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Economics and Governance of the wireless Internet

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Introduction

The undisputed success of the Internet is based on the creation of a market place, which has created the right incentives with regard to investments in network expansion and service development, on the one hand, and usage, on the other. This market place has developed largely without any regulatory intervention from governments.

At the same time, the Internet has undergone a growing diversification with regard to types of users, kinds of services and use of transmission technologies and infrastructures. Today, internet services are delivered by the use of many different wired and wireless communication technologies with different technical capabilities and limitations, and with different techno-economic characteristics. Users include both advanced corporate users as well as users with low technological competences and limited willingness to pay. Services include high bandwidth demanding services such as videoconferencing as well as Internet of things services requiring occasional transmission of a few bits. Most services used by private users are web-based, but app-based applications are becoming more important – especially in the wireless Internet.

The question is whether these trends challenge the current mode of governance for the Internet. In the early days, the Internet was considered to be open, free, competitive, with a high level of entrepreneurialism, and with low barriers of entry (Noam et al., 2003). The current debate on network neutrality indicates that this might no longer be the case.

In this paper we will however not go into the content side of the network neutrality debate, but focus on whether entry barriers will remain sufficiently low to maintain entrepreneurialism and real competition, and whether the current market structure and related pricing schemes provide the right incentives for further innovations and investments.

Three issues are discussed:

1) Developments in pricing schemes for Internet interconnection and Internet access with special focus on the role of wireless access.

2) Developments in supporting infrastructures with special focus on the increasing role of wireless technologies.
3) Developments in service platforms with special focus on increasing use of app based services especially in mobile internet applications.

First the paper provides a general introduction to telecom pricing. This section is followed by an overview of technology developments and a section on service developments. Finally, the conclusion discusses the impact of these developments on future pricing schemes and business models for Internet provision.

Pricing of Telecom Services

Pricing of telecommunication services is a scientific discipline of its own. Much of the research in this area is done with the objective of designing a scheme for price regulation, which optimizes public welfare. The concept of public welfare should in this context be seen as a broader objective than just achievement of pareto-optimality. Objectives such as promotion of competition, equity between regions and groups of consumers, protection of consumers from abuse of monopoly power, and stimulation of innovation and investments have all played major roles in pricing schemes designed by regulators. Similar issues are analysed under the heading of public utility pricing (Brown & Sibley, 1986) (Coase, 1970). Here the point of departure is the similarities in both the economics and the institutional framework for public utility sectors such as electricity, water and gas. Another related trail of research is information economy or network economy, which includes analysis of the pricing of information services, which are characterized by having marginal costs close to zero (Shapiro and Varian, 2013). Even though prices for Internet services are largely unregulated today, this research is relevant for a discussion on how Internet pricing will develop, and how prices will affect financing and efficiency in the future.

Hank Intvent (Intvent, 2000) categorizes the objectives of price regulation in three broad categories: Financing objectives, efficiency objectives and equity objective. Three different types of efficiency are identified:

1. Allocative efficiency – relating to consumer behaviour: consumer behaviour should reflect scarcity and relative costs of various services
2. Productive efficiency – relating to optimization of production resources
3. Dynamic efficiency – relating to optimization of innovations and investments

In public utility pricing and in telecom pricing the most important major issue has been related to designing of pricing schemes that would lead to allocative efficiency. The production was carried out primarily by public or semi-public entities with a monopoly status, and the task of pricing schemes were mainly seen as a way to achieve the highest possible level of welfare defined as the sum of consumer and producer surplus taking the condition of break-even of producing companies into account (Brown & Sibley, 1986).

Public utilities are among others characterized by high investment costs and low marginal costs both with regard to the number of users and actual usage. This implies that costs per user decreases if more users are using the service. It is, therefore, important to connect as many users as possible in order to obtain a break even. Network effects and positive externalities add to the importance of this objective not only for the operator but also from a societal point of view.

This problem is to a certain extent addressed by the use of non-linear pricing. This often implies that access and usage are treated as two different services, which are paid separately. This enables the construction of a pricing scheme that better reflects the production costs related to the individual consumers.

One challenge is to cover investment costs. A pure cost based pricing scheme would be to let consumers pay the entire investment costs up-front. This would, however, exclude a large group of consumers, who would be unable or unwilling to pay such a high installation fee. The obvious solution is here to cover the major part of the investment costs through a subscription fee. This solution implies that operators will have to cover investment costs in the first round. While it makes it easier for new customers to enter the market, it creates a barrier of entry for new operators.

