CHAPTER 7

Connecting Mobile Operators for SMS-MO

What was that snaky-headed Gorgon shield
That wise Minerva wore unconquered virgin,
Where with she freezed her foes to congealed stone?
But rigid looks of chaste austerity,
And noble grace, that dashed brute violence
With sudden adoration and blank awe.

—Milton

7.1 Business Need for an SMS Interworking Operator to Connect Multiple Mobile Operators

We saw in Chapter 6 how a third-party SMS interworking network may send SMS to other networks. The third party needs to get the revenues from as many senders as providers, especially if it pays for the SMS-MT termination. So it needs to connect quickly, using the standard procedures of their SMSCs, as many mobile operators as possible and charge them for the SMS-MO sent by their subscribers.

It is very important to have the mobile operators as customers. They have a stable business structure (unlike application service providers), regular revenues, and stable administrative structures. This chapter explains how to connect the SMSCs of mobile operators so that they can use a third party to transmit their SMS to other networks with which they are not able to interwork (Figure 7.1). The chapter is divided into three parts: (1) the virtual HLR/MSC approach, (2) a discussion of how to route SMS traffic to a third party (the setup of the SMSC or the GMSC), and (3) how to create SCCP routing for SMS between the SMSC of the mobile operator and the third party when a GT translation is not available in the SMSC or GMSC.

7.2 Principle of the Virtual HLR/MSC Approach

7.2.1 Relay Mode

Mobile operators may connect their SMSCs to an SMS interworking network using the relay mode. They consider the SMS interworking network to be a worldwide HLR and MSC, and through a proper GT translation in their SMSCs or GMSC, the MAP signals addressed to networks with which they do not have roaming agreements are redirected to the SMS interworking network (Figure 7.2). We call this the

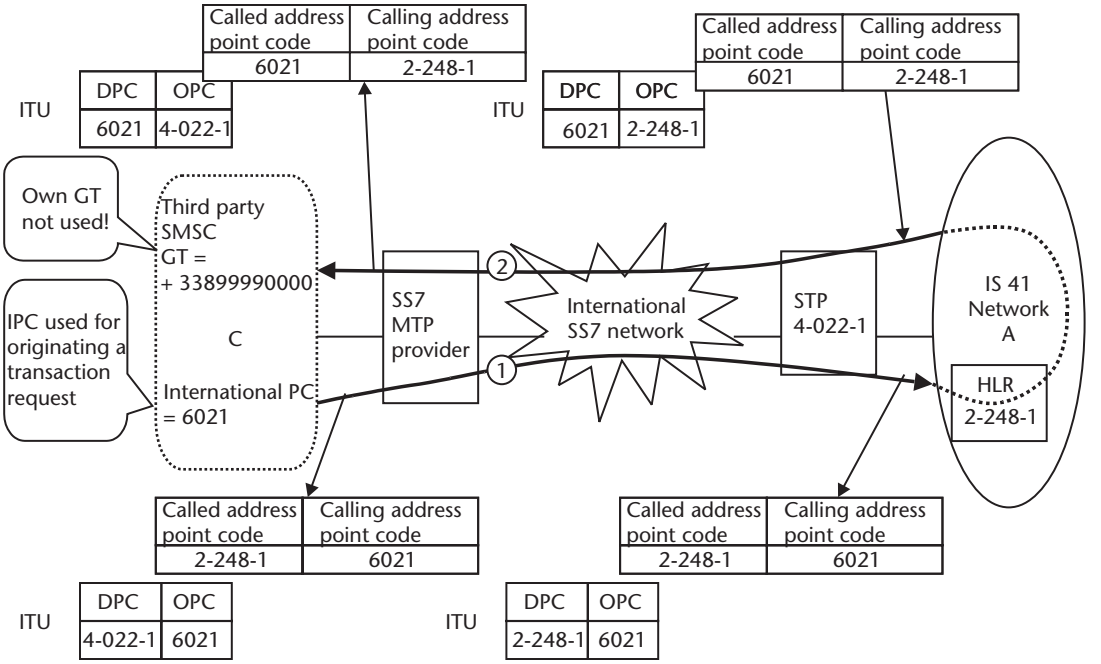

Figure 7.1 Transmission of signaling between a GSM and an IS-41 network.

relay mode because if the SMS interworking network finds that a retry is necessary (for example, because a network is not reachable or memory is full) it responds successfully, and the SMS interworking network will handle the retry. The reason is economy in terms of SS7 traffic. The retry is performed in the farthest servicing node.

