

# Strategic Choices for Mobile Network Operators in Future Flexible UHF Spectrum Concepts?

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**Abstract.** This paper seeks to identify and discuss for mobile network operators business opportunities and strategic choices in the new flexible hybrid use concept of the Ultra High Frequency spectrum (470–790 MHz) by Digital Terrestrial TV and Mobile Broadband. More flexible use of the band aims to increase the efficiency of spectrum use in delivering fast growing and converging MBB, media and TV content to meet changing consumer needs. The framed opportunities and created simple rules indicate that the MNOs could benefit significantly from the new UHF bands enabling to cope with increasing asymmetric media data traffic and to offer differentiation through personalized broadcasting and new media services. As a collaborative benefit concept opens up new business opportunities in delivering TV and media content using MBB network. Furthermore, it had potential to transform the business ecosystem around both the broadcasting and the MBB by introducing new convergence opportunities.

**Keywords:** Strategy · Simple rules · Business opportunity · Mobile network operator · Broadcasting · Mobile broadband · UHF · Spectrum sharing · 5G

## 1 Introduction

The mobile broadband industry is starting to suffer from the scarcity of radio spectrum with the increasing data traffic and rapidly changing user habits [1]. As the downstream media content, video in particular, is the biggest and fastest growing part of the traffic [2], asymmetry in MBB networks is increasing with average downlink to uplink ratio in the new 4<sup>th</sup> generation LTE networks being approximately 10:1 and growing. Latest changes in consumption characteristics with ubiquitous high data speed demand, has put mobile network operators against a disruptive change.

Thus, in the broadcasting industry the importance of DTT platform providing audiovisual media and traditional free-to-air services have been challenged by competing delivery platforms, Over the Top (OTT) media delivery over the Internet, bypassing operators and higher general regulatory UHF spectrum fees. While the customers' TV

type of media content consumption has been on steady growth, the media content delivery and consumption mechanism will and have already started to change. Consumers are changing their consumption habits from linear real time to non-linear usage with the growing demand for more personalized longtail content ranging from commercial on-demand services to user generated content and channels with interactivity [3]. Reception of the TV content is happening more via cable, satellite, fixed broadband and, particularly, via MBB. Especially the broadband delivery is meeting the requirements of personalized content better than traditional broadcast methods.

The exclusive spectrum availability through auctions has been limited and even the largest MNOs face the risk of running out of spectrum in the future provided that the predicted data rate growth continues as estimated. Making new exclusive spectrum available for MBB networks is difficult due to the lack of unallocated spectrum and the costly and lengthy traditional ‘command & control’ spectrum auctioning & re-farming process. This is becoming increasingly complex in the future due to difficulties in finding unused exclusive spectrum and high costs and time needed for the re-allocation process.

As it is well-known that many spectrum bands are currently only lightly occupied in time and space, more flexible ways of allocating spectrum, e.g., spectrum sharing, has lately received growing interest among regulators considering new ways of fulfilling the different spectrum demands to meet the mobile traffic growth while maintaining the rights of the original incumbent systems operating in the bands. Currently regulation can be regarded as the key driver for speeding up spectrum sharing, see e.g. [4] and [5].

With these views to the future, spectrum regulators are on one hand considering responding to the changing environment by gradually compressing and withdrawing some DTT licenses of lower demand and repurposing these for MBB. On the other hand, in order to continue fulfilling the national public social service obligations the most used and in particular national broadcasters’ DTT licenses will continue to seize part of the UHF spectrum for the foreseeable future on a non market determined basis. The DTT technology evolution will improve the efficiency of the spectrum utilization through evolution from DTT to Terrestrial Digital Video Broadcasting DVB-T2 technology which is more spectrum efficient than DVB-T and also better supports wide area single frequency networks (SFN).

All discussed trends and drivers are transforming broadcasting business environment, in particular for the UHF broadcasting spectrum holders, and opens up new business opportunities as well as risks due to increasing pressure for innovative flexibility and sharing in spectrum usage. For the present, it may be observed that DTT operators have not been offered incentives for changing their spectrum usage. Instead, they have seen unilateral acts from regulators and MNOs towards further compressing their DTT spectrum to give room for additional MBB capacity.

