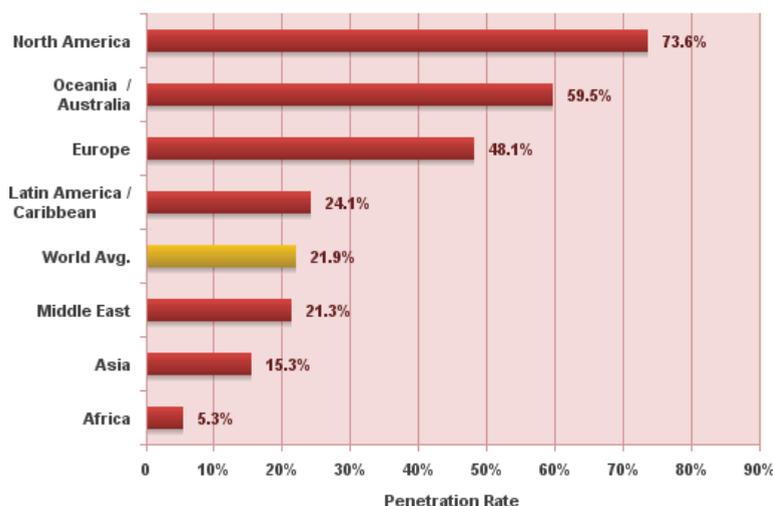


Wireless Technologies and Business Models for Municipal Wireless Networks

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1. Introduction

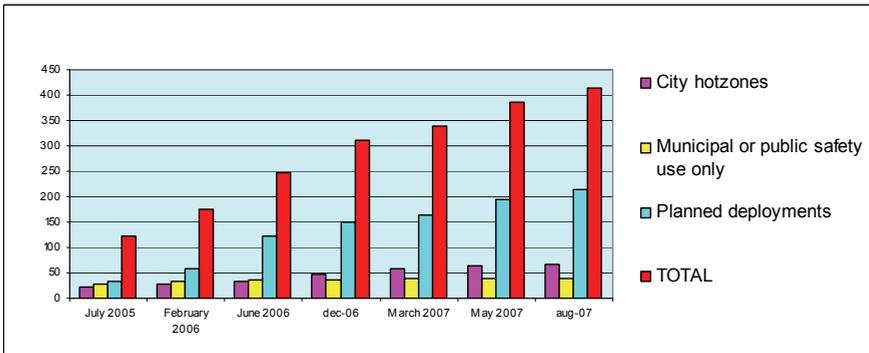
Municipal wireless network is a recently established infrastructure of city-based wireless network, which provides mainly outdoor broadband wireless access to Internet for public usages. The municipal network is usually regarded as a public-utility service, which not only delivers well connected broadband services in the city at an affordable price but also promotes society interaction and brings sustainable development to support municipalities. Therefore, the concept is attracting more and more attention from city authorities both in developed and developing countries. Graph 1 shows the Internet usage worldwide in 2008 (Stats, 2008). It can be seen that there is a distinctive penetration rate between developed and developing regions.



Graph 1. Internet usage services worldwide by 2008

There are hundreds of cities, which have deployed and have plans to build municipal broadband networks over their territories. Graph 2 shows a tendency of wireless internet services covered by city-wide wireless network (Muniwireless, 2008).

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Graph 2. An illustration of tendency to have wireless services in a city

City authorities are closely involved in network initiatives and rolling out with various forms and scales at different stages, because it is often argued that inexpensive or even free of charge broadband access network are impossible, or at least time-consuming to be realized by depending on market forces only. Generally, private network investors are cautious to protect investment, which could make the end goal of rolling out a full coverage area with an affordable price to be out of consideration. Therefore, employing a suitable business model of wireless city becomes an important choice regarding the basis and design of wireless city networks.

In this chapter, we first investigate and summarize existing and emerging concepts of business models for municipal networks implemented worldwide by distinguishing between ownership of the network infrastructure and service provisioning. The step demonstrates the way to find appropriate rationale and system architecture of municipal networks. To support our reasoning, we select examples of existing and emerging business models for municipal networks in different countries as our main focus to illustrate significant challenges to introduce municipal networks in a city and achieve low investments as well as open access to wireless services within affordable price for local residents.

2. Existing business models and examples of municipal network

2.1 Descriptions of business models for municipal networks

A proposed classification is constituted by all potential combinations between two key roles (network ownership and provisions) that can be taken up by common sorts of affiliation, such as public, private and a combination of them (MetroFi, 2008).

