Co-primary Spectrum Sharing and Its Impact on MNOs' Business Model Scalability

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Abstract. This paper focuses on inter-operator spectrum sharing, specifically co-primary spectrum sharing (CoPSS), that denotes the case where two or more MNOs (mobile network operators) operate in the same frequency band. Specifically, we discuss the concept and its impact on the mobile network operators' (MNO) business model scalability potential. CoPSS has several technical and business advantages in volatile demand conditions. It highlights predefined policies and rules for sharing, utilization of subscriber and usage profiles for spectrum resource allocation, hybrid business models, value differentiation between exclusive and shared spectrum licenses, utilization of customer experience management systems (CEM) for value differentiation, and utilization of the LTE ecosystem.

Keywords: Co-primary · Spectrum sharing · Business models · MNOs

1 Introduction

Inter-MNO (mobile network operator) spectrum sharing has raised research interests under a variety of terms, concepts and settings. Inter-MNO spectrum sharing denotes the case where two or more MNOs to operate in the same frequency band. In practice, MNOs have been reluctant to consider inter-operator spectrum sharing within currently used spectrum bands. However, research indicates inter-MNO spectrum sharing to be beneficial in bursty and fluctuating traffic/spectrum demand conditions [1]. In addition, spectrum sharing between MNOs is particularly beneficial in small cells where interference can easily be controlled [2]. Also, the gains from sharing differ depending on the user locations within the cells [3].

For MNOs, starting a spectrum sharing based business is a disruptive innovation that changes and challenges their traditional strategy and business models [4]. Co-primary spectrum sharing (CoPSS) is one of the new emerging conceptions enabling inter-MNO spectrum sharing. In the CoPSS concept, licenses are issued for at least two MNOs which agree on the conditions for operating in the given band. The CoPSS concept brings new value creation and capture possibilities, i.e., business model opportunities for MNOs both from technological and business perspective. Typically, MNOs' business foci

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comprise either an aggressive approach where the aim is to generate new revenue from new business opportunities, or a defensive approach where the aim is to increase cost efficiency within existing businesses and operations [5]. However, as CoPSS does not work in isolation but as an addition to MNOs' other business operations, attention needs to be paid to the scalability potential of the CoPSS concept, especially in small cell contexts.

This paper focuses on the aggressive approach, where the possibilities of CoPSS could open up MNOs new business opportunities. Therefore, the purpose of this paper is to *explore the CoPSS elements required for business model scalability among MNOs*. To this aim, the structure of the paper is as follows: after introduction we present the research domain, i.e., the concept and business domain for CoPSS, discuss the business model concept and scalability, and present the business domain for CoPSS. After that, we will present our key findings, the CoPSS elements contributing to business model scalability among MNOs. We end the paper with conclusions.

2 Understanding CoPSS as a Research Domain

This chapter discusses the CoPSS concept, business model concept and scalability, and CoPSS as business domain for MNOs.

2.1 Co-primary Spectrum Sharing, CoPSS

The definition of CoPSS as a dynamic spectrum-sharing concept is currently emerging [6]. The three different elements that help to define CoPSS as a concept comprise the following. First, the *type of the spectrum* authorized for sharing (licensed or license exempt). Second, the *dimensions of shared resources* (temporal, spatial, or spectral, where the first dimension refers to the length of time scale of spectrum sharing-related decisions, the second to the geographical resolution (size of area) of the decisions, and the final one to the resolution in the frequency domain (size of spectrum chunks)). Third, *degree and type of information sharing* (proactive, reactive or enhance intra-operator sharing schemes).

Based on these elements, paper [6] defines CoPSS as follows:

1. CoPSS concerns a specific spectrum band for which licenses are issued for at least two MNOs,
2. These MNOs enter into an agreement regarding the conditions of sharing,
3. CoPSS requires real-time information sharing between the MNOs, information about the type and level of sharing resolution, which is agreed between the MNOs so as to guarantee efficient spectrum sharing,
4. The dynamics of spectrum sharing in CoPSS is considerably high, approaching the level of intra-operator resource allocation, and
5. Sufficient guaranteed QoS is part of CoPSS.

Figure 1 illustrates the CoPSS concept. In this example, two MNOs originally have licensed spectrum bands. Through CoPSS they maintain a part of their licensed band

for their own use while offering the remaining part to a shared spectrum pool that can be accessed by both MNOs under agreed terms.

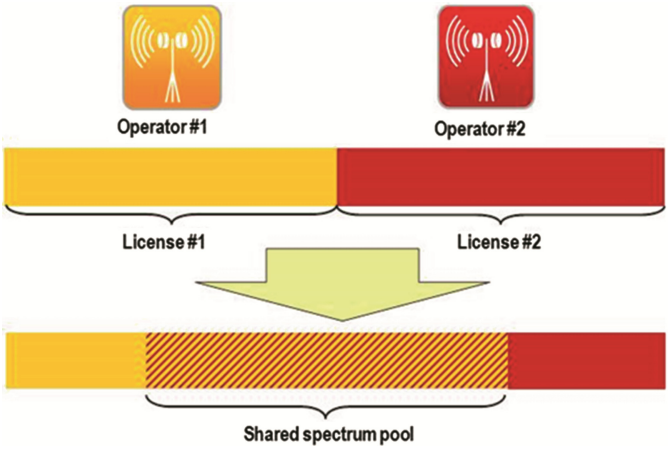

Fig. 1. CoPSS framework.