It should be noted that it is not always this model which is applied. Investments in new fibre based broadband networks are sometimes fully financed by users directly.

Another challenge is coverage in high cost regions. Application of purely cost-based pricing schemes would imply that each customer should pay the marginal cost for providing the service plus a fair share of the common costs. However, the costs of connecting customers in rural areas may be many times higher than in urban areas. A pure cost-based pricing scheme may therefore lead to prohibitive costs in certain areas. Due to network effects and economies of scale, there is a common interest in extending network coverage to rural as well as urban areas. As long as users pay a price higher than the marginal costs, they contribute to the profitability of the network. Even if they pay a price lower than marginal costs, positive network effects may result in a positive impact on the total welfare gain.

A third challenge is pricing of low volume users versus high volume users. A high subscription fee will scare away low volume users. This can be avoided by letting a higher part of the costs be funded by a high usage charge. However a usage charge higher than the marginal costs will lead to a level of usage which is lower than the optimal.

Flat fee is a pricing scheme, where payment is independent of the level of usage. This pricing model is widely used for pricing of Internet services, but is also applied for other kinds of services. One major advantage with this pricing scheme is that it provides full transparency to the user.

Use of price discrimination, offering different pricing schemes to different schemes to different kinds of users, might seem to collide with equity objectives, but can actually improve welfare gains (Brown & Sibley, 1986. However, price discrimination as a pricing model depends on the ability to define distinct user groups.

A variation of price discrimination can be to offer multiple pricing schemes, so that users can choose the most attractive pricing scheme according to their expected usage.

In the following sections developments in infrastructure and in services/application will be presented feeding into the concluding section, where their implications on costing and pricing issues are discussed.

Developments in supporting infrastructures and applications

The Internet has proven to have potentials beyond a communications infrastructure for simple text messages that it originally was designed for. Today, virtually everybody and all sectors in society use the Internet and ICTs as enabling technologies for production, distribution, and innovation of products, services, and business models. In this still wider adoption, the Internet has, however, shown to have fundamental limitations bound to the fact that it was designed as a specific communication infrastructure whereas in a new paradigm it is increasingly used as a generic digital exchange and distribution platform. In this section, we study the development of the future Internet and discuss the development of broadband infrastructures with focus on the mobile and wireless infrastructures. This has been researched in the FP7 program under the title ‘Future Internet’; at the ITU level under the title ‘Future Networks’ and also in other regions with different names and titles. Two trends with particular importance for Internet pricing and governance are described: The increasing use of the Internet as a platform for machine to machine communication and the tendency towards mobile and wireless use of the Internet. Furthermore the impact of these trends on the requirements of new applications and services to the future networks is discussed.

Machine to Machine communication (M2M) and the Internet of Things (IoT) paradigm put other types of requirement to the networks such as scalability, reliability, coordination, control etc. These factors should be seen in connection with other economic and market developments regarding demand oriented factors and supply oriented factors including scale and scope economies. The reason for taking IoTs into consideration in this paper is the huge growth of the smart objects and devices and their impacts on future services and app development in particular in mobile wireless platforms accessed by smart phones or other personal devices like smart watches, intelligent fitness and health related bands. Consultancy reports and white papers from equipment vendors estimate that looking in 2020 perspective there will be 50 billion devices and things connected to the Internet (Barker, 2014). The specific characteristic of devices and things connected to the Internet is that they are not so much capacity / throughput hungry, some of them need only to transmit a few Bytes and need to be connected to the Internet once in a while. In these applications, throughput is not an issue but the power consumption can be a major issue and they can require battery life of 15/16 years (Nokia Networks, 2015). Other devices can have low capacity needs, but they are very sensitive to latency and highly dependent on the reliability of the network. This can apply to car to car communication, e.g., when it comes to applications assisting the driver for collision avoidance.

These evidences point to the fact that the future Internet, on the one hand, must meet requirements from audio-visual, information and entertainment, services of high throughput/capacity and low latency and jitter and, on the other hand, and be able to cope with billions of devices with a number of diversified requirements to be able to create optimal conditions for future advanced app development and smart services that enable more efficient production and processes in practically all the sectors in the society.

