Roaming

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In wireless telecommunications, **roaming** is a general term referring to the extension of connectivity service in a location that is different from the home location where the service was registered. Roaming ensures that the wireless device is kept connected to the network, without losing the connection. The term "roaming" originates from the GSM (Global System for Mobile Communications) sphere[*citation needed*]; the term "roaming" can also be applied to the CDMA technology. Traditional GSM Roaming is defined (cf. GSM Association Permanent Reference Document AA.39) as the ability for a cellular customer to automatically make and receive voice calls, send and receive data, or access other services, including home data services, when travelling outside the geographical coverage area of the home network, by means of using a visited network. This can be done by using a communication terminal or else just by using the subscriber identity in the visited network. Roaming is technically supported by mobility management, authentication, authorization and billing procedures.

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Roaming in general

Roaming is divided into "SIM-based roaming" and "Username/password-based roaming", whereby the technical term "roaming" also encompasses roaming between networks of different network standards, e.g. WLAN (Wireless Local Area Network) or GSM. Device equipment and functionality, such as SIM card capability, antenna and network interfaces, and power management, determine the access possibilities.

Using the example of WLAN/GSM roaming, the following scenarios can be differentiated (cf. GSM Association Permanent Reference Document AA.39):

- **SIM-based (roaming)**: GSM subscriber roams onto a Public WLAN operated by:
  - their GSM Operator, or
  - another Operator who has a roaming agreement with their GSM Operator.
- **Username/password based roaming**: GSM subscriber roams onto a Public WLAN operated by:
  - their GSM Operator, or

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- another Operator who has a roaming agreement with their GSM Operator.

Although these user/network scenarios focus on roaming from GSM Network Operator's network(s), clearly roaming can be bi-directional, i.e. from Public WLAN Operators to GSM Networks. Traditional roaming in networks of the same standard, e.g. from a WLAN to a WLAN or a GSM network to a GSM network, has already been described above and is likewise defined by the foreignness of the network based on the type of subscriber entry in the home subscriber register. In the case of session continuity, seamless access to these services across different access types is provided.

Home and visited networks

The differentiation between **home network** and **visited network** is technically given by the type of subscriber entry in a specific network. If a subscriber has no entry in the home subscriber register of the network (e.g. Home Location Register (HLR) in GSM networks or local customer database in WLANs), the required subscriber data must first be requested by the visited network e.g. from the subscriber's home network in order that the subscriber can be authenticated and any authorization for using the network services can be checked. The "visiting" subscriber acquires an entry in a user database of the visited network (e.g. Visited Location Register (VLR)) and the authorized network services are enabled. For the roaming procedure in practice, the possibility of assigning the subscriber data is always indispensable in order that authentication, authorization and billing of the subscriber can be performed in the corresponding network. Thus, the term roaming is not linked to a specific network standard, but rather to the type of subscriber entry in the home subscriber register of the mobile radio network. If a subscriber can use his personal service profile, which he uses in the home network, in the visited network as well, this is also referred to as Global Service Roaming Capability.

Roaming agreements

The legal roaming business aspects negotiated between the roaming partners for billing of the services obtained are usually stipulated in so called **roaming agreements**. The GSM Association broadly outlines the content of such roaming agreements in standardized form for its members. For the legal aspects of authentication, authorization and billing of the visiting subscriber, the roaming agreements typically can comprise minimal safety standards, as e.g. location update procedures or financial security or warranty procedures.

The roaming process

The details of the roaming process differ among types of cellular networks, but in general, the process resembles the following:

Location Update

Location updating is the mechanism that is used to determine the location of an MS in the idle state (Connected to the network, but with no active call).

1. When the mobile device is turned on or is transferred via a handover to the network, this new "visited" network sees the device, notices that it is not registered with its own system, and attempts to identify its home network. If there is no roaming agreement between the two networks,

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maintenance of service is impossible, and service is denied by the visited network.
2. The visited network contacts the home network and requests service information (including whether or not the mobile should be allowed to roam) about the roaming device using the IMSI number.
3. If successful, the visited network begins to maintain a temporary subscriber record for the device. Likewise, the home network updates its information to indicate that the cell phone is on the host network so that any information sent to that device can be correctly routed.

Mobile Terminated Call

It occurs for example when a call is made to a roaming cell phone.

