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Xperi Inc. Written Comments to TRAI's September 30, 2024, Consultation Paper on Inputs for formulating a Digital Radio Broadcast Policy for private Radio broadcasters

Introduction

On September 30, 2024, the Telecom Regulatory Authority of India ("**TRAI**") issued the "Consultation Paper on formulating a Digital Radio Broadcast Policy for private Radio broadcasters" ("**Consultation Paper 2024**"). Trai has sought comments on various issues relating to formulation of digital radio broadcast policy for private Radio broadcasters.

Xperi Inc. wholeheartedly supports the TRAI and the Ministry of Information and Broadcasting ("**MIB"**) in their initiatives to transition to digital radio broadcasting. In the rapidly evolving digital communication landscape, the adoption of digital radio broadcasting is a pivotal step toward modernizing India's radio infrastructure. Digital radio is crucial for the future of broadcasting, ensuring that radio remains a competitive and innovative medium in the face of emerging digital services. By embracing digital radio, India can enhance the quality of its broadcasting services, offer a wider range of content, and provide listeners with a superior audio experience.

HD Radio digital FM broadcasting should be selected as the technology standard for India. The technology innovations of the HD Radio system, the variety of services which create business opportunities for broadcasters, the plethora of affordable receiver products, and the preference of consumers all demonstrate the success of HD Radio broadcasting compared to other technologies available.

The HD Radio system, a hallmark of digital innovation, offers unparalleled audio quality, efficient spectrum use, and a plethora of value-added services. Embracing HD Radio technology aligns with India's vision of a digitally empowered society, ensuring that radio remains a vital medium for information, education, and entertainment. This transition enhances the listening experience and fosters a more inclusive and connected nation.

Advantages of HD Radio:

- **Simulcasting Capability**: Allows simultaneous broadcast of analog and digital signals.

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- **Enhanced Audio Quality**: Comparable to CD quality for FM and FM quality for AM.
- **Multicasting**: Broadcast multiple audio channels on a single frequency (HD2, HD3, HD4) allows for more efficient use of spectrum Radio operators provide innovative content and are able to reach specific ethnic and language populations with unique programming.
- **Data Services**: Provides traffic updates, weather alerts, and song information. Data services enable a variety of local applications and can generate additional revenue for the radio operator.
- **Emergency Alerting**: Provides real-time critical information for public safety and public awareness. The emergency alert service is successfully deployed across hundreds of radio stations in North America and has been essential during storms, wildfires, and COVID pandemic.

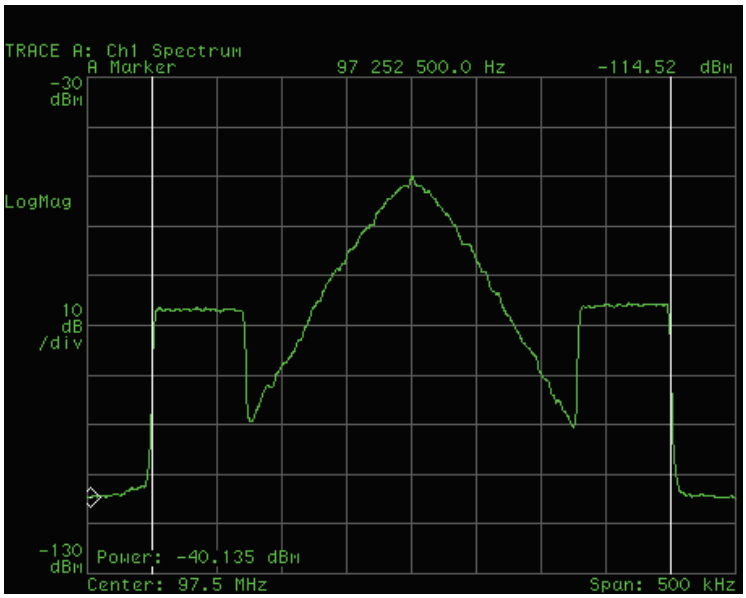
Spectral characteristics

HD Radio simulcast, also known as hybrid digital broadcasting, is a technology that allows radio stations to broadcast both analog and digital signals simultaneously on the same frequency. This approach leverages the existing FM or AM spectrum to deliver enhanced audio quality and additional services without disrupting the traditional analog broadcast.

The hybrid approach ensures **backward compatibility** with existing analog receivers. Listeners with traditional analog radios can continue to receive the main broadcast without any changes, while those with HD Radio receivers can enjoy the enhanced digital services. This smooth transition is crucial for widespread adoption, as it does not alienate the existing audience base.

