# ASSESSING THE VALUE OF ROAMING OVER MOBILE NETWORKS

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## Abstract

Roaming, a mandatory feature in mobile communications has traditionally provided major revenue for the operators. Convergence, i.e., usage of the same service over multiple access network technologies is an emerging area that will further enhance the significance of roaming in future. In this paper, we propose a simple model to assess the value of roaming over mobile networks. Major parameters that influence the value of roaming are identified. We apply our value model on three different roaming business models (bilateral, clustered and centralised). Our analysis shows that value of roaming for an operator is maximum in a centralised state and hence would achieve equilibrium, subject to certain conditions. We discuss the role of pricing and regulation with increasing value of roaming. The impact of inter-access technology (such as UMTS/WLAN) roaming on the value model is also studied in this paper. Finally, we provide a list of recommendations for increasing a mobile operator's roaming revenue.

Keywords: Roaming, value model, roaming business model, clustered, UMTS

JEL-Code: C20, D46,L51,L14

# 1 Introduction

Roaming, a key feature of GSM business family has played a major role in the success and faster acceptance of these technologies among users across the world. Currently, roaming services are estimated to generate approximately 15 to 25% of the total revenue for a mobile network operator in Europe [1]. Convergence of services over multiple access network technologies will also make roaming inevitable in the future.

Traditionally, roaming services have been solely provided by mobile network operators or service operators (MNO/SOs) using bilateral agreements. However, with the introduction of packet switched mobile access technologies such as GPRS and beyond, advent of new players in the industry such as mobile virtual network operators (MVNOs), GPRS roaming exchange service providers (GRX SPs) and value-added content, roaming value chains are undergoing major evolution.

Figure 1 illustrates the roaming value chain evolution for the GSM family with the introduction of GPRS, UMTS and beyond.

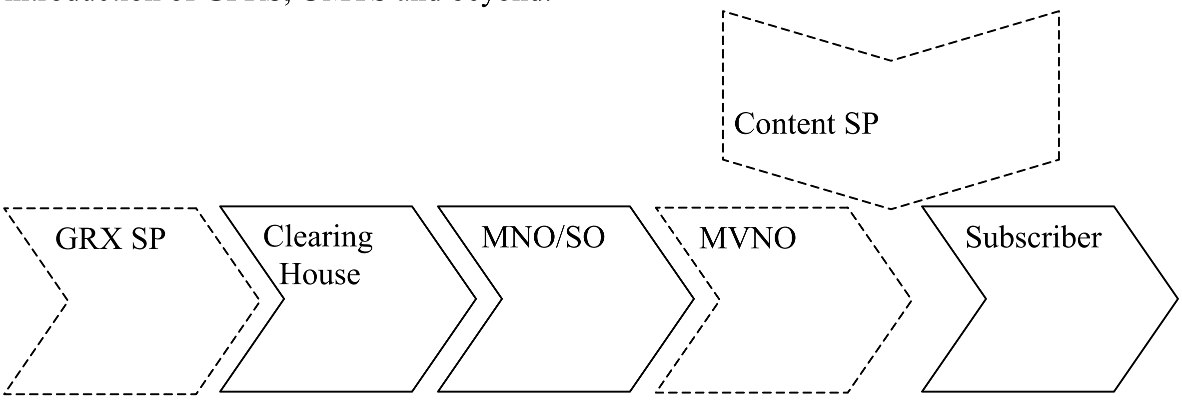


**Figure 1: Roaming Value Chain evolution for the GSM family**

All the above mentioned reasons make it essential to estimate the value of roaming over mobile networks.

Estimating the value of roaming and the parameters that influence it would enable all the players in the value chain to carry out appropriate strategies to maximise their respective revenue shares.

## 1.1 Definitions

Here, we define some of the frequently used terms in this paper:

*mobile roaming*: the ability of a subscriber A to reach or be reached by subscriber B. This creates a fundamental difference in value vis-à-vis fixed Internet. The value of fixed Internet is attributed to connectivity among networks, or in other words, interconnection while mobile communication and roaming in particular provides reachability. The value of interconnection and group formation is given by Reed's law [2].

*bilateral roaming model*: This refers to an agreement between two operators. This model is currently widely seen in mobile industry.

*clustered roaming model*: Here, two or more operators form alliances or clusters.

*centralized roaming model*: Here, all the operators come under one single alliance that may be administered by a non-partisan authority.