We follow the classification which fits the selected examples. In order to have a convincing reason, we consider both the ownership of network and service provisioning. Business roles are often taken up by different actors. Infrastructures of network operations are usually either associated with network ownership or service provisioning. Thus we can define following types of network in terms of the ownership of the infrastructure.

Private owner - the network is operated on the basis of a contractual arrangement in form of a license and concession. Therefore, municipality can deliver the rights of access to city's sites (streetlights, traffic lights, municipal buildings and so on), existing backbones (fiber, wired backhauls), as well as financial support.

Public owner - as the city authority that owns the network and operates it by using municipality enterprise funds to cover infrastructure costs.

Open site owner - the municipality provides open access to city's sites for the deployment of wireless network.

Next, we can define following types of networks in terms of service provisioning ownership.

Private owner - usually, a service provider, who supports and creates services to the network by gaining money from users' subscriptions and advertisements.

Public or Non-Profit owner - a provider, who allows an access to network services by using municipality's funding or applying for state or philanthropic grants.

Wholesale - can be consisted of a group of private owners, who offer and provide services to end users.

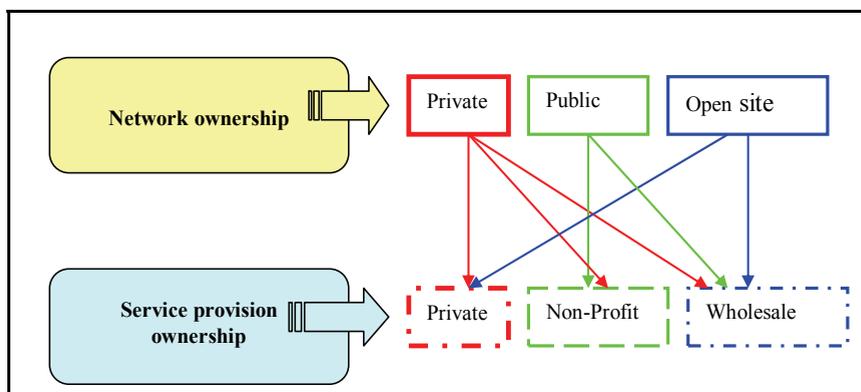


Fig. 1. Types of business model of municipal network providers (Yang et al., 2008)

Private-Private Model - In this model the key roles, such as network implementation, network operation as well as service providing, are performed by the same private company. The influence from the municipality can be limited in terms of financial supports or exclusive rent access to city assets. In return the private actor would provide limited Internet access to residents with low or no cost.

Private-Wholesale model - One of the most often implemented models in the US cities. The model is supported by deploying large mesh wireless clouds to deliver towards the public usage. Public entity's prospects of costs to deploy municipal networks are "nothing", though its profits are limited in rewarding from the network. Therefore, the public entity could retain a relative high level of influence, and take a less risk of claims to fairness among different service providers.

Private-Public or Non-Profit model - The model is mostly used for large mesh wireless clouds to offer services for public purposes. Financial inputs are from the authorities, therefore there is unlikely unfair service providers' competition.

Public-Public or Non-Profit model - The municipality builds and operates the network by itself in this model. All expenditures of network deployment and its operation are covered by the municipality, and service provision functions are also managed by the municipality. However, it is obvious that it is not an attractive model for the long term run.

Public-Wholesale model - The city builds and owns the municipal network. It signs an agreement with wholesale service providers, who can offer different contents with different

pricing subscriptions. This model is not widely implemented by large cities like Boston (Muniwireless, 2008).

Open site - Wholesale model - This model is similar to "Public-Wholesale" model. There is a difference that the access to build the network is granted either to the open sites in order to provide the wireless access to the community (city's inhabitants) or to limited region of the city for a particular group of users (low-income families, or only for the public safety purpose). The service provision is managed by a group of ISPs (Internet service providers) by allowing customers to access to the limited services (Metrofi, 2008).

