

Verizon Wireless Dynamic Mobile Network Routing LTE - Cisco Integrated Services Router (ISR) and Connected Grid Router

Mobile Router Configuration Guide for
Router Redundancy
Primary Wireless Access

Revision 6.4

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Overview

Verizon Wireless Dynamic Mobile Network Routing is a network-based Mobile IP technology capable of providing dynamic routing and support for mobile or stationary enterprise routers in primary wireless access or automatic wireless backup configurations. It enables integration between wireless and wireline enterprise services (4G Wireless WAN) by making use of the Mobile IPv4 NEtwork MObility (NEMO) protocol and without the need for end to end overlay tunneling.

Dynamic Mobile Network Routing (DMNR) is part of the Verizon Wireless Mobile Private Network. DMNR is compatible with the Cisco IOS Mobile IP Mobile Networks feature. DMNR makes use of the Collocated-Care-of-Address (CCOA) option and supports IP sub-net registration, routing and forwarding.

This configuration guide shows an example using Verizon Wireless DMNR service with always-on 4G LTE access for the purpose of providing backup communications between two co-located redundant branch routers.

The always-on backup configuration shown in this example can be used to maintain the backup routing path all the time and switch to it based on loss of routing over the primary path through the primary router. Since the connection and routing state of the backup path is always maintained the switch to backup does not involve the time to activate the wireless and NEMO sessions.

Notes

1. Cisco Integrated Services Routers Generation 2 (ISR G2) and CGR routers with integrated 4G LTE cards are supported (V or VZ SKUs, 1900, 2900, 3900, and CGR2010 Series with LTE GRWIC). Cisco 819 and 899 ISRs with embedded LTE are supported. Cisco ISR 4Ks (4321, 4331, 4351, 4431, 4451) with LTE NIM are supported.
2. The minimum Cisco IOS software release depends on the LTE modem firmware level (seen via IOS command "show cell 0/x/0 hardware" for LTE eHWIC/NIM/GRWIC, "show cell 0 hardware" for 819/899).
 - a. EHWIC-4G-LTE-V, C819G-4G-V-K9, GRWIC-4G-LTE-V: Firmware release 1.0.9.3 is no longer recommended. It should be upgraded to firmware 3.5.10.6. IOS 15.2(4M2) should be used to upgrade the firmware. Firmware 3.5.10.6 and install instructions are available at: <http://software.cisco.com/download/release.html?i=y&msgid=284772061&softwareid=284285628&release=3.5.10.6&os=>
 - b. EHWIC-4G-LTE-V, C819G-4G-V-K9, GRWIC-4G-LTE-V: Firmware release 3.5.10.6 is the recommended release: The IOS recommended release with LTE firmware 3.5.10.6 is IOS 15.5(2)T or later T release.
 - c. EHWIC-4G-LTE-VZ, NIM-4G-LTE-VZ, 8x9 VZ models (XLTE models):
Firmware release 5.5.58.1 is the minimum release. The recommended IOS release is 15.5(2)T or later T release for ISR 1900/2900/3900 series, and IOS XE 3.16 for ISR 4000 series.
3. ISR 1900, 2900, 3900 and 4000 series require an IOS Software data license for MPN/DMNR (NeMo support). This is included by default with 800 series. The data license is acquired by ordering the AppX license. A 60 day temporary data license can be immediately generated using an IOS configuration mode command (requires an IOS reload to take effect). Below are examples for ISR G2 and 4K series.
license boot module c1900 technology-package datak9. The keyword following "module" varies based on ISR model c1900, c2900, c3900. For ISR 4000 series, the configuration mode command is as follows:
license boot level appxk9 the command is the same for all ISR 4K models.

4. To connect a Network Mobility (NEMO) session to the Verizon Wireless Enterprise GateWay (EXGW), the enterprise MPN must be provisioned for 4G, and the subscriber mobile line (subscriber identity module [SIM]) used by the mobile router enhanced high-speed WAN interface card (eHWIC, NIM or GRWIC or embedded in an 819 or 899) must have NEMO permission provisioned by Verizon Wireless.

