2

Developments in Television Band Frequency Sharing Technology

HAJIME YAMADA
Affiliated Fellow

1 Introduction

The digitalization of television broadcasting, scheduled for completion on July 24, 2011, is underway. All broadcast stations are building digital broadcast relay networks. The statistics compiled by the Japan Electronics and Information Technology Industries Association (JEITA) show that, as of the end of August 2008, the number of receivers for terrestrial digital television broadcasting shipped to domestic markets reached 24,380,000, which is attributable to the rapid penetration of liquid crystal and plasma flat-panel televisions.

The ultimate aim of the digitalization of television broadcasting is the effective use of radio waves. Analog broadcasting uses Channels 1 to 62, whereas digital broadcasting only uses Channels 13 to 52. The unused 22 channels, which correspond to a frequency bandwidth of 130 megahertz (MHz), are converted to other uses. Given the current pressure on available radio wave resources due to the spread and development of various information and communications technologies such as cell phones and intelligent transport systems (ITS), the availability of such a wide bandwidth for use raises expectations for new applications.

The Committee on the Effective Use of Radio Waves, a subsidiary organization of the Telecommunications Council under the Ministry of Internal Affairs and Communications, studied the effective use of the 22 channels and submitted a report to the Ministry in July 2007[1]. Figure 1 summarizes the report. The recommendations include a variety of uses for non-television broadcasting, private communications, ITS, and telecommunications (for cell phones). Digitalization projects are also in progress in other countries.

If it is possible for multiple applications to share the same frequency, radio waves can be used

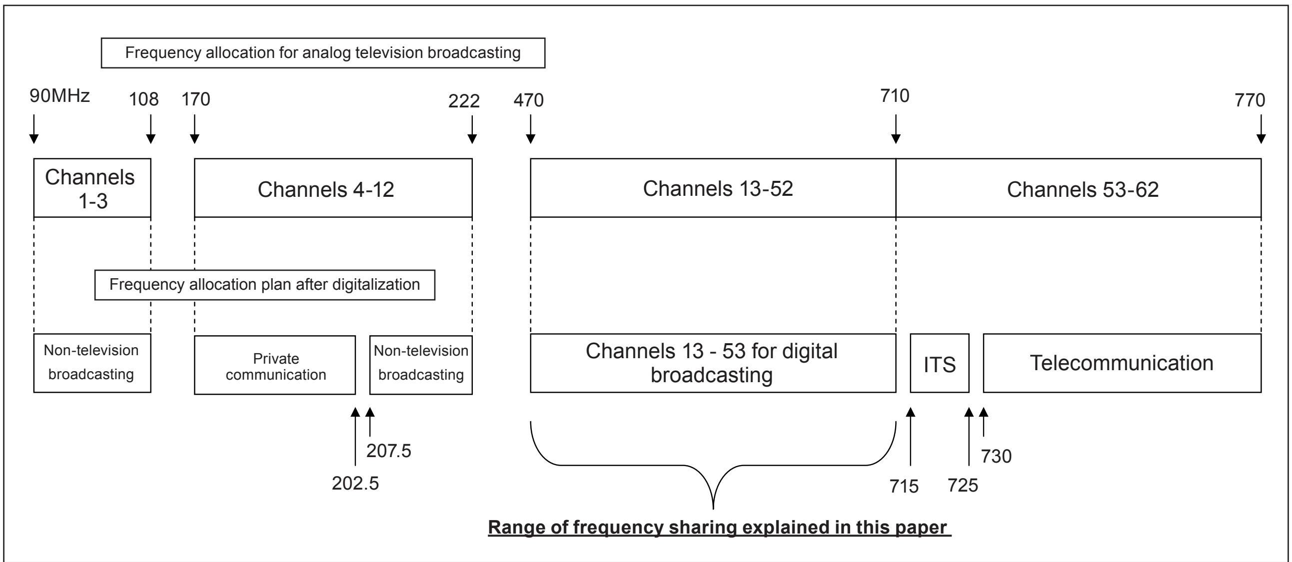

Figure 1 : Conversion plan for frequency bands made available by the digitalization of television broadcasting

Prepared by the STFC based on reference [1] more effectively. The status of the basic research on frequency sharing technology was published previously in the November 2004 issue of Science and Technology Trends[2]. Advances in technology have made television band frequency sharing after the completion of digitalization a realistic possibility. Besides the newly available 22 channels described above, the shared use of the frequency range between Channels 13 and 52 for other applications will have a significant effect on our society.

Community FM stations, which started in 1992, soon spread throughout Japan. According to the statistics compiled by the Ministry of Internal Affairs and Communications, their number had reached 218 by the end of 2007[3]. These stations are positioned as media which meet community needs not covered by the conventional prefecture-based radio stations. This paper introduces two experimental projects on frequency sharing, which aim at a kind of community television broadcasting with a possibility of evolving into a new medium in the same way as community FM broadcasting.

2 Interference protection ratios and channel plans

Let us assume that broadcast stations A and B are located at Points A and B, respectively, as shown in Figure 2. The intensity of the radio waves (received field intensity) from Station A decreases with distance, reaching the sensitivity limit of the receiver at Point C. In other words, broadcasts from Station A can be received between Points A and C. In the same way, broadcasts from Station B can be received between Points B and D.

