discovery
 - ◆ 5 secs ± rand (multicast)
 - ◆ 60 secs on NBMA slower than T1 (unicast)
 - ◆ Contains HOLD-TIME = 3 × Hello interval
- ip hello-interval eigrp *hello-interval*
- ip hold-time eigrp *hold-time*
- Recorded in a neighbor table

Neighbor Table Example



```
router# show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H Address      Interface Hold  Uptime   SRTT  RTO    Q    Seq
              (sec)           (ms)  Cnt     Num
3  10.1.0.2    Et0           12  04:10:21  13  200   0    8
2  10.2.1.1    Se1           10  04:11:38  20  200   0   15
1  10.5.2.7    Se2           14  04:11:02  23  200   0   11
0  10.4.5.5    Et0           11  04:11:02   9  200   0   13
router#
```

Retransmission Timeout:
Time in ms a router will wait for a ACK of a unicast packet

Number of unacknowledged queued packets for retransmission

IP address of neighbor

Interface on which hellos are received

If hold time expires before hello is received then neighbor is declared unreachable

Time since neighbor was added to the table

Smooth RTT:
Average elapsed time between transmission of packet and receipt of ACK

Sequence numbers of received hellos to check order

DUAL States



- **Route in passive state**
 - ♦ As long as there is a feasible successor available
- **Route in active state**
 - ♦ Successor lost and feasible successor not available → Start diffusing computation
 - ♦ Query packets are sent to all neighbors to discover a new route

Active State (1)



- After receiving a query packet for a certain destination, a neighbor sends a reply packet with the desired information
- If the neighbor doesn't know about the requested destination, it queries its own neighbors

Active State (2)



- If neighbors do not reply before the **active timer** expires they will be removed from the neighbor table
 - ♦ Default: 3 minutes
 - ♦ Can be changed with the command `timers active-time time`
- Route is declared stuck-in-active (SIA)
 - ♦ Should never occur in a well-designed network
- Both queries and replies are acknowledged by receivers

Route Tagging



- EIGRP differentiates between internal and external routes
- **Internal routes** have been originated within an EIGRP autonomous system
 - ♦ Administrative Distance 90
- **External routes** have been learned by another routing protocol
 - ♦ Or entered as static route
 - ♦ Administrative Distance 170

Route Redistribution



- **IGRP routes are automatically redistributed**
 - ◆ Compatible metric
 - ◆ EIGRP and IGRP must belong to the same Autonomous System
- **All non-EIGRP routes are regarded as external routes**
 - ◆ IGRP, OSPF, RIP, EGP, BGP, ...

Additional Timers



- **Multicast Flow Timer**
 - ◆ Time to wait for an ACK before switching to unicast

No Areas

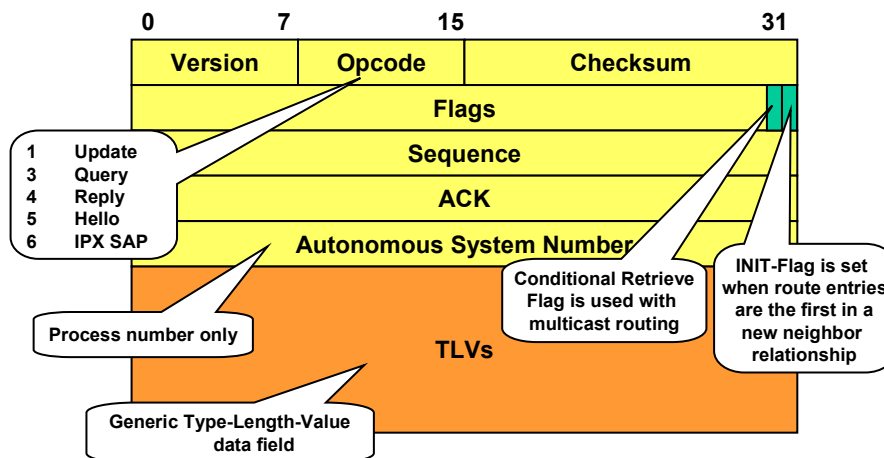


- EIGRP process number is used instead
- Within the process, information can be filtered and aggregated at any interface boundary
- Since DUAL itself limits route propagation, multiple routing processes are typically used to define organizational boundaries

EIGRP Packet Format



Carried directly in IP with protocol number 88



Automatic Redistribution



- **IPX EIGRP automatically redistributes IPX, RIP and NLSP routes**
- **AppleTalk EIGRP automatically redistributes AppleTalk RTMP routes**
- **IP EIGRP automatically redistributes IGRP routes**