The increasing use of mobile infrastructures and the high penetration and use of smart phones challenge the available resources in the mobile networks. More spectrum resources are allocated for mobile communication and mobile broadband standards evolve towards increasingly higher spectrum efficiency. Still the increasing usage develops in a way, so the throughput offered in the mobile networks is unable to meet the demand. In this regard the wireless access to the fixed broadband infrastructures plays a vital role, a wireless access that is dominated by the WiFi technologies. Studies show that more than 75% of internet access from a smart phone is through WiFi (Hetting, 2013). This has driven the development towards integration of WiFi and mobile networks. In the beginning the development was discussed under the heading of 'WiFi offload' and recently under the heading 'Mobile WiFi integration / convergence'. The idea is that by the use of Hotspot 2.0 standards and the ANDSF protocol, it is possible to create seamless mobility between mobile networks and Carrier Grade WiFi networks and by that it is possible to give the devices and networks the possibility to choose the best network in a given time and context. Another development looking at the same problem and promoted by 3GPP is the development of LTE Unlicensed (LTE U) with the aim of offloading the data from licensed spectrum used by LTE to unlicensed spectrum and take the same advantages as WiFi offload, however, here with better control from the Mobile Network operators.

The heterogeneous character of combining different network technologies will be even more needed, when specialized network infrastructures will be developed to take care of specialized Machine to Machine communication like IEE802.11P, LTE-M (Nokia Networks, 2015) and SigFox technologies. When new wireless broadband technologies are developed to take care of rural connectivity like Super WiFi (IEE802.22) or to enable broadcast in LTE networks using LTE Broadcast, even more capacity will be needed (Qualcomm, 2013). These technology developments are in line with the visions of 5G mobile that looks at the heterogeneity of network infrastructures rather than coming up with a new standard able to solve all the problems.

A final issue related to infrastructure development is that even though mobile and wireless networks are highly important for the future services and applications these networks rely heavily on the fixed broadband networks. For example when it comes to the WiFi networks the wireless part of a WiFi network is only ten to a few hundred meters while the rest is a part of fixed broadband infrastructure. Therefore the developments in fixed networks are as important as the wireless networks, when we look at future applications and services and at the app market.

In the fixed broadband networks, fibre based solutions are absolutely the most efficient and offer the highest throughput, however, they are costly to deploy. Other fixed broadband network solutions like cable TV and DSL family of standards offer cheaper alternatives with a rapid growth in throughput and capacity. The first by introduction of the DOCSIS 3.1 in cable TV networks (Zahao et al., 2012) which changes the spectrum allocation and increase spectrum radically by removing the TV channel as the basis unit for spectrum use and by introduction of OFDM. Use of new technologies like bonding, vectoring and the DSL 'Phantom mode' will double the available capacity in the VDSL network infrastructures many times (Finne, 2012) (Timmers et al., 2011).

Development in Service Platforms

The development of the mobile Internet has added a new dimension to the application of Internet services, and greatly contributed to the development of new kinds of applications and usage. The increased flexibility offered by the use of a wireless infrastructure is, however, not the only implication of the wireless Internet. Mobile Internet is accessed through a variety of different kinds of devices (PCs, laptops, tablet and mobile phones). This is something that must be taken into account in design of new services.

In this context, the most important difference is not a purely technical one, but also related to the business models behind service provision. In contrast to the fixed Internet, where services are almost entirely web- based, services designed for the wireless Internet is very much based on the use of apps. This has huge implications not only in terms of differences in technologies but, first and foremost, in terms of economic potentials. The so-called app economy has developed tremendously since it really took off after the launch of the iPhone in 2007.

The term wireless Internet includes mobile access as well as other kinds of wireless access, primarily Wifi. Whether a mobile connection (3G or 4G) or a Wifi connection is used makes a great difference – or, at least, it has made a lot of difference – as the broadband capacity of mobile access until only few years ago normally has been much lower than for local area access networks and has been much more costly. This has meant that wireless Internet mostly has been Wifi-based. However, this has been changing during the past few years, as mobile broadband capacity has increased greatly and as prices for Mbps and GB have dropped considerably. This may eventually equal out the difference between wireless and wired Internet, but it has made a huge footprint on wireless Internet use – a footprint that is not likely to go away for a foreseeable time. This footprint is the use of apps and the whole app economy.

