

Trans-Tasman Roaming: Service Costs

Authors:

Imme Philbeck, J. Scott Marcus, Jasper Mikkelsen, Dr. Werner Neu

WIK-Consult GmbH
Rhöndorfer Str. 68
53604 Bad Honnef
Germany



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1 Introduction and methodology

WIK-Consult is pleased to provide this Final Report on service costs of Trans-Tasman Roaming to the Department of Broadband, Communications and the Digital Economy (DBCDE) of Australia, working in conjunction with the MED of New Zealand.

This report presents service costs in Australia and New Zealand based on (1) the interviews of MNOs that we conducted together with DBCDE and MED, (2) all MNO responses to the DBCDE/MED spreadsheet / questionnaire, and (3) MNO responses to a follow-on set of questions that WIK-Consult sent to the MNOs. It also provides extensive background on roaming in general, and benchmark data to the extent available.

Consistent with our terms of reference, and direction from the governments, we have confined ourselves to an analysis of costs. We have not analysed revenues or profits.

This is a public version of the Final Report. Through a small number of redactions (identified as [X]), commercial in confidence information has been removed.

1.1 Background

Many governments have been concerned over mobile roaming prices that appear to be unjustifiably high. The DBCDE and MED jointly initiated this study in order to better understand whether this is the case in Australia and New Zealand, and if so, to what degree.

The study does not seek to make recommendations as to what steps, if any, might be taken to address roaming prices that might be found to be high. Instead, the study presents, based primarily on MNO responses received, the roaming cost components and service costs by roaming scenario as requested.

1.2 Study methodology

Our basic methodology reflects desk research, interviews (conducted with DBCDE and/or MED) and detailed modelling and analysis.

Our assessment of international experience relies on actual measures of wholesale and retail prices of mobile roaming in other jurisdictions, especially in Europe (where extensive data is available).

Our analysis of Australia and New Zealand relies heavily on information provided by the MNOs during interviews and in response to questionnaires provided by DBCDE, MED and the study team.

We have considered the evolution of roaming cost elements over time, but we do not feel that the data available is sufficiently detailed to support meaningful conclusions.

1.3 Structure of the study

This Final Report continues with a general background discussion of international roaming and its components (Section 2). Next, we discuss cost components of mobile roaming, based on international experience (Section 3), followed by a discussion of international retail and wholesale roaming prices (Section 4). Finally, we present the cost components and respective individual costs for each of the identified cost components for Australia and New Zealand (Section 5), and conclude with our presentation of the total roaming costs by roaming scenario and the roaming cost proportions to the visited and home networks in Australia and New Zealand (Section 6).

2 International Mobile Roaming Service and its components

International mobile roaming is a service that enables a mobile subscriber to automatically and seamlessly make / send / access and receive voice calls, SMS and data when travelling abroad without losing the connection. The GSMA defines it ‘as the ability for a cellular customer to automatically make and receive voice calls, send receive data, or access other services when travelling outside the geographical coverage area of the home network, by means of using a network in the area visited’¹.

The international mobile roaming service is complex in that it entails a number of different interrelated and non-transparent components that need to be well understood. These include legal / commercial aspects (roaming agreements / negotiation between MNOs), procedural aspects (what happens in terms of sequential process when a subscriber switches on his mobile device in a visited country and places or receives a call), technical aspects (how do the home and visited networks “talk” to each other), and, lastly, what type of costs are incurred during the roaming process.

This section presents an overview of the legal / commercial, procedural, and technical aspects and cost components of the international mobile roaming service for voice, SMS and data, respectively.

2.1 Description of the International Mobile Roaming Service

This section sets out the different aspects of the IMR service.

2.1.1 Legal / commercial aspects of roaming

In order for a subscriber to be able to roam, MNOs have to be present across a number of geographical locations. Most MNOs extend their geographical coverage by concluding international roaming agreements with selected MNOs from different countries (other MNOs create a physical network presence in as many locations as possible and internalise roaming). The conclusion of roaming agreements and the subsequent set-up and installation of a roaming service requires a number of legal, commercial and technical preparatory steps which include:

- Find prospective roaming partners in relevant locations and establish contact and interest
- Negotiate international roaming agreements

¹ See http://www.gsmaw.org/how_it_work.cfm?lang=ENG.

- Exchange test SIM cards and set-up signalling links²
- Undertake IREG (International Roaming Expert Group) and TADIG (Transferred Account Data Interchange Group) tests
- Set-up roaming support services:
 - Data clearing: relates to the clearing / analysis / sending / checking of TAP (Transferred Accounts Procedure) records, which are generated for every roaming call³. TAP records are aggregated into TAP files and send from the visited network to the home network. TAP files contain the details of a call made by a subscriber, including location, calling party, called party, time of call and duration. TAP files have to be analysed and checked as to ensure the integrity of the data (e.g. not subject to fraud etc.). Moreover, analysis of TAP records helps optimising inter-operator tariffs ("IOTs") and data reconciliation. This function is resource intensive and therefore often performed by a Data Clearing House.
 - Financial clearing: financial clearing relates to the bilateral invoicing between roaming partners. This is very resource intensive, as it entails sending and receiving invoices from every roaming partner that an agreement has been signed with. This function is therefore often outsourced so as to minimize the administrative burden.

A mobile operator wishing to offer roaming to his customers for a suite of mobile services such as voice, SMS, video, GPRS, 3G and CAMEL⁴ prepaid roaming needs to first decide where he would like to offer these services, establish contact with respective mobile operators in the chosen countries and start negotiating roaming agreements. Standard documents provided by the GSMA are used, including AA.12, AA.13 and AA.14⁵ and other documents specific to different services⁶. The negotiation of roaming agreements includes not only the negotiation over prospective volumes sent and

² Signalling is often carried out by international carriers such as BT Global or Belgacom or by data clearing houses. Signalling is required all the time to establish the location of the roamer. It therefore incurs costs also in the absence of calls placed or received.

³ For all roaming services, the visited network collects and records the details of every call / session in a Call Detail Record (CDR), which are used to calculate the wholesale roaming charges payable by the home network operator and which are saved in a TAP file.

⁴ CAMEL stands for "Customised Applications for Mobile networks Enhanced Logic".

⁵ See <http://www.gsmaw.org>, AA.12: standard international roaming agreement for operators who would like to establish bilateral international roaming agreements; AA.13: agreement management principles on how to update the roaming agreement in relation to billing data, settlement procedure, testing and fraud), AA.14: contains operator specific information some of the information is classified as operator confidential such as the IOT.

⁶ See <http://www.gsmaw.org>, AA.19 is an addendum to the International GSM Roaming agreement AA.12 and AA.13 specifically for SMS interworking – most operators who signed the agreement will agree to pay the termination fee for each SMS MT; AA.40: is the Addendum to the International GSM Roaming Agreement for MMS interworking; IR.21 document contains operator specific technical details, i.e. GSMA roaming database for each operator; and billing and transfer information is the summarized information required for TAP files transfer and other billing and details of the operator. This is part of AA.14.

corresponding prices, but also includes a test of technical feasibility of roaming between the prospective roaming partner networks. For these purposes, technical documentation and test SIM cards are exchanged. Once the agreements are concluded and signed, a roaming database is set up and the network is configured accordingly. Furthermore, an international transit carrier link and SS7 network signalling is set up, followed by IREG and TADIG testing. While IREG testing is used to test the proper functioning of the established communication links, the TADIG testing is used to check the billability of the calls, SMS, data and other roaming services. The mobile operator also has to set up roaming support services including data clearing and financial clearing, which can either be provided in-house or outsourced. An operator's roaming capability has been successfully established, when all test cases are complete⁷, the TADIG completion certificate has been received and the commercial launch letter has been written. It should be noted that in particular for smaller operators, roaming presents a significant cost. Some operators therefore completely outsource roaming by contracting out the capability to a roaming hub⁸.

The technical and commercial aspects do not differ greatly between voice, SMS and data. Generally, operators send as much as possible of their voice, SMS and data traffic to one or two preferred network partners in each country based on a general agreement for voice, SMS and data. Agreements with more than one MNO in a single country address any gaps in geographic coverage.

2.1.2 The roaming process

International roaming involves the making / sending or receiving of a call / SMS / MMS or the down- and upload of data, while travelling outside the home country. Parties involved in roaming include the home network, the visited network and / or a third network, an international transit carrier, an internet service provider, a financial clearing house and a data clearing house, the roamer and his mobile station and a second party that makes or receives the call / SMS / data from the roamer. Once a mobile phone is switched on when travelling abroad, the visited network checks whether it is registered in its HLR, and if not, it attempts to identify the mobile phone's home network by contacting the home network and requesting service information using the IMSI number (International Mobile Subscriber Identity) embedded on the SIM card⁹.

⁷ See <http://www.gsmaw.org>, test cases include IR.24 – IREG test cases for voice and SMS testing; IR.27 – IREG test cases for CSD such as 3G Video; IR32 – IREG test cases for Camel Roaming ; IR.35 IREG test cases for GPRS testing.

⁸ Roaming hub services are offered by roaming hubs such as BICS (Vodafone, Belgacom, MTN, and Swisscom – joined forces in 2011) and Telefonica Roaming Services, which enable smaller operators to outsource the administratively costly and burdensome roaming service completely.

⁹ The IMSI is also contained in the subscription data in the HLR. The IMSI is used for identifying a subscriber for various processes in the GSM network, which include location update, terminating call and roaming charging.

There are five main scenarios that can be identified regarding voice and SMS / MMS roaming. These include:

- Scenario 1: Calls and SMS / MMS made inside a visited country (domestic calls) terminating on the visited network, the fixed network or another mobile network
- Scenario 2: Calls and SMS / MMS made from a visited country to the subscriber's home country, terminating on the home network, the fixed network or on another mobile network
- Scenario 3: Calls and SMS / MMS made from a visited country to a third country terminating on a fixed or mobile network
- Scenario 4: Calls and SMS / MMS received from home / a third country in a visited country
- Scenario 5: Calls and SMS / MMS received from a subscriber of the visited country – the subscriber can be part of the visited network, the fixed network or another mobile network of the visited country

The same applies in principle to data, but there tends to be little focus on the destination of data, in part because no termination fees are relevant.¹⁰ However, data roaming also comprises a number of different scenarios / activities. The most common mobile data roaming services include MMS¹¹, mobile broadband¹², push e-mail¹³, accessing the Internet using a handset or tablet for music / video downloads or streaming, Web browser, email etc. Data services are measured in kilobytes and megabytes¹⁴. Data roaming services are delivered across different mobile networks, e.g. GPRS, UMTS/3G or 4G/LTE (Long Term Evolution) depending on the technology and adoption by the respective mobile operators¹⁵. The different standards have an impact on network architecture and network elements involved, however the generic sequence of data moving through the network remains very similar. The differences between the different technologies are briefly further discussed in Section 2.1.4.

The generic sequential process that an international roaming activity follows is:

- origination (including routing to the switch) and network access;

¹⁰ As with voice and SMS / MMS, data roaming comprises different scenarios. These are push email, handset internet and mobile broadband.

¹¹ Note that MMS is defined as a data service, however does not use the Internet.

¹² Mobile broadband includes connecting to the Internet using USB dongles or data cards to access email, Web browsers etc.

¹³ Push email includes reading and replying to e-mails while abroad, automatically 'pushed' to mobile devices such as BlackBerries, personal digital assistants and sophisticated mobile phones.

¹⁴ An e-mail without an attachment is typically between 1 and 50KB; an average web page can use several 100KBs or even more depending on the number of graphical elements; and a downloaded song usually consumes 2 to 5MBs of data, depending on quality and length.

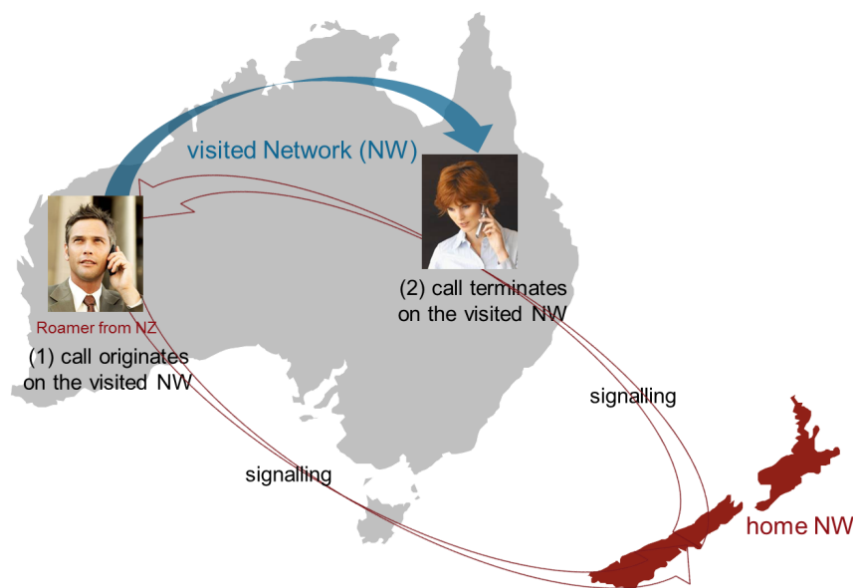
¹⁵ The technology standard CDMA and its evolution are not discussed in this study.

- signalling and routing between the visited and home networks;
- international transit, and
- termination.¹⁶

Roaming call scenarios 1 - 5 are depicted in Figure 1 - Figure 5. Because SMS and MMS scenarios are very similar to the voice call scenarios, they have not been graphically depicted. Technical aspects of SMS roaming are dealt with in Section 2.1.3. As regards data roaming, a general scenario is presented in Figure 6 and technical aspects of data roaming are discussed in Section 2.1.4.

Figure 1 shows a call made by a New Zealand roamer to an Australian subscriber. Note that the roaming scenario could be reversed, where an Australian roamer roams in New Zealand calling a New Zealand subscriber. For simplicity, we are presenting Australia as the visited country and New Zealand as the home country in all roaming scenarios included in this section.

Figure 1: Scenario 1 – Calls made inside a visited country



Scenario 1 depicts the situation where a New Zealander makes a call from his New Zealand mobile to an Australian subscriber of the visited network while roaming in Australia. Note that the red arrows mean signalling activity and the blue arrows show the direction of the call flow. The call is originated on the Australian visited network and

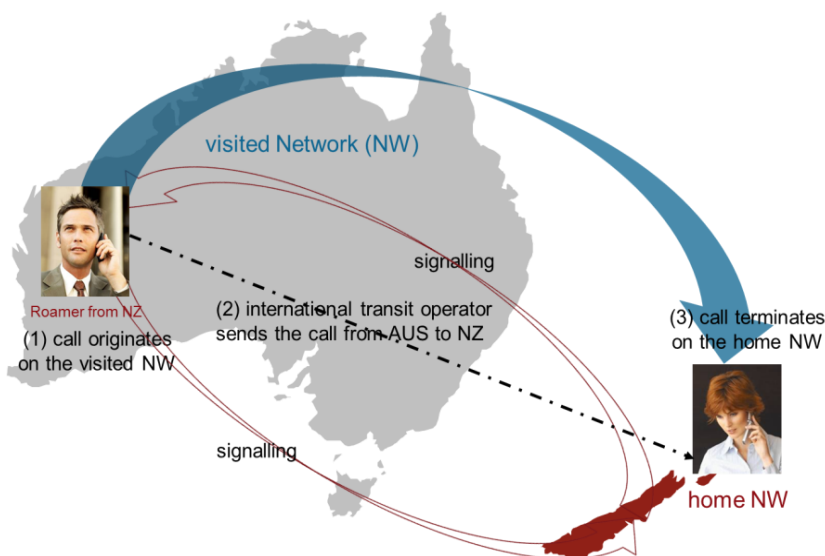
¹⁶ For data and MMS roaming, there is no such thing as origination and termination – instead data is transported across the network and costs that are incurred are data traffic and data network costs.

terminates on the Australian visited network. Given that the roamer's home network is not the destination network, it is not involved in technically placing the call, other than in relation to non-call related signalling.

As regards the charging mechanism for Scenario 1, the roamer's home network in New Zealand makes a wholesale Inter-Operator-Tariff ("IOT")¹⁷ payment to the visited network in Australia, which covers call origination and access, and termination on the end network, in this case the visited network (no international transit is applicable in this call scenario). The visited network in Australia is responsible for providing the call, and typically pays a termination fee to the fixed or mobile terminating network if the call is not on-net to the visited network (whether it is in New Zealand, Australia or some third country). The New Zealand roamer makes a retail payment to his or her home network in New Zealand.

Figure 2 shows scenario 2, where calls are made by a New Zealand roamer back to New Zealand.

Figure 2: Scenario 2 – Calls made from a visited country to the subscriber's home country



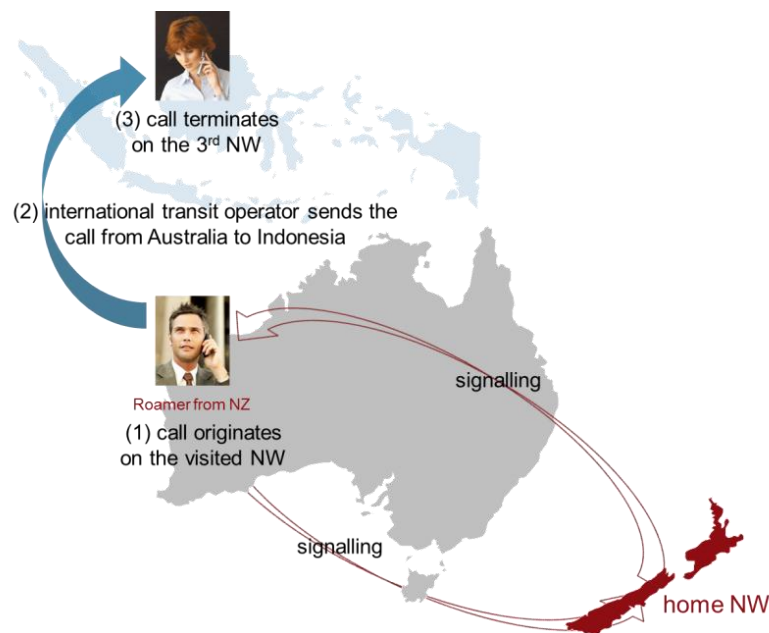
In scenario 2 the call originates on the Australian visited network and is then routed via an international transit carrier (or via self-supplied transit) to New Zealand instead of being terminated on an Australian visited network. Note that the red arrows mean signalling activity and the blue arrows show the direction of the call flow. The black

¹⁷ The wholesale IOT payment is formally defined as a tariff scheme between mobile network operators, charged by the visited network operator to the home network operator for calls, SMSs or data originated on the visited network.

arrow signifies international transit. Depending on the recipient's network and location, the call is terminated on one of the New Zealand MNO's networks or on the New Zealand fixed network.

As regards the charging mechanism for Scenario 2, the roamer's home network in New Zealand makes an IOT payment to the visited network in Australia, which covers call origination and access, the arranging for and payment of international transit and termination on the end network (in this case either the home network, one of the other New Zealand mobile networks or the fixed network. If the end-network is the home network, the home network self-supplies termination). The visited network in Australia is responsible for providing the call, and pays a transit fee to the transit operator and a termination fee to the fixed or mobile terminating network in New Zealand. Some visited network operators also make a bundled payment of transit and termination to the transit operator, who then passes on the termination fee to the terminating network, thereby creating a cascading billing structure. The New Zealand roamer makes a retail payment to his or her home network in New Zealand.

Figure 3: Scenario 3 – Calls made from a visited country to a third country



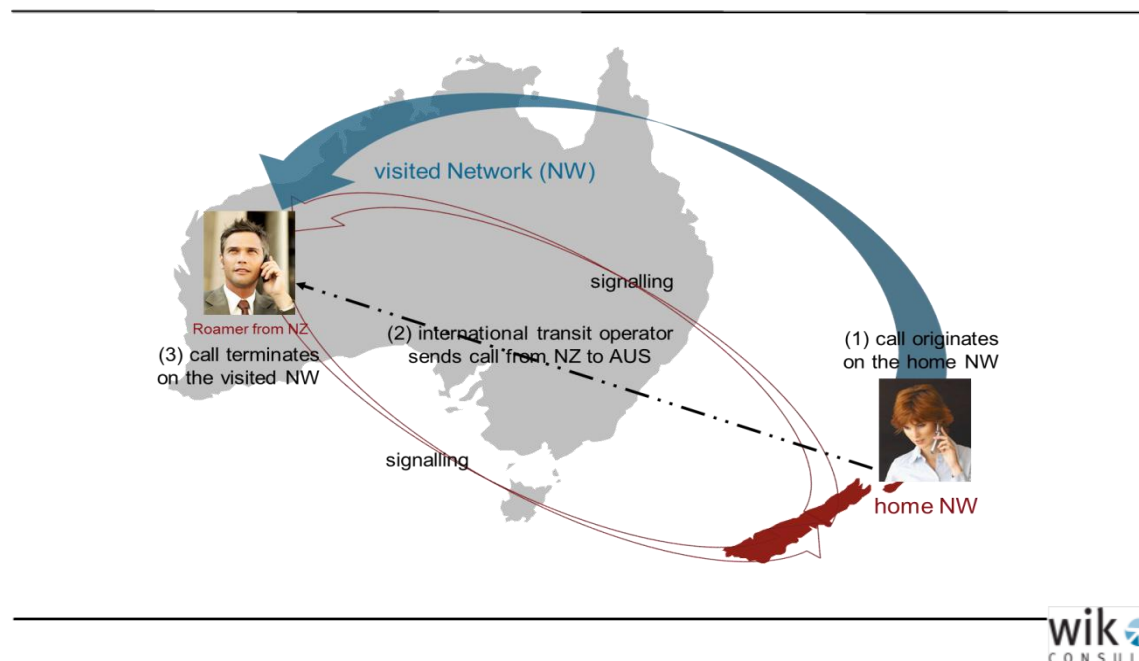
Scenario 3 shows a New Zealand roamer making a call to Indonesia while roaming in Australia. The call originates on the visited network and is then routed via an international transit carrier to Indonesia instead of being terminated on an Australian visited network. Note that the red arrows mean signalling activity and the blue arrows

show the direction of the call flow. Depending on the recipient's network and location, the call is terminated on one of the Indonesian MNO's networks or on the Indonesian fixed network.

As regards the charging mechanism for Scenario 3, the roamer's home network in New Zealand makes an IOT payment to the visited network in Australia, which covers call origination and access, the arranging for and payment of international transit and termination on the end network. The visited network in Australia is responsible for providing the call, and pays a transit fee to the transit operator and a termination fee to the fixed or mobile terminating network in Indonesia. Some visited network operators also make a bundled payment of transit and termination to the transit operator, who then passes on the termination fee to the terminating network, thereby creating a cascading billing structure. The New Zealand roamer makes a retail payment to his or her home network in New Zealand.

Figure 4 depicts a call from home received by a New Zealander while roaming in Australia.

Figure 4: Scenario 4 – Calls received from home in a visited country



Scenario 4 shows the steps involved in a call received by a New Zealander roaming in Australia. The call originates on the home network and is sent via the home network's preferred international transit carrier to the Australian visited network for termination. Both networks are involved in technically placing the call. Note that the red arrows mean signalling activity and the blue arrows show the direction of the call flow.

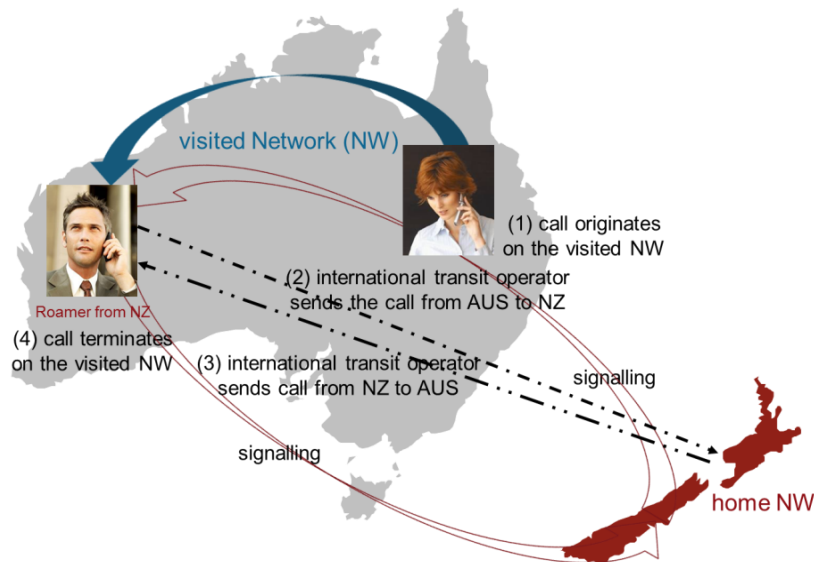
In terms of charging mechanism for a voice call received from home while roaming (Scenario 4), the visited operator charges the international transit operator an MSRN fee (mobile station roaming number)¹⁸ for terminating the call and the international transit operator charges the home operator for transit costs incurred, thereby creating a cascading billing structure. No wholesale IOT payment is applicable to calls received while roaming; however, the home network typically pays a mobile termination fee to the visited network.

In terms of consumer payment, the caller in New Zealand typically pays the normal domestic price to his or her fixed or mobile network operator, which is appropriate since the caller does not necessarily know that the called party is roaming outside of New Zealand. A caller in some other country would generally pay the international direct dial calling charge for a call placed to New Zealand. The New Zealand roamer makes a retail payment to his or her home network in New Zealand. This is unusual inasmuch as it is one of the few instances where the recipient of a normal voice call (in a country subject to the calling party pays principle) is obliged to pay to receive it. The home network in Australia is responsible for completing the call in this case.

Figure 5 shows calls received by a New Zealand roamer from an Australian network subscriber in Australia.

18 The MSRN is the temporary mobile service roaming number which is assigned by the VLR of the visited network to a roaming mobile and helps determine the location of the roaming mobile. The MSRN maps back to the original phone number being dialled. It is used for routing a call to a mobile station. The HLR of the home network will request the MSRN from the visited network's VLR. The need for the MSRN stems from the fact that the MSISDN (Mobile Station Integrated Services Digital Network Number) identifies a subscriber, but not the current location of that subscriber in a network. The MSRN is allocated to a subscriber during mobile termination call handling and is released when the call to that subscriber is established.

Figure 5: Scenario 5 – Calls received from a subscriber of the visited country



Scenario 5 depicts a situation where a New Zealand roamer while roaming in Australia receives a 'local' call from an Australian network subscriber. The call both originates and terminates on the Australian visited network; however both the home and visited network are technically involved in placing the call. Note that the red arrows mean signalling activity and the blue arrows show the direction of the call flow. The black dotted arrows show international transit. This scenario is also referred to as tromboning, as the call is first routed to New Zealand via an international transit operator and then back to Australia, following the HLR query regarding the recipient's location.

