Marja Matinmikko

Centre for Wireless Communications (CWC)

University of Oulu

Oulu, Finland

Email: marja.matinmikko@oulu.fi

Miia Mustonen

VTT Technical Research Centre of Finland Ltd.

Oulu, Finland

Email: miia.mustonen@vtt.fi

Harri Haapasalo

Industrial Engineering and Management

University of Oulu

Oulu, Finland

Email: harri.haapasalo@oulu.fi

Biographical notes:

Marja Matinmikko is a University Researcher and Project Manager at Centre for Wireless Communications (CWC), University of Oulu, in Finland. She holds a M.Sc. degree in Industrial Engineering and Management and a Dr. Sc. degree in Telecommunications Engineering from University of Oulu. She conducts multi-disciplinary research combining business, regulation, and technology aspects for the development of future mobile communication systems.

Miia Mustonen is a Research Scientist at VTT Technical Research Centre of Finland. She holds a M.Sc. degree in Electrical Engineering from University of Oulu, Finland, where she is currently finalizing her Ph.D. degree on spectrum-sharing models in policy making. She has been actively involved in European and international regulatory activities on various topics, e.g. IMT-Advanced, cognitive radio systems, and licensed shared access.

Harri Haapasalo is a Professor of Product Management at Industrial Engineering and Management, University of Oulu in Finland. He has two main areas of research; one in product management, product development and second one in area of complex systems management, lean construction and business models. He has been very active in obtaining research projects, and active in journal publications. His list of publications contains more than 250 international items. He has supervised more than 30 doctoral theses and been external examiner for roughly 30 doctoral dissertations.

Stakeholder Analysis for Future Use of the Ultra-High Frequency (UHF) Band

Abstract

Changes in media consumption and growing use of video on-demand (VOD) services are challenging the traditional media service delivery mechanisms. Linear over-the-air television (TV) service operating in the ultra-high frequency (UHF) broadcasting band is no longer sufficient to meet the changing demand. Growing mobile use of multimedia content is putting pressure on mobile broadband networks to support high data rates for large numbers of simultaneous users. Policy makers in Europe are discussing more flexible use of the UHF band between broadcasting and mobile broadband services for more efficient media delivery. This paper explores the future use of the UHF band through strategic management of stakeholders. We identify key stakeholders, analyse their partner networks, and evaluate their salience using power, legitimacy and urgency attributes. The developed stakeholder analysis helps to reach a long-term compromise and reveals the emergence of a new role for flexible use of the UHF band between broadcasting and mobile communication sectors.

Keywords: broadcasting; frequency allocation; mobile broadband; mobile network operator (MNO); policy making; spectrum sharing; strategic management; stakeholder management; stakeholder salience; ultra-high frequency (UHF) band.

1. Introduction

For several decades terrestrial television (TV) broadcasting has used the ultra-high frequency (UHF) band in the frequency range 470-862 MHz to provide linear over-the-air TV services with nation-wide coverage using high power high tower transmission mechanisms. While linear TV viewing will remain dominant for the foreseeable future, non-linear TV (e.g. video on-demand (VOD) or catch-up TV) keeps increasing (Lamy, 2014). As a recent trend in parallel with the use of the linear over-the-air TV, other delivery mechanisms, such as Internet Protocol (IP) network, have

gained more subscriptions. In particular, VOD services are representing a large portion of the time that is spent on watching TV and video, see (Ericsson, 2015). In fact, the watching of streamed TV series, programs and movies per week has more than doubled in the time span from 2011 to 2015. The recent changes in media consumption have shown that the traditional large screen TV viewing at home is being complemented by the consumption of versatile media services using handheld devices anytime anywhere. These devices are not equipped with technology for receiving the traditional broadcasting TV. Instead, they are using mobile access networks (such as long-term evolution (LTE) networks or wireless local area networks (WLAN)) as the delivery channel for loading the media content. Moreover, this downloaded media content is further passed on from the mobile devices to the large screens. The increasing use of the media content is leading to increasing amounts of mobile data traffic in high demand areas which is challenging to be met with today's mobile communication networks.

Under the changing consumer behaviour the broadcasting sector has received a growing pressure from the mobile communication sector to give up parts of its traditional UHF broadcasting spectrum to be used by the mobile service, see e.g. (Radio Spectrum Policy Group, 2015; European Commission, 2016). In Europe a part of the UHF band, so called 800 MHz band (790-862 MHz), has been cleared from broadcasting during the switch from analogue to digital TV to make room for the deployment of LTE networks to provide mobile broadband services. For example in Finland the analogue TV transmissions ended in 2007 and the 800 MHz band was taken to mobile broadband use in 2014 according to decisions made in 2009. More recently, the regulators are also clearing the 700 MHz band (694-790 MHz) from broadcasting use to be used by mobile communication networks (Radio Spectrum Policy Group, 2015), which in Finland starts in 2017. However, this transition of repurposing the usage of the upper UHF band from broadcasting to mobile communication has not taken place easily and has taken a considerable time as the two sectors have had conflicting goals for the future use of the band.

The growing pressure to provide high quality media services for the end users has led to ever increasing demand by the mobile communication sector to gain access to the remaining UHF band (470-694 MHz) currently used by the broadcasting sector in Europe. At the same time, the broadcasting sector wants to maintain its position in the UHF band for providing terrestrial TV services as the band has favourable characteristics for broadcast operations providing wide coverage areas with high tower deployments. To seek compromises, attempts are being made towards the convergence of broadcasting and mobile broadband services (see e.g. Calabuig et al., 2015) where both could operate in the UHF band with agreed rules and conditions on a shared basis. Yrjölä et al. (2016) describe scenarios for the convergence of broadcast and mobile broadband where the primary usage of the UHF band by existing and future digital video broadcasting (DVB) progresses towards future communication technologies through a hybrid usage of the band by DVB and/or downlink LTE and hybrid usage by DVB and/or LTE including uplink. Architectures for implementing the convergence are further discussed in (Marques et al. 2015).

To look into the future use of the UHF band, a high level European group tried to find a win-win situation for both the mobile and broadcasting sectors, which turned out to be difficult, see (Lamy, 2014). As the topic has long-term implications and is highly controversial involving stakeholders with very distinct viewpoints, the strategic management of stakeholders provides a new insight into the problem by identifying the relevant stakeholders, their roles and expectations as well as their standpoints.

The future use of the UHF band and especially its shared use is clearly a complex system to initiate and organise – one could easily refer on ecosystem. Business and management science has started to use the concept of "Business Ecosystem" on describing complex constellations of systems' actors and their relationships, emphasizing organizational diversity, relationship dependency and joint evolution. (Moore, 1993; Iansiti and Levien, 2004; Gobble, 2014). An ecosystem consist of different type of actors and their aims. To initiate, organise and govern these ecosystems we must

have tools to analyse what are the key stakeholders in these ecosystems and how to organise those for the planning purposes of the future use. The number of possible stakeholders may, in some cases, be tens or even hundreds, therefore we also need methods how to classify those (see Mitchell et al., 1997; Olander, 2007; Aapaoja & Haapasalo, 2014). In fact, Aapaoja and Haapasalo (2014) have presented a stepwise model for stakeholder identification, classification, and management in terms of the functional role of stakeholders, according to salience and probability to impact/ability to contribute to the project. Moreover, the actors and their roles and ties can be analysed and presented with the help of value networks as previously done for the mobile communication business ecosystem in (Al-Debei et al., 2013; Peppard & Rylander, 2006; Basole, 2009).

Based on the previous research on stakeholder management, this paper seeks to explore the future use of the UHF broadcasting band (470-694 MHz) and respond to the following research questions:

       -Who are the stakeholders in the future use of the UHF band?

       -What are their business benefits and partner networks?

       -What is the salience of the stakeholders?

The paper follows method presented in Aapaoja and Haapasalo (2014), to identify, classify and manage stakeholders. The main aim is to find stakeholders and their salience for the best of long-term compromise and the emergence of flexible use of the UHF band between broadcasting and mobile communication sectors. The focus is on the case of Finland but the results can be applicable to analyse the future use of the UHF band also more broadly in Europe where the same discussions are taking place. While there is some national variation in the spectrum use, there is considerable harmonisation in the European level. Thus, this paper can help to analyse the future use of the UHF band in Europe. The rest of this paper is organized as follows. Section 2 presents the current use of the UHF band and depicts its future use. Section 3 introduces the theoretical framework of stakeholder analysis. Section 4 presents the research method. The results of the stakeholder analysis

for the future use of the UHF band are given in Section 5. Finally, conclusions are drawn in Section 6.

2. Current and future use of the UHF broadcasting band

The UHF band denotes the frequencies between 300 MHz and 3 GHz where of the original UHF broadcasting band was 470-862 MHz. In 2007, the World Radiocommunication Conference (WRC) of International Telecommunication Union (ITU) (WRC-07) decided to allocate the upper part of the UHF broadcasting band (790-862 MHz) for mobile service in ITU Region 1 – including Europe. This band is now widely used in Europe for mobile broadband services to provide wide area coverage. Similarly in 2012, WRC-12 allocated the 694-790 MHz band to the mobile service on a co-primary basis alongside the broadcasting service with effect in 2015. This 700 MHz band is currently being cleared in Europe from broadcasting use in order to be auctioned for use by mobile cellular networks. In many other parts of the world it is already widely used for mobile services. Thus almost half of the traditional UHF broadcasting band has already been allocated to the mobile service. On the other hand, the total amount of mobile spectrum that ITU-R has estimated to be required to respond to the increasing trend on the use of mobile services by 2020 in (ITU-R, 2013) has not yet been reached.

