

Wireless Enabling Technologies to Support Interworking of Networks

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Introduction

Wireless is today recognised as a key enabler of future consumer products, with potential applications ranging from high bit-rate video conferencing and movie viewing to simple 'house keeping' tasks in domestic appliances. Furthermore, in the next 5 to 10 years wireless technology is expected to witness further phenomenal growth not least because of the foreseen interworking of Broadcast and Personal Communications. To support this trend, significant technological advances will be required to ensure that wireless devices can provide appropriate transport mechanisms for the new applications that the interworking of mobile and broadcast industries will offer the end user.

The Core 3 programme of the Mobile and Personal Communications Virtual Centre of Excellence (MVCE) is focussed on researching topics relevant to the interworking of networks. The programme is divided into three work areas; Interworking of Networks (IoN), Personal Distributed Environment (PDE) and Wireless Enablers. This position paper reviews the background and work programme for the Wireless Enablers work area, which is addressing new physical and data link layer technologies required to enable the concept of interworking of networks.

Programme Motivations

Mass deployment of wireless devices (10's or 100's of devices per person or home), together with bandwidth hungry applications (such as store-and-forward concepts for less-time-critical services), will place tremendous new challenges upon both efficient usage and regulation of the spectrum. Such dense and intense user environments will demand development of new approaches to managing spectrum efficiency, with 'polite' radio being an essential component, if the deployment of wireless personal networking is to be a viable concept. Here, new wireless technologies, such as emerging ultra-high data rate short-range communication methodologies, are key drivers. Higher level modulation methods, advanced source and channel encoding as well as smart antenna techniques are also potential candidates, with multiple-input multiple-output (MIMO) wireless architectures known to offer significant gains. Although understanding of the operation and suitability of the latter for mass-deployment is currently poor, such generic technologies form a good basis for research of optimised high rate, in-home, in-vehicle and personal environment wireless systems.

The provision of a single user device serving as the 'porthole' to broadcast services, personal interconnect to both cellular and LAN networks, as well as control of appliances within the home environment, is also a main driver within this work area. Clearly, such a wireless device must be capable of attaching to many interface standards at least serially or possibly even in parallel (concurrent multimode). This raises issues both of co-existence of many standards in one device and of transparent reconfiguration to the numerous air interface standards in use today, as well as accommodating future developments and refinements. Clearly for a multi-ported device, schemes for mitigating interference between the different radio access systems will be required. This issue may be compounded by the drive towards Software Defined Radio (SDR), which tends to rule out fixed filtering solutions to such problems.

Objectives

Within the scope of the MVCE Core 3 programme, the objectives of the research within this work area fall within two distinct classes:

- High speed personal area networks (PANs) to enable rapid transfer of data or content during brief periods when in the proximity of a suitable source.
- Multi-standard terminals which can handle simultaneous connections to the networks of both industries.

The key research problems to be addressed for the high-speed PAN concept are summarized as:

- Identification of bandwidth efficient transmission methods, as well the potential utilisation of higher frequencies.
- Improved methods of spectrum sharing to accommodate both bursty and isochronous data types.

- Identification of suitable metrics for (overall network) spectrum efficiency in dense personal environments in order to assess new access methodologies.

Additionally, for multi-standard terminals the following problems will be appraised:

- Identify architectures which allow a single silicon implementation to demodulate multiple standards in a cost and power efficient way.
- Support of mobility in systems such as DVB-T, where current implementations are unsuitable for handheld devices.
- Methods and enablers of achieving simultaneous support of multiple bearers (e.g.: OFDM based technologies, UTRA & GSM (including variants), as well as possible future developments of air interface standards.

Work Items

The Wireless Enablers work areas is divided into two work packages, one to address opportunistic PAN technologies, and another to address the multimode terminal aspects.

High speed PANs for opportunistic communications

Much of the work in this package relies on having a good understanding of the radio channel characteristics. This is particularly true for body worn devices, where, although mobility may be low, variation of path loss due to body shadow can be substantial and radio paths between devices will rely on multipath. Thus channel characterisation forms a critical activity. Following from this the design of efficient and resilient coding and modulation schemes (the air interface) can be carried out, to make best use of the available channel.

Many PAN technologies are expected to operate in shared spectrum, and at the least a PAN will have to co-exist with other PANs. Efficient medium access control (MAC) and radio resource management (RRM) algorithms are being assessed in the PAN environment. To be considered is whether distributed or centralised algorithms are the best approach, balancing spectrum efficiency and QoS requirements. The level of coordination between devices will be considered, for both the same and different PANs. Interaction with the PDE work area will ensure QoS provision can be managed and supported across protocol layers. In most situations a degree of interference has to be accepted, and so the optimisation of the air interface along with interference mitigation processing (in the temporal and spatial domains) will be considered.

Multimode terminals

Where multiple standards are to be supported, a common architecture that allows the sharing of hardware resources between standards will lead to cost minimisation. Aspects to be considered are the sampling architecture to allow common clocks (with appropriate sample rate conversions), time scheduling of resources (such as FFT processors or decoders) and common synchronisation processes. New concepts in linearised power amplifier design are being investigated to support the increased linearity requirements for multiple concurrent transmissions.

Terminals will only have finite resources, and users will have different terminal capabilities. Interaction with the PDE work area will ensure the feature discovery protocol is aware of terminal hardware capabilities (such as FFT symbol rate and buffer size), and the associated QoS limitations (such as limited support for real time applications).

While much of the Core 3 programme is considering interworking with existing air interface standards, some of the work is considering how these may be extended using new multi-channel and multi-antenna concepts. Associated synchronisation processing to enhance mobility will also be investigated.

Conclusions

A multi-faceted research programme has been described to support the physical and data link layer aspects of the interworking of networks concept, as part of the MVCE Core 3 work programme. Two broad topics are addressed; PAN technologies for interference dominated environments and multimode terminal architectures and technologies. The programme will maintain close links with the two other work areas within the Core 3 programme (IoN and PDE) to ensure cross-layer interactions maximise performance and QoS provision.

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