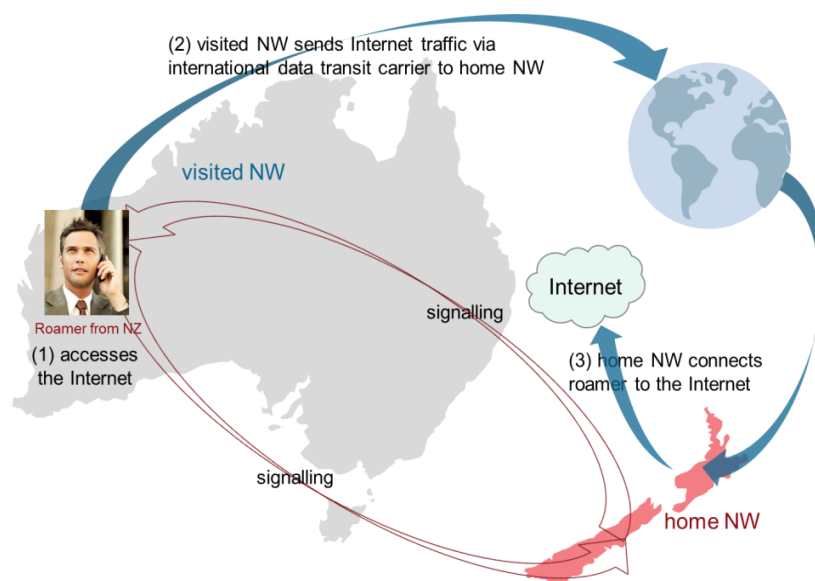
In terms of charging mechanism for a voice call received from a subscriber of the visited country while roaming (Scenario 5), the visited network operator charges the international transit operator an MSRN fee for terminating the call and the international transit operator charges the home network operator for costs incurred. The home network operator also incurs international transit costs for sending the call back to Australia. No wholesale IOT payment is applicable to calls received while roaming; however, the home network typically pays a mobile termination fee to the visited network.

As regards consumer payment, the caller in Australia pays the international direct dial price to his or her fixed or mobile network operator for a call to a New Zealand mobile number. The New Zealand roamer makes a retail payment to his or her home network in New Zealand. This is unusual inasmuch as it is one of the few instances where the recipient of a normal voice call (in a country subject to the calling party pays principle) is

obliged to pay to receive it. The home network in Australia is responsible for completing the call in this case.

Figure 6 shows the generic process of a New Zealand customer accessing the Internet while roaming in Australia.

Figure 6: Accessing the Internet while roaming



When abroad and accessing the Internet via the mobile phone, the visited network establishes the connection to the roamer's home network. As with calls and SMS / MMS, the signalling between the visited network's VLR and the home network's HLR and transfer of subscription data establishes the current location of the roamer. The visited network then sends the internet traffic generated by the New Zealand roamer via an international transit data carrier to the roamer's home network. The home network operator connects the roamer to the Internet or the email account or other data services.

In terms of charging, the home operator pays an IOT to the visited network operator, which covers the origination and access cost of the visited network, the international data transit costs to deliver the data to the home network as well as any roaming overheads incurred by the visited network operator.

Section 2.1.3 examines the technical aspects of roaming in terms of network elements involved.

2.1.3 Technical aspects of roaming

From a technical perspective, international roaming involves signalling and routing of a call made or received by / from a roaming mobile subscriber to / from another mobile or fixed subscriber between a home and a visited network. The added complexity with roaming is the location of the roaming subscriber on a foreign / visited network. Roaming is made possible through the separation of switching capability and subscription data. It is technically supported by mobility management (MSC/VLR/HLR/SS7), authentication¹⁹, authorization²⁰ and billing²¹.

The most important GSM network elements used to provide call routing and roaming capabilities when roaming internationally are the HLR, the VLR, and the MSC. In addition, signalling is needed to establish communication between the different components to complete a roaming call. In a GSM network, the signalling system used is Signalling System 7 ("SS7").

The network elements and their functions involved in roaming calls and SMSs are shown in Table 1. The technical aspects of data roaming are discussed in Section 2.1.4.

Table 1: Network elements involved in GSM and Data Roaming

Network element	Function
MS / ME (Mobile Station / mobile equipment)	The mobile station or mobile equipment is simply the subscriber's mobile handset.
BSS (Base Station System, incl. BSC and BTS)	The base station system (BSS) comprises one or more base station controllers (BSC) and one or more base transceiver stations (BTS) and is part of the radio access network (RAN), which in turn is part of the Public Land Mobile Network (PLMN). The BTS contains one or more transceivers, which are responsible for radio signal transmission and reception.
MSC (Mobile service switching centre)	The MSC is the core switching unit in the network. It is connected to the radio access network. GSM network subscribers are registered with an MSC, which controls all calls to and from the subscriber based on information from the VLR. The MSC connects outgoing calls to other mobile subscribers or PSTN; it delivers SMSs from subscribers to the SMSC and vice versa; it arranges handovers between BSC-BSC and MSC-MSC; it generates billing information. A GSM network has one or more MSCs in different geographic locations depending on the size of the network.

¹⁹ Authentication is carried out by the Authentication Centre (AuC), which authenticates every SIM card that attempts to connect to the GSM core network.

²⁰ Authorization is performed by the VLR query.

²¹ The Billing Centre (BC) carries out the generation of toll tickets generated by the VLRs and HLRs to generate a bill for each subscriber. The BC also generates the billing data for roaming subscribers.

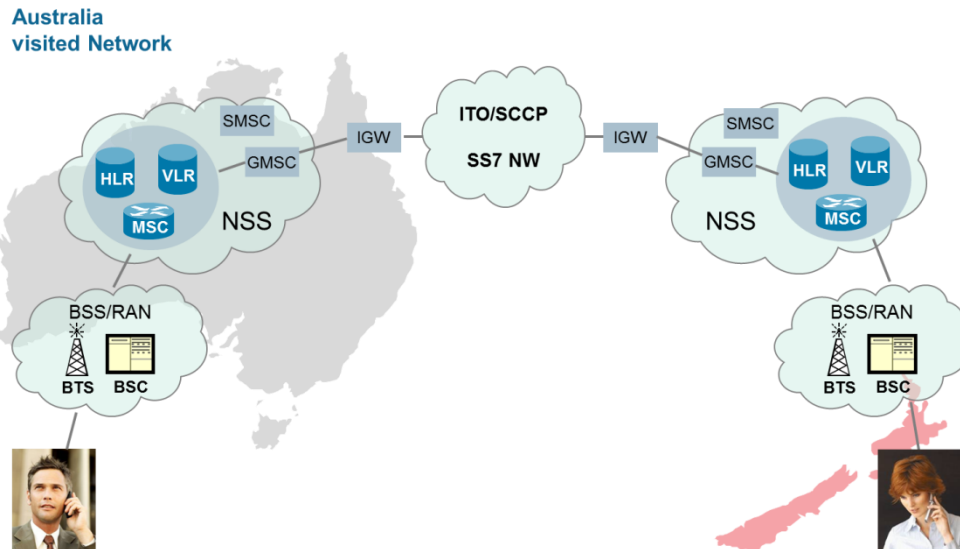
Network element	Function
HLR (Home Location Register)	The HLR stores information (subscription records) of the subscribers belonging to the coverage area of a MSC. This includes the current location of the subscribers and the services to which they have access. The location of the subscriber maps to the SS7 address of the VLR. A GSM subscriber is normally associated with one particular HLR. The HLR is responsible for the sending of subscription data to the VLR (during registration) or to the GMSC (during mobile terminating call handling).
VLR (Visitor Location Register)	The VLR contains subscriber data from a subscriber's HLR necessary to provide services to visiting users. When a subscriber enters the covering area of a new MSC, the VLR associated to this MSC will request information about the new subscriber to this corresponding HLR. The VLR will have enough data to assure the subscribed services without needing to ask the HLR each time a communication is established. Every MSC contains a VLR. Although MSC and VLR are individually addressable, they are always contained in one integrated node and control the same area.
SMSC (Short messaging switching centre)	When a message is sent, it is received by the SMSC, which has to forward it on to the respective mobile station. The SMSC sends an SMS request to the HLR to find the roaming customer, and once the HLR receives the request, it will respond to the SMSC with the subscriber's status of either "inactive" or "active" where the subscriber is roaming. The SMSC will hold onto the message for a period of time if the response is "inactive". When the subscriber accesses his mobile again, the HLR sends an SMS notification to the SMSC, and the SMSC will attempt to deliver the message. The SMSC transfers the message in a Short Message Delivery Point to Point format to the serving system. The system pages the device, and if it responds, the message gets delivered. The SMSC receives verification that the message was received by the end user, then categorizes the message as "sent" and will not attempt to send again.
GMSC (Gateway MSC)	The gateway MSC is the MSC that determines which visited MSC the subscriber who is being called is currently located at. It also interfaces with the PSTN, thus it is also used as a gateway that interconnects two networks: the cellular network and the PSTN network. All M2M and F2M calls are routed through the GMSC. It is also the switching unit that controls mobile terminating calls: When a call is established towards a GSM subscriber from the fixed network, a GMSC contacts the HLR of that subscriber, to obtain the address of the MSC where that subscriber is currently registered. That MSC address is used to route the call to that subscriber. The GMSC is often integrated in the MSC.
NSS (Network Switching Subsystem)	The NSS consists of the MSC, GMSC, HLR, VLR, authentication centre (AuC), Equipment Identity Register (EIR), and the GSM Interworking Unit (GIWU). These entities are the main components for call handling and subscriber management.
IGW (International Gateway)	An International Gateway is defined as any facility through which international telecommunications traffic is sent and received.
International transit	For voice, MMS and data, an international transit backbone / network is needed to transfer the call, MMS or data between the home and visited or a 3 rd network

Network element	Function
SS7 Network and Signalling Protocols	<p>Signalling is the transfer of information between subscriber interface points and the network, and between different network elements to help establish a call. Signalling information is interchanged as standard sets of messages that were developed and standardized into the present SS7 system. GSM networks need non-call related signalling, which is possible with SS7. The SS7 used in PSTN networks is not sufficient to fulfil the signalling requirements of GSM networks, thus new protocols specific to GSM were developed as follows:</p> <ul style="list-style-type: none"> • The MTP (message transfer part) is the basis of SS7, and it is responsible for transferring signalling messages from one element to another within the same signalling network • The TUP/ISUP (telephone user part / ISDN user part) are the user parts of the MTP that handle call control • The SCCP (signalling connection control part) is needed for virtual connections and connectionless signalling • The BSSAP (base station system application part) is used for signalling between MSC-BSC and MSC-MS • The MAP (mobile application part) is needed for signalling between MSC-HLR, MSC-VLR, HLR-VLR (and MSC-MSC in the case of non-call related signalling)
Traffic management platforms	Service platforms that allow operators to determine preferred networks for roaming and manage roaming traffic distribution
SMS welcome servers	To send SMSs to customers upon arrival, operators use computer servers
SGSN	The SGSN is a GPRS Support Node – this forms a gateway to the services within the network. It sends data to and receives data from mobile stations, and maintains information about the location of a mobile station (MS). The SGSN communicates between the MS and the GGSN.
GGSN	The GGSN is the gateway GPRS Support Node which forms the gateway to the outside world. It is a wireless gateway that allows mobile cell phone users to access the public data network (PDN) or specified private IP networks.
GRX / IPX	GRX is a Roaming Exchange that acts as a hub for GPRS connections from roaming users, removing the need for a dedicated link between each GPRS service provider. It was developed to facilitate a more efficient way for operators to interconnect networks, and played a large part in the transition to third-generation systems. IPX stands for Internetwork Packet Exchange. It is a networking protocol that interconnects IP networks used for connections other than GPRS. IPX is a datagram or packet protocol. IPX works at the Network layer of communication protocols and is connectionless.

Source: WIK, www.gsm.org, www.cisco.com, www.wikipedia.org, www.webopedia.com,
www.searchmobilecomputing.techtarget.com, <http://www.telecomspace.com>,
<http://whytelecom.com/content/intelligent-network-camel-inap>

Figure 7 shows a generic GSM Network Roaming Flow Diagram that depicts the network elements involved in an international roaming call. For SMS, the SMSC would be included in the NSS. MMSs fall under data roaming and are discussed in Section 2.1.4.

Figure 7: Generic GSM Network Roaming Flow Diagram



A call back home made by a New Zealand roamer while roaming in Australia will be routed from the roamer's MS through the Australian RAN to the NSS, then via the IGW and international transit carrier to the New Zealand IGW, GMSC / MSC and RAN to the recipient's MS. Signalling occurs during call set-up between New Zealand's HLR and Australia's VLR and between the MS and network elements of each network.

Calls made and SMS sent while roaming

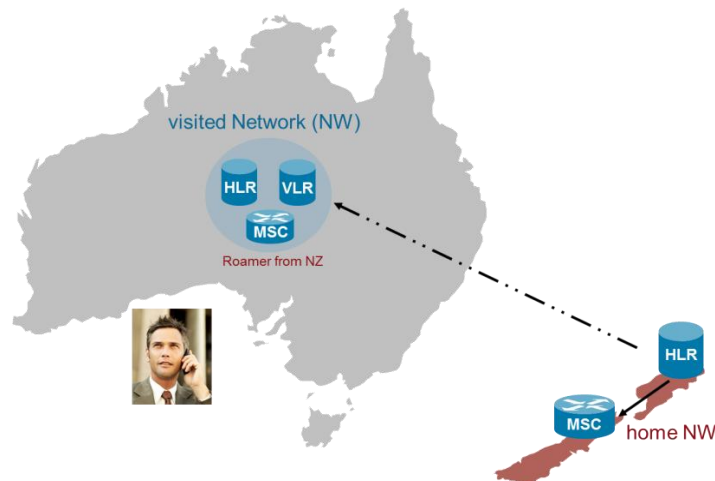
This section briefly describes the technicalities involved in roaming calls made, and roaming SMS sent.

Calls made

For calls made while roaming in Australia, once the New Zealand roamer has switched on her mobile phone in Australia, the Australian network contacts the New Zealand network and requests service information for the New Zealand roamer. The MSC / HLR in New Zealand transfers the subscriber data to the MSC / VLR in Australia. The subscription data remains in the MSC / VLR as long as the New Zealand roamer is

served by a BSS that is connected to that MSC. This is depicted in Figure 8. At this stage, only signalling has taken place without any calls having been routed.

Figure 8: Transfer of subscription data for a New Zealand roamer



Once the New Zealand roamer decides to place a call, the call is routed from the MSC of the visited Australian network to the MSC of the destination network using the relevant gateways. The HLR of the destination network is then queried to identify the BSS of the recipient. If the two networks are in two different countries the call is routed via the preferred international transit carrier of the visited network.

If the call is made back to New Zealand, the call is routed from the Australian MSC via the international gateways and international transit carriers to the relevant New Zealand home network's (G)MSC. Again, the HLR of the destination network is queried to identify the BSS of the recipient.

If the roamer's home network is not the destination network, it is not involved in technically placing the call.

SMS sent

If a New Zealand roamer decides to send an SMS while roaming in Australia, the VLR of the visited Australian network is queried to identify the home network of the New Zealand roamer. The SMS is then routed to the home network's MSC via the relevant gateways and to the SMSC. There it is stored. If the recipient is on the home network the SMSC queries the HLR to identify the BSS; the HLR provides the routing information (this includes IMSI and serving MSC of recipient) to the SMSC; the SMSC delivers the message to the serving MSC and the MSC forwards the SMS to the

recipient. If the recipient is on a third network, the SMS is routed to the MSC of the third network. The HLR of the third network is then queried to identify the BSS. Irrespective of the final destination of the SMS, the visited network always routes the SMS via the home network. Therefore, the destination of the SMS does not affect the SMS-IOT fee charged by the visited operator. SMSs can be sent via a SMS hub / international transit or they are passed between the networks via dedicated signalling links of the SS/network²². WIK has included international transit in the SMS scenarios in this study.

Calls and SMS received while roaming

This section briefly describes the technicalities involved in roaming calls and SMS received.

Calls received

The signalling path for switching on the phone for the first time when a New Zealander is roaming in Australia is the same as for calls made: the roamer switches on the mobile phone, the visited network contacts the home network, the MSC / HLR in New Zealand transfers the subscriber data to the MSC / VLR in Australia. The subscription data remains in the MSC / VLR as long as the New Zealand roamer is served by a BSS that is connected to that MSC.

When the NZ roamer receives a call while roaming in Australia, the generic call flow is as follows: the call is routed from the originating network (this can be either the fixed network, the home network or another mobile network in the home country) to the home network via the relevant gateways. The home network queries its HLR, finds the location information of the user and passes it on to the appropriate MSC in the visited network. This is carried out via an international transit carrier. The VLR of the visited network is then queried to determine the BSS and BTS of the user.

If the NZ roamer receives a call from home and the call originates in the home network, the call is routed from the New Zealand home network via the MSC and IGW and the home network's preferred international transit carrier to the relevant MSC of the visited Australian network. If the NZ roamer receives a call from an Australian subscriber, the call is first routed back to New Zealand and then back to Australia following the query of the home HLR, given that the caller has dialled an international access code for New Zealand. This is also referred to as 'tromboning', because the voice channel is sent to the home network and back. It should be noted that there are technologies that allow call termination to stay local and which would eliminate tromboning. As this would require agreement and standardization between operators and as this would incur additional costs, these technologies find little use.

²² See: <http://serving.webgen.gsm.org/5926DA9A-2DD6-48E7-BAD4-50D4CD3AF30A/assets/smsdataroamingexplained.pdf>.

SMS received

If a New Zealand roamer receives an SMS while roaming in Australia, the originating network sends the SMS to the home network's MSC via the relevant MSC gateway and to the SMSC. The HLR is then queried and the message is passed on to the visited network via the SMSC. A VLR query is carried out to identify the BSS of the recipient. In terms of charging mechanism, typically there is no charge by the visited operator for the delivery of an SMS.

2.1.4 Using the Internet / Data while roaming

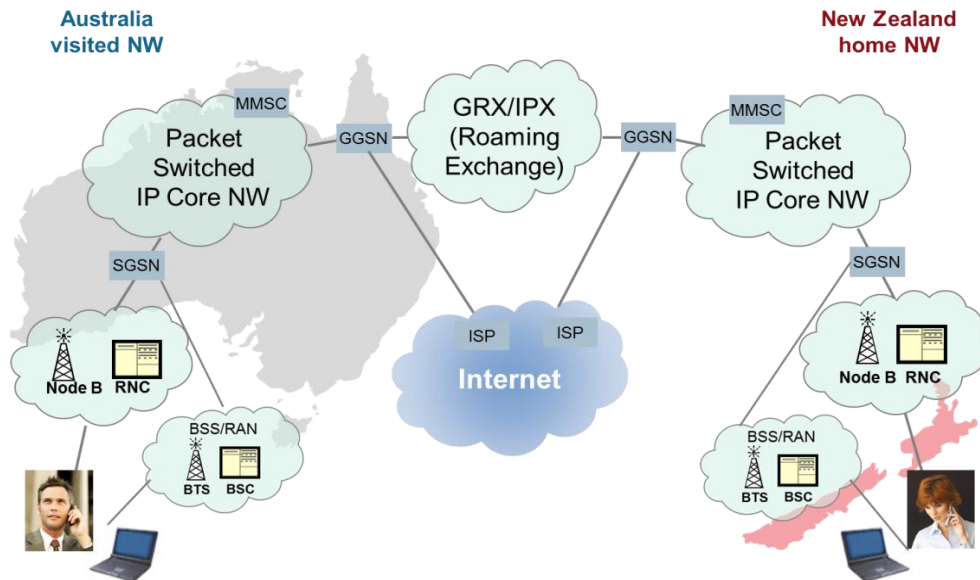
As briefly mentioned in Section 2.1.2, the technological evolvement of mobile data networks has generated different GSM technology standards such as GPRS, EDGE, UMTS (3G) and LTE (4G), adding new network and functional elements, new interfaces and new protocols.²³ In terms of implications for roaming scenarios and the basic workings of roaming, little changes other than costs.²⁴ Figure 9 shows a generic data roaming diagram for GPRS and 3G roaming.²⁵

²³ For example, instead of Node B in a 3G network, an LTE network has a eNode B and the HLR is replaced with the HSS (Home Subscriber Server). Other network elements that are replaced include the RNC and the GGSN. See: <http://www.huawei.com/en/static/hw-072388.pdf> and <http://www.networkur.com/wp-content/uploads/2011/04/Copy-of-Drawing6.jpg>.

²⁴ As with every new mobile standard, cost reductions are said to be significant with a move to LTE.

²⁵ LTE roaming network diagram would include the eNode B in the Access network and the S-GW instead of the SGSN, as well as the PDN-GW instead of the GGSN, the HSS instead of the HLR, the MME instead of the VLR, as well as other protocols and interfaces. See: <http://www.syniverse.com/files/LTE-Roaming-BARG-Workshop-bj.pdf>.

Figure 9: Generic Data Roaming diagram



When a roamer uses data services, he will download or send data. Unlike with SMS and MMS, the download or sending of data does not involve termination to the another user. Figure 9 shows the high-level stages involved in data roaming. A New Zealand roamer accesses the Internet in Australia. The data is sent to the home network via the mobile access network, the SGSN and the GGSN to the GRX/IPX. An international transit data carrier (or via self-supplied international transit) sends the data from Australia to New Zealand and the home network operator connects the subscriber to the Internet. Regardless of the roamer's location, the data is always sent back to the home network.

2.1.4.1 Internet accessed while roaming

If a New Zealand roamer decides to access the Internet with his mobile phone (including push e-mail, handset Internet and mobile broadband services) while roaming in Australia, the Australian visited network operator establishes a connection back to the New Zealand home network. This works as follows: the visited SGSN authenticates the roamer with the home network's HLR. A data request is routed to the home GGSN via the GRX/IPX network and on to the home or external IP network, depending on where the subscriber has his or her internet service. Thus, the visited network sends the internet traffic generated by the New Zealand roamer via the visited SGSN, the GRX/IPX network, an international transit data carrier, via the home GGSN to the roamer's home network. The home network operator connects the roamer to the

Internet or the email account or other data services. The visited network operator's billing system creates billing records (CDRs) for inter-operator accounting, which are sent via the Data Clearing House of the visited MNO and the Data Clearing House of the home MNO to the billing system of the home MNO. When a roamer is downloading data, the data is sent from the home network's ISP through the home network's GGSN via the GRX / IPX and international transit data carrier to the roamer's mobile phone. If a roamer sends data, then the traffic is routed the other way from the roamer's phone through the visited network to the home network and on to the ISP.

2.1.4.2 MMS sent and received while roaming

Just like other data service, MMS use GPRS or UMTS networks with the difference that MMS traffic involves termination. When a roamer decides to send an MMS, the MMS will always be routed via the MMSC in the visited network to the MMSC in the home network. International transit is carried out by the GRX.

MMS sent

If a New Zealand roamer decides to send an MMS while roaming in Australia, the VLR of the visited Australian network is queried to identify the home network of the New Zealand roamer. The SMS is then routed to the home network's MSC via the GRX and the relevant gateways and to the MMSC. If the recipient is on the home network the MMSC queries the HLR to identify the BSS; the HLR provides the routing information (this includes IMSI and serving MSC of recipient) to the MMSC; the MMSC delivers the message to the serving MSC and the MSC forwards the MMS to the recipient. If the recipient is on a third network in the home country, the MMS is routed to the MSC of the third network. The HLR of the third network is then queried to identify the BSS. Irrespective of the final destination of the MMS, the visited network always routes the MMS via the home network. Therefore, the destination of the MMS does not affect the MMS-IOT fee charged by the visited operator (for origination and arranging international transit).

MMS received while roaming

If a New Zealand roamer receives an MMS while roaming in Australia, the originating network sends an SMS notification to the roamer's mobile phone. Once acknowledged, the MMS is sent by the home network via international data transit and the relevant gateways to the roamer's mobile phone.

2.1.5 CAMEL Roaming

CAMEL stands for "customized application for mobile network enhanced logic" and refers to a set of standards that has been designed in order to enable the seamless working of prepaid roaming by migrating proprietary intelligent network (IN) services

and operator specific services solutions towards standardized mobile network solutions. CAMEL is a standardized network feature (as opposed to a supplementary service) that adds intelligent applications to mobile networks and that has been designed to work on a GSM core network or on a UMTS network. CAMEL consists of 4 phases, of which the first phase was introduced in 2000 and the last phase (phase 4) in 2002 as part of the 3GPP release 5. Each phase added new features and functionalities to address additional requirements depending on the technology standard and type of roaming services (voice, SMS, data) to be offered. Whereas phase 1 introduced the basic mechanism to consistently support value-added services that are independent of the serving network, CAMEL phase 2 added features to facilitate service control of operator specific services external to the HPLMN. The third phase of CAMEL introduced the CAMEL features for GPRS / UMTS services alongside new features for subscriptions and charging.²⁶ Phase 4 built on the capabilities of phase 3²⁷.

In terms of network architecture, CAMEL uses the CAMEL application part (CAP) protocol, a signalling protocol used in the IN architecture, which is layered on top of the transaction capabilities application part (TCAP) of the SS7 protocol suite and allows for the implementation of value-added services including unified messaging, fraud control and Freephone²⁸. The CAMEL service platform (or the CAMEL Service Environment (CSE), which is a logical entity that processes activities related to operator specific services – originally known as the service control point (SCP) or the CAMEL service platform) introduces a number of additional network elements, of which the most important ones include: the Service Control Point (SCP), which is integrated into the CES; the Service Switching Point (SSP), which is normally integrated into a MSC and is also referred to as the M-SSP; the GPRS Service switching function (gprsSSF), which is integrated into a SGSN; and the GSM Service Switching Function (gsmSSF), which interfaces with the MSC or the GMSC.²⁹

The process of a simple prepaid voice call being made works as follows: When a subscriber starts to make a call, a request is received by the MSC. The MSC sends a query to the SCP's database. The SCP hosts a database which holds the instructions needed for an intelligent application. The SCP processes the query and generates a response and then sends a message back to the MSC instructing it on the action it should take with the subscriber's request for a specific service. The difference to a post-paid roaming call is, that with CAMEL roaming, credit checks have to be performed for the duration of the roamed activity, which requires more signalling activity. Thus, in addition to the MSC being used for a postpaid roamed call, a prepaid call uses the SCP

²⁶ For further information regarding the different functionalities of CAMEL phases 1-4, please refer to http://www.3g4g.co.uk/Tutorial/ZG/zg_camel.html.

²⁷ For a general overview see http://en.wikipedia.org/wiki/Customised_Applications_for_Mobile_networks_Enhanced_Logig.