For FM stations, the HD Radio simulcast (hybrid) transmission uses a total of 400 kHz channel bandwidth allocated to each station. The digital signal is transmitted alongside the analog signal within this bandwidth – 200 kHz for the analog transmission and additional 2 sidebands of 100kHz each for the digital service. Specifically, the digital carriers are placed in the sidebands of the analog signal, which means they occupy the spectral space immediately adjacent to the analog carrier. This hybrid approach allows the digital and analog signals to coexist without interfering with each other. The digital carriers are located

in the white-space or protection space between channel assignments with power levels designed to minimize interference.



Dual digital sidebands

Multipath fading and non-uniform interference from a short-spaced first-adjacent signal occasionally corrupt some subcarriers comprising an HD Radio signal while simultaneously sparing others. These frequency-selective effects are dynamic (i.e., they can change from symbol to symbol) and are largely independent between the upper and lower sidebands. HD Radio signals mitigate this effect via frequency diversity – simulcasting information content on upper and lower digital sidebands located on either side of the analog host signal. In this manner, if one sideband is compromised, the other digital sideband can often successfully recover the transmitted information.

The upper and lower digital sidebands can be independently detected and decoded. If one sideband were completely corrupted by multipath or a strong first-adjacent FM signal, the opposite sideband could still be recovered.

Additional decoding gain can be achieved when both sidebands are combined. This occurs when the FEC code on each sideband is a stand-alone subset of a larger (lower rate) code. When both sidebands contain useful information not corrupted by an interferer, the combined code provides additional coding gain above that achieved by power combining the two sides.

Furthermore, the FM HD Radio system permits the upper and lower digital sidebands to be independently adjusted from 1% to 10% of the analog host power to accommodate transmitter sizing, adjacent channel protection ratios, or coverage optimization. Independent selection of sideband power allows short-spaced stations to meet the protected contour requirement without impacting the other full-spaced sideband level.

HDC – HD Radio CODEC

Digital radio technologies lack the bandwidth to transmit linear CD audio quality stream (16 bits per channel sampled at 44.1 kHz). Therefore, bit reduction (compression) is needed to reduce the audio data bit rate. The HDC™ audio coder/decoder (CODEC) is specifically designed to minimize the bits required for a quality audio signal.

Using advanced signal processing and psycho-acoustic modeling, CODECs interpret human hearing to eliminate redundancies in the audio signal. HDC compresses FM audio at a ratio of 15:1, enabling 96kb/s to deliver CD-like quality. The AM CODEC compresses at around 40:1 for FM-like quality.

HDC is compatible with broadcast multichannel audio modes (e.g., 96 through 64 kbps for 5.1 channel audio) and includes built-in data channels and transport features. It's optimized for digital audio broadcast systems, incorporating error-concealment techniques to mitigate channel errors. These features enhance broadcast system design to match prevailing channel conditions and interference scenarios better.

HDC was evaluated against analog and other CODEC technologies and was compatible across various program content at bitrates between 16-96 kb/s. National Public Radio conducted independent verification in 2004 in a study[12] developed by Dr. Ellyn Sheffield, PhD, Sheffield Audio Consulting.

[1] "Report on Perceptual Tests of Coders at Low- and Very Low-Bit Rates." Ellyn G. Sheffield, PhD., Sheffield Audio Consulting. NPR Reports, 2004.
[2] "Perceptual Tests of iBiquity's HD Coder At Multiple Bit Rates." Ellyn G. Sheffield, PhD., Sheffield Audio Consulting. NPR Reports, 2004.

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Adopting HD Radio in India presents a compelling opportunity to revolutionize the country's broadcasting landscape through robust transmission technology, an extensive product ecosystem, and strong consumer satisfaction.

Robust Transmission Technology: HD Radio offers a hybrid digital broadcasting system that seamlessly integrates with existing analog infrastructure. This technology ensures superior audio quality, with FM broadcasts delivering CD-like sound and AM broadcasts achieving FM-like clarity. The digital signal's resilience to interference and noise further enhances the listening experience, providing consistent and high-quality audio across diverse environments. Additionally, HD Radio's ability to transmit multiple digital subchannels on a single frequency maximizes spectrum efficiency, allowing broadcasters to offer a wider variety of content without requiring additional spectrum allocations.

Extensive Product Ecosystem: The global adoption of HD Radio has led to the development of a comprehensive ecosystem of compatible devices, including car radios, home receivers, and portable units. This extensive product ecosystem ensures that consumers have access to a wide range of HD Radio-enabled devices, facilitating easy adoption and integration into daily life. Manufacturers and retailers in India can leverage this established ecosystem to provide consumers with reliable and high-quality HD Radio products, driving market growth and technological advancement.

Strong Consumer Satisfaction: HD Radio significantly enhances the listener experience by offering improved audio quality, additional content options, and valuable data services such as song titles, artist information, traffic updates, and weather alerts. These features cater to the diverse preferences of Indian consumers, providing them with a richer and more engaging listening experience. The backward compatibility with existing analog receivers ensures a smooth transition, allowing all listeners to benefit from the advancements in digital broadcasting without disruption.