Signaling process:

1. The calling subscriber (from within the public telephone network) dials the mobile subscriber's MSISDN (the telephone number) of the roaming cell phone.
2. Based on the information contained in the MSISDN (national destination code and the country code), the call is routed to the mobile network gateway MSC (GMSC). It's done with an ISUP IAM message.
3. To locate the MS, the GMSC sends to the HLR a MAP SRI (Send Routing Information) message. The MAP SRI message contains the MSISDN number and with this MSISDN the HLR will obtain the IMSI.
4. Because of past location updates, the HLR already knows the VLR that currently serves the subscriber. The HLR will sent to the VLR a MAP PRN (Provide Roaming Number) message to obtain the MSRN of the roaming cell phone. Like that the HLR will be able to route the call to the correct MSC.
5. With the IMSI contained in the MAP PRN message, the VLR assigns a temporary number known as the mobile station roaming number (MSRN) to the roaming cell phone. This MSRN number is sent back to the HLR in a MAP RIA (Routing Information Acknowledgement) message.
6. Now with the MSRN number, the GMSC knows how to route the call to reach the roaming cell phone. Then, the call is made using ISUP (or TUP) signaling between the GMSC and the visited MSC. The GMSC will generate an ISUP IAM message with the MSRN as the called party number (and NOT the MSISDN as the called party number).
7. When the MSC of the visitor network receives the IAM, it recognizes the MSRN and knows the IMSI for which the MSRN was allocated. The MSC then returns the MSRN to the pool for future use on another call. Afterwards, the MSC sends to the VLR a MAP SI (Send Information) message to requeste information like the called MS's capabilities, services subscribed to, and so on. If the called MS is authorized and capable of taking the call, the VLR sends a MAP CC (Complete Call) message back to the MSC.

In order that a subscriber is able to "latch" on to a visited network, a roaming agreement needs to be in place between the visited network and the home network. This agreement is established after a series of testing processes called **IREG** (International Roaming Expert Group) and **TADIG** (Transferred Account Data Interchange Group). While the IREG testing is to test the proper functioning of the established communication links, the TADIG testing is to check the billability of the calls.

The usage by a subscriber in a visited network is captured in a file called the **TAP** (Transferred Account Procedure) for GSM / **CIBER** (Cellular Intercarrier Billing Exchange Record) for CDMA, AMPS etc... file and is transferred to the home network. A TAP/CIBER file contains details of the calls made by the subscriber viz. location, calling party, called party, time of call and duration, etc. The TAP/CIBER files

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are rated as per the tariffs charged by the visited operator. The home operator then bills these calls to its subscribers and may charge a mark-up/tax applicable locally. As recently many carriers launched own retail rate plans and bundles for Roaming, TAP records are generally used for wholesale Inter-Operators settlements only.

Tariffs

Roaming fees are traditionally charged on a per-minute basis and they are typically determined by the service provider's pricing plan. Several carriers in both the United States and India have eliminated these fees in their nationwide pricing plans. All of the major carriers now offer pricing plans that allow consumers to purchase nationwide roaming-free minutes. However, carriers define "nationwide" in different ways. For example, some carriers define "nationwide" as anywhere in the U.S., whereas others define it as anywhere within the carrier's network.

An operator intending to provide roaming services to visitors publishes the tariffs that would be charged in his network at least sixty days prior to its implementation under normal situations. The visited operator tariffs may include tax, discounts etc. and would be based on duration in case of voice calls. For data calls, the charging may be based on the data volume sent and received. Some operators also charge a separate fee for call setup i.e. for the establishment of a call. This charge is called a **flagfall** charge.

Roaming between European countries

Main article: European Commission roaming regulations

In the European Union, the Regulation on roaming charges has been in force since 30 June 2007, forcing service providers to lower their roaming fees across the 28-member bloc. It later also included EEA member states. The regulation sets a price cap of €0.39 (€0.49 in 2007, €0.46 in 2008, €0.43 in 2009) per minute for outgoing calls, and €0.15 (€0.24 in 2007, €0.22 in 2008, €0.19 in 2009) per minute for incoming calls - excluding tax.[1] If the Commission is satisfied that competition will continue to keep prices at this level, or lower, the regulation will expire in mid-2012. Since mid-2009 there is also an €0.11 (excluding tax) maximum price for SMS text message included into this regulation.

