Novel Access Provisioning

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Abstract

New network and business architectures/Novel Access Provisioning (NAP) with low cost factors are necessary to promote development of extensive usage of a multitude of high data rate wireless services similar to the Internet. The NAP project focus in particular on the investigation of possibilities in local access and service provisioning as a complement to existing Mobile Network Operators. We expect that successful high bandwidth mobility services require more than local coverage. Many local access providers need to cooperate to make the service reasonably accessible. Those can then be used to offload heavy and less price worthy traffic e.g. large down loads from the cellular network to local access points. Different drivers of new market players and business models are analyzed.

1 Introduction

Conventional cellular networks does not scale in bandwidth in an economical sense [1]. Other, and partly new, wireless solutions are needed as a supplement to provide data rates higher than a few kbps at affordable rates. We label these supplementary solutions Novel Access Provisioning (NAP).

1.1 Background

We believe that there is large demand for a multitude of non-voice mobile communication services in the next 3 – 10 years. Operator revenues from non-voice services, besides SMS, are still a very small part of total revenues. There are however numerous initiatives from operators today to promote new non-voice services both among wide-area coverage cellular operators and among public WLAN operators.

Development of mobile non-voice services is to a large extent driven by comparisons with the fixed-line Internet. Operators even promote service packages as the Mobile Internet. It is reasonable to assume that demand and product design will tend towards services similar to the fixed-line Internet. The consequences will then be demand for:

- Increasing data-rates
- Increasing data volumes
- More of indoor traffic
- Interactivity i.e. high data-rate uplink

Fixed-line Internet services are increasingly based on higher and higher data-rates to support a lot of pictures, audio and video content etc. with high quality (large screen, high resolution) presentation. It is reasonable to assume that mobile services will have to follow that trend subsequently. We expect demand to present information received by a mobile device on PC screens or projectors. The cellular concept however does not scale in bandwidth in an economical sense (Shannon bound). Access costs tend to increase with data-rates in contrast to the fixed-line concept where access costs have remained stable or declined even with rising bandwidth thanks to easily upgradeable copper- and fiber circuits..

Increasing data volumes add further to transmission costs in cellular systems built for something like 15 MB per user per month. Data volumes similar to the Internet will not only

be in excess of 100 times the volumes from present voice service. Operators´ spectrum resources will also be strained if customers make use of several GB per month each.

In addition to the expected growth above there is another source for substantial growth arising from the increased use in business activities e.g. by sales and service people or in the process industry.

Increasing mobile usage has already contributed to a high share of indoor traffic. We expect that further increased mobile usage in general and mobile broadband in particular will increase the share of indoor traffic, which will contribute to worse link-budgets and higher access costs.

Uplink throughput is limiting interactivity possibilities severely in present cellular systems. High data-rate uplink will be quite exacting from a cost point of view already at a few hundred kbps.

We expect that not only higher bandwidths need to be provided but also that the users' mobile communication expenses per month must be comparable or even lower than for anywhere/anytime services in second and third generation cellular systems. Only low and moderate data rates are economically viable to provide with cellular networks. If affordable mobile services are to be possible, with high data rates at constant or lower access cost either capacity, coverage or QoS have to be compromised and/or architectures with radically lower cost factors have to be found. We call that Novel Access Provisioning (NAP).

1.2 The NAP project

The purpose of the NAP project is to indicate feasible new network and business architectures with very low cost factors that may fulfill the target of high bandwidth mobility services with no higher user expenses than present cellular services. The research activities and expected result includes identification and analysis of the drivers for a segmented mobile service market as well as analysis of candidates for the proposed market players, the related business models and value constellations. Our discussion model is an interdependent system of supply, demand and technology drivers. As we focus on new and virtually unproven services, business models and technologies, we begin discussions with supply initiatives necessary to trigger change in early phases. We assume that drivers of development and change within our time horizon (3 – 10 years) are issues that can be derived from trends and tendencies that are possible to observe today in the markets for telecommunications and IT.