Even if Stations A and B broadcast in the same channel, no interference occurs if Points C and D are sufficiently distant from each other. The distance between the two stations using the same channel can, in principle, be narrowed until Points C and D approach each other infinitely. In actual cases, however, the field intensity of the radio waves from Station B received at Point C (in the same way, the field intensity of the radio waves from Station A received at Point D) is limited to a lower level than the sensitivity limit of the receiver in order to avoid interference with a good margin under a technical condition called the “interference protection ratio.”

Based on experimental results obtained by NHK (Japan Broadcasting Corporation), the Telecommunications Technology Council submitted a report on the interference protection ratio in digital broadcasting in 1999[4]. Then the Ministry of Posts and Telecommunications issued an ordinance and a notice on the basis of the findings of that report in the same year. The revised versions of these documents were published in 2003 as Ministry of Internal Affairs and Communications Ordinance No. 26 of 2003 and Ministry of Internal Affairs and Communications Notice No. 37 of 2003, respectively.

Table 1 shows the interference protection ratios extracted from the above ordinance and notice.

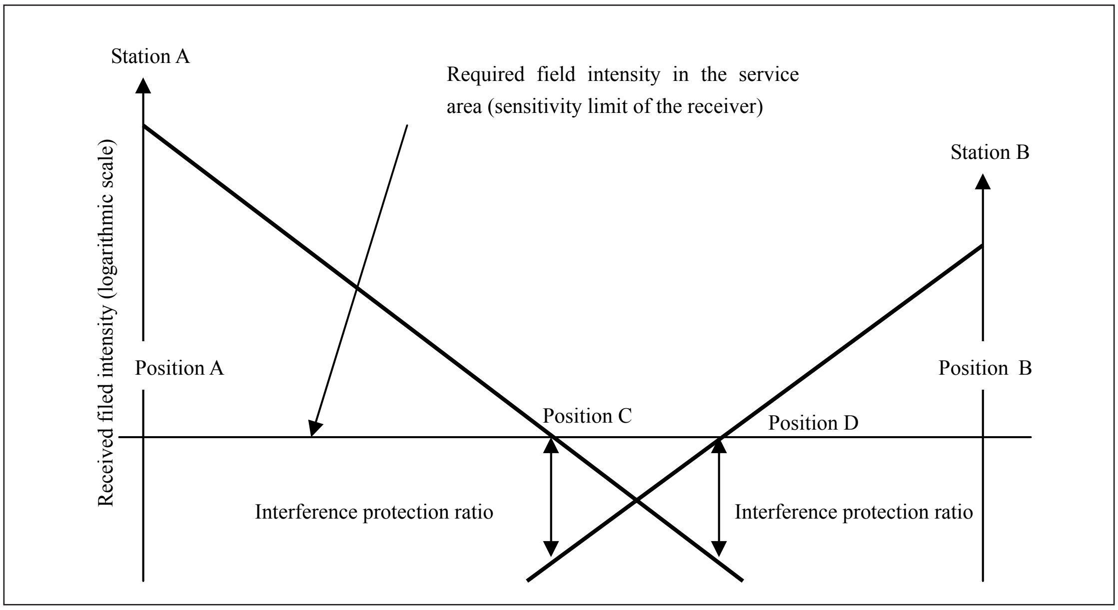

Figure 2 : Field intensity condition for enabling shared use of the same channel (explanation of principle)

Prepared by the STFC

Table 1 : Interference protection ratio

Station A (Desired wave)	Station B (Interference wave)	Frequency difference	Interference protection ratio
Analog	Analog	Same channel	45dB
		Lower adjacent (Interference with lower adjacent channel)	0dB
		Upper adjacent (Interference with upper adjacent channel)	10dB
	Digital	Same channel	45dB
		Lower adjacent (Interference with lower adjacent channel	0dB
		Upper adjacent (Interference with upper adjacent channel)	10dB
Digital	Analog	Same channel	30dB[Note]
		Lower adjacent (Interference with lower adjacent channel)	-21dB
		Upper adjacent (Interference with upper adjacent channel)	-24dB
	Digital	Same channel	28dB
		Lower adjacent (Interference with lower adjacent channel)	-26dB
		Upper adjacent (Interference with upper adjacent channel)	-29dB

Note : Changed to 20dB in the channel allocation plan with the expectation of improved receiver characteristics

Prepared by the STFC based on the report of the Telecommunications Council and other references

When the desired wave to be received at Point C is the analog broadcast wave from the antenna of Station A, the digital broadcast wave from the antenna of Station B interferes with the desired wave at Point C. The technical condition for this case specified in Table 1 requires that the field intensity of the radio wave from Station B must be 45dB smaller than that from Station A. When the desired wave is analog, the same interference protection ratio value is required for both analog and digital interference waves. On the other hand, the interference protection ratio when both the desired and interference waves are digital is specified as 28dB, which allows the field intensity of the interference wave to be 17dB larger than that in the case of analog versus digital waves.

The “upper adjacent” and “lower adjacent” mean the cases where the interference wave uses an upper channel and a lower channel, respectively, immediately adjacent to the channel used by the station transmitting the desired wave. When Station A uses Channel 30 and Station B uses its upper adjacent, i.e., Channel 31, the required interference protection ratios for the cases of analog versus analog waves and digital versus digital waves are 10dB and −29dB, respectively. A negative value of the interference protection ratio means that the desired wave can be properly received without interference even if the field intensity of the interference wave is larger than that of the desired wave.

