

PRICING POLICIES AND NEW BUSINESS MODELS FOR DATA COMMUNICATION OVER 5G NETWORKS

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Abstract

5G networks is expected to provide higher speed in data communication for different usage scenarios. Three main groups of usage scenarios of 5G networks require high key performance indicators (KPIs). Massive Machine type of Communication (mMTC) as part of IoT, vertical data usage with very demanding KPI-s and very low latency requests, are related with 5G networks developments. There are a number of challenges under discussion which are related to 5G standardization and developments. This article will be focused on pricing policies for data communication in 5G networks and new business models.

Key words: 5G networks, pricing policies, data communications, pricing models

1. INTRODUCTION

Mobile network evolution started from the first generation (1G) in 1980s, to second generation (2G), third generation (3G), 4G and now we discuss for 5G networks. During these developments, the services provided over mobile networks have changed from: only voice in analogue, to voice and data with low rate, to voice and data with higher rate, to data with high speed and voice. The evolution of mobile industry from 1G to 5G with key characteristics of each generation is summarized in the figure below.

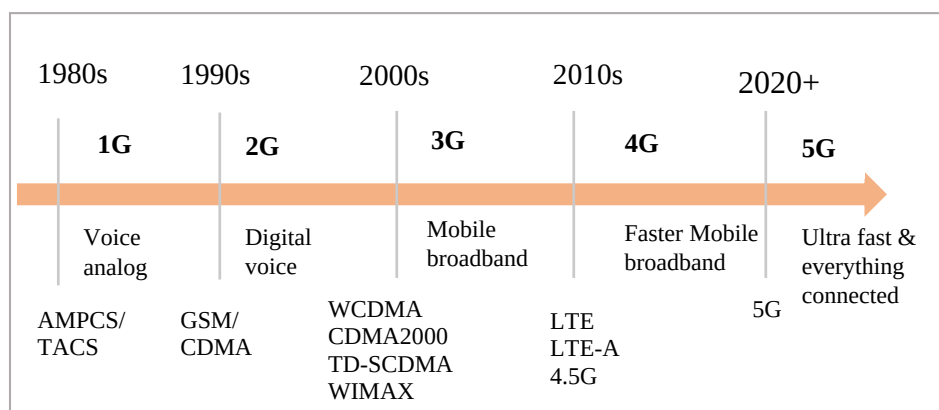


Figure 1. Evolution of mobile technology from 1G to 5G

Source: Adopted by Author based on different sources

The changes of mobile technology are associated with improvement of quality of the services, the capability of network to support new applications and of course with changes to the business models and with the adoption and introduction of new pricing policies. In addition, these changes are linked with the trend of the communications during these years. The mobile users at the very beginning have only the voice choice, after that voice and SMS, later data communication and internet access with low speed. Introduction of 3G and 4G led to a new trend of communication: more data than voice. Different applications are available now through smart devices. Regarding to 5G expectations, the ITU recommendation [1] and other studies notice that comparing with current 3G/4G mobile networks, 5G networks will support:

- 1000 times higher mobile data volume per area,
- 10 times to 100 times higher number of connected devices,
- 10 times to 100 times higher typical user data rate,
- 10 times longer battery life for low power Massive Machine Communication (MMC) devices,
- 5 times reduced End-to-End (E2E) latency

The key challenge for 5G network is to achieve these objectives at a similar cost and energy consumption as today's networks [1]. The question is what business model and what pricing policies will be appropriate for 5G networks? This article explores some issues on pricing models and pricing methods which might be appropriate for data communication over 5G networks.

