REPORT

of the

International Round Table on Radio Diversity

16 November 2009
Karlsruhe Institute of Technology (KIT)

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EXECUTIVE SUMMARY

The International Round Table on Radio Diversity was held 16 November 2009 at KIT Karlsruhe. Nineteen participants from nine countries with extensive industry, academic and regulatory experience found that Europe's effective use of radio spectrum is seriously threatened by weak technology competition in radio interfaces and terminals, emerging mobile and wireless technologies, and a fragmented, old-fashioned regulatory system.

Europe's wireless communication services are characterised by high consumer and business costs, a lack of regulatory innovation and inflexible allocation mechanisms for current and new radio spectrum. Significant opportunities exist in using radio spectrum, particularly former analogue TV bands, for new modes of shared, open access. Greater technology competition will foster efficiency, global competitiveness, lower costs and reduced energy usage and will boost innovation in services, applications and hardware.

The Round Table findings strongly highlight the need for continued research, future exchange of ideas and the development of an impartial view over Europe's regulatory and technological landscape. Future round-table events, online discussions and the development of concrete regulatory and technical proposals for national and EU action are fundamental and urgent requirements, ideally hosted within a Radio Diversity 'centre of excellence' framework organisation.

SYNOPSIS

GENERAL

The International Round Table on Radio Diversity was held 16 November 2009 at KIT Karlsruhe. Nineteen invited participants from nine countries in three continents with extensive industry, academia, media and regulatory experience met for a day-long conference chaired by Dr Arnd Weber, KIT-ITAS. Round Table participants agreed in advance to address the theme of how to enhance diversity with respect to technical, commercial, regulatory and social benefits in the wireless communications domain.

Invited participants included representatives from the European arm of ACCESS Co., Ltd. (Japan's largest mobile browser developer), Intel Europe (a large technology maker), Kleos (a partner of Kyocera), the Soros-supported Open Spectrum Foundation, the US Information Technology & Innovation Foundation and the former chairperson of the Irish Telecommunications Regulator[1].

A press release, "Findings of the International Round Table on Radio Diversity," was issued by KIT on 20 November 2009[2]. The document was subsequently republished in German and English in a variety of online media serving academic, technical and specialist audiences.

SCOPE

Within this theme, the event was structured around a series of presentations and follow-on discussions addressing a wide range of topics including wireless and mobile infrastructure, network operators, business and service models, handset technology, applications, commercial requirements, market trends, competitive factors, comparisons between Europe and the USA, China, and Japan, and regulatory trends, policies and measures of effectiveness.

FINDINGS

Many presentations identified critical trends and drivers affecting Europe's radio regulatory landscape, including the continuing development and impact of new communication technologies, particularly those derived from the US and Asia, and the broadly supported the idea that increased technology competition is essential for the effective future use of radio spectrum in Europe.

Numerous participants stated that changes in this direction are far too slow, often due to outmoded licensing approaches, which in turn stem from old-fashioned regulatory systems and decades-old national licensing laws. Fragmentation across European national boarders was also identified as a serious issue. Despite positive initial change, such as the WAPECS process[3], there is no common market for spectrum.

Greater technology competition, be it in radio interfaces or terminals, it was reported, will provide strong benefits and enable unique features in different manufacturers' prod-

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[1] International Round Table on Radio Diversity – please see the agenda below.

[2] Technology competition vital for Europe's wireless future: Findings of the International Round Table on Radio Diversity, Karlsruhe Institute of Technology (KIT) http://www.kit.edu/visit/1838_552.php and German: http://www.kit.edu/besuchen/pi_2009_552.php.

[3] http://ec.europa.eu/information_society/policy/ecomm/radio_spectrum/topics/ecs/wapecs/index_en.htm

ucts – in terms of usability, technical efficiency, cost and energy consumption – to become visible to the marketplace and to business and consumer end-users. China, Japan and the USA have this type of technology competition already today, and those markets enjoy some of the world's lowest-cost communication services while providers obtain some of the best profit margins.

Round Table chair Arnd Weber has identified the fact that the most important innovations in the field of mobile communication during the last ten years have come from outside Europe, i.e. devices from Apple (USA) and RIM (Canada), components such as digital cameras and colour displays from Sharp & J-Phone (Japan), flat rates and online sales such as music by Qualcomm & KDDI (Japan) and, most importantly, openness for the Internet from NTT DoCoMo (Japan).

According to his research, Japan became the world's top mobile market because its national regulators fostered technology competition from an early stage of the second-generation wireless (2G digital) era, which has today led to extremely deep consumer and business adoption and famously cheap mobile emails (about 1 Yen = 1 Euro cent) and multifunctional handsets. Participants pointed out that critical elements of the iPhone had emerged earlier in Japan, such as a match of service quality, devices and content, colour displays and openness for the Internet.

