RECEIVER SOLUTIONS AND TECHNOLOGY

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ABSTRACT

The evolution of the Eureka 147-Digital Audio Broadcasting (DAB) standard for delivery of audio data to its application for digital mobile video delivery, such as with the Terrestrial Digital Multimedia Broadcasting (T-DMB) standard, heralds a new age of flexibility in broadcast-related technologies. The increasing pervasiveness of digital broadcasting will be seen in not only changing the face of traditional audio and video broadcasting, but also in an increase in breadth of scope for future applications that deliver a wide spectrum of data for diverse fields beyond entertainment. In this paper, the authors survey existing, as well as suggest novel applications of digital broadcast technologies that may emerge outside of the traditional area of audio and video broadcast applications and discuss the technology-enablers that may be required to realise such applications.

INTRODUCTION

There are numerous open and proprietary digital broadcasting standards that are in different stages of adoption and maturity around the world today and more are yet emerging. There is little doubt that the future of broadcasting will be quite different from traditional analogue broadcasting as we know it. This migration towards digital broadcasting rides on the convergence of a myriad of technological advances that enhance quality, drive down costs and create new opportunities.

These technological advances amongst others include: the digitisation of broadcast content that enables high quality reproduction of audio and video; the development of audio and video codecs delivering high levels of data compression without perceived loss of quality; the development of high performance, low power digital signal processing; the development of high performance colour displays and exponentially decreasing cost of functionality.

However, in many cases these advances are not limited to broadcasting. As such, broadcasters no longer have a monopoly over such content provision as entertainment, news or documentaries by electronic networks. The increasingly widespread availability of high speed Internet connections, through wired connections such as xDSL-enabled lines, cable, as well as unwired means[1] such as 3G and future mobile telephony platforms and 802.16 wireless metropolitan area networks (MANs), provide additional and increasingly pervasive channels for the delivery of media content to end-users on-demand.

While the monopoly on content provision no longer exist, nevertheless the very nature of broadcasting makes it still a very compelling and efficient means of delivering information to a large population. This broadcast of data over existing broadcast infrastructure is often simply termed as datacasting[2].

For this discussion, we focused on terrestrial datacasting that is possible such as with terrestrial DAB and DMB infrastructure as opposed to satellite or other forms of datacasting. Terrestrial datacasting as a conduit offers numerous advantages, including:

1. Near real time, simultaneous reception at all locations[3]
2. Indoor and mobile reception is possible
3. Well defined end-user coverage possible through conditional access[4]
4. Multiplexing of different data services on a single channel
5. Single frequency networks possible in some implementations[5]
6. Push-based content
7. Secure content possible through encryption[4]
8. Distribution costs are independent of the number of receivers[3]
9. Highly scalable and congestion free[4]
10. Very low cost broadband data service possible[6]

In this paper, we looked beyond the delivery of enhanced quality of audio and video content that is possible with digital broadcasting and survey existing datacasting applications, as well as explore novel datacasting applications that leverage these advantages of terrestrial broadcasting. With the capability of non-programme associated datacasting, the broadcasting medium has the potential to undergo a paradigm shift and play a significant role in the revolution towards a society of pervasive and ubiquitous data consumption.

APPLICATIONS OF DATACASTING

Datacasting is not new at all and its earliest incarnation is probably the Teletext system developed by the BBC and launched in 1976 [7]. In many Teletext systems that were available then and now offers both programme associated data (PAD), such as electronic programme guides (EPG), subtitles, instructions for programming video recorders, as well as non-PAD information such as regularly updated news, weather, and even airline schedules in airports. The available bandwidth for Teletext is very narrow by today’s standard and many decoders use a cache to speed up browsing times.

With digital broadcasting, the bandwidth for datacasting need not be limited to during the vertical blanking interval of analogue broadcast television systems without loss of video quality, nor restricted to video broadcasting; datacasting is possible over both digital audio and video broadcast systems. This significant increase in available bandwidth allows for richer audio and video consumption with PAD information as well as creates new opportunities with non-PAD information.

Programme Associated Data

Besides high quality audio and video data, digital broadcasting is often sold as delivering enhanced programme associated data, such as electronic programme guides (EPGs), song lyrics and album art, as well as multi-language subtitles as an extension to the Teletext system.

