CCNA3; Module3: Enhanced IGRP (Interior Gateway Routing Protocol)

Prednáška 3

Dnes ...

- Porovnanie s IGRP
- EIGRP základy
- EIGRP vlastnosti
- EIGRP komponenty
- EIGRP operácie
- Konfigurácia EIGRP
- Monitoring EIGRP

Porovnanie IGRP a EIGRP

Porovnanie medzi IGRP a EIGRP		
Protokol	IGRP	EIGRP
Cisco proprietárny	Áno	Áno
Kompatibilita	Kompatibilné (jednoduchá integrácia oboch)	
Metrika	Kompozitná: Bandwidth, Delay, Reliability, Load, MTU	
Dĺžka metriky	24bit	32bit
Hop count	255	224
Podpora VLSM a CIDR	Nie	Áno
Classfull	Áno	Nie

EIGRP a IGRP: Výpočet metriky

Both EIGRP and IGRP use the following metric calculation:

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

The following are the default constant values:

- K1 = 1, K2 = 0, K3 = 1, K4 = 0, K5 = 0
- metric = bandwidth + delay

When K4 and K5 are 0, the [K5/(reliability + K4)] portion of the equation is not factored in to the metric. Thus, with the default constant values, the metric equation is: Bandwidth + Delay

IGRP and EIGRP use the following equations to determine the values used in the metric calculation (note that EIGRP scales the value by 256):

- bandwidth for IGRP = (10000000/bandwidth)
- bandwidth for EIGRP = (10000000/bandwidth) * 256
- delay for IGRP = delay/10
- delay for EIGRP = delay/10 * 256

EIGRP – Dizajn a vlastnosti

- Proprietárny smerovací protokol založený na IGRP
  - Enhanced IGRP
- Hybridný smerovací protokol
  - Ponúka vlastností distance vector aj link-state protokolov
- Podporuje CIDR a VLSM
- Rýchla konvergencia siete
  - Neighbor database
  - Backup routes
  - Event driven partial updates
  - Neighbor queries for alternate routes
- Posielanie parciálnych, smerových updates
  - Prvý update full
  - Potom žiadné pravidelné updates
  - Info len o zmene a len tým routrom čo sa to týka
- Multicastové zasielanie updates

EIGRP – Dizajn a vlastnosti

- Zlepšená škálovateľnosť a ochrana voči vzniku smerovacích slučiek (100 % loop free)
  - DUAL smerovací algoritmus
  - Kompozitná metrika
- Podpora viacerých L3 smerovacích protokolov
  - Protocol Dependent Modules (PDM)
    - Podporuje IPX, AppleTalk siete a pod.
- Nezávislý od „routed“ protokolov (napr. IP)
  - Používa vlastný transportný protokol (RTP)
- Load balancing
  - Equal and non-equal cost
- Vhodný pre veľké, viac protokolové siete postavené hlavne na Cisco smerovačoch

EIGRP – Dizajn a vlastnosti - Sumár

- Advanced distance vector
- Fast convergence
- Support for VLSM and discontiguous subnets
- Partial updates
- Support for multiple network-layer protocols
- Flexible network design
- Multicast and unicast instead of broadcast address
- Manual summarization at any point
- 100% loop-free classless routing
- Easy configuration for WANs and LANs
- Load balancing across equal and unequal cost pathways

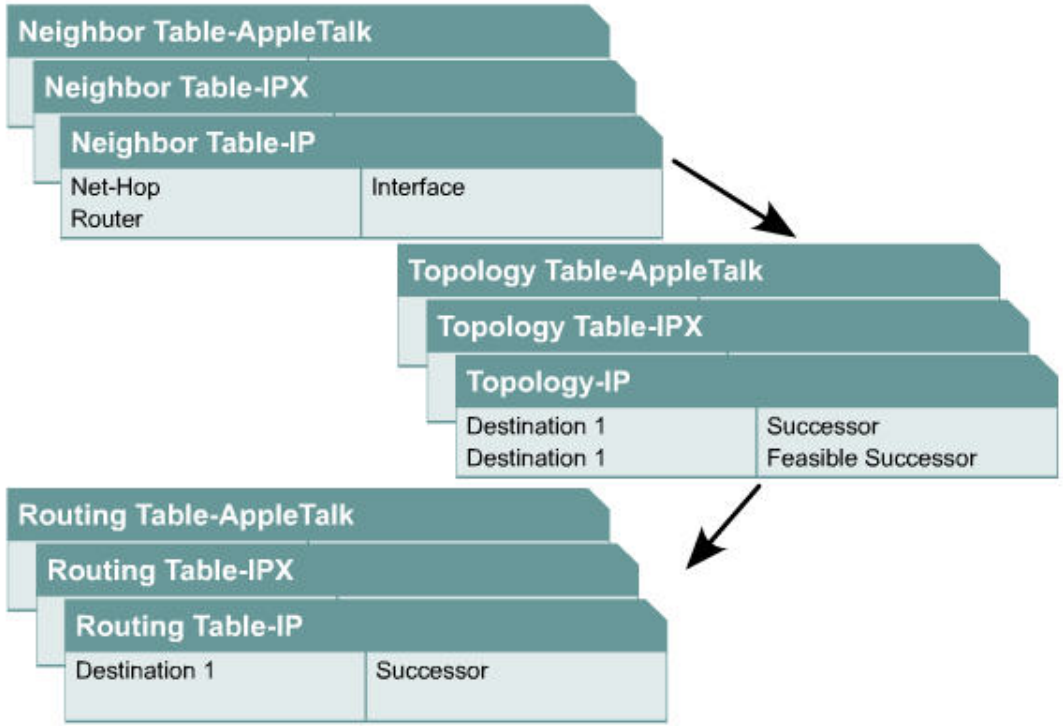
EIGRP – Kľúčové komponenty

- Odlišujú EIGRP od iných smerovacích protokolov:
  - Protocol-dependent modules
  - Reliable transport protocol (RTP)
  - Neighbor discovery and recovery
  - DUAL finite-state machine

- Protocol-dependent modules (PDMs)
  - EIGRP supports IP, AppleTalk, and Novell NetWare.
  - Each protocol has its own EIGRP module and operates independently from any of the others that may be running.
  - Guaranteed, ordered delivery of EIGRP packets to all neighbors.
- Reliable Transport Protocol (RTP)
  - Guaranteed, ordered delivery of EIGRP packets to all neighbors.
- Neighbor discovery/recovery
  - Uses Hello packets between neighbors.
- DUAL finite-state machine
  - Selects lowest cost, loop-free paths to each destination

Protocol-dependent modules (PDM)

- Podpora rôznych L3 protokolov cez moduly
  - Pridávané podľa potreby
  - Teraz: IP, Novell NetWare, AppleTalk
- Každý modul pracuje nezávisle a samostatne
  - Vlastné tabuľky