The enterprise Access Point Name (APN) must be correctly provisioned in the Verizon Wireless network in order to make a successful private network connection. In addition, the APN must be appropriately set on the modem for LTE and eHRPD profiles, either automatically through Over-The-Air Device Management (OTA-DM) or locally on the ISR. If OTA-DM does not update the APN, it can be set manually on the ISR. The method of manually setting the APN is via a single enable-mode IOS command. An example is shown below:

```
cellular 0/0/0 lte profile create 3 ne01.VZWSTATIC
```

(Note that the Data APN is profile 3). The middle “0” can be 0, 1, 2 or 3 depending on which ISR slot the LTE module is installed. For 819 and 899, use “cellular 0”. The value “ne01.VZWSTATIC” is a sample APN. The appropriate APN must be provided by Verizon Wireless.

5. To connect a NEMO session to the EXGW, the mobile router must be configured with the correct Security Parameter Index (SPI) and key. For the current release of DMNR, the correct values are provided in this guide.
6. To connect a NEMO session to the EXGW, the mobile router must be configured with the correct IP address of the NEMO High Availability (NEMO-HA) service. The address depends on the location of the EXGW. For the appropriate address, please contact your Verizon representative.
7. At least one ISR interface must be registered by the mobile router when the NEMO call is made to the EXGW. The interface must be in UP/UP state (loopback interface is recommended).
8. Directly connected and non-connected mobile network prefixes may be configured for registration by the mobile router. The mobile networks are registered by specifying the connected interface name or by using the “non-connected-network” command. If non-connected subnets are required, please refer to the guide “DMNR with Secondary IP and Nonconnected Subnets” available here: www.cisco.com/c/en/us/support/interfaces-modules/high-speed-wan-interface-cards/products-installation-and-configuration-guides-list.html
9. It is not recommended to configure secondary IP addresses on the interfaces that are registered by the mobile router unless it is intended by design. In Cisco IOS Software a secondary IP address is listed first under the interface configuration, and its subnet will be the only one that is inserted into the NEMO prefix list from that interface. If secondary IP addresses are required, please refer to configuration guide “DMNR with Secondary IP and Nonconnected Subnets” mentioned above.
10. The EXGW will accept up to 8 subnets in the NEMO registration prefix list. Subnets in excess of 8 will be silently ignored. Registering a summary address using “non-connected-network” stated above may assist.
11. After a successful NEMO registration, the mobile router will automatically bring up a generic-routing-encapsulation (GRE) tunnel interface (Tunnel0) and will install a dynamic Mobile Default route to that interface.
12. Ensure that no static routes pointing to interface **Cellular 0/x/0** (Cellular 0 for 819 or 899) exist in the mobile router configuration.
13. The dynamic Tunnel0 interface will have the IP maximum transmission unit (MTU) of 1476 bytes. IP packets whose lengths exceed 1440 bytes will require fragmentation. For TCP traffic the **ip tcp adjust-mss** command may be used as shown in this guide to avoid fragmentation. If the mobile router needs to handle large non-TCP packets that have the Don't Fragment (DF) bit set, a route-map that clears the DF bit should be applied to the LAN interface of the mobile router.
14. Ensure that the **ip virtual-reassembly** command is not present on interface **Cellular 0/x/0**.

15. The Verizon Wireless Network will preserve the quality-of-service (QoS) markings (type of service/differentiated services code point [ToS/DSCP]) that have been set in the original IP packet header.
16. The changes to the subnet (prefix) list registered by the mobile router take effect on EXGW immediately while the NEMO session is running. No coordination is needed to advertise new subnets beyond ISR configuration.
17. While the Wireless/NEMO session is on periodic (~every 10 min) NEMO re-registration packets (~200 bytes) will be sent by the router and replies sent by EHA. At all other times the backup connection state will be maintained but the radio traffic channel will be in a dormant state.
18. The administrative distance for routes learned via NEMO (M routes) can be changed from the default value of 3. The “distance” command can be configured under the “router mobile” stanza.
19. While the primary BGP routing is operational, the traffic will be routed symmetrically over the primary path.

Always-On Backup Access Design Requirements and Recommendations

When the primary circuit is operational the backup wireless/NEMO session shall be connected.

Switch to backup shall be triggered by physical or logical failure on the primary circuit (e.g. loss of routing).

Once the primary circuit is restored all traffic shall be reverted to the primary path. When the primary path is operational traffic will be routed over the primary path symmetrically.