All of the retries are handled by the servicing node (which has roaming with the destination), so no SS7 traffic is generated between nodes. This allows the SMS to be more cheaply priced, but has the following limitations:

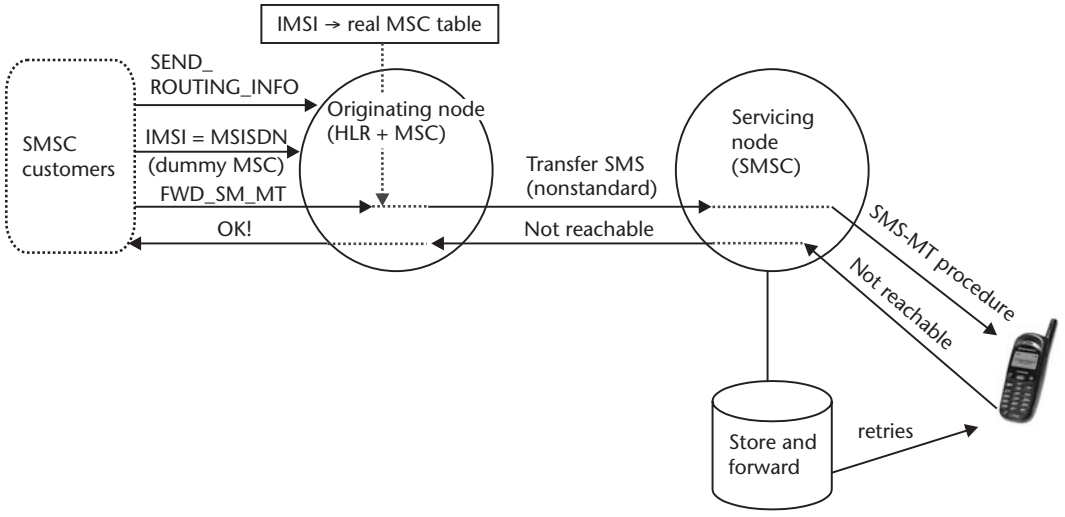

Figure 7.2 The relay mode.

- The SMSC sees "OK" when it may not be okay.
- The request for a status report is not transmitted to the SMS interworking network (it is not a parameter in the MAP SMS-MT service), so the sender will not receive a real status report.

The answer to the SRI is based only on the reachability, as detailed in the SMS interworking network routing table of the destination network. The real HLR interrogation is only performed when the SMS-MT is received from the SMSC with an IMSI = MSISDN, which is returned by the third party in this relay mode, so the SMSC never receives the real IMSI (which is not really a problem).

7.2.2 Transparent Mode

Operators may select the transparent mode (the price could be higher because of the additional SS7 traffic) when connecting to a third-party SMS interworking network (Figure 7.3). It is called *transparent mode* because the result is that the service behaves exactly as if the operators had direct roaming agreements with the operators that they reach through the third party. They get the real IMSI when they do a SEND_ROUTING_INFO_FOR_SM message (see Chapter 1) so they can create accurate reports that include the name of the destination network. They get the exact error back for each SMS-MT attempt; their own SMSC handles the retries and receives the ALERT from the HLRs with which they do not have roaming agreements. So it is much better for them, for the third party, because there is more SS7 traffic.

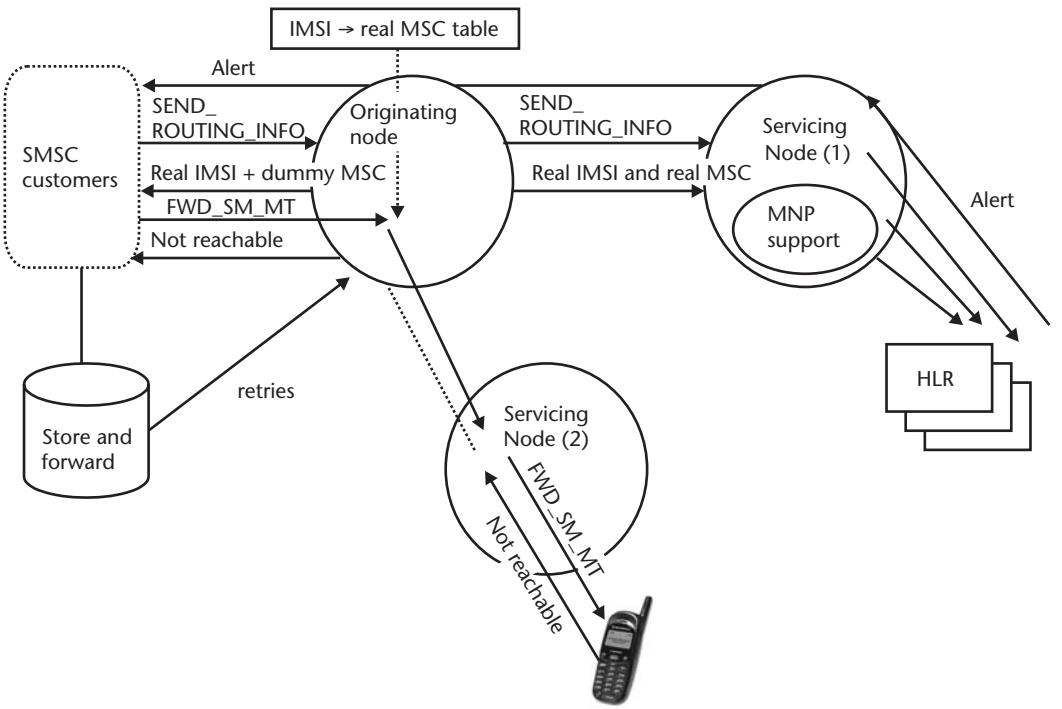

Figure 7.3 The transparent mode.

