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# **Signalling Relay Intelligence**

## **Alternatives to the Intelligent Network Architecture in Mobile Networks**

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## 1. Introduction

Mobile Application Part (MAP) signalling used by digital cellular networks provides the core network intelligence.

Indeed, it is worth noting that in the late 1980s, when initial work was being done to define a general purpose intelligent network architecture, the home location register (HLR) functionality of GSM was identified as a function that could (indeed, should) be performed by a service control point.

This is recognised in the wireless intelligent network (WIN) architecture defined for ANSI 41, which identifies that a service control function (SCF) can exist within an HLR.

Unfortunately, few, if any, HLRs currently available, have the flexibility to enable network operators to create special services for their subscribers. Other network elements, such as VLRs are even less flexible.

Traditional intelligent networking is concerned with handling call set-up through a conventional telephone switch. Whilst this is useful, in mobile networks there are a significant number of functions that are not call associated (such as location registration, short messages, etc). Modelling such functions into the state models and protocols of IN have proved difficult.

However, the interactions between network elements to support these functions are all carried by MAP messages. An alternative approach to IN is to monitor and, if necessary, modify this signalling traffic. This function is known as Signalling Relay Function.

The concept of signalling relay intelligence was first considered as a core network solution for mobile number portability. However it has a much wider use.

## 2. Signalling relay technology

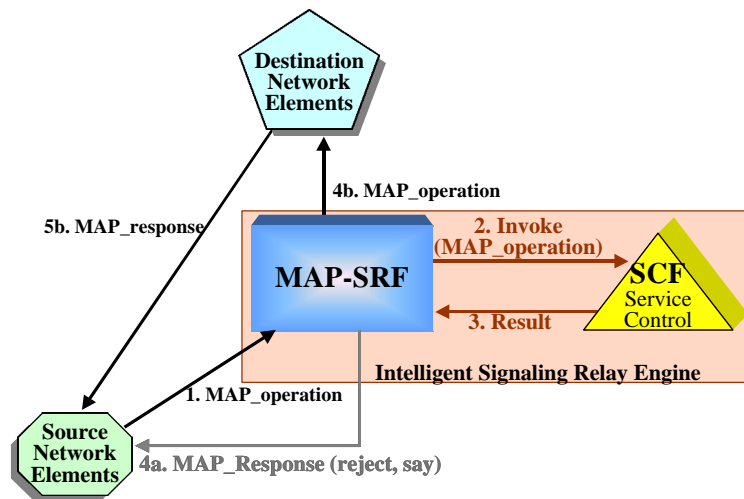
The principle of signalling relay intelligence is that (MAP) signalling traffic is used to trigger service applications. This is done by a system acting as an SCCP routing node in an SS7 network. Signalling traffic that is potentially subject to signalling relay intelligence must be routed through such a node.

In general a MAP operation is sent from one network element to another. an intelligent signalling relay engine intercepts the operation and can then perform one of the following:

- a. Relay the operation, unchanged, to the appropriate destination network element (e.g. an HLR). In this case it simply acts as an SCCP routing node (or STP). Typically the SRF will use information in the SCCP header or even the MAP operation itself to determine the appropriate destination.
- b. Relay the operation with changes to the pay load.
- c. Respond to the MAP operation acting as though it were the destination network element.
- d. Discard the operation completely (but this would be unusual).

Whilst handling an operation, an intelligent signalling relay engine may also send and receive other MAP operations and, indeed, interact with other network elements such as service control points, data points, etc.

A typical signalling scenario is shown in the following figure:



### Intelligent Signalling Relay Engine

1. A network element (such as an MSC) sends a MAP operation to some destination network element (such as an HLR). This is routed via an intelligent signalling relay engine.
2. On examination of the SCCP header or even MAP payload, the signalling relay function invokes a service control function.

3. The service control function returns a result, which causes one of:
  - 4a. A response is sent to the originating network element. This is known as the MAP Application Termination Function (MATF)
  - 4b/5b The operation is relayed to the appropriate destination. The SCCP addressing is such that this is a pure relay and the destination may return the result directly to the original sender.

Typically the service control function will be contained on the same platform as the SRF itself, but there is no reason why it should not be distributed. If service control is on a separate platform then an appropriate protocol is needed for invoking it. There are no standards for such an interface. In some cases it is possible to map the required information flow onto a sort of simplified INAP, however this lacks generality and flexibility. A common approach is to use a TCP/IP link with CORBA as a bearer technology; for complete flexibility the triggering MAP operation may be provided to the SCF.

