

Draft list of potential research topics
(Version 3 24/06/02 04/07/02)

1. Introduction

This document intends to provide a draft list of "hot topics" for further discussion at a future RRAC meeting.

2. Topics for consideration

2.1 Convergence of digital and mobile

Two different models have been proposed for the provision of broadcast data to mobiles. Either might, for example, use UHF spectrum released by the completion of the switchover from analogue to digital TV broadcasting. The first model assumes the use of mobile variants of the digital broadcast standard (DVB-T), and "dual standard" UMTS/DVB terminals. The second assumes the development of a broadcast protocol within the UMTS standard, with a single standard receiver. A study to examine the spectrum efficiency implications of these alternatives may be useful.

2.2 Effect of planning models on spectrum efficiency

Current planning tools used for broadcast TV use only statistical clutter data based at best on averages over 50m squares. Might the use of more precise 3D data with buildings and trees etc enable a more efficient use of spectrum?

2.3 OPTIMISING USE OF SPECTRUM FOR BROADCAST RETURN CHANNEL SYSTEMS

European standards are emerging for satellite interactive terminals with radio return channels operating in the 29.5 to 30 GHz band from the home to geostationary satellites. These include a facility for uplink power control and as a consequence issues on performance prediction should be addressed.

2.4 Spectrum for wireless home area networks. The wireless used in these networks will be part of a home network that will use a mixture of communication media in a pervasive computing, communications and entertainment environment. The wireless transmissions will not escape far from the property and so these systems should be allocated a wide band of unregulated unlicensed spectrum. The choice of this band requires an investigation. We should not confine ourselves to thinking about Bluetooth, 802.11, or Hiperlan 2.

2.5 High bit rate services to the home. Home networks will need very wide bandwidth trunks to the outside networks. Fibre can provide this, but fibre-to-the-home still seems uneconomic. There is a case for studying high frequency, high bit rate, point-to-multipoint delivery systems to the home.

2.6 : 2.4 GHz ISM band. There is a danger of this band becoming useless because of congestion. The fear is of excessive use by short-range communications, eg tagging, Bluetooth, etc. However, the worse may never happen, as communications will be so local in nature. We need to start monitoring a range of locations to observe the type of usage, and hence to see if some services within this band should move to other parts of the spectrum.

2.7 Efficient utilisation of spectrum. We need to know how efficiently spectrum is being used on a time and space basis. This information is a pre-requisite in terms of spectrum trading, spectrum sharing and other scenarios.

2.8 Use of broadcasting spectrum. It is thought that mobile systems could gain from broadcasts when many users want to receive the same signals. We recall that small hand-held television sets were a commercial failure, and now the hope is that a combined television broadcasting and communications hand-held is what people want and that this combination constitutes an efficient use of spectrum. My view is that better utilisation of the spectrum would be achieved if we confined broadcasting services to satellite (and fibre) and use their current spectrum for wireless mobility. Perhaps a study examining whether all these 'life belts' being thrown to the television establishment are worth the effort.

2.9 Wireless ad hoc networks. These networks should be compared with more conventional networks to evaluate their relative spectral efficiency in a range of operational scenarios, eg in home networks and cellular networks.

2.10 SOFTWARE RADIO:

Software Radio takes advantage of advanced DSP and RF ASIC technology so that software NOT only calls and manages the functions of the radio but IS the function. Multiple waveforms give multiple modes and thus different "radios". In addition, there are multiple protocols and standards. Software Radio determines the waveform and automatically recognises the protocol, IS95 cellular or LEO or a new Universal standard or even a new one.

2.11 SIGNAL PROCESSING FOR BEAM FORMING TRANSMITTERS AND RECEIVERS IN WIRELESS SYSTEMS:

Signal processing for beamforming encompasses the design and adaptation of signals to transmit information over multiple antennas so as to minimize the interference seen by fixed or moving terminals. Space-time coding may be used to achieve space-time diversity and robustness against fading in space and time. On the receiver side multi-antenna signals are detected, combined and demodulated so as to minimize the effects of multi-user interference.

2.12 SIGNAL PROCESSING FOR BEAM IMT2000:

IMT2000 would give mobile terminals abilities to communicate using video/audio interfaces. This requires new signal processing technologies with higher performance and lower power dissipation.

2.13 CONSUMER COMMUNICATIONS ELECTRONICS:

Consumer products will have capability of high-speed communication in the near future. At the same time, audio and video signals should be networked within SOHO and Home Networks. These markets would require low cost implementation of communication circuits.

2.14 MULTI-ANTENNA SYSTEMS:

Multi-antenna systems are expected to increase the call capacity and the data rates supported by third-generation cellular systems and fixed wireless systems, particularly CDMA.

2.15 ADAPTIVE ANTENNAS:

In order to achieve the ambitious requirements introduced for future wireless systems, new Adaptive Antennas can offer several operational benefits ranging from capacity enhancements to high-bit rates.

2.16 PROPAGATION MODELING: In order to meet the growth in demand for mobile communications and to plan for the provision ...