Discussions took place at WRC in 2015 to allocate the remaining broadcasting band 470-694 MHz to mobile on a co-primary basis in ITU-Region 1 as the allocation already exists for large other parts of the world. Largely due to the recent changes in the 700 MHz band, majority of the European administrations were against the co-primary allocation to mobile at this point of time. Therefore the decision was made in WRC-15 that this part of the UHF band continues to be primarily used for broadcasting in Europe even if co-primary mobile allocation was decided for US. However, more flexible use of the UHF band is envisaged for the future in Europe as discussed in (Lamy, 2014).

Radio Spectrum Policy Group (RSPG) of the European Commission (EC) has issued an opinion in 2015 on the future use of the UHF band 470-790 MHz supporting the provisioning of wireless broadband services in the 700 MHz band. RSPG recommended that the frequency band 470-694 MHz remains available for broadcasting in the future but encouraged flexibility for countries to use the band for wireless broadband in downlink. In fact the discussions in Europe continue for flexible use of the 470-694 band that could allow broadcast and mobile sharing of the band, as in February 2016 the EC published a draft decision to allow mobile downlink use on the band (European Commission, 2016). With this decision Member States of the European Union (EU) would be able to introduce mobile use on the band on a national basis in accordance to the current regulatory boundary conditions, without causing interference or claiming protection from broadcasting in the neighbouring countries. In practice this means that the availability of the spectrum would vary in different parts of the country and there may be areas, especially close to the borders of the country, where no spectrum would be available for mobile use. The shared use with broadcasting and variable availability of the spectrum may motivate an administration to consider more tailored local licensing based on for example Licensed Shared Access (LSA) concept described in (Electronic Communications Committee, 2015). The LSA concept allows certainty for the involved stakeholders by setting up a sharing framework that defines the rules and conditions for operations. Its architecture for allowing the mobile broadband to share with broadcasting consists of a repository to deliver the information on spectrum availability and associated conditions, and a controller for managing the access to the shared spectrum (Electronic Communications Committee, 2015).

The frequency bands available in the UHF broadcasting band are particularly attractive for the mobile communication sector due to their propagation characteristics that allow large geographical areas to be covered with a smaller amount of transmitting stations resulting in lower infrastructure costs. The broadcasting sector on the other hand sees the flexible use of the band as an opportunity

to enhance their reach to the customers that are increasingly consuming media on the move and through handheld devices (Yrjölä et al., 2016). Thus, both broadcasting and mobile communication sectors see them as desirable.

Discussions on making the lower part of the UHF band available for mobile are on-going outside Europe and for example in US the Federal Communications Commission (FCC) is making incentive auctions on the band (Federal Communications Commission, 2012; Gomez-Barquero & Caldwell, 2015). Incentive auctions in the 600 MHz band in US aim at clearing TV broadcasters' spectrum through a reverse auction where broadcasters establish prices for their spectrum, and FCC further auctions these bands for wireless services. Outcome of the incentive auctions as well as the fact that the band is available for mobile use also in Asian Pacific region is bound to accelerate the development of the mobile devices capable to operate on the band. This will in part make mobile use on the band feasible also in Europe and further stresses the timeliness of the considerations for the future use of the UHF broadcasting band. For this reason, the rest of the paper concentrates on the lower part of the UHF broadcasting band, namely the range 470-694 MHz, for the stakeholder analysis.

3. Strategic Management of Stakeholders

When planning any future oriented activity that involves several entities with distinct views, it is important to understand the operational environment and identify the influential entities. According to an internal memorandum at the Stanford Research Institute in 1963 cited in (Freeman and Reed, 1983), the term 'stakeholder' refers to "those groups without whose support the organization would cease to exist". Freeman and Reed (1983) propose to define a stakeholder in a wide sense as "any identifiable group or individual who can affect the achievement of an organization's objectives or who is affected by the achievement of an organization's objectives." Freeman (1984) has defined a stakeholder as "any group or individual who can affect or is affected by the achievement of the organization's objectives".

Stakeholder management highlights the importance of actors and interest groups in the policy making process. The fundamental stakeholder framework developed by Freeman (1984) has defined three levels of analysis. The *rational level* includes the development of stakeholder maps to identify who are the groups and individuals who can affect and are affected by the achievement of an organization's purpose. In the *process level* it is important to understand the organization's processes to manage the relationship with its stakeholders and how these fit with the stakeholder map. In the *transactional level* the actions that managers in organizations have with the stakeholders are defined and implemented.

Following Freeman (1984), Ackermann and Eden (2011) have developed a systematic method for strategic management of stakeholders that consists of the following three phases: 1) identifying who the stakeholders are in the specific situation; 2) exploring the impact of stakeholder dynamics; and 3) developing stakeholder management strategies. A five step stakeholder analysis process was presented by Bunn et al. (2002) in the context of multi-sector innovations where the steps were to 1) identify key sectors and stakeholders; 2) describe important characteristics of each stakeholder group; 3) analyse and classify stakeholders; 4) examine dynamic relationships among stakeholders; and 5) evaluate generic stakeholder management strategies.

While Ackerman and Eden (2011) stay at a general level in their three-step stakeholder management approach, Bunn et al. (2002) go into more details with their five steps while some of the steps are better examined when they are combined. By combining the previous approaches for stakeholder management (Freeman, 1984; Ackermann & Eden, 2011; Bunn et al., 2002) and capturing all their elements, in this study the stakeholder management is discussed focusing on the following three steps: 1) stakeholder identification; 2) stakeholder dynamics and relations; and 3) stakeholder salience.

Stakeholder identification

In the first step, the stakeholders in the considered context are identified. The use of the generic stakeholder definition from Freeman (1984) can result in a long list of stakeholders when identifying "group or individual who can affect or is affected by the achievement of the organization's objectives". As discussed in Freeman (1984) the stakeholders of a firm can vary significantly depending on the topic considered and thus a detailed analysis for the specific situation is needed. As highlighted by Ackermann and Eden (2011) paying attention to and managing a specific set of stakeholders and being clear around their significance in that context is important to avoid generic level analysis that does not help in stakeholder management. Therefore, for more detailed analysis a relevant subset of stakeholders needs to be chosen for the topic under study.

The concept of value networks (Peppard & Rylander, 2006; Funk, 2009; Al-Debei et al., 2013) highlights that value is co-created by a combination of players in the network. In fact, a model for value network analysis and design in (Al-Debei et al., 2013) differentiates between the 'actor' who participate in the creation of value and the 'roles' of each actor. As firms can operate in multiple ecosystems, the roles a firm takes can differ in different ecosystems (Bosch-Sijtsema & Bosch, 2015).

Stakeholder dynamics and relations

In the second step, the roles and relations of the stakeholders' networks are investigated. The relationships between stakeholders can reveal responses and counter responses to organizational actions (Ackermann and Eden, 2011). According to Rowley (1995) stakeholder relationships do not occur in a vacuum of dyadic ties but rather in a network of influences. Therefore, it is important to characterize the partner network of the key stakeholders carefully. The dynamics and relations between the stakeholders can be characterized with the links/relationships between value network's actors (Al-Debei et al., 2013).

Stakeholder salience

In the third step, the stakeholders' salience is evaluated. Stakeholder salience is the degree to which managers give priority to competing stakeholder claims (Mitchell et al., 1997). To expand the traditional power and interest as the significant dimensions for stakeholder management, Mitchell et al. (1997) have developed a framework of Power – Legitimacy – Urgency attributes to assess stakeholders salience. In this framework the stakeholder salience is characterized by the possession of the following three attributes:

- Stakeholder's **power to influence** the firm

- **Legitimacy of** the stakeholder's **relationship** with the firm

- **Urgency of** the stakeholder's **claim** on the firm.

The stakeholder salience attributes are illustrated in Figure 1 based on the framework of Mitchell et al. (1997). Power refers to the stakeholder's ability to conduct its operations and influence others in order to achieve its goals. According to Mitchel et al. (1997), power is transitory and it can be acquired and lost. Suchman (1995) has defined legitimacy as a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions. Finally, urgency refers to the timeliness of stakeholder's claims on the matter. It presents the degree to which the stakeholder claims call for immediate action.

Based on the three salience attributes, Mitchel et al. (1997) further define eight stakeholder classes in terms of how many and which of the attributes the stakeholder encompasses as illustrated in Figure 1. In one extreme, a stakeholder possesses all three attributes and in the other extreme it does not have any of them. The latter case Mitchell et al. (1997) define as "non-stakeholder" which is why there are seven distinct stakeholder classes depending on which of the attributes each stakeholder encompasses. Stakeholder salience is seen to be the higher the more attributes a

stakeholder possesses. Low salience classes where stakeholders only have one attribute, i.e. power (P), legitimacy (L) or urgency (U), are considered to be latent stakeholders and including dormant, discretionary or demanding stakeholder classes, respectively. Moderately salient stakeholders with two attributes are expectant stakeholders including dominant, dependent and dangerous stakeholder classes. Highly salient stakeholders have all three attributes and are considered to be definitive stakeholders. Stakeholders with no power, legitimacy or urgency are not considered to be stakeholders at all.

Figure 1. Stakeholder salience attributes and stakeholder classes.

4. Research method and process

The research applies stakeholder management approach in the context of wireless communications by envisaging the future use of the UHF broadcasting band towards convergence and flexible use by both broadcasting and mobile communication sectors. The research process consisted of two workshops in Finland in 2015 with 11 to 15 participants representing key national stakeholders in broadcasting and mobile broadband business ecosystems as well as from academia from a national research project consortium "Future of UHF band" (FUHF). Figure 2 illustrates the research process describing the phases in the stakeholder management and the corresponding workshops. The first workshop was arranged to identify the stakeholders and their business benefits and partner networks. The second workshop had two goals: first to revisit the stakeholders and identify any new stakeholders as well as to review and update the partner networks, and second to analyse the salience of the stakeholders.