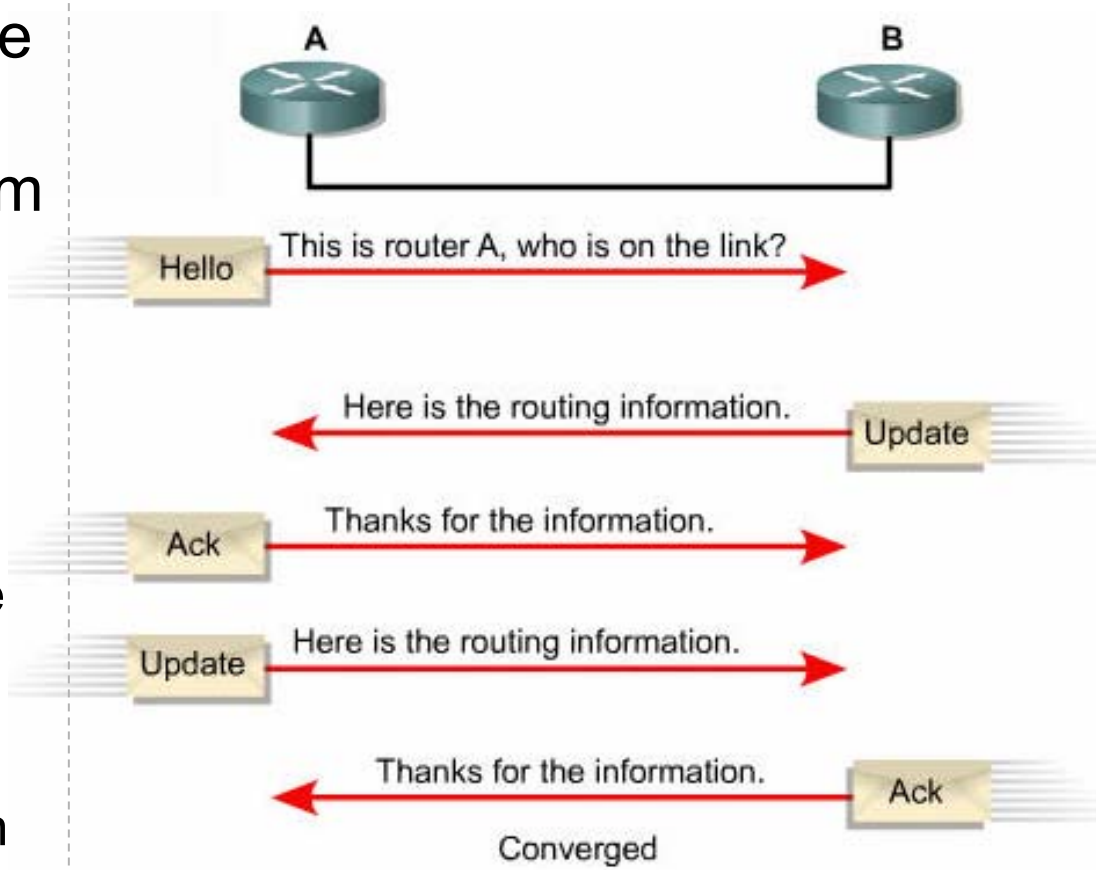
Reliable Transport Protocol (RTP)

- EIGRP používa RTP na:
  - Spoľahlivé, usporiadané alebo nespoľahlivé doručovanie EIGRP paketov susedom
    - Len niektoré pakety sú posielané spoľahlivo
      - HELLO nie
  - Podpora mcastu aj unicastu

- EIGRP can call on RTP to provide reliable or unreliable service as the situation warrants.
- With RTP, EIGRP can multicast and unicast to different peers simultaneously, allowing for maximum efficiency.

Neighbor discovery and recovery

- EIGRP router udržuje routing table pravidelným a trvalým monitorovaním:
  - svojich liniek
  - susedných routrov
- Routre:
  - Monit. cez periodické zasielanie Hello
- Výhoda
  - Rýchle zistene zmien



DUAL finite-state machine

- DUAL používa na výber cesty distance info (cost, metrika)
- Terminológia:
  - **Advertised distance (AD); Reported distance (RD)**:
    - Cost between the next hop router and destination
  - **Feasible distance (FD):**
    - Cost between the router and destination
    - **FD = AD + link cost** (cost between the router and its neighbor)

DUAL

- **Successor:**
  - is a neighboring router that has a least cost path to a destination (the lowest FD)
  - Zapísaný do routing tabuľky na smerovane paketov
  - Router môže mať viac Successors
    - Až šesť per destination
- **Feasible successor:**
  - Backup routes
  - Route, which AD (RD) is less as FD
- Pracuje na základe údajov z EIGRP tabuliek

EIGRP Components and operation

- EIGRP packet types
- EIGRP tables
- Route tagging with EIGRP

EIGRP packet types

EIGRP Packets

- Hello:
  - Establish neighbor relationships.
- Update:
  - Send routing updates., **Topology changes**
- Query:
  - Ask neighbors about routing information.
- Reply:
  - Respond to query about routing information.
- ACK:
  - Acknowledge a reliable packet.

Bandwidth	Example Link	Default Hello Interval	Default Hold Time
1.544 Mbps or less	Multipoint Frame Relay	60 seconds	180 seconds
Greater than 1.544 Mbps	T1, Ethernet	5 seconds	15 seconds

HELLO 224.0.0.10

EIGRP tabuľky

- **Tri tabuľky:**
  - Všetky v RAM
  - **Neighbor table**
  - **Topology table**
  - **Routing table**

Topology table

- Keď router dynamický objaví suseda
  - Pošle susedovi update o všetkých jemu známych cestách
- Nový sused
  - Pošle späť update o všetkých jemu známych cestách
- Pomocou týchto updates
  - Budujem topology table
    - Obsahuje všetky ciele reportované susedmi
- Topo tab je aktualizovaná:
  - Ak sa zmení stav priamo pripojeného interfejsu (linka)alebo routera
  - Ak sused reportuje zmenu

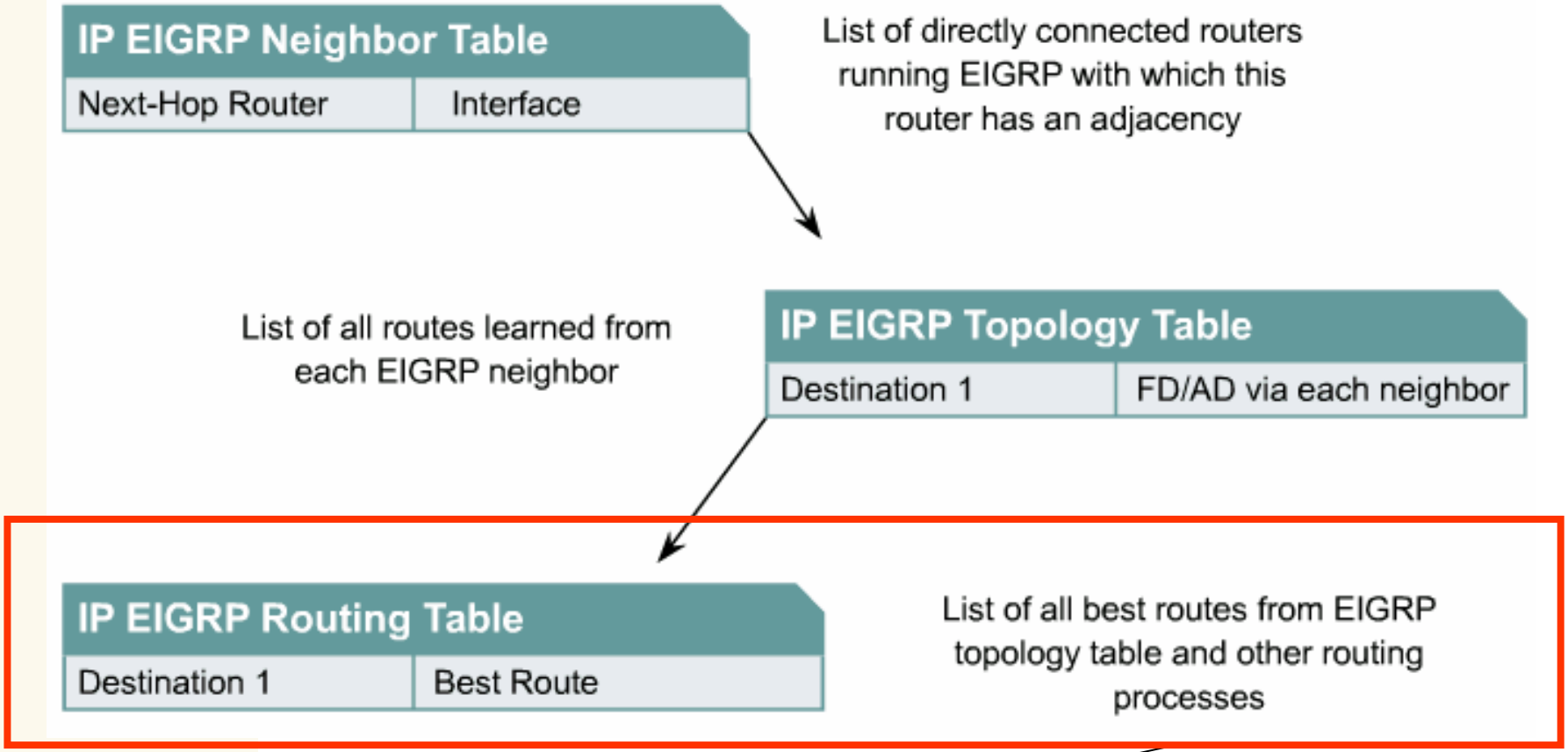
Topology table

- Topo tab obsahuje:
  - AD
  - FD
- Ciele môžu byť v dvoch stavoch:
  - Passive:
    - Keď sa nerobí prepočet cesty, alias všetko je OK
  - Active:
    - Keď router robí prepočet cesty/ciest pri zmene

