# Looking for New Allies in Mobile Internet Market

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**The unprecedented increase in the mobile data traffic volume, as well as the need for network coverage expansion are major concerns for mobile operators. Although new pricing regimes have been actually employed to affect user's behavior over the usage of the network resources, operators still face challenges related to congestion management, cost reduction and revenue generation. Operators are induced to look for new allies in the mobile Internet market and introduce more innovative incentive mechanisms. *Sponsored data*, where an operator negotiates with a content provider so that content of the latter is free to end-users, motivates content providers to be more actively involved within the Internet value-chain. Another paradigm is *offloading via user-provided networks* (UPN), which motivates end-users acting as providers to extend mobile network coverage. We investigate incentives provision by network operators for making alliances with both content providers and end-users, including insights from the business perspective.**

***Index Terms*— smart data pricing; incentives; sponsored data; offloading; user-provided networks.**

## I. INTRODUCTION

DUE TO the need for network coverage expansion, as well as the unprecedented increase in the mobile data traffic volume, network operators are forced to operate close to their capacity limits. According to [1], the mobile data traffic will grow at a compound annual growth rate (CAGR) of 57% from 2014 to 2019, reaching 24.3 exabytes per month by 2019. How can the network operators react to this drift, and what are the alternatives for facing the arising challenges?

One solution is exclusively related to the network operator. The operator could make additional investments in order to increase its network capacity. This could be achieved by building more cell towers, base stations of smaller cell sizes (e.g., femtocells), or by fully upgrading the existing network infrastructure (e.g., LTE). Here, the decisions of a network operator are mainly cost-driven, based on the feasibility, sustainability and viability of the investment plan.

Instead of adopting a completely innovative technology, network operators are induced to introduce appropriate pricing schemes (e.g., *data caps*, *shared data plans*, *congestion pricing*) [2]. Although numerous pricing regimes have been actually employed to affect user's behavior over the usage of the resources, network operators still face challenges related to congestion management, cost reduction and revenue generation.

In response, network operators are looking for new incentive mechanisms to attract allies within the Internet market. For example, with *sponsored data* [3] network operators collaborate with content providers so as to make a fraction or all of the requested content free to end-users. The network operators benefit from this arrangement, since they are enabled to collect additional revenues from a source other than the users. Additionally, this scheme is also attractive to the content provider, since it makes the bandwidth for its content free to the end-users, and hence it could increase the number of end-users who consume this content. Furthermore, it eliminates the risk that a user will stop requesting additional content to avoid consuming his available data cap.

Another alliance that network operators are looking for, is the collaboration with the end-users for extending mobile connectivity. In particular, network operators employ incentive mechanisms to promote user participation as micro-providers for expanding the existing network coverage. Such incentive mechanisms are motivated by *offloading via user-provided networks* (UPNs). Offloading has been recently proposed as a candidate solution for improving the cellular utilization by delivering data originally targeted for cellular networks via complementary network technologies. This promising solution can significantly lower the operational cost of a network operator, especially when existing deployed infrastructure is exploited. User-provided networks (UPN) ensure ubiquitous connectivity using the existing infrastructure and devices [4], since users are enabled to share either their connection or a fraction of their available data plan to other users belonging in the same network community. The network externalities effect is apparent, since as more people join in such communities, the performance and availability of the Internet connection will be increased. UPNs can be seen as an offloading paradigm, since connection sharing may imply traffic shift among heterogeneous networks.

This paper investigates incentives provision by network operators for making alliances with both content providers and end-users, including insights from the business perspective. We consider the incapability of current pricing regimes to provide sufficient incentives for efficient resource usage, and explore the reasons for their limited adoption. Then, we focus on the arising alliances of network operators with content providers and end-users, as well as how the current business models within the Internet market are actually affected.

The paper is organized as follows: Section II explores how the existing pricing regimes provide incentives for efficient network resource usage, and investigates which charging schemes have been mostly employed by the network operators. Section III considers the alliances between network operators and content providers in the context of sponsored data. Section IV investigates the alliances between network operators and end-users in the context of offloading via UPNs.

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In particular, we present a set of representative UPN services, and provide a qualitative evaluation of the adopted incentive mechanisms. We conclude our remarks in Section V.

## II. PRICING SCHEMES ADOPTION

The increasing demand for bandwidth forces the network operators to over-provision capacity for demand at peak times of the day. Since data streams still remain a critical revenue generator, network operators are forced to adapt their pricing strategies properly to maximize their revenues, as well as use them as congestion control mechanism to minimize their cost. This section considers whether and how the proposed pricing regimes provide users the necessary incentives for efficient resource usage, and investigates which of them have been actually adopted within the Internet market so far.