In the MNO business regarding CoPSS, the spectrum is no longer necessarily owned, but borrowed or co-owned with actors that still view each other as competitors. In this situation, we need to understand the horizontal collaborative aspects of a business relationship in parallel with the vertical, competitive aspects of a business relationship. The main theories around business relationships, such as Network Theory, Industrial Organization Theory or Strategic Alliances Theory, do not describe the dyad situation where companies compete and cooperate with each other's simultaneously [7]. Instead, coopetition is shown to emerge in horizontal relationships. Coopetition [7, p. 412] is "the dyadic and paradoxical relationship that emerges when two firms cooperate in some activities, such as in strategic alliance, and at the same time compete with each other in other activities… And (coopetition) must be regarded as the most advantageous one, when companies in some respect help each other and to some extent force each other toward, for example, more innovative performance." Especially, this can be regarded to hold when the MNOs in coopetition have differing customer profiles, the servicing of which becomes feasible for using the CoPPS band resources.

In general, sharing may take several forms from no sharing to complete sharing (commonly operated infrastructure) [8–11]. Compared to CoPSS, the performance of no sharing is lower, whereas complete sharing might bring about considerable performance improvement. Considering the costs, CoPSS might mean savings in license costs, albeit with own infrastructure. In complete sharing, the problem is the access to sharing arrangements and division of costs across the stakeholders. In no sharing the all stakeholders cover their own costs.

Coopetition has a strategic role [12] as it captures the benefits from both competition and cooperation but it can create a tension between the players. In short, the coopetition is about creating value and capturing value together between two or more players, so

called value co-creation and value co-capture. Coopetition can also be seen as an enabler for developing scalable business models.

2.2 Business Model Concept and Scalability

Business model has established its position as conceptual tool that helps managers to translate abstract strategies practical, especially by looking the exploration and exploitation of opportunities and advantages of firms. This can be done by looking at how value is co-created and co-captured in business relationships [13]. Business model concept [13] revolves around business opportunity and answers four questions: what the company is offering to their customers, how it is doing it, where the activities are located, and why the company thinks it can do everything profitably:

1. *What?* Including offering, value proposition, customer segments, and differentiation,
2. *How?* Including key operations, basis of advantage, mode of delivery, selling, and marketing,
3. *Why?* Including basis of pricing, way of charging, cost elements and cost drivers, and
4. *Where?* Including the location of activities, either internally or externally to the firm.

Scalability, one unique characteristic of business, is an important concept when innovating a business model. The scalability of the business model fundamentally stems from the synchronization of a business model to the respective business opportunity. In addition, a scalable company can maintain or improve its profit margins when sales volume increases. There are two approaches related to scalability concept [14]. *Scale-up* is the vertical approach to scale a system (i.e. only one node of the system will be modified by adding more resource), and *scale-out* is the horizontal approach to scale a system (i.e. takes an effect on the whole system by adding more nodes to the system). In this paper, we consider four categories of elements that affect the scalability of CoPSS based business model among MNOs:

1. Mission criticality and uniqueness which shows the value of the concept for the customer,
2. Superior value proposition across value chain describes the strength of the business model compared to other in the value chain,
3. Potential for sustainable, continuous revenue stream, and
4. Location of the business activities.

3 CoPSS and MNO Business Model Scalability

We have evaluated the proposed CoPSS concept according to the presented business model scalability elements by arranging workshops that gathered experts from industry and academia. The identified elements are summarized in Table 1.

Table 1. Elements contributing to MNOs' business model scalability in CoPSS.

CoPSS as mission critical and unique for MNOs	• Licensed spectrum shared among competing MNOs by predefined policies and rules • Spectrum licenses for specific locations or specific universal services • Utilization of subscriber profiles and usage profiles for spectrum resource allocation
CoPSS as providing MNOs a sustainable and continuous revenue stream	• Using by MNO and other stakeholders a hybrid business model that links commerce, content, context and connection based business models, also between MNOs • Shared license may include dedicated share for base operation for each MNO and other stakeholders
CoPSS as providing MNOs a superior value proposition	• Value differentiation between exclusive license and shared license enabled • Opportunity to utilize the whole shared pool as a resource asset by each MNO • Utilization of customer experience management as a tool for value differentiation
Location of the MNOs CoPSS based business	• Business both for location-dependent services and location-independent specific universal services • Utilizing LTE ecosystem for all services to ease the standardization efforts • Virtual network operation for MNOs by local operator

