13th International Conference & Exhibition
on Terrestrial & Satellite Broadcasting

1st, 2nd & 3rd February, 2007
Pragati Maidan, New Delhi (India)

Conference Proceedings

Organised by
Broadcast Engineering Society (India)
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Message

Hon'ble Vice-President of India is glad to know that Broadcast Engineering Society (India) is organising the 13th International Conference and Exhibition – BES Expo 2007 during February 1-3, 2007 in New Delhi.

Vice-President of India extends his good wishes to the organisers and wishes the Conference and Exhibition BES Expo all success.

(K.L. Kochar)

New Delhi
8th December 2006
The Prime Minister is happy to know that the Broadcast Engineering Society (India) is organizing the 13th International Conference and Exhibition on Terrestrial & Satellite Broadcasting – BES EXPO 2007 from 1st to 3rd February, 2007 at New Delhi.

On this occasion the Prime Minister extends his greetings and good wishes to the organisers and participants for the success of the BES EXPO 2007.
Message

I am happy to note that the Broadcast Engineering Society (India) is organizing the 13th International Conference and Exhibition, BES EXPO 2007 from 1-3 February 2007 in New Delhi: 'Multi-faceted Broadcasting - Present and Future', is very apt theme for the conference in the present challenging media scenario in the country for assessing our potentials and to take timely measures for further progress.

The EXPO will provide a common platform for international companies to show case their latest equipment in the broadcast sector available today. With the representation of a good number of companies from different countries the EXPO will definitely be a great opportunity to all to interact on the latest know-how in this field.

My warm greetings to all the participants and the organizers and wish for the success of the EXPO.

(P.R. DASMUNSI)
Message

भारत के हरे का विश्वास है कि ब्राह्मणवादुप्रदेश निर्माण दिवस एक अवसर है। यह दिवस सामाजिक समृद्धि की दिशा में आगे आने के लिए देश के सभी स्तरों के लोगों के लिए एक अवसर है।

मंत्री चयन व विकास भवन, नई दिल्ली-110 001
Message

I am indeed very happy to know that the Broadcast Engineering Society (India) is working for the dissemination of knowledge and practice in the field of broadcasting since long. In their effort to update the engineering fraternity of India the Society will be organizing its 13th International Conference and Exhibition - BES EXPO 2007 on a very befitting theme Multifaceted Broadcasting : Present and Future from 1 - 3 February 2007 at New Delhi.

I am confident that this international show shall definitely be helpful to the participants in updating themselves with the latest technologies and services in the field of broadcasting available world over.

I convey my heartiest greetings to the organizers and the delegates and wish the BES EXPO 2007 a grand success.

With all the Best Wishes and Happy New Year

[ M. H. AMBAREESH ]
Message

I am pleased to learn that the Broadcasting Engineering Society (India) is organizing its 13th International Conference and Exhibition on Terrestrial & Satellite Broadcasting from 1st - 3rd February, 2007 at Pragati Maidan, New Delhi.

Broadcast technology is witnessing rapid development and I believe, an international conference like BES Expo 2007, provides an ideal platform for exchange of views and ideas among broadcast professionals from across the world. The theme of the Conference – “Multifaceted Broadcasting: Present and Future” is befitting to current needs.

I wish the event a grand success.

(B. S. Lalli)
I am delighted to learn that the Broadcast Engineering Society (India) is organising the 13th International Conference and Exhibition on Terrestrial & Satellite Broadcasting – EXPO 2007 from 1st to 3rd February 2007, in New Delhi.

Terrestrial and Satellite link capability brought a new dimension of excitement to the world of broadcast television, an area in which the development of digital techniques is progressing rapidly. The contribution of Broadcast Engineering Society (India) in this area is laudable. I am sure that the deliberations in this conference and the global exposure to state-of-the-art products will be of immense help to our broadcasting professionals.

I wish all success to the organisers of the BES EXPO 2007 in their endeavour.
Message

It is a matter of great pleasure that Broadcast Engineering Society (I) will be organizing their 13th consecutive international Conference and Exhibition on Terrestrial & Satellite Broadcasting from 1-3 February, 2007 at New Delhi.

I have the privilege of having seen the previous events organized by the Society, which had really been very informative, interactive and useful not only to the engineers but to the entire broadcasting fraternity.

I hope that this show will be even more useful in the present scenario of broadcasting when new technologies are coming very quickly throughout the globe. This Expo shall definitely be providing an opportunity to the broadcasters to update their knowledge.

I offer my best wishes for the success of the Conference.

(Brijeshwar Singh)
Message

I am pleased to know that the Broadcast Engineering Society (India) is organizing 13th International Conference & Exhibition on Terrestrial Satellite Broadcasting on the theme : Multi-Faceted Broadcasting: Present and Future during February 1-3, 2007 at Pragati Maidan, New Delhi.

Indian economy is on the boom cycle. The communication sector’s modernization will further give stability to this growth cycle of the economy and therefore the event is apt and timely.

The broadcasting segment of the communication sector in India has grown rapidly over the last few years and the trend is expected to continue. In terms of growth which includes all the segments of the broadcasting industry including Film and Entertainment, TV and Radio, the growth during the period from 2007-2010 is anticipated from US $ 10 billion to around 30 billion respectively.

Over 350 companies from 25 countries are participating in the event which will bring under one roof a display of the latest state-of-the-art technology of the satellite broadcasting from the technologically advanced countries. This technological showcasing will go a long way for Indian companies and other players of broadcasting to innovate and come up to the standards of the advanced countries in the competitive area of broadcasting apart from bringing in more DTH to the sector. With this, India will emerge as one of the important players in the international broadcasting market.

I would like to congratulate the organizers particularly Shri A.S. Guin, President of the Broadcast Engineering Society (India) - a Member Association of the Engineering Council of India- for organizing this important event.

I wish the event all success.

(Uddesh Kohli)

Tel.: (0) 2337 9472/8521/9471/8620
Fax: 2337 9478 E-mail: ecindia@vsnl.net
www.ecindia.org
I am extremely delighted to note that the Broadcast Engineering Society (India) with the approval of the Ministry of Information & Broadcasting, Government of India is organizing 13th International Conference and Exhibition – BES EXPO 2007 on the theme “Multi-Faceted Broadcasting – Present and Future” under (Terrestrial & Satellite Broadcasting) on 1-3 Feb 2007 at Pragati Maidan, New Delhi.

The technological changes around the world are stimulating the growth of Terrestrial & Satellite Broadcasting and evolution of innovative products and services in India as well as in the other countries. I am sure the deliberations of the Conference will bring out the latest advancements in these fields and will be educative as well as purposeful for professionals and exhibitors.

I extend my heartiest felicitations to the organizers and exhibitors and wish the Exhibition and Conference a grand success.

(S NARAYANA)
Message

I am delighted to see that the BES International Conference & Exhibition is going from strength to strength, and establishing itself as one of the premier broadcasting industry events in South Asia.

I had the honour of presenting the keynote address at the BES Expo in 2004. A lot has happened globally on the broadcasting field in the three years since. India has seen emergence of a large number of FM commercial radio broadcasters. Several DTH platforms have emerged as viable and successful business ventures. While mobile broadcasting has made quite a splash in Korea and Japan, efforts are underway to set up services in India. Additionally, the Internet now poses a greater challenge to broadcasters, with broadband networks and IPTV becoming a reality.

India continues to be one of the most dynamic broadcasting markets attracting many new players. In this context, the BES Expo is called upon to play quite a crucial role, channelling information and creating platforms for exchange of industry related know-how. As a BES Honorary Fellow, I am delighted to see that the BES is carrying out this role most effectively. The ABU is pleased to be a supporter of this activity in India and in the region.

David Asley
Secretary-General
Asia-Pacific Broadcasting Union
“This is the first year that the International Association of Broadcasting Manufacturers (IABM) is endorsing BES Expo. I visited the 2006 event and was most impressed with the event and my visit together with member opinion has provided the justification we needed to formalise our support for 2007.

BES EXPO is now a flagship event in the suppliers' calendar and one which is important for companies who want to partner with Prasar Bharati and other content creators in India. The creation, capture and production of digital content is an exciting area to be working in at present. File based workflows, high definition, new delivery platforms and convergence with IT and Telecomms are creating new challenges and opportunities. Broadcast and Media Technology is facing unprecedented change and that means events like BES EXPO give everyone an opportunity to update, understand and form new relationships.

Recent research, undertaken by the IABM, highlights that fact that exhibitions and conferences are the most popular way for broadcasters and others to keep up to date with products, services, technology and best practice. The move to Pragati Maidan will provide new challenges and opportunities for this important event. The Indian Market is valued at about US$2BN for broadcast and media technology products and services and BES EXPO provides an ideal opportunity to connect suppliers with their potential customers.

Our 250+ supplier members around the world closely follow the IABM’s reviews of events and use them as part of their decision making process. I’m delighted to see so many of our members represented at BESexpo2007 and I look forward to meeting industry friends and colleagues in Delhi this February.”

Roger Crumpton
Chief Executive Officer
IABM
Message

UNESCO fully endorses the objectives of the Broadcast Engineering Society (BES) of India and its contribution over the past two decades to the advancement and dissemination of technological knowledge in the field of radio and television broadcasting.

The LIES EXPO 2007, Conference and Exhibition is taking place at a critically important time as the pace of technological innovation globally continues to outstrip that achieved by all previous generations. It also comes in the wake of broadcast legislation recently passed in the Indian Parliament to widen the scope of broadcasting to include community groupings. The EXPO 2007 theme itself, "Multi-Channel broadcasting — present and future", heralds new and far-reaching approaches in overcoming problems of universal access to information, particularly for marginalized and isolated citizens in society, both in terms of diversified local content creation as well as technology.

On behalf of UNESCO, I bring you greetings and warmest wishes for a successful 2007 Conference and Exhibition focused on current realities and future prospects of serving people's needs through diversified broadcasting.