2.17 RADIO RESOURCE MANAGEMENT TECHNOLOGIES:

As applications become more bandwidth hungry, wireless systems demand higher spectrum efficiency. Radio resource management methodologies are essential to enhance the efficiency. These include at least the following:

- Power control
- Dynamic channel assignment and Interference avoidance
- Handoff and macroscopic diversity techniques
- New cellular frequency reuse architectures
- New propagation prediction and automated planning techniques

2.18 MOBILITY MANAGEMENT TECHNOLOGIES: When communications and networking move from fixed to mobile platform, it is essential that the user can enjoy the same services and applications with a great degree of transparency. Example of research topics include:

- Mobile IP; multicasting, dynamic routing, etc.
- Wireless ATM; mobility and resource allocation issues
- Protocol enhancement to support existing service in mobile platform

2.19 WIRELESS - WIRELINE TECHNOLOGIES: As wired services evolve and wireless services grow in popularity, users have to navigate easily between wired and wireless terminals. At present these domains are disjoint and integration/interworking can bring advantages to user services as well as network infrastructure. Standards are also needed.

2.20 Measurement of Spectral Efficiency

There is a need to identify and collate the parameters relating to spectral efficiency right across the spectrum together with its usage, leading to metrics. This is embodied in Topic 2.7 and needs to be carried out by in-depth research with a sound practical appreciation. The expectation is for seminal results that pave the way for more specific studies as in Topics 2.2, 2.3 and 2.8. The deliverables in this work will be metrics whose practical value to spectrum planners has been unequivocally demonstrated.

2.21 Interference reduction

New techniques for screening buildings, rooms and equipment will be in increasing demand. An overall assessment of advances and possibilities across the spectrum and its use, is needed for a start. Deliverables from a 6 month study would set the way forward for new research projects.

2.22 Adaptive/Mimo antenna systems

This is embraced in Topics 2.14, 2.15 and 2.16. These concepts have been shown to have great benefit based on idealised simulated data but in reality, the algorithms must precisely relate to the channel of interest. A formulative study is needed to identify how to readily apply these techniques

in practice without extensive channel measurements. The deliverables here are demonstrations that the techniques can be engineered and realised in given systems at acceptable cost.

2.23 UWB and Soft Radio

I think that the fundamental issue here is how much the perceived benefits of these new techniques are off-set by the possible raising of the noise/interference floor and degradation of the service. A fundamental study investigating the spectral efficiency is needed and Topics 2.6 and 2.9 are in keeping with this aim. Topics 2.4 and 2.5 are too general in their present wording. Topic 2.10 needs developing to reflect the effects on spectral efficiency.

2.24 Propagation

Whilst the available spectrum has already been extensively studied over the years there will be a continual need to identify new opportunities for improved use of the spectrum. A short study is needed to give a forward looking view of likely areas for advance, (Topic 2.16).

3.0 The following topics were considered "outside the radio related field" (Some topics may be of interest in the wider "OFCOM" context.)

INTERNET MODEMS: Cable modems have now overtaken xDSL by a factor of 10 and they look like becoming the Access vehicle of choice to the consumer. Use of Internet Modems as Internet feeders to large Multidwelling high-rise buildings and "Ethernet"-centric twisted pair distribution within the buildings is also a new direction. (US viewpoint)

INTERACTIVE MOVIES: Interactive movies is one of the future concepts of the entertainment media in which participants will be able to dynamically interact with the actors and environments in the movies. The combination of web-based mediation and computer generative simulation of story events and scene creation will enable participants to experience the dynamic unfolding of movies through the interactive involvement with virtual actors and the world which they inhabit.

AUDIO/VIDEO ON NEXT GEN. INTERNET: Multimedia signals which have been conventionally sent via telephone networks or via broadcast networks are now ready to be transmitted via Internet. Those signals are either in stream or large bulk data type and will be required a variety of quality. We need new technologies to ensure quality of services for transmitting these signals on Internet because Internet has been designed for best-effort services. The new technologies include signal processing, layers 1 to 3 protocols, and collaborations of signal processing and protocols for QoS assurance.

DENSE WAVELENGTH DIVISION MULTIPLEXING: Optical communications is an area in which Ultra-high data rates have reached a speed with which many "Encyclopedias" may be transmitted within a second. However, this comes at a premium cost. The following are some HOT topics in Optical Communications:

Anti-dispersion techniques to increase span of fiber
High Density of wavelengths in a single fiber

- High bit-rate per wavelength
- Transmission methods to decrease wavelength interaction
- High density and fast optical cross-connects
- Drop and Add optical muxes, for single wavelength and for a band of wavelength
- Fast optical tunable components: transmitters, receivers and filters
- Accurate wavelength converters
- Wide-range flat-spectrum optical amplifiers
- Low loss optical components
- Low cost optical components
- Optical switching fabrics (MEMS and other technologies)
- Tunable optical components
- New optical material (ultra-prisms, ultra-fast switches, etc)

HIGH-SPEED PASSIVE OPTICAL ACCESS NETWORKS: Fiber to the Curb, Fiber to the Home and Fiber to the Office are technologies that promise the delivery of massive amount of bits in a short period. Multimedia and Internet services, including video, will require high-BW to the home. Although broadcasting video requires asymmetrical transmission, interactive video and terminal to terminal video communication requires symmetrical. Thus, in "optical access" networks new bandwidth management algorithms are needed to manage BW efficiently.

VOICE over IP:

(BT Labs may be doing some research on this.?)