Failover and Route Redundancy for IP Based Networks

Willem AC0KQ

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The Goal

- Provide redundant connectivity using IPv4 network connections
- Requirements
  - Multiple connections
  - Router with multiple WAN ports
    - Consumer style hardware does not support this
- Purpose
  - Full redundancy vs. command and control backup
  - Inbound or outbound

Applications

- QTH acess to outside world
  - ISP failover to Starlink
  - ISP failover to Starlink, then cellphone network
- Remote site
  - Microwave link and VPN backup
  - VPN only site with multiple ISPs

Note that these make outbound connections

Failover vs. Load Balancing

- **Failover** uses one connection at a time
  - Selected using specified order
  - Link State Routing
  - Outbound is easier than symmetric or inbound
- **Load Balancing** uses all the connections on a per packet or per connection basis
  - Link aggregation or bonding for point-to-point
  - Usually includes failover

Connection Selections

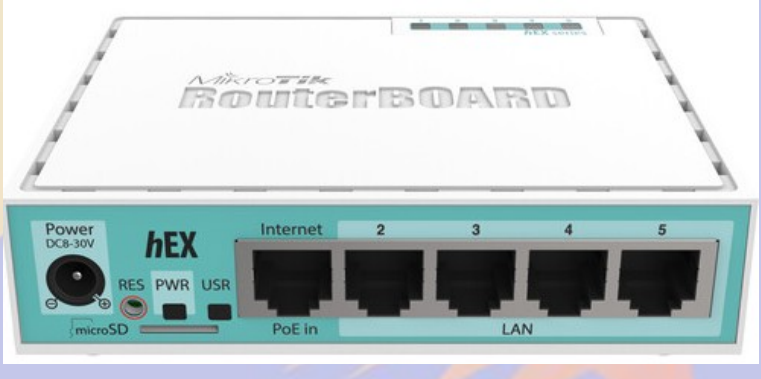
- Terrestrial microwave links
- Commercial ISPs (fiber, copper, wireless)
- Starlink (attractive metered pricing)
- Cellphone data networks
- Other data networks (CellWave, LoRa, ...)
  - Anything with an ethernet or fiber interface

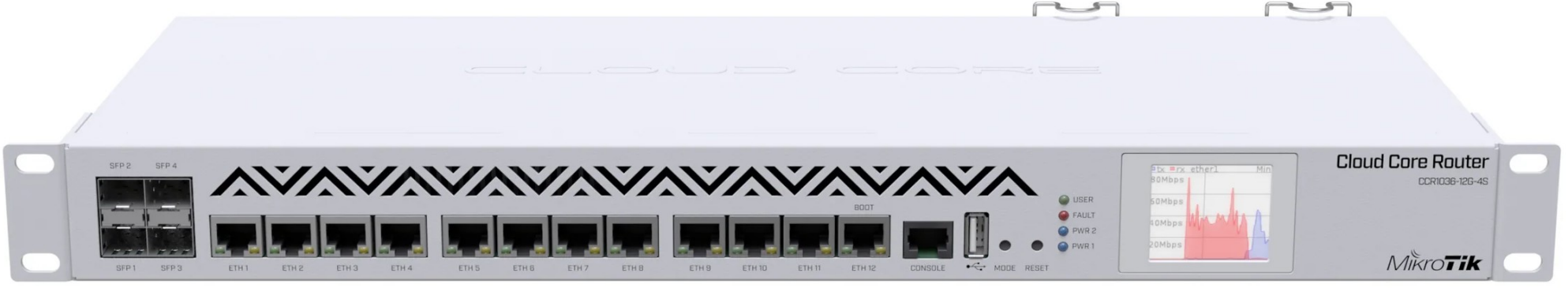
Router Hardware

- Any Unix/Linux box with multiple ethernet cards
  - Routing in software via the linux kernel
  - Wrapper programs like ***Sonicwall*** and ***pfSense*** do this
- Mikrotik Routerboard
  - Any port can serve any function
  - Hardware switching fabric for wire speed routing
  - Linux kernel tuned for routing
  - Inexpensive and wide range of capabilities
  - WinBox GUI simplifies configuration
- Cisco, Juniper, Arista, ...

Mikrotik Hardware

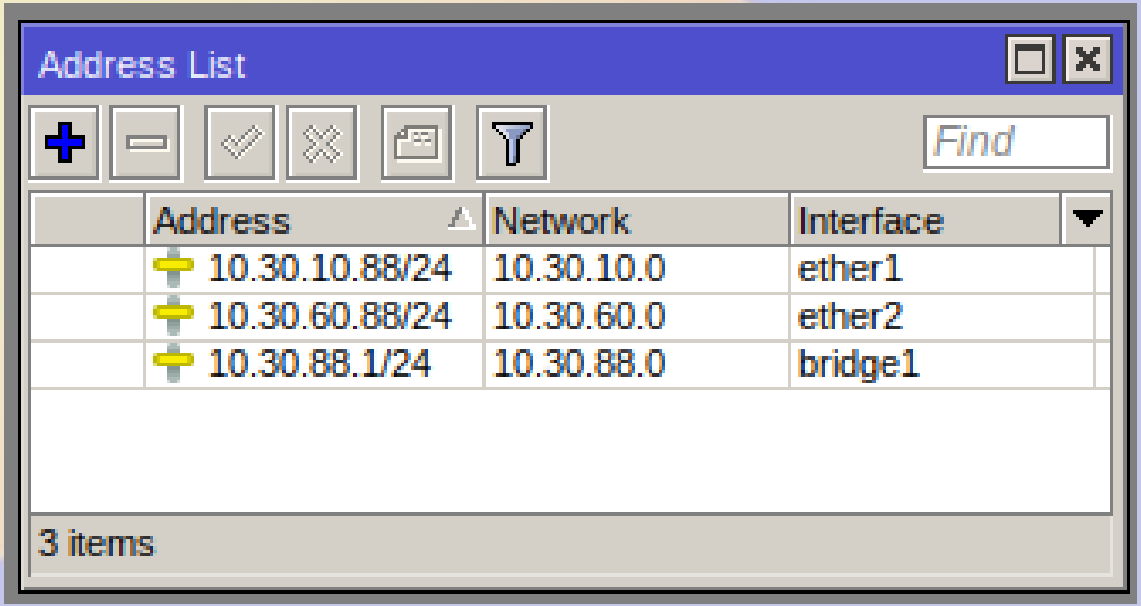
- Very capable
- Wide range of speeds
- Same user interface
- Inexpensive