In conclusion, adopting HD Radio in India will harness the power of robust transmission technology, capitalize on an extensive product ecosystem, and deliver strong consumer satisfaction. This strategic move will not only modernize India's broadcasting infrastructure but also foster innovation, competition, and growth in the digital radio sector, ultimately enriching the listening experience for millions of Indian consumers.

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Q1: Do you agree that single digital radio technology adoption is preferable for entire country? If not, support your reply with justification.

Adopting a single digital radio technology across the entire country is indeed preferable. A unified approach simplifies the transition from analog to digital, ensuring consistency in technology deployment, reducing costs, and facilitating the availability of compatible receivers. With its proven track record in the United States, Canada, and Mexico, HD Radio offers a robust and scalable solution that can meet India's diverse broadcasting needs. This uniformity will streamline regulatory processes and foster a cohesive digital radio ecosystem.

- **United States**: HD Radio has been successfully implemented nationwide, providing a consistent, high-quality listening experience. In 2002, the Federal Communications Commission codified the rules[3] for digital radio based on the NRSC-5 technology standard[4].
- **Canada**: Over 49 FM stations, offering 100 digital channels in 20 markets broadcast with HD Radio technology, covering more than 53% of the population. HD Radio has been operating experimentally in Canada since 2014, and the technical specifications for IBOC were formally adopted in August 2024[5].
- **Mexico**: HD Radio technology has been adopted, with 149 FM stations carrying 230 program services, covering 41% of the population. The HD Radio standard was adopted in Mexico in 2011[6].

[3] "Digital Audio Broadcasting Systems and Their Impact on the Terrestrial Radio Broadcast Service." Docket 99-325. Federal Communications Commission, October 11, 2002.
[4] NRSC-5, "In-band/on-channel Digital Radio Broadcasting Standard." National Radio Systems Committee, 2001.
[5] BPR-3, "Rules for FM Broadcast Undertakings in Canada." Innovation, Science, and Economic Development Canada, May 2024.
[6] "Acuerdo Por El Que Se Adopta El Estandar Para La Radio Digital Terrestre Y Se Establece La Politica Para Que Los Concesionarios Y Permisionarios De Radiodifusion En Las Bandas 535-1705 Khz Y 88-108 Mhz, Lleven A Cabo La Transicion A La Tecnologia Digital En Forma Voluntaria." Comisión Federal de Telecomunicaciones, June 2011.

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Q2: In case a single digital radio broadcast technology is to be adopted for the entire country, which technology should be adopted for digital radio broadcasting? Please give your suggestions with detailed justification.

HD Radio broadcast technology should be the technology of choice for digital radio broadcasting in India. Its ability to provide superior audio quality, robust reception in challenging signal environments, support for multiple channels on a single frequency, and enhanced data services make it an ideal choice. HD Radio in-band on-channel (IBOC) technology allows for a seamless transition from analog to digital, enabling broadcasters to simulcast both formats during the transition period. This ensures that listeners can continue to access their favorite stations without interruption while gradually experiencing the benefits of digital radio. The advanced suite of HD Radio metadata tools boosts consumer satisfaction by providing rich visual and textual content, leading to longer listening times and increased station brand loyalty.

The HD Radio system was extensively evaluated by the National Radio Systems Committee (NRSC) and other technical and standards organizations. The NRSC-R203[7] report evaluated the FM IBOC system, which was selected by the FCC to enable FM radio broadcasters to introduce digital operations. The report details extensive laboratory and field tests conducted to assess the system's digital performance and its compatibility with existing analog signals. Key findings indicate that the FM IBOC system significantly improves audio quality and robustness against interference compared to traditional analog FM, particularly in mobile environments. The system's blend-to-analog feature ensures a smooth transition in areas of weak signal strength, maintaining audio quality. The report concludes that the FM IBOC system offers enhanced performance and flexibility, paving the way for a smooth transition to digital broadcasting with minimal disruption to existing analog services.

Additional industry test reports provide further documentation of HD Radio performance. Technical reports filed during field evaluations of HD Radio services in Canada concluded the HD Radio transmission created minimal interference and highlighted that existing broadcast protection policies for analog can be applied to HD Radio broadcasts.[8] Field

[7] "NRSC-R203. Evaluation of the iBiquity Digital Corporation IBOC System – Part 1 – FM IBOC." National Radio Systems Committee, November 2001.
[8] "TECHNICAL REPORT Compatibility Study – Analog and HD Radio Broadcasting Systems in the 88 – 108 MHz Band." Sébastien Laflèche Martin Quenneville Adrian Florea. Innovation, Science, and Economic Development Canada (ISED) Document # CRC Technical Report 031017-TR-01, February 2019

testing in Korea also highlighted the resilience of HD Radio transmissions where digital performance exceeded FM analog performance across many mountainous test conditions.[9]