2. THE IMPORTANCE OF DATA PRICING POLICIES OVER 5G

Based on different sources and statistics it is noticed that mobile data traffic has experienced an extremely rapid growth during the last decade. This trend is expected to continue and mobile data traffic will be the core of business in 5G. According to the latest Cisco Visual Networking Index [2], is forecasting a seven-fold increase in global mobile data traffic from 2016 to 2021, with 5G traffic expected to start having a relatively small but measurable impact on mobile growth starting in 2020. By 2021, Cisco projects that mobile data traffic to reach the following milestones:

- global mobile data traffic will reach 49 Exabyte per month or 587 Exabyte annually.
- mobile data traffic will represent 20% of total IP traffic
- nearly 12 billion mobile-connected devices (up from 8 billion and 1.1 per capita in 2016), including M2M modules.
- Machine-to-machine (M2M) connections will represent 29% (3.3 billion) of total mobile connections.
- the total number of smartphones (including tablets) will be over 50% of global devices and connections (6.2 billion)—up from 3.6 billion in 2016.

The future communication over 5G is closely related with IoT, and massive type of communication mMTC, which is a communication between devices, and objects so it is simple data traffic. New pricing policies needs to be introduced in order to maintain market share, keep the level of profitability as well as avoid the subscribers churn. According to [1], "In the future, however, it is foreseen that new demands, such as more traffic volume, many more devices with diverse service requirements, better quality of user experience (QoE) and better affordability by further reducing costs, will require an increasing number of innovative solutions". The pricing policies for data need to be adopted and developed for different categories of services grouped based on their technical requirements and QoS.

3. THE COMPLEXITY OF 5G NETWORKS

5G is not yet standardized, so a great number of research teams are working on different aspects of 5G mainly focused on technical aspect. In order to discuss on pricing policies and new business models for 5G it is important to understand the 5G and its complexity. According to Cardona [3] presentation, on "5G mobile networks, A revolutionary evolution towards the wireless internet of things", 5G is seen as a consolidation of harmonized 2G, 3G, 4G, Wi-Fi and other innovations, providing far greater coverage and always on reliability.

Furthermore as it is given in [4], the 5G networks is expected to be deployed in different frequency bands under 1GHz, 3GHz and above 6GHz. For each frequency band there are different technical requirements such as: regarding carrier bandwidth from $n \times 20\text{MHz}$ for frequencies under 1GHz, to

n*100MHz for frequencies in the 10 GHz bands and 1-2GHz band required for frequencies over 30 GHz.

A number of services can be delivered by existing networks 3G/4G and some new services asking for 5G capabilities. These services needs ultra-reliable and low latency and would be possible to be delivered only over 5G.

On the other hand, referring to [5] the report “Understanding 5G”, it is noticed that several key new technologies are emerging as key building blocks for 5G. Based on the same document, it was mentioned that cloud services, network function visualization and software defined networks will be the key elements to the network infrastructure, providing a more flexible, scalable, and dynamic network infrastructure that can adapt different use cases and requirements in a faster and cost effective way.

This is related with the concept of network ‘slicing’ to manage and deliver services. 5G is seen as a heterogeneous network, there is not a single access technology, but a combination of different legacy and new technologies which will work as complementary to each other. In addition, 5G is related with new ‘users’, devices, business models, applications, new players. The description as above of 5G networks, gives us the complexity of the case, and especially the difficulties of developments of pricing policies over 5G considering all new elements and combinations of business models.

4. 5G NETWORKS AND USAGE SCENARIOS

5G networks is expected to provide services for three main groups of usage scenarios of 5G networks which requires high key performance indicators (KPIs). Massive Machine type of Communication (mMTC) as part of IoT, vertical data usage with very demanding KPI-s and very low latency requests are related with 5G networks developments. The figure below gives the slicing model of these three main groups.

