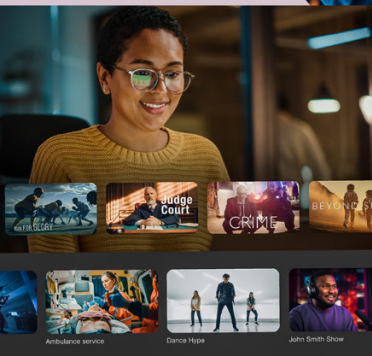


ITU-D第2/1号课题输出成果报告

数字广播技术的过渡和采用（包括针对各种环境提供新业务）的战略、政策、规则和方法

2022-2025年研究期



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ISBN 978-92-61-41025-4（电子版）

ISBN 978-92-61-41035-3（EPUB版）

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International Telecommunication Union, Place des Nations, CH-1211 Geneva, Switzerland

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鸣谢

国际电联电信发展部门（ITU-D）研究组提供了一个中立性平台，来自世界各地的政府、业界、电信组织和学术界的专家可在此汇聚一堂，开发解决发展问题的实用工具和资源。为此，ITU-D的两个研究组负责在成员所提出输入意见的基础上编写报告、导则和建议。研究课题每四年由世界电信发展大会（WTDC）确定。国际电联成员于2022年6月在基加利举行的WTDC-22上商定，在2022-2025年期间，第1研究组将在“为有意义的连接创造有利环境”的总体范围内处理七项课题。

本报告是针对“第2/1号课题：数字广播技术的过渡和采用（包括针对各种环境提供新业务）的战略、政策、规则和方法”编写的，由ITU-D第1研究组的管理班子提供全面指导和协调。该研究组由主席Regina Fleur Assoumou-Bessou女士（科特迪瓦共和国）领导，并得到以下副主席的支持：Ali Rasheed Hamad Al-Hamad先生（科威特国）、Amah Vinyo Capo先生（多哥共和国）、George Anthony Giannoumis先生（挪威）、Roberto Mitsuke Hirayama先生（巴西联邦共和国）、Sangwon Ko先生（大韩民国）、Umida Musaeva女士（乌兹别克斯坦共和国）、Caecilia Nyamutswa女士（津巴布韦共和国）、Memiko Otsuki女士（日本）、Khayala Pashazade女士（阿塞拜疆共和国）、Sunil Singhal先生（印度共和国）、Mehmet Alper Tekin先生（土耳其共和国）。

本报告由第2/1号课题共同报告人Roberto Mitsuke Hirayama先生（巴西）与以下副报告人：Nataša Kuzmanovic女士（波斯尼亚和黑塞哥维那）、Malick Ndiaye先生（塞内加尔共和国）、赵鲁豫先生（中华人民共和国）、Jean Marie Magnan先生（海地共和国）、Therese Koivogui女士（几内亚共和国）、Saeed Addow Himmaida先生（苏丹共和国），以及共同报告人Stanislas Kanvoli先生（科特迪瓦共和国）协作撰写。

谨向章节牵头作者Roberto Hirayama先生（第1、2、5章）、Nataša Kuzmanovic女士（第4章）、Malick Ndiaye先生（第3章），以及积极参与报告审阅的Teddy Woodhouse先生（大不列颠及北爱尔兰联合王国）和Joseph Burton先生（美利坚合众国）致以特别感谢。本报告是在ITU-D第2/1号课题联系人、编辑以及出版物制作团队和ITU-D第1研究组秘书处的支持下编写的。

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内容提要

本最后报告借鉴了关于内容分发业务与技术新环境的持续讨论，同时考虑到：一些国家已经完成向数字广播技术的迁移，而其他国家则正处于完成过渡的进程中；不同环境（尤其是广播与宽带）之间的关系要求传送视听内容的各类网络相互协作；最后但同样重要的是，广播领域正在发生变化，为用户提供的业务也在不断演进。

因此，本报告研究了新广播技术、业务、系统及应用在环境中的实施情况，而新环境似乎正朝着服务提供商向全球媒体战略转型的方向发展，服务提供不再局限于传统广播市场，更将广播视为关键基础设施—通过与其他网络及服务平台相结合，提供创新应用与服务。

在此背景下，本报告重点介绍了广播系统的最新发展动态，以及互联网协议（IP）在制作、贡献和传输系统等整个广播链条中的应用。此外，本报告还从两个角度概述了广播领域数字技术的采用情况：一是介绍制造商推出的前沿广播技术产品；二是通过公开数据，以基准数据的形式展示广播机构采用这些技术的情况。

本报告的另一核心内容是电视广播在从模拟向数字过渡进程中采用数字广播的情况，包括频谱管理方面的考虑以及“数字红利”的使用。本报告介绍了最佳做法和经验，明确阐述了发展中国家在该领域的需求，为规划并实施模拟向数字过渡的各方提供参考。

基于从文稿提交方分享的经验和案例研究中所汲取的经验教训和最佳做法，本报告为广播行业采用数字技术的利益攸关方提供了一些导则。

本报告初步指出，近年来广播业务所处的环境发生了巨变，其适应与演进的必要性不言而喻。广播行业利益攸关方（包括制造商、服务提供商和监管机构）均对此达成共识。本报告研究结果同时表明，数字技术的采用情况因区域而异，各区域面临特定挑战，包括基础设施有限和资金短缺，因此过渡进程仍然是一个重大问题。

本报告还讨论了下一代广播系统（ATSC 3.0、5G广播、DVB-NIP、ISDB-T）的采用状况，强调了标准化对于推动向这些系统更高效过渡的重要性。同样，本报告指出，发展中国家在获得为消费者带来交互性、内容个性化等益处的同时，面临成本与监管等具体挑战。

最后，考虑到这些因素，本报告建议利益攸关方在广播业务演进中考虑以下导则，并强调：

- 利益攸关方（政府、监管机构、行业参与者、服务提供商和消费者/观众）应共同做出一切必要努力，完成电视广播业务向数字技术的过渡和采用，并完成关停模拟广播的进程；
- 在向数字广播技术过渡和采用进程中，应正式制定战略和路线图，并基于所有利益攸关方的合作与协作开展各项活动；

- 频谱规划（包括使用数字红利）应遵循最佳做法以及国际导则和标准审慎实施；
- 视听内容分发与消费生态系统应作为整体考量，因为多种技术（包括广播和宽带）之间可能存在相互作用，这对于政策制定者营造有利于提供满足消费者/观众需求的广播业务的环境至关重要；
- 在尊重各成员国主权的前提下，监管和法律框架应应对数字广播业务的新挑战和机遇，并助力提升用户体验；
- 任何关于视听内容分发（包括广播）的监管和法律讨论，均应通过开放及参与性的监管及规则制定流程，确保所有利益攸关方充分参与。

缩写词和首字母缩略语

缩略语	扩展形式
2G / 3G / 4G / 5G / 6G	第二代/第三代/第四代/第五代/第六代移动通信（见以下注1）
AAC	高级音频编码
AI	人工智能
AR	增强现实
ASO	模拟停播
ATSC	先进电视系统委员会
AVC	音频和视频编码
DASH	基于HTTP的动态自适应流媒体
DTT	数字地面电视
DVB	数字视频广播
FeMBMS	进一步增强型多媒体广播组播业务
HD	高清晰度
IBB	综合广播-宽带
IP	互联网协议
ISDB	综合业务数字广播
ITU-D	国际电联电信发展部门
ITU-R	国际电联无线电通信部门
ITU-T	国际电联电信标准化部门
MABR	组播自适应比特率
ML	机器语言
UHD	超高清
UHF	超高频
VHF	甚高频
VR	虚拟现实
XR	扩展现实

注：

1. 尽管本文件谨慎适当使用并参引了各代IMT的官方定义（见ITU-R第56号决议“国际移动通信的命名”），但国际电联电信发展部门（ITU-D）希望指出，本文件的某些部分包含了国际电联成员提供的涉及常用市场名称“xG”的资料：这些资料不一定与某一代特定的IMT相对应，因为成员采用的基础标准尚不清楚，但总体而言，IMT-2000、IMT-Advanced、IMT-2020和IMT-2030分别被称为3G/4G/5G/6G。此外，全球移动通信系统（GSM）、EDGE和通用分组无线电业务（GPRS）等较早可用的技术有时通常被称为2G，也可纳入考虑范围。

第1章 – 广播领域的数字技术采用现状

一些国家已经完成向数字广播技术的迁移，而其他国家则正处于完成过渡的进程中。在此背景下，以往研究周期的报告通过多个案例研究，介绍了通过部署新业务加快过渡并缩小数字鸿沟的最佳做法以及提高公众对数字广播认识的宣传策略，并探讨了与模拟停播进程相关的无线电频谱问题。

重要的是，要认识到广播与宽带环境之间的关系和以更普遍的方式对待广播的必要性，同时考虑提供视听内容的各种网络之间关系。

广播领域正在发生变化，提供给用户的服务在不断演进。人们正在经历获取视听内容的新体验，而这些新服务带来的一个结果是用户不再只拥有传统的媒体服务/应用。相反，他们开始在广播业务中体验不同的视听内容观看方式。

为了在这个似乎正朝着服务提供商向全球化媒体战略方向发展，而不是局限于传统广播市场提供业务的新环境下实施新的广播技术、业务和应用，如今愈发清晰的是，整合、共同投资和基础设施共享是降低成本、实现网络部署和内容传送大规模投资的重要趋势。

因此，研究广播基础设施作为与其他网络和服务平台相结合、提供创新应用和业务的关键要素是有益的。此外，需从监管、经济和技术角度审视这些相互作用，以发挥各个网络的优势为用户带来惠益，并提供更加多样化的服务。

需要强调的是，广播系统在整个广播链（包括制作、贡献和传输环节）中采用互联网协议（IP）方面已有所进展，而且基于IP的技术在这些环节中的发展尤为迅猛。此外，超高频（UHF）频段广播领域正在实施的创新，以及这些创新如何催生广播业务与应用的新业态，同样引人瞩目。

“数字红利”的使用是另一重要议题，广播机构与使用相同频段的电信及其他服务运营商对此持续展开广泛讨论。其他重要研究课题涉及模拟向数字广播过渡相关的频谱规划问题。

最后，另一个关乎广播未来的重要问题是新的广播技术和标准的出现，发展中国家实施数字电视过渡时可予以考虑。还应考虑传统广播业务，无论它们是否与其他平台和网络进行交互。

本章概述了数字技术在广播领域的采用情况。第1.1节讨论了制造商提出的广播技术最新进展，第1.2节通过公开可得的基准数据，介绍了广播机构采用这些技术的进展情况。

1.1 制造商提出的最新技术

广播的演进是国际电信联盟（ITU）激烈讨论的议题。ITU-R报告BS.2522.0《未来广播的框架》汇集了当前及预期的广播发展态势。该报告的范围是提出“未来广播的框

架，同时考虑到最终用户的期望以及广播节目制作和传送技术的进步。它旨在就广播系统、技术和应用的未来发展向广播行业、研究人员和监管机构提供信息、协助和指导”。

本报告重点阐述了未来用户体验的一些关键问题，指出“广播内容和技术将提供 stronger 的现实感。随着更多的媒体个性化和互动选择的出现，围绕相同内容形成的虚拟社区所发挥的纽带作用将大大加强”。

本报告还详细阐述了用户体验趋势，在利用对消费者有用的技术和服务提供方面，这是一个重要主题。这些趋势可分为以下七类：

- 共同体验；
- 个性化用户体验；
- 无所不在的媒体消费体验；
- 数字助理和环境计算生态体验；
- 无障碍获取体验；
- 沉浸式体验；和
- 将物理世界和数字世界融为一体的体验。

广播行业正在响应这些趋势，数字电视广播系统的最新进展与其中一些趋势相吻合，预示着更具交互性、沉浸感和丰富性的用户体验。下一代广播电视技术可提供更高的音视频质量（4K超高清画质与影院级音效）、增强的移动接收能力，以及创新性的新功能，从而提升和拓展观看体验等。在那些支持新用户体验用例的功能中，结合了广播电视和宽带的功能与内容，例如通过信息与交互功能提供个性化广播，使用户能获取最契合自身需求的内容与服务。这些创新服务得以实现，源于下一代系统基于互联网协议（IP），实现在线与广播电视的结合。

下一代广播电视技术系统还能支持增强型移动接收功能，观众可通过无线方式在移动设备上获取内容，无需依赖蜂窝数据业务，也不会产生相应的数据使用和费用。另一项预期功能是通过广播系统实现应急预警，提供交互式移动化定向公共通知。能够展现此类潜力的下一代广播电视技术包括：ATSC 3.0¹、5G广播²、DVB-NIP³、先进ISDB-T⁴等。本报告附件1着重介绍了其中每个系统的一些关键功能，包括但不限于：

- 建立在与当前流行的流媒体平台相同的互联网协议（IP）骨干网上的技术；
- 先进的紧急告警和通知能力；
- 高效的免费或零费率媒体内容传送；
- 基于5G IP基础设施的独立地面广播系统（5G广播）；

¹ <https://www.atsc.org/nextgen-tv/>

² <https://www.qualcomm.com/news/onq/2023/12/5g-broadcast-what-can-consumers-expect>

³ <https://dvb.org/?standard=native-ip-broadcasting>

⁴ <https://www.dibeg.org/advanced/>

— IP和HTML5应用环境（先进ISDB-T）；

欲了解有关下一代广播电视技术系统的更多信息，请参阅本报告第2章和所提及系统的网页。

1.2 对广播领域的数字技术采用情况进行基准化分析

值得注意的是，IP数字广播业务的演进以传统数字广播系统为基础，而向全数字化环境的过渡，正是提供新业务的起点。国际电信联盟（国际电联）持续追踪广播领域数字技术采用方面的不断进步。总体而言，由国际电联托管的数字转换数据库是数字广播采用状况的一个重要信息来源，其网址为：<https://www.itu.int/en/ITU-D/Spectrum-Broadcasting/DSO/Pages/default.aspx>。

数字转换数据库提供全球数字地面电视（DTT）部署状况的信息。自2009年起，国际电联发展部门（ITU-D）已协助各国实现模拟向数字广播的过渡，为制造商、广播机构及终端用户等所有利益攸关方带来了新机遇。数字转换过渡状况通过图1至图5进行图像化展示：图1展示了转换状况（已完成、进行中、未开始或未知）；图2按国家数量统计了全球推出数字电视和停播模拟信号的年份。图3展示全球各国采用的第一代与第二代数字电视系统的数量。图4展示了编解码器使用情况的演进，可见H.264/AVC使用率呈下降趋势，而H.265/HEVC使用率持续上升。最后，图5则以百分比形式展示全球流媒体编码类型及其应用占比。

图1：全球数字转换状况，特别是GE06规划国家的数字转换状况（DSO数据库，2025年3月）

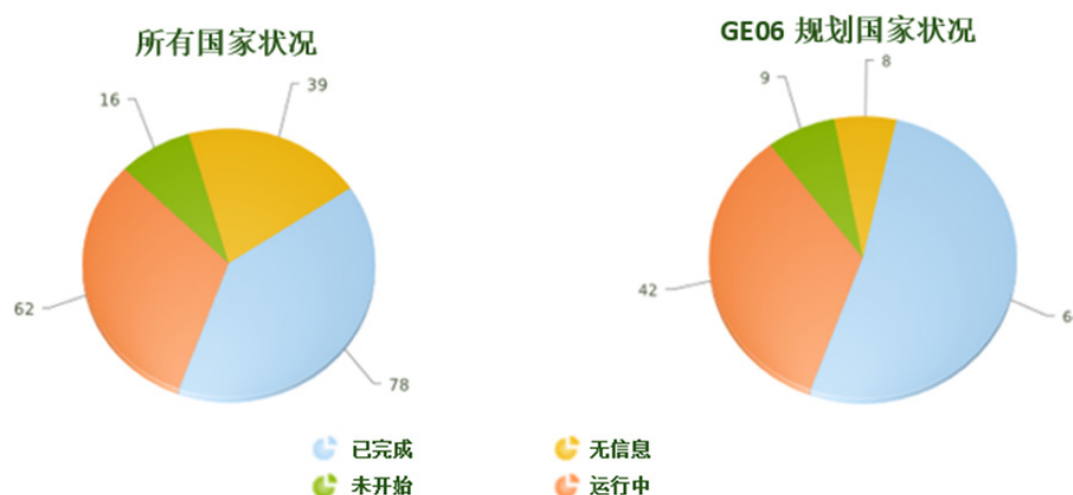


图2：推出数字电视和停播模拟的年份（DSO数据库，2025年3月）

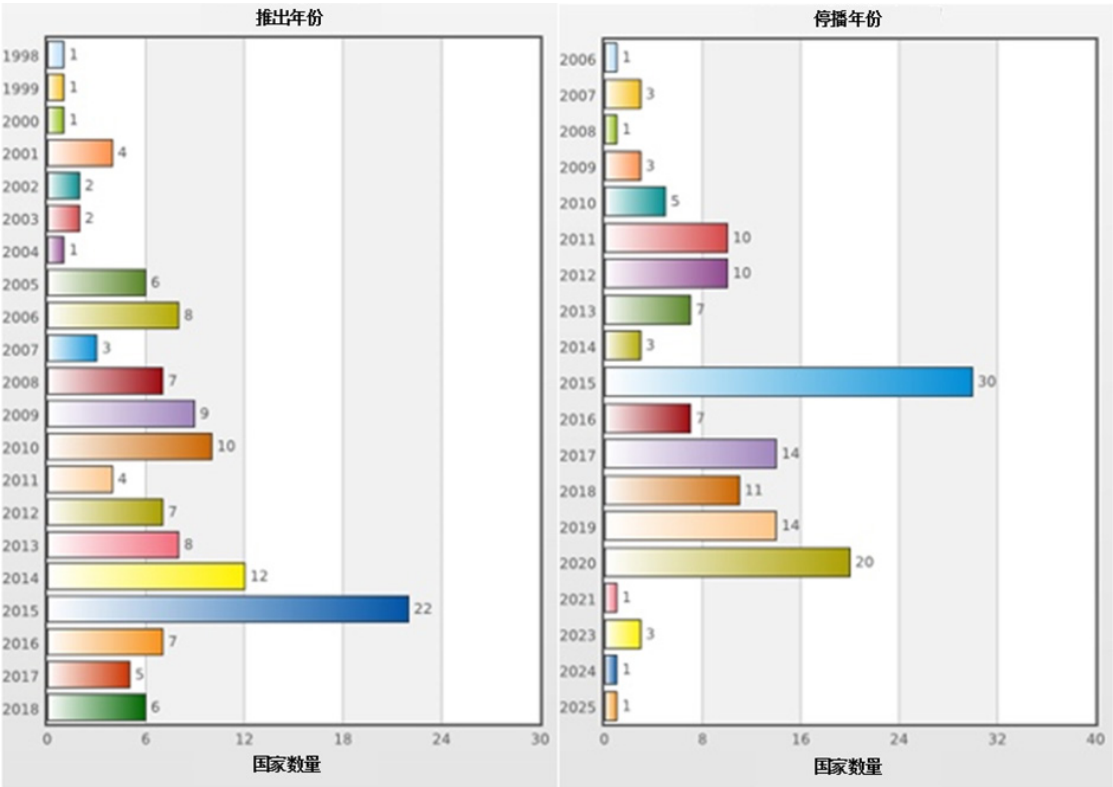


图3：第一代和第二代数字电视系统采用情况（DSO数据库，2025年3月）

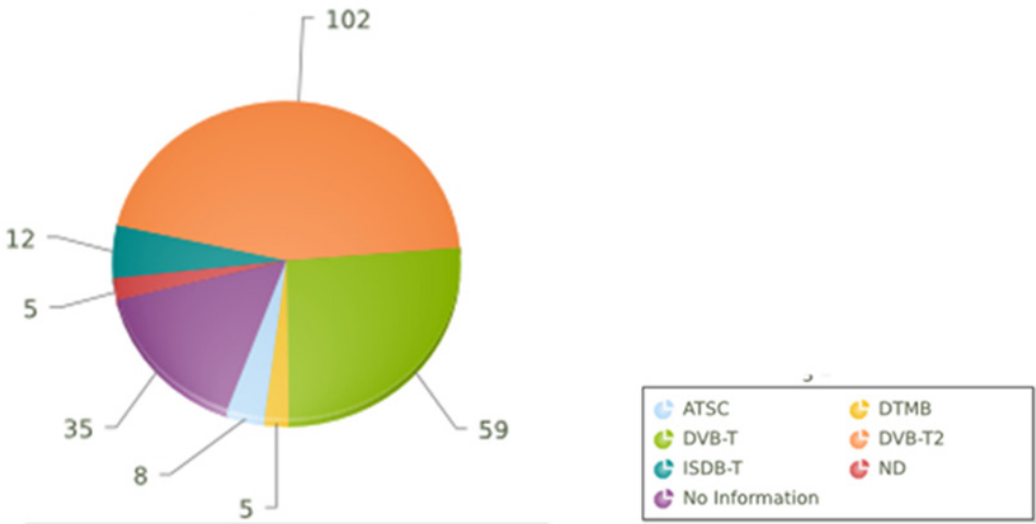


图4：编解码器使用的演进情况（来源：2024年《广播转型报告》）

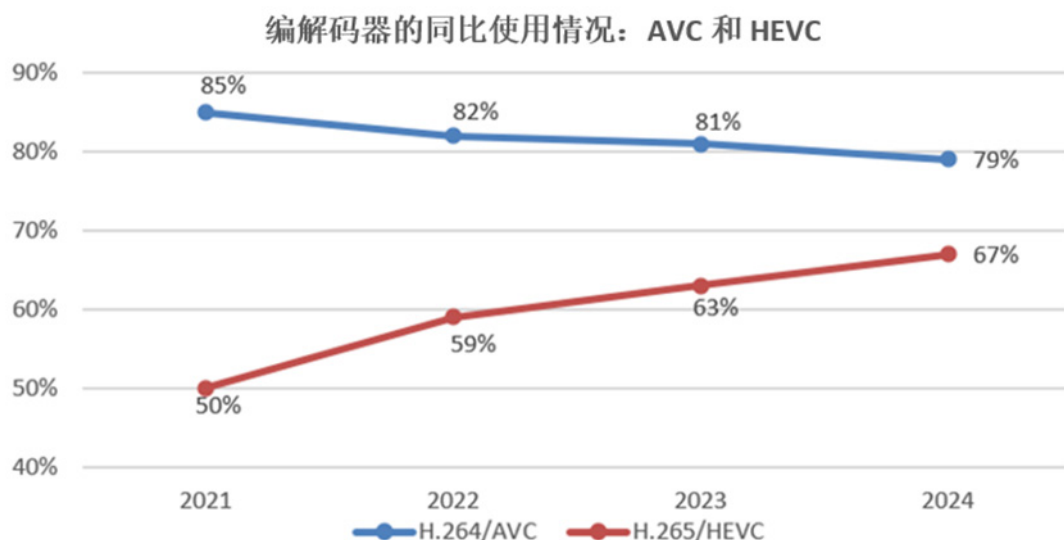
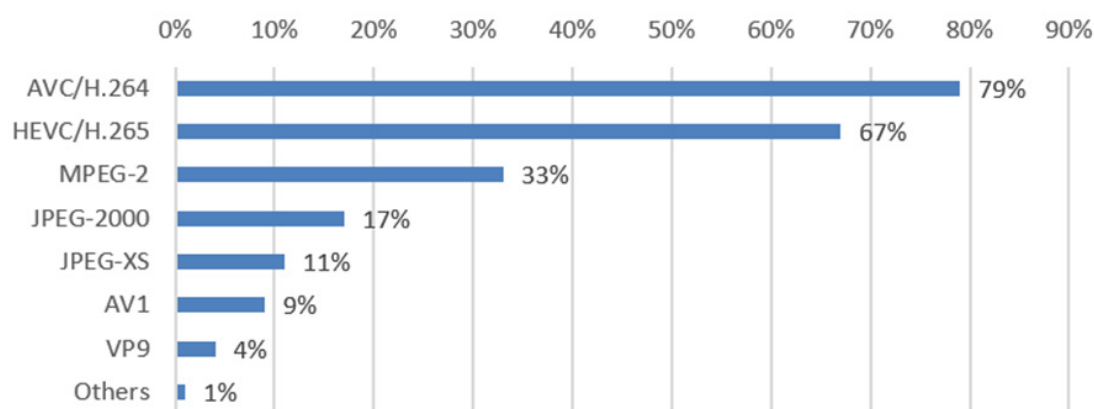


图5：当前用于直播视频的流媒体编码



数字电视系统正向下一代系统演进，包括ATSC 3.0、5G广播、原生IP广播系统（DVB-NIP）、先进ISDB-T等。这些系统的采用信息具有重要意义，广播行业的所有利益攸关方都在密切关注。下文中介绍了一些系统的当前部署信息：