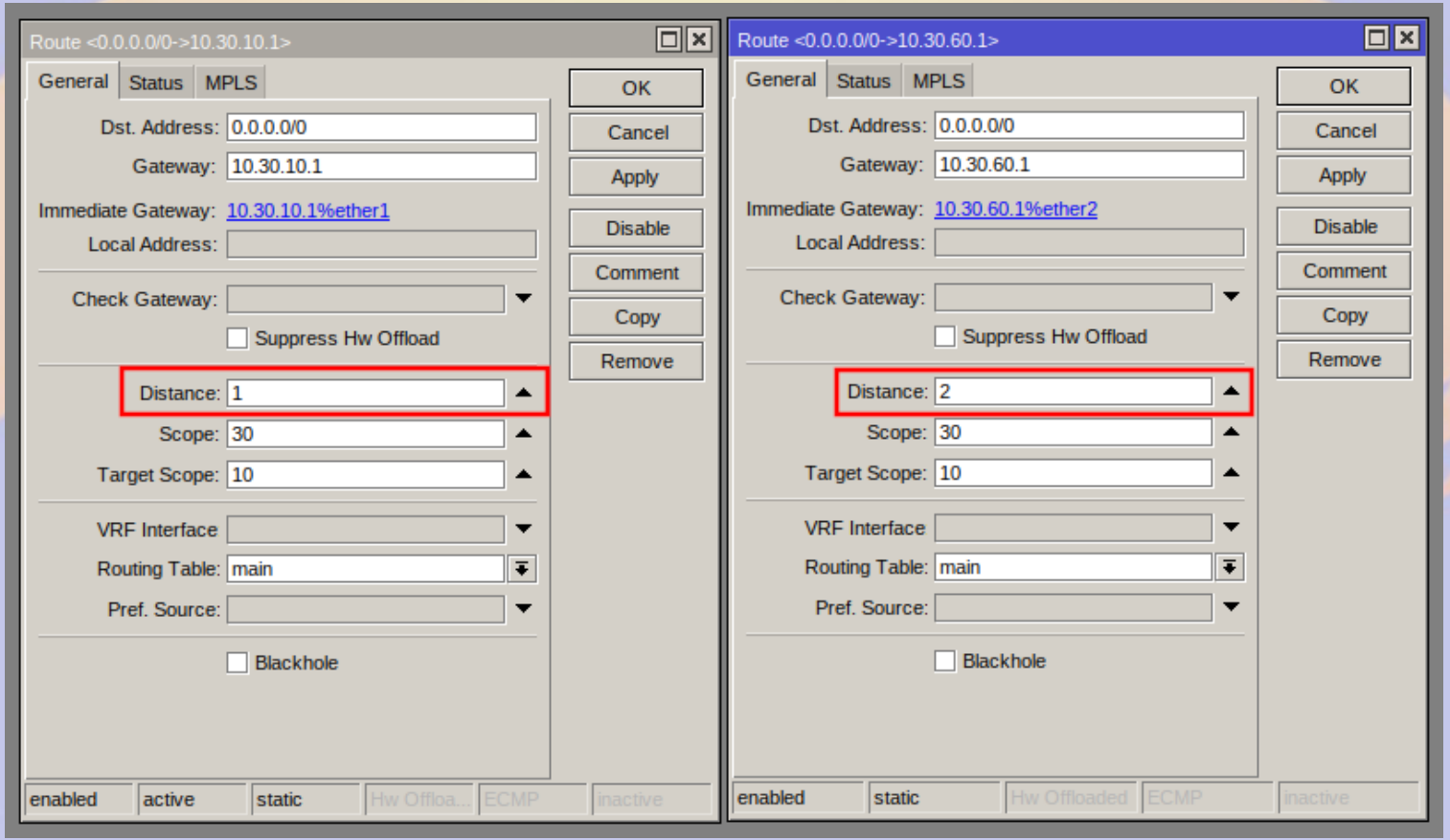


Route Distance Failover Scenario

- Two WAN addresses
  - 10.30.10.88/24, GW=10.30.10.1
  - 10.30.60.88/24, GW=10.30.60.1
- Local network
  - 10.30.88.1/24