The GT of the sending SMSC [which is included in SRI, *FORWARD_SHORT_MESSAGE_MT* (FWD_SM_MT), REPORT_STATUS_DELIVERY, and ALERT_ SERVICE_CENTER] is used by the originating node and the servicing node to determine whether this request is for the relay or the new transparent mode. In the latter case, *the SRI is relayed to a node that has roaming with the destination network*. If the number has MNP, it is routed to a node that has roaming agreements with all of the operators in the country. (For every country that has MNP, there must be at least one SMS interworking network node that has roaming with all of them.)

The distant servicing node will find the proper network and return the IMSI and the visited MSC. Then the SMSC will send the FWD_SM_MT, which may be sent by another servicing node. The *real status is returned*. So the retries are handled by the SMSC, as is the sending to the HLR of the STATUS_DELIVERY_REPORT, which will trigger an ALERT_SERVICE_CENTER from the HLR.

The ALERT_SERVICE_CENTER will be sent by the HLR to the servicing node. A mapping to the real SMSC is performed and the servicing node will send the ALERT_SERVICE_CENTER through the originating node, using the dynamically created MSISDN-to-SMSC table.

This transparent service is designed for major operators who want to fully handle by themselves the delivery of SMS.

Figure 7.2 shows an "IMSI → real MSC" table. The originating node has returned a dummy MSC (its own GT) to the SRI, so that the FWD_SM_MT is sent to it (not directly by the SMSC; otherwise the third party would lose this traffic!). So the FWD_SM_MT does not address the real MSC. The originating node may again find the real MSC with the table.

The system allows customers to connect either in relay mode or transparent mode. They distinguish this by means of the "SMSC GT → Mode" table in the originating node. How do the nodes know that they must provide the transparent mode or not for a received SRI? If a node receives an SRI from another node (it has a table of their GTs), it knows that it must be the transparent service.

7.2.3 Direct Interrogation of the HLR by the Client Operator

An operator α that wants to optimize its costs will perform directly the SEND_ROUTING_INFO_FOR_SM to interrogate the HLRs of its roaming partners, so as to avoid the charges of the SMS interworking network. However, if its SMSC finds that it does not have a roaming agreement with the visited operator , it *must send the FORWARD_SHORT_MESSAGE_FOR_MT to the SMS interworking network and pass the IMSI and the visited MSC GT*. With standard SMSC software, the only way to do this is to insert in front of the SCCP called party address (the visited MSC GT) a *short suffix* belonging to the SMS interworking network, as explained for the 338 insertion method in Section 7.3.1. Then the SMS interworking network will drop the suffix 338 and find the original visited MSC GT. It can send the SMS-MT *without interrogating the HLR* (it does not have necessarily roaming with it).

The SMS interworking network must return the FWD_SM_MT_CNF to the SMSC, because, since the MSISDN is not known (it just has the IMSI), the retry procedure must be handled by the sending SMSC. Thus, when the SMS interworking network receives a FWD_SM_MT with a called party address that is not the SMS

interworking network (after dropping the suffix), *it must always use the transparent mode*.

7.2.4 SMS Interworking Network and the Status Report

Normally connected operators use their own SMSCs to send SMS to their own subscribers. There are a few exceptions such as Hutchison 3G, which uses an SMS interworking network for their outbound roamers. When H3G wants to send a STATUS_REPORT (with the FWD_SM_MT procedure) to one of its outbound roamers, its SMSC interrogates their HLR, finds that the visited MSC is not H3G, and sends the FWD_SM_MT (STATUS_REPORT) to the SMS interworking network.

The STATUS_REPORT type SMS is recognized from a COMMAND type SMS (up to MAP V2) by the value of the calling party GT.

7.3 Configuration of the SMSC or GMSC to Route to the Third Party

SMSC or GMSC equipment can be configured to route SMS traffic to a third party in four different ways:

1. Do an address translation in the GMSC.
2. Do an address translation in the SMSC.
3. Use a private conversion unit, which is a private STP that is able to do a GT translation.
4. Do nothing; use the services of a smart intelligent gateway provider.

7.3.1 GT Address Translation in the GMSC

When using the SMS interworking network, the operator may want to optimize its costs, which it can do by sending its SMS-MT directly if it has a roaming (and SMS interworking) agreement with the network of the destination handset *and* with the visited network. Most of them will also send to the SMS interworking network when it is too complicated to update all of the changes. For example, the United States has a total numbering plan of more than 65,000 lines.

A setup has been developed, called the *338 method,* that is optimum and that also resolves the paradigm (Figure 7.4): "α has roaming with network β, but the subscriber of β is roaming in network ε and α does not have roaming with ε. Note that many big operators do not handle this and, of course, still charge their subscribers for the SMS that could not be delivered!

