APPLICATION NOTE No. 350040405-01

Date: April 2005
Author: Eli Shmulenson, ITC Tier IV Product Support Engineering
Product: Avaya G250, G350
General: Dynamic-CAC, IGAR and Modem-Dial-Backup configuration
examples

Table of Contents

1. General Description

Voice systems survivability has always been a challenge for network designers. Vendors put much effort and thought into products to increase their ability to stay online, to automatically overcome failure events and increase the total uptime of critical systems. New survivability functionality is always welcome in the market place. Therefore, the new generation of intelligent Media Gateways from Avaya with the new Communication Manager 3.0 provides new survivability features that increase the Gateway's connectivity availability and maintain functionality, even during major network outages.

This document includes four detailed examples and configurations utilizing the following survivability related features:

MDB – Dial Modem Backup

This feature allows a G250/G350 Media Gateway to backup any of its IP interfaces with a dialup interface that will be automatically activated when the primary interface becomes inactive.

The main application of this feature is to maintain connectivity of the branch Media Gateway and IP phones registered with the primary CM, even during major a network event, such as WAN failure. This is an attractive low-cost option as it can function without an S8300/LSP in the branch.

> *Note*
>
> *The G250 Standard Local Survivability (SLS) can provide basic PBX features when there is no connectivity to CM, which is used as the "last resort" option.*

D-CAC – Dynamic Call Admission Control

D-CAC allows Communication Manager to calculate available bandwidth for voice bearer between every two Network Regions. The Communication Manager calculates the available bandwidth based on the BBL (Bearer Bandwidth Limit) as reported by the Media Gateways and on concurrent active calls between the network regions.

IGAR – Inter Gateway Alternate Routing

When the IP network between two Gateways in two different network regions is not capable of delivering additional voice bearer traffic (because of insufficient bandwidth or connection failure), an alternate route for voice bearer is established via the PSTN. IGAR

relies on Call Admission Control to check for available bandwidth for voice bearer and to trigger it. IGAR can also be triggered by VoIP resources exhaustion.

RTR – Remote Track

RTR allows the Gateway to track (reach) remote objects by periodic pinging or TCP connection attempts. The RTR is used as keep-alive mechanism and can be bind to interfaces and local VPN peer of Gateways.

1.1. Typical Scenario

1.1.1. Normal Operation

In a typical Avaya IP based voice installations, the primary CM (Communication Manager) is installed at the headquarters, on a Linux-based media server. Medium or large enterprises use the S8500 or S8700 media server with a port network Media Gateway, like the G650 with IP enabled boards: IPSI, CLAN, etc.. Smaller enterprises use the S8300 media server. Branch offices are connected to the headquarters via private WAN links. These links are used for all the voice-related traffic (signaling and voice bearer) as well as for pure IP traffic for data applications between the branches and the HQ. The core router in the HQ holds the WAN interface to the branches.

Small branch offices have branch Media Gateways installed (G250 or G350) that provide LAN switching and routing capabilities to serve the local phones and the PCs. The IP phones and the PCs are located on different VLANs and belong to different IP subnets.

The Gateway also could be used as the WAN edge router for the branch or use an external edge router.

The Gateway has an S8300B/LSP installed to support the branch voice functionality in case the Gateway loses its connection to the primary CM (one or more CLAN boards) in the HQ. See Figure 1.

Figure 1
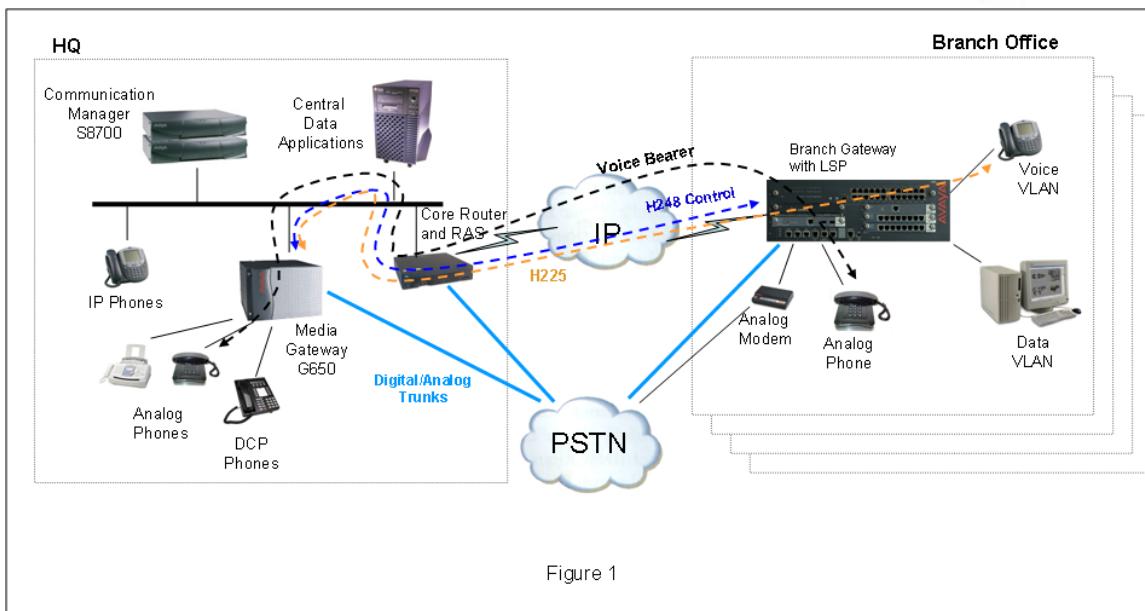
The Gateway in the HQ and each branch Gateway have trunks to the PSTN via the local CO.

With CM Call-Admission-Control via Bandwidth Limit (CAC-BL), the administrator can associate VoIP elements - media-Gateways, CLAN, VoIP engines and IP phones via subnets - to network regions, and define bandwidth available for bearer between network regions. This allows the CM to keep track of the bandwidth usage for VoIP bearer and reject or redirect calls when bandwidth is exhausted. Dynamic-CAC extends this feature by allowing a media-gateway to update CM CAC-BL bandwidth to its network region, in real time.

Note

In large network deployments it is recommended to use configuration aids like Avaya Network Region Wizard and Provisioning and Installation Manager (PIM) tools.

1.1.2. Backup Operation

The branch Gateways have an analog USB or Serial modem that is used for backup in case of WAN failure to the branch. During a WAN link failure in a particular branch office, the Gateway will not immediately register to the LSP, but will use its Modem-Dial-Backup feature to reach the CLAN in HQ by using its directly attached USB modem. The Gateway can establish backup PPP connection by dialing to one of the following entities:

a) Dial directly to the core router in the HQ. This will require the router to have RAS capabilities via single phone line or a trunk with modems nest (as shown in Figure 2).
b) Dial directly to an external Remote Access Server (RAS) in the HQ. The server should support routing protocols and LAN-to-LAN connection type.
c) Dial to a local Internet Service Provider and establish a PPP connection to the Internet. In order to provide a secured IP tunnel over the public Internet, this type of connection requires the use of VPN over the dialup link to a VPN Gateway in the HQ.

In this document we cover option (a). Option (c) is covered in detail in the "*G350/G250 dial backup with VPN configuration example*" document.

By establishing a backup link instead the failed WAN connection, the Gateway can stay registered to the CM in the HQ. This situation is preferred over registering to the local LSP. The Gateway will register into the LSP only in case both WAN link and the dial modem backup fail.

However, the dialup connection has a very limited bandwidth which will not be sufficient for voice bearer. Therefore the Gateway reports the CM that there is no available bandwidth for the voice bearer to its network region over the dialup connection. As a result, the CM will use IGAR functionality, and will use the dial link only for voice signaling traffic (H248, H323-RAS). When a call has to be made to/from the branch, the CM will signal the Gateway and to the Gateway which is on the other party's network region to establish a PSTN call between them, which will hold the voice bearer for the call between the two parties. See Figure 2.
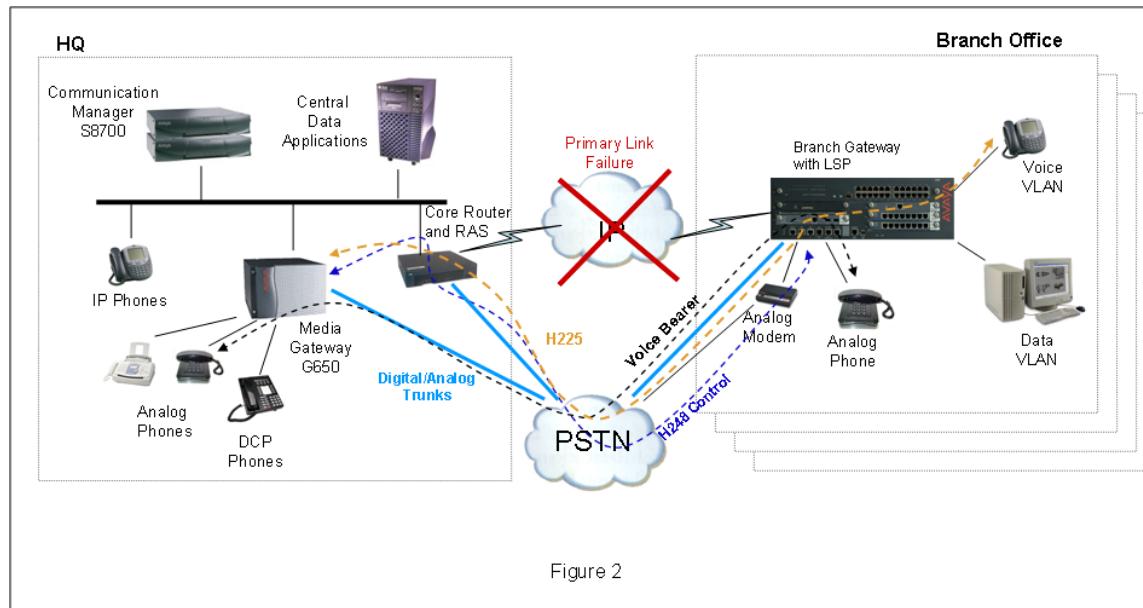
Figure 2

When the WAN link resumes, the primary interface of the Gateway that is connected towards the WAN (or the edge router) will be up again, and the backup interface will be automatically deactivated. The Gateway will report the CM of the available bandwidth for voice bearer over the WAN link, so both voice bearer and signaling will be re-routed through it as normally.

> *Note*
> *The dialup backup feature supports external Multitech ISDN-BRI modems. This option is beyond the scope of this document.*

> *Important Note*
>
> *The modem being used for dialup backup feature is the same modem that is used by the Avaya Services to dial into the Gateway for Out-of-Band system support. Please note that when the backup dial link is active, the technical support personnel will not be able to dial into the Gateway. Also, when the modem is used for Out-of-Band support, it will not be available for the dial backup feature.*

1.1.3. The MGC List

A Media Gateway must be registered to a controller in order to provide voice functionality. Controllers can be defined in the Gateway's MGC list in order for the Gateway to search a reachable one and to register through it to the CM. However, only registering to the primary controller will provide the users on the Gateway the full telephony system functionality, like voice mail, internal dialing to reach people in other branches, etc. Controllers can have more than one IP interface (i.e. S8700 with multiple CLANs) thus few consecutive entries in the MGC list can represent the same controller. Use the `set reset-timers transition-point` CLI command in the Gateway to configure the point at which the primary MGCs in the list end and the LSPs begin.

Registering to the LSP is a second-choice option, as the LSP still has the full CM functionality but the users will feel they are disconnected from the corporate telephony system and now they are on a stand-alone PBX. Calling parties in other branches will require them to call via outside line and their voice mail access is limited.

The G250 Gateway has also an SLS mode, which is used when the Gateway can't register to any CM system (neither to the primary, nor to the LSP). In the SLS the users on the G250 get very basic PBX functionality. Therefore the SLS mode is always the last (fifth) choice in the G250's MGC list.

In the scenario described here, the Gateway's MGC list includes the CLAN in the HQ as the primary controller and local installed S8300B as the LSP. But some installations could have more than one primary controller defined; like in a case there are two CLANs

in the HQ. In such cases, it is necessary to set the Transition Point in the Gateway's recovery configuration to 2, as there are two primary controllers (CLANs) while the third controller in the list is the LSP. Use the `set reset-times transition-point` CLI command in the Gateway to set the Transition Point.

For full telephony system functionality, the Gateway must be registered to the primary controller. The modem dial backup feature on the Gateways is one of the ways of keeping the Gateway registered to the primary controller even when major network events take place.

1.1.4. Timing Issues

Some H248 keepalives (from the Gateway to its CM) could get lost from the moment the WAN link failure took place until the dial backup link is established. If the modem backup line is established faster than the H248 keepalive timeout (about 60 to 70 seconds), the Gateway will continue being registered to the primary CM via the CLAN. Otherwise the Gateway will consider the H248 link to be down and start trying to re-register to the primary call controller for another 1 minute (Primary Search Timer default value). In case the backup dial link was not established by then (approx 2 minutes after the WAN link failure event), the Gateway will try to register to the next call controller in its MGC list, which in our case is the LSP.

Still, it is possible to increase the value of the Primary Search Timer in order to keep the Gateway being registered to its primary CM. Use the `set reset-times primary-search` CLI command on the Gateway to set the Primary Search Timer. Please note that the Primary Search Timer refers to searching time for all the primary controllers defined in the MGC list of the Gateway, according on the Transition Point setting.

By default, the backup Dialer interface is activated immediately after the primary interface is discovered to be inactive. However, it can take another 20-40 seconds to establish the call and have the routing tables to be updated, depending on the phone line quality and the routing method (Static/OSPF/RIP).

This immediate activation is good in case of primary interface failure, but, in the case of Gateway reboot the Dialer interface could be activated immediately instead of the primary WAN interface, as it can sometimes take some time to get the WAN connection up. In order to avoid this scenario, use the `dialer persistent initial delay` CLI command under the "Interface Dialer" context, to set the delay in seconds for how long to wait after reboot before dialing. In the examples in this document the delay was set to 45 seconds as it was assumed that after the device reboot the primary link will be established by that time.