In this paper, we present a simple quantitative model to calculate the value of roaming over mobile networks. This value model is then applied to three different roaming business models (bilateral, clustered and centralized) [3] in order to understand the roaming evolution path in terms of its value. The paper considers GSM family as the basis for analysis. However, the model could also be used to understand other existing mobile technologies such as CDMA.

The organization of the paper is as follows: Section 2 describes our roaming value model. In this section we also describe the assumptions and define the parameters that influence the value model. Section 3 analyses the impact of three different models on the value model. Using this analysis, we arrive at the equilibrium state roaming model. In section 4, we discuss the role of pricing, regulations and inter-access technology roaming. Section 5 concludes the paper with recommendations for increasing an operator's roaming revenue.

## 2 Roaming Value model

In this section, we present our roaming value model and the major assumptions and parameters that influence the model. In order to derive the value model, we first identified the key elements necessary for roaming over mobile networks. This is illustrated in Figure 2. Interoperability at the transport and service layers is a primary pre-requisite for successful establishment of roaming. This enables the establishment of roaming agreements between two or more mobile network operators. The agreements further increase the number of roaming subscribers thus increasing the value.

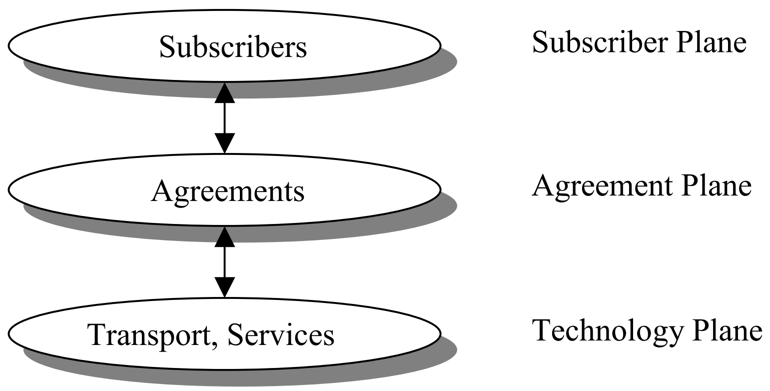


**Figure 2: Key elements required for roaming**

This results in network externalities generating positive feedback and an increase in the value of roaming as illustrated in figure 3.

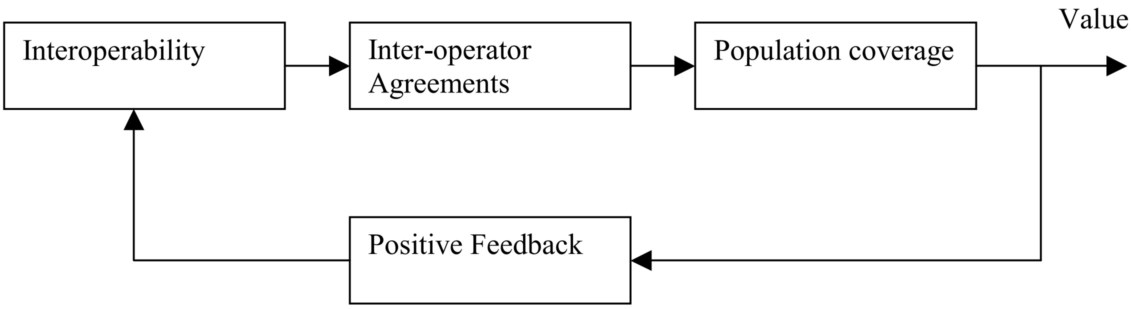


**Figure 3: Mobile roaming dynamics**

Our model calculates the value of roaming from a service operator's perspective. However, the same model can be utilised by other players as well.

## 2.1 Assumptions

The major assumptions made for the model are as follows:

1. Every mobile network has the same number of roaming subscribers.
2. Every network supports the same average number of interoperable services.
3. A network is part of one and only one cluster.
4. Only one agreement is needed for an operator to be part of a cluster.
5. Members of a cluster can make one or more bilateral agreements with those not included in the cluster.
6. The roaming ARPU parameter (inbound and outbound) includes revenue from both mobile originated (MO) and mobile terminated (MT) services.
7. The transaction costs include CAPEX and OPEX.

## 2.2 Parameters

The parameters that influence the value of roaming are identified from the key elements mentioned in Figure 2. It is to be noted here that many of the parameters have been simplified in order to achieve clarity in our analysis. The model can be extended to address more complex scenarios such as networks with uneven number of roaming subscribers and services.

