# Idle Mode Signaling Reduction on the S4-SGSN

This chapter describes the Idle Mode Signaling Reduction (ISR) feature and its implementation and use on the S4-SGSN.

**Important** A separate feature license is required to enable the ISR feature. Contact your Cisco representative for licensing information.



# Feature Description

The Idle mode signaling reduction (ISR) feature on the S4-SGSN provides a mechanism to optimize and/or reduce signaling load during inter-RAT cell-reselection in idle mode (that is, in the ECM-IDLE, PMM-IDLE, and GPRS-STANDBY states). It is a mechanism that allows the UE to remain simultaneously registered in a UTRAN/GERAN Routing Area (RA) and an E-UTRAN Tracking Area (TA) list. This allows the UE to make cell reselections between E-UTRAN and UTRAN/GERAN without having to send any TAU or RAU requests, as long as the UE remains within the registered RA and TA list.

ISR is a feature that reduces the mobility signalling and improves the battery life of UEs. ISR also reduces the unnecessary signalling with the core network nodes and air interface. This is important especially in initial deployments when E-UTRAN coverage will be limited and inter-RAT changes will be frequent.

The benefit of the ISR functionality comes at the cost of more complex paging procedures for UEs, which must be paged on both the registered RA and all registered TAs. The HSS also must maintain two PS registrations (one from the MME and another from the SGSN).

**Important** The Gn/Gp SGSN does not support ISR functionality.

# Relationships

The ISR feature on the S4-SGSN is related to:

- ISR must be enabled on the peer MME and SGW nodes.
- The SGSN must be configured with the following:
  - 2G Service + S4 Support
  - 3G Service + S4 Support
  - 2G + 3G Services + S4 Support

**Important** If the S4-SGSN is configured to support both 3G and 2G services, it is recommended to enable both 2G and 3G ISR functionality. This ensures that for the ISR activated subscribers, inter-RAT routing area updates between 2G and 3G preserve the ISR status if there is no SGW relocation.

# How ISR Works

ISR requires special functionality in both the UE and the network (i.e. in the SGSN, MME, SGW and HSS) to activate ISR for a UE. The network can decide for ISR activation individually for each UE. ISR support is mandatory for E-UTRAN UEs that support GERAN and/or UTRAN and optional for the network. Note that the Gn/Gp SGSN does not support ISR functionality.

ISR is not activated on Attach. ISR can only be activated when a UE first registers in a RA on an SGSN and then registers in a TA on an MME or vice-versa. It is an inherent functionality of the mobility management (MM) procedures to enable ISR activation only when the UE is able to register via E-UTRAN and via GERAN/UTRAN. For example, when there is no E-UTRAN coverage there will be also no ISR activation. Once ISR is activated it remains active until one of the criteria for deactivation in the UE occurs, or until the SGSN or the MME indicate ISR is no longer activated during an update procedure, i.e. the ISR status of the UE has to be refreshed with every update.

When ISR is activated this means the UE is registered with both the MME and the SGSN. Both the SGSN and the MME have a control connection with the SGW. The MME and the SGSN are both registered at the HSS. The UE stores mobility management parameters from the SGSN (for example, P-TMSI and RA) and from the MME (for example, GUTI and TAs). The UE stores session management (bearer) contexts that are common for E-UTRAN and GERAN/UTRAN accesses. In an idle state the UE can reselect between E-UTRAN and GERAN/UTRAN (within the registered RA and TAs) without any need to perform TAU or RAU procedures with the network. the SGSN and MME store each other's address when ISR is activated.