7.3.1.1 How Does It Work?

The third party must have a short global title such as +338 or +3204 that includes all of the numbers that follow. So the SMSC or the GMSC (whichever is configured to do the GT translation; it is simpler in the SMSC) will simply translate the SCCP called party address *with any GT,* regardless of any roaming agreements, whether it is the MAP service SEND_ROUTING_INFO_FOR_SM or the FORWARD_SHORT_MESSAGE_MT used in the sending of SMS or anything else:

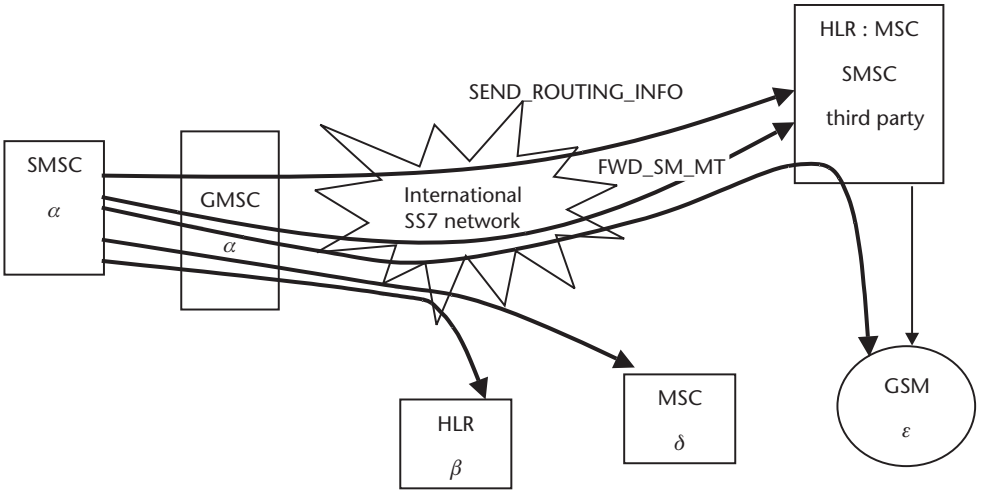

Figure 7.4 The 338 method.

$$+5372541212\ (\text{Cuba}) \rightarrow\ +3385372541212$$

Thus, any such SCCP signal will be sent to the SMS interworking network!

If this GT (case of an FWD_SM_MT from α to ε) is the called party address of a visited MSC, by stripping 338, the SMS interworking network routers get back the real MSC GT and can send it (using a path of the network). This process works because by adding 3 digits to the longest current GT (14 digits), the resulting GT address is no longer than 18 digits, which is the current maximum length in many international SCCP gateways (and the maximum limit in the current GSM specification for E164 numbers). So it works even with Chinese numbers (14 digits), and +3204 would also work.

7.3.1.2 Reason to Do the Address Translation in the GMSC

Address translation can be done in the GMSC for those operators that:

1. Have an SMSC that does not have a numbering plan (also called *HLR tables*). It can only send the SEND_ROUTING_INFO_FOR_SM to a GMSC (Gateway MSC), which then "translates" the MSISDN send in the called party address of SCCP to the corresponding HLR number.
2. Have an SMSC that is unable to perform any address translation at the MAP level (destination address) or at the SCCP level (called party addresses) in the SRI.

For example, Logica SMSC (before Release 2700) and CMG could send a SEND_ROUTING_INFO_FOR_SM in one of two formats only (what we call the standard SMSC addressing mode).

1. *GT SCCP addresses*. Routing indicator is set to route on GT. The SCCP called address is the GT of the MSISDN and SSN, and the SCCP calling address is the GT and SSN of the SMSC.

2. *National PC addresses*. Routing indicator is set to route on DPC. The SCCP called address is the DPC of the local HLR and SSN (as defined in MAPs table), and the SCCP calling address is the DPC and SSN of the SMSC.

The GT translations (MSISDN-to-SMS interworking network HLR GT) *must be performed in one of the GMSCs in this case*.

7.3.1.3 Method to Do the Address Translation in the GMSC

To do the address translation in the GMSC, the GT translation is performed by the GMSC to which the SMSC is connected. The setup of the global SMS service will not impact the existing voice roaming agreement. Table 7.1 shows the old table, without translation, prior to setting up the address translation in the GMSC.

Note that there is a common habit in the network department of creating *all NDCs of their roaming partners* in the GMSC's routing table for outgoing SCCP traffic. In fact, only the MGT (one of the NDCs) is used for voice roaming (update-location) and FWD_SM_MO (when their outbound roaming subscribers are sending an SMS-MO to their SMSC). All of the other NDCs such as 661, 662, and 663 *are used only to allow the transmission of SEND_ROUTING_INFO_FOR_SM in order to send SMS-MT to their subscribers*. So, if you do not have an SMS interworking agreement with them, *it is completely useless*. You should remove these ranges, which also allows you to avoid the work of maintaining these useless ranges.