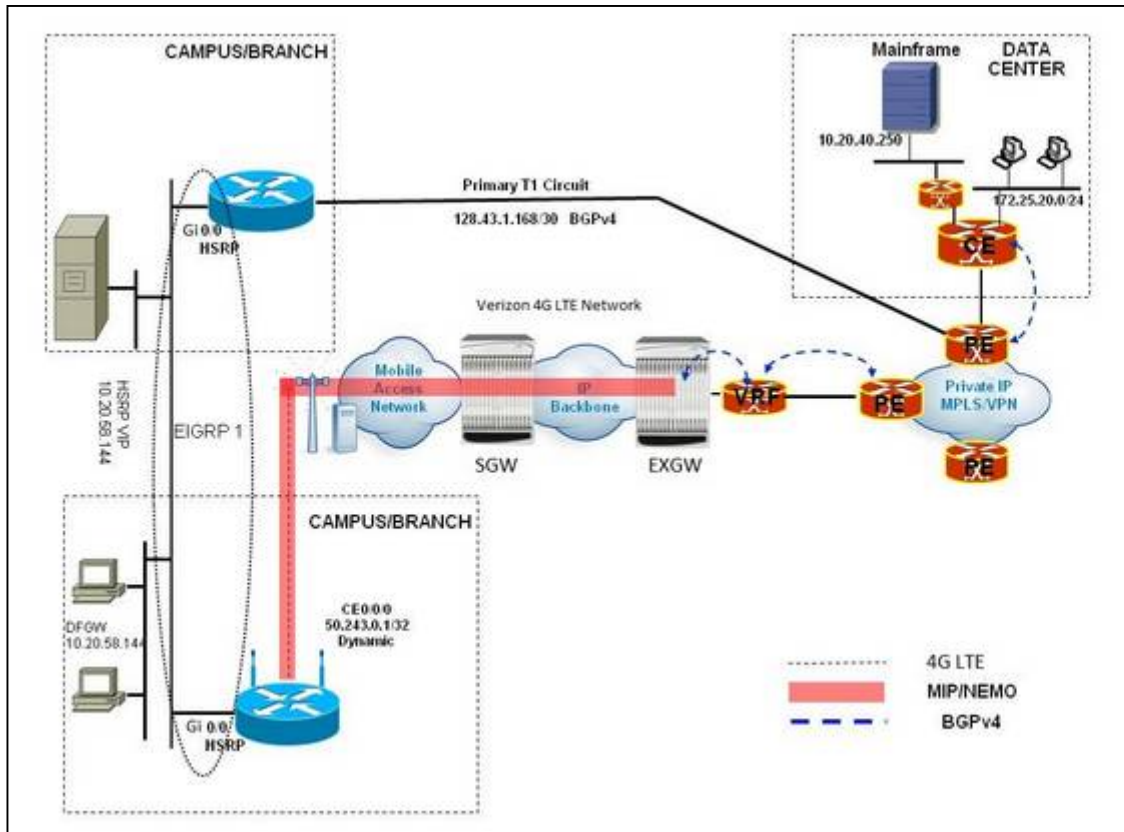
If an LTE connection cannot be made, the APN value on the LTE eHwic modem should be checked (ISR command **show cellular 0/x/0 profile**). If it is not the enterprise APN, please refer to planning section above.

Although this configuration guide should be used first, additional information is available at:

- www.cisco.com/go/4g under "Configuration and Deployment Guides"
- LTE eHwic (ISR G2) hardware overview, SIM installs, antenna connection, and module install: www.cisco.com/en/US/docs/routers/access/interfaces/ic/hardware/installation/guide/EHWIC-4G-LTEHW.html.
- LTE eHwic (ISR G2) Cisco IOS Software configuration monitoring and troubleshooting: www.cisco.com/en/US/docs/routers/access/interfaces/software/feature/guide/EHWIC-4G-LTESW.html.
- LTE NIM (ISR 4K) hardware overview, SIM installs, antenna connection, and module install: www.cisco.com/c/en/us/td/docs/routers/access/interfaces/NIM/hardware/installation/guide/4GLTENIM_HIG.html
- LTE NIM (ISR 4K) IOS XE Software configuration guide www.cisco.com/c/en/us/td/docs/routers/access/interfaces/NIM/software/configuration/guide/4GLTENIM_SW.html

The CGR-2010 LTE GRwic is configured in the same manner as the LTE eHwic.