Mina Yang
Representative and Director
UNESCO Office in New Delhi
# Conference Programme

**Theme:** Multifaceted Broadcasting: Present & Future

**Venue:** Hall No. 9, Pragati Maidan, New Delhi

### 1st February 2007

**Session I: Mobile TV Anytime & Anywhere**

- **Session Chairman:** Mr. Sharad Sadhu, ABU
- **Speakers:**
  1. Mobile TV: More than TV, more than 3G: Mr. N. Jain, Qualcomm
  2. Broadcast to handheld technologies: Mr. Pawan Gandhi, Nokia
  3. Receivers for mobile broadcasting: Mr. William Lam, Zentek Technologies
  4. 3G technologies: Mr. R. N. Padukone, DoT

**Tea Break**

**Session II: Digital Radio: Emerging Scenario**

- **Session Chairman:** Mr. A. Bhaskaranarayana, ISRO
- **Speakers:**
  1. Digital Radio production & transmission technologies: Mr. Y. Pal, AIR
  2. DRM: Mr. Peter Senger, DRM
  3. HD Radio: Mr. Charles W Kelly, Nautel Ltd. Canada

**Lunch**

### 2nd February 2007

**Session III: Role of Broadcasting in Warning and Disaster Management**

- **Session Chairman:** Mr. Baljeet Singh Lalli, CEO, Prasar Bharati
- **Speakers:**
  1. Broadcasters’ preparedness for disaster: Mr. P.G. Dharchakraborty, NIDM
  2. Emergency Warning System with Analogue & Digital Broadcasting: Dr. Yasuhiro Ito, NHK
  3. Emergency Warning System with Analogue & Digital Broadcasting: Mr. Rahul Kumar, World Space
  4. Community Radio: Ms. J. Josiah, UNESCO

**Tea Break**

### 3rd February 2007

**Session IV: Digital Media Lifestyle**

- **Session Chairman:** Mr. R. C. Chopra, Deptt. of IT
- **Speakers:**
  1. Consumers expectations/more media or more services/PRDs [Personal digital recorders]: Mr. A. Saxena, DMCL
  2. HDTV Trends: Mr. C.K. Jain, Doordarshan India
  3. DTTB Issues and Challenges: Mr. Hing Tung Lau, Media Corp.
  4. WiMax: Mr. A.K. Bhargava, MTNL

**Panel Discussion**

**Session VII: Panel Discussion**

- **Session Chairman:** Mr. Brijeshwar Singh, Director General, All India Radio
- **Panelists:**
  1. Dr. C. Muralikrishna, Advisor (ICT), Planning Comm.
  2. Mr. L. D. Mandloi, DG, Doordarshan India
  3. Mr. Rajiv Mehrotra, Managing Trustee, PSBT
  4. Mr. Vikram Kaushik, MD & CEO, TataSky
  5. Rajesh Sawhney, President, Reliance Entertainment
# BES Council 2006-2009

<table>
<thead>
<tr>
<th>Name</th>
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### Local Chapters

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<th>Hon. Treasurer</th>
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### BES Committees

**Advisory Committee:** H.S. Jolly, N.K. Trivedi, B.K. De, R.K. Gupta & N.S. Ganesan

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<td>1.</td>
<td>BES EXPO Event (Exhibition)</td>
<td>A.V. Swaminathan</td>
<td>P.K. Singh</td>
<td>R.K. Buthinjaa, George Kuruvila</td>
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<td>BES EXPO Event (International Conference)</td>
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<td>W.B. Prasad</td>
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<td>BES Journal</td>
<td>Ashish Bhatnagar</td>
<td>N.E. Kumaraswamy, P. Das</td>
<td>Pradeep Mehra</td>
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<td>8.</td>
<td>Industrial Relations &amp; Awards</td>
<td>D. Ray</td>
<td>Ghanshyam, S.C. Khasgiwal</td>
<td>Abhishek Aggarwal</td>
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<td>10.</td>
<td>New Members Induction</td>
<td>O.P. Bhatti</td>
<td>S.J.D. Derasahayam, G. Biswas</td>
<td>V.K. Upadhyaya, Sunil</td>
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<td>11.</td>
<td>Local Chapters Coordination</td>
<td>L.V. Sharma</td>
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<td>BES Website Management</td>
<td>Yogendra Pal</td>
<td>R.P. Joshi, Neeraj Goel</td>
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Mr. Roger Crumpton
CEO (IABM)

Keynote Address

Abstract
During 2006 the IABM has undertaken several major pieces of market research to explore the size and structure of the broadcast and media technology marketplace. Those studies have also examined the strategies being pursued by the market leaders and have explored the way the global market is likely to develop. In this keynote address the outcomes of this work will be explained and developed to help delegates examine the changing nature of the market in India in a wider international context.

The Broadcast & Media Technology Business, Global Market Value, Structure & Strategy To 2010
Mr. Roger Crumpton  
CEO (IABM)

Abstract
During 2006 the IABM has undertaken several major pieces of market research to explore the size and structure of the broadcast and media technology marketplace. Those studies have also examined the strategies being pursued by the market leaders and have explored the way the global market is likely to develop. In this keynote address the outcomes of this work will be explained and developed to help delegates examine the changing nature of the market in India in a wider international context.
Roger Crumpton has more than 25 years experience as a company director in the technology sector. Originally trained as an electronics engineer, Roger has spent most of his working life in sales, marketing and general management and has been responsible for setting up, acquiring and managing businesses in the UK, USA, Germany and Norway. Prior to joining the IABM, Roger was most recently European Managing Director of AIIM the US based Enterprise Content Management Association.
Introductory comments
Thank you for inviting me back to BES Expo. I am honoured to be invited to address your conference. In this presentation I am going to review the changes issues that we as broadcast and media technologists all have to face up to in the months and years ahead. But first of all let me set the scene. I’m going to show you a commercial.

New generation advertising
Transitions by broadcasters from single channel to multi-channel delivery, the rise of subscription based pay TV services and the arrival of the personal video recorder have advertising executives and commercial operators anxious about the future. One of their responses to these issues is to create advertisements like the one you’ve just seen. They have real entertainment value in their own right. More of the future in a moment. I’d just like to spend a little time reflecting on the past.

Reflections
I can remember, no doubt like many of you, when the first TV set came into our wider family and everyone was transfixed by the concept of television. I can also remember when my mother and father bought their first black and white TV set and we had one in our own home. We felt very privileged. Some years later that same sense of elation and excitement was back when I first saw colour television. It was at the home of an affluent neighbour – my family couldn’t afford it! I similarly remember the installation of our own telephone and then many years later my first sight of a mobile telephone. What a size that was!

These reflections and memories are something that many of today’s generation of young people will never have. So many of them are growing up with television and other electronic entertainment, universal telephony and connectivity as the default. They expect and demand nothing less and they are typically not impressed with it. It is a “given”. What excites the younger generation is the content and not the delivery platform. They expect to access and interact with the content of their choice at the time they choose, in the place they choose. They also expect to interact with anyone that they choose.

Changing demography
For those of us familiar with, and typically comfortable with, linear broadcast output, this is often a difficult phenomenon to truly grasp. Our lives have been framed by the integration of parts of the linear TV and radio schedule into our everyday activity. There is a danger therefore that we are slow to fully appreciate the change dynamic that is impacting broadcasting and media technology. It’s useful to look at the age demographic to put the situation into perspective. Less than 19% of the population of the UK is under 15, in the US it’s about 20% and in India that is more than 35%. The average age in the US is 36 years and here it is 24 years. The aspirations and demands of the next generation will dictate the broadcasting environment that you and I must understand, specify and help to implement.

Multiple platforms
The new young consumers are, or will quickly become, platform neutral. They will expect to view their favourite soap or download the latest music video, watch the live cricket or play their favourite game wherever they are and on the device of their choice. Their behaviour and their demands will be non-linear. As time passes they will become more “cash positive” and “time negative”. The time deficit will mean they will set their own priorities for their entertainment and information resources and those priorities will set the agenda for content creation, production and delivery in the years ahead.

As Broadcasters you will increasingly be specifying and implementing an infrastructure to support both linear and non-linear delivery of digital content to a wide variety of platforms. Over the years ahead you will create or acquire that content to the highest standard possible and you will repeatedly re-
Telecom sectors are much bigger than the technical training courses. The issues facing the global market are also helping to fund the development on two new technical training courses. At the last count I identified up to 20 different video and audio delivery platforms. You will capture live sporting events in HD for viewing on large screens or in community gatherings. You will also supply those feeds to other international broadcasters. At the same time you will be repurposing that HD feed in real-time for highlights to be delivered to Mobile TV for fans on the move. You may also be preparing replays and post-event analysis for the internet or a video podcast. At the same time you may be supplying an SD feed to a telco for its IPTV service.

**Knowledge & skills**

This new paradigm will require that you will transition from an analogue tape based and hardware denominated environment to a digital file based and software denominated one. Increasingly baseband video will disappear as content is captured as a digital file and will stay that way right through to play-out, distribution and delivery over a digital medium. These new approaches will require a radical change in working methods for technicians, engineers and creative staff. They also pose real challenges for the development of technical training, qualifications and accreditation schemes.

Skill shortages are beginning to develop in the global broadcast and media technology space and the education system here in India has a reputation for producing high calibre engineering graduates who will be sought after by the worldwide media community. The knowledge and skill mix employers will require will be a complex combination of analogue and digital engineering bridging the IT, media and telecoms domains. In a small way the IABM is assisting in that change process by working in partnership with the Staff Training Institute here in Delhi. They are the deserved recipient of the IABM Tom McGann Bursary for 2007 which is helping to fund the development on two new technical training courses.

**Convergence**

This technology transition often referred to as “convergence” is challenging all of us. The IT and Telecom sectors are much bigger than the Broadcast business and are able to commit very considerable sums to research and development in a way that broadcast manufacturers are unable to do so. Until now broadcast products and services have been characterised by bespoke and often proprietary approaches. These have been demanded by the performance, functionality and reliability requirements of broadcasters.

We have now reached a point where fundamental IT and Telecom technology can meet the needs of the broadcast and media technology sector. This is typically not in the commodity form and there is, and will continue to be, a need for specialist suppliers to factor commodity elements into specific systems, products and services tailored to meet the needs of the media business. What we will see is the increasing adoption of universal interface and interoperability standards that give flexibility and configurability that will make a huge difference for system designers, integrators and operators.

**The Marketplace**

Over the last year the IABM has undertaken in-depth research of the global supply-side of this business and a major element of that research has focused on India in particular. Our researchers and analysts have interviewed a significant number of executives in broadcasters, government departments, distributors and suppliers in India to gain an in-depth understanding of the national market and the change issues that you are facing. We have also aggregated worldwide supply-side data from over 40 international vendors to segment, model and size the market to forecast its development between now and 2010. Just in case you hadn’t noticed, 2010 is 2 years and 11 months away!

- [Graphic - Global Market]
- [Graphic - Segment Growth Rates]
- [Graphic - Indian Market Size]
- [Graphic - Indian Market Growth Rate]

The issues facing the global market are also characterised in the national market. Time frames my sometime differ. In some areas India is an early adopter and in some areas there may be later...
adoption but the underlying fundamentals are the same. The change issues facing broadcasters include:

- Technology pull from consumers
- New media and competitive landscape
- Changing viewer/listener demography
- Delivery of content on multiple platforms
- Linear and non-linear delivery
- New regulatory frameworks
- International attention to rights management
- Technology push from suppliers

Drivers
These issues are changing the world in which broadcasters have to operate in and the range of change is increasing dramatically. The whole broadcast and media landscape will be very different 5, 10 and 15 years from now. These changes are driven at the fundamental level by issues like economic growth, changing population demography, and cultural diversity. The catalyst for some of those changes is emerging technology.

As we head toward 2010 and beyond the technology drivers are:

- Transition from analogue to digital
- File based workflows and digital storage
- Introduction of HD
- IT & Telecoms convergence
- Multi-play environments
- Increasing platform diversity
- Interoperable software based environments

The broadcast sector will increasingly embrace commodity IT methodologies and integrate them with IP based delivery capabilities which will challenge broadcast engineers in an unprecedented way. Content acquisition will be based on “ingest once - use many” scenarios with HD origination and multiple and parallel re-purposing for different output requirements. Content delivery will become software denominated and the current signal path will transition into a standards based, highly interoperable, file based infrastructure. As part of our Market Study the IABM have developed an industry model which is designed to aid understanding of the new operating environment.

