REVENUE - THE CRITERION

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ABSTRACT

The paper discusses business models for future wide-area covering wireless mobile networks. The approach in this work is as direct as possible: Maximize the gain for the stakeholders involved in the different phases of a wireless network life cycle. The main focus will naturally be on the *operation* phase, where *network operators* operate the network, *service providers* offer their services to the *end users*, and *equipment manufacturers* produce and sell the necessary equipment, all in order to uphold attractive and competitive services.

A framework with Service Level Agreements is outlined, and the conclusion is that in order to obtain as high a revenue as possible, the air interface must be as flexible as possible, maybe even spanning over several access technologies. A general resource manager, including admission control and short term resource scheduling, is required to direct traffic through the most efficient path.

INTRODUCTION

The paper begins with an outline of the involved stakeholders or actors followed by an outline of some existing and suggested business models in the following section. The business models describe how the actors may interact in order to generate revenue, and in some cases, to make an investment economically feasible and therefore possible at all. In the following three sections we look at the interactions during three phases in the wireless network life cycle, namely: The deployment phase, the operation phase, and finally the exit phase. The main focus will naturally be on the operation phase, where the contribution from a signal processing point of view will be most obvious. But this view is also important in the deployment phase, since the network planning takes place in this phase, and we have the possibility to choose designs that will enable an efficient operation phase. The operation phase occurs when the network is running in “steady state”. Possible business and pricing models for this phase are then described and disucssed.

The paper is concluded with a discussion.

WHO ARE THE ACTORS?

A normal way to understand how companies are created to offer products, such as goods or services, is based on the insight that something is needed on the market, termed *market pull*. A company specialises in providing the required product at a certain market, since there is a vaccuum to fill. An alternative way, that is commonly referred to in the scope of high-tech products, is the *technology push*, where it is said that the companies inventing the product (or other interested parties) are creating the vaccuum on the market by manipulating the public opinion through marketing or such similar campaigns.

Since there are several stakeholders involved in a high-tech infrastructural project, the case is more like a chain of *market pull* companies, with at least one *technology push* company somewhere in the chain, the latter facing the major risk in the project.

In the case of today’s deployment of 3G networks, the companies that have been forced to take the blow when “the market” seemingly fails, have been the network operators. Of course, their problems have propagated backwards in the chain, to venture capitalists, banks, and equipment manufacturers, that have to accept big debts from the operators, debts that may never be paid at all.

Deployment

In the deployment phase, the main actors economically involved are banks, governmental bodies, network operators, equipment manufacturers, building contractors, real estate owners, and venture capitalists. The number of users is small and the primary target for the service deployment is to achieve good coverage, so that the early users accept the new services offered as valuable and useful.

Operation

During this phase, the idea is that the infrastructural system shuld be accessible to the users. The users, or rather - the customers, are now the source of revenue for the involved actors. They pay for services accessed through the network.

Exit

A stakeholder should be able to exit from the venture at a certain point. Either, a stakeholder could sell its shares in a phase when the expected payback is yet to come, or it could transfer its interest to a new venture in a phase when payback is considered complete.

BUSINESS MODELS

In this outline, we make the distinction between service providers *making or buying* the wireless access to the end users or subscribers.

In today's business model for the operation of 2G and 3G mobile systems, simply put, the network operators own the end subscribers by also taking a role as service provider. This may not necessarily prevail in future networks where, as we will see, the end-user service provisioning may be separated from the network operation.

Single Operator/Service Provider

This is the traditional "monopoly" situation in the wireless telco business. The network operator also provides the end-user services, such as voice telephony and Internet access.

Single Operator - Multiple Service Providers

In a different business model that could be used, the end user subscribes to a service provider, or a content provider, not to a network operator. The user wants to access a certain service he finds useful. In this case, the network is merely a bearer of the service, a way for the content to reach the user. The subscription to the network operator will be an issue for the service or content provider, not for the end user. The service provider will choose to *buy* the wireless access service from the network operator.

We have seen a development in other infrastructural areas, such as railways and telcos, towards this business model. In Sweden, for example, there was traditionally a monopoly situation in the railway business, where the same state company (Statens Järnvägar) owned the rails and ran the trains. In 1988 it was split into two parts, one responsible for running the trains, and one responsible for maintaining the railways. Later, in 1995, the Swedish parliament decided that trains should be run in competition with other comapnies, thus sharing the same rails among different "transport service providers" [5]. This has been further expanded by making it possible to buy trips to places even without railways, through collaborations with coach companies and car rental companies. This resembles using different access technologies for the same service, in a telco context where the service is independent from the technology.