The iPhone has demonstrated that European subscribers appreciate Japanese-style services, in contrast to earlier claims in the European mobile industry that Japanese users are different. This lack of innovativeness threatens the European mobile industry, as has become visible with Nokia's attempts to copy and improve elements of the iPhone, as well as with Siemens' mobile phone business, which disappeared in 2005.

Several participants, including Mr. Legutko of Intel and Mr. Cosh-Ishii of Mobikyo, pointed out that future radio spectrum regulation in Europe should not only assure benefits to consumers and taxpayers and reasonable profitability for equipment manufacturers and service operators, but must also consider factors that were not yet relevant when most regulatory schemes were devised decades ago. These include economic effects on other industries (wireless communications are now strategically vital for all levels of European commercial activity), social effects on citizens and effects on energy usage and the environment.

Furthermore, future regulatory modes must ensure quantifiable benefits in terms of end-user costs – specifically costs per megabyte of data. In Europe today, these stand in stark contrast to those in other markets. Several speakers described Europe as having a cartel-like structure, imposing high roaming fees and high SMS prices on their customers. As was discussed, the wireless industry is used to charging €10-€50 for 10-50 kbps per month, but will have to deliver 1-5 Mbps for €10-€30 instead. It has been claimed that full costs of €0.01/MB are achievable by wireless service providers within existing technology envelopes (Mr. Saffari of Kleos). What is lacking is regulatory initiative and imagination.

One heavily discussed topic was that of new allocation of former analogue TV spectrum, which many participants reported offers a unique chance to remake Europe's regulatory modes. These bands may not only be used for licensed communications but may also be used to support the positive opportunities foreseen in open-access, unlicensed communications. A pan-European allocation of these bands would make sense. Such a remaking of regulatory modes would also offer an opportunity to explore entirely new

concepts such as dynamic spectrum access (e.g., sensing and re-use) and allocation that is decoupled from specific technologies or usages (much more so than the WAPECS process now foresees).

CONCLUSION

While individual research findings and opinions varied widely, the Radio Diversity Round Table saw a consensus requirement for new forms of radio spectrum allocation, including pan-European licenses, cooperative use (such as use mediated through professional bodies such as IEEE), open use (such as unlicensed use) and an increased obligation for incumbent licensees to make better use of spectrum. Efficiency gains could help foster low-cost mobile Internet services for citizens and businesses, while addressing the growth in energy consumption due to operating networks and providing services.

Many participants expressed a strong desire to see this exchange of ideas on Radio Diversity – unique in Europe – continue in the future, ideally placed on a sustainable footing. Proposals include additional, wider Round Table events, additional research and the development of concrete regulatory and technical proposals, as well as through open discussions via the Internet.

ROUND TABLE AGENDA

Chair: Arnd Weber (ITAS, KIT). Co-chair: Michael Haas (A.T. Kearney), Secretary: Daniel Scuka, representing Mobikyo KK (Tokyo)

Welcome and Introduction

Welcoming Remarks	Jun.-Prof. Stefan Seifert, Research Group Industrial Organization in Telecommunications Markets, KIT
Presentation of Agenda and Introduction of Participants	Arnd Weber, ITAS, KIT

Presentations: Licensing and Innovation

Making Content Accessible	Yusuke Kanda, CEO, Access Systems Europe, Germany
The Business of Mobile in Japan	Lars Cosh-Ishii, Director, Mobikyo, Japan
Implementing the WAPECS Concept	Isolde Goggin, former Chairperson of ComReg, Ireland
Spectral Efficiency, an Inevitable Path for Successful Technologies	Arnaud Saffari, Chairman of Kleos (France) and Co-founder of iBurst
Enabling Broadband. Incumbents' and goverments' dilemma. Do we direct the right things?	Christoph Legutko, Manager, Intel

Presentations: Innovations for Shared Use

Questioning National Sovereignty	Robert Horvitz, Director, Open Spectrum Foundation, Czech Republic
Clogging the Mesh: Issues with Open Spectrum Models	Richard Bennett, Research Fellow, Information Technology & Innovation Foundation, USA
Regulation of Shared Spectrum - Technical Issues Arising in Heterogeneous Networks	Jens Elsner, Communications Engineering Lab, KIT
Research Issues with Collective Use	Simon Forge, SCF Associates, UK

Discussion and Agreement on Next Steps

Comments	Gregor Dürrenberger, Executive Officer, Swiss Research Foundation on Mobile Communication
Discussion and Agreement on Next Steps	All

REPORT

INTRODUCTION

The International Round Table on Radio Diversity was organised 16 November 2009 at KIT Karlsruhe. Nineteen invited participants from nine countries in three continents with extensive experience in industry, academia and regulatory bodies met for a day-long conference chaired by Dr Arnd Weber of KIT-ITAS. ITAS is KIT's Institute for Technology Assessment and Systems Analysis. ITAS is lead partner with both the Office of Technology Assessment with the German Parliament, as well as the European Parliament's Technology Assessment Group, and provides consultancy to various German ministries and to the European Commission (see related ITAS publications in Annex B).