Feasible Successor Route Selection Rules

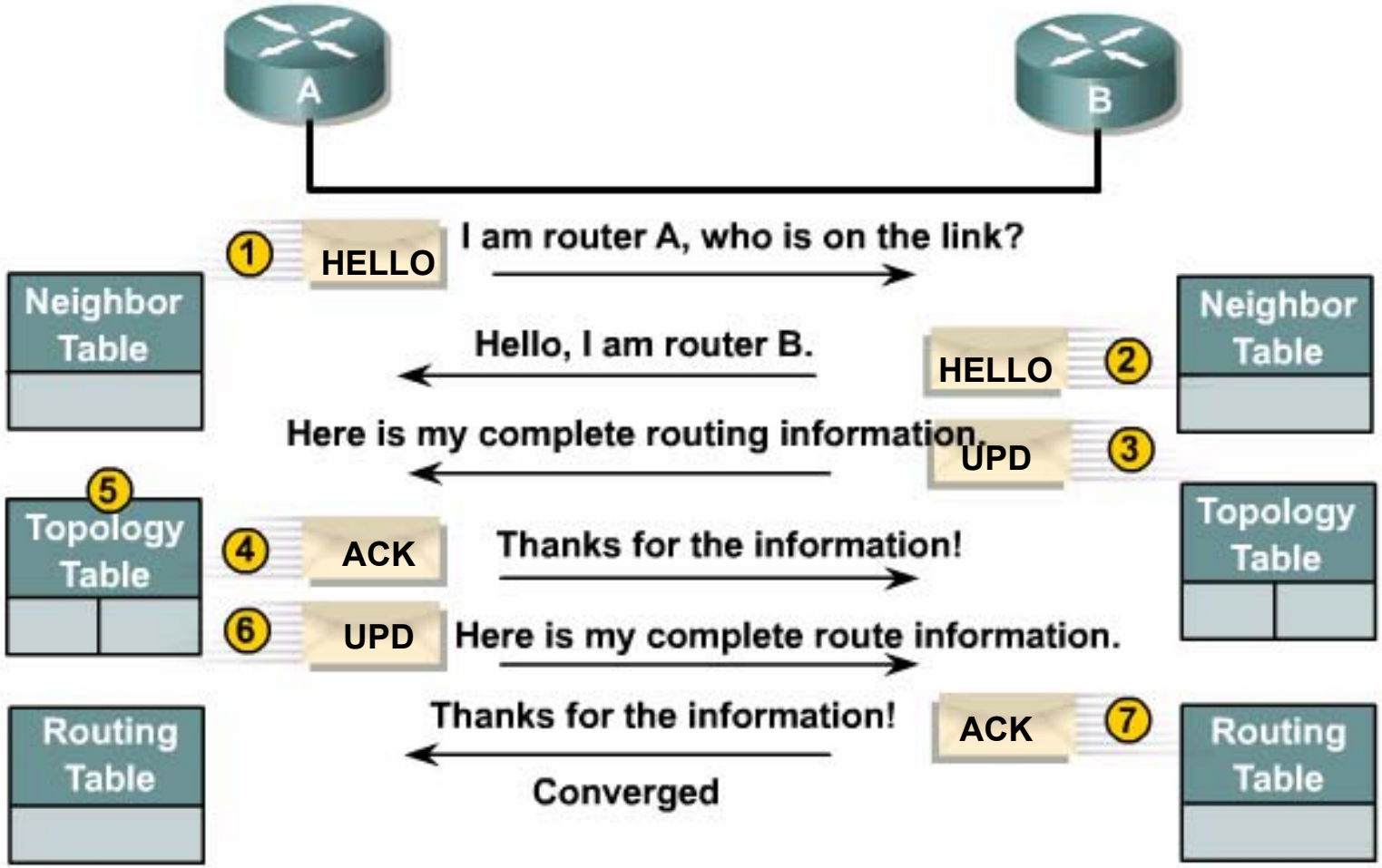
1. The feasibility successor route is an alternative backup route in case the successor route goes down.
2. The Reported Distance (RD) to the destination, as advertised by the neighboring router, must be less than the Feasible Distance (FD) of the primary successor route.
3. If this criterion is met, and there is no routing loop, the route can be selected as the feasible successor route.
4. The feasible successor route can now be promoted to the status of a successor route.
5. If the alternative route RD is equal to, or exceeds the original successor FD, the route is rejected as a feasible successor route.
6. The router must recompute the topology of the network by gathering information for all neighbors.
7. The router sends a query packet to all neighbors requesting available routing paths and associated metric cost to the destination network.
8. All neighboring routers must send a reply packet to answer the query packet request.
9. Data received is written into the topology table of the querying router.
10. DUAL can now identify new successor routes and, where appropriate, new feasible successor routes based on this new information.

Routing table



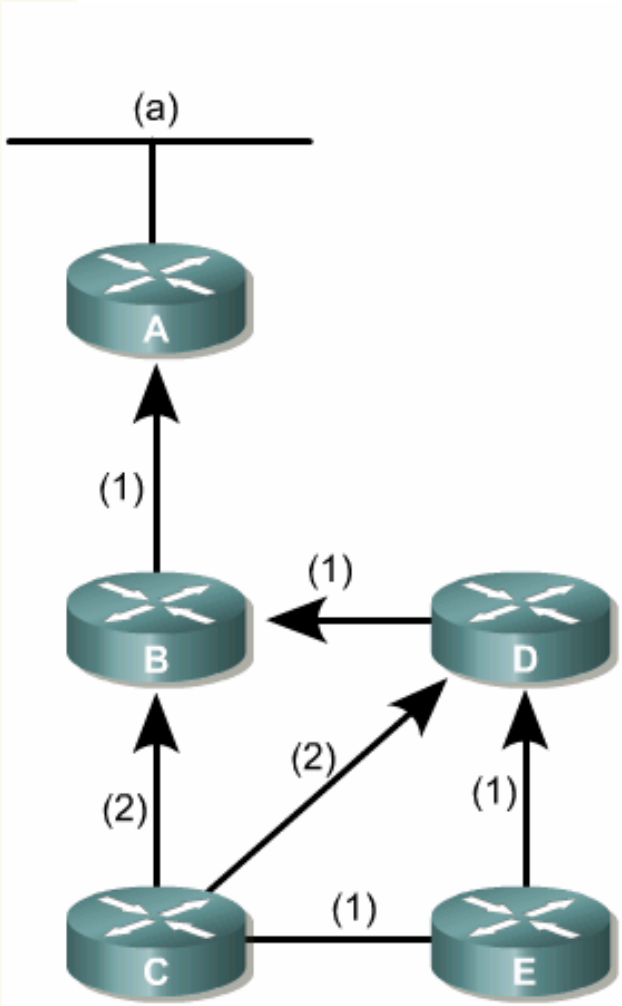
Router vyberie do najnižší FD s pomedzi všetkých FD v topo table

Budovanie tabuliek



DUAL example (1)

Stabilný stav



Router C

	EIGRP	FD	AD	Topology
(a)		3		(fd)
	via B	3	1	(Successor)
	via D	4	2	(fs)
	via E	4	3	