### 3. Services Implemented Using Signalling Relay

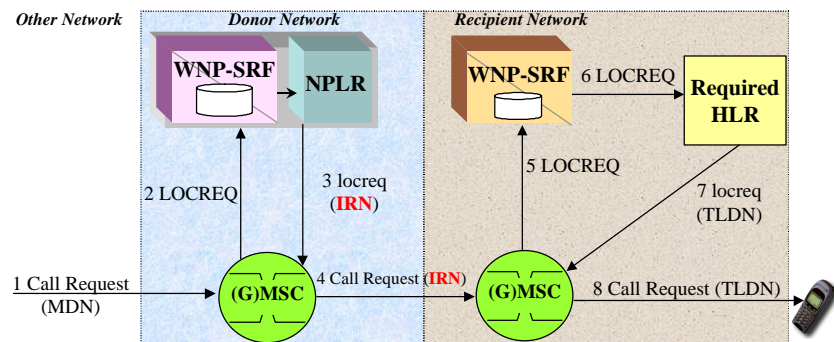
The signalling relay technology can be used for a wide range of applications. Its power lies in its ability to inject intelligence where conventional IN (or WIN) cannot reach and the fact that it has minimum performance impact on existing network elements

The following are examples of service features that have been implemented with signalling relay technology.

- Wireless (Mobile) number portability was the original application for which signalling relay intelligence was devised. In GSM its use is defined in GSM 03.66. The same architecture is equally applicable for ANSI 41 core networks. See the section below for more details on how signalling relay can be used for wireless number portability.
- General purpose address register for locating HLR or other network element from the MIN/MDN (or, in GSM, the IMSI/MSISDN). The signalling relay function can use information in the MAP operation as well as in the SCCP header. This can allow, for example, a set of HLRs to be addressed by a single point code by the rest of the network.
- Roaming Triggers. Services implemented on detection of subscribers roaming into or out of an operator's network. An example is described in more detail below.
- Short messaging control for pre-paid and number portability.
- Pseudo USSD (unstructured supplementary services data) features for ANSI 41. Feature codes that are not supported by the HLRs can be intercepted by a signalling relay engine and the feature request treated like a basic GSM USSD operation.
- SCCP Screening. As MAP becomes more powerful, there is a need to police interconnection interfaces. This is a straightforward application for a signalling relay engine.

#### 3.1. Wireless Number Portability

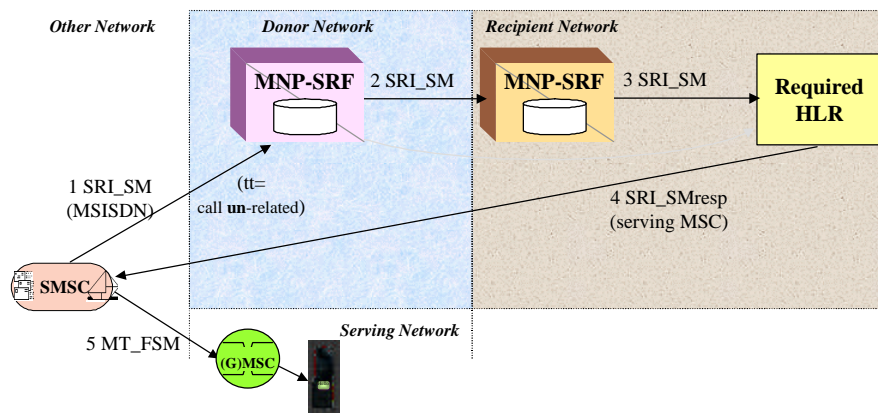
The figure below shows the number portability architecture for a call to a ported number. The signalling operations used in the diagram are ANSI 41; for GSM the same scenario applies, except that the HLR query operation is called Send-Routing-Information (SRI).