In the call for participation, the following challenges for the European wireless communications system were spelt out:

(1) External players continually undermine the dominant business models with innovations.

(2) Technology and service-neutral regulation will challenge the single-standard approach practised so far.

(3) The success of WiFi creates the impetus for more sharing in spectrum use.

This list of challenges emerged during preparations for the meeting as well as in past ITAS research projects. Round Table participants had approached each other and recommended to each other to meet. This led to an agenda which addressed technical, commercial, regulatory and social aspects of an enhanced "Radio Diversity" segment, and to a meeting in a very constructive and collegial atmosphere. The presentations given at the Round Table are available at http://www.itas.fzk.de/eng/projects/2009/webe09_e.htm.

The event was supported in the context of the German "Excellence Initiative." In his introduction, Jun.-Prof. Stefan Seifert mentioned the newly formed KIT, a merger of Karlsruhe University and Karlsruhe Research Centre (Universität Karlsruhe, Forschungszentrum Karlsruhe), which was conducted as a part of the initiative. Seifert also mentioned that it was Karlsruhe University where Heinrich Hertz discovered radio waves, in 1886.

With its scope and atmosphere, the event was certainly unique in Europe, if not beyond. Immediately after the event, one participant, Richard Bennett of the Information Technology and Innovation Foundation (Washington/Livermore, USA), posted the following on his website:

Venue of the Round Table was the *Fasanenschlösschen*, a former hunting lodge in Karlsruhe (photo: A. Weber).

Daniel Scuka introducing Lars Cosh-Ishii (Mobikyo, Tokyo), who participated via a Skype session over HSPA (photo M. Breig, KIT).

"A couple of weeks ago I took part in a Round Table at the Karlsruhe Institute of Technology in Germany on open spectrum that combined one of most interesting gatherings of people of different viewpoints and ranges of expertise ever assembled in one setting. The group included a former chief national regulator [Isolde Goggin from Ireland], the technologist who wrote the first IEEE 802 standard for beam-forming [Arnaud Saffari, Kleos], a very serious grad student working with Software-Defined Radios [Jens Elsner, KIT], as well as a number of academics and economists. Together we explored the obstacles and value of the wireless third pipe, including the research problems that will need to be solved to make it a reality. This is the kind of gathering that's rarely assembled in the USA."
Source (slightly edited): http://broadbandpolitics.com/2009/12/whats-cooking-in-europe/

For more feedback in the media on this event, see also:

- http://wirelesswatch.jp/2009/11/23/intl-round-table-on-radio-diversity
- http://www.heise.de/tr/artikel/Mobilfunk-Mehr-Freiheit-wagen-976896.html

ANALYSIS: EUROPE NOT LEADING, NOT INNOVATIVE

Lead market Japan

Round Table chair Arnd Weber has identified the fact that the most important innovations in the field of mobile communication during the last ten years have come from outside Europe, i.e. from Apple (USA), RIM (Canada), Sharp & J-Phone (Japan), Qualcomm & KDDI (Japan) and NTT DoCoMo (Japan).

Left: Japanese operator KDDI advertising broadband flat-rate services over cdma 1X EV-DO, in 2004, used in particular for selling music (photo Weber). Right: Round Table chairperson Arnd Weber (photo M. Breig).

According to his research, Japan became the world's top mobile market because its national regulators fostered technology competition from an early stage of the second-generation wireless (2G digital) era, which has today led to extremely deep consumer and business adoption, based on famously cheap mobile emails (costing about €0.01 each) and multifunctional handsets. The competition of several groups, each consisting of operators, handset manufacturers and innovative providers of content or technical modules, paired with quality demanding customers, and companies exquisitely sensitive

to quality and customer satisfaction, led to the lead. An early example is the Personal Handyphone System (PHS), which lead to low voice prices already in the 1990s, and flat-rate data services for laptop users starting in 2000. Another example is the use of Qualcomm cdma 1X technology by Japanese operator KDDI for the wireless sales of music, starting in 2003, four years before the Apple iPhone.

Lars Cosh-Ishii, Chairman and co-founder of mobile consultancy Mobikyo KK, Tokyo, speaking via a wireless Skype connection, provided up-to-date information on the ongoing effects of having several 'clubs of companies' competing against each other with different technologies (radio interface, devices, software), which led to the early introduction and uptake of services such as QR codes (2-dimensional bar codes to be photographed for reading data such as URLs), location-based services and mobile TV (under the '1seg' brand in Japan).