The parameters for our model are described in table 1.

| Parameter | Description |
|---|---|
| | |
| $N_{net}$ | Total number of roaming networks. |
| S | Average number of interoperable services per network. |
| $A_{in}$ | Roaming ARPU for inbound subscribers per service per network |
| $A_{out}$ | Roaming ARPU for outbound subscribers per service per network |
| $N_{in}$ | Number of inbound subscribers per network |
| $N_{out}$ | Number of outbound subscribers per network |
| $N_{agree}$ | Number of basic roaming agreements per network. |
| $C_T$ | Total transaction cost incurred per service |
| $m_{clust}$ | Number of members in a cluster |
| $N_{cagree}$ | Number of agreements to be made by an operator within a cluster. |

**Table 1: Parameters of the roaming value model**

It is to be noted that many of the above parameters have been simplified in order to achieve clarity in our analysis. The model can be extended to address more complex scenarios such as networks with uneven number of roaming subscribers and services.

### 2.3 The model

Based on the previously mentioned assumptions and parameters, we construct the value model for a service operator.

Let there be $N_{net} + 1$ number of networks. From a service operator's perspective, roaming revenue is the sum total of revenue generated from inbound (incoming) and outbound (outgoing) subscribers.

Revenue from inbound subscribers for a service operator is calculated as follows:

Inbound roaming revenue per subscriber = $S*A_{in}$
Total inbound subscribers = $N_{net}*N_{in}$
Value from inbound subscribers = $V_{in}= (N_{net}*N_{in})(S*A_{in})$

Revenue from outbound subscribers is calculated as follows:

Outbound revenue per subscriber =$S*A_{out}*N_{net}$
Total outbound subscribers = $N_{out}$
Value from Outbound subscribers = $V_{out}= N_{out}\,(S*A_{out}*N_{net})$

Cost of roaming incurred by an operator = $C_{roam} = C_T*N_{agree}*S$

Total value of roaming is given as $V_{roam} = V_{in} + V_{out} - C_{roam}$

$$\text{or,}\quad \mathbf{V_{roam} = (N_{net}*N_{in})(S*A_{in}) + N_{out}(S*A_{out}*N_{net}) - C_T*N_{agree}*S} \qquad \mathbf{(1)}$$

## 3 Impact of roaming business models on value (provide propositions)

Three roaming business models have been identified in [3]. They are: bilateral, clustered and centralized. These are defined in section 1. We apply our value model on these three cases to understand the changes in value of roaming as the model evolves from bilateral to clustered and finally to a centralized model.

**Case Bilateral:**

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In this case,

$N_{net} = N_{agree}$, as the agreements are bilateral between operators of $N_{net} + 1$ networks.

Hence, eqn (1) becomes,

$$\mathbf{V_{bilat} = N_{agree}*S\,[\,(N_{in}*A_{in} + N_{out}*A_{out}) - C_T\,]} \qquad \mathbf{(2)}$$

From eqn (2), we realise that for a roaming service to be profitable for an operator, the condition to be satisfied is:

$\mathbf{N_{in}*A_{in} + N_{out}*A_{out} - C_T \geq 0}$**, where** $\mathbf{N_{agree}*S > 0}$

or, $C_T \leq (N_{in}*A_{in} + N_{out}*A_{out})$

A pictrorial representation of the bilateral roaming case is given by figure 4. The figure shows the number of subscribers (in subscriber plane), number of agreements (in agreement plane) resulting in the cost incurred and number of interoperable services (in technology plane) that together enable the roaming services in a bilateral case.

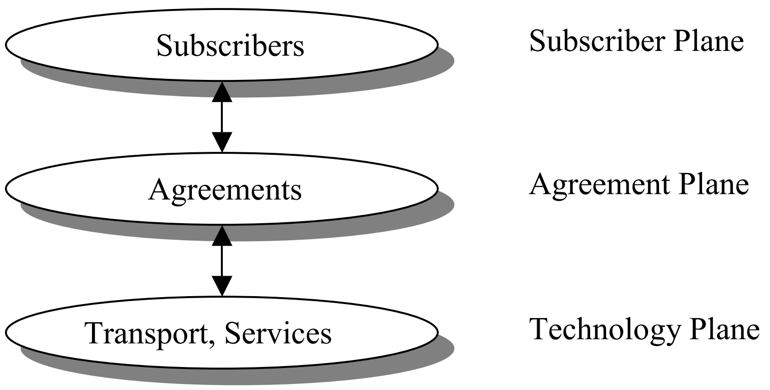


**Figure 4: Bilateral roaming case**

**Case Clustered:**

In this case,

$N_{agree}$ decreases while $N_{net}$ remains the same as two or more operators get together to form clusters.