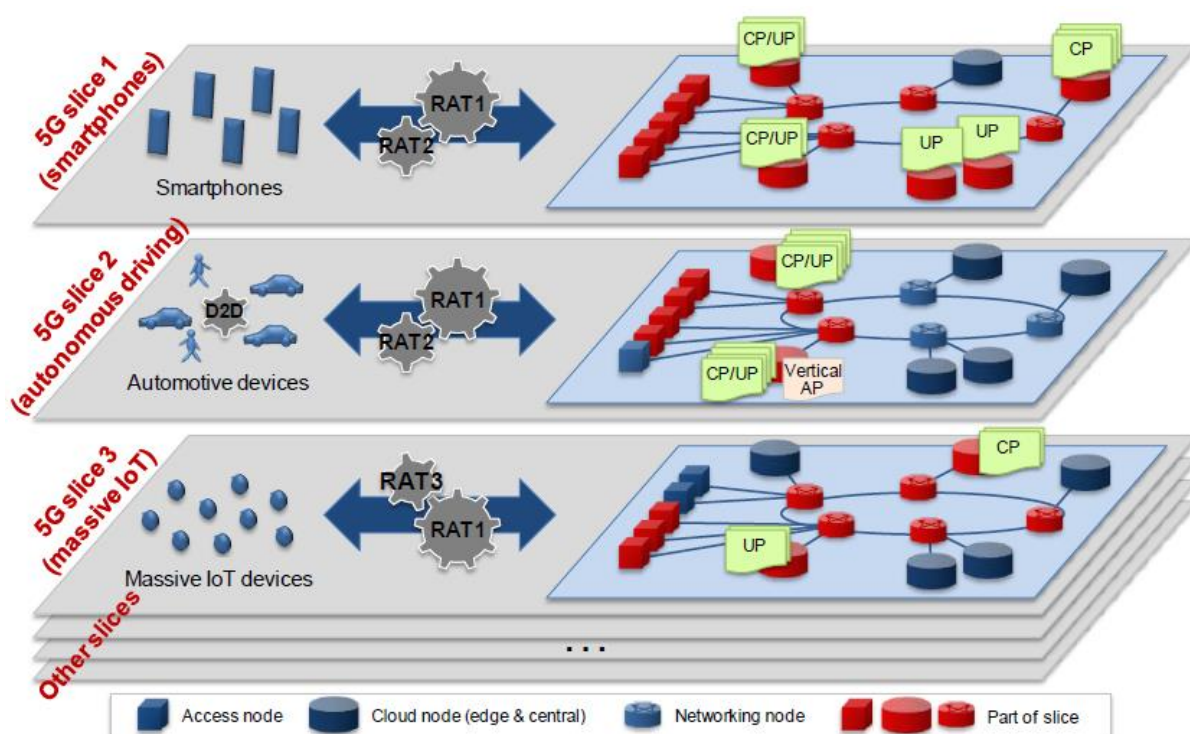


Figure 2. 5G slicing model

Source: NGNM white paper

According to GSMA white paper ‘Smarter Traffic Management’ [6], network slicing allows the allocation of network resources appropriate to the service being consumed and its particular delivery characteristics. These characteristics include:

- Latency – how quickly packets are delivered
- Packing – the consistency of delivery rate, ensuring packets arrive in order
- Durability – the ability for a connection to be long-lived, or dormant and then woken over a multi-year period
- Resilience – guarantees that packets are delivered within a certain timescale
- Capacity – the ability to deliver high volumes of packet data to a service
- Mobility – services persist seamlessly as devices transit access points
- Coverage – services are supported across a wide geographic area

In addition, according to [7], 5G slice model supports the communication service of a particular connection types with a specific way of handling the C and U plane for this service. The slicing model gives also the combination of resources for specific use cases or business models. Referring to [3], network slicing will facilitate new business models. Furthermore network slice instance is dedicated to logical (virtual) network with specific functionalities of customers (e.g. vertical industry company) hosted on a common infrastructure with other slices. It was noticed that network slicing will help to optimize virtualized radio access/core network to deliver a different network experience for different kinds of traffic: video, autonomous driving, internet of things. This paper explores how slicing model will help in the adoption of pricing models.

5. NEW BUSINESS MODELS FOR 5G NETWORKS

The necessity for new business models of 5G is related to the fact that 5G is composed by multiple types of access technology, multi layers of networks, multiple types of devices, multi types of user interactions etc. In 5G we have new users, new services and innovations in existing services, new market with partnership etc. This “multiple” of different things model lead to new roles of providers. From the tradition in the telecommunication we had a situation with vertical integrated providers: which provide access, connectivity, services and in some cases the terminal devices of user. Later on the network provider and service provider was separated in some cases. With smart devices new applications were available and delivered to end users. Content provider was not the same with network provider or service provider.