1.3 Objective and outline of the paper

The aim of this paper is to elaborate on the NAP concept and to discuss a few feasible business models that may fulfill the target of high bandwidth mobility services with no higher user expenses than present cellular services. Characteristics of present mobile market players are summarized in chapter 2. Limitations of cellular networks for broadband wireless access are discussed in chapter 3. Chapter 4 summarizes basic requirements of mobile broadband including feasible market structures. The NAP thesis and local NAP players are introduced in chapter 5. Chapter 6 contains references to related work. In chapter 7 a few different business cases based on assets and competencies useful for local network operations. Drivers and obstacles from the supply, the demand and the technology perspective are presented in chapter 8. Chapter 9 contains conclusions.

2 Today´s market players

The core of business concepts of present cellular mobile network operators (MNOs) is connected to coverage, mobility support and uniform pricing, the key building stones of anywhere/anytime provisioning, which has spurred network competition and the emergence of vertically integrated MNOs.

2.1 Core business concept

Coverage is a core requirement for the traditional mobile communication anywhere/anytime provisioning. All limited coverage services in industrialized markets have failed, e.g. PHS in Japan, CT2 and public DECT service in some European countries. Users obviously demand to be always connected and may excuse bad coverage only in remote areas. Bad quality of service (QoS) in terms of blocking, disconnected calls etc. are major drivers of high churn but have not prevented rapid penetration of the service. The key role of coverage has spurred network competition and the emergence of vertically integrated MNOs.

A major focus in system specifications has been seamless handover. Being always connected is interpreted to include the entire coverage area during a call and irrespective of travel speed.

Uniform pricing in Calling-Party-Pays markets was driven by the model that the calling party needed to know the cost of the call even though he did not know the location of the called party. There have been a few trials in terms of “home-cell” pricing, but the uniform pricing model still dominates all markets.

2.2 Present organizations

Present MNO´s provide both network resources and services. Network planning and Operation & Maintenance (O&M) is usually handled internally, but it can also be outsourced, e.g. to telecom vendors. Own units take care of marketing & sales, customer care and billing etc. The users have subscriptions with one MNO and can only access the network of their “own” MNO.

Mobile Virtual Network Operators (MVNO´s) provide their own services but buy transport and access network resources from other operators, see figure 1 where the MVNO uses the network of the Green MNO. Sometimes the terms Heavy and Light MVNO are used where the heavy MVNO has its own core network. Both types have marketing, customer care and billing resources. Service (content) providers offer services to all users. The services are delivered using the networks of other operators.

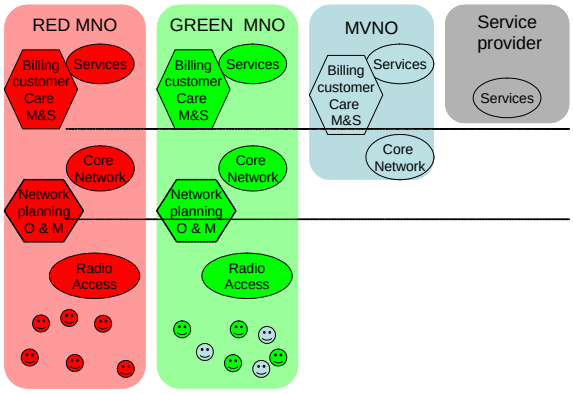

Figure 1. Traditional market players

2.3 Cost structure

Analysing the cost structure of wireless infrastructure systems reveals that the cost component representing the actual electronic equipment is a rather small fraction of the total cost in current systems. Further this cost component is shrinking due to the advances in microelectronics, providing more functionality at lower cost and size. The dominating cost factors are instead related to the physical deployment of the infrastructure, such as site acquisition and rentals, planning and installation of antennas, towers and cabling as well as current expenses for operation and maintenance of the networks and for customer acquisition, support and retention. Public reports from MNO´s in the US indicate that network costs, including accounted depreciation, customer acquisition costs and administration and customer support costs, make around a third each of total operating costs excluding roaming, interconnection and long-distance charges. Network costs include costs for sites, radio access, transmission and core network. [15]

3 Cellular access limitations

Present and planned wide-area coverage cellular networks have a number of critical limitations from our point of view. Throughput to end users is not possible at higher speed than a few hundreds kbps at reasonable costs for mass markets. Requirement of in-door coverage as well as handling of large data volumes and higher uplink speeds would further add significantly to costs if wireless broadband traffic volumes become comparable to wire-line.

3.1 Bandwidth

The access cost issue in cellular provisioning has been covered by [1] and [3]. It is shown that costs are more or less proportional to data-rate.