Already in 2003, Japan's government issued a second tranche of 3G licenses in order to boost competition in a strongly profitable environment. Meanwhile, Wimax has been added, too. As of January 2010, the last remaining PHS operator, Willcom, has gone bankrupt and was acquired by No. 3 operator Softbank, providing a stark reminder of the intense competition in the market.
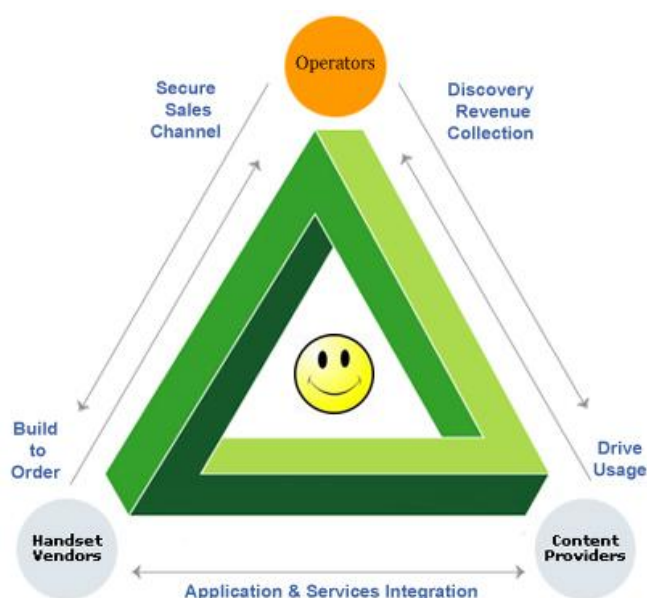
Lars Cosh-Ishii: Japanese ecosystem.

Cosh-Ishii illustrated the heavily competing "clubs" with a triangle, to show:

- The providers of content or modules suggesting new ideas, and the operators preparing for the necessary data or services; the operators give the bulk of the content revenues to the content providers.
- The operators ordering millions of custom-made phones from the handset manufacturers.
- The operators' quality control assures that, by the launch of the services, all components are in place and work with each other flawlessly.

This system has a knock-on effect into the market, as not only the content providers flourish, but also various other industries, who benefit from the availability of working, affordable new features. The most important single element in all these food chains is mobile email, which one can use to access arbitrary company websites, but in particular content providers. Weber quoted Sandra Baron, who led mobile content introduction with KPN and Vodafone at the beginning of the century, at an ITAS-organised European Parliament Hearing in 2008 (see Böhle, Rader Weber 2008):

> *"If there is a killer application in Japan, it is the one-click-to-content via email."*

When she introduced content with i-mode and Vodafone live, she would very much have liked a move towards affordable push emails, to get users onto content sites. However, due to fears of cannibalising SMS revenues, such cheap emails were not pushed, she said.

Already at the beginning of the century, Japanese ideas, such as mobile email and mega-pixel cameras, led to disturbances in the European mobile market. However, the effect of both "walled gardens" of content and open websites was limited due to European operators being afraid of cannibalising their SMS revenues. Another factor was that KPN and its partners, E-Plus and Bouygues, did not order enough good handsets, as Yusuke Kanda, then CEO of iMode Europe, reported. Nevertheless, standards proprietary to the mobile world, such as WAP, found no significant uptake, either. Also, multifunctional handsets became standard, even with 2G, while originally it was thought that a simple digital camera would mostly be used in UMTS phones for video telephony only.

iPhone

Speakers pointed out that Apple, with the iPhone, actually copied the Japanese ecosystem model, with itself playing the role of an operator, without actually owning a network. The similarities are overwhelming:

- Content of high quality is available (Apple shop), and Apple obtains a reasonable fee. These models were invented by NTT DoCoMo and Sony/KDDI.

- Services, handsets and networks fit perfectly from the day of launch, with no user intervention required.

- The system is open for any kind of content as it offers access to the Internet, as pioneered by DoCoMo.

All services, such as wireless Internet access or mobile music, existed already prior to the introduction of the iPhone. New, of course, was the user interface. Weber attributed the independence and open-mindedness of Apple to the Californian pioneer spirit and traditional US spirit of innovation. Anyway, the existing European business models were challenged by both US and Japanese concepts. With the introduction of the iPhone, cannibalisation actually played a smaller role, as it was made available only with high flat rates, which lead to sufficient revenues. However, selling only to the more affluent hinders the emergence of network effects, as most subscribers do not use Internet access and data services by default.

Left: Daniel Scuka, Mobikyo; Yusuke Kanda, Access Systems Europe.
Right: Richard Bennett (photos M. Breig, KIT).

The iPhone has become a wake-up call for European industry for introducing good handsets with working services, as Yusuke Kanda, now CEO of the European branch of Japanese software developer Access, put it. Access produced the first mobile browser, back in 1999, in Japan.

Kanda expects that iPhone-like devices might become used in the mid-tier ('iPhone mini'), but not in the lower, most cost-sensitive segments of the market. The mobile Internet market might become much larger with low flat rates, in particular with double flat rates, one as a minimum, and another one as a ceiling. Kanda also expects to see more and larger non-phone devices in the near future (such as the iPad, which has since appeared).