²⁸ See http://en.wikipedia.org/wiki/Camel_Application_Part.

²⁹ See: http://www.tik.ee.ethz.ch/~mobydick/related_work/umts/p36-45_allIP_UMTS.pdf and <http://www.itu.int/ITU-D/asp/CMS/ASP-CoE/2010/InterRoaming/session-7.pdf> and <http://www.google.de/search?q=3g+CAMEL+network+diagram&hl=de&qscrl=1&nord=1&rlz=1T4ADF A deDE342DE343&site=webhp&prmd=imvns&tbn=isch&tbo=u&source=univ&sa=X&ei=CV5XT8 ZJl zesgaxvuSfDA&ved=0CDwQsAQ&biw=1280&bih=744>.

(or the CAMEL prepaid platform) and additional signalling, to enable the roamer to use his prepaid credit. Given that the basic prepaid call flow is otherwise very similar to the postpaid call flow, CAMEL roaming is not further discussed in this study.

2.2 Cost components

Mobile roaming tends to be somewhat more costly to provide than a typical domestic mobile call, which can be attributed to the additional network elements (such as the GGSN, SGSN, the GRX, interconnect billing and management systems and CAMEL platform) and signalling that is involved in international mobile roaming calls, as well as additional administration. The activities that contribute to the wholesale cost of international voice roaming include mobile origination and network access, mobile or fixed termination, international transit, and roaming specific costs including costs associated with management, billing and accounting.

Roaming specific costs are also incurred at the retail level. However, given that roaming is part of a mobile services bundle, costs incurred due to, e.g., marketing efforts cannot be identified for roaming calls or roaming SMS alone, but apply to all the bundled services that are purchased by subscribers. Retail costs of roaming are dealt with in further detail in the benchmarking section (Section 3.6).

Table 2 shows the roaming cost components that can be derived from the commercial / legal and technical aspects of roaming as set out above for calls received and calls made while roaming:

Table 2: Roaming cost components

Cost Component	Description
Network Costs	
Origination and access costs (OC)	Costs that are incurred on the visited or home or a third network when a call / SMS is originated (including network access) while roaming
Termination costs (TC, FTC, MTC)	Costs that are incurred on the visited or home or another network when a call / SMS is received while roaming – termination can be fixed or mobile: fixed termination cost (FTC) and mobile termination cost (MTC)
Internal termination / re-origination costs (ITROC)	Costs that are incurred by the home network when a call is received by a roamer from home (on-net / off-net) or a third country for re-sending the call on to the visited network. These costs exclude airlink.
International transit costs (ITC)	Costs that are incurred on the visited network or on the home network when a call is made / MMS / data is sent back to the home network or to a third country while roaming SMS, although sent via dedicated signalling links, use

Cost Component	Description
	international transit capacity
Signalling costs (SC)	<p>Signalling costs are typically incurred during call set-up, however are also incurred when there are no calls being placed, due to continual location update. These costs are levied on a per signal basis. For prepaid CAMEL roaming, the signalling volume increases, which may increase the importance of signalling as a cost driver.</p> <p>Signalling costs apply to all voice, SMS, MMS and data Roaming services give rise to additional signalling, so a minute of roamed conversation implies marginally bigger capacity requirements (although of small entity) than a minute of conversation originating from the home network. This should be taken into account when costing roaming services.</p>
SMS network cost (SMSNC)	This cost is incurred by the home network when an SMS is sent for handling and receiving in the home network. The network elements that are used during this process are the MSC and the SMSC. This cost is normally included under SMS termination costs.
MMS and Data	
MMS network cost (MMSNC)	When the home network receives an MMS, it is routed via the GGSN and the MMSC in the home network, incurring MMS-specific network costs in the home network
Data traffic cost (DTC)	Data traffic costs are incurred by the visited network when data is received or sent by the roamer (downloading or sending of data)
Data network cost (DNC)	The home network incurs costs when the GGSN is used while data is handled / received in the home network
ISP costs (ISPC)	These are costs incurred to interconnect with external IP networks / ISPs – this cost is sometimes incurred by smaller operators; generally does not apply to larger operators
Roaming overhead costs (ROC)	
Roaming negotiation / agreement costs	Costs that are incurred when a MNO decides to expand its geographic coverage by entering into roaming agreements
Testing (IREG, TADIG) costs	Costs that are incurred when communication links and billability of roaming services are tested
Operations and maintenance costs	This cost component includes dedicated staff costs, software and systems for roaming operations, fraud prevention, accounting, and payments that are incurred periodically
Data clearing costs	Costs are incurred for outsourcing the data clearing function – this function includes TAP record generation and clearing

Cost Component	Description
Financial clearing costs	Costs are incurred for bilateral invoicing – processing of invoices received and invoices sent – this function is often outsourced
Hubbing costs (where applicable)	Hubbing costs are only incurred, if a MNO decides to outsource the roaming capability in its entirety
Retail Costs	
Retail Costs (RT)	Retail costs are those costs incurred for sales and marketing activities at the retail level that relate to roaming.
Common Costs	
Common Costs	Wholesale and retail costs may include a share of common costs (administration, management, human resources) that arise in the visited and home networks due to the activity of roaming subscribers roaming on the respective visited network. When modelling termination and origination costs, a mark-up of common costs is often included.

Source: WIK

As shown in Table 2, there are a number of different types of costs that are relevant to the international roaming service. The overarching cost groups are network costs, roaming overhead costs, retail costs and common costs and apply to all relevant roaming services. While most costs listed in the table are direct costs that are incurred each time a roamed activity is performed, some of the costs are indirect costs that have been incurred for more than one service and need to be spread across the suite of roaming services. The costs that can be directly attributed to each of the different roaming activities and converted into a per-minute cost include the network costs (i.e. origination and access costs, termination costs, international transit costs, SMS-, MMS-, and data network costs, as well as data traffic costs and ISP costs). The indirect costs that cannot be attributed to each individual roaming service include retail costs, common costs, signalling costs (which have been classified as network costs) as well as roaming overhead costs. The relative proportions of the costs incurred are examined in Section 4.3.³⁰

³⁰ BEREC in its Roaming Report “International Mobile Roaming Regulation” of December 2010 (pp. 135-146) classifies costs slightly differently in that it splits costs into the following categories and components: Technical costs: access and call origination (ACO), transit, platforms (signalling), termination; Sales and marketing costs: wholesale contracts management, wholesale and retail billing, retail marketing (ads, leaflets...); and Common Costs. The wholesale cost stack that BEREC produces includes: access and call origination (ACO); transit and platforms (signalling); termination cost (T); network cost (N) = ACO + T; sales cost (S); common cost (CC); and total wholesale costs = $(N) \cdot (1+(S)) \cdot (1+(CC))$. Transit and platform (signalling) costs were excluded from the analysis, as these costs in the EU were so low, that the margin for errors would have been larger than those costs.

2.3 Cost incurred and charges paid by call scenario

This section describes the costs incurred in and charges paid by the home and the visited network split by call scenario.

Table 3: Cost components and charges by network and call, SMS, MMS and data scenario

Cost Component	Roaming Scenario	
	Home Network	Visited Network
Scenario 1: Calls made inside the visited country		
Costs incurred	ROC + SC + RTC + IOT	OC + SC + (FTC or MTC or on-net) + ROC
Charges paid	IOT payment to visited NW to cover origination, and termination	Fixed or mobile termination fee to the terminating NW if call is not on-net
Scenario 2: Calls made from a visited country back home		
Costs incurred	SC + ROC + RTC + IOT	OC + SC + (FTC or MTC) + ITC + ROC
Charges paid	IOT payment to visited NW to cover origination and international transit and termination	Fixed or mobile termination fee to terminating network
Scenario 3: Calls made from a visited country to a 3rd country		
Costs incurred	ROC + SC + RTC + IOT	OC + SC + (FTC or MTC) + ITC + ROC
Charges paid	IOT payment to visited NW to cover origination, international transit and termination in 3 rd country Customer pays retail fee to home MNO	Fixed or mobile termination fee to 3 rd country terminating network
Scenario 4: Calls received from home while roaming in a visited country		
Costs incurred	ITROC + SC + ITC + ROC + RTC + MTCH	MTC + SC + ROC
Charges paid	International Mobile Termination fee paid to visited NW, payment of international transit to transit carrier, no IOT payment applicable to received calls	
Scenario 5: Calls received from a 3rd country while roaming in a visited country		
Costs incurred	ITROC + SC + ITC + ROC + RTC + MTCH	MTC + SC + ROC
Charges paid	International Mobile Termination fee paid to visited NW, receipt of termination fee from 3 rd NW, no IOT payment applicable to received calls, payment of international transit to transit	3 rd network pays termination to home network

Cost Component	Roaming Scenario	
	carrier	
Scenario 6: Calls received from a subscriber from the visited country		
Costs incurred	ITROC + ITC + SC + ROC + RTC + MTCH	MTC + SC + ROC + ITC
Charges paid	Payment to international transit operator, payment of international mobile termination fee to visited NW operator	
Scenario 7: SMS sent home while roaming		
Costs incurred	TC + SC+ ROC + RTC + IOT	OC + ITC+ SC + ROC
Charges paid	IOT payment to visited NW for origination and delivery to home / destination ³¹	
Scenario 8: SMS sent to a 3rd country while roaming		
Costs incurred	TC + SC+ ROC + RTC + IOT + ITC	OC + ITC + SC + ROC
Charges paid	Mobile SMS termination fee to 3 rd country network IOT payment to visited NW for origination and delivery to destination ³²	
Scenario 9: SMS sent within the visited country while roaming		
Costs incurred	TC + ITC + SC+ ROC + RTC + IOT	OC + SC + ROC + ITC
Charges paid	IOT payment to visited NW for origination and delivery to destination	
Scenario 10: SMS received from home while roaming		
Costs incurred	SC + ROC + RTC	TC + SC + ROC
Charges paid		No charge by the visited operator for SMS delivery ³³
Scenario 11: SMS received from a subscriber of the visited NW or 3rd NW while roaming		
Costs incurred	SC + ROC + RTC	TC + SC + ROC
Charges paid		No charge by the visited operator for SMS delivery ³⁴
Scenario 12: MMS sent home while roaming		
Costs incurred	MMSNC + TC + ITC + SC + ROC + RTC + IOT	DTC + ITC + SC + ROC

³¹ The mobile originated SMS costs must compensate for all mobile terminated SMS traffic because mobile terminated SMS traffic is free of charge for the receiving user. NITA in its 2008 Analysis of prices and costs for mobile data services abroad stated that the visited network should be compensated for the lack of wholesale cost coverage for receiving an SMS. The most suitable way in NITA's opinion is to include the cost of receiving an SMS under the costs of sending an SMS.

³² Ibid, see footnote 31.

³³ Ibid, see footnote 31.

³⁴ Ibid, see footnote 31.

Cost Component	Roaming Scenario	
Charges paid	IOT payment to visited NW covering radio-based data transfer and international transit to the GRX If terminated on other MNO network, then termination payment to other home network	
Scenario 13: MMS sent to a 3rd country while roaming		
Costs incurred	MMSNC + TC + ITC + SC + ROC + RTC + IOT	DTC + ITC + SC + ROC
Charges paid	Payment of termination to 3 rd country network IOT payment to visited NW covering data transfer and international transit to the nearest GRX provider	
MMS sent within the visited country while roaming		
Costs incurred	MMSNC + TC + ITC + SC + ROC + RTC + IOT	DTC + ITC + SC + ROC
Charges paid	IOT payment to visited NW covering data transfer and international transit to the nearest GRX provider	
Scenario 14: MMS received from home while roaming		
Costs incurred	OC(SMS) + MMSNC + ITC + SC + ROC + RTC + IOT	TC(SMS) + ITC + DTC + SC + ROC
Charges paid	IOT payment to visited NW covering data transfer and international transit to the nearest GRX provider	
Scenario 15: Data / Using the Internet while roaming		
Costs incurred	DNC + ITC + ISPC + SC + ROC + RTC + IOT	DTC + SC + ITC + ROC
Charges paid	IOT payment to the visited network, which covers data traffic on the visited network and international transit up to the GRX	

Source: WIK

As can be seen in Table 3, charging and payment flows differ between all activities, although there are similarities as regards the network involvement.

In summary, for calls made / originated while roaming in a visited country (Scenarios 1-3), the visited network incurs origination and access costs, signalling costs, roaming overheads and termination costs that differ by the destination of the call. If the call is made inside the visited country and terminates on the visited country's fixed network, fixed termination costs are incurred and the visited network pays a fixed termination fee to the fixed network. If the call terminates on another mobile network in the visited

country, the visited network pays a mobile termination rate (MTR) to the respective mobile network and if the call terminates on-net, the visited network incurs an internal termination fee. If the call terminates in the home or in a 3rd country, the same scenarios apply, but instead international termination costs are incurred plus international transit costs. The costs that are generated in the home network when a call is made include roaming overhead costs, signalling costs and retail costs. In addition, the home network makes a wholesale IOT payment to the visited network to allow the visited network to recover its costs of origination, termination, signalling and roaming overheads.

When a call is received in the visited country (Scenarios 4-6), the visited network incurs domestic termination costs, signalling costs, roaming overhead costs and common costs. Even though the caller dials an international number, this is not roaming specific but instead is a normal international call for which the caller is charged a normal international direct dial charge. The home network incurs internal termination / re-origination costs, international transit costs for sending the call back to the visited network, roaming overhead costs and retail costs. The home network pays the visited network a mobile termination rate.

As regards SMS, the principle is similar to voice. When an SMS is sent (Scenarios 7-9), the visited network incurs origination costs, international transit costs, signalling costs and roaming overhead costs. The SMS sent is carried to the home network (as signalling) and sent from the home network, rather than being sent from the visited network as is the case with voice. The home network therefore incurs SMS network costs for handling and receiving an SMS, SMS termination costs, signalling costs, roaming overhead costs and retail costs. For international SMS, no wholesale termination payment is relevant (i.e. the visited network does not charge the home network a termination fee; the home network does not pay the visited network a termination fee; and the home network does not receive a termination fee from the visited or third country network). The home network makes an IOT payment to the visited network, which covers origination and delivery to the home network. Depending on the destination of the SMS, the home network pays an SMS termination fee to the terminating network. When an SMS is received in the visited country (Scenarios 10-11), the visited network incurs termination costs, which it is not compensated for³⁵. Because SMSs are routed directly to the visited network, the home network does not incur any costs when an SMS is received on the visited network.

35 Recital 30 of the 2009 EU Roaming Regulation states that *“The wholesale price limit for regulated SMS should include all costs incurred by the provider of the wholesale service, including, inter alia, origination, transit, and the unrecovered cost of termination of roaming SMS messages on the visited network. Wholesale providers of regulated roaming SMS services should therefore be prohibited from introducing a separate charge for the termination of roaming SMS messages on their network, in order to ensure the consistent application of the rules established by this Regulation.”* At the retail level, incoming SMS are free of charge to consumers. The Regulation states that those costs should be covered as part of the retail charge for outgoing roaming SMS services, assuming a ratio of one SMS received for each SMS sent.

When an MMS is sent while roaming (Scenario 12-14), the visited network incurs data traffic costs, international transit costs for sending the MMS to the home network, as well as signalling and roaming overhead costs. The home network incurs MMS network costs for handling / receiving the MMS (this uses the MSC and the MMSC), as well as termination costs, international transit costs, signalling costs, roaming overheads and retail costs. The home network pays the visited network an IOT which covers the radio-based data transfer and international transit to the GRX. If the MMS terminates on a competing home network, the home network pays a termination fee to that network. When an MMS is sent to a third country, the home network pays a termination fee to the third country. If an MMS is sent within the visited country while roaming, the home network pays a termination fee to the terminating network. If an MMS is received (Scenario 15), the visited network incurs costs of SMS termination for the SMS that notifies the roamer that he received an MMS, international transit costs, data traffic costs, signalling and roaming overheads. The home network incurs SMS origination costs for the notification SMS, MMS network costs for receiving and handling the MMS, international transit costs, signalling, roaming overheads and retail costs.

When a roamer uses the Internet while roaming (Scenario 16), the visited network incurs data traffic costs, international transit costs, signalling costs and roaming overhead costs. The home network pays an IOT to the visited network to cover data traffic and international transit up to the GRX. The home network in turn incurs data network costs (usage of the GGSN), international transit costs, ISP costs to connect the roamer to the Internet, signalling costs, roaming overhead costs and retail costs. It should be noted that data is always carried via the home network, and only there is it sent or received over Internet transit. Thus, the visited network bears the cost of transferring all data sent internationally and the home network bears the cost of presenting all data (except for on-net Internet data) to Internet transit and arranging the return path to the visited network. The home network is subject to a data IOT charge payable to the visited network. Termination charges do not apply.

3 Costs of different mobile roaming components

This section provides an overview of the costs for each of the mobile roaming cost components that were identified in section 2.2. It provides a general overview of cost components together with the corresponding estimates of their magnitude. Given that mobile roaming has been regulated in the European Union since 2007, and that extensive data has been collected, most figures presented are European. Data from other regions is presented to the extent available and relevant.

3.1 Origination costs (OC)

Origination costs of the roaming service are the costs incurred when a call is originated on the (visited) network. Origination costs comprise two separate components, namely origination and network access. These can be assessed separately, e.g. origination as one component based on an incremental cost standard plus an appropriate mark-up to reflect the network access costs as the second component, or as one unit based on a fully distributed cost standard³⁶.

If origination costs are not available, they can be approximated using different benchmarks. Generally, most roaming studies and cost modelling exercises have used termination rates to approximate origination costs, given their ready availability due to termination rate regulation. Benchmarks and methods used for origination and access costs are set out in Table 4.

Table 4: Origination and access cost benchmark methods

Method	Comment
Incremental termination derived from bottom-up (BU) LRIC and top-down (TD) models	If not specifically designed to provide origination and access costs, then this methods should be used with care
Top-down models used within regulatory accounting	More robust than LRIC models, but regulatory accounting data is generally not readily available.
Relevant domestic rates offered to MVNOs to serve as upper bound	Domestic origination and access costs for MVNOs are unregulated in most countries. Using commercially negotiated rates for a regulated roaming product, if available, may not be desirable.
National roaming rates offered to MVNOs to serve as upper bound	National roaming rates for MVNOs are unregulated in most countries. Using commercially negotiated rates for a regulated roaming product, if available, may not be desirable.

³⁶ See BEREC BoR(10)58.

Method	Comment
Termination rates	Termination rates are probably the most suitable proxy for origination costs and termination rates are mostly readily available. To reflect access costs, a mark-up should be added.

Source: WIK, BEREC

In 2006, the European Commission in its Staff Working Paper Impact Assessment on Roaming³⁷ assumed values for call origination (and call termination) as the average termination costs per minute in the EU. This was estimated at €c12.64.

In its December 2010 Report on the EU International Roaming Regulation,³⁸ BEREC used the MTR as an approximation of call origination and access cost. It viewed the incremental cost-based MTR as a most practical proxy for origination costs.³⁹ BEREC noted that a mark-up should normally be added to account for a share of unavoidable access costs that are allocated to the roaming service, but given that most EU Member States were still transitioning from a fully distributed cost standard to an incremental pure LRIC standard when the report was written, MTRs practically already included a mark-up. According to BEREC, this justified the unadjusted usage of MTRs as a proxy for origination costs with the caveat, that once MTRs reached pure LRIC levels in the future (by 2012), a mark-up would have to be added to account for the access costs or a cost trend would have to be applied to the last rate based on the fully distributed cost standard.⁴⁰

Table 5 shows the EU benchmarks for call, SMS and data origination and access costs as set out in the December 2010 BEREC Report compared with estimates generated by the Danish National IT and Telecom Agency (NITA) in 2008. Copenhagen Economics also estimated origination costs. Because the assessment dates back to 2006, it has not been included in the table. Copenhagen Economics' estimate of €c12.34 is a weighted average comprising both mobile and fixed termination and has been calculated on the basis of the method applied by the European Commission (2006) updated to reflect the then latest 2006 available ERG data. The proportion of roaming calls terminated in fixed and mobile networks was provided by industry as 30% fixed and 70% mobile.

³⁷ See European Commission's Staff Working Paper July 2006
http://ec.europa.eu/governance/impact/ia_carried_out/docs/ia_2006/sec_2006_0925_en.pdf.

³⁸ BEREC Report: International Mobile Roaming Regulation, December 2010, p. 144.

³⁹ Origination and termination use almost the same network elements in similar proportions, which makes them very similar services.

⁴⁰ See BEREC Report: International Mobile Roaming Regulation, December 2010, p. 144.

Table 5: Benchmarks for origination and access costs of the international roaming service for outgoing calls, outgoing SMS and data in the EU and Denmark

	BEREC EU, Pure LRIC + mark-up (in €c) (2010)	Nita ⁴¹ Denmark (in €c) (2008)
Call OC (MTR)	<ul style="list-style-type: none"> • Min 2.02 • Max 5.23 • Ave 3.18 • Median 2.29 	n.a.
SMS OC⁴²	<ul style="list-style-type: none"> • Min 0.03 • Max 1.12 • Ave 0.36 • Median 0.24 	0.4
MMS OC	n.a.	3.35 weighted average of 3G and GPRS
Data OC (3G)⁴³	<ul style="list-style-type: none"> • Min 1.24 • Max 13.05 • Ave 7.03 • Median 7.58 	61.86 (GPRS) (1 MB) 37.04 (3G) (1 MB)

Source: WIK, BEREC Report: International Mobile Roaming Regulation, December 2010, NITA 2008 and Europe Economics (2006)

As regards origination cost for SMS, BEREC's benchmarks are based on available origination and termination or total domestic wholesale cost of an SMS and quantitative data input by 9 countries. For data, the figures are conservative estimates, given that little evidence was available and because the data relies on 2009 data from cost models developed in 2007. BEREC therefore notes that underlying costs of providing mobile data services in 2012 would be more in line with the lower bound of the range provided. NITA's cost estimates were generated by NITA's LRAIC model for mobile termination, which is not specific to roaming. The unit costs of national mobile services have been used as estimates of unit costs for the international roaming services.

⁴¹ See NITA roaming report 2008, pp. 30-44 <http://en.itst.dk/telecom-internet-regulation/filarkiv-international-roaming/Analyse%20af%20priser%20og%20omkostninger%20for%20brug%20af%20mobile%20data%20i%20udlandet.pdf>.

⁴² For SMS, the origination costs were not available separately. The values provided are network costs, which includes both origination and access and termination.

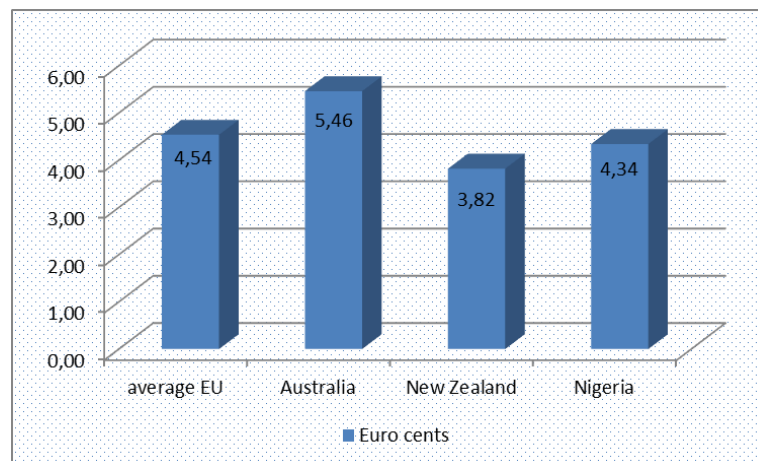
⁴³ Downloading and sending data does not involve origination or termination to an end-user. The values provided in the table are therefore network costs. Data is settled per MB or per KB. The home network settles with the GRX for the home network's share of the international transit and the home network also settles with its ISP for access to the Internet.

3.2 Termination (TC, FTC, MTC)

Termination costs are incurred when a call or SMS or MMS is terminated on the home or visited or a third network. Depending on the terminating network (mobile, fixed, on-net, off-net), the cost of termination varies.

In the EU, MTRs have served as a proxy for termination; however, MTRs present only a second-best approximation for on-net termination costs as they have not yet reached cost levels and include a substantial profit margin. The proportion of traffic terminating on mobile and fixed networks also needs to be taken into consideration when assessing termination costs. If such information is not available, the MTR can serve as an upper bound estimate of the termination costs. It should be noted that for off-net calls, the cost of termination equals exactly the MTR paid to the visited network. If the call is on-net, i.e. a New Zealand roamer makes a call to a subscriber of the visited Australian network, the underlying cost of termination is equal to the (internal) network costs incurred to terminate the call. Figure 10 shows 2011 average MTRs across Europe, Australia, New Zealand and Nigeria.

Figure 10: MTRs across European Member States, Nigeria, Australia and New Zealand July 2011



Source: EU Implementation Report 2011, ACCC and ComCom,⁴⁴ Nigeria⁴⁵

⁴⁴ Australia:

<http://www.accc.gov.au/content/item.phtml?itemId=1008711&nodeId=55a030ad4aa7adc7dda5dba6b2623e5c&fn=MTAS%20-%20draft%20final%20access%20determination%20-%2023%20September%202011.pdf>; New Zealand:

<http://media.nzherald.co.nz/webcontent/document/pdf/201119/Final-MTAS.pdf>.

⁴⁵ <http://www.cn-c114.net/583/a472524.html>.

As shown in Figure 10, the average 2011 MTR in Australia is highest followed by Nigeria, the EU and New Zealand with the lowest MTR.⁴⁶

Table 6 shows MTRs for the EU and Denmark estimated by BEREC in 2010 based on a pure LRIC plus mark-up standard,⁴⁷ by NITA based on a LRAIC standard, and the actual 2011 average EU BEREC MTR snapshot.

Table 6: MTR Benchmarks in the EU and Denmark

	BEREC Snapshot 2011 (in €c per min)	MTR July (in €c per min)	BEREC EU, Pure LRIC + mark-up (in €c per min) (2010)	NITA ⁴⁸ Denmark (in €c per min) (2008)
Call TC (MTR)	4.5		<ul style="list-style-type: none"> Min 0.61 Max 3.24 Ave 1.54 Median 1.27 	n.a.
SMS TC	n.a.		<ul style="list-style-type: none"> Min 0.03 Max 1.12 Ave 0.36 Median 0.24 	0.4 (weighted average of 2G and 3G technology)
MMS TC	n.a.		n.a.	3.35 weighted average of 3G and GPRS
Data TC (3G) ⁴⁹	n.a.		<ul style="list-style-type: none"> Min 1.24 Max 13.05 Ave 7.03 Median 7.58 	61.86 (GPRS) (1 MB) 37.04 (3G) (1 MB)

Source: WIK, BEREC 2010, NITA 2008

⁴⁶ The 10-year average exchange rate of monthly measurements from July 2001-June 2011 of EUR/AUD 1.65 and EUR/NZD 1.95 sourced from the Reserve Bank of Australia was used to convert the Australian and New Zealand values into Euro.

