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

Mobile Router Configuration Guide for
Always on Backup Verizon Wireless Access

Revision 3.8

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Introduction

Verizon Wireless Dynamic Mobile Network Routing (DMNR) 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 (fourth-generation [4G] wireless WAN [WWAN]) by using the Mobile IPv4 NEtwork MObility (NeMo) protocol, without the need for end-to-end overlay tunneling.

DMNR is part of the Verizon Wireless Mobile Private Network (MPN). DMNR is compatible with the Cisco IOS® Mobile IP Mobile Networks feature. Please note that not all features specific to Cisco are supported by the DMNR service. DMNR uses the Collocated-Care-of-Address (CCOA) option and supports IP subnet registration, routing, and forwarding. DMNR does not support any other additional Cisco® Mobile IP Mobile Networks features such as mobile networks multipath or mobile networks multicast.

This configuration guide shows an example of using the Cisco Mobile IP Mobile Networks feature with the Verizon Wireless DMNR service to provide always-on backup communications over Verizon Wireless Long Term Evolution (LTE) and evolved high-rate packet data (eHRPD) access and MPNs between an enterprise branch office and a data center connected to the Verizon Private IP Multiprotocol Label Switching/VPN (MPLS/VPN) network.

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. Because 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 and the time required for the Layer 3 routing to converge.

There are three example configurations, for ISR G2 LTE eHWIC, ISR 4K LTE NIM, and 819. GRWIC and 899 configurations are similar to eHIWC and 819 respectively.

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 insructions are available at:
   http://software.cisco.com/download/release.html?i=!y&mdfid=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. The minimum mainline release is 15.4(3)M2.

   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 APN must be provded by a Verizon Wireless representative). 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 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 and 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. While the primary Border Gateway Protocol (BGP) routing is operational, the traffic will be routed symmetrically over the primary path.

19. 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.

20. Please refer to the notes in the configuration syntax for an explanation of the commands.

Design Requirements and Recommendations

1. 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.

2. 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 hardware overview, SIM installs, antenna connection, and module install:
     http://www.cisco.com/en/US/docs/routers/access/interfaces/ic/hardware/installation/guide/EHWIC-4G-LTEHW.html.

   - LTE eHWIC Cisco IOS Software configuration monitoring and troubleshooting:
     http://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.

Always-On Backup Access Design Requirements

This configuration example is based on the following logical design requirements:

1. When the primary circuit is operational, the backup wireless/NEMO session must be connected.

2. Switch to backup must be triggered by the physical or logical failure on the primary circuit (such as loss of routing).

3. Only select traffic from the branch office will be allowed to use the backup wireless link.

4. When the primary circuit is restored, all traffic must be reverted to the primary path. When the primary path is operational, traffic will be routed over the primary path symmetrically.