- ATSC 3.0：美国、大韩民国、牙买加及特立尼达和多巴哥的部署信息（来源：<https://www.atsc.org/nextgen-tv/deployments/>）。
- 欧洲的5G广播试验：奥地利、克罗地亚共和国、斯洛文尼亚共和国、捷克共和国、芬兰、西班牙、法国、意大利和德国（来源：<https://broadcast-networks.eu/wp-content/uploads/5G-broadcast-trial-leaflet.pdf>）。
- 先进ISDB-T：日本（来源：<https://www.dibeg.org/advanced/schedule-2/>）。

第2章 – 广播业务和相关应用的新的和新兴技术趋势（包括基于IP的技术）

2.1 面向消费者/观众的新广播业务和应用

近年来，面向视听内容消费者/观众的业务与应用范围显著拓宽。今天除了传统广播机构之外，还有众多不同的内容分发平台、应用和业务。

评估传统服务提供商与数字生态系统新参与者之间的共生关系至关重要。俄罗斯联邦的“数字经济计划”⁵旨在加快经济和社会领域引入数字技术、为高科技企业创造条件，从而开发人力资本、创造舒适的生活环境并推动经济增长、提高国家在全球市场上的竞争力，以及提高公民的生活质量。

媒体技术的未来将首要取决于新系统、业务和应用的效益程度与破坏程度之间的关系，如图6所示。那些效益高、破坏小的系统、业务和应用将首先得到广泛使用。新技术要实现普及之前，仍有许多步骤需要完成、许多需求需要满足，而新技术的效率往往并非影响其采用的唯一因素。

图6：技术采用情况（来源：欧洲广播联盟（EBU⁶））

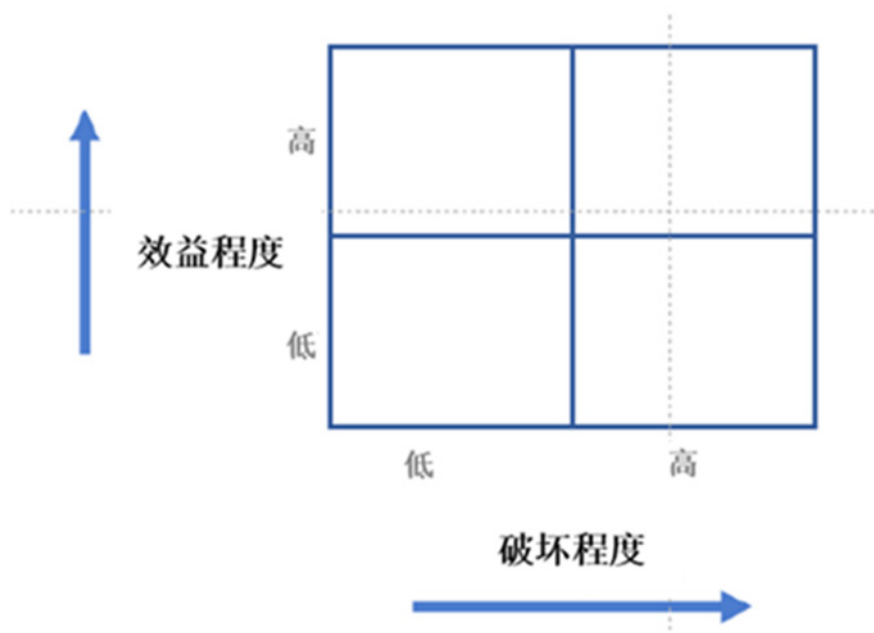


图6展示了一种判断系统成败的方法，其流程如下：

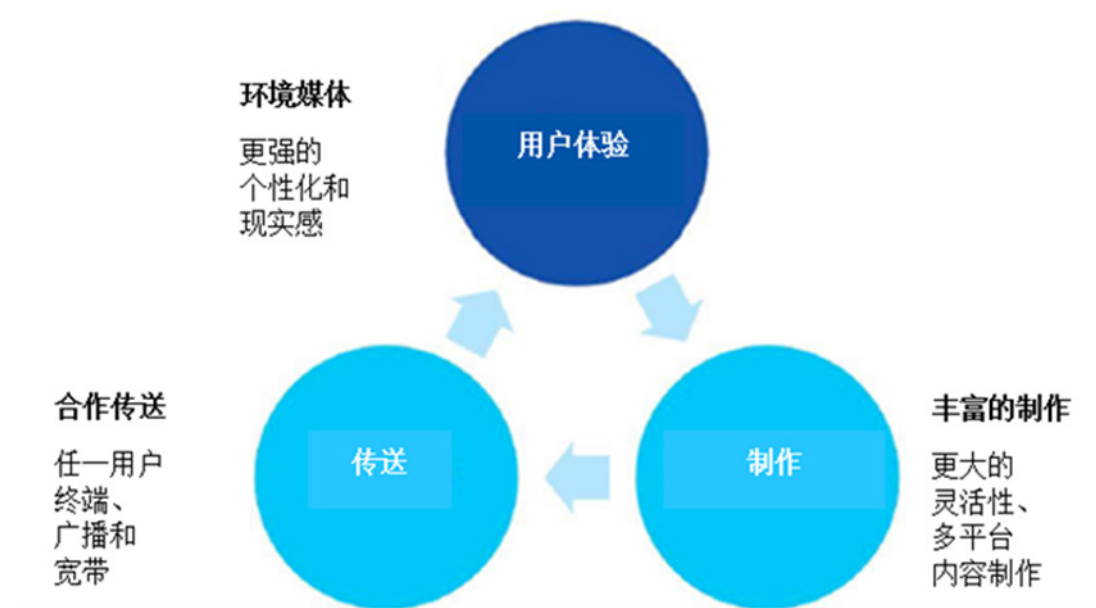
⁵ 俄罗斯联邦提交的ITU-D文件：<https://www.itu.int/md/D22-SG01.RGQ-C-0117/>

⁶ David Wood博士在ITU-D第2/1号课题焦点会议上的介绍，见：https://www.itu.int/dms_pub/itu-d/oth/07/2e/D072E0000020018PDFE.pdf

- 检查效益程度与破坏程度之间的关系。
- 检查是否有可用的手段来完成从构思到广泛使用所需的所有步骤
- 检查系统是否介于“太早”和“太晚”之间。
- 检查是否具备运行该业务的能力。

因此，要评估新业务与新应用的当前趋势，关键在于评估视听内容传送领域的当前技术和新技术及其演进方式。目前正在实施和提供给消费者的、采用创新技术的新业务和新应用主要涉及三个领域：(i) 用户体验、(ii) 合作传送、(iii) 丰富的制作。图7展示了这些领域中的一些潜在应用。

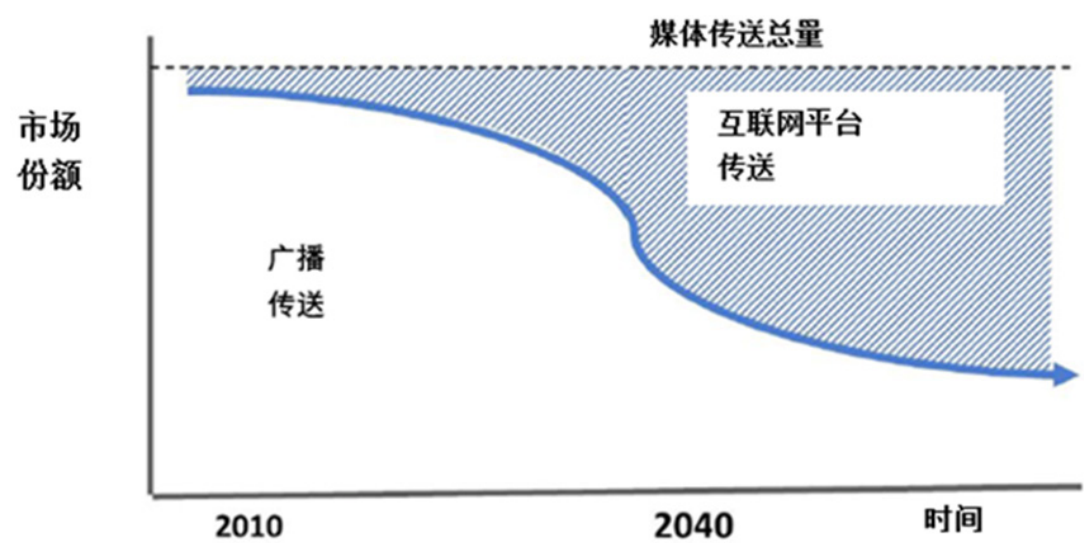
图7：新业务和新应用的主要创新领域（来源：EBU⁷）



在传送领域，广播与宽带平台及网络并存，并共享媒体传送市场。用户的实际内容消费似乎在增加，然而，新的传送形式已广泛出现并在改变消费模式。图8展示了媒体传送技术的可能演进路径。

⁷ 同上。

图8：媒体传送的可能演进（来源：EBU⁸）



评估现有技术时，从技术发展的角度了解促成商业成功的因素至关重要。标准化是其中最重要的考量之一。图9展示了一项技术从研发到成功商业化实施需经历各个阶段。

图9：从研发到共同政策，再到临界点的进程（来源：EBU⁹）

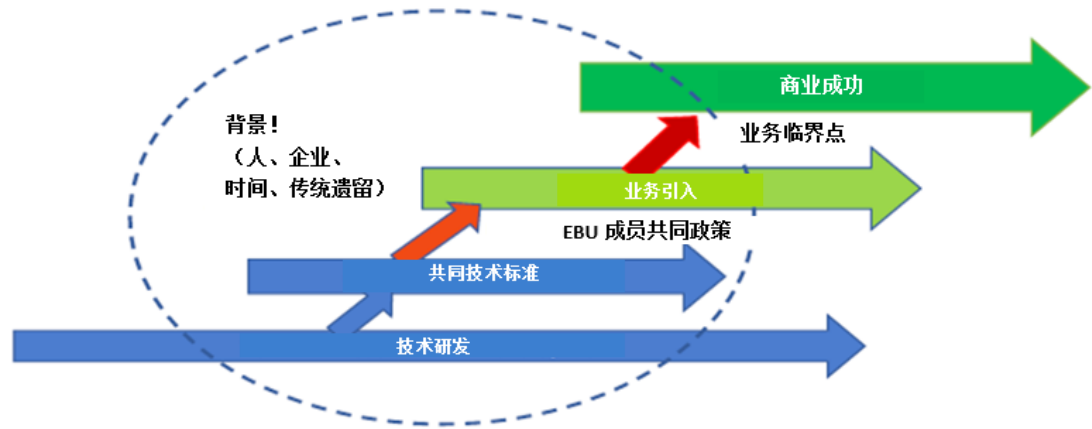


图9展示了一个部分包含在虚线椭圆形中的工作流程，该椭圆形标注“背景！（人、公司、时间、传统遗留）”。工作流程始于一条水平粗箭头，箭头内标注“技术研发”案文。该箭头在左右两侧延伸超出椭圆形边界。第一条箭头从左向右上方斜指第二条箭头，第二条箭头标注“共同技术标准”文字。该箭头位于椭圆虚线框内。第二条箭头右上方斜指第三条箭头，标注“业务引入”文字。箭头下方标注“EBU成员共同政策”。第三条箭头仅右侧超出椭圆虚线框。该箭头右上方斜指第四条箭头，标注“商业成功”文字。该箭头主体位于椭圆虚线区域右侧之外。箭头下方标注“业务临界点”文字。

⁸ 同上。

⁹ 同上。

在广播与宽带传送共存互补的新环境中，后续小节将探讨并评估在此背景下广播领域新业务与新应用的当前趋势。同时考量这些新业务与新应用如何推动生态系统的多元化发展，从而为消费者提供更多选择。

2.1.1 视听内容进步，包括超高清电视（UHDTV）及最新趋势

视听内容领域的一些创新给终端设备带来了压力。例如，HD/UHD数字地面电视（DTT）传输增加了电视机、机顶盒（STB）、手机、平板电脑等设备对视频的需求。与此同时，其它采用虚拟现实（VR）和/或增强现实（AR）技术的新业务可能会进一步加剧这种情况。

以中华人民共和国¹⁰为例：自2022年7月1日起，新增的有线电视和卫星电视频道应具有HD/UHD视频分辨率，新增的卫星电视机顶盒应为HD/UHD智能机顶盒。自2023年1月1日起，互联网协议电视（IPTV）及有线电视的新机顶盒也须升级为UHD机顶盒。预计到2025年底HD/UHD机顶盒的普及率将显著增加，这将导致IPTV标准分辨率（SD）频道信号关闭。

视听内容领域的这些创新是提高质量的关键驱动力，也是内容传送不断演变的趋势。因此，评估这些创新对终端和网络的影响很重要。

2.1.2 增强现实（AR）与虚拟现实（VR）、边缘计算、人工智能（AI）及内容传送背景下的其他新兴技术

增强现实和虚拟现实

沉浸式体验技术正推动内容传送领域的一个重要趋势。本节旨在评估其中一些新兴技术，例如增强现实（AR）与虚拟现实（VR）标准格局，全面介绍该主题及其与创新业务（如元宇宙创新业务）的相关性、5G用例以及内容分发平台。广播业务可利用这些技术为观众/消费者提供新的应用和业务，以满足与新用户体验和视听内容消费相关的创新需求。

本报告参考了《2022年大视野学术大会论文集》¹¹中的一篇论文，该论文基于处理扩展现实（XR）技术问题的标准制定组织（SDO）、论坛和联盟已完成和正在进行的一系列工作，介绍了对XR标准的调查，以此作为考虑这些技术的基础。

考虑到国际电联提出的XR定义，即“包含真实或虚拟组成部分或其组合的环境，其中变量X作为任何形式的新环境的占位符”，该论文通过回顾相关文献、标准化文件和讨论，广泛汇编了包含真实/虚拟组成部分或其组合环境（即涉及AR、混合现实（MR）、VR及元宇宙和元宇宙等方面标准）的技术规范。

¹⁰ 赵鲁豫博士在ITU-D第2/1号课题焦点会议上的介绍，见：https://www.itu.int/dms_pub/itu-d/oth/07/2e/D072E0000020017PDFE.pdf。

¹¹ Makamara, G.和Adolph, M., 《扩展现实（XR）标准调查》。《国际电联大视野学术大会论文集》，第xxxi-xl页，阿克拉，2022年。https://www.itu.int/dms_pub/itu-t/opb/proc/T-PROC-KALEI-2022-PDF-E.pdf (apud)。

在开展的工作中，确定了3GPP¹²、ETSI¹³、ISO/IEC JTC 1 SC29¹⁴、国际电联和W3C¹⁵等SDO，CTA¹⁶、IDEA¹⁷、Khronos Group、元宇宙标准论坛、SVTA¹⁸和VRIF¹⁹等联盟、论坛和贸易组织，以及Qualinet等研究网络。除上述机构外，值得注意的是电信、视频编码及流媒体视频标准协会也参与了讨论，表明这些技术与视听内容分发及其相关业务和应用具有相关性。

此外，该论文还指出了XR标准化工作正在探索的两个主题：“(1) 通过建立共识（标准术语），确定关键系统和用户要求（设计导则和系统标准）以及开发XR业务和应用的兼容接口和数据格式，来建设XR互操作能力；(2) 定义XR用户体验要求，解决无障碍获取和质量问题”。

就当前报告而言，定义XR用户体验要求的第二个主题对于研究标准化趋势和用例具有重要意义，有助于让人们了解可以提供的业务和应用。下文所确定的趋势，基于用户体验需求和用例，与内容分发环境（包括广播）中新业务和应用的研究最为相关：

- 远程终端沉浸式视频会议与网真用例（3GPP TR 26.862）；
- 3GPP上的虚拟现实（VR）媒体业务（3GPP TR 26.928）；
- 5G中的AR、MR和XR（3GPP TR 26.928和TR 26.998）；
- 基于IP的广播系统中沉浸式视听内容的传输（ITU-R BT.2133）；
- 智能电视系统和业务中的AR（ITU-T J.301、J.302）；
- 使用AR对文物和艺术品进行数字化呈现（ITU-T F.740.2）；
- 沉浸式现场体验业务（ITU-T H.430.1、H.430.2、H.430.3、H.430.4、H.430.5）；
- XR无障碍获取用户要求（W3C NOTE-xaur）。

总之，注意到一些AR/MR/XR应用和业务场景，包括通过基于IP的广播系统和5G移动网络，已经实现标准化并将继续演进。在包括新冠疫情在内的各种因素的推动下，数据流量增加，需要对电信基础设施进行快速和创新性的适应。文中概述的战略—包括边缘计算、人工智能（AI）、下一代网络、网络虚拟化及核心基础设施升级—对于确保高质量服务和有效满足日益增长的需求至关重要。

在采用XR技术方面，我们以马来西亚²⁰为例，VR/AR通过创造沉浸式环境，提供更大灵活性和创造力，正在彻底改变内容制作。当地广播机构采用VR/AR虚拟演播室，使马来

¹² 第三代合作伙伴计划（3GPP）。

¹³ 欧洲电信标准协会（ETSI）。

¹⁴ 国际标准化组织（ISO）和国际电工委员会（IEC）联合技术委员会（JTC 1）是一个基于共识、自愿参加的信息技术国际标准组织。第29分委员会（SC29）“音频、图像、多媒体和超媒体信息编码”由联合图像专家组（JPEG）和运动图像专家组（MPEG）组成。

¹⁵ 万维网联盟（W3C）。

¹⁶ 消费者技术协会（CTA）。

¹⁷ 沉浸式数字体验联盟（IDEA）。

¹⁸ 流媒体视频技术联盟（SVTA）。

¹⁹ 虚拟现实产业论坛（VRIF）。

²⁰ 马来西亚提交的ITU-D文件：<https://www.itu.int/md/D22-SG01-C-0341/>。

西亚的广播行业处于最前沿，为观众提供身临其境的体验，为内容质量和参与度树立了新的标准。VR和AR虚拟演播室现在被本地广播机构普遍用于各种直播节目。

边缘计算

边缘计算是一个相对较新的概念，根据美国咨询和研究公司Gartner和其他专家的估计，全球四分之三的数据将通过边缘计算进行管理。这是另一个有趣的用例，特别是因为5G和物联网（IoT）业务需要物体快速移动。没有边缘计算，自动驾驶汽车将无法高效行驶，通过5G网络上传视频也无法如此之快。

边缘计算的主要优势之一在于它能够显著减少延迟对应用的影响。因此，尤其得益于5G技术的进步，能够在网络上引入新型低延迟应用与业务，并改善现有应用的体验。

客户希望在边缘网络使用的应用和业务，在推动电信运营商的收入增长方面发挥着关键作用。然而，为了增加收入，运营商必须建立适当的系统，并与利益攸关方和技术合作伙伴进行协调。²¹

国际电联内部，特别是ITU-T第11研究组正在研究这一问题。²²

以GSMA为例说明这些技术的影响。值得关注的是，两年前，GSMA启动了“电信边缘云”（TEC）举措，19家运营商承诺基于多个提供商的边缘基础设施联盟设计和开发全球边缘计算服务²³。一些国家已经采用了这项技术，包括走在前沿的中国²⁴、南非共和国²⁵和几个欧洲国家²⁶。

人工智能（AI）

AI可用于优化网络管理、预测流量高峰并自动解决问题。AI算法可以实时分析数据，以主动调整网络资源、提高服务质量（QoS）并尽量减少中断。

AI网络管理的优势	举例
积极主动的网络管理	- 沃达丰使用AI来实时监控和优化其网络。²⁷ - Orange正在法国部署AI解决方案，以预测故障并优化网络性能。²⁸
降低运营成本	
提升用户体验	

²¹ <https://www.redhat.com/fr/topics/edge-computing/telecommunications>（法文）

²² <https://www.itu.int/en/ITU-T/studygroups/2017-2020/11/Pages/q7.aspx>

²³ <https://www.gsma.com/solutions-and-impact/technologies/networks/latest-news/gsma-launches-new-whitepaper-telco-edge-cloud-value-achievements/>

²⁴ <https://techmonitor.ai/focus/what-chinas-lead-in-edge-computing-means-for-the-world>

²⁵ <https://seacom.co.za/news/why-is-edge-computing-the-next-big-thing-in-africa>

²⁶ <https://digital-strategy.ec.europa.eu/en/library/europes-potential-edge-computing-supporting-industrial-innovation-through-large-scale-pilots>

²⁷ <https://ch.zonebourse.com/cours/action/META-PLATFORMS-INC-10547141/actualite/Meta-et-Vodafone-optimisent-la-video-pour-ameliorer-l-efficacite-des-reseaux-47340829/>（法文）

²⁸ <https://newsroom.orange.com/orange-sassocie-a-la-plateforme-dia-reseau-augtera-pour-offrir-une-qualite-de-service-et-une-experience-client-optimales/>（法文）

未来网络（5G及未来）

5G网络和6G等未来网络技术可以提供更高的带宽、更低的延迟以及同时连接大量设备的能力。这些技术对于满足日益增长的数据需求和支持新的带宽密集型应用至关重要。

5G网络和未来网络技术的优势	举例
更高的传输速度	– 大韩民国的SK电信正在部署5G网络，以支持智慧城市和物联网应用。²⁹ – NTT Docomo在日本试验6G超高速、低延迟应用。³⁰ – 国际电联内部，特别是ITU-T第13研究组正在研究这一问题。³¹
更低的延迟	
更强的物联网管理能力	

网络虚拟化（SDN/NFV）

软件定义网络（SDN）和网络功能虚拟化（NFV）等网络虚拟化技术可以实现更加灵活和动态的网络资源管理。它们也促进了新业务的快速部署，提高了运营效率。

网络虚拟化技术的优势	举例
更大的灵活性和敏捷性	– 德国电信正在德意志联邦共和国使用SDN和NFV来提高网络效率。³² – Telefónica正在西班牙部署SDN解决方案，以优化网络性能和灵活性。³³
更低的网络管理成本	
新业务的快速部署	

在刚果共和国³⁴，新冠疫情暴露了电信基础设施的脆弱性，但同时也促进了创新性和补充性技术解决方案的采用。各国需调整战略，以保持连通性并满足日益增长的数据需求，同时实施从扩大4G/5G网络到使用全社区卫星和Wi-Fi解决方案的各种举措。这些行动展现了一些非洲国家在面对前所未有的危机时所表现出的复原力和适应力。

2.1.3 交互式应用和业务，包括广播和宽带内容交换

下一代电视即将引入创新用例，凸显多媒体应用在广播业务中的重要作用。这些电视应用将使广播机构及其合作伙伴能够利用备受期待的创新，包括个性化的电视体验、有针对性的广告和节目制作、内容推荐、无线（OTA）与过顶（OTT）之间的无缝切换、沉浸式内容提供、增强无障碍获取、感官效果渲染和新颖的交互模式等。

因此，多媒体电视应用预计将从作为广播机构单纯附属品的传统角色转变为所有电视内容控制和消费的中心枢纽。这种向“以应用为导向的电视”的转变对于在整个内容消费过程中实现对观众资料的主动管理至关重要，并将其塑造成个性化、沉浸式和引人入胜的体验。它还可以使内容传送方法对观众完全透明，促进与宽带内容和业务的无缝

²⁹ <https://www.lesechos.fr/monde/asie-pacifique/en-coree-dans-les-laboratoires-de-la-5g-1161409>（法文）

³⁰ <https://fleetinfo.info/le-japon-developpe-le-premier-appareil-6g-au-monde-20-fois-plus-rapide-que-la-5g/>（法文）

³¹ <https://www.itu.int/en/ITU-T/studygroups/2022-2024/13/Pages/default.aspx>

³² <https://www.juniper.net/fr/fr/customers/deutsche-telekom-case-study.html>（法文）

³³ <https://www.telefonica.de/news/press-releases-telefonica-germany/2021/12/milestone-in-software-defined-networking-sdn-o2-telefonica-uses-new-standardized-sdn-interface-for-30000-microwave-links.html>

³⁴ 刚果共和国提交的ITU-D文件：<https://www.itu.int/md/D22-SG01-C-0291/>。

集成。此外，它重新定义了电视频道的传统概念。总体而言，这种方法与智能设备通常提供的基于应用程序的用户体验相一致。为了说明这种以应用为导向的新电视范式，可以参考巴西有关接入交互式应用新环境的电视3.0（TV 3.0）³⁵项目中正在研究中的工作和规范作为示例。更多信息，请参见本报告附件2。