As described above, digital broadcasting has a stronger tolerance for interference than analog broadcasting, making it possible to narrow the distances between broadcast stations using the same channel and facilitating the effective use of adjacent channels. Thus, digital broadcasting can make more effective use of radio waves than analog broadcasting. This is the technical justification of the bold policy of digitalizing television broadcasting, which reduces the frequency range by using the range for only 40 channels instead of that for 62 channels in order to make the remaining range available for new applications.

The interference protection ratios and the calculation formula[NOTE 1]for field intensities are specified in the technical conditions given by the ordinance and notice.

[NOTE1]
The formula calculates the received field intensity decreasing with the distance from a broadcast station.

Actual channel plans are determined considering the perturbations caused by urban areas, mountains, sea surfaces, etc., in addition to the calculated results. Simulation software programs for this purpose have been developed and are being used[5]. The specified channel plans of digital broadcasting are published by the Ministry of Internal Affairs and Communications[6].

3 Principle of frequency sharing

In the Kanto Region, which includes Tokyo, NHK and key commercial broadcast stations are using Channels 21-27 to broadcast in digital from antennas installed on Tokyo Tower. The number of channels used is 10 at most, including one other local station in Tokyo and the Open University of Japan. It therefore appears that the remaining 30 channels are unused.

In actual broadcasting, the radio waves from Tokyo Tower cannot cover the whole Kanto area due to the disturbing effects of intervening mountains. Relay stations have been built to retransmit television broadcast signals to areas with poor reception. NHK General TV uses Channel 27 for transmissions from Tokyo Tower, but its relay stations in Odawara, Kiryu, and Chichibu use Channels 19, 37, and 13, respectively, for retransmission. Such relay stations consume a considerable part of the remaining 30 channels.

The system in which relay stations use a different channel to retransmit transmitted signals is called a Multi Frequency Network (MFN). Integrated Services Digital Broadcasting–Terrestrial (ISDB-T), the Japanese digital broadcasting system, can in fact be constructed as a Single Frequency Network (SFN). The Ministry of Internal Affairs and Communications and the industry are running a publicity campaign to market the ISDB-T in South American countries, explaining that the ISDB-T can be constructed as an SFN[NOTE 2].By nature, the frequency use efficiency of the SFN is higher than that of the MFN.

Bound by the design concept in the age of analog broadcasting, the Japanese domestic system uses an MFN. The number of unused channels (hereafter called empty channels) is small, but a few exist in the Kanto Region. For example, the residents of Minato Ward directly under Tokyo Tower do not need to receive NHK General TV transmissions from Chichibu, and in any case, it is virtually meaningless for radio waves from Chichibu to reach Minato Ward. As a result, Channel 13 is empty in the ward. On the other hand, Channel 27 is empty in Chichibu City, Saitama Prefecture, because NHK General TV over that channel cannot reach Chichibu.

In regions with a small number of television stations, the number of empty channels is larger. A sample survey of Okayama Prefecture based on the channel plan published by the Ministry of Internal Affairs and Communications shows that 32 relay stations use Channel 29 and 29 relay stations use Channel 13, whereas Channels 23, 25, and 35 are not used at all. Channel 23, for example, is used at Hachibuse in Tottori Prefecture, Hamada in Shimane Prefecture, Hiroshima, Kure, and Miyoshi in Hiroshima Prefecture, and Iwaki in Ehime Prefecture. All of these areas are distant from Okayama City in Okayama Prefecture. Hence, Channel 23 is practically empty within Okayama City.

Digital broadcast relay networks are under construction. The first-step construction of the systems for relaying broadcasts from prefectural capitals has been finished. The second- and third-step construction of the systems for relaying broadcasts to mountainous areas is underway. The second and third steps also use the MFN. Meanwhile, the Ministry of Internal Affairs and Communications has already succeeded in developing a relay technology for SFN using a simple technology called a gap filler[7]. Using this technology in the second- and third-step systems to reduce the number of channels to be used will be effective for increasing the number of empty channels.

The absolute requirement for using an empty channel is not to cause interference with the digital braodcasting. This means that using Channel 23 in Okayama City must not disturb broadcast reception in Hiroshima City. For this, the user of the empty

[NOTE2]
Mr. Takada from NHK, for example, emphasized the SFN in his lecture "ISDB-T Technologías de transmisión y sistemas de alertas de emergencia," which was presented at a seminar held in Columbia on March 12, 2008. (http://www.dibeg.org/seminar/0803colombia_ISDB-T_seminar/2_ISBT_ews_Spanish.pdf)

channel should control the antenna power (power provided from the transmitter to the antenna). As shown in Figure 2, a small difference in distance may reduce the field intensity of the radio waves from Station B to a level lower than the sensitivity limit of the receiver if the antenna power is small.

As described so far, television band frequency sharing is a technology for using different empty channels in different areas, and emits radio waves with low antenna power.

4 Experimental projects for the shared use of empty channels

Two experimental projects for sharing unused channels are being conducted in Japan. One is a project being conducted by the Yokosuka Research Park (YRP) R&D Promotion Committee and Area Portal Company Limited. The other is an experimental project being conducted at the Specified Ubiquitous District in Matsue City, Shimane Prefecture. Both projects intend to develop a new broadcasting system, which can be properly called a community television system, with a possibility of evolving into a new medium in local communities.