Figure 1. Design Diagram for Configuration Example
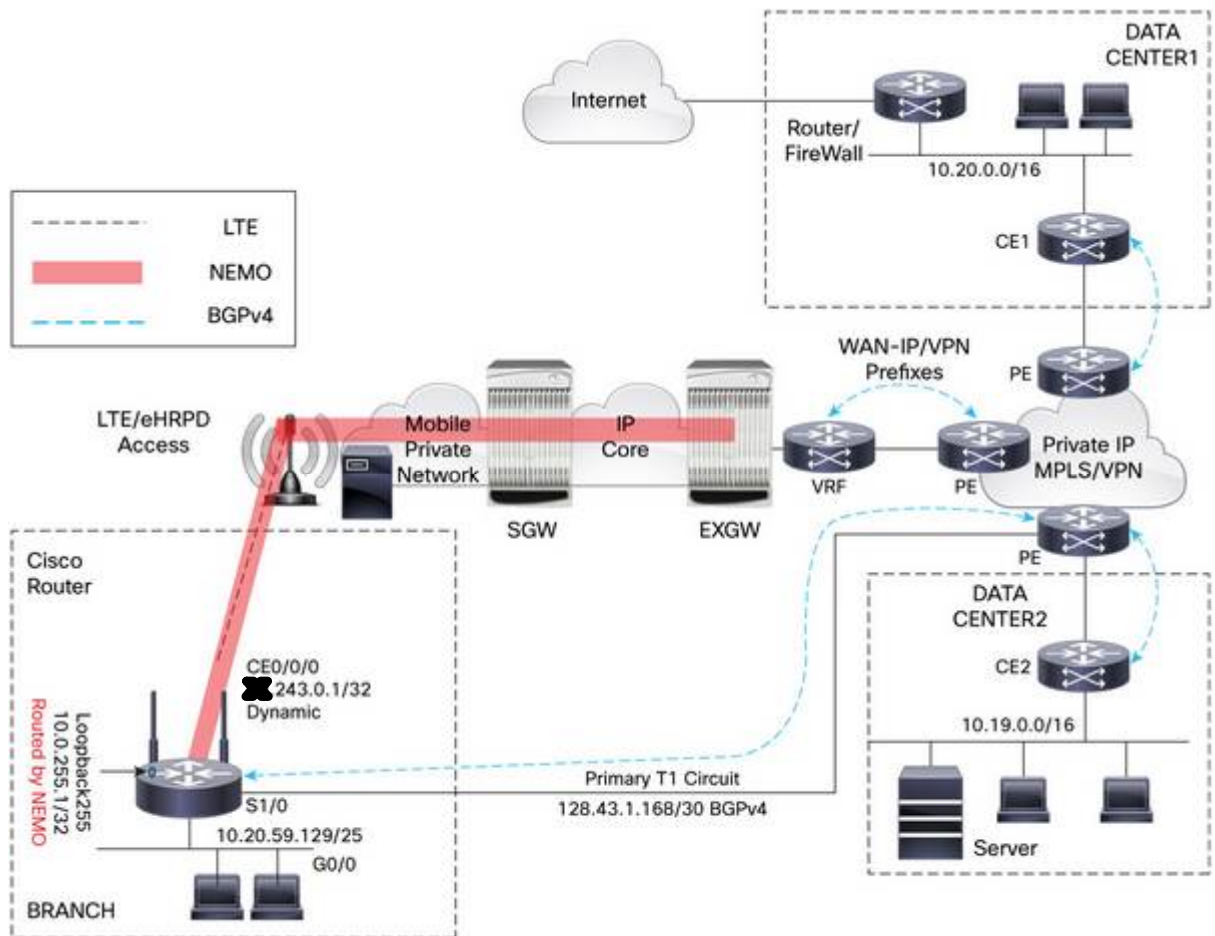
NEMO Router Configuration for ISR G2 - EHWIC-4G-LTE-V, EHWIC-4G-LTE-VZ

```
!### command allowing for "LTE test cellular" enable mode commands ###
service internal
!
!### IOS 15.5(2)T and later is recommended ###
boot system flash:c1900-universalk9-mz.SPA.155-2.T.bin
!
ip cef
!
!### CHAT Script to make a data call, name is case-sensitive ###
chat-script LTE "" "AT!CALL1" TIMEOUT 20 "OK"
!
!### T1 Controller for Primary Circuit ###
controller T1 0/1/0
 channel-group 0 timeslots 1-24
!
!### The following two commands define a default route 0.0.0.0 as the
tracked object. If this object changes state to DOWN the routers event
manager (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 434 ip route 0.0.0.0 0.0.0.0 reachability

!### This Loopback and IP are required to setup NEMO. This address is not
routable and is used as a placeholder "dummy" address. It may be the same on
all customer 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
!
!### This Subnet will be routed by NEMO ###
!
interface Loopback255
 ip address 10.0.255.1 255.255.255.255
!
!### This subnet is routed by NEMO. The maximum TCP MSS is set to 1390
bytes. The route-map clears DF bits in the IP headers. ###
!
interface GigabitEthernet0/0
 ip address 10.20.59.129 255.255.255.128
 ip tcp adjust-mss 1390
 ip policy route-map clear-df
!
!### This subnet is not routed by NEMO. ###
!
interface GigabitEthernet0/1
 ip address 10.10.20.233 255.255.255.0
!
!### Interface Cellular – the LTE and NEMO interface. Receives Pool/WAN IP
(dynamic or static) from EXGW. "pulse-time 0" requires 15.5(2)T. ###
```

```
!
interface Cellular0/0/0
 ip address negotiated
 no ip unreachables
 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 Primary access circuit. Interface Dialer1 is used to backup
this circuit in the event of a physical failure on this circuit. ###
!
interface Serial0/1/0:0
 ip address 128.43.1.170 255.255.255.252
!
!### This stanza enables NEMO Routing. Admin distance can be adjusted ###
!
router mobile
!
!### This is the BGP routing process for the primary circuit. BGP
administrative distance is set to 2 so that routing can revert to BGP from
Mobile routes [Admin. Distance = 3] when Primary Circuit recovers. ###
!
router bgp 65435
 bgp log-neighbor-changes
 neighbor 128.43.1.169 remote-as 19262
 !
 address-family ipv4
  redistribute connected
  neighbor 128.43.1.169 activate
  distance bgp 2 2 2
  no auto-summary
  no synchronization
 exit-address-family

!### This command configures NEMO Authentication with EXGW. Use the
appropriate EXGW IP address based on the geographic location. Note that SPI
and KEY must match to what is set on the EXGW under the NEMO service. Note
that the algorithm must be set to "hmac-md5". ###
!
ip mobile secure home-agent 66.174.X.Y spi decimal 256 key ascii VzWNeMo
algorithm hmac-md5
!
!### This section configures the NEMO Mobile Router parameters and defines
what router interfaces and their subnets to be included into the NEMO
registration with EXGW. ###
!
ip mobile router
 address 1.2.3.4 255.255.255.0
```

```
  collocated single-tunnel
  home-agent 66.174.X.Y
  mobile-network Loopback255
  mobile-network GigabitEthernet0/0
  register extend expire 10 retry 3 interval 5
  reverse-tunnel
  tunnel mode gre
!
no cdp run
!
!### This route-map clears the DF-bit in IP packets that come into the
router from the GE0/0 interface. ###
!
route-map clear-df permit 10
 set ip df 0
!
!### 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 sec. before activating the call after the
intitial boot. ###
dialer watch-list 1 delay route-check initial 30
!### The router will wait 1 sec. before activating the call. ###
dialer watch-list 1 delay connect 1
!
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 clears the mobile IP registration. Traffic is
routed immediately to the backup mobile tunnel (without waiting for the next
NEMO re-registration). Starting in IOS 15.0(1)M, optional keywords
"authorization bypass" were added to the command "event manager applet".
When a policy is triggered and if AAA is configured it will contact the AAA
server for authorization. Using the "authorization bypass" keyword
combination, you can bypass AAA authorization and run the policy
immediately. ###
event manager applet NEMO-BACKUP
 event track 434 state down
 action 10 cli command "enable"
 action 20 cli command "clear ip mobile router registration" pattern "confirm"
 action 40 cli command "y"
```