3.2 Data volumes

An average voice user in Western Europe generates something like 15 MB per month while a typical fixed-line Internet user demands between one and two GB per month, around 100 times more. Leased-line infrastructure represents between 6% and 12% of a typical MNO's operational expenditures today. Mass market adoption of mobile broadband will increase backhaul costs significantly if other transmission solutions cannot be found.

3.3 Indoor coverage

The share of indoor traffic is estimated by different studies to be quite high already today at 50 – 80% of all mobile traffic. We expect that increased mobile usage in general and mobile broadband in particular will increase the share of traffic that is sent or received indoors. Increasing indoor traffic will elevate access costs.

3.4 Uplink data-rate

With spectrum at 2 GHz the COST231-Hata model for outdoor, urban propagation indicates Shannon-bound for 500 kbps at around 350 meters with a 3,84 MHz carrier in a noise limited system[16]. At present the uplink data-rate in 3G systems is 64 kbps.

4 Basic requirements of mobile broadband

We argue that the characteristics of high bandwidth data communications are such that continuous wide area coverage is not necessary. Compromising coverage allow the much lower cost levels than cellular that will make mobile broadband affordable for a mass market. This being said, there are several possible market structures that may emerge in order to fulfil demand for reasonable broadband coverage.

4.1 Somewhere/anytime service

Present cellular operator's service revenues come almost exclusively from voice and related low bandwidth services like messaging, brief information retrieval and ring-tones. The service concept is anywhere/anytime provisioning. Voice and voice-related services follows the logic of real-time anywhere/anytime demand. Quality of service is time-sensitive and dependent on very short delay also when it comes to messaging, answers to information retrievals etc. Users expect messages to be delivered immediately and useful information to be available promptly.

Capacity demanding downloads requires more seldom real-time access. Quality is not significantly impaired if the download has to wait until the terminal is within reach of a local wireless access or connected to fixed-line broadband. This type of service concept may be called somewhere/anytime provisioning.

The user may of course prefer real-time access if the price is the same. But price elasticity of demand for somewhere/anytime access should be very high as delivery and quality of service is considered almost equal. No other than very urgent downloads will be transferred over the anywhere/anytime service if there is a significant price difference.

4.2 Demand for coverage

We expect demand for coverage in places where users make a stop also for other reasons than using a broadband service. That may be meeting points (hotels, restaurants, sports arenas, libraries and other public premises), communication points (terminals for trains, buses, aircraft, lorries as well as stopping-places, cabstands and petrol stations), commercial premises and some coverage in connection with such points.

A review of reasonable mass market coverage of urban areas in the Stockholm region [17] indicated 6900 access points (APs) at 2650 sites in an urban region with 1,85 million inhabitants (PoPs) or around 270 PoPs per AP. Total area coverage was around 3% of total urban area. Other studies suggest similar results for the US or double the number if shops are included. Reasonable coverage seems to require between 4000 and 7000 APs per million PoPs.

Present public WLAN coverage is much smaller and focused at specific user groups who are prepared to pay the very high prices operators charge today. A mass market would however require much better coverage allocated for many different user cathegories.

4.3 Alternative market structures

There are several potential actors in future wireless broadband markets judging from present activities in public WLAN.

1. Existing MNOs may deploy large networks of local APs. T-mobile and Sprint are among those who have expressed intention in that direction.
2. Specialised WLAN operators may continue to build large networks of local APs and act as network operator only, such as the Cloud, or as both network and services operators.

3. Public municipalities may build regional networks and act in similar ways as they do with municipality fibre networks. A number of municipalities in Europe and North America have announced such intentions.
4. Local operators may build networks of local APs and act as network operator only or as both network and services operators. The business model may be independent or as franchising partner to a large operator or both.
5. Enterprises and other organisations in other industries than telecom may build networks for their own needs and expand those for public access. The business model may be independent or as franchising partner to a large operator or both.
6. Small enterprises and private individuals may form co-operative network groups by connecting their respective sites to a larger network for their own needs and public access.

We expect that future demand for wireless broadband will potentially include a significant number of APs, in the order of 30 000 – 50 000 for a small country like Sweden. The sheer number may make it quite difficult for a few large players to dominate and will open up for several small operators and for segmented markets. The actual outcome is of course not possible to estimate. We expect however a mixture of all operator categories as well a large number of service operators delivering through these networks.