Another important command is `dialer wait-for-ipcp`, which defines how long the dialer should wait from the moment of dialing the number until a successful PPP/IPCP

connection is established (default value is 45 seconds). You can increase this timer if it takes long time for the modems to synchronize because of a poor connection quality.

If the Dialer interface was activated and a dial attempt has failed for any reason, you can set when will the next attempt take place, using the `dialer persistent delay` CLI command under the Interface Dialer context on the Gateway (default is 1 second). You can also set the number of dial attempts by the `dialer persistence max attempts` CLI command and then set the delay time before retrying to dial again after all the previous attempts were failed and the max attempts counter was exhausted, by using the `dialer persistent re-enable` CLI command.

1.1.5. Dial Backup Routing considerations

Dial backup is considerably more complex than regular remote user dial access as it should provide routing connectivity not only to the dialer address, but also to one or more subnets (e.g. the voice-VLAN subnet), in RAS terminology this is sometimes referred as a LAN-to-LAN scenario. While routing in the enterprise backbone is almost always based on dynamic routing protocols (RIP, OSPF etc), in some cases, static routing is enough for the branch as it may only have a single active WAN interface at each given moment. However, to assure connectivity, the network designer must assure correct routing also from the headquarters back to the branch.

1.1.5.1 Static routing

One common routing approach is to use static-routing at the RAS server and static IP address at the branch Gateway dialer. In this case, the RAS is configured with static routes to the branches subnets, each with its dialer address as next-hop.
For example:

```
ip route 123.2.44.0 255.255.255.0 149.49.78.22
ip route 123.2.45.0 255.255.255.0 149.49.78.44
```

The above example shows static routes to two branch offices. The first one 'Voice-VLAN' subnet is 123.2.44.xx and its dialer address is 149.49.78.22. The second one 'voice-VLAN' subnet is 123.2.45.xx and its dialer address is 149.49.78.44.
Now, as long as the modem backup is not connected to the RAS, these static routes are inactive. However, once connected, the static routes became active, and if the RAS server supports a routing protocol, it can redistribute these static routes throughout the headquarters networks with OSPF or RIP.

The configuration at the branch side is even simpler, a single "via" static 'default Gateway' can simply redirect all traffic to the dialer. This route will be active only when the dialer is up (in this case, the assumption is that the main interface is down).

```
ip default-gateway Dialer 1        1 low
```

Note: This is a 'low priority' static route, which means that it is weaker than OSPF/RIP routes.

If the RAS server does not support static-route to RIP/OSPF distribution, static routes can be configured on an adjunct router redirecting traffic to the branches subnets to the RAS server. For example:

```
ip route 123.2.44.0 255.255.255.0 149.49.99.2 3000 low
ip route 123.2.45.0 255.255.255.0 149.49.99.2 3000 low
```

Where 149.49.99.2 is the IP address of the RAS server and '3000' is the cost for this route, which should be larger than the cost via the primary link, as this static route is always active (as the link between the RAS and the adjunct router may always be 'up').

Note: The default OSPF cost is '100,000,000/bandwith in bps'

One of the limitation of installing static route in the adjunct router is that it cannot support multiple alternative RAS, because the router does not have any indication whether dial backup to a specific branch is active or not.

An alternative for configuring static routes in the RAS itself is to configure them in a RADIUS server and let the RAS retrieve this information. Here is an example for RADIUS configuration:

```
branch43 Password = "password",
User-Service-Type = Framed-User,
Framed-Protocol = PPP,
Framed-Address = 149.49.78.22,        # Static address for WAN of remote router
Framed-Netmask = 255.255.255.252,
Framed-Routing = None,
Framed-Route = "123.2.44.0/24 0.0.0.0 1", # Network, mask & hop info for remote
                                          # router
Framed-Compression = Van-Jacobsen-TCP-IP,
Framed-MTU = 1500,
```

The drawback of this approach is that it mandates the usage of a unique username for each branch ('branch43'). An advantage is that it allows the calling dialer to retrieve its address from the RAS server ('ip address negotiated').

Dial backup is a classic 'LAN-to-LAN' scenario as it should support not only the Gateway itself but also IP phones. However, there are few tricks that can allow it to be used with RAS server that does not support 'LAN-to-LAN':

- Establish a GRE tunnel from the dialer ip-address to a router behind the RAS. Thus, the RAS will only have to route the GRE packets to the dialer address. The drawback of this approach is GRE tunnel overhead. Another drawback is that it cannot use dynamic addresses (as the tunnel source and destination addresses must be known in order to configure the tunnel).
- Establish a VPN tunnel over the dialer, as VPN supports dynamic IP addressing (Aggressive Mode).
- If there are no IP phones (e.g. a DCP/analog only installation), the dialer can "borrow" the PMI address using 'ip unnumbered' configuration. Unlike, the previous options, it does not add any bandwidth overheads.

1.1.5.2 Dynamic routing

While static routing is simple to understand, it is difficult to correctly configure and maintain all the static routes, if there is a large number of branches. The alternative is to use dynamic routing protocol like OSPF or RIP (from the two, OSPF is usually the preferable solution as it is more bandwidth efficient).
Activation of routing protocols is done on the subnet basis e.g.

```
router ospf 1
 network 10.20.30.40 0.0.0.0 area 0.0.0.0
 network 24.4.4.0 0.0.0.255 area 0.0.0.0
!
```

Consequently, it is not possible to run a routing protocol over a Dialer with dynamic IP address ('ip address negotiated'). Furthermore, the subnet configuration at both sides of the link must mach. Now, if there is only one RAS server, this isn't a problem. But if there are multiple RAS servers it became problematic as a subnet can be associated to a single PPP connection.
There are two ways to overcome this problem. One option is to assign each branch a unique 'username' and let the RAS retrieve the PPP information, including the subnet' from a RADIUS server. Another option is to use 'ip unnumbered' link. This option overcomes the subnet problem as the routing protocol simply ignores the IP address of the link.
The CLI command:

```
 ip unnumbered 1 Vlan 1
```

marks the link as 'unnumbered' and 'borrows' the IP address of 'interface vlan 1' for PPP/IPCP negotiation. Using unnumbered links, all branch offices can use the same dialer and IP configuration, and the RAS would learn which subnets belongs to each branch from OSPF.

1.2. Setup Scenario

This document includes detailed examples and configurations based on the following scenario (see Figures 3 and 4):

- The HQ office has a G700/S8300B media server running Communication Manager, i.e., the primary call controller (149.49.43.96).
- The core router in the HQ is connecting remote branches via WAN links.
- The core router in the HQ has a modem attached to it and has RAS capabilities.
- The G700 in the HQ is defined on network region 1.
- One of the branch offices, branch #8, is connected to the HQ via a T1 WAN connection, with total bandwidth of 1.5 Mbps that is used for data and voice traffic towards the HQ.
- Branch office #8 is defined on network region 8.
- 1 Mbps of the T1 is the maximum allocated bandwidth (Bandwidth Bearer Limit - BBL) for the voice bearer towards the branch (network region 8).
- A G350 is used as the branch office Gateway, which can function as the edge router for the brunch (Figure 3) or use an external router as the edge router (Figure 4).
- The branch Gateway reports of the BBL to the CM.
- An S8300B/LSP is installed in the branch Gateway and ready to be used when the primary call controller in the HQ is not reachable.
- In the branch the data and voice traffic are assigned to separate VLANs and IP subnets:
    - Data – VLAN 1 – 192.168.8.128 mask 255.255.255.128
    - Voice – VLAN 2 – 192.168.8.0 mask 255.255.255.128
  The branch Gateway's PMI is on VLAN 2, but it has an interface on VLAN 1 as well in order to route the data traffic towards the HQ and be used as the PCs default router.
- The branch Gateway has a backup dialer interface that will be automatically activated when the Gateway discovers that the WAN connection is down. In a WAN failure event the Gateway will dial to the core router and establish a backup PPP link.
- When the backup dial connection is active, it will be used for keeping the IP phones and the Gateway in the branch registered to the CM in the HQ (only H225 and H248 voice signaling traffic). Some low priority data traffic will also be able to go over that link but with low performance.
- Voice bearer will not go over the dial link, as the branch Gateway will report no BBL over the dial link. Instead the IGAR functionality will be activated by the CM and establish on-demand inter-region PSTN calls to hold the voice bearer.
- After the WAN link is resumed, the Gateway automatically disconnects the dial connections and start using the WAN for full voice and data functionality.

The following sections cover the following examples:

- **Example 1** - The branch Gateway is the branch edge router, working with dynamic routing (OSPF).
- **Example 2** - The branch Gateway is the branch edge router, working with static routing.
- **Example 3** - The branch Gateway is connected to branch edge router, working with dynamic routing (OSPF)
- **Example 4** - The branch Gateway is connected to branch edge router, working with static routing

These examples relate to the following functionalities:

- Branch LAN configuration (G350)
- Branch WAN configuration (G350 and/or the edge router)
- BBL reporting (G350)
- Dial backup configuration (G350)
- WAN failure discovery (G350)
- Routing between the HQ and the branch.
- Dynamic-CAC (CM)
- IGAR (CM)

Dial backup function can also be provided by the branch external edge router. In this case Dynamic-CAC can still be configured. More details can be found in "*Configuring G350 Dynamic-CAC for branch offices with a Cisco WAN router*" document.

2. Configuration Example 1 -

The branch Gateway is the branch edge router, working with dynamic routing (see Figure 3)

In example 1, the G350 Gateway has an MM340 data WAN module installed. The G350 uses basic OSPF routing scheme with the core router on OSPF area 0.0.0.0. However, in large scale network deployment it is recommended to use hierarchal routing approach, with separate OSPF areas for each bunch of remote branches.

In this example interface 'Dialer 1' is configured as a backup interface to the Gateway's WAN interface ('Serial'), so in case of WAN link failure interface 'Serial' will become inactive and 'Dialer 1' interface will be activated. The routing between the HQ and branch will be restored automatically by OSPF advertisements over the dialup link.

In this example, the default PPP keepalive setting is used for WAN link failure detection.

Figure 3
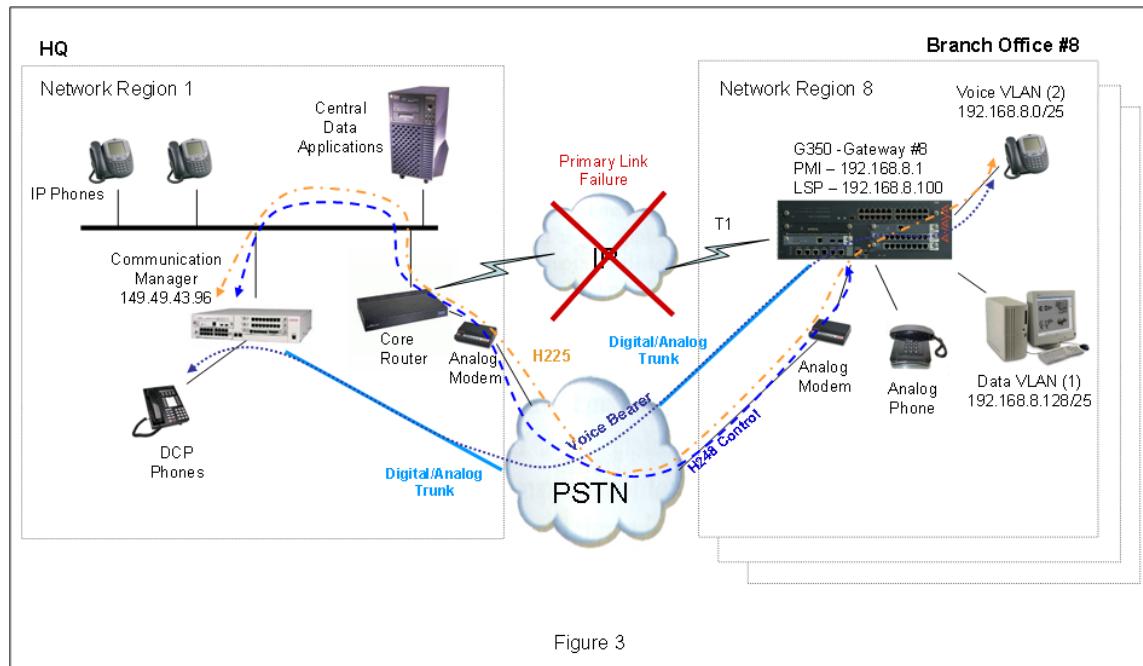
2.1. Configuring the G350 in Branch Office #8

The G350 configuration includes the following functions:

2.1.1. Branch Office LAN
Below is the LAN related command set as was taken from the G350 configuration file:

```
set vlan 2 name "V2"                              # Vlan 1 is for Data traffic.
!
interface Vlan 1
 description "Data-Vlan"
 ip address 192.168.8.129   255.255.255.128   # Default-gateway for the PCs.
 exit
!
interface Vlan 2                               # Vlan 2 is for Voice traffic.
 description "Voice-Vlan"
 icc-vlan
 ip address 192.168.8.1    255.255.255.128    # Default-Gateway for the phones
 pmi                                          # and the Gateway's PMI.
 exit
!
```

It is also required to assign the physical ports where the IP Phones and the PCs are attached to the appropriate VLAN. According to the example below, the G350 in the branch has an MM314 24-port POE module is installed in slot 6. As by default all ports are assigned to VLAN 1, the user has to configure the ports to be assigned for VLAN 2. In some installations the PCs are connected behind the IP phone.

In this example, we assume that the ports 1 to 5 on the POE module (slot 6) would be used for phones and therefore will be assigned to VLAN 2. Ports 6 to 10 will be used for phones and PCs will be attached behind the phones, therefore these ports will be bound to both VLANs 1 and 2. The rest of the ports will stay on the default VLAN (1) and can be used for connecting PCs:

```
set port static-vlan 6/6-10 2    # Binding ports 6-10 to V2 in addition to the
                                 # default binding to V1.

set port vlan 2 6/1-5            # Assign ports 1-5 to V2.
```

Please note that as PCs cannot accept VLAN tagged packets (802.1Q), the ports where the PCs are attached to must not tag, even though there is more than one VLAN bound to them (as ports 6 to 10 in this example). However, some new model IP phones (like the 4620SW) are able to strip the tag from the packet that is destined to the PC attached to them.