Coming back to the 5G requirements based on ITU model [1], the essence of requirements are technical ones needs to be provided by connectivity provider who remain in the core of the new business models of 5G. Without connectivity and transport layer we couldn’t receive any kind of service. In this context this role remains as a key one for 5G, but needs to adopt innovation in order to monetize the network and services in a new environment where in some cases cooperation with asset provider is needed, in other ones cooperation and win-win strategy need to be adopted with partners which enrich the services. A special attention is needed to new market such as automotive industry where the cost of infrastructure building asks for synergies. In the figure below are given the examples of business models considering the roles of providers in 5G, as per NGNM white paper [7].

Role	Business Models	
Asset Provider	XaaS: IaaS, NaaS, PaaS Ability to offer to and operate for a 3 rd party provider different network infrastructure capabilities as a service	Network Sharing Ability to share Network Infrastructure between two or more Operators based on static or dynamic policies
Connectivity Provider	Basic Connectivity Best effort IP connectivity in retail (consumer/business) & wholesale/MVNO	Enhanced Connectivity IP connectivity with differentiated feature set (QoS, zero rating, latency etc) and enhanced configurability of the different connectivity characteristics
Partner Service Provider	Operator Offer enriched by Partner operator offering to its end customers, based on its capabilities (connectivity, context) enriched by partner capabilities (content application etc)	Operator Offer enriched by Operator Partner offer to its end customers enriched by operator network and other value creation capabilities (connectivity, context, identity etc)

Figure 3. 5G business models, examples

Source: Based on NGNM “5G white paper”

6. THE EVOLUTION OF DATA PRICING POLICIES

Evolution of data pricing policies is related mainly with Internet evolution. At the beginning, the access of Internet was provided through fixed line by a dial up connection. The price for internet access included the telephony service and a fix connection access fee. After that, the common model of data pricing was known as flat rate model where the user or consumer eat what prepaid as flat rate.

But soon the flat rate model was shift to data caps model. The data traffic increased and the forecast for near future raise a number of questions even for pricing models. A number of studies are done and the issue is under discussion to see which the best way to address the problem is.

High data traffic asks for higher network capacities to keep the performance, QoS and the market share in a competitive market. On the other hand the average revenue per user is decreasing and the main reason is that the competition leads to low cost.

The competition imposes the service providers to find alternative solutions to remain attractive for their users and keep market share. A great number of tariff packages are in the market.

Different methodologies for pricing are in place such as: Usage based pricing, Data cap is one of the models of usage based pricing, Simple metering price model, Ramsey pricing and price discrimination in broadband services. Usage based price as a congestion management tool, data caps help the providers to make the difference in the competitive market. It is notices that usage based pricing policy, is combined with different traffic management techniques. Some of the traffic management tools/methods are: throttling, additional charging, policy control, prioritizing etc. These traffic management tools are criticized since are not in conformity with net neutrality principle and lead to some kind of discrimination.

7. PRICING MODELS IN 5G AND BUSINESS MODELS

Pricing policies and adoption of new business models is critical for future generation in communication and for 5G. According to European Leadership in 5G [8], the key question is „*whether 5G enables services that consumers – business and individuals – are willing to pay for*“. Furthermore the fulfillment of 5G technical requirements especially for ultrahigh bandwidth and very low latency in high density M2M communications, asks for high CAPEX, but not all services and ‘users’ will use the same sources, or need the same capacities. In other words different ‘users’ consume of CAPEX and OPEX is different. How we may calculate the respective portion of these consumption and how to define the fair pricing? A fair pricing logically is related with costs based module which will be a solution.

According to ICC [9], “Traditionally, cost modelling of telecommunications networks has been carried out based on principles of cost causation and network utilization by each service.” In addition in a competitive environment the pricing should take the following factors into account: fixed and variable costs, competition, company objectives, positioning strategies, target groups and their willingness to pay. In this context a company can adopt a number of pricing strategies. In 5G we need to consider the relations between different actors, providers and customers in retail and wholesale market as it is given below.