4.4 Cost issues

Cellular networks with large cells covering many users may be deployed with high capacity utilization due to large number effects. Capacity utilization may be as high as 70 – 80%. Alternative architectures with small cells with few users cannot reach such levels of utilization. Local access points and local operator business concepts therefore need to be not only based on inexpensive equipment but also to rely on re-use of existing assets and other means to make very low-cost operations possible.

5 Novel access provisioning

We focus on the local NAP players, local operators and enterprises, in the remaining part of this paper keeping in mind that also large players and co-operatives may be active in the wireless broadband markets. Irrespective of the market structure, the service will require more than local coverage even if wide area coverage is compromised. New roaming structures will be needed.

5.1 The NAP thesis

We have chosen to study wireless local access architectures and adaptation of deployment to local demand. Our thesis is that local network and business architectures may provide low cost factors that fulfill the target of high bandwidth mobility services with no higher user expenses than present cellular end-user services.

We expect that successful high bandwidth mobility services require more than local coverage even if wide area continuous coverage is compromised. Many local access providers need to cooperate to make the service reasonably accessible. Such architectures requires not only local radio access and network services but also new roles and actors like clearing houses, access brokers and trust managers to form sustainable platforms for useful mobility services to end-users.

Our thesis implies that such a network of local access networks, similar to the Internet architecture, need to be an open access end-user service concept, similar to the Internet. A

home-network service roaming concept (like e.g. CAMEL) will not fully benefit from the documented strength of the open Internet model.

Users will of course also demand wide area coverage anytime/anywhere type of services like voice and messaging. Most services that require high bandwidth, like different heavy downloads, are however of a character that does not require coverage everywhere if local access is sufficiently cheaper. Cooperation with the wide area cellular networks may however increase the quality of the combined service package.

Local access operations are expected to benefit significantly from re-use of available assets that existing players already possess for other purposes than telecommunication. Such assets may be existing networks, sites, power supply and others related to networks provisioning but also brand, marketing, customer support, billing and others related to market presence.

We also emphasize the importance of local presence in many aspects; knowledge of the local customer base may promote efficient network deployment as well as marketing and sales of locally oriented services.

5.2 Feasible local NAP players

Feasible market players for NAP are presented in this section, see Figure 2. Actors with existing local wireless and/or core wire line networks as well as sites suitable for local wireless access, support organisations etc. may cooperate with MNO´s or fixed line operators with a convergence strategy or alternatively find business models for an independent local access provider.

Large national/global companies represent another type of potential NAP market player with combinations of large customer bases, strong brands and wide spread local presence, e.g. chains of retail or food stores or gas stations. These actors may also re-use marketing, customer support and billing units, either in co-operation with established telecom players or as independent operators.

A number of other market players are required if NAP operators want to be independent. **Access brokers** will handle contacts between users and service providers. A related actor is the **Trust manager** that can handle trust issues enabling “access of any user to any network”. Accounting, exchange of charging records and billing can be taken care of by **Clearing Houses**.

The NAP concept comprise cooperating wireless local operators and different forms of "middlemen" that are needed to handle interconnection, trust, charging and billing, forming an open access low cost high bandwidth mobility services network.

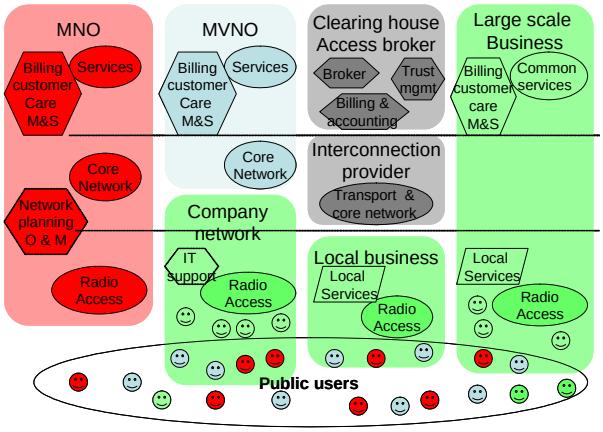

Figure 2. MNO and MVNO together with the proposed new types of market players for Novel Access provisioning

6 NAP and related work

The Whyless.com project argues that the present structure of vertically integrated operators "restricts the unfolding of the full economical potential of mobile communications". A "disassociation of content and network infrastructure, aiming at access on demand to wired and spectrum resources" is proposed where the core issue is about sharing and trading of radio access resources. Suggested structures do not relate to presently existing market players. Whyless.Com is related to other work on access brokers and clearing houses (6).