新广播业务和应用的一个非常关键且相关的用例是无障碍获取视听内容。其中一个用例是针对失聪和重听者的灾害预警。90%以上的失聪儿童出生在健听家庭³⁶。除非全家人一起学习手语，否则失聪儿童很容易被孤立，也可能得不到充分的家庭教育，而大多数国家都没有针对这种情况的手语教育。大多数国家已通过使用地面电视和付费电视开/关字幕以及向手机发送文本类型消息建立了灾害预警系统。但问题在于，半数以上的聋人在理解文本方面有困难，这意味着有阅读障碍的聋人无法获取最重要的信息。电视设备的演进离不开连接。无论电视或机顶盒基于何种基础设施，现在大多数设备通过电缆调制解调器、互联网服务提供商（ISP/IPTV）的直接IP通信，或低轨道卫星星座等实现了某种形式的连接。然而，在当前的传统广播系统中，如数字视频广播（DVB）和ATSC，连接通常不是通过地面频率提供的。为此，美国约有20%的家庭没有宽带连接³⁷，美国政府正在通过下一代地面电视系统（ATSC 3.0）的数据广播功能提供电子学习内容，以减少教育不平等问题。

广播应用有益于促进包容性，特别是对有具体需求的人士而言。另一个有趣的案例研究是来自大韩民国³⁸，其中展示了ATSC 3.0等下一代广播系统如何通过向电视、机顶盒和手机屏幕发送以文字形式字幕的灾害告警信息，为建设一个更具包容性和安全的社会做出贡献。有关灾害告警案例的更多信息，请参见本报告附件3，包括告警发送平台总体架构概念的信息。

2.2 使用基于IP技术的广播系统的发展

本节重点介绍广播系统使用IP技术取得的一些进展，不仅体现在分发/传送方面，而且体现在从制作到内容消费、分发和传送的整个价值链中。本报告指出了一些趋势，并提到了在此背景下正在进行标准化和部署的技术，作为相关经验的简要介绍。再次审查了ITU-R BS.2522.0号报告《未来广播的框架》，因为该报告认识到一些重要问题，包括消费者和专业媒体广播技术的融合，实现新内容的创作、传送和消费机会；以及将IP技术和云计算纳入广播技术，实现宽带接入以及更灵活、更高效的内容创作和分发。

使用基于IP的技术对于广播系统的发展至关重要，随着与可在任何地点使用的、联网和智能设备上提供的游戏、流媒体和基于内容的服务相融合，它有可能重塑传统的广播理念。这也凸显了紧跟趋势的必要性，因为这些趋势持续影响新媒体技术的发展，并在塑造未来社会性质方面发挥作用。

在讨论使用基于IP的技术和网络的广播系统发展时，值得注意的是广播分发的益处，以及思考为什么在广播环境中使用IP基础设施能够带来创新和效率，因为广播与宽带这两种环境均能从融合服务提供中受益。

³⁵ 巴西提交的ITU-D文件：<https://www.itu.int/md/D22-SG01-RGQ-C-0239/>。

³⁶ 大韩民国提交的ITU-D文件：<https://www.itu.int/md/D22-SG01-C-0153/>。

³⁷ 同上。

³⁸ 同上。

第一个好处是成本效益，因为广播业务的特点是分发成本固定，无论观众规模如何，而且从最终用户的角度看，建设卫星或地面接收站的成本很低。

另一个好处是普遍覆盖，因为广播业务凭借地面和卫星广播业务的混合，通常可以提供对目标市场的全面覆盖，相比之下，宽带网络的部署成本可能很高。

最后，服务质量可能是另一个好处，随着宽带网络变得拥挤，广播网络，无论是地面广播网络还是卫星广播网络，都可以实现无损的观看体验，这是一种高效的内容消费方式，而且支持按需要和按用户需求通过不同平台的混合分发方式。

历史上，广播和宽带业务的发展产生了平行的网络基础设施和生态系统，在这种环境下，重复建设接收机和内容分发平台，以满足用户/签约用户的消费需求。在以视频为中心的融合业务基础上，在内容消费背景下的业务融合可打造真正的广播和宽带融合解决方案。

从这个意义上说，开发以IP为中心的解决方案来解决从传统广播向基于IP的平台过渡问题，可以让利益攸关方建立一个5G/IP/广播融合生态系统，为广播机构带来新的机会，为用户带来新的服务体验。主要理念是充分利用现有的宽带和广播基础设施，实现互补，当其中一个平台不可用时，可使用另一个平台，反之亦然。

作为基于IP的广播系统的示例，DVB-NIP（DVB原生IP）、5G广播和ATSC 3.0均具有相关性。本报告第2.3节讨论了这些下一代广播系统的一些细节。下文中介绍了关于在价值链的其他部分使用IP的一些考虑。

2.2.1 整个广播链中基于IP的技术和其它新兴技术

关于IP技术在广播中的使用，可以观察到一些趋势。其中一个趋势是传送平台在合作网络中的组合，例如将广播系统与IP网络的交互能力结合应用。

关于广播的未来的ITU-R BS.2522.0号报告还指出，媒体传送的未来在于所谓的“混合媒体”传送环境，它是广播和IP传送的总和，并根据公众的需求、区域、以及技术发展的状况和可用性来平衡。

此外，该报告提到，综合广播宽带（IBB）等技术的加入使广播和宽带网络能够协同工作，高效地向用户传送个性化增强内容。预计这种改进将会继续下去，实现广播和宽带网络之间以合作方式传送更先进的电视内容格式。

此外，未来的传送框架必须考虑用户接收媒体和与媒体交互的方式。未来的传送系统将需要采用灵活多样的技术，能够实现不断增长的用户体验期望，并同时考虑到：

- 用户驱动的新传送业务趋势；
- 在采用新传送系统时基础设施类型的变化；和
- 新传送系统的覆盖要求。

如上所述，地面广播和互联网传送的结合，是满足来自用户驱动的新传送业务趋势的需求的有效方式。传送网络的组合将因市场而异，取决于多种因素，包括之前的投资

以及互联网连接的可用性、质量和成本。虽然每种方式的经济性将影响所用传送网络的最终组合，但监管要求等其他因素也会产生影响。

虽然互联网传送是地面广播传送的重要补充，特别是在实现按需、非线性内容消费和交互/个性化用例方面，但地面广播仍将必不可少。

在媒体内容制作方面，基于IP的技术也会产生影响，而且制作的内容需要具有更强的现实感、个性化和互动性。

ITU-R BS.2522.0号报告指出了若干组针对媒体内容制作而设计的、由未来技术驱动的创新：

- 基于软件的制作；
- 虚拟化制作；
- 基于云的制作；
- 复杂媒体制作；
- 数据驱动型制作；
- 通过AI和机器学习（ML）实现自动化制作；
- 沉浸式和无障碍媒体制作；和
- 可持续制作。

关于上述许多概念的更详细阐述，可参见ITU-R BT.2420号报告《先进沉浸式感官媒体系统的使用场景集合》和ITU-R BT.2447号报告《用于广播节目制作和交换的人工智能系统》。

IP视听内容传送经验也是IP在广播价值链中的使用一个重要方面。塞内加尔共和国³⁹提供的IPTV业务可作为一个示例，该国在视听内容权利方面存在某些法律挑战。尽管塞内加尔实施了数字地面电视（DTT），但其有限的覆盖范围和技术问题促使人们采用互联网协议电视（IPTV），利用互联网提供丰富多彩的内容。IPTV可能为盗版（未经授权获取、使用、分享或销售受版权保护的内容）提供机会，对合法运营商和本地内容创作者的收入构成威胁。

虽然IPTV在某些情况下是合法的，但未经授权的IPTV，特别是由海外分销商提供的业务，不仅在国家层面，而且在整个非洲大陆都会对视听内容的制作造成经济后果。虽然已出台了应对这些负面影响的监管措施，但区域协调和更严格的视听产业保护措施可助力打击IPTV盗版的斗争。尽管IPTV在技术层面为接入多样化内容提供了极大机遇，但其非法使用却对视听行业构成严重威胁。采取协调一致的方法，让监管机构、授权分销商、互联网服务提供商、内容制作商和公众共同参与进来，创造一个有利于视听行业合法、可持续发展的环境，有助于应对这一现象。

³⁹ 塞内加尔提交的ITU-D文件：<https://www.itu.int/md/D22-SG01-C-0363/>。

为了增加取得成功的机会，在区域层面采取行动至关重要，特别是在西非经济货币联盟（WAEMU）⁴⁰和西非国家经济共同体（ECOWAS）⁴¹内为有关非洲国家采取行动。请这些组织的成员国考虑改革其电信和媒体法，以纳入有关IPTV和基于互联网的内容的具体规定。

与国际性技术公司协作有助于从源头识别和阻止非法的IPTV流。在马来西亚⁴²，人们还发现了IP在广播价值链中的另一种使用形式，该国正在向基于云的解决方案转变，使广播机构能够更有效地扩大其业务规模。云广播具有灵活性、成本节约和快速适应不断变化的观众需求的能力。当地广播机构已采用的一些应用包括：

- **媒体资产管理系统（MAMS）**：马来西亚的主要广播机构已经从传统的基于文件的系统过渡到基于云的MAMS。这种转变使内容管理更加可靠，同时降低了运营成本，提高了高效存储、管理和分发媒体资产的能力。
- **过顶（OTT）应用**：云技术也是马来西亚广播机构广泛使用的OTT应用的基础。这些OTT应用使观众能够随时随地访问内容，进一步扩大了广播机构在数字时代的覆盖范围。例如，数字电视内容集成商MYTV推出了自己的OTT应用“MYTV Mana Mana”，旨在成为马来西亚主要的通用免费（FTA）OTT平台。

同样值得一提的是人工智能和机器学习（ML）在马来西亚的使用，以及这些技术如何通过自动化流程、增强内容创作和个性化观众体验来改变广播行业。这些技术正越来越多地用于内容创作、分发和收视率测量。

- **广播AI**：虽然仍处于早期阶段，马来西亚广播机构正在试验采用AI技术，如AI电视节目主持人和AI音乐广播节目主持人（DJ），以及AI驱动的内容推荐。RTM电台与Fly FM和Hot FM等几家广播机构率先在其节目中使用AI主持人/DJ。
- **生成式人工智能（Gen AI）**：马来西亚的广播机构也在尝试使用Gen AI技术，用于自动生成字幕和新闻报道等任务，尽管这项技术目前仍处于试验阶段。为确保AI的使用合乎道德，马来西亚通信和多媒体委员会（MCM）正在制定AI道德准则。这一举措旨在促进治理，防止AI模型出现偏见，确保遵守数据隐私法规，并建立观众信任，使AI成为更可靠的广播工具。

2.3 UHF频段的广播创新、拟议的新广播系统

为了解未来可能出现的新业务场景以及这些业务的发展潜力，有必要考虑当前旨在评估广播未来走向的发展动态与各项研究。

ITU-R BT.2522-0号报告⁴³《未来广播的框架》为评估广播业务创新路线图提供了参考。关于该文件的范围和一般性结论的更多信息，请参见本报告附件4。

在广播系统演进的背景下，本节介绍一些下一代系统及其主要用例和功能。

⁴⁰ 西非经济货币联盟（WAEMU）。

⁴¹ 西非国家经济共同体（ECOWAS）。

⁴² 马来西亚提交的ITU-D文件：<https://www.itu.int/md/D22-SG01-C-0341/>。

⁴³ <https://www.itu.int/pub/R-REP-BT.2522>

2.3.1 5G广播

近年来，5G生态系统中出现了广播新范式。5G广播技术能够通过单一数据流在不损失质量的情况下触及无限数量的用户。5G广播以“第三代合作伙伴项目”（3GPP）开发的**基于LTE的5G地面广播标准**（简称5G广播）为基础。

3GPP一直在通过多个技术标准版本（Release）为5G广播制定标准。5G广播首次是在**版本14（2017年第2季度）**中推出，通过基于LTE的广播和组播增强功能（被称为“进一步增强型多媒体广播组播业务”（FeMBMS））实现，为在移动网络中集成广播能力奠定了基础。**版本15（2018年）**标志着5G新空口（NR）标准的初始阶段，重点是增强型移动宽带（eMBB）。虽然主要以单播业务为中心，但版本15还加入了支持5G广播和组播业务的基本元素。2020年发布的**版本16**对5G NR进行了重大增强，包括支持NR组播和广播业务（NR-MBS）。该版本定义了5G网络有效传送广播内容所需的规范。2022年最终确定的3GPP标准**版本17**显著增强了5G广播能力，并在版本16奠定的基础上继续开发和完善NR-MBS。这包括了为提高通过5G网络传送组播和广播内容的效率和灵活性所做的增强。它还专注于支持5G广播的更广泛用例，包括直播活动流、软件更新、紧急告警和其它受益于高效广播能力的高需求应用。关于每个版本、5G NR组播广播技术的总体架构、所用频段和其他技术特性以及用例的更多详细信息，请参见本报告附件5。

5G组播广播技术将具备以下新特点：**(1)** 可提供全场景、全终端的广播业务，支持通用移动设备；**(2)** 能够为公共安全、关键任务应急通信、车联网（V2X）应用、IPv4/IPv6组播传输、IPTV、有线软件升级、集群通信和物联网等服务提供有效支持；**(3)** 广泛灵活性，例如单播与组播传输之间的动态无线电资源分配、支持同一视频内容的不同视频质量/分辨率的并行传输、内容传输期间用户移动性的变化以及支持特定的组播/广播传输区域。

由于其3GPP的传统，5G广播主要关注移动用例（例如智能手机）。但是，5G广播不要求网络支持单播，也不要求设备具有SIM卡或蜂窝订阅来接收免费广播。虽然不需要单播，但5G广播可以与单播结合，利用单播和广播技术的优势来提供完全混合、集成的用户体验。特别是，5G广播调制解调器可在硬件上与现有的蜂窝调制解调器技术兼容，因此不需要新的硬件。与以往技术相比，这种硬件兼容性有望大大降低主流移动设备采用广播技术的障碍。⁴⁴ 关于5G广播一些用例的更详细描述，请参见本报告附件6。

近年来，更广泛的移动和广播生态系统明显加大了对5G广播的支持。超过25个3GPP成员共同签署了版本16工作项便是例证，该工作项随后于2020年完成。[5G多媒体行动组（5G MAG）](#)成立于2019年，是一个跨行业组织，如今，在整个媒体行业有40多个活跃成员，致力于推动5G广播的商业采用。已经进行了几项5G广播试验，并计划在全球范围内⁴⁵开展新的试验，正迅速为以虚拟方式向我们的5G设备无缝传送富媒体内容奠定基础。

2023年，[中国](#)、[美国](#)、[德国](#)、[法国](#)、[西班牙](#)、[意大利](#)、[奥地利](#)、[爱沙尼亚](#)和[捷克共和国](#)等几个国家进行了大量演示和小规模试验。印度、马来西亚和土耳其共和国等其他国家也在研究5G广播。有关部署的示例，请参见本报告附件6中的中国案例研究。

以马来西亚为例，5G广播的采用预计将对广播业务产生变革性影响，将使广播机构能够以最小的延迟向更广泛的受众传送高清内容。此外，5G广播可以作为移动网络的补

⁴⁴ 高通公司提交的ITU-D文件：<https://www.itu.int/md/D22-SG01.RGQ-C-0219/>。

⁴⁵ <https://www.5g-mag.com/trials>

充，广播文本、音频或视频内容，甚至在农村地区也可以，无需数据计划或用户身份模块（SIM）卡。另外，5G广播可以在危机期间支持紧急预警系统，为相关政府部门提供最快的公众预警平台。从基础设施的角度来看，5G广播要求对现有广播网络进行重大升级，但可以利用马来西亚现有的数字地面电视（DTT）基础设施来最大限度地降低部署成本。

由5G新空口（NR）实现的远程制作正在改变马来西亚现场活动的制作方式。凭借更快、更可靠和更低时延的连接，5G对于远程实时广播至关重要。目前，一家国家广播机构和一家私营广播机构已经在体育赛事、大选等多个现场活动中尝试通过5G NR进行远程制作。使用5G无线摄像机消除了对实况转播（OB）车的需求，简化了设置过程，使部署更容易。

最近，马来西亚在砂拉越州古晋举行的2024年运动会（Sukan Malaysia, SUKMA）开幕式上使用毫米波（mmWave）频段再一次试验了5G Advanced制式。此次试验涉及移动运营商与国家广播机构之间的合作。这项技术提供了报道活动的创新方式，大大减少了资源使用，降低了制作成本，同时提高了可靠性。

2.3.2 ATSC3.0

本节探讨由先进电视制式委员会开发的另一个下一代广播系统 – ATSC 3.0的发展情况，以及该系统的一些主要功能和用例。

ATSC 3.0是一个广播系统，使广播机构还能使用基于IP的技术通过互联网分发数据和媒体内容。IP数据的广播为满足对数字内容日益增长的需求提供了手段，为弥合数字鸿沟提供了解决方案，并为私营和公共部门带来了创新。

数字连接需求的加速增长为广播机构创造了在通信领域创造新商机的潜力。高效广播高质量视频和IP数据的能力为满足日益增长的消费者需求提供了一种选择。

随着ATSC 3.0在一个国家全面部署后，预计在建成全国性网络后，该国将具备向民众、特别是那些无法接入高速宽带的群体传输基于IP的内容的能力。鉴于目前无论发达国家还是发展中国家，大多数人已能接收广播电视信号，下一代广播系统具备在弥合数字鸿沟方面发挥强大作用的潜力。

ATSC 3.0采用一对多广播传送模式，其中一个信号可以广播给每个铁塔覆盖区内的大量用户。预计部署ATSC 3.0后，广播机构能够增强其观众观看直播视频内容的体验，包括将文本、音频、视频或软件等互联网数据以及先进的全球定位系统（GPS）数据传送到他们的直播视频广播中。与传统宽带网络相比，ATSC 3.0广播机构的一对多网络架构使他们能够以经济高效的方式传送内容，并利用已有的基础设施传送内容和数据。

ATSC 3.0的一些主要功能包括⁴⁶：

- 内容通过电视高塔和单频网（SFN）广播。
- 信号通过多频网（MFN）联网。

⁴⁶ 德勤。《ATSC 3.0白皮书》，2022年。见：<https://www2.deloitte.com/us/en/pages/consulting/articles/atsc3-benefits-and-applications.html>。获取于2024年9月。

- 同时传输直播内容和基于IP的内容的数据管道。
- 向装有ATSC 3.0接收机的设备传送内容和数据。
- 接收机设备应用与宽带融合时的互动解决方案。

注：功能及用例详细说明见本报告附件7。

ATSC 3.0可以实现宽带和广播业务的集成，利用现有的连接方式为交互式体验、点播业务、物联网等新用例提供双向通信信道。

此外，ATSC 3.0的一些用例和可能的应用包括：

- 增强观众体验。
- 定向广告。
- 频谱即服务：数据卸载、视频流和边缘缓存。
- 物联网：网联汽车。
- 远程学习。
- 高级应急告警和通知。

已应用ATSC 3.0技术的国家示例

- **巴西：**2024年7月22日，巴西数字地面电视系统（SBTVD）论坛发布了第三阶段的最后建议，并转呈巴西通信部，该部将研究采用这些建议作为该国的TV 3.0系统，包括ATSC 3.0传输技术。⁴⁷
- **美国：**公共媒体企业集团（PMVG）—由32家公共电台组成的商业发展联盟—在其位于田纳西州库克维尔的低功率电台W35DZ-D上推出了NextGen广播业务。⁴⁸监管机构已通过标准，允许从2017年起使用这项技术。⁴⁹
- **加拿大：**汉博学院（Humber College）已建立ATSC 3.0实验室。

挑战和问题

作为新一代数字地面广播标准，ATSC 3.0技术提出了许多重大挑战和问题。主要挑战包括对兼容性广播基础设施的需求、从以往的标准过渡所需的巨额投资以及与现有技术的融合，特别是在IP数据压缩和传输方面。

主要问题之一是专利问题。ATSC 3.0受一系列专利的保护，由于相关的特许权使用费和许可费，采用这项标准的成本很高。这阻碍了进入许多市场的机会，特别是发展中市

⁴⁷ <https://www.atsc.org/news/atsc-3-0-transmission-technology-unanimously-recommended-as-final-ingredient-for-brazils-tv-3-0-project>

⁴⁸ <https://www.atsc.org/news/tv-tech-pmvg-launches-nextgen-tv-station-in-cookeville-tenn/>

⁴⁹ https://www.itu.int/dms_pub/itu-d/opb/stg/D-STG-SG01.02.2-2021-PDF-C.pdf

场，例如非洲，支持这种转换的财政资源有限。例如，这促使LG在生产下一代电视时放弃了对这项技术的支持。⁵⁰

大韩民国将ATSC 3.0用于超高清电视标准的示例

在大韩民国，ATSC 3.0作为UHD电视标准的采用标志着技术和监管的重大进步。这一转变得到了政府与行业利益攸关方之间的强有力合作推动。主要决定包括在700 MHz频段为UHD广播业务划分30 MHz频谱，授权给KBS、MBC、SBS和EBS等主要广播机构。

2015年12月制定的政策计划概述了分阶段部署策略，从2017年开始在首尔同时广播ATSC 1.0和ATSC 3.0，到2021年扩展到主要城市，再到2027年扩展到全国。政府通过投资研发、制定技术开发激励措施和促进行业参与的战略举措来支持这一目标。

2017年5月，大韩民国推出了全球首个地面4K UHD业务，KBS、MBC和SBS广播ATSC 3.0信号。这一里程碑涉及广播机构、LG和三星等制造商（生产ATSC 3.0电视）以及公共机构之间的合作。2018年平昌奥运会展示了这些能力，重点展示了在5G和使用ATSC 3.0的移动广播方面的进步。

总体而言，大韩民国采用ATSC 3.0展示了其在超高清广播方面的领先地位，利用技术创新和战略规划在全球市场建立了竞争优势。

2.3.3 DVB原生IP（DVB-NIP）

在继续介绍下一代系统的基础上，本节将探讨DVB原生IP（DVB-NIP）⁵¹。DVB-NIP是一种基于IP的端到端广播系统，以当前的欧洲数字视频广播（DVB）标准系列为构件，尽可能依靠已发布的DVB规范，并在必要时对之进行补充。简而言之，DVB原生IP广播系统建立在相关DVB标准之上，例如：

- DVB-I业务发现和节目元数据；
- 针对源媒体编码的DVB-AVC（音频和视频编码）；
- 针对流格式化的DVB-DASH（通过HTTP传输的动态自适应流）；
- DVB-MABR（组播自适应比特率）；
- DVB-GSE（通用流封装）– 逻辑链路控制；
- DVB-GSE（通用流封装）– 强健的报头压缩；
- 针对卫星传输和传送的DVB-S2X（第二代卫星扩展）和DVB-S2（第二代卫星）；
- 针对地面传输和传送的DVB-T2（第二代地面）。

⁵⁰ <https://www.theverge.com/2023/9/30/23897460/lg-drops-atsc-3-0-support-fcc-broadcast-tv>

⁵¹ 参考资料：<https://dvb.org/?standard=native-ip-broadcasting>和DVB A180r3蓝皮书（TS 103 876 V1.1.1草案）标准。

DVB原生IP⁵²旨在促进将过顶业务（OTT）和广播技术集成至IP媒体传送系统。通过DVB-NIP和DVB-I，现有的数字视频广播（DVB）网络可作为融合广播/宽带系统的一部分进行集成，从而实现平台和网络的整合，并从两边获取内容。新系统的一些特性包括：

- 利用现有基础设施连接传统设备：
 - 现有基础设施可用于连接农村地区的人口，或利用传统设备在公共场所或交通工具中提供新业务，例如，接入直播流媒体和高级视频点播（PVOD）。
- 现有参与者可从广播和宽带生态系统中DVB-NIP的整合中获益：
 - 卫星和地面广播业务提供商可以使用通过卫星/地面网络的DVB NIP保持相关性，而OTT服务提供商可以降低基础设施成本并扩大市场覆盖范围。
- 无需互联网的流媒体：
 - 无论同时连接的设备数量有多少，直播OTT都能以广播级质量提供服务。
- 助力环境可持续性：
 - 作为一种广播技术，该系统是一种助力IP业务触及数百万台设备的可持续方式。
- 能够实现5G/IP/广播融合：
 - “基于5G的DVB-I”有望在未来实现与5G广播（更恰当地说，5G媒体流）的结合，用于支持5G的新设备和可能逐渐提供5G覆盖的区域。

DVB-NIP可为用户提供新的业务和新应用，这一新技术可实施的一些新用例包括：

- 混合使用地面和卫星传输技术，在连通性较差且电视较少的环境中启用直播电视。
- 移动性：为公交车、铁路和水上部署场景中的“被动受众”提供娱乐。
- 教育：帮助相关机构触达农村学生。
- 实现融合媒体传送生态系统：
 - 相同的IP流提供给所有屏幕：
 - 统一的内容分发平台；
 - 多屏幕和多房间应用。
 - 标准化推送视频点播（VOD）；
 - 定向广告。