Router D

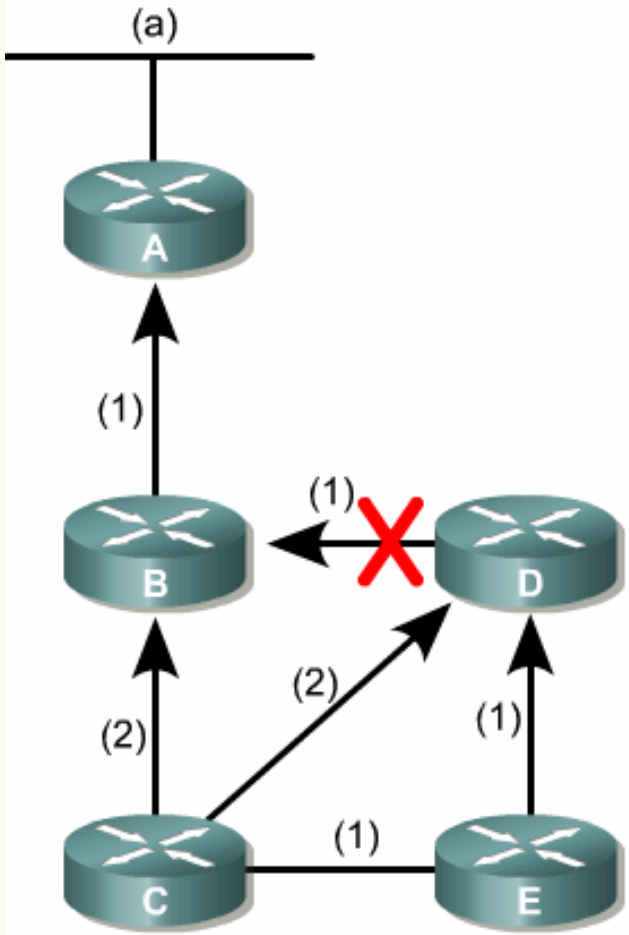
	EIGRP	FD	AD	Topology
(a)		2		(fd)
	via B	2	1	(Successor)
	via C	5	3	

Router E

	EIGRP	FD	AD	Topology
(a)		3		(fd)
	via D	3	2	(Successor)
	via C	4	3	

DUAL example (2)

D stratil konektivitu do (a)



Router C

	EIGRP	FD	AD	Topology
(a)		3		(fd)
	via B	3	1	(Successor)
	via D	4	2	(fs)
	via E	4	3	

Router D

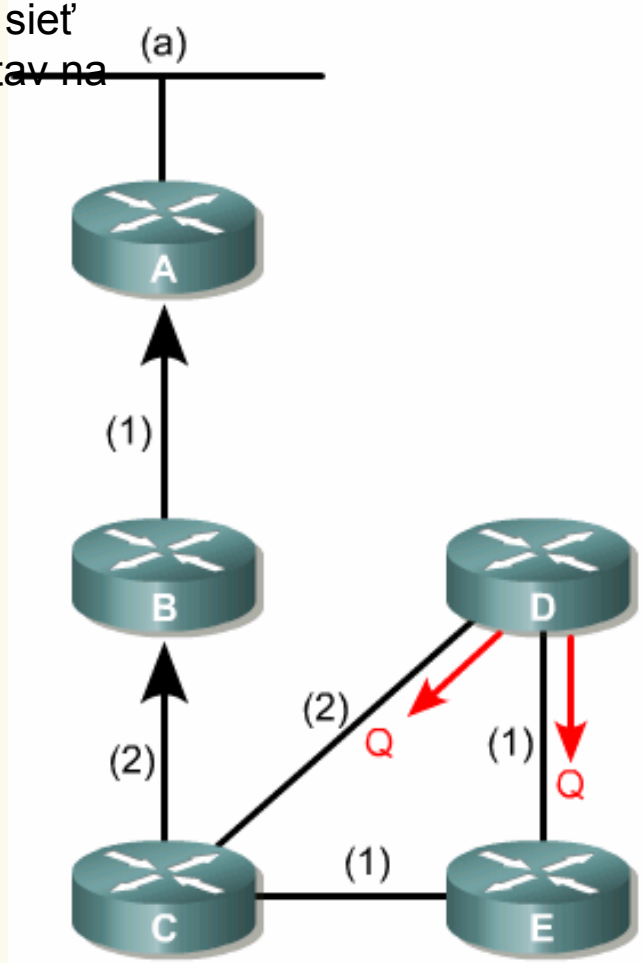
	EIGRP	FD	AD	Topology
(a)		2		(fd)
	~~via B~~	~~2~~	~~1~~	~~(Successor)~~
	via C	5	3	

Router E

	EIGRP	FD	AD	Topology
(a)		3		(fd)
	via D	3	2	(Successor)
	via C	4	3	

DUAL example (3)

D Query na susedov pre sieť (a). Zmení stav na Active



Router C

	EIGRP	FD	AD	Topology
(a)		3		(fd)
	via B	3	1	(Successor)
	via D			
	via E	4	3	

Router D

	EIGRP	FD	AD	Topology
(a)	**ACTIVE**	-1		(fd)
	via E			(q)
	via C	5	3	(q)

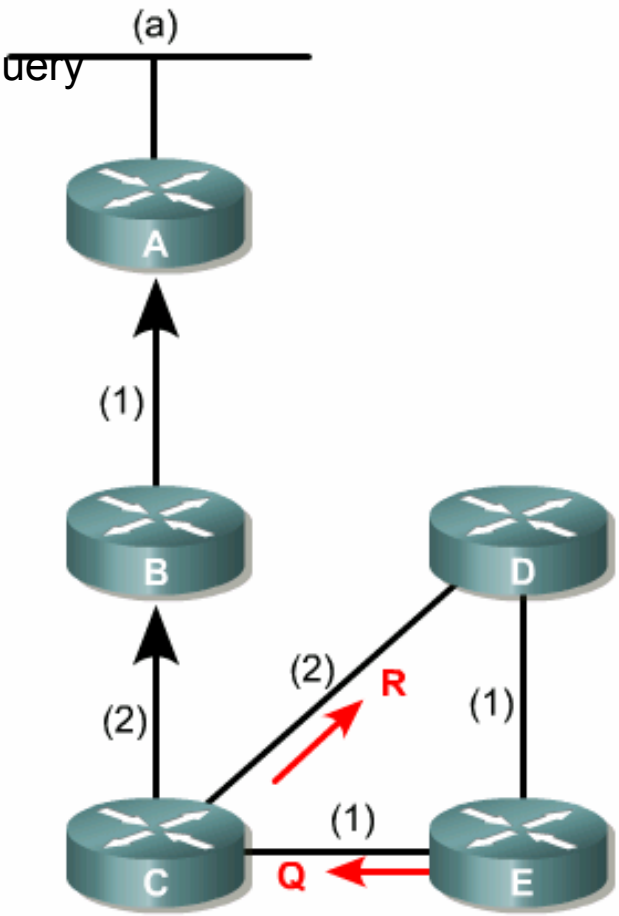
Router E

	EIGRP	FD	AD	Topology
(a)		3		(fd)
	~~via D~~	~~3~~	~~2~~	~~(Successor)~~
	via C	4	3	

DUAL example (4)

E stav do Active, Query na C.

C Report na Query na D.



