Wireless Ticket Exchange Boosts Telecommunication Sector

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Abstract— **Telecommunication Market evolution poses challenges for future mobile networks. On one side, pressure on network operators regarding technology investments and decreasing revenue; while on the other side, changes in customer behavior and perception give rise to the quest for structural re-organization and for new business strategies in the telecommunications business. This paper gives attention to the telecommunication market from the microeconomic perspective and describes a solution for a near perfect telecommunications market where the market innovation and the efficiency of underlying telecommunication system are optimized by forces of demand and supply. The author envisions a pervasive telecommunication market based on the marketplace concept proven over 200 years' combined with advanced wireless network architecture.**

Keywords- Wireless Ticket Exchange; multi-tenancy; telecommunications market; marketplace.

I. INTRODUCTION

The telecommunication market evolution poses challenges to future mobile networks. There is an enormous pressure on the network operators to reverse the trend of decreasing revenues, to adopt new cloud infrastructure, to provide broadband, delay and reliability stringent services, as described in [1] and to ensure necessary technological investments as discussed in [2] and [3]. On one hand, higher transmission peak capacity is required and on the other, networks are highly underutilized, as stated in [4]. From the user perspective, rapid changes in customer behavior (and perception) set special requirements for network and new service categories force redefinition of the provider-to-customer relationship [5].

A promising approach towards network cost reduction is sharing of radio resource. The pure infrastructure sharing can be realized, but at the expense of suboptimal profits. In contrast, radio resource sharing between "equal" partners is very challenging - interoperability and responsibility in management decisions are the main problems to solve. The literature proposes a lot of strategies for sharing of physical radio resources, e.g. game theoretical approaches, but the strategies deal with some potential sharing ideals and concern mostly single aspects reduced to one specific problem, which do not help to solve short term realistic multi-dimensional situation in radio resource sharing, as discussed in [6] and [7]. There is also a well known concept concerning "non-equal" cooperating partners, on one side the Mobile Virtual Network Operator (MVNO) and on the other the Mobile Network Operator (MNO). MVNO does not dispose of own radio infrastructure and has to cooperate with an incumbent network operator by leasing radio resources within the condition of a service level agreement (SLA). Since the SLA contrasts are long-lasting contracts, they are not adaptable to changing situation during the contract time. So, they are not dynamic to readjust for real capacity need in terms of location and time needed and not flexible for fast reaction to global market changes. Furthermore, the MNO dominance makes impossible for upcoming 3rd parties to enter the telecommunication market. With other words, the telecommunication market does not meet all conditions for flexibility, business dynamicity and price discrimination. Therefore we propose Wireless Ticket Exchange (WTE) a solution which makes possible, that the telecommunication market will be:

- Open for and transparent to all market players,
- Flexible and dynamic,
- Can quickly respond to rapid market changes,
- Guarantees easy entry to the market for newcomers,
- Decision freedom and independence of network and service providers will retain,
- Service providers have the possibility to address targeted consumer groups rapidly, and
- Contracts between providers as well as between providers and users are flexible with regard to contract subject, price, and duration.

Our approach does not focus only on technology as such, but also on integration of economic and user aspects into a holistic framework realized by the WTE approach.

The rest of this paper is organized as follows. Section II provides economic background and introduces basics of market mechanisms in user–provider interaction. Section III addresses necessary changes towards a future telecommunication market. Section IV goes into details of the idea of the Wireless Ticket Exchange. Section V addresses the user integration into the upcoming pervasive telecommunications market. Section VI concludes the paper.

II. MARKET MECHANISMS

To understand the issues arising in telecommunication network economics, we focus first on some basic microeconomics market mechanisms.

Due to market mechanisms, demand and supply balances towards an optimum. The higher the price of a product the more the supplier is willing to produce and sell. As seen in Figure 1, product demand follows the inverse of the product price. The market clears at the equilibrium price p* and the quantity q*. The variation of the price and quantity over time depends on the way in which supply and demand respond to economic variables such as demander's income, production costs, etc. If the price p* is regulated to p_1, the quantity supplied decreases and a demand shortage develops [8].