Table 7.2 shows the new table, which takes translation into account: Send SMS to the SMS interworking network for this network and all others. You find that the MSCs and HLRs GT in your partner's IR-21 (the standard document that gives the numbering scheme of their equipment) is:

33 6600 Bouygues (France)
33 68900 Orange France

The setup of the GMSC is very simple because the pattern matching is such that it looks for the longest matching GT chain. After it has failed to match the number +33612123456 (SFR France) with one of the GTs in the table, it will translate to the third-party HLR. You need to take these steps:

Table 7.1 Old Table: Set Up of Your GMSC for a Voice Roaming Agreement

	CC	*NDC*	*Translation to*	*Destination Point Code*
	33	660 (MGT)	NONE	IGP
No translation	33	*661*	NONE	IGP
	33	*662*	NONE	IGP
	33	*670*	NONE	IGP
	33	689 (MGT)	NONE	IGP
	33	*607*	NONE	IGP
	33	*608*	NONE	IGP
	33	*680*	NONE	IGP
	33	*681*	NONE	IGP
	46	707(MGT)	NONE	IGP
	46	*704*	NONE	IGP
	46	*739*	NONE	IGP
	46	*736*	NONE	IGP
	46	*7016*	NONE	IGP

Table 7.2 New GMSC E164 Translation Table

	CC	*NDC*	*Translation to*	*Destination Point Code*
1: No translation	33	6600 (no SMS interworking)	NONE (All MSCs and HLRs will remain untranslated so voice roaming is not a concern.)	IGP
	33	68900 (no SMS interworking)	NONE	IGP
	46	707 (MGT) (SMS interworking OK)	NONE	IGP
	46	*704*	NONE	IGP
	46	*739*	NONE	IGP
	46	*736*	NONE	IGP
	46	*7016*	NONE	IGP
2: Translate to the SMS working network	1	Any other ranges	HLR of the third party (All SMSs sent to a number starting with 1 will go to the third party.)	IGP
	2	Any other ranges	HLR of the third party (All SMSs sent to +225, +20, and so on, will go to the third party.)	IGP
	3		And so on...	
	4			
	5			
	6			
	7			
	8			
	9			

1. Add at the end 1, 2, …, 9.
2. Take out the NDCs of the networks with which you do not have SMS interworking, while retaining only the MGT extended to include only the network equipment GT.

Note that this has no effect on the UPDATE_LOCATION, which uses separate E214 tables. Operators using this method include Cell C (South Africa) and Celltel (Sri Lanka).

7.3.2 Doing the Address Translation in the SMSC

7.3.2.1 GT Address Translation

These SMSCs are able to address directly a HLR in another (foreign) network using GTs. The third-party HLR will be addressed by the GT that the SMS interworking network gives you.

Principle. Separate tables exist for the HLR and MSC/SGSN addressing in the SMSC. Based on the destination party MSISDN, a translation to either SPC or *another GT* (using the SMS interworking network's GT) is available. If no translation has been found, the MSISDN itself is used as a GT; simply set the translation to the SMS interworking network GT with routing on GT.

In conclusion, you can route routing information requests to specific entities for different number ranges, for example, to the SMS interworking network routers for Irish subscribers and to Orange for Orange subscribers.

Typical Layout of GT Translation in an SMSC. Here is a typical layout for GT translation in an SMSC:

	GT	PC
Your numbers→	HLR GT	HLR PC
Default (sent to the third party)→	HLR third party assigned to you	IGP PC

Operators using this method include Mobitai (Comverse), FT Dominica (Logica), and Hutchison (Logica).

7.3.2.2 Destination Address Modification at the MAP Level by the SMSC

The SMSC is configured so that for any international (all the destination MSISDNs) number starting with a plus sign (+), it inserts 338 (the third-party MGT):

MSISDN +33608123456→ +338 33608123456

The SMSC will then address the HLR with this SCCP called party address +33833608123456 and routing on GT. The GT is 18 digits, which is the maximum (current ITU standard) for an E164 GT. So, because the SMS interworking network has a very short MGT, we are able with this method to address U.K. MSISDNs, which have 12 digits.

The GMSC/STP will route to France Telecom International (the SMS interworking network IGP supplier in this example), which will then route it to the SMS interworking network (France) because the GT is +338xxxxxx.

The SMS interworking network HLR (also MSC and SMSC) will take out the 338, giving back +33608123456, and then send the SMS-MT to the final network throughout our SMSC. Also, all of the international SMS traffic will be routed to the SMS interworking network but this method is very simple.

Operators using this method include New World PCS (Nokia) and Malitel (Alcatel).

7.3.3 Use of a Private Conversion Unit

A conversion unit is a "SS7 box" capable of performing a GT translation and of behaving as a HLR, MSC, and SMSC. It is installed in an operator's own networks. It has the same function as an originating node in the relay mode (see Figure 7.1) and the same procedure. It is a connection solution when there is no possibility to do any address translation in the GMSC (which is rare) or in the SMSC (either at the SCCP level or at the MAP level; see Chapter 3).

7.3.3.1 Consider the Conversion Unit to Be One of Your HLRs

One of the only possibilities in the SMSC is to declare another (internal) HLR and address it with routing on PC. So the idea is to create a new HLR, that is, the conversion unit.