The multiple service provider business model offers the best conditions for competition at the service level. Many service providers can get involved in the operation phase, generating a high expected revenue for the network operator, that in turn gets an incentive and a prerequisite to maintain, enhance, and develop the network. It is within this business model that the ideas presented in this paper will find their best use.

Multiple Operators - Multiple Service Providers

This is a special branch in the wireless access business that seems to be deploying quite fast. Many public places, such as restaurants, cafés, libraries, malls, etc, offer wireless hotspot access for their customers to access Internet and other specific services. These networks are often referred to as "4G" or "fourth generation" nomadic wireless networks. It is an interesting development that is taking place, not only involving access points belonging to different "operators" but also across different access technologies, however out of the scope of this paper to investigate further. See e.g. [1] for some references on business models for these networks.

REVENUE FROM OPERATION

In this section we expound on the operative phase of the network lifetime. Furthermore, we focus on the "Single Operator - Multiple Service Providers" business model, but the discussion could be applied also to the "Multiple Operators - Multiple Service Providers" business model, if the client technology allows.

Service Differentiation

The services offered by the network operator should be general in the sense that they should support any reasonable traffic type. Anything from on-demand reservation of broadband data connections, through real-time multimedia conversations, to short bursts of application data, should be possible to host on the network.

Different voice service providers could buy their user access from the same network operator. They may have different target customers that require different quality of service. One could aim at high-end users that need a reliable service with high speech quality, being willing to pay more than the other service providers' target customers, that expect less from the service and thus have a smaller budget for the voice service. This could also be true for a single service provider, since different network services could be bought for different profile customers. Since the two user groups belong to two different service categories that may be bought separately from the network operator, they do not compete for the same resources from the voice service provider's point of view, which differs from the case where the service provider also runs the network.

Service Level Agreement

Depending on the type of service a service provider is running over the operator's network, different pricing criteria could be adopted. A network operator and a service provider must come to a Service Level Agreement (SLA), dictating the requirements both parties have on each other. It mandates the required service quality that the network operator should provide, but it may also put a limit on the amount of resources that can be consumed by a service provider or service class. An agreement may include maximum and/or minimum limits on:

- Number of simultaneous users (globally and locally, and perhaps time-varying)
- Active connection throughput and delay
- Usage of available resources (for one, several, or all connections)
- Connection establishment latency
- Pricing for normal operation (within the limits) and exceptions
- Portion of time that the SLA should be fulfilled
- Penalties for not fulfilling requirements

Breaking the SLA should lead to economic compensation for the suffering party, and a penalty for the erring party. In the most probable cases, the penalties should be included in the SLA itself, thereby avoiding expensive disputes and external arbitration. It is thus necessary to monitor and trace performance and important events in the wireless network in order to ensure that the SLA is fulfilled. In case of dissatisfied users or customers, it should be possible to deduct from the network traces and reports whether the SLA has been fulfilled or not. If the SLA was fulfilled, the service provider should consider a re-negotiation of the SLA, in order to buy a better network service for its customers. If the SLA was not fulfilled the network operator should consider an upgrade of its network or a re-negotiation of the SLA.

Overbooking

An opportunity for the network operator to earn more money is by overbooking the resources. The operator then signs SLAs that he will most probably not be able to fulfill when the demand becomes high, e.g. at peak hours. At these events it is the task of the admission control to maximise the revenue for the operator, in the long term by not excessively breaking any SLAs, and in the short term by carefully choosing which SLAs to break. The scheduler will play an important role in minimizing the damage by efficiently allocating the available resources to the remaining clients. This is a calculated risk taken by the network operator in order to increase revenue at the expense of damaging the trust in the service. The theory of this behaviour is referred to as *yield management*. It is found in business areas where (a), the resources cannot be stored for later use, and (b), the same resource can be sold at different prices to different customers at different times. Examples of such resources are hotel nights, flight seats, and in the wireless communications case; channel resources. See for example [3] for a summarizing introduction to yield management.

Contingent Pricing

The penalty that the network operator has to pay to the customer according to the SLA could be regarded as a special case of *contingent pricing*. Then there is an agreemet between the seller and the buyer, that if a buyer is intersted in booking a service at a low price, the seller offers a compensation to the interested buyer, should the seller later find a different buyer offering a higher price for the booked service. Contingent (uncertain) pricing thereby helps both the seller and the buyer to reduce risks in a transaction. It also has the effect of prioritizing between customers that value the same resource differently. A customer that needs the service more badly will pay a higher price than another customer, and thus be a more profitable choice when running short of resources. Contingent pricing is explained and analyzed in [2].