Above mentioned mechanisms show the native market feedback balancing demand and supply to the optimum. Any external influence violates market forces [9].

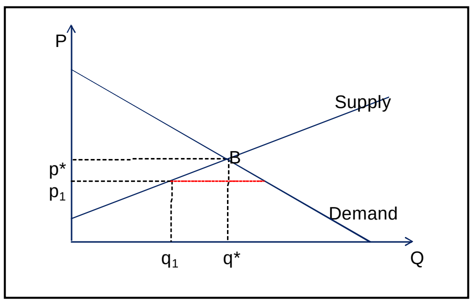

Figure 1. Market mechanisms.

As shown in Figure 2 the number of potential customer base *C*, as given in (1) depends on users' affordability *A*, defined as the relationship between the disposable incomes *I* and price *p*, as shown in (2), where *k* is a constant.

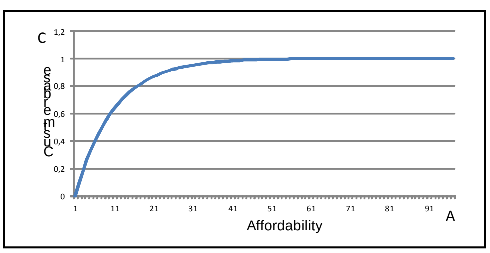

Figure 2. Normalized customer base vs. product affordability.

$$C = 1 - e^{-A}, \tag{1}$$

$$A = k\frac{I}{p}. \tag{2}$$

Price changes of a product affect the affordability and so the number of potential customers in such way that the higher the product's affordability the higher the market size. Also, the lower the product price, the more price-sensitive users will be attracted [10]. Besides the price, user's non-monetary preferences must be taken into account in strategic decisions of a provider.

A. *Users utility*

The preferences of a user *i* using a telecommunication service can be therefore represented by a utility function U_i which is an abstract concept in economy and which represents the satisfaction or benefit that a user gains from consuming a given amount of resources. The utility maps the set of outcomes *q*, e.g., Quality of Service (QoS), access time to the network, etc., to the set of real values, as e.g. proposed in [11]. Usually, the utility function strictly decreases in price p_i, which means, the user prefers to pay as little as possible. The reference utility we can define as $U_i(q_0,0)$, i.e., a utility without monetary outcome, and then the valuation function for the outcome *q* is the maximum price the user is willing to pay for the preferred outcome over the reference utility:

$$V_1(q) := \sup\{p_i : U_i(q, p_i) - U_i(q_0, 0) \geq 0\}. \tag{3}$$

Now we assume, the user would like to stream a video with a high quality ϱ and his utility function $U_i(\varrho,p_i)$ is increasing in ϱ. Additionally, we suppose that the user is willing to pay an additional fee β for a higher streaming quality and will not pay for the service with a lower quality than defined as ϱ_{min} even if the service is for free. In this case for all $0 \leq \rho_{\min} \leq \rho_{\min} + x$ the utility function is defined as

$$U_i(\rho_{\min} + x, p_i + \beta x) = U_i(\rho_{\min}, p_i).$$

Applying $q_0 = \rho_{\min}$ and concerning (3)

$$V_i(\rho) := \sup\{p_i : U_i(\rho, p_i) \geq U_i(\rho_{\min}, 0)\} = \sup\{p_i : U_i(\rho, p_i) \geq U_i(\rho, \beta(\rho - \rho_{\min})\} = \beta(\rho - \rho_{\min}).$$

If $\rho < \rho_{\min}$, the user is not willing to pay for the service improvement, hence the user gets the same utility as $\rho = \rho_{\min}$. The valuation function

$$V_i(\rho) = \beta[(\rho - \rho_{\min})]^+.$$

reflects the maximum price the user will be willing to pay. Therefore the utility function

$$U_i(\rho, p_i) = \beta[(\rho - \rho_{\min})]^+ - p_i.$$

can be used by the operator to compute an equivalent price for a service with quality ϱ. The above model indicates the importance of the effects of user preferences on product, in this case, on service design. Operator has the opportunity to create an extensive service portfolio to measure the demand structure, and to calibrate the service parameters according to users' valuation. The wider the service portfolio, the higher the probability that certain services comply with users' requirements and the faster an operator can optimize services and the revenue.

