Roaming Dynamics in GPRS and Beyond: Options and Strategies

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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 some issues with content roaming still exist. While implementing roaming, an operator has to make several decisions that affect the operator's business in various, complex ways. In this paper, we provide an insight into the end-to-end roaming models in the mobile communications industry and identify the possible roaming business model scenarios for GPRS and beyond. We discuss the key business and technological triggers that would encourage an operator to adopt one of these identified models. We also highlight the major concerns an operator has while choosing a roaming model. The basic assumptions and constraints considered for our model have also been listed in this paper. Roaming dynamics has been explained based on MOB, a mobile business game being developed at Helsinki University of Technology.

Keywords: *Roaming agreements, GPRS, GRX, Roaming models, dynamics, MOB*

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 competing 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 amount 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 Reed's law [2] and KK-law [3].

This paper concentrates mainly on roaming models in GPRS and beyond. The GPRS roaming architecture however will also be used in EDGE, MMS, 3G networks and beyond. We identify three possible roaming model scenarios that would exist as the technologies evolve. The key triggers responsible for an operator to favour one of these models are also identified. We further analyse these triggers to understand the dynamics involved and check the possibility

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of an equilibrium state that may exist, in which, one of the models may find greater acceptability.

As roaming agreements are a specialty of the mobile market, they deserve special attention in domain-specific computerized business games. In this paper, we explain the roaming scenarios and dynamics based on Mobile Operator Business game (MOB), an educational software tool developed at Helsinki University of Technology (HUT) [4]. It enables the simulation of inter-operator competition among a small set of players. MOB is targeted to simulate a single national market with the assumption that mobile operators are the only active decision-makers. Similar tools have been developed on commercial basis [5]. Roaming is visible to operators as a set of annual roaming-related decisions and market responses. This feedback loop educates players about the cost and revenue implications of their decisions. Our key challenge is to model the feedback loop so that the game is relevant and exciting for the players.

The paper is organised as follows. Section 2 gives an overview of the technological developments in roaming architecture. This is followed by section 3 that provides an insight into the end-to-end business models evolving in roaming over GPRS and beyond. In section 4, we discuss the major concerns of an operator while making roaming decisions. In section 5, the basic assumptions and constraints of our models are mentioned. Section 6 describes the three roaming model scenarios, triggers and the overall dynamics of roaming in the future. We conclude the paper with an inference in section 7.

2. Roaming in GPRS and Beyond

In GSM world, roaming is a fairly simple procedure. However, many new aspects due to data network make the roaming in GPRS more complex. GSM Association have identified two possible architectures for GPRS roaming [6]:

- ISP roaming – in which the visited network provides the GPRS service, including interconnection to the Internet.

- Home Public Land Mobile Network (HPLMN) roaming – in which the home network provides the GPRS service. The visited network only provides air interface connectivity and routes the traffic back to the home GPRS gateway nodes.

ISP roaming is in principle cheaper and more efficient, but has limited security and variable service quality level. Most operators are, however, implementing “home network” roaming, since it provides better end-to-end quality of the user experience, good security, and allows the operator to track its customers 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 **Fig. 1**).

Fig. 1 HPLMN roaming: direct connections

GPRS Roaming eXchange (GRX), a standard from GSM Association, is the answer to this problem (see **Fig. 2**). It provides dedicated IP connections between GPRS networks to route the traffic from visited network back to the home network. As the GRX network is dedicated only for the mobile operators’ roaming traffic the network is able to maintain high security and quality level.

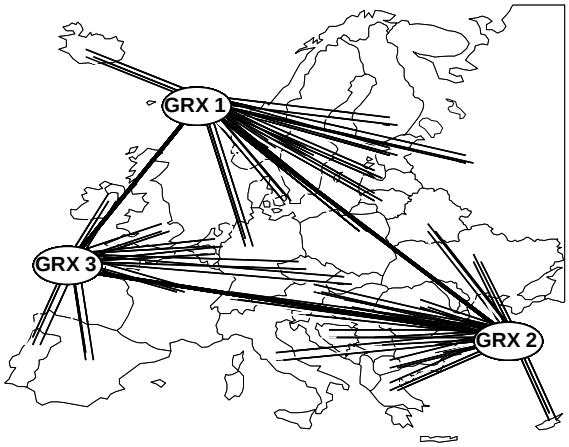

Fig. 2 HPLMN roaming: GRX network

Currently, the number of GRX operators is growing rapidly [7]. 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, TeliaSonera; some are Internet carriers like Cable & Wireless, Equant, Infonet, BT; and there are also clearing houses like Comfone. Some of these also co-operate like Comfone and Infonet, Sonera and Equant. GRX operators are interconnected in the peering points. Currently there are two peering points in Amsterdam and one in Singapore.