4-1 Experiments in Yokosuka research Park

The YRP R&D Promotion Committee has been conducting experiments in which it offers community programs to a limited area using One Segment Broadcasting. The ISDB-T divides a channel into 13 segments and bundles several segments to transmit moving images and sounds. One Segment Broadcasting broadcasts information to mobile devices such as cell phones using only one segment.

Based on the experimental results, the first general meeting of the Preparatory Committee for New Narrow-area Digital Community Broadcasting was held on September 29, 2008. Aiming at the practical use of One Segment Broadcasting, the Committee will play a central role in conducting demonstration experiments at the Yokosuka Specified Ubiquitous District[8].

The basic technology for new narrow-area community broadcasting was transferred to the Area Portal Company, which has conducted several verification experiments[9]. The main point of this narrow-area broadcasting is to offer community programs with a very low antenna power of 10 milliwatts (mW). This output power is used to meet

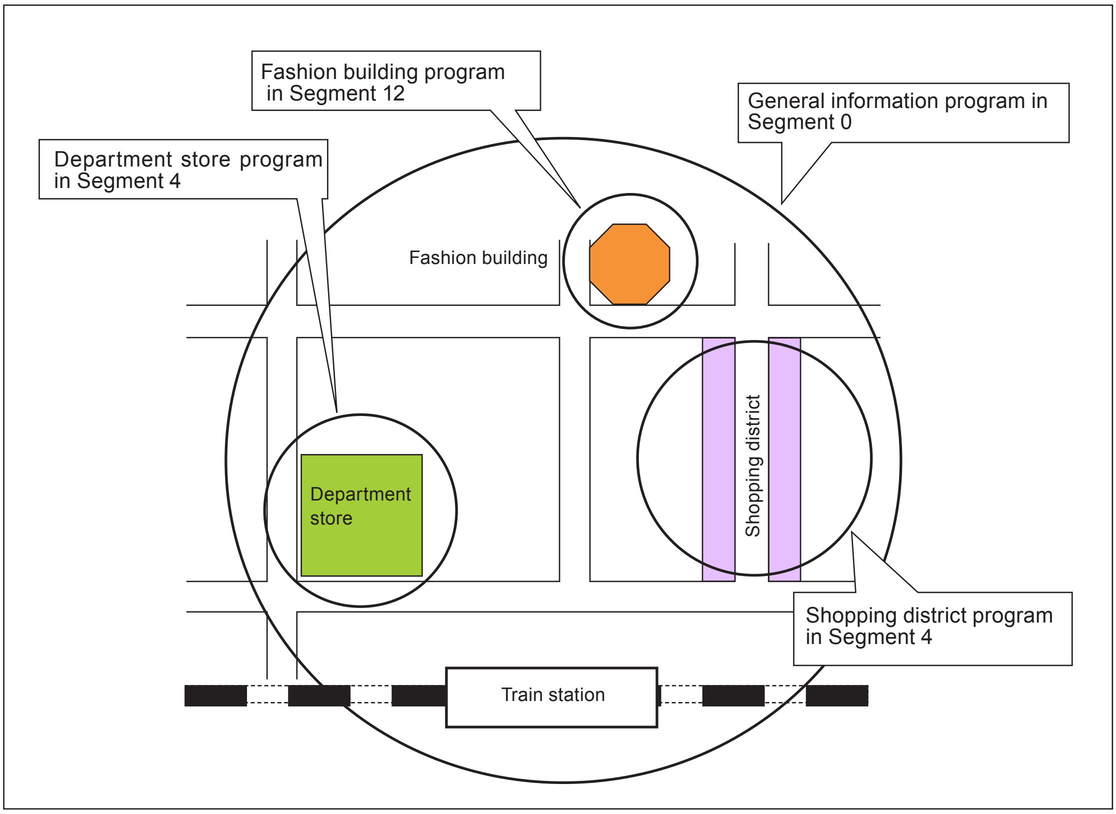

Figure 3 : Image of broadcasting in front of a train station where a department store and shopping district broadcast various programs

Prepared by the STFC based on the references provided by Area Portal Company the regulation specifying that a wireless station license is not needed to run a station with an antenna power of less than 10mW in the frequency ranges used for wireless LANs and other applications.

In the case of an antenna power of 10mW, the calculation formula for field intensities specified by the ordinance mentioned above gives a receivable area radius of about 300 meters. This is why the broadcasting is called "narrow-area." There is no possibility of disturbing distant relay stations using the same channel. One Segment Broadcasting is part of the ISDB-T technology, and its interference protection ratios can be determined using Table 1.

Cell phones can receive One Segment Broadcasting, but with a minor software change, can also receive new narrow-area digital community broadcasting. Each television channel is divided into 13 segments, and hence provides 13 independent programs at the same time. Even if alternate segments are used in order to improve tolerance against interference, it can provide 7 programs.

The new narrow-area digital community broadcasting technology enables independent broadcasting using the same channel at points several kilometers distant from each other. In the Tokyo metropolitan area, for example, broadcasting is possible in front of the large train stations at Shibuya, Shinjuku, and Ikebukuro, even though these stations are located only minutes apart.

Figure 3 shows an image of broadcasting in front of a train station. The youth-oriented fashion building and the department store use Segment 12 and Segment 4, respectively, and the shopping district, which is somewhat distant from the department store reuses and Segment to broadcast their original programs. A general information program is broadcast to the whole area using Segment 0.