2.1.2. Branch Office Backup Dialup configuration

The dialer interface is planned to be used as a backup interface for the T1 WAN connection. However the voice bearer traffic (RTP) is not meant to be routed through this interface but only via the PSTN. Therefore, to avoid any possibility of voice bearer going through this interface, an access-list blocking RTP is defined. Voice bearer RTP traffic recognized by its unique DSCP value of 46:

```
ip access-control-list 301
 name "Bearer-Block"
!
 ip-rule 10
  composite-operation "Deny"          # Block all traffic with DSCP 46 value.
  dscp 46
  description "Block-RTP"
 exit
```

The default-action for the above list is Permit, so it will allow any other traffic.

Below is the interface Dialer definition:

```
interface Dialer 1
 description "Backup-of-WAN-link"
 ppp chap hostname "G350"            # Hostname for CHAP authentication.
 ppp pap refuse                      # Use CHAP only.
 dynamic-cac 0                       # Set this Gateway to be the Dynamic-
                                     # CAC Gateway for its Network Region
                                     # and report the CM there is no
                                     # available bandwidth for voice bearer
                                     # over the Dialer interface.
 dialer persistent initial delay 45  # After reboot, wait for 45 seconds
                                     # before activating this interface (in
                                     # order to wait for the primary link to
                                     # become active first).
 dialer string 1 7273201147          # That's the number to dial.
 dialer persistent delay 1           # Set redial interval to 1 second.
 dialer modem-interface USB-Modem    # Use the USB attached modem.
 ! dialer modem-interface Console    # Or use a serial attached modem.
 ip access-group 301 out             # Activate ACL 301 on the egress of
                                     # this interface.
 ip unnumbered 1 Vlan 2              # This is an Unnumbered interface that
                                     # uses the IP address from Interface
                                     # Vlan 2.
 exit
```

The following section enables the USB modem:

```
interface USB-Modem
 no shutdown
 exit
```

In case a serial modem is used:

```
interface Console
```

```
 async mode interactive
 exit
```

2.1.3. Branch Office WAN

In our example, the G350 has an MM340 data WAN module installed in slot v4.
Below is the WAN related command set as was taken from the G350 configuration file:

```
ds-mode t1                               # Set the controller to T1.
!
controller t1 4/1                        # Controller configuration.
 linecode b8zs
 framing esf
 description "WAN-To-HQ"
 fdl ansi
 channel-group 0 timeslots 1-24 speed 64   # 1.5M total bandwidth.
 exit


interface Serial 4/1:0                    # The MM340 is in slot v4.
 encapsulation ppp
 description "WAN-To-HQ"
 backup interface Dialer 1               # Backup interface definition.
 dynamic-cac 1024                        # Set this Gateway to be the
                                         # Dynamic-CAC Gateway for its
                                         # Network Region and report the
                                         # CM this interface supports
                                         # maximum of 1Mbps for
                                         # voice bearer.
 ip address 24.4.4.2      255.255.255.252  # IP address for WAN interface.
 exit
```

> *Note*
>
> *In the above example the Serial interface is not 'Unnumbered', in order to allow remotely check the link status with ping.*

2.1.4. Branch Office Routing

Bellow is the definition of OSPF routing in the Gateway:

```
router ospf
 redistribute connected                               # Redistribute local
                                                      # connected networks.
 network 24.4.4.0        0.0.0.3        area 0.0.0.0  # Activate OSPF over the
                                                      # WAN interface.
 network 192.168.8.0     0.0.0.127      area 0.0.0.0  # Activate OSPF over the
                                                      # Dialer interface (it
                                                      # has the same IP as
                                                      # interface Vlan 2).
 exit
```

In large network deployments, it is recommended to use a hierarchal routing approach, with separate OSPF areas for each bunch of remote branches. This will reduce OSPF traffic over the low bandwidth dial link.

2.1.5. Branch Office MGC list

Bellow is the definition of the MGC related information:

```
set mgc list 149.49.43.96,192.168.8.100                    # Primary CM and LSP.
set mediaserver 149.49.43.96 149.49.43.96 23 telnet
set mediaserver 149.49.43.96 149.49.43.96 5023 sat
set mediaserver 192.168.8.100 192.168.8.100 23 telnet
set mediaserver 192.168.8.100 192.168.8.100 5023 sat
```

2.1.6. Full Branch Office G350 configuration

The full G350 configuration file is displayed below:

```
G350-008(super)# show running-config
G350-008(super)#
! version 24.14.0
!
set vlan 2 name "V2"
set port static-vlan 6/6 2
set port static-vlan 6/7 2
set port static-vlan 6/8 2
set port static-vlan 6/9 2
set port static-vlan 6/10 2
set port vlan 2 6/1 2
set port vlan 2 6/2 2
set port vlan 2 6/3 2
set port vlan 2 6/4 2
set port vlan 2 6/5 2
!
ip access-control-list 301
 name "Bearer-Block"
!
 ip-rule 10
  composite-operation "Deny"
  dscp 46
  description "Block-RTP"
 exit
!
exit
!
ds-mode t1
!
controller t1 4/1
 linecode b8zs
 framing esf
 description "WAN-To-HQ"
 fdl ansi
 channel-group 0 timeslots 1-24 speed 64
 exit
!
interface Vlan 1
```

```
  description "Data-Vlan"
  ip address 192.168.8.129    255.255.255.128
  exit

interface Vlan 2
 description "Voice-Vlan"
 icc-vlan
 ip address 192.168.8.1     255.255.255.128
 pmi
 exit
!
!
interface FastEthernet 10/2
 exit
!
interface Dialer 1
 description "Backup-of-WAN-link"
 ppp chap hostname "G350"
 ppp pap refuse
 dynamic-cac 0
 dialer persistent initial delay 45
 dialer string 1 7273201147
 dialer persistent delay 1
 dialer modem-interface USB-Modem
 ip access-group 301 out
 ip unnumbered 1 Vlan 2
 exit
!
interface Serial 4/1:0
 encapsulation ppp
 description "WAN-To-HQ"
 backup interface Dialer 1
 dynamic-cac 1024
 ip address 24.4.4.2        255.255.255.252
 exit
!
interface Console
 async modem-type MultiTech-ZBA
 exit
!
interface USB-Modem
 no shutdown
  exit
!
router ospf
 redistribute connected
 network 24.4.4.0        0.0.0.3          area 0.0.0.0
 network 192.168.8.0     0.0.0.127        area 0.0.0.0
 exit
!
set mgc list 149.49.43.96,192.168.8.100
set mediaserver 149.49.43.96 149.49.43.96 23 telnet
set mediaserver 149.49.43.96 149.49.43.96 5023 sat
set mediaserver 192.168.8.100 192.168.8.100 23 telnet
set mediaserver 192.168.8.100 192.168.8.100 5023 sat
rtp-stat qos-trap
no rtp-stat fault
!#
!# End of Configuration File. Press Enter to continue.
```

2.2. Configuring the Core Router in the HQ

As the core router can hold many configurations, the following section includes only the configuration relevant to branch office 8. The configuration below is compatible with Cisco:

```
hostname Cisco_HQ
!
aaa new-model
aaa authentication enable default none
aaa authentication ppp default local
aaa authentication ppp G350 local
enable password cisco
!
username G350 password 0 G350
ip subnet-zero
!
!
no ip domain-lookup
!
!
chat-script DialIn ABORT ERROR ABORT BUSY"" "AT" OK "ATDT \T" TIMEOUT 45
CONNECT
modemcap entry 65
modemcap entry MULTITECH:MSC=&FS0=1&C4&D
modemcap entry USR:MSC=1
call rsvp-sync
!
!
controller T1 1/0
 framing esf
 fdl ansi
 linecode b8zs
 channel-group 0 timeslots 1-24 speed 64
!
!
class-map match-all voice-class
  match access-group name voice-traffic
class-map match-all data-class
  match access-group name data-traffic
!
!
policy-map QoS-input
  class voice-class
   set qos-group 99
  class data-class
     police 500000 15625 15625 conform-action transmit exceed-action drop
policy-map QoS
  class voice-class
    priority 1000
  class data-class
    priority 500
!
!
!
interface Loopback1
 ip address 10.20.30.40 255.255.255.255
!
!
```

```
interface FastEthernet0/1
 ip address 149.49.43.1 255.255.255.0
 service-policy input QoS-input
 duplex auto
 speed auto
!
interface Serial1/0:0
 ip address 24.4.4.1 255.255.255.252
 encapsulation ppp
 ip tcp header-compression
!
!
interface Async65
 description DialIn-from-branches
 ip unnumbered Loopback1
 encapsulation ppp
 autodetect encapsulation ppp
 async default routing
 async mode dedicated
 no peer default ip address
 ppp chap hostname G350
 ppp chap password 0 G350
 ppp pap refuse
 ppp ipcp dns 192.100.106.100
 ppp ipcp mask 255.255.255.255
!
router ospf 1
 log-adjacency-changes
 network 10.20.30.40 0.0.0.0 area 0.0.0.0
 network 24.4.4.0 0.0.0.3 area 0.0.0.0
!
!
exec-timeout 0 0
 script connection DialIn
 script dialer DialIn
 modem Dialin
 modem autoconfigure type usr_sportster
 transport input all
 autoselect ppp
 speed 115200
 flowcontrol hardware
line vty 0
 password enable
line vty 1 4
!
end
```

2.3. Configuring IGAR/D-CAC on the Communication Manager

2.3.1. Configure the Gateway's Network Region

Each Media Gateway in each remote branch will be placed on a different Network Region. The G700 in the HQ is placed on Network Region 1. In our example, the Gateway in branch office #8 will be placed on Network Region 8.

Use the media-Gateway SAT screen to set the Media Gateway's Network Region.

```
C:\WINNT\system32\cmd.exe - telnet 149.49.43.96                          _ □ ×
change media-gateway 8                                        Page   1 of   1
                           MEDIA GATEWAY
          Number: 8                        IP Address: 192.168.8  .1
            Type: g350             FW Version/HW Vintage: 24 .14 .0  /1
            Name: G350DCP                  MAC Address: 00:04:0d:29:f4:6d
       Serial No: 05IS27654536            Encrypt Link? y
  Network Region: 8                          Location: 1
      Registered? y              Controller IP Address: 149.49 .43 .96
   Recovery Rule: 1                          Site Data:
      Slot   Module Type              Name
      V1:    S8300                    ICC MM
      V2:    MM710                    DS1 MM
      V3:
      V4:    MM340                    DS1 WAN MM
      V5:    MM711                    ANA MM
      V6:    MM312                    DCP MM
      V7:    1T+2L Integ Analog       ANA IMM
      V8:
      V9:    gateway-announcements    ANN VMM



ESC-x=Cancel Esc-e=Submit Esc-p=Prev Pg Esc-n=Next Pg Esc-h=Help Esc-r=Refresh
```

2.3.2. Configure the Network Region's IGAR parameters

When IGAR is activated, the CM will signal the two Gateways on the two Network Regions to establish a PSTN-call between them which will hold the voice bearer for each call between the two Network Regions.

On page 2 of the ip-network-region SAT screen we will define few parameters that relate to IGAR use of PSTN calls between the Gateway representing a Network Region and other Gateways from other Network Regions.

- Incoming LDN Extension –
  The extension number that IGAR will use to accept calls from other Gateways in order to establish PSTN call with other Network Regions. The extension number must fit the dial plan.

- Conversion to Full Public Number –
  What modifications should be made to the above extension number in order to reach this extension by dialing in through the public PSTN. In the example below it says that no digits has to be removed, but just add 97 before the extension number, i.e, the number that a Gateway from another Network Region will dial to set the PSTN call with a Gateway on Network Region 8 will be 9780800.

- Maximum Number of Trunks to Use –
  The maximum number of trunks (calls) that IGAR can use for dialing out of this Network Region to establish PSTN calls with other Network Regions.

```
C:\WINNT\system32\cmd.exe - telnet 149.49.43.96                    _ □ ×
change ip-network-region 8                             Page   2 of  19
                          IP NETWORK REGION


INTER-GATEWAY ALTERNATE ROUTING
 Incoming LDN Extension: 80800
 Conversion To Full Public Number - Delete: 0   Insert: 97
 Maximum Number of Trunks to Use: 2

 LSP NAMES IN PRIORITY ORDER           SECURITY PROCEDURES
 1    008_LSP                          1    challenge
 2                                     2
 3                                     3
 4                                     4
 5
 6






ESC-x=Cancel Esc-e=Submit Esc-p=Prev Pg Esc-n=Next Pg Esc-h=Help Esc-r=Refresh
```

You have to set the above parameters for each Network Region in the system.

2.3.3. Configure the Network Region's Dynamic-CAC

Page 3 of the ip-network-region SAT screen is used to configure the Inter-Region connection management. The following parameters should be set:

- Codec set – The codec set that should be used for voice bearer RTP traffic between each Network Regions pair. Use ip-codec-set SAT screens to set the codecs for each codec-set.

- Direct WAN - Indicates whether the two regions are directly connected by a WAN link.

- WAN-BW-limits - The bandwidth limit for voice bearer for the direct WAN links. This field accepts fixed numbered values (in Kbps or Mbps), to NoLimit or to Dynamic. Entering 'Dynamic' in this field indicates the CM that it should receive the bandwidth limit from the Gateway that is assigned to report the voice bearer bandwidth limit (Dynamic CAC Gateway).

- Intervening-regions – The intervening Network Region numbers between the two indirectly-connected regions. You can enter up to 4 intervening region numbers. As in our example Network Region 1 and 8 are directly connected, we left this field blank.

- Dynamic CAC Gateway – This field only appears if the WAN-BW-limit field is set to 'Dynamic'. Enter the Gateway number that is configured to be the Dynamic-CAC Gateway for its region. This Gateway should report the CM about the voice bearer bandwidth limit in the Network Region. In our example we configured Gateway #8 to be the Dynamic-CAC Gateway for its region (see sections 2.1.2 and 2.1.3).