Call Associated Signalling for SRF Implementation of Number Portability

1. A call is received at a (Gateway) MSC in the donor network.
2. A LOCREQ is sent by the MSC via an intelligent signalling relay engine.
3. The number has been out-ported, so the signalling relay engine invokes a number portability location register (NPLR), which is a MAP application Termination Function (MATF) that responds to the LOCREQ with an intermediate routing number (IRN).
4. The IRN causes the call to be routed to the recipient network.. Note that the format of the IRN and associated signalling must be agreed between operators.
5. Assuming the recipient network also uses a signalling relay function (as opposed to the IN-like approach defined in IS756), the gateway MSC in the recipient sends a LOCREQ query to its HLR via a signalling relay engine.
6. As the number is a subscriber of the recipient network, the SRF relays the query to the appropriate HLR,
7. which responds with the appropriate routing number,
- 8 so that the call may be completed to the mobile.

For non-call associated signalling (e.g. for delivery of a short message to a ported subscriber), the query operation may be routed directly to the recipient networks HLR. The following figure shows the signalling for GSM short message delivery to a ported subscriber.

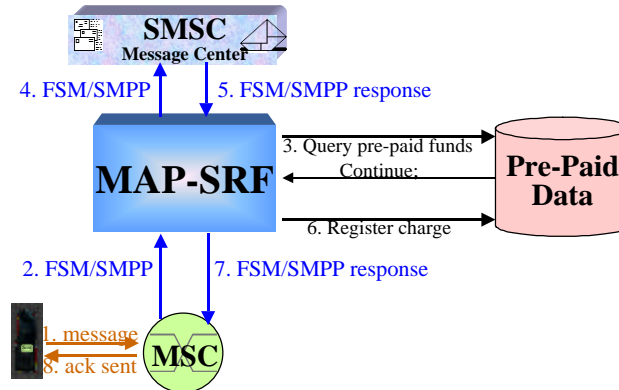


GSM Short Message Delivery to Ported Subscriber

1. A short message service centre (in any network) attempts a query of a mobiles location. This query, addressed by the directory number (the MSISDN) is routed by the donor network through its mobile number portability SRF.
2. As the number is ported, the query is relayed to the recipient network.
3. A signalling relay function (or other global title translation engine) routes the query to the required HLR,
4. which replies with the serving MSC,
- 5 so that the message may be delivered.

**3.2. Pre-Paid Mobile Originated Short Messages**

A signalling relay engine can be used as a generic capability to monitor for mobile originated short messages for pre-paid subscribers. The scenario would be something like the following.



Signalling Relay as SMSC front-end for Pre-Paid Subscribers

A scenario for mobile originated short messages is shown in the above figure.

1. A mobile subscriber sends attempts to send a short message
2. This is routed through an intelligent signalling relay engine using the appropriate MAP operation (Forward Short-Message for GSM or Short-Message-Point-to-Point for ANSI 41).
3. Available funds are queried. This may be internal to the SRF or to an external system. Note that, if it external, a caching technique might be applied to avoid querying for every short message.
4. If funds are available, the message is submitted to the appropriate message centre.
5. On receipt of a positive acknowledgement from the message centre,
6. the charge is registered,
- 7/8. and the acknowledgement relayed to the initiator.

**3.3. Roaming Triggers – Services to In-bound Roamers**

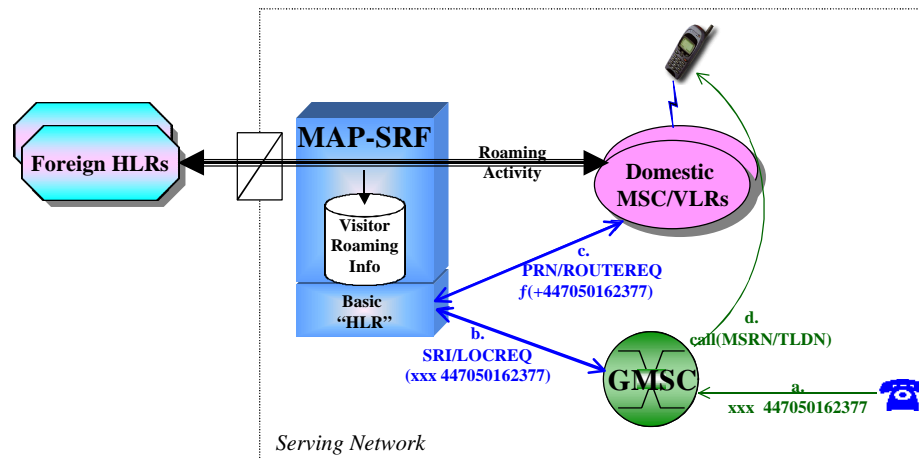
Services can be offered to in-bound roamers by monitoring the location update (registration notification) signalling traffic between one’s MSCs and HLRs in other networks. The kind of features that can be offered from such roaming triggers include:

- Short welcome message on entering a network
- Advertising
- Selective roaming restrictions
- Optimised routing to in-bound roamers (see following paragraphs)

When a foreign subscriber roams into a network, people in that country can call that subscriber. However they have to use the subscriber’s international number and, therefore, have to pay international call charges. Furthermore the subscriber has to pay the international call from his/her home network back into the visited network.