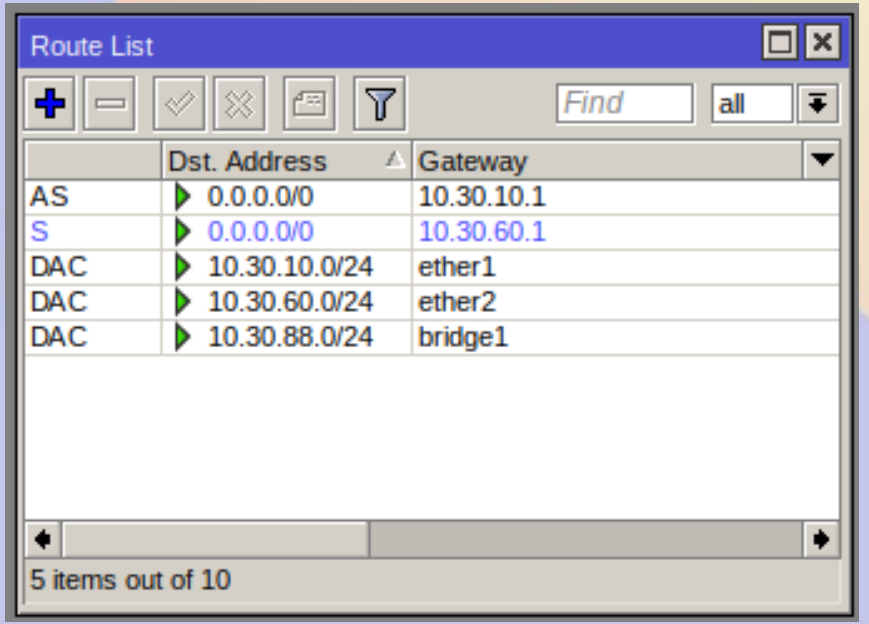


Distance Failover Default Routes

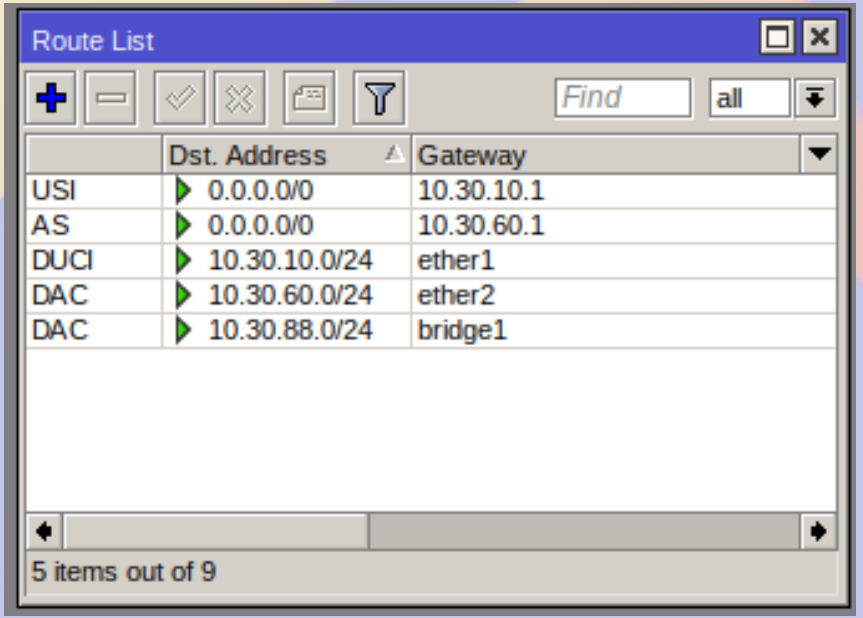


Route Failover

- Both active
  - AS=Active Static
  - blue means not selected



- Failed primary
  - USI=Unreachable, Static, Inactive

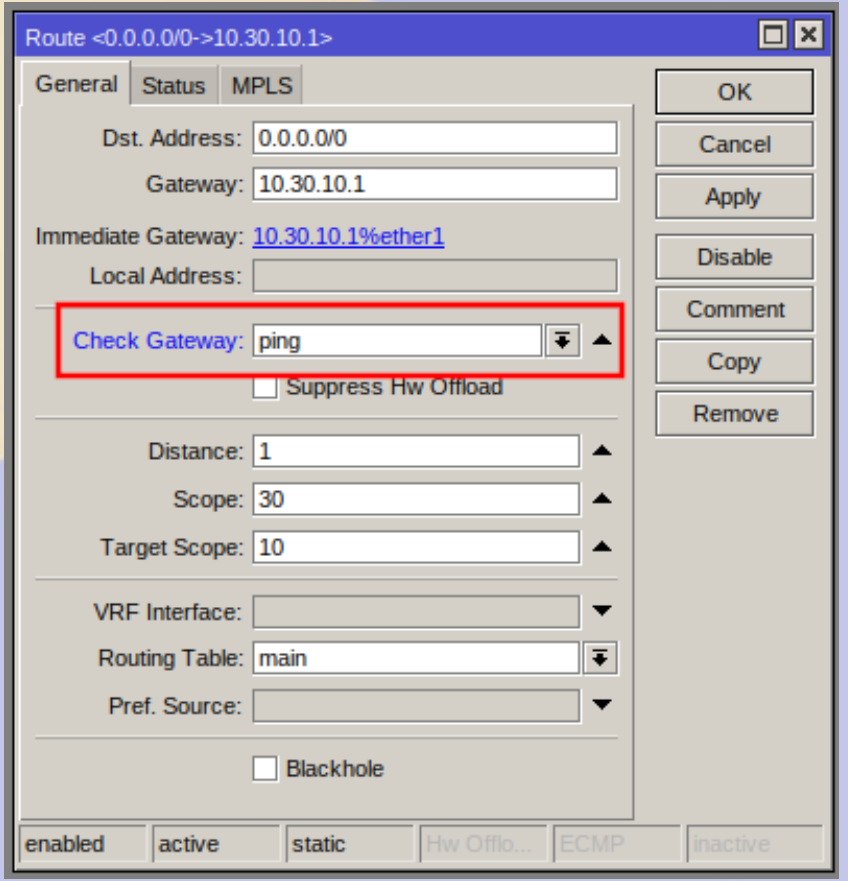


Route Distance Pros and Cons

- **Pros**
  - Easy to configure
  - Works with >2 links
  - Senses failure from link
  - Fails over/back fast
  - Works with default route
  - Works for static route
- **Cons**
  - Requires link to fail
  - Cannot sense downstream failures
    - Wireless link local radio OK but remote radio failed
    - Failure after next device
    - Failure at ISP