⁴⁷ See BEREC BoR(19)58: BEREC's approach to calculating the costs relies on input by 6-9 operators that provided detailed input on network costs for voice, SMS and data service based on their existing cost modelling work. BEREC makes the following assumptions: (1) for outgoing calls it is assumed that all calls terminate as off-net calls to mobile networks. In practice, some calls terminate on fixed some on mobile networks and the cost of termination for such calls would be lower. This produces an upward bias of the estimates, but BEREC found the upward bias reasonable, given that call ratios varied from operator to operator; (2) the approach is forward-looking by using the actual incremental costs of 2009.

⁴⁸ See NITA roaming report 2008, pp. 30-44 <http://en.itst.dk/telecom-internet-regulation/filarkiv-international-roaming/Analyse%20af%20priser%20og%20omkostninger%20for%20brug%20af%20mobile%20dataat%20i%20udlandet.pdf>.

⁴⁹ Downloading and sending data does not involve origination or termination to an end-user. The values provided in the table are therefore network costs. Data is settled per MB or per KB. The home network settles with the GRX for the home network's share of the international transit and the home network also settles with its ISP for access to the Internet.

For voice, the snapshot average EU MTR is highest. The estimated cost-based rates are significantly lower with an average for outgoing voice totalling €c1.54.

Table 7 shows the effective weighted per minute EU fixed termination rate benchmark snapshots from January 2011. The rates have been produced by BEREC for layer 1 (local level interconnection in fixed networks), layer 2 (single transit interconnection service) and layer 3 (double transit interconnection service).⁵⁰ The layer 3 is the rate that is applicable to international roaming.

Table 7: EU effective weighted per minute FTR Benchmark Snapshot January 2011 (in €cent)

Layer 1	Layer 2	Layer 3
0.58	0.67	0.80

Source: WIK

3.3 International Transit (ITC)

International transit costs are incurred when a roamed call is carried between the home and the visited network. The principle is similar to a normal international call: the respective network will pay his preferred international carrier to deliver a call to a respective country, with the difference that the subscriber is roaming on a visited network.

Estimates of international transit costs for voice vary in their magnitude as they depend on access to international gateways⁵¹ as well as traffic volumes on different routes and taxes. In the EU, however, transit costs are similar between the different Member States and BEREC found in its 2010 Report that transit costs were negligible. Thus it was excluded from the analysis.

Most studies that have assessed roaming costs, however, have estimated international voice transit costs at about 2 €cents per minute.⁵² Table 8 provides an overview of the different cost estimates for international transit in the EU.

⁵⁰ See BEREC BoR (11) 57 FTR Benchmark snapshot (as of January 2011).

⁵¹ Where gateways are liberalised, costs are low, where gateways are not liberalised, gateway costs contribute significantly to transit.

⁵² See European Commission's Staff Working Paper July 2006

http://ec.europa.eu/governance/impact/ia_carried_out/docs/ia_2006/sec_2006_0925_en.pdf.

Table 8: International transit costs estimates for intra-EU calls (in €cent)

Study	Estimate (in €cent / minute)
European Staff Commission Paper, SEC (2011) 870 final, July 2011	2
Copenhagen Economics, "Roaming: An Assessment of the Commission Proposal on Roaming", 2006	1 - 2.5 Weighted average of 2 per minute is used as a high estimate for international transit costs
INTUG response to the European Commission's Consultation on Roaming Charges, 2006 ⁵³	1

Source: WIK

As can be seen in Table 8, international transit estimates for voice lay between €c1-€c2.5 for the years 2006 and 2011, which implies that international transit prices have either not changed significantly between 2006 and 2011, or that international transit has not been properly estimated in later studies. It should be noted that most studies refer back to the European Commission's 2006 impact assessment when quoting estimates for international transit for voice.

As regards international transit for SMS, the European Commission in 2006 does not explicitly estimate it. NITA in its 2008 report uses the European Commission's 2006 international transit for voice estimate of €c2 per minute and approximates an estimate for SMS that is close to zero by converting the per minute value to a capacity-based value used in NITA's LRAIC model.^{54, 55} NITA argues that SMS is not a real-time application and should therefore be cheaper than speech in terms of capacity it uses when transmitted over the network.

For MMS and data, NITA estimates that GRX providers on average charge no more than €c6.71 per MB, which corresponds to €c0.4 for an MMS of 60 kB.⁵⁶

We have calculated average median international data transit prices per 1,000 Mbps charged by international transit providers for the year 2010 for Europe, North America, Asia and Latin America. These are presented in Table 9.

⁵³ http://ec.europa.eu/information_society/activities/roaming/docs/phase2/intug.pdf.

⁵⁴ One minute's speech corresponds to about 1.150 SMS in terms of capacity.

⁵⁵ WIK notes that in the WIK model, WIK assumes that 432 domestic SMS represent the traffic load equivalent to 1 minute of voice. Roaming SMS probably represent a somewhat higher traffic load. Given that the contribution of SMS to traffic is de minimis in any case, we have simply taken 1/400th of the voice traffic as a crude estimate.

⁵⁶ NITA assumes that the average size of an MMS is 60 kB.

Table 9: Average median international data transit prices per Mbps for the year 2010 for Europe, North America, Asia and Latin America

Region	Average median IP transit prices per Mbps, Gigabit Ethernet (1,000 Mbps) (in US\$)*
Europe	8
North America	7
Asia	33
Latin America	47
Sydney	115

*monthly US\$ prices for a full-port commit, excluding local access and installation fees, as of Q2 2010

Source: WIK, adapted from TeleGeography Research

As can be seen in Table 9, average median IP transit prices per Mbps vary significantly across the different regions, which has a bearing on roaming costs. Whereas Europe and North America average at fairly low prices of US\$8 and US\$7, IP transit is significantly more expensive in Asia and Latin America, averaging at US\$33 and US\$47, respectively. Sydney is the most expensive at US\$115.

3.4 Signalling (SC)

Signalling costs are incurred in both the home and visited networks for both calls made / SMS / MMS sent and calls / SMS / MMS received and depend on the number of location updates made by a roamer as well as the type of the call placed. Signalling costs are also incurred when no calls are being placed. Table 10 shows estimates of roaming specific signalling costs.

Table 10: Roaming specific signalling costs

Source	Roaming specific signalling costs
Analysys Mason	US\$0.0005 per signal basis
BEREC	negligible
Qualcomm	around 1% of total roaming service costs

Source: WIK, Analysys Mason, BEREC December 2010

As can be deduced from Table 10, roaming-specific signalling costs appear to be of small magnitude. Analysys Mason estimated in its “Regulatory Impact assessment study on SADC Home and Away Roaming” the charge for signalling to be around USD0.0005 and notes that it is difficult to estimate the costs per roamed activity. Based on industry data, BEREC in its December 2010 report found that signalling or platform costs were very low and should therefore be excluded from the analysis. They argued

that the margin for errors would be larger than the costs, given that industry data only relied on 2 data points. Qualcomm estimated the costs of roaming for a generic CDMA operator in December 2003 to be US\$5.5 million, of which US\$55,750 (or 1%) were apportioned to signalling (US\$12,000 for leased line for frame relay and US\$43,750 for third party processing / routing service)⁵⁷.

3.5 Roaming overhead costs (ROC)

Roaming overhead costs consist of a variety of administrative and network-related components. Little is known about the precise magnitude of these costs, because the different cost components vary significantly in size due to for instance economies of scale that lower costs for larger operators with significant traffic volumes and that increase costs to smaller operators; however, total roaming overhead costs are said to be in the general range of 10% of total roaming costs⁵⁸.

Table 11: Roaming overhead costs

Cost component	Cost estimate
Agreement / negotiation management	n.a.
Testing (IREG, TADIG)	n.a.
Operations and maintenance (this may include accounting, payments, revenue assurance, fraud prevention, dedicated staff costs, software and systems for roaming operations)	<ul style="list-style-type: none"> accounting US\$500-US\$1,000 per month if using an FCH revenue assurance mainly during set-up phase US\$500 per partner implementation fraud prevention US\$10,000-US\$20,000 per year / Qualcomm estimate for fraud management per annum totalled US\$3,750 dedicated staff costs US\$10,000-US\$20,000 per year software and systems for roaming operations US\$50,000-US\$100,000 per year
Data clearing	<ul style="list-style-type: none"> TAP record conversion at a fixed monthly fee of US\$2,000 and fee per TAP record of US\$0.008
Financial clearing	<ul style="list-style-type: none"> Per invoice charge of US\$12 Annual costs of US\$115,188 or 2% of total roaming costs (Qualcomm generic CDMA operator estimate 2003)
Hubbing	<ul style="list-style-type: none"> 10% of the IOT for either originating or terminating traffic with a minimum charge of US\$2,500 per month

Source: WIK, Analysys Mason, Qualcomm

⁵⁷ Qualcomm, International Roaming Business Overview, December 2003.

⁵⁸ Analysys Mason in its "Regulatory impact assessment study on SADC home and away roaming" estimate that signalling, financial and data clearing amount in aggregate to as little as 10% of total roaming costs.

The European Commission estimated special roaming costs for voice and roaming-specific marketing costs for voice each at €c1 per minute in its July 2006 staff working paper on “Roaming on public mobile networks within the Community”.⁵⁹ Copenhagen Economics estimated the roaming specific costs for voice to be in the range of €c1-2 per minute based on confidential information of mobile operators as well as the European Commission’s 2006 estimate.⁶⁰ Most other estimates that can be found in the literature and which post-date 2006 are quotations of the European Commission’s 2006 estimate. No estimates of roaming specific costs were available for SMS or data.

3.6 Retail costs

Retail costs are those costs incurred for sales and marketing activities at the retail level that relate to roaming. Retail costs are difficult to estimate as they are unrelated to wholesale costs and cannot be derived based on a bottom-up approach. Retail costs have therefore been captured in most studies as different levels of percentage mark-ups (5%-50%) or as absolute mark-ups added to total wholesale costs.⁶¹

⁵⁹ See European Commission’s Staff Working Paper of 12 July 2006, SEC(2006)925, p. 70.

⁶⁰ See Copenhagen Economics “Roaming – An Assessment of the Commission Proposal on Roaming”, 2006.

⁶¹ Retail mark-ups to cover retail costs vary and lie between 5% - 50% - BEREC in its 2011 Impact Assessment calculates retail mark-ups for 5%, 10%, 25%, 33% and 50%. Analysys Mason in its 2010 Regulatory Impact Assessment study on SADC Home and Away roaming states that retail mark-ups range from 10%-25% based on the majority of opinions expressed by mobile operators interviewed.

Table 12: Retail costs used in other studies

	BEREC (in €) (2010)	Nita ⁶² (in €) (2008)	Copenhagen Economics ⁶³ (in €) (2006)	AT Kerney (in €) (2006)
Call	<ul style="list-style-type: none"> Outgoing € 0.03 – € 0.15 per minute Incoming 0.03 – 0.04 € cent per minute 	n.a.	<ul style="list-style-type: none"> € 0.14 per min including a reasonable return on retail investment 	AT Kearney estimates, excluding a reasonable return on retail investment: <ul style="list-style-type: none"> 0.1009 € per min – large Western European operators 0.1215 € per min – small and medium Western European operators 0.0735 € per min – Eastern European operators Weighted average across all 19 operators in sample: 0.102 € per min
SMS	€ 0.006 – 0.05 per SMS	€ 0.0081 per message	n.a.	n.a.
MMS	n.a.	€ 0.0805 per message	n.a.	n.a.
Data	€ 0.0171 - € 0.2248 per MB	€ 0.4026 per MB	n.a.	n.a.

Source: BEREC Report: International Mobile Roaming Regulation, December 2010, NITA 2008 and Copenhagen Economics (2006)

In 2010, BEREC in its December Report proposed different approaches to estimating retail costs, the first of which suggested to collect absolute values for retail sales and marketing costs and distributing them, based on allocation keys derived from retail revenues. The second approach suggested to estimate what the retail cost should be using domestic markets as a reference. Little consistent information was provided by 10 countries, however BEREC used the share of roaming sales and marketing costs in

⁶² See NITA roaming report 2008, pp. 30-44 <http://en.itst.dk/telecom-internet-regulation/filarkiv-international-roaming/Analyse%20af%20priser%20og%20omkostninger%20for%20brug%20af%20mobile%20data%20i%20udlandet.pdf>.

⁶³ See Copenhagen Economics “An Assessment of the Commission Proposal on Roaming”, 2006.

total roaming costs provided by two NRAs, of which the range was 3%-10% of roaming sales and marketing costs in total roaming costs. The median of 5% was used.

Based on the 5% revenue proportion, BEREC's approach generated different retail costs for outgoing and incoming voice calls and SMS and data at different mark-up levels of 5%-50%.⁶⁴ For outgoing voice calls, BEREC estimated the retail costs to range between €cent 3 per minute and €cent 15 per minute, for incoming voice calls the retail costs were estimated to range between €cent 3 per minute and €cent 4 per minute, for SMS the retail costs were estimated to range between €cent 0.6 per SMS and €cent 5 per SMS, and for data retail costs were estimated to range between €cent 1.71 per MB and €cent 22.48 per MB.

In 2008 the Danish National IT and Telecom Agency (NITA) published a report on the "Analysis of Prices and Costs for Mobile Data Services Abroad", including retail cost estimates relating to the provision of the international roaming data service. The estimates were derived by comparing wholesale prices with end-user prices of Danish operators Sonfon and TDC. The results were for SMS €c0.81 per message, for MMS €c8.05 per message, and for Data €c40.26 per MB.

In 2006, The Committee on Internal Market and Consumer Protection (IMCO) asked Copenhagen Economics to review the European Commission's 2006 proposal to regulate international roaming (COM(2006)382 final of 12 July 2006) in order to bring down roaming prices. Copenhagen Economics considers that an additive mark-up rather than a multiplicative mark-up is a better way of assessing retail costs for roaming.⁶⁵ Copenhagen Economics considers that roaming is part of a 'bundled' service consisting of roaming calls, domestic calls, SMS, and more which means that an operator incurs retail costs such as marketing and subsidisation of handsets in the hope of receiving revenue for each of the services in the bundle. Accordingly, retail costs cannot be separated out to cover only some of the bundled services; rather, they should be borne proportionately by all the mobile services. Copenhagen Economics also notes that there are no links between the network costs and interconnection costs at the wholesale level, while the costs of marketing and subsidization of handsets at the retail level. They thus reason that an additive mark-up where retail costs are independent of wholesale costs is appropriate. Moreover, Copenhagen Economics contends that a proportionate allocation of retail costs should apply to both outgoing and receiving calls, (1) because based on a proportionate allocation the operator would achieve the same revenue for making or receiving calls, and (2) consumers would not have the incentive to substitute one for the other, if the price difference is significant.

⁶⁴ See "International Mobile Roaming Regulation" BEREC Report, BoR (10) 58, December 2010, pp. 138-140, 146-147, 151, 158, 161.

⁶⁵ Mark-ups can be either additive or multiplicative. An additive mark-up implies that the allocation of costs is independent of the underlying costs. A multiplicative mark-up implies that costs are split in relation to the relative level of costs, the EC markup of 30 per cent is a multiplicative mark-up.

Copenhagen Economics also report retail costs from a 2006 AT Kearney report:⁶⁶

- Large Western European operators – 10.09 euro cents per min.
- Small and medium Western European operators – 12.15 euro cents per min.
- Eastern European operators – 7.35 euro cents per min.
- Weighted average across all 19 operators in sample – 10.2 euro cents per min.

These estimates do not account for return on retail investment. Copenhagen Economics estimate that an appropriate return is 15 per cent and add this to the weighted average above to yield a final estimate of a retail mark-up of €c14 per minute. Copenhagen Economics considers that the replies they received from regulatory authorities and mobile operators in relation to retail costs suggest that retail costs appear to be positively related to the competition intensity as e.g. retention and acquisition costs are higher in a more competitive market.⁶⁷

WIK notes that Copenhagen Economics express considerable reservation with regards to their estimates noting that they were never actually in possession or saw the actual cost data on an operator level. Nor did they have knowledge of operator practices for reporting costs and traffic minutes to the ECB database and hence were unaware of whether some of these practices may produce a bias in the estimated retail cost per minute. Further, Copenhagen Economics note that estimates are based on a single year which increases the uncertainty of the results if extraordinary expenses had been held that year.

⁶⁶ A.T. Kearney (2006), International Roaming Regulation – Proposed retail mark-up and allocation of actual industry average retail costs, November 2006.

⁶⁷ Policy Department Economic and Scientific Policy, ROAMING An Assessment of the Commission Proposal on Roaming, IP/A/ALL/FWC/2006-105/Lot4/SC1, Copenhagen Economics, p. 29.

4 Mobile roaming retail and wholesale prices

This section provides an overview of international mobile roaming retail and wholesale prices for calls, SMS and data in different regions around the world. Prices have been extracted from the OECD Roaming reports⁶⁸ and from BEREC roaming reports 2009 - 2011.⁶⁹

4.1 Retail prices

The retail prices presented are retail prices in US\$ (not presented in PPP) for subscribers of a home network, roaming on a visited network, i.e. prices charged by the home MNOs to their subscribers for outbound roaming. The OECD terms this scenario 'retail charges for making a call or sending an SMS by country of destination'.⁷⁰ Note that published retail prices could differ significantly to prices actually paid on average.

All figures show significant differences in prices across the different countries. These differences can be mainly explained by the IOTs that mobile operators charge each other for letting the other network's subscribers use their network while travelling. Two-thirds of the retail prices are roughly accounted for by the IOT⁷¹. The IOTs in turn depend on the costs incurred by the visited network for origination or termination, international transit and applicable taxes. The remainder of the retail price is made up by the home network's margin and taxes applied. Most countries tax outbound roaming activities at the respective value-added tax rate.⁷²

Figure 11 shows average retail roaming prices for European subscribers making a 3-minute call while roaming in 31 countries.

⁶⁸ OECD Report "International Mobile Data Roaming", 30 May 2011; OECD Report "International Mobile Roaming Charging in the OECD Area", 21 December 2009.

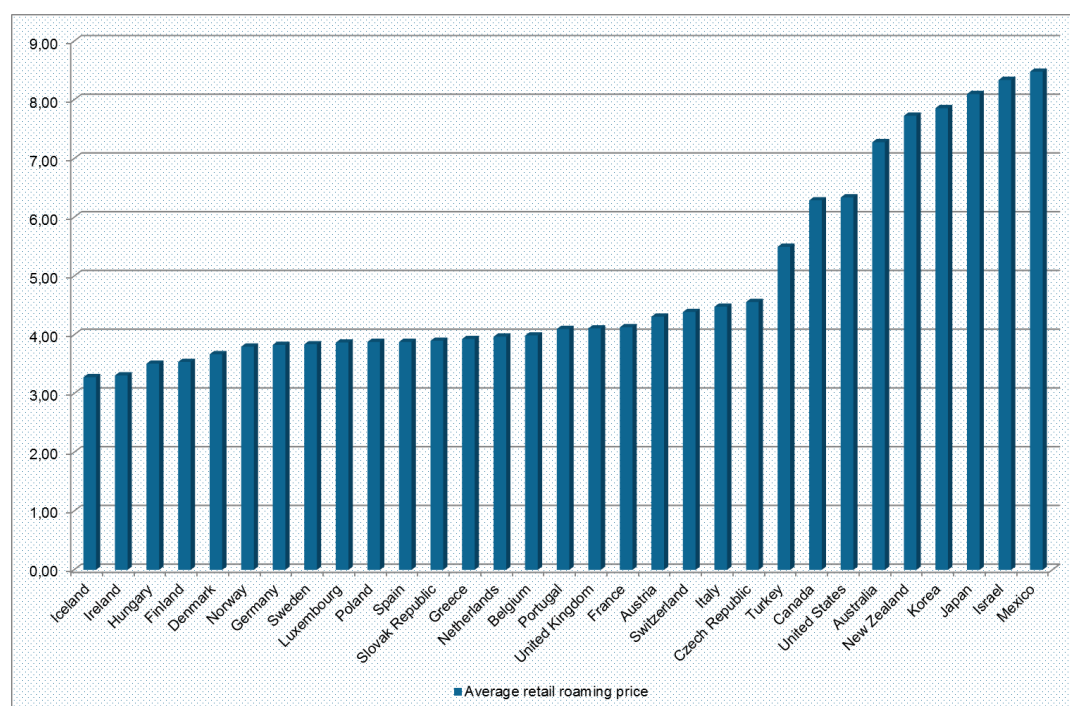
⁶⁹ See <http://www.erg.eu.int/>.

⁷⁰ The OECD used prices for the firm with the largest (subscriber-based) market share that do not include any applicable discount plans. Moreover, prices are averages across frequently and infrequently used routes and may therefore be subject to different demand conditions.

⁷¹ See "International Mobile Roaming Charging in the OECD Area", December 2009, p.71.

⁷² For further detail on the VAT rates see "International Mobile Roaming Charging in the OECD Area", December 2009, Table 7, p.48.

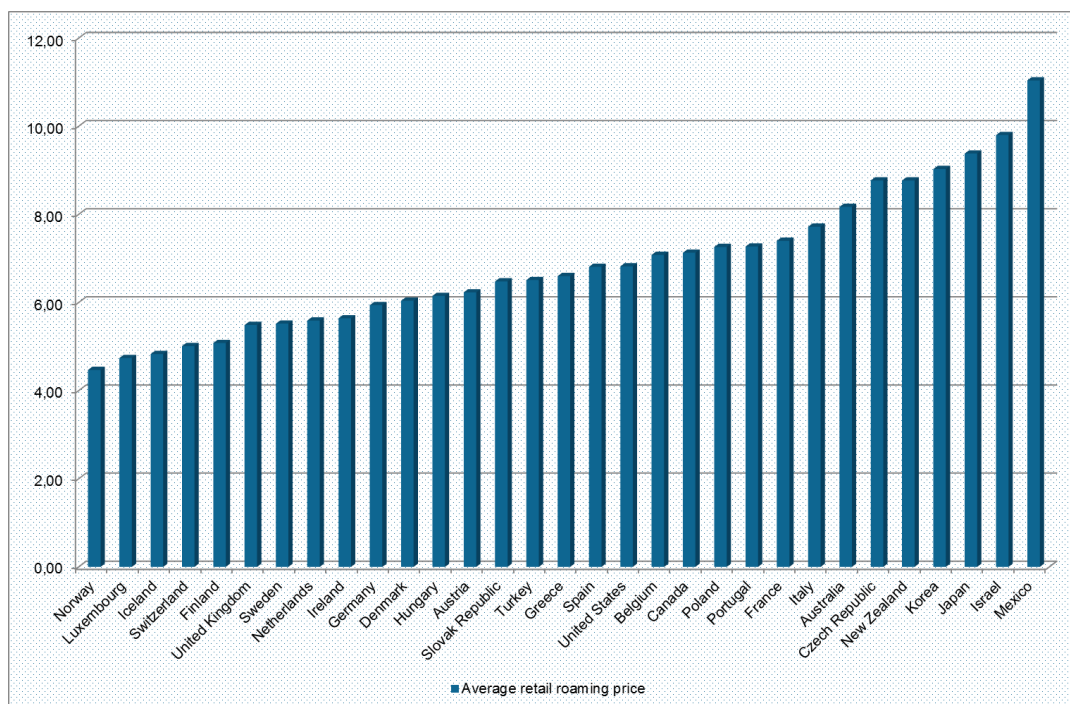
Figure 11: Average retail roaming price for subscribers making a 3 minute local call while roaming in 31 countries (US\$)



Source: OECD Roaming Report: International Mobile Roaming Charging in the OECD Area, 21 December 2009

As can be seen in Figure 11, prices vary significantly across the OECD countries with subscribers making a call while roaming in Iceland (US\$3.28), Ireland (US\$3.31) and Hungary (US\$3.51) paying the lowest and making a call while roaming in Mexico (US\$8.48), Israel (US\$8.34) and Japan (US\$8.10) paying the highest price. Figure 12 shows the average price for a 3 minute call back home.

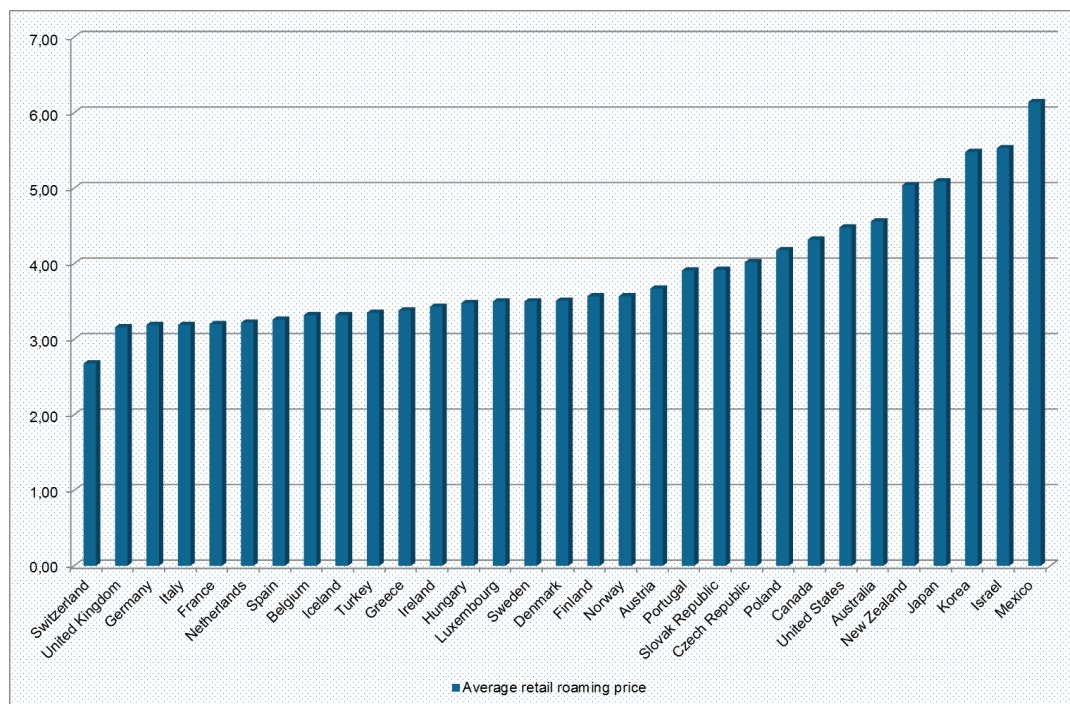
Figure 12: Average retail roaming price for subscribers making a 3 minute call back home while roaming in 31 countries (US\$)



Source: OECD Roaming Report: International Mobile Roaming Charging in the OECD Area, 21 December 2009

Figure 12 shows average retail prices for subscribers making a call back home while roaming. As with local calls made, subscribers that roam in Mexico and Israel pay the highest retail price (US\$11.04 and US\$9.80), whereas roaming charges for Norway (US\$4.47), Luxembourg (US\$4.74) and Iceland (US\$4.83) are relatively low. Calls made back home while roaming in Mexico (US\$) are just under 3 times more expensive than making a call from Norway or Luxembourg (US\$). As compared to local calls made while roaming, making a call back home is significantly more expensive in most OECD countries. The main difference in prices should be explained by international transit that needs to be accounted for in relation to calls made back home. Local calls on the other hand do not involve international transit.