2.2 Examples - Portland wireless city in USA

The business model of Portland wireless city can be interpreted as an "advertiser-supported" model (Muniwireless, 2008). The network is supported by the "private-wholesale" type of business relations, where network assets belong to MetroFi, the main network provider. Free web access services are supported by national and local advertisers. As an alternative, users who prefer an Internet access without advertisement can pay for premium services. Portland municipality becomes the major "anchor tenant" for MetroFi's wireless network provider. The main advantage of this public network is to allow all municipal employees to have an access to the network with certain functionalities. Fig. 2 gives an insight view of main actors' relations. Therefore, all functions in the public side belong to Portland's authority. However functions in the private part show only the influence to the outsourcing service providers, who provide advertising, consulting and customer-helpdesk support.

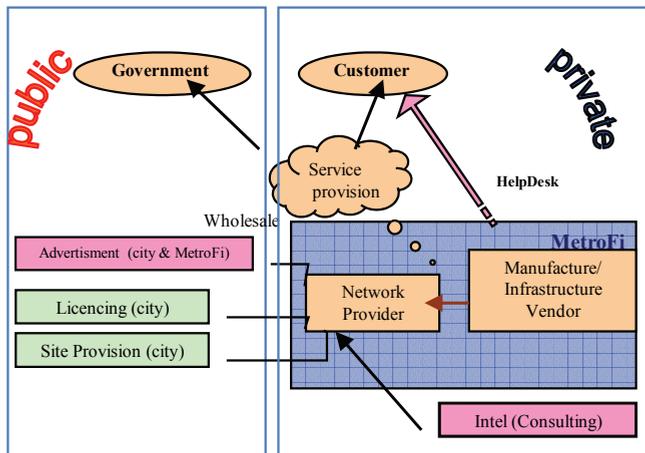


Fig. 2. Business model of Portland wireless City, USA

3. Emerging concepts of business model for Municipal networks

In middle 2007, Karlskrona, a city known as a historic naval and Telecom city on the southeast coast of Sweden, announced to have co-operations with *The Cloud*, the European wireless broadband network operator, to provide wireless city access in the city area, enhance an already rich suite of social services and improve innovations via services of the wireless city. A fixed fiber network operator, *Affärsverken Karlskrona AB* which is fully

owned by the Karlskrona commune, is on behalf of the municipality commune to cooperate with *The Cloud* to let the city be wireless (Affärsverken, 2006).

3.1 Wireless city of Karlskrona in Sweden and its motivations

The motivations and benefits of building a wireless city in Karlskrona have closely linked to the history and development strategies of the city. These are:

Making the city more attractive to IT and Telecom companies - A wireless enabled city can be more attractive to new IT and Telecoms companies, as well as facilitate business of companies in Karlskrona. Karlskrona, which was previously known as a 300-year-old fortress as well as an old ship-building yard, has now successfully created a new type of city based on its strategy to support IT and telecom industries after 1990s. Wireless city gives these companies a new approach to provide services as service providers. In addition, becoming a service partner of *The Cloud* can deliver their local services internationally without investing on the network infrastructures.

Delivery of social municipal and tourist services - Wireless city gives local residents more freedom to acquire information through wireless broadband at anywhere in anytime. It is easy to access public internet resources, such as transportation, education, leisure services, and society activities. Additionally, wireless city can assist tourists to access the local websites in Karlskrona via different Wi-Fi enabled terminals.

A natural expansion of the city's broadband network and increasing traffic - Wireless city can be naturally regarded as an expansion of the city fixed fiber network, which is owned and managed by *Affärsverken*. Since all the wireless network operators have to be the partner of *Affärsverken* in the business model, traffic passing through the fiber network is accordingly increases, therefore brings more revenue to this municipal company.

The main motivation for the wireless network operator *The Cloud* is the predicted increase usage of wireless network by local companies and residents. The sustainable strategy of city attracts growing attention and investment on IT and Telecom industries, and facilities internet connection for residents. For example, customers of *Telenor* can access *The Cloud's* network for free, and therefore generate traffic passing through the network of *The Cloud*. It is also predicted that mobile broadband is going to replace the fixed broadband in the future, which creates a profitable market for wireless network operator.

3.2 The business model and SWOT analysis

3.2.1 Implementation and strength

The business model implemented in the wireless city of Karlskrona can be generally categorized as the Public-Wholesale model (Cloud, 2007), where the local fixed network operator has established partnership with wireless network operator. Based on the partnership with *The Cloud*, *Affärsverken* can accordingly extend its fixed fibre network to include wireless infrastructure at nearly zero cost, and subsequently achieve the goal of wireless city. It has to be noticed that the Karlskrona municipality has branded the network as "*Wireless City of Karlskrona*" and fully owned the brand. It indicates that the municipality absolutely controls the wireless city network, and implements a neutral and open business model. New service providers and network operators can freely cooperate with *Affärsverken* and access to the business model.

