Game analysis: Roaming agreements

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ABSTRACT

Roaming is a service that allows a subscriber of one operator to use the services of another operator when inside the latter's coverage area. Over 20000 roaming agreements have made the GSM service available around the world; the same is expected also for GPRS, and further for 3G. Operators are now implementing GPRS roaming using so called "home network" model where traffic from visited network is routed back to home network using GRX networks. The model offers good service quality, security and control of customers, but generates some problems with content roaming. When implementing roaming, the operator has to make several decisions that affect the operator's business in various, complex ways.

Keywords: *Roaming, GPRS, GRX, agreements, business objective*

1. INTRODUCTION

Roaming is a service that allows a subscriber of one operator to use the services of another operator when inside the latter's coverage area. Four main types of roaming are:

- international roaming – ability to use services of a foreign operator in another country,
- inter-regional roaming – ability to use services of a foreign operator in the same country where the operators have non-overlapping service areas,
- national roaming – ability to use services of a foreign operator in the same country where the operators have the same or substantially overlapping service areas, and
- inter-technology roaming – roaming between different technologies, e.g. 2G – 3G, Cellular – WLAN.

Roaming over GSM networks has become a key service over the last few years and one which has generated a good source of revenue for the network operators. Operators have made more than 20 000 roaming agreements [1] until the end of year 2001, and the GSM Association estimates that more than 6 billion roaming calls were made in year 2000 in GSM networks.

Roaming increases the number of connected customers in the network, as a subscriber is reachable and able to use the service on a wider area; in GSM around the world. This increases the value of the service and network according to the Reed's law, where total value of the network is proportional to the number of customers N through connection, pairing, and group forming effects [2]:

$$\textit{Total value} = c_1 \cdot N + c_2 \cdot N^2 + c_3 \cdot 2^N. \qquad (1)$$

Other law in describing the value of the network is a so called KK-law [3], after Matti Kalervo and Kalevi Kilkki, which states that the value of the service or the network is merely proportional to the penetration of the service in the population:

Total value =

$$K \cdot \{m_1 \cdot p + m_2 \cdot p^2 + (m_3 \cdot p^3)/(r\text{-}2 - (r\text{-}3)p)\}, \qquad (2)$$

where K is the size of population, p is penetration, and r is the average group size. Roaming increases penetration, but more important is the interoperability between operators and services. Example of the importance of interoperability is the SMS growth in US after the operators had signed interoperability agreements: number of SMSs send almost doubled 820 Millions to 1600 Millions in 3 months [4].

This paper concentrates on GPRS roaming though roaming is important also in GSM voice, SMS, circuit switched data, EDGE, MMS, 3G, and WLAN. The GPRS roaming architecture will be used also in EDGE, MMS, and 3G networks, in all-IP version also in voice.

2. GPRS ROAMING

In GSM world roaming was fairly simple procedure. However, many new aspects due to data network make the roaming in GPRS more complex. Two possible architectures have been identified for GRPS

roaming (though only one of these is currently being implemented) [5]:

- ISP roaming – in which the GPRS service, including interconnection to the Internet, is provided by the visited network (see Figure 1),
- Home Public Land Mobile Network (HPLMN) roaming – in which the GPRS service is provided by the home network, with the visited network providing only air interface connectivity and "tunneling" back to the home GPRS gateway nodes (see Figure 2).

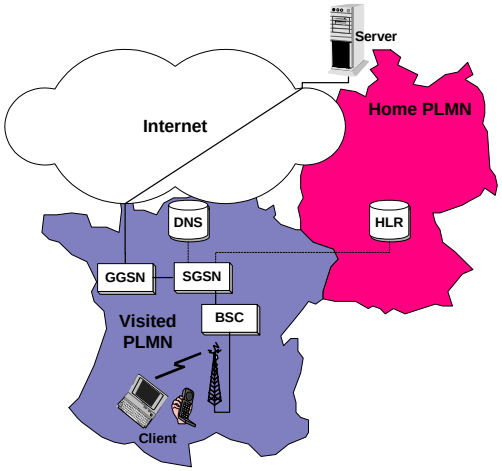

Figure 1. ISP roaming. GGSN = Gateway GPRS Support Node, SGSN = Serving GPRS Support Node, BSC = base station controller, HLR = home location register, DNS = domain name server.