The following diagram shows the customer design scenario:



PRIMARY ISR Configuration (2911)

```

hostname NEMO-2911
!
ip cef
!
!### T1 Controller for Primary Circuit ###
controller T1 0/0/0
channel-group 0 timeslots 1-24
!
! ### The next 2 commands define the Serial Interface state as the tracked
object. If this object changes state to line-protocol down the router's HSRP
application will decrement the HSRP priority of the F0/0 interface by 20,
making the NEMO router LAN interface the active HSRP interface. ###
!
track 1 interface Serial0/0/0:0 line-protocol
carrier-delay
!
interface Loopback1985
 ip address 198.50.1.1 255.255.255.0
!
! ### HSRP is configured on the LAN interface. LAN traffic is sent to the
active router. HSRP priority is changed from the default 100 to 110 so this is
the HSRP Active Router. Upon state change, priority is decremented by 20, and
the NEMO router LAN interface the HSRP Active Router. ###
!
interface GigabitEthernet0/0
 ip address 10.20.58.141 255.255.255.128
 duplex auto
 speed auto
 standby 1 ip 10.20.58.144
 standby 1 priority 110
 standby 1 preempt
 standby 1 track 1 decrement 20
!
! ### This is the Primary access circuit. ###
interface Serial0/0/0:0
 ip address 128.43.1.174 255.255.255.252
!
! ### This is the EIGRP routing process required to run between the Primary
Router and the NEMO Backup Router. ###
!
router eigrp 1
 redistribute bgp 65435 metric 1500 1000 255 1 1500
 network 10.20.58.141 0.0.0.0
 network 198.50.1.1 0.0.0.0
 no auto-summary
!
! ### This is the BGP routing process for the primary circuit. ###
!
!
router bgp 65435
 bgp log-neighbor-changes
 neighbor 128.43.1.173 remote-as 19262
!

```

```

address-family ipv4
  redistribute connected
  redistribute eigrp 1
  neighbor 128.43.1.173 activate
  no auto-summary
  no synchronization
exit-address-family
!
end
  
```

Backup ISR Configuration (1941 with LTE and Verizon DMNR service)

```

hostname c1941-NEMO
!
ip cef
!
! ### CHAT script to make a data call ###.
chat-script lte "" "AT!CALL1" TIMEOUT 20 "OK"
!
controller Cellular 0/0
!
! ### The following two commands define a default route (0/0) as the tracked
object. If this object changes state to DOWN the router's EEM applet (see
later in config) will refresh the local IP routing table so that the Mobile
default route takes over immediately. ###
!
track timer ip route 1
track 1 ip route 0.0.0.0 0.0.0.0 reachability
!
interface Loopback1
 ip address 10.20.58.2 255.255.255.128
!
! ### This Loopback and IP are required to setup NEMO. This address is not
routable and is used as a placeholder "dummy" address. It should be the same
on all NEMO routers. Any interface number and any IP can be used. Please use
1.2.3.4 for consistency if possible. ###
!
interface Loopback1234
  description ### NEMO Router Home Address - Dummy non-Routable IP ###
  ip address 1.2.3.4 255.255.255.255
!
interface Loopback1985
 ip address 198.50.2.2 255.255.255.0
!
interface Loopback2911
 ip address 198.50.1.1 255.255.255.0
!
! ### This subnet is routed by NEMO. The maximum TCP MSS is set to 1390 bytes
resulting in maximum TCP/IP packet size that will not cause fragmentation
after NEMO and other network overhead. The route-map applied clears the DF bit
in the IP headers. HSRP is configured on this interface. It is part of the
  