Further enhancement to the user experience may be obtained by providing browsing, filtering and summarisation functionality in conjunction with time-shifting of content. As hard disk recorders gain popularity and increase in storage, it would be possible to amass a lot of multimedia data, not all of which may be interesting to the user. Salient information may be extracted from the content through automatic or human analysis to provide browsing, filtering and summarisation functionality through the automatic or manual analysis of the content[8]. The analysed content may be annotated with XML tags, and this auxiliary data may then be broadcasted together with the content, allowing compatible receivers to decode and offer browsing, filtering and summarisation functionality[9].

Non-Programme Associated Data

Non-PAD datacasting breaks away from the traditional audio and video content associated with broadcasting and as such serves as a technology enabler for new applications and business opportunities that will increase bandwidth usage.

Low cost data transfer.

Datacasting may serve as a conduit for low cost background data transfer. This would be useful in applications where large volumes of data for later consumption, in contrast to streaming data such as in digital audio and video broadcast, have to be distributed over a wide area. Such systems would have to consider off-peak transmission times for cost and bandwidth optimisation, re-transmission of data packets at regular intervals over a fixed period to deal with receivers that are not operational during the datacast, or transmission errors, and receivers with data storage functionality at least to cache the data until the complete payload is delivered and applied. In these applications, it may be useful to have receivers which are regularly polling if useful data is being transmitted to optimise network usage. Ideally, these receivers are power efficient to minimise the power overheads that this entails. Example applications include datacasting of music- and video-on-demand, remote learning content, dynamic advertisement billboards and software packages.

Targeted recipients.

In many cases, such applications would need to restrict the usage of the data to specific recipients. This may be achieved by scrambling/descrambling the data either with the conditional access in the transport layer as codified in the broadcasting standard or through IP-based or other means in the application layer.

Timeliness of data.

With smaller chunks of data, datacasting may be applied to provide timely information updates to a large number of receivers. Common applications that require timely delivery includes stock market information, environment information such as weather, traffic, news and time, as well as homeland security alerts which may be increasingly pertinent in a post-9-11 world[4].

Simultaneous reception.

This timeliness of datacasting may also be exploited to coordinate systems that require simultaneous reception and are spread over a large geographical area. One possible application may be in the centralised coordination of traffic lights to optimise traffic flow and minimise congestion in metropolitan areas. Traffic conditions may be fed back via various means to a centralised command centre, which may then react by transmitting parameters governing the changing of individual or groups of traffic lights accordingly. Such a system would simplify the maintenance of the traffic light network and reduce infrastructure cost as low cost receivers replace expensive costs associated with wiring.

Another possible application is in the coordination of prices and promotions in chain stores and franchises spread over a large geographical area. The prices of goods or specific promotional activity may be updated to all stores within broadcast coverage simultaneously from a centralised location. While similar functionality may be achieved through an Internet-based system, in such cases, timeliness is not guaranteed. Furthermore, the operating costs scale with the number of nodes or stores as Internet services are often subscription based.

Rapid scalability.

Another application requiring coordinated systems spread over a large area is the emergency and security response system of a city or a country. In such a system, beyond simultaneous communications, there is also a need for rapid scalability which is easily achieved with datacasting but not with Internet- or other point-to-point based solutions[4].

Location-derived context.

Datacasting may operate in conjunction with global positioning system (GPS) units to enable intelligent receivers that are capable of delivering information depending on its location. For example, location specific information such as tourist attractions, restaurants, as well as traffic conditions may be broadcasted over a wide area at regular intervals. An intelligent receiver would be able to cache, filter out and select only the information pertinent to its vicinity as predefined by user preference.

PRACTICAL RECEIVER CONSIDERATIONS

Datacasting applications may come into its own when the necessary transmitter infrastructure is in place, there is available low cost bandwidth for data applications, and there are data-enabled low cost and portable receiver modules available.

As more countries move to meet their schedule to transition from analogue to digital broadcasting, transmitter infrastructure are being put in place to enable this migration. Bandwidth for datacasting applications would become increasingly available and at reducing cost as spectrum is allocated or made available for digital broadcasting and as legislative bodies recognise the value of datacasting.