In 2004 a group from industry and telecom operators finalized specification for UMA (Unlicensed Mobile Access). UMA is a proposed standard for extension of GSM/GPRS mobile service. It is achieved by tunnelling GSM/GPRS protocols through a broadband IP network and an unlicensed radio link in the customer's premises. Additional protocols control and manage the UMA access network, and carry bearer traffic over IP. The standard can be seen as an extension of traditional mobile operators´ access into WiFi networks owned and operated by customers.

The EU integrated project Ambient Networks focus at multi-operator multi-radio access architecture that works across administrative boundaries providing other technology possibilities for NAP players.

The cited works as well as NAP have the common concentration on small-scale solutions for mobile access and services. The NAP contribution is to focus on feasible new business models based on the re-use of existing and identifiable assets and competences in other business operations.

7 Analysis of new market players

In this chapter we will discuss a few different business cases for local NAP players based on assets and competencies useful for local network operations. Such assets are:

- Network: site locations, actual sites, power supply, local transmission, radio equipment, radio network control systems, resources and knowledge of network management etc.
- Customer relations: Brand, marketing and sales, customer support organization, billing systems etc.
- Services: Service platforms, content, telecom business experience etc.

We have chosen to discuss the following set of business cases for Local Network Operators (LNOs) here.

- Network franchising; LNO cooperating with MNO
- Large-scale business with strong brand, many local offices and large customer base acting as operator.
- Local business operator.
- Many independent LNO´s cooperating with trust managers, access brokers and clearing houses.

7.1 Network franchising

Most large and medium sized companies have internal communication networks and services. The usage of these company networks is characterized by fully known internal users (no public users), focus on internal services & needs and no internal charging or billing issues.

Within the NAP context these companies can act as LNO´s where the company network and infrastructure is "re-used" for local public wireless access.. The LNO´s can offer company assets to a MNO, offering an alternative to, as we argue, a more costly network build out of the MNO network using the traditional base station site approach. Common assets to offer, or to use for negotiation with, MNOs include

- Site space, " power & stable environment",
- Transmission & fixed line infrastructure
- Local network operation & maintenance.

This offers a potential for reduced network CAPEX and OPEX, the principle is illustrated in figure 3.

In addition, if the agreement between the MNO and LNO also includes "access to all traffic", both internal and public, the MNO will experience lowered costs for customer acquisition (see figure 3). Since the traffic most likely can be considered to be both stable and established it represent a low risk investment for the MNO.

In summary, co-operation between companies and MNO have a high potential to be a win-win deal.

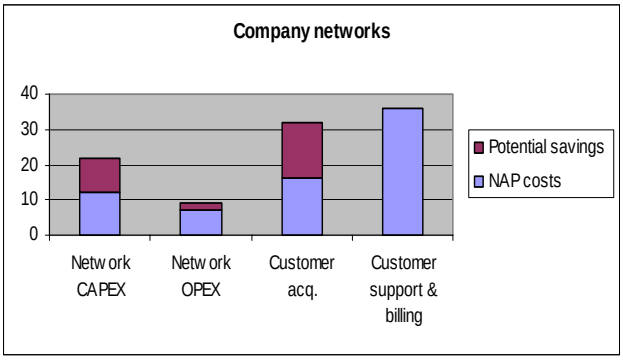

Figure 3. Potential savings for different cost components for Network franchising Note! Illustrates the principle, no real numbers.

7.2 Large scale business operator

This type of market actor is a large-scale business with widespread local presence with many local offices, shops, terminals, restaurants or the like ensuring daily contact with customers. Possible candidates include chains of food or retail stores, fast food companies, gas stations, cinemas but also railway, bus companies and banks. These kinds of actors possess the resources of "the large company" when it comes to general support for marketing & sales, service development, IT and communication services, payment and billing.