NEMO Router Configuration for ISR C819G-4G-LTE-V, C819G-4G-VZ, C899G-LTE-VZ

```
!### command allowing for "LTE test cellular" enable mode commands ###
service internal
!
!### IOS 15.5(2)T and later is recommended ###
boot system flash:c800-universalk9-mz.SPA.155-2.T.bin
!
ip cef
!
!### CHAT Script to make a data call, name is case-sensitive ###
chat-script LTE "" "AT!CALL1" TIMEOUT 20 "OK"
!
!### The following two commands define a default route 0.0.0.0 as the
tracked object. If this object changes state to DOWN the routers event
manager (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 434 ip route 0.0.0.0 0.0.0.0 reachability
!
!### This Loopback and IP are required to setup NEMO. This address is not
routable and is used as a placeholder "dummy" address. It may be the same on
all customer 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
!
!### This Subnet will be routed by NEMO ###
!
interface Loopback255
 ip address 10.0.255.1 255.255.255.255
!
!### This is the Primary access circuit. Interface Cellular0 is used to
backup this circuit in the event of a physical failure on this circuit. ###
!
Interface GigabitEthernet0
ip address 128.43.1.170 255.255.255.252
!
!### This subnet will be routed by NEMO. The maximum TCP MSS is set to 1390
bytes. The route-map clears DF bits in the IP headers. ###
!
interface VLAN1
 ip address 10.10.20.233 255.255.255.0
 ip tcp adjust-mss 1390
 ip policy route-map clear-df
!
!### Interface Cellular – the LTE and NEMO interface. Receives Pool/WAN IP
(dynamic or static) from EXGW. "pulse-time 0" requires 15.5(2)T. ###
!
interface Cellular0
 ip address negotiated
```

```
  no ip unreachables
  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 stanza enables NEMO Routing. Admin distance can be adjusted ###
!
router mobile
!
!### This is the BGP routing process for the primary circuit. BGP
administrative distance is set to 2 so that routing can revert to BGP from
Mobile routes [Admin. Distance = 3] when Primary Circuit recovers. ###
!
router bgp 65435
 bgp log-neighbor-changes
 neighbor 128.43.1.169 remote-as 19262
 !
 address-family ipv4
  redistribute connected
  neighbor 128.43.1.169 activate
  distance bgp 2 2 2
  no auto-summary
  no synchronization
 exit-address-family
!
!### This command configures NEMO Authentication with EXGW. Use the
appropriate EXGW IP address based on the geographic location. Note that SPI
and KEY must match to what is set on the EXGW under the NEMO service. Note
that the algorithm must be set to "hmac-md5". ###
!
ip mobile secure home-agent 66.174.X.Y spi decimal 256 key ascii VzWNeMo
algorithm hmac-md5
!
!### This section configures NEMO Mobile Router parameters and defines what
router interfaces/subnets to include in the NEMO registration with EXGW. ###
!
ip mobile router
 address 1.2.3.4 255.255.255.0
 collocated single-tunnel
 home-agent 66.174.X.Y
 mobile-network Loopback255
 mobile-network Vlan1
 register extend expire 10 retry 3 interval 5
 reverse-tunnel
 tunnel mode gre
!
no cdp run
!
```

```
!### This route-map clears the DF-bit in IP packets that come into the
router from the GE0/0 interface. ###
!
route-map clear-df permit 10
 set ip df 0
!
!### 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 sec. before activating the call after the
intitial boot. ###
dialer watch-list 1 delay route-check initial 30
!### The router will wait 1 sec. before activating the call. ###
dialer watch-list 1 delay connect 1
!
line 3
 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 clears the mobile IP registration. Traffic is
routed immediately to the backup mobile tunnel (without waiting for the next
NEMO re-registration). Starting in IOS 15.0(1)M, optional keywords
"authorization bypass" were added to the command "event manager applet".
When a policy is triggered and if AAA is configured it will contact the AAA
server for authorization. Using the "authorization bypass" keyword
combination, you can bypass AAA authorization and run the policy
immediately. ###
event manager applet NEMO-BACKUP
 event track 434 state down
 action 10 cli command "enable"
 action 20 cli command "clear ip mobile router registration" pattern "confirm"
 action 40 cli command "y"
```