The eqn (1) now becomes,

$$\mathbf{V_{clust} = N_{net}*S\,[N_{in}*A_{in} + N_{out}*A_{out}] - C_T*S*N_{cagree}} \quad \mathbf{(3)}$$

where $\mathbf{N_{cagree} = N_{agree} - m_{clust}*1}$ **(4)**

Thus, in a clustered case, the total number of agreements required by an operator decreases as the members of a cluster increase as shown in eqn (3).

The condition for profitability is given by

$$\mathbf{N_{net}*S\,[N_{in}*A_{in} + N_{out}*A_{out}] - C_T*S*N_{cagree} \geq 0} \quad \mathbf{(5)}$$

or, $C_T \leq (N_{net}[N_{in}*A_{in} + N_{out}*A_{out}])/N_{cagree}$ where $N_{cagree} > 0$

The pictorial representation of the clustered case is as shown in figure 5.

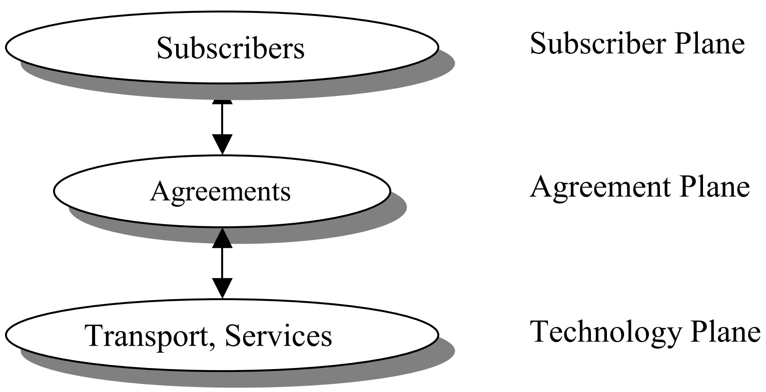


**Figure 5: Clustered roaming case**

Due to the formation of clusters, the agreement plane reduces as the number of agreements decreases and this will reduce the cost incurred in roaming service provisioning. Here, the number of subscribers and the interoperable services are considered the same as in bilateral case.

**Case centralized:**

In a centralized case, every operator has to make only one agreement.

i.e., $N_{agree} = 1$

Hence, eqn (1) becomes,

$$\mathbf{V_{centre} = N_{net} * S\ [N_{in} * A_{in} + N_{out} * A_{out}] - C_T * S} \qquad \textbf{(6)}$$

Pictorially, this can be represented as in figure 6. In a centralized roaming model, the value is the maximum among all the roaming models due to the lowest number of agreements and the costs incurred by an operator. Here, the number of subscribers and the interoperable services are considered the same as in bilateral or clustered case.

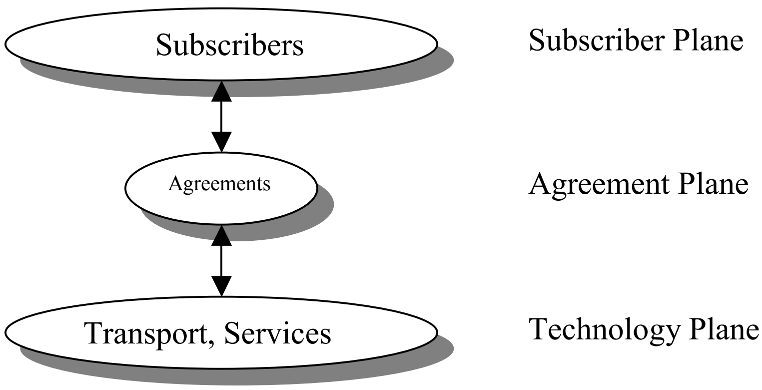


**Figure 6: Centralized roaming case**

### 3.1 The equilibrium state

Based on our value model, we arrived at the following values for the bilateral, clustered and centralized cases.