```

```

same HSRP group as the Primary Router and configured with the default priority
of 100. In normal operation this interface will be in HSRP Standby state. ###
!
interface GigabitEthernet0/0
 ip address 10.20.58.140 255.255.255.128
 standby 1 ip 10.20.58.144
 standby 1 preempt
 ip tcp adjust-mss 1390
 ip policy route-map clear-df
 duplex auto
 speed auto
!
!### Interface Cellular - the LTE and NEMO interface. Receives Pool/WAN IP
(dynamic or static) from EXGW. ###
!
interface Cellular0/0/0
 ip address negotiated
 no ip unreachable
 ip mobile router-service roam
 ip mobile router-service collocated ccoa-only
 encapsulation slip
 load-interval 30
 dialer in-band
 dialer idle-timeout 0
 dialer enable-timeout 1
 dialer string lte
 dialer watch-group 1
 async mode interactive
 pulse-time 0
!
! ### This is the EIGRP routing process required to run between the Primary
Router and the NEMO Backup Router. The EIGRP external AD is set to 2 so that
in normal operation the default route redistributed from BGP on the Primary
Router gets installed in the RIB and not the Mobile default [AD = 3]. ###
!
router eigrp 1
 network 10.20.58.140 0.0.0.0
 network 198.50.2.2 0.0.0.0
 redistribute mobile metric 1500 1000 255 1 1500
 distance eigrp 90 2
!
! ### Enables the Mobile IP routing process. ###
router mobile
!
! ### This command configures NEMO authentication with the EHA. Note that
66.174.160.160 is the IP address of the NEMO service on the EHA. Please use
the appropriate EXGW IP address based on the geographic location. Note that
SPI and KEY must match to what is set on the EHA under the NEMO service. Note
that the algorithm must be set to "hmac-md5". ###
!
ip mobile secure home-agent 66.174.160.160 spi decimal 256 key ascii VzWNeMo
algorithm hmac-md5
!
! ### This configures NEMO Mobile Router parameters and defines what router
interfaces/subnets to be included into the NEMO registration with the EHA. ###
!

```



```

ip mobile router
  address 1.2.3.4 255.255.255.0
  collocated single-tunnel
  home-agent 66.174.160.160
  mobile-network GigabitEthernet0/0
  mobile-network Loopback2911
  register extend expire 10 retry 3 interval 5
  reverse-tunnel
  tunnel mode gre
!
! ### This section defines wireless call activation triggers and timers. ###
! ### The call will be triggered by this statement. The address "5.6.7.8" is
! a "dummy" route. Any "dummy" value can be used. ###
!
dialer watch-list 1 ip 5.6.7.8 0.0.0.0
!
! ### The router will wait for 30 seconds before activating the call after the
! initial boot. ###
!
dialer watch-list 1 delay route-check initial 30
!
! ### The router will wait 1 second before activating the call. ###
!
dialer watch-list 1 delay connect 1
!
! ### Route-map clears the DF-bit (allows fragmentation) in IP packets that
! come into the router from the GE0/0 interface. ###
!
route-map clear-df permit 10
  set ip df 0
!
line 0/0/0
  script dialer lte
  modem InOut
  no exec
  transport input telnet
!
! ### This section defines a local event manager applet to track the state of
! the primary default route and will refresh the IP routing table in the event
! the default route gets withdrawn so that the mobile default route takes over
! immediately (without waiting for the next NEMO re-registration). ###
!
event manager applet NEMO-BACKUP
  event track 1 state down
  action 1.0 cli command "enable"
  action 2.0 cli command "clear ip route *"
  
```

Operation and Show commands

Primary Path is Operational – Normal State

Primary Router: 2911

```
NEMO-2911#show ip route
```

```
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
```

```
Gateway of last resort is 128.43.1.173 to network 0.0.0.0
```

```
128.43.0.0/30 is subnetted, 1 subnets
C    128.43.1.172 is directly connected, Serial0/0/0:0
D    198.50.2.0/24 [90/156160] via 10.20.58.140, 4d00h, GigabitEthernet0/0
10.0.0.0/25 is subnetted, 1 subnets
C    10.20.58.128 is directly connected, GigabitEthernet0/0
C    198.50.1.0/24 is directly connected, Loopback1985
B*   0.0.0.0/0 [20/0] via 128.43.1.173, 00:02:57
```

```
NEMO-2911#show ip bgp summary
```

```
BGP router identifier 198.50.1.1, local AS number 65435
```