In the first step, *stakeholder identification*, the participants of the first workshop were asked to identify all stakeholders regarding the future use of the UHF band. The first workshop gathered 15 participants with long experience in management positions in broadcasting, mobile communications, regulation, and research domains. After the identification phase, these

stakeholders were grouped to reduce the number of stakeholders to be addressed and to emphasise the most essential ones. The second step, *stakeholder dynamics and relations*, was to derive the business benefits for each of the key stakeholder group and depict their partner networks. The workshop participants identified the needs, benefits and constraints for the stakeholders. In addition, the participants named the stakeholders for each of the key stakeholder group and described their relations in order to understand and depict the partner networks.

The second workshop reviewed the identified stakeholders and their dynamics and relations in order to identify possibly missing stakeholders and revise the stakeholder dynamics and relations. The second workshop had 11 participants who were to a large extent the same as in the first workshop. This allowed the outcome of the first workshop to be commented by both attendants from the first workshop as well as new comers to present a fresh look into the stakeholder identification. This revisiting of the stakeholders and their roles and networks in fact identified missing stakeholders that had not been identified in the first round. While the second workshop was attended by a smaller number of participants than the first workshop, all the same organizations were present in the second workshop as well. The second workshop continued the stakeholder management by analysing the stakeholder salience using the framework of Mitchell et al. (1997). The workshop participants were instructed to assess the power, legitimacy and urgency attributes of the key stakeholder groups by evaluating whether or not they possess these attributes.

Figure 2. Research process for stakeholder management for the future of UHF band.

5. Results on stakeholder management in the future of UHF band

Stakeholder identification

The first phase in stakeholder management is to identify the stakeholders in the context of the future use of the UHF band in the Finnish setting. While the case focuses on a single nation, it provides

useful insight into the European level discussion due to regional policy harmonization taking place in Europe. As the future use of the UHF band is currently foreseen to go towards more flexible use with broadcasting and mobile communications on a shared basis, it involves stakeholders from both the broadcasting and mobile communication sectors as well as policy making. Identification of stakeholders includes the identification of actors involved in the value creation of using the UHF band. The workshop identified the following stakeholders as depicted in Figure 3: commercial media company (such as MTV in Finland), public service media company (e.g. YLE), content aggregator (e.g. YLE, MTV), broadcast network operator (BNO) (e.g. Digita), broadcasting technology vendor, mobile technology vendor (e.g. Nokia), mobile network operator (MNO) (e.g. TeliaSonera, Elisa), ministry (Ministry of Transport and Communications Finland (MINTC)) and national regulatory authority (NRA) (Finnish Communications Regulatory Authority (FICORA)). In the stakeholder identification phase, the discussions on the facilitation of more flexible use of the UHF band between broadcasting and mobile actors led to the emergence of a new role at the intersection of the mobile communication and broadcasting sectors which is here denoted as the "band manager" presented with a white circle. It is not an actor or a stakeholder but more of a separate role that traditionally has been taken by the NRA but in the introduction of more flexible and dynamic framework could also be taken by some of the identified actors or a third party with the authorisation from the NRA.

The stakeholders denoted by circles with black line in Figure 3 had representatives participating in the workshops. In the initial discussions on the future use of the UHF band, there was a common consensus that the ministry as the highest policy making authority for governing the spectrum the spectrum policy in Finland needs to be kept in the analysis. Additionally, the NRA needs to be analysed because it is central in the implementation and enforcement of the spectrum policy decisions. From the broadcasting sector the content aggregator and BNO actors were chosen for

more detailed analysis. From the mobile sector both the MNO and mobile technology vendor were taken. Additionally the new stakeholder role (band manager) also needs a careful analysis.

Figure 3. Identification of stakeholders in the future use of the UHF band.

Stakeholder dynamics and relations

The second phase in stakeholder management is to acknowledge multiple and interdependent interactions between the stakeholders, in order to explore the impact of stakeholder dynamics and relations. To understand the interests of the different stakeholders in the future use of the UHF band, an analysis of the business needs, benefits, and constraints of the key stakeholders was performed. The results are summarized in Table 1.

Regulator's needs for the future use of the UHF band are related to the efficient use of the band as well as supporting innovation and digitalization and collecting income for the state from spectrum use. Here the needs, benefits and constraints of the regulator are analysed jointly for the NRA and the ministry. In general, the ministry is in charge of the nation's communications policy which aims at ensuring the availability of well-functioning and reliable data connections and services with high quality and reasonable price (Ministry of Transport and Communications, 2016). In particular, the ministry in Finland promotes the provision of high-speed broadband access. Benefits from the flexible use of the UHF band in the future could ensure fair competition conditions for the stakeholders providing their services in the UHF band. Constraints for the regulator are coming from international spectrum regulations and the time-scales of those that may slow down the changes in the use of the band and limit the national options for taking action.

Content aggregator's needs are to broadcast TV and radio content to users' mobile devices and to develop better personalized services and get them delivered cost efficiently to the end users. More flexible future use of the UHF band could provide them with more capacity to serve especially users with various body area network (BAN) devices that consume more and more media services.

Constraints are coming from regulation such as those set for public services. In addition, attaining wide coverage at low cost while responding to the growing demand is a constraint.

BNO is the stakeholder that currently operates in the UHF broadcasting band to deliver the TV and radio broadcasts. The BNO wants to continue using the UHF band for broadcasting with primary allocation for providing improved broadcast services such as high definition (HD) television. BNO sees the flexible use of the UHF band as an opportunity to provision of new services by improving the efficiency of mass delivery of audio-visual (AV) contents targeted for mobile users. Constraints are arising from technological challenges and spectrum efficiency, cost efficiency and time scales of implementation of flexible use.

MNO operates mobile communication networks and searches for more spectrum to support the growing traffic demand of mobile broadband services. It considers the UHF band as an attractive new band due to the good coverage provided by the propagation characteristics of these lower frequency bands and global harmonization. It could provide new services in a cost efficient way to especially rural and indoor urban areas. With the use of UHF band, MNO could generate new revenue and increase customer satisfaction by responding to the changing usage type of media. Constraints include e.g. technological challenges from hybrid use of mobile networks for broadcast type services including the availability of new equipment needed, as well as constraints from regulation such as neighbouring countries decisions and interference considerations.

Mobile technology vendors see the UHF band as a potential new band to deploy mobile communication networks for providing multimedia services by the future developments of mobile communication technologies, such as LTE technology evolvements. Vendors could expand their market from traditional mobile operator market to broadcasting industry while leveraging on the LTE scale from harmonization. Mobile technology vendors serve the global market and there are developments outside Europe to take the UHF broadcast band to mobile use which increases their

interest to gain access to this band in Europe. Constraints are related to the dependency on regulation, time-scales, and technological feasibility.

Table 1. Needs, benefits and constraints for key stakeholders

Band manager is a new role that is expected to emerge with the advent of more flexible use of the UHF band between broadcasting and mobile sectors to coordinate the shared use of the UHF band. Traditionally spectrum band management has been conducted by the NRA in the means of frequency allocations and licenses. However, for flexible use of UHF based on sharing it can be foreseen that the need for licensing may become more frequent with varying conditions and could therefore be undertaken by another entity under the authorisation of the NRA. The band manager role may refer to a technology solution – such as database, control channel or sensing – or it may refer to regulatory processes such as licensing. The emergence of the band manager stakeholder role needs a solid framework for the flexible spectrum use where its role in terms of e.g. rights and responsibilities is clearly defined. It is not a new regulator but a facilitator for the practical realizations of sharing and can be taken up by various actors. The emergence of the new role offers new business opportunities. Constraints are related to the complexity of realizing the sharing between broadcast and mobile sector players while fulfilling the regulator's requirements set for the future use of the band.

Next the high level stakeholder dynamics were examined and results are illustrated in Figure 4. Regulator issues licenses to MNO, BNO and content aggregator. Band manager acts in the intersection of broadcasting and mobile sectors for providing the relevant information needed for sharing to fulfil the rules set by the regulator. Mobile technology vendor provides the technology to both MNO and BNO and collaborates with the content aggregator to validate that the flexible use of the UHF band is appropriate. BNO and MNO provide service to the content aggregator by

providing the delivery channel for media content to end users. BNO and MNO collaborate on ensuring protection from interference to each other while sharing the UHF band.

Figure 4. High level partner network and relations for key stakeholders.

The more detailed partner networks for each individual key stakeholder are addressed next and presented in detail in the following. Figure 5 illustrates the stakeholders of the regulator which here includes both the ministry (MINTC) and the NRA (FICORA). The regulator issues licenses to MNO and BNO to operate on certain frequency bands and licenses to content aggregator to allow the provision of services. It also issues test licenses to mobile technology vendors. The potential new role of band manager for coordinating the more flexible use of the UHF band between broadcasting and mobile sectors requires authorisation from the regulator. Collaboration in international and regional levels of spectrum regulation is important to the national regulator as spectrum matters are discussed and agreed at international level at the ITU, and European level at European Conference of Postal and Telecommunications Administrations (CEPT) and EU. Moreover, coordination with neighbouring countries is essential and involves bi-lateral agreements.

Figure 5. Partner network for regulator.

The stakeholders and the corresponding partner network of the content aggregator are illustrated in Figure 6. The content aggregator deals with the regulators at national (NRA, MINTC), European (CEPT; EC, RSPG and Body of European Regulators for Electronic Communications (BEREC) of the EU) and international levels (ITU-R and its WRCs) in terms of regulatory matters. The European Broadcasting Union (EBU) is an alliance of public service media entities. The content delivery mechanisms for providing the service of the content aggregator include cable and satellite delivery network operators, BNOs, MNOs and Content Delivery Network (CDN) providers. Standardisation for broadcasting is done in DVB for the delivery of digital media and broadcast services, and in NorDig that specifies a common platform within the Nordic region based on the

developed DVB standards. Content aggregator collaborates with technology vendors consisting of both device and network manufacturers for in the design of new services and delivery mechanisms, respectively.