### A. Flat-Rate Pricing and Data Caps

Flat-rate pricing refers to a fixed fee charged for network access, regardless of the usage volume. The flat periodical access fee is a common charging scheme, mainly for fixed-access networks, in which there are rarely restrictions over the traffic volume consumption. Flat pricing was not initially used for charging mobile networks. Nowadays, in response to users' increasing demand, most of the network operators offer flat *data caps* for given time-periods. Although flat pricing is not considered as an appropriate charging scheme for controlling resource usage, it is widely adopted due to its cheap implementation, easy operation, and simplicity for users (e.g., *T-Mobile*[1], *Vodafone*[2]).

### B. Usage-based Pricing

Usage-based pricing charges users proportionally to their actual data usage. Many mobile network operators offer a form of usage-based pricing (e.g., *Bell*[3]). A hybrid approach of flat and usage based pricing is the *two-part tariff*. A two-part tariff is a price discrimination technique in which the price of a service is composed of a fixed fee, plus a per-unit charge. The fixed fee is usually introduced for a monthly cap on a predefined usage volume (e.g., the first 2GBs) and, if the user surpasses this threshold, usage-based pricing is applied for the overage charges. Usage-based pricing is a widely-adopted scheme, which does provide users the incentives to control data consumption based on their budget constraints.

### C. Shared Data Plans

A shared data plan allows sharing data caps among multiple users or even multiple devices of the same user. The conservative data plans only allow the use of a single device by one user. Several network operators, mainly in US, have already terminated unlimited offerings.

In response, shared data plans are offered by the network operators in order to further control or limit users' demand. For example, AT&T offers *Mobile Share Value & Data*[4], in which users can share the mobile connection with other WiFi enabled devices. The charges depend on the chosen traffic level, as well as on the number of the different devices. A similar example is *Verizon Shared Data Plan*[5] in which price discrimination is applied based on the *device type* being used.

Some network operators are offering *roll-overs*, which enable the unused data plan in a given bill cycle to be used within the next bill cycle. From a user's perspective, roll-overs are useful mainly if data usage wildly fluctuates across different billing periods. However, from a network operator's point of view, roll-overs could reduce their revenues. According to [5], a large fraction of mobile users consume less than 50% of their data quota. Hence, for the network operators there is a trade-off between having a competitive advantage by offering roll-overs, and loosing potential revenues. To mitigate this problem, network operators offer limited roll-over data, which automatically expires after one billing period, so that unused roll-over data will not carry over to the next billing period (e.g. *T-Mobile Data Stash*[6]).

### D. Speed-based Pricing

This is an innovative pricing scheme related to traffic prioritization. The scheme could be viewed under two different angles; as a *service differentiation*, or as a *penalty* mechanism [6]. A speed-based data plan for service differentiation purposes is mainly adopted by fixed broadband providers (e.g., *Comcast*[7]). On the other hand, a data plan may include a penalty for exceeding the monthly plan limit (e.g., *Swisscom*[8]). This penalty could be applied in terms of an overage charge or a degradation of the provided network speed. Such pricing scheme incentivizes users to not exceed their data caps.

### E. Congestion Pricing

Congestion pricing intends to incentivize users to reduce or even shift their traffic to less congested timeslots by making prices dependent on the actual network congestion [7]. In fact, users are aware of the congestion they impose upon each other when consuming during the peak demand, and consequently, are forced to pay for the negative network externalities they create. Based on arising congestion levels, the network operator announces prices or directly charges. Subsequently, the operator computes the new prices based on user responses, in terms of demand adaptation or time shift.

There are currently some interesting proposals on how to implement congestion pricing in practice. The *ECN* protocol allows routers to mark packets that would otherwise have been dropped as having experienced congestion. The proportion of marked packets can be used by the network as a metric for charging end-users for their upstream congestion, i.e., charging based on the number of ECN marks. *Re-feedback of Explicit Congestion Notification* (Re-ECN) and *Congestion Exposure* (Conex) provide information about the expected level of congestion along the entire path [8]. Such protocols

[1] http://www.t-mobile.com/cell-phone-plans/mobile-internet.html
[2] https://www.vodafone.co.ug/price-plans
[3] http://support.bell.ca/Mobility/Rate_plans_features/What-are-Bell-Mobilitys-current-pay-per-use-rates
[4] http://www.att.com/shop/wireless/data-plans.html
[5] http://www.verizonwireless.com/landingpages/more-everything
[6] http://www.t-mobile.com/offer/data-stash-for-business.html
[7] http://www.xfinity.com/internet-service.html
[8] https://www.swisscom.ch/en/residential/mobile/subscription-tariffs.html

could enable flat congestion allowance contracts. Although R&D departments of several network operators work on standardization and deployment of such mechanisms (e.g., *BT* [9]), congestion pricing has not been actually implemented commercially yet, due to technological challenges (e.g., additional equipment required, billing complexity).