| Neighbor | V | AS | MsgRcvd | MsgSent | TblVer | InQ | OutQ | Up/Down |
|--------------|---|-------|---------|---------|--------|-----|------|----------|
| State/PfxRcd | | | | | | | | |
| 128.43.1.173 | 4 | 19262 | 27189 | 26975 | 23 | 0 | 0 | 00:03:04 |
| | | | | | | | | 1 |

```
NEMO-2911#show standby
```

```
GigabitEthernet0/0 - Group 1
```

```
State is Active
```

```
32 state changes, last state change 4d00h
```

```
Virtual IP address is 10.20.58.144
```

```
Active virtual MAC address is 0000.0c07.ac01
```

```
Local virtual MAC address is 0000.0c07.ac01 (v1 default)
```

```
Hello time 3 sec, hold time 10 sec
```

```
Next hello sent in 2.384 secs
```

```
Preemption enabled
```

```
Active router is local
```

```
Standby router is 10.20.58.140, priority 100 (expires in 9.712 sec)
```

```
Priority 110 (configured 110)
```

```
Track object 1 state Up decrement 20
```

```
Group name is "hsrp-Fa0/0-1" (default)
```

```

NEMO-2911#show track
Track 1
  Interface Serial0/0/0:0 line-protocol
  Line protocol is Up
    5 changes, last change 4d00h
  Tracked by:
    HSRP GigabitEthernet0/0 1
  
```

```

NEMO-2911#ping 10.20.40.250 sour 10.20.58.141

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.20.40.250, timeout is 2 seconds:
Packet sent with a source address of 10.20.58.141
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/4 ms
  
```

Backup Router: 1941

```

c1941-NEMO#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

Gateway of last resort is 10.20.58.141 to network 0.0.0.0

D*EX 0.0.0.0/0 [2/1965056] via 10.20.58.141, 00:02:13, GigabitEthernet0/0
  1.0.0.0/32 is subnetted, 1 subnets
C    1.2.3.4 is directly connected, Loopback1234
  10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C    10.20.58.0/25 is directly connected, Loopback1
L    10.20.58.2/32 is directly connected, Loopback1
C    10.20.58.128/25 is directly connected, GigabitEthernet0/0
L    10.20.58.140/32 is directly connected, GigabitEthernet0/0
  50.0.0.0/32 is subnetted, 1 subnets
C    50.243.0.31 is directly connected, Cellular0/0/0
  66.0.0.0/32 is subnetted, 2 subnets
C    66.92.228.35 is directly connected, Cellular0/0/0
M    66.174.160.160 [3/1] via 0.0.0.0, 00:04:54, Cellular0/0/0
D    198.50.1.0/24 [90/156160] via 10.20.58.141, 00:04:54, GigabitEthernet0/0
  198.50.2.0/24 is variably subnetted, 2 subnets, 2 masks
C    198.50.2.0/24 is directly connected, Loopback1985
L    198.50.2.2/32 is directly connected, Loopback1985
  
```

```
c1941-NEMO#show dialer
```

```
Ce0/0/0 - dialer type = IN-BAND ASYNC NO-PARITY
Idle timer (never), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (6 secs)
Dialer state is data link layer up
Dial reason: Dialing on watched route loss
Time until disconnect never
Current call connected 00:54:54
Connected to lte
```

| Dial String | Successes | Failures | Last DNIS | Last status | Default |
|-------------|-----------|----------|-----------|-------------|---------|
| lte | 131 | 1044 | 00:54:54 | successful | Default |

```
c1941-NEMO#show ip mobile tunnel
```

```
Mobile Tunnels:
```

```
Total mobile ip tunnels 1
```

```
Tunnel0:
```

```
src 50.243.0.31, dest 66.174.160.160, key 0
encap GRE/IP, mode reverse-allowed, tunnel-users 1
Input ACL users 0, Output ACL users 0
IP MTU 1476 bytes
Path MTU Discovery, mtu: 0, age: 10 mins, expires: never
outbound interface Cellular0/0/0
MR created, CEF switching enabled, ICMP unreachable enabled
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
0 packets input, 0 bytes, 0 drops
3 packets output, 300 bytes
```

```
c1941-NEMO#show ip mobile router
```

```
Mobile Router
```

```
Enabled 03/01/11 21:04:18
```

```
Last redundancy state transition NEVER
```

```
Configuration:
```

```
Home Address 1.2.3.4 Mask 255.255.255.0
Home Agent 66.174.160.160 Priority 100 (best) (current)
Registration lifetime 65534 sec
Retransmit Init 1000, Max 5000 msec, Limit 3
Extend Expire 10, Retry 3, Interval 5
Reverse tunnel required
Request GRE tunnel
Multi-path denied by HA, Requested metric: bandwidth
Mobile Networks: GigabitEthernet0/0 (10.20.58.128/255.255.255.128)
                  Loopback2911 (198.50.1.0/255.255.255.0)
```

```
Status -Registered-
```

```
Using collocated care-of address 50.243.0.31
```

```
On interface Cellular0/0/0
```

```
Tunnel0 mode GRE/IP
```

```

c1941-NEMO#show standby
GigabitEthernet0/0 - Group 1
  State is Standby
    22 state changes, last state change 4d00h
  Virtual IP address is 10.20.58.144
  Active virtual MAC address is 0000.0c07.ac01
    Local virtual MAC address is 0000.0c07.ac01 (v1 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 0.624 secs
  Preemption enabled
  Active router is 10.20.58.141, priority 110 (expires in 10.192 sec)
  Standby router is local
  Priority 100 (default 100)
  Group name is "hsrp-Gi0/0-1" (default)
  