Configuration Principle of the SMSC. The SMSC has a numbering plan (also called a HLR levels table), like that shown in Table 7.3, which is used for the address translation for the MAP_SEND_ROUTING_INFO_FOR_SM function. Table 7.3 shows that subscriber +436640312345 is assigned to the Salzburg HLR.

Assume that one wants to send an SMS to other subscribers (foreign) that are not in this table, but are accessible by the SMS interworking network. Usually the default SCCP called party address, when a number is not found in the table of HLR levels for the SRI, is

Routing indicator = route on GT
GT = MSISDN
SSN = 6

and is in the routed (MTP3 level) to the international gateway.

One could add the SMS interworking network router like one of your new HLRs just by adding a new line in this table, after assigning one of your GTs and PCs to the conversion unit in your network either (depending on your SMSC) like this:

default +436649000050 The SPC that you adjust to the conversion unit

or like this:

+000000000000 +99999999999 +436649000050 7-004-8

(After scanning with your subscriber numbers, for any other number, it will find the conversion unit and the routing will go *through your network*, so you must give its SPC.) This HLR will return *its own address* as the localization MSC address (+436649000050 in the example), so that it will also receive the SMS-MT sent by your SMSC. (Remember that SMS-MT is a two-phase process: First is the interrogation of the HLR to obtain the MSC localization and second is the sending of an SMS-MT to this MSC.) With this method, the SMS interworking network SS7/IP router behaves like a HLR and a MSC on your network. Note that the operator can select the traffic that is routed through the conversion unit then to the third party by simply configuring the HLR levels of the new HLR.

Operators using this method include Telkomsel and SINGTEL.

7.3.3.2 Consider the Conversion Unit as the GMSC of the SMSC

One of the only other things you can do when you configure any SMSC, including CMG, is to set the point code of the GMSC. If you set it to be the conversion unit, any SEND_ROUTING_INFO_FOR_SM for a foreign subscriber or any

Table 7.3 Numbering Plan for Address Translation

Min	*Max*	*HLR GT(GT)*	*HLR (SPC)*	*Comment*
+436640000000	+436640149999	+436649000010	7-002-1	Vienna 1
+436640150000	+436640299999	+436649000020	7-003-1	Vienna 2
+436640300000	+436640449999	+436649000030	7-004-2	Salzburg
+436640450000	+436640599999	+436649000040	7-004-3	Innsbruck

FORWARD_SHORT_MESSAGE_MT to one of your subscribers roaming in another network will address the conversion unit.

The configuration is very simple, but the third party is used even for one's own subscribers when they are roaming abroad. So, the method of Section 7.3.3.1 would be preferred in terms of cost reduction.

One operator using this method is Hutchison 3G (Hong Kong) (CMG).

7.3.4 Intelligent SCCP Routing by Your IGP

Using a third party for the sending of SMS to other networks requires a the SMSC or GMSC to be set up to do so. Here is an architecture in which the IGP provides the service with the set up *only on its side* (Figure 7.5). Remember that the method was to reroute all signaling messages going to nonroaming partners to a specialized third-party router. This rerouting could be handled transparently by the IGP with its own roaming agreements and an SCCP gateway that holds a database of the roaming agreements of all their customers. It involves only SCCP levels—it does not need to analyze higher MAP levels—so that the equipment remains a simple SCCP gateway with all the international SCCP traffic transiting through.

Because GSM A does not have roaming with GSM B, no mobility MAP messages will be attempted to be sent by GSM A to GSM F through the IGP. So, no undue load is created on the IGP. Whenever the IGP intelligent SCCP gateway, which processes only SCCP, sees a calling party address GT it checks (from the call-