B. *Operators revenue*

Building on the above observation we construct a business valuation function representing operator's revenue from transactions at the time services are sold. In general, the revenue *R* is the quantity of the sold product times the selling price *p*.

The number of sold products results from the number of customers *C* who bought a number *N* of the product. The number of sold products results from the number of customers *C* who bought a number *N* of the product snd so the revenue *R* can be defined

$$R = C * N * p\,. \qquad (4)$$

Considering (1) we define

$$C = \lambda(1 - e^{-\eta A})\,, \qquad (5)$$

where $\lambda \geq 0$ is the fraction of users who bought the service, and $\eta > 0$ is a constant. We define product demand as

$$N = k * e^{-(\Gamma-\mu)^2}\,, \qquad (6)$$

where k>0 is number of transactions per user, $\Gamma > 0$ is the parameter describing service characteristics, and $\mu > 0$ the most demanded service. Hence with (4), (5) and (6) we can define the total revenue R_{tot} from service:

$$R_{tot} = \sum_{i=1}^{n} (k_i * e^{-(\Gamma-\mu)^2} * \lambda(1 - e^{-A_i}) * p_i)\,. \qquad (7)$$

In summary, a telecommunication market model, as shown in Figure 2 and Figure 3 can be characterized by a number of potential customers interested in a specific telecommunication product and by a number of units of this product, the potential customer efforts in dependence on product embodiment.

As shown in Figure 2 the higher the product affordability the more customers will probably buy this product. It is advantageous to have cheap products due to higher customer base. Furthermore cheap product have better profit margin. Figure 3 shows, that the better product's embodiment fulfills customer demand the more product units will be sold per customer. Services (see Figure 3) described by the service depiction value considering affordability, price, QoS, duration time, target group, etc. have to be carefully designed in order to attract users and to maximize the demand.

The telecommunication market today does not have a mechanism which guarantees that a general demand/supply balance can be maintained on the market. This entails a need for information on market conditions and its capacities.

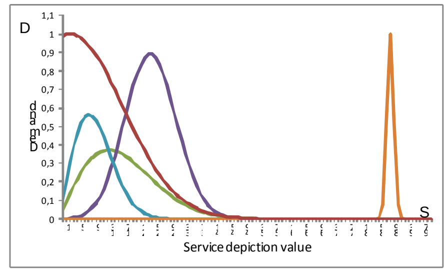

Figure 3. Different services and their normalized demand on the market.

Conventional distribution channels such as shops or provider's own internet platform are cost intensive and address to low customer base. Therefore, the provider is forced to maximize products volume, e.g., to create complex and expensive product packages and/or to force the customer to accept a long-term contract. This is in turn contradictive to above findings. As a result, the provider cannot exhaust the market potential and let business opportunities unexploited. If the provider would get the opportunity to reduce distribution costs and to adopt contract volume and duration to customers' needs more closely he would increase its revenues significantly.

A remedy can be a marketplace that integrates all customers having demand for telecommunication products. Such marketplace is provided online and so marketing and customer assistance in dedicated shops is not needed. Purposive provider's internet pages are superfluous too. In addition, contrary to provider's web pages, offers provided on a marketplace are transparent and help customers to understand the presented service and price plan. An online marketplace provides the product presentation and the trading for every provider and will therefore reduce the unit costs.

To enable the telecommunication market fulfilling the mentioned requirements in Section I we propose a telecommunication marketplace empowering natural market forces. Such a marketplace can be represented by an auction or an exchange.