From a technical point of view, the difference between wireless app and wireless web is that apps are downloaded on the mobile device while web access is rendered through a browser. This means that an app is a piece of software running on the mobile device. It can be integrated with web services, but it can also, in many instances, function without Internet access. Often, the term used is native apps as opposed to web applications. However, as browser technology has developed, the dividing lines between native apps and web applications have become increasingly blurred, as, for instance, HTML5 technologies can render comparable functionalities to native apps, and as native apps and web applications are increasingly integrated.

Nevertheless, the heavy footprint of mobile apps and the whole app economy will keep on having a huge influence on wireless Internet, and the topic dealt with in the present section is what this means for wireless access to Internet and the Internet economy in general.

An illustrative example of the importance of wireless apps is when Facebook entered the wireless arena. Facebook had from its start mostly been used on devices with larger screens such as PC and laptops, but with the massive growth of wireless Internet access, Facebook took the leap into the wireless world - however, at first, with no great success. The reason was that they started out with a web platform where the functionality was not sufficiently good. This resulted in a change in 2012 to using an app approach, where they acquired WhatsApp as well as Instagram, which business-wise meant that wireless advertising within 3 years went from practically zero to constitute around 70% of their advertising revenue (Natanson, 2015).

This is an indication of the great changes that have taken place in the whole wireless area. While revenues in mobile communications for many years primarily came from traffic fees and mobile handsets, the whole app area plays an increasingly important economic role in the wireless area. According to Portio Research, 18% of the combined worldwide app services and handset markets came from the app economy in 2012 (Voskoglou, 2013). And, the projection was that the app part would keep on increasing in the following years. This is an illustration of the changing mobile landscape from a situation with the mobile network operators as the keystones of the mobile ecosystems (Iansiti and Levien, 2004) to a new situation with the app platform providers as the central organizers of the mobile ecosystems.

The figures available illustrating the size and growth of the app economy are mostly from consultancy companies. Rewrite estimates that there are 2 billion smartphone users in 2015, and the global number of app downloads is estimated to being 180 billion in 2015 (Rewrite). With respect to Europe, Vision Mobile estimates that there were 1 million jobs in the EU in 2014 directly or indirectly related to the app economy of which approximately 400,000 app developers (Vision Mobile, 2014).

What started happening with the launch of the iPhone in 2007 and quickly was followed up by the Android development was that the whole mobile landscape, ecosystem or whatever the preferred term is, started changing from an operator centric system with the mobile network operators organizing the mobile ecosystems of users, application providers, network operators, and equipment providers including handset providers to an app platform centric system with Apple's App Store and Google's Android Market as the central organizing nodes mediating between app users and app developers.

This economic system is based on downloads of apps. This is a technology system that fits well into the traditional mode of operation of IT companies like Apple and Google, while it does not fit in well with the operator centric tradition of telecom operators. However, even though technological development is blurring the lines between native apps and web applications, and HTML5 based applications may provide similar functionality to apps, our projection is that the app based mobile ecosystems will persist to be dominant for a foreseeable future. Just as this system has been driven by the hitherto lower broadband capacities of mobile networks, the app system will keep on affecting mobile Internet with the relatively lower requirements on broadband capacity of download based applications.

Other important implications are related to how open or closed native app-based systems are as opposed to systems based on web applications. An app-based system is relatively closed, as the platform provider has control of the platform but, at the same time, has created a platform where different kinds of application providers can interact with their users. Such a system has been characterized as combining control and generativity (Eaton et al., 2011), meaning the generation of applications not developed by the platform owner. The App Store and Android Market are iconic examples of such platforms. The software development kits used for developing applications for such platforms do not necessarily use general standards. When an application developer wants to develop applications for different platforms, s/he will in most cases have to develop different versions for the different platforms. This does not apply to web applications. There is, obviously, a continuous development of web standards, and there are therefore different standards being used. But the aim is, all the while, to reach agreements of common standards for web tools. This makes an important difference with respect to the governance of Internet – i.e. whether the basis is general and common standards or proprietary standards.

Often, it is easier to get started with a more closed system, as there is an organizing stakeholder in control instead of diverse interests and differences in the direction of developments. The App Store is once again an illustrative example of how developments, systems, and tools that already where there on the market did not set off a decisive development, but where the App Store initiative around the iPhone got the market started. Later in development tracks, it may be that more open systems will have greater advantages, as the network effects will become greater the more users participate. However, if more proprietary and closed systems already have a decisive market share, more open system may have difficulties in getting traction.