For the category *mission critical and uniqueness* we have identified several features of CoPSS which might make it unique. An essential unique feature of CoPSS is that the licensed spectrum resources are being shared among competing MNOs by predefined policies and rules. The sharing could happen in certain locations like public premises or public places, where each MNO shall offer services its subscribers. The MNOs could have different subscriber profiles with different usage behaviors, and the sharing could be based on the utilization of the differences of the profiles. I.e., at a time one MNO operator might have high need for extra resources to serve its subscribers, the others could serve their customers with their basic resources. Compared to the traditional situation where the extra resources are coming from over Wi-Fi, the licensed spectrum offers continued connectivity without breaks and guaranteed quality of service with quality of service differentiation according to the used pricing model. Additionally, security is inbuilt in MNOs' services. The local nature of the sharing may include offering local services (e.g. multimedia broadcasting, advertisement etc.), which might be provided by (specific) companies located in public premises. The spectrum to be shared could be shared also with venue owners. One specific location for shared spectrum could be roadsides, and there especially for the purpose of vehicle-to-vehicle communications [15].

For the *superior value proposition* category we have also identified several features. A national regulator authority influences the CoPSS type of sharing as it will define indirectly the constraints for sensible pricing of the spectrum. This could be done e.g., by comparing the value of the spectrum sold as exclusive licenses to that of shared licenses. The MNOs will make the same comparison in their side. The value of CoPSS spectrum could be lower than that of the licensed spectrum of the same blot, but an MNO may consider that the part it has bought includes the possibility to utilize other MNOs' spectrum. This extra utilization may give opportunities to extra value proposition to subscribers. Getting this extra value depends heavily on how well MNOs could predict and utilize their subscribers' profiles and usage behaviors in time and across locations. Customer experience management (CEM) has an essential role in this, as it could be the implementation platform for all information gathering and decision making influencing the user experience. There is a need of information what content a user is requesting and what is the most suitable delivery channel for the content, considering user location and time of the delivery (e.g., certain content may allow delayed delivery in a predictable location if user movement is known). The suitability consideration of the delivery channel may include also different pricing models, which, in turn, may take into account the specific features of CoPPS spectrum.

In the *sustainable, continuous revenue stream* category MNOs may consider that in addition subscribers, their customers include also content providers, venue owners and local companies, which form a business network with hybrid business models. The hybrid business models link commerce (e.g. shops, restaurants, etc.) to the content provided (e.g. advertising, info searching, etc.) and to the context information available (e.g. shopping mall) through various connections (both wireless and wire-line). CoPSS spectrum could be considered as a common band for all MNOs and other stakeholders for delivering local content. MNOs and other stakeholders could have a basic share for the common band, enabling the generation of a base revenue to operate, and extra revenue could come from the underutilized shares of the other MNOs and stakeholders in that location.

Considering the *location* category, as mentioned earlier in text, the locations for CoPSS business are assumed to be limited places, for example such as public premises or roadsides, but there could be also specific services or applications (e.g. machine-to-machine communication, device-to-device, proximity services [16, 17]), that are not location specific but for which there could be reserved a common spectrum. The latter cases are in nature as multi-tenant services where the communicating entities may belong to different MNOs' customers. In case of both location-dependent and location-independent businesses, the scaling potential is stemming from the utilization of the LTE ecosystem. The LTE ecosystem provides solutions for small cells and proximity services, as solutions for the vehicle-to-vehicle communication build on proximity services [15]. The LTE ecosystem provides easy standardization approaches as the standardization takes place within the ecosystem. The location-dependent business might utilize the benefits of urban areas like dense population and easy implementation of infrastructure for communication. A general infrastructure provider may also provide the whole communication system and so enable the MNOs to act as local virtual operators. The spectrum licenses could also be location-specific for both local network operator and

MNOs. Although it is recognized that CoPSS can be utilized in wide and local areas, it can be acknowledged that the investments needed may vary considerably across the cases.

4 Conclusions

Co-primary spectrum sharing (CoPSS) is one of the emerging concepts to increase spectral efficiency among MNOs and other actors. In this paper, we have examined the elements of business model scalability for CoPSS, especially from the MNO perspective. We define business model scalability as a possibility to maintain or improve profit margins when sales volume increases. To reach its full potential, CoPSS as a concept for inter-MNO spectrum sharing should utilize the LTE ecosystem and technology platforms. We argue that the scalability potential of the concept stems from the mission-critical and unique features of the concept, especially from the utilization of pre-defined policies and rules for sharing and from the utilization of subscriber and usage profiles.

From location perspective, CoPSS enables both location-dependent and location-independent but specific services. CoPSS enables sustainable and continuous revenue streams through hybrid business models that allow for various combinations of connectivity, content, context and commerce services. It is also possible to grant MNOs sharing spectrum resources a dedicated share of the shared resource that guarantees them an opportunity to generate revenue. From the value differentiation perspective, CoPSS enables the differentiation between exclusive and shared spectrum resources, and if combined with customer experience management, this differentiation can be made even clearer. In conclusion, we see CoPSS showing a great deal of potential for MNOs' business operations, also in the near future.

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