Advantages of Having Multiple Service Providers on One Network

Why should there be multiple service providers using a single operator's network? Wouldn't it be more efficient to also let the network operator run the end-user services? Then he would control all resources and be more flexible in allocating them to different services. Won't there be a waste of capital by having more stakeholders involved, that all want to earn a profit from their involvement?

Richer service selection It is not likely that a single service provider / network operator would produce all types of end user services since different services require different pricing policies and different customer support, thus making it cumbersome for a large corporation to introduce a new small revenue service. Small companies offering limited revenue services to end users will enrich the selection of available services.

Competition More service providers producing similar services give the end user the option to choose one or another, resulting in competition between service providers. Services need to improve over the competitors' in order to keep customers and get new ones. Services will thus improve and prices will also probably drop.

Cost sharing The network operator will only pay for building and operating the network. All other end user service related costs will be covered by the service providers or their end users. Moreover, the pricing policy utilized by the network operator towards the service provider allows for a variety of cost or risk sharing setups by dividing the fee into a fixed part and a service related part.

Efficient resource utilization It is more efficient to build one general wireless data fat-pipe over building two separate half-pipes. This is clear when we understand that we employ a wide frequency band to pick occasionally good subcarriers for transmission. The more subcarriers to choose from, the higher the probability of the chosen one being good. This is often referred to as *statistical multiplexing*. However, we expect that there are thresholds where cost increases more than gain when adding new bandwidth, for example when new radio technology needs to be developed in order to support seamless roaming across access technologies.

Pricing Models

A simple model for pricing is to pay for the service that you get, completely proportional to the usage. This fits very well into a best effort service, where there are no explicit Quality of Service (QoS) demands for the service to be meaningful. This simple case is illustrated in Figure 1.

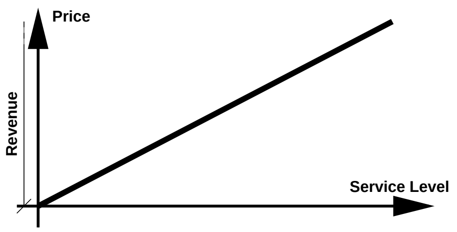

Figure 1: Best effort pricing should be completely proportional to the provided service. There is no penalty on low service provisioning, and no fixed fee to protect the network operator from low usage. Thus, the pricing model has no incentives for providing any guarantees on QoS.

However, when QoS demands are introduced, this simple best effort case does not apply properly. Some extended pricing models are introduced below, that together with figures 2 through 6 serve as examples of what could be used when we need to take QoS into account.

1. Simple proportional pricing without QoS requirements
2. Fixed pricing for fulfilling the minimum SLA requirements
3. Proportional pricing with QoS requirements
4. Fixed + proportional, a mix
5. Progressive pricing when running short of resources

Depending on what pricing models are applied, and depending on the extra demand from users currently not included by the minimum SLA requirements, actions can be taken to increase revenue.

There are also requirements in the opposite direction: The customer has to pay a fee even if he is not utilizing all the services he is entitled to. This is illustrated by the dashed lines in the figures, where the system is under demand limited operation, meaning that the service demand is less than the service supply.

Under the fixed pricing model 2, there is no direct additional gain in fulfilling more than a minimal requirement. This minimal requirement is found in Figure 2, at the point where the dashed line changes into a continuous one. We can see that even if the customer gets a higher service level, the network operator will not increase its revenue.

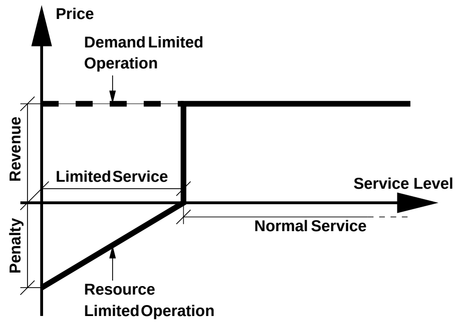

Figure 2: The fixed pricing model 2 allows the operator to receive a fixed fee for the service, regardless of the usage. However, if the resources set the limit, so that the agreed minimum service level cannot be provided, the network operator will have to pay a penalty to its customer.

However, under model 3 it could be fruitful to add another connection when the system state allows, since this will give the network operator additional revenue. Again, if the network resources saturate, a penalty fee will be paid to the affected customer.