On 11 June 2013, the European Commission voted to end mobile roaming charges. It is expected to come into force on 1 July 2014.[2]

Roaming between other countries

Countries that do not share a supra-national authority have also begun examining the provision of international roaming services. In April 2011, Singapore and Malaysia announced that they had agreed with operators to reduce voice and SMS rates for roaming between their two countries.[3] In August 2012, Australia and New Zealand published a draft report proposing coordinated action on roaming services.[4] This was followed by a final report in February 2013 recommending that the two countries equip their telecommunications regulators with an extended palette of regulatory remedies, when they investigate international roaming.[5] The Australian and New Zealand Prime Ministers subsequently announced that they would introduce legislation to effect the recommendations of the final report.[6]

Additional notions and types of roaming

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- Regional roaming:

This type of roaming refers to the ability of moving from one region to another region inside national coverage of the mobile operator. Initially, operators may have provide commercial offers restricted to a region (sometimes to a town). Due to the success of GSM and the decrease in cost, regional roaming is rarely offered to clients except in nations with wide geographic areas like the USA, Russia, India, etc., in which there are a number of regional operators.

- National roaming:

This type of roaming refers to the ability to move from one mobile operator to another in the same country. For example, a subscriber of T-Mobile USA who is allowed to roam on AT&T Mobility's service would have national roaming rights. For commercial and license reasons, this type of roaming is not allowed unless under very specific circumstances and under regulatory scrutiny. This has often taken place when a new company is assigned a mobile telephony license, to create a more competitive market by allowing the new entrant to offer coverage comparable to that of established operators (by requiring the existing operators to allow roaming while the new entrant has time to build up its own network). In a country like India, where the number of regional operators is high and the country is divided into **circles**, this type of roaming is common[*citation needed*]. Following the merger of Orange UK and T-Mobile UK on 1 July 2010, national roaming has been possible between these two networks since 5 October 2010 at no additional cost pending the technical merging of the two networks.

- International roaming:

This type of roaming refers to the ability to move to a foreign service provider's network. It is, consequently, of particular interest to international tourists and business travellers.

Broadly speaking, international roaming is easiest using the GSM standard, as it is used by over 80% of the world's mobile operators. However, even then, there may be problems, since countries have allocated different frequency bands for GSM communications (there are two groups of countries: most GSM countries use 900/1800 MHz, but the United States and some other countries in the Americas have allocated 850/1900 MHz): for a phone to work in a country with a different frequency allocation, it must support one or both of that country's frequencies, and thus be tri or quad band.

- Inter-standards roaming:

Inter Standard Roaming refers to roaming between two standards. This term is now widely used in mobile communnications where especially CDMA customers want to use their phone in areas where there is no CDMA network or there is no roaming agreement in place to support roaming on the used standard. In Europe there is hardly any CDMA network. Most CDMA customers originate from the Americas or the Far East. In order to enable them to roam in Europe Inter Standard Roaming is the solution. The CDMA customers arriving in Europe can register on the available GSM networks.

Since mobile communication technologies have evolved independently across continents, there is significant challenge in achieving seamless roaming across these technologies. Typically, these technologies were implemented in accordance with technological standards laid down by different industry bodies and hence the name.

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A number of the standards making industry bodies have come together to define and achieve interoperability between the technologies as a means to achieve inter-standards roaming. This is currently an ongoing effort.

- Mobile Signature Roaming:

Mobile signature Roaming allows an access point to get a Mobile Signature from any end-user, even if the AP and the end-user have not contracted a commercial relationship with the same MSSP. Otherwise, an AP would have to build commercial terms with as many MSSPs as possible, and this might be a cost burden. This means that a Mobile Signature transaction issued by an Application Provider should be able to reach the appropriate MSSP, and this should be transparent for the AP(reference).

- Inter MSC Roaming[7]

Network elements belonging to the same Operator but located in different areas (a typical situation where assignment of local licenses is a common practice)pair depends on the switch and its location.Hence, software changes and a greater processing capability are required, but furthermore this situation could introduce the fairly new concept of roaming on a per MSC basis instead of per Operator basis. But this is actually a burden, so it is avoided.

- Permanent Roaming:

This type of roaming refers to customers who purchase service with a mobile phone operator intending to permanently roaming, or be off-network. This becomes possible because of the increasing popularity and availability of "free roaming" service plan, where there is no cost difference between on and off network usage. The benefits of getting service from a mobile phone operator that isn't local to you can include cheaper rates, or features and phones that aren't available on your local mobile phone operator, or to get to a particular mobile phone operator's network to get free calls to other customers of that mobile phone operator through a free unlimited mobile to mobile feature. To accidentally become a permanent roaming customer does not usually happen. Most mobile phone operators will require the customer's living or billing address be inside their coverage area or less often inside the government issued radio frequency license of the mobile phone operator, this is usually determined by a computer estimate because it is impossible to guarantee coverage. If a potential customer's address is not within the requirements of that mobile phone operator, they will be denied service. In order to permanently roam customers may use a false address and online billing, or a relative or friends address which is in the required area, and a 3rd party billing option.