The S4 SGSN supports the following scenarios for 2G ISR:

- ISR activation by SGSN on new SGSN RAU from MME
- ISR activation on SGSN in old SGSN RAU to MME
- Ready to standby state transition triggered Release Access Bearer Request to SGW
- Downlink data notification from SGW:
  - Downlink data notification UE responds to SGSN
  - Downlink data notification no response from UE
- Stop paging indication
- UE initiated detach for ISR activated subscriber under GERAN

- UE initiated detach under EUTRAN/MME initiated detach or Detach notification from MME
- SGSN initiated detach for ISR activated subscriber
- HSS/HLR initiated detach for ISR activated subscriber
- ISR deactivation due to delete bearer request with ISR deactivation cause
- ISR deactivation due to last PDN connection deletion (SGSN/UE/PGW/HSS/HLR-initiated)
- ISR deactivation due to SGW change
- ISR-deactivation due to context transfer between same Node types(S4 SGSN to and from S4 SGSN)
- Intra-RAU without SGW change for ISR-activated subscriber
- Inter-GPRS service RAU without SGW change for ISR-activated subscriber
- Intra-SGSN inter-system handover from 2G to 3G without SGW change for ISR activated subscriber
- Intra-SGSN inter-system handover from 3G to 2G without SGW change for ISR activated subscriber

The following scenarios are supported for 3G ISR:

- ISR activation by 3G SGSN on new 3G SGSN RAU from MME
- ISR activation by 3G SGSN on old 3G SGSN RAU to MME
- ISR activation by 3G SGSN on new 3G SGSN SRNS relocation from MME (Connected mode IRAT handover from MME to SGSN)
- ISR activation by 3G SGSN on old 3G SGSN SRNS relocation to MME (Connected mode IRAT handover from SGSN to MME)
- Iu release triggered Release Access Bearer Request to SGW
- Downlink data notification from SGW:
  - Downlink data notification UE responds to SGSN
  - Downlink data notification no response from UE
- Stop paging indication
- UE initiated detach for ISR activated subscriber under UTRAN
- UE initiated detach under EUTRAN/MME initiated detach or Detach notification from MME
- SGSN initiated detach for ISR activated subscriber
- HSS/HLR initiated detach for ISR activated subscriber
- ISR deactivation due to delete bearer request with ISR deactivation cause
- ISR deactivation due to last PDN connection deletion (SGSN/UE/PGW/HSS/HLR-initiated)
- ISR deactivation due to SGW change
- ISR-deactivation due to context transfer between same Node types (S4 SGSN to and from S4 SGSN)
- Intra-RAU without SGW change for ISR-activated subscriber
- Intra-SRNS without SGW change for ISR activated subscriber

# Limitations

There are no known limitations to the 2G ISR feature.

For the 3G SGSN, if an ISR is already active between the SGSN and an MME and the system receives a relocation required towards an eNodeB served by the same ISR associated with the MME, the S4-SGSN first tears down the existing S3 tunnel and will initiate a forward relocation request on a new tunnel. If the procedure completes successfully, ISR association would be continued on the new tunnel. However, if the relocation is cancelled then the tunnel is lost and the ISR is deactivated.

# Call Flows

This section provides various call flows that illustrate the primary procedures used for the ISR feature:

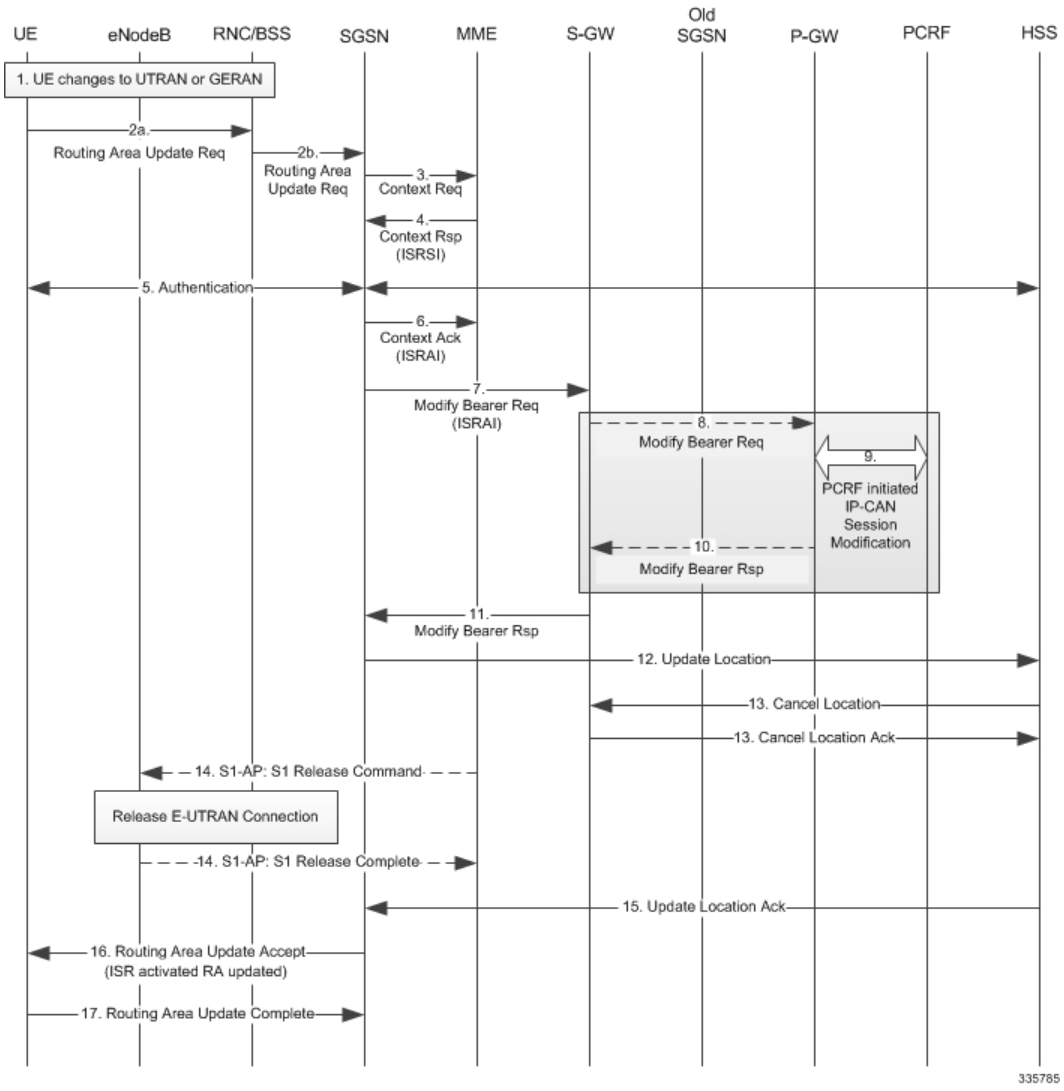
## 2G ISR Activation by the S4-SGSN

The following illustration shows the ISR activation procedure when initiated by the S4-SGSN for a 2G subscriber.

Note the following major procedural functions:

- E-URTRAN attach at the MME.
- A Routing Area Update is sent to the SGSN.
- The SGSN sends a Context Request to the MME upon receiving the RAU Request. If the MME supports ISR, it will set the ISRSI bit in the Context Response message.
- Upon receiving the Context Response from the MME, the GMM sets the ISRAI flag if ISR is already activated for the subscriber or if all of following conditions are satisfied:
  - The UE is EPC-capable.
  - ISR is enabled in the configuration.
  - The peer node is the MME.
  - The peer node has indicated that ISR is supported in the Context Response message.
- The SGSN will not activate ISR if there is change in SGW. So, the SGSN will be setting the 'ISRAI' bit in the Modify Bearer Request/Context Ack message provided there is no change in SGW and all of above conditions in the previous bullet point are satisfied.
- If the SGSN also monitors the *SGSN-MME-Separated* flag in the Update location Response or the *Separation Indicator* in Update Location Ack - ULA Flags IE to activate ISR for subscriber and ISR status is marked deactivated if not indicated by HLR/HSS.
- The SGSN sends a RAU accept with update type *RA updated and ISR activated* or *combined RA/LA updated and ISR activated* depending on the update request.
- The SGSN sends a Periodic RAU timer to the UE in a RAU accept message and also a GERAN/UTRAN Deactivate ISR timer (T3323) timer value to the UE. Parallel to the periodic RAU timer, the SGSN starts its mobile reachability timer (MNR timer) which is configurable. The default is 4 minutes greater than the periodic RAU timer. The UE is expected to contact the SGSN again within the mobile reachability timer duration either by sending a periodic RAU or some other signalling. If the UE fails to contact the SGSN during this timer, SGSN will start the implicit detach timer which by default is 4 minutes greater than T3323 timer. The implicit detach timer value is also configurable at the SGSN. If the UE fails to contact even within this implicit detach timer, then the SGSN will locally detach the UE and will send a Detach Notification with cause *Local detach* to the MME so that ISR gets deactivated at the MME.