In addition to a large customer base with a large number of billing relations and a strong brand, this kind of market player has a substantial potential to act as a network operator, either independently or in cooperation with mobile or fixed line network operators.

Compared to LNO´s this kind of market player has a more widespread local presence combined with regional, national or global service units. See figure 4 where savings also can be expected by reuse of IT support, customer care, and financial and billing support. For MNO´s both the risk and the potential benefits of cooperation are believed to be quite large since business support systems of two large companies have to be adapted in order to cooperate closely.

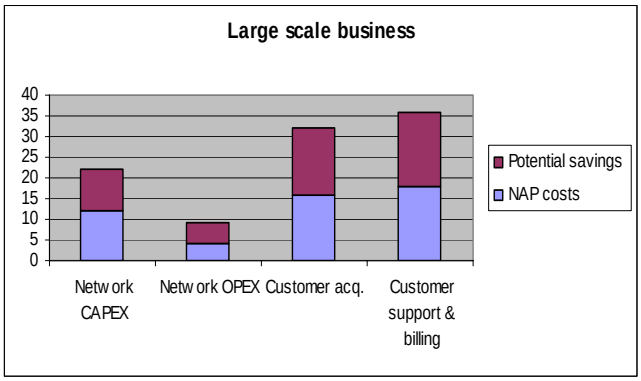

Figure 4. Potential savings for different cost components for large scale companies acting as Network operators Note! Illustrates the principle, no real numbers.

7.3 Local business operator

The local business operator offers local services, which may be provided by wireless access, e.g. local **Information** at railway stations, airports, bus stops, museums or libraries. It may also be **Advertising** of products and offers at stores, shopping malls, airports or amusement parks. Another possibility is **Media delivery** using ”down load stations” for music, news, games etc.

The local business operator as LNO is characterized by mostly public users (customers) and no or very few internal users. In addition to the re-use of the local network, this kind of LNO can probably also offer support for identification of users/customers and for payment to a MNO.

The network aspects are the same as for network franchising, but for the MNO´s the co-operation with this type of LNO is believed to represent a business case with a higher risk, since the traffic is less known and stable, and for small businesses also lower and more fragmented. For this case the MNO may be less keen to co-operate, hence, the LNO will be more dependent on other market players as e.g. access brokers and clearing houses.

7.4 Independent LNO´s cooperating with trust managers, access brokers and clearing houses.

The new types of operators, described above, can cooperate with traditional MNO´s or, alternatively, join and form “business coalitions” with access brokers, trust managers and clearing houses. These business coalitions can offer locally adapted services and common services with local coverage and compete with the traditional MNO´s

Since the vertically integrated value chain of MNO´s is disintegrated, new business roles and relationships as well as technical and business interfaces have to be designed.

Access brokers and **Trust manager** are needed to handle contacts between users and service providers. Compared to the authentication procedures used today by MNO´s, where the identity of the user is used, the trust manager will ensure that a user that wants to access a network or to use a service can be trusted in some way, no matter the identity. An access broker acts on behalf of both users and service providers in order to evaluate offers of network capacity from **access and transport network providers** and to select the best mix of providers for the service session.

In the situation with many different service, access and transport providers a **clearinghouse** is a trusted 3rd party responsible for accounting and exchange of charging records between providers and also for the end-user billing.

8 Novel Access Provisioning drivers and obstacles

A number of factors may promote NAP/wireless broadband and others may work in the opposite direction. We have chosen to differentiate drivers and obstacles for the NAP thesis in three groups as supply, demand and technology oriented aspects, keeping in mind that these issues are more or less interdependent.

8.1 Drivers and obstacles

Among several drivers on the supply side we have the re-use of available assets in other businesses as a vehicle to promote emergence of new market structures as well as promoting operations at lower cost levels than traditional architectures. Independent local providers have potential cost and marketing advantages. There are in addition tendencies in telecom market change that indicate that large operators possibly may be increasingly dependent on cooperation with local access providers once a NAP market develops. Emerging municipality WLAN networks may also spur the NAP thesis by the use of open architectures and promote emergence of other local operators and independent interconnection possibilities. Local deployments of WLAN networks make low capex/low risk projects possible. Public regulation promoting increased competition, is potentially an important driving factor for NAP.