The situation in Europe, with mobile Internet usage not widespread at the lower market segments, is unlike the situation in Japan, where mobile email on all handsets for all users allows for significant network effects. The iPhone has demonstrated that the subscribers appreciate Japanese-style services, in contrast to earlier claims in the European mobile industry that Japanese users are different.

Commons

With regards to commons, the discussion started from the point that WiFi led to congestion in densely populated areas. Old IEEE 802.11b implementations degrade the improved congestion scheme in IEEE 802.11g devices. Richard Bennett pointed out that any good that is free ultimately becomes scarce. The proposals by Werbach (2004) to allow people to transmit freely (much like the use of air for vocal talking or one's emission of red light when wearing red socks) will lead to congestion, unless countermeasures are taken. As important as WiFi is, implementing the current versions of WiFi services using TV spectrum would mean wasting resources.

Emerging trends, status of Europe

Having discussed the major innovations from the US and Japan, participants examined trends in Europe. While WAPECS (Wireless Access Policy for Electronic Communications Services) is meant to introduce technology and service-neutral regulation, and change the old adherence to the single-standards model of GSM, there is little enthusiasm within the mobile industry to see technology competition in practice. This became visible from two presentations.

Spectral Efficiency (on Downlink)

unit: bit/sec/Hz/sector
value: Theoretical (Actual)

	2004	···	2006	···	2008	2009	2010	2011	??
iBurst	7.3 (3.5)					9.8 (4.7)		13.8	
HSPA			2.8 (1.1)		5.6 (1.4)	8.4 (1.6)			
Mobile WiMAX					3.1 (1.1)	6.1 (1.3)			
LTE							6 - 8 (??)		17.0 (??)

Spectral efficiency of various technologies, slide by Arnaud Saffari.

One was by Arnaud Saffari, who claimed that the technology his company is recommending, iBurst of Arraycom and Kyocera, is more efficient. He is Chairman of mobile broadband system integrator Kleos and co-inventor of iBurst. He claims iBurst would allow for a full cost of US$0.01/MB to deliver data. LTE (Long-Term Evolution, the planned evolution of the current W-CDMA/HSDPA 3G systems used in Europe), with its separate bands for uplink and downlink, it was argued, would lead to a waste of spectrum. The first bands have already been awarded for iBurst, e.g., in Ireland and in the Netherlands[4].

> *"As technology development is leading to shrinking total cost of ownership, regulation should allow for a much faster Europe-wide implementation of new radio technologies."* (*Arnaud Saffari, Kleos*)

Another speaker, Christoph Legutko of Intel, pointed out that the European mobile industry faces huge challenges. Currently, it delivers 10–50 kbps for $10–$50 ARPU (average revenue pre user). In the future, it will have to deliver 1–5 Mbps for $10–$30, as would become feasible with Wimax. In Tokyo and Moscow, Wimax is already in widespread use. Unlike DSL, this allows for the mobility of the user. Deutsche Telekom, for instance, currently has about 160,000 employees in Germany to serve a population of about 80 million; one Russian operator provides a wireless broadband service to a popu-

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[4] http://global.kyocera.com/prdct/telecom/office/iburst/field.html

lation of about 20 million with 2,000 employees, Legutko said[5]. This will mean huge challenges for the existing mobile industry. "I've seen many industries disappear in Europe and move to Asia, such as consumer electronics, mainframe computers, and the landline telecommunications business."
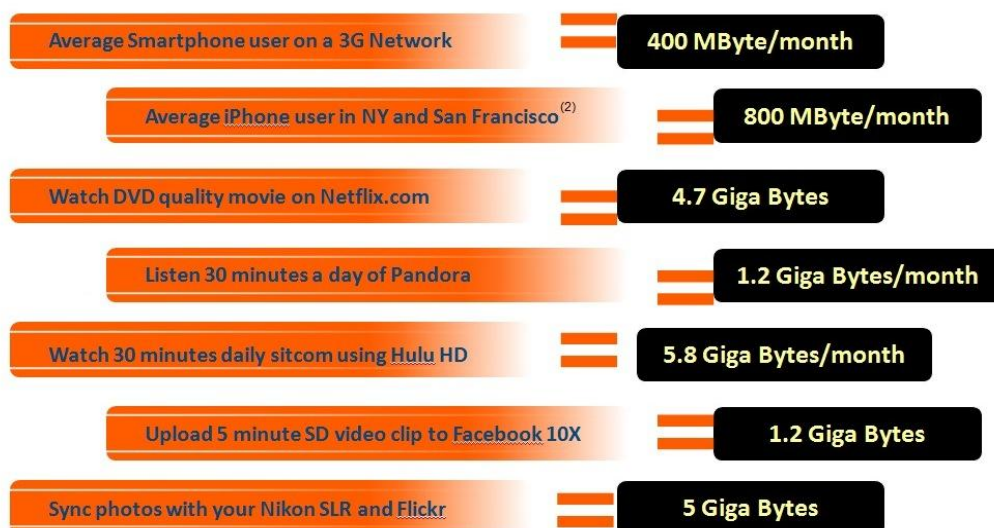
Bandwidth consumption of new applications (presentation Legutko).