Router C

	EIGRP	FD	AD	Topology
(a)		3		(fd)
	via B	3	1	(Successor)
	via D			
	via E			

Router D

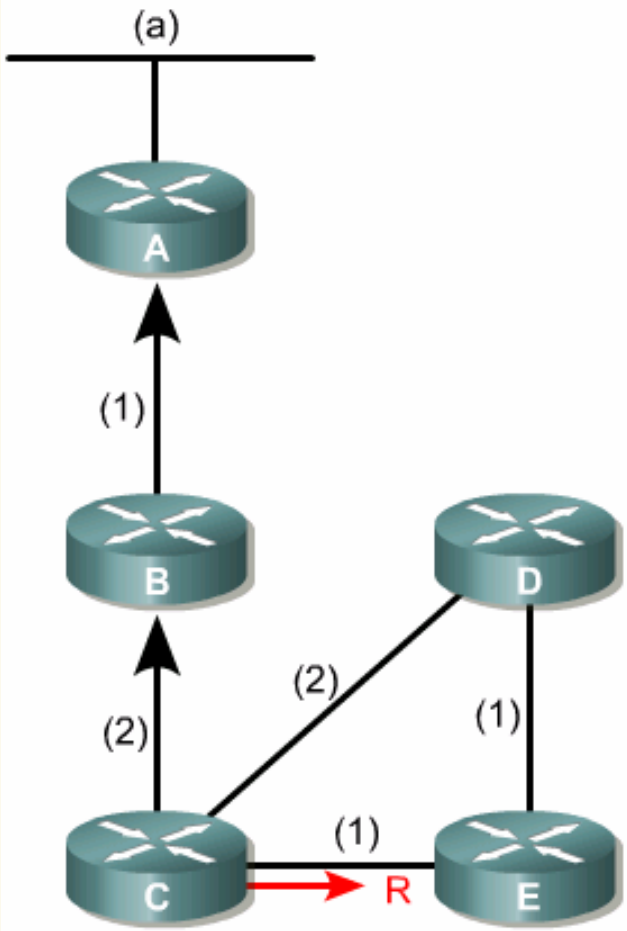
	EIGRP	FD	AD	Topology
(a)	**ACTIVE**	-1		(fd)
	via E			(q)
	via C	5	3	(q)

Router E

	EIGRP	FD	AD	Topology
(a)	**ACTIVE**	-1		(fd)
	via C	4	3	(q)

DUAL example (5)

C Report na Query
Ečka



Router C

	EIGRP	FD	AD	Topology
(a)		3		(fd)
	via B	3	1	(Successor)
	via D			
	via E			

Router D

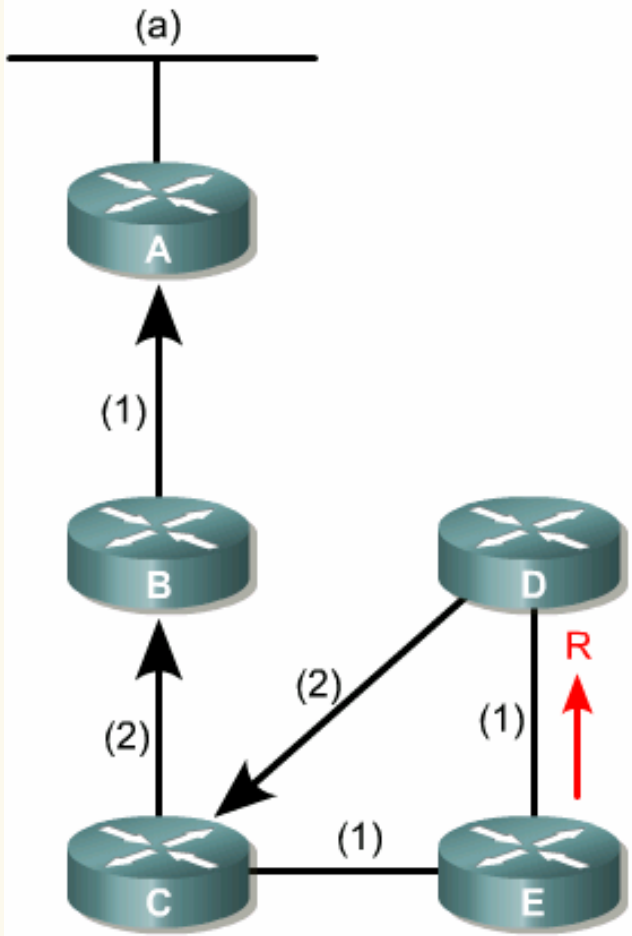
	EIGRP	FD	AD	Topology
(a)	**ACTIVE**	-1		(fd)
	via E			(q)
	via C	5	3	

Router E

	EIGRP	FD	AD	Topology
(a)	**ACTIVE**	-1		(fd)
	via C	4	3	(q)

DUAL example (6)

E Report na Query
Dčka



Router C

	EIGRP	FD	AD	Topology
(a)		3		(fd)
	via B	3	1	(Successor)
	via D			
	via E			

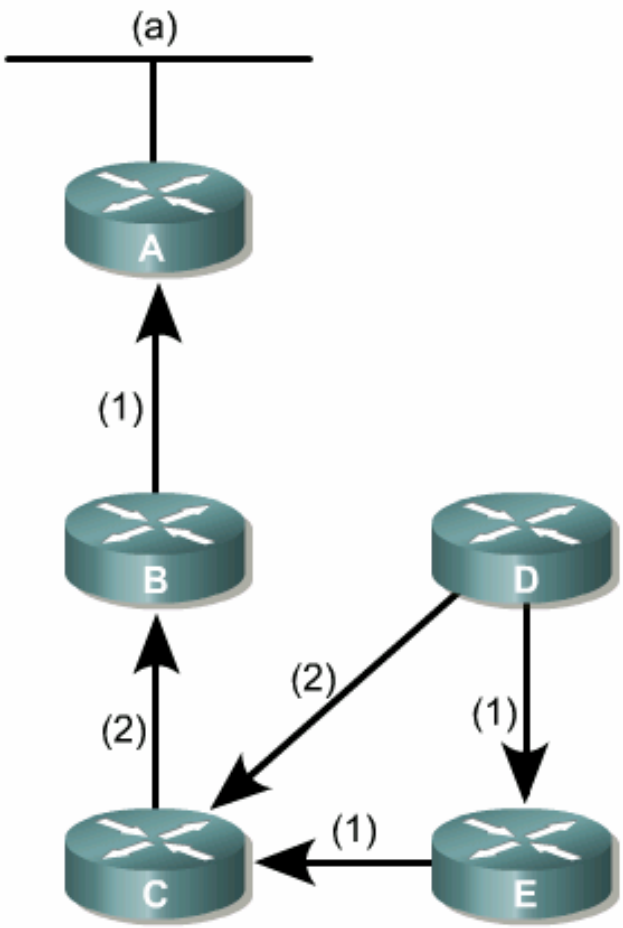
Router D

	EIGRP	FD	AD	Topology
(a)		5		(fd)
	via E	5	4	
	via C	5	3	(Successor)

Router E

	EIGRP	FD	AD	Topology
(a)		4		(fd)
	via C	4	3	(Successor)

DUAL example (7)



Router C

	EIGRP	FD	AD	Topology
(a)		3		(fd)
	via B	3	1	(Successor)
	via D			
	via E			

Router D

	EIGRP	FD	AD	Topology
(a)		5		(fd)
	via E	5	4	(fs)
	via C	5	3	(Successor)