- IGAR – Whether IGAR will be activated between the two regions in case the voice bearer bandwidth limit is reached. If set to 'n', no new calls will be allowed to set.

```
C:\WINNT\system32\cmd.exe - telnet 149.49.43.96                         _ □ ✕
change ip-network-region 8                              Page   3 of  19 ▲

                    Inter Network Region Connection Management

    src dst  codec  direct                                Dynamic CAC
    rgn rgn   set    WAN    WAN-BW-limits  Intervening-regions  Gateway    IGAR
    8   1     2      y          :Dynamic                         8         y
    8   2
    8   3
    8   4
    8   5
    8   6     2      y          :NoLimit                                   n
    8   7
    8   8     1
    8   9
    8   10
    8   11
    8   12
    8   13
    8   14
    8   15


ESC-x=Cancel Esc-e=Submit Esc-p=Prev Pg Esc-n=Next Pg Esc-h=Help Esc-r=Refresh ▼
```

You have to set the above parameters for each Network Region in the system.

2.3.4. Configure the Trunks to PSTN

You have to configure Trunk groups to PSTN for each Network Region. In this example we configured two Trunk Groups (ISDN-PRI) with ten channels each: Trunk Group 20 for the G350 branch office Gateway #8 and Trunk Group 30 for the G700 in the HQ.

Use trunk-groups SAT screen to manage Trunk Groups. Trunk Group definition description is out of scope of this document.

```
C:\WINNT\system32\cmd.exe - telnet 149.49.43.96                        _ □ ×
list trunk-group

                            TRUNK GROUPS

Grp                                              No.                Out Que
No.   TAC  Group Type   Group Name               Mem TN  COR CDR Meas Dsp Len

20    02   isdn         G350->PSTN               10  1   1   y   none  y   0
30    03   isdn         G700HQ->PSTN             10  1   1   y   none  y   0













Command successfully completed
Command:
ESC-x=Cancel Esc-e=Submit Esc-p=Prev Pg Esc-n=Next Pg Esc-h=Help Esc-r=Refresh
```

2.3.5. Configure the PSTN path between Network Regions

You have to associate Route Patterns with Trunk Groups. These Route Patterns will be selected by ARS to reach PSTN. In this example, Route Pattern #20 chooses Trunk Group #20 (to reach the PSTN for branch office #8).

Use the route-pattern SAT screen to manage Route Patterns. Route Patterns definition description is out of scope of this document

```
C:\WINNT\system32\cmd.exe - telnet 149.49.43.96                        _ □ ×
list route-pattern

                              ROUTE PATTERNS
  Route Name/Trk FRL Hop IXC       BCC      TSC  CA-TSC     ITC    Service/Feature
  Pat    Pref Grp    Lmt       0 1 2 3 4 W       Request
   20    RP_G350<->PSTN
          1   20   0        user y y y y y n   n   none       rest
   30    G700<->PSTN
          1   30   0        user y y y y y n   n   none       rest


















Command successfully completed
Command: _
ESC-x=Cancel Esc-e=Submit Esc-p=Prev Pg Esc-n=Next Pg Esc-h=Help Esc-r=Refresh
```

2.3.6. Configure the ARS Route Scheme

You have to configure the ARS analysis in which you associate a dialed string to Route Pattern. To enable IGAR functionality, it is required to bind the actual dial string as derived from the LDN extension and suffixes (as were defined in section 2.3.2) to the appropriate route pattern. In this example, the actual LDN number to dial to branch office #8 is 9780800, which will be routed to Trunk Group 30 via Route Pattern 30.

```
C:\WINNT\system32\cmd.exe - telnet 149.49.43.96                          _ □ ×
display ars analysis 9                                        Page    1 of    2
                           ARS DIGIT ANALYSIS TABLE
                              Location:   all              Percent Full:    3

            Dialed              Total        Route    Call    Node   ANI
            String           Min   Max     Pattern    Type    Num    Reqd
        9                     7     7         2        hnpa           n
        911                   3     3         1        svcl           n
        9780800               7     7        30        hnpa           n
        9780809               7     7        20        hnpa           n
                                                                      n
                                                                      n
                                                                      n
                                                                      n
                                                                      n
                                                                      n
                                                                      n
                                                                      n
                                                                      n
                                                                      n
                                                                      n

ESC-x=Cancel Esc-e=Submit Esc-p=Prev Pg Esc-n=Next Pg Esc-h=Help Esc-r=Refresh
```

Note

Detailed information about IGAR can be found in the "Inter-Gateway Alternate Routing Guide - an IGAR White Paper" document.

2.4. Normal Operation Scenario

During normal operation, the WAN link is active and the G350 in branch office #8 is normally registered to the CM in the HQ.

The G350's interfaces will be in the following state:

```
G350-008(super)# show ip interface brief
Showing 4 Interfaces
        Interface             Address     Mask Method        Status
------------------------- -------------- ---- ------ ---------------------
Serial   4/1:0             24.4.4.1        30 manual       up
Dialer   1                 192.168.8.1     25 manual       down
Vlan     1                 192.168.8.129   25 manual       up
Vlan     2                 192.168.8.1     25 manual       up


G350-008(super)# show interfaces Serial 4/1:0

Serial 4/1:0 is up, line protocol is up
Description: WAN-To-HQ
 Internet address is 24.4.4.2, mask is 255.255.255.252 (advertised IPCP)
 Peer internet address is 24.4.4.1
 Backup interface Dialer 1, failure delay 0 sec, secondary disable delay 0 sec
 MTU 1500 bytes, Bandwidth 1536 kbit
 Reliability 211/255 txLoad 1/255 rxLoad 1/255
 Encapsulation PPP
 Link status trap enabled
 Keepalive-track not set
 Keepalive set (10 sec)
 LCP  Opened
 IPCP Opened
 Weighted Fair VoIP queueing mode
 Dynamic CAC BBL: 1024 kbps
 Dynamic CAC activation priority : 128
 Dynamic CAC interface status : active
 Last input 00:00:00, Last output 00:00:00
 Last clearing of 'show interface' counters never
 5 minute input rate 531 bits/sec, 0 packets/sec
 5 minute output rate 457 bits/sec, 0 packets/sec
 0 input drops, 4 output drops, 4 unknown protocols
 1934 packets input, 164949 bytes
 0 broadcasts received, 0 giants
 10 input errors, 10 CRC, 0 abort
 1888 packets output, 129383 bytes
 0 output errors, 0 collisions


G350-008(super)# show interfaces Dialer 1

Dialer 1 is in standby mode, line protocol is down
Description: Backup-of-WAN-link
 Internet address is 192.168.8.1, mask is 255.255.255.128
 Internet address is unnumbered. Using address of Vlan 2
 Primary management interface
 MTU 1500 bytes, Bandwidth 28 kbit
 Reliability 46/255 txLoad 255/255 rxLoad 255/255
```

```
Encapsulation PPP
Link status trap disabled
Keepalive-track not set
Keepalive set (10 sec)
LCP  Starting
IPCP Starting
PAP refuse
CHAP hostname: G350
CHAP password: configured
Dialer modem-interface: USB-Modem
Dialer state is:  idle
Last dialed string: 7273201147
Dial strings:
   1: 7273201147
Dialing order is sequential
Persistent initial delay 45 sec
Persistent: delay 1 sec
Wait 45 sec for IPCP
Weighted Fair VoIP queueing mode
Last input 00:01:43, Last output 00:01:43
Last clearing of 'show interface' counters never
5 minute input rate 296 bits/sec, 0 packets/sec
5 minute output rate 329 bits/sec, 0 packets/sec
0 input drops, 0 output drops, 0 unknown protocols
2574 packets input, 220238 bytes
0 broadcasts received, 0 giants
0 input errors, 0 CRC
2848 packets output, 243174 bytes
0 output errors, 0 collisions
```

The G350's routing table:

```
G350-008(super)# show ip route
Showing 5 rows
    Network      Mask     Interface           Next-Hop          Cost  TTL  Source
--------------- ----  ------------------  ------------------ ----- ---
24.4.4.0          30 Serial   4/1:0      24.4.4.2               1 n/a LOCAL
24.4.4.1          32 Serial   4/1:0      24.4.4.2               1 n/a LOCAL
149.49.43.0       24 Serial   4/1:0      24.4.4.1              20 n/a OSPF-E2
192.168.8.0       25 Vlan     2         192.168.8.1            1 n/a LOCAL
192.168.8.128     25 Vlan     1         192.168.8.129          1 n/a LOCAL
```

The G350 reports of the available bandwidth for voice bearer:

```
G350-008(super)# show dynamic-cac

Current RBBL  : 1024 kbps
Last event    : 0 Days, 00:03:45
Last event BBL: 1024 kbps
```

The G350's MGC list:

```
G350-008(super)# show mgc

CALL CONTROLLER STATUS
------------------------------------------
Registered          : YES
Active Controller   : 149.49.43.96
H248 Link Status    : UP
H248 Link Error Code: 0x0

CONFIGURED MGC HOST
--------------------
149.49.43.96
192.168.8.100
-- Not Available --
-- Not Available –
```

2.5. Dial Backup Operation Scenario

On a WAN link failure event, the G350's primary Serial interface will become inactive and the backup Dialer interface will be automatically activated. By default, the backup dial interface will be activated immediately when the primary interface becomes inactive. However, it is possible to configure the delay for backup interface activation and the delay to fall back. This configuration is made on the primary interface context.

At WAN link failure the G350 console will show the following:

```
Controller T1 4/1 changed state to down (LOS)

Line protocol on Interface Serial 4/1:0, changed state to down

Interface Dialer 1, out of standby mode

Line protocol on Interface Dialer 1, changed state to up
```

The G350's interfaces will be in the following state:

```
G350-008(super)# show ip interface brief
Showing 4 Interfaces
        Interface            Address       Mask Method       Status
------------------------- --------------- ---- ------ --------------------
Serial   4/1:0             24.4.4.2          30 manual     down
Dialer   1                 192.168.8.1       25 manual     up
Vlan     1                 192.168.8.129     25 manual     up
Vlan     2                 192.168.8.1       25 manual     up


G350-008(super)# show interfaces Dialer 1

Dialer 1 is up, line protocol is up
Description: Backup-of-WAN-link
 Internet address is 192.168.8.1, mask is 255.255.255.128
 Peer internet address is 10.20.30.40
 Internet address is unnumbered. Using address of Vlan 2
 Primary management interface
 MTU 1500 bytes, Bandwidth 28 kbit
 Reliability 69/255 txLoad 4/255 rxLoad 4/255
 Encapsulation PPP
 Link status trap disabled
 Keepalive-track not set
 Keepalive set (10 sec)
 LCP  Opened
 IPCP Opened
 PAP refuse
 CHAP hostname: G350
 CHAP password: configured
 Dialer modem-interface: USB-Modem
 Dialer state is:  connected
 Last dialed string: 7273201147
```

```
 Dial strings:
    1: 7273201147
 Dialing order is sequential
 Persistent initial delay 45 sec
 Persistent: delay 1 sec
 Wait 45 sec for IPCP
 Weighted Fair VoIP queueing mode
 Last input 00:00:00, Last output 00:00:00
 Last clearing of 'show interface' counters never
 5 minute input rate 494 bits/sec, 1 packets/sec
 5 minute output rate 448 bits/sec, 1 packets/sec
 0 input drops, 0 output drops, 0 unknown protocols
 2777 packets input, 238841 bytes
 0 broadcasts received, 0 giants
 0 input errors, 0 CRC
 3061 packets output, 255745 bytes
 0 output errors, 0 collisions
```

The G350 reports of no available bandwidth for voice bearer:

G350-008(super)# show dynamic-cac

```
Current RBBL  : 0 kbps
Last event    : 0 Days, 00:01:26
Last event BBL: 0 kbps
```

The G350's routing table:

G350-008(super)# show ip route
```
Showing 4 rows
    Network        Mask     Interface            Next-Hop           Cost  TTL  Source
--------------- ---- -------------------- -------------------- ----- --- --------
10.20.30.40      32 Dialer   1           Via Dia.1              1 n/a LOCAL
149.49.43.0      24 Dialer   1           Via Dia.1             20 n/a OSPF-E2
192.168.8.0      25 Vlan     2           192.168.8.1            1 n/a LOCAL
192.168.8.128    25 Vlan     1           192.168.8.129          1 n/a LOCAL
```

The G350's MGC list:

G350-008(super)# show mgc

```
CALL CONTROLLER STATUS
-------------------------------------------
Registered          : YES
Active Controller   : 149.49.43.96
H248 Link Status    : UP
H248 Link Error Code: 0x0

CONFIGURED MGC HOST
--------------------
149.49.43.96
192.168.8.100
-- Not Available --
-- Not Available -
```

Important Note

From the moment the WAN link failure took place until the dial backup link was established some H248 keepalives (from the Gateway to its CM) were lost. If the modem backup line is established faster than the H248 keepalive timeout (about 60 to 70 seconds), the Gateway will continue being registered to the primary CM. Otherwise the Gateway will consider the H248 link to be down and start trying to re-register to the primary call controller for another one minute (Primary Search Timer default value). If the backup dial link was not established by then (approx two minutes after the WAN link failure event), the Gateway will try to register to the next call controller in its MGC list, which in our example is the LSP.

It is possible to increase the value of the Primary Search Timer in order to keep the Gateway being registered to its primary CM. Use the `set reset-times primary-search` *CLI command on the Gateway to set the Primary Search Timer.*

By default, the backup Dialer interface is activated immediately after the primary interface was discovered to be inactive. However, it can take another 20 to 40 seconds to establish the call and have the routing tables to be updated, depends on the dialup line quality and the routing method. During that time, there is no signaling connectivity to the CM, thus the Gateway cannot generate new dial tones, no features can be requested, incoming calls will not be answered, etc. However, existing intra-branch calls and calls to local trunk facilities remains active.

3. Configuration Example 2 -

The branch Gateway is the branch edge router, working with static routing (see Figure 3)

In example 2, the G350 Gateway has an MM340 data WAN module. The core router and the Gateways in the remote branches are configured with static routing.

In this example interface 'Dialer 1' is configured as a backup interface to the Gateway's WAN interface ('Serial'), so in the case of a WAN link failure, interface 'Serial' will become inactive and 'Dialer 1' interface will be activated. The routing between the HQ and branch will be restored automatically by OSPF advertisements over the dialup link.