One type of obstacles is factors that hinder or slow down development of wireless broadband as such. MNOs are deeply invested in wide area networks with moderate bandwidth, which still have a potential from a low level of non-voice service usage. Their market power and insistence that they offer broadband may lure users from more potent alternatives. Another obstacle may be incumbent operators´ ambitions to build closed networks for their internal services, as illustrated by recent declarations from Sprint.

On the demand side the characteristics of high bandwidth data communications are such that wide area coverage is not necessary. Since local access is much less costly there is a feasible business case for local access provisioning. One obstacle may be the relative attractiveness of competing broadband facilities for e.g. downloading or over fixed access or DVB-H.

Several technology developments favors the NAP thesis: local access air interfaces, multi-mode protocols for interaction with wide area cellular access like UMA and others, the Ambient Networks project developing interconnection procedures. One obstacle may be that too many protocols may complicate interconnection and limit economics of scale in systems and terminals manufacturing.

Drivers in our discussion refer to circumstances that constitute generic strength of a feasible business foundation for NAP. Drivers do not necessarily trigger actual development and change. But we limit our discussion to feasible business and network architectures and do not evaluate if and how they can be realized. Still the discussion is based on issues that can be derived from trends and tendencies that are possible to observe today in the markets for telecommunications and IT. In the following we elaborate more on supply side drivers.

8.2 Supply side drivers

Re-use of available assets that existing players already possess for other purposes than telecommunication have the potential of functioning as catalysts for the emergence of new market structures as well as providing operations at lower cost levels than traditional architectures.

We would like to emphasize two different types of re-use possibilities that may give Novel Access Providers advantages over large telecommunication operators in general.

8.2.1 Market related assets

Commercial entities may have assets in the form of existing customer relations in other business operations. Such relations could be re-used to build a market position in telecommunications. One example is a strong brand in operations somewhat related to telecom, such as power provisioning, heating or water supply and fuel supply. Such companies have regular billing and customer support contact with a large number of potential telecom users and may also have a reputation for reliability and smooth operations.

Another example is transport and travel business, which have their customers locked-up for a period of time with no other or limited possibilities to communicate other than by means supplied by the transporters. Similar lock-up situations could be attained indoors by supermarkets, department stores and shopping centres. Content related brands could also function as basis for a telecom operation, not only entertainment and other content related but also life-style images like Virgin.

Sales, general and administrative costs constitute the major part of operating costs for MNOs today. More than half of that are commercial and customer acquisition costs pulled by the continuing high churn rate of the industry. Customer service and support, billing and the like is the major share of back-office costs. Re-use of sales and back-office assets may make it possible to reduce operating costs significantly.

8.2.2 Network operations

Potential NAP players may have assets in the form of existing radio access or core networks as well as assets related to the physical deployment of the infrastructure, such as sites, antennas, towers and cabling and organisations for operation and maintenance of the networks. Local access providers already possessing such assets for other purposes, which can be re-used in radio access, should be able to offer the service at lower cost.

The dominating cost factors of wireless infrastructure systems are related to the physical deployment of the infrastructure. Re-use of such factors may therefore have significant influence on the resulting cost structure.

The organisation of other entities´ idle or underutilised assets is a special case. One example of that is FON, which is trying to organise private WiFi access points into an international hot-spot network.

9 **Conclusion**

We have ventured into explaining the NAP concept in this paper as well as positioning the NAP project focus on local NAP players among other possible development paths towards a mobility broadband market. We conclude that a NAP environment is necessary to realize a mobility broadband market. The cellular concept cannot handle more than a few hounded kbps at reasonable costs for a mass market.

NAP implies a compromise of wide area coverage on the basis that high bandwidth data communications does not require real time access and the fact that limited coverage make a much lower cost level possible. The conclusion is technology neutral among different WLAN standards. These technologies however necessitate numerous simple access points. This fact in combination with municipality interest to promote local networks, pave the ground for differentiated markets with many independent local players.

The NAP scenario is not only driven by the low cost WLAN technologies but also by the cost benefits and market access advantages that a local player may have. We emphasise possible re-use of strategic assets with players in other industries than telecommunications. A

few example business models include network franchising as the wide area service narrowband access complements the broadband service.

A major obstacle to broadband mobility service and the NAP concept is the fact that MNOs with their very strong market position have not yet succeeded to exploit narrow/medium high band service potential.

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