In Karlskrona, *The Cloud* establishes the wireless network infrastructure and works actively with service providers, device providers and application partners to bring a range of services into its sites (Cloud, 2010). Consequently, *Affärsverken* can share the revenue of *The*

Cloud based on the traffic passing through its fiber network, and fully control activities of *The Cloud* for the purpose of a fair competition environment for different service providers and network operators. Fig. 3 shows the areas with wireless city service available in Karlskrona in 2007.

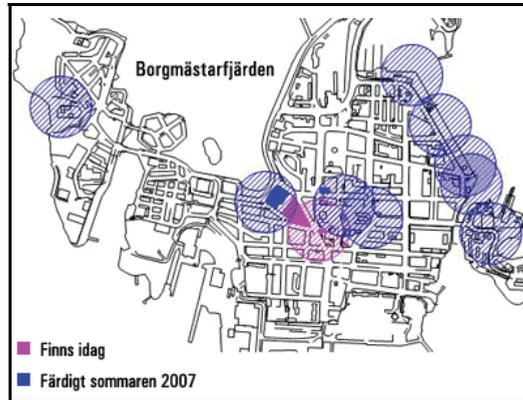


Fig. 3. Wireless city services available in the city centre of Karlskrona in 2007

Different roles of public and private actors involved in the business model are listed below:
Local authority - The Karlskrona municipality initializes the wireless city and provides funding to *Affärsverken* on behalf of the municipality to act as a public force to build wireless city. The local authority also gives access to buildings and light poles for mounting access equipment (Cisco, 2010).

Fixed network operator - *Affärsverken* provides backbone and shares revenue of the wireless network operator (Bar & Park, 2006). At the same time, it also acts as a regulator, which takes control over the network on behalf of the Municipality.

Wireless Network Operator - *The Cloud* mainly acts as a wireless network operator and brings services to end users. Being a network operator, it deploys and maintains the wireless network infrastructure in the wireless city. It is also responsible for managing and outsourcing the network capacity for service providers, and subsequently shares the revenue of service providers (Cisco, 2010). At the same time, *The Cloud* also provides an internet connection to end users paying through the Credit Card Company or mobile phones.

Service Provider - It pays the network operator to let its customers to access the wireless network for free, or attracts new customers in the wireless city. In wireless city of Karlskrona, *The Cloud* has established partnership with various service partners, e.g. *Telenor*, *iPass*, *Spring PCS*, *Boingo*, *Trustive*, *Echovox SMS*, *AT&T*.

Technology Partner - It manufactures and sells devices to network operators as well as end users.

Credit Card Company or 3rd party - In wireless city of Karlskrona, it is responsible for charging and identifying end users, who don't have partner accounts of *The Cloud* in order to access the network. The payment module is widely used and gives a convenient way for users to subscribe services in the wireless city.

The business model of the wireless city in Karlskrona is shown in Fig. 4. By implementing the business model, Municipality can manage different actors in network rolling out, service

provision and revenue sharing. Based on the collaborations with *The Cloud*, Municipality has low investment on the wireless city infrastructure and low administrative burden. It fully achieves the goal of owning and controlling the network, open access for any wireless network operators and service providers, and delivering services at an affordable price for public access in the city.