*Figure 1: ISR Activation on the S4-SGSN*




## 2G ISR Activation by the MME

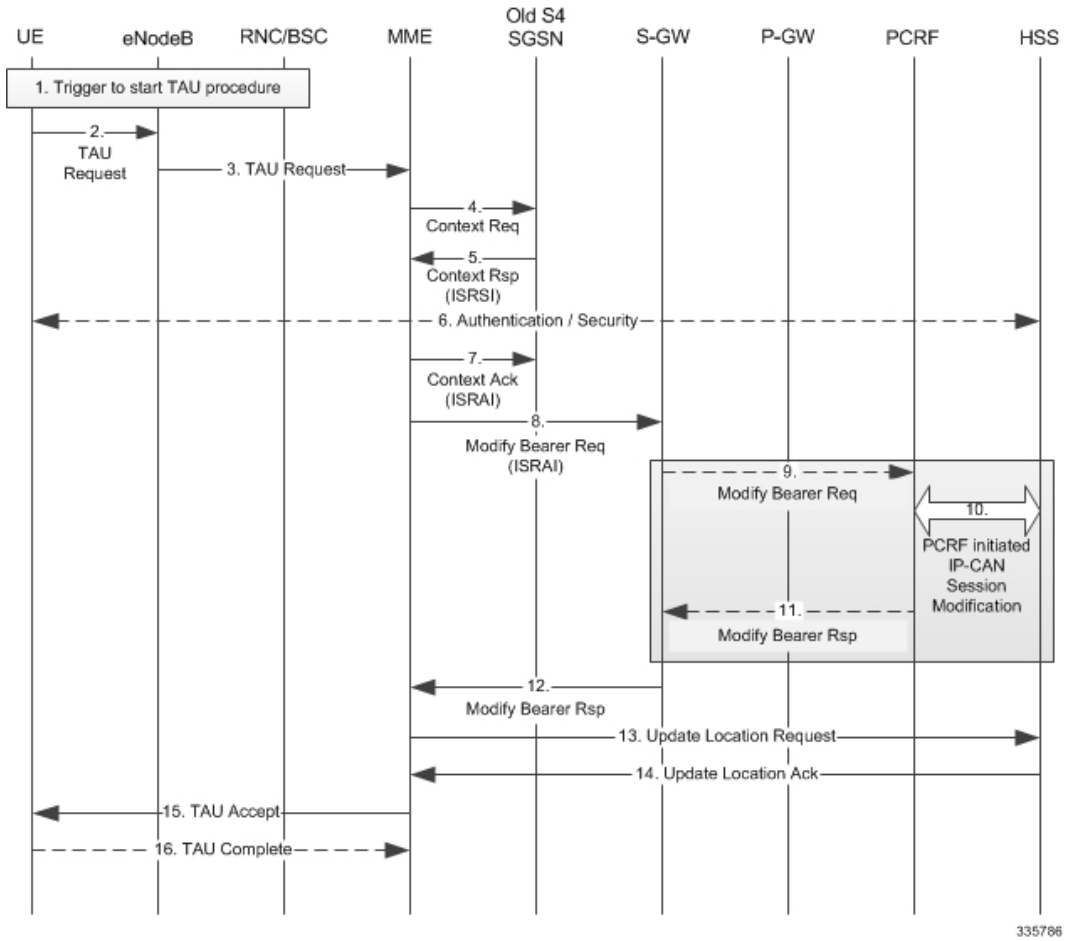
The following illustration shows the ISR activation procedure when initiated by the MME for a 2G subscriber.

Note the following major procedural functions:

- Context request from MME.
- The SGSN sends a Context Response to the MME with the 'ISRSI' bit set provided all of following conditions are satisfied:
  - The UE is EPC-capable.
  - The UE is ISR-capable.
  - The ISR is enabled by configuration.
  - The peer node is an MME.