[Model]

Broadcast and media technology model
This is an exciting time for broadcast engineers and media technologists. There are huge opportunities to conceive, develop and deliver new operating environments to manage the creation, production and delivery of exceptional quality content and deliver it to the consumer when they want, where they want and how they want.

The future
In closing I’d like to take you back to where I started with the commercial. The rapidly increasing number of free-to-air channels, the growth of pay TV subscription models by both cable and satellite and the emergence of personal video recorders (PVR’s) are putting established advertising revenues at risk. State funded broadcasting is only one finance mechanism for the sector. Many delivery channels rely on advertising to support their business model. They are now increasingly competing with minority channels and the internet for their advertising income. PVR’s mean viewers can skip advertisements unless they find them entertaining or engaging. If they do they can develop a cult following. Take a look at this.

Summary
As we move forward, there is an exciting time ahead for anyone involved in the deployment of broadcast and media technology. Things will change fast, creating new challenges, new opportunities and plenty of scope for innovation and development. Broadcasters need to plan for a future that is faster moving, more diverse and with more exciting technologies than you can even conceive of today. I am looking forward to the rest of this conference and to meeting with many of you. I wish you well. Thank you.
Session-1

Mobile TV - Anytime & Anywhere

Mr. Sharad Sadhu
ABU

Mr. Nikhil Jain
Qualcomm

Mr. Pawan Gandhi
Nokia

Mr. William Lam
Zentek Technologies

Mr. R. N. Padukone
DoT
Sharad Sadhu is presently Head of Transmission Technology and Spectrum in the Asia-Pacific Broadcasting Union. He has 38 years’ experience covering all areas of TV broadcast engineering. He has previously worked as Director Engineering in Doordarshan, India and as General Manager in Telecommunication Consultants India Ltd.

Mr Sadhu's current position has given him extensive exposure to international developments in broadcasting technologies and spectrum regulation. He maintains close interaction with senior executives of broadcasting industry and national spectrum regulators.

Mr Sadhu has made contributions in frequency planning and standards setting at international forums like the ITU and the Asia Pacific Telecommunity. He has presented papers at several international conferences and has lectured at training institutions.

Mr Sadhu has considerable interest in the new delivery technologies addressing handheld devices and in broadband delivery.
Mobile TV: More than TV, more than 3G

Abstract

Even though there is an abundance of available information and explosion in the number of connectivity options, the end user seems to be falling behind. The user does not seem to have a clear and integrated means of accessing this information in an easier, meaningful and timely manner. To enable users, there exists a need to invent new usage patterns that will positively influence users’ day to day lives and arm them with useful information in timely manner. The basic building blocks for this new paradigm need to be invented and deployed. The ecosystem of broadcast, broadband and application technologies can provide a foundation to create the necessary systems and tools that enrich users’ lives. Broadcaster, Operators and Regulators have to look at Mobile TV with this new vision that Mobile TV has to offer more than TV and more than 3G.
Mobile TV: More than TV, more than 3G

1. Mobile TV – More than TV, More than 3G

2. Worldwide Penetration

3. Interest in Video Outstrips Other Cell Phone Features

4. Industry Forecasts Promising Mobile TV Market

5. The Mobile Opportunity

6. Complete Entertainment
What is Mobile TV?
- A mobile platform that provides digital broadcast services
- Unlocked to an individual subscriber identity
- Requires no separate subscription
- Integrated with Cellular Network

Simplicity & Quality Drives Adoption
- Rapid channel change
- Extended watch time - low power consumption
- Wide & local coverage areas
- Enhanced interactive services
- Easy to use TV-like Program Guide

Current Mobile TV Landscape

<table>
<thead>
<tr>
<th>Service</th>
<th>Network Type</th>
<th>Transmission Channels</th>
<th>Transmission Parameters</th>
<th>Power Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile TV</td>
<td>Tmobile</td>
<td>~30 MHz</td>
<td>~18 MHz</td>
<td>~2 mW</td>
</tr>
<tr>
<td>3GPP</td>
<td>3G/4G</td>
<td>~1.8 GHz</td>
<td>5 MHz</td>
<td>1 mW</td>
</tr>
<tr>
<td>Wi-Fi</td>
<td>802.11</td>
<td>~2.4 GHz</td>
<td>~11 MHz</td>
<td>&gt;1 mW</td>
</tr>
</tbody>
</table>

Mobile TV integrates broadcast and cellular services with interactive consumer experience.

Efficient Distribution System

- Client/Server system
  - Serves broadcast, multicast, and unicast multimedia services
  - VoD, H.264, Mpeg-4, and MP3

Integrated Service Across Multiple Networks

- Build mall or programming on OFDM WiFi network
- Deliver multimedia on OFDM TDO network

Clipcast!” - Network Scheduled Media

- Network address is delivered to mobile devices
- Device can be off network
- Service provider can package of programs
- Stop service contains fall-back information
- Broadcast only - no service involved
- No permanent server
Dr. Nikhil Jain is a Chief Technology Advisor at Qualcomm, India. He has been involved in various businesses that have been created and commercialized at Qualcomm. He was the inventor and the lead for GSM1x and involved with the conception of MediaFLO. Dr. Jain was also involved in the deployment and development of the GLOBALSTAR system. In addition, he has worked on the next-generation wireless technology based on OFDMA. Currently, Dr. Jain is examining new opportunities for Qualcomm in areas like healthcare and entertainment.

Before joining Qualcomm, Dr. Jain worked at Nortel where he was in the system engineering division. He has worked on various aspects of CDMA technology such as infrastructure design and development, deployment and optimization. Dr. Jain is an Associate Editor of the IEEE Networking Magazine and the Communication Systems Journal. Dr. Jain has 10 awarded and 13 pending patents.

Dr. Jain received an MBA from the University of Rochester and is a graduate from IIT Madras (1985) with a BTech in Electrical Engineering.
ABOUT THE SPEAKER

Dr. Nikhil Jain is a Chief Technology Advisor, QUALCOMM, India. He has been involved in various businesses that have been created and commercialized at QUALCOMM. He was the inventor and the lead for GSM1x and involved with the conception of MediaFLO. Dr. Jain was also involved in the deployment and development of the GLOBALSTAR system. In addition, he has worked on the next generation wireless technology based on OFDMA. Currently, Dr. Jain is examining new opportunities for QUALCOMM in areas like healthcare and entertainment.

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Broadcast to Handheld Technologies
Mr. Pawan Gandhi
Nokia, Singapore

Abstract
The Presentation intents to give a global perspective of Mobile TV and its tremendous potential for the broadcasting industry. Most of the research data reflect that Mobile TV would soon become a compelling personal entertainment device and give a fillip to the broadcasting industry ushering in a revolution since the color TV phenomenon. It will generate new user entertainment consumption habits and increase interactivity. Being an IP based service, this will also find creative application over different platforms like the internet, interactive TV and Video on Demand.

The presentation with also provide some real LIVE demonstrations of Mobile TV services based on DVB-H technology.
Abstract

The presentation intends to give a global perspective of Mobile TV and its tremendous potential for the broadcasting industry. Most of the research data reflect that Mobile TV would soon become a compelling personal entertainment device and give a fillip to the broadcasting industry ushering in a revolution since the color TV phenomenon. It will generate new user entertainment consumption habits and increase interactivity. Being an IP based service, this will also find creative application over different platforms like the internet, interactive TV and Video on Demand.

The presentation will also provide some real LIVE demonstrations of Mobile TV services based on DVB-H technology.
Broadcast Mobile TV Key Messages

I-8

Mobile TV Potential

France
1.2 million
50c per month
40% of homes
2. France
1.2 million
50c per month
40% of homes
3. Spain
60% of homes
50c per month
2.4 million
4. UK
3.5 million
100p per month
3.0 million

Why mobile TV?
1. Cycle of 2011: nearly half a billion people will be watching TV on mobile phones.
2. Driven primarily by the adoption of subscription-based services such as DVB-H.
3. Mobile TV will experience 30% year-on-year growth through 2010. (Infonetics Research 2004)
4. Infonetics Research (2006) estimates revenue generated from mobile video services around the world is set to skyrocket from $4.2 billion in 2005 to $5.4 billion in 2009.

Pawan Gandhi

is working with Nokia Pte Ltd based in Singapore as Head for Mobile TV and Video Experience for Asia Pacific.

After completing his Masters in Business Administration, Pawan has been working in the field of broadcasting and communication since over 12 years.

Pawan currently leads Nokia's DVB-H and video experience business for Asia Pacific.

Prior to Nokia, Pawan worked with Worldspace for 6 years. As part of the early start up team in WorldSpace he was responsible for several successful milestone activities like setting up the first commercial Satellite DAB services in India, first digital satellite based LIVE weather information network for the defense forces, Disaster warning and Management system, Near LIVE news wire services for PTI and several other initiatives. After contributing as a Director in WorldSpace, he moved to Nokia as part of the Asia Pacific Video experiences initiatives.

He is a life member of Broadcast Engineering Society.
ABOUT THE SPEAKER

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Receivers for Mobile Broadcasting

Mr. William Lam
Zentek Technologies, Singapore

Abstract

DAB/DMB is being fast deployed by broadcasters and telco operators across the globe especially in Europe and Asia as a good platform for Mobile Radio and TV application.

The paper will describe the advantages of DAB/DMB on spectrum availability, low cost infrastructure and falling receiver price. It outlines the landscape of the DAB/DMB deployment in the world with specific countries like China, Korea, UK and Germany and the network roll out plan.

It also gives an overview of the broadcast infrastructures, services, business models and most importantly highlighting various receiver/terminal availability on the market. The new catch phrase is "Content is the King and Receiver is the Queen!"

Olympic Games 2008 in China is a driving force for further DAB/DMB deployment in the broadcast and telecom industry.
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ABOUT THE SPEAKER

William is Director of Zentek Technology which is a public listed company in Japan. Until very recently, he was the General Manager of RadioScape Asia Pacific. He is the Secretary of ADC (Asia DAB Committee). He also sits on various digital broadcasting committees in Singapore. He has been actively promoting digital broadcasting of DAB/DMB/DVB in Asia Pacific over the last ten years.

William had been working with broadcasters in Beijing, Shanghai and Guangdong in setting up the DAB/DMB trial projects. He was also involved in setting up the world first DVB-T Mobile TV in Singapore and the first DAB SFN network in Guangdong, China.

William graduated from United Kingdom with B.Sc. degree in Electronics. His post graduate engineering experience was in RF design and Signal Processing. He was Senior Design Engineer at Sinclair Research in Cambridge and Toshiba International, in Plymouth, UK.

His Sales and Marketing experience includes Sales Manager at Rohde & Schwarz UK, Business Development Manager at Tektronix Inc. in USA, Sales Manager- Asia Pacific at Rohde & Schwarz GmbH in Germany, General Sales Manager at Hirschmann Asia Pacific in Singapore and Director of Business Development at Harris Corporation in USA.
Abstract

India is on the verge of takeoff as a dominant player in the Information and Knowledge society. It will soon be joining the exclusive club of the Trillion Dollar GDP countries. It is noteworthy that ‘technology’ is one of the major drivers that is pushing advanced economies forward. New technologies are enabling what is known as ‘Next Generation Networks’ or NGN, which makes it possible to have a single convergent network infrastructure capable of providing a multitude of services, be it voice, video or data. Such convergence results in unprecedented reduction in Capex as well as Opex. 3G Cellular technologies is one of several technologies that supports the convergence advantage bringing a host of applications such as Digital TV to Cellular Subscribers, who form the major part of the Telecommunications network users.