⁵² 《利用广播网络扩大OTT业务的覆盖范围—DVB原生IP简介》。国际电联“南亚、阿拉伯和非洲区域电视的未来”讲习班，2023年5月，印度班加罗尔。

2.3.4 其它下一代系统

为应对视听内容市场正在经历的创新，其它系统也正在开发之中，例如巴西正在讨论和规划对数字地面电视系统⁵³进行改进，该系统被称为TV 3.0。

巴西讨论和采用TV 3.0的过程

对于其第一代数字地面电视系统，巴西政府在经过全面测试和仔细研究后，于2006年6月采用了ISDB-T标准，纳入了其认为相关的技术创新，如MPEG-4 AVC（H.264）视频编码、MPEG-4 AAC音频编码、适用于巴西葡萄牙语的适当闭路字幕字符集以及一种新的交互式应用中间件（Ginga，H.761）。

SBTVD论坛⁵⁴开发了第一个SBTVD标准并于2007年发布，同年正式实现了开放传输。此后，该论坛不断修订和更新这些标准。巴西提出的技术创新被纳入了综合业务数字广播-地面（ISDB-T）标准，该标准目前已被20个国家采用。

随着部署的推进，以及已纳入和拟纳入数字电视标准及系统的创新，SBTVD确立了TV3.0项目，旨在将这些最新进展纳入巴西数字电视系统。巴西采用TV 3.0的讨论分阶段进行，包括就使能技术、测试和评估以及现场测试征集建议。更多信息见本报告附件8。

有关TV 3.0候选技术和所做的评估的更多信息，请参见本报告附件9。

计划于2024年8月进行TV 3.0的端到端演示，集成其所有系统组件。TV 3.0预计将于2025年推出。更多信息，请参见：https://forumsbtvd.org.br/tv3_0/。

2.4 各国在制定新技术、新兴业务和能力引入战略方面的经验，及其对广播的影响

在欧盟内部，政策制定者和监管机构认识到观看习惯发生了重大转变，特别是在年轻一代中，传统电视正逐渐被移动设备取代。用户生成视频等新内容格式的兴起提升了视频点播业务和视频分享平台的作用，对传统广播机构的市场产生影响。这些新技术创造了新的市场动态并影响了广播领域的商业模式。

为了应对这些市场新动态，欧盟引入了一项重大的监管创新，将视频分享平台纳入监管框架。这一转变在2018年得到正式确立，将视频分享平台（VSP）纳入欧盟《视听媒体服务指令》（AVMSD）的范围内，该《指令》现在规范着欧盟范围内各国关于所有视听媒体、传统电视广播和视频点播业务的立法协调。⁵⁵

因此，欧盟层面的监管仅限于视听媒体服务（线性电视节目和通过互联网分发的视频）以及视频分享平台业务。欧盟通过了《数字服务一揽子计划》（包括两项法案，即《数字服务法案》和《数字市场法案》），表明，适用于广播行业的法规应顺应技术创新，例如本案例中应顺应新兴技术的采用，并与之同步发展。在许多情况下，这要求负责机构投入更多资源并采取融合监管方法。

⁵³ 巴西采用了巴西数字电视系统（SBTVD），该系统基于日本的ISDB-T系统，并融入了其他创新。

⁵⁴ 巴西数字电视系统论坛：<https://forumsbtvd.org.br>。

⁵⁵ <https://digital-strategy.ec.europa.eu/en/policies/audiovisual-and-media-services>

为了应对这些发展态势，欧盟委员会在2021年通过一项改革和政策计划，通过了“塑造欧洲数字未来”⁵⁶的战略，并通过了所谓的《数字服务一揽子计划》，由两项法案组成：《数字服务法案》（DSA）和《数字市场法案》（DMA），这两项法案旨在应对广播领域的新数字业务的出现所带来的发展。

这些立法法案的目的是更新现有的欧洲数字服务监管规则并使之现代化。《数字服务一揽子计划》的两个主要目标是保护数字服务用户并确保他们的基本权利得到尊重；其次，在数字生态系统中创造一个公平的竞争环境，以促进创新和提高竞争力。详细信息见本报告附件10。

作为欧盟层面实施新监管框架的示例，本报告附件10介绍了**波斯尼亚和黑塞哥维那**的案例研究，总结如下：

与世界其他地区一样，数字技术已经从根本上影响了内容的传送、制作、分发和消费方式。互联网用户数量不断增加（根据通信管理局（CRA）的RAK年度报告，2021年互联网普及率几乎达到96%）。在线信息资源的使用也在增加。根据2022年对波斯尼亚和黑塞哥维那成年人媒体习惯的研究，十分之九的成年人使用互联网，十分之八的成年人使用社交网络。对于大多数成年人来说，电视仍然是获取国内和全世界新闻信息的主要来源（78%），其次是社交网络（52%）和在线信息门户网站（45%）。42%的成年人使用视频交换平台。相当比例的成年人（35%）表示，他们在媒体和ICT环境中接触过可能有害的内容，其中仇恨言论位居榜首（48%）。⁵⁷

为了应对这些发展情况，2023年5月，CRA理事会通过了一套与2018年修订后的AVMSD保持一致的细则，从而将监管范围扩大到视频分享平台。

新法规包括**视听媒体服务提供规定、视频分享平台业务规定**，以及两项法规：**节目内容法规和商业通信法规**。这些规定，作为示例，说明了波斯尼亚和黑塞哥维那如何更新其国家法规以应对影响广播机构的新市场动态。

监管机构定期与其他利益攸关方接触，并在这一过程中开展新的研究。为解决公众日益关注的问题，并更好地理解其监管在线媒体（视听除外）的法律职责，CRA一直在倡导该国有必要基于在在线媒体生态系统中发挥作用的各利益攸关方之间的合作，实施一种系统性方法。为此，在欧洲理事会实施的JUFREX项目（东南欧言论自由和媒体自由项目）支持下开展了一项研究，确定了相关的地方利益攸关方（诸如选举机构、在线媒体自我监管机构、民间团体组织（CSO）、专业协会等机构），并评估了它们承担这一共同责任的能力和准备情况。2022年12月，发布了题为《**欧洲打击有害在线内容的共同监管做法对照 – 波斯尼亚和黑塞哥维那的环境以及寻找有效的媒体共同监管模式**》⁵⁸的研究。在随后的几个月里，召集所有已确定的利益攸关方，以便根据研究提供的建议，就合作平台的建立和运作以及这种合作潜在的制度化达成协议。

⁵⁶ https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/shaping-europes-digital-future_en

⁵⁷ <https://rm.coe.int/mil-media-habits-bos-nova-verzija/1680a845ff>

⁵⁸ <https://www.coe.int/en/web/freedom-expression/-/towards-the-co-regulation-of-harmful-online-content-in-bosnia-and-herzegovina>

此外，在西巴尔干开放社会基金会的支持下，开展了“**数字欧洲西巴尔干的未来**”⁵⁹的研究，以阐述西巴尔干国家将其国家法规与欧盟《数字服务法案》保持协调一致的准备情况。

2.4.1 监管、经济和技术问题

在过去的几年里，数字化已成为我们生活中不可或缺的一部分，并影响着我们的生活和互动方式。技术的发展促进了面向最终用户的新的创新产品和服务的出现。这些创新对许多经济部门产生了颠覆性影响，影响到消费者、企业和政策制定者。在某些情况下，这引发了对竞争问题的担忧，也引发了如何更新相关法律和法规以应对部分由这些新的和新兴技术造成的新现实。

此类创新的一个示例是固定、移动和媒体网络的融合，这种融合使新进入者得以提供创新服务，对传统的电信价值链和包括广播行业在内的媒体商业模式产生了影响。⁶⁰,
⁶¹, ⁶²

2.4.2 对广播业务的影响

如上一节所述，欧盟《数字服务一揽子计划》出台了一套监管数字生态系统的新规定。这可作为一个示例，说明各国如何针对新技术的出现而更新其法规，以及这些法规会对广播业务产生什么影响，而这些法规为不断发展的数字格局营造了有利环境。

通过更新其法规，政策制定者可以在日益以在线为导向的媒体生态系统中支持公平竞争并保护用户利益。这些立法框架为透明度要求确定了明确的规则，确保广播业务在数字领域负责任地运营。最终，以响应迅速和包容的方式更新监管框架有助于创造有利的环境，在不断变化的数字领域维护广播业务的完整性和长久性。关于欧盟《数字服务一揽子计划》的详细信息，请参见本报告附件10。

⁵⁹ https://metamorphosis.org.mk/en/izdaniya_arhiva/towards-a-feasible-implementation-of-the-digital-services-act-in-the-western-balkans/

⁶⁰ https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/shaping-europes-digital-future_en

⁶¹ 2022年10月19日欧洲议会和理事会关于数字服务单一市场以及修订第2000/31/EC号指令的第2022/2065号条例（欧盟）：<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022R2065&qid=1666857835014>

⁶² https://digital-markets-act.ec.europa.eu/index_en

第3章 – 向数字广播的过渡

3.1 数字电视过渡

人们认识到，在实施向数字技术迁移的进程中，关键挑战之一在于在政策和法规制定以及项目实施过程中需要在利益攸关方进行协调，正如不丹王国在其提交的有关该国宽带部署战略的文稿中所述⁶³。本章节将讨论与向数字电视广播过渡有关的一些关键问题，包括规划和协调工作。

另一个重要方面是制定实施数字转换的国家战略和路线图。可以引用喀麦隆共和国案例⁶⁴作为示例，该国在体制层面向数字广播迁移的行动分两个阶段进行。第一阶段是**制定战略**，成立指导委员会⁶⁵，并制定战略文件。下一阶段是**实施战略**，成立实施机构⁶⁶。

根据已实施向数字广播过渡和采用数字广播战略的国家的经验，可以发现其中的一些相关问题和最佳做法，以下小节将探讨这些问题，并针对总体战略各组成部分列举相关案例研究，包括：

- 国家战略；
- 政策和监管框架；
- 确定向数字地面电视（DTT）过渡的方法；
- 战略实施；
- 面向低收入人群的DTT接收机。

3.1.1 相关问题和最佳做法

a) 国家战略

为了成功实现数字广播过渡，必须制定并密切遵循一项国家战略文件，以指导实施数字转换和停播模拟广播所涉及的所有活动。

以喀麦隆的案例⁶⁷为例，2012年，该国政府通过了一份模拟向数字广播过渡的**国家战略文件**。该文件包括四个主要部分：

- 关于过渡的一般性信息；
- 审查和分析该国的广播情况；

⁶³ 不丹提交的ITU-D文件：<https://www.itu.int/md/D22-SG01-C-0048/>。

⁶⁴ 喀麦隆提交的ITU-D文件：<https://www.itu.int/md/D22-SG01.RGQ-C-0014/>。

⁶⁵ 根据2009年9月24日第222/CAB/PM号政府令成立的数字广播转换委员会（CAM-DBS）。

⁶⁶ 根据2012年8月30日第122/CAB/PM号令成立的数字广播过渡实施机构（CAM-DTV）。

⁶⁷ 喀麦隆提交的ITU-D文件：<https://www.itu.int/md/D22-SG01.RGQ-C-0014/>。

- 喀麦隆数字电视领域的当前愿景；
- 实施过渡的机制。

国家过渡战略分为六个部分，包括大约40个项目，即：

- 机构和法律项目；
- 经济和财务问题；
- 技术项目；
- 与广播内容开发相关的项目；
- 人力资源和能力开发项目；
- 提高决策者和普通公众对数字过渡认识的项目。

喀麦隆制定国家战略的过程具有参考价值，见本报告附件11。此外，喀麦隆的过渡进程的主要阶段见本报告附件12。

几内亚共和国⁶⁸也启动了一个项目，目的是在全国范围内部署地面数字电视（DTT）。该项目是为了满足对频谱进行现代化和优化的战略需要，同时为民众提供更优质的服务。经过几年的拖延和规划努力，几内亚目前致力于加快数字过渡，以利用其带来的技术和经济效益。

几内亚从模拟向数字广播的过渡对该国的发展至关重要，以期实现基础设施的现代化、优化无线电频谱的使用并提供更好的服务。数字地面电视（DTT）项目旨在解决干扰和频谱使用效率低下等问题，将几内亚更有效地连接到数字世界。

几内亚的案例研究提出了一些重要问题，建议在制定整体过渡战略时将这些问题纳入考量。

几内亚共和国案例研究：

几内亚政府已为DTT项目支付了15%的首期款项，但还需要捐助方提供额外资金来满足正式启动所需的30%的资金。目前正在努力确保获得必要的资金，以避免进一步延误。

资金对于实施至关重要，建议从一开始就在国家战略框架中加以考虑。

- 频率划分和频谱规划

关于数字广播的频率划分，尽管实施伙伴对必要的信道提出了建议，一些电视和调频频率已被其他运营商使用。法国邮电监管局（ARPT）与几内亚政府合作，已采取措施释放这些频率，但仍需提交频率划分的正式申请，并遵循相关程序。

从几内亚的案例可以看出，应对频谱划分和重耕活动进行全面规划，以便明确实施阶段需考虑的必要步骤。

⁶⁸ 几内亚提交的ITU-D文件：<https://www.itu.int/md/D22-SG01-C-0451/>。

— 其他挑战和后续步骤

该项目面临的一项挑战是固定预算限制，这可能会造成覆盖范围的缺口，妨碍提供足够的传输支持，特别是在连接广播站点的光纤方面。此外，还缺乏对可扩大覆盖范围的老旧模拟站点的修复工作。后续步骤包括最后确定缺失的文件，确保频率划分，以及完成合规性法律框架。几内亚政府非常明确地指出，所有这些步骤对整体过渡战略至关重要。

值得注意的是，几内亚的实施案例持续演进，有关利益攸关方如何解决此处讨论的问题的最新情况见本报告附件13。

b) 政策和监管框架

另一个最佳做法是在国家有关向数字广播过渡的政策和监管框架中正式确定战略。在正式确定战略过程中，需要考虑的关键问题是建立激励机制，以争取利益攸关方的支持。因此必须出台一项明确的政策，以便建立一个清晰的法律框架。唯有在建立清晰的法律框架之后，所有相关法律文书才能付诸实施。

首先，需要确立战略目标。建议该战略：

- 制定向数字地面电视（DTT）过渡的所有关键要求；
- 停止所有UHF频段的模拟广播；
- 允许为其他将使用释放频谱（数字红利）其他部分的业务（如移动电话）分配新的许可证；
- 将向DTT过渡期间正在运营的所有利益攸关方都包括在内。

其次，该战略必须兼顾从模拟广播向DTT的过渡。

最后，该政策必须计划建立一个机制，以确定现有立法中可能存在的漏洞，因为这些漏洞可以被用来绕过广播条款。这些漏洞需要新的法律文书中予以纠正⁶⁹。

c) 确定向DTT过渡的方法

为了使实施工作切实有效，必须规定一个模拟和数字业务并存的过渡期。在此期间，必须提供必要的操作工具。

过渡期应允许尽可能迅速地向DTT过渡，因为同时使用模拟和数字业务可能导致业务中断。马达加斯加共和国选择的一个方案是先在地区一级过渡，然后再转向国家层面⁷⁰。

⁶⁹ 就马达加斯加而言，向数字地面电视（DTT）的过渡由第2020-006号法案（修订了第2016-029号法案《媒体通讯法典》）予以筹备。根据新的第126条，“所有公共及私营媒体在转换为数字地面电视传输模式并遵守相关法律法规的前提下，均应获得全国覆盖许可。其规范须确定授权的传输和广播方式。私营广播电台和电视台可以选择七个主题，即教育、信息、体育、娱乐、艺术和文化、经济和音乐。一个许可证对应一个主题。每个主题的许可证须通过招标分配。”上述条款允许所有具备DTT传输能力的公共和私营媒体频道在全国范围内进行广播。为了监管新的DTT传输模式，马达加斯加政府目前正在起草一项法案，规定运营DTT的所有规则和条件。

⁷⁰ 2015年，诺西贝镇（Nosy Be）被选为试点城市，以便实现更平稳的过渡。目前，两家私营运营商在该国其他一些城镇提供数字地面电视业务。

一般而言，向DTT的过渡是不可避免的。制定过渡政策和营造有利的法律环境将极大助力实现这一目标。一旦这些要素就位，实际的过渡就可以从同时使用模拟和数字业务开始。

正如马达加斯加的案例一样，过渡时期的融资是另一个关键问题，寻找捐助者和财政援助组织不能被放在次要位置。

d) 战略的实施

从上述提交和提及的案例研究中，可以确定一些与战略实施有关的最佳做法：

技术方面：

- 试验项目可能很有价值；
- 为建设数字广播的技术基础设施招募战略合作伙伴可能十分重要；
- 确定资金来源至关重要；
- 数据采集是全面调查全国现有广播基础设施的关键；
- 开展公共宣传活动，包括在不同区域举办研讨会，使人们认识到向DTT过渡的重要性及其面临的挑战，这一点非常重要；
- 修订超高频（UHF）和甚高频（VHF）频段的频率规划，增加这些频段的规划频谱资源容量至关重要；
- 制定向DTT过渡的场景，同时考虑到覆盖国家领土的成本和目标，至关重要。

与内容相关的方面：

- 必须考虑内容（电视节目）的筹备和创作。

人力资源方面：

- 提高参与过渡进程的主管部门和公共机构选定人员的能力是关键。

d.1) 实施进程中的协调

成功进行数字转换的另一个重要因素是利益攸关方之间的协调。巴西的案例研究尤其值得关注。政府发布的一系列规范性文件确立了巴西⁷¹从模拟电视向数字电视过渡的管理办法，其重点是建立合作与协作机制，实现数字转换的目标⁷²。

在此背景下，依据法令成立巴西数字地面电视系统（SBTVD）论坛，就与批准SBTVD的技术创新、规范、开发和实施有关的政策和技术问题向巴西政府提出建议。SBTVD论

⁷¹ 2006年6月，巴西政府通过第5820/2006号法令采纳ISDB-T系统作为数字地面电视（DTT）传输的基础。2007年12月2日，巴西DTT系统正式发布，在圣保罗市启动商业运营，自此，部署正在顺利推进。

⁷² 欲了解更多信息，请参阅ITU-D第2/1号课题2017-2021年研究期最后报告第1章第1.3.2、1.4.3.3节和附件2，见<https://www.itu.int/hub/publication/D-STG-SG01.02.2-2021/>。

坛由广播、学术界、传输、接收和软件行业的代表组成，政府代表作为无表决权成员参与其中。

除了SBTVD论坛之外，为了监督这一进程并开展所有利益攸关方共同规划的行动，成立了一个第三方实体来执行国家战略中包含的任务，其中包括：

- 关于关停模拟传输的强制性宣传活动，包括广告、新闻节目和社会动员活动；
- 为低收入家庭分发数字地面电视广播（DTTB）就绪包（机顶盒、天线和配件）；
- 提供一个网站和一个24/7免费呼叫中心，在此进程中向受影响的人群提供支持；
- 开展家庭调查，以验证是否满足模拟停播的条件；
- 重新整理电视频道，以释放700 MHz频段；和
- 减缓国际移动通信（IMT）对电视接收系统可能产生的干扰。

马来西亚为从模拟电视向数字电视的过渡提供了又一示例⁷³，这是该国广播发展的一个重要里程碑。马来西亚政府负责确保免费（FTA）电视台从模拟电视向数字电视的平稳过渡。该举措得到了进一步支持，指定了一家特殊目的公司作为通用综合基础设施提供商（CIIP），负责监督DTT基础设施的建设和管理。DTT的过渡旨在实现FTA电视广播的现代化，提供更高的效率和更好的观众体验。部署了直接到户解决方案（DTH）以补充偏远地区的DTT覆盖。

马来西亚已成功完成模拟停播（ASO），并于2019年完全过渡到数字广播。这一成就为覆盖城市和农村地区的现代化的、无障碍的电视基础设施奠定了基础。这增强了该国的广播能力，确保提供更具包容性和面向未来的电视业务，DTT平台上的FTA电视频道已增至15个数字电视频道和17个广播频道，改善了公众在全国范围内获取信息和娱乐的机会。

d.2) 模拟停播（ASO）战略

模拟停播战略是实施阶段的另一个关键问题。ITU-D第2/1号课题2017-2021年研究期⁷⁴最后报告中提出了几个方案，其中包括一次性方法和分阶段方法。

作为分阶段实施的示例，可考虑巴西的案例研究。巴西将其ASO分为两个阶段。在ASO的第一阶段，首都及其他主要城市和城镇关停了模拟传输，以便在700 MHz频段（698-806 MHz）上运行第四代IMT-Advanced系统；在第二阶段，在所有仍在运行模拟电视的地区⁷⁵完成转换。

为了完成第一阶段的工作，巴西对700 MHz频段的电视频道进行了重新规划和划分，将其下移到VHF频段（7至13信道），同时对其余的UHF频段（14至51信道）进行了重新规划和分配。

⁷³ 马来西亚提交的ITU-D文件：<https://www.itu.int/md/D22-SG01-C-0340/>。

⁷⁴ 可在以下网址获取：<https://www.itu.int/hub/publication/D-STG-SG01.02.2-2021/>。

⁷⁵ 第一阶段于2016年至2018年期间实施，第二阶段从2021年开始，计划于2023年12月结束。

第二阶段制定了一项政府计划—**数字化巴西**（Digitaliza Brasil），该计划的资金来自拍卖第一阶段原始划分中剩余的700 MHz频段⁷⁶。

巴西的模拟停播（ASO）战略是成功的，向数字电视广播的过渡对免费收看地面电视的观众没有显著影响。这一成功对于巴西尤为重要，因为该国大多数人的视听内容消费依赖于免费电视。数字转换带来了若干积极成果，包括提振国内各行业（包括机顶盒、电视、接收天线、数字电视发射机和发射天线）的发展，并重新唤起了公众对免费地面电视的兴趣。巴西ASO战略的主要经验教训包括利益攸关方之间合作和协作的重要性，以及由第三方对计划行动进行操作实施。消费者的意识和参与对顺利实施至关重要，为此，决定逐步分阶段在零售市场销售的所有电视机中纳入数字电视（DTV）转换盒。向低收入人群免费提供DTV转换盒和天线等必要设备也极大促进了这一过渡进程。当地各方的参与促进了转换工作，凸显了社区参与的重要性。对于幅员辽阔的国家来说，长期ASO规划是可取的，同时应考虑在小城市维持作为次要业务的模拟传输，以刺激这些地区向数字系统的过渡。有关**数字化巴西**（Digitaliza Brasil）计划的更多信息，请参见本报告附件14。

e) DTT接收机在低收入人群中的可及性

另一个需要考虑的问题是DTT接收机在低收入人群中的可及性问题。ITU-D第2/1号课题2017-2021年研究期的最后报告（可在<https://www.itu.int/hub/publication/D-STG-SG01.02.2-2021/>上查阅）对这一问题进行了审议，同时还应研究其他类似举措。

在巴西⁷⁷，2021年针对5G技术的移动宽带频谱拍卖对该国广播市场产生了重大影响。由于5G网络在其中一个频段（3.5 GHz）对卫星广播业务的发射造成干扰，因此决定有必要从现有的卫星广播技术进行迁移，这涉及将接收机的基础数字化，即从模拟转为数字卫星广播。

5G频谱拍卖程序的一项规定涉及利用拍卖所得资金为低收入家庭购置设备，以覆盖这些家庭从模拟转为数字卫星广播业务的费用。

具体而言，做出决定将使用3.5 GHz频段的现有C频段卫星系统迁移到另一个频段，称为Ku频段。这涉及大约2 070万个使用卫星广播接收电视节目的家庭，其中约1 700万户家庭接收的是免费卫星频道，其余则使用付费订阅电视业务。

在所有免费电视家庭中，有830万户是登记在国家社会福利计划中的家庭，他们的过渡将得到拍卖所得资金的支持。另有920万户家庭需更换设备，安装一套价值约250巴西雷亚尔（约合50美元）的套件。

基于5G拍卖规定，这一举措的好处包括：

- 将广播覆盖范围扩大到偏远和闭塞地区；
- 第三方实体进行资金管理；
- 为830万个享受国家社会福利计划的家庭购置接收设备。据估计，这涉及2 070万个通过卫星广播接收电视的家庭，其中包括1 700万个通过卫星频道接收电视的家庭。

⁷⁶ 为巴西ASO战略第二阶段预留的资金总额约为8.50亿雷亚尔（约合1.60亿美元）。

⁷⁷ 更多信息见本最后报告第4.1节。

关于卫星电台实施过渡和向用户交付设备的更多信息，可查阅本报告附件15。

3.1.2 发展中国家在向数字广播过渡方面的需求

虽然许多国家已完成了数字转换进程，但仍有相当一部分仍在进行之中，这些国家的具体需求各不相同，需要在采用和迁移到数字广播的背景下予以考虑。

本节涉及具体案例研究，试图把握处于不同转型阶段的各国所持的多元观点，一些国家的具体需求如下所述，详见本报告附件16。

对阿根廷共和国、波斯尼亚和黑塞哥维那、巴西联邦共和国、科特迪瓦共和国、几内亚共和国和塞内加尔共和国关于数字转换进程的案例研究中所确定具体需求进行考量至关重要。本报告确定的需求包括以下方面：