CEPT recently set up Task Group 6 (TG6) “*Long term vision for the UHF broadcasting band*” [4], to identify and analyze possible scenarios for the development of the band taking account technology and service development. Accordingly, in the European Commission’s Radio Spectrum Policy Groups’ (RSPG) published report [6] on a long-term strategy on the future use of the UHF band (470-790 MHz) in the EU

states as follows [6]: “*The RSPG recommends that member states should have the flexibility to use the 470-694 MHz band for WBB downlink, provided that such use is compatible with the broadcasting needs in the relevant Member State and does not create a constraint on the operations of DTT in this band, including for neighboring countries.*”

LTE for broadcasting as a mobile centric broadcast solution, it is not entirely “new.” Precursors such as Digital Video Broadcasting–Handheld (DVB-H) or Qualcomm developed Media Forward Link Only (MediaFLO) were less than successful suffering costly investments in dedicated infrastructure and devices and the lack of scale and harmonization in spectrum and devices. Favorable national regulation and standardization supported more successful deployments in China with China Multimedia Mobile Broadcasting (CMMB) system and South Korea with Digital Mobile Broadcasting (DMB) both currently considering ways to scale up with global 3GPP based ecosystem. Although the underlying technical concepts, in particular LTE-Advanced Carrier Aggregation (CA) and evolved Multimedia Broadcast Multicast Service Broadcast (eMBMS) are known and have been standardized in 3GPP [7] and [8], whereas technical flexible use concept with DTT TV broadcasting has not been validated. In addition, there is no work on the business impacts of the concept related to flexible UHF use.

Previous works on business analysis for DTT MBB – UHF spectrum hybrid use or sharing was limited as focus has been on TVWS concept [9]. The general business drivers, enablers and potential impacts of the spectrum sharing on the MBB market were described in [10] and incentives and strategic dynamic capabilities for the key stakeholders in the flexible use of the UHF were discussed in [11]. In this paper we focus on analyzing the flexible use of the UHF spectrum by DTT and MBB. In the development of new flexible spectrum usage or sharing models, it is important to consider the underlying business opportunities and strategic choices to create business models that are sound for all the key stakeholders. This paper investigates:

- 1) What are the business opportunities and how are they framed for MNOs exploring the flexible UHF concept?
- 2) What kind of strategic choices do MNOs have to make regarding flexible use?

The anticipatory action learning in a future-oriented mode research methodology [12] was applied in this paper utilizing the capacity and expertise of the policy, business and technology research communities. Simple Rules strategic framework [13] was used in analyzing MNOs strategic choices. The rest of this paper is organized as follows. First, the flexible DTT MBB usage concept is presented in Section 2. Theoretical background for strategic framework is introduced in Section 3. The research methodology applied and the business opportunities and Simple Rules strategy for MNOs in using flexible UHF concept are derived in Section 4. Finally, conclusions are drawn in Section 5.

## 2 Overview of the Flexible Use of UHF Spectrum

The DTT broadcast has traditionally operated on spectrum bands from 470 to 862 MHz. The 800 MHz band (790-862 MHz) is under deployment for MBB use throughout Europe and World Radiocommunication Conference (WRC) 2012 made a decision on 700 MHz band re-allocation after the WRC-15. In the coming WRC-15 the new IMT spectrum identification agenda point will address co-primary allocation with mobile of the lower UHF band (470–694 MHz) that currently has a primary allocation to broadcasting. Further in the 2012 FCC in USA published the notice of proposed rulemaking on 600 MHz BC television spectrum incentive auction [14].

TG6 in their long term vision for the UHF broadcasting Band developed the following scenarios how to accommodate both delivery of TV content as well as additional capacity for MBB [4]:

- 1) Class A: Primary usage of the band by existing and future DVB terrestrial networks.
- 2) Class B: Hybrid usage of the band by DVB and/or downlink LTE terrestrial networks.
- 3) Class C: Hybrid usage of the band by DVB and/or LTE (including uplink) terrestrial networks.
- 4) Class D: Usage of the band by future communication technologies.

In the following analysis we will focus on the flexible hybrid scenario Class B in which the LTE Supplemental downlink (SDL) CA technology introduces a flexible way of how to take freed TV channels to mobile use while maintaining capability to deliver TV content both in conventional living room large screen use cases as well as in new mobile use cases on smart phones and tablets. Supplemental downlink combines traditional paired FDD spectrum pair with additional downlink channel [7].