Several speakers described the European mobile industry as a cartel-like structure of operators and manufacturers, which tries to keep prices high and move slowly. Packet-switching technologies will provide higher channel utilisation than current wireless systems, as based on CDMA and OFDMA (see Bennett 2009). Given these facts and figures, the incumbent mobile industry players face real risks of commercial irrelevancy, as several speakers mentioned.


Arnaud Saffari, Christoph Legutko (photos M. Breig, KIT).

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[5] Figures for 2010.

Participants expressed different views as to the benefits of infrastructure competition. While its merits became visible in the presentations of Cosh-Ishii, Weber, and Saffari, it was also expressed that for wireless broadband of up to 50 or 100 Mbps, it will become too expensive, in particular as fibre, needed to connect to the backbone, is expensive. Rather, so-called 'pico base stations' located on every corner lamp post, connected to a fibre network, would be needed, as proposed by Intel.

Isolde Goggin, former Chairperson of ComReg, the Irish telecommunications regulator next to Franco Furger, Net Landscapes, Switzerland.
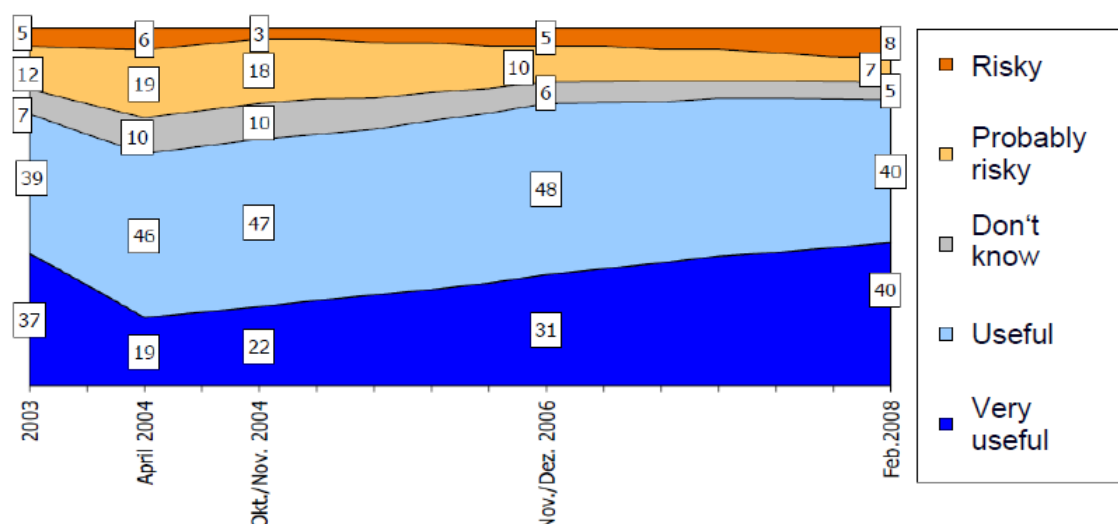
Risk perception in Switzerland (presentation Dürrenberger; source: gfs-Bern, Mobilfunk, 2008).

In any case, as long as licenses are provided at a national level, with different scope and duration, even if WAPEPCs is applied, there is a risk of fragmentation of the European market, as Isolde Goggin put it, the former Chairperson of ComReg, the Irish telecommunications regulator. Goggin was the key editor of the original WAPECS paper (RSPG 2005).

Fragmentation will make it very difficult for an investor outside the existing ones to start a new service, be it with existing radio technologies and new data services, or be it

with new radio technologies. China Mobile and Google have been mentioned as having the power to do so.

One might wonder whether the changes discussed will be accepted by the European population. Gregor Dürrenberger of Swiss Research Foundation on Mobile Communication presented some Swiss survey results. These show that the perception of benefits clearly dominates the perception of risks, as becomes visible from his graph.

PROPOSALS

The Round Table findings strongly illustrate the need for continued research, future exchange of ideas and the development of an impartial view over Europe's regulatory landscape.

Greater technology competition, it was reported, will provide strong benefits and enable unique features in different manufacturers' products, in terms of usability, technical efficiency, cost and energy consumption, to become visible to the marketplace and to business and consumer end-users.

China, Japan and the USA already have this type of technology competition, and those markets enjoy some of the world's lowest-cost communication services, which is beneficial for the economy, while providers obtain some of the best profit margins.

Left. Robert Horvitz, director of the Soros-supported Open Spectrum Foundation. Right: Simon Forge, UK (photo M. Breig, KIT).