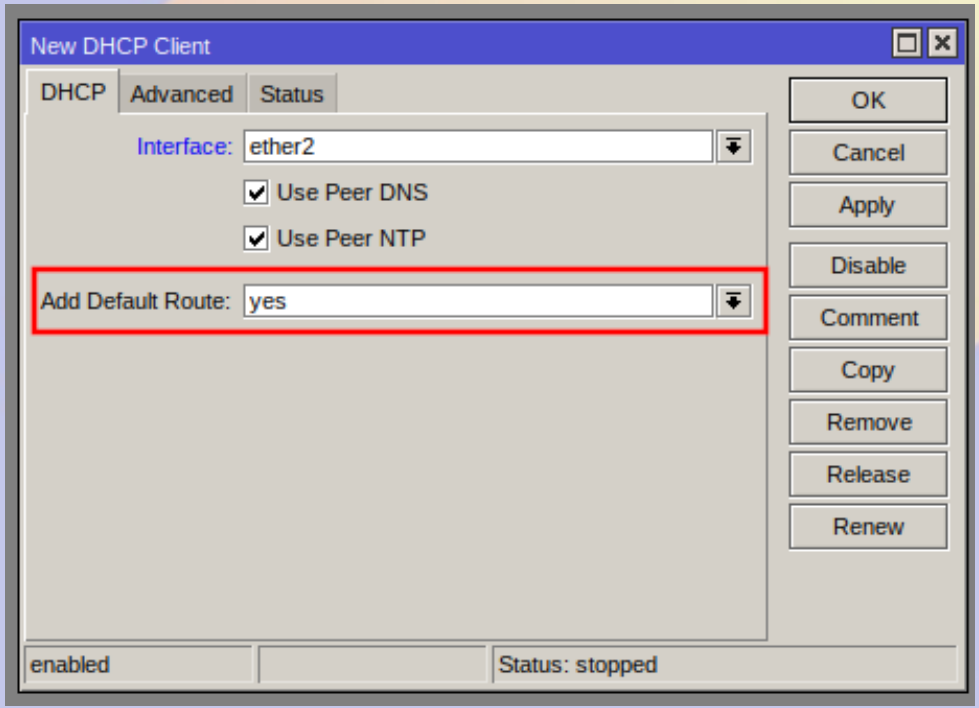
Failure on Wireless Links

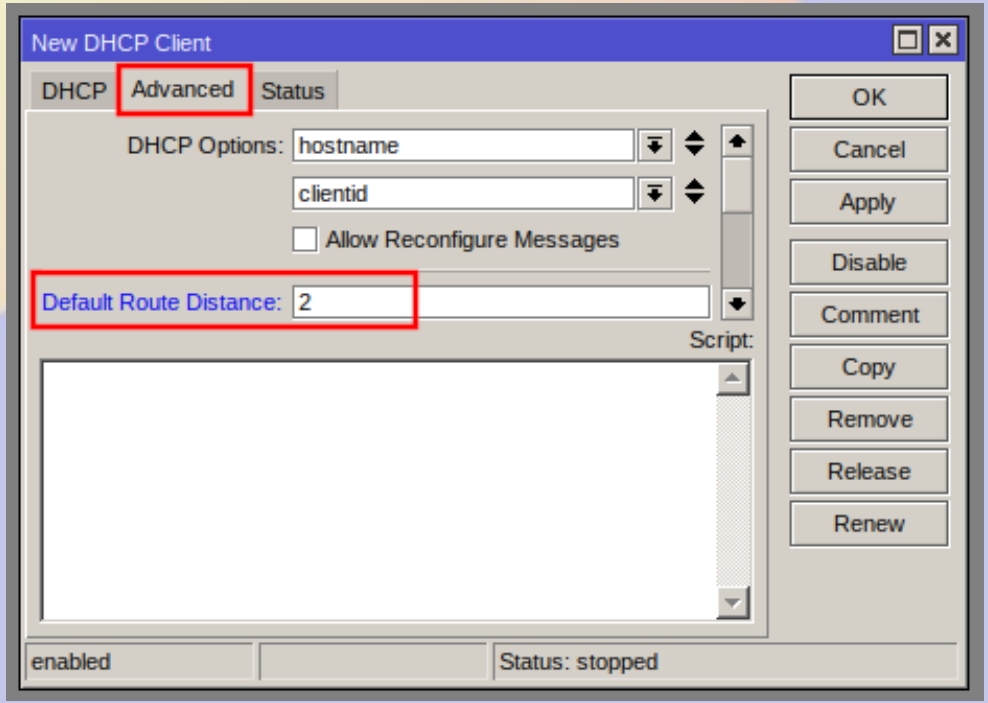
- Wireless links are bridged
  - Wireless link works like a wire
  - Link check only to local radio
- Set **check-gateway=ping**
- When pings fail, route is deactivated



Interfaces with DHCP

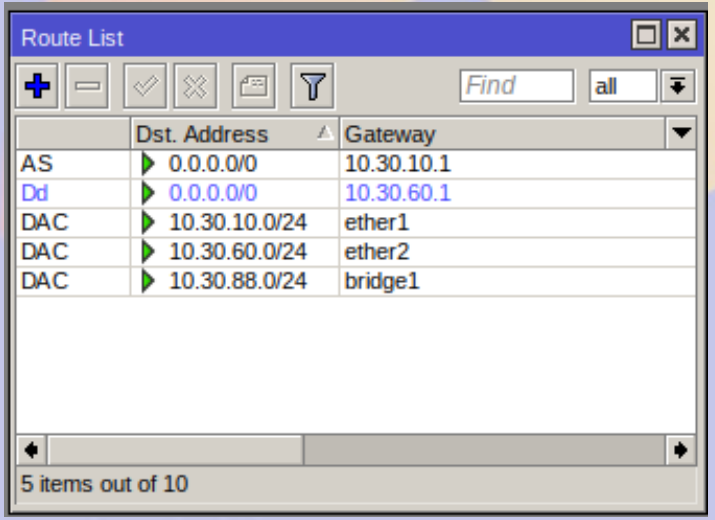
- Set default distance when adding interface