- 连通性和基础设施发展；
- 通过DTT改善地域覆盖并完成数字转换进程；
- 除地面广播外，结合其他技术，如直接到户（DTH）卫星业务，实现领土覆盖；
- 综合解码器方案，包括DTT、卫星和互联网业务提供；
- 移动电视业务（智能手机和平板电脑）；
- 创造有利环境，促进包括地方和区域在内的更多内容和更多样化的节目；
- 数字电视节目的演进，提供新业务和新功能；
- 视频点播和电视回看业务；
- 为广播技术的实施和迁移创造有利环境，包括OTT、数字平台、视频共享平台等技术；
- 特别关注监管部门对新的广播格局和消费者习惯变化的回应；
- 改善通信，更容易获得免费DTT；
- 纳入最弱势群体；
- 能力建设需求；
- 资金需求。

3.1.3 相关利益攸关方的实施费用

实施过程中涉及的费用是向数字广播迁移的总体战略的一个相关方面。继ITU-D第2/1号课题2017-2021年研究期最后报告中收集的成本核算数据（可查阅：<https://www.itu.int/hub/publication/D-STG-SG01.02.2-2021/>）之后，值得一提的还有关于成本核算数据的最新情况，特别是发展中国家提供的所有更新。

以几内亚的情况为例⁷⁸，其案例研究涉及在经历了大约15年的延迟之后，从模拟向数字电视过渡的进展程度。几内亚意在推进过渡进程，以便收获新技术带来的好处，同时释放可重复使用的频段。该案例研究还强调了几内亚政府愿意实施为此目的而设立的项目，并指出了项目的不足之处，其数字地面电视业务仅覆盖了全国33个省的15个站点。因此，该提案还包括通过卫星广播来实现项目规划的地面数字电视网络加密。

请注意，该项目的总成本估算为6 600万欧元，其中85%的资金将通过贷款从外部来源获得⁷⁹。其余15%将由几内亚政府通过国家银行系统提供支持。

项目实施程度

作为项目实施的一部分，采取了以下行动：

- a) 通过总统令成立了数字迁移进程监督和协调委员会；
- b) 与技术操作者签订商业合同；
- c) 与技术操作者进行实地访问；
- d) 评估合作伙伴发出的报价。

3.1.4 从该进程实施中汲取的经验教训

巴西

模拟停播（ASO）战略第一阶段的实施经验取得了成功，因为模拟停播对免费地面电视的观众没有显著影响。这对巴西尤为重要，因为绝大多数人口都依赖免费电视。数字转换的其他影响还包括对国家产业（机顶盒、电视、接收天线、数字电视发射机、发射天线等）的积极影响，以及公众对免费地面电视的重新关注。

在巴西实施的ASO战略第一阶段发挥重要作用的其它方面包括：

- 所有利益攸关方开展合作与协作的重要性，就巴西而言，通过与实施计划行动的第三方进行；
- 消费者的认识和参与对顺利实施ASO的重要性；
- 确保数字电视转换顺利推进的一项关键举措在于作出一项决定，在零售市场销售的所有电视机中分阶段逐步配备DTV转换盒；
- 另一个关键决定是根据需要为低收入人群免费提供必要的设备，包括DTV转换盒、天线等；
- 地方行动者的参与促进了数字转换，这是一项重要发现，激发了第二阶段计划的一些行动。

⁷⁸ 几内亚提交ITU-D文件：<https://www.itu.int/md/D22-SG01-C-0250/>。

⁷⁹ 法国公共投资银行（BPI France）和法国财政部总局。

波斯尼亚和黑塞哥维那

- 尽管政策制定者是采用战略框架和战略决策的关键，但事实证明，监管机构的作用在克服挑战方面至关重要。在波斯尼亚和黑塞哥维那，监管机构在该进程的几乎所有活动中都充当了发起者和合作伙伴的角色。监管机构决定采取行动，保护最终用户，刺激行业发展并遵守国际协议；
- 无论向数字地面电视的过渡有任何延迟，监管机构总可以在其职责范围内采取行动，推进甚至领导这一进程；
- 区域环境的重要性，特别是在频率干扰的情况下，是这一进程取得成功的重要因素。监管机构必须与区域伙伴保持良好的沟通和协作，以确保国际协议得到充分执行；
- 尽管与其他欧洲国家相比，进程的严重积压和延误使最终用户接入和行业面临危险，但由于有线电视和IPTV行业自此经历了显著增长，公民并没有被剥夺服务。有线电视传送普及率达到电视用户总数的45%，而IPTV和DTH分别占总用户的39%和16%，包括节目多样性和媒体多元化在内的电视信号可用性一直保持在一个令人满意的水平。因此，可以得出这样的结论，尽管有所延误，波斯尼亚和黑塞哥维那引入数字地面广播的进程取得了成功，而且即将完成。

喀麦隆

喀麦隆从模拟向数字广播过渡的进程目前面临若干普遍性困难：

- 过渡进程中的责任分工问题；
- 作为恢复公共广播机构“CRTV”工作的一部分，该项目必须兼顾与广播节目制作、电视制作和无线电广播有关的问题；
- 项目为满足各种需求而进行反复修改；
- 资金困难。

3.2 数字广播过渡

3.2.1 相关问题和最佳做法，包括将VHF频段III用于DAB或DTT

与数字电视过渡一样，数字电台广播的过渡也需要规划和协调。巴西的案例为数字电台广播过渡提供了示例。2007年，巴西开始讨论采用数字广播的问题，国家电信管理局（Anatel）、电信监管机构和通信部（MCom）联合广播行业，对高清广播（HD）及数字版权管理（DRM）系统展开协同测试。

巴西的普遍共识是，测试必须针对“带内频道”（IBOC）系统，该系统使用与模拟系统相同的频段，这是因为有关方面当时认为，这些系统更易于部署，成本更低（它们可以与使用相邻频道的模拟电台相同的物理结构来激活）。此外，通信部和巴西广播电

视协会（ABERT）⁸⁰认为，建议在FM和AM中同时部署这些系统，对广播机构的财务影响最小。

近期，就如何划分频谱、在数字和模拟广播系统上实现组播传输展开了讨论。然而，数字广播在巴西的部署仍在讨论中，因为模拟电台仍然非常流行，而且因此还采取了一些举措来扩大FM频段的使用，FM频段具有更好的服务质量。附件17简要介绍了巴西的经验作为案例研究，包括AM电台向FM频段的迁移以及将FM频段进行扩展以包括更多信道的信息。

有关数字广播过渡和采用的更多信息载于ITU-D第2/1号课题2017-2021年研究期最后报告第4章第4.2.7节，可查阅：<https://www.itu.int/hub/publication/D-STG-SG01.02.2-2021/>。下文总结了关于采用数字广播技术的一些重要参考资料。

3.2.1.1 数字广播技术的采用

数字广播技术的采用因国家而异。挪威是唯一在国家无线电广播中完全过渡到数字音频广播（DAB）技术并停止FM传输的国家。

匈牙利、葡萄牙、爱尔兰、罗马尼亚等其他国家已经引入了DAB+，但基于几年的经验后，他们停止了DAB广播并关闭了接收机网络。

其他国家同时保留模拟FM和数字DAB系统，两者共存而非相互取代。因此，大多数国家同时运营DAB和FM，一些电台通过不同的网络扩大覆盖范围。

一些国家拥有正式的DAB+多路复用，全球有30个这样的国家，而在28个国家，DAB+作为一个试点项目存在。⁸¹在欧盟国家，DAB+信号的人口覆盖率很高，从欧盟排名垫底的法国的42%到意大利的86%、德国的98%、英国的97%，或位居榜首的丹麦的99.9%（数据来自WorldDAB）。

数字音频广播（DAB）的未来既带来了机遇，也提出了挑战，尤其是在面对来自其他广播平台和流媒体业务的竞争时。由于FM电台仍然是最后的模拟技术之一，其局限性决定了有必要向数字平台转变。年轻听众通常认为传统广播已经过时，更喜欢YouTube、Spotify和播客等替代品。然而，完全过渡到流媒体业务面临着移动网络覆盖有限、数据成本高和容量问题等障碍。政策制定者在实施DAB时应考虑若干因素：DAB由于卓越的音质和附加功能日益普及、监管支持和内容多样性对用户兴趣的影响、以及互动功能和智能设备集成等潜在创新。尽管竞争激烈，但DAB在广播可靠性、频谱效率和本地化内容方面的优势可以帮助其保持相关性。DAB在发展中国家的未来将取决于经济发展、技术进步、监管支持和不断变化的用户偏好。

本报告附件17详细介绍了有关波斯尼亚和黑塞哥维那、挪威和塞内加尔采用DAB和DAB+的更多信息。

⁸⁰ ABERT – 巴西广播和电视台协会（Associação Brasileira de Emissoras de Rádio e TV）。

⁸¹ <https://www.worlddab.org/countries>

3.2.1.2 下一代无线电和音频系统

本节介绍了无线电和音频广播演进的一些实例。这些新系统的目的是将互联网应用的特性纳入无线电系统，包括更加稳健和创新的内容，以及在制作、组播和IP传送中使用人工智能（AI）。

介绍的案例涉及下一代调频（NextGen FM），这是一个新名词，指未来一代的调频广播，通过结合先进的数字技术，使传统调频广播现代化，并提升传统调频广播的体验。⁸²下文简要列举的实例包括：(i) 美国高清广播的发展，(ii) 可视广播和播客，以及(iii) 马来西亚的IP媒体（MoIP）应用。

美国的高清广播

多年来，高清广播架构在技术上不断进步，稳定了信号复用和传输，改善了带宽管理，并加入了更多增强功能。大多数增强都源于一个更强大的端到端平台，该平台由越来越多的软件定义架构提供支持。⁸³

高清广播是一种使广播电台以类似CD的音质进行数字广播的技术。它还使电台能够在单个频率上组播额外的信道。这意味着使用高清收音机的听众有更多选择，电台也有更多选择来探索新的创新内容。

例如，明尼苏达州公共广播电台现在正在全州多个社区的高清广播中播放其所有三项业务 – MPR News、YourClassical MPR和The Current®。⁸⁴国际电联在2020年对高清广播进行了几项研究。⁸⁵

马来西亚的可视广播和播客

可视广播通过添加可视元素增强了传统音频广播的效果，为听众创造了更具吸引力的体验。国家广播电台和许多其他广播电台在其内容创作中采用了可视广播元素。可视广播将视觉效果与音频广播相结合，提供更加丰富的体验。这可以包括电台演播室的实时视频馈送、同步图形、文本和互动元素。演播室安装了高质量的摄像机和视频系统，并配备了AI摄像机控制功能，有助于内容创建。为马来西亚国家广播电台提供可视广播内容，通过全高清视频节目向新闻和体育频道提供内容，并实现广播与电视演播室之间的互动。为通过在线和社交媒体平台提供用于第二代地面数字视频广播（DVBT-2）的全高清视频传输业务，需要高带宽网络连接。

商业频道和一些社区广播电台利用可视广播和播客创作节目。这些内容通常通过社交媒体平台进行流式传输，并以播客的形式在云端发布。可视化使广播更具吸引力，可以吸引更广泛的听众。听众可以通过问答、投票和社交媒体与广播进行互动。可视广播可以通过广告开辟新的收入渠道。可能需要实施内容监管要素和准则，以确保这种媒体不被滥用，不会被用于给社会和任何社区造成不适。

⁸² <https://www.gatesair.com/fr/solutions/hd-radio>（法文）

⁸³ 同上。

⁸⁴ <https://www.mpr.org/listen/hd-radio>

⁸⁵ https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-BS.2482-2020-PDF-E.pdf

马来西亚的IP媒体应用

马来西亚实施了基于IP的媒体传输技术（MoIP）来升级其无线电广播系统。国家广播机构和一些商业电台在其基础设施为音频网络采用了符合AES-67标准的基于IP的音频（AoIP）技术，以提高信号管理效率。

国家广播机构旗下的34个公共无线电广播频道使用固定IP网络，为新闻、集中式内容和跨区域节目制作提供电台到电台的内容。

AoIP移动编解码器利用4G/5G移动网络，通过电信移动运营商提供的移动网络，采用Opus、HE-AAC和APT-X等低延迟编解码器，将节目发送回广播演播室进行实况广播。通过5G的网络切片技术将提升网络可靠性，并在直播活动中有效缓解电信网络拥塞问题。

演播室至发射机链路（STL）利用固定网络的IP技术，在不影响音频质量的情况下，利用AoIP编解码器远距离发送信号，从无线电演播室到FM发射机站点发送信号。IP技术不仅用于贡献和分发信号，也用于监测和控制从广播演播室的控制室远程安装的广播设备。已安装的FM发射机设备可以通过移动和固定网络的远程访问进行控制。从远程站点收集的数据可以存储在基于云的存储器中，以便未来进行分析并协助预防性维护工作。

第4章 – 与向数字广播过渡有关的频谱规划相关问题和最佳做法

4.1 解决频谱规划和干扰减缓问题的国家经验

在数字广播技术方面，一个国家的发展与技术部门的发展密不可分。老旧广播技术的问题在于，除了在相邻频段造成干扰外，还限制了无线电波的使用和信道数量，并限制了频谱的使用。数字广播的使用为这些问题提供了一个持久的解决方案。目前，数字广播技术已广泛应用，但许多国家仍然希望充分采用数字广播，以享受其带来的所有好处。人们将这些技术视为联络、获得信息和娱乐的资源。

以下各节将探讨与广播业务频谱优化利用（包括频谱规划与迁移）以及数字红利使用相关的挑战。

4.1.1 频谱规划和向数字广播的过渡

正如喀麦隆⁸⁶所指出的，国际社会已在2006年日内瓦协议的背景下通过了新的频率规划⁸⁷，同时还就以下过渡截止日期达成了一致：**470-862 MHz频段（频段IV/V）为2015年6月17日，174-230 MHz频段（频段III）为2020年6月17日**。工作完成后，国际电联建议成员国设立机构，以制定从模拟向数字广播过渡的国家战略。这些国际截止日期标志着模拟广播业务不再受到数字广播业务的保护。

从模拟向数字过渡的决定基于以下几个因素：

- 通信技术的进步；
- 无线电频谱需求旺盛；
- 在其经济、社会和文化影响的推动下向数字电视的转变；
- 具体而言，在发展中国家，由于缺乏数字电台接收机和调频（FM）技术的持续普及，无线电数字化步伐较慢，而调频（FM）技术能以适中的成本向拥有FM收音机的人们提供令人满意的收听体验。

关于GE-06协议和协调邻国之间频谱使用的一个重要案例是波斯尼亚和黑塞哥维那，该国已接受协议，其中规定在2015年6月17日之前完全终止模拟电视并实现向数字地面广播的过渡⁸⁸。

⁸⁶ 喀麦隆提交的ITU-D文件：<https://www.itu.int/md/D22-SG01.RGQ-C-0014/>。

⁸⁷ 参考文件：[区域性无线电大会（RRC-06）（2006年，日内瓦）最后文件（itu.int）和itu.int/en/ITU-R/terrestrial/workshops/SRME-19/Documents/Workshop/GE06-Agreement-and-etools.pdf#:~:text=GE06%20Agreement%3A%20General%20Aspects%20Adopted%20by%20the%20Regional,in%20Geneva%20Entry%20into%20force%3A%2017%20June%202007](#)

⁸⁸ 波斯尼亚和黑塞哥维那提交的ITU-D文件：<https://www.itu.int/md/D22-SG01.RGQ-C-0214/>。

在政府、部委和监管机构等所有相关利益攸关方的共同努力下，波斯尼亚和黑塞哥维那通过了主要战略性文件，并指定了关键机构，明确了各方在该进程中的责任。根据其权限，监管机构还通过了相关的次级立法，设定了必要的先决条件，并释放了用于数字广播的频段。在覆盖该国全境的每个复用频道中总共确定了九个数字分配。按照其他国家的最佳做法，第一步是公共广播的数字化，并在此进程的后期扩展到商业部门。然而，由于该国复杂的政治环境，该项目多年来一直滞后。

公共广播业务数字化进程的第一阶段尚未完成。由于国家公共广播业务结构的复杂性，当公共广播机构未能建立一个联合法律实体来管理公共广播复用频道时，问题就出现了。由于由此造成的延迟，波斯尼亚和黑塞哥维那与已经完成了数字化进程并在使用释放的频谱（数字红利）发展5G方面取得了进展的周边国家之间出现了问题。由于受到干扰，邻国主管部门要求波斯尼亚和黑塞哥维那关闭边境地区的模拟信号。

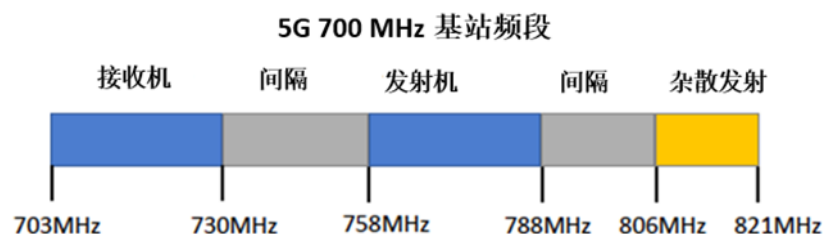
尽管如此，监管机构还是决定根据其职责采取行动，着手为商业广播划分复用频道。宣布了一项新的公开征集活动，商业部门对加入复用频道表示了极大的兴趣。因此，商业复用频道现已全面投入使用，覆盖全国50%至80%的领土，并为20家加入复用系统的电视台提供服务，这些电视台目前正在通过数字地面信号进行广播，其中大多数覆盖全国。最近，宣布了区域性征集数字广播的活动，电视台也表达了兴趣。关于公共广播业务的复用问题，这一进程仍在进行中。

另一个需要强调的相关案例是中国广播业务频谱的调整⁸⁹。该国实施了以下重耕举措：

- 702-798 MHz频段从广播业务中移除，并指配给5G移动通信使用。
- 703-743/758-798 MHz频段由频分双工（FDD）移动通信系统使用。
- 之前位于702-798 MHz频段的电视频道迁移到较低频段。
- 迁移后用于电视频道的部分较低频段包括：187 MHz、482 MHz、554 MHz、634 MHz、690 MHz。

图10展示了中国如何将700 MHz数字红利频段用于5G业务。

图10：中国用于5G业务的数字红利中的基站频段



⁸⁹ 中国通信学会提交ITU-D文件：<https://www.itu.int/md/D22-SG01.RGQ-C-0229/>。

如下表所示，一些基站可实现700 MHz和4.9 GHz频段的5G组合传输，主要是为了从特定频段的覆盖差异中受益。

表4.1：特定频段的覆盖差异

覆盖半径 (单个基站)/km (按频段)	城区	农村
700 MHz	1.34	4.66
2.6 GHz	0.82	2.03
3.5 GHz	0.72	1.85
4.9 GHz	0.61	1.55

另一个值得注意的案例是阿根廷⁹⁰，该国的目标是提高频谱资源的使用效率，这是实现主权政策目标的一个重要因素（更多信息见附件18）。该国在无线电频谱行政和管理方面采取的政策不仅定义了电信业务的提供，也影响到依赖频谱资源开发服务和解决方案的公司，即使它们不一定会获得信息通信技术（ICT）业务的许可。生产流程创新的未来与高容量无线网络部署的进步和推广息息相关，这是提升国家生产矩阵的一个关键因素。

4.1.2 干扰减缓方面的国家经验

本节旨在通过国家经验用例，阐释一些国家为减缓使用数字红利频段时的干扰问题所采取的战略。

巴西

巴西在实施减缓干扰的政策方面提供了一个示例⁹¹。该案例强调了为将电视广播的覆盖范围扩大到偏远和农村地区以及没有最佳数字地面电视覆盖的郊区而采取的卫星广播政策。该举措还旨在解决C频段卫星广播业务在3.5 GHz频段遭遇的干扰问题，因为邻国/台站的5G网络同样使用该3.5 GHz频段。

找到的解决方案是将C频段现有的卫星广播技术迁移到另一个频段 – Ku频段。这种迁移就需要向低收入人群提供合适的数字接收机，但同时也促进了数字卫星广播覆盖范围在这些地区的扩展。

除了避免对卫星广播业务造成干扰这一主要目标外，其他的具体目标包括允许在3.5 GHz频段使用5G，另一方面是促进现有模拟卫星业务向免受干扰的数字广播业务迁移。

更多信息见本报告附件15和18。

⁹⁰ 阿根廷提交的ITU-D文件：<https://www.itu.int/md/D22-SG01-C-0184/>。

⁹¹ 巴西提交的ITU-D文件：<https://www.itu.int/md/D22-SG01-C-0143/>。

波斯尼亚和黑塞哥维那

波斯尼亚和黑塞哥维那⁹²从模拟向数字广播业务的过渡始于2006年，旨在遵守日内瓦GE-06协议。该协议要求各国履行已核准的国际协议，并立即采取措施消除不再拥有模拟信号广播权的电视频道所造成的干扰。

波斯尼亚和黑塞哥维那将2015年6月17日定为过渡期结束日，同时旨在通过高效利用频段范围，为其公民提供质量更好、服务更先进的电视广播。

遗憾的是，该项目遭遇延误。延误导致对邻国系统造成干扰，而这些国家已经完成了数字化进程，并在引进新技术，特别是5G部署方面取得了进展。2021年4月，克罗地亚就波斯尼亚和黑塞哥维那模拟广播引发的700 MHz频段范围（归属于5G技术）干扰向波斯尼亚和黑塞哥维那提出投诉。

附件18详细介绍了为应对克罗地亚对波斯尼亚和黑塞哥维那提出的消除电视频道对移动通信干扰的投诉而实施的战略。可以指出的是，在实施了若干措施后，克罗地亚投诉所涉的26家电视台节目，也被纳入了波斯尼亚和黑塞哥维那几乎所有有线电视运营商的服务范围，覆盖了该国90%的家庭，这促进了模拟停播，并缓解了这些被重新划分的频道所造成的干扰。

波斯尼亚和黑塞哥维那能够迅速做出响应，采取了若干行动，包括为商业广播授予复用频道。由此，波斯尼亚和黑塞哥维那现在有两家全面运行的复用频道运营商：用于公共广播的MUX A和用于商业广播的MUX D。

在处理程序中，波斯尼亚和黑塞哥维那监管机构向主管机构和许可证持有者通报了从克罗地亚收到的投诉。在这方面，与广播机构代表举行了会议，会上确定了从2021年7月1日至12月31日关闭模拟信号的时间表。应当指出的是，全国26家电视台的171台发射机受到了模拟广播关闭的影响。

塞内加尔、冈比亚、几内亚、几内亚比绍、马里、毛里塔尼亚和佛得角

干扰是无线电通信的一个主要问题，因为它会干扰信号的传输。VHF/UHF频段的广播业务是西部非洲区域使用无线电频谱的大户，由于技术的快速发展，对这些频段的频谱需求不断增加，因此面临的干扰问题也越来越多。

广播电台的增多不仅增加了广播电台之间的干扰，也增加了对其他无线电通信业务的干扰。

此外，西非各国尚未全面终止组播（即数字与模拟无线电通信系统并行传输）。这可能导致邻国之间的干扰。事实上，一些国家已在一些数字红利频段部署了4G移动网络，而模拟电视则在另一些频段继续运行。

西非次区域减缓干扰的方法

为预防和管理干扰，塞内加尔共和国、冈比亚共和国、几内亚共和国、几内亚比绍共和国、马里共和国、毛里塔尼亚伊斯兰共和国和佛得角共和国于2009年8月通过了边境地区频率协调与共用协调框架协议，共有21家电信运营商参与其中。

⁹² 波斯尼亚和黑塞哥维那提交的ITU-D文件：<https://www.itu.int/md/D22-SG01-C-0201/>。

该协议的主要目标是：

- 协调相邻国家的频率使用；
- 防范边境区的有害干扰；
- 就特定频段的频率共用和协调提出条款建议。

注：边界区/协调区是与两国边界相邻的区域，每个国家内部15公里纵深。

本协议在2013年至2020年期间已多次更新。

协调框架文件的法律和监管框架参考了《无线电规则》第6条“特别协议”。协议由五项一般性条款和七项技术附件构成。

实际上，协调程序完全基于公平获取频率资源的原则。除了协调文件提供的总体框架外，还与相邻国家签署了双边协议，提供了有关中继信道和发射门限值的细节。

此后，已为不同边界区的国家确定并划分了信道，而且这一新计划正由国家运营商实施。

针对投诉，每年都会执行监测任务。这些监测任务提供了一个机会，来验证是否符合划分的信道以及是否符合设定的发射门限值。例如，塞内加尔和毛里塔尼亚定期开展联合监测工作，以验证双边协议的有效性，并在必要时采取纠正措施。