It is possible to use the PPP keepalive mechanism for WAN link failure detection, but it is not used in the given example.

In this type of configuration, the routing is restored faster when using static route than with dynamic routing. However, static routing configuration is difficult to maintain and manage in large scale networks.

Figure 3
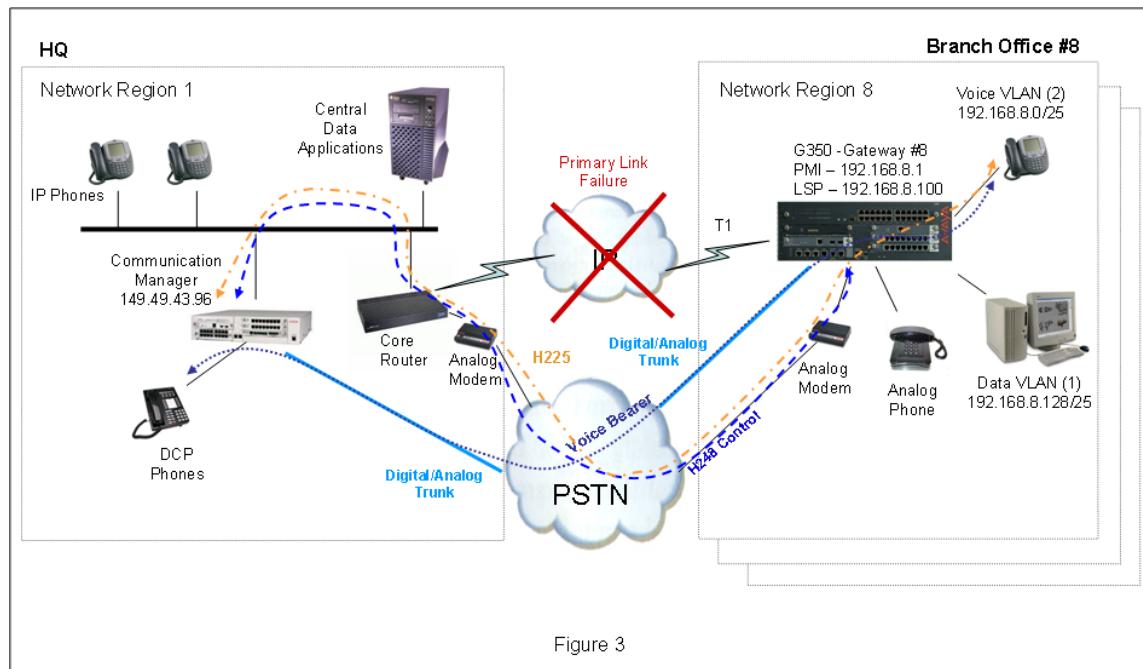
3.1. Configuring the G350 in Branch Office #8

The G350 configuration includes the following functions:

3.1.1. Branch Office LAN
See section 2.1.1.

3.1.2. Branch Office Backup Dialup configuration
See section 2.1.2.

3.1.3. Branch Office WAN
See section 2.1.3.

3.1.4. Branch Office Routing
The Gateway will be configured with two static definitions of default Gateway – one via the Serial (WAN) and the other via the Dialer:

```
ip default-gateway Serial 4/1:0    1 low
ip default-gateway Dialer 1        1 low
```

Since during normal operation the Dialer interface is down, its associated routing entry will not appear in the active routing table. During backup event the Serial interface is down and the Dialer interface is up, so the route entry associated with the Serial interface will not appear in the active routing table but the entry associated with the Dialer interface.

The same concept is used in the core router configuration (section 3.2).

3.1.5. Branch Office MGC list
See section 2.1.5.

3.1.6. Full Branch Office G350 configuration

The full G350 configuration file is displayed below:

```
G350-008(super)# show running-config
G350-008(super)#
! version 24.14.0
!
set vlan 2 name "V2"
set port static-vlan 6/6 2
set port static-vlan 6/7 2
set port static-vlan 6/8 2
set port static-vlan 6/9 2
set port static-vlan 6/10 2
set port vlan 2 6/1 2
set port vlan 2 6/2 2
set port vlan 2 6/3 2
set port vlan 2 6/4 2
set port vlan 2 6/5 2
!
ip access-control-list 301
 name "Bearer-Block"
!
 ip-rule 10
  composite-operation "Deny"
  dscp 46
  description "Block-RTP"
 exit
!
exit
!
ds-mode t1
!
controller t1 4/1
 linecode b8zs
 framing esf
 description "WAN-To-HQ"
 fdl ansi
 channel-group 0 timeslots 1-24 speed 64
 exit
!
interface Vlan 1
 description "Data-Vlan"
 ip address 192.168.8.129   255.255.255.128
 exit
!
interface Vlan 2
 description "Voice-Vlan"
 icc-vlan
 ip address 192.168.8.1     255.255.255.128
 pmi
 exit
!
interface FastEthernet 10/2
 exit
!
interface Dialer 1
 description "Backup-of-WAN-link"
```

```
ppp pap refuse
 dynamic-cac 0
 dialer persistent initial delay 45
 dialer string 1 7273201147
 dialer persistent delay 1
 dialer modem-interface USB-Modem
 ip access-group 301 out
 ip unnumbered 1 Vlan 2
 exit
!
interface Serial 4/1:0
 encapsulation ppp
 description "WAN-To-HQ"
 backup interface Dialer 1
 dynamic-cac 1024
 ip address 24.4.4.2        255.255.255.252
 exit
!
interface Console
 async modem-type MultiTech-ZBA
 exit
!
interface USB-Modem
 no shutdown
 exit
!
ip default-gateway Serial 4/1:0    1 low
ip default-gateway Dialer 1        1 low
!
set mgc list 149.49.43.96,192.168.8.100
set mediaserver 149.49.43.96 149.49.43.96 23 telnet
set mediaserver 149.49.43.96 149.49.43.96 5023 sat
set mediaserver 192.168.8.100 192.168.8.100 23 telnet
set mediaserver 192.168.8.100 192.168.8.100 5023 sat
rtp-stat qos-trap
no rtp-stat fault
!#
!# End of Configuration File. Press Enter to continue.
```

3.2. Configuring the Core Router in the HQ

As the core router can include lots of configuration, the following section includes only the relevant configuration to branch office 8. The configuration below is compatible with Cisco:

```
hostname Cisco_HQ
!
!
aaa authentication ppp G350 local
enable password cisco
!
username G350 password 0 G350
ip subnet-zero
!
!
no ip domain-lookup
!
!
chat-script DialIn ABORT ERROR ABORT BUSY"" "AT" OK "ATDT \T" TIMEOUT 45
CONNECT
modemcap entry 65
modemcap entry MULTITECH:MSC=&FS0=1&C4&D
modemcap entry USR:MSC=1
call rsvp-sync
!
!
controller T1 1/0
 framing esf
 fdl ansi
 linecode b8zs
 channel-group 0 timeslots 1-24 speed 64
!
!
class-map match-all voice-class
  match access-group name voice-traffic
class-map match-all data-class
  match access-group name data-traffic
!
!
policy-map QoS-input
  class voice-class
   set qos-group 99
  class data-class
     police 500000 15625 15625 conform-action transmit exceed-action drop
policy-map QoS
  class voice-class
    priority 1000
  class data-class
    priority 500
!
!
!
interface Loopback1
 ip address 10.20.30.40 255.255.255.255
!
!
interface FastEthernet0/1
 ip address 149.49.43.1 255.255.255.0
```

```
 service-policy input QoS-input
 duplex auto
 speed auto
!
interface Serial1/0:0
 ip address 24.4.4.1 255.255.255.252
 encapsulation ppp
 ip tcp header-compression
!
interface Async65
 description DialIn-from-2173
 ip unnumbered Loopback1
 encapsulation ppp
 autodetect encapsulation ppp
 async default routing
 async mode dedicated
 no peer default ip address
 ppp authentication chap
ppp pap refuse
 ppp ipcp dns 192.100.106.100
 ppp ipcp mask 255.255.255.255
!
!
ip route 192.168.8.0 255.255.255.128 Serial1/0:0
ip route 192.168.8.0 255.255.255.128 192.168.8.1
ip route 192.168.8.128 255.255.255.128 Serial1/0:0
ip route 192.168.8.128 255.255.255.128 192.168.8.1
!
!
end
```

3.3. Configuring IGAR/D-CAC on the Communication Manager

See section 2.3.

3.4. Normal Operation Scenario

During normal operation the WAN link is active and the G350 in branch office #8 is normally registered to the CM in the HQ.

The G350's interfaces will be in the following state:

```
G350-008(super)# show ip interface brief
Showing 4 Interfaces
        Interface              Address      Mask Method        Status
------------------------- -------------- ---- ------ ---------------------
Serial   4/1:0            24.4.4.2          30 manual        up
Dialer   1                192.168.8.1       25 manual        down
Vlan     1                192.168.8.129     25 manual        up
Vlan     2                192.168.8.1       25 manual        up


G350-008(super)# show interfaces Serial 4/1:0

Serial 4/1:0 is up, line protocol is up
Description: WAN-To-HQ
 Internet address is 24.4.4.2, mask is 255.255.255.252 (advertised IPCP)
 Peer internet address is 24.4.4.1
 Backup interface Dialer 1, failure delay 0 sec, secondary disable delay 0 sec
 MTU 1500 bytes, Bandwidth 1536 kbit
 Reliability 211/255 txLoad 1/255 rxLoad 1/255
 Encapsulation PPP
 Link status trap enabled
 Keepalive-track not set
 Keepalive set (10 sec)
 LCP  Opened
 IPCP Opened
 Weighted Fair VoIP queueing mode
 Dynamic CAC BBL: 1024 kbps
 Dynamic CAC activation priority : 128
 Dynamic CAC interface status : active
 Last input 00:00:00, Last output 00:00:00
 Last clearing of 'show interface' counters never
 5 minute input rate 531 bits/sec, 0 packets/sec
 5 minute output rate 457 bits/sec, 0 packets/sec
 0 input drops, 4 output drops, 4 unknown protocols
 1934 packets input, 164949 bytes
 0 broadcasts received, 0 giants
 10 input errors, 10 CRC, 0 abort
 1888 packets output, 129383 bytes
 0 output errors, 0 collisions
```

```
G350-008(super)# show interfaces Dialer 1

Dialer 1 is in standby mode, line protocol is down
Description: Backup-of-WAN-link
 Internet address is 192.168.8.1, mask is 255.255.255.128
 Internet address is unnumbered. Using address of Vlan 2
 Primary management interface
 MTU 1500 bytes, Bandwidth 28 kbit
 Reliability 46/255 txLoad 255/255 rxLoad 255/255
 Encapsulation PPP
 Link status trap disabled
 Keepalive-track not set
 Keepalive set (10 sec)
 LCP  Starting
 IPCP Starting
 PAP refuse
 CHAP hostname: G350
 CHAP password: configured
 Dialer modem-interface: USB-Modem
 Dialer state is:  idle
 Last dialed string: 7273201147
 Dial strings:
    1: 7273201147
 Dialing order is sequential
 Persistent initial delay 45 sec
 Persistent: delay 1 sec
 Wait 45 sec for IPCP
 Weighted Fair VoIP queueing mode
 Last input 00:01:43, Last output 00:01:43
 Last clearing of 'show interface' counters never
 5 minute input rate 296 bits/sec, 0 packets/sec
 5 minute output rate 329 bits/sec, 0 packets/sec
 0 input drops, 0 output drops, 0 unknown protocols
 2574 packets input, 220238 bytes
 0 broadcasts received, 0 giants
 0 input errors, 0 CRC
 2848 packets output, 243174 bytes
 0 output errors, 0 collisions
```

The G350's routing table:

```
G350-008(super)# show ip route
Showing 5 rows
   Network       Mask      Interface           Next-Hop           Cost  TTL  Source
--------------- ---- ------------------- ------------------- ----- --- --------
0.0.0.0           0 Serial   4/1:0      Via Ser.4/1:0           1 n/a STAT-LO
24.4.4.0         30 Serial   4/1:0      24.4.4.2                1 n/a LOCAL
24.4.4.1         32 Serial   4/1:0      24.4.4.2                1 n/a LOCAL
192.168.8.0      25 Vlan     2          192.168.8.1             1 n/a LOCAL
192.168.8.128    25 Vlan     1          192.168.8.129           1 n/a LOCAL
```

The G350 reports of the available bandwidth for voice bearer:

```
G350-008(super)# show dynamic-cac

Current RBBL  : 1024 kbps
Last event    : 0 Days, 00:03:45
Last event BBL: 1024 kbps
```

The G350's MGC list:

```
G350-008(super)# show mgc

CALL CONTROLLER STATUS
-------------------------------------------
Registered          : YES
Active Controller   : 149.49.43.96
H248 Link Status    : UP
H248 Link Error Code: 0x0

CONFIGURED MGC HOST
--------------------
149.49.43.96
192.168.8.100
-- Not Available --
-- Not Available –
```

3.5. Dial Backup Operation Scenario

On a WAN link failure event, the G350's primary Serial interface will become inactive and the backup Dialer interface will be automatically activated. By default, the backup dial interface will be activated immediately when the primary interface becomes inactive. However, it is possible to configure the delay for backup interface activation and the delay to fall back. This configuration is made on the primary interface context.