3G Cellular technology handsets are capable of supporting Broadcasting of TV signals. Convergence of various technologies and services over a single infrastructure is the key to a successful business case. Digital Video Broadcasting Handheld (DVB-H) is a protocol that combines broadcasting with a set of measures to ensure that the target receivers can operate from a battery and on the move, and is thus an ideal candidate for value addition to 3G Cellular telecommunications, offering symmetrical and asymmetrical bi-directional multimedia services.

Despite the success of mobile DVB-T reception, the major concern with any handheld device is that of battery life. The current and projected power consumption of DVB-T front ends is too high to support handheld receivers that are expected to last from one to several days on a single charge. DVB-H is the latest development from the DVB project and is largely based on the successful DVB-T specifications for digital terrestrial television adding to it a number of features designed to take account of the limited battery life of small handheld devices and the particular environment in which such receivers must operate. DVB-H allows simultaneous transmission of multi-channel television, radio, video, audio and IP data to a range of multimedia receivers including cellular phones, PDAs, PCs and other handheld devices. It can co-exist with DVB-T.

DVB-H trials are already underway in Germany, Finland and U.S. Such trials will help frequency planning and improve understanding of the complex issue of interoperability with telecommunications networks and services. In India, DVB-H services are being tested. The DVB-H IPDC specifications for IP Datacast are essential to the convergence of broadcast networks and mobile telecommunications networks that will almost certainly be the majority of commercial launches of DVB-H services.

Further, Fixed Mobile Convergence (FMC) is also being developed using Internet Protocol Multimedia Subsystems (IMS) that come from the mobile market and is adapting the IMS equipment, protocols, and services to work with Cable’s data over cable standards to enable fixed-line subscribers to use IPTV services.

Thus the service providers can make the best use of their existing network infrastructure investments and provide mobile-IPTV services at affordable costs that are easy & attractive for subscribers to use. Using the converged network, the service providers can also deliver mobile-TV services seamlessly and consistently to users anywhere, anytime irrespective of the underlying access technology.
ABOUT THE SPEAKER

R.N. Padukone is heading the Telecom Engineering Centre as Senior Deputy Director General in the Department of Telecommunications, Ministry of Communications & Information Technology, Government of India. Telecom Engineering Centre is an apex Organisation under Department of Telecommunications, entrusted with the task of standardisation, engineering, evaluation and approval of Telecom products, services and networks. It also provides technical advice and support to the Telecom Commission on various technology-related activities and subjects.

Mr. Padukone graduated from Indian Institute of Technology, Kanpur in 1974 and joined the Indian Telecom Services of Department of Telecom. During the course of his career with Department of Telecom., he has been involved in the installation and maintenance of Satellite and Terrestrial Communication networks in Western and Southern Telecom Regions. He initiated drawing up of specification of SDH, DLC and Pair Gain Systems and the induction of SDH technologies in the national network during his tenure at Telecom Engineering Centre, New Delhi. He has extensive management experience as General Manager Telecom in Aurangabad in delivering telecom services. His projects/achievements include the planning of infrastructure for National Internet Backbone and broadband services in the BSNL network as Deputy Director General (Internet) in the BSNL's Corporate Office. Before joining Telecom Engineering Centre, Mr. Padukone served as Senior Deputy Director General (Strategic Planning) in the BSNL Corporate office and was responsible for planning Strategic business approach focusing on Next Generation Networks for induction in the BSNL network.
Session-2

Digital Radio: Emerging Scenario

Mr. A. Bhaskaranarayana
ISRO

Mr. Yogendra Pal
AIR

Mr. Peter Senger
DRM

Mr. Charles W Kelly
Nautel Ltd. Canada
Mr. A. Bhaskaranarayana
ISRO

A. Bhaskaranarayana is at present the Director, Satellite Communication Programmes and Frequency Management at ISRO Headquarters, Bangalore. He is also the Programme Director, INSAT and Programme Director-Edusat and Telemedicine programmes at the Department of Space.

Shri Bhaskaranarayana, holds a degree in Electronics Engineering from the IIT-Madras. He is a fellow of the IETE and a member of the Astronautic Society of India. At present he is a member of the IETE Council. He was awarded the “Distinguished Achievement Award” by ISRO, for his contribution to the Aryabhata project. He also received a National Research and Development Council, Govt. of India Award for “Innovative Hardware Development”. He has won the ASI Outstanding Achievement Award for his contribution to the spacecraft and related technologies and the Distinguished Alumni Award from the Alumni Association IIT-Madras. He has published several technical papers in the National and International journals.
Digital Radio Production & Transmission Technologies

Abstract

The media and entertainment industry is experiencing an unprecedented change on transition from analog to digital domain. The shape, size and working of recording and production equipment used in the broadcast studios now a days have totally changed from the conventional tape recorders which are practically non-existent. Computers and computer-based equipment have taken their place. The techniques of programme storage and transmission have also undergone a sea change. The digital systems not only provide much better technical quality but have also enabled ease in working with additional facilities like non-destructive editing, noise reduction, signal processing and automation. With the invention of these systems, anytime anywhere services on demand with interactivity, not only on radio and TV sets, but also on computers, pods and cell phones, has also now become a reality.

Numbers of professional recording, production and transmission systems are now available in the market for use in the radio studios. An overview of the latest production and transmission technologies used in these systems and special precautions to be taken in the use of these systems are given in this paper.
1. Introduction
From the gramophone records (LP & EP), compact cassettes and spool magnetic tapes, analogue audio recording, production and storage have been based on the same principles upon which human hearing are based. The analogue audio production and transmission systems not only have limited signal to noise ratio, dynamic range and distortion figures but are also susceptible to significant information loss, as noise and distortions tend to creep in at each stage. The analogue systems are good enough for the production of programmes to be broadcast on AM or FM transmitters as these have also got limited response and dynamic range, but digital systems which can give a dynamic range of about 100 dB are essential to produce the programmes to be broadcast on digital radio transmitters, directly through satellite and for HQ home theater systems. Fully digital studios are now becoming the norm as it is possible to control signal losses, carry out signal processing and make copies of the digital signals more conveniently.

Microphones, mixing consoles, recorders/players, digital audio workstations (DAWs) and signal processors are the major equipment used in the broadcast studios. Salient features of commercially available equipment for the digital studios and their interfaces are outlined here.

2. Microphones
Microphone is the starting point in any recording. Choice of microphones and their placement is very critical particularly for digital recordings. The pre-amplifiers used with the microphones should also be of high quality as any deterioration in quality is difficult to correct at a later stage.

Many microphones used for the analog recording have rising high-end response which is acceptable as tape recorders have poor high frequency response. Using such microphones for digital recording makes the high frequencies more biting and shrill. To avoid this problem, microphones with smooth high-end response only are used in digital studios.

Pre-amplifiers in condenser microphones generate noise. In analog recording, this noise is usually masked but in digital recording this is audible. High quality **large-diaphragm condenser microphones** which have very low level self-generated pre-amplifier noise are preferred for digital recording. Examples: AKG C12VR, C414 and C3000B; Audio Technica AT2020, 3035 and 4040; Neumann U87 and TLM 103; Shure KSM Series MXL V67G, V69, 900, 2001 and 2003.

**Digital microphones**, which have built-in analog to digital (A to D) converter, have large diaphragm, flat response and very low self-noise. Their output is immune to picking up hum being a digital signal. So these are gaining popularity for digital systems. Examples: Beyerdynamic MCD 100 and Neumann Solution-D.

Response of **ribbon microphones** is inherently nontailored, smooth and warm. These are also popular for digital recordings. Examples: models by Beyerdynamic, Coles, Royer and AEA.
3. Digital Mixing Consoles

The heart of the recording studio is the mixing console. It is a control centre where we plug in all sorts of signals; amplify and mix them; add effects, EQ and stereo position; and route the signals for broadcast or recording and to monitoring speakers.

Digital consoles are preferred over analog consoles as these are virtually distortion and noise-free and have a number of signal processing features.

Mixing consoles used in radio studios are mainly of two types: on-air consoles and production consoles. On-air consoles are not as elaborate as production consoles because most of the audio they handle has been produced already.

The digital mixing console accept analog as well as digital signals. It converts the analog signals to digital and processes all signals internally in digital format. The signal stays in the digital domain for all mixer processing. Level changes, EQ and so on are also done by digital signal processing rather than by analog circuits.

Aside from their differences in technologies, the main innovation in digital consoles compared with analog consoles is the divorcing of circuitry from panel controls. The control surface is still made up of familiar controls - faders, EQ, sends, returns, and so on - but there is no physical connection between the controls on the control surface and the audio circuit elements, nor are specific controls necessarily dedicated to particular channels.

The digital console has actuators which send out digital commands for various operations. The commands are stored for instant recall at any time and are assignable. The assignable concept was first developed in analog consoles as a way to reduce their ever increasing size and to improve manageability. Assignable consoles are available in two configurations. In one configuration, instead of each input module carrying its own set of functions, only one control module is used. The second configuration uses as many modules as there are input channels. But each module has only one control fader that works in conjunction with a group of function buttons. All required effects are distributed among the function buttons. The assignable console design is very useful for large production consoles as it makes many more operations possible in more compact chassis.

Digital consoles are available in three configurations: (1) One configuration is actually an analog console that is digitally controlled but signals are distributed and processed in analog form only. (2) All-digital consoles which accepts digital as well as analog inputs. The analog inputs are first encoded into a digital signal. The data are distributed and processed digitally and also controlled digitally. (3) A third type of digital mixer is actually a virtual console which is an integrated system that combines a hard-disk computer and specialised software to record and process audio direct to disk. Instead of feeding a sound source to a conventional console, it is fed directly to the computer. On the computer monitor are displayed the console controls which are manoeuvered by mouse, keyboard or touch-screen.

4. Digital recording & playback systems

Live stereo recording, using a single stereo microphone or two mono microphones, is simple, cheap and fast but balances are difficult as these can only be made by physically moving the artists. Microphone choices and placement are also critical in this method because the sound cannot be adjusted later on. Multiple microphones are thus used for recording. Each microphone is placed close to each instrument or singer(s). In live-mix recording, mixed output of all the microphones is recorded after adjusting their levels. This method is also fairly simple and quick. However it is rarely used except for live broadcasts as any mistake made in mixing while recording can only be corrected by re-recording. To overcome all these problems, multitrack recording is becoming a norm in broadcast studios. Each track of the recorder contains the sound of a different instrument or a group of instruments. Mixing of tracks is made after the recording is done. Multitrack recording has many other advantages. A musical mistake can be corrected by recording a new, correct part over the mistake. More instruments can be recording later on unused tracks wherein the performer listens to the recorded tracks on a headphone and plays or sings along with them. The recording of the performer is made on an unused track.