Receiver costs

By providing greater functionality through broadcast networks, datacasting applications increase the perceive value of the network and help drive adoption of the solution and drives down costs. Data-enabled receiver modules are required as fundamental hardware in the datacasting ecosystem to support the applications built on top of them. The development and adoption of standards provide manufacturers with greater confidence to migrate from using generic solutions to develop increasingly dedicated and optimised solutions that will increase performance and reduce costs. Dedicated and optimised receivers reduce the bill of material, improve manufacturability and result in faster time to market, all of which help to reduce the overall cost of the solution.

In commercial applications, the attractiveness of datacasting would increase as the cost of incorporating wireless datacast receiver modules at every node falls below the cost of building up and maintaining alternative infrastructure such as wired networks or other wireless point-to-point solutions that depend on a subscription model. Notwithstanding electricity cost, the distribution cost of a datacasting network is independent on the number of receivers. This drives down operational costs as well as the cost of scalability.

Power consumption

Terrestrial datacasting is part of the strategy towards ubiquitous and pervasive computing and the consumption of content anywhere[10]. To this end, receivers must be portable in size and power efficient. Power efficiency in receivers is important as it impacts operating time of portable devices before requiring a recharge, heat dissipation and comfort factor for devices requiring human interfacing and interaction, and in the long run have a significant impact on the energy demands of power distribution networks particularly during peak usage.

As with other digital electronic devices, datacast receivers would benefit from higher levels of integration and reducing supply voltages that are required to support ever smaller transistors. Beyond this, there is much scope to exploit the time multiplexing of services on a multiplex to reduce the operation time of receivers to the bare minimum through the use of time-slicing and power cycling. This is supported in both DVB-H[11] as well as in DAB[11, 12]. Through the use of time-slicing and power cycling, the actual operation time of the receiver may be made proportional to the fraction of the data rate that is required of the active application.

CONCLUSION

Digital broadcasting redefines the traditional boundaries of broadcasting and offers great flexibility and potential to play a significant role in the way people consume information. Realisation of this goal requires a convergence of numerous factors, including technology, business models and favourable legislature. Future Waves is aggressively innovating in the area of receiver technologies to reduce the overall cost and power consumption of radio receivers and are constantly seeking out collaboration with like-minded entities to realise the dream of a pervasively connected world.

BIBLIOGRAPHY

[1] D. Maxson, "Lessons from DTV Datacasting As They Apply to Digital Radio Deployment Strategy," *Broadcast Signal Lab*, 2002.

[2] "Datacasting", Wikipedia, http://en.wikipedia.org/wiki/Datacasting.

[3] J. C. W. van der Waal, "DAB datacasting in the Netherlands," presented at Broadcasting Convention, 1995. IBC 95., International, 1995.

[4] Testimony of J. M. Lawson, President and CEO, Association of Public Television Stations, before the U.S. Senate Subcommittee on Disaster Prevention and Prediction hearing, "Digital Television Transition," on 27 July, 2005.

[5] W. Hoeg and T. Lauterbach, *Digital Audio Broadcasting: Principles and Applications of Digital Radio*, 2nd ed. Chichester, England: John Wiley & Sons, 2003.

[6] R. Johansson, "Value added services in digital radio," presented at WorldDAB Forum Conference - Delivering Digital Broadcasting, KaoHsiung, Taiwan, June 2005.

[7] "Teletext", Wikipedia, http://en.wikipedia.org/wiki/Teletext.

[8] Y. Rui, Z. Xiong, R. Radhakrishnan, A. Divakaran, and T. S. Huang, "A Unified Framework for Video Summarization, Browsing and Retrieval," *Mitsubishi Electric Research Laboratory Technical Report*, 2004.

[9] B. L. Tseng, C.-Y. Lin, and J. R. Smith, "Video Summarization and Personalization for Pervasive Mobile Devices," presented at SPIE Electronic Imaging 2002 - Storage and Retrieval for Media Databases, San Jose, 2002.

[10] S. Pizzi, "DAB's Place in a Convergent Media World," presented at Radio in the iPod age - WorldDAB Programmers Conference, Munich, 2004.

[11] A. Sieber and C. Weck, "What's the difference between DVB-H and DAB - in the mobile environment?," *EBU Technical Review - Broadcasting to Mobiles*, July 2004.

[12] C. Sim, "Power cycling to reduce power consumption in DAB tuners," presented at WorldDAB Forum Conference - Delivering Digital Broadcasting, KaoHsiung, Taiwan, 2005.