C. *Auction and Exchange*

Economics know different embodiments of competitive markets, depending on traded artifacts and trading rules. Auction and exchange are examples of marketplaces. For example, Google proposed recently a concept, where a user pings service providers for their best offers while placing a call [12]. Then, either the user or an appropriate application evaluates the bids and completes the call. In a traditional auction there are usually many prospective buyers and one auctioneer conducting the auction process which lasts for a defined time period. Auctions are in general appropriate for

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unique objects and in telecommunication markets often used to trade licensed radio spectrum [13]. Unlike auctions, an exchange is a marketplace with many sellers and many prospective buyers, where the prices are posted [14]. Trades are made directly between the buyers and the sellers and the clearing process is conducted immediately if there is a call. Sellers compete by submitting offers to the exchange or, in a simplified way, directly to the user.

Therefore, in order to decide whether auction or exchange is more preferable as a trading concept for telecommunication products by considering criteria, inter alia, transaction duration, dynamicity, openness and transactions simplicity, we decided that an exchange is better suited as a platform for trading of telecommunication artifacts than the auction.

III. NEW ARCHITECTURAL AND BUSINESS MODEL

The above theoretical analysis shows that mentioned requirements on the telecommunication sector can be fulfilled by creation of a flexible operating platform, the marketplace. Marketplace architecture implies multitenancy and network virtualization, as claimed in [13]. This opens the value-chain of the telecommunication sector and so leads to separation of telecommunication provider roles. As a consequence, previously closed proprietary interfaces are turned into non-proprietary interfaces and thus offer infrastructure facilities to upcoming 3rd parties.

Therefore, in the next generation wireless network a possible business model can be based on increased specialization of the market players towards:

- Mobile Network Infrastructure Providers (MNIP).
- Mobile Virtual Network Operators (MVNO).
- Service Providers (SP), Content Providers (CP), etc.
- Marketplace Operator.

Mobile Network Infrastructure Provider offers network infrastructure and technologies as well as connectivity service. To make physical resources multi-tenant scalable, a MNIP transforms its network resources into logical resources by virtualization and wraps them to telco artifacts targeted to different customers. Telco artifacts are described by a number of parameters as QoS, traffic volume, location, radio access technology, contract duration, price, etc. The MNIP is obligated to guarantee the complete performance of the telecommunication artifacts.

Networks created and managed by *Mobile Virtual Network Operator* are based on virtual resources purchased from MNIPs on a marketplace. Note that the proposed MVNO differs from the today's defined MVNO. Since the MVNO does not own its own network, no customers can roam to that operator. However, all the customers of the MVNO have roamed to the networks of the MNOs. This makes the situation asymmetric, and this is not the case in our concept. MVNO can purchase connectivity services to expand its virtual network by additional area. Thanks to the flexibility given by the marketplace, MVNO can freely design spacial extend of its network and dynamically adopt resource volume to predicted traffic load. The calculation of needed resource in respect of amount, contract duration time and price is in its own responsibility.

Service Provider cooperates with MVNOs and offers services targeting current customer needs. Depending on the business model the services can be either integrated into existing virtual network or can be offered to the customer separately.

Marketplace Operator provides marketplace platform where the MNIPs, MVNOs, and other players offer their products and make business.

Besides providers and operators also *users* will play an important role on the changing telecommunication market. Users will have the possibility to adopt contracts to their needs, preferences and actual location and ask for means supporting the creation of individual service bundles. Furthermore users expect also to have access to networks of different operators in order to get the specified service.

IV. WIRELESS TICKET EXCHANGE – THE MARKETPLACE

The envisioned telecommunication market is based on well defined and straight trading rules and creates a trading environment transparent to all parties. Each bidder knows the offerings by competitors and the asked prices. The proposed telecommunication market comprises the platform WTE, the WTE Operator, various telco artifact providers and users.