To cater to these requirements, digital recording and playback systems come in 2-track and multitrack formats.
Digital recorders can be categorised in three main groups: tape-based recorders, disk-based recorders and solid-state recorders.

4.1 Tape-based record/playback systems: Stationary head as well as rotary head digital tape recorders, which are similar in looks and operation to the open-reel analog recorders, but having different recording format and head configuration, came in the market. Technical parameters of these recorders were much better than that of analog tape recorders but these have practically been superseded by disk-based digital recorders which offer greatly increased creative and technical possibilities, such as nonlinear and virtual instantaneous information retrieval; nondestructive editing; extensive synchronisation options and substantial storage capacity.

4.2 Disk-based audio record/playback systems: Disk-based audio record/playback systems include the magneto-optical disk, mini-disk, digital cartridge disk, recordable and rewritable compact disk, digital versatile disc, super audio compact disk and hard disk.

4.2.1 Magneto-optical (MO) disc recorders: Stereo recording time in MO recorders is 60 minutes on 640 megabyte (MB) disks at a sampling rate of 44.1 kHz.

The MO disc’s advantages are: (i) it is erasable and can be used like tape; (ii) it is two-sided to increase playing time and (iii) it uses optical instead of mechanical process, which makes it wear resistant. Its main disadvantages are that it is not interchangeable with ordinary CD players and compared with other disk-based formats playing time is limited even with two-sided recording.

4.2.2 Mini-disc (MD) recorder: MiniDisc is a convenient removable and low-cost rewritable magneto-optical medium read by a laser. The disc is like a miniature compact disk inside a 2/5-inch square housing.

Three types of blank discs are available: the regular 74-minute mini-disc used in 2-track recorders, the hi-MD 1-GB disc and the MD data disc used in multitrack recorders.

Most mini-disc devices record at 44.1 kHz in 16 bits but some at 24 bits and the encoded data is compressed. Hi-MD recorders can record uncompressed also.

4.2.3 Digital cartridge disk recorder: It is the successor to the analog tape cartridge system. The disk cart can be a recorder/player unit or a player-only unit. The disk cart’s medium can be a compact disc, magneto-optical disc, mini disc, Zip disc or hard disk.

4.2.4 Compact disc (CD) recorders: Recordable compact disc (CD-R) is write-once medium with unlimited playback but rewritable CD (CD-RW) is like recording tape in that it can be recorded on, erased and used again for another recording. CDs are recorded at 44.1 kHz in 16 bits. The encoded data is compressed.

CD technology had revolutionised pre-mastering, particularly in music recording, by making it convenient and relatively inexpensive to produce a finished, customised CD at the end of a recording session.

4.2.5 Digital versatile disc (DVD): DVD is of the same diameter and thickness as the CD but it can hold much greater amount of data.
Digital audio workstations (DAWs) are an electronic music production environment that can be used stand-alone but these are generally networked with a centralized server attached to a large storage. The audio interface can be a sound card plugged into the computer, an I/O breakout box with input/ output connections or a controller resembling a mixer that controls the virtual controls on the computer screen.

DAWs are now being used for all the studio functions such as programme recording, editing, scheduling, playback, logging, commercial billing, refurbishing, mastering and archiving. DAWs are also used to edit tracks that were originally recorded on standalone recorders. Elaborate data such as title, artist(s), producer, director, lyrics, composer, raag/ tal, occasion, and duration etc for each programme can also be maintained which helps in easy search. keyboard shortcuts are also available.

**Stand-alone DAW-cum-Mixer**

4.2.7 Hard-disk (HD) recorder: Hard-disk recorders are multitrack recorders. In these recorders Channel/ track configuration is versatile; information access is nonlinear, random and quick; and storage capacity is practically unlimited. With hard-disk recording the relationships of channels to inputs, outputs and tracks are not directly linked. Once the audio data is recorded and stored, it can be assigned to any output(s) and moved in time.

Recorders with up to 24-bit resolution, 96 kHz sampling and 36 tracks are now available with elaborate signal processing and editing capabilities.

There are two basic types of hard-disk recorders: modular (stand-alone) and computer-based.

**4.2.7.1 Modular HD recorder:** It is a multitrack recorder and a mixer combined in one portable chassis. It is also called Recorder-Mixer. Stand-alone recorders are all-in-one system which are easy to use, portable and less likely to crash than a computer-based systems. These are produced by a number of firms such as Orban Audicy, Roland Corporation (V-Studio) etc but the popularity of these costly integrated systems is dropping as personal computers are becoming very cheap and powerful enough to run application software.

**4.2.7.2 Computer-based HD recorders:** Also called the digital audio workstation (DAW), this system includes a computer, recording software and an audio interface that gets audio into and out of the computer. The audio interface can be a sound card plugged into the computer, an I/O breakout box with input/ output connections or a controller resembling a mixer that controls the virtual controls on the computer screen.

DAW is inexpensive, powerful and flexible. These rules the roost in the modern radio studios.

DAWs can be used stand-alone but these are generally networked with a centralized server attached to a large storage.

DAWs are now being used for all the studio functions such as programme recording, editing, scheduling, playback, logging, commercial billing, refurbishing, mastering and archiving. DAWs are also used to edit tracks that were originally recorded on standalone recorders. Elaborate data such as title, artist(s), producer, director, lyrics, composer, raag/ tal, occasion, and duration etc for each programme can also be maintained which helps in easy search. Keyboard shortcuts are also available.

**4.2.6 Super Audio CD (SACD):** SACD is a read-only optical disc which also looks exactly like a normal CD. It was developed by Sony and Philips Electronics, the same companies that created the CD. The disc can contain up to 7.95 GB of data. It offers a frequency response from DC to 100 kHz with 120 dB dynamic range.

SACD uses a 1-bit DSD (Direct Stream Digital) code at a very high sampling rate of 2.8224 MHz.

Sony asserts that SACD recordings are unbelievably close to original analog sound.

**4.2.5 Digital versatile disc (DVD):** DVD is a write-once format that can store 4.9 GB on a single-sided disc and 9.8 GB on a double-sided disc. Data capacity in the erasable DVD-RW format is 3 GB on a single-sided disc and is expected to go to 9.4 GB for a double-sided disc.

**4.2.4 Mini-disc (MD):** MD is a miniature compact disc inside a 2-inch cartridge. It came in the market. Technical parameters of these different recording format and head configuration, audio quality and head design. Stationary head as well as rotary head digital tape like a miniature compact disk.

**4.2.3 Compact disc (CD):** CD technology had revolutionised pre-mastering, mastering and archiving. CD-R is a rewritable format. CD-RW is a red-rewriteable format. DVD-Video (DVD-V), DVD-Audio (DVD-A), and DVD-Video (DVD-V) are the three main formats of digital versatile disc (DVD) technology. DVD-Video (DVD-V), DVD-Audio (DVD-A), and DVD-Video (DVD-V) are the three main formats of digital versatile disc (DVD) technology. The disc can contain up to 7.95 GB of data. It was developed by Sony and Philips Corporation (V-Studio) etc but the popularity of these costly integrated systems is dropping as personal computers are becoming very cheap and powerful enough to run application software.

**4.2.2 Mini-disc (MD):** MD model Sony MZ-NHF800, MD model Sony MZ-NHF800, MD model Sony MZ-NHF800, MD model Sony MZ-NHF800, MD model Sony MZ-NHF800, MD model Sony MZ-NHF800, MD model Sony MZ-NHF800.

**4.2.1 Magneto-optical (MO) disc recorder:** MO disc is a read-only optical disc which also looks exactly like a normal CD. It was developed by Sony and Philips Electronics, the same companies that created the CD. The disc can contain up to 7.95 GB of data. It offers a frequency response from DC to 100 kHz with 120 dB dynamic range.

MO Discs uses a 1-bit DSD (Direct Stream Digital) code at a very high sampling rate of 2.8224 MHz.

Sony asserts that SACD recordings are unbelievably close to original analog sound.
On the launch of the recording software, simulated tracks and recorder transport buttons such as fast-forward, rewind, record and play are displayed. We also see mixer with virtual controls; simulated faders, knobs, buttons, waveforms and meters. Access is random.

A number of leading manufacturers like Broadcast Electronics, ENCO, RCS, DALET, D’ACCORD, ORBAN etc are offering studio automation software. These are modular. The salient features available in these commercially available systems are:

**Recording** software have provision to record two or more simultaneous recordings on the same DAW; insert markers during recording, play and edit the programme while being recorded, automatic recording by time or level, recording in pre-designated files etc.

**Editing** functions of cut or trim, cut and paste, copy and paste, fade-in and fade-out, cross-fade and slip are available in most of the software. Facility of zoom to locate the precise edit points; indication of time duration of marked portion; time stretch and time compression without pitch change; selectable colours for different cuts; import/export of audio files from/to other systems with format and sampling rate conversions; voice-over and creation of effects is also available. The editing is nondestructive.

**Scheduling** software enables preparation of play lists by drag and drop with provision for fade-in, fade-out or cross-fade during playback. Schedules may contain audio, text or mixed titles along with their icons for easy identification. Provision exists for the preparation of blocks; monitoring and editing of transition points; copy of schedule; last minute changes; scheduling of part programme without copying and chaining of multiple schedules. Schedules can also be generated automatically as per the defined criterion.

**Playback** module has provision for manual, automatic and live-assist modes of play; two or more virtual playback panels for cueing scheduled as well other programmes; monitoring of start and end points of a scheduled programme; assignable hot-keys for frequently used items; automatic playback of the schedule at the specified time; fader start and stop of the schedule; and continuous playback of a schedule even if the player window is accidentally closed.

**Bills** for commercials and royalty payment can automatically be generated as per the played back items.

Facility for **logging** of on-air programmes, with provision for time/date stamping, is also available.

Effect and signal processing features possible in DAWs are outlined in section 6.

Other important available features are: listing of aired programmes; assignment of access rights; automatic deletion of old recordings by specifying the kill date and printing of logs.

### 4.3 Solid-state digital audio recorders

These are portable with no moving parts. The recording media is a Flash memory card, such as Compact Flash, Smart Media, Sony Memory Stick, PCMCIA (Personal Computer Memory Card International Association) card or SD (Secure Digital) card. Flash memory cards of up to 2-GB capacity are now available.

Recording can be made in uncompressed PCM or in different compressed formats. Markers can also be put during recording. Available sampling frequencies are up to 48 kHz and resolutions up to 24-bit.

Digital audio files from most of the recorders can be transferred to a DAW through the USB port. These recorders are accessible as an external drive on plugging on to a DAW.

Two versions of the recorders are commercially available: Portable and handheld.
4.3.1 Portable solid-state digital recorders: These can be used with an external microphone. The recorder can be hung from the shoulder and can be used for recording while moving. These recorders have built-in editing provisions. Some of the portable recorders have even built-in modem for transfer of digital audio files on telephone lines. Examples of the portable recorders are: Fostex (FR-2), Marantz (PMD series), Sonifex (courier), YouCom (Parrot) and Nagra (ARES-BB+).

4.3.2 Handheld solid-state digital recorders: These recorders have very limited or no editing provision but are very convenient for news-gathering. Examples of the handheld recorders are: AEQ (PAW 120), Nagra (ARES-M), HHB (DRM 85), Edirol (R-09), and Samson (H-4).