Simulcast operation is a primary consideration for success in India and HD Radio technology offers superior performance and operational cost benefits for this service. In the 2022 Ernst & Young report on digital broadcast for India, the analysts concluded "Digital radio system must support simulcast of analogue and digital services during transition period."[10]

From a manufacturing and product perspective, the HD Radio system has developed a mature ecosystem over the past 20 years. With over 5000 different models of receivers certified and 110 million receiver products sold, the consumer market is well established with over 40 major product manufacturers leading innovations in product design and cost optimizations. The HD Radio platform is standard on major automotive manufacturers, established in home and portable solutions, and integrated into feature phones and smartphones at affordable prices. The Indian market will benefit from this robust manufacturing support and locally-designed radios will have a strong market in other countries.

For radio broadcasters, the HD Radio services have created new revenue models and innovative ways of monetizing the broadcast assets. Three primary revenue options have been successful in contributing to the $9 Billion USD radio industry. First, radio stations have partnered with traffic service providers and car manufacturers to deliver real-time traffic updates to vehicles and navigation systems. These services augment existing navigation features. Second, radio broadcasters have been allowed to lease their multicast (HD2 or HD3) program channels to content creators who do not have direct access to broadcast spectrum. Partnerships with sports teams have been very successful in building brand equity for the sports team and the broadcaster. Finally, broadcasters are finding value in visual advertising whereby the text and image services from HD Radio are increasing advertising revenue with pictures and logos. Research has shown that a visual advertisement can result in greater recall and brand awareness compared to an audio-only

[9] "Field Trials and Evaluations of In-Band Digital Radio Technologies: HD Radio and DRM+." Myung-Sun Baek, Yong-Hoon Lee, Sora Park, Geon Kim, Bo-mi Lim, and Yong-Tae Lee - Electronics and Telecommunications Research Institute (ETRI). IEEE Transactions on Broadcasting, Vol. 59, No. 3, September 2013

[10] "Digital broadcast radio in India Perspectives on the opportunity and requirements for a successful implementation." Ernst & Young. April 2022.

advertisement[11]. Each of these success cases have been demonstrated across hundreds of HD Radio stations in North America and resulted in a strong return on investment of the digital radio installation.

Furthermore, HD Radio technology has significantly enhanced the listening experience for radio consumers, offering superior sound quality and additional programming options. According to market research, an impressive 96% of HD Radio owners express satisfaction with their experience, and 94% would recommend HD Radio technology to their friends and family[12].

Q3: In case multiple digital broadcasting technologies are to be adopted, please specify whether it should be left to the market forces to decide the appropriate technologies and what could be the potential problems due to adoption of multiple technologies?

Please suggest probable solutions to the problems, with detailed justification.

While multiple digital broadcasting technologies could theoretically coexist, it is advisable to adopt a single technology to avoid potential regulatory complexity, market fragmentation, increased costs for broadcasters and consumers, and interoperability challenges. If multiple technologies were to be adopted, it would be essential to establish clear guidelines and standards to ensure compatibility and minimize interference. However, the benefits of a single, unified technology like HD Radio far outweigh the complexities of managing multiple systems.

Problems with Multiple Technologies:

- **Consumer Confusion**: Different receivers would be needed for different technologies, leading to confusion and inconvenience for consumers. For example, a listener might need separate devices to access different stations, complicating the user experience.
- **Increased Costs**: Broadcasters would face higher costs to support multiple systems, including the need for additional infrastructure and maintenance. This

[11] Nielsen Custom Advertising Effectiveness Report. August 2016.
[12] IPSOS Survey, December 2021.

could deter smaller broadcasters from adopting digital technology due to financial constraints.

- **Interoperability Issues**: Ensuring compatibility between different technologies can be challenging, potentially leading to interference and degraded service quality. For instance, signals from different digital systems might interfere with each other, reducing the overall effectiveness of digital broadcasting.

Q4: What should be the approach for migration of existing FM radio broadcasters to digital radio broadcasting?

The migration of existing FM broadcasters to digital radio broadcasting should be approached in a phased manner. And Indian FM broadcasters could leverage years of experience and lessons learned from the HD Radio system rollout in North America to ensure an efficient migration to digital radio services.

Initially, broadcasters in major metropolitan areas can be encouraged to adopt HD Radio technology, leveraging its ability to simulcast analog and digital signals. This phased approach allows for the gradual build-up of digital radio receivers in the market, ensuring listeners are not abruptly cut off from their preferred stations. Financial incentives and technical support should be provided to broadcasters to facilitate this transition.

Chapter VI of The Telecommunications Act, 2023 establishes the process for a "regulatory sandbox" to allow for innovation and experimentation of broadcasting.[13] This process can be utilized in the early ears to accelerate digital radio transmissions while more directive policies are drafted.