Most mobile phone operator discourage or prohibit permanent roaming since they must pay per minute rates to the network operator their customer is roaming onto to,[8] while they can not pass that extra cost onto customers ("free roaming").

- Trombone roaming:

Roaming calls within a local tariff area, when at least one of the phones belong outside that area. Usually implemented with *trombone routing*[9] also known as *tromboning*[10]

The routing of *trombone roaming*.

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See also

- IEEE 802.11
  - IEEE 802.11f
  - IEEE 802.11r
- Home Location Register
- Handoff
- Mobile IP
- Mobile phone
- Mobile phones on aircraft
- Mobility management
- Regulation on roaming charges in the European Union
- Roaming sim
- GSM frequency bands
- UMTS frequency bands
- Vertical handoff
- Visitor Location Register
- Starhome

References

1. ^ "New caps on roaming charges in place for August", 8 June 2007
2. ^ Williams, Christopher (2013-06-13). "EU to end mobile roaming charges next year". The Telegraph. Retrieved 2013-06-30.
3. ^ [1]
4. ^ "Trans-Tasman Roaming - Draft Report". Ministry of Business, Innovation and Employment. Retrieved 2013-06-30.
5. ^ [www.med.govt.nz/sectors-industries/technology-communication/communications/mobile-phones/trans-tasman-roaming]
6. ^ [www.pm.gov.au/press-office/joint-statement-prime-ministers-key-and-gillard-february-2013]
7. ^ "Signalling interoperability as a key enabler to GSM/PCS roaming with North America". IEEE Xplore. doi:10.1109/VETEC.1998.686490. Retrieved 2013-06-30.
8. ^ *Roaming-Included Plans: .... Sprint may terminate service if (1) more than 800 minutes, (2) a majority of minutes or (3) a majority of data kilobytes in a given month are used while roaming.* [2] *Termination By Us We may limit, interrupt, terminate or refuse to provide a Service for the following reasons, or for any other good cause: .... (f) if the majority of your Service is used roaming on a network not owned or operated by Alltel.* [3] *OFF-NET USAGE If your minutes of use (including unlimited services) on other carrier networks ("off-net usage") during any two consecutive months exceed your off-net usage allowance, AT&T may, at its option terminate your service, deny your continued use of other carriers' coverage or change your plan to one imposing usage charges for off-net usage. Your off-net usage allowance is equal to the lesser of 750 minutes or 40% of the Anytime Minutes included with your plan. AT&T will provide notice that it intends to take any of the above actions, and you may terminate the agreement.* [4] Zeman, Eric (Nov 20, 2007). "T-Mobile Dumps Customers Who Roam Too Much". InformationWeek. Retrieved 2008-03-15. *b. Roaming Services. Roaming services typically refers to coverage on another carrier's network that we make available to you based on our agreements with other carriers. If your minutes of use for roaming services during any two consecutive months exceeds a reasonable roaming usage allowance or if a majority of minutes in a given month are used while roaming, we may, at our sole option, terminate your Services, deny your continued use of roaming services, or change your plan to one imposing usage charges for roaming services. Your roaming usage allowance is equal to the lesser of (i) 300 minutes or (ii) 30% of the anytime minutes included in your plan. In the event that we intend to take any of the above actions, we will provide you with prior notice, and you may choose to terminate your Customer Agreement without incurring any additional fees for termination.* [5] *Additional Terms .... Customers must have a mailing address and live in Centennial's Primary Service Area. Centennial Wireless may discontinue your service if, over two consecutive billing cycle, any of the following apply: 40% of airtime minutes or 750 minutes of usage are incurred outside Centennial-owned*

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systems; there is excessive use of free minutes from included calling features.... [6] *[7]*).
9. ^ PHS MoU Group: Note - Trombone Rooting
10. ^ Competition Commission: Telephone number portability: A report on a reference under section 13 of the Telecommunications Act 1984

Standardisation Organizations

- ETSI website, European Telecommunications Standards Institute.
- Direct access to ETSI standards publications.
- GSM website, Global System for Mobile communications by the GSM Association (GSMA)

External links

- Roaming - Using my mobile abroad: are prices dropping ? - *European Commission*
- Intra MSC Roaming
- Mobile Europe describes how the roaming industry will cope with pending EU legislation and the arrival of mobile VoIP
- GSM operators and their roaming agreements - *Index of GSM operators in a country, and their roaming partners indexed by country. Maintained by GSM Alliance*

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Categories: GSM standard | Mobile technology

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