3. End-to-end Roaming model

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 bilateral roaming agreement [8]. 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.

Besides legal agreements the operators have to conclude traffic or transport 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 on transmission amount [9][10]. 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 **Fig. 3**) [11].

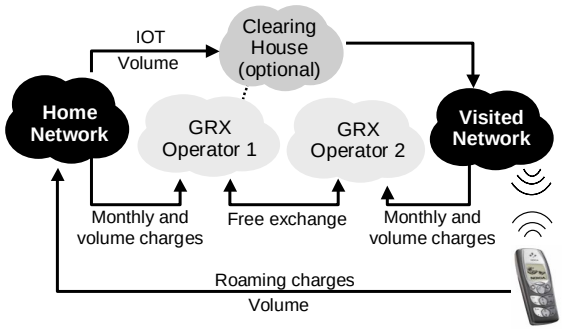

Fig. 3 Financial flows in a GPRS roaming model (transport)

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) [12].

In HPLMN roaming, one still open question is how a customer can access the local commercial content of the visited network. There are basically three options: 1) operator makes a contract with the content provider of the visited network, 2) operator makes a contract with the visited network that allows access to its content provider, or 3) operators use some kind of clearing house, which makes contracts with content providers. If a clearinghouse were also GRX, it would have control for both transport and content. **Fig. 4** presents the financial flows in these three cases.

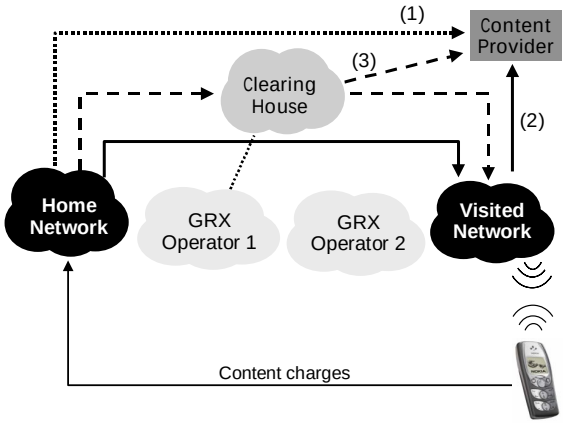

Fig. 4 Financial flows in GPRS roaming model (content)

4. Roaming issues and concerns

A mobile operator's business consists of providing services or products to customers. A simplified business objective would be to maximize the profit of the total business, i.e.,

$$Profit = ARPU * Customers – Cost,$$

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 an 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 do 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 the value of the services and products. Roaming decisions have indirect implication to general pricing through the resources and services but also direct impact through roaming charges and 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 customers, 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 an operator's business objective (see **Fig. 5**) [13].

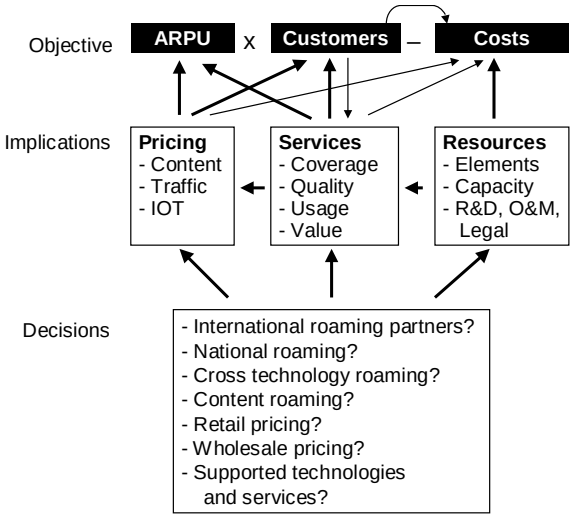

Fig. 5 Roaming decisions and their implications on mobile operator business

5. Assumptions and Constraints

In this section we list the assumptions and constraints for our roaming model scenarios explained in section 6. The MOB model makes a difference between international and national roaming. For simplicity, we limit our analysis here to the international GPRS roaming and the related indirect competition between national operators. Our analysis also focuses mainly on transport level roaming agreements. Content roaming agreements as mentioned in section 3 are not considered at this stage.