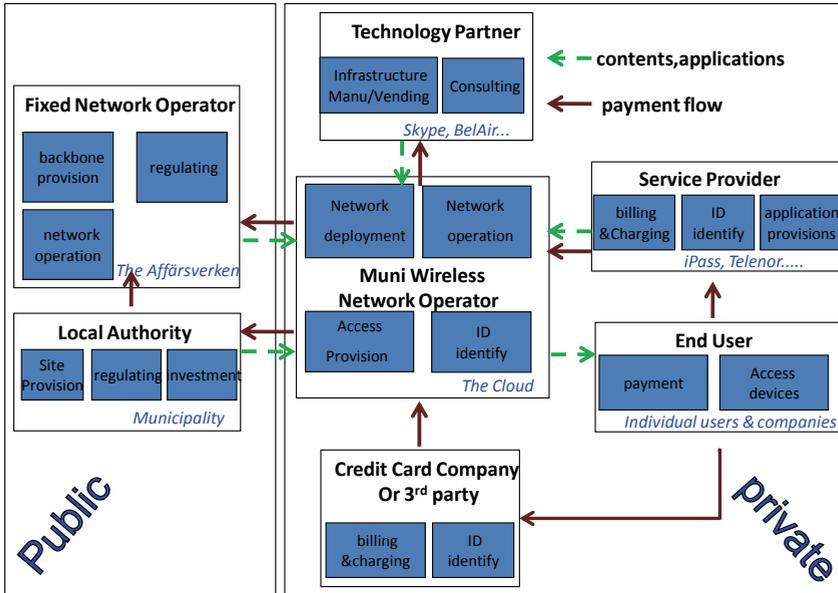


Fig. 4. Business model of wireless city in Karlskrona, Sweden

3.2.2 Weakness of the business model

The Cloud could not be a really open and fair network operator in the wireless city. Ideally, *The Cloud* should not be involved in selling internet services to end users as network operator. This distinct weakness is due to the natural conflict of *The Cloud* acting as an ISP and network operator. Being an ISP, *The Cloud* expects as many customers to buy service directly from it. However, as a network operator, *The Cloud* needs to sell access to other competitive ISPs. It can be hard for an ISP as well as a network operator not to discriminate against its competitors as well as customers. It is to some extent against the neutrality in the business model.

The Wireless City is collaborating with a potential competitor. Basically, there are no limitations to be accepted as a partner of the wireless city due to the revenue sharing module. Therefore, *The Cloud* can establish partnership with mobile network operator (MNOs) like *Telenor*, which can be regarded as the most potential competitors due to competitive 3G data technology and a large user subscriptions. These partners could terminate collaborations with *The Cloud*, and provide mobile broadband services as competitors.

The partnership may be not stable if some service providers are going to collaborate in the same type of business with new network operators. Currently *Skype* is a major service provider of *The Cloud* and accordingly is a service provider in the wireless city. However

customers now make *Skype* calls in some mobile handsets, which means it is possible to attract customers to use mobile broadband services from MNOs rather than wireless city.

3.3 Opportunities and threats driven by alternative wireless technologies

Cities can also be connected in a wireless fashion based on broadband infrastructures and services from fixed ISPs and mobile network operators, which are obvious competitors to Wi-Fi based municipal networks in terms of providing wireless connections in the cities areas.

Easy subscriptions, reasonable price with no binding offerings are provided by the wireless city of Karlskrona to give users more freedom to choose the time and period of subscribing services in order to attract more customers to access the network. Users have four alternatives to subscribe services from wireless city of Karlskrona:

- Paying to different service providers, e.g. *Telenor, iPass*.
- Buying airtime and making a payment through the Credit Card Company.
- Paying by sending a message via mobile operator network to acquire user name and password to log in.
- Buying coupons valid for one-day or seven-day at local coupon retailers in the city.

The price of accessing the municipal networks by paying through credit card for 30 minutes is SEK 40 and SEK 295 for 30 days. There is no binding and cancellation notice included in the offer. Compared with other ISPs in Karlskrona, e.g. the *Jacket Broadband AB, Tele2, Telia* and *Telenor*, the price offered by wireless city of Karlskrona is reasonable regarding to the broadband services available in most areas of the city. Users could also choose to be the customer of *The Cloud's* service partners, and therefore have free access to the network of wireless city. This module is suitable for local IT and Telecom companies to attract more customers by giving them free access in the wireless city as a reward.

Table 1 gives a comparison on subscriptions between wireless city and other fixed ISPs in Karlskrona. The information is collected from the websites of each operator in 2009.

Items/Provider	Wireless City	Jacket	Tele2	Telia	Telenor
Charge (Kr/Mon)	295	298	299	279	349
Speed limit (Mbps)	11 or 54	24	100	8	24
Connectivity	Wi-Fi	ADSL	LAN (ADSL)	ADSL	ADSL
Connection fee (Kr)	0	495	0	495	0
Binding period (Mon)	0	12	12	18	12
Cancellation notice in advance (Mon)	0	3	3	3	3
Mobility	Yes	No	No	No	No

Table 1. Subscription from fixed ISPs in Karlskrona

Since the wireless city service is not free, it is obvious to face a threat from mobile broadband services provided by MNOs. Table 2 shows a comparison on subscriptions between wireless city and MNOs in Karlskrona in terms of mobile broadband services. It can be seen that mobile broadband services from MNOs are more competitive in terms of mobility and coverage over the country. However, wireless city services can be more suitable for local residents and industries since speed and stable services are more important.