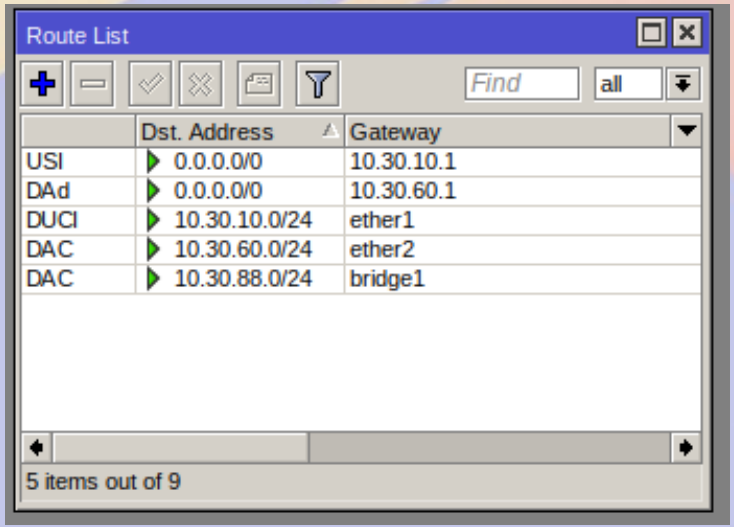




Failover with DHCP

- Primary active
  - Dd=Dynamic,DHCP
  - blue means not selected
- Failed primary
  - Dad=Dynamic,Active,DHCP



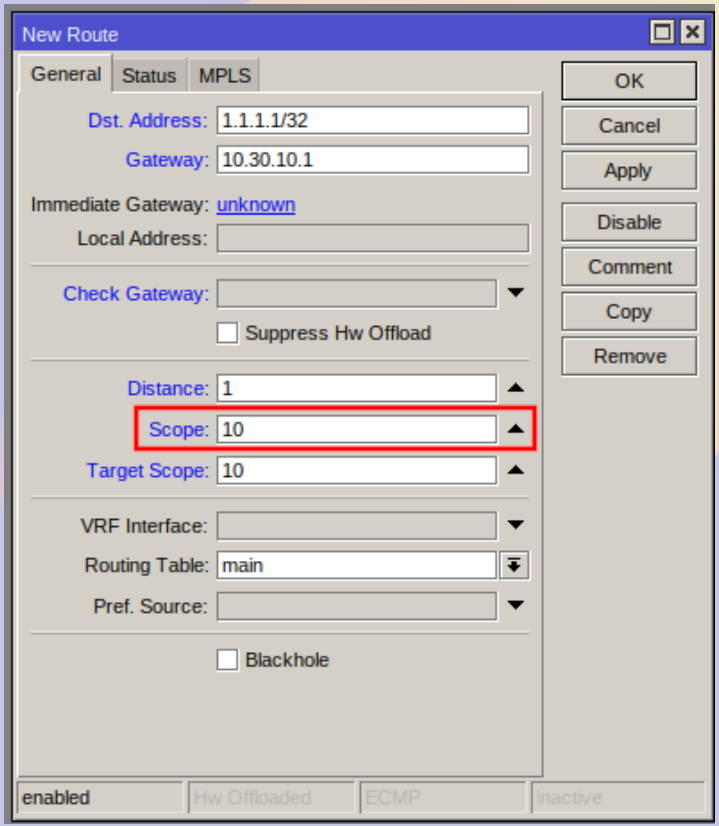


Recursive Routing

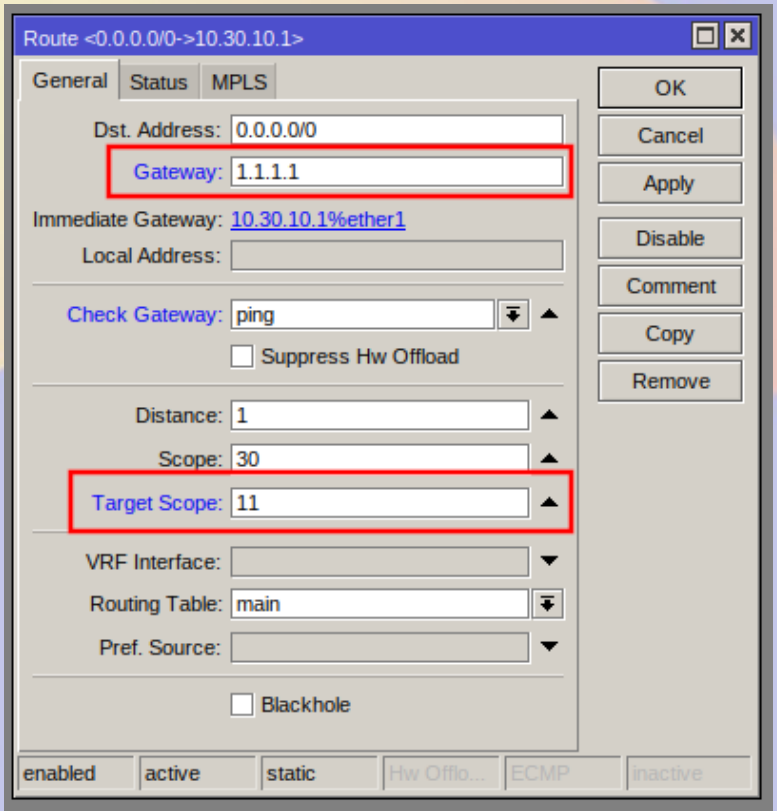
- Select a reliable remote target (e.g. 1.1.1.1)
  - This address will not be available if primary route fails
- Set a route to this address with **scope=10**
- Add a default route using
  - target address as gateway
  - **target scope** > scope of remote target (11>10)