5. Digital interfaces
Digital systems make it possible to maintain a high and consistent quality from the beginning to the end of a production provided the signal remains in the digital domain throughout the signal chain. A true 'clone' copy can be made digitally if both the devices are operating at the same sampling rate and the resolution. When sampling parameters differ, digital interconnects can still be used, by incorporating sample rate converter, but the copy has some side effects though these are negligible. In broadcast studios attempts are therefore made to maintain the audio in digital domain and to follow the uniform sampling parameters throughout the chain.

The commonly used digital audio formats and data transfer formats are:

5.1 AES/EBU interface: The AES/EBU interface (also called AES3) is a professional digital audio connection standard specified jointly by the Audio Engineering Society (AES) and the European Broadcasting Union (EBU). This has become a de-facto standard in the broadcast industry. Its standard calls for two audio channels to be encoded in a serial data stream and transmitted through balanced line (110 ohms characteristic impedance) using 3-pin XLR connectors. The two channels can be independent mono signals or left and right channels of a stereo pair. The data rate depends upon the sampling rate. At a sampling rate of 48 kHz, the data rate is 3.072 Mb/s. Only one receiving device is connected across each line and digital DA (Distribution Amplifier) is used if more than one receiving devices are to be fed from a single source.

5.2 SPDIF (Sony/Philips Digital Interface): It is the consumer version of the AES/EBU standard. It calls for an unbalanced line using phono connectors. SPDIF is implemented on consumer audio equipment such as CD players.

5.3 MADI (Multichannel Audio Digital Interface): This standard is used when interfacing Multichannel digital audio. It allows up to 56 channels of digital audio to be sent down one coaxial cable.

5.4 ADAT Optical: It is a proprietary digital connection format designed for use with Alesis MDM digital tape recorder. It is designed to carry
eight channels of digital audio on a single fiber-optic cable.

5.5 TDIF (Tascam Digital Interface Format): It is Tascam's proprietary digital audio format to carry eight channels of digital audio.

5.6 SCSI (Small Computer Systems Interface): It is the standard for hardware and software command language. It allows two-way communication between, primarily, hard disk and CD-ROM drives to exchange data at fast speeds.

5.7 USB and FireWire: These two protocols are used for quick transfer of digital data from one device to another, for example, to transfer digital audio from a portable digital portable recorder to a computer. USB transfers at the speed of 480 Mbps. FireWire comes in two speeds: 400 Mbps and 800 Mbps. USB and FireWire devices are hot swappable.

6. Effects and signal processors

Effects and signal processors are being used extensively these days to alter some of the characteristics of the sound.

Some of the effects and signal processing functions are available in the mixing consoles. These can also be applied externally by using hardware effects units or by using software processors.

Available effects and signal processors can be grouped into four categories: spectrum processors, time processors, amplitude processors and noise processors. Some of the signal processor functions belong to more than one of these categories.

To add a hardware effect to a track, the signal from the mixer's aux bus is sent to the effects device or signal processor which modifies the signal in a controlled way. Then the modified signal is fed back to the mixer to blend with the dry unprocessed signal.

Software signal processors, called plug-ins, can be used in a DAW for virtually every signal processing function. Each effect is an algorithm that runs either in the DAW's CPU (Central Processing Unit) or in a DSP (Digital Signal Processor) card. Some plug-ins come bundled with the recording software. A few plug-ins are available free and can be downloaded from websites. Others can be purchased and then installed on the DAW's hard-disk. Digidesign Pro Tools, Adobe Audition and Cakewalk Sonar are the examples of a few professional software having elaborate effects and signal processing features.

7. Sampling and data rates

The initial and potentially most important aspect of digital audio is the conversion from analog to digital signal representation. Any error created at this stage persists throughout the recording and playback process. The analog signal to be digitized is sampled at a high rate and each sample is quantized in a string of binary numbers (called words). Higher sampling rates sound smoother and more transparent but need more storage space and faster storage devices. In theory, the sample rate must be higher than twice the highest frequency present in the signal to be digitized. How much higher it must be in practice is open to argument. On the other hand, number of bits used for quantization affects the dynamic range, noise and distortion of the signal. Dynamic range can be approximated as 20 log \( 2^n \) where \( n \) is the number of quantization bits. 16, 20 and 24 bit systems enable theoretic dynamic range of 96, 120 and 144 dB respectively. So what should be the word length?

The 44.1 kHz sample rate and 16 bits quantization in CDs and many other digital devices was established at a time when digital storage space was limited, in both delivery media and recording devices. We are now able to handle much higher
data rates and can use higher sample rates and longer words, but it is not clear how much is enough.

As the ability to convert from analog to digital representations has been refined, we find up to 192 kHz sample rates and 24 bit word lengths are now available. Higher sample rates mean that much less complex anti-alias filters are possible, reducing the potential for signal distortion. Higher speed data handling improves sound quality by improving the time resolution important for transient signals. Further, the ability to perform digital filtering on the data after it is acquired reduces the complexity of analog filters needed without increasing the final amount of data. Any added data that must be stored and the higher data acquisition and transfer rates needed to handle the conversions are now easily accomplished even by inexpensive personal computer systems. Prices of hard disks are falling sharply. Sony and Philips SACD’s (Super Audio CD), DVD’s and hard disks have much higher data storage capabilities than CDs.

The answer to the quantization rate is to do with the headroom also. Maximum possible digital level is 0 dBFS (FS means full scale). In a 16-bit recorder, 0 dBFS means all 16 bits are on. If the input signal level exceeds, it is chopped off at 0 dBFS with a ruler flat line producing very annoying clipping. If we keep the modulation level low, we don’t make full use of 65,536 quantization levels available with 16-bit recording. If the recording level doesn’t get above -6dBFS, effectively we are recording in 15-bits. If the low recording level is normalized by digitally amplifying, we increase quantization noise along with the signal. Using more bits of resolution avoids these problems completely as the extra bits to play with for momentary signal peaks.

Keeping all these aspects in view, sampling rate of 96 kHz and 24-bits resolutions are becoming standard for digital studios with lossless compression, to conserve the storage space, for the final programmes. Initial recording are however made for PC in Microsoft's WAVeform PCM encoding (.wav) and Audio Interchange File Format (.aiff) for Apple Mac system.

8. IP-based audio networking
Local area networks (LANs) are being set up in studio centres with several DAWs connected to a server computer through an ethernet switch. The server has a network-attached storage and is also provided with internet access if required. This has become the backbone of the fast audio data access for the server. Wide area networks (WAN) and Metropolitan are networks (MAN) are also being established by big broadcasters for programme exchange. These networks work on IP protocol. But the interconnection of studio equipment as well the inter-studio connectivity is still in conventional manner. Though the connectivity is now using AES/EBU digital format, which offers great immunity to transport alteration, but this format has not been designed for long distance transport and routing. Also the connectivity is well defined and there is virtually no interoperability.

IP protocol was not designed for transmission of continuous stream of synchronized time critical data, but keeping in view that IP protocol has brought exponential growth of Internet as it provides an already accepted, manufacturer independent standard for transporting data over short and long distances and that the Ethernet products are so common with enough competition that we can’t beat the cost of equipment, it is also being used with suitable changes to set up audio networks in audio studios.

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these are likely to be very popular in the foreseeable future.

8. Conclusion

The move to fully digital systems is well underway. Ultimately digital production systems are going to replace analog systems totally. However, the following aspects must be kept in view:

A analog material does suffer as a result of passage of time but some portion is still playable or listenable in most cases, provided hardware is available to play, but the corrupted digital files are totally unplayable. Digital systems must therefore be protected from viruses. Since new viruses are appearing everyday, regular updating of virus detection and cleaning software is very important.

Very fast advancements are taking place in the field of digital technology, for example migration from CD to DVD and SACD. New software formats and interfaces are also emerging. Life of computers and servers is also limited. Audio data should therefore be backed up regularly in different physical medium for restoration. Since the computers are prone to failures, a clustered server configuration should generally be adopted for uninterrupted transmission. A disaster recovery site, with provision for on-line updation of data, should also be setup so that content is not lost in the case of natural disasters of flood, fire, earth quakes and tsunami etc. The on-air DAW should also keep sufficient programme in its hard disk to take care of eventualities of the network failure.

Data reduction techniques, based on perceptual coding, are used to conserve storage capacity. But data reduction does not permit the restoration of the signal to its original acoustic condition and, in addition, limit the further use of the recording because of the production of artifacts generated when cascading perceptually coded material for example, in the production of a new programme incorporating the original recording. Initial recordings should therefore be made only in uncompressed format.

Computer-based low cost digital systems are coming up in the market but the quality of these systems is far from satisfactory. Already there are reports that some producers still prefer valve type equipment on the pretext that digital recordings lack in warmth, depth and roundness of sound. Some companies are still producing analog record players and vinyl discs. Broadcasters should therefore ensure that non-professional and semi-professional digital equipment are not used in the broadcast studios.

ABOUT THE SPEAKER

Yogendra Pal is having BE (Electronics) and MBA degrees from Delhi University. He joined the Indian Broadcast (Engineering) Service in 1975. Since then he has worked in different offices of All India Radio and Doordarshan in design, planning, execution, research, training and maintenance in various capacities. At present, he is working as Director (Engg) in the Headquarters of All India Radio in Delhi.

Mr Pal has been a force behind a number of important projects, such as, Radio coverage of ASIAD ’82 and launching of a number of new services like Internet Radio, Radio-on-Demand, News-on-Phone and design of first ever fully digital studio set up of AIR.

He has contributed a number of technical papers. He has conducted many training courses abroad on behalf of Asia Pacific Institute for Broadcasting Development (AIBD). He has also been a technical consultant to Philippines Broadcasting Corporation on behalf of Asia Pacific Broadcasting Union (ABU).
Abstract

Digital Radio Mondiale (DRM) is a digital broadcasting system for the bands up to 30 MHz that is fully standardised and recommended by the ITU to all members as a replacement for analogue technology in the corresponding broadcasting bands. It is used by nearly forty stations around the world with more than 800 hours daily on air. Since the last quarter of 2006, consumer receivers are available for different markets. Chip-set solutions will follow during the last quarter of 2007 for car- and portable receivers.

The DRM consortium has exceeded 100 members and with growing interest in the development of the DRM system up to 108 MHz, membership will further increase.

Many broadcasters around the world have followed the market entrance of DRM first in Europe and have studied the usage of DRM for their own national or international transmitter network. DRM equipment is either ordered or already installed and with the expected low price DRM receivers they will start in 2007 with DRM transmissions.