Figure 6. Partner network for content aggregator.

Figure 7 presents the partner network for the BNO. It obtains licenses to operate on certain frequencies from the regulator, and spectrum harmonization via ITU, CEPT and EU is important. The Broadcast Networks Europe (BNE) is a European alliance to facilitate co-operation between BNOs and to make common contributions to the spectrum regulation. BNO's customers include content aggregators and pay TV operators for whom it provides the delivery channel. BNO buys broadcasting infrastructure from broadcasting technology vendor and in the flexible use of the UHF band it could additionally buy mobile communication infrastructure from the mobile technology vendor. Similarly as for the content aggregator, the technical standards developed in DVB and NorDig specifications are important for BNO. In addition, other national level collaboration between stakeholders takes place in terms of e.g. technical parameterization and device testing. BNOs are also in contact with consumers by offering information and guidance.

Figure 7. Partner network for broadcast network operator.

Figure 8 presents the partner network for the MNO. MNO offers services to business-to-business (B2B) and business-to-consumer (B2C) customers. It procures network infrastructure from the mobile technology vendor who implements the harmonized standards agreed at 3rd Generation Partnership Project (3GPP) and European Telecommunication Standards Institute (ETSI) standardization fora. MNOs' operations are highly dependent on the actions of the national regulator in terms of obtaining licenses to operate on specific frequency bands. MNO collaborates with forums such as GSM Association (GSMA) and European Telecommunications Network

Operators' Association (ETNO) by lobbying their view points to be included in standards in 3GPP and ETSI and regulation in EC, CEPT and ITU-R.

Figure 8. Partner network for mobile network operator.

The partner network of the mobile technology vendor is presented in Figure 9. Currently, MNO is the customer for the mobile technology vendor. Flexible use of the UHF band could expand mobile technology vendor's customer base to include the BNOs as new customers. Spectrum harmonization is obtained via ITU-R, CEPT and EC. Harmonized standards via 3GPP and ETSI are important for providing economies of scale. MNOs conduct lobbying and information acquisition via various forums such as Digital Europe, GSMA and EBU to influence the regulation and standards bodies. Mobile technology vendors also have their own forums such as Mobile Manufacturers Forum (MMF) for these purposes.

Figure 9. Partner network for mobile technology vendor.

Finally, Figure 10 illustrates the partner network of the new band manager role. It collects information from both broadcasting (BNO and broadcasting technology vendor) and mobile communication (MNO and mobile technology vendor) sectors to provide the required information to the MNO and BNO to implement flexible use of the UHF band according to the policies for operations coming from the regulator. Spectrum harmonization through ITU, CEPT and EC as well as harmonized standards through ETSI and 3GPP are important to be taken into account. Tasks of the band manager are currently performed by the regulator and they can also be taken over by any of the other stakeholders. The current regulatory framework sets the limits to the flexibility of the spectrum use. In order to increase the flexibility, there needs to be a way to either enhance (speed up) these regulatory processes or to allow another entity or technology assist in these tasks.

Figure 10. Partner network for band manager.

Stakeholder salience

The third phase of the stakeholder management is to develop management strategies on how and when to intervene based on the power and interest of individual stakeholders. An important part of this phase is to assess the role of the different stakeholders. The stakeholder salience by Mitchell et al. (1997) illustrated also in Figure 1 defines three independent dimensions to evaluate stakeholders: power, legitimacy and urgency attributes. This leads to 7 different stakeholder classes depending on which and how many attributes the stakeholder encompasses. In the following, the salience of the different stakeholders in the future use of the UHF band are discussed. For analysing the stakeholder salience, it was seen that the regulator actor should be split back to NRA and ministry in order to capture the different roles of these two entities involved in policy making.

Participants of the second workshop (11 people) assessed the seven stakeholders in terms of whether or not they possess power, legitimacy or urgency. There was approximately an equal number of representatives of BNO, content aggregator, MNO, mobile technology vendor, NRA and research. The results are collected into Table 2.

Figure 11 illustrates the stakeholder salience where the arrow depicts the mapping of UHF band stakeholders to Mitchell et al. (1997) stakeholder classes going from the most salient stakeholders to non-stakeholders. The percentage for each stakeholder in Figure 11 denotes the relative salience of that stakeholder where the total over all stakeholders is 100%. The relative salience is obtained by weighting the individual salience attributes by 0.4, 0.3 and 0.3 for power, legitimacy and urgency, respectively, following (Olander 2007). The workshop participants were allowed to comment on their evaluations by explaining what factors were considered for each stakeholder in evaluating its salience attribute. Regulator (ministry and NRA) were seen to possess high power and legitimacy. The broadcasting stakeholders (content aggregator and BNO) were seen to possess high legitimacy. The content aggregator was found to possess higher urgency in comparison to the BNO. The mobile broadband stakeholders (MNO and mobile technology vendor) were seen to possess

high urgency. MNO was additionally found to have high legitimacy. Finally, the band manager had only low power, legitimacy and urgency. The salience of each stakeholder is discussed in more detail in the following.

Table 2. Results of stakeholder salience analysis for future use of UHF band

Figure 11. Stakeholder salience for the future use of the UHF band.

Ministry

Ministry's high power and legitimacy were seen to come from its position in the society – it has the power to develop legislation and decide on the future use of the UHF band. Ministry has medium urgency which comes from the need to understand the changes in media consumption and react to the changes in a timely manner. However, the urgency and power of the ministry were seen to be decreased by the growing importance of regional bodies (such as EU) in decision making regarding the spectrum use.

NRA

NRA has the role of implementing political decisions of the ministry and following and monitoring these implementations. The NRA was seen to possess high power and legitimacy due to its position in the society in implementing the policy decisions. In terms of urgency, the NRA was considered to possess lower urgency than the ministry as the decisions are made at the ministry level while the NRA is more involved in the implementation of the decisions.

Content aggregator

Content aggregator here encompasses both public and commercial entities which have different goals and basis for operations in terms of e.g. income (government funding vs. commercial). The legitimacy of the content aggregator was seen to be high due to its well established position in the society as the provider of public services such as TV which are important in the daily life of citizens. The power of the content aggregator was seen to be low but it considered to be in the

position of gaining power through market share and close collaboration with ministry. Urgency was evaluated to be medium as the changing media consumption behaviour of end users is significantly affecting the business where the content aggregators operate.

BNO

As the current main incumbent user of the UHF broadcasting band, the BNO was seen to possess very high legitimacy. TV broadcasting is societally important, which further promotes the legitimacy of the BNO. Power and urgency were seen to be low. Some urgency arises from the importance of the UHF band to the BNO business and therefore any considerations on the future use of this band directly affect the BNO. The BNO needs to secure its business in the changing environment.

MNO

MNO was seen to possess high legitimacy and urgency and medium power. The power was seen to come from its dominating position in the development of new mobile broadband technology through e.g. steering the development direction via standardization. The legitimacy of the MNO was seen to come from the MNO's role to respond to the end users' needs. In modern society, virtually everybody is their customer and thus the MNOs were seen to have a legitimate position. Urgency comes from the growing amount of mobile data traffic which cannot be supported with current deployments and calls for new bands to operate on.

Mobile technology vendor

Mobile technology vendor was considered to possess medium power, urgency, and legitimacy. The power was seen to come through the mobile technology vendor's key position as being the stakeholder that influences the development of new technologies for providing mobile services through standardization and it was seen to have developed over time. Urgency was seen to come from the fact that by being the technology provider that actually implements the technology, vendor

has to be ahead in the development cycle by offering new technology to meet the emerging demands in a timely manner. Thus, when the demand for technology arises, the vendor with the most mature technology will be selected. The mobile technology vendor was not seen to possess much legitimacy.

Band manager

The band manager was the new role that was expected to emerge to implement increasing flexibility in the future use of the UHF band to be an intermediate entity between the different users of the band. The discussions around this role revealed that understanding the power, legitimacy and urgency of this new role was difficult and would call for future studies. Here, all three attributes were evaluated to be low. The band manager is the entity that is at the heart of implementing the flexible use of the UHF band between broadcasting and mobile broadband services by exchanging information between different stakeholders. It was not seen to possess any power beyond operational power. Actions of the band manager are defined in the framework provided by the policy makers (regulators). It has some legitimacy as the envisaged future use of the UHF calls for a new approach that implements the required flexibility. It has some urgency as its whole business is new and solely based on the regulatory decisions on the future use of the UHF band. The stakeholder analysis revealed the emergence of this new role that was not previously present in the use of the UHF band.

6. Conclusions

This paper has presented a stakeholder identification and analysis for the future use of the UHF broadcasting band in the convergence of broadcasting and mobile broadband businesses. This convergence can occur stepwise where mobile broadband networks gradually expand to deliver media content to consumers. The concept developed and applied facilitates the systematic identification, classification and further management of project stakeholders in terms of the functional roles of project stakeholders, salience especially probability and ability to contribute to

the best of the whole. It is also critical to bring forward the stakeholders type of salience to understand their role and approach (see the variation between salience attributes power, legitimacy and urgency between stakeholders in Figure 11) for the best of the future use of UHF. As the future use of the spectrum band is long-term, it requires strategic management thinking and stakeholder management to provide a framework to characterize the situation as a basis for future decisions. This concept will also help to avoid conflicts among major stakeholders from involving them in the future use of UHF and from facilitating the assessment of the future use of UHF purpose, constraints, and means of execution.