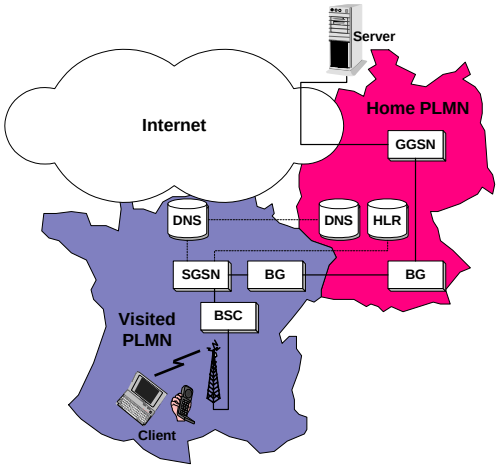

Figure 2. HPLMN roaming, BG = border gateway

ISP roaming is closer aligned with the traditional GSM voice roaming model. In principle, it is cheaper and more efficient, but has limited security and variable service quality level. Nevertheless, almost all operators are favoring "home network" roaming, since it provides better end-to-end quality of the user experience, good security, and allows the operator to track its customer more efficiently.

In implementing HPLMN roaming, operators have to create IP connections between their mobile networks. Operators could use public Internet, but that would bring similar problems as ISP roaming. They could also connect to their roaming partners directly via leased lines. This method is very expensive, although it offers good security and level of service. One option could be to use VPN through third party carries, however this would create a complex mesh (see Figure 3).

Figure 3. HPLMN roaming: direct connections

GPRS Roaming eXchange (GRX), a standard from GSM Association, is the answer to this problem. It provides dedicated IP connections between GPRS networks to route the traffic from visited network back to the home network. A GRX is thus a dedicated IP network providing connectivity with additional security and quality of service guarantees. The dedicated part is important since mobile operators are very concerned to keep other kinds of traffic – even other kinds of mobile applications provider traffic – off the GRX network.

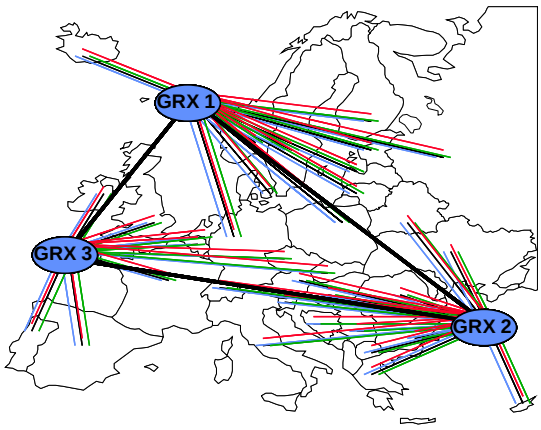

Figure 4. HPLMN roaming: GRX network

At the moment, there exist several GRX operators (at least 21 in December 2003) [6]. In principle, almost any IP provider that can meet the GSM specification can participate. The roles vary between GRX operators. Some are just bit pipes providing basic connectivity, quality, and security; some provide more sophisticated value-added services like DNS services and network management; some are also data clearing houses managing billing.

Also the implementations vary; segregation from other networks can be logical using IP-VPN and MPLS technologies, or physical (as e.g. in Cable & Wireless). GRX can act only as a "backbone" or offer also the access link and point-of-presence to its GPRS customer's premises.

Most of GRX operators are mobile operators, like France Telecom, T-Systems, Telecom Italia, Telenor, Telia, Sonera; some are internet carriers like Cable & Wireless, Uunet, Infonet, BT; and there are also clearing houses like Comfone. Some of these also co-operate like Comfone and Infonet, Sonera and Equant. There is concern that there are too many GRXes, and that the number should rather be six.

GRX operators are interconnected in the peering points. Currently there are two peering points in Amsterdam, and one in Singapore.

2.1 Roaming agreements

In GSM the roaming agreements have typically been made bilaterally between operators. Operators have agreed on the general terms (Standard Terms of Roaming Agreements, STIRA) and on the Inter-Operator Tariff (IOT). Both these are procedures developed in the GSM Association. Beside voice calls, the agreement usually includes agreements on other services such as SMS and data services.

Option to bilateral agreements is to negotiate agreement with so called roaming brokers or aggregators. These have ready agreements with several operators, and thus, a new operator can have roaming service to several operators' network at once.