NEMO Router Configuration for ISR 4K NIM-4G-LTE-VZ

```
!### Chat script and cellular line definitions not needed w/ISR4K ###
!### command allowing for "LTE test cellular" enable mode commands ###
service internal
!
hostname C4321-4G
!
!### IOS XE 3.16 or later ###
boot-start-marker
boot system bootflash:isr4300-universalk9.03.16.00.S.155-3.S-ext.SPA.bin
boot-end-marker
!
ip dhcp pool 10dot250dot1
 network 10.250.1.0 255.255.255.0
 default-router 10.250.1.1
 dns-server 10.20.45.20
 domain-name test.verizon.com
 option 150 ip 10.20.80.9
!
username cisco privilege 15 secret 5 xxxxxxxxxxxx
!
controller Cellular 0/1/0
!
!### The following two commands define a default route 0.0.0.0 as the
tracked object. If this object changes state to DOWN the routers event
manager (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 434 ip route 0.0.0.0 0.0.0.0 reachability
!
!### This Loopback and IP are required to setup NEMO. This address is not
routable and is used as a placeholder "dummy" address. It may be the same on
all customer routers. Any interface number and any IP can be used. Please
use 1.2.3.4 for consistency. ###
!
interface Loopback1234
 description ### NEMO Router Home Address
 ip address 1.2.3.4 255.255.255.255
!
!### This Subnet will be routed by NEMO ###
!
interface Loopback255
 ip address 10.0.255.1 255.255.255.255
!
!### This subnet is routed by NEMO. TCP MSS 1390 bytes, clear DF bits. ###
!
interface GigabitEthernet0/0/0
 ip address 10.250.1.1 255.255.255.0
 ip tcp adjust-mss 1390
 ip policy route-map clear-df
!
!
```

```
!### This is the Primary access circuit. Cellular Interface is used to
backup this circuit in the event of a physical failure on this circuit. ###
!
interface GigabitEthernet0/0/1
 ip address 128.43.1.170 255.255.255.252
!
interface Cellular0/1/0
 ip address negotiated
 ip mobile router-service roam
 ip mobile router-service collocated ccoa-only
 dialer in-band
 dialer idle-timeout 0
 dialer enable-timeout 1
 dialer watch-group 1
 pulse-time 0
!
interface GigabitEthernet0
 vrf forwarding Mgmt-intf
 ip address 10.0.0.2 255.255.255.254
 negotiation auto
!
!### This stanza enables NEMO Routing. Admin distance can be adjusted ###
router mobile
!
!### This is the BGP routing process for the primary circuit. BGP
administrative distance is set to 2 so that routing can revert to BGP from
Mobile routes [Admin. Distance = 3] when Primary Circuit recovers. ###
!
router bgp 65435
 bgp log-neighbor-changes
 neighbor 128.43.1.169 remote-as 19262
 !
 address-family ipv4
  redistribute connected
  neighbor 128.43.1.169 activate
  distance bgp 2 2 2
  no auto-summary
  no synchronization
 exit-address-family
!
!### This command configures NEMO Authentication with EXGW. Use the
appropriate EXGW IP address based on the geographic location. Note that SPI
and KEY must match to what is set on the EXGW under the NEMO service. Note
that the algorithm must be set to "hmac-md5". ###
!
ip mobile secure home-agent 66.174.X.Y spi decimal 256 key ascii VzWNeMo
algorithm hmac-md5
!
!### This section configures the NEMO Mobile Router parameters and defines
what router interfaces and their subnets to be included into the NEMO
registration with EXGW. Use the appropriate EXGW IP address as above. ###
!
ip mobile router
 address 1.2.3.4 255.255.255.0
 collocated single-tunnel
 home-agent 66.174.X.Y
```

```
 mobile-network Loopback255
 mobile-network GigabitEthernet0/0/0
 register extend expire 10 retry 3 interval 5
 reverse-tunnel
 tunnel mode gre
!
!### Route-map clears the DF-bit in IP packets from the VLAN1 interface. ###
!
route-map clear-df permit 10
 set ip df 0
!
!### This section defines the 4G 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 60 sec. before activating the call after the
intitial boot. ###
dialer watch-list 1 delay route-check initial 60
!### The router will wait 1 sec. before activating the call. ###
dialer watch-list 1 delay connect 1
!
!### This section defines a local event manager applet to track the state of
the primary default route and clears the mobile IP registration. Traffic is
routed immediately to the backup mobile tunnel (without waiting for the next
NEMO re-registration). Starting in IOS 15.0(1)M, optional keywords
"authorization bypass" were added to the command "event manager applet".
When a policy is triggered and if AAA is configured it will contact the AAA
server for authorization. Using the "authorization bypass" keyword
combination, you can bypass AAA authorization and run the policy
immediately. ###
event manager applet NEMO-BACKUP
 event track 434 state down
 action 10 cli command "enable"
 action 20 cli command "clear ip mobile router registration" pattern "confirm"
 action 40 cli command "y"
!
end
```