While stakeholder management has not been traditionally applied to the context of wireless communications, this study has shown its usefulness to provide a comprehensive view for the development of a new concept by identifying the partners involved and their positions for reaching compromises. The stakeholder analysis has identified the emerging need for a new role in the hybrid use of the UHF band for broadcasting and mobile broadband: that of the band manager that acts in the intersection to facilitate flexible spectrum use. In principle, the band manager will perform the tasks of the spectrum regulator in a more flexible way allowing more real-time management of the spectrum resources. The role of band manager can be taken by a new stakeholder, the regulator, or any other of the existing stakeholders and it can be implemented by a technology or by increasing the flexibility of licensing process. In the development of new approaches for the shared use of the UHF band, the assessment of stakeholder salience can give insight into which stakeholders are most influential when planning the future use of the band. From this assessment it's evident that the flexible use of UHF is highly dependent on the prevailing policies and therefore the highest power is held by the regulator including both ministry and NRA and their partner networks in regional and international scale. The regulator also has high legitimacy which further stresses its key role. As the current users of the UHF band and with an established position in the society, the broadcasting side is seen to have high legitimacy. The mobile

communication sector is seen to possess the highest urgency on the topic, due to increasing mobile data arising from the changing trend in the multimedia consumption on mobile devices. Identification and categorization of the stakeholders groups in the ecosystem provides a view on the most salient stakeholders and enables optimum value creation in the future use of UHF. It may enable a balanced view on the future use of UHF to help in the decision making process. The findings from this research are specific to future use of UHF band, however, the process on defining salience applies on this kind of case too.

This particular study is limited to the case of a single country and the setups vary between countries. Overall, this study confirmed the feasibility and adaptability of the stakeholder identification and analysis concept. It is of course evident that further research is needed to verify the concept in different settings, but also analysing much deeper the specific stakeholders in this study. In addition, future research could apply the concept throughout an entire use of UHF, from the feasibility study to initialization, to focus on the stakeholders.

References

Aapaoja, A. and Haapasalo, H. (2014) 'A framework for stakeholder identification and classification in construction projects', *Open Journal of Business and Management*, Vol. 2 No. 1, pp.43 - 55

Ackermann, F. and Eden, C. (2011) 'Strategic management of stakeholders: Theory and practise', *Long Range Planning*, Vol. 44 No. 1, pp.179 - 196

Al-Debei, M. M., Al.-Lozi, E. and Fitzgerald, G. (2013) 'Engineering innovative mobile data services: Developing a model for value network analysis and design', *Business Process Management Journal*, Vol. 19 No. 2, pp. 336-363

Basole, R. C. (2009) 'Visualization of interfirm relations in a converging mobile ecosystem', *Journal of Information Technology*, Vol. 24 No. 2, pp. 144 - 159

Bosch-Sijtsema, P. M. and Bosch, J. (2015) 'Plays nice with others? Multiple ecosystems, various roles and divergent engagement models', *Technology Analysis & Strategic Management*, Vol. 27 No. 8, pp. 960 - 974

Bunn, M. D., Savage, G. T. and Holloway, B. B. (2002) 'Stakeholder analysis for multi-sector innovations', *Journal of Business & Industrial Marketing*, Vol. 17 No. 2/3, pp.181 - 203

Calabuig, J., Monserrat J. F. and Gomez-Barquero D. (2015) '5th Generation mobile networks: A new opportunity for the convergence of mobile broadband and broadcast services', *IEEE Communications Magazine*, Vol. 42 No. 2, pp.198 - 205

Ericsson. (2015) *TV AND MEDIA 2015: The empowered TV and media consumer's influence*. [online] Ericsson Consumer Insight Report, Stockholm. http://www.ericsson.com/res/docs/2015/consumerlab/ericsson-consumerlab-tv-media-2015.pdf (Accessed 1 April 2016)

European Commission. (2016) *Proposal for a Decision of the European Parliament and of the Council on the use of the 470-790 MHz frequency band in the Union*. EC COM/2016/043, Brussels.

Electronic Communications Committee. (2015) *Licensed Shared Access*. ECC Report 205.

Federal Communications Commission. (2012) *Broadcast Television Spectrum Incentive Auction NPRM*. FCC report 12-118.

Freeman, R. E. and Reed, D. L. (1983) 'Stockholders and stakeholders: a new perspective on corporate governance', *California Management Review*, vol. 25 No. 3, pp.88 - 106

Freeman, R. E. (1984) *Strategic Management: A Stakeholder Approach*, Pitman Publishing, Boston.

Funk, J. L. (2009) 'The emerging value network in the mobile phone industry: The case of Japan and its implications for the rest of the world', *Telecommunications Policy*, vol. 33 No. 1, pp.4 - 18

Gobble, M. (2014) 'Charting the Innovation Ecosystem', *Research Technology Management*, Vol. 57 No. 4, pp.55 - 59

Gomez-Barquero, D. and Caldwell, M. W. (2015) 'Broadcast television spectrum incentive auctions in the U.S.: trends, challenges, and opportunities', *IEEE Communications Magazine*, Vol. 53 No. 7, pp.50 - 56

Iansiti, M. and Levien, R. (2004) 'Strategy as Ecology', *Harvard Business Review*, Vol. 82 No. 3, pp.68 – 78

ITU-R. 2013. Future spectrum requirements estimate for terrestrial IMT. International Telecommunication Union, ITU-R Report M.2290. 42 p.

Lamy, P. 2014. Results of the work of the high level group on the future use of the UHF band (470-790 MHz). Report to the European Commission. 34 p.

Marques, P., Rodriguez, J., Forde, T., Doyle, L., Sung, K. W., Lauterjung, J. and Reimers, U. H. (2015) Towards a Unified 5G Broadcast-Broadband Architecture, in Fundamentals of 5G Mobile Networks (ed J. Rodriguez), John Wiley & Sons, Ltd, Chichester, UK.

Ministry of Transport and Communications Finland. (2016) *The Ministry* [online]. http://www.lvm.fi/en/the-ministry (Accessed 1 April 2016)

Mitchell, R. K., Agle, B. R. and Wood, D. J. (1997) 'Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts', *Academy of Management Review*, Vol. 22 No. 4, pp.853 - 886

Moore, J. F. (1993) 'Predators and Prey: A New Ecology of Competition', *Harvard Business Review*, Vol. 71 No. 3, pp.75 - 86

Olander, S. (2007) 'Stakeholder impact analysis in construction project management', *Construction Management and Economics*, Vol. 25 No. 3, pp.277 - 287

Peppard, J. and Rylander, A. (2006) 'From value chain to value network: Insights for mobile operators', *European Management Journal*, Vol. 24 No. 2, pp.128 - 141

Radio Spectrum Policy Group (2015). *RSPG Opinion on a long-term strategy on the future use of the UHF band (470-790 MHz) in the European Union*. RSPG15-595, Brussels.

Rowley, T. J. (1997) 'Moving beyond dyadic ties: A network theory of stakeholder influence', *Academy of Management Review*, Vol. 22 No. 4, pp.887 - 910

Suchman, M. C. (1995) 'Managing legitimacy: Strategic and institutional approaches', *Academy of Management Review*, Vol. 20 No. 3, pp.571 – 610

Yrjölä, S., Mustonen, M., Matinmikko, M. and Talmola, P. (2016) 'LTE broadcast and supplemental downlink enablers for exploiting novel service and business opportunities in the flexible use of the uhf broadcasting spectrum', *IEEE Communications Magazine*, Vol. 54 No. 7, pp.76 - 83
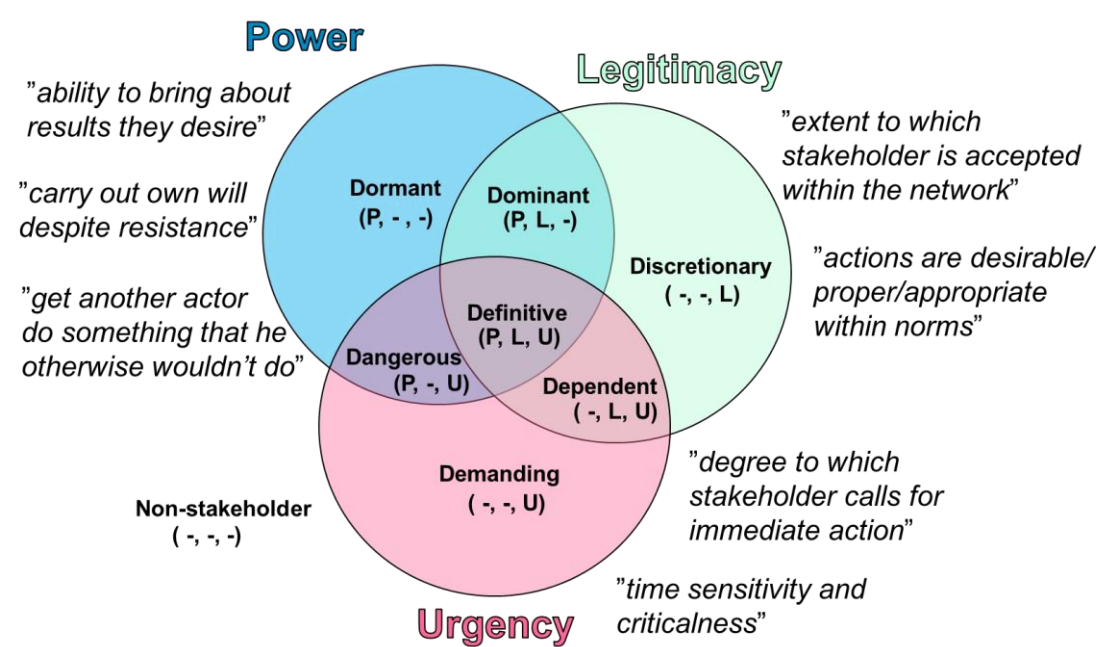
Figures and tables:

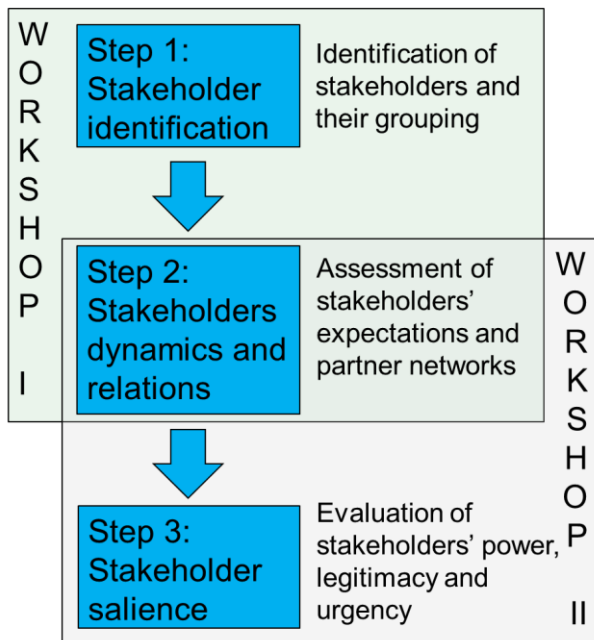**Figure 1. Stakeholder salience attributes and stakeholder classes.**

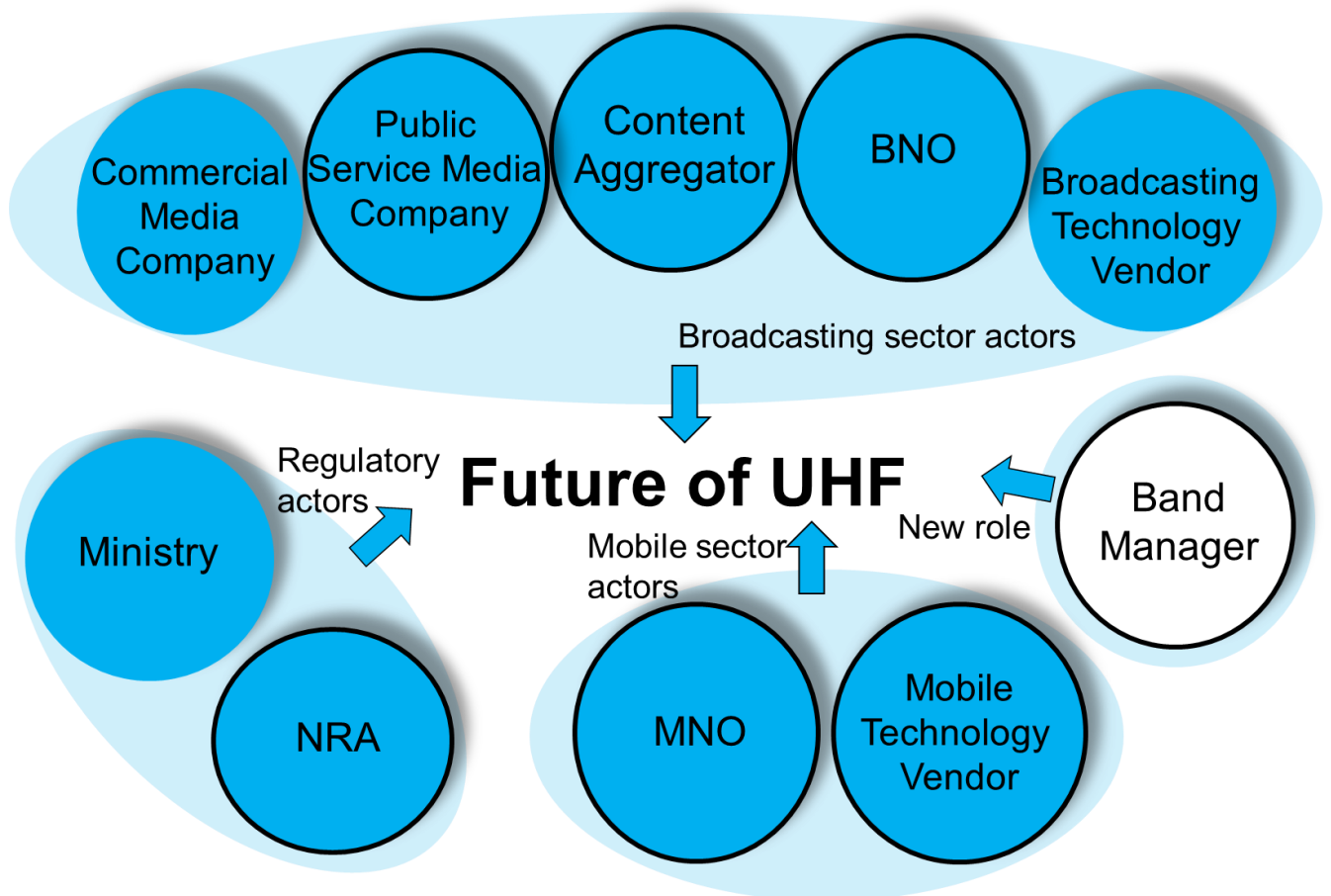**Figure 2. Research process for stakeholder management for the future of the UHF band.**