Items/Provider	Wireless City	3G	Tele2	Telia	Telenor
Charge (Kr/Mon)	295	199	189	229	199
Speed limit (Mbps)	11 or 54	7.2	7.2	7.2	24
Connectivity	Wi-Fi	3G	3G	3G WLAN	3G WLAN
Connection fee (Kr)	0	250	0	0	250
Binding period (Mon)	0	12	12	18	0~24
Cancellation notice in advance (Mon)	0	3	3	3	3
Mobility	Yes	Yes	Yes	Yes	Yes

Table 2. Subscriptions from MNOs in Karlskrona

Flexible and easy subscriptions, competitive pricing schemes and high-speed connection could make municipal networks in Karlskrona to be the most promising alternative to displace traditional fixed broadband and succeed ubiquitous mobility as a bonus.

4. Conclusions and future research

In this chapter, we have provided an overview of existing business models of wireless cities worldwide based on the ownership of network infrastructure and service provisioning. An example from Portland in US is given to illustrate an existing example of traditional advertisement-supported business model. Furthermore, we have introduced an emerging concept of business model and taken the wireless city of Karlskrona in Sweden as an example to illustrate main drivers, business actors, pricing and subscription schemes.

In general, the concept of wireless cities can not be treated as a pure business case since it has public and non-profit attributes. Based on our analysis, we come to the following conclusions:

- *Municipal initiative is essential.* Wireless city can be regarded as a symbol of a city and facilitate local activities. In our case, the Karlskrona municipality plays an important role to take the decision of building municipal networks based on local municipal profiles and development strategies.
- *Fair and open environment is more efficient for supporting competition among all parties involved.* Moreover, transparent business interactions inside municipal networks are mostly expected from the municipality. Whether being forced or volunteered to open its network, the municipal network operators need to provide opportunities for any ISPs and wireless network operators to be fairly associated into the network. It could be regarded as an emerging intention compared with traditional concept of wireless city, where a monopoly company occupies the most positions in the business model of the wireless city.
- *Wireless city services could be necessary to be free of charge.* Free services could be provided by municipal networks for people to acquire certain public information, e.g. public transportation timetable.
- *Low investments from a municipality could be achieved through the public-wholesale partnership business model.* In Karlskrona, the municipality can be regarded as a lossless actor in the market. It doesn't need to put much investment funds to the wireless network infrastructure, but it gains the privileges for its residents and local businesses.

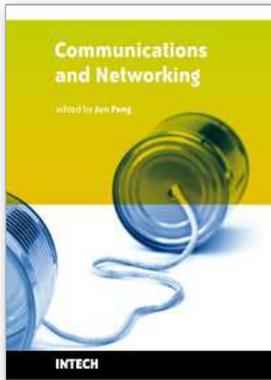
The investment of all the actors involved in the business model is economical compared with the traditional monopoly model.

Based on our investigations, the emerging business model based on partnership collaboration is a suitable solution for regions to deploy municipal network. It could maximize users' choices, create a fair competition environment, remain the municipality as a leading regulator and activate all actors in the business model. In the future, it will be interesting to investigate the best combination of merging the emerging concepts into the traditional business scenarios. Below we list three interesting directions for further research.

- *Influence and regulation from municipality.* In the emerging concept, the municipality only forms a partnership with the network operator and highly involved in the network operation by delivering traffic through its fiber network. Furthermore, the municipality has a stronger influence on activities of municipal network operators. It will be interesting to explore the possibilities of introducing a second network operator as a competitor in two models to raise the competition or balance the influence from the existing operator.
- *A mixture of customer relationship with end users is also an interesting topic.* In traditional models, network operator acts more likely as an ISP and builds a direct relationship with end users. However the network operator in the emerging concept tries to avoid establishing a direct and long-term relationship with end-users in order to keep its neutral position for other ISP as its customers.
- *Types of collaboration with service providers involved in the model can be explored.* municipal network operator in the emerging concept has actively established extensive partnership with different service providers, but it acts actively as an ISP in the traditional business model. A combination of two types can be explored by forcing some service providers to access the municipal networks based on geographic divisions according to some agreements.

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