### *F. Time-dependent Pricing*

Time-dependent pricing (TDP) focuses on the *time-of-the-day* at which data is consumed, and not on *how much* data is used. It is in the same spirit as congestion pricing, since a given timeslot could be seen as a coarse proxy for network congestion. Likewise, users have an incentive to reduce their traffic demand or shift their usage to less expensive times of the day. Nevertheless, TDP does not explicitly make prices dependent on actual network congestion. In such approach, network congestion is estimated mainly based on the time of the day (e.g., morning, night) or historical usage patterns (e.g., charging based on the network congestion perceived at different timeslots during past days). Ha *et al.* [10] conducted an experimental study of an end-to-end TDP system, called "TUBE". Although TDP has been discussed for years, it has not been commercially adopted by network operators so far, due to technological challenges (e.g., implementation of real-time monitoring mechanisms, billing complexity).

## III. Alliances With Content or Service Providers: Sponsored Data

Revisiting the existing pricing regimes for Internet service provision is a well-known problem for the research community. This problem is humorously stated in [11]; *But why paying the truck driver in the Internet?* Network operators are likened as truck drivers, in terms of only transmitting (not producing) data. However, content providers are not always actually involved within the Internet value-chain. End-users mainly pay the network operators for connectivity services, while most of the content providers offer their content for free. Of course, there are several services, including IPTV or VoIP, charging directly the end-users for the provided services and not for connectivity. On the other hand, assuming that content providers ensure alternative revenue streams for their services (e.g., via advertisements), network operators still face the growth of the mobile data traffic.

In response to the aforementioned inefficiencies on pricing content provision, several network operators recently started offering *sponsored data* (e.g., *AT&T*[9]). This recent trend can be also viewed as "*application-based pricing*". Network operators offer access to a wide range of applications, either for a fixed price regardless of the bandwidth usage, or free of charge as a part of a bundled service. So far, the main strategy behind this scheme is to boost the adoption of specific application and use it for marketing purposes. For example, the generated traffic of a given application could be offered for free, in order to increase the critical mass of the application adopters. In addition, it eliminates the risk that a user will stop requesting additional content to avoid consuming his available data cap. Network operators provide the aforementioned incentives, since they also do benefit from this arrangement due to the additional revenues coming from a source other than the users. It should be noted here that new players (e.g., *Aquto*[10], *DataMi*[11]) also enter the market by offering marketplaces for content or service providers to sponsor data via different applications.

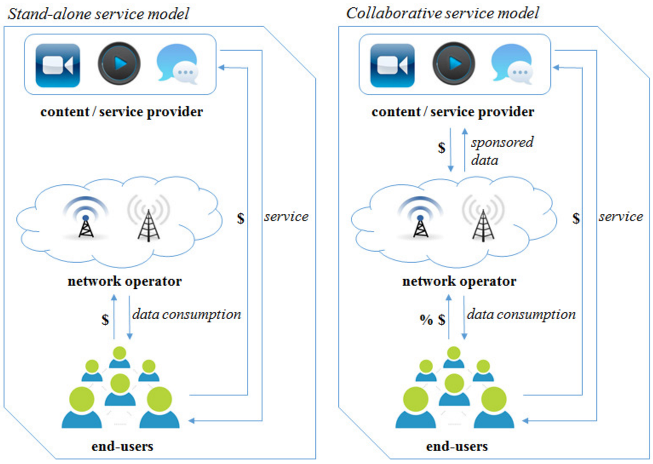


**Fig. 1: Stand-alone and collaborative service model with sponsored data**

Fig. 1 shows the revenue streams among the different stakeholders in each service model within the context of sponsored data. Particularly, in the stand-alone service model (i.e., no alliance is made by the network operator), users are being charged by the network operator based on their data consumption, but no charging is applied to the content or service providers. With sponsored data, the content or service provider collaborates with the network operator, and the former is being charged based on the data traffic requested by users. Correspondingly, users will be partially charged or they will receive this content for free. The revenue stream between content or service providers and end-users remains the same, regardless of whether sponsored data are provided or not.