In 2006, the Area Portal Company conducted an experiment at the National Museum of Western Art, in which it broadcasts a museum information program and individual programs for each artist in a batch. In 2007, the company conducted an experiment in which it broadcasts university life programs at Hiyoshi Campus, Keio University. The company also carried out several experiments in which it broadcasts car racing at Fuji International Speedway and Suzuka International Racing Course.

4-2 Experiments at the Matsue specified ubiquitous district, shimane prefecture

Using the system of Specified Ubiquitous Districts established by the Ministry of Internal Affairs and Communications, Matsue City in Shimane Prefecture started an experimental Shimane Ubiquitous Project on the shared use of television bands. The district was approved in January 2008. It is planning to continue verification experiments on the next-generation broadcast medium based at Shimane University until March 2011.

Shimane Prefecture, Matsue City, and Shimane University, and MediaScope, a local company playing a central role, are participating in the Shimane Ubiquitous Project Promotion Council[10]. The project uses MediaFLO wireless technology. MediaFLO is a multimedia broadcasting standard for mobile terminals specified in ITU-R BT.1833 which was standardized by the ITU (International Telecommunication Union)[11]. The standard also includes One Segment Broadcasting.

Using an antenna installed on the roof of a building on the campus of Shimane University, the project broadcasts programs to Matsue City over Channel 62 with an antenna power of 100W. The antenna power is as large as 10,000 times that for the new narrow-area digital community broadcasting described above. Since the analog Channel 62 is an empty channel in this area and no interference is expected, the Ministry of Internal Affairs and Communications issued a license for the project.

One Segment Broadcasting is designed so that all individual segments carry the same amount of information. On the other hand, MediaFLO dynamically allocates appropriate amounts of bit to individual program on an instant-by-instant basis. For example, when the instant-by-instant image movement is slight and contains much written information, as in news programs, a small amount of bit is allocated to the program. On the other hand, in sports programs, where movement is rapid, a large amount of bit is allocated to the program. Using the statistical characteristic that programs requiring large and small amounts of bit appear randomly at each moment, MediaFLO can transmit more programs in a channel than One Segment Broadcasting.

MediaFLO does not need to broadcast all programs to cell phones. As shown in Figure 4, it is also possible to transmit some programming to electric display

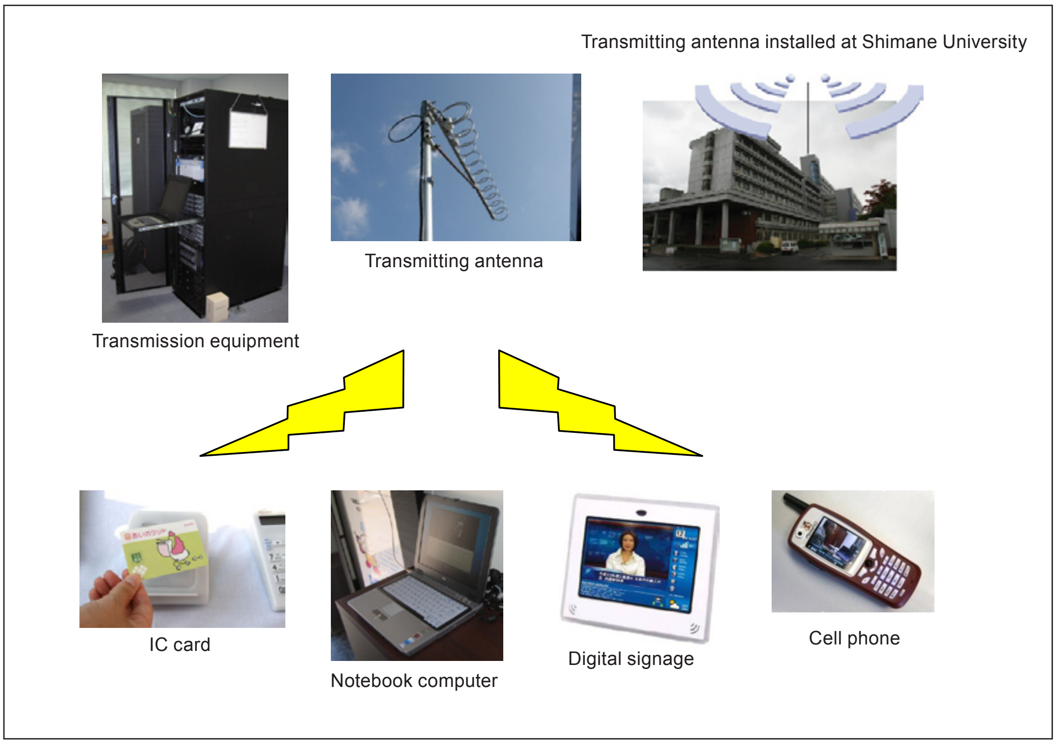

Figure 4 : Types of information services provided by the Shimane Ubiquitous Project

Source: Shimane Ubiquitous Project

boards, store display boards, and giant street screens (collectively called "digital signage"). Shimane Prefecture actually plans to broadcast advertising and area information to digital signage.

Sending disaster prevention information to digital signage can also be an important application. Since disasters due to sudden heavy downpours are geographically localized, broadcast stations can provide individual communities with unique information using digital signage, rather than using a digital television broadcast covering the whole area of a prefecture. Digital signage broadcasting can also be used in night-time storage of information for reproducing high-resolution moving images, which requires much time, and reproduction of those images on giant screens during the day.