```

```

c1941-NEMO#show track
Track 1
  IP route 0.0.0.0 0.0.0.0 reachability
  Reachability is Up (EIGRP)
    5 changes, last change 00:05:29
  First-hop interface is GigabitEthernet0/0
  Tracked by:
    EEM applet NEMO-BACKUP
  
```

```

c1941-NEMO#ping 10.20.40.250 source 10.20.58.140

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.20.40.250, timeout is 2 seconds:
Packet sent with a source address of 10.20.58.140
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/4 ms
  
```

Primary Path Routing is Lost Primary Router: 2911

```

NEMO-2911(config)#int s0/0/0:0
NEMO-2911(config-if)#shutdown
*Mar 21 14:10:53.226: %BGP-5-ADJCHANGE: neighbor 128.43.1.173 Down Interface
flap
*Mar 21 14:10:55.222: %LINK-5-CHANGED: Interface Serial0/0/0:0, changed state
to administratively down
*Mar 21 14:10:55.566: %TRACKING-5-STATE: 1 interface Se0/0/0:0 line-protocol
Up->Down
*Mar 21 14:10:55.590: %HSRP-5-STATECHANGE: GigabitEthernet0/0 Grp 1 state
Active -> Speak
*Mar 21 14:10:56.222: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/0:0, changed state to down
*Mar 21 14:11:05.982:
  
```

```
NEMO-2911#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP,

Gateway of last resort is 10.20.58.140 to network 0.0.0.0

D    198.50.2.0/24 [90/156160] via 10.20.58.140, 4d00h, GigabitEthernet0/0
    10.0.0.0/25 is subnetted, 1 subnets
C      10.20.58.128 is directly connected, GigabitEthernet0/0
C    198.50.1.0/24 is directly connected, Loopback1985
D*EX 0.0.0.0/0 [170/1965056] via 10.20.58.140, 00:01:13, GigabitEthernet0/0
```

Backup Router: 1941

```

c1941-NEMO#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

M*   0.0.0.0/0 is directly connected, Tunnel0
     1.0.0.0/32 is subnetted, 1 subnets
C     1.2.3.4 is directly connected, Loopback1234
     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C     10.20.58.0/25 is directly connected, Loopback1
L     10.20.58.2/32 is directly connected, Loopback1
C     10.20.58.128/25 is directly connected, GigabitEthernet0/0
L     10.20.58.140/32 is directly connected, GigabitEthernet0/0
     50.0.0.0/32 is subnetted, 1 subnets
C     50.243.0.31 is directly connected, Cellular0/0/0
     66.0.0.0/32 is subnetted, 2 subnets
C     66.92.228.35 is directly connected, Cellular0/0/0
M     66.174.160.160 [3/1] via 0.0.0.0, 00:00:40, Cellular0/0/0
D     198.50.1.0/24 [90/156160] via 10.20.58.141, 00:00:40, GigabitEthernet0/0
     198.50.2.0/24 is variably subnetted, 2 subnets, 2 masks
C     198.50.2.0/24 is directly connected, Loopback1985
L     198.50.2.2/32 is directly connected, Loopback1985
  
```

```

c1941-NEMO#show standby
GigabitEthernet0/0 - Group 1
  State is Active
    23 state changes, last state change 00:00:43
  Virtual IP address is 10.20.58.144
  Active virtual MAC address is 0000.0c07.ac01
  Local virtual MAC address is 0000.0c07.ac01 (v1 default)
  Hello time 3 sec, hold time 10 sec
  Next hello sent in 0.016 secs
  Preemption enabled
  Active router is local
  Standby router is 10.20.58.141, priority 90 (expires in 11.088 sec)
  Priority 100 (default 100)
  Group name is "hsrp-Gi0/0-1" (default)
  