At WAN link failure the G350 console will show the following:

```
Controller T1 4/1 changed state to down (LOS)

Line protocol on Interface Serial 4/1:0, changed state to down

Interface Dialer 1, out of standby mode

Line protocol on Interface Dialer 1, changed state to up
```

The G350's interfaces will be in the following state:

```
G350-008(super)# show ip interface brief
Showing 4 Interfaces
        Interface            Address       Mask Method        Status
------------------------- --------------- ---- ------ --------------------
Serial  4/1:0             24.4.4.2         30 manual      down
Dialer  1                 192.168.8.1      25 manual      up
Vlan    1                 192.168.8.129    25 manual      up
Vlan    2                 192.168.8.1      25 manual      up




G350-008(super)# show interfaces Dialer 1

Dialer 1 is up, line protocol is up
Description: Backup-of-WAN-link
 Internet address is 192.168.8.1, mask is 255.255.255.128
 Peer internet address is 10.20.30.40
 Internet address is unnumbered. Using address of Vlan 2
 Primary management interface
 MTU 1500 bytes, Bandwidth 28 kbit
 Reliability 69/255 txLoad 4/255 rxLoad 4/255
 Encapsulation PPP
 Link status trap disabled
 Keepalive-track not set
 Keepalive set (10 sec)
 LCP  Opened
 IPCP Opened
 PAP refuse
 CHAP hostname: G350
 CHAP password: configured
 Dialer modem-interface: USB-Modem
 Dialer state is:  connected
 Last dialed string: 7273201147
```

```
  Dial strings:
     1: 7273201147
  Dialing order is sequential
  Persistent initial delay 45 sec
  Persistent: delay 1 sec
  Wait 45 sec for IPCP
  Weighted Fair VoIP queueing mode
  Last input 00:00:00, Last output 00:00:00
  Last clearing of 'show interface' counters never
  5 minute input rate 494 bits/sec, 1 packets/sec
  5 minute output rate 448 bits/sec, 1 packets/sec
  0 input drops, 0 output drops, 0 unknown protocols
  2777 packets input, 238841 bytes
  0 broadcasts received, 0 giants
  0 input errors, 0 CRC
  3061 packets output, 255745 bytes
  0 output errors, 0 collisions
```

The G350 reports of no available bandwidth for voice bearer:

G350-008(super)# show dynamic-cac

```
Current RBBL  : 0 kbps
Last event    : 0 Days, 00:01:26
Last event BBL: 0 kbps
```

The G350's routing table:

G350-008(super)# show ip route
```
Showing 4 rows
    Network        Mask      Interface            Next-Hop            Cost  TTL  Source
--------------- ---- ------------------- ------------------- ----- --- --------
0.0.0.0            0 Dialer   1          Via Dia.1                1 n/a STAT-LO
10.20.30.40       32 Dialer   1          Via Dia.1                1 n/a LOCAL
192.168.8.0       25 Vlan     2          192.168.8.1              1 n/a LOCAL
192.168.8.128     25 Vlan     1          192.168.8.129            1 n/a LOCAL
```

The G350's MGC list:

G350-008(super)# show mgc

```
CALL CONTROLLER STATUS
--------------------------------------------
Registered         : YES
Active Controller  : 149.49.43.96
H248 Link Status   : UP
H248 Link Error Code: 0x0

CONFIGURED MGC HOST
---------------------
149.49.43.96
192.168.8.100
-- Not Available --
-- Not Available –
```

Important Note

From the moment the WAN link failure took place until the dial backup link was established some H248 keepalives (from the Gateway to its CM) were lost. If the modem backup line is established faster than the H248 keepalive timeout (about 60 to 70 seconds), the Gateway will continue being registered to the primary CM. Otherwise the Gateway will consider the H248 link to be down and start trying to re-register to the primary call controller for another 1 minute (Primary Search Timer default value). In case the backup dial link was not established by then (approx two minutes after the WAN link failure event), the Gateway will try to register to the next call controller in its MGC list, which in our example is the LSP.

Still, it is possible to increase the value of the Primary Search Timer in order to keep the Gateway being registered to its primary CM. Use the `set reset-times primary-search` *command on the Gateway to set the Primary Search Timer.*

By default, the backup Dialer interface is activated immediately after the primary interface was discovered to be inactive. However, it can take another 20 to 40 seconds to establish the call and have the routing tables to be updated, depends on the dialup line quality and the routing method. During that time, there is no signaling connectivity to the CM, thus the Gateway cannot generate new dial tones, no features can be requested, incoming calls will not be answered, etc. However, existing intra-branch calls and calls to local trunk facilities remains active.
.

4. Configuration Example 3 -

The branch Gateway is connected to branch edge router, working with dynamic routing (see Figure 4)

In example 3, the core router, the branch edge router and the Gateways in the remote branches are running OSPF routing protocol among themselves. The edge router is connected to the Gateway via the Fast Ethernet WAN port.

Since in this example the Gateway is not used as edge router, we used the RTR feature as keepalive mechanism with the HQ over the WAN in order for the Gateway be able to discover WAN link failure and to activate the backup dialup link. In this example the RTR is rapidly pinging over the WAN to the CM in HQ (S8300B server, 149.49.43.96) and the core router serial interface (24.4.4.1). As long as one of them is responding, the WAN is considered to be OK.

Figure 4

In this example the RTR keepalive was associated to interface 'Loopback 10' of the Gateway. This is a virtual interface serving no other purpose than using as primary interface for the RTR keepalive with the HQ. The 'Dialer 1' interface is set as backup interface for 'Loopback 10'.

In this example a default RTR ping rate of 5000 msec is used, however this value is configurable.

In case of WAN link failure, the RTR keepalives will fail, the Loopback interface will be brought down and the Gateway will automatically activate the backup Dialer interface

and dial to the HQ. The routing between the HQ and branch will be restored automatically by OSPF advertisements over the dialup link.

4.1. Configuring the G350 in Branch Office #8

The G350 configuration includes the following functions:

4.1.1. Branch Office LAN

See section 2.1.1.

4.1.2. Branch Office Gateway Connection to the Branch Edge Router

In our example, the G350 uses an external branch edge router for WAN connectivity. The edge router is connected to the Gateway via the Fast Ethernet WAN interface:

```
interface FastEthernet 10/2
 description "to-Edge_Router"
 bandwidth 1500                             # Bandwidth setting for OSPF to
                                            # calculate cost for this intf.
 traffic-shape rate 1500000                 # Traffic shaping setting.
 ip address 10.0.0.2      255.255.255.252   # Small subnet between the G350
                                            # and the edge router.
 exit
```

The traffic shaping setting was added in order to control access to available bandwidth, to ensure that traffic conforms to the policies established for it, and to regulate the flow of traffic in order to avoid congestion that can occur when the sent traffic exceeds the access speed of its remote, target interface. As the FastEthernet interface is much faster than the destination serial WAN interface of the edge router, a traffic shaping setting is highly recommended.

4.1.3. Branch Office Backup Dialup configuration

See section 2.1.2.

4.1.4. Branch Office Remote Tracking of WAN Availability

In our example, the G350 uses an external branch edge router for WAN connectivity.
In order for the Gateway to discover failure of the WAN connection to the HQ, the G350
will use RTR keepalive mechanism to rapidly ping the CM and the core router over the
WAN. In case keepalive fail the G350 will conclude there is a WAN link failure and
backup dial connection will be established to the HQ.

The following section defines remote objects to be tracked (RTRs) for keepalive usage:

```
rtr 1                                          # RTR 1 definition.
 type echo protocol ipIcmpEcho 149.49.43.96    # Track the primary call
                                               # controller by pinging.
 fail-retries 3                                # RTR is failed after 3
                                               # unsuccessful pings.
 source-address 192.168.8.1                    # Source IP for RTR pings.


        # Send the RTR pings via the Gateway's FastEthernet interface through the
        # edge router (the indicated MAC address belongs to the Ethernetn port of
        # the edge router):
 next-hop interface FastEthernet 10/2 mac-address 00-06-28-16-60-21


 interface-keepalive bypass-logic              # Future use command.
 exit
!
rtr-schedule 1 start-time now life forever     # Start sending RTR 1.
!
rtr 2                                          # RTR 2 definition.
 type echo protocol ipIcmpEcho 24.4.4.1        # Track the Core Router by
                                               # pinging.
 fail-retries 3                                # RTR is failed after 3
                                               # unsuccessful pings.
 source-address 192.168.8.1                    # Source IP for RTR pings.


        # Send the RTR pings via the Gateway's FastEthernet interface through the
        # edge router (the indicated MAC address belongs to the Ethernetn port of
        # the edge router):
 next-hop interface FastEthernet 10/2 mac-address 00-06-28-16-60-21


 interface-keepalive bypass-logic              # Future use command.
 exit
rtr-schedule 2 start-time now life forever     # Start sending RTR 2.
!
track 1 rtr 1                                  # Set RTR 1 as Tracking-
                                               # Object 1
 description "Track Primary-CC"
 exit
!
track 2 rtr 2                                  # Set RTR 2 as Tracking-
                                               # Object 2
 description "Track Core Router"
 exit
!
```

```
track 20 list                                   # Define a track list
                                                # and include in it the
                                                # above tracking-objects.
 object 1                                       # If one of these tacked
 object 2                                        # objects is failed then
 exit                                           # whole track list is
!                                               # failed.
```

The RTR keepalive are associated to the 'Loopback 10' interface, as following:

```
interface Loopback 10
 backup interface Dialer 1                       # Backup interface definition.
 dynamic-cac 1024                                # Set this Gateway to be the
                                                 # Dynamic-CAC Gateway for its
                                                 # Network Region and report the
                                                 # CM this Gateway supports
                                                 # maximum of 1Mbps for
                                                 # voice bearer.
 keepalive-track 20                              # Use tracking list 20 as the
                                                 # keepalive mechanism for this
                                                 # interface.

 ip address 198.0.0.1       255.255.255.255
 exit
```

4.1.5. Branch Office Routing

Bellow is the definition of OSPF routing in the Gateway:

```
router ospf
 redistribute connected                                  # Redistribute local
                                                         # connected networks.
 network 10.0.0.0       0.0.0.3       area 0.0.0.0  # Activate OSPF twards
                                                         # the edge router.
 network 192.168.8.0    0.0.0.127     area 0.0.0.0  # Activate OSPF over the
                                                         # Dialer interface (it
                                                         # has the same IP as
                                                         # interface Vlan 1).

 exit
```

In large network deployments it is recommended to use hierarchal routing approach, with separate OSPF areas for each bunch of remote branches. This will reduce OSPF traffic over the low bandwidth dial link.

4.1.6. Branch Office MGC list

See section 2.1.5.

4.1.7. Full Branch Office G350 configuration

The full G350 configuration file is displayed below:

```
G350-008(super)# show running-config
! version 24.14.0
set vlan 2 name "V2"
set port static-vlan 6/6 2
set port static-vlan 6/7 2
set port static-vlan 6/8 2
set port static-vlan 6/9 2
set port static-vlan 6/10 2
set port vlan 2 6/1 2
set port vlan 2 6/2 2
set port vlan 2 6/3 2
set port vlan 2 6/4 2
set port vlan 2 6/5 2
!
ip access-control-list 301
 name "Block Voice Bearer"
!
 ip-rule 10
  composite-operation "Deny"
  dscp 46
  description "Block-RTP"
 exit
!
exit
!
ds-mode t1
!
rtr 1
 type echo protocol ipIcmpEcho 149.49.43.96
 fail-retries 3
 source-address 192.168.8.1
 next-hop interface FastEthernet 10/2 mac-address 00-06-28-16-60-21
 interface-keepalive bypass-logic
 exit
rtr-schedule 1 start-time now life forever
!
rtr 2
 type echo protocol ipIcmpEcho 24.4.4.1
 fail-retries 3
 source-address 192.168.8.1
 next-hop interface FastEthernet 10/2 mac-address 00-06-28-16-60-21
 interface-keepalive bypass-logic
 exit
rtr-schedule 2 start-time now life forever
!
track 1 rtr 1
 description "Track CM"
 exit
!
track 2 rtr 2
 description "Track Core Router"
 exit
!
track 20 list
 object 1
 object 2
 exit
```

```
!
interface Vlan 1
 description "Data-Vlan"
 ip address 192.168.8.129    255.255.255.128
 exit
!
interface Vlan 2
 description "Voice-Vlan"
 icc-vlan
 ip address 192.168.8.1     255.255.255.128
 pmi
 exit
!
interface FastEthernet 10/2
 description "to-Edge_Router"
 bandwidth 1500
 traffic-shape rate 1500000
 ip address 10.0.0.2        255.255.255.252
 exit
!
interface Loopback 10
 backup interface Dialer 1
 dynamic-cac 1024
 keepalive-track 20
 ip address 198.0.0.1       255.255.255.255
 exit
!
interface Dialer 1
 description "Backup-of-WAN-link"
 ppp pap refuse
 dynamic-cac 0
 dialer persistent initial delay 45
 dialer string 1 7273201147
 dialer persistent delay 1
 dialer modem-interface USB-Modem
 ip access-group 301 out
 ip unnumbered 1 Vlan 1
 exit
!
interface Console
 async modem-type MultiTech-ZBA
 exit
!
interface USB-Modem
 no shutdown
 exit
!
router ospf
 redistribute connected
 network 10.0.0.0          0.0.0.3         area 0.0.0.0
 network 192.168.8.0      0.0.0.127       area 0.0.0.0
 exit
!
set mgc list 149.49.43.96,192.168.8.100
set mediaserver 149.49.43.96 149.49.43.96 23 telnet
set mediaserver 149.49.43.96 149.49.43.96 5023 sat
set mediaserver 192.168.8.100 192.168.8.100 23 telnet
set mediaserver 192.168.8.100 192.168.8.100 5023 sat
rtp-stat qos-trap
no rtp-stat fault
!# End of Configuration File. Press Enter to continue.
```

4.2. Configuring the Branch Edge Router in the HQ

In our example the branch edge router will use basic OSPF routing scheme with the core router and with the branch Gateway. However, in large scale network deployment it is recommended to use hierarchal routing approach, with separate OSPF areas for each bunch of remote branches.

The following section includes branch office related portions from the edge router configuration, in Cisco format. The actual router configuration may include additional configuration which is out of scope for this document.

```
hostname Branch-Router
!
enable password cisco
!
ip subnet-zero
!
!
!
!
controller T1 1/0
 framing esf
 fdl ansi
 clock source free-running
 linecode b8zs
 channel-group 0 timeslots 1-24 speed 64
!
!
interface FastEthernet0/1
 ip address 10.0.0.1 255.255.255.252
 duplex auto
 speed auto
!
interface Serial1/0:0
 ip address 24.4.4.2 255.255.255.252
 encapsulation ppp
!
router ospf 1
 log-adjacency-changes
 network 10.0.0.0 0.0.0.3 area 0.0.0.0
 network 24.4.4.0 0.0.0.3 area 0.0.0.0
!
ip classless
ip http server
!
end
```

4.3. Configuring the Core Router in the HQ

See section 2.2.