One of the features of the Shimane Ubiquitous Project is the integration of IC card technology and multimedia broadcasting. A broadcast station sends service information to digital signage equipment placed at storefronts through MediaFLO. Customers use the points and coupons taken from the digital signage equipment and stored in their IC cards (Felica Pockets). The circulation patterns of the customers can be observed from their card usage histories. The project is planning to conduct experiments on such area-oriented information services.

4-3 New possibilities found through the two experiments

The new narrow-area ubiquitous community broadcasting and the Shimane Ubiquitous Project described above have commonalities and differences.

One of the commonalities is that they intend to realize a new type of broadcasting directed to narrow areas such as station squares and particular areas within a city. Conventional television broadcasting covers a whole prefecture in the smallest case and a wider area like Kanto Region in the largest case. Information programs such as those on small events in front of Shibuya Station and on local restaurants for the tourists visiting Matsue Castle have never been broadcast daily. Only companies like those in automobile, food, beverage, and cosmetic industries, which have customers in a wide area, advertise by conventional commercial broadcasting. In contrast, the two experimental projects target small sponsors in towns.

In other words, their business models are clearly different from that of the conventional television broadcasting in that they are intended to "respond to the needs of the smallest possible number of people in the narrowest possible area," whereas the conventional model is oriented toward "the largest possible number of people in the widest possible area." Commercial broadcast stations are participating in new narrow-area digital community broadcasting, possibly because they expect that the new type of broadcasting will not cannibalize the conventional type.

The new type of broadcasting differs from the conventional one in its interoperability with the Internet. The new broadcasting systems are more active in using the Internet, for example, to link receivers to the websites of local restaurants. This kind of service is a step closer to the integration of communications and broadcasting.

On the other hand, the following differences may be mentioned.

With a minor software change, the new narrow-area digital community broadcasting provides programs to One Segment Broadcasting-supporting cell phones, whose domestic sales volume is larger than 30 million units. Since this type of broadcasting already has a large number of potential users, immediate penetration can be expected, provided it interests potential users. For the time being, the Shimane Ubiquitous Project using MediaFLO requires dedicated receivers. Thus, this system must develop services for which users are willing to use a dedicated receiver. As described above, MediaFLO can send more programs than One Segment Broadcasting at the same time and can provide digital signage with information programs. It also enables high-resolution broadcasting using stored program data. It is thought that the two new types of broadcasting systems will be commercialized through a process of mutual competition.

The interference protection ratio for One Segment Broadcasting is already specified in existing regulations, whereas it will be necessary to determine the ratio for MediaFLO experimentally before it can be put into practical use. This is a serious problem for MediaFLO applications. The Specified Ubiquitous Districts were implemented to evaluate the experimental results in the districts as a basis for determining whether nationwide application is feasible and appropriate. Therefore, if the Shimane Ubiquitous Project succeeds, moves to establish the interference protection ratio for MediaFLO are likely. Since both MediaFLO and ISDB-T use a transmission method of orthogonal frequency division multiplexing (OFDM), the radio wave characteristics of MediaFLO are considered to be approximately the same as those of ISDB-T. From this viewpoint, there is a high possibility that the same interference protection ratio as that for ISDB-T will be established for MediaFLO.

5 Aiming at further shared use of empty channels

The two experiments described previously are pioneering in demonstrating the feasibility of television band frequency sharing to the world. Their further development will contribute to the more effective use of radio waves. What direction will sharing technology take in the future? This will be explained using Figure 5.

Figure 5 explains the degrees of difficulty in frequency sharing. Low antenna power technically means that short distance movement of a receiver will reduce the received field intensity to below the receiver sensitivity limit. This means that frequency sharing is easier with low antenna power than with high antenna power. Increasing the amount of information transmitted per second requires using a wider frequency bandwidth. Whether multiple channels can be used simultaneously depends on whether empty channels are available, which makes the realization of higher bit-rate frequency sharing more difficult.

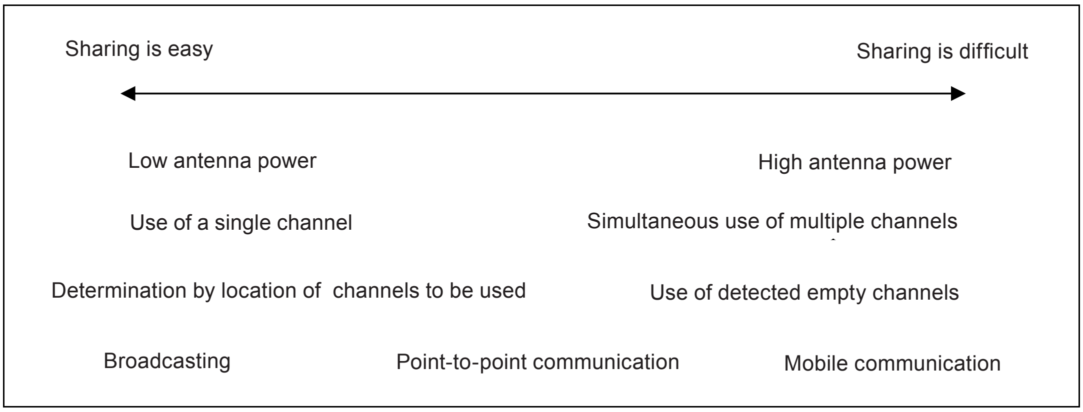

Figure 5 : Conceptual diagram showing the degrees of difficulty in frequency sharing