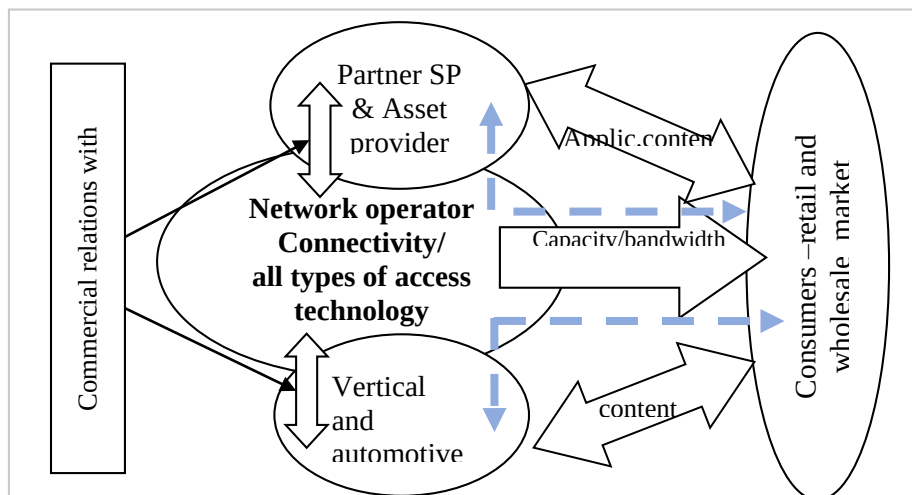


Figure 4. The relations in 5G business models

Source: Author

The customers are not limited to the individuals and business users. We have new customers in a double role: the partner providers with commercial relationship with network provider and also as costumer for some kind of services. Also new vertical market such as automotive industry will be part of costumers in 5G with some specifics and commercial relations with network provide e.g share infrastructure. In retail market there are consumers, normal users that have a subscription with connectivity provider. Besides access the retail user consumes content from partner service provider and use the applications provided from the partners. The way of communication is interactive. The new market of the vertical automotive industry, mainly will provide their own services but will communicate in both directions with retail customers too. The main service is content provision through connection, so the connectivity provider is in the middle of the relation of consumer and partner service provider, and vertical industry.

The relations of a consumer are multiple but the connectivity is critical to support the other services besides the access. Furthermore the connectivity will be able in different types of access technology. In this case who will be the main provider for consumer? The normal way is the provider who has a subscription with customer/user. Through connectivity the user has options for direct relation with content provider. According to NGNM white paper [7], in the sense connection attributes provided to

end user, 5G should enable openness and multivendor capability at all levels and introduce modular provisioning concept. At the end the 'good/product' to sell is the data communication. If we consider the price based on costs to provide the unit of data communication e.g unit price for a MB we can adopt the pricing policies for each service or user in a flexible and adaptable way based on different use case and its respective requirements and sources user or "consumed".

7.1. A cost based price model in 5G

According to [9], ICC, "Next Generation Networks, Creating a dedicated cost model", without a detailed understanding of the costs of delivering services, businesses have no real idea about product or service profitability.

Based on METIS study [10] on Scenarios, requirements and KPIs for 5G mobile and wireless system, for a cellular network solution, the cost typically includes a part related to infrastructure, a part related to the end user-user equipment, and a part related to spectrum licenses. The infrastructure part is typically divided into the capital investment to acquire and deploy the network called capital expenditure CAPEX and the costs to operators the network called OPEX. For instance the CAPEX of a macro site covers the site acquisition and preparation; the equipment acquisition, installation and configuration; to backhaul installation, the antenna systems, the power cables. Typically, CAPEX consists of one-time expenditures. However for practical reasons these expenditures are spread over several years e.g. annualized. The OPEX for such a site covers site rental, power consumption, maintenance, optimization, preparations and replacements, backhaul transmission costs, software and operation services.