Although the consumers' interest in the traditional TV programs remains or even increases, the ways how TV content is delivered and consumed is radically changing. Users are more and more receiving the TV media content via cable, satellite, fixed broadband and, especially, via MBB. Furthermore real time linear one way usage is gradually changing into non-linear usage, location independent consumption with increasing demand for interactivity. This reduced demand of DTT as the main delivery mechanism impacted negatively on the value of the service spectrum use [3]. With these insights and foresights it could be further hypothesized that some 'underutilized' and lower valued TV frequencies could and will be reassigned and/or shared with mobile use.

As the availability of the freed TV channels can vary largely between different geographical areas and countries, the scenario b) above proposes to assign them first for the MBB downlink use only. Compared with widely deployed Frequency Division Duplex (FDD) or Time Division Duplex (TDD) access methods, the SDL technique offers better interference free compatibility with the remaining DTT use in the country and across the national borders: FDD operation requires more harmonized conditions with a wider spectrum and also TDD utilizes uplink which is less compatible with the DTT use. Additional flexibility, if needed, to hybrid use of the UHF band allowing different deployment schedules in different regions and countries could be

gained through utilizing functionalities that are already developed for shared spectrum access like e.g. recently widely discussed Licensed Shared Access (LSA) concept [15]. SDL allows both the unicast and multicast uses in a flexible way based on demand with eMBMS [8] technique providing tools for cell capacity optimization to cope with present large traffic asymmetry as well as future converged broadcasting services. Additionally, as the SDL base station radios start utilizing freed DTT frequencies one by one locally, there will be no impact on interleaved spectrum used by Program Making and Special Events (PMSE) services.

In the flexible hybrid use concept the evolution of the UHF spectrum can follow the market demand within regulatory frame. Potential evolution of flexible use of the UHF band for Europe is illustrated in the Fig. 1. Already in the first phase hybrid SDL CA concept [7] could be utilized in the deployment of the 700MHz band after WRC-15 through better co-existence characteristics with potential across the border TV transmitters. In the Flexible DTT-MBB scenario the amount of SDL MBB and DTT in the lower UHF band are determined by the market needs and in the long term future integrated UHF Multimedia network vision DTT technologies could even be completely replaced by converged LTE based delivery platform using either SDL and/or eMBMS to deliver TV media content [11].

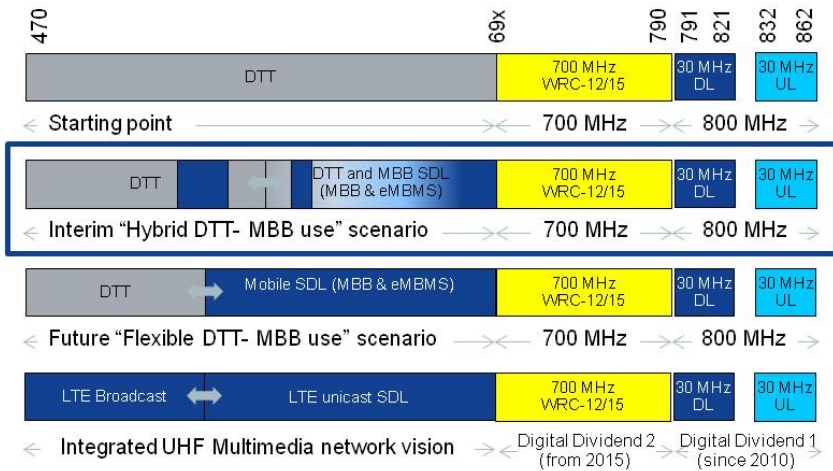


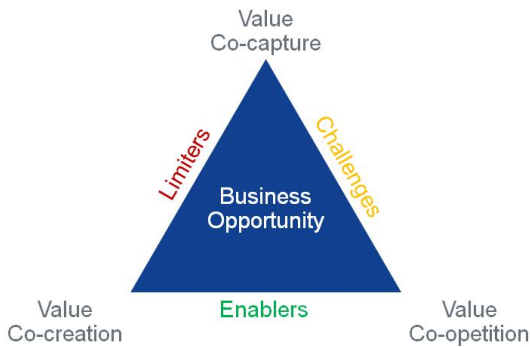
Fig. 1. Evolution of the flexible use of the UHF band with MBB [11].