**Bilateral:** $\mathbf{V_{bilat} = N_{agree} * S\ [N_{in} * A_{in} + N_{out} * A_{out}] - C_T * S * N_{agree}}$

**Clustered:** $\mathbf{V_{clust} = N_{net} * S\ [N_{in} * A_{in} + N_{out} * A_{out}] - C_T * S * N_{cagree}}$

**Centralised:** $\mathbf{V_{centre} = N_{net} * S\ [N_{in} * A_{in} + N_{out} * A_{out}] - C_T * S}$

While the revenue generated in all the three cases are the same, the profitability is highest in the centralized case, followed by clustered and bilateral. This is mainly due to the lower costs incurred as a result of lower number of roaming agreements. In other words, the costs are shared among the operators in the case of clustered and centralised roaming business models.

Thus we have,

$$\mathbf{V_{centre} \geq V_{clust} \geq V_{bilat}}$$

Because, $\mathbf{C_{centre} \leq C_{clust} \leq C_{bilat}}$

or, $\mathbf{1 \leq (N_{agree} - m*1) \leq N_{agree}}$

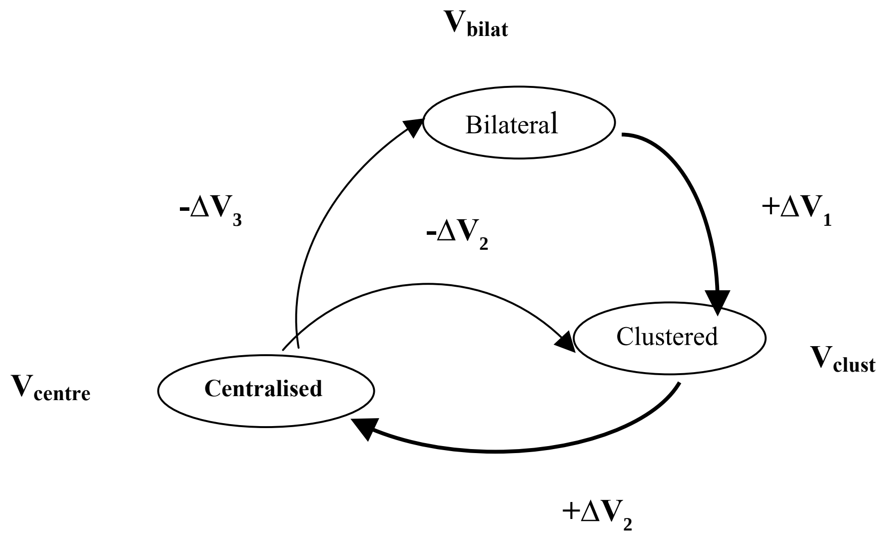


**Figure 7: Roaming value state diagram**

Hence, our analysis shows that the roaming business models will evolve from bilateral to clustered and finally to centralized due to the added value that an operator might achieve from this. At equilibrium, all the operators will adopt a centralised model since they will have no incentive to revert to bilateral or clustered models due to negative value offered by such a move. This is illustrated by the roaming value state diagram in figure 7 and explained as follows.

In practice, we are already witnessing the transition from bilateral to clustered model with recent alliances such as Freemove [8] and Vodafone's alliance through its own networks and partnerships [9]. Together, these alliances currently cover more than 40 countries which makes up approximately 20% of the total number of countries covered under the GSM business family (assuming 200 countries in total). Currently, these alliances are formed mainly for competitive advantage such as low cost and greater service differentiation. Hence, there is a value advantage ($+\Delta V_1$) that is motivating the operators to forge clusters or alliances as has been identified by our model. With the emergence of convergence and stabilisation in roaming technology in the future, the main innovations would happen at the application layer. This would leave little incentive for the operators to maintain their clusters for roaming services. Hence, in such a scenario, operators can achieve greater value ($+\Delta V_2$) for roaming by coming under a non-partisan authority such as GSMA [10] which can control the centralised model, providing seamless roaming across the mobile industry with a single agreement, thus enabling the operators to concentrate on service differentiation over the stable roaming layer. Thus, the conditions necessary for a centralised model at equilibrium is to have a stable roaming technology layer with no additional revenue generated by maintaining clusters. However, this equilibrium may be disturbed, i.e., It may revert to a bilateral or clustered state as soon as these conditions are altered. This may happen due to any instability in roaming technology caused as a result of the introduction of disruptiveness that could provide differentiation benefits with a bilateral or clustered model.