边界区存在诸多干扰问题，特别是移动通信业务的干扰问题。在现阶段，框架文件和双边协议的重点主要是移动通信业务，而不是广播，因为西非次区域各国DTT的发展尚不够先进。

然而，这一既定框架可能有助于解决和预防未来与数字地面电视以不同速度广泛部署相关的干扰冲突。本报告附件18提供了更详细的信息。

4.2 基于当前国家经验的最新数字红利使用情况

数字红利的使用是实现向数字广播迁移的一个关键目标，有了它就能够使用相同数量的频谱来提供更多的业务，包括移动和广播业务。

本节旨在各国经验的基础上，编纂有关使用数字红利频段战略方面的最佳做法，并补充ITU-D第2/1号课题以往研究期最后报告中所提供的信息。

随着欧洲等地区对数字红利频段1和频段2的处理及其对电台规划和重新划分等方面的影响，补充了一个新的背景。下一节将讨论这些问题。

4.2.1 数字红利频段1和频段2的处理

意大利案例研究

第一个详述的案例是意大利⁹³，意大利释放700 MHz频段和重组数字地面电视（DTT）的方式遵循了欧洲层面的协调讨论和国家战略规划。过渡的一个关键部分涉及减缓对邻国的干扰，重耕频段，以容纳以前使用700 MHz频段的信道。

为促进重新划分，实施了若干技术措施：

- 排他性使用指配给意大利的协调频率。
- 广泛部署单频网络（SFN）。
- 采用高效编码技术，包括高效视频编码（HEVC）。
- 重新指配全国和本地/区域复用信道。

监管框架发挥了关键作用，第129/19/CONS号决定规定国家和本地DTT运营商必须逐步迁移到700 MHz以下频率。具体政策包括：

- 国家和地方运营商采取差异化做法，地方广播机构有市场退出机制。
- 支持从DVB-T向DVB-T2过渡的费用退还机制。
- 对撤回频谱使用权的本地运营商的补偿。
- 将DVB-T频谱权转换为DVB-T2传输容量。

后来引入了竞争性程序，大队通过重新划分本地广播容量获得的额外频谱进行拍卖（第564/20/CONS号决定）。

汲取的重要经验教训

- 重组对广播行业产生了重大影响，需要运营商和国家的大量投资。
- 由于意大利DTT普及率高，大量家庭需要得到过渡支持。
- DVB-T2频谱权在2019年进行指配，为期十年，预计从2024年起完全过渡到DVB-T2。
- 在过渡阶段，使用DVB-T的国家和本地网络减少（从20个减少到12个），导致传输容量不足。
- 对高质量视频业务（HD/UHD）日益增长的需求进一步限制了可用带宽。
- 目前仍在评估地方广播从纵向整合到横向进入模式的转变。
- 尽管技术过渡在持续，DTT仍然是意大利的主要电视分发平台。

⁹³ ITU-D第2/1号课题焦点会议，4月2-24日，AGCOM，意大利：https://www.itu.int/dms_pub/itu-d/oth/07/31/D07310000010005PDFE.pdf。

这一案例研究强调了协调规划、监管框架和财政支持机制在管理频率重新划分和确保尽量减少对广播业务的干扰方面的重要性。有关意大利案例研究的详情见本报告附件19。

巴西案例研究

2013年，巴西批准将700 MHz频段划分给固定和移动业务，以提供话音和数据通信业务⁹⁴。

拍卖确定了三个10 + 10 MHz的国家频段以及一个相同规模用于某些地区的频段。在拍卖第二轮中，剩余频谱需要以5 + 5 MHz这种更小的块出售。

目前，700 MHz频段已完全空出，可供巴西各地的移动业务使用。更多信息见本报告附件19。

南非案例研究

最后，以南非为例，由于宽带流量的显著增长，该国对频谱的需求持续增长。划分给国际移动通信（IMT）的无线电频谱的短缺对提供宽带业务构成了限制和挑战。

为解决南非带宽不足的问题，监管机构提议同时对IMT700、IMT800、IMT2600和IMT3500频段发放许可，因为这些频段已在全球范围内确定用于IMT业务。这些频段在满足容量和覆盖要求方面具有互补性，既适用于城乡地区，又可弥合数字鸿沟以及城乡宽带网络接入差距。

监管机构于2022年3月17日成功完成了高需求无线电频谱拍卖的许可工作⁹⁵，包括数字红利频段。

⁹⁴ Anatel第757号决议，2022年11月8日，可查阅：<https://informacoes.anatel.gov.br/legislacao/resolucoes/2022/1760-resolucao-757>。

⁹⁵ 南非IMT频段的拍卖涉及六个合格的投标方，即Cell C、Liquid Intelligent Technologies、MTN、Rain Networks、Telkom和Vodacom。此次拍卖的收入总额超过144亿兰特，已进入国家公共财政。尽管如此，高需求频谱的划分将加速第五代（5G）技术等新技术的推广，降低移动数据的成本，并确保更大的互联网连接。

第5章 – 结论和从各国经验中吸取的教训

在分析了向数字广播技术过渡和采用的战略、政策、规则和方法等方面以及为各种环境提供新业务的不同案例和经验之后，现在有必要对所汲取的一些经验教训进行评估，并制定一些建议和导则，作为当前和未来实施传统和创新广播业务和应用的有益参考。

基于各国为本最后报告提供的文稿中所分享的经验，本章旨在提供得出的结论和汲取的经验教训。本章还汇编了有关向数字广播技术演进和采用数字广播技术（包括在各种环境下提供新业务）的战略、政策、规则和方法的最佳做法。此外，它还建议了国际电联成员国在规划、监管、部署和实施数字广播技术中应考虑的具体议题。

5.1 从各国经验和案例研究中汲取的经验教训

本节汇总了已识别的经验教训，并审查了与本最后报告议题相关的最佳做法。为此，本节审查了诸如下一代广播系统、新的和新兴的广播技术及应用、数字技术的采用（特别是电视和广播）以及频谱的使用等领域。

首先，正如ITU-R BT.2522-0号报告⁹⁶“未来广播框架”中所强调的，在下一代广播系统和未来广播的大背景下，需要考虑一些新的功能和创新，以适应未来的广播解决方案和业务。鉴此，上述报告指出了以下需要考虑的概念：

- 用户的期望正在推动以下领域的变化：
 - 媒体的创建、分发和消费方式；
 - 随时随地在任何设备上获取服务和个性化方案；
 - 对公共和共享媒体消费的渴望；
 - 根据个人喜好呈现越来越沉浸式的内容。
- 广播机构必须利用辅助和自动化创建和交换的技术来满足未来的用户需求并参与竞争，加速向基于云的虚拟制作转变；和
- 媒体作为平台和最终用户设备的组合来实现传送，其内涵包括：
 - 灵活的制作技术和通用标准至关重要；
 - 地面广播仍必不可少且必须不断演进，传播新的媒体制作形式并实现新的用户体验；
 - 地面广播可与互联网传送相结合提供了有效和高效的解决方案。

⁹⁶ <https://www.itu.int/pub/R-REP-BT.2522>

用户在内容分发平台上的体验及其对广播行业的影响、以及广播机构业务的调整（不仅源于竞争性技术，也是通过广播和宽带环境之间的协作），对于广播的未来以及通过这些业务实现内容消费方式的不断演变至关重要。关于新的用户体验，还应考虑一些重要因素，包括：

- 多媒体应用在广播业务中的重要作用；
- 在广播电视应用中利用其他内容分发平台创新的重要性；
- 对个性化电视体验、定向的广告和节目、内容推荐、无线（OTA）与过顶（OTT）之间相互的无缝切换、沉浸式内容提供、增强的无障碍获取、感官效果渲染和新颖的交互模式等的需求。

在新的广播环境中需要考虑的其他重要问题包括其他媒体服务的监管影响，特别是通过互联网提供的媒体服务。应强调以下几个方面：

- 按照国家规定监督视听分发市场具有现实意义；
- 法规有助于为不断发展的数字环境及其与广播业务的关系创造有利环境；
- 在日益以在线为导向的媒体生态系统中，尽可能确保公平竞争和保护用户利益，这对包括广播业在内的所有利益攸关方而言是关键所在；
- 监管框架必须制定明确的规则，例如关于透明度的要求，确保广播业务在数字领域负责任地运营，并与国家监管框架保持一致；
- 在瞬息万变的数字领域中，遵守全面的监管框架，维护广播业务的完整性和持久性，至关重要。

此外，在这份最佳做法和经验教训汇编中，还考虑了从模拟向数字广播的过渡。值得强调的是，在广播领域向数字技术的过渡和采用始于从模拟向数字的迁移，这将带来众多的新业务、功能和能力。因此，对许多仍处于数字转换进程中的国家而言，完成过渡进程至关重要。此外，有必要回顾这方面的经验教训和最佳做法，其中包括：

- 详细制定从模拟向数字广播过渡的战略，涉及数字转换和模拟停播的所有活动，并以合作和集体的方式实施所述战略，包括成立一个向所有利益攸关方开放的指导委员会；
- 既定的政策和监管框架对于正式确立数字转换战略以及为整个进程（包括频谱规划和数字红利的使用）提供指导至关重要；
- 确定向数字广播过渡的方法，包括模拟和数字业务如何共存以及如何逐步淘汰模拟业务（模拟停播），这对于有效和高效的实施至关重要；
- 在实施过程中考虑技术、内容、人力资源和消费者等方面至关重要；
- 利益攸关方之间的协调对于实施进程至关重要；
- 考虑如何将低收入和较弱势群体纳入提供接收机和所采取的通信战略中，这是成功实施的基础；

- 考虑每个国家在数字转换进程中的具体需求至关重要。本报告确定的此类具体需求如下：
 - 该国的连通性和基础设施的发展；
 - 通过DTT改善地域覆盖并完成数字转换进程；
 - 在地面广播的基础上结合其他技术，如直接到户（DTH）卫星业务，以覆盖领土；
 - 综合解码器方案，包括DTT、卫星和互联网业务提供。
 - 移动电视业务（智能手机和平板电脑）；
 - 一个有利的环境，以培育更多的内容和多样化的节目，包括地方和区域节目；
 - 通过新业务和功能实现数字电视产品的演变；
 - 视频点播（VoD）和电视回看业务；
 - 为实施和迁移广播技术，特别是过顶（OTT）、数字平台和视频共享平台创造有利环境。
 - 应特别关注监管部门对新的广播格局和消费者习惯变化的回应；
 - 改善通信，更容易获得免费DTT；
 - 纳入最弱势群体；
 - 能力建设需求；
 - 资金需求。

在模拟停播（ASO）方面，获得了以下经验教训：

- 所有利益攸关方之间合作和协作的重要性；
- 消费者的意识和参与对顺利实施模拟停播的重要性；
- 为实现平稳的数字转换，可考虑以渐进和分阶段的方式在零售市场销售的所有电视机上安装DTV转换盒；
- 根据需要向低收入人群免费提供必要的设备，包括DTV转换盒、天线等；
- 当地各方的参与，以促进数字转换。

最后，重要的是要考虑在频谱规划和数字红利频段使用方面所汲取的经验教训，其中确定了以下方面：

- 在国际领域就GE-06协议等频率划分规划进行谈判十分重要；
- 考虑与数字转换进程相关的频谱规划问题至关重要；

- 评估如何在模拟停播后减少其他业务使用腾出的频段所造成的干扰，仍然具有重要意义；
- 尽管有广播业务的需求，但解决对宽带业务划分频段的需求同样重要。

5.2 结论和导则

基于上一节文稿提交方分享的经验和案例研究中的经验教训和最佳做法，本节为广播行业中参与采用数字技术的利益攸关方提供导则。

初步反思表明，必须认识到近年来广播业务的运营环境发生了巨大变化，其适应和发展的必要性显而易见。广播行业的利益攸关方，包括制造商、服务提供商和监管机构，均对此表示认同。

同样显而易见，不同地区，如美洲、非洲和亚洲及太平洋的部分地区，采用数字技术的情况也不尽相同，因为这些地区面临着特定的挑战，包括基础设施有限和资金短缺。

此外，在今后的工作中，值得考虑有关采用下一代广播系统（ATSC 3.0、5G广播、DVB-NIP、ISDB-T）的讨论，重点是标准化问题，以促进更有效地向这些系统过渡。同样，可以指出的是，发展中国家在利用互动性和内容个性化等消费者利益方面面临着具体挑战，包括成本和监管。

总之，针对新兴创新（如根据个人喜好定制内容和使用人工智能）的分析，可在下一个研究期完善报告，并为数字广播的发展提供有价值的见解。

有鉴于此，建议利益攸关方在广播业务的演进中考虑以下导则：

- 利益攸关方（政府、监管机构、业界、服务提供商和消费者/观众）共同做出所有必要的努力，以完成向数字电视和广播技术的过渡和采用，并停播模拟广播；
- 在向数字广播技术过渡和采用进程中，应正式制定战略和路线图，并在所有利益攸关方合作和协作的基础上开展活动；
- 频谱规划，包括数字红利的使用，应遵循最佳做法和国际导则与标准谨慎进行；
- 视听内容分发和消费生态系统被视为一个整体，因为若干技术（包括广播和宽带）之间可能存在相互作用，而这些技术与政策制定者为提供满足消费者/观众需求的广播业务创造有利环境有关；
- 在每个成员国主权范围内，监管和法律框架要应对数字广播业务的新挑战和新机遇，并为更好的用户体验做出贡献；
- 任何有关音视频内容分发（包括广播）的监管和法律讨论，均应通过开放及参与性的监管及规则制定流程，确保所有利益攸关方充分参与。

Annex 1 – Main features of next generation broadcast systems

ATSC 3.0⁹⁷: A next generation terrestrial broadcast system that is designed to improve the television viewing experience with higher audio and video quality, improved compression efficiency, robust transmission for reception on both fixed and mobile devices, and more accessibility, personalization and interactivity. The ATSC 3.0 standard is defined in a suite of more than 20 standards and companion recommended practices. Key features of ATSC 3.0 include:

- Built on the same Internet protocol backbone as today's popular streaming media platforms;
- Designed to bring together over-the-air (OTA) with over-the-top (OTT) content;
- Delivers better video quality and immersive audio to viewers;
- Provides the capability of 'advanced emergency alerting and informing';
- Easily adaptable for future technologies.

5G Broadcast⁹⁸: A terrestrial broadcast standard completed in 2020 as part of the 3GPP Release 16 specifications, that enhanced features of the initial enhanced TV (eTV) standard of 3GPP Release 14. 5G Broadcast has been endorsed as a standalone terrestrial broadcast system, with all the characteristics of a broadcast technology, via the ETSI TS103 720 technical specification, and most recently by ITU-R where it is defined as a worldwide standard within the ultra-high frequency (UHF) band. Key features of 5G Broadcast include:

- Efficient free-to-air or zero-rated media content delivery;
- Robust emergency notification for public safety;
- Enhanced venue casting at sporting events and concerts;
- Standalone terrestrial broadcast system based on IP over 5G infrastructure.

DVB-NIP⁹⁹: An end-to-end native IP broadcast system for digital video broadcast (DVB) bearers. It relies as much as possible on existing DVB specifications, and complements those where necessary. The native IP broadcast system is built upon DVB-I for service discovery and programme metadata, DVB-AVC and DVB-DASH for source coding and stream formatting and DVB-MABR, DVB-GSE and the physical layer specifications DVB-S2X, DVB-S2 and DVB-T2 for transport. DVB-NIP facilitates the integration of over-the-top (OTT) and broadcast technologies into an IP media distribution solution.

Advanced ISDB-T¹⁰⁰: The next iteration of integrated services digital broadcasting- terrestrial (ISDB-T), Advanced ISDB-T will enable an offering beyond the existing audio, video and multimedia services, and will enable provision of UltraHD based service on both broadcast and integrated broadcast-broadband (IBB) systems. Key features include:

⁹⁷ <https://www.atsc.org/nextgen-tv/>

⁹⁸ <https://www.qualcomm.com/news/onq/2023/12/5g-broadcast-what-can-consumers-expect>

⁹⁹ <https://dvb.org/?standard=native-ip-broadcasting>

¹⁰⁰ <https://www.dibeg.org/advanced/>

- Capability of varied and flexible service provisioning with high efficiency;
- Emergency warning notification;
- Interactive UltraHD streaming;
- IP and HTML5 application environment;
- Over-the-air 2×2 multi-input multi-output (MIMO) transmission.

Annex 2 – Application-oriented television paradigm

The TV 3.0 project in Brazil¹⁰¹ is actively engaged in meticulous research and specification of the application-oriented television paradigm. Employing a rigorous scientific methodology, the investigation extends beyond the exploration of state-of-the-art approaches to encompass the prototyping of each component within the application-oriented TV architecture. These prototypes undergo thorough assessments for viability and performance. Furthermore, they are subjected to evaluations by focal groups, providing valuable insights and opinions on the novel experiences introduced. This iterative process allows researchers to refine concepts, and even to replace certain lines of thinking with new ones.

Application-oriented television represents a paradigm shift, where the entry point for TV content consumption moves from selecting a broadcaster's channel to selecting a broadcaster's application. This means that from the beginning of a TV viewer's journey, an application can proactively manage viewer profiles (with their consent), which is essential for delivering personalized and engaging TV experiences that broadcasters can leverage. While this new paradigm offers numerous advantages, it also raises concerns about potentially compromising some of the existing fair, convenient, and well-established broadcasting experiences.

The application-oriented television paradigm requires several basic functionalities. These include adaptations to channel scanning to address performance issues, the instantiation and installation of broadcasters' applications, and the management of application metadata. A dedicated user interface is needed for listing installed broadcasters' applications, and these applications must be able to handle all OTA/OTT multimedia content. There should be support for quick application switching, allowing broadcasters to use sequences of small applications instead of a single complex one. Additionally, the paradigm necessitates TV content metadata, new possibilities for the electronic programme guide (EPG) in OTA/OTT, and the introduction of an electronic content guide (ECG).

Based on the Brazilian experience, it is proposed that the concept needs to consider a general architecture for application-oriented television in a technology-agnostic way, including some relevant architecture components, that may include:

- Persistent media player: Media player that needs to ensure continuous presentation of selected content during application switches, with the player's lifecycle not tied to a specific application, allowing applications to freely modify the player state and its media source;
- Broadcaster's bootstrap application: Application that is automatically instantiated and installed for each identified service (entry point for a specific TV service, and launching when the viewer selects the corresponding icon on the application catalogue user interface);
- Legacy broadcasting system support;
- Broadcaster's additional applications: Other applications to provide next-generation TV experiences, such as access to personalized experiences based on recommendations, dynamic programming, targeted advertisements, and so on;

¹⁰¹ <https://www.itu.int/md/D22-SG01.RGQ-C-0239/en>

- Viewer profiles: From the application catalogue user interface, viewers could create their profiles once on a specific device, with the flexibility to use this profile across multiple broadcasters at their discretion;
- Application catalogue: Dedicated TV-exclusive section within a device, designed to display all bootstrap applications installed following a scan or rescan process. Additionally, it offers access to other broadcasters' applications and modules such as the EPG and the ECG;
- EPG module: The electronic programme guide (EPG) is a familiar user interface found in existing broadcasting systems, presenting programming in a timeline format;
- ECG module: The electronic content guide (ECG) is a recognizable user interface commonly seen in current IPTV services, used to display a content catalogue available in video-on-demand (VoD) services, and characterized by its non-linear nature.

Annex 3 – Disaster alerting information in Republic of Korea

The Ministry of science and ICT of the Republic of Korea operates a nationwide emergency disaster alerting system. This system aggregates all disaster information and sends it to the broadcaster with CAP format* and the broadcaster will automatically show the text in subtitles.

*CAP example:<identifier>KR.T7-20230416</Identifier><sender>mmdip@mict</><event>Flooding</>..

Figure A.3.1: Accessible disaster alerting system with avatar sign language

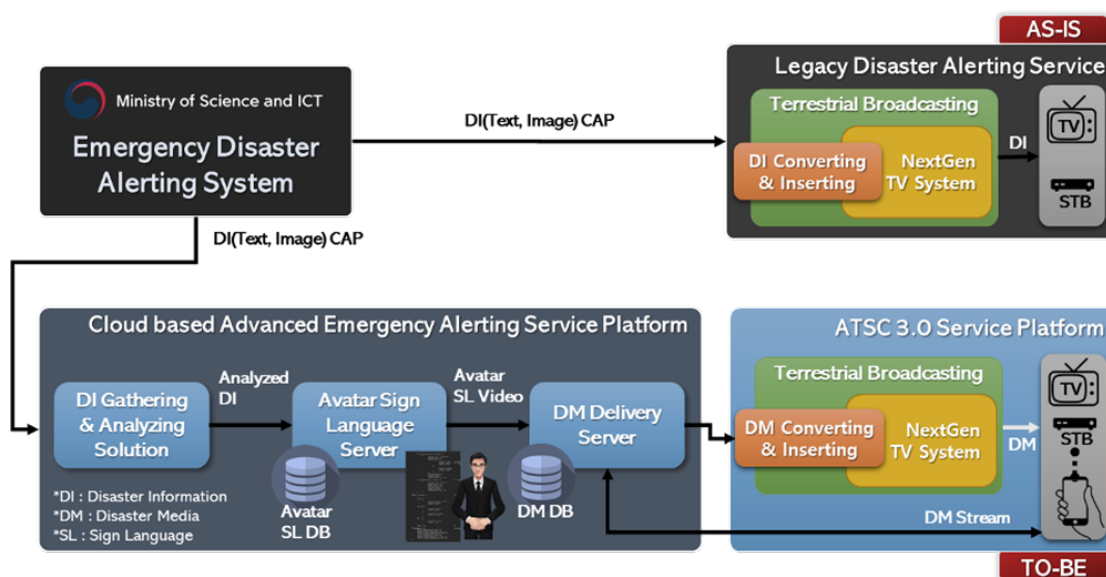


As captions (text only information) are not fully accessible by deaf people, the Republic of Korea consortium is developing a new system based on the latest terrestrial standard specification of ATSC 3.0 where IP communication for avatar signing is possible.

The project also covers pay TV set-top-boxes and smart phones so that deaf citizens can always have accessibility to any disaster information.

Figure A.3.1 shows the current system where the text and image are directly delivered by terrestrial and push streams to STBs and televisions. Figure A.3.2 shows the new system where the disaster information (DI) is converted to disaster media (DM) formats including avatar signing, and transmitted with a terrestrial signal. The disaster media stream can be directly streamed to mobile phones with a text message and link.

Figure A.3.2: Accessible disaster alerting system



The system is now under development, not only for the Republic of Korea public broadcaster, but also for some public broadcasters in the United States, where the same terrestrial specification is deployed. The pilot broadcasting was scheduled for the end of 2023 on Jeju Island in the Republic of Korea, with nationwide deployment in 2025.

As the latest European Union digital terrestrial standard specification also includes IP communication, the system can be implemented in more countries.

Annex 4 – Overall scope and general conclusions of Report ITU-R BT.2522-0 – A framework for the future of broadcasting

The objective of the framework for the future of broadcasting is to evaluate the changing landscape of media and audience expectation, evaluating the potential of mergers of medias, such as gaming, social media, traditional media, etc., and the rapid and accelerating media technology development competition.

The Report delves into the following aspects:

- User experience trends, broken down into seven key trends: collective; personalized; ubiquitous media consumption; digital assistant; accessible; immersive; and merging physical and digital worlds.
- Production challenges, broken down into eight key trends: software based; virtualized; cloud based; complex media; data driven; automation through AI/ML; immersive and accessible; and sustainable broadcast delivery.
- Opportunities and challenges to realizing user and production trends through a combination of terrestrial broadcasting and Internet delivery.

The conclusions of the Report include:

- The notion that user expectations are driving changes in:
 - how media is created, delivered and consumed;
 - services and personalized options accessible on any device, at any location, at any time;
 - desire for communal and shared media consumption;
 - increasingly immersive content presented according to personal preferences.
- The notion that broadcasters must meet future user demands and compete using technologies that assist and automate creation and exchange, accelerating the shift to cloud based virtual production.
- The notion of media delivery as a combination of platforms and end user devices, wherein:
 - flexible production technologies and common standards are vital;
 - terrestrial broadcasting remains essential and must keep evolving, distributing new media production formats, and enabling new user experiences;
 - terrestrial broadcasting combined with Internet delivery offers effective and efficient solutions.

Annex 5 – Architecture, frequencies, and features of selected releases of 5G broadcasting

This annex presents additional information regarding the architecture, assigned frequencies, and main features of selected releases of 5G Broadcast, as specified by the 3GPP consortium, as well as, a more detailed description of use cases.