### 3 Business Opportunity Based Simple Rules Strategic Framework

#### 3.1 Co-opetitive Business Opportunity Framework

An opportunity has been generally defined in the business literature as the possibility to serve customers better and differently [16] framed by enablers, limiting factors as well as challenges caused by the business context. In the flexible UHF context business opportunities are made to create and deliver value for the stakeholders, value that

is co-created among various actors from converging MBB and broadcast (BC) ecosystems as a joint effort. In addition to value co-creation, an equally important aspect of value is the ability to capture value by the stakeholders, i.e., obtain profits [17] which in the context of this research can be called value co-capture. The term co-opetition, defined as the coexistence of competition and cooperation within the value creating business context, illustrates the increased complexity of the UHF co-primary business environment, where companies simultaneously compete and cooperate with each other not only over spectrum but also over customers. Value co-creation could be seen as a cooperative and the parallel value co-capture as a competitive process [18]. Fig. 2 below illustrates the analysis frame used in this paper to develop and frame the business opportunities for MNOs.



**Fig. 2.** Co-opetitive business opportunity framework

### 3.2 Simple Rules Strategic Framework

Business research provides us with numerous examples of business strategy approaches and elements utilized. Position based strategic logic try to find answer to question: where should we be through identifying an attractive market segment and sustainable position and then establishing, strengthening and defending it e.g. [19]. The other approach widely used as well in well structured businesses is to leverage resources and core competences i.e. “What” to achieve sustained long term market dominance e.g. [20].

Traditional approaches, however, include several limitations in rapidly changing complex markets: they do not build around the business opportunity, have only weak linkages to the key business processes, depict resources rather than activities, and lack needed flexibility to seize fast changing opportunities. In this paper we adopt the business strategy approach presented in [13] that partly helps to answer to the concerns discussed above.

In emerging, dynamic and systemic environments this novel “Simple Rules” approach sees business strategies as built around the business opportunity and the key processes needed to seize them flexibly and timely. A simple rule provides guidelines within which opportunities could be pursued with selected key processes. The proposed framework consists of five categories:

- 1) How-to rules for conducting business in an unique way
- 2) Boundary rules for defining the boundaries of the business opportunities of the stakeholders,
- 3) Priority rules that help to identify and rank the criteria for opportunity decision making,
- 4) Timing rules that help in synchronizing, coordinating and pacing emerging opportunities, and
- 5) Exit rules that help in identifying basis for exit or selecting initiatives to be stopped.

## **4 Analysis of the Simple Rules for MNO's Flexible UHF Business**

The research methodology applied, business opportunities and strategic choices as Simple Rules created and their analysis are summarized in this section.

### **4.1 Methodology**

Business opportunities and strategic choices as simple rules were created utilizing the Anticipatory Action Learning (AAL) methodology, in a future-oriented mode [12]. In developing foresight the methodology represents a unique, reflexive, and iterative process of questioning and creating the future from transformational point of view. In this interactive and collaborative approach conversation and dialog among cross-disciplinary participants, from multiple domains concerned with the research project is essential.

The elements of business opportunity and strategy analysis discussed in this paper were created in a series of future oriented project planning workshops in April-October 2014 organized by the Finnish FUHF research consortium consisting of end to end Finnish UHF ecosystem with expertise in the areas of policy, business and technology.

### **4.2 Business Opportunities**

In the analysis for the business opportunity elements of flexible UHF use, five key ecosystem roles are identified: the National Regulator (NRA), MNOs, BC Network Operators (BNO), TV media content providers and device and infrastructure vendors. As far as flexible UHF concept is concerned, the roles of the regulator and both the broadcasting and mobile broadband operators are vital in adopting of novel UHF concept and spectrum sharing technologies in general. In addition when developing and analyzing the opportunity frame authors argue that three domains; policy, business, and technology, affecting flexible spectrum usage concepts should proceed in tandem. Enabling, limiting and challenging elements framing the business opportunities for the MNO are listed in Table 1.

Business and technology elements can be identified as enablers for value co-creation. Fast growing demand and lack of exclusive spectrum combined with the radical changes in the TV media consumption habits will urge the adoption of novel more flexible and efficient spectrum management concepts. Furthermore different spectrum sharing schemes are high in regulators agenda. Utilization of the LTE ecosystem scale and harmonization will reduce risk related technology maturity. High adjacent collaborative new business potential with media content players for MNOs could emerge with broadcasting content delivery to variety of smart devices. However, at the same time with lowered entry barrier to UHF spectrum BNOs and new types of operators could consider entering the MBB business.

Regarding limiting factors, sound, sustainable and harmonized regulatory environment can be the limiter that needs to be addressed before MNO can co-create and co-capture value from it with broadcasting & media partners. The limited spectrum availability with potential national restriction and obligations may negatively influence the MNOs outlook on flexible use and the spectrum valuation. A specific technology item to be considered is the need to relocate PMSE services essential for the media program making. In addition to MNO opportunities it is essential to consider reciprocal incentives for the current BC spectrum holders to further transition to flexible use.