Phased Approach:

- **Phase 1: Major Metropolitan Areas**: Focus on cities like Delhi, Mumbai, and Bangalore, where the infrastructure and market readiness are higher. Broadcasters in these areas can start by simulcasting analog and digital signals, reducing implementation costs and providing listeners with the benefits of existing analog and new digital services without changing their behavior in tuning the radio.

[13] "Telecommunications Act, 2023." Government of India, December 2023.

Simulcasting also retains digital services on the same transmission frequency as analog, thereby maintaining the brand identity of the broadcaster.

- **Phase 2: Expansion to Smaller Cities**: Once the initial phase is successful, expand to smaller cities and towns. This phase will build on the established infrastructure and market acceptance from the first phase, ensuring a smoother transition.
- **Phase 3: Rural Areas and Nationwide Coverage**: Finally, extend digital radio broadcasting to rural areas, ensuring that the entire nation benefits from the enhanced audio quality and additional services offered by HD Radio. This phase will require targeted efforts to ensure the affordability and accessibility of digital radio receivers in less urbanized regions.

Q5: What should be the timeframe for various activities related to the migration of existing FM radio broadcasters to digital radio broadcasting?

A realistic timeframe for migrating existing FM broadcasters to digital radio broadcasting would span five to seven years. Every market which has adopted HD Radio technology has seen a multi-year adoption of the digital services. For the transition to be effective, broadcasters have focused their resources to upgrade stations in the major metropolitan areas. This approach creates faster adoption of products and accelerates manufacturing, thereby, reducing costs for consumers across all market segments.

The first two years should focus on establishing the necessary infrastructure and conducting pilot projects in major cities. The subsequent three to five years can be dedicated to expanding digital radio coverage to smaller cities and rural areas. This phased approach ensures that the transition is smooth and that all stakeholders have adequate time to adapt to the new technology. MIB should establish an institutional mechanism to design a roadmap of the digital radio policy and to oversee its proper implementation. Its role and responsibilities should be clearly defined.

Proposed Timeline:

- **Years 1-2**: Infrastructure development and initial commercial projects in major cities.
- **Years 3-5**: Expansion to smaller cities and rural areas.
- **Years 6-7**: Full nationwide implementation.

As part of the rollout plan, MIB should partner with private broadcast sector to evaluate suitable CTI sites and any required infrastructure upgrades for those locations. Adopting either digital radio technology will require some level of government investment to upgrade CTI sites to support the additional transmission power.

HD Radio has been extremely successful operating in a CTI environment. More than 20 CTI transmission sites in major metro cities across North America are operating with this combined infrastructure for many years.

Success of Integrating HD Radio into Multi-Station Combiner Systems[14]:

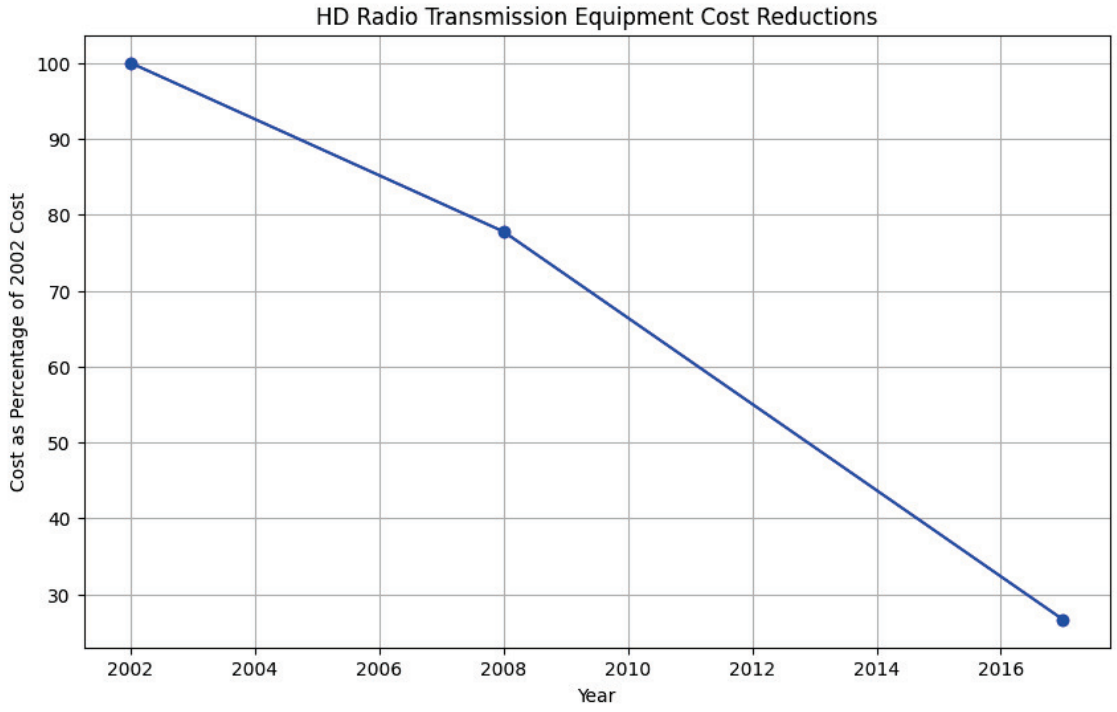
- **Empire State Building, New York City**: The Empire State Building is a prime example of the successful integration of HD Radio into multi-station combiner systems. This iconic site hosts multiple broadcasters, all utilizing HD Radio technology to deliver high-quality digital broadcasts alongside their analog signals. Using combiners allows these stations to share the most desirable transmission location and infrastructure efficiently, reducing costs and maximizing signal integrity.
- **Miami**: The most extensive combined transmitter site in the Southeast US is located equidistant 20 km (12 mi) Southwest of Ft. Lauderdale and North of Miami in the city of Andover, FL. The Guy Gannett/441 Tower is one of the largest and highest power facilities of its kind in the United States of America. In 2004, the site was upgraded with new RF combining hardware specifically designed to accommodate more stations and their digital transmission requirements.
- **Houston**: The most extensive combined transmitter site in Houston, Texas, is located approximately 24 km (15 mi) Southwest of the city center. Often referred to as 'Senior Road', it is one of the largest and highest power facilities of its kind in the United States. In 2011, the site was upgraded with new RF combining hardware specifically designed to accommodate more stations and their digital transmission requirements.