On the WTE market players meet one another and conduct transactions by trading telco artifacts. Telco artifacts can be any telecommunication object provided by telecommunication players. This can be hardware such as a Base Station, Small Cells, Backhaul as well as spectrum, bandwidth, service, etc. The telco artifacts are described in a form of standardized Telco Tickets whereby the structure of Telco Ticket can differ for commercial and private users. In general, Telco Tickets describe details of the offer

As already indicated, the WTE is provided by the WTE Operator. He has a broker role and provides an exchange infrastructure supporting the execution and fulfilling of transactions. The broker role comprises in getting Telco Tickets from the telco artifacts provider and managing the transaction process. A transaction is executed in real-time. Since demand and supply interact in a closed-loop, the price level and service characteristics have important effect on quantity demanded and inversely, the demand influences supply. We would like to emphasize, that the future networks will be definitely dominated by solutions allowing ***m:n*** customer to provider relationships. Assuming so, customers are not necessarily bound to long term contracts and can choose between multiple providers according to user's specific demand. This will be an opportunity for providers to create innovative products and so to differentiate from each other. Broad base services in terms of technology, service type, service quality and price will in turn generate positive stimuli for the market success of the market players. The WTE is separated into the Commercial Ticket Exchange and the End User Ticket Exchange. The Commercial Ticket Exchange covers trading between business companies trading with business addressed artifacts, i.e., Business-to-Business (B2B) market. They have the possibility to sell and to buy network resources, different services, network nodes, etc. Furthermore, the companies offer services to the users. Their offers are traded on the End User Ticket Exchange serving users demand i.e., a Business-to-Customer (B2C) market. Furthermore, services such as Machine-to-Machine (M2M) are also provided at the WTE.

A. *WTE functions*

The WTE has to perform three tasks:

- Admission as a trader.
- Telco Ticket presentation.
- Transaction processing and fulfilling.

Admission as a trader is performed in a registration procedure where the applicant data is collected. The application procedure is different for commercial and for end user applicants.

Telco Tickets will be exposed by a WTE service application presenting submitted bids and asks to the customers and allowing the customers to purchase selected artifacts. The WTE provides exchange facilities with interfaces for human interaction and machine type communication.

B. *WTE functional architecture*

The main functional entities of the WTE architecture are the *Trading Facility*, the *Communication Facility*, the *Service Register*, the *Root Home Register*, the *Trader Register*, the *Subscriber Name Server (SNS)*, and the *Authentication Center* (AuC) (see Figure 4).

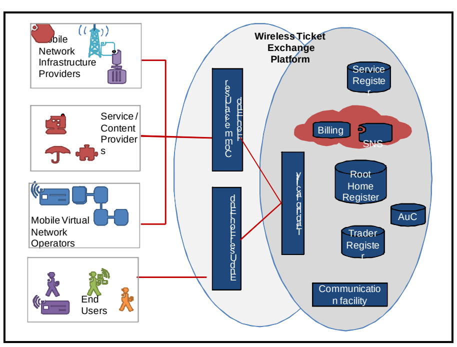

Figure 4. WTE functional architecture.

The *Trading Facility* allows users to access the WTE as a visitor or as a subscriber. Rights a granted to a visitor to see the offered bids and asks, but without the privilege to close transactions. The WTE subscriber may be the end user as well as a commercial user, a commercial company. After the registration as a WTE subscriber, the End User gets a Subscriber Identity Module (SIM) card authorizing to trade on the WTE. Registration data of both, commercial as well as non-commercial users' are stored in the *Trader Register*. The *Service Register* stores Telco artifacts to be traded. The content of the Service Register, bids and asks uploaded from the contractors, is presented in a human readable form to allow traders to choose and to select services they need, and to buy corresponding tickets. The *Communication facility* supports internal communication between the Registers, between the Registers and Trading Facility, and external communication between the Wireless Ticket Exchange and subsystems of the network. The *Root Home Register* (RHR) receives data from the Trading Facility and stores the data and sends it to the Home Service Server of the involved network. The *Subscriber Name Server* (SNS) guaranties that the call is routed directly to user's current location.

C. *Integration of marketplayers infrastructure into WTE*

Trading of products on the WTE requires an integration of the infrastructure belonging to market players into the WTE functionality, as shown in Figure 5.