In 5G business models the calculation of CAPEX and OPEX related to a specific service and use case is quite complex. Considering the slicing model of use case categories/families we can adopt a model of calculation of costs for slicing based on the main sources used or consumed. Some part of network is common used or represent common cost as fixed costs so we need to share the cost between two slicing/use cases, based on percentage potentially that slice/use case should use the respective source.

According to NGNM white paper [7], 5G may involve a combination of radio access technologies (RATs). Referring to slicing model for example RAT1 is used in slice 1, 2 and 3, RAT 2 is used in slice 1 and 2. Sharing common costs based on use case categories, theoretically seems easy, but in practice we need to consider the very diverse services and the business models in 5G as it is described above.

The user application should be always connected to the RAT or combination of RATs. The respective cost elements and % of respective usage for each use case need to be considered and calculated in this case for sharing cost of RAT. In the same way we need to identify the elements for other parts of network, applications used such as: elements related to infrastructure resources layer, business enablement layer, business applications layer etc. In addition the pricing model needs to reflect different types of services and consumer profiles in different situations.

The 5G architecture described as below will help in the process of identification of elements involved in different cases. In this explanation we are not speaking for relation with OTT, or other partner providers.

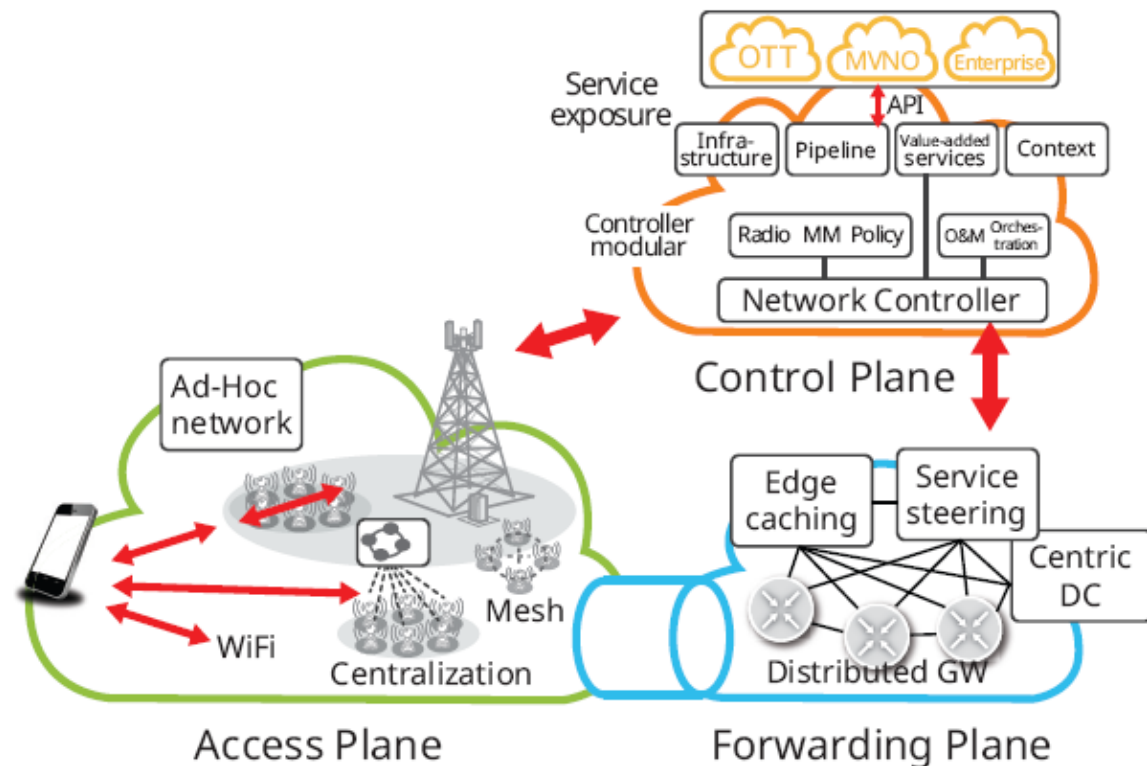


Figure 5. The planes of 5G architecture

Source: Understanding 5G

Grouping the use cases under categories/families and each category in specific use cases will help the analysis to identify the elements of network the respective proportion of use from each of them. The requirements, KPIs are different for each family of use cases, so under the group of Broadband access in dense areas the user experience data rate is 300 Mbps in DL and 50 Mbps in UL, the requirement for E2E latency 10ms and mobility is ‘on demand’ from 0-100km/H, while in case of ultra-high reliability and ultra-low latency group of use cases the KPIs requirements are data rate 50kbps to 10Mbps in DL, from a few bps to 10 Mbps in UL, while latency is required under 1ms and mobility lies from 0 to 500km/h. Due to very diverse requirements and KPIs the consumption of network costs the costs by each use case normally is different.

In this situation calculation of a cost for a specific service is too complicated if we want to present a cost based model for any individual user. Furthermore 5G needs to adopt a flexible and modular provisioning concept in partnership with XaaS and Partner providers. The matrix of sources used or consumed from each use case for a specific service is very diverse. We need to consider a different pricing model instead of simple cost based model such as the combinations of SBIFT model [8], based on five dimensions.