- If the old node is an old S4-SGSN, the MME sends a Context Acknowledge (ISR Activated) message to the old SGSN.
- Unless ISR Activated is indicated by the MME, the old S4-SGSN marks in its context that the information in the Gateways is invalid. This ensures that the old S4-SGSN updates the Gateways if the UE initiates a RAU procedure back to the old S4-SGSN before completing the ongoing TAU procedure. If ISR Activated is indicated to the old S4-SGSN, this indicates that the old S4-SGSN shall maintain its UE context including authentication quintets and stop the inter-SGSN handover procedure guard timer (2G).When the UE is initially attached, the SGSN started the Mobile Reachability Timer (MNR timer). This timer value is slightly larger than the Periodic RAU Timer value given to the UE by SGSN. The default is 4 minutes longer. The UE is expected to contact SGSN through a periodic RAU or some other signalling message within this timer. If the UE did not contact SGSN within this timer, the S4-SGSN shall start the implicit detach timer with a slightly larger value than the UE's GERAN/UTRAN Deactivate ISR timer (T3323). The implicit detach timer value is also configurable at the SGSN. If the UE fails to contact even within this implicit detach timer, then the SGSN will locally detach the UE and will send a Detach Notification with cause *Local detach* to the MME so that ISR is deactivated at the MME.
- When ISR Activated is not indicated and an inter-SGSN handover procedure guard timer expires, the old SGSN deletes all bearer resources of that UE. As the Context Acknowledge from the MME does not include any S-GW change, the S4 SGSN does not send any Delete Session Request message to the S-GW.

***Figure 2: 2G ISR Activation by the MME***



## Standards Compliance

The 2G ISR feature complies with the following standards:

- **TS 23.060 version 10**: *3rd Generation Partnership Project Technical Specification Group Services and System Aspects General Packet Radio Service (GPRS) Service description Stage 2*.
- **TS 23.401 version 10**: *3rd Generation Partnership Project Technical Specification Group Services and System Aspects General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access.*
- **TS 23.272 version 10**: *Universal Mobile Telecommunications System (UMTS) LTE 3GPP Evolved Packet System (EPS) Evolved General Packet Radio Service (GPRS) Tunnelling Protocol for Control plane (GTPv2-C) Stage 3*.
- **TS 29.274 version 10**: *Universal Mobile Telecommunications System (UMTS) LTE 3GPP Evolved Packet System (EPS) Evolved General Packet Radio Service (GPRS) Tunnelling Protocol for Control plane (GTPv2-C) Stage 3*.

# Configuring Idle-Mode-Signaling Reduction

This section describes how to configure ISR on the S4-SGSN.

## Configuring 2G ISR

Configuring 2G ISR includes creating a call-control-profile with ISR enabled for GPRS, and configuring an implicit-detach-timeout in the configured GPRS service on the S4-SGSN.

```
config
 call-control-profile name
 idle-mode-signaling-reduction access-type gprs
 end
config
      context plmn_name
 gprs-service gprs_service_name
                  gmm implicit-detach-timeout value
                  end
```

Notes:

- Where **call-control-profile** *name* specifies the name of the call-control-profile tin which 2G ISR functionality is to be configured.
- **gprs** enables 2G ISR functionality.
- Alternatively, **remove idle-mode-signaling-reduction access-type gprs** can be used to disable 2G ISR functionality.
- **context** *plmn_name* is the name of the public land mobile network context in which the GPRS (2G) service is configured.
- **gprs-service** *gprs_service_name* specifies the name of the configured GPRS (2G) service for which you want to configure the implicit-detach-timeout value.
- **gmm implicit-detach-timeout** *value* specifies the implicit detach timeout value to use for 2G ISR. Valid entries are from 240 to 86400 seconds. The default value is 3600 seconds.

## Verifying the 2G ISR Configuration

This section describes how to verify the 2G ISR configuration.