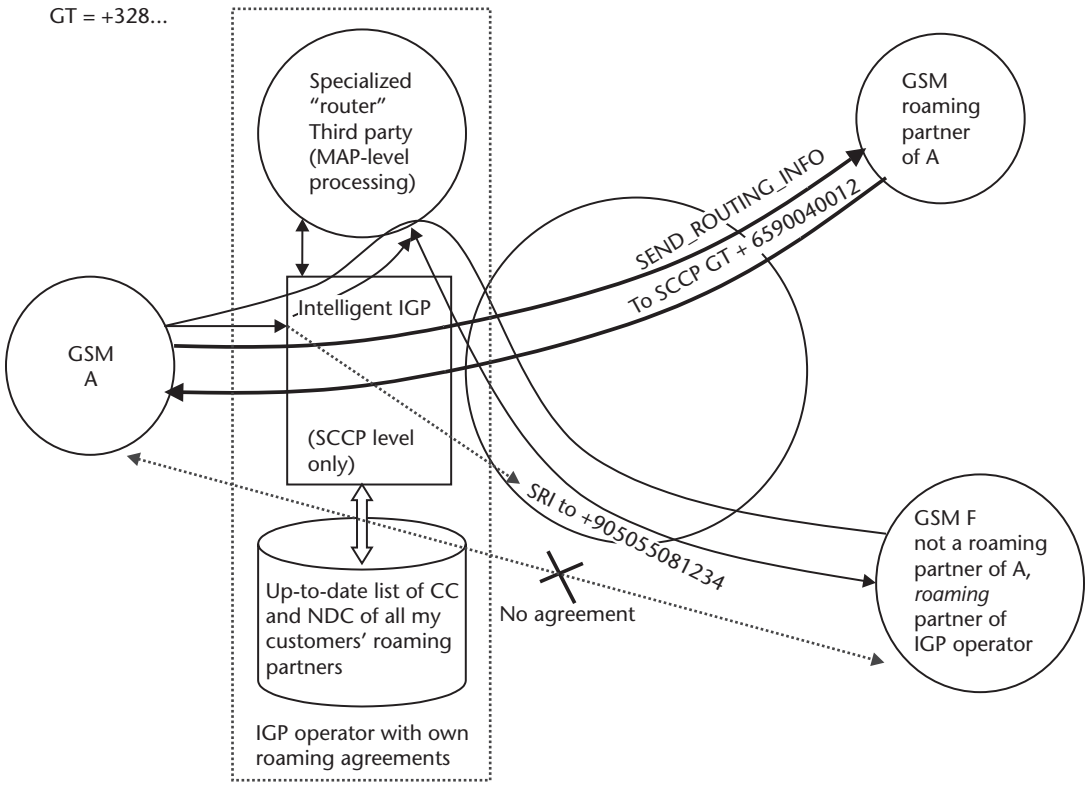

Figure 7.5 Intelligent SCCP routing by the IGP.

ing party address, e.g., Proximus) whether GSM A has roaming with Aycell (Turkey). If not, it translates the GT Aycell (+905055081234 to +3204 905055081234) so that the SRI is sent to the router function (the 338 method becomes a 3204 method). Then the rest is obvious. The SRI is relayed using the roaming agreement that exists between the IGP and GSM F. No setup at all is required in GSM A.

7.4 Creating Third-Party SCCP Routing When a GT Translation Is Unavailable

If the connected mobile operator can do an address translation, the question is trivial. They just open an SCCP route according to the roaming procedure involving their respective IGPs. If the operator cannot do address translation, the process is more complicated.

This was the case as of 2002 for networks that have a CMG SMSC (no GT translation) and an Ericsson GMSC with the R8 software: Nowhere is there a GT translation facility. A setup can be provided without GT translation if the interworking SMS network has an international point code.

7.4.1 Case in Which Connected Operator Acts as Its Own SCCP Gateway

When an operator acts as its own SCCP gateway, it means that their SS7 carrier provides them with MTP transit service. To address the virtual HLR of SMS interworking network C (Figure 7.6), consider these two cases:

1. *First case:* You will set up your STP to route to the IPC of the SMS network any GT with which A does not have roaming. So this is simple because *any*

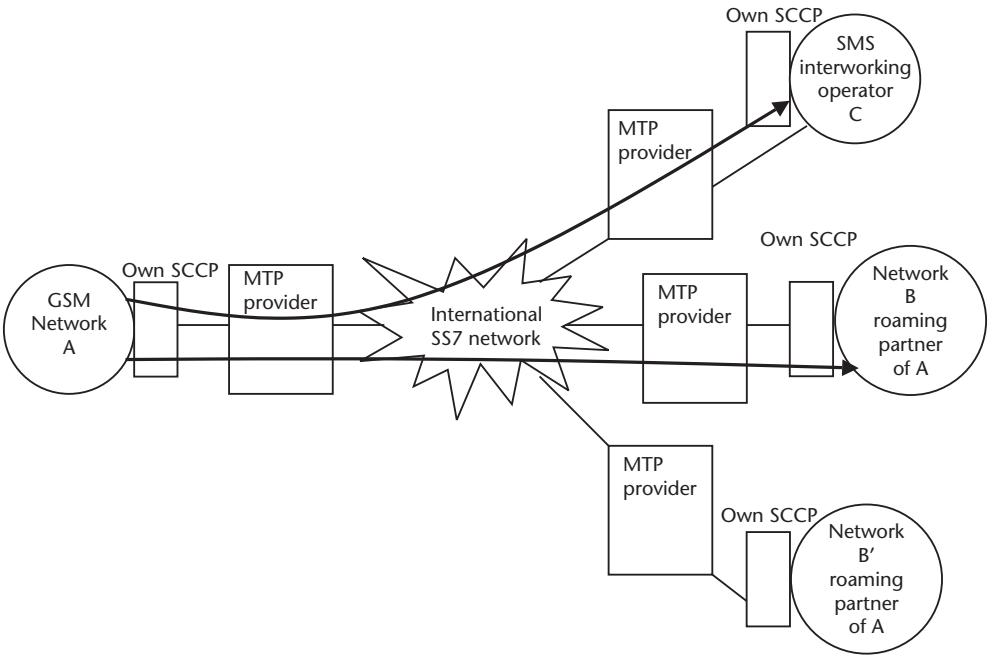

Figure 7.6 Connecting with one's own SCCP gateway.