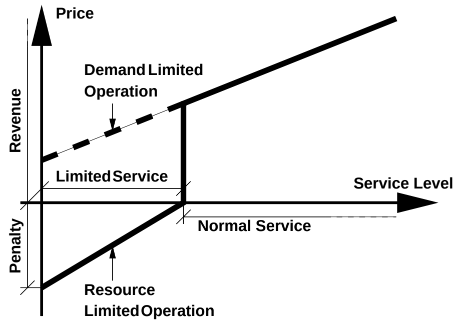

Figure 3: The proportional pricing model allows a high flexibility in the normal service region. If additional resources are released, they could be used to increase the service level for a customer under this pricing model, given that there is a demand for it.

The outcome from the pricing policies becomes interesting when the system actually is saturated. There should be an incentive for the network operator to increase the capacity if this saturated state is reached frequently. One incentive is the penalty that he will have to pay to service providers with unsatisfied SLAs. A different way to look at the resource shortage is by the traditional supply-demand interaction. When there is a shortage in supply, prices tend to increase, whereas when the market is oversupplied, the prices decrease. In figures 5 and 6 these cases are illustrated. However, if model 5 is used for some customers, and the service level has been broken for some other customer leading to a penalty being paid, it

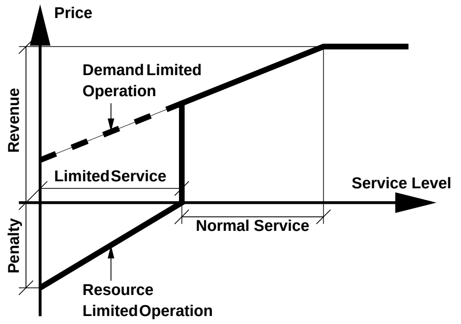

Figure 4: A mix between fixed and proportional pricing is illustrated here. It provides a ceiling on the price for the service, and a proportional part upto that ceiling.

may be fruitful to further break that SLA in order to accomodate more users from the class using pricing model 5. The extra income from customers under model 5 can be used to compensate the overlooked customers. Therefore, it is important that the transition from "normal load" to "high load" is made only on temporary high service demand peaks, rather than on a continuous shortage of resources.

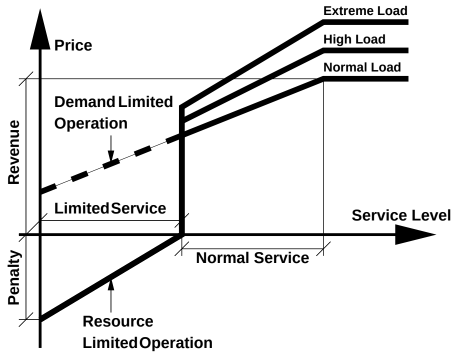

Figure 5: Services become more expensive when the network operator runs short of resources. This is illustrated by the transition from one price/service curve to another when the system becomes highly loaded.

In Figure 6 we illsutrate another alternative for a progressive pricing model. In this case, the customer desires a ceiling on the price paid, and agrees to receive a lower service level at the same price when the system becomes highly utilized.

In [4], an outline of different pricing models is given, along with references to the literature in the area. However, the models outlined there are focused on the problem of setting the correct price when moving away from a monopoly situation: An incumbent telco has to, by regulation, share parts of its network with newcoming actors. This cannot be done for free, so what should the price be? The main difference is that the present work focuses on horizontal services where the actors complement each other on different segments, whereas in [4] the actors compete for the same customers. This is not the case in the present work, since we do not want the service providers to build their own networks, but we want them to pay a

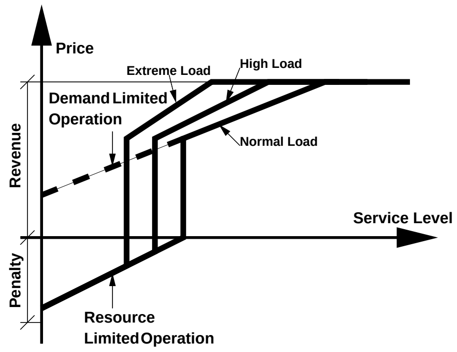

Figure 6: In this progressive pricing model we again see that services become more expensive when the network operator runs short of resources. However, the customer has a ceiling on its costs for a certain service level.

fair price for the wireless access service they use.

DISCUSSION

Are the business models suggested viable for a future wireless mobile communications system? The technology development and standardization should be aimed at creating a fundament for the introduction of service level agreements between network operators and service providers. They should come to agreements that they expect will be profitable for them.

The physical layer of such a technology should allow for a high flexibility in terms of resource usage policies that, among other things, enable fast allocation of channel resources where they are best utilized. Network operators could compete in this sense; being more flexible and efficient than the other, thereby offering cheaper access to the end users.

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