Router E

	EIGRP	FD	AD	Topology
(a)		4		(fd)
	via C	4	3	(Successor)
	via D			

DUAL - Select Routes

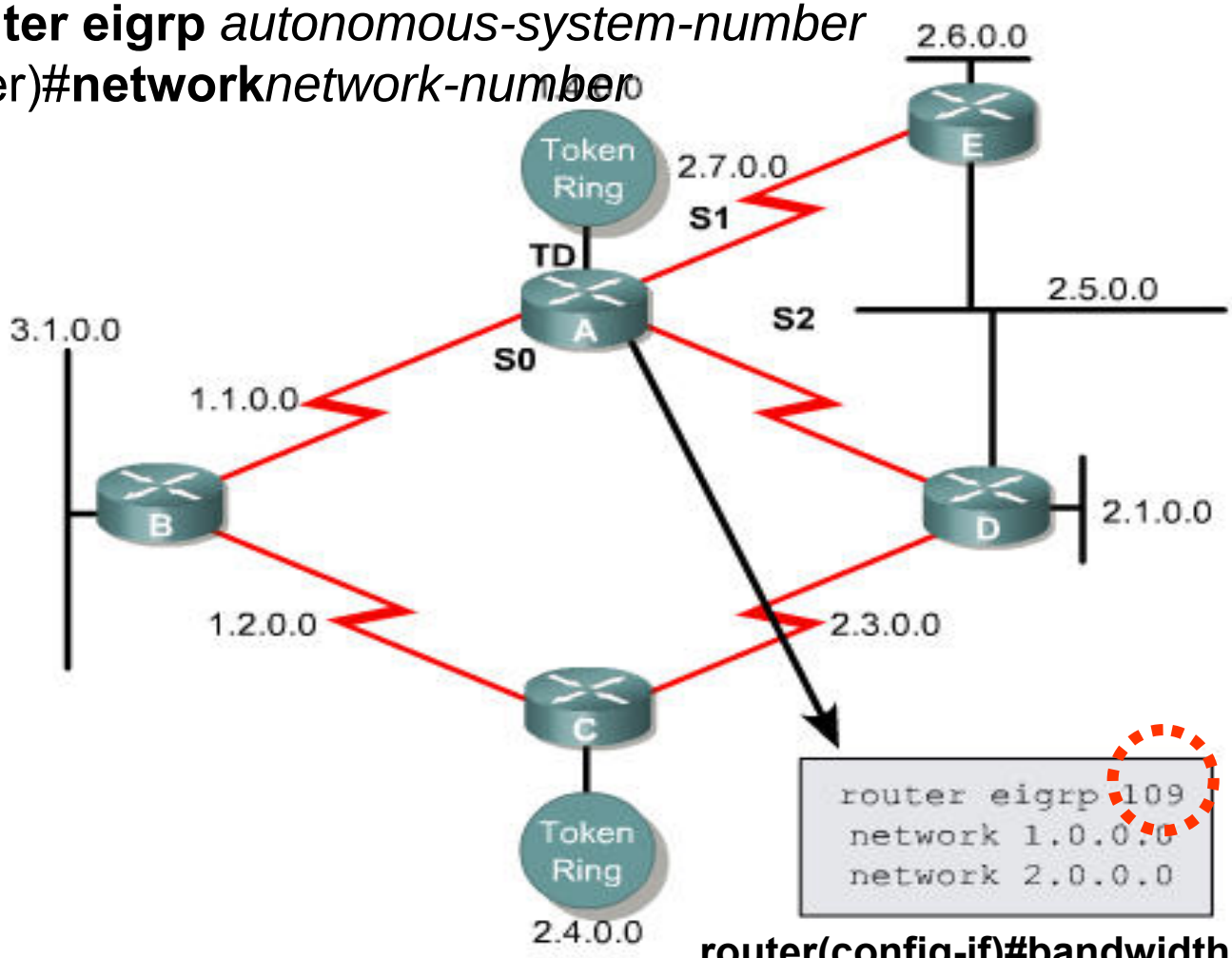
- If a link goes down, DUAL looks for an alternative route path, or feasible successor, in the topology table.
- If a feasible successor is not found, the route is flagged as Active, or unusable at present.
- Query packets are sent to neighboring routers requesting topology information.
- DUAL uses this information to recalculate successor and feasible successor routes to the destination.

Configuring EIGRP

- Configuring EIGRP for IP networks
- Summarizing EIGRP Routes: Interface Summarization
- Summarizing EIGRP Routes: no auto-summary
- Default route propagation
- Show commands

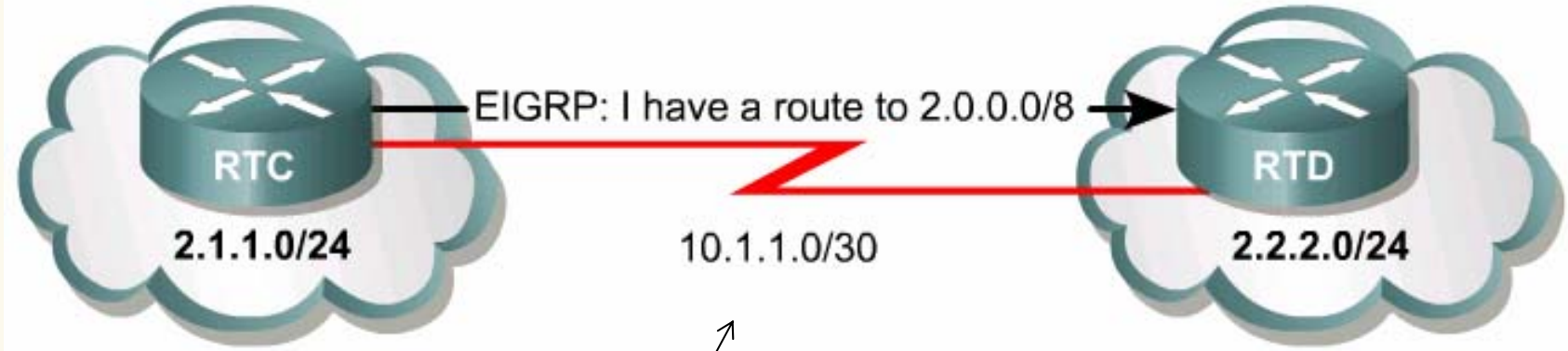
Configuring EIGRP for IP networks

router(config)#**router eigrp** *autonomous-system-number*
router(config-router)#**network***network-number*



router(config-if)#bandwidth*kbps*

Summarizing EIGRP Routes: Interface Auto Summarization

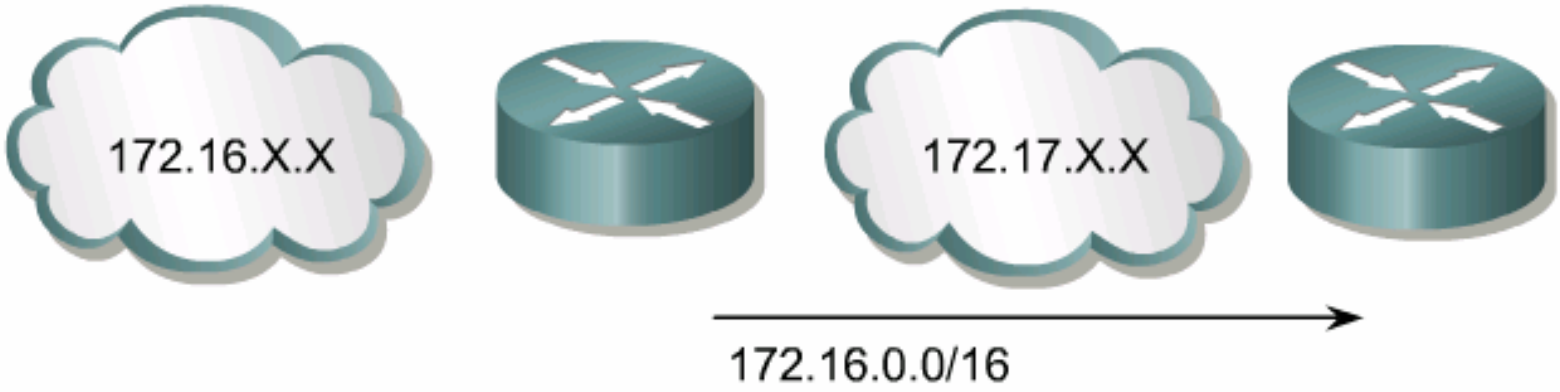


Problém s updates.

Aký?????

Summarizing EIGRP Routes: Interface Auto Summarization

- Purpose: Smaller routing tables, smaller updates
- Automatic summarization:
  - On major network boundaries, subnetworks are summarized to a single classful (major) network.
  - Automatic summarization occurs by default.