Figure 3. Identification of stakeholders in the future use of the UHF band.
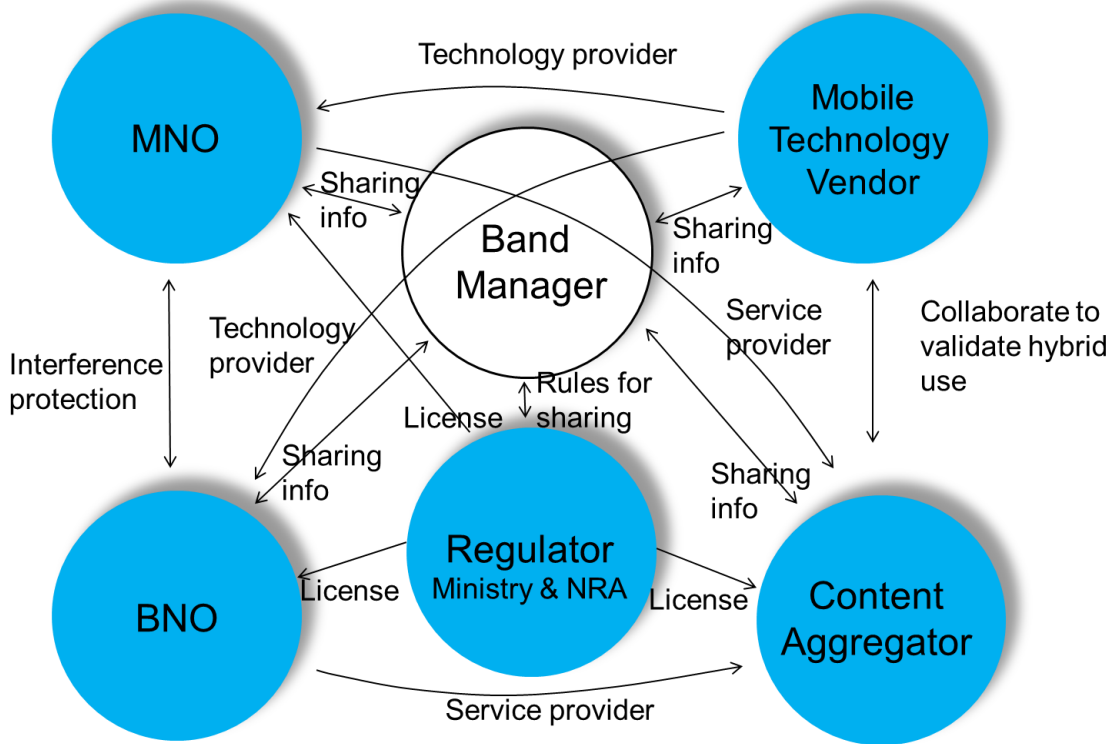
Figure 4. High level partner network and relations of key stakeholders.
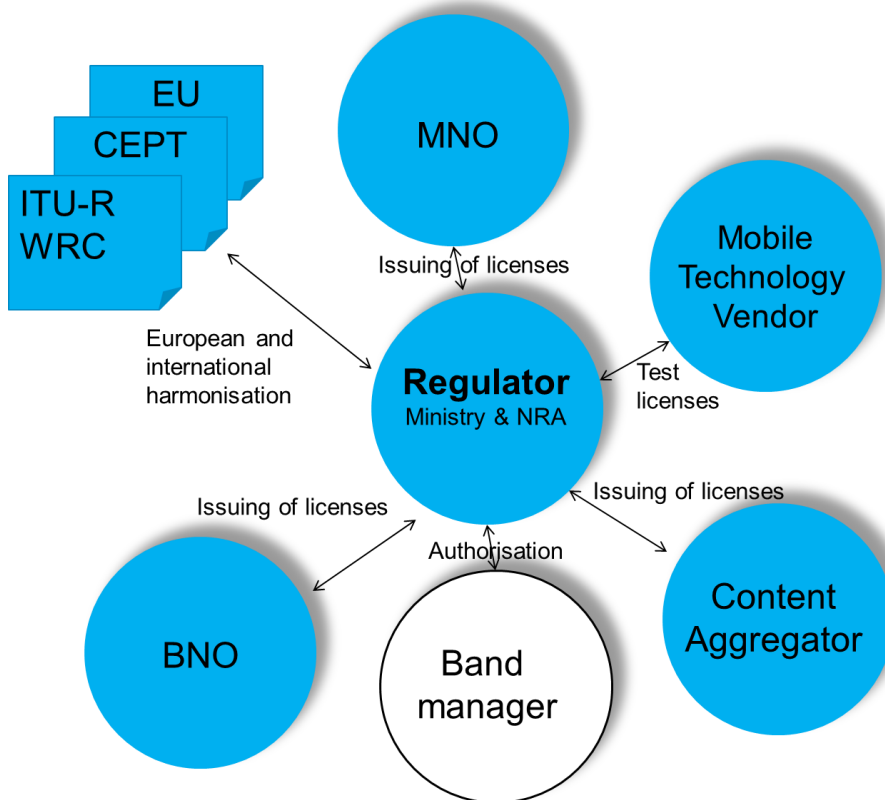
Figure 5. Partner network for regulator.
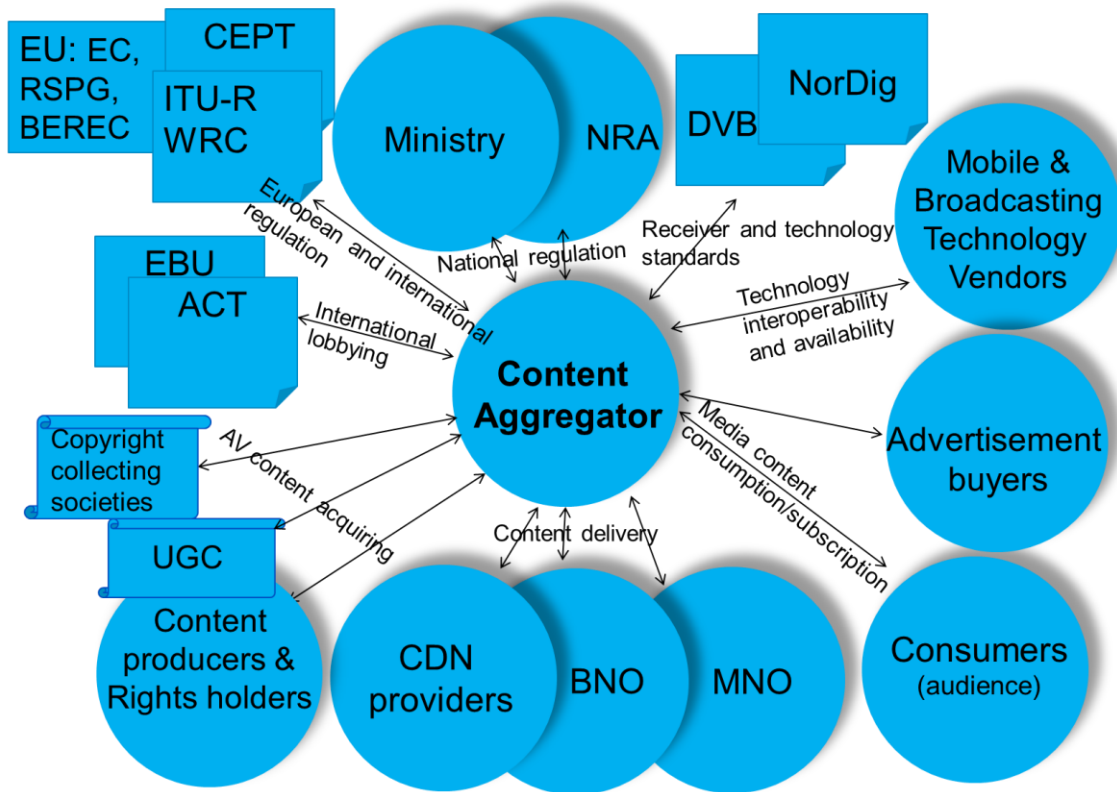
Figure 6. Partner network for content aggregator.
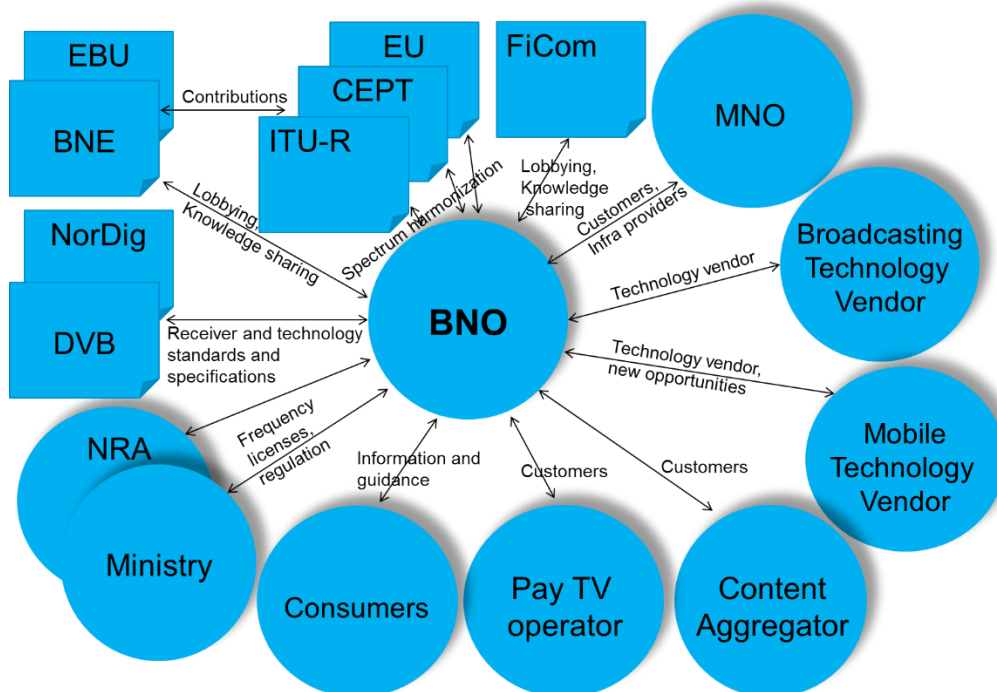
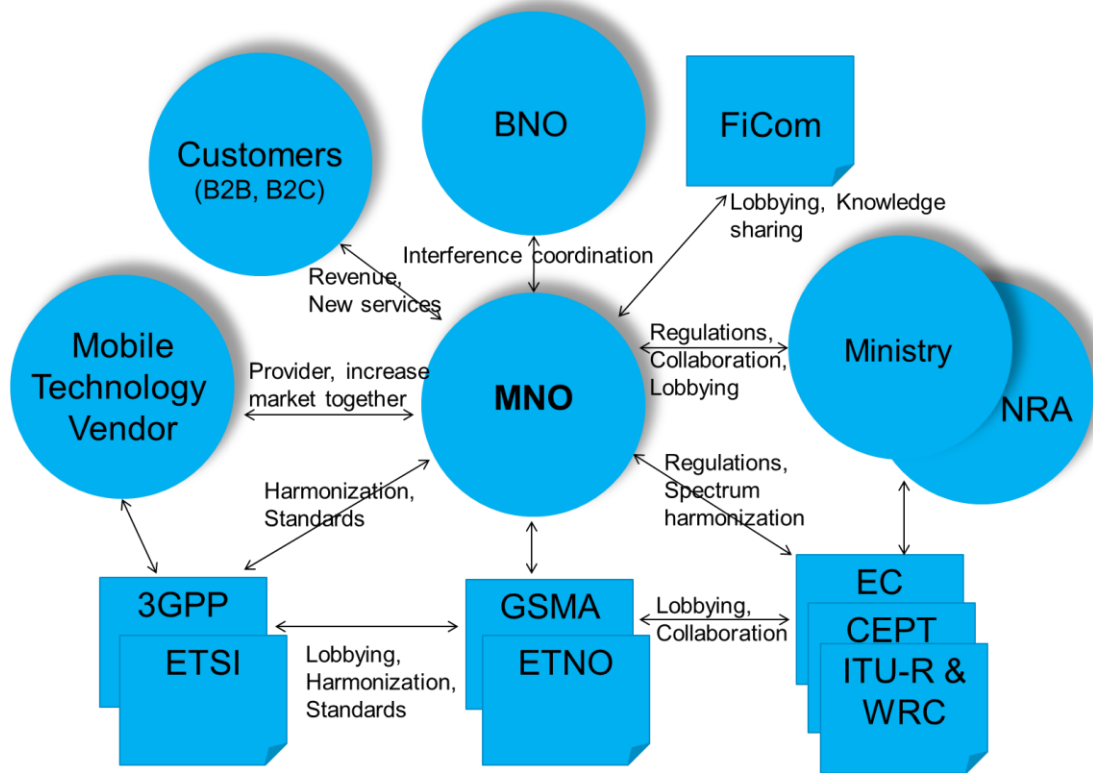**Figure 7. Partner network for broadcast network operator.**
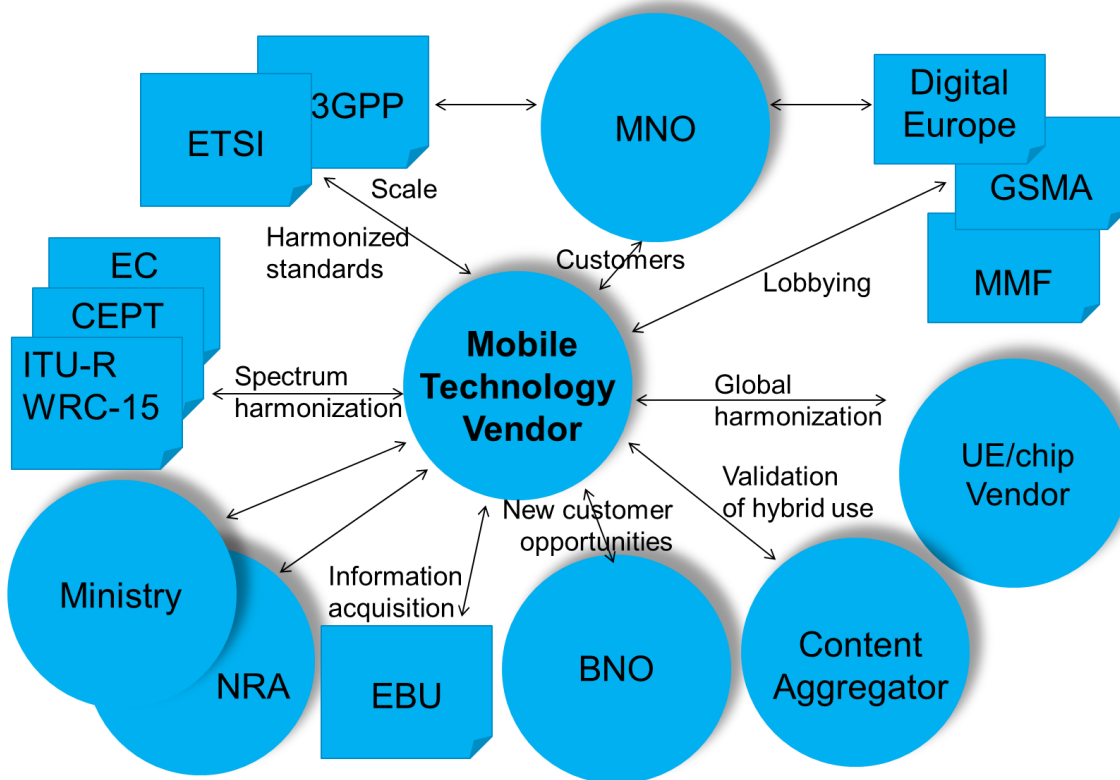
Figure 8. Partner network for mobile network operator.