[14] "In-band, on-channel digital sound (System C) transmission systems: Considerations for operational installations." Report ITU-R BS.2503-0, March 2023.

- **CN Tower, Toronto**: Similarly, the CN Tower in Toronto serves as a central hub for multiple broadcasters using HD Radio. The integration of HD Radio into the combiner systems at this site has enabled broadcasters to offer enhanced digital services without the need for separate transmission facilities. This setup optimizes the use of available infrastructure and ensures listeners receive consistent and high-quality broadcasts.

Q6: Please suggest measures that should be taken to encourage existing FM radio broadcasters to adopt digital radio broadcasting.

HD Radio transmission solutions are currently in the fourth generation and new solutions are in development for a generation 5 based on cloud distribution. Over time, the technology architecture innovations and manufacturing innovations have led to significant cost reductions. In 2024, the cost of HD Radio signal generators is 22% of the cost of earlier models. These reductions are clearly driven by a mature industry constantly seeking to increase value for broadcasters.



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Several measures can be implemented to encourage existing FM broadcasters to adopt digital radio broadcasting. Financial incentives such as tax breaks and subsidies for upgrading equipment can significantly reduce the financial burden on broadcasters. Offering tax deductions or credits for investments in digital radio technology and providing direct financial support through grants or low-interest loans can make the transition more affordable, especially for smaller broadcasters. Additionally, comprehensive training programs and ongoing technical support are essential to help broadcasters familiarize themselves with HD Radio technology and troubleshoot any issues that arise. This can include workshops, online courses, hands-on training sessions, a dedicated helpline, and online resources.

Regulatory frameworks should be streamlined to facilitate the licensing and operation of digital radio services. Simplifying the licensing process, adapting existing regulations to accommodate digital radio, and creating regulatory incentives such as charging a token license fee from the broadcasters until the significant migration takes place from analog to digital radio and digital radio gains some scale for early adopters can significantly reduce bureaucratic hurdles and encourage broadcasters to make the transition. The Government should run sponsored pilot programs through the “regulatory sandbox” outlined in the Telecommunications Act 2023 to allow broadcasters to test digital broadcasting technology with minimal risk, providing technical support during early stages of adoption.

Furthermore, public awareness campaigns are also crucial to highlight the benefits of digital radio to the general public. To promote the technology launch and new features available for US consumers, broadcasters formed an HD Radio Alliance. This consumer-facing resource activated nationwide educational campaigns, used various media channels, hosted demonstration events where consumers could experience HD Radio firsthand, and formed partnerships with popular influencers that effectively promoted digital radio. A comprehensive HD Radio marketing and promotion guidebook was published; artwork, scripts, and step-by-step instructions served as an instructional guide for broadcasters. During the rollout period, a consumer-facing website was launched to enhance listeners’ interest and interactively promote discovering the benefits of HD Radio broadcasting.

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Q7: What measures should be taken to facilitate the availability of affordable digital radio receivers?

Over the past 20 years, the HD Radio integration costs have reduced by approximately 90%. This significant decrease is a result of strategic efforts and innovations by Xperi, aimed at making HD Radio technology more accessible and cost-effective. As manufacturing innovations have optimized the radio design, the mature product ecosystem and scale of manufacturing have contributed to lower cost products. Such cost reductions are not seen in other technology options which have not established strong manufacturing partnerships.