```

```

c1941-NEMO#ping 10.20.40.250 source 10.20.58.140
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.20.40.250, timeout is 2 seconds:
Packet sent with a source address of 10.20.58.140
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/59/72 ms
  
```

```

NEMO-2911#ping 10.20.40.250 sour 10.20.58.141
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.20.40.250, timeout is 2 seconds:
Packet sent with a source address of 10.20.58.141
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/208/780 ms
  
```

Primary Path Recovers

Primary Router: 2911

```
NEMO-2911(config)#int s0/0/0:0
NEMO-2911(config-if)#no shutdown
*Mar 21 14:27:02.414: %LINK-3-UPDOWN: Interface Serial0/0/0:0, changed state
to up
*Mar 21 14:27:02.418: %TRACKING-5-STATE: 1 interface Se0/0/0:0 line-protocol
Down->Up
*Mar 21 14:27:03.414: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/0:0, changed state to up
*Mar 21 14:27:03.898: %HSRP-5-STATECHANGE: GigabitEthernet0/0 Grp 1 state
Standby -> Active
*Mar 21 14:27:35.834: %BGP-5-ADJCHANGE: neighbor 128.43.1.173 Up
```

```
NEMO-2911#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile,
       D - EIGRP,

Gateway of last resort is 128.43.1.173 to network 0.0.0.0
```

```
128.43.0.0/30 is subnetted, 1 subnets
C    128.43.1.172 is directly connected, Serial0/0/0:0
D    198.50.2.0/24 [90/156160] via 10.20.58.140, 4d01h, GigabitEthernet0/0
10.0.0.0/25 is subnetted, 1 subnets
C    10.20.58.128 is directly connected, GigabitEthernet0/0
C    198.50.1.0/24 is directly connected, Loopback1985
B* 0.0.0.0/0 [20/0] via 128.43.1.173, 00:01:32
```

```
NEMO-2911#show standby
FastEthernet0/0 - Group 1
State is Active
  35 state changes, last state change 00:02:09
Virtual IP address is 10.20.58.144
Active virtual MAC address is 0000.0c07.ac01
Local virtual MAC address is 0000.0c07.ac01 (v1 default)
Hello time 3 sec, hold time 10 sec
Next hello sent in 2.432 secs
Preemption enabled
Active router is local
Standby router is 10.20.58.140, priority 100 (expires in 9.184 sec)
Priority 110 (configured 110)
Track object 1 state Up decrement 20
Group name is "hsrp-Fa0/0-1" (default)
```

```
NEMO-2911#ping 10.20.40.250 source 10.20.58.141
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.20.40.250, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/4 ms
```


Backup Router: 1941

```
c1941-NEMO#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile,
       D - EIGRP, EX - EIGRP external

Gateway of last resort is 10.20.58.141 to network 0.0.0.0

D*EX 0.0.0.0/0 [2/1965056] via 10.20.58.141, 00:01:57, GigabitEthernet0/0
     1.0.0.0/32 is subnetted, 1 subnets
C       1.2.3.4 is directly connected, Loopback1234
     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.20.58.0/25 is directly connected, Loopback1
L       10.20.58.2/32 is directly connected, Loopback1
C       10.20.58.128/25 is directly connected, GigabitEthernet0/0
L       10.20.58.140/32 is directly connected, GigabitEthernet0/0
     50.0.0.0/32 is subnetted, 1 subnets
C       50.243.0.31 is directly connected, Cellular0/0/0
     66.0.0.0/32 is subnetted, 2 subnets
C       66.92.228.35 is directly connected, Cellular0/0/0
M       66.174.160.160 [3/1] via 0.0.0.0, 00:18:39, Cellular0/0/0
D       198.50.1.0/24 [90/156160] via 10.20.58.141, 00:18:39, GigabitEthernet0/0
     198.50.2.0/24 is variably subnetted, 2 subnets, 2 masks
C       198.50.2.0/24 is directly connected, Loopback1985
L       198.50.2.2/32 is directly connected, Loopback1985
```

```
c1941-NEMO#ping 10.20.40.250 sour 10.20.58.140
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.20.40.250, timeout is 2 seconds:
Packet sent with a source address of 10.20.58.140
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/4 ms
```



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