The introduction of the DRM system in many countries has initiated the replacement of the more than 80 years old analogue technology in the long-, medium-, and short-wave broadcasting bands. Together with the extension to 108 MHz, the DRM system will be a unique digital broadcasting system for all radio broadcasting bands up to 108 MHz.
Session II: Digital Radio Emerging Scenarios

Digital Radio Mondiale/DRM

Peter Senger
DRM - Chairman &
Deutsche Welle DRM - Director

DEUTSCHE WELLE

AGENDA:

- DRM - Consortium
- DRM - System
- World-Wide Interest and Implementation
- Deutsche Welle and DRM
- Receiver Situation
- Conclusion

DEUTSCHE WELLE

DRM-Consortium:

- A NOT-FOR-PROFIT consortium for the development of a digital
  transmission system in the Long-, AM/Medium- and Short-Wave
  broadcasting bands
- DEW: Also for the FM-Bands
- Registered in Geneva/Switzerland, Project Office at DW in
  Bonn/Germany
- 166 members from 34 countries (February 2007)
- DRM members are coming from all continents and the whole
  broadcast industry
- Membership increases now with the availability of DRM receivers
- DRM has cooperation agreements with WorldDAB and
  Blixt/Hi-Radio
- DRM is open for other cooperation such as WorldSpace
- DRM decision to extend the system up to 168 MHz has created
  great interest
- Soon broadcasters can choose DRM for all radio broadcasting
  bands

DEUTSCHE WELLE

69 DRM-Supporters from 19 Countries (02/2007)

- Evces Corporation Pty Ltd, Wireless Communications, WorldAudio Radio2 (Australia)
- =Sonofil Ltd, (Bulgaria) Taurus APS (Austria), Antenna Digital Radio, La Radio, Littoral AM
  (France)
- Chalet Hart, MARC, EBP Evangelism Rundfunk, Economic, Forkhouse
- Ei-Kien, Taeon, KFMB Digital Radio Berlin, Radiocommunications GmbH, Michael Plass, Radio
del Estado/Mexico, DRB World Network Association, Special Radio
- Peter R. Senger, Starwaves GmbH, TD-Broadcast, Radio Satel, Satel Service Deutschland,
  StarSat Radiosat, Hoły Tym, TMD, Video Media - Spanish (Japan)
- Jee-Ho, LMN, Commercial Radio Society, WorldWave Technologies Ltd, WorldCast
  Media, XMM, YMP Communications
- DRM-Member by Continent

DEUTSCHE WELLE
Digital transmission system for Long-, Medium- and Short-Wave
Recommended by the ITU and standardized by ETSI and IEC

Advantages for the listener:
- clear FM audio quality
- stereo
- reception without noticeable interference, noise and fading
- transmission frequency not to be known, station name on the display
- receiver will switch automatically to the best frequency without interruptions
- Associated data possible such as: Text, pictures, HTML,
- Storage on a SD-Card, Pause, EPG

Advantages for the broadcasters:
- existing transmitters can be used
- investment for DRM upgrade about 15-20% of the price of a new transmitter
- power consumption reduced by about 50% for same coverage area
- new types of programme are possible
- DRM transmissions are reaching status of local stations

New Programme Possibilities:

1. Stage: Main Programme 24 kbps
   Simple text displayed

2. Stage: Music programme 20 kbps Stereo
   Plus information programme in parallel speech only 4 kbps

3. Stage: Main Programme 24 kbps Stereo
   Text, Graph, Picture, HTML 100 kbps

4. Stage: Speech channel A 44 kbps
   Speech channel B 44 kbps
   Music 36 Stereos 24 kbps

What is DRM+?
An extended version of the present system up to 108 MHz
Developed for all broadcasting bands between 39 and 108 MHz

Why is it needed?
- Broadcasters need one single digital system for all bands
- Allows for low price receivers for all bands
- Present DRM-system is only developed for frequencies up to 30 MHz
- Other digital broadcasting systems work in higher bands
- Much more efficient use of the frequency spectrum: more channels as of today in CD-like quality
- Surround sound possible
- Closes the gap between DRM30 and DAB
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Peter was co-founder of the DRM consortium and its chairman since 1998.

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From the UK to Ukraine and Malaysia to Mexico, the digital radio format debates are heating up. The interest is at its highest level ever, with the idea of analog to digital transformation being reviewed around the world. This change is a logical next step; for radio is one of the oldest communication technologies in existence, yet it is among the last information and entertainment medium to operate on an analog transmission platform.

It is clear to broadcasters around the world that radio must change in order to compete with many new technologies; today's listener demands more choices, more interactivity and higher quality sound; this has been established by the fast implementation of DVD and MP3 players and also by digital cable and digital terrestrial TV. With all new opportunities there are many requirements; the broadcaster wants a low capital investment, equipment manufacturers want fast returns on R&D and government regulatory agencies want to use the least amount of valuable bandwidth while providing the maximum benefit to the country. So what is a country to do when choosing a digital standard?

The contents of this paper will include a discussion on HD Radio and how it differs from other technologies, why digital radio in general is necessary, what is HD Radio, how is HD Radio being marketed in the USA, the status of HD Radio implementation worldwide and most importantly how can HD Radio and IBOC technology benefit India.
HD Radio

Mr. Charles W Kelly
Nautel Ltd. Canada

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HD Radio

Introduction to HD Radio technology and iBiquity Digital Corporation

iBiquity Digital Corporation is the developer of the HD Radio brand of IBOC (In-Band-On-Channel) technology. iBiquity is a company formed by the merger of USA Digital Radio and Lucent Digital Radio, with the goal of creating an IBOC digital radio system. The HD Radio system operates on both AM-MW and FM VHF Band II either in a digital-only mode or in a “hybrid” digital plus analog mode. The result is that AM stations have “FM quality” sound and FM stations can achieve “CD-like quality” audio and carry multiple audio programs streams (known as multicasting).

IBOC, as the name implies, allows a digital signal to be added to the existing analog service within a radio station’s allocated AM and FM channel assignment. This simulcast mode is know as “hybrid” and applies to both AM and FM. The HD Radio hybrid mode places low-level digital carriers in the upper and lower sidebands of the analog signal. The implementation on AM is similar in that the upper and lower sidebands contain low-level digital signals. Since, the analog AM signal is amplitude modulated (as opposed to frequency modulated), the AM HD Radio hybrid signal can carry digital information in a quadrature phase component. Thus it can be placed directly beneath, or in quadrature to the analog modulation.

Why Digital Radio?
Many previous entertainment and information innovations; such as television, were deemed the end of radio. Even when FM was invented is was considered the death of AM, and with the advent of cassettes, CDs, DVD, cell phones and even the internet, the ultimate demise of radio was strongly predicted. However to the contrary radio has consistently adapted and ultimately thrived. Today radio is still one of the most powerful mediums available and, in almost every country in the world, it is where people go the majority of the time to get news, information and entertainment. It has been deemed time and time again the most dependable technology during an emergency, as it is invaluable during the loss of power following extreme weather conditions, for instance.

However, the playing field is changing… it is clear that the radio industry must respond differently. The new media technologies are actually changing the way people obtain news and entertainment. The new generation of listener expects quality, choice and interactivity, “when”, “what”, “how” and “where” they want.

Historical precedents show that the key to success of any new media technology is to provide more choice, new content, interactivity and high quality. The popularity of the CD came from its inherent quality improvement, even when it did not record the content was more expensive than the vinyl equivalent. The recent success of the MP3-type player, satellite radio and cable TV is clearly due to the choices they provide; and finally, one of the internet's most redeeming qualities and the reason for its ubiquitous and gargantuan use is its intrinsic interactivity. The predicament that AM and FM broadcasters face is analog technology simply is unable to satisfy these constituents.

Things are Getting Worse
A study in the USA of the Time Spent Listening (TSL) shows reductions in the last 8 years from between 10 and 20 percent. Although the greatest reductions are for ages 14-17, the decreases are for all demographics. One of the main reasons is that terrestrial radio’s main competition comes from two of the three fastest consumer electronics product launches in history; the MP3 player and SDARS. Satellite radio in North America is expected to have over 14.4 million subscribers before the end of the year, and the MP3 player industry is expected to have sold over 71 million units. The millions of music downloads a year represent revenue loss to the radio industry; and of course this is not limited to North America but throughout the world. To make matters worse more competition is coming; from WiFi, WiMax, DMB, DVB-H, Mobile TV, Internet Streaming, Media Flo® and 3G to name just a few.

So it is clear that the radio industry must respond; it
has to find a way to offer more services, interactivity and better quality. Only by embracing digital radio technology can this be accomplished.

**Digital Radio Technologies**

In addition to the HD Radio system, two digital radio technologies have been implemented to some extent around the world: Digital Radio Mondiale (DRM) and Eureka 147 Digital Audio Broadcasting (DAB). One key aspect is that to a large extent the technologies of IBOC, DRM and DAB are not mutually exclusive. They can all be operated on their intended spectrums without interference and can be mutually beneficial.

The technologies also share many similarities such as the type of modulation; COFDM, they all contain audio compression algorithms and the ability to carry multiple channels and provide data services. The three digital technologies all include types of Coded Forward Error Correction (C-FEC), Interleaving, and to some extent diversity to improve reception in multipath conditions.

However, it is also important to point out that there are differences. The audio compression algorithm (CODEC), for instance, that DAB employs is nearly 15 years old and consequently is very inefficient compared to that of coding of HD Radio technology or DRM. To rectify this problem the WorldDAB group have now begun to finalize a new system called DAB+, which will soon be available and will employ the newer AAC+ codec, consequently providing similar coding efficiencies to that of HD Radio technology and DRM. However, DAB+ will not be backward compatible to the existing DAB standard, and hence the existing DAB receivers sold to date in parts of Europe and Canada will not be able to receive the DAB+ signal.

DRM can carry multiple programs, like HD Radio broadcasting and DAB but to do this it requires bandwidths greater than that typically allocated to one radio station and as of yet DRM is limited to the Short, Medium and Long wave bands. DRM+ is a system based on DRM for the VHF Band II or Band III spectrum and is now in the early development stage. However, due the expected complexity of the redistribution of a countries FM band and the already over populated band III, DRM+ is unlikely to be very practical in most countries in the short or mid term.

Other key differences are that both DRM and DAB/DAB+ do not have complete time and frequency diversity nor provide a main channel fade-to-analog (blending) option. Without the time and frequency diversity there is less immunity to adjacent interference and multipath. Without a blending technology there is no smooth transition to analog.

**The HD Radio Standard**

While iBiquity is responsible for the development of HD Radio technology and the IBOC standards and the FCC regulates its use in the US, it is the National Radio Systems Committee (NRSC) that is the actual standards body for IBOC in the States. The standard is officially known as NRSC-5, with the latest version being NRSC-5-A. The International Telecommunications Union’s recommendation of iBiquity's AM and FM HD Radio systems for worldwide implementation of digital broadcasting is documented in ITU-R Recommendation BS.1514 (April 2001) and ITU-R Recommendation BS.1114.

**About the HD Radio™ System**

HD Radio technology enables analog radio stations to transition to digital broadcasting without the need for new spectrum, infrastructure or changes in listener behavior. HD Radio broadcasters operate on both AM-MW and FM VHF Band II, either in a digital-only mode or in a "hybrid" digital
How It Works

The HD Radio system includes hundreds of examples of first and second adjacent reception under major interference conditions. Potential interference from a first adjacent channel.

Complimentary combining and analog service diversity. All these techniques significantly improve channel state information, subcarrier and pulse time interleaving, forward error correction, technology has been designed with frequency and interference.

Multipath dispersion bandwidth, exposure to long delay multipath, first adjacent interference and host adverse channel conditions such as narrow but does mean complications regarding extreme AM plus data and forward error correction codes. COFDM is very convenient for implementation but does mean complications regarding extreme adverse channel conditions such as narrow multipath dispersion bandwidth, exposure to long delay multipath, first adjacent interference and host interference.