## IV. Alliances With End-Users: User as a Provider

### *A. Offloading*

Offloading has been proposed as a candidate solution for improving the cellular utilization by delivering data originally targeted for cellular networks via complementary network technologies. This promising solution can significantly lower the operational cost of a network operator, especially when existing deployed infrastructure is exploited.

*WiFi* has emerged as the most preferred offloading technology. Using WiFi for offloading is attractive for network operators, since it shifts traffic from expensive licensed bands to free unlicensed ones. Several research papers, such as [12], experimentally evaluate the benefits of WiFi offloading to network operators and users.

An alternative offloading solution is using *femtocells*, which

[9] http://www.att.com/att/sponsoreddata/

[10] http://www.aquto.com/
[11] http://www.datami.com/

are wireless access points (APs) acting as small cellular base stations. They are designed for internal use intending to improve cellular reception. Femtocells connect to the network of an operator via broadband (e.g., DSL) and facilitate the latter to handle capacity limitations or just to extend its network, mainly in areas with poor access coverage. It is an ideal offloading solution, especially for network operators offering both fixed and mobile connectivity services. We omit other offloading technologies from our analysis, since they do not actually encompass end-users [13]. The different types of offloading can be briefly summarized as follows:

*On-the-spot offloading* refers to the use of spontaneous connectivity to WiFi and transfer data on the spot. This is the most common offloading case. In particular, when users move out of the WiFi coverage, all the unfinished transfers are transmitted through cellular networks. Such offloading type is supported by most of the available commercial devices, since by default they give priority to WiFi over the cellular interface in data transmissions.

*Delayed offloading* alleviates mobile data explosion by persuading users to wait for a certain time period before sending their delay-tolerant traffic, in order to exploit the chance of users to meet a WiFi AP. Each data transfer is associated with a deadline and, depending on whether users are within WiFi coverage, it repeatedly resumes data transfer until the transfer is complete. Unless the data transfer finishes within its deadline, cellular networks are used to complete the transfer (as in on-the-spot offloading). The idea of delayed offloading comes from *delay-tolerant networking* (DTN), which seeks to address the technical issues in heterogeneous networks lacking continuous network connectivity.

*Offloading through opportunistic communication* is an end user-driven solution, inspired by the *Mobile Social Networks* (MoSoNets). It takes advantage of the available information extracted by social service providers (e.g., via a mobile social application). Such service providers deliver information to a fraction of selected users in order to reduce cellular data traffic. Then, the selected users are able to propagate information among the remaining subscribed users, when their mobile phones are within the transmission range of each other and can communicate opportunistically [14]. User-provided networks (UPN) can be viewed as an offloading paradigm through opportunistic communication. Within a UPN, users are enabled to be micro-providers by sharing their connection, which implies traffic shift among heterogeneous networks.

Unlike offloading which transfers cellular traffic to WiFi APs, *onloading* shifts WiFi traffic to cellular networks [15]. The offloading decisions mainly depend on the *data usage* and *energy cost* incurred by the users, while the onloading decisions depend primarily on the *congestion of WiFi APs*.

### *B. UPN as a Service*

UPNs enable users to contribute more actively with respect to the network coverage expansion and the efficiency of resource usage. Apart from considering UPNs as an offloading paradigm, they may bring new business opportunities to the network operators by introducing new services.

The UPN services can be classified based on two dimensions; *which type of network* is needed to provide the UPN service, and *who controls the overall operation* of the service. In response to the first question, we identify services that are offered using fixed or mobile networks. Concerning the overall operation, we ascertain centralized network operator-driven services, as well as services running in a distributed manner. In each combination based on the two aforementioned criteria, a UPN may either use the existing infrastructure, or require additional hardware devices for the service provision. Below, we investigate four representative business cases of UPN services, focused on the incentive mechanisms provided to the end-users.

#### *1) FON*

*Fon*[12] is a large WiFi network with more than 16 million hotspots worldwide. The main idea of this service is that users constantly share a fraction of the available bandwidth of their fixed WiFi (i.e., home ADSL line), and in exchange get the right to use other members' hot spots worldwide. The available hotspots create a crowd-sourced network, where each user who shares his own fixed network is reimbursed by being connected to other WiFi networks for free.