6. Scenarios and dynamics

In this section we list out the possible business model scenarios in roaming and the key enablers or triggers involved in initiating the decision by an operator to choose a particular model.

We have identified three possible roaming business models. They are:

1. *Bilateral* model: This includes bilateral roaming agreements and bilateral transport resource allocations. This is comparable with the early GPRS deployments. Bilateral agreements alone in MOB game are non-exciting because they appear only

as straightforward cumulative decisions for building global coverage.

2. *Clustered* model: This model assumes competition between international operator alliances. An operator's decision to join an international alliance secures the necessary global roaming coverage. This captures the current formation of global mobile operator families and corresponding GRX operator clusters. Note that operators already having subsidiaries or joint ventures with other operators are more likely to favour a clustered model.
3. *Centralized* model: This model represents an ideal vision about a global centralized non-profit clearing house for international roaming based on inter-governmental treaties. There is no existing real-world counterpart for this scenario.

Table 1 Roaming dynamics triggers

Triggers\Models	Bilateral	Clustered	Centralized
Number of roaming contracts	High	Low	Low
Complexity of single contract	High	High	Low
Management structure	Distributed	Centralized	Centralized
Vertical bundling	Yes	Yes	No
Control of standards' specifications	GSM MoU	Global Operator	Inter-governmental
Competition in roaming features	No	Yes	No
Price control	No	No	Yes
Cost per operator	High	Medium	Low
Profit opportunity	Medium	High	Low
Time-to-coverage	Long	Medium	Short
Technological evolution (2G/2.5G/3G)	Slow	Fast	Slow

Table 1 summarises the triggers responsible for an operator to choose one of these roaming models. We classify these triggers as business and technological in nature.

6.1 Business Triggers

The business triggers and their impact on the three models are as follows:

- *Number of roaming contracts*: This gets higher in a bilateral model and hence an operator may find it beneficial to choose a clustered or centralized model.
- *Complexity of single contract*: This remains high in vertically bundled bilateral and clustered models and hence an unbundled centralized model is preferable.
- *Management structure*: Bilateral model will have a distributed structure providing greater opportunity for experimentation. The other two models will be centralized making it more rigid.
- *Vertical bundling*: Tying the transport with the content is possible in bilateral and clustered models while centralized will follow agreements only at the transport level (horizontal). This reduces the complexity of agreements. There remains of course a possibility that a single centralized global model for micro payments may appear based on the charging machinery of mobile operators.
- *Price control*: Regulators will find it difficult to control the prices in a bilateral or clustered model. Hence, regulators may prefer a centralized model.
- *Cost per operator*: This would be higher in a bilateral model due to a greater number of contracts.
- *Profit opportunity*: A clustered model will have greater profits. This is explained later.
- *Time-to-coverage*: Bilateral model takes a longer time to achieve the same geographical coverage compared to other two models.
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6.2 Technological Triggers

The technological triggers and their impacts are as follows:

- *Control of standards' specifications*: A dominant cluster will have greater influence on standards specifications unlike in bilateral or a centralized model in which standards are created based on consensus among all operators.
- *Competition in roaming features*: The control of standards would provide the clusters an opportunity to offer better features unlike other two models. This would encourage competition among the clusters.
- *Technological evolution*: As the technology evolves from a circuit-switched GSM to a packet-switched 3G and beyond, a clustered model will

achieve a higher degree of acceptance among the operators. It is also likely to promote competition which speeds up the adoption of new technologies.

7. Inference

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 analytical or simulation tools [4][5][13].

In this paper, we identified three possible roaming model scenarios and the triggers that would enable an operator to decide on choosing one of those models. Our analysis shows that there is no clear winner among the three models. An operator could choose any of these models based on the list of triggers that matters most. These scenarios will be later implemented into MOB game.

A centralized model can become a reality if the regulators plan to control the roaming regime and thus curtail the increased pricing. This would in turn mean lower roaming profits for the operators.

A clustered model may become more common as the technology evolves from a circuit-switched GSM to a packet-switched 3G and beyond. The usage of GRXs would further act as a catalyst. A clustered model also enhances profits for an operator as it provides greater opportunity for roaming feature differentiation. A clustered model will also indirectly impact national competition among operators. An operator can become more competitive at the national level by becoming a member of a large international cluster, thus providing wider international coverage and other benefits to its customers in roaming services.

Having said that, there is a greater possibility of bilateral and clustered models existing in parallel and is more likely to be the case in future unless a centralized model is introduced by internationally recognised bodies such as the European Union.

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