Challenges for Pricing of Internet services

Developments in technologies and services create at least three different issues to be addressed by the current pricing system:

1. Impact from increasing use of Internet of Things services
2. Differences in cost profiles for wired and wireless Internet access
3. Funding of network infrastructure services

These all have an impact on how allocative, productive and dynamic efficiency can be achieved through a well-designed pricing scheme, and whether this is something that can be achieved through the market mechanism without regulatory intervention.

Use of the Internet will become even more diverse in the future. In addition to business users, content providers, content consumers etc. there will be still more non-human users such as metering stations, traffic and car management systems and smart homes. User needs and behavior are very different for these different kinds of user groups. However, all users are in principle provided with the core kind of service: Access to two-way data communication using the IP protocol. Even though it is possible to offer multiple pricing schemes designed for particular user groups, it is not possible to prevent users from switching from one pricing scheme to another. Demanding more than a symbolic subscription fee would kill many Internet of Things applications, on the other hand a high user dependent charge will be detrimental for other kinds of applications.

This issue is complicated by the fact that Internet access is provided by use of different partly substitutable network solutions. Especially the cost profiles for provision of wired and wireless services are very different. In wired network the major cost driver is provision of access, while the major costs drivers in the mobile networks are capacity and coverage. This is reflected in the pricing schemes applied. Fixed network users are usually charged with a flat rate according the bandwidth offered. For mobile users the situation is the opposite. Capacity is offered on a best effort base, and users are charged according to a predefined maximum use.

These differences in pricing schemes affect not only user behavior but also the entire Internet business, where design of network architectures, services and applications must take different cost profiles into account.

The Internet is today primarily funded through payment of retail charges paid to the Internet Service Providers (ISPs). At the wholesale level, Internet services are priced according to a complicated set of agreements between network operators. In principle two kinds of agreements exist: Peering and transit. In a peering arrangement costs of interconnection are shared between the partners involved. Peering is mostly used for interconnection of two operators with comparable level of coverage. In this situation both operators enjoy the same amount of benefits from the exchange of traffic between the two networks.

Transit agreements are agreements, where a smaller ISP pays a larger ISP to provide a wider coverage. A special case is here transit agreements made with one of the so-called tier-1 ISPs. These are the ones having full coverage. Typically a flat fee is charged for bandwidth available and peak throughput. A usage based charge may be paid if traffic goes beyond the peak level (Vanberg, 2009). For small ISPs it will often be attractive to obtain universal coverage through a transit agreement instead of having the troubles with engaging in a large number of peering arrangements.

The Internet backbone provided by the tier-1 ISPs is in this way partly financed through transit agreements with smaller ISPs, which receive their revenue from selling Internet access to their customers. Customers content providers as well as content consumers. However, there are no clear demarcations between the two groups.

Content providers contribute to the financing of the network only through their payment of Internet access. Content production is financed basically from three different sources: Advertisements, selling of big data and – to a limited extent - user charges (per download or subscription).

There is a clear trend that content provision is becoming still more profitable, while provision of network access is becoming less profitable. Especially mobile operators are facing problems as competition is more intense on mobile markets. The development of content delivery networks illustrate very well the problems related to lack of funding of investments in the Internet backbone. Major content providers such as Google invest in their own network facilities in order to ensure fast delivery of their own services. In this way content providers contribute to the funding of network facilities, but it collides with the concept of the free and open Internet.

Another trend has been bundling of network services with certain information services, such as Spotify, e-books, electronic newspapers etc. This is a way that ISPs can brand their services and benefit from the lucrative content market. This trend should be seen in the context of the app economy. Provision of app based solutions gives (compare to web based solutions) the platform provider much better opportunities to control traffic and service provision – and maybe even more important, it also gives better access to customer data, which can be applied for marketing and advertisement purposes.

Conclusion

This paper analyses developments in infrastructure and in services/application with regard to their implications for creation of sustaining pricing schemes, which can ensure allocative, productive and dynamic efficiency. Especially the impact from the increasing use of Internet of Things services, differences in cost profiles for wired and wireless Internet access, and funding of network infrastructure services are discussed.

An important implication of this is the changing roles of network and content providers, where content providers become more dominant. Content providers move into the network provision business in order to secure efficient delivery of their service, while network operators try to bundle their network provision with provision of particular content services. Mobile Internet services have traditionally been provided by the use of a business model, which is more closed than the one that has dominated the fixed business model, and it may be expected that more closed business models may become widespread, as mobile interconnection becomes the dominant type of Internet access for private users.

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