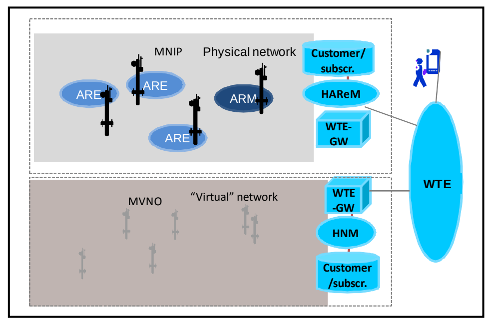

Figure 5. WTE extensions to the network.

This can be achieved by means of a specialized gateway, the WTE-Gateway, which is able to translate heterogeneous interfaces into WTE standard. The WTE-Gateway is moreover connected to other specialized nodes on the MNIP, MVNO or SP side. Figure 5 depicts an example of MNIP and MVNO. MNIP is equipped with a logical entity called Heterogeneous Atomic Resource Manager (HAReM) and a customer database. HAReM combines Atomic Resource Entities (ARE) collected by Atomic Resource Manager (ARM) to larger data transport entities, and creates Telco Tickets that will be delivering to the WTE in order to sell. Additional architectural entities on the MVNO side are Heterogeneous Network Manager (HNM) and Customer & Supplier database. HNM is responsible for virtual network creation, management of the virtual network, forecasting the network capacity due to subscriber's requirements, and foreseen traffic load in respect of considered user demands on throughput. The HNM includes also creation and management of Telco Tickets.

V. USERS CENTRIC APPROACH

To enjoy the benefits of the WTE user has to register to WTE service as a trader. After the registration procedure the user becomes a trader who can benefit from different offers of various MVNOs and Service Providers. The user can purchase telco services on the WTE and (in exceptional case) the user can sell acquired Telco Tickets back. Every WTE subscriber is equipped with a SIM card identifying him as a trader. The SIM card storing user's identification number (WTE identifier) allows him to access the network of MVNOs registered on the WTE. It is quite evident, that the trader has to possess Telco Tickets from one or more MVNOs before he can do calls in corresponding network. When a subscriber buys a service on the WTE, the subscriber's data is automatically transferred to MVNOs Home Subscriber Server or corresponding facility in such a way that the buyer becomes the status of native subscriber of the seller for the time covered by closed transaction. If required, transaction procedure can be repeated by any number of times with different network operators. As a result a user has access to networks belonging to those MVNOs.

In case off Telco Tickets containing combine services, as for example content service and corresponding streaming service, both providers are informed about conducted transaction.

At the time the user enters a network of a MVNO that has an agreement with the user the MVNO provides the user with a MVNO local identifier. The telecommunication system uses the local identifier to route the call to the destination address. The user gets the status of a native subscriber of the seller for the time covered by the closed transaction.

VI. CONCLUSIONS

We conclude that separation of telecommunication players' roles is necessary to fulfill actual and future market requirements. By opening the value chain more business opportunities for traditional and new players will be available. The results will be welfare in maximizing market equilibrium by the forces of supply and demand. From this point of view we did not restrict our research to pure engineering on technological solution but we integrate economic and user perspectives, as well. As a consequence we draw the idea of WTE where various telecommunication providers, network operators, business customers and end users trade telecommunication artifacts in a free, dynamic, transparent environment with associated functional network and marketplace architecture. The many-to-many customer to provider relationship forces competitive advantage and boost performance in product differentiation and innovation. In opposite to known business models, we propose that providers retain their independence and freedom of decision in issues: which, with whom and how much resource to share. Due to flexible and dynamic contracts the WTE operators can cope with rapid changes in customers' behavior, attitude and requirements. Again, due to market transparency users will generate immense dynamics and leverage expected assets.

From the regulation point of view, WTE allows an easily entering the market for upcoming 3rd parties. However, putting such an approach into practice reduces dominancy of today players in the mobile radio communication. Since the market offers new possibilities too, they can expect additional value by developing their commercial creativity. To this end, we are confident, trading of telecommunication artifacts addressed to commercial companies, as well as to private consumers opens new streams of revenue, brings opportunity for network monetization, radically improves cost structure and increases users' satisfaction.

In future works we will provide numerical methods and SON market driven algorithms applied to WTE service.

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