To deal with these conditions HD Radio technology has been designed with frequency and time interleaving, forward error correction, channel state information, subcarrier and pulse shaping, adjacent channel cancellation, complimentary combining and analog service diversity. All these techniques significantly improve reception under major interference conditions.

Time interleaving for instance is a technique where consecutive bits are spread in time so that they never travel sequentially, thus mitigating the effects of groups of bit errors. The HD Radio interleaver is about 4 seconds long, which means that consecutive bits may travel many seconds apart making the system extremely immune to digital errors.

One of the most problematic issues of digital radio is the phenomenon of multipath propagation in which a signal is received from many different routes and consequently at different times and at times up to several microseconds apart.

The HD Radio system includes frequency interleaving to eliminate multipath interference. The HD Radio technique employed is based on the division of the total payload to be carried in a single carrier into many hundreds of narrow band carriers. By virtue of dividing the total payload into smaller parts the symbol duration becomes much longer. Longer symbol duration permits the containment of the interference within the same symbol avoiding inter-symbol interference, which consequently improves the resistance signal multipath.

AM-MW Hybrid Waveform

How It Works

The HD Radio main bank of COFDM symbols carries a payload of 96 kb/s for FM and 24 kb/s for AM plus data and forward error correction codes. COFDM is very convenient for implementation but does mean complications regarding extreme adverse channel conditions such as narrow multipath dispersion bandwidth, exposure to long delay multipath, first adjacent interference and host interference.

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FM-VHF BII Waveform

HD Radio technology also employs and advance forward error correction (FEC) technique in which a given number of overhead bits are added to a bit stream to help the receiver correct errors that may have occurred in the transmission process.

One myth about HD Radio broadcasting is the
locations with no problems underscores this particular point.

Implementation
There are many transmission methods that have been successfully proven to implement the HD Radio system in both AM and FM. For AM the signals are integrated, which means that both the analog and digital signal must pass through the same amplifier system. For FM the analog and digital signals are discrete, hence separate amplifiers may be chosen. There are currently at least 5 different methods of implementation, including separate, hybrid and common amplification and alternatives such as antenna combining and the use of separate antennas. All have been developed for different installations and each has its advantages and disadvantages depending on the situation and condition of the existing transmitter site.

HD Radio Features
Features that are currently under development include surround sound, a premium sound experience in the car as well as at home; store-and-replay, which allows the ability to rewind a song that was just played or record an entire program for listening at a more convenient time; on-demand capabilities permitting instant access to news and information; and an electronic program guide (EPG) so the listener can easily review future content.

In FM HD Radio technology, supplementary channels can be added for programs like weather, traffic, or a radio reading service. Datacasting is also possible and Program Associated Data (PAD), which is metadata about the program and station, are included in the standard. The hybrid mode has an advantage that an HD Radio receiver will first lock onto an analog signal, then FM stereo and then transition smoothly to digital. If the digital signal is lost, it will blend slowly back to analog, the same way a car radio will blend from stereo to mono given a weak signal.

A very beneficial characteristic of HD Radio technology is that can be implemented at the pace determined by the market not mandated by a government. And a radio station can choose the type of implementation method ideally suited to its own timeframe.

Worldwide Implementation
Nearly 1,200 AM and FM stations in the US and 20 in Brazil are either on-air or planning to go on air in the near future. There are over 15 other stations in Europe, Asia and Africa employing HD Radio technology in one form or another.

USA HD Radio roll out graph
Tests have taken place in Asia, Africa, Europe and South America. Many countries including the Philippines, Nigeria and Brazil are at the early stages of adopting HD Radio technology. Brazil is
operating HD Radio transmissions in both AM and FM in three states and expects to have over 1000 stations on-air before the end of the decade, with 90% population coverage before 2012.

**Receivers**

HD Radio receivers have been available in the USA for approximately 2 years. Although initially only a few types of radios were available at prices of $400-600, it is expected that there will be over 60 models on sale by February 2007, some with prices lower than $100.

Receiver manufacturers view the potential size and accessibility to be most important. For a radio receiver manufacturer to sell radios there must be a well-installed base of broadcasters and an incentive for the listener buy a new radio. This maybe more channels, services or exciting and new content, which was demonstrated in both the UK and Canada with DAB that listeners were just not willing to buy a new radio based on a marginal improvement in sound quality or reception.

**Some of the many HD Radio receivers available**

All technologies mentioned require the purchase of a new radio to receive a digital signal. It can be assumed that the potential market for receivers will be proportional to the existing analog base. The installed world base of radio receivers is approximately 2.5 billion radios, of which the over 30 percent are in the continents of North and South America. Based on this huge potential market, it would be reasonable to conclude that HD Radio receivers will ultimately be the most abundant and least expensive.

**Benefits of HD Radio technology for India**

With the conclusion of the second phase of the FM licensing program in spring of this year, which included over 240 frequencies in over 85 cities across the countries, the FM Industry in India is set for a promising future. FM radio has become very important in India due to its common place in the workplace and the automobile. The FM Industry is very likely to grow fast in India because it can offer local content which provides a good platform for local brands to advertise their products in their specific locality. This often increases advertising because it can serve better the smaller industries and can attract businesses that have not advertised previously, generally a win-win for the local economies.

Although slower than most countries when implementing FM technology, India stands on the verge a great opportunity being able to economically take advantage of one of the latest digital radio systems, HD Radio technology (IBOC). As the name IBOC, In-Band-On-Channel, implies, the HD Radio system operates on the existing analog AM-medium wave and FM-VHF Band II. This very fact has advantages to all involved: the station’s position on the dial does not change. And, for the broadcaster, there will be fewer infrastructure changes necessary and lower capital costs to implement than the other systems. As most transmitters will be of the latest design, HD Radio equipment can therefore be simply, economically and quickly implemented.

From the listener's point of view, the existing analog radio still works, so they only need to buy a radio when they feel the need; i.e. when the right content and services are offered.

From the transmitter and receiver manufacturers point of view, there is less risk and lower R&D necessary; as the equipment is simply an upgrade of existing know-how. There is also the possibility of Indian suppliers manufacturing HD Radio receivers. iBiquity has already designed both the exciter and receiver modules, making it a simple matter of implementation into any applicable manufacturing organization.

The sheer numbers of existing installation and number of receivers sold to date worldwide clearly indicates that HD Radio technology can be the lowest cost and most effective technology for all radio broadcast organizations.

**Reaching Radio Listeners**

Just as Indian broadcasters can gain from the technological rollout in the Americas, it can also benefit from the marketing successes there. Broadcasters in the US and in Brazil have banded together to accelerate the rollout of digital HD Radio broadcasting in their respective countries:
HD Digital Radio Alliance and the Brazilian HD Radio Alliance.

In the US, the country's leading radio groups organized the HD Digital Radio Alliance to greatly enhance the visibility of HD Radio broadcasting and speed up rollout of new multicast formats. Together the groups have committed more than $200 million for national advertising in conjunction with HD Radio receiver manufacturers, retailers, and the automotive industry.

It has been determined by the Alliance that when implementing digital radio, it is important to do the necessary research and find out what your listeners want and then define specific marketing targets and objectives.

The Alliance recommends working on the primary, national message development in order to be consistent from station to station, and then be creative with content and the local opportunities that digital radio can offer. During the implementation of any digital radio technology organizing a digital radio alliance similar to that in the USA and Brazil is strongly recommend. (For more information on the USA HD Radio Digital Alliance go to www.hdradioalliance.com).

**Conclusion**

We're living in a time of unprecedented change in the radio broadcast industry. There are threats yet there are opportunities too, and HD Radio technology is a critical weapon to compete with new technologies. The shear numbers of existing installation and number of receivers sold to date worldwide clearly indicates that HD Radio can be the lowest cost and most effective technology for all radio broadcast organizations. It could be very easy for India to take advantage of this technology just as many other countries around the world are doing.

For broadcasters HD Radio technology is very easy to implement as all components to the system are commercially available from many suppliers.

The fact that it is a market driven technology makes it politically uncomplicated to put into operation.

The fundamental simplicity of the system makes it inexpensive, easy and quick to implement.

The technology has been proven on almost every continent and is available now.

HD Radio broadcasting has seen dramatic success worldwide simply because it has features and benefits to suit all.

**Acknowledgements**

HD Radio™ is a trademark of iBiquity Digital Corporation.


AM & FM HD Radio™ TRANSMISSION by Jeff R. D etweiler

FM IBOC System description by Brian Kroeger iBiquity Digital Corporation

Conversion requirements for FM and AM IBOC Transmission by Jeff R Detweiler

The structure and generation of Robust AM and FM waveforms by Stephen Johnson iBiquity Digital Corporation.

ETSI Standard: Digital Radio Mondiale (DRM); System Specification, ETSI ETS 201 980 V2.1.1 (2005-10)

ETSI Standard: Digital Radio Mondiale (DRM); Multiplex Distribution Interface (MDI), ETSI TS 102 820 V 1.2.1 (2005-10)

ETSI specification, for DAB EN ES 201 980 V 2.2.1 (2005-10)

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ABOUT THE SPEAKER

Charles W. Kelly, Jr. is a 34 year veteran of Radio, starting as a DJ at his college station at the University of Illinois. He has held positions as News Director, Program Director and Chief Engineer at stations in Illinois and Colorado. He was educated at the University of Illinois, Illinois State University, Parkland College, and Fort Lewis College. Prior to joining Nautel Limited, in Halifax, Nova Scotia, Canada in October 2006 as Director, International Sales, he was with Broadcast Electronics in the same capacity for 18 years, and Sales Manager of ITC/3M for 7 years.

Mr. Kelly is a two term Past President of the Society of Broadcast Engineers (SBE), a professional society with over 5000 members in over 30 countries. He has been a speaker at numerous seminars and conventions, including NAB, NRBA, BES (India), Broadcast Asia, ABU, Broadcast Indonesia, ABA (Australia) and SMPTE, and has authored technical articles for Radio World, Broadcast Engineering and Broadcast Management/Engineering.

ABOUT THE AUTHOR

Perry Priestley has worked in the professional broadcast industry in technical and commercial positions for over 25 years. Most recently Perry worked for Thomson Broadcast & Multimedia as a Director of Sales and previously has held positions with Comark, EEV, Varian, Philips and Pye TVT.

As a Broadcast Engineer with Philips and Pye TVT he was responsible for the design and implementation of television transmitter installations on most continents. His most recent activities with Thomson included the marketing and broadcast standards promotion of digital radio and television.

In his position with Thomson and iBiquity Perry has written and presented technical presentations at broadcast symposiums and conferences worldwide including Australia, Argentina, Brazil, Canada, India, Indonesia, Malaysia, Mexico and the USA.

Perry earned an HND in Electrical Engineering and a Bachelor of Science in Applied Mathematics from Anglia University in Cambridge, England.

He is the Director of International Broadcast Business Development at iBiquity Digital Corporation the sole inventor of In-Band-On-Channel (IBOC) technology, and is responsible for developing and promoting the adoption of HD Radio™ worldwide.