Recursive setting

- Gateway route

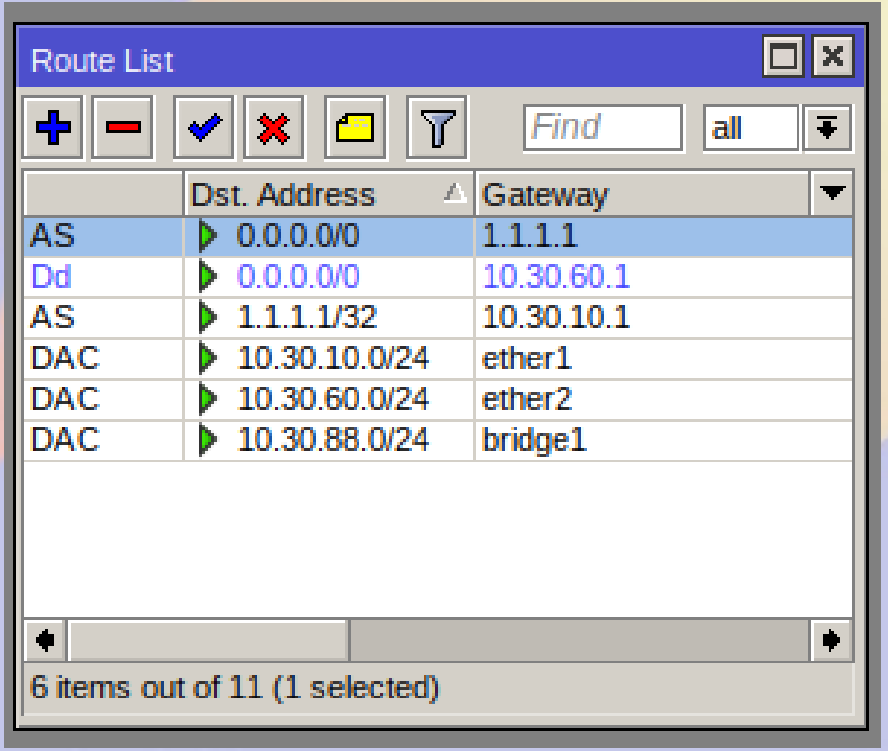


- Recursive default route

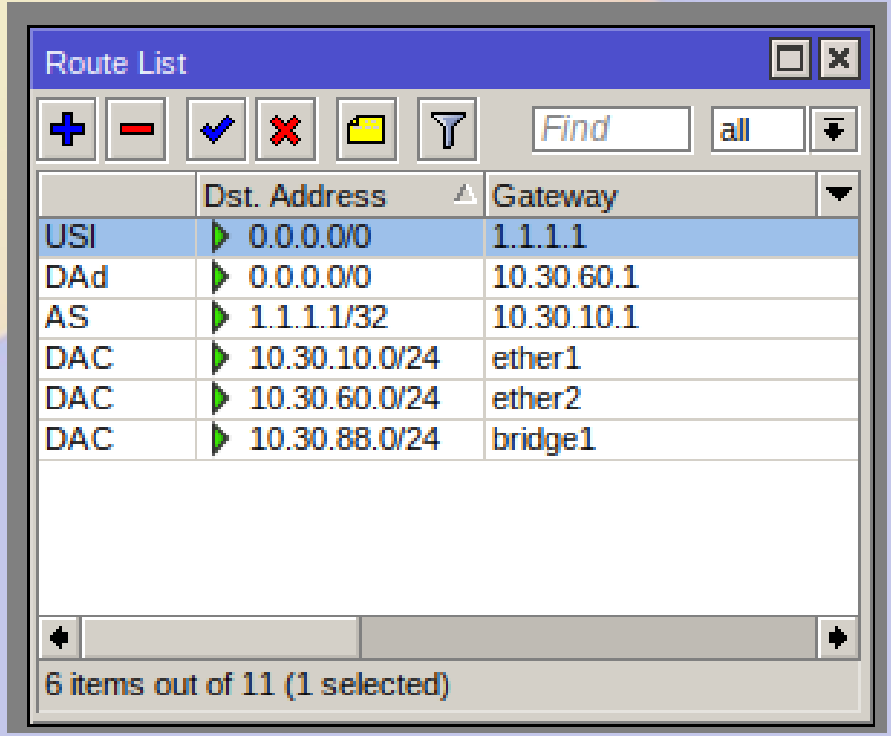


Recursive Routing in Action

- 1.1.1.1 reachable

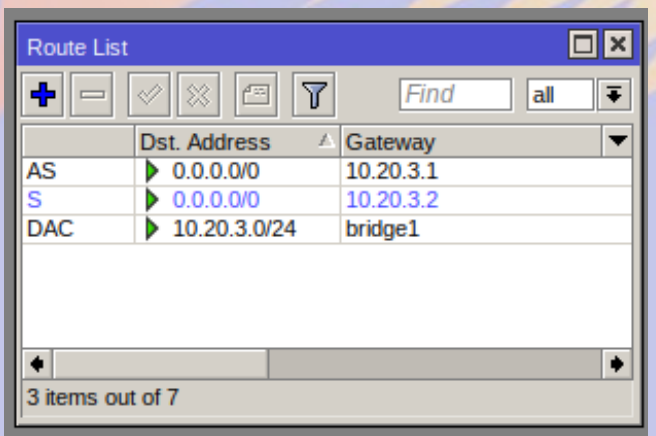


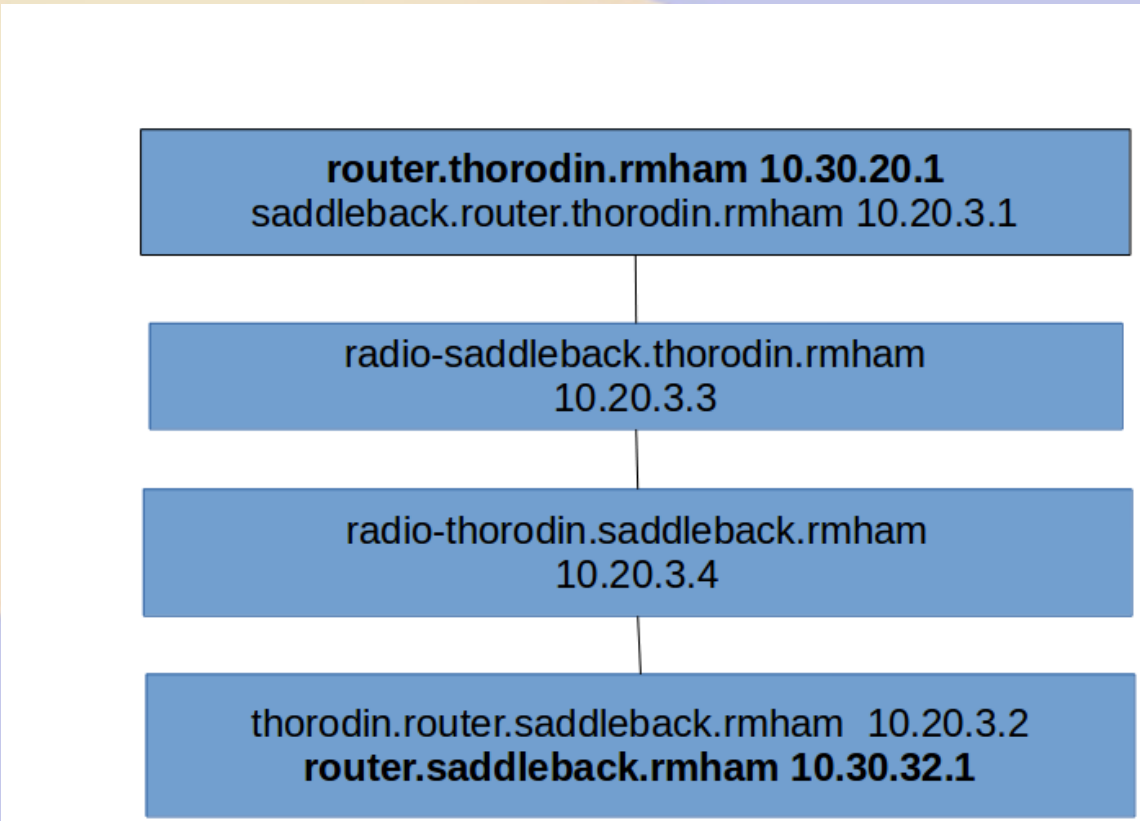
- 1.1.1.1 unreachable



Link radio Default Gateway failover