4.4. Configuring IGAR/D-CAC on the Communication Manager

See section 2.3.

4.5. Normal Operation Scenario

During normal operation the WAN link is active and the G350 in branch office #8 is normally registered to the CM in the HQ.

The G350's interfaces will be in the following state:

```
G350-008(super)# show ip interface brief
Showing 5 Interfaces
        Interface              Address     Mask Method        Status
------------------------- --------------- ---- ------ --------------------
FastEth  10/2              10.0.0.2         30 manual        up
Dialer   1                 192.168.8.1      25 manual        down
Vlan     1                 192.168.8.129    25 manual        up
Vlan     2                 192.168.8.1      25 manual        up
Loopback 10                198.0.0.1        32 manual        up
```

The G350's routing table:

```
G350-008(super)# show ip route
Showing 7 rows
    Network       Mask      Interface           Next-Hop           Cost TTL  Source
-------------- ---- ------------------ ------------------ ----- --- --------
10.0.0.0         30 FastEth   10/2     10.0.0.2               1 n/a LOCAL
10.20.30.40      32 FastEth   10/2     10.0.0.1             132 n/a OSPF
24.4.4.0         30 FastEth   10/2     10.0.0.1             131 n/a OSPF
149.49.43.0      24 FastEth   10/2     10.0.0.1              20 n/a OSPF-E2
192.168.8.0      25 Vlan      1        192.168.8.1           1 n/a LOCAL
192.168.8.128    25 Vlan      2        192.168.8.129         1 n/a LOCAL
198.0.0.1        32 Loopback  10       198.0.0.1             1 n/a MY-ADDR
```

The G350 reports of the available bandwidth for voice bearer:

```
G350-008(super)# show dynamic-cac

Current RBBL  : 1024 kbps
Last event    : 0 Days, 00:00:32
Last event BBL: 1024 kbps
```

The RTR keepalive status:

```
G350-008(super)# show rtr operational-state

                                             Wait-            Last Change
ID    Type      Dest Address    State   S/C F/C Freq  Inter S/R F/R  d,h:m:s
-- ---------- --------------- -------- --- --- ----- ----- --- --- ------------
 1 ipIcmpEcho 149.49.43.96    up        1   0  5000  5000   1   3    0,0:5:20
 2 ipIcmpEcho 24.4.4.1        up        1   0  5000  5000   1   3    0,0:1:2
```

The G350's MGC list:

```
G350-008(super)# show mgc

CALL CONTROLLER STATUS
-------------------------------------------
Registered         : YES
Active Controller  : 149.49.43.96
H248 Link Status   : UP
H248 Link Error Code: 0x0

CONFIGURED MGC HOST
--------------------
149.49.43.96
192.168.8.100
-- Not Available --
-- Not Available –
```

4.6. Dial Backup Operation Scenario

On a WAN link failure event, the RTR keepalive mechanism will start losing pings to the CM and to the core router. When the F/C (Failed Count) of an RTR reaches the configured threshold (in this example it is set to 3), the RTR track list will be declared as failed. Since the RTR track list is associated to interface 'Loopback 10' as its keepalive mechanism, interface 'Loopback 10' will become inactive. This will activate the backup Dialer interface will be automatically. By default, the backup dial interface will be activated immediately when the primary interface becomes inactive. However, it is possible to configure the delay for backup interface activation and the delay to fall back. This configuration is made on the primary interface context.

At WAN link failure the G350 console will show the following:

```
Keepalive track 20 on Interface Loopback 10, changed state to down

Interface Dialer 1, out of standby mode

Line protocol on Interface Dialer 1, changed state to up
```

The RTR keepalive status:

```
G350-008(super)# show rtr operational-state

                                              Wait-          Last Change
ID   Type      Dest Address    State   S/C F/C Freq  Inter S/R F/R   d,h:m:s
-- ---------- --------------- -------- --- --- ----- ----- --- --- ------------
 1 ipIcmpEcho 149.49.43.96    down      0   3  5000  5000   1   3    0,0:1:13
 2 ipIcmpEcho 24.4.4.1        down      0   3  5000  5000   1   3    0,0:1:11
```

Important Note

In this example the Failed Retries (F/R) is set to 3, which means three unsuccessful pings are required in order to conclude that the RTR keepalive is failed and to deactivate interface 'Loopback 10'. Since the frequency of the pings is set to 5,000 msec (the default value), it will take at least 15 seconds to discover that a WAN link failure event took place. As faster as the failure is discovered the faster the backup dial link will be established. However, too quick keepalive fail can cause interface bounce for false reasons. On the other hand, the Success Retries (S/R) value is set to 1, which means one successful ping is required in order to conclude that the RTR keepalive is successful and to activate interface 'Loopback 10'.

These values can be configured under RTR configuration context in the Gateway's CLI.

The G350's interfaces will be in the following state:

```
G350-008(super)# show ip interface brief
Showing 5 Interfaces
        Interface            Address      Mask Method        Status
-------------------------- --------------- ---- ------ ---------------------
FastEth  10/2              10.0.0.2       30 manual       up
Dialer   1                 192.168.8.1    25 manual       up
Vlan     1                 192.168.8.129  25 manual       up
Vlan     2                 192.168.8.1    25 manual       up
Loopback 10                198.0.0.1      32 manual       up
```

Please note that despite that interface 'Loopback 10' is shown above as in up status, its actual operational status is inactive as its associated keepalive RTR is down:

```
G350-008(super)# show interfaces Loopback 10

Loopback 10 is up, line protocol is up, keepalive-track is down
 Internet address is 198.0.0.1, mask is 255.255.255.255
 Backup interface Dialer 1, failure delay 0 sec, secondary disable delay 0 sec
 MTU 1514 bytes, Bandwidth 8000000 kbit
 Reliability 255/255 txLoad 1/255 rxLoad 1/255
 Encapsulation LOOPBACK
 Link status trap disabled
 Keepalive-track set (track 20)
 Dynamic CAC BBL: 1024 kbps
 Dynamic CAC activation priority : 128
 Dynamic CAC interface status : inactive
 Last input never, Last output never
 Last clearing of 'show interface' counters never
 5 minute input rate 0 bits/sec, 0 packets/sec
 5 minute output rate 0 bits/sec, 0 packets/sec
 0 input drops, 0 output drops, 0 unknown protocols
 0 packets input, 0 bytes
 0 broadcasts received, 0 giants
 0 input errors, 0 CRC
 0 packets output, 0 bytes
 0 output errors, 0 collisions
```
The G350's routing table:

```
G350-008(super)# show ip route
Showing 6 rows
    Network      Mask     Interface          Next-Hop         Cost TTL  Source
-------------- ---- ------------------- ------------------ ----- --- --------
10.0.0.0         30 FastEth  10/2        10.0.0.2              1 n/a LOCAL
10.20.30.40      32 Dialer   1           Via Dia.1            1 n/a LOCAL
149.49.43.0      24 Dialer   1           Via Dia.1           20 n/a OSPF-E2
192.168.8.0      25 Vlan     2           192.168.8.1          1 n/a LOCAL
192.168.8.128    25 Vlan     1           192.168.8.129        1 n/a LOCAL
198.0.0.1        32 Loopback 10          198.0.0.1            1 n/a MY-ADDR
```

The G350 reports of no available bandwidth for voice bearer:

```
G350-008(super)# show dynamic-cac

Current RBBL  : 0 kbps
Last event    : 0 Days, 00:02:29
Last event BBL: 0 kbps
```

The G350's MGC list:

```
G350-008(super)# show mgc

CALL CONTROLLER STATUS
------------------------------------------
Registered         : YES
Active Controller  : 149.49.43.96
H248 Link Status   : UP
H248 Link Error Code: 0x0

CONFIGURED MGC HOST
--------------------
149.49.43.96
192.168.8.100
-- Not Available --
-- Not Available –
```

Important Note

From the moment the WAN link failure took place until the dial backup link was established some H248 keepalives (from the Gateway to its CM) were lost. If the modem backup line is established faster than the H248 keepalive timeout (about 60 to 70 seconds), the Gateway will continue being registered to the primary CM. Otherwise the Gateway will consider the H248 link to be down and start trying to re-register to the primary call controller for another one minute (Primary Search Timer default value). In case the backup dial link was not established by then (approx two minutes after the WAN link failure event), the Gateway will try to register to the next call controller in its MGC list, which in our example is the LSP.

Still, it is possible to increase the value of the Primary Search Timer in order to keep the Gateway being registered to its primary CM. Use the `set reset-times primary-search` *CLI command on the Gateway to set the Primary Search Timer.*

By default, the backup Dialer interface is activated immediately after the primary interface was discovered to be inactive. However, it can take another 20 to 40 seconds to establish the call and have the routing tables to be updated, depends on the dialup line quality and the routing method. During that time, there is no signaling connectivity to the CM, thus the Gateway cannot generate new dial tones, no features can be requested, incoming calls will not be answered, etc. However, existing intra-branch calls and calls to local trunk facilities remains active.

5. Configuration Example 4 -

**The branch Gateway is connected to branch edge router, working with static routing (see Figure 4)**

In example 4, the core router, the branch edge router and the Gateways in the remote branches are all configured with static routing. The edge router is connected to the Gateway via the Fast Ethernet WAN port.

Since in this example the Gateway is not used as edge router, we used the RTR feature as keepalive mechanism with the HQ over the WAN in order for it be able to discover a WAN link failure and to activate the backup dialup link. In this example the RTR is rapidly pinging over the WAN to the HQ S8300 (149.49.43.96) and the core router serial interface (24.4.4.1). As long as one of them is responding the WAN is considered to be OK.

In this example the RTR keepalive was associated to interface 'Loopback 10' of the Gateway. This is a virtual interface serving no other purpose than using as primary interface for the RTR keepalive with the HQ. The 'Dialer 1' interface is set as backup interface for 'Loopback 10'.

In this example a default RTR ping rate of 5,000 msec is used, however this value is configurable.

In case of WAN link failure and dial modem backup activation, the routing between the HQ and branch will be restored by static routing definition (see the following sections for details). This is the place to say that in this type of configuration the routing is restored faster when using static route than with dynamic routing. However, static routing configuration is difficult to maintain and manage in large scale networks.

Figure 4
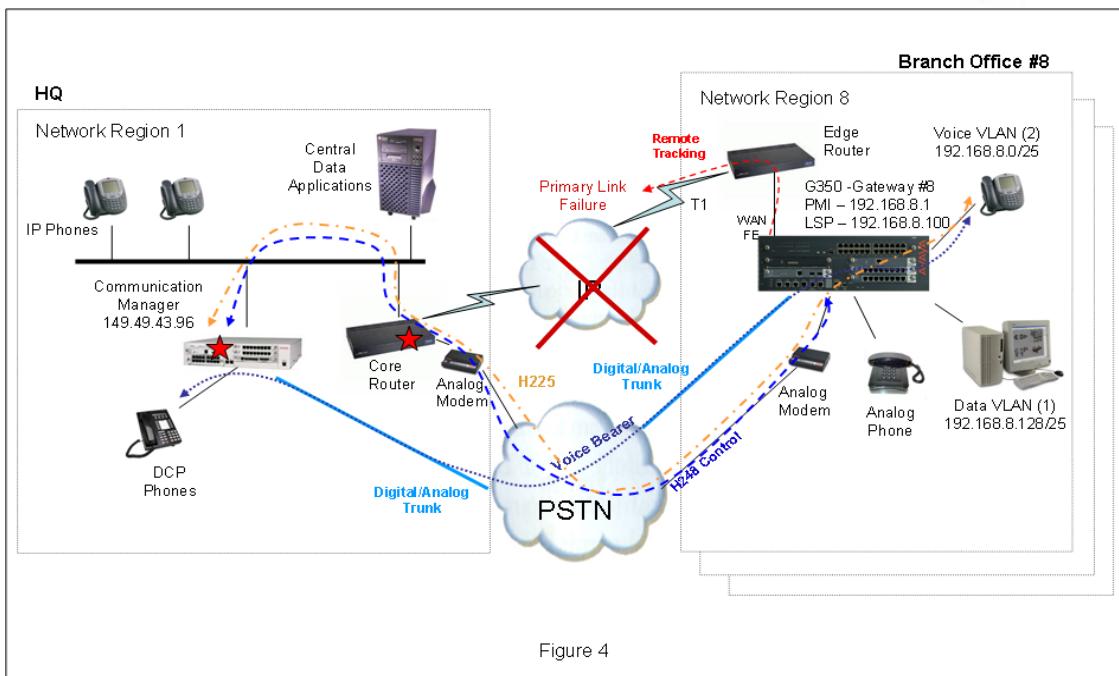
5.1. Configuring the G350 in Branch Office #8

The G350 configuration includes the following functions:

5.1.1. Branch Office LAN
See section 2.1.1.

5.1.2. Branch Office Gateway Connection to the Branch Edge Router
See section 4.1.2.

5.1.3. Branch Office Backup Dialup configuration
See section 2.1.2.

5.1.4. Branch Office Remote Tracking of WAN Availability
See section 4.1.4.

5.1.5. Branch Office Routing
The Gateway will be configured with two static definitions of default Gateway – one via the external router (10.0.0.1) and the other via the Dialer:

```
ip default-gateway 10.0.0.1       1 low
ip route   0.0.0.0 0.0.0.0  Dialer 1  1 high
```

Since during normal operation the Dialer interface is down, its associated routing entry will not appear in the active routing table. During backup event the FastEthernet interface is up and the 'Dialer 1' interface is up as well. In order to force the Gateway to use only the 'Dialer 1'interface as the default-Gateway (when it is active), the route path via the 'Dialer 1' was configured with high priority. So when the dial backup link is up the route entry associated with the FastEthernet interface will not appear in the active routing table but the entry associated with the 'Dialer 1' interface.

5.1.6. Branch Office MGC list

See section 2.1.5.