Some speakers pointed to the contingencies in the process of spectrum regulation. As Robert Horvitz put it, the history of the current international spectrum management regime is not dictated by technology. Initially, Marconi had claimed that his patents were so fundamental that only his companies could transmit or receive radio waves, which Germany found unacceptable and therefore demanded international control over radio communications. Werbach wondered what would have happened if the government had not intervened and left it up to private companies to find a solution to the interference problem. Horvitz also pointed to the increasing role of international groups, such as CEPT and ITU. He stressed that it is as well possible to give the task of spectrum coordination to user groups or even devices. In other words, spectrum use has evolved in a political way and therefore, in the future, it can and should be shaped as needed by the political process.

Many participants stated that changes in Europe are far too slow. The mobile industry is rather reluctant to introduce more technology competition. This may change, as even single operators may diverge. However, any push currently visible comes from abroad, with Apple, RIM, Intel and Kyocera as examples.

Anybody interested in jobs and benefits accruing to European workers and shareholders must ask the question: How to become better than these companies? Or, must we find entirely new markets?

Plenty of proposals were made on how to stir up the current situation. Significant opportunities exist in using radio spectrum, particularly former analogue TV bands, for new modes of licensed access, as well as open access.

Several participants, including Mr. Legutko of Intel and Mr. Cosh-Ishii of Mobikyo, pointed out that future radio spectrum regulation in Europe should not only assure benefits to consumers and taxpayers and reasonable profitability for equipment manufacturers and service operators, but must also consider factors that were not yet relevant when most regulatory schemes were devised decades ago.

Jens Elsner, KIT; Filip Perich, Shared Spectrum Company, Czech Republic (photo M. Breig, KIT).

These include economic effects on other industries (wireless communications are now strategically vital for all levels of European commercial activity), social effects on citizens and effects on energy usage and the environment.

A pan-European allocation of bands would make sense. Such a remaking of regulatory modes would also offer an opportunity to explore entirely new concepts such as dynamic spectrum access (e.g. sensing and re-use).

In the next section, we list the proposals participants made. This is very much a raw listing so as to simply illustrate the proposals that were made so as to give the reader an impression of the wide scope of the Round Table and the depth of the required future research. The list begins with somewhat generic proposals, moving subsequently to proposals with regard to licensed communications, followed by proposals beyond licensed usage, and ends with research proposals.

General proposals

1. Have more technology competition. Allow the market to identify the best breed of technology.

2. Allow for a much faster Europe-wide implementation of new radio technologies.

3. Liberalise rules (flexibility, trading) to allow new technologies to access spectrum, even if they have to start small or start with non-primary access.

4. Show or prove that technology competition can make a difference at a national or societal level. This question has to be looked at from a technology point of view, an economic point of view, a social point of view, and a regulatory point of view.

5. Understand economic efficiencies & benefits to society, e.g., 'social benefit/MHz'.

6. De-monopolize regulation: devolving spectrum management responsibilities to professions, locales, facility owners, user groups, and devices. Conduct experiments, e.g., give a band to IEEE.

7. Set aside a portion of future auction revenues for the future benefit of the industry, SMEs and consumers.

8. Give somebody test networks to attract FDI, perhaps without auctioning.

9. Unleash incumbent operators from the dilemma of cannibalizing their legacy business.

10. Establish an Ombudsman for issues related to spectrum use.

11. In Germany, regulation of broadcasting frequencies should be incorporated into the regulation of all other frequencies.

Proposals for licensed communications

12. Enforce the use of some radio technology other than LTE.

13. Give spectrum to disruptive players. Bring in new players, even those without track records (but who otherwise can prove competency).

14. Force 'Open Internet'; do not control customers as planned by the NGN (Next Generation Network) fraction.

Proposals beyond licensed communications

This list is much based on proposals made by Jens Elsner, KIT.

15. Have more license-exempt, service-neutral bands, in diverse frequency ranges.

16. License exemptions should be extended to TV spectrum. Try to use it for long distances, up to the radio horizon. 100 MHz below 1 GHz should be allocated under a general authorization with high power (e.g. 1 Watt EIRP). Regulation should be smart and enforce good sharing.

17. Include primary system receiver characteristics in regulation to better predict results of interference.

18. Standardize spectrum sharing with dynamic spectrum access protocols for coordination of resources.

19. Work out a new type of spectrum allocation between 'hard' (traditional, exclusive ownership), 'soft' (traditional unlicensed) → 'Firm' = sub-licensed, borrowed, collective, cooperative.

Research proposals

We continue with a similarly long list of mostly technical research proposals, essentially made by Simon Forge (see his slides at http://www.itas.fzk.de/eng/projects/2009/webe09_e.htm or Bohlin et al. 2007).

20. More research on interference, e.g. accept some interference or user collaboration.

21. Use Unlicensed Mobile Access with unlicensed spectrum technologies and 'legacy" mobile networks to provide seamless access especially for backhaul. This is jolly useful for mesh networking.