Figure 13: Average retail roaming price for subscribers receiving a 3 minute call while roaming in 31 countries (US\$)

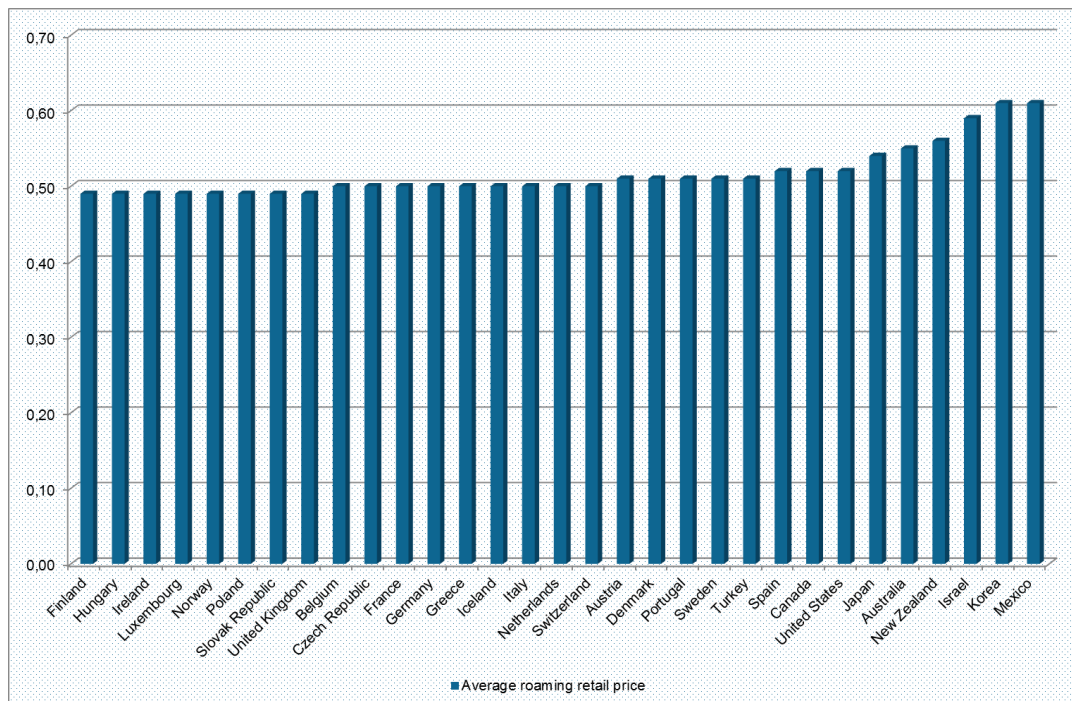


Source: OECD Roaming Report: International Mobile Roaming Charging in the OECD Area, 21 December 2009

For calls received while roaming as shown in Figure 13, subscribers roaming in Switzerland (US\$2.68) pay the lowest and subscribers roaming in Mexico (US\$6.14) pay the highest prices. Subscribers roaming in Switzerland pay a little under one-third of the price that they pay in Mexico.

Figure 14 shows average retail roaming prices for subscribers sending an SMS while roaming in 31 countries.

Figure 14: Average retail roaming price for subscribers sending an SMS while roaming in 31 countries (US\$)



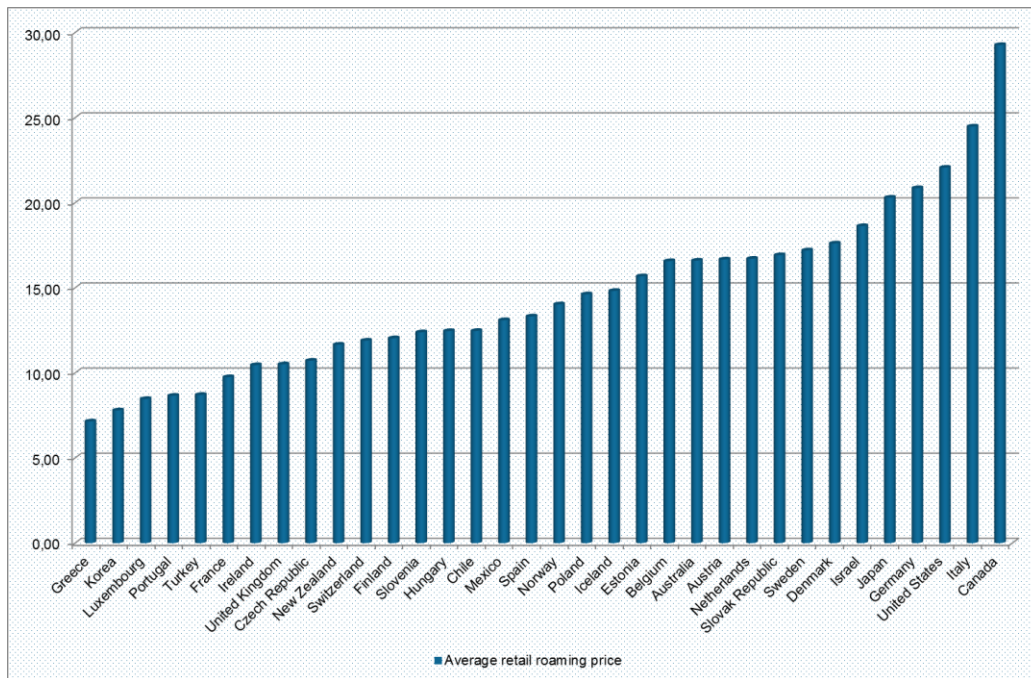
Source: OECD Roaming Report: International Mobile Roaming Charging in the OECD Area, 21 December 2009

For SMS sent, subscribers from 25 of the 31 presented OECD countries pay about US\$0.50 per SMS sent while roaming. This is interesting, as it appears fairly homogenous. Subscribers pay less than US\$0.50 when roaming in Finland, Hungary, Ireland, Luxembourg, Norway, Poland, the Slovak Republic, the United Kingdom, Belgium, the Czech Republic, France, Germany, Greece, Iceland, Italy, the Netherlands and Switzerland. Prices in Mexico and Korea are a little over US\$0.60.

Data and MMS scenarios are presented by country of origin, for example, how much a home subscriber of a New Zealand network would pay on average when roaming in different countries across the OECD.

As regards data access, Canadian, Italian and US American subscribers pay excessive prices: US\$29.27, US\$24.48 and US\$22.06, respectively, for 1 MB data access, whereas prices are a fifth of the Canadian price for Greek and Korean subscribers (Greece US\$7.15 and Korea US\$7.80) as shown in Figure 15.

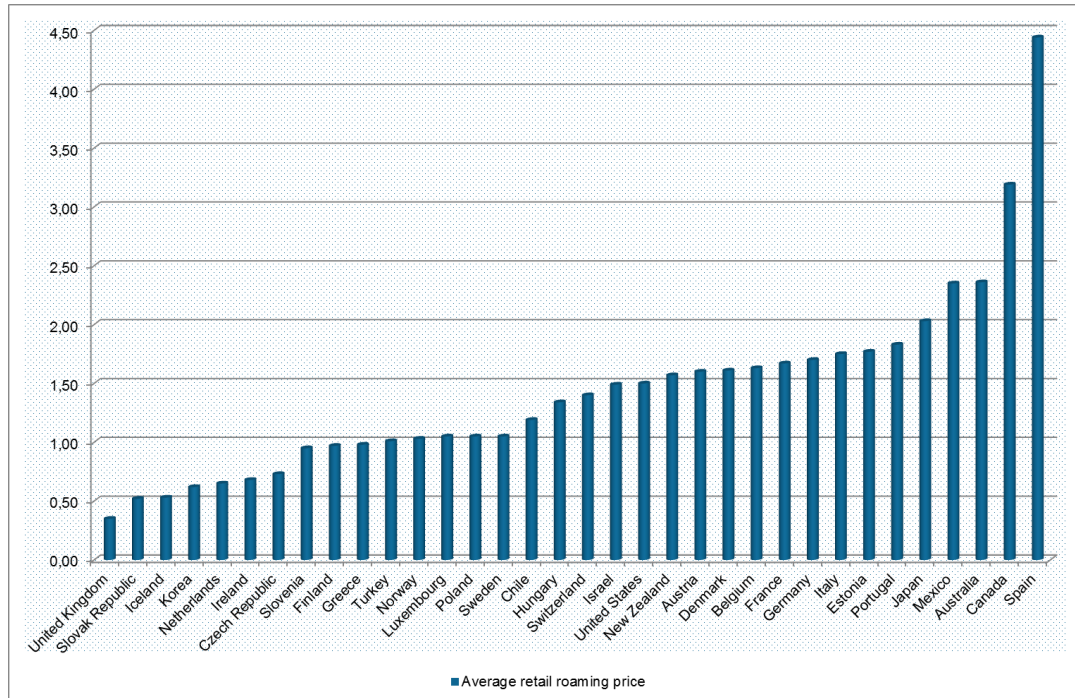
Figure 15: Average retail roaming price for 1 MB in one session data access – intra EU/EEA routes excluded (US\$)



Source: OECD Roaming Report: International Mobile Data Roaming, 30 May 2011

MMS are cheapest for UK subscribers (US\$0.35) and Slovak subscribers (US\$0.52) roaming across the OECD and most expensive for Spanish (US\$4.44 - 9 times the price of the UK, the Slovak Republic and Iceland (US\$0.53)) and Canadian (US\$3.19) subscribers.

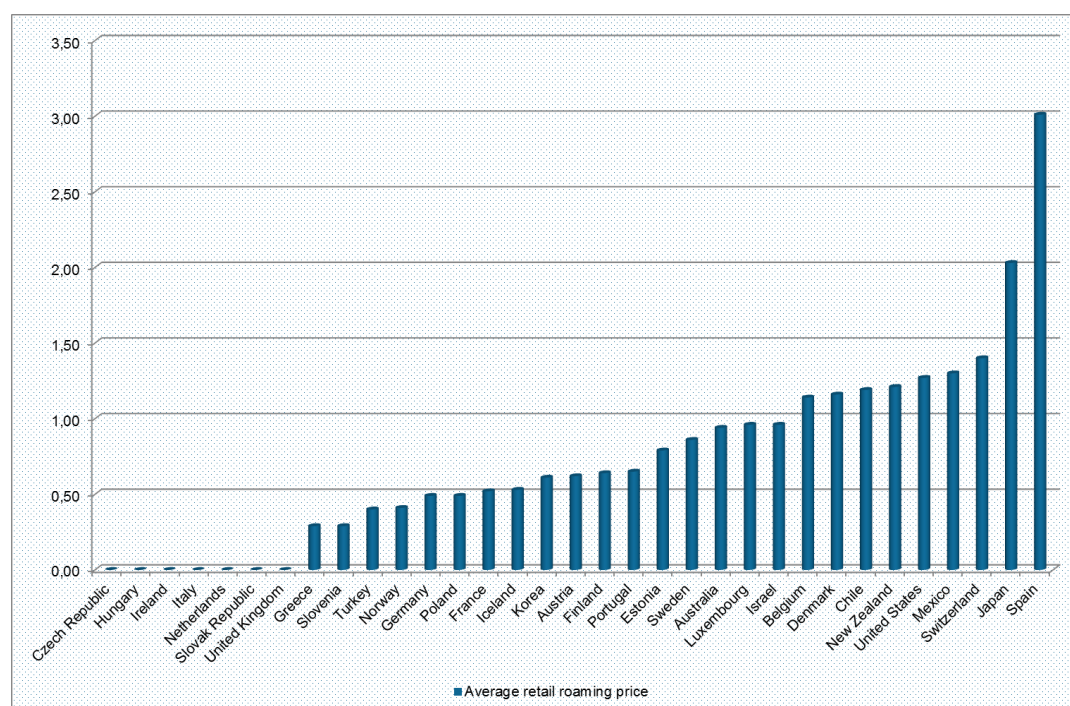
Figure 16: Average retail roaming price for an MMS sent (US\$)



Source: OECD Roaming Report: International Mobile Data Roaming, 30 May 2011

For MMS received as shown in Figure 17, the largest two operators in the Czech Republic, Hungary, Ireland, Italy, the Netherlands, the Slovak Republic and the United Kingdom do not charge their customers for receiving MMS while roaming, whereas prices for Spanish subscribers are highest at US\$3 per received MMS.

Figure 17: Average retail roaming price for an MMS received while roaming (US\$)



Source: OECD Roaming Report: International Mobile Data Roaming, 30 May 2011

In summary, Figure 11 to Figure 17 show that the lowest average prices for calls made and SMS sent by subscribers are paid when roaming in Iceland, Ireland, Norway, Finland, Hungary and Luxembourg, while for calls received lowest prices are paid when roaming in Switzerland, the United Kingdom, and Germany. The most expensive countries to roam in for calls and SMS made and calls received are Mexico, Israel, Japan and Korea. As regards data, subscribers from Canada, Italy, Spain and the USA pay most when roaming across the OECD. Subscribers from Greece, Korea, the Slovak Republic and Iceland pay the least when roaming across the OECD.

Intra-EU/EEA average 2011 per minute retail prices for voice are regulated at the Eurotariff of €0.359 for Q1 and €0.354 for Q2, respectively. In 2009, the Eurotariff was at around €0.43 in Q1 and €0.425 in Q2 per minute⁷³. In comparison to what subscribers paid across the OECD in 2009 for a 3 minute call, EU subscribers paid significantly less: for a 3 minute local call made while roaming, EU subscribers paid about US\$1.42 less than the price charged in the cheapest OECD country and for a

⁷³ See BEREC International Roaming Benchmark Data Report April 2009-December 2009.

3-minute call made back home while roaming, EU subscribers paid about US\$2.72 less than the price charged in the cheapest OECD country⁷⁴.

4.2 Wholesale prices

This section provides an overview of international roaming wholesale prices expressed as the inter-operator tariff ("IOT"), where available. The IOT was extracted from BEREC roaming reports 2009-2011 for Europe expressed in € and from the December 2009 OECD Report for regional IOTs expressed in US\$.

The Inter-Operator Tariff is the tariff a visited network operator levies on the home network operator for the use of the visited network by a home subscriber roaming in the visited country. The IOT that is paid by the home network to the visited network typically covers the visited network's domestic (origination, transmission, termination) and international costs (international transit), as well as any applicable taxes. The IOT varies across operators and depends on a number of different variables, including the destination of the roamed activity, length of the call, time of day, and possible call set-up fees. Operators often apply zonally differentiated pricing across different countries and may or may not make a distinction by time of day and sometimes apply the same rate to internationally and domestically roamed calls for simplification purposes. Table 13 shows EU average quarterly IOTs for voice, SMS and Data for the years 2009-2011.

⁷⁴ The EU per minute Eurotariff has been converted into US\$ using the exchange rate of 25 May 2009 of €1 = US\$1.3995 (see Oanda.com) and then it has been simply multiplied by 3 to reflect a 3 minute call. Moreover, no distinction has been made regarding the Eurotariff between local calls and calls back home while roaming.

Table 13: EU average quarterly IOTs 2009-2011 for voice, SMS and data (in €)

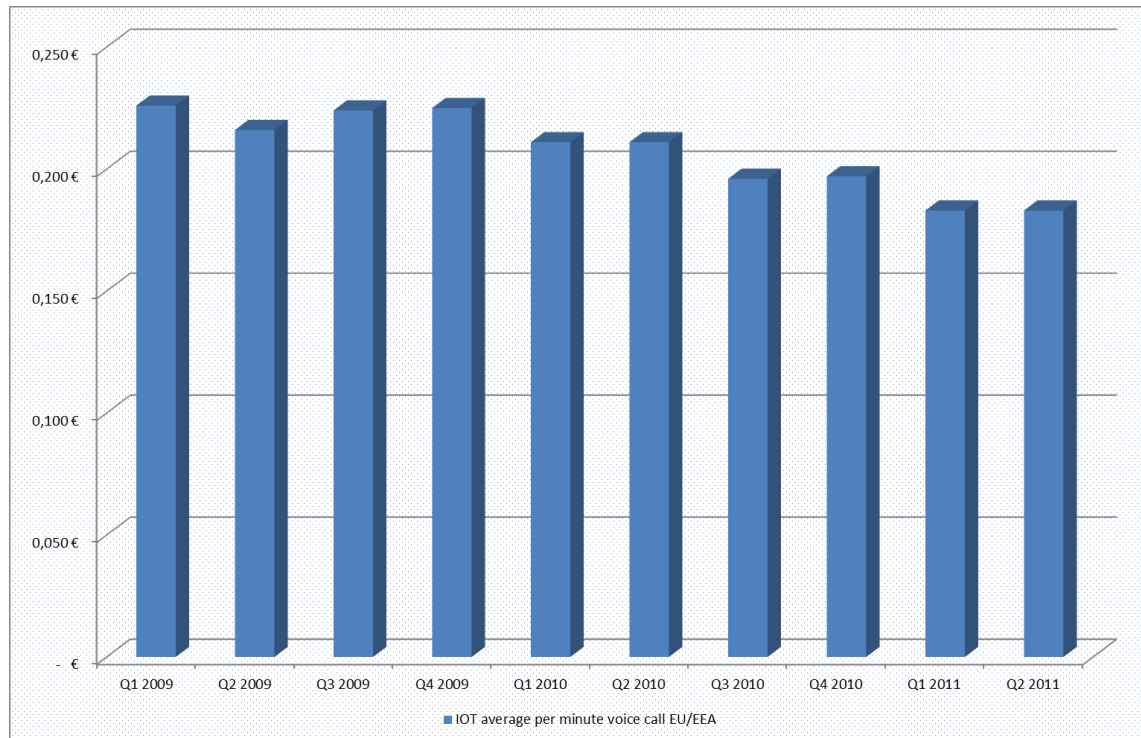
Quarter	IOT average per minute voice call EU/EEA	IOT SMS EU/EEA	IOT Data per Mb	IOT Data per Mb inbound Roaming EU/EEA
Q1 2009	0.226 €	0.136 €	1.906 €	n.a.
Q2 2009	0.216 €	0.133 €	1.205 €	n.a.
Q3 2009	0.224 €	0.042 €	0.585 €	0.585 €
Q4 2009	0.225 €	0.039 €	0.554 €	0.554 €
Q1 2010	0.211 €	0.039 €	0.585 €	0.443 €
Q2 2010	0.211 €	0.038 €	0.487 €	0.364 €
Q3 2010	0.196 €	0.038 €	n.a.	0.353 €
Q4 2010	0.197 €	0.038 €	n.a.	0.340 €
Q1 2011	0.183 €	0.038 €	0.385 €	n.a.
Q2 2011	0.183 €	0.038 €	0.355 €	n.a.

Source: WIK, BEREC Benchmark Reports⁷⁵

As can be seen in Table 13, average wholesale prices for voice, SMS and data have declined between 2009 and 2011 due to wholesale regulation. A closer look at price development is taken in Figure 18 to Figure 20. Figure 18 shows average per minute wholesale prices intra EU/EEA voice calls between 2009-2011.

⁷⁵ BEREC (2010) International Roaming BEREC Benchmark Data Report April 2009 - December 2009, BoR (10) 20, April 2010; BEREC (2010) International Roaming BEREC Benchmark Data Report January 2010 – June 2010, BoR (10) 50, October 2010; BEREC (2011) International Roaming BEREC Benchmark Data Report July 2010 – December 2010, BoR (11) 21 final, May 2011; BEREC (2011) International Roaming BEREC Benchmark Data Report January 2011 – June 2011, BoR (11) 51, October 2011.

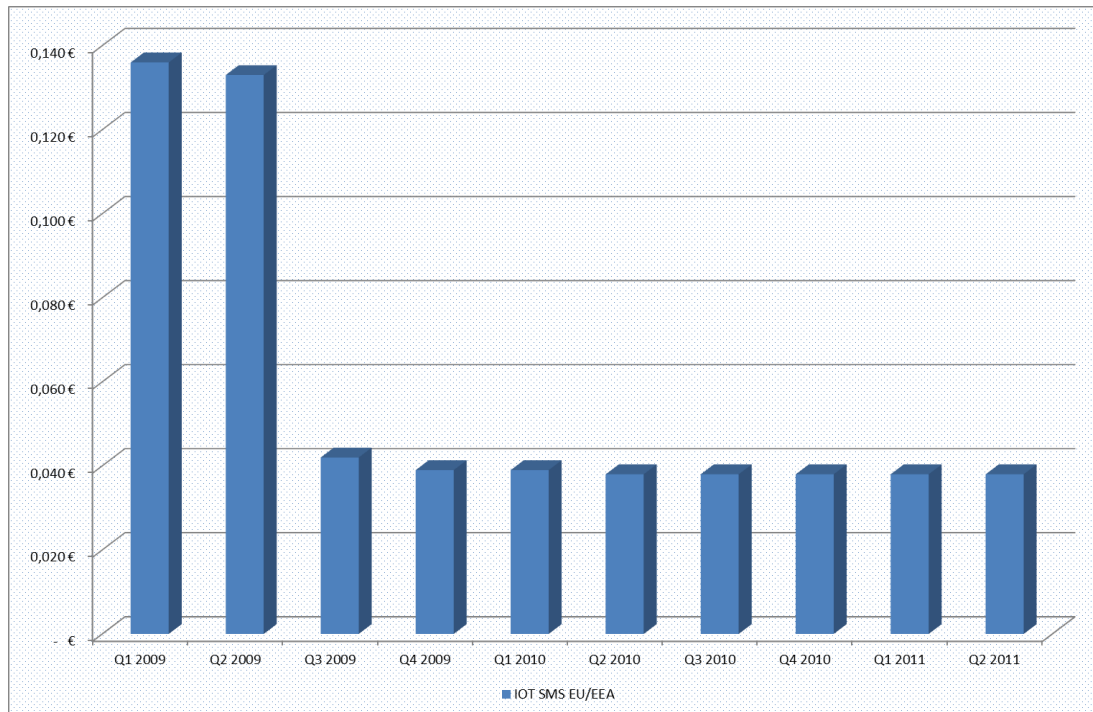
Figure 18: Average per minute wholesale prices for EU/EEA voice calls 2009-2011 (in €)



Source: WIK, BEREC Benchmark Reports

For voice, the average wholesale prices were almost 4 cents below the regulated wholesale price cap of €0.22 in Q1 and Q2 2011.

Figure 19: Average wholesale prices for EU/EEAN SMS 2009-2011 (in €)

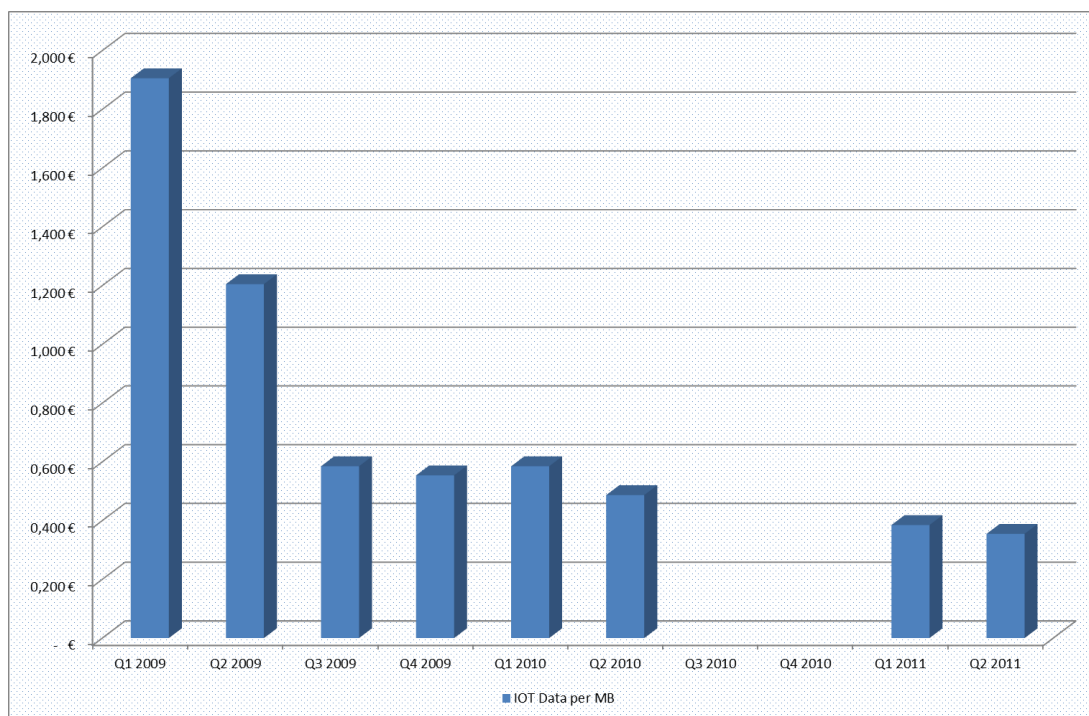


Source: WIK, BEREC Benchmark Reports

For SMS, average 2011 wholesale prices were in compliance with the regulated cap of €0.04 per SMS.

Figure 20 shows average wholesale prices for 1 Mb of intra-EU/EEA data usage for the period 2009-2011.

Figure 20: Average wholesale prices for 1 Mb of intra EU/EEA data usage for the period 2009-2011 (in €)



Source: WIK, BEREC Benchmark Reports

As can be seen in Figure 20, average wholesale prices for 1 Mb data usage declined significantly and complied with regulation. The 2011 Q1 and Q2 average wholesale prices for data were well below the safeguard cap of €0.80 per Mb.

Table 14 shows 2009 foreign per minute IOTs paid by Turkcell to operators across different regions. While IOTs for voice calls paid to Russian operators were one-third higher than IOTs for voice calls paid to operators in the USA, Canada and other countries, European operators charged the lowest IOTs. When compared with IOTs charged for voice calls within the EU as shown in Figure 18, it can be seen that IOTs charged to non-EU operators in 2009 are a multiple of 5 times as high as those charged to EU operators⁷⁶.

⁷⁶ US\$1.41 converted into € amounts to €1.11 at the exchange rate of 0.7890 of 1 March 2009 (www.oanda.com).