The GPRS legal roaming agreement between the operators is typically based on the existing bilateral GSM roaming agreement. Other option is to use roaming brokers or aggregators, which could also be GRX operators. In the agreements, the operators agree on general terms, service levels, and IOT, which is usually volume based.

Beside legal agreements the operators have to conclude traffic agreements. Sometimes operators form direct connections, especially between main partners. However, typically an agreement is made with one or two GRX operators. The GRX charges a monthly fee based on capacity and sometimes also data fee based transmission amount [7]. GRX operators have also made agreements with each other, either directly or through a GRX peering point. Currently, peering traffic is free of charge (see Figure 5).

The roaming tariffs are naturally charged from the roaming customers. Charges are typically volume based, and range from 0 €/MB (Radiolinja – Vodafone Sweden) to lower typical 5 €/MB (Radiolinja – Libertel, Netherlands), and from higher typical 13 €/MB (Radiolinja – SFR, France) to 51 €/MB (Radiolinja – Telecom Italia, GPRS WAP).

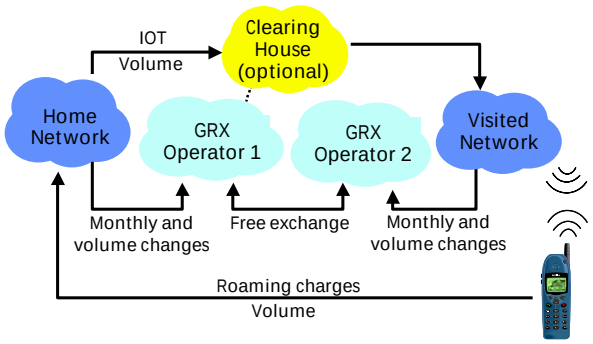

Figure 5. Financial flows in GPRS roaming due to traffic.

In HPLMN roaming, one still open question is how a customer can access to the local content of the visited network. There are basically three options:

- operator makes a contract with the content provider of the visited network,

- operator makes a contract with the visited network that allows access to its content provider, or
- operators use some kind of clearing house, which makes contracts with content providers. If a clearing house is also GRX, it would have control for both traffic and content.

Figure 6 presents the financial flows in these three cases.

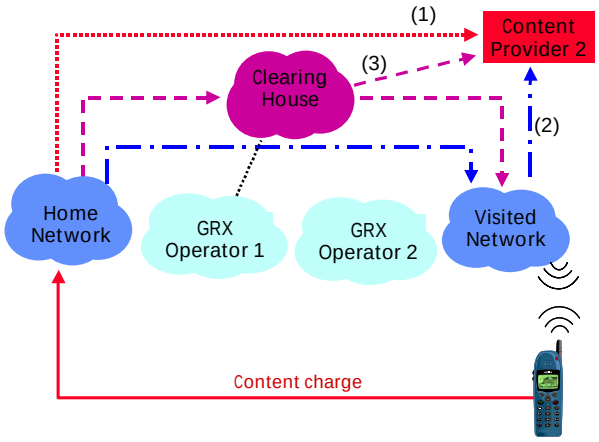

Figure 6. Financial flows in GPRS roaming due to content.

3. ROAMING IN MOB

The mobile operator business (MOB) consists of providing services or products to customers. The simplified business objective would be to maximize the profit of the total business

*Profit = ARPU * Customers – Cost,* (3)

where *ARPU* = Average Revenue Per User. This does not mean that the profit of each individual service, such as roaming, will be maximized.

When making roaming decisions the basic questions the operator should consider are:

- How to gain the most value to my customers?
- How to attract new customers?
- How to get the maximum number of visiting customers?
- How to get the most money from visiting customers?
- How to minimize the cost?

The operator has to make several roaming decisions. These are e.g.:

- Who are the international roaming partners?
- Do we benefit from national roaming?
- How we arrange content roaming?
- Is cross technology roaming needed?
- To which technologies and services do we offer roaming?
- Should we implement prepaid roaming?
- What is pricing for end-users?
- What is pricing for other operators? What do we have to pay for other operators?

These decisions have several implications. First they all affect operator's resources: Network may need new elements and capacity, more personnel may be needed in R&D, O&M, and legal departments.