Disabling auto-summary

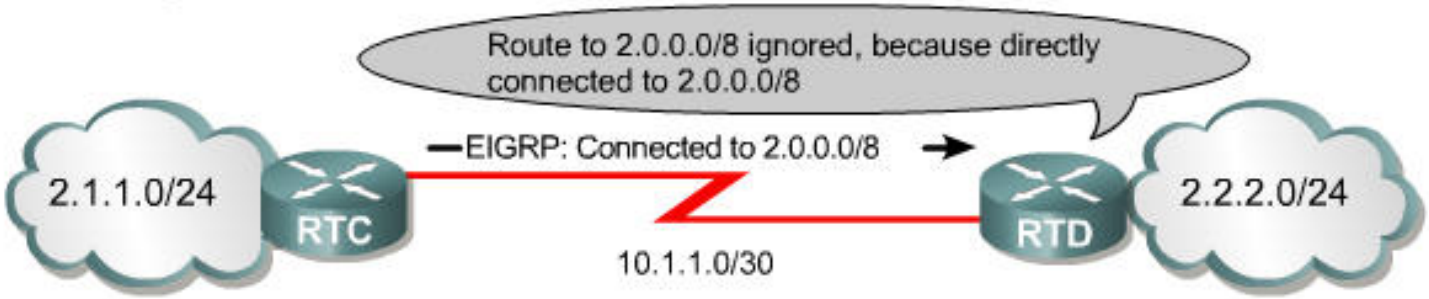
```
(config-router)#
```

```
no auto-summary
```

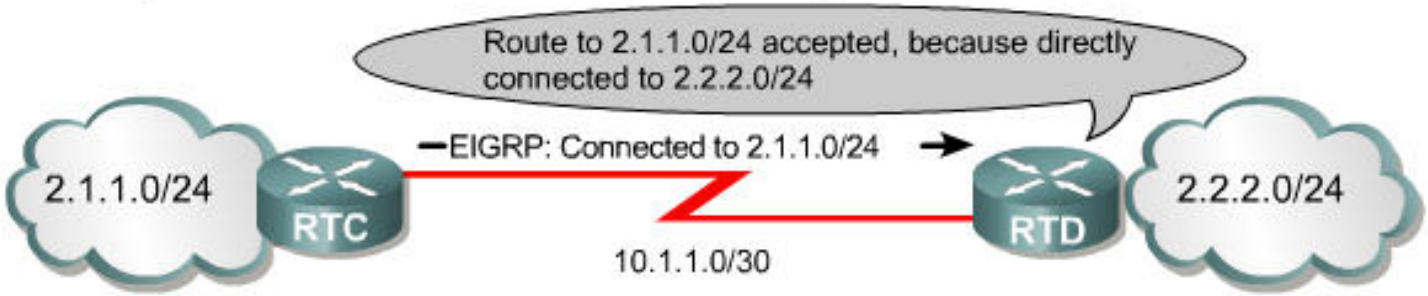
- Turns off automatic summarization for the EIGRP process

Discontiguous networks

Discontiguous Networks with Autosummarization



Discontiguous Networks with `no auto-summary`



Auto-summarization prevents routers from learning about discontiguous subnets. With summarization turned off, EIGRP routers will advertise subnets.

Configuring manual auto summarization

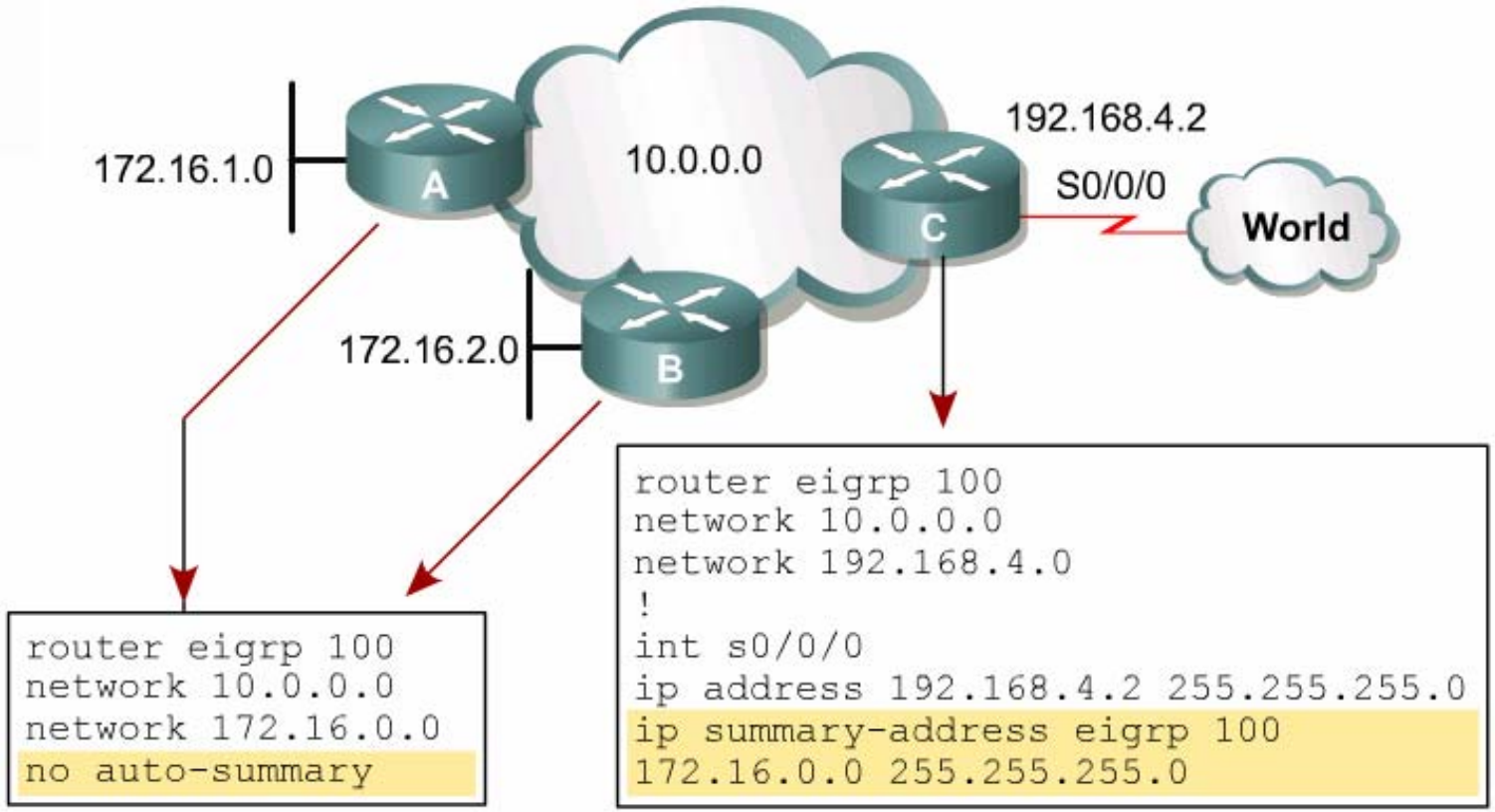
```
(config-if)#
```

```
ip summary-address eigrp [as-number] [address] [mask]
```

- Creates a summary address that this interface will generate

Parameters	Description
as-number	EIGRP autonomous system (AS) number.
address	The IP address advertised as the summary address. This address does not need to be aligned on Class A, B, or C boundaries.
mask	The IP mask used to create the summary address.
admin-distance	(Optional) Administrative distance. A value from 0 to 255.