Fon service requires a special device at customer premises, which enables a dual access wireless network. In particular, this customer-provided equipment (CPE) enables two separate, dedicated WiFi signals; a *private* signal, and a *shared* signal with a common SSID (e.g, Fon-public) for the visitors to the network.

Fon collaborates with a wide range of telecom operators (e.g., *BT*[13], *T-Systems*). The service is provided for free to the end-users either indirectly via the FON telecom partners, or directly by the Fon as a standalone service. In the first case, the telecom partners offer to their subscribers a pre-configured CPE (e.g., DSL or cable modem) supporting this service. However, in the second case, the cost of the necessary equipment is undertaken by the customers. If a customer does not own such a CPE, she is enabled to buy a voucher in order to get access to the global Fon WiFi network. The offered vouchers are time period-based (e.g., per hour, per day) and can be purchased directly from the AP's portal page. Its incentive mechanism includes the following aspects:

- When the service was introduced in the market, the users who were sharing their WiFi, were further rewarded by getting 50% of the net revenues when a visitor purchased a voucher at their hot spot.
- The connectivity time to public AP, without being charged, is increased.
- The service is disabled after a certain period of time (usually after one month) as a penalty, in case a user decides to not share his WiFi (by disabling the public SSID or even turning off his home CPE).
- Users are not given further incentives to limit their usage, since they are not accountable or charged for the total data they consume.

[12] https://corp.fon.com/en
[13] BT recently began offering bundled data plans for both WiFi and LTE.

*2) Karma*

The *Karma*[14] hotspot provides WiFi access "on the go" within the United States. The Karma requires an external hotspot device that provides internet access to others nearby. The device runs on 4G LTE with support for Sprint Spark and fallback to CDMA (3G) on Sprint.

This device supports multiple simultaneous connections. The more a customer shares their hotspot access, the more free data he gets in return. In particular, every time a new user logs onto a user's Karma hotspot, he is rewarded with extra data. The person who logs into a user's Karma also receives a free data cap. Such rewarding scheme intends to boost the adoption of this service, and hence, increase the market share of the provider. Anyone that connects to a user's hotspot for first time uses the connection, though this traffic consumption is "excluded" from the data consumption of the owner of the connection. That is, users do not share their data, but only their connection to potential new Karma users.

The cost of the external device needed for the service provision is paid by the end customers. Apart from this cost, users chose and prepay one of the available data plans (e.g., \$10/GB), without any periodical data cap expiration. No contract is required between customers and the operator. Its incentive mechanism includes the following aspects:

- Users are able to try this service before buying it, since they gain 100 MB for free when they connect to a Karma WiFi hotspot.
- Users are enabled to earn free data as a reward (100 MB) each time they share their connection with a new user.

*3) Open Garden*

*Open Garden*[15] is a large network that allows mobile devices to share their data with others via WiFi or Bluetooth. An application is required to enable users to access the most appropriate connection, since they can move between networks seamlessly. Moreover, it enables the use of multiple paths simultaneously, improving the perceived Quality of Experience (QoE) and resilience through resource pooling. When there is no direct Internet connection, users are able to access the Internet through chains of other devices.

According to the Open Garden's official website[12], several telecom operators intended to disrupt its operation (by blocking traffic unless customers pay for tethering, or even asking Google Play to prohibit access to the application).

The service is provided for free. Open Garden adopts a freemium business model, where revenues are obtained by sponsorships and advertising. However, the incentives provided to customers are limited, since they do not have any control on how much data they share and are not rewarded based their overall contribution. Its incentive mechanism includes the following aspects:

- The connectivity time using neighboring users, without being charged, is increased.
- Users are able to improve their QoE, by increasing their total throughput through their connections with the available neighboring users.

*4) Airmobs*

*Airmobs*[16] is an application providing a mobile Internet sharing community for free. The application is part of a research project initiated by the Viral Spaces research group at the MIT Media Lab.

Users are able to advertise parts of their data plan and let other members of the Airmobs community to tether to them. This is beneficial to users, since the application enables them to consume unused volume before certain data caps expire. In particular, users determine information related to their billing cycle, such as the billing day, the maximum data plan, as well as the maximum data they are willing to share. Furthermore, users are enabled to choose the battery level threshold in order to share their data plan (i.e., when battery is more than 50%).