Prepared by the STFC

The method currently being tested, which determines empty channels based on locations, such as Minato Ward in Tokyo and Okayama City in Okayama Prefecture, is the closest to practical use. The next development target would be a system, called Geo Location System, which memorizes data on the relationship between locations and empty channels in the transmitter, uses GPS (Global Positioning System) to identify a location, and selects empty channels at the location. Practical application of "cognitive wireless systems," which scan frequencies just before transmission from the transmitter in order to find and use empty channels, is more difficult. Without the establishment of a method of avoiding mistakes, such as misidentifying a channel as an unused channel due to blockage by a building, practical application will be difficult. Research on cognitive radio technology is active in Japan, as shown by the fact that National Institute for Information and Communications Technology has established a New Generation Wireless Communications Research Center. Interest in cognitive radio technology has also been increasing in other countries. For example, the in-house magazine of the IEEE (Institute of Electrical and Electronics Engineers) published a report on cognitive radio in 2004[12]. Cognitive radio will be a focal point of the future research and development on frequency sharing.

Frequency sharing for broadcasting is easiest from the viewpoint of applications. Since the number of transmitting broadcast stations is limited, measures against possible interference are relatively simple. Communications between fixed stations are also a relatively easy application. One of its possible uses is a high-speed wireless LAN for home use. Application to mobile communications is the most difficult. To ensure that empty channels can be found, responding to every movement of mobile terminal, will require adoption of the previously described technologies such as Geo Location and cognitive radio, which have many technical problems.

The explanation presented above indicates that the two experiments discussed here, namely, new narrow-area digital community broadcasting and the Shimane Ubiquitous Project, are the frequency sharing methods with the highest possibility of application. Future research and development will be more advanced and challenging.

6 Trends in the United States and Europe

Both the United States and Europe are also working on television band frequency sharing.

In the United States, empty channels in television bands are called "white spaces." The American information and communications industries have proposed that white spaces should be used for applications other than broadcasting. The proponent companies organized the Wireless Innovation Alliance[13] to put pressure on the FCC (Federal Communications Commission). Consumers formed the Public Interest Spectrum Coalition[14] to support the movement[15]. Under this pressure, the FCC has been conducting experiments to verify the feasibility of this proposal since about 2006. Before meeting to vote on whether the FCC will authorize the use of white spaces, FCC Chairman Kevin Martin showed a positive attitude[16], and the FCC meeting on November 4, 2008 unanimously approved the use of white spaces[17]. The new use includes unlicensed communication devices with small antenna power. This decision will encourage many American companies to begin developing the use of white spaces.

In Europe, radio wave resources which become available by digitalizing television broadcasting are called "digital dividends." The European countries are interested in how to use these digital dividends.

The most active among them is the United Kingdom. OFCOM (Office of Communications) published a report supporting the active use of digital dividends[18]. Europe adopted a system of Digital Video Broadcasting for Terrestrial (DVB-T) for digital broadcasting. The UK is standardizing a technology to more effectively use frequencies called DVB-T2 (transmitting highly compressed moving image information), and has also begun the development of broadcast equipment[19]. DVB-T2 assumes about 45% higher capacity than that of DVB-T[20]. The concept is that, since the system produces some room in frequency space, licensed broadcasters may use the remaining frequencies for other applications.

Among the European countries which are building DVB-T broadcast networks, Germany, France, and Spain have adopted the SFN in order to conserve radio wave resources. Thus, the European countries are developing policies and measures to actively use digital dividends.

7 Conclusion and suggestions

Television band frequency sharing will be put to practical use in the near future. The new narrow-area digital community broadcasting and the Shimane Ubiquitous Project are pioneering activities from a global perspective. Accumulating such experimental experience before other countries will secure a position of technical leadership for Japan. From this viewpoint, the policy of the Ministry of Internal Affairs and Communications which established the Specified Ubiquitous Districts in order to conduct experiments on new radio wave applications can be highly praised.

For effective use of radio waves, further promotion of these moves is necessary. Revisions of the regulations specified in the ordinances and notices concerned should be accelerated so that official licenses can be issued to qualified applicants rather than temporary and experimental ones, under the condition that they do not cause interference with existing television broadcasting. Particularly for MediaFLO, experiments should be conducted to determine the interference protection ratio.

In future research and development on advanced frequency sharing technologies, efforts should be made in the direction outlined in Chapter 5.

Moreover, it is not inevitable that frequency sharing will be limited in television bands. Allowing other frequency bands to share frequencies, so long as they do not disturb existing applications, will bring our society closer to a real ubiquitous society which is capable of using radio waves more effectively.

The new broadcasting service oriented toward "responding to the needs of the smallest possible number of people in the narrowest possible area" was proposed based on an idea completely different from the concept of conventional television broadcasting. Internet websites have given an unprecedentedly number of people the opportunity to transmit information. Likewise, some say that this new type of broadcasting represents the "webification of broadcasting."[21] It can also be considered a service which is closer to the integration of communications and broadcasting. The culture of using cell phones for email appeared in Japan and spread to the world. If the "webification of broadcasting" spreads to the world in a similar manner, it will create new business opportunities for Japanese industry.

Acknowledgments

The author interviewed Yoshiyuki Takeda of NTT DOCOMO, Junichi Kato of Area Portal, Mamoru Yano of MediaScope, Jun Yamada of Qualcomm Japan, and many other persons concerned. He would like to express his deep gratitude to them.