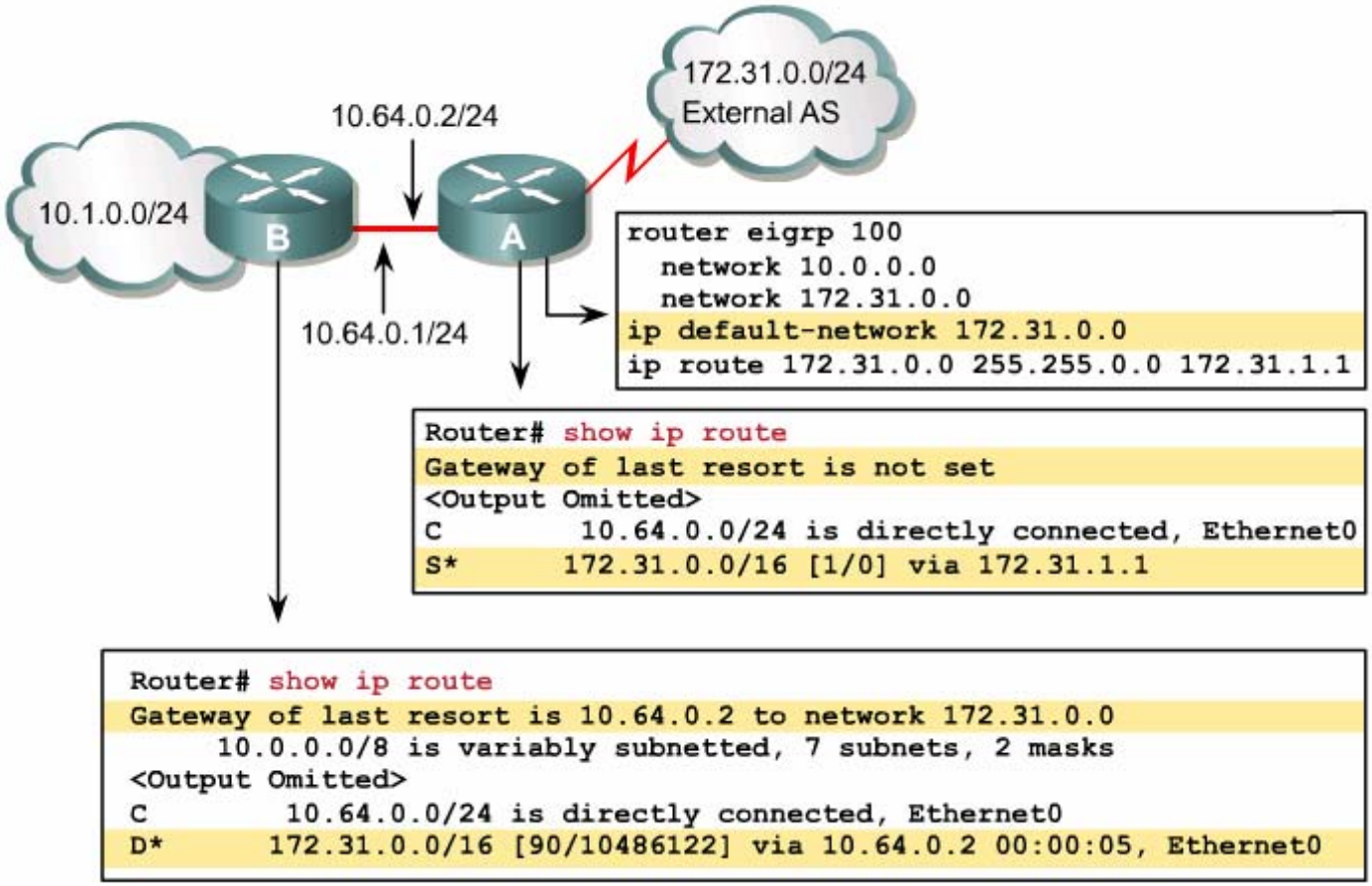
Manual auto summarization example



Router C sees 172.16.1.0 and 172.16.2.0, but sends only 172.16.0.0/16 out S0/0/0.

Propagácia default route

ip default-network NET_ID



Verifying EIGRP operation

Command	Description
show ip eigrp neighbors [type number] **[details]**	Displays EIGRP neighbor table. Use the type and number options to specify an interface. The details keyword expands the output.
show ip eigrp interfaces [type number] [as-number] **[details]**	Shows EIGRP information for each interface. The optional keywords limit the output to a specific interface or AS. The details keyword expands the output.
show ip eigrp topology [**as-number** | [[**ip-address**] mask]]	Displays all feasible successors in the EIGRP topology table. Optional keywords can filter output based on AS number or specific network address.
show ip eigrp topology [**active** | **pending** | **zero-successors**	Depending on which keyword is used, displays all routes in the topology table that are either active, pending, or without successors.
show ip eigrp topology all-links	Displays all routes, not just feasible successors, in the EIGRP topology.
show ip eigrp traffic [as-number]	Displays the number of EIGRP packets sent and recieved. Command output can be filtered by including an optional AS number.

Command	Description
debug eigrp fsm	This command helps in observing EIGRP feasible successor activity and to determine whether route updates are being installed and deleted by the routing process.
debug eigrp packet	The output of the command shows transmission and receipt of EIGRP packets. These packet types may be hello, update, request, query, or reply packets. The sequence and acknowledgment numbers by the EIGRP reliable transport algorithm are shown in the output.

Troubleshooting Routing Protocols

Troubleshooting Process

1. Analyze the network failure, make a clear problem statement.
2. Gather the facts needed to help isolate possible causes.
3. Consider possible problems based on the facts that have been gathered.
4. Create an action plan based on the remaining potential problems.
5. Implement the action plan, performing each step carefully while testing to see whether the symptom disappears.
6. Analyze the results to determine whether the problem has been resolved. If it has, the process is complete.
7. If the problem has not been resolved, create an action plan based on the next most likely problem in the list. Return to Step 4, change one variable at a time, and repeat the process until the problem is solved.
8. Once the actual cause of the problem is identified, try to solve it.

Use show Commands and TCP/IP Tools

Use Cisco IOS `show` Commands for the following activities:

- Monitoring router behavior during initial installation
- Monitoring normal network operation
- Isolating problem interfaces, nodes, media, or applications
- Determining when a network is congested
- Determining the status of servers, clients, or other neighbors

TCP/IP network tools:

- Extended **ping** refines basic **ping** operation for finer control.
- **ping** quickly tests end-to-end network connectivity.
- **traceroute** is used to identify bottlenecks or possibly locate broken network connections.
- **telnet** can be used to test proper end-to-end network connectivity.

Troubleshooting RIP Configuration

- Layer 1 or Layer 2 connectivity issues exist.
- VLSM subnetting is configured. VLSM subnetting cannot be used with RIPv1
- Mismatched RIPv1 and RIPv2 routing configurations exist.
- Network statements are missing or incorrectly assigned.
- The outgoing interface is down.
- The advertised network interface is down.

Cisco

```
R1#show ip protocols
Routing Protocol is "rip"
  Sending update every 30 seconds, next due in 19 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Outgoing update filter list for all interfaces is
  Incoming update filter list for all interfaces is
  Resdistributing: rip
  Default version control: send version 1, receive any version
  Interface               Send     Recv     Triggered RIP
  Key-chain
      FastEthernet0/0          1        1 2
    Automatic network summarization is in effect
  Routing for Networks:
       192.188.3.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.169.3.1           120      00:00:12
    Distance: (default is 120)
```

Cisco

```
R1#debug ip rip
R1#clear ip route *
3d08h: RIP: sending request on FastEthernet0/0 to
255.255.255.255
R1#
3d08h:  RIP: sending v1 flash update to
255.255.255.255 via FastEthernet0/0 (192.168.3.2)
3d08h:  RIP: build flash update entries
3d08h:   network 172.31.0.0 metric 1
R1#
3d08h:  RIP: received v1 update frmo 192.168.3.1 on
FastEthernet0/0
3d08h:       172.30.0.0 in 1 hops
3d08h:       172.16.0.0 in 2 hops

R1#
```

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Troubleshooting IGRP Configuration

- Check
  - Layer 1 or Layer 2 connectivity issues
  - Mismatched autonomous system numbers on IGRP routers
  - Network statements are missing or incorrectly assigned.
  - The outgoing interface is down.
  - The advertised network interface is down.

- To view IGRP debugging information, use the following commands:
  - **`debug ip igrp transactions [host ip address]`** `to view IGRP transaction information`
  - **`debug ip igrp events [host ip address]`** `to view routing update information`
- To turn off debugging, use one of the following commands
  - **`no debug ip igrp`**
  - **`no debug all`**
  - **`undebug all`**

Troubleshooting EIGRP Configuration

- V dnešnej prednáške.....

Troubleshooting OSPF Configuration

Command	Usage
`show ip protocols`	Displays parameters about timers, filters, metrics, networks, and other information for the OSPF routing process.
`show ip ospf interface`	Use this command to: • Display timer intervals and neighbor adjacencies • Determine if OSPF is enabled on the interface • Verify that interfaces between OSPF routers are in the same OSPF area
`show ip ospf neighbor`	Displays OSPF neighbor information on a per-interface basis.
`show ip route`	Displays the routes known to the router and how they were learned. This command is one of the best ways to determine connectivity between the local router and the rest of the Internetwork.