Regulatory risk and uncertainty are the main elements of the co-opetitive challenges in the competitive domain. First, the complexity of the flexible spectrum framework and the license and transaction cost might impact the value of the spectrum and the required time of recovering the network investments. Secondly, in their regulatory strategy MNOs have to balance between exclusive spectrum and flexible/shared spectrum options and their interdependencies. On the technology domain MNOs need to pay attention to dynamic capabilities needed to deploy, manage and optimize multilayered unicast-multicast network under flexible sharing conditions.

In summary, in order to realize the business potential and opportunities of flexible UHF spectrum use, MNO have occasion to simultaneously co-create and co-capture value with broadcasting media players in a co-opetitive business environment where co-operation (spectrum) and competition (customers & services) exist parallel to each other.

MNOs are in unique position to leverage additional downlink capacity flexible UHF concept offers. Faster access to QoS licensed UHF spectrum without mandatory coverage obligations will help them to timely cope with booming asymmetric data needs. Additional capacity combined with scalable and flexible unicast-multicast solution will enable MNOs to better retain and grow existing customer base with changing demand and consumer habits. Furthermore, personalized converged mobile broadband and media broadcasting services offer opportunity for differentiation.



**Table 1.** Elements framing business opportunities

|            | Business opportunity framing elements  |
|------------|--|
| Enablers   | <p>Lack of exclusive spectrum triggers new spectrum access approaches</p> <p>Consumers TV and media consumption habits are changing towards unlinear, mobile and multi-device usage</p> <p>Commercial TV service providers and national BS are already offering streaming services</p> <p>Additional potentially lower cost capacity to cope with asymmetric traffic</p> <p>UHF spectrum offers superior coverage and in building data penetration</p> <p>New DTT technologies improves UHF spectrum utilization efficiency, DVB-T2 transition on the other hand might delay opening</p> <p>Co-primary allocation improves overall spectrum use efficiency</p> <p>Lower entry barrier to broadcasting/video-on-demand business</p> <p>Potential to extend MNO's business to broadcasting content delivery</p> <p>Spectrum sharing in general on regulatory agenda</p> <p>Harmonized LTE technology base offering scale</p> |
| Limiters   | <p>Need for global and national spectrum regulation may slow down entry - Harmonization is a pre-condition to enable potential benefit fully.</p> <p>Lack of BCs willing to discuss flexible co-primary use. Seen as a threat.</p> <p>Limited spectrum availability limits MNO business opportunities</p> <p>Regulatory framework restrictions may reduce the economic value</p> <p>Other UHF incumbent like PMSE or TV White Space might delay and constrain introduction</p> <p>National broadcasting policy and regulatory requirement e.g. coverage, reliability, free-to-air and must carry rules, consumer data</p>  |
| Challenges | <p>Regulatory risk and uncertainty related to timing, term, licenses and flexibility</p> <p>Impact on the further availability of traditional exclusive spectrum</p> <p>Spectrum license cost with potentially higher transaction costs associated with shared use.</p> <p>May change the competitive environment with BC interest in deploying their own LTE networks.</p> <p>Increased technical and operational complexity with related capital and operational costs</p> <p>New capabilities needed for network management and optimization</p> <p>Timely availability of terminals and potential impact on cost and complexity</p>  |

### 4.3 Simple Rules

Using the above summarized future-oriented action research method; we created a strategy as Simple Rules for mobile network operators deploying the flexible UHF concept applying the Simple Rules strategy approach from [13]. The developed MNOs' strategic rules are summarized in Table 2.

How to reinforce customer retention and acquisition while further strengthen dominant market position are key strategic elements of MNOs. Fundamental means to achieve these is to obtain all available spectrum, prioritizing exclusive, and to manage and optimize it across all the spectrum resources. In addition to network parameter based load balancing, novel traffic steering concepts considering as well QoE view enables MNOs to best match the personalized user demand with the network capacity supply. Collaborating with the TV and media domain could enhance the utilization of the dominant market position in MBB as well as to explore growth pockets in broadcasting.

Regarding opportunity boundaries, MNOs should exploit their existing infrastructure assets and 3GPP ecosystem with available LTE technologies to ensure early use and economies of scale. Active participation to policy and regulation processes is needed to educate the regulator about converging technology and business opportunities in UHF and the long term investment nature of MBB business.