GMSC has this function (no GT translation involved) of PC routing (choice of the distant SCCP gateway A). So the interworking network will be in the same situation as any partner of A: A will route to the IPC of C any GT with which it does not have roaming agreements. This is a nonstandard routing: It routes to France GT for the United States!

2. *Second case:* In these SMSCs, the only addressing provider that can really act is in the PC of the IGP (usually the operator's GMSC). If you set it to the SMS interworking network, all the traffic directed toward a foreign GT will reach it.

7.4.2 Case in Which Connected Operator Uses an International SCCP Gateway Service: No Solution

This case is the same as the preceding one; however, Operator A cannot do the routing itself (Figure 7.7). It should instruct (give a list) the IGP to route to C a list of GTs. However, the SCCP provider has several customers such as A' in addition to A. For A' it implements the standard routing on GT; a number starting with +65 is routed to Singapore. And most of the SCCP gateway (let's say all of it) cannot provide selective routing based on the calling address. So it will not be possible to route the +65 to C just when A is originating.

7.4.3 Case in Which GT Translation Is Not Possible and the Operator Is Not Its Own SCCP Provider: Use a Conversion Unit

In this case, the only thing that A can do is to route all traffic to GTs because it does not have roaming with an internal PC. The conversion unit is a private SCCP gateway, capable of GT translation, which its main GMSC does not have. The process is as follows: The conversion unit is a simple SS7 box with a GT translation capability. As an alternative, A may compare the price of the conversion unit and that of buying the software from its GMSC vendor.

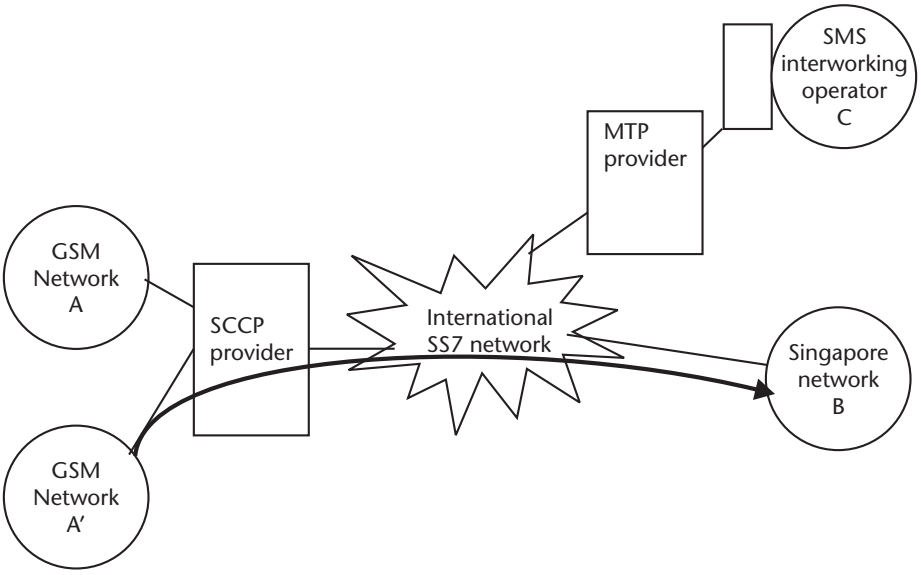

Figure 7.7 No connection possible to an SMS interworking network.

7.4.4 Transmission of Signaling Between a GSM and an IS-41 Network

The routing must be established at two levels:

1. *MTP:* The mobile operator and the third-party SMSC must use either ITU or ANSI or connect through an ANSI/ITU converter. This is the case, for example, between Europe and Southeast Asia where the CDMA networks are built on the ITU MTP.
2. *At the SCCP level:* The IS-41 networks do not use GT addressing inside their networks; however, they can agree with a third party to assign GTs to their equipment and *perform the routing on GTs to routing on PCs in their STP*. In this case the third party can easily connect through its ordinary SCCP provider.

An alternative if the third party has its own international PC is as follows: The IS-41 network could give the third party the private PC of all its equipment, HLR, and MSC. Then the third party would address them directly using routing on PCs at the SCCP level while using a direct MTP route between its international PC 6021 and the PC of the STP, that is, 4-022-1.

7.5 Conclusion

Table 7.4 sums up the different cases discussed in this chapter [1].

Table 7.4 Various Solutions for Rerouting to SMS Interworking Network C

A	*Solution for Rerouting to the SMS Interworking Network C*
1. A can do a GT translation (in the SMSC or the MSC); no investment.	A translates the GT, inserts +338, and then sends to its SCCP provider.
2. A cannot do a GT translation but is its own SCCP gateway; no investment.	Route any GT it does not have roaming with to C's international point code.
3. A has no GT translation and uses an SCCP gateway provider.	Practically, not possible without a conversion unit.
4. Conversion unit; investment.	There is an investment in equipment installed in A's network.
5. Intelligent SCCP routing by your IGP.	Nothing to do!

Reference

[1] *Système de routage optimal de messages courts d'un center de messages vers un autre, avec traduction globale d'adresses,* French Patent FR-0209667.