To verify that 2G ISR and the gmm implicit-detach-timeout is configured:

```
show configuration
...
      call-control-profile name
 idle-mode-signaling-reduction access-type gprs
....
      context context_name
            gmm T3323-timeout value
 gmm implicit-detach-timeout value
```

To verify that 2G ISR is enabled in the call-control-profile:

```
show call-control-profile full name cc-profile-name
...
Treat as PLMN
 :Disabled
Idle-Mode-Signaling-Reduction (ISR) for UMTS               :Disabled
Idle-Mode-Signaling-Reduction (ISR) for GPRS                    :Enabled
Location Reporting for UMTS                                      :Disabled
...
```

# Configuring 3G ISR

Configuring 3G ISR includes creating a call-control-profile with ISR enabled for UMTS, and configuring an implicit-detach-timeout in the configured SGSN service on the S4-SGSN.

```
config
 call-control-profile cc-profile-name
 idle-mode-signaling-reduction access-type umts
 end
config
 context context_name
 sgsn-service sgsn_service_name
 gmm T3323-timeout mins
 end
```

Notes:

- **idle-mode-signaling-reduction access-type umts** enables 3G ISR in the call-control-profile.
- **gmm t3323-timeout** *mins* specifies the amount of time, in minutes, the UE should wait after the Periodic RAU timer (t3312 timer) expiry before deactivating ISR. Valid entries are from 1 to 186. The default is 54.

## Verifying the 3G ISR Configuration

This section describes how to verify the 3G ISR configuration.

To verify that 3G ISR is enabled and the gmm T3323 timeout is configured:

```
show configuration
...
      call-control-profile name
 idle-mode-signaling-reduction access-type umts
....
```

```
      context context_name
 gmm T3323-timeout value
...
```

To verify that 3G ISR is enabled in the call-control-profile:

```
show call-control-profile full name cc-profile-name
...
Treat as PLMN
 :Disabled
Idle-Mode_Signaling-Reduction (ISR) for UMTS                    :Enabled
...
```

# Monitoring and Troubleshooting the ISR Feature

This section provides information on how to monitor the ISR feature and to determine that it is working correctly.

# ISR Show Command(s) and Outputs

This section provides information regarding show commands and/or their outputs in support of the ISR feature.

## show subscribers gprs-only full

This command provides information that indicates whether ISR is activated for 2G subscribers, provides the MME tunnel endpoint ID being used for the ISR-activated 2G subscriber, and the IP address of the MME associated with the ISR-activated 2G subscriber.

- ISR-Activated: (True or False)
- MME Ctrl Teid: (MME Control Tunnel Endpoint Identifier)
- MME IP Address: (IP address of MME)

## show subscribers sgsn-only full

This command provides information that indicates whether ISR is activated for 3G subscribers, provides the specific S3 tunnel on the MME being used for this ISR-activated subscriber, and the IP address of the MME associated with the ISR-activated 3G subscriber.

- ISR-Activated: (True or False)
- MME Ctrl Teid: (MME Control Tunnel Endpoint Identifier)
- MME IP Address: (IP address of MME)

## show s4-sgsn statistics (2G ISR)

The output of this command provides information on the various reasons for deactivations of ISR-activated 2G subscribers:

- 2G Intra RAU with SGW Relocation
- Detach Notification from MME to 2G
- 2G MS Initiated Detach
- 2G Cancel Location from HSS/HLR
- 2G Local Admin Detach

- 2G Implicit Detach Timer Expiry

## show s4-sgsn statistics (3G ISR)

The output of this command tracks the number of ISR deactivations due to various reasons for a 3G ISR-activated subscriber:

- 3G Intra RAU with SGW Relocation
- 3G NW Initiated Detach
  - 3G MR IDT Expiry
- 3G MS Initiated Detach
- 3G Cancel Location from HSS/HLR
- 3G SRNS Abort
- 3G Local Admin Detach
- 3G SGW Change During SRNS

## show gmm statistics (2G ISR)

The output of this command indicates the total of currently activated 2G ISR subscribers:

- ISR Activated Subscribers:
  - 2G Intra RAU with SGW Relocation

## show gmm statistics (3G ISR)

The output of this command tracks the number of currently ISR-activated 3G subscribers:

- ISR Activated Subscribers:
  - 3G-ISR-Activated