Table 14: IOTs paid by Turkcell to different regions 2009

Region	IOT paid
Calls per minute in US\$	
Europe	1.41
Russia and Ukraine	2.98
USA and Canada	1.94
Other	1.94
Sending SMS (US\$ per message)	
All regions	0.26

Source: WIK, OECD⁷⁷

4.3 Proportions of roaming costs

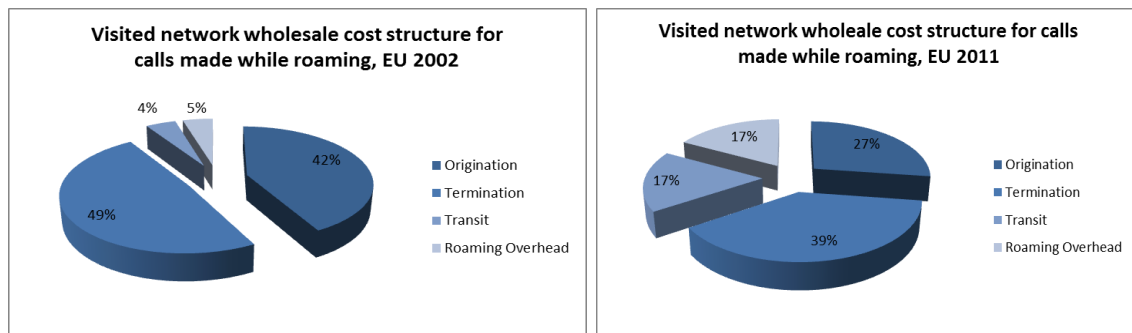
This section provides an overview of the different proportions of roaming cost components in the EU. It presents for each roaming scenario each relevant cost as a percentage of visited network wholesale costs and home network retail costs. Historically, the largest costs of roaming calls are associated with origination and access, termination and transit, while the roaming overheads only take a small share in the total cost of a roaming call / activity.

4.3.1 Calls made while roaming in the EU

Figure 21 shows the wholesale cost structure in the EU for a call originated in a visited MNO network before and after regulation. The largest cost components are origination and termination, which reduce significantly following the introduction of regulation. Because the cost of signalling is less than €cent1, it has not been depicted in the chart but has been indicated in the table.

⁷⁷ Adapted from "International mobile roaming charging in the OECD area", 2009, Table 21, p. 74.

Figure 21: Wholesale cost structure of the visited network in the EU for a call originated in the visited MNO NW in 2002 and 2011



The cost estimates used to produce Figure 21 are set out in Table 15.⁷⁸ The variables that have changed most due to regulation include termination and wholesale charges.

Table 15: Visited network wholesale cost estimates for calls made in the EU in 2002 and 2011

Cost component	2002 (per minute in €cent)	2011 (per minute in €cent)
Origination	19	3
Termination	22	4
Transit	2	2
Signalling	n.a. (less than €cent1)	n.a. (less than €cent1)
Roaming overheads	2	2

Source: WIK

Figure 22 shows the retail cost structure of the home network for outbound roaming in 2002 and 2011. The largest cost component to the home network is the IOT paid to the visited network, which decreased significantly from 86% to 53% of total roaming costs. Costs of signalling are less than €cent1 per minute and are therefore not depicted in the chart.

⁷⁸ The estimates contained in Table 15 were sourced as follows: for 2002 values: origination and termination estimates have been sourced from www.anacom.pt "Anacom's view on call origination in national mobile networks, 28.10.2008; roaming overhead costs have been sourced from Copenhagen Economics 2006; wholesale IOT price is a WIK estimate; for 2011 values: origination was sourced from Table 5 and is BEREC's average estimate of € 0,0318. Termination is the BEREC MTR Benchmark snapshot of July 2011, which includes fixed-to-mobile termination charges in case there is a difference in mobile-to-mobile termination charges (see http://erg.eu.int/doc/berec/bor_11_35.pdf); roaming overhead costs were sourced from Copenhagen Economics 2006; the IOT was sourced from BEREC Roaming Benchmarking Report 2011.

Figure 22: Retail cost structure of the home network in the EU for a call originated in the visited MNO NW in 2002 and 2011

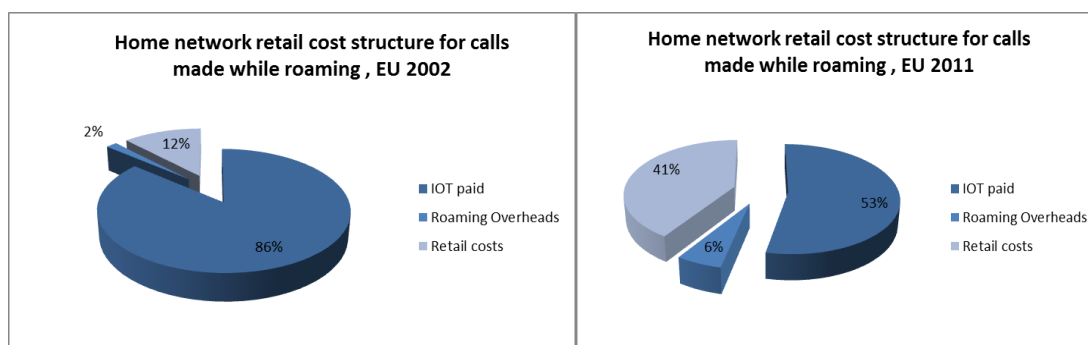


Table 16 shows the cost estimates used to produce the charts in Figure 22.⁷⁹ As regards retail costs, the cost estimate used in the charts is an absolute mark-up that was calculated by Copenhagen Economics in its 2006 roaming report.

Table 16: Home network costs estimates for roaming call made in the EU in 2002 and 2011

Cost component	2002 (per minute in €cent)	2011 (per minute in €cent)
IOT paid	100	18
Roaming overheads	2	2
Signalling	n.a. (less than €cent1)	n.a. (less than €cent1)
Retail costs	14	14

Source: WIK

4.3.2 Calls received while roaming in the EU

Figure 23 shows the visited network wholesale cost structure for inbound roaming (a call received) in the EU in 2007 and 2011. As depicted, termination costs decreased from 82% to 69% due to regulation. Signalling costs have not been included in the chart as they are less than €cent1.

⁷⁹ Estimates for 2002: IOT and the retail price is a WIK estimate; roaming overheads and retail costs were sourced from Copenhagen Economics 2006; estimates for 2011: the IOT and the retail price were sourced from BEREC Roaming Report 2011; the roaming overheads and retail costs were sourced from Copenhagen Economics.

Figure 23: Wholesale cost structure of the visited network in the EU for a call received in the visited MNO NW in 2007 and 2011

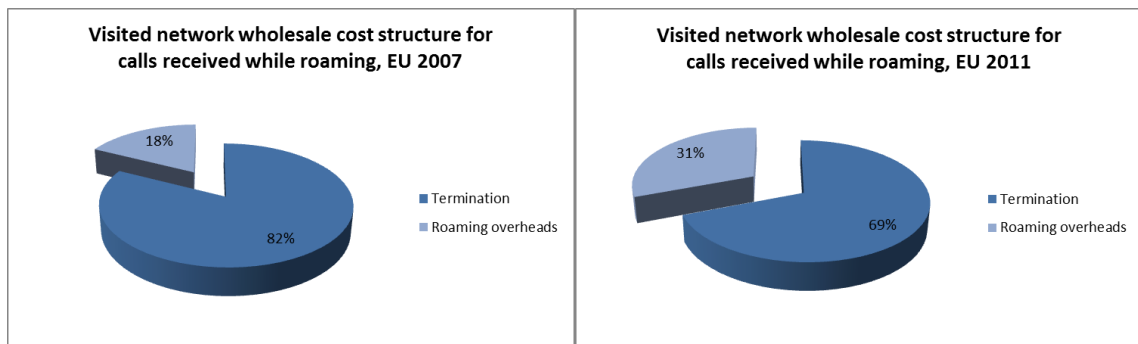


Table 17 shows the cost estimates used to produce the charts contained in Figure 23. For calls received, the visited network faces local termination costs that make the largest component of costs incurred. In 2007, the EU MTR averaged at €c9.4 and declined year-on-year according to the glide-path to €c4.5 in 2011.

Table 17: Visited network cost estimates for a call received in the EU in 2007 and 2011

Cost component	2007 (per minute in €cent)	2011 (per minute in €cent)
Termination	9	4
Roaming overheads	2	2
Signalling	n.a. (less than €cent1)	n.a. (less than €cent1)

Source: WIK

Figure 24 shows the retail cost structure of the home network for outbound roaming (call received) in the EU in 2007 and 2011. The largest costs to the home network associated with a call that is received by a home subscriber on a visited network are the retail costs. Due to regulation, termination reduced from 26% in 2007 to 19% in 2011.

Figure 24: Retail cost structure of the home network in the EU for a call received in the visited MNO NW in 2007 and 2011

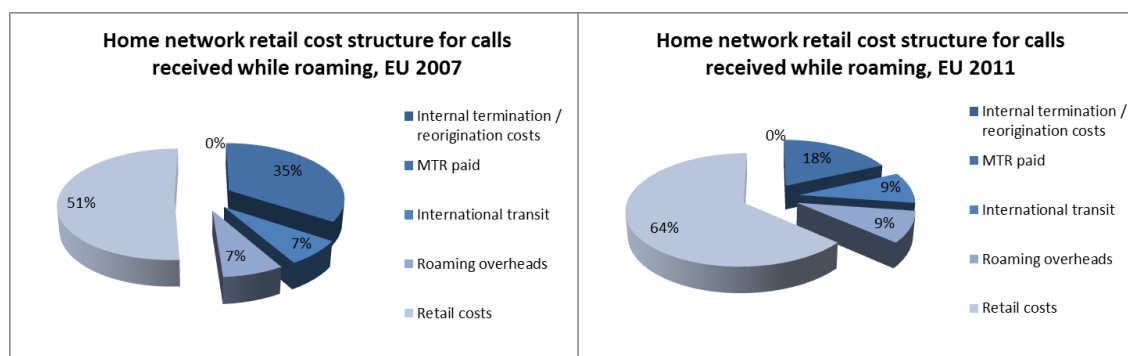


Table 18 shows the home network cost estimates used to generate the charts contained in Figure 24.⁸⁰

Table 18: Home network cost estimates for calls received in the EU in 2011

Cost component	2007 (per minute in €cent)	2011 (per minute in €cent)
MTR paid	9	4
Internal termination / re-origination costs	0	0
International transit	2	2
Roaming overheads	2	2
Signalling	n.a. (less than €cent 1)	n.a. (less than €cent 1)
Retail costs	14	14

Source: WIK

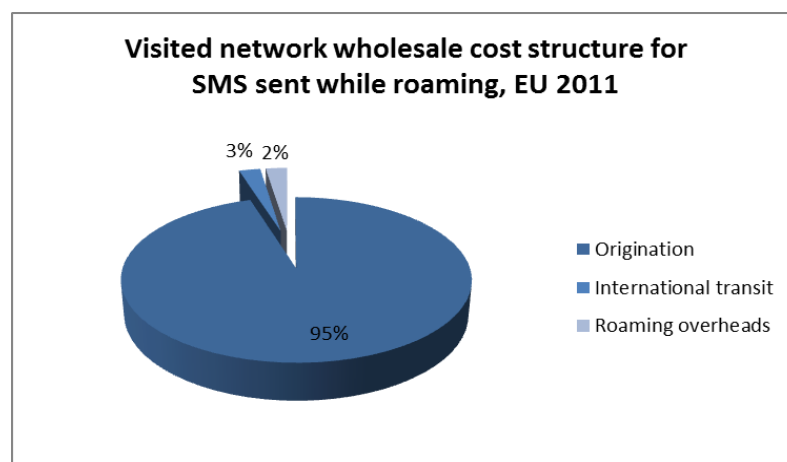
WIK notes that the internal termination / re-origination costs are incurred by the home network when a call is received from home (off-net or on-net) or a third country by a roamer roaming on the visited network. These are costs that the home network incurs for re-sending (forwarding) the call to the visited network. These do not include airlink resources, and are estimated by WIK to be negligible and therefore set to zero.

⁸⁰ Termination and retail prices: 2007 figures were taken from the 2007 ERG Roaming Benchmark Report for Q2, and 2011 figures were taken from BEREC Roaming Report 2011 Q2.

4.3.3 SMS sent while roaming in the EU

Figure 25 shows the wholesale cost structure of the visited network in the EU for an SMS sent by a roaming home subscriber. When comparing all cost items with the network costs associated with an SMS, the largest costs that the visited network faces are roaming overhead costs. Table 19 shows the estimates used to generate the charts contained in Figure 25.

Figure 25: Wholesale cost structure of the visited network in the EU for an SMS originated in the visited MNO NW in 2007 and 2011



As can be seen in Table 19, the visited network incurs very little in terms of costs when an SMS is originated on its network by a roaming subscriber.⁸¹ The IOT that is received by the visited network of 4 ¢cent (as shown in Table 20) is largely in excess of the underlying costs of ¢cent 0.42.

Table 19: Visited network cost estimates for SMS sent in 2007 and 2011

Cost component	2007 (per SMS in ¢cent)	2011 (per SMS in ¢cent)
Origination	0.4	0.4
Signalling	n.a. (less than ¢cent1)	n.a. (less than ¢cent1)
International transit	0.01	0.01
Roaming overheads	0.01	0.01

Source: WIK

⁸¹ The estimates contained in Table 19 are sourced from: NITA 2008 for origination, wholesale costs for SMS, and international transit; and BEREC / ERG 2008 and 2011. For origination, BEREC's 2010 average estimate as set out in Table 5 is €0.0036, which is very close to NITA's 2008 estimate.

As regards the costs to the home network that are incurred when a home subscriber sends an SMS while roaming on a visited network, the wholesale costs (i.e. the IOT payment made to the visited network) are largest as shown in Figure 26 and Table 20.⁸²

Figure 26: Retail cost structure of the home network in the EU for an SMS originated in the visited MNO NW in 2007 and 2011

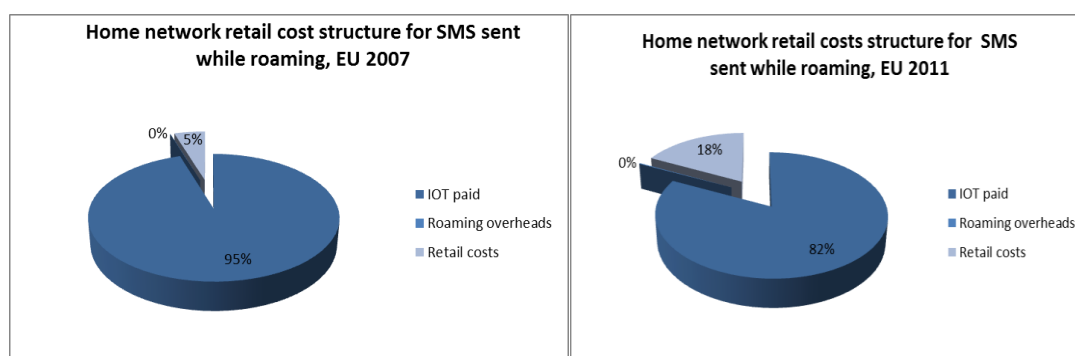


Table 20: Home network cost estimates for SMS sent in the EU in 2007 and 2011

Cost component	2007 (per minute in €cent)	2011 (per minute in €cent)
IOT paid	16	4
Signalling	n.a. (less than €cent1)	n.a. (less than €cent1)
Roaming overheads	0.01	0.01
Retail costs	0.81	0.81

Source: WIK

4.3.4 Data accessed while roaming in the EU

Figure 27 shows the wholesale cost structure of the visited network for inbound data roaming. In terms of cost elements, data traffic costs are largest in both years.

⁸² The figures contained in Table 20 are sourced from: ERG / BEREC 2007 and 2011 Benchmarking reports. For retail costs, a 20% mark-up has been assumed.

Figure 27: Wholesale cost structure of the visited network in the EU for data roaming in the visited MNO NW 2008 and 2011

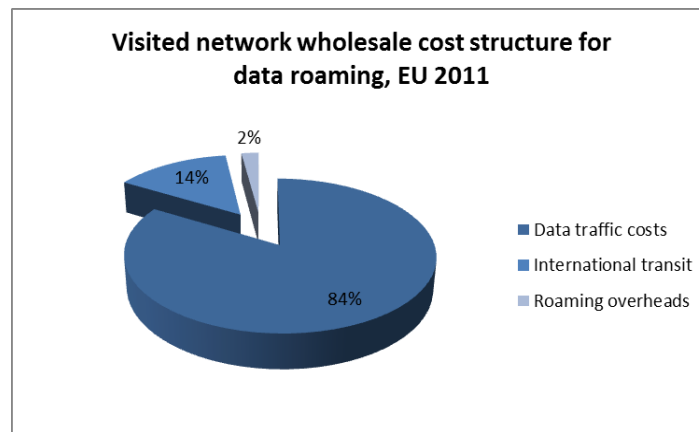


Table 20 shows the values that have been used to generate the charts contained in Figure 27. It should be noted that the 2011 value for the data traffic costs was not available. Given that data traffic costs are the costs incurred in the visited network when downloading or sending 1 MB of data and therefore present an internal network cost, it is likely that little will have changed. We have therefore assumed the costs of data traffic to have remained constant from 2008 to 2011. Moreover, roaming overhead costs were estimated by WIK at around €cent 1 per MB and to be constant. We have therefore only provided figures for 2011.

Table 21: Visited network cost estimates for data roaming in 2008 and 2011

Cost component	2011 (per MB in €cent)
Data traffic cost	39
Signalling	n.a. (less than €cent1)
International transit	7
Roaming overheads	1

Source: WIK

Figure 28 and Table 22 show the retail cost structure of the home network in the EU for outbound data roaming in 2011. As is apparent from both charts and the table, retail costs represent the main bulk of costs to the home network, followed by international transit costs and roaming overhead costs.

Figure 28: Retail cost structure of the home network in the EU for data accessed in the visited MNO NW in 2011

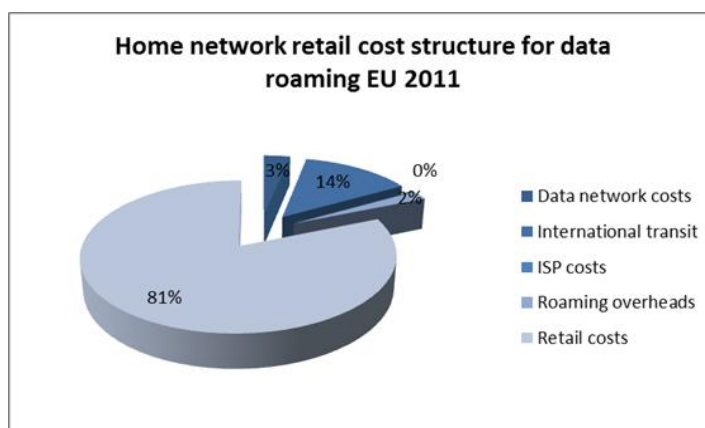


Table 22: Home network cost estimates for data roaming in 2011

Cost component	2011 (per MB in €cent)
Data network costs	2
ISP costs	insignificant
Signalling	n.a. (less than €cent1)
International transit	7
Roaming overheads	1
Retail costs	40

Source: WIK

In summary it can be noted, that for all of the roaming scenarios presented, the largest costs that the visited and the home network face are:

Visited network:

- network costs (origination, termination) for calls made and received;
- network costs (origination) for SMS sent; and
- data traffic costs for data accessed.

Home network:

- the IOT paid for calls made and the retail costs for calls received

- the IOT paid for SMS sent; and
- the retail costs for data accessed.

Overall, for all roaming scenarios presented, internal network costs to the visited network appear to be significantly lower than IOTs paid by the home network. BEREC supports the finding of low internal network costs going forward in its latest brief “Analysis of Wholesale Roaming Costs” of 23 February 2012, where BEREC states that for outgoing voice, the maximum wholesale costs will be below €c5 per minute; maximum wholesale costs for SMS will be at €c1 per minute (cautious estimate); and for data BEREC estimates that wholesale costs will be below €c5 per Mb.⁸³

4.4 Relationship between roaming retail prices and roaming wholesale costs

MNOs pay each other an IOT, which covers the roaming overhead costs, origination-, transit- and termination costs. Even if payments tended to be in rough balance, the level of IOTs would tend to influence the level of retail prices.⁸⁴ An MNO normally establishes retail prices above the usage-based wholesale cost in order to avoid the risk of an imbalance. If they fail to do so, they risk attracting too many customers who place too many roaming calls, and thus running a deficit. As long as the usage-based retail price exceeds the usage-based wholesale cost, the MNO avoids this risk.

MNOs in the EU frequently negotiate two distinct IOT rates: the regulated IOT cap is usually charged for matched minutes, while a lower IOT rate governs the payment for unmatched minutes. Where this is the case, we believe that *it is the lower IOT rate for unmatched minutes that sets an effective floor on the retail price*, because where both rates are present there can never be a deficit payment associated with the matched minute rate.

Retail price is thus unlikely to be set at average levels less than that of the unmatched minute IOT (assuming that the IOT is too great to ignore); however, there is nothing today (other than regulation) to prevent retail prices that are considerably greater than the IOT. If the market for mobile roaming were more competitive, or if the price elasticity of demand for mobile roaming were greater, MNOs might be motivated to set retail prices at levels more closely linked to real costs.

In other words, there is no assurance (absent regulation) that reductions in the wholesale cost associated with the IOT would be passed through to consumers in the form of reduced retail prices.

⁸³ See BEREC BoR(12)14 “Analysis of Wholesale Roaming Costs”, 23 February 2012.

⁸⁴ See Jean Tirole and Jean-Jacques Laffont (2000), *Competition in Telecommunications*, MIT Press. They make the point about call termination rather than about roaming, but the logic is the same.

5 Cost components of Trans-Tasman roaming for Australia and New Zealand

This section sets out the estimates of wholesale and retail roaming cost components calculated by WIK and provides a description of the methodology applied.

5.1 Cost estimates overview table

Table 23 shows all cost estimates (in AU\$ cent and NZ\$ cent) for the relevant cost components that were identified and calculated by WIK for the purposes of this study. These include for voice, SMS and data: the IOT, origination costs, termination costs, termination charge (mobile and fixed and blended), data network costs, signalling costs, international transit costs, roaming overhead costs and retail costs. Where there are no figures provided, the costs or inputs to allow WIK to calculate costs were either not provided or the costs were negligible and considered to be zero (e.g. data network costs).

WIK notes that the home network incurs an internal termination / re-origination cost for voice calls received from home or a third country by a roamer while roaming on the visited network. WIK estimates these costs to be negligible and have therefore set these costs to zero.

Given that Australian MNOs operate a bill and keep system for SMS, the SMS termination charge for Australia is zero.

As regards ISP costs (transit costs that are incurred in the home network for transmitting data to and from external IP networks) none of the operators provided or mentioned ISP costs. NITA in its 2008 study found ISP costs to be insignificant. A review of ISP transit price data from the firm Telegeography supports the view that these costs are *de minimis*. WIK has therefore treated ISP costs as being negligible.

The cost components as set out in Table 23 and how they were derived or calculated are described in sections 5.2 to 5.5.

Table 23: 2011 Cost components estimates overview table

Cost component	Abbreviation	Australia (AU\$ cent)	New Zealand (NZ\$ cent)	Unit
Inter Operator Tariff Voice paid	IOTV	75.136	45.922	per min
Inter Operator Tariff SMS paid	IOTS	19.462	17.196	per message
Inter Operator Tariff Data paid	IOTD	• 63.7	• 42.8	per MB

Cost component	Abbreviation	Australia (AU\$ cent)	New Zealand (NZ\$ cent)	Unit
		32	56	
Origination Cost Voice	OCV	2.950	3.320	per min
Termination Cost Voice	TCV	3.750	3.670	per min
Internal termination / re-origination cost voice (on-net and off-net)	ITROC	-	-	per min
Mobile Termination Charge	MTCHV	9.000	7.000	per min
Fixed Termination Charge	FTCHV	0.950	1.000	per min
Weighted average termination charge (mobile on-net, off-net, fixed off-net)	WATCH3	1.8	1.47	per min
Weighted average termination charge (fixed and mobile)	WATCH2	3.3	2.6	per min
SMS Termination Cost	TCS	0.009	0.013	per message
SMS Origination Cost	OCS	0.009	0.013	per message
SMS Termination Charge	TCHS	-	0.060	per message
Data Traffic Cost	DTC	18.900	20.790	per MB
Data Network Cost	DNC	-	-	per MB
ISP charge	ISPCH	-	-	per MB
Signalling Cost Voice Local Call Made VN	SCVLCM.VN	0.078	0.064	per min*
Signalling Cost Voice Local Call	SCVLCM.HN	0.031	0.026	per min*

Cost component	Abbreviation	Australia (AU\$ cent)	New Zealand (NZ\$ cent)	Unit
Made HN				
Signalling Cost Voice Home Call Made VN	SCVHCM.VN	0.140	0.115	per min*
Signalling Cost Voice Home Call Made HN	SCVHCM.HN	0.093	0.077	per min*
Signalling Cost Voice 3rd Country Call Made NV	SCV3CM.VN	0.140	0.115	per min*
Signalling Cost Voice 3rd Country Call Made HN	SCV3CM.HN	0.031	0.026	per min*
Signalling Cost Voice Local Call Received HN	SCVLCR.VN	0.117	0.096	per min*
Signalling Cost Voice Local Call Received VN	SCVLCR.HN	0.117	0.096	per min*
Signalling Cost Voice Home Call Received HN	SCVHCR.VN	0.109	0.089	per min*
Signalling Cost Voice Home Call Received VN	SCVHCR.HN	0.117	0.096	per min*
Signalling Cost Voice 3rd Country Call Received HN	SCV3CR.VN	0.109	0.089	per min*
Signalling Cost Voice 3rd Country Call Received VN	SCV3CR.HN	0.117	0.096	per min*
Signalling Cost SMS Sent VN	SCSS.VN	0.093	0.077	per message
Signalling Cost SMS Sent HN	SCSS.HN	0.093	0.077	per message
Signalling Cost SMS Received VN	SCSR.VN	0.093	0.077	per message
Signalling Cost SMS Received HN	SCSR.HN	0.093	0.077	per message

Cost component	Abbreviation	Australia (AU\$ cent)	New Zealand (NZ\$ cent)	Unit
Signalling Cost Data VN	SCD.VN	0.140	0.115	per MB
Signalling Cost Data HN	SCD.HN	0.140	0.115	per MB
International Transit Charge Voice	ITCHV	3.298	3.907	per min
International Transit Charge SMS	ITCHS	0.016	0.020	per message
International Transit Charge Data	ITCHD	2.849	3.357	per MB
Roaming Overhead Cost Voice	ROCV	1.198	1.412	per min
Roaming Overhead Cost SMS	ROCS	0.657	0.774	per message
Roaming Overhead Data	ROCD	2.784	3.281	per MB
Retail Cost Voice	RTCV	26.685	31.450	per min
Retail Cost SMS	RTCS	17.055	20.100	per message
Retail Cost Data	RTCD	25.183	29.680	per MB

*average call length was assumed to be 3 minutes

Source: WIK

5.2 Model results for call and SMS origination and termination, and data traffic and network costs

To estimate the forward-looking efficient cost of call origination, call termination, SMS origination, SMS termination, and data traffic and network costs in Australia and New Zealand, we updated the WIK Mobile Network and Cost Model (WIK-MNCM) originally developed for Australian Competition & Consumer Commission (ACCC). The WIK-MNCM is a bottom-up cost model, using a Total Service Long-Run Incremental Cost framework. It was developed as a regulatory tool to inform the ACCC about the estimated efficient cost of providing services on mobile networks in an Australian context. The modelled network can flexibly be configured to a hypothetical 2G/2.5G operator based on different assumptions regarding coverage and market share and for scenario applications to existing networks.