The application could be mainly used due to network coverage-related aspects (i.e., a user being within a weak or no coverage zone). It checks the strength of the cellular connection, and if it detects another available community member nearby, it automatically switches on the WiFi transmitter. Another reason for using this application is related to charging (i.e., a user facing high roaming charges, reaching his data plan's limit, etc.). A website tracks the evolution of the community and posts the most important donators and users of the system. Users are rewarded by data credits for future use, based on how much data they have already shared. The credit score can be increased by running the application in the background in order to activate the sharing. Its incentive mechanism includes the following aspects:

- The connectivity time using neighboring users, without being charged, is increased.
- For every kilobyte shared, the application awards a data credit that can be used later.
- Users are ranked based on their overall sharing contribution. Under increased demand for data volume, higher priority is given to the community members with good community credit score.
- The use of market credits is under consideration by the development team.

Table I provides a qualitative comparison of the aforementioned services based on several criteria, namely the operation of the service (community-driven vs. network operator-driven), network type (fixed vs. mobile), requirement for additional hardware/equipment, multi-hop support, pricing scheme as well as the implementation of accountability, penalty and rewarding mechanisms for the end-users.

Fig. 2 shows the revenue streams among the different stakeholders in each service model within the context of UPN. Particularly, in the stand-alone service model (i.e., no alliance is made by the network operator), users are being charged by the network operator for connectivity service provision. With employing UPN-like services, end-users collaborate with the network operator and the formers act as connectivity providers by means of sharing either their connection, or part of their

[14] https://yourkarma.com
[15] https://opengarden.com
[16] https://play.google.com/store/apps/details?id=org.eeiiaa.airmobs

unused data plan. The rewarding mechanisms (e.g., free data, market credits) are interpreted as inverse revenue flow from the network operator to the end-users.

| CRITERIA | UPN SERVICES | | | |
|---|---|---|---|---|
| | **Fon** | **Karma** | **Open Garden** | **Airmobs** |
| *Operation* | Operator-driven | Operator-driven | Community - driven | Community-driven |
| *Type of network* | Fixed | Mobile | Mobile | Mobile |
| *Additional equipment* | Yes | Yes | No | No |
| *Multi-hop support* | No | No | Yes | No |
| *Pricing* | Free / voucher | Voucher | Free | Free |
| *Accountability* | No | Yes | No | Yes |
| *Penalty* | Yes | No | No | No |
| *Rewarding* | Static | Dynamic | Dynamic | Dynamic |

**Table 1: Qualitative evaluation for selected UPN services**

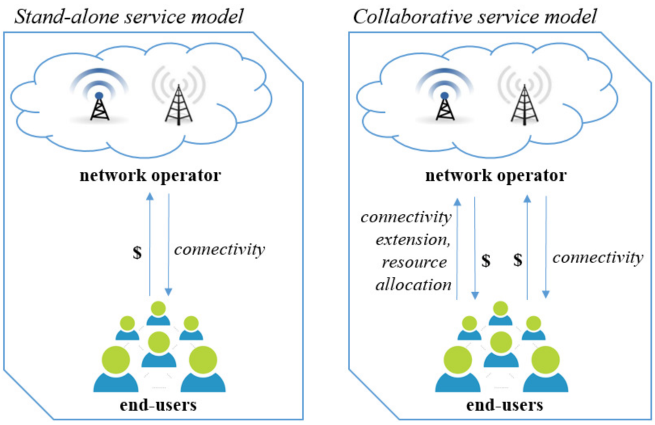


**Fig. 2: Stand-alone and collaborative service model for UPN services**

## V. DISCUSSION

This paper investigates incentives provision by network operators for making alliances with both content providers and end-users, including insights from the business perspective. We highlighted the incapability of current pricing regimes to provide the appropriate incentives for efficient resource usage, and investigated the reasons for their limited adoption. We also considered the arising alliances of network operators with content providers and end-users, as well as how the current business models and revenue streams within the Internet market are actually affected.

Although numerous pricing regimes have been actually employed to affect user's behavior over resource usage, network operators still face challenges related to congestion management, cost reduction and revenue generation. In response, operators began making new allies in the Internet market, either with content or service providers (in the context of sponsored data), or with end-users (in the context of UPNs).

Sponsored data introduces content or service providers as new players to data pricing. Also, UPNs bring new business opportunities by introducing new services. Although the participation within such community-based networks implies several technical challenges [16], as well as additional costs for the end-users (e.g., lower throughput, data cap and battery consumption), we ascertain that evolving the current rewarding mechanisms is undoubtedly required.

Promoting new alliances and user empowerment differentiate traditional pricing schemes, and enable new business models. Such evolution of the Internet market is accelerated not only due to technological advances, but also due to business, economic and regulatory changes on access and competition rules.

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