Operation and Show Commands

Primary Path Is Operational - Normal State

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


Gateway of last resort is 128.43.1.169 to network 0.0.0.0

B*      0.0.0.0/0 [2/0] via 128.43.1.169, 00:57:12
        10.0.0.0/8 is variably subnetted, 15 subnets, 3 masks
C          10.0.255.0/24 is directly connected, Loopback255
L          10.0.255.1/32 is directly connected, Loopback255
C          10.20.59.128/25 is directly connected, GigabitEthernet0/0
L          10.20.59.129/32 is directly connected, GigabitEthernet0/0
        ██0.0.0/32 is subnetted, 1 subnets
C          ██.243.0.1 is directly connected, Cellular0/0/0
        66.0.0.0/32 is subnetted, 2 subnets
C          66.92██ ██is directly connected, Cellular0/0/0
M          66.174.██ ██ [3/1] via 0.0.0.0, 00:57:44, Cellular0/0/0
        128.43.0.0/16 is variably subnetted, 2 subnets, 2 masks
C          128.43.1.168/30 is directly connected, Serial0/1/0:0
L          128.43.1.170/32 is directly connected, Serial0/1/0:0
```

```
c1941-NEMO#show ip bgp summary
BGP router identifier 10.0.255.1, local AS number 65435


Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
128.43.1.169    4 19262     150     139       25    0    0 01:07:49           1
```

```
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 00:57:35
Connected to #777


Dial String     Successes    Failures    Last DNIS   Last status
#777                    2           0     00:57:35    successful   Default
```

```
c1941-NEMO#show ip mobile tunnel
Mobile Tunnels:

Total mobile ip tunnels 1
Tunnel0:
    src ██243.0.1, dest 66.174.██.██, 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, ager: 10 mins, expires: never
    outbound interface Cellular0/0/0
    MR created, CEF switching enabled, ICMP unreachable enabled
    5 minute input rate 0 bits/sec, 1 packets/sec
    5 minute output rate 0 bits/sec, 1 packets/sec
    1308 packets input, 113352 bytes, 0 drops
    1614 packets output, 133239 bytes

c1941-NEMO#show ip mobile router

Mobile Router
    Enabled 05/20/10 20:18:42
    Last redundancy state transition NEVER
```

```
Configuration:
    Home Address 1.2.3.4 Mask 255.255.255.0
    Home Agent 66.174.██.██ 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
    Mobile Networks: Loopback255 (10.0.255.0/255.255.255.0)
                     GigabitEthernet0/0 (10.20.59.128/255.255.255.128)

Monitor:

Mobile Router
    Status -Registered-
    Using collocated care-of address ██243.0.1
    On interface Cellular0/0/0
    Tunnel0 mode GRE/IP
```

Primary Path Routing Is Lost

```
c1941-NEMO(config)#router bgp 65435
c1941-NEMO(config-router)#neighbor 128.43.1.169 shutdown
*May 21 14:40:59.907: %BGP-5-ADJCHANGE: neighbor 128.43.1.169 Down Admin. shutdown
*May 21 14:40:59.907: %BGP_SESSION-5-ADJCHANGE: neighbor 128.43.1.169 IPv4 Unicast
topology base removed from session  Admin. shutdown
*May 21 14:41:00.739: %TRACKING-5-STATE: 434 ip route 0.0.0.0/0 reachability
Up->Down
*May 21 14:41:01.787: %TRACKING-5-STATE: 434 ip route 0.0.0.0/0 reachability
Down->Up
```

```
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
C        10.0.255.0/24 is directly connected, Loopback255
L        10.0.255.1/32 is directly connected, Loopback255
C        10.20.59.128/25 is directly connected, GigabitEthernet0/0
L        10.20.59.129/32 is directly connected, GigabitEthernet0/0
      ██.0.0/32 is subnetted, 1 subnets
C        50.243.0.1 is directly connected, Cellular0/0/0
      66.0.0.0/32 is subnetted, 2 subnets
```

```
C        66.92.██.██ is directly connected, Cellular0/0/0
M        66.174.██.██ [3/1] via 0.0.0.0, 00:15:59, Cellular0/0/0
```

```
c1941-NEMO#ping ██.11.11.11 source 10.20.59.129


Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to ██.11.11.11, timeout is 2 seconds:
Packet sent with a source address of 10.20.59.129
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/68/72 ms
```

Primary Path Recovers

```
c1941-NEMO#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
c1941-NEMO(config)#router b 65435
c1941-NEMO(config-router)#no neighbor 128.43.1.169 shutdown
c1941-NEMO(config-router)#
*May 20 17:11:55.575: %BGP-5-ADJCHANGE: neighbor 128.43.1.169 Up
```

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

Gateway of last resort is 128.43.1.169 to network 0.0.0.0

B*      0.0.0.0/0 [2/0] via 128.43.1.169, 00:00:33
        10.0.0.0/8 is variably subnetted, 15 subnets, 3 masks
C          10.0.255.0/24 is directly connected, Loopback255
L          10.0.255.1/32 is directly connected, Loopback255
C          10.20.59.128/25 is directly connected, GigabitEthernet0/0
L          10.20.59.129/32 is directly connected, GigabitEthernet0/0
        ██.0.0.0/32 is subnetted, 1 subnets
C          ██.243.0.1 is directly connected, Cellular0/0/0
        66.0.0.0/32 is subnetted, 2 subnets
C          66.92.██.██ is directly connected, Cellular0/0/0
M          66.174.██.██ [3/1] via 0.0.0.0, 00:13:14, Cellular0/0/0
        128.43.0.0/16 is variably subnetted, 2 subnets, 2 masks
C          128.43.1.168/30 is directly connected, Serial0/1/0:0
L          128.43.1.170/32 is directly connected, Serial0/1/0:0
```

```
c1941-NEMO#ping ██.11.11.11 source 10.20.59.129

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to ██.11.11.11, timeout is 2 seconds:
Packet sent with a source address of 10.20.59.129
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/4 ms
```

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CISCO.