## 4 Discussion

Thus far, we have presented our value model and discussed the impact of different roaming models on the value. In this section, we look at other value-related issues in roaming and our proposals to solve them.

### 4.1 Role of pricing

Pricing is a major issue in international roaming. Operators are often accused of lack of transparency in pricing of roaming. The situation will only get complicated in future due to the emergence of mobile content services resulting in complex pricing models (both retail and wholesale) adding stress to the existing charging and billing mechanism, resulting in an increase in overall cost. Hence, the primary requirement for an operator is to have a simple pricing model. This can be achieved mainly by unification or standardisation across the industry which is possible only in the case of a clustered or centralized model. These models would also enable operators to get a better deal from a content provider. Larger the cluster, greater is the possibility of seamless service provisioning by using concepts such as virtual home environment (VHE) [4]. Thus, a reduction in costs incurred due to clustered or centralized models could enable operators to reduce the prices (both retail and wholesale), resulting in increased usage and higher profitability. It would also enable operators to experiment with subscriber-friendly pricing models such as flat-rate and block pricing. Empirical evidences have shown that such pricing models increase the usage of services [5].

### 4.2 Role of regulators

However, if the operators adopt the clustered model, regulator's role might become paramount in cases where one or more of these alliances become significant market powers (SMPs) in the international roaming market. This can occur if the clusters are formed based on the operators' market power. For instance, operators with higher market share of subscribers and area of coverage would create a powerful cluster, thus forcing the weak operators (with lower value) to make asymmetric roaming agreements (due to imbalance in value) and hence higher prices for subscribers of networks with lower value. Switching cost for subscribers may also increase with increasing power of the cluster. In such a scenario, regulators will have a key role to play in order to maintain the competitiveness in the international market. Since international roaming, by its very nature, transcends national boundaries, the national regulatory authorities (NRAs) will have to cooperate in order to put appropriate laws in place. Europe has a greater likelihood of achieving such cooperation.

### 4.3 Role of inter-access network technology roaming

First and second generation mobile communications have been circuit-switched with limited services, mainly voice, available for the subscribers. Hence, the interoperability requirements were quite limited making bilateral model suitable. The adoption of packet-switched bearer technology and subsequent emergence of data services have increased the need for interoperability and greater cooperation among the operators to reduce the costs incurred. All these factors support the evolution of bilateral to clustered and ultimately centralized roaming model. The development of GRX [6] architecture for GPRS and beyond is a step in this direction. Convergence, i.e., seamless service provisioning over multiple-access technologies, is an emerging phenomenon, primarily attributed to the adoption of (Internet Protocol) IP [7] as the network layer protocol. Roaming over multiple-access networks is a mandatory requirement for seamless service provisioning. Thus, interworking of UMTS/WLAN and seamless roaming are some implications of such convergence.

Mobile handsets with multiple interfaces will play a major role to enhance the roaming revenue in such a scenario. This can be explained based on our roaming value model (eqn (1)). As the number of networks ($N_{net}$) increase with the co-existence of multi-access networks, the number of services and subscribers would increase leading to an increase in roaming ARPU (both inbound and outbound). Thus, the overall value of roaming from an operator's perspective will increase with convergence.

## 5 Conclusions

In this paper, we have presented a roaming value model based on the major parameters that influence roaming over mobile networks. The value model presented in this paper can prove to be useful for operators and regulators in order to understand the roaming dynamics in GPRS networks and beyond and identify the benefits and issues concerned with this evolution.

Our analysis shows that centralized roaming model will exist at equilibrium providing maximum value to an operator, subject to certain conditions. Prior to this, the bilateral model (which is in majority now) will evolve in to a cluster-based model. Such an evolution is already evident from the recently announced alliances. We argue that this trend will continue with more clusters emerging in the roaming market. These clusters will benefit from such alliances in not only reducing the roaming costs incurred but also in other areas such as procuring mobile handsets at lower costs and standardisation in the area of services and pricing. Such developments would ultimately improve the quality of services offered to the subscriber at a lower price resulting in higher usage and higher revenue.

Based on our model and analysis, we propose the following steps for an operator to increase value generated from roaming:

- Increase the roaming population and area coverage
- Increase interoperability of access/core technology and services
- Increase the number of services offered
- Reduce transaction and agreement costs by adopting a clustered or centralized model.
- Adopt simple and uniform roaming pricing models.
- Enable inter-access technology roaming by introducing multi-access mobile handsets.

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