Logica Aldiscon has patented a signalling relay application that allows people in a visited country to call the subscriber without incurring the international charges and without the subscriber having to pay any incoming call charges. This is done by the caller “knowing” that the subscriber is in the country and prefixing their international number with a “carrier select” dialling prefix.

A signalling relay engine monitors roaming location management and maintains a register of in-bound roamers. The same system provides a primitive HLR capability to which the GMSCs route all queries for calls dialled using the optimised routing prefix. If the subscriber is indeed roaming in the network, this “HLR” obtains the necessary routing information to enable the GMSC to set-up the call direct.



Optimised Routing to In-coming Roaming Subscriber

#### 4. Signalling relay as an alternative to WIN/CAMEL

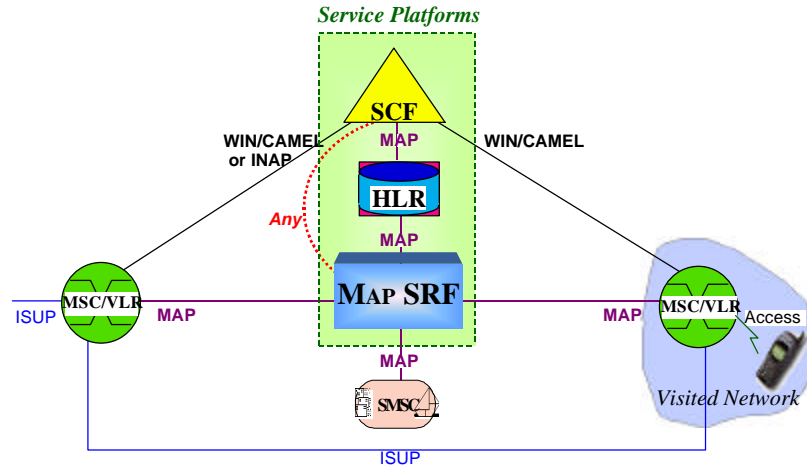
There is currently an explosion in the use of mobile communications, which itself is causing a flurry of activity to define new capabilities, standards, etc. A significant feature of modern telecommunications is that a significant part of service intelligence is performed in the access devices. Nevertheless there will always be a requirement for core network based intelligence.

There is no one way of delivering such intelligence. The various techniques and standards that are available complement each other. Any particular service feature is likely to use more than one technique. Conversely, there is more than one way of implementing a service feature. In a typical network, one would expect to see a combination of IN technology as well as a signalling relay capability.

Superficially there are significant differences between a signalling relay approach and that of intelligent networking (WIN, CAMEL, etc). However, the underlying principles are the same – an event in the core network triggers some service feature logic. From the service platform perspective, the requirements are very similar – it has to handle a transaction involving a signalling message. The only essential difference is that the application protocols used are different.

Ultimately the decision on whether to use MAP signalling relay or IN for a service feature will depend on many factors. There are, however, some general principles to be considered:

- MAP signalling relay does not have access to the basic call state model in the switches and, therefore, is unsuitable for call related services other than number portability and basic number translation.
- IN based services can impose a heavy performance load on the service switching points. Signalling relay does not entail any load on the switches.
- Signalling relay can be used anywhere in the core network. However the appropriate traffic must go through the signalling relay engines. In some cases this may be impractical due to the volume of such traffic.
- WIN and CAMEL are standards specifically aimed at providing services, whilst roaming. This is done by forcing a signalling operation to be sent to the home network. No equivalent exists for MAP signalling. Thus a signalling relay engine can only deliver service to roaming subscribers in cases where signals are exchanged between the serving and home network.



Intelligent Service Platforms

In a typical network, a variety of service platforms will be used, including the traditional service control point, the HLRs themselves, and signalling relay intelligence.