References

[1] Ministry of Internal Affairs and Communications, Partial Report from Telecommunications Council and the Results of the Call for Opinions on the Technical Conditions for the Effective Use of Radio Waves in VHF/UHF Bands, July 2007. (Japanese) :
http://www.soumu.go.jp/s-news/2007/070627_4.html

[2] Hajime Yamada and Akihiro Fujii, "Technology and Policy Trends in Frequency Sharing," Science and Technology Trends, No. 44, November 2004. (Japanese) which was published in English in Science & Technology Trends Quarterly Review, No.15, April 2005

[3] Information and Communications Statistics Database compiled by the Ministry of Internal Affairs and Communications. (Japanese) :
http://www.johotsusintokei.soumu.go.jp/field/index.html

[4] (Former) Ministry of Posts and Telecommunications, Reports from Telecommunications Council on Terrestrial Digital Television Broadcasting, May 24, 1999. (Japanese) :
http://www.soumu.go.jp/joho_tsusin/pressrelease/japanese/housou/990524j701.html

[5] For example, Hiroshi Murakami, Taiji Murakami, and Tomoaki Kaneko, "Transmission Network Systems for Terrestrial Digital Broadcasting," Toshiba Review, Vol. 62, No. 2 (2007), 58. (Japanese)

[6] Ministry of Internal Affairs and Communications, Channel Plan for Terrestrial Television Broadcast Stations (as of June 30, 2008). (Japanese) :
http://www.soumu.go.jp/s-news/2008/pdf/080331_11_bt1.pdf

[7] Ministry of Internal Affairs and Communications, "On the Reports on 'Survey Study on Terrestrial Digital Broadcast Transmission Equipment in Disadvantaged Areas,'" March 2007. (Japanese) :
http://www.ktab.go.jp/new/2006/0315-4.pdf

[8] Yokosuka Research Park, "Report on the First General Assembly on 'Preparatory Committee for New Narrow-area Digital Community Broadcasting." (Japanese) :
http://www.yrp.co.jp/yrprdc/nb_digital-bc/n_digil-bc.html

[9] Website of Area Portal (Japanese) : http://www.areaportal.co.jp/

[10] Website of MediaScope. (Japanese) : http://www.ms-ltd.co.jp/

[11] Ministry of Internal Affairs and Communications, Comparison of Terrestrial Digital Broadcasting Systems for Mobile Terminals. (Japanese) :
http://www.soumu.go.jp/joho_tsusin/policyreports/chousa/mobile_media/pdf/080218_2_si1.pdf

[12] Gregory Staple and Kevin Werbach, "The End of Spectrum Scarcity," IEEE Spectrum, March 2004. :
http://www.spectrum.ieee.org/mar04/3811

[13] Website of Wireless Innovation Alliance. : http://www.wirelessinnovationalliance.com/

[14] Website of Public Interest Spectrum Coalition (PISC). :
http://www.newamerica.net/people/public_interest_spectrum_coalition_pisc/recent_work

[15] Kevin Werbach, "From Broadcasting to Network Age: Lessons from the Digital TV Transition in the United States," the First 2008 Symposium of Information and Communications Policy Forum, July 25, 2008. The video of Mr. Werbach's lecture can be viewed on the following websites :
http://jp.youtube.com/watch?v=Z25E-VupMj4&fmt=18
http://jp.youtube.com/watch?v=jn5yD5s8Occ&fmt=18
http://jp.youtube.com/watch?v=-Do4_HgCPaw&fmt=18

[16] "FCC's Martin backs 'white space' use, eyes Nov. vote," CTIA Smartbrief, October 2008. :
http://www.smartbrief.com/news/ctia/storyDetails.jsp?issueid=1F427BDB-88EE-42C4-AA81-DF0ED0563ED5&copyid=2C430C09-EF44-476C-96DD-6865039640E6&brief=ctia&sb_code=rss&&campaign=rss

[17] Federal Communications Commission, "FCC adopts rules for unlicensed use of television white spaces," November 2008. :
http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-286566A1.doc

[18] OFCOM, Digital Dividend Review, December 2007. :
http://www.ofcom.org.uk/consult/condocs/ddr/statement/

[19] OFCOM, "Broadcasters awarded licenses for HD programmes on Digital Terrestrial TV," October 2008. :
http://www.ofcom.org.uk/media/news/2008/10/nr_20081017

[20] DVB Project, "2nd Generation Terrestrial: The world's most advanced Digital Terrestrial TV System," August 2008. :
http://www.dvb.org/technology/fact_sheets/DVB-T2%20Fact%20Sheet.0808.pdf

[21] Hisashi Kamio, "MediaFLO aims at the Webification of Broadcasting–An Interview with Qualcomm Japan Chairman Jun Yamada," ITmedia, September 2008. (Japanese) :
http://plusd.itmedia.co.jp/mobile/articles/0809/17/news038.html

Profile

Hajime YAMADA
Affiliated Fellow,NISTEP

Professor, Department of Social Economic Systems, Faculty of Economics, Toyo University
Dr. Yamada holds a Master's Degree and Dr. Eng. from Keio University. He also holds a Master's Degree in Management of Technology from the Massachusetts Institute of Technology. After direct involvement in research at NTT, Dr. Yamada began working in management, including creating and proposing research strategies. He has been a professor at the Toyo University Faculty of Economics since 2002.

(Original Japanese version: published in December 2008)