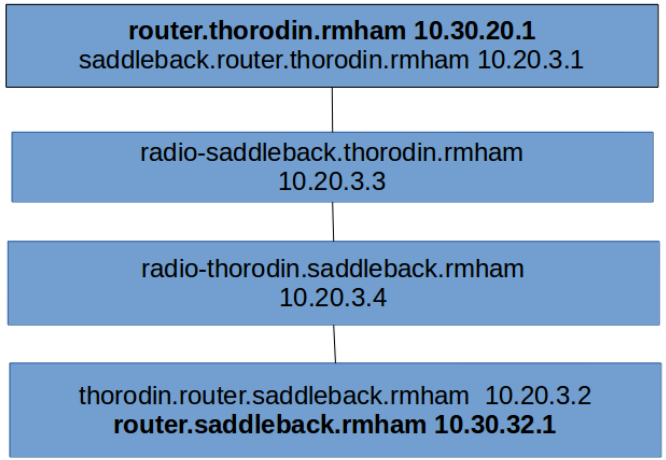
- Router link IP is **10.20.3.1** and **10.20.3.2**
- Radio IP is **10.20.3.3** and **10.20.3.4**

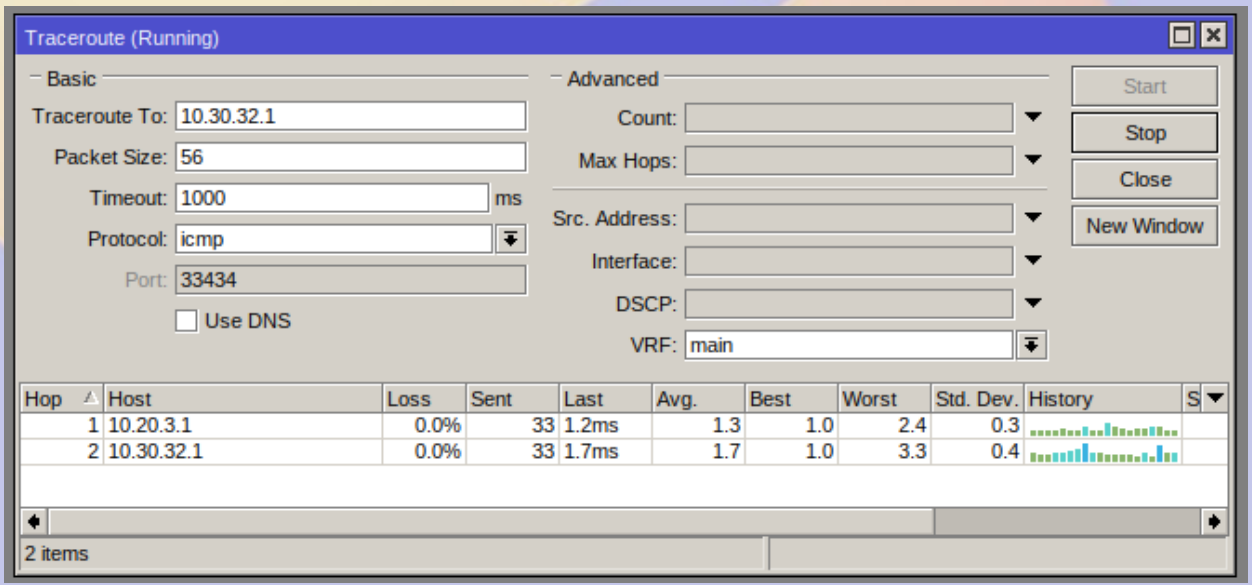




Traceroute from 10.20.3.4 to 10.30.32.1

- With only a default route, packets go to the default gateway, so they traverse RF link twice