Roaming decisions as well as resources have an effect on coverage, usage, and quality of the services and products that the operator is offering in the markets. These all influence to the value of the service and product. Roaming decisions have mainly indirect implication to pricing through the resources and services, but also direct impact through the inter-operator tariff.

The implications of the roaming decisions have further implications to the business objective, e.g. to profit. Pricing affects ARPU directly, but also to the number of customers and costs. The service and product offering affect ARPU as well as the number of customer, but also costs. Resources generate costs, but they also affect ARPU and the number of customers indirectly. The number of customers has further an effect to costs and services, and so on. As can be seen, these implications have strong interdependencies and it is very difficult to fully understand how a single roaming decision affects to the operator's business objective (see Figure 7).

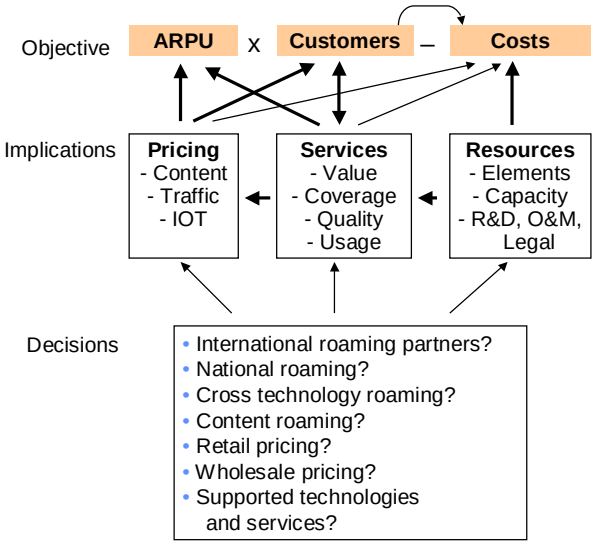

Figure 7. Roaming decisions and their implications in mobile operator business.

4. SUMMARY

GSM association has introduced two possible architectures for GPRS roaming: ISP roaming and "home network" roaming. At the moment, almost all operators favour the "home network" roaming, which offers better service quality, security, and ability to keep track on the customers. Roaming is typically implemented using GRX networks, which are dedicated IP networks connecting operators' GPRS networks.

An operator has to make several agreements when implementing the GPRS roaming. The operator typically signs bilateral legal agreements with other operators and then makes traffic agreements with one or two GRX operators. GRX operators make peering agreements to connect the customers of different GRXes. Still open question is how the content roaming is organized. It probably requires more agreements.

A mobile operator has to make numerous decisions related to roaming. These decisions affect pricing, various aspects of services and products, required network and human resources, and further the operator's business objective in various, complex ways which are almost impossible to comprehend without the help of an analytical tool [8].

Voice roaming has generated substantial revenues for the mobile operators. Now they are expecting the same from the data roaming especially when the 3G networks and their more data centric services are emerging. GRX networks are ready for this development.

[1] GSM Association homepages; URL: http://www.gsmworld.com/using/billing/potential.shtml (Referenced 4 November 2003)

[2] David P. Reed, That Sneaky Exponential—Beyond Metcalfe's Law to the Power of Community Building, URL: http://www.reed.com/Papers/GFN/reedslaw.html (Referenced 4 November 2003)

[3] Kalevi Kilkki, KK-law for group forming services, to published in proceedings of ISSLS 2004, March 2004, Edinburgh.

[4] GSM Association: SMS growth in US

[5] Gerhard Heinzel, GRX presence and future, GPRS roaming conference, London 2001. URL: http://www.gsmworld.com/cgi/bounce.pl5/www.gsmworld.com/technology/gprs/presentations/gerhard_heinzel.zip (Referenced 4 November 2003)

[6] AMX-IX homepage, URL: http://www.ams-ix.net/memlist/index.html (Referenced 4 November 2003)

[7] Sonera homepage, URL: http://search.sonera.com/query.jsp?qt=GRX+pricing (Referenced 4 November 2003)
Cable&Wireless homepage, URL: http://www.cw.com/services/ connectivity/sold_by_SP/grx/index.html (Referenced 4 November 2003)

[8] Kalevi Kilkki, Olli-Pekka Pohjola, Antrea – an extensive tool for optimising service provider's business, to be published in WiOpt'04 proceedings, March 2004, Cambridge.