5.1.7. Full Branch Office G350 configuration

The full G350 configuration file is displayed below:

```
! version 24.14.0
!
set vlan 2 name "V2"
set port static-vlan 6/6 2
set port static-vlan 6/7 2
set port static-vlan 6/8 2
set port static-vlan 6/9 2
set port static-vlan 6/10 2
set port vlan 2 6/1 2
set port vlan 2 6/2 2
set port vlan 2 6/3 2
set port vlan 2 6/4 2
set port vlan 2 6/5 2
!
ip access-control-list 301
 name "Block Voice Bearer"
!
 ip-rule 10
  composite-operation "Deny"
  dscp 46
  description "Block-RTP"
 exit
!
exit
!
ds-mode t1
!
rtr 1
 type echo protocol ipIcmpEcho 149.49.43.96
 fail-retries 3
 source-address 192.168.8.1
 next-hop interface FastEthernet 10/2 mac-address 00-06-28-16-60-21
 interface-keepalive bypass-logic
 exit
rtr-schedule 1 start-time now life forever
!
rtr 2
 type echo protocol ipIcmpEcho 24.4.4.1
 fail-retries 3
 source-address 192.168.8.1
```

```
 next-hop interface FastEthernet 10/2 mac-address 00-06-28-16-60-21
 interface-keepalive bypass-logic
 exit
rtr-schedule 2 start-time now life forever
!
track 1 rtr 1
 description "Track CM"
 exit
!
track 2 rtr 2
 description "Track Core Router"
 exit
!
track 20 list
 object 1
 object 2
 exit
!
interface Vlan 1
 description "Data-Vlan"
 ip address 192.168.8.129   255.255.255.128
 exit
!
interface Vlan 2
 description "Voice-Vlan"
 icc-vlan
 ip address 192.168.8.1     255.255.255.128
 pmi
 exit
!
interface FastEthernet 10/2
 description "to-Edge_Router"
 bandwidth 1500
 traffic-shape rate 1500000
 ip address 10.0.0.2        255.255.255.252
 exit
!
interface Loopback 10
 backup interface Dialer 1
 dynamic-cac 1024
 keepalive-track 20
 ip address 198.0.0.1       255.255.255.255
 exit
!
interface Dialer 1
 description "Backup-of-WAN-link"
 ppp pap refuse
 dynamic-cac 0
 dialer persistent initial delay 45
 dialer string 1 7273201147
 dialer persistent delay 1
 dialer modem-interface USB-Modem
 ip access-group 301 out
 ip unnumbered 1 Vlan 1
 exit
!
interface Console
 async modem-type MultiTech-ZBA
 exit
!
interface USB-Modem
```

```
 no shutdown
 exit
!
ip default-gateway       10.0.0.1        1 low
ip route   0.0.0.0        0.0.0.0        Dialer 1        1 high
!
set mgc list 149.49.43.96,192.168.8.100
set mediaserver 149.49.43.96 149.49.43.96 23 telnet
set mediaserver 149.49.43.96 149.49.43.96 5023 sat
set mediaserver 192.168.8.100 192.168.8.100 23 telnet
set mediaserver 192.168.8.100 192.168.8.100 5023 sat
rtp-stat qos-trap
no rtp-stat fault
!#
!# End of Configuration File. Press Enter to continue.
```

5.2. Configuring the Branch Edge Router in the HQ

In our example the branch edge router will use a static routing scheme with the core router and with the branch Gateway.

The following section includes branch office related portions from the edge router configuration in Cisco format. The actual router configuration may include additional definitions which are beyond the scope of this document.

```
version 12.2
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Branch-Router
!
enable password cisco
!
ip subnet-zero
!
!
!
!
controller T1 1/0
 framing esf
 fdl ansi
 clock source free-running
 linecode b8zs
 channel-group 0 timeslots 1-24 speed 64
!
!
interface FastEthernet0/1
 ip address 10.0.0.1 255.255.255.252
 duplex auto
 speed auto
!
interface Serial1/0:0
 ip address 24.4.4.2 255.255.255.252
 encapsulation ppp
!
ip classless
ip route 0.0.0.0 0.0.0.0 Serial1/0:0
ip route 192.168.8.0 255.255.255.128 10.0.0.2
ip route 192.168.8.128 255.255.255.128 10.0.0.2
!
end
```

5.3. Configuring the Core Router in the HQ

See section 3.2.

5.4. Configuring IGAR/D-CAC on the Communication Manager

See section 2.3.

5.5. Normal Operation Scenario

During normal operation the WAN link is active and the G350 in branch office #8 is normally registered to CM in the HQ.

The G350's interfaces will be in the following state:

```
G350-008(super)# show ip interface brief
Showing 5 Interfaces
        Interface              Address       Mask Method        Status
------------------------- -------------- ---- ------ --------------------
FastEth  10/2              10.0.0.2         30 manual        up
Dialer   1                 192.168.8.1      25 manual        down
Vlan     1                 192.168.8.129    25 manual        up
Vlan     2                 192.168.8.1      25 manual        up
Loopback 10                198.0.0.1        32 manual        up
```

The G350's routing table:

```
G350-008(super)# show ip route
Showing 5 rows
    Network      Mask        Interface            Next-Hop        Cost TTL  Source
--------------- ---- ------------------- ------------------- ----- --- --------
0.0.0.0            0 FastEth  10/2        10.0.0.1               1 n/a STAT-LO
10.0.0.0          30 FastEth  10/2        10.0.0.2               1 n/a LOCAL
192.168.8.0       25 Vlan     2           192.168.8.1            1 n/a LOCAL
192.168.8.128     25 Vlan     1           192.168.8.129          1 n/a LOCAL
198.0.0.1         32 Loopback 10          198.0.0.1              1 n/a MY-ADDR
```

The G350 reports of the available bandwidth for voice bearer:

```
G350-008(super)# show dynamic-cac

Current RBBL  : 1024 kbps
Last event    : 0 Days, 00:00:32
Last event BBL: 1024 kbps
```

The RTR keepalive status:

```
G350-008(super)# show rtr operational-state

                                             Wait-               Last Change
ID    Type       Dest Address    State   S/C F/C Freq  Inter S/R F/R  d,h:m:s
-- ---------- --------------- -------- --- --- ----- ----- --- --- ------------
 1 ipIcmpEcho 149.49.43.96    up        1   0  5000  5000   1   3     0,0:5:20
 2 ipIcmpEcho 24.4.4.1        up        1   0  5000  5000   1   3     0,0:1:2
```

The G350's MGC list:

```
G350-008(super)# show mgc

CALL CONTROLLER STATUS
---------------------------------------------
Registered        : YES
Active Controller : 149.49.43.96
H248 Link Status  : UP
H248 Link Error Code: 0x0

CONFIGURED MGC HOST
--------------------
149.49.43.96
192.168.8.100
-- Not Available --
-- Not Available –
```

5.6. Dial Backup Operation Scenario

On a WAN link failure event, the RTR keepalive mechanism will start losing pings to the CM and to the core router. When the F/C (Failed Count) of an RTR reaches the configured threshold (in this example it is set to 3), the RTR track list will be declared as failed. Since the RTR track list is associated to interface 'Loopback 10' as its keepalive mechanism, interface 'Loopback 10' will become inactive. This will activate the backup Dialer interface will be automatically. By default, the backup dial interface will be activated immediately when the primary interface becomes inactive. However, it is possible to configure the delay for backup interface activation and the delay to fall back. This configuration is made on the primary interface context.

At WAN link failure the G350 console will show the following:

```
Keepalive track 20 on Interface Loopback 10, changed state to down

Interface Dialer 1, out of standby mode

Line protocol on Interface Dialer 1, changed state to up
```

The RTR keepalive status:

```
G350-008(super)# show rtr operational-state

                                             Wait-            Last Change
ID    Type      Dest Address    State   S/C F/C Freq  Inter S/R F/R   d,h:m:s
-- ---------- --------------- -------- --- --- ----- ----- --- --- ------------
 1 ipIcmpEcho 149.49.43.96    down       0   3  5000  5000   1   3    0,0:1:13
 2 ipIcmpEcho 24.4.4.1        down       0   3  5000  5000   1   3    0,0:1:11
```

Important Note

In this example the Failed Retries (F/R) is set to 3, which means three unsuccessful pings are required in order to conclude that the RTR keepalive is failed and to deactivate interface 'Loopback 10'. Since the frequency of the pings is set to 5,000 msec (the default value), it will take at least 15 seconds to discover that a WAN link failure event took place. As faster as the failure is discovered the faster the backup dial link will be established. However, too quick keepalive fail can cause interface bounce for false reasons. On the other hand, the Success Retries (S/R) value is set to 1, which means one successful ping is required in order to conclude that the RTR keepalive is successful and to activate interface ' Loopback 10'.

These values can be configured under RTR configuration context in the Gateway's CLI.

The G350's interfaces will be in the following state:

```
G350-008(super)# show ip interface brief
Showing 5 Interfaces
         Interface             Address      Mask Method      Status
------------------------ --------------- ---- ------ --------------------
FastEth  10/2            10.0.0.2          30 manual      up
Dialer   1               192.168.8.1       25 manual      up
Vlan     1               192.168.8.129     25 manual      up
Vlan     2               192.168.8.1       25 manual      up
Loopback 10              198.0.0.1         32 manual      up
```

Please note that despite that interface 'Loopback 10' is shown above as in up status, its actual operational status is inactive as its associated keepalive RTR is down:

```
G350-008(super)# show interfaces Loopback 10

Loopback 10 is up, line protocol is up, keepalive-track is down
 Internet address is 198.0.0.1, mask is 255.255.255.255
 Backup interface Dialer 1, failure delay 0 sec, secondary disable delay 0 sec
 MTU 1514 bytes, Bandwidth 8000000 kbit
 Reliability 255/255 txLoad 1/255 rxLoad 1/255
 Encapsulation LOOPBACK
 Link status trap disabled
 Keepalive-track set (track 20)
 Dynamic CAC BBL: 1024 kbps
 Dynamic CAC activation priority : 128
 Dynamic CAC interface status : inactive
 Last input never, Last output never
 Last clearing of 'show interface' counters never
 5 minute input rate 0 bits/sec, 0 packets/sec
 5 minute output rate 0 bits/sec, 0 packets/sec
 0 input drops, 0 output drops, 0 unknown protocols
 0 packets input, 0 bytes
 0 broadcasts received, 0 giants
 0 input errors, 0 CRC
 0 packets output, 0 bytes
 0 output errors, 0 collisions
```

The G350's routing table:

```
G350-008(super)# show ip route
Showing 6 rows
    Network      Mask     Interface         Next-Hop          Cost TTL  Source
--------------- ---- ------------------ ------------------ ----- --- --------
0.0.0.0            0 Dialer   1         Via Dia.1             1 n/a STAT-HI
10.0.0.0          30 FastEth  10/2      10.0.0.2              1 n/a LOCAL
10.20.30.40       32 Dialer   1         Via Dia.1             1 n/a LOCAL
192.168.8.0       25 Vlan     2         192.168.8.1           1 n/a LOCAL
192.168.8.128     25 Vlan     1         192.168.8.129         1 n/a LOCAL
198.0.0.1         32 Loopback 10        198.0.0.1             1 n/a MY-ADDR
```

The G350 reports of no available bandwidth for voice bearer:

```
G350-008(super)# show dynamic-cac

Current RBBL  : 0 kbps
Last event    : 0 Days, 00:02:29
Last event BBL: 0 kbps
```

The G350's MGC list:

```
G350-008(super)# show mgc

CALL CONTROLLER STATUS
------------------------------------------
Registered          : YES
Active Controller   : 149.49.43.96
H248 Link Status    : UP
H248 Link Error Code: 0x0

CONFIGURED MGC HOST
--------------------
149.49.43.96
192.168.8.100
-- Not Available --
-- Not Available –
```

Important Note

From the moment the WAN link failure took place until the dial backup link was established some H248 keepalives (from the Gateway to its CM) were lost. If the modem backup line is established faster than the H248 keepalive timeout (about 60 to 70 seconds), the Gateway will continue being registered to the primary CM. Otherwise the Gateway will consider the H248 link to be down and start trying to re-register to the primary call controller for another 1 minute (Primary Search Timer default value). In case the backup dial link was not established by then (approx 2 minutes after the WAN link failure event), the Gateway will try to register to the next call controller in its MGC list, which in our example is the LSP.

Still, it is possible to increase the value of the Primary Search Timer in order to keep the Gateway being registered to its primary CM. Use the `set reset-times primary-search` CLI command on the Gateway to set the Primary Search Timer.

By default, the backup Dialer interface is activated immediately after the primary interface was discovered to be inactive. However, it can take another 20 to 40 seconds to establish the call and have the routing tables to be updated, depends on the dialup line quality and the routing method. During that time, there is no signaling connectivity to the CM, thus the Gateway cannot generate new dial tones, no features can be requested, incoming calls will not be answered, etc. However, existing intra-branch calls and calls to local trunk facilities remains active.

6. Dialup Connection Troubleshooting

For basic dialup connection troubleshooting, follow these steps:

1. Make sure the modem is properly connected to the Gateway.
    The MDM LED on the front panel should be on.
    Use `show interfaces USB-modem` or `show interfaces console` CLI command to make sure the modem is ready and there are no init string errors.

2. Make sure the modem receives a dial tone from the telephone line.

3. Make sure the dial string (the phone number to dial) is properly configured.
    Use the `show interfaces dialer` CLI command to review the dial strings.

4. Check the IP configuration of the dialer interface and the authentication method (PAP or CHAP), using the `show interfaces dialer` CLI command

5. Try to establish a dialup connection manually
    Removing the interface backup definition from the primary interface (`no backup interface` CLI command in the primary interface context) will immediately activate the dialup interface. Pay attention to routing table changes that may occur as a result of the dialer interface activation. If you are remotely connected to the Gateway, prior to the dialer interface activation, make sure that resulted routing table changes will not cause a disconnection of your current remote session to the Gateway.

6. Check for successful dialup link activation.
    Use `show interfaces USB-modem` or `show interfaces console` CLI command to check for the connection status. Use `show interfaces dialer` or `show ip interface brief` CLI command to check the interface status. Verify dialup link presence in the Gateway's routing table by using the `show ip route` CLI command. Try pinging a remote host via the dialup link.