When the RF link fails

- Default gateway **10.20.3.1** becomes unreachable from link radio **10.20.3.4**
- Therefore **10.20.3.4** is unreachable even when directly connected to **10.30.32.1**
  - Laptop IP is (say) **10.30.32.200**, default gateway **10.30.32.1**
  - **10.30.32.1** knows to send packets to **10.20.3.4**, but **10.20.3.4** tries to reply via **10.20.3.1**
  - Unless secondary default gateway is set to directly attached secondary interface **10.20.3.2**
  - Or you use a Layer 2 protocol like ROMON

Inbound Failover

- How do I know what IP to connect to
  - Where does this subnet connect to my network?
- DNS based failover
  - Publish both IP addresses with DNS
  - Connecting programs try other IP if first is unavailble
  - Does not work with NAT
    - When primary is up, request on secondary replies via primary

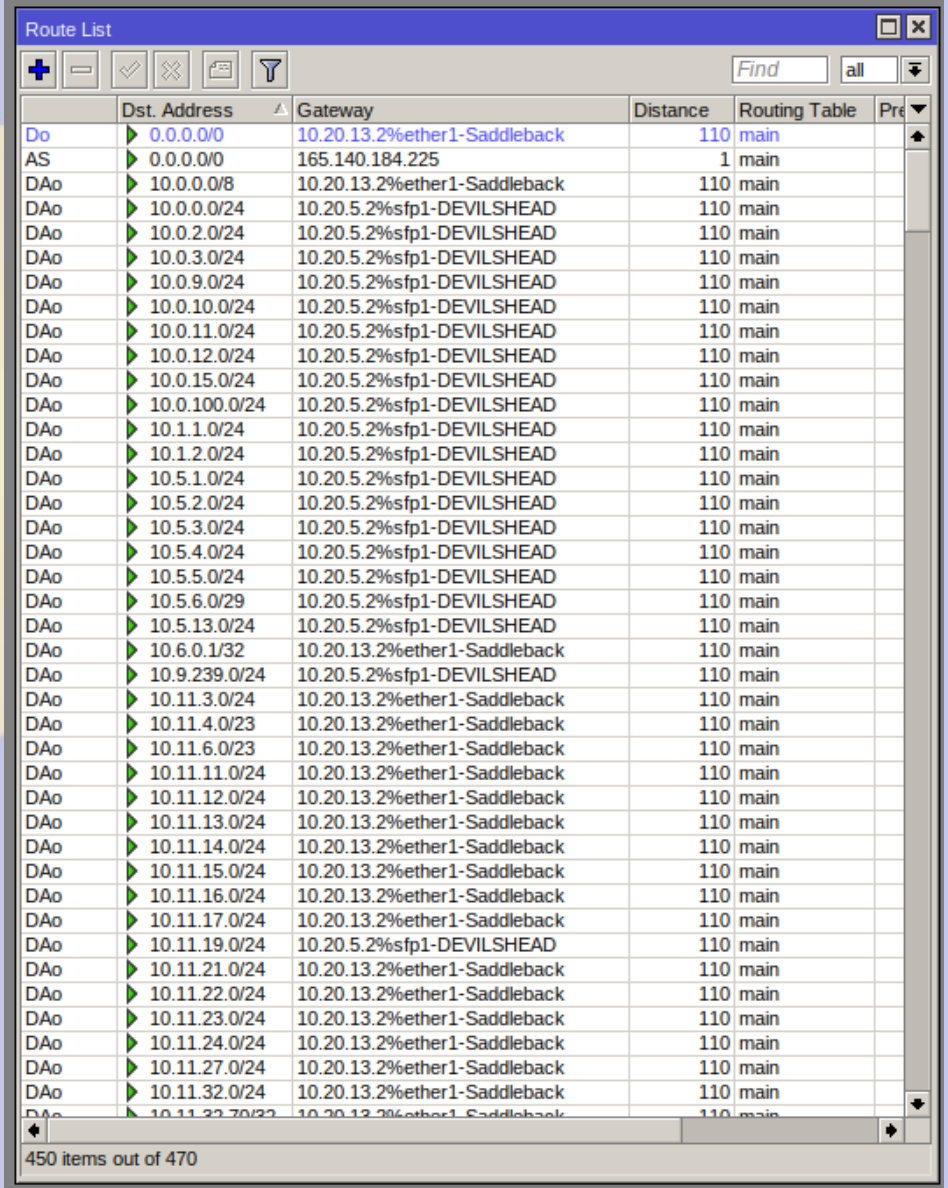
Network Wide Failover with OSPF

- **O**pen **S**hortest **P**ath **F**irst
  - Each link has an associated distance (weight)
  - Each router publishes routes it knows to neighbors
  - Dijkstra's algorithm find shortest open path
  - Each router only needs to know whom to send to next
- Link State Routing
  - Preferred route to each subnet (lowest weight/distance)
  - All routers know about all subnets (scales to 1000s)

OSPF Routes

(RMHAM Squaw Pass Site)

- Default route set both as static and OSPF
  - Fails to RF when ISP is down
- Other subnets discovered from neighbors
  - Devilshead
  - Saddleback



OSPF on the RMHAM network

- Alternate RF paths with failover to VPN
- Multi-homed VPN only sites
- Multiple outlets to commercial internet
- Fast (<5 seconds to fail over)

Questions?