Several key strategies have contributed to this reduction:

- Creating strong consumer demand for HD Radio.
- Enhancing software quality and user experience through continuous improvements.
- Fostering market competition by collaborating with multiple IC suppliers.
- Integrating the HD Radio decoder with other parts of the radio subsystem, such as DSP, tuners, and memory.
- Developing cost-effective HD Radio decoder software releases.
- Improving processor utilization and reducing memory requirements.
- Designing a modular decoder library that allows OEMs and T1s to run the HD Radio decoder as a software library on existing system processors.
- Providing comprehensive engineering support and consultation to assist with product integration.

These efforts have collectively enabled a substantial reduction in the hardware costs associated with HD Radio receivers, making the technology more affordable and widely available.

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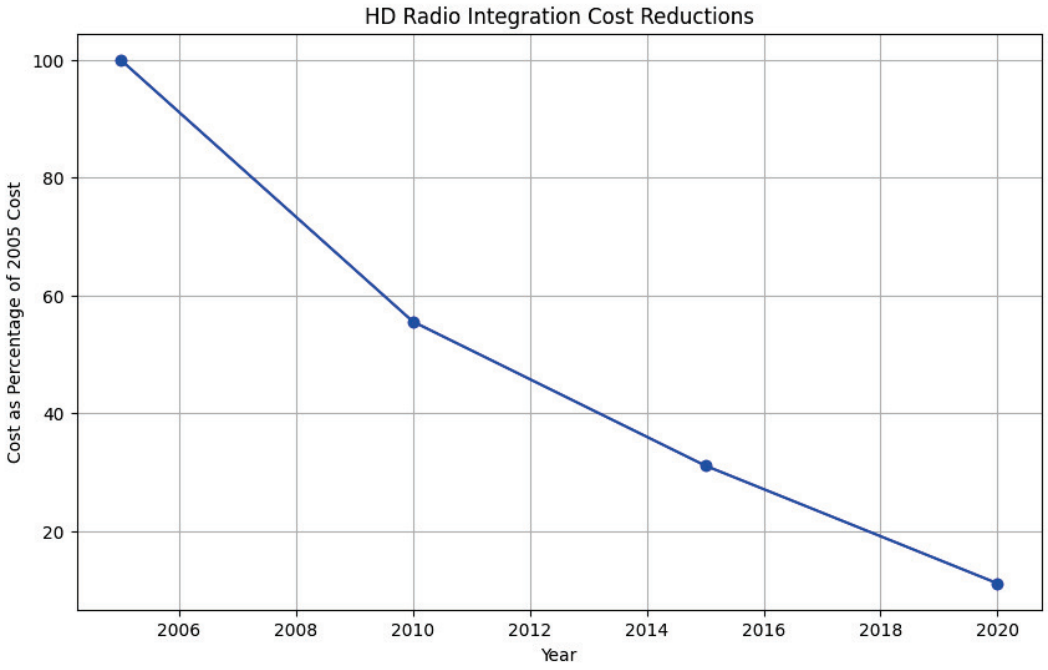

Ensuring the availability of affordable digital radio receivers is crucial for the widespread adoption of digital radio broadcasting. This can be achieved by promoting local manufacturing of HD Radio receivers, offering subsidies to manufacturers, and encouraging the integration of digital radio capabilities in mobile phones and automotive systems. Public-private partnerships can significantly reduce costs, making digital radio receivers accessible to a broader audience. Additionally, educational campaigns can inform consumers about the benefits of digital radio, driving demand and further reducing costs through economies of scale.

Strategies for Affordable Receivers:

- **Local Manufacturing**: Promote domestic production of HD Radio receivers.
- **Subsidies and Tax Incentives**: Government to incentivize the digital receiver manufacturers, digital radio test services, software developers for digital radio etc., so that the digital receivers and transmitters are available at commercially reasonable prices.
- **Production-linked Schemes (PLI) Schemes**: In line with the vision of Atmanirbhar Bharat, the MIB should launch the Production-Linked Incentive (PLI) schemes for digital receivers to catalyze the growth of the digital receiver base in India.

- **Integration**: Encourage digital radio capabilities in mobile phones and cars.
- **Public-Private Partnerships**: Establish collaborations between government research organizations (e.g. MEITY CDAC Centre of Excellence) and domestic manufacturing to accelerate product development and reduce costs.
- **Consumer Education**: Campaigns to highlight the benefits of digital radio and availability of affordable options.
- **Phased-transition period:** Gradual approach to the digital transition, giving users the time to purchase affordable digital receivers.

Q21. Should the frequency be considered, or multiple channels operated on single frequency be considered for the purpose of putting restriction on multiple channels in a city? Please provide your suggestions with detailed justification.