The original WIK-MNCM was developed in 2006/07 and was since subject to certain minor updates and is now more than 3 years out of date. Since it was first produced there have been significant developments in the mobile industry in both New Zealand and Australia, including a migration to 3G networks, increased penetration, and growth of data services. These changes pose a number of challenges for the WIK-MNCM. In addition, the WIK-MNCM is necessarily Australia specific. In “Cost of call origination, call termination, SMS and Data in Australia and New Zealand”, we explore the changes to the WIK-MNCM in more detail. They are briefly summarised in the following.

First, updates to the basic parameters like demand, equipment prices, asset lives, and population growth have been made. These are largely straightforward from a modelling perspective as they are direct inputs to the model and not elements that alter the basic fabric of the model. For both Australia and New Zealand, we assume the hypothetical operator has a 33.3 per cent market share. Second, by its very nature, the WIK-MNCM is a model of Australia and not New Zealand. It would take very considerable re-work to convert it to a true New Zealand specific model; however, it was possible to make adjustments to the basic geographical parameters of the model to create a proxy for New Zealand. Finally, the WIK-MNCM is a 2G/2.5G only model. As such, it would be impractical to adjust this model to accommodate newer generations of mobile technology that rely on IP. Instead, we investigated the impacts of newer technologies using newer WIK mobile models.

The table below summarises the service costs of an efficient Australian mobile operator with a 33.3 per cent market share based on the results of the WIK-MNCM model. A minute of voice origination is produced at lower costs than a minute of voice termination because on average origination user fewer network elements than termination.

Table 24: Costs per unit of services for an efficient operator (33.3 per cent market share), in Australia output of WIK-MNCM

Service	AU cents	Unit
Voice Termination	3.75	Per minute
Voice Origination	2.95	Per minute
Data (GPRS)	18.90	Per MB
SMS	0.009	Per message

Source: WIK

Since these cost outputs are based on 2G technology, they should be regarded as upper bound estimates. An operator facing existing and future demand patterns (especially demand for data) would not deploy 2G technology, but would instead deploy 3.5G or higher technologies, e.g. HSPA or LTE to cater for the increased data demand. Testing the implications of this using newer WIK models suggested that the use of

newer mobile technology does not lead to any substantial unit cost reduction at the current demand levels. Nevertheless, the service cost estimates should still be regarded as upper bound.

The table below summarises the service costs of an efficient New Zealand mobile operator with a 33.3 per cent market as produced by the WIK-MNCM.

Table 25: Costs per minute (cpm) of services for an efficient operator (33.3 per cent market share) in New Zealand, output of WIK-MNCM

Service	NZ cents (AU cents)	Unit
Voice Termination	3.67	Per minute
Voice Origination	3.32	Per minute
Data (GPRS)	20.79	Per MB
SMS	0.013	Per message

Source: WIK

The costs arrived at for New Zealand are similar to those for Australia. New Zealand is smaller than Australia and has a higher population density, which would tend to lead to lower mobile unit costs. More importantly, while the degree of urbanisation in New Zealand and the degree of penetration is similar to Australia, the share of cells that are required for coverage instead of traffic-driven is likely smaller than in Australia where the non-urbanised population would be expected to be dispersed over a much larger area. This also implies slightly lower unit cost for New Zealand. For the purpose of the modelling, we have assumed a more rugged landscape in New Zealand; however, the overall effect of this has not been to increase cost significantly. Likewise, the lower traffic per user would also be expected to increase cost. Again the impact is not enough to increase them above the levels in Australia.

5.3 International transit

International transit services are typically purchased by MNOs from an international transit operator for voice (and SMS) services⁸⁵ and from a GRX (roaming exchange) provider for data services. The service entails the transport of voice, SMS, and data between two countries' points of interconnection (international gateways) or the respective GRXs in the case of data.

Three Australian and three New Zealand MNOs provided responses to the questionnaires.

⁸⁵ Some may self-supply.

For voice, SMS and data, no explicit indication was given in the questionnaires as to the magnitude of the commercially agreed per minute, per message or per MB data international transit charge paid; however, three MNOs provided Trans-Tasman annual GRX fees that they paid to their respective GRX providers. One MNO reasoned that it was unable to provide a split between roaming related international transit and other international transit services [X].

Given the absence of useful data for voice and SMS, and given that the data transit charge calculated is an average across Australian and New Zealand MNOs, we have presented a summarized section, rather than splitting it between Australia and New Zealand.

5.3.1.1 Voice

Some figures were provided by MNOs for voice termination, including international transit; however, the proportion of termination versus transit was unclear. When isolating the transit part of the charge, the resulting value of [X] appears high, particularly when considering that origination and termination costs, which make the biggest bulk of roaming wholesale costs for voice, are around AU\$0.03 each. [X]

Given the uncertainty regarding the transit charge derived, we have relied on the European estimate of €0.02 per minute for voice (NZ\$0.04 and AU\$0.03 per minute based on the 10 year average exchange rate).

5.3.1.2 SMS

For SMS, no figure was provided. We have relied on the European estimate provided by NITA in its 2008 “Analysis of Prices and Costs for Mobile Data Services Abroad” of zero.

5.3.1.3 Data

For data, three MNOs provided their 2011 annual fees paid to their respective GRX providers for Trans-Tasman roaming. (One MNO only provided a GRX figure for roaming on all foreign networks.) [X] WIK believes that it is likely that GRX charges exhibit scale economies. In any case, we took the GRX figures that were provided as a starting point to calculate the per MB charges and based them each on the total outgoing Trans-Tasman roaming traffic generated by each of the three MNOs. Subsequently, we calculated the average per MB charge of AU\$0.02 [X].

5.4 Signalling

This section provides our estimates for signalling by roaming scenario. Two Australian and three New Zealand operators responded to the questionnaires.

5.4.1 Australia

Two responses were received in relation to signalling. One response showed that signalling is charged on a cost per message signalling unit basis (MSU). The number of MSUs varies for each of the different roaming scenarios, and MSUs are also generated for registration of idle customers. Thus, none of the operators were able to provide an estimate for the costs of signalling per roaming scenario; however, the response of one operator placed the per MSU costs at US\$[<], which is significantly below the Analysys Mason cost per signal estimate of US\$0.0005. We therefore assume an average cost per MSU of US\$0.000305 as a conservative estimate.

One MNO provided a detailed breakdown of the number of MSUs incurred / the number of signalling messages generated per roaming scenario for inbound and outbound roaming. The number of MSUs for prepaid and postpaid inbound and outbound call roaming (making and receiving a call), for inbound and outbound SMS roaming (sending and receiving an SMS), and for inbound and outbound data roaming is summarized in Table 26.

Table 26: Number of MSUs generated per prepaid (CAMEL) and postpaid (Non-CAMEL) roaming scenario

Roaming Scenario	Prepaid (CAMEL)	Postpaid (Non-CAMEL)
Inbound (calls made)		
Local call	6-10 MSUs	0-2 MSUs
Call back home	12-18 MSUs	6-10 MSUs
Call to a 3 rd country	12-18 MSUs	6-10 MSUs
Outbound (calls made)		
Local call	2-4 MSUs	0-2 MSUs
Call back home	8-12 MSUs	6-10 MSUs
Call to a 3 rd country	2-4 MSUs	0-2 MSUs
Inbound (calls received)		
Local call	9-15 MSUs	9-15 MSUs
Call back home	8-14 MSUs	8-14 MSUs
Call to a 3 rd country	8-14 MSUs	8-14 MSUs

Roaming Scenario	Prepaid (CAMEL)	Postpaid (Non-CAMEL)
Outbound (calls received)		
Local call	9-15 MSUs	9-15 MSUs
Call back home	8-14 MSUs	8-14 MSUs
Call to a 3rd country	9-15 MSUs	9-15 MSUs
Inbound SMS sent	2-4 MSUs	2-4 MSUs
Inbound SMS received	2-4 MSUs	2-4 MSUs
Outbound SMS sent	2-4 MSUs	2-4 MSUs
Outbound SMS received	2-4 MSUs	2-4 MSUs
Inbound data	2-6 MSUs	2-6 MSUs
Outbound data	2-6 MSUs	2-6 MSUs

Source: WIK, Australian operator

On the basis of this breakdown, and assuming the average cost of US\$0.000305, as calculated above, we estimate the costs of signalling per inbound and outbound roaming scenario in Table 27. In the absence of a meaningful split for prepaid and postpaid traffic across New Zealand and Australia, we show the prepaid values as a conservative upper bound estimate.

Table 27: Signalling costs per roaming scenario (per call, per SMS and per MB)

Type of call	Prepaid (max MSUs)	Postpaid (max MSUs)	Blended (max MSUs)	Australia Costs (AU\$ cents)	New Zealand Costs (NZ\$)
Inbound calls made					
Local call	10.0	2.0	2.8	0.19	0.23
Call back home	18.0	10.0	10.8	0.34	0.42
Call to a 3rd country	18.0	10.0	10.8	0.34	0.42
Outbound calls made					
Local call	4.0	2.0	2.2	0.08	0.09
Call back home	12.0	10.0	10.2	0.23	0.28
Call to a 3rd country	4.0	2.0	2.2	0.08	0.09
Inbound calls received					
Local call	15.0	15.0	15.0	0.29	0.35
Call back home	14.0	14.0	14.0	0.27	0.33
Call to a 3rd country	14.0	14.0	14.0	0.27	0.33
Outbound calls received					
Local call	15.0	15.0	15.0	0.29	0.35

Type of call	Prepaid (max MSUs)	Postpaid (max MSUs)	Blended (max MSUs)	Australia Costs (AU\$ cents)	New Zealand Costs (NZ\$ cents)
Call back home	15.0	14.0	14.1	0.29	0.35
Call to a 3rd country	15.0	15.0	15.0	0.29	0.35
SMS					
Inbound SMS sent	4.0	4.0	4.0	0.08	0.09
Inbound SMS received	4.0	4.0	4.0	0.08	0.09
Outbound SMS sent	4.0	4.0	4.0	0.08	0.09
Outbound SMS received	4.0	4.0	4.0	0.08	0.09
Data					
Inbound data	6.0	6.0	6.0	0.11	0.14
Outbound data	6.0	6.0	6.0	0.11	0.14

Source: WIK

5.4.2 New Zealand

For New Zealand, three operators provided responses to the questionnaires. One operator stated that although they recorded the total number of signalling messages related to roaming voice and SMS, they were unable to differentiate between roaming scenarios, or between inbound and outbound roaming or SMS; moreover, they did not count the signalling messages related to voice separately. None of the New Zealand operators provided an estimate as to the MSU costs.

Given the absence of New Zealand specific figures, but also given that signalling probably does not differ significantly between different operators, we have used the Australian figures for New Zealand.

5.5 Retail costs

This section sets out the roaming retail costs estimated for Australia and New Zealand. Three Australian and three New Zealand operators responded to the questionnaires.

5.5.1 Australia

Only one MNO provided an estimate of total Trans-Tasman roaming retail costs derived from total roaming revenues. In the absence of other data, we used this as the basis for our estimate for all Australian MNOs (and also for all New Zealand MNOs). We had no basis on which to assess the degree to which these costs might vary among the MNOs.

In order to derive per minute, per SMS and per MB retail costs, WIK made necessary adjustments to the retail revenue provided, and then allocated the revenue-share-based total Trans-Tasman roaming retail cost per annum provided by the MNO that responded. WIK apportioned that retail cost across voice, SMS and data using the percentage retail revenues for voice, SMS and data for that MNO for Trans-Tasman roaming traffic, suitably adjusted and consistent with international best practice.

Traffic is often used as a basis of allocating modelled network costs; however, it is clearly inappropriate for allocating retail costs, which have little or nothing to do with traffic volumes.

Retail costs are generally considered to lie in the range of 20-25% of retail revenues. The single MNO that provided data fell [X] in this range [X].

Allocating retail costs in proportion to retail revenues for the respective services generated a per minute voice retail cost of AU\$ cent 26.7, a per SMS retail cost of AU\$ cent 17, and a per MB data retail cost of AU\$ cent 25. The calculations are set out in Table 28. Note that voice minutes reflect both incoming and outgoing calls, since both are associated with retail revenues.

Table 28: Calculation of retail cost per unit

Traffic type	Percentage split	Retail cost allocation	Unit cost in AU\$ cents (per minute, per SMS, per MB)
Allocation using revenue			
Voice	[X]	[X]	26.685
Data	[X]	[X]	25.183
SMS	[X]	[X]	17.055

Source: WIK

5.5.2 New Zealand

None of the New Zealand operators provided any indication of retail costs.

Given the absence of information received for New Zealand, we used the roaming retail cost figures derived for Australia and converted them into NZ\$ cents based on the 10-year average exchange rate of 1.18 in our scenario cost calculations.

5.6 Roaming overheads

This section sets out the roaming overhead costs estimated for Australia and New Zealand. Three Australian and three New Zealand operators responded to the questionnaires; however, only one MNO provided complete and comprehensive answers. Thus, we once again had only limited ability to assess the degree to which these costs might vary among the MNOs.

5.6.1 Australia

Three responses were received from Australian MNOs, who were all in agreement that roaming overhead costs consisted of the overarching components of agreements and testing, signalling, data clearing; and financial clearing.

One operator provided a detailed breakdown of roaming specific costs, which we used as the basis on which to derive per minute, per SMS and per MB roaming overhead costs; however, our derived values reflect substantial re-work and interpretation of the data provided. In the absence of other data, we used this estimate for all Australian MNOs (and also for all New Zealand MNOs).

WIK considered apportioning roaming specific costs across voice, SMS and data using (1) the percentage traffic volumes for voice, SMS and data for that MNO for Trans-Tasman roaming traffic, (2) the percentage revenues for voice, SMS and data for that MNO for Trans-Tasman roaming traffic, and (3) the simple arithmetic mean of those percentages for voice, SMS and data.

Traffic is often used as a basis of allocating modelled network costs, but in this case we felt that the traffic percentages generated inappropriate results for two reasons. First, many of the mobile roaming specific costs have little to do with network traffic, but are rather driven by the number of subscribers. Second, the results would have allocated nearly all of the costs to roaming data, which seemed improper given that about half of the revenues were associated with voice and SMS.

We settled on taking the simple average of these two percentages as a perhaps somewhat crude but pragmatic approach. Costs derived are AU\$ cent 1.9 per minute for voice, AU\$ cent 0.66 per SMS, and AU\$ cent 2.8 per MB for data. The calculations are set out in Table 29.

Table 29: Calculation of roaming overhead costs per unit

Traffic type	Percentage split	Roaming overhead cost allocation	Unit cost in AU\$ cents (per minute, per SMS, per MB)
Allocation using traffic (MB)			
Voice	[X]	[X]	0.343
Data	[X]	[X]	3.631
SMS	[X]	[X]	0.001
Allocation using revenue			
Voice	[X]	[X]	2.053
Data	[X]	[X]	1.937
SMS	[X]	[X]	1.312
Allocation using the average of traffic and revenue			
Voice	23%	192.039	1.198
Data	72%	607.870	2.784
SMS	6%	48.008	0.657

Source: WIK

To enable comparison, we have converted voice and SMS traffic into the number of MB of traffic per year that they represent over the airlink, recognising that airlink consumption is the greatest contributor to cost of a mobile network. We have assumed that UMTS technology will be used for voice in the coming years, that approximately 20 Kbps are required to carry a voice channel over UMTS under realistic assumptions, and that bidirectionality can be ignored since the medium provides symmetric bandwidth in any case. For SMS, we have once again assumed that 400 SMS messages represent a traffic load equivalent to 1 minute of voice.

5.6.2 New Zealand

Two responses were received from New Zealand MNOs that, however, did not provide any quantification of total roaming specific costs for voice, SMS and data. One operator did provide estimates for financial clearing and for data clearing for 2011, as well as full time equivalents for the maintenance of roaming agreements and explained that testing costs were ongoing costs rather than initial one-off costs.

Given the limited usability of information received for New Zealand, we have used the roaming overhead cost figures derived for Australia and converted into NZ\$ cents based on the 10-year average exchange rate of 1.18 in our scenario cost calculations.

6 Trans-Tasman mobile roaming costs for Australian and New Zealand visited and home networks

This section provides an overview of (1) the total 2011 cost per Trans-Tasman roaming scenario for all Trans-Tasman roaming scenarios presented in Table 30; and (2) the different 2011 proportions of roaming cost components for a selection of Trans-Tasman roaming scenarios shown in Sections 6.2 - 6.6. The cost proportions are presented as a percentage of visited network wholesale costs and home network retail costs for

- calls made home;
- calls received from home;
- SMS sent home;
- SMS received from home; and
- data accessed.

In order to interpret figures correctly, it should be noted that IOTs that are paid by the home network to the visited network represent an external cost to the home network, i.e. these costs are not incurred internally by the home network as a consequence of roaming activities of its subscribers. However, the internal network costs incurred by the visited network presumably set a lower bound on the IOT charged by the visited network to the home network. As can be seen in all figures and graphs contained in this section, IOTs charged by the visited networks are well in excess of the costs that MNOs actually incur.

As regards the sources of the estimates used to create the graphs and tables, where estimates were not available from the questionnaire responses, we have used available European estimates. Where Trans-Tasman estimates were not available for all operators, we have used estimates of one operator as a proxy for the other operators. For currency conversion, we have used the 10-year average exchange rate of monthly measurements from July 2001 to June 2011 sourced from the Reserve Bank of Australia.

6.1 Trans-Tasman roaming scenario overview table

This section provides an overview table of the Trans-Tasman roaming scenarios and respective total roaming costs incurred per scenario for both Australia and New Zealand (1) in the capacity of the home network and (2) in the capacity of the visited network. For example, for scenario 1, an Australian MNO in the capacity of the home network incurs AU\$ cent 103 of cost per minute when one of its roamers makes a call in New Zealand; in the capacity of the visited network, the Australian network incurs AU\$ cent 60 of cost per minute when a New Zealand roamer makes a call on its network.

In relation to Scenarios 4-6, WIK notes that total home network scenario costs should slightly in principle differ slightly based on where the call originates and the different corresponding internal termination and re-origination costs incurred in the home network; however, we consider these differences to be de minimis. Given that WIK estimates these costs to be negligible and has set them to zero, the cost stacks for Scenarios 4-6 are the same.

Table 30: Overview table of total Trans-Tasman 2011 costs per roaming scenario by visited and home network

	Cost components	Australia (AU\$ cent)	New Zealand (NZ\$ cent)
Scenario 1: Calls made inside the visited country			
Home network	IOTV + ROCV + SCVLCM.HN + RTCV	103.0	78.8
Visited network	OCV + SCVLCM.VN + (TCV or FTCHV or MTCHV) + ROCV	6	6.3
Scenario 2: Calls made back home from a visited country			
Home network	IOTV + ROCV + SCVHCM.HN + RTCV	103.1	78.9
Visited network	OCV + SCVHCM.VN + (FTCHV or MTCHV) + ITCHV + ROCV	9.8	12.6
Scenario 3: Calls made from a visited country to a third country			
Home network	IOTV + ROCV + SCVHCM.HN + RTCV	103.0	78.8
Visited network	OCV + SCVHCM.VN + (FTCHV or MTCHV) + ITCHV + ROCV	10.9	12.6
Scenario 4: Calls received from home while roaming in a visited country			
Home network	ITROC + SCVHCM.HN + ITCHV + ROCV + RTCV + MTCHV	37.2	47.5
Visited network	TCV + SCHCM.VN + ROCV	5.1	5.2
Scenario 5: Calls received from a third country while roaming in a visited country			
Home network	ITROC + SCVHCM.HN + ITCHV + ROCV + RTCV + MTCHV	37.2	47.5
Visited network	TCV + SCHCM.VN + ROCV	5.1	5.2
Scenario 6: Calls received while roaming on a visited network from a subscriber from the visited country			
Home network	ITROC + ITCHV + SCVLCR.HN + ROCV + (TCV visited - TCV home) + RTCV +	37.2	47.5

	Cost components	Australia (AU\$ cent)	New Zealand (NZ\$ cent)
	MTCHV		
Visited network	TCV + SCVLCR.VN + ROCV + ITCHV	8.4	9.1
Scenario 7: SMS sent home while roaming on a visited network			
Home network	IOTS + TCS + SCSS.HN + ROCS + RTCS	37.3	38.2
Visited network	OCS + ITCHS+ SCSS.VN + ROCS	0.8	0.9
Scenario 8: SMS sent to a third country while roaming on a visited network			
Home network	IOTS + ITCHS + TCHS.VN + SCSS.HN + ROCS + RTCS	37.3	38.2
Visited network	OCS + ITCHS+ SCSS.VN + ROCS	0.8	0.9
Scenario 9: SMS sent within the visited country while roaming on a visited network			
Home network	IOTS + ITCHS + TCS + SCSS.HN + ROCS + RTCS	37.3	38.2
Visited network	OCS + ITCHS + SCSS.VN + ROCS	0.8	0.9
Scenario 10: SMS received from home while roaming on a visited network			
Home network	SCSR.HN + ROCS + RTCS	17.8	21.0
Visited network	TCS + SCSR.VN + ROCS	0.8	0.9
Scenario 11: SMS received while roaming on a visited network from a subscriber of the visited country			
Home network	SCSR.HN + ROCV + RTCS	17.8	21.0
Visited network	TCS + SCSR.VN + ROCS	0.8	0.9
Scenario 12: SMS received from a third country while roaming on a visited network			
Home network	SCSR.HN + ROCS + RTCS	17.8	21.0
Visited network	TCS + SCSR.VN + ROCS	0.8	0.9
Scenario 13: Data / Using the Internet while roaming on a visited network			
Home network	IOTD + DNC + ITCHD + ISPCH + SCD.HN + ROCD + RTCD	94.7	79.3
Visited network	DTC + SCD.VN + ROCD + ITCHD	24.7	27.5

Source: WIK

The table shows that the magnitude of the costs incurred by Australian and New Zealand networks in the capacity of visited and home networks are similar. It should be noted, however, that the apparent similarity is to some extent a consequence of the fact that the same retail costs and roaming-specific costs were estimated for both countries, given the absence of country-specific data. Moreover, the 10-year average exchange rate has been used to convert currencies, which may have had a smoothing effect. Differences in costs can be explained by the country-specific network costs modelled and the country-specific IOTs paid.

IOTs are the weighted average Trans-Tasman third-party payments made to visited networks that MNOs provided in response to questionnaire B. The questionnaire responses indicate that trans-Tasman IOT payment rates can vary greatly among different pairs of Australian and New Zealand MNOs.

For Scenario 1 (calls made inside the visited country), WIK notes that a blended termination charge was used to account for mobile on-net termination and fixed and mobile off-net termination. The assumptions used for on-net and off-net traffic were those used in the WIK cost model, namely 23% on-net mobile, 47% off-net mobile and 30% off-net fixed. Scenarios 2 and 3 use a blended termination charge to account for fixed and mobile traffic based on the assumption of 30% and 70%, respectively.

The weighted average termination charge calculated for Australia and New Zealand for a call made inside the visited country (Scenario 1), is AU\$1.8 and NZ\$1.47. For a call made home (Scenario 2), the weighted average termination charge that is paid by the visited network to the terminating network is AU\$3.29 and NZ\$2.6.⁸⁶

For Scenario 3 (calls made from a visited country to a third country) it should be noted that the visited country network incurs termination costs in the form of a termination charge paid to the terminating third country network. As no average third country termination charge was available to us, we have used the blended termination rate charged by Australian fixed and mobile operators, which is higher than the fee for New Zealand, to account for a potentially higher third country weighted average termination charge. For Scenario 8 (an SMS sent to a third country), the home network incurs SMS termination costs in the form of an SMS termination charge paid to the terminating third country network. As no average third country SMS termination charge was available to us, we have used the New Zealand SMS termination charge.

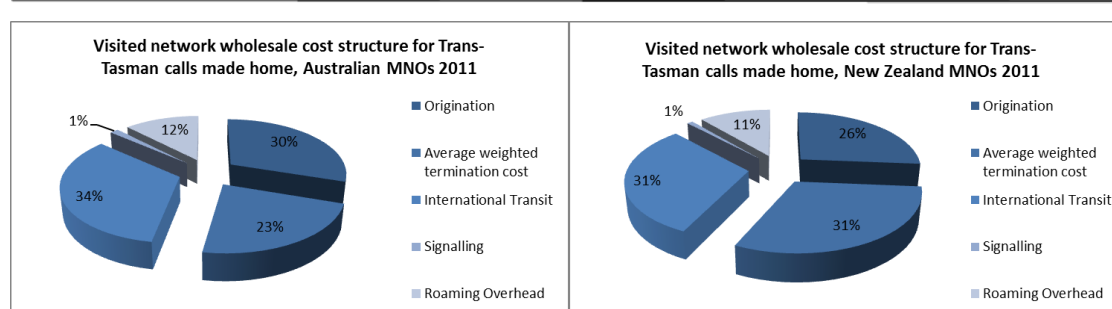
⁸⁶ Please note that the visited network pays the other country's termination charge – for Australia, the New Zealand charge is taken and converted based on the 10 year average exchange rate of 0.848. Thus, an Australian MNO pays AU\$2.20. For New Zealand, the Australia charge is taken and converted based on the 10 year average exchange rate of 1.179. Thus, a New Zealand MNO pays NZ\$3.88.

6.2 Calls made while roaming on an Australian or New Zealand visited network

This section shows the wholesale cost structure of the visited network and the retail cost structure of the home network for a call made home by a roamer on the visited network for Australia and New Zealand.

Figure 29 shows the wholesale cost structure of the Australian visited network and the New Zealand visited network for a Trans-Tasman call made home while roaming in Australia and New Zealand, respectively.