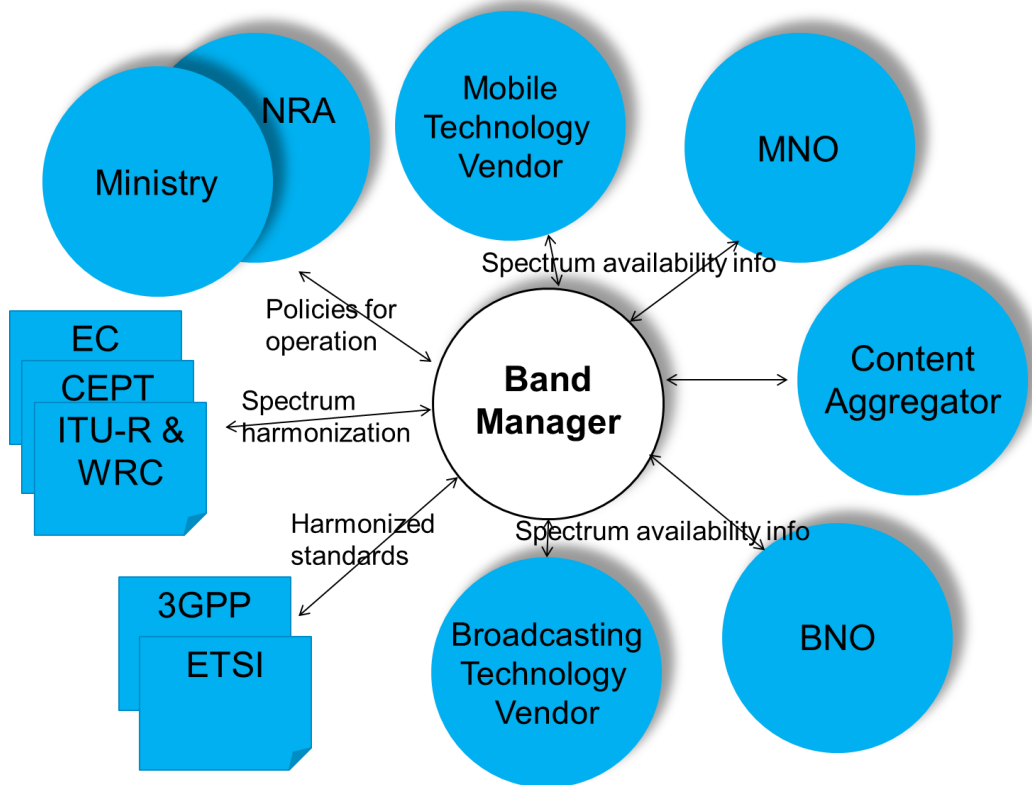**Figure 9. Partner network for mobile technology vendor.**

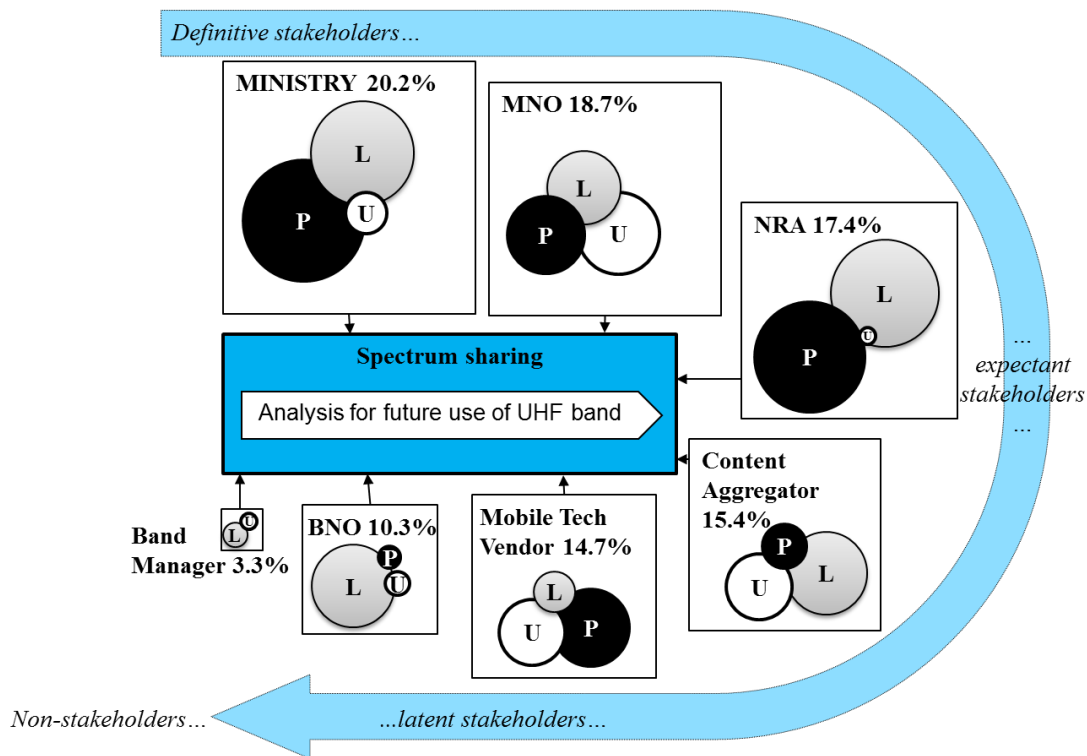**Figure 10. Partner network for band manager.**

Figure 11. Stakeholder salience for the future use of the UHF band.

Table 1. Needs, benefits and constraints for key stakeholders

Stakeholder	Needs	Benefits	Constraints
Regulator (NRA and ministry)	• Efficient use of frequency bands • Income from auctions • Support innovation • Support digitalization (digital agenda) • Ensure equal access to public service media	• Fair competition conditions • Pro-development • Versatility	• Time scales for regulation changes • International restrictions • Political restrictions
Content Aggregator	• Develop new and better services/customer experience to keep up with evolving market • Provide personalized services to end users • Deliver content to users that don't use linear content/services	• Better position in competition • More capacity for non-linear usage, especially with handheld devices	• Regulation • Handling of public service constraints (e.g. emergency alerts) • Demand of linear vs. non-linear • Coverage • Cost (network + terminals)
BNO	• UHF primary allocation for DVB • Guarantee spectrum for current and new services (e.g. HD) • DVB services secured and interference-free • Flexible use of UHF band • Mass delivery of AV contents	• Service development of DVB (SD->HD) on UHF • Cost efficient and good quality UHF DVB services • Flexible use helps to utilize valuable spectrum • AV mass delivery services to other terminals than DVB receivers	• Cost efficiency, QoS and time scales of the SDL/eMBMS implementation • Spectrum efficiency compared to the DVB • Lack of LTE infrastructure
MNO	• More spectrum to support growing traffic demand • Additional capacity for coverage especially for areas of low population • Finding new business models • Efficient handling of local areas (venue casting)	• Better quality, higher data rate for services • Potential for new type of services • Wide band of "available" spectrum • Cost efficient coverage and capacity especially for rural and indoor urban • Changing usage type of media • Customer satisfaction • Generate new revenue	• Technological challenges from hybrid use • Investment on solutions and spectrum • Availability of the spectrum (potential requirement to provide free-to-air for BC) • Availability of the equipment • Constraints from neighboring countries • Interference • Administrative burden • Dependency on regulation • Time scales • Availability of the information from/to other operators
Mobile Technology Vendor	• Use of 4G/5G technology on UHF band	• Expand accessible market/customer base into broadcast industry • Leverage LTE scale harmonization	• Dependency on regulation and politics • Time scales • Technical feasibility of eMBMS • Initial network planning • Delivery of the broadcasting data • Encryption
Band Manager	• Solid framework for spectrum sharing where the role of band manager is included	• New business opportunity	• Fulfillment of regulatory requirements • Complexity of the solution • Required development effort

Table 2. Results of stakeholder salience analysis for future use of UHF band

Stakeholder	Power	Legitimacy	Urgency	Sum
Ministry	11	11	5	27
NRA	10	11	2	23
Content Aggregator	4	10	8	22
BNO	2	10	3	15
MNO	7	9	10	26
Mobile Technology Vendor	7	5	8	20
Band Manager	0	3	2	5