The HD Radio system (IBOC) has been successfully implemented and approved by regulatory authorities in the U.S., Canada, Mexico, and the Philippines. In these countries, the licensing for simulcast digital radio services is based on the existing analog frequency licenses, without additional regulations for the number of program services transmitted. This policy focuses on spectrum assignment rather than the specific use or capacity of the spectrum, which has significantly encouraged the growth of digital services and spurred competition among broadcasters to develop innovative content and services for their local audiences.

Adopting a similar regulatory approach in India could greatly benefit the digital radio landscape. By basing licensing on spectrum assignment and not on the number of digital services, India can foster a more dynamic and competitive broadcasting environment. This would not only accelerate the adoption of digital radio but also encourage broadcasters to create diverse and high-quality content tailored to local audiences. Such a policy perspective could drive technological advancements and enhance the overall listening experience for Indian consumers. Therefore, it is strongly recommended that India consider this proven regulatory framework to support the growth and innovation of digital

radio services. These conclusions were identified in the 2022 E&Y report on digital radio for India.[15]

Q27. What should be the methodology for examination and creation of new Common Transmission Infrastructure (CTI) setups required for new channels including their upkeep, given that existing CTI setups and towers may not have vacant space and apertures, respectively, for accommodating additional new channels in category A+ and A cities?

For individual stations broadcasting a hybrid IBOC signal, common amplification and a single-antenna array offer the most cost-effective implementation and optimal signal transmission. Where it is desirable to collocate multiple stations at a single site, it is most cost-effective to use several band-pass filter-balanced combiner modules to aggregate signals into a common master antenna with stations combined at a minimum of 800-kHz spacing.[16] Spacing at 400 kHz, while technically feasible, comes at a significant premium in cost and complexity.

Q28. What should be the methodology for examination and modifications to existing CTI setups or creation of new CTI setups required for transmission of digital components/ simulcast operation by existing broadcasters including its upkeep given that existing CTI setups, including towers, may not support the addition of digital components without modifications?

Modifying any CTI setup for additional transmission and power will require thorough engineering analysis to ensure safety ratings are not exceed and the confirm the digital signal is not distorted. OFDM signals (used in both HD Radio and DRM) have peak power considerations, and integration into an existing infrastructure requires proper analysis to ensure sufficient power margins. These points should be addressed regardless of which digital technology is implemented at the transmission site.

[15] "Digital broadcast radio in India Perspectives on the opportunity and requirements for a successful implementation." Ernst & Young. April 2022.
[16] "In-band, on-channel Digital Sound (System C) Transmission Systems: Considerations for Operational Installations." Report ITU-R BS.2503-0, International Telecommunications Union. March 2022.

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Existing CTI facilities should be evaluated for conformity with the following criteria:

- Voltage Breakdown
- Phase Distortion
- Amplitude Distortion
- Impedance Match
- Isolation
- Linearity
- Noise and Spurious Emission

Complete subsystem specifications are contained within ITU-R Report on In-band / On-channel implementation considerations[17].

Q34. Stakeholders may also provide their comments/ suggestions along with detailed justification on any other issue that may be relevant to the present consultation.

The Wireless Planning and Coordination (WPC) Wing of the Ministry of Communications, Government of India, is urged to review and revise the existing transmitter power limits. These limits, established over 20 years ago, were established for an analog transmission environment and do not adequately accommodate the requirements of modern digital transmission technologies.

With the advent of digital broadcasting and the increasing need for transmitters that support both analog and digital transmission (Simulcast mode), it is essential to update these power limits. Digital transmission requires higher peak power to ensure robust signal quality and coverage. Therefore, new power limits should be considered to provide sufficient headroom for digital peak power while maintaining the integrity of analog transmission.

A provision for separate power ratings for analog and digital transmissions can be made. This approach will ensure that the analog power limits are preserved, while allowing for the necessary adjustments to support digital transmission. By doing so, the WPC will facilitate

[17] Ibid.

the import and deployment of advanced transmitters capable of Simulcast mode, thereby enhancing the overall broadcasting infrastructure in India.

This revision is crucial for keeping pace with technological advancements and ensuring that India's broadcasting capabilities remain competitive and efficient in the digital age.

Conclusion

HD Radio broadcasting is an extremely robust and successful technology and service. Over the past 20 years, the broadcast industry has adopted HD Radio technology and created strong business opportunities in the digital age, allowing the radio operators to compete with other content services. And consumers have benefited from the increase in local information content as well as real-time public safety notifications.

By adopting HD Radio technology, India can benefit from the established ecosystem and revolutionize its radio broadcasting landscape, providing listeners with superior audio quality, diverse content, and enhanced services. This transition will not only preserve the cultural significance of radio but also propel it into the digital age, ensuring its relevance for future generations.

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