7.2. The SBIFT model for data communication over 5G networks

The evolution of data pricing policies as presented above, has changed during last twenty years. The dynamic of telecom sector, the data communication traffic growth, and the presentation of smart devices and consumption of new applications change the user behaviors and communication trends. Metering based on pulses was at very begging of Internet provided through dial up connection. Flat rate was also valid during a period of data consumption, flat rate with caps and usage based pricing are also used in data communication. According to [7], the pricing models in 5G will also evolve and adapt to represent different types of services and customer profiles, for example: evolve usage based pricing, which reflects the throughput, latency, data consumption and device movement, event based/real time charging which

may cover e.g a bandwidth consuming services and tiered offers based on differentiated customer profiles and services.

The pricing models suggested as above might be developed based on SBIFT model [8] presented by a group of authors in study: “How to differentiate by price: Proposal for a five dimensional mode”, we have different models of pricing for different situations. The SBIFT model which is summarized in the table below is based in five dimensions. Considering the multiple use cases, multiple situations in practice and multiple relations between customers and providers in 5G business models, a flexible SBIFT model might be appropriate to monetize the 5G and services provided over 5G.

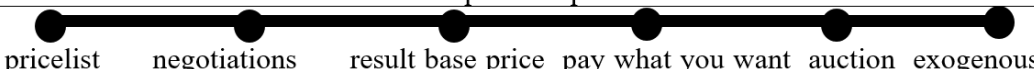
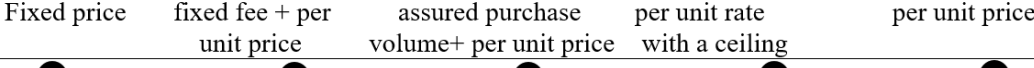
Scope						attribute
Base						competitors' price customer value
Influence						pricelist negotiations result base price pay what you want auction exogenous pricing
Formula						Fixed price fixed fee + per unit price assured purchase volume+ per unit price per unit rate with a ceiling per unit price
Temporal rights						Perpetual leasing rent subscription pay per use

Figure 6. SBIFT pricing model

Source: Based on “How to differentiate by price: Proposal for a five dimensional mode”

Further work in order to consider in details each use case and 5G business models with five dimensions of SBIFT model is needed.

8. CONCLUSIONS AND RECOMMENDATIONS

The process of standardization of 5G is ongoing. The 5G network will be a heterogeneous network with different access technology and different players with their role in new business models. Examples of business models are linked with role of asset providers, connectivity provider and partners which help to enriched the offer of operator. Slicing models is a way to have a better management of service delivery over 5G. Pricing models and pricing policies for data communication over 5G seems to be more difficult due to increased complexity of heterogeneous network and new players due to respective roles in new business environment. No any classic model of pricing should be considered as appropriate. A flexible and case by case adoption of pricing model will be the right way to monetize the 5G and services provided over 5G.

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