Release 16 5G Broadcast technology can provide an independent broadcasting service, which does not rely on a mobile communication network. It is similar to conventional terrestrial digital television broadcasting services. R16 5G Broadcast technology can be used for high-power large-tower transmission, supports single-frequency networks, and achieves large-scale continuous coverage of radio and television. The architecture of R16 5G Broadcast technology and the frequency bands, are shown in Figure A.5.1.

Release 17 5G new radio (NR) multicast and broadcasting technology supports point-to-multipoint, multicast and broadcast functions by extending the functions of the 5G core network and wireless network. In essence, this technology adds two multicast and broadcast communication modes to the mobile communication network. Consequently, the mobile communication network has more transmission modes to choose from in a one-to-many transmission of 'common data' scenario, and so can aggregate traffic and improve efficiency. Common data is not limited to video content, but can also be data in application scenarios, such as data in Internet of vehicles (IoV) and Internet of things (IoT) scenarios.

Essentially, R16 5G Broadcast, is a one-way broadcast technology, which supports high-power tower deployment and a large-scale single-frequency network. It can be used to form a radio and television network independent of the mobile communication network, and can form a 5G radio and television network by transforming the exciter, and multiplexing most of the radio and television station resources. 5G radio and television technology could be considered as essentially a new generation of terrestrial digital television technology, which is suitable for the deployment of radio and television operators in the radio and television industry. R17 5G NR multicast broadcasting is a functional extension of the 5G mobile communication network, which can realize a multicast broadcast communication mode. It can dynamically configure to provide a multicast broadcasting service when needed, or to release resources to provide mobile communication and mobile Internet services, when multicast broadcasting service is not needed. This flexibility facilitates mobile operators to provide regional and temporary multicast broadcasting services.

Figure A.5.1: Architectures of R16 5G Broadcast technology and R17 5G NR (New Radio) multicast broadcasting technology. (a) R16 5G Broadcast technology (b) R17 5G NR (New Radio) multicast broadcasting technology

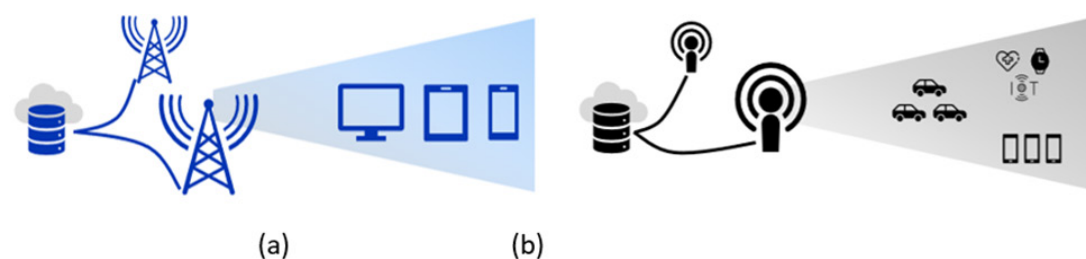


Table A.5.1: Frequency bands of R16 5G Broadcast technology

R16 5G Broadcast bands	Uplink	Downlink	Duplex type
B107	N/A	612~652 MHz	Standalone Downlink Only
B108	N/A	470~698 MHz	Standalone Downlink Only

Table A.5.2: Features of R16 5G Broadcast technology

Classification	Features
Frequency band	Support for the standalone downlink only (SDO) frequency band types.
	Support for B107 and B108 bands on the UHF broadcast television bands.
Channel resource	Support for 6 MHz/7 MHz/8 MHz channel bandwidth.
	Almost 100% of the resources are available for broadcast service hosting.
Network access	Free to acceptance (FTA), no SIM card required, no mobile carrier contract required.
	Receive only mode (ROM), suitable for terminals other than mobile phones, such as televisions.
Mobility	Up to 250 km/h (theoretical).
Network deployment	Base station spacing greater than 100 km (theoretical), low cost, wide coverage.
	Support for broadcast single frequency network, efficient use of spectrum resources.
	It supports independent networking and does not rely on mobile communication networks.

Table A.5.3: R17 5G NR multicast broadcasting technology frequency band allocation example related to China Broadnet (See Annex 6 for more information)

R17 5G NR multicast broadcasting bands	Uplink	Downlink	Duplex type
703-733 MHz/758-788 MHz	703~733 MHz	758~788 MHz	FDD

Table A.5.4: Features of R17 5G NR multicast broadcasting technology

Classification	Features
Frequency band	703-733 MHz/758-788 MHz, frequency division duplex
Channel resource	Support for 5 MHz/10 MHz/5 MHz/20 MHz/25 MHz/30 MHz channel bandwidth; Communications, multicast and broadcast share the channel resources.
	Channel resources are dynamically scheduled according to the requirements of two-way communication and multicast broadcasting services, and multicast broadcasting can only work in the pre-configured frequency range.

Table A.5.4: Features of R17 5G NR multicast broadcasting technology (continued)

Classification	Features
Network access	Multicast requires SIM card and access authentication, and does not FTA or ROM.
	For broadcast, standard project file does not support FTA and ROM, but technically they can be realized by pre-configuration of the information needed for receiving broadcast in terminal. The feasibility of the real-life operating conditions for the preconfigured method need to be verified.
Mobility	Multicast can support mobile switch.
	For broadcasting, the validity and business continuity of the preconfigured method needs to be verified in the event of mobile switching
Network deployment	Base station spacing is generally several hundred metres, it cannot support low-cost, wide coverage for broadcast television
	It does not support broadcast single-frequency networks and cannot be deployed nearby for the same frequency networks
	It is built on mobile communication networks and does not support independent multicast broadcast networks

5G Broadcast new use cases

Beyond the technology benefits, 5G Broadcast can also enable many attractive new use cases that bring value to consumers. Some of these new use cases outlined below¹⁰²:

- **Efficient free-to-air or zero-rated media content delivery:** An example of this could be from a livestream of a soccer match or a presidential debate. When this content is watched simultaneously by a large number of viewers over unicast cellular connections, it creates a huge burden on the network, reducing quality of service and increasing delivery costs for network operators. With 5G Broadcast, live content can be delivered to thousands or even millions of users, without the same data being sent individually to each user as is the case when using unicast.
- **Robust emergency notification for public safety:** During public emergencies and disaster events such as earthquakes, wildfires, floods and tornados, a smartphone can become a life-saving device if it is robustly connected. In a scenario where the cellular network becomes disabled due to structural damage (e.g., in the case of an earthquake), public authorities could still use the broadcast infrastructure to communicate with smartphones that support broadcast services. This is because the high-tower broadcasting sites are more physically resilient. This is a priority for many public safety agencies, and 5G Broadcast has become a prime candidate to enable services that can facilitate invaluable direct communications (e.g., sending of emergency information and lifesaving instructions) with those who need it the most.
- **Enhanced venue casting at sporting events or concerts:** Events such as motorsports racing, the Olympic games, football matches, and large festivals pose a real challenge for mobile operators as large numbers of users in close proximity, will share nearby limited network

¹⁰² For more details, refer to [5G Broadcast: What can consumers expect? | Qualcomm](#)

resources such as nearby cellular towers, simultaneously. For such scenarios, 5G Broadcast could fill a much-needed role in ensuring all users in the area can smoothly stream high-definition video content from the event, without overloading the cellular towers in the area.

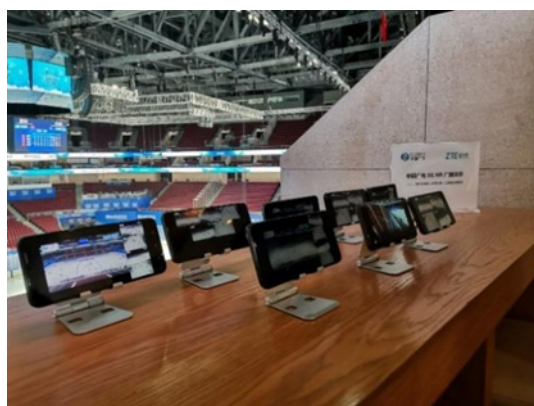
Annex 6 – 5G Broadcast implementation in China

In December 2023, it was announced through the China Mobile and China Broadnet co-construction and sharing initiative, that China Broadnet has now co-constructed more than 600 000 5G base stations, becoming the world's largest 700 MHz 5G network with nationwide coverage¹⁰³. At the same time, China Broadnet has promoted 929 network access terminals to support the 700 MHz frequency band. This makes 700 MHz the main 5G frequency band fully supported by the global industry chain. Mainstream manufacturers have completed software adaptation of more than 630 mobile phone models within 6 months of the opening of the China Broadnet 5G network, covering the principal mobile phone models of mainstream brands of the past four years. Mobile phone models adapted to the China Broadnet 700 MHz 5G network currently comprise more than 90 per cent of the country's 1.2 billion stock of mobile terminals. In addition, China Broadnet has essentially completed the national network testing and optimization. There are currently over 20 million China Broadnet 5G users in China.

China Broadnet cooperated with Chinese manufacturing companies to implement, by 19 December 2023, the 5G NR broadcasting end-to-end service network, based on the 3GPP R17 standard. This enables mobile phones equipped with 5G chips to receive 5G broadcast. The jointly constructed 5G NR broadcasting 700 MHz band end-to-end service network, covers many functions such as basic broadcasting services, concurrent broadcasting and unicast, card-free broadcast reception, and emergency broadcasting. After verification, the results were declared to meet the 3GPP standard protocol process and performance expectations.

Figure A.6.1 shows an image from the 2022 Beijing Olympic Winter Games, where 5G NR broadcast successfully provided video signals for 9 different mobile phone models from different manufacturers.

Figure A.6.1: 5G NR broadcast successfully provides 9 different video signals for 9 mobile phone models in the 2022 Beijing Olympic Winter Games



¹⁰³ Note: The 700 MHz band here is specifically 703-733 MHz/758-788 MHz band.

The 5G NR multicast and broadcast services (NR-MBS) prototype system test was completed in Beijing by China Broadnet (3GPP R17 5G MBS). China Broadnet and its industry chain partners, used the commercial 5G NR network and universal 5G smart terminals, to develop the world's first 5G NR MBS end-to-end prototype test system. Using this system, field tests of 5G NR multicast broadcast, including cellular deployment, and TV high tower deployment, were carried out. The field testing has mainly been for the unidirectional broadcast service of the non-connected terminal, and subsequent testing will be carried out for the multicast service of the connected terminal.

Concerning cellular deployment, the base stations are installed according to conventional cellular communication base stations, and for TV high tower deployment, base stations are installed in TV high towers. There are several test routes in the cellular deployment testing scenario and in the high tower deployment testing scenario, and all test routes are in dense urban areas.

The results show the coverage ranges of cellular deployment and high tower deployment. Tests on the business continuity of cellular deployment and tests on high-speed movement and high tower terminal deployment is also being carried out. High-power high tower transmission sites, which broadcast the signals to the terminal devices.

Annex 7 – Detailed functionalities, use cases and available terminals for ATSC 3.0

Some of the main functionalities of ATSC 3.0 include¹⁰⁴:

- **Content is broadcasted via TV high towers and SFNs**

Broadcast TV towers deliver TV content and IP data through over-the-air signals to receiver devices within a coverage area. To ensure uniform coverage and service, single frequency networks (SFNs) can be used to reinforce signals in areas where signals are weaker.

- **Signals are networked via MFNs**

Utilizing multiple frequency networks (MFNs) on overlapping ATSC 3.0 signals can create a mesh network among TV broadcasters. Handoff integrated in MFNs enables IP-based content to be transferred from one signal to another, extending the distribution reach beyond a single market.

- **A data pipe that simultaneously transmits live and IP-based content**

ATSC 3.0 can deliver a variety of content with a single TV channel, for example, broadcast TV, on-screen interactive applications, and software updates. The standard can allow a single television channel to be divided into multiple "physical layer pipes" enabling a broadcaster to optimize certain content for mobile reception, while transmitting other content at higher bitrates for traditional television reception.

- **Delivering content and data to devices with ATSC 3.0 receivers**

Broadcast video and IP content is delivered to consumers through ATSC 3.0 receivers connected to an over-the-air antenna, including smart TVs with built-in receivers, stand-alone tuners, and home gateways. ATSC 3.0 chips can also be included in mobile phones, tablets, connected cars, and other Internet of things (IoT) devices making it possible to broadcast to devices beyond televisions.

- **Interactive solutions when receiver device applications converge with broadband**

ATSC 3.0 can allow the integration of broadband and broadcast services, providing a two-way communications channel for new use cases, such as interactive experiences, on-demand services, IoT, etc., using existing connectivity options.

In addition, some use cases and applications possible with ATSC 3.0 include:

- **Enhanced viewer experience:** ATSC.3.0 can deliver more content, and interactive experiences, with enhanced video quality using 4K and high-dynamic range (HDR) with immersive sound. It can allow viewers to select from multiple live feeds.
- **Targeted advertising:** Accessing household data, broadcasters will be able to deliver more relevant, targeted advertising, increasing the value of their audience reach for advertisers, using customized and creative audience-targeting.

¹⁰⁴ Deloitte. ATSC 3.0 white paper, 2022. Available at <https://www2.deloitte.com/us/en/pages/consulting/articles/atsc3-benefits-and-applications.html>. Access in September/2024

- **Spectrum-as-a-service:**
 - Data offload: Broadcasters can sell data capacity to companies seeking to download data to consumers at scale, creating synergistic partnerships between broadcasters and broadband providers.
 - Video streaming and edge caching: Third-parties will be able to develop applications to transmit video streaming over the air in a one-to-many fashion. This is a more economical method of transporting large amounts of data and making it available locally on demand by caching the content on the edge of the network.
- **IoT - Connected cars:** IoT devices with ATSC 3.0 chips send and receive essential data via broadcast signals to and from many devices, including those on the move. This use case can be a cost-effective alternative to broadband, using broadcasters' one-to-many infrastructure. Specific use cases can include transmitting in-vehicle entertainment, vehicle software updates, and sending data to autonomous long-haul trucking fleets.
- **Remote learning:** ATSC 3.0 can improve the quality of distance learning services, enhancing live educational experiences for students by delivering a combination of live instruction and interactive content. The interactive experiences can integrate live TV content with mobile devices, and broadcaster applications with connectivity solutions, to deliver virtual educational services to students.
- **Advanced emergency alerting and informing:** In times of crisis, the one-to-many broadcast architecture allows for resiliency, being an alternative to broadband networks. With the increasing prevalence of hurricanes, wildfires, and other extreme weather events, TV datacasting capability can help by supporting the emergency alert systems, and for communications and services of communities during power outages and destructive events, including those in rural and underserved areas.

Examples of commercially available television sets incorporating ATSC 3.0 technology

- **Sony:** [Sony Bravia XR A95L OLED](https://www.rtings.com/tv/reviews/sony/a95l-oled)¹⁰⁵
- **Samsung:** Samsung S95C¹⁰⁶
- **LG:** LG OLED¹⁰⁷

¹⁰⁵ <https://www.rtings.com/tv/reviews/sony/a95l-oled>

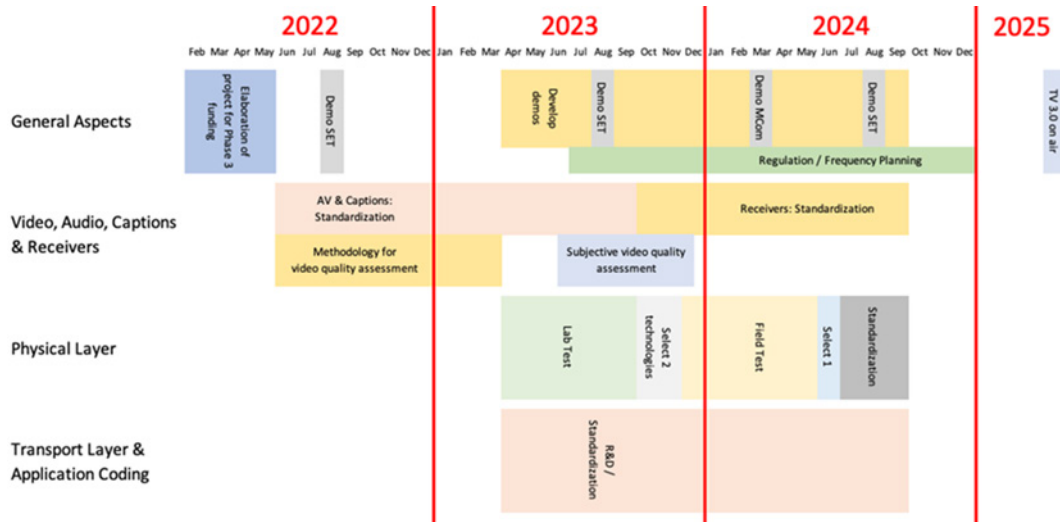
¹⁰⁶ <https://www.kitele.com/fr/tv-samsung-qe55s95c> (in French)

¹⁰⁷ <https://www.tomsguide.com/best-picks/best-tvs-with-atsc-30-tuners>

Annex 8 – Progress report on Phase 3 of the TV 3.0 Project in Brazil

The Phase 3 schedule of the TV 3.0 Project in Brazil experienced some minor adjustments, as illustrated in Figure A.8.

Figure A.8: Phase 3 progress report



The Brazilian digital terrestrial television system (SBTVD) Forum, is working cooperatively with a group of Brazilian universities, funded by the Ministry of Communications through the National Education and Research Network (Rede Nacional de Ensino e Pesquisa). From April 2023 to September 2024 this cooperative work comprised:

- performing complementary tests for the selection of the physical layer technology (laboratory and field tests), among the current candidate technologies (Advanced ISDB-T, ATSC 3.0 and 5G Broadcast);
- developing the necessary adaptations and extensions to the ROUTE/DASH transport layer specification alongside a reference mux/demux implementation;
- performing a subjective assessment of the quality of TV 3.0 video coding technologies (VVC and LCEVC) for the determination of the required bitrate;
- developing adaptations and extensions to DTV play for TV 3.0 application coding alongside an integrated development environment (IDE) and a test suite;
- finalizing technical standards, operational guidelines and conformance testing for TV 3.0; and
- developing end-to-end system demonstrations.

Approximately 90 researchers from 7 Universities in Brazil participated in research for Phase 3 of the TV 3.0 Project. Research areas included:

- Application coding – R&D;
- Video coding – Subjective quality assessment;
- Transport layer – R&D;
- Physical layer – Laboratory tests;
- Physical layer – Field tests.

Annex 9 – Call for proposals (CfP) concerning system components for the TV 3.0 Project in Brazil

The Brazilian digital terrestrial television system (SBTVD) Forum, issued a call for proposals (CfP) for the TV 3.0 Project in July 2020, targeting 6 system components: 1) over-the-air physical layer system component, 2) transport layer system component, 3) video coding system component, 4) audio coding system component, 5) captions system component, and 6) application coding system component. The CfP deadline was extended, exclusively for the application coding system component, to March 2021. For the remaining 5 system components there were 24 candidate technologies, and these technologies are listed in Table A.9.1.

The SBTVD Forum also released Phase 2 of the TV 3.0 CfP. Phase 2 targeted testing and evaluation to compare the proposals of candidate technologies, and included reception performance, video coding quality, and laboratory tests to select two physical layer technologies for final field tests.

The reports of Phase 2 testing and evaluation are available on the SBTVD Forum website, along with the selected technologies for each system component, a consideration of the test results, and market and intellectual property aspects of the candidate technologies. Reports of the testing and evaluation from Phase 2 of the TV 3.0 Project and technologies selected, are presented in Table A.9.2.

For the reception performance and to assist with the definition of the minimum required field strength for indoor reception of the candidate technologies, the SBTVD Forum also released a Call for Prototypes for multi-input multi-output (MIMO) indoor antennas (Phase 3).

The TV 3.0 Project, through the SBTVD discussion process, is expected to issue new technical specifications for video coding, audio coding, captions, transport layer and application coding, to reflect the new evolutions selected. Alongside with that, after the field tests referred to above, the related technical specification will also be drafted and issued.

Following the establishment of the TV3.0 Project by the SBTVD Forum, the Government of Brazil encompassed the activity in a formal public policy enacted in April 2023, by Presidential Decree No. 11 484/2023, which provides the guidelines for the evolution of the Brazilian digital terrestrial television system (SBTVD) and for ensuring the availability of radio frequency spectrum for its deployment¹⁰⁸.

The TV3.0 Project formal policy establishes that the next-generation digital terrestrial television broadcasting (DTTB) system in Brazil, to be called TV 3.0, shall have the following characteristics:

- audiovisual quality superior to that of the first-generation Brazilian DTTB system;
- fixed reception, with external and internal antenna, and mobile reception;
- integration between contents transmitted by the broadcasting service and over the Internet;
- app-based user interface;
- content segmentation according to viewers' geographic location;

¹⁰⁸ Available at http://www.planalto.gov.br/ccivil_03/_ato2023-2026/2023/decreto/D11484.htm.

- customization of content according to viewers' preferences;
- optimized use of the radio frequency spectrum destined for terrestrial television broadcasting; and
- new forms of access to cultural, educational, artistic, and informative contents.

The TV3.0 Project formal policy states that the Ministry of Communications will support the SBTVD Forum so that the studies related to the technological innovations that may comprise TV 3.0 are completed by 31 December 2024, including the technical requirements for the receivers that will allow the adaptation from the current digital television technology to TV 3.0.

It determines that the National Telecommunications Agency (Anatel) shall conduct studies on the frequency planning of TV 3.0 until 31 December 2024, and promote actions to ensure:

- regulatory stability, through the availability of frequency bands necessary for the evolution of terrestrial television broadcasting; and
- implementation of digital terrestrial television in Brazil and its technological evolution.

Finally, TV3.0 Project formal policy states that the Ministry of Communications will constitute and coordinate a working group to propose regulations for TV 3.0, with the participation of representatives from the National Telecommunications Agency (Anatel), the Ministry of Science, Technology and Innovation, the Ministry of Finance, the SBTVD Forum and entities representing the broadcasting sector. The deadline for the completion of activities by the working group is 31 December 2024.

A.9.1 Candidate technologies for TV 3.0 Phase 1 CfP

Component	Candidate technology	Proponents
Over-the-air physical layer	Advanced ISDB-T	DiBEG
	ATSC 3.0	ETRI
		ATSC
	5G Broadcast / EnTV	Qualcomm / Rohde & Schwarz GmbH
	DTMB-A	DTNEL
Transport layer	ROUTE/DASH	ATSC
	SMT	DTNEL
		NERC DTV
	OTT-B	OTT-Broadcast Consortium
	MMT	DiBEG
		ATSC

(continued)

Component	Candidate technology	Proponents
Video coding	VVC	DiBEG
		InterDigital / Ateame / Fraunhofer HHI
	HEVC / SHVC	ATSC
	AVS3	DTNEL
	LCEVC	V-Nova
		Phase / Harmonic
	Dynamic resolution encoding	Phase / Harmonic
	SL-HDR (1/2/3)	InterDigital / Philips
		ATSC
	SMPTE ST 2094-10 (Dolby Vision)	Dolby
		ATSC
	SMPTE ST 2094-40 (HDR10+)	Samsung
Audio coding	V3C (V-PCC / MIV)	InterDigital / Philips / Harmonic / Phase
		ATSC 3.0 AEA
	AC-4	ATSC
		Dolby
	AVSA	DTNEL
	MPEG-H Audio	DiBEG
		Ateame / Fraunhofer IIS
		ATSC
Captions	IMSC1	ATSC
	ARIB-TTML	DiBEG
	Captions	DTNEL

A.9.2 Reports of the testing and evaluation from TV3.0 Phase 2 and technologies selected

Component	Report issued by the SBTVD Forum
Physical layer – Lab tests	https://forumsbtvd.org.br/wp-content/uploads/2021/12/SBTVD-TV_3_0-PL-Lab-Report.pdf
Physical layer – Field tests	https://forumsbtvd.org.br/wp-content/uploads/2021/12/SBTVD-TV_3_0-PL-Field-Report.pdf
Transport layer	https://forumsbtvd.org.br/wp-content/uploads/2021/12/SBTVD-TV_3_0-TL-Report.pdf
Video coding	https://forumsbtvd.org.br/wp-content/uploads/2021/12/SBTVD-TV_3_0-VC-Report.pdf
Audio coding	https://forumsbtvd.org.br/wp-content/uploads/2021/12/SBTVD-TV_3_0-AC-Report.pdf
Captions	https://forumsbtvd.org.br/wp-content/uploads/2021/12/SBTVD-TV_3_0-CC-Report.pdf
Application coding	https://forumsbtvd.org.br/wp-content/uploads/2021/12/SBTVD-TV_3_0-AP-Report.pdf

Technologies recommended as per the testing and evaluation performed, and other considerations, subject to final adoption by the SBTVD Forum. More information can be found in document 6/210¹⁰⁹, A Brazilian Contribution to the ITU-R SG6.