22. Power allocation and energy saving for optimal routing with task migration

23. Optimal resource management – throughput, power/error rate, consumption

24. Efficient spectrum context discovery methods

25. Modelling propagation and relaying – offline and online – for multi-hop and multi-path contexts with minimised interference

26. Nearest relay discovery - detection for direction and distance in real time

27. Adaptive attenuation with path analysis working, for indoors/outdoors/ fading/ shadows

28. Co-operative interference in mesh networking – path-blocking, security

29. Location awareness for cognitive radio ad hoc networking

30. Optimal coverage with path choices with multiple relays in ad hoc networks

31. Carrier sensing and multiple access with collision minimisation

32. Capacity limits for throughput with multiple paths and mesh partners – sensing, optimising and adaptive strategies

33. Directional beam forming

34. Sensing and efficient dynamic set up of multiple parallel channels

35. Adaptive white space use - hopping policies from context sensing for local conditions (with mesh conditions)

36. Topology control; for optimal throughput and capacity

37. White space location and hopping

38. Co-operation diversity – frequencies, b/w, hopping & handover, direction, power

39. Delay and caching co-operatively

40. Self –healing – failure detection adaptive compensation and policy choice for recovery

41. Co-operative application scheduling – e.g. isochronous, non-isochronous traffic (e.g. sensor networking)

42. Broadcast, narrowcast, multi-cast operations and protocols

43. Identification of signals in presence of jamming, active or unintentional – mitigation actions

44. Sharing GSM/UMTS/LTE networks with UMA access network

45. Recovery using mobile agents

46. Lightweight communications protocols for ad hoc networks

47. Multipath environments for optimal operation

48. Mutual adaptive synchronisation networks for mesh networking in multipath contexts

49. Hybrid mesh networks with static and mobile participants

50. Bandwidth sharing policies for multimedia traffic with transactions and file transfer

51. Partitioning networks via safe distance in space, frequency

52. Set up a European Research Radio Institute (ERRI; see Bohlin et al. 2007).

We are unaware of any other meeting in Europe during the last 10 years at which so many proposals for action have been made.
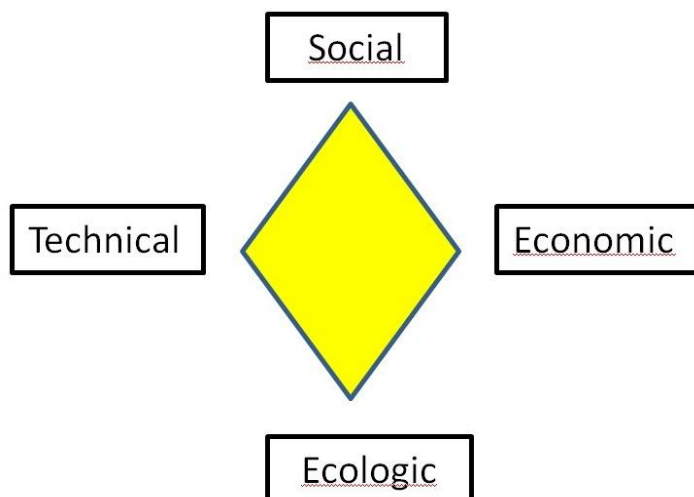
Dimensions to be addressed at future events.

NEXT STEPS

The meeting was a gathering of "people who would like to modernize the regulatory environment in Europe" (Christoph Legutko, Intel). Many participants expressed a strong desire to see this exchange of ideas on Radio Diversity – unique in Europe – continue in the future, ideally placed on a sustainable footing.

> *"I liked the wide variety of views represented, from manufacturers to operators and applications providers to regulators, and the fact that the discussion was not just technical or economic, but also covered wider issues such as social acceptance of emissions and masts." (Isolde Goggin)*

Therefore, it is necessary to show or prove that technology competition can make a difference at a national or societal level. This question has to be looked at from a technology point of view, an economic point of view, a social point of view, an environmental sustainability point of view, and from a regulatory point of view. The following more or less concrete proposals were made:

1. Have additional, wider, Round Table events. Have a two-day conference with sub-groups on technology competition, economic point of view, regulation, social good, green benefits; have session chairs producing conclusions.
2. Organise open discussions via Internet.
3. Develop a declaration, a mission statement.
4. Participate in national & EU lobbying, with commenting, etc. Take part in formal events/processes at the EU/EC level.
5. Develop concrete regulatory and technical proposals.
6. Write regular press releases and opinion notes issued to media, bloggers, etc.
7. Conduct additional independent research, exploring alternative developments paths. This could be part of a green industrial stimulation programme.
8. Create the ERRI, a European Radio Research Institute (a proposal by Simon Forge).
9. Create an organisation, such as a study group, or a Radio Diversity 'centre of excellence' framework organisation.

If you are interested in participating, contact arnd.weber@kit.edu.

ANNEX: REFERENCES AND PUBLICATIONS

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