MNOs could prioritize emerging opportunities through retaining control over spectrum and the network enabling to enhance QoS and QoE for the current mobile services e.g. video streaming that offers new revenue opportunities. As an option at early phase of flexible UHF spectrum businesses, MNOs could value average revenue per user (ARPU) over operational efficiency to utilize their customer base. In the future as potential MBB broadcasting convergence proceeds MNOs could consider acquire BC network assets to gain spectrum and infra.

Timing rules are essential in synchronizing opportunities across the company. High efficiency scalable data offload could be implemented first in order to optimize the use of the spectrum assets. Next improved capacity and QoS enables to personalize mobile broadband data to different customer segments. Broadcasting business opportunities exploration in confined areas e.g. live events could follow after the internal asset leverage. In collaborative set up with media content players complementary TV and broadcast content delivery could be next with evolution to potential future wide area TV distribution replacement by LTE broadcast technologies.

Regarding mandatory go / no-go opportunity exit rules MNOs should defend their “bloodline” scarce and finite exclusive spectrum. Another source of differentiation in entering more personalized “unicast” services is the detailed network data. The subscriber data management and customer billing relationship will be a unique asset in the design of new services and the service level differentiations.

**Table 2.** Summary of Developed Simple Rules

| Opportunities  | How to  | Boundary  | Priority   | Timing  | Exit   |
|--|---|---|--|---|--|
| Utilize and grow existing customer base with changing demand<br>Gain faster access to QoS licensed UHF spectrum without mandatory coverage obligations<br>Offer personalized mobile broadband data and “unicast” media delivery services for differentiation | Advance customer retention and acquisition<br>Invest in scale and dominant market position<br>Always prioritize exclusive spectrum<br>Optimize usage of all spectrum assets<br>Partner with the TV and media industry in the future | Exploit existing infrastructure assets<br>Leverage available LTE technologies to ensure early use and economies of scale<br>Actively participate in the policy and regulation process<br>Turn media ICT convergence a source of competitive advantage | Retain control over spectrum and the network<br>Enhance QoS and QoE for the current mobile services e.g. video streaming first<br>New revenue opportunities, higher ARPU<br>Acquire BC network assets to gain spectrum and infra | High efficiency scalable data offload first<br>Personalized mobile broadband data next<br>Explore BC business opportunities in confined areas e.g. live events then<br>Complement TV and broadcast content delivery<br>Future wide area TV distribution replacement | If defending exclusive spectrum becomes impossible<br>If withholding customer data inside company becomes impossible<br>If one cannot keep detailed network information to oneself |

## 5 Conclusions

This paper discuss the transformative role of flexible co-primary UHF area spectrum concept in the future mobile broadband and broadcasting networks as an endeavor to meet the growing traffic demand and changing consumption characteristics of the customers.

We utilized co-opetitive business opportunity framework for understanding mobile network operator's opportunities and how they are framed from policy, technology, and business perspectives in future flexible co-primary UHF spectrum networks. Opportunity analysis was used in creating and discussing strategic choices as simple rules. In developing foresight the Anticipatory Action Learning and in particular action research in a future-oriented mode was used.

We argue that policy and regulation will be on the one hand the key enabler in the path toward flexible use of UHF spectrum and on the other hand play key role in removing limiting and challenging elements critical in the first steps of that path. Ongoing transformative change in media and broadcasting business lower the barrier for change supported by mobile technology development in particular related to 3GPP LTE evolution.

The proposed opportunities and related simple rules could help operators to retain existing customers, strengthen market position and win over new customers by offering personalized mobile broadband data and "unicast" media delivery services. With MBB broadcast concept on flexible UHF spectrum, linear, traditional TV broadcast can be extended to smart devices providing the scalability and flexibility to combine linear and non-linear TV, on-demand and interactive TV. This can significantly reshape the business ecosystem around the mobile broadband and media and open up new converging and co-operative business opportunities with media and TV industry. MNOs are optimally positioned to explore new business opportunities in parallel with traditional business model.

The strategic choices as simple rules provide a dynamic framework for MNOs for exploring and exploiting emerging opportunities, developing dynamic capabilities to respond transforming environment and building business models to leverage new flexible UHF spectrum access approaches.

In the future, flexible UHF usage concept business studies will need to be expanded to cover also other key stakeholders. In particular, co-operative business model with broadcast domain will be an important aspect to study.

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