Figure 29: Wholesale cost structure of the visited network for Australia and New Zealand for a Trans-Tasman call made home while roaming on the visited network for Australia and New Zealand in 2011



As one might expect, for both Australian and New Zealand MNOs, origination and termination take the largest share. The estimates used to create the charts are set out in Table 31.

Table 31: Visited network cost estimates for Trans-Tasman calls made home while roaming for Australia and New Zealand 2011

Cost Component ⁸⁷	Australia visited network cost 2011 (per minute in AU\$ cent)	New Zealand visited network cost 2011 (per minute in NZ\$ cent)
Origination	2.95	3.32
Weighted average termination cost	2.20	3.88
International transit	3.30	3.91
Signalling	0.14	0.11
Roaming overheads	1.20	1.41

Source: WIK

As regards the sources of the estimates, origination is the origination cost in the respective Australian and New Zealand visited network generated by the WIK mobile cost model. Termination entails a blended termination charge, given that a call made home could terminate either on the roamer's home network or on another mobile network or the fixed network in the home country. The charge consists of on-net, off-net mobile and off-net fixed termination based on the typical traffic assumptions of 23% on-net, 47% off-net mobile and 30% off-net fixed as used in the WIK mobile cost model. The mobile termination charge for Australia was sourced from the ACCC's "Inquiry into final access determination for the domestic mobile termination access service (MTAS)" of 23 September 2011 for Australia, and for New Zealand from the Commerce Commission's Decision 724 of 5 May 2011.⁸⁸ The on-net termination costs are outputs from the WIK cost model, and the fixed termination charges were provided to us by MED and DBCDE.⁸⁹

The questionnaire responses did not generate sufficiently robust estimates for international transit. We have therefore used European estimates of €c2.

⁸⁷ The estimates contained in

Table 31 have been sourced as follows: origination and termination from Australia:

<http://www.accc.gov.au/content/item.phtml?itemId=1008711&nodeId=55a030ad4aa7adc7dda5dba6b2623e5c&fn=MTAS%20-%20draft%20final%20access%20determination%20-%2023%20September%202011.pdf> ; New Zealand:

<http://media.nzherald.co.nz/webcontent/document/pdf/201119/Final-MTAS.pdf>. The European estimates of €c2 has been taken and converted into NZ\$ and AU\$ based on the exchange rate of 29 March 2011 from www.xe.com ; signaling estimates have been taken from Table 27 and converted into AU\$ and NZ\$ based on the exchange rate of 29 March 2011 from www.xe.com. For roaming overheads the European of €c2 value has been taken and converted. The wholesale price was provided in the responses to the questionnaires as third-party charges to the home network.

⁸⁸ Australia:

<http://www.accc.gov.au/content/item.phtml?itemId=1008711&nodeId=55a030ad4aa7adc7dda5dba6b2623e5c&fn=MTAS%20-%20draft%20final%20access%20determination%20-%2023%20September%202011.pdf> ;

New Zealand: <http://media.nzherald.co.nz/webcontent/document/pdf/201119/Final-MTAS.pdf>.

⁸⁹ Fixed termination figures were sourced by MED and DBCDE from the ACCC and ComCom.

As regards signalling, we have used the estimates as set out in Table 27 based on inputs from operators and WIK's calculations. We have used the maximum values of the prepaid ranges provided to generate a conservative estimate.

Retail costs and roaming overhead costs were calculated as described in Sections 5.5 and 5.6 respectively to arrive at per minute, per SMS and per MB costs.

Figure 30 shows the retail cost structure of the Australian home network and the New Zealand home network for a Trans-Tasman call made while roaming in Australia and New Zealand, respectively. The charts show that the IOT represents a sizable external cost to the home network. IOT costs are higher to the Australian home networks than costs to the New Zealand home networks for a call made while roaming, which implies that New Zealand MNOs charge Australian MNOs more for enabling their subscribers to roam on New Zealand networks than Australian operators charge for the same service. IOTs are the weighted average Trans-Tasman third-party charges provided by the MNOs in response to questionnaire B. Retail costs to both Australian and New Zealand MNOs are the largest internal costs incurred; however, one should bear in mind that the level of retail cost allocated is itself an artefact of the overall level of retail prices for mobile roaming. The estimates used to create the charts are set out in Table 32 and described below.

Figure 30: Retail cost structure of the home network in Australia or New Zealand for a Trans-Tasman call made home in the visited network 2011

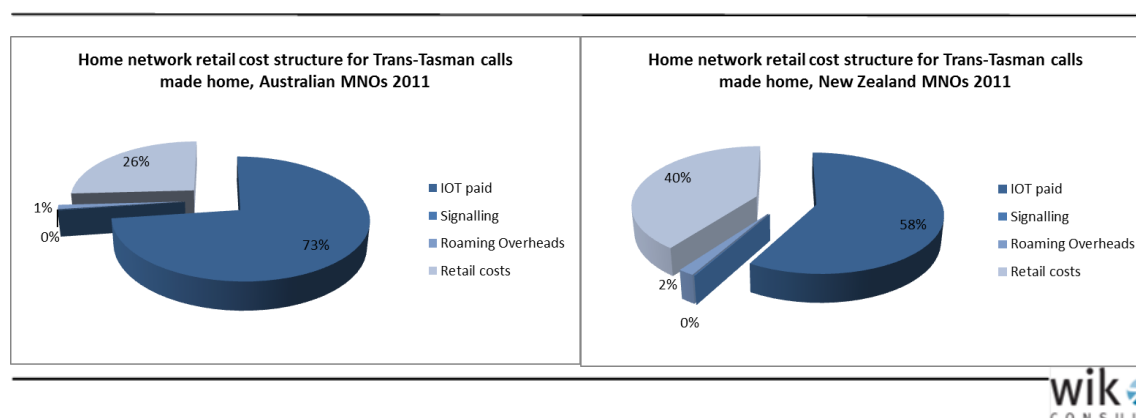


Table 32 shows the cost estimates to the home networks used for Trans-Tasman calls made while roaming in Australia and New Zealand.

Table 32: Home network cost estimates for Trans-Tasman calls made home in Australia or New Zealand 2011

Cost Component	Australia home network cost 2011 (per minute in AU\$ cent)	New Zealand home network cost 2011 (per minute in NZ\$ cent)
IOT paid	75.14	45.92
Roaming overheads	1.20	1.41
Signalling	0.09	0.08
Retail costs	26.68	31.45

Source: WIK

6.3 Calls received while roaming on an Australian or New Zealand visited network

This section presents the wholesale cost structure of the visited network and the retail cost structure of the home network for a call received from home by a roamer on the visited network in Australia or New Zealand.

Figure 31 shows the wholesale cost structure of the Australian visited network and New Zealand visited network for a Trans-Tasman call received while roaming in Australia and New Zealand, respectively. As is apparent, termination costs take up the largest proportion of costs for both Australia and New Zealand, in this scenario. Roaming overhead costs also represent a sizable share, whereas signalling is only around 1% of total roaming costs.

Figure 31: Wholesale cost structure of the visited network in Australia and New Zealand for a call received in the visited network in 2011

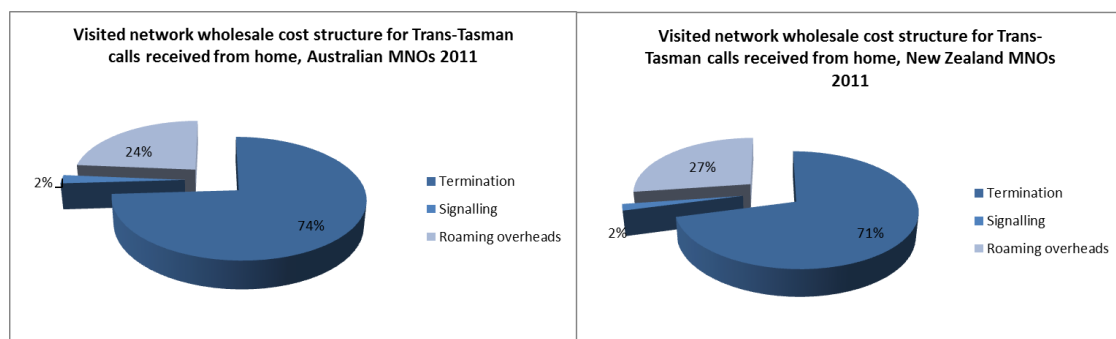


Table 33 shows the Australian and New Zealand visited networks' Trans-Tasman cost estimates for a call received while roaming in Australia and New Zealand.

Table 33: Visited network cost estimates for a call received from home while roaming for Australia and New Zealand 2011

Cost Component	Australia visited network costs 2011 (per minute in AU\$ cent)	New Zealand visited network costs 2011 (per minute in NZ\$ cent)
Termination	3.75	3.67
Signalling	0.12	0.10
Roaming overheads	1.20	1.41

Source: WIK

As regards the sources of the estimates as used in above tables and charts, termination was sourced from the WIK cost model, international transit is based on GRX fees over traffic provided by MNOs, while signalling is sourced from Table 27 based on inputs from operators and WIK's calculations. Roaming overhead costs were calculated as described in Section 5.6.

Figure 32 shows the retail cost structure of the home network in Australia and the home network in New Zealand for a call received in the visited network. The largest cost component that both networks face is the retail cost. WIK notes that retail costs have been calculated based on a revenue-derived total Trans-Tasman cost figure as described in Section 5.5. The level of retail costs allocated to mobile roaming thus reflects the overall level of retail costs for mobile roaming.

Figure 32: Retail cost structure of the home network in Australia and New Zealand for a call received from home in the visited network 2011

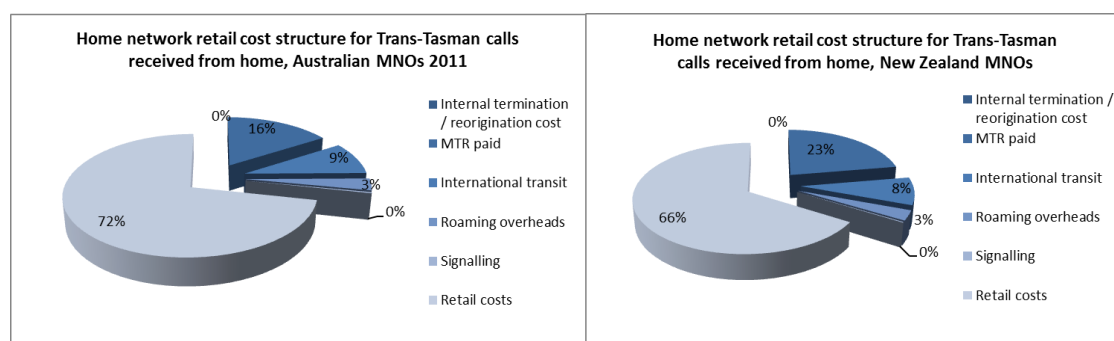


Table 34 shows the home network cost estimates for a call received while roaming in Australia and New Zealand.

Table 34: Home network cost estimates for a call received while roaming for Australia and New Zealand 2011

Cost Component	Australia home network cost 2011 (per minute in AU\$ cent)	New Zealand home network cost 2011 (per minute in NZ\$ cent)
MTR paid	5.94	10.61
Internal termination and re-origination cost	0	0
International transit	3.30	3.91
Roaming overheads	1.20	1.41
Signalling	0.12	0.10
Retail costs	26.68	31.45

Source: WIK

6.4 SMS sent while roaming on an Australian or New Zealand visited network

This section shows the wholesale cost structure of the visited network and the retail cost structure of the home network for an SMS sent home by a roamer on the visited network for Australia or New Zealand.

Figure 33 shows the wholesale cost structure of the visited network in Australia and of the visited network in New Zealand for an SMS sent in the visited network. The largest costs faced by both Australian and New Zealand MNOs in the capacity of visited networks for the roaming scenario where a foreign roamer sends an SMS are roaming overhead costs, followed by signalling costs. Network costs of origination are very small.

Figure 33: Wholesale cost structure of the visited network for an SMS sent while roaming on the visited network for Australia and New Zealand in 2011

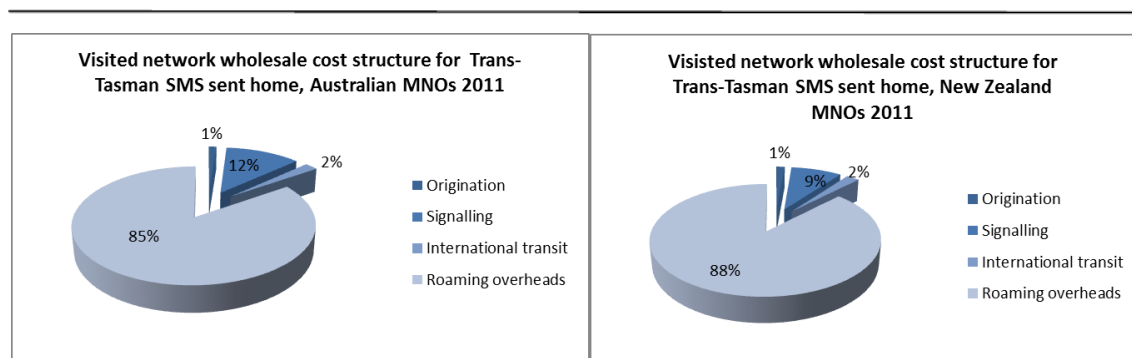


Table 35 presents the estimates used to produce the charts. As is apparent, costs to the home network for an SMS sent by one of the home network's customers while roaming in Australia and New Zealand are very small at around AU\$ cent 1 and NZ\$ cent 1.1. Origination was sourced from the WIK cost model, signalling is based on MNO input and WIK calculations, and roaming overhead costs have been calculated based on MNOs' estimates of total Trans-Tasman roaming-related overhead costs and then allocated as described in Section 5.6 to arrive at per minute, per SMS and per MB costs. No information was provided by MNOs regarding international transit charges for SMS. WIK notes that SMS messages are sent via dedicated signalling links over the SS7 network or sent to an SMS hub. We also note NITA's estimation that SMS international transit costs are "close to zero". With all of this in mind, we have calculated a cost of AU\$ cent 0.016 and NZ\$ cent 0.02 per SMS.

Table 35: Visited network cost estimates for SMS sent while roaming for Australia and New Zealand 2011

Cost Component	Australia visited network costs 2011 (per minute in AU\$ cent)	New Zealand visited network cost 2011 (per minute in NZ\$ cent)
Origination	0.01	0.01
Signalling	0.09	0.08
International transit	0.02	0.02
Roaming overheads	0.66	0.77

Source: WIK

Figure 34 shows the retail cost structure of the home network in Australia and New Zealand for an SMS sent. Wholesale costs are slightly higher to Australian MNOs, given

the higher IOTs charged by New Zealand operators. While costs of signalling and roaming overheads are small, retail costs present a little under and a little over half of the total roaming costs for Australian and New Zealand MNOs in the capacity of home networks, respectively. As always, one should bear in mind that the level of retail cost allocated to the mobile roaming service is itself a function of the overall level of mobile roaming retail prices.

Figure 34: Retail cost structure of the home network for Australia and New Zealand for an SMS sent while roaming on the visited network in 2011

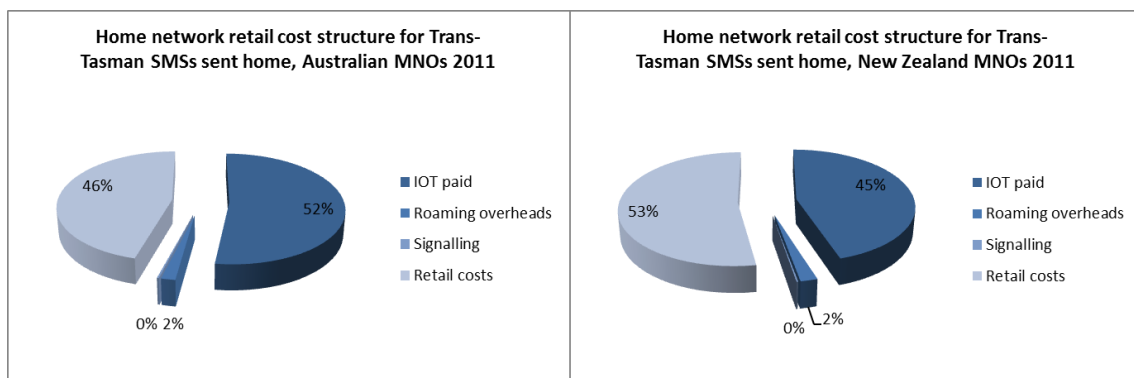


Table 36 shows the home network retail cost estimates for an SMS sent while roaming in Australia and New Zealand. Once again, the IOTs are average Trans-Tasman third-party charges provided by the MNOs in response to questionnaire B, signalling is based on MNO inputs and WIK calculations, and roaming overhead and retail costs were calculated as described in Sections 5.6 and 5.5 respectively to arrive at per minute, per SMS and per MB costs.

Table 36: Home network cost estimates for a Trans-Tasman SMS sent in Australia and New Zealand in 2011

Cost Component	Australia home network cost 2011 (per minute in AU\$ cent)	New Zealand home network cost 2011 (per minute in NZ\$ cent)
IOT paid	19.46	17.20
Signalling	0.09	0.08
Roaming overheads	0.66	0.77
Retail costs	17.06	20.10

Source: WIK

6.5 SMS received from home while roaming on an Australian or New Zealand visited network

This section shows the wholesale cost structure of the visited network and the retail cost structure of the home network for an SMS received from home by a roamer on the visited network for Australia and New Zealand.

Figure 35 shows the wholesale cost structure of the visited network in Australia and the visited network in New Zealand for an SMS received from home in the visited network in 2011.

Figure 35: Wholesale cost structure of the visited network in Australia or New Zealand for an SMS received while roaming on the visited network in 2011

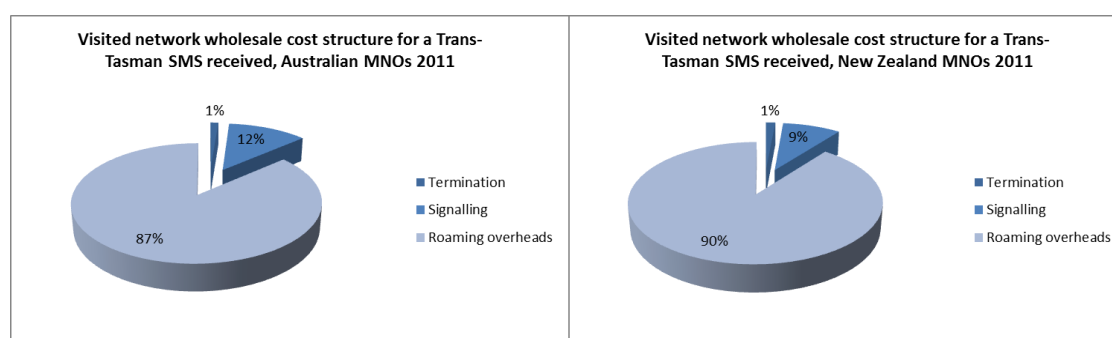


Table 37 shows the wholesale cost structure of the home network in Australia and New Zealand for an SMS received. The largest costs incurred by the visited network are the roaming overhead costs. However it should be noted, that cost incurred by the visited network for an SMS received are very small at less than one Australian and less than one New Zealand cent.

Table 37: Visited network cost estimates for a Trans-Tasman SMS received in Australia and New Zealand 2011

Cost Component	Australia visited network costs 2011 (per minute in AU\$ cent)	New Zealand visited network cost 2011 (per minute in NZ\$ cent)
Termination	0.01	0.01
Signalling	0.09	0.08
Roaming overheads	0.66	0.77

Source: WIK

Figure 36 shows the retail cost structure of the home network in Australia and New Zealand for an SMS received.

Figure 36: Retail cost structure of the home network for Australia and New Zealand for an SMS received while roaming on the visited network in 2011

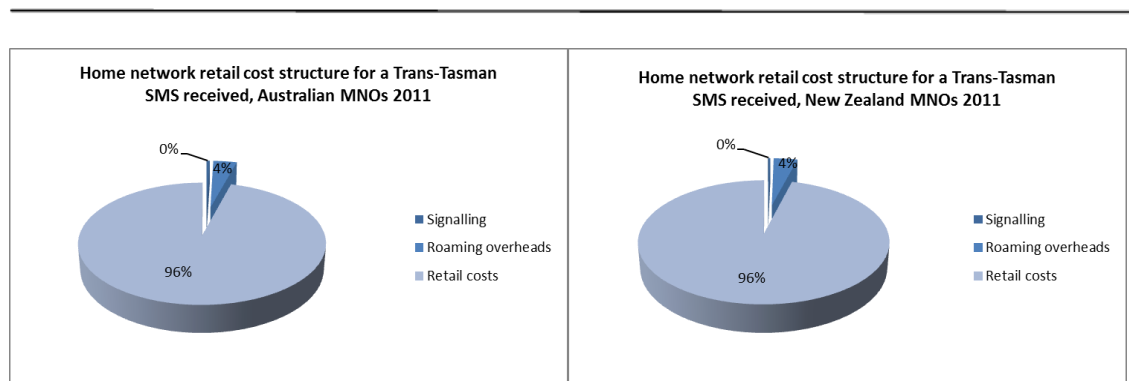


Table 38 shows the home network retail cost estimates for an SMS received while roaming in Australia and New Zealand. Given that the SMS is routed directly from the sending network to the visited network on which the roamer is roaming, the home network does not incur any origination or international transit costs.

Table 38: Home network cost estimates for a Trans-Tasman SMS received in Australia and New Zealand in 2011

Cost Component	Australia home network costs 2011 (per minute in AU\$ cent)	New Zealand home network cost 2011 (per minute in NZ\$ cent)
Signalling	0.09	0.08
Roaming overheads	0.66	0.77
Retail costs	17.06	20.10

Source: WIK

6.6 Data accessed while roaming on an Australian or New Zealand visited network

This section shows the wholesale cost structure of the visited network and the retail cost structure of the home network for data accessed by a roamer on the visited network for Australia and New Zealand.

Figure 37 shows the wholesale cost structure of the visited network in Australia and the visited network in New Zealand for data accessed in the visited network in 2011. Data traffic costs take the highest share for both Australian and New Zealand MNOs.

Figure 37: Wholesale cost structure of the visited network in Australia or New Zealand for data accessed while roaming on the visited network in 2011

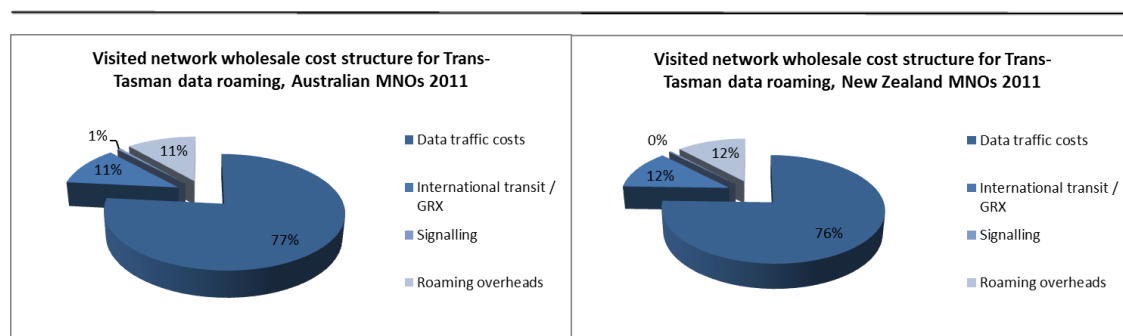


Table 39 shows the visited network cost estimates for Trans-Tasman data roaming in Australia and New Zealand. The data traffic cost estimates are an output from the WIK model, while international transit, roaming overheads and signalling have been calculated by WIK based on MNO input.

Table 39: Visited network cost estimates for Trans-Tasman data roaming in Australia and New Zealand 2011

Cost Component	Australia visited network cost 2011 (per minute in AU\$ cent)	New Zealand visited network cost 2011 (per minute in NZ\$ cent)
Data traffic costs	18.90	20.79
International transit	2.85	3.36
Signalling	0.14	0.11
Roaming overheads	2.78	3.28

Source: WIK

Figure 38 shows the retail cost structure of the Australian home network and the New Zealand home network for Trans-Tasman data accessed in the visited network. While international transit, signalling and roaming overhead costs take a smaller share, the IOT paid and the retail costs incurred make the largest contribution to both Australian

and New Zealand MNO costs. Australian MNOs pay higher unit prices to New Zealand MNOs for the usage of New Zealand networks by their roaming subscribers than New Zealand MNOs pay to Australian MNOs. Once again, in interpreting retail costs one should bear in mind that the overall level of retail costs is to a significant degree a result of the level of retail prices.

Figure 38: Retail cost structure of the home network in Australia or New Zealand for data accessed in the visited network in 2011

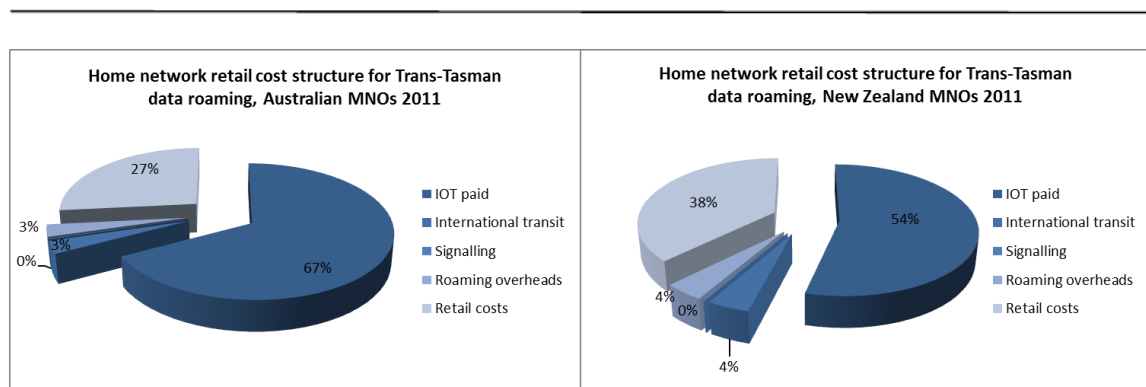


Table 40 shows the home network cost estimates for Trans-Tasman data roaming for Australia and New Zealand. The IOT is the average third-party charges provided by Australian and New Zealand MNOs in response to questionnaire B. International transit, signalling, roaming overheads and retail costs were calculated by WIK based on MNO input.

Table 40: Home network cost estimates for Trans-Tasman data roaming in Australia or New Zealand in 2011

Cost Component	Australia home network cost 2011 (per minute in AU\$ cent)	New Zealand home network cost 2011 (per minute in NZ\$ cent)
IOT paid	63.73	42.86
International transit	2.85	3.36
Signalling	0.14	0.11
Roaming overheads	2.78	3.28
Retail costs	25.18	29.68

Source: WIK