¹⁰⁹ <https://www.itu.int/md/R19-SG06-C-0210/en>

Annex 10 – European Union digital services regulatory framework

A.10.1 Digital Services Act

The Digital Services Act (DSA)¹¹⁰ is a new set of rules which imposes clear obligations on digital services providers that act as online intermediaries, and that are able to transmit or store content of third-parties, and thus connect consumers with goods, services, advertisers and content providers. The DSA addresses platform practices in terms of content management and distribution.

The DSA aims at creating a safer online environment and an improved protection of users and their fundamental rights by establishing:

- the regulatory framework for the handling of illegal and potentially harmful content, products or services offered online;
- a transparency and accountability framework for online platforms;
- a system for oversight and enforcement.

The DSA applies to three categories of intermediary services:

- "Mere conduit" services that provide access to, or the transmission of, information over a communication network (e.g., Internet access providers, Internet exchange points, virtual private networks, domain name registries, and voice over IP);
- "Caching" services that provide for the automatic, intermediate, and temporary storage of information, as it is transmitted over such networks, in order to improve the efficiency of that data exchange (e.g., content delivery networks or reverse proxies);
- "Hosting" services that provide for the permanent storage of information provided by, and at the request of, a user. This category includes online platforms which disseminate information to the public, such as online marketplaces, app stores, collaborative economy platforms, and social media platforms.

The obligations placed on different service providers are proportionate to their role, size and impact in the online ecosystem. Whereas the first two categories that provide network infrastructure and are more technical in nature, are subject to a basic tier of rules, "hosting" services and in particular online platforms, have additional obligations that reflect their role in making user-provided information available to a potentially unlimited number of users. The most detailed and stringent set of rules is reserved for the so-called very large online platforms (VLOPs) and very large online search engines (VLOSEs), platforms which reach at least 45 million users in the European Union.

The DSA requires companies to take a more active role in monitoring and responding to issues such as disinformation campaigns, harmful content, or hate speech and applies financial penalties if platforms

¹¹⁰ Regulation (EU) 2022/2065 of the European Parliament and of the Council of 19 October 2022 on a Single Market For Digital Services and amending Directive 2000/31/EC, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022R2065&qid=1666857835014>

are in breach. These fines can be up to 6 per cent of the company's worldwide annual turnover from the concerned intermediary service and, ultimately, a ban on operating in the European Union single market for repeat serious offenders, can be imposed.

The Digital Services Act entered into force on 16 November 2022. On 25 April 2023, the European Commission designated 17 VLOPs and two VLOSEs as platforms reaching at least 45 million monthly active users.

The platforms have been designated based on the user data that they were obliged to publish by 17 February 2023. Following their designation, the application of the DSA set of rules applies within four months of the designation. The DSA set of rules includes: more user empowerment, strong protection of minors, more diligent content moderation, less disinformation, and more transparency and accountability.

The implementation of the Digital Services Act across European Union countries involves the designation of **digital service coordinators (DSCs)** as national regulatory authorities responsible for overseeing compliance with the DSA and ensuring its proper enforcement. The situation across the European Union varies, since each Member State is allowed to designate one or more institutions as the DSC, based on their existing regulatory frameworks. The DSC role can be assigned to either a single regulatory authority, or split between multiple institutions, depending on a country's approach.

In several European Union countries, the national regulators for electronic communications have been designated as the DSC, due to their experience in handling digital infrastructure, and the intersection between telecommunications and digital services. Broadcasting regulators, who already have oversight over audiovisual media services, have also been designated in several member states. This decision leverages the existing roles that broadcasting regulators have in monitoring and regulating content distribution, such as their work with video-on-demand services. Other possible solutions for DSCs include institutions such as consumer protection authorities of newly established hybrid authorities.

A.10.2 Digital Market Act

The Digital Market Act (DMA)¹¹¹ focuses on the role of platforms as "gatekeepers" between businesses and consumers.

The two main objectives of the Digital Market Act are:

- to ensure contestability in the digital sector by promoting competition among digital platforms;
- to ensure fairness for business users depending on gatekeepers for providing their products and services.

The Digital Market Act set ex ante prohibitions and obligations that will be applied to companies designated by the European Commission as "gatekeepers". This "gatekeeper" designation is applied to providers of one or more core platform services (CPS), that are considered as having significant intermediation power.

¹¹¹ https://digital-markets-act.ec.europa.eu/index_en

Article 2 of the DMA lists core platform services (CPS) as follows:

- a) online intermediation services;
- b) online search engines;
- c) online social networking services;
- d) video-sharing platform services;
- e) number-independent interpersonal communications services;
- f) operating systems;
- g) web browsers;
- h) virtual assistants;
- i) cloud computing services;
- j) online advertising services, including any advertising networks, advertising exchanges and any other advertising intermediation services, provided by an undertaking that provides any of the core platform services listed in points (a) to (i).

The Digital Market Act provides an asymmetrical regulation, meaning its obligations can be applied only to certain CPS providers, that can be designated as gatekeepers, for one or several core platform services.

The DMA proposes that the designation or identification as a gatekeeper is applied on the basis of three cumulative criteria:

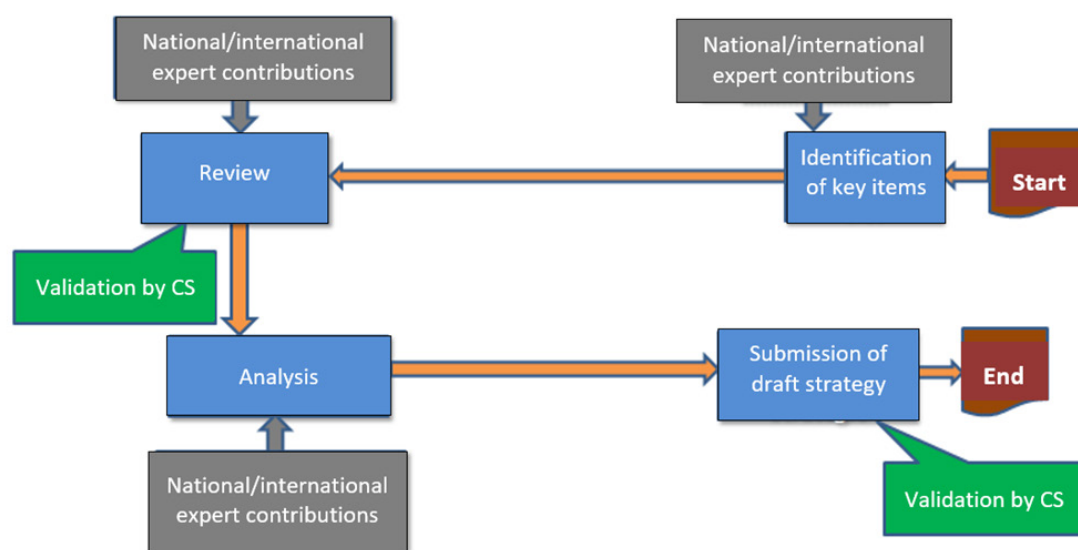
- a) Significant impact on the internal market;
- b) Operates a core platform service which serves as an important gateway for business users to reach end users; and
- c) Enjoys an entrenched and durable position in its operations, or that it is foreseeable that it will enjoy such a position in the near future.

The DMA entered into force on 1 November 2022, and the application began as of 2 May 2023.

Following the 45-day review process, on 6 September 2023, the European Commission designated a number of platforms as gatekeepers. Gatekeepers then have six months to ensure full compliance with the DMA obligations for each of their designated core platform services.

Annex 11 – Methodology for elaboration of the strategy for the digital broadcasting transition in Cameroon

Figure A.11: Workflow of digital broadcasting transition strategy



A.11.1 Strategic directions

The strategy covers a number of directions, set out below:

Institutional and regulatory

- Respect of Cameroon's commitments to the international institutions (2006 Geneva Agreement and related conferences);
- Creation of a legal and regulatory framework (regulatory authority, fund to support production, determination of the legal regimes, separation of creation and broadcasting functions, a body charged with archival of broadcast work).

Technical

The principal planned technical characteristics are as follows:

- Coverage of the population: 85 per cent by DTT;
- Frequency band at the start: band 3;
- Standard: DVB-T2;
- Video coding: MPEG-4 AVC (MPEG-4 AVC or H.264);

- Audio coding: HE AAC;
- DTT backbone within Cameroon: national public operators' networks with CRTV for broadcasting and CAMTEL for transmission. To be augmented by satellite.

Content development

- Industrialize content production;
- Establish production obligations and broadcast quotas;
- Promote and protect local cultures;
- Foster the creation of a market for programmes;
- Archive production nation-wide.

Human resources development

- Personnel training: technical and artistic professions, broadcast support professions (legal, sales, advertising, etc.);
- Train-the-trainer schemes;
- Strengthening of the training platforms, sharing.

Economic and financial

- Construction of a DTT network that will be a good fit for the requirements of the new digital economy;
- A new economic model for television based on the creation of digital value-added services;
- Creation of a broadcasting development fund.

Communication

- Establish communication strategies to involve all stakeholders and inform the population.

Annex 12 – Principal stages of the migration process at the national level in Cameroon

A.12.1 From a migration strategy to the implementation of DTT switchover projects

At the national level, a prerequisite for implementation of the migration to digital broadcasting, was a complex of administrative, technical and legal measures, defined in a specially created strategy document.

The Prime Minister and Head of Government, in a participative and inclusive approach involving all the concerned players, issued **order No.222/CAB/PM of 24 September 2009** establishing a **national supervisory body, the Cameroon Digital Broadcasting Switchover Committee (CAM-DBS)**. The main task of the committee was to prepare for the Government a proposal on a national strategy for the switchover to digital broadcasting, by producing a review and an analysis of the current state of national broadcasting, under all of its aspects. On 24 September 2012, the Government adopted a **national strategy document for the migration from analogue to digital broadcasting** (known by the French acronym **DSMN**). To implement the various projects that emerged from the national strategy document, by an order of the Prime Minister and Head of Government in 2012, the CAM-DBS committee was recast into a new project structure called **Cameroon Digital Television Project (CAM-DTV)**. This committee had two working bodies: a steering committee (**Comité de pilotage, COPIL**), chaired by the secretary general to the Prime Minister and assisted by the Minister of Communications as vice-chair; and a technical operational unit (**Unité technique opérationnelle, UTO**) made up of experts from the different administrations involved in the switchover process.

A.12.2 The migration to DTT in Cameroon with the technical rehabilitation of CRTV and an experimental DTT project at CRTV

On the authority of the President of the Republic, a contract for the technical rehabilitation of Cameroon Radio and Television (CRTV) was awarded in November 2012, after the tender dossier had been cleared by the office of the President. Further negotiations resulted in a commercial contract, between the Government of Cameroon, represented by the Minister of Communication, and the contractor, being signed in December 2014. This in turn made it possible effectively to begin implementation of the project in the cities of Douala and Yaoundé at the following sites:

- The Yaoundé earth station (Mballa II), where the multiplexing platform, the head-end and their power equipment are installed;
- The Yaoundé broadcasting station (Mbankolo), where the DTT transmitters are installed, along with their power equipment;
- The Douala broadcasting station (Logbessou), where all facilities have been completed, including the rebuilding of a 200-metre high pylon.

After a further revision to the terms in 2017, a new contract for the technical rehabilitation of CRTV was signed, with the objective of setting up a joint venture with the contractor. That approach was subsequently rejected by the office of the President. Currently, the search for funding is being pursued within the framework of a public-private partnership (PPP). Previously, the Ministry of Communication and CRTV had elaborated and sought funds to implement an experimental DTT project in two cities,

Yaoundé and Douala. The purpose of the project was to allow CRTV and the State to obtain a better appreciation of the constraints and realities of DTT before deploying the technology country-wide. The delay in identifying funding sources for the project meant that the contract was signed just one year before the deadline set by ITU for migration. Implementation of the contract, the execution period for which was four months, made the actual official launch of DTT at Yaoundé and Douala possible in July 2015, with a multiplex of 12 television channels available free to analogue television sets equipped with a special decoder or directly to DVBT-2/MPEG4-capable digital television sets.

A.12.3 Current situation in Cameroon

Technical aspects:

- The experimental DTT project is operational, with a 12-channel multiplex and two equipped DTT broadcasting centres (Yaoundé and Douala);
- Preparation of terms of reference relating to the recruitment of a strategic partner to construct the technical infrastructure for digital broadcasting in Cameroon;
- The technical partner has been chosen and has commenced certain work lots;
- Funding is being negotiated;
- An office has been chosen to provide support to the contract principal;
- A dossier being prepared for the call for proposals (CfP) for a prime contractor;
- Data is being collected for a complete survey of the existing broadcasting infrastructure country-wide;
- A public information campaign is in progress to build awareness of the importance of migration and its challenges. Seminars have been organized in different regions;
- Revision of frequency plans in the UHF and VHF bands with an increase of the planned spectrum resource capacity in those bands;
- Development of scenarios for migration to DTT, taking into account the costs and objectives of coverage of the national territory (minimum of 60 per cent, corresponding to the current coverage by analogue television).

Content-related aspects: Preparation and creation of the first digital DTT package in Cameroon (12 TV channels currently broadcasting in Yaoundé and Douala) with eight local and four foreign channels.

Human resources aspects: Upgrading of the competencies of selected personnel in administration and public bodies involved in the migration process. Two training sessions on terrestrial digital broadcasting have been held in Yaoundé.

A.12.4 Forthcoming activities and outlook

On the institutional and legal front, the regulatory framework will be further finalized with the elaboration of subsidiary texts for law no. 2015/007 of 20 April 2015, on broadcasting. **On the technical front**, now that the installation of head-end equipment at the CRTV headquarters in Yaoundé-Mballa II and the broadcasting centre at Yaoundé-Mbankolo has been completed, the deployment of equipment for the experimental DTT solution will continue in other cities, along with the progressive digitalization of the other broadcasting centres throughout the country. **After phase 1 of the contract for rehabilitation of CRTV**, implementation of the project will continue at other locations, as indicated above. It will take into account all of the business activities affected, in particular: radio production, TV production, the information system, audio/video transmission, radio and DTT broadcasting, and commercial services for the distribution of decoders.

Annex 13 – Digital broadcasting television migration strategy and implementation in Guinea

A.13.1 Background

The development of a country is intertwined with the development of the telecommunications sector, especially in terms of digital technologies for broadcasting. The problem with analogue in this area is that it limits the use of radio spectrum, not to mention the interference that it is subject to, and the interference it causes even in the adjacent frequency bands. The use of digital broadcasting provides a lasting solution to these problems. Today, digital technologies for broadcasting have been widely developed. People see these types of technologies as a resource that allows them to connect, inform and entertain themselves. Like many countries, Guinea also aspires to the effective adoption of digital broadcasting to benefit from all of its associated advantages.

A.13.2 Latest information on the transition to digital broadcasting in Guinea

The transition to DTT began in Guinea in 2008. The initial involvement from the private sector was followed by the State in 2015, with a total coverage rate of 3.37 per cent. Nine licences were awarded, four of these to TV promoters, and five to broadcasters. The technology standards currently being employed are MPEG-2, and MPEG-4/ SD, as well as HD/DVB-T, DVB-T2 and DVB-S2 and the main transmission media are radio beam, cable and satellite.

The Government of Guinea recently restarted the project to migrate from analogue to digital broadcasting nationwide. This project will comprise:

- the construction of 15 sites throughout Guinea (one in the capital and the other 14 in the interior of the country) and five regional studios (Kindia, Boké, Kankan, Labé and Nzérékoré);
- two mobile studios are also planned, as well as mobile production vehicles for live events;
- a national service centre;
- a digital archive centre;
- a number of reception kits;
- a staff training programme;
- the construction in Koloma (Conakry) of a DRC+3 building to house the network supervision centre, the Lower Guinea maintenance centre, the multiviewers, the offices and meeting room, and the local project management unit;
- the modernisation of the RTG public broadcaster studios in Conakry (Koloma and Boulbinet);
- the distribution of TV services to all sites via satellite (Ku-band);
- the broadcasting of public services programmes via satellite in DTH (Ku-band).

The total cost of the project is projected to be EUR 66 million, which will be 85 per cent financed by the Public Investment Bank of France (BPI France) and the General Directorate of the French Treasury on the basis of a loan. The remaining 15 per cent will be supported by the Government of Guinea through the ECOBANK which is a primary bank of the country.

The projected duration of the project is 24 months, from the effective start date of the project, which also depends on funding.

A.13.3 Project delivery level

As part of the implementation of the project, the following actions were taken:

a) The creation, by presidential decree, of a Monitoring and Coordination Committee for the digital migration process. This committee is composed of:

- The Minister in charge of communication and information, Chairman of the Committee;
- The Deputy Head of administration and control of major projects and Government procurement (ACGP.MP), Rapporteur.

Committee members:

- The Minister in charge of telecommunication or his representative;
- The Minister in charge of finance or his representative.

b) In March 2022, a commercial contract with the technical operator was signed. The technical operator chosen by the Government to carry out the project was the Thomson Broadcast group.

c) In July 2022, the official site visit was carried out with the technical operator.

d) An evaluation of the offer was sent by the Thomson Broadcast partner.

A.13.4 Deficiencies noted in the partners offer

To implement the recommendations of the presidential decree, a Technical Commission, a Legal Commission and a Communication and Audiovisual Content Commission were established.

As part of their activities, these Commissions were asked to evaluate the offer from the technical partner. Following their assessment, the following deficiencies were identified:

- The evaluation of the offer of the technical partner was requested at a time when the budget for the realization of the project was already fixed. This could either lead to either a blockage in the implementation of the project, or to the failure of the objective which is to attain DTT coverage of the territory;
- The sites planned to cover the country are insufficient because there are 33 Prefectures in Guinea;
- The lack of sufficient transmission medium support (optical fibre) provided for the connection of broadcasting sites to the national backbone at each of the Prefectures.

Such a connection would allow interconnection between the sites, and so allow additional transport of the signal from the production studios to the head of the RTG public broadcaster studios in Conakry;

- The failure to support the other fourteen sites (former analogue sites that could be rehabilitated for DTT) by the project.

Please note that the evaluation of the offer from the partner is ongoing at the level of the various commissions.

Annex 14 – Digitize Brazil Programme – ASO strategy Phase II

It is useful to consider the example the analogue switch-off (ASO) strategy implemented by Brazil, as the strategy of 'phased analogue switch-off' implemented in the case of Brazil, has been chosen by a significant number of other countries. The Brazil case study can therefore serve as an example for the evaluation of a phased analogue switch-off (ASO) strategy. Brazil divided the ASO into Phase I and Phase II. In Phase I, all Brazilian capitals and other major cities shut-down their analogue transmissions to allow for the operation of a Fourth Generation IMT advanced system operating in the 700 MHz band (698-806 MHz). In Phase II the switchover was completed in all locations where analogue TV was still in operation¹¹².

In order to accomplish Phase I, all TV channels from the 700 MHz band, down to the VHF band (channels 7 to 13) and the remaining UHF band (channels 14 to 51) were subject to replanning and reallocation.

By January 2019, 1 379 municipalities, comprising 129.6 million people, had completed the analogue switch-off, including all state capitals, metropolitan areas, and other areas, corresponding to 62.6 per cent of the Brazilian population. The analogue switch-off was required, in order to release the 700 MHz band, and this was successfully accomplished in Phase I of the phased ASO strategy.

For Phase II of the phased ASO strategy, a Government programme, **Digitaliza Brasil** (Digitize Brazil) was established utilizing funds remaining from the 700 MHz band auction, after the initial funds allocation utilized for Phase I¹¹³.

Phase II comprised 2 896 municipalities, some of these municipalities had partially digitized transmissions, while others (1 639 municipalities) had analogue TV only. These remaining municipalities were the target of the **Digitaliza Brasil** programme. The objective of the **Digitaliza Brasil** programme was the completion of the transition to digital terrestrial television by December 2023, the final deadline for the analogue switch-off (ASO).

The population in these areas will not receive set-top-boxes and antennas, and their analogue switch-off is not conditioned to household surveys, as it is expected, based on the previously mentioned projection, that they will naturally and progressively migrate from analogue to digital TV as the currently existing analogue TV sets stop receiving transmissions.

Two main courses of action are planned for the programme:

- Continue the distribution of DTV reception kits to low-income families, where deemed necessary; and
- Digitize stations in analogue-only locations.

For the first course of action, preliminary estimates are that 4.2 million DTV kits will be distributed (in addition to the 12 million that were distributed in the first phase of the ASO). The second course of action involves acquiring and installing DTV transmitters for the analogue broadcasters, as well as bearing the costs with regulatory demands (mainly taxes and engineering labour).

¹¹² The first phase was implemented between 2016 and 2018, and the second one started 2021 and is planned to finish December 2023.

¹¹³ The total amount of funds reserved for the second phase of the Brazilian ASO strategy is approximately R\$ 850 million (around US\$ 160 million).

A standardized transmission assembly will be used as a reference for the deployment of stations in each of the municipalities, which can be modified to meet local conditions. The equipment will allow sharing of common infrastructure, such as combiners, transmission lines, towers, and antennas between up to eight DTV broadcasters' channels, and reducing equipment, deployment, energy, and maintenance costs. A maximum transmitter power of 50W will be provided for each channel.

The infrastructure will be maintained under the municipal administration premises and will be operated by local broadcasters. Both municipal administrations and broadcasters will undergo a selection process to complete requirements established by the programme. Qualified broadcasters are to deploy the necessary equipment at their own expense. On the other hand, the existing infrastructure (sites, housing, towers, antennas, etc.) can be used on a shared basis by incoming broadcasters, greatly reducing total deployment costs. Additionally, municipalities bear electricity costs, reducing operational expenditures.

The analogue switch-off (ASO) strategy in Brazil was successful, with the transition to digital TV broadcasting having no significant impact on the free-to-air terrestrial TV audience. This success is particularly important for Brazil, where the majority of the population relies on free-to-air television for audiovisual content consumption. The digital switchover had several positive outcomes, including a boost to the national industry (covering set-top boxes, TVs, receiving antennas, digital TV transmitters, and transmission antennas) and a renewed public interest in free-to-air terrestrial television. Key lessons from the ASO strategy in Brazil include the importance of cooperation and collaboration among stakeholders, with the operationalization of planned actions by a third-party. Consumer awareness and involvement were crucial for smooth implementation, supported by the decision to include DTV converter boxes in all TV sets sold in the retail market in a gradual and phased manner. Providing necessary equipment, such as DTV converter boxes and antennas, for free to low-income populations, also contributed significantly to the transition. Local actor involvement facilitated the switchover, underscoring the importance of community engagement. For countries with vast geographical territories, a long-term ASO plan is advisable, with considerations such as maintaining analogue transmissions on a secondary basis in small municipalities to stimulate the migration to digital in these areas.

Annex 15 – Analogue to digital satellite broadcasting migration in Brazil

The task of migrating to satellite broadcasting free-to-air services involved the distribution of receiver kits for low-income families and the installation of the new equipment. To achieve this, a third-party entity was created, in a similar way to that employed during the digital terrestrial television switchover to 700 MHz band for 4G, which involved the creation of a governance structure to monitor the process. Among other activities, this third-party entity implemented the relocation of analogue television stations to other parts of the spectrum, to allow for the usage of the 700 MHz digital dividend band. More information can be found in the Final Report of Question 2/1 for the 2017-2021 study period.

A monitoring group (GAISPI) for the implementation of solutions to interference problems in the 3 625 to 3 700 MHz band was constituted, as was the 3.5 GHz band managing entity (EAF – Siga Antenado). This entity is fully operational and provided a communication plan to produce information on the necessary procedures enabling each family to claim their kit or request its installation. More information can be found at <https://sigaantenado.com.br/>.

The migration process is planned to continue until 2025, and consequently a simulcast period with concurrent transmissions in the current band (C band) and the new band (Ku band), will be followed by the shutdown of the C band transmissions. Only those homes that either received kits, or who have purchased the new devices will be able to continue watching satellite TV.

The equipment that composes the kits, the acquisition and distribution costs, and the scheduling of activities are responsibilities of GAISPI and the EAF. Initially, 16 types of antennas were identified, of these eight were of low noise block-down converter feedhorn (LNBF) type, which are satellite-to-TV signal converters used in satellite dishes, and the remaining eight comprised candidate receivers to compose the kits.

Sensibilization and information campaigns were also amongst the responsibilities of both GAISPI and the EAF. These campaigns were carried out to update the registration of land stations of the fixed satellite service operating in the C band, both for data correction, such as geographic coordinates, and for the creation of new records, mainly from receiving stations. Receiving stations are under no obligation to register with the National Telecommunications Agency (Anatel), but in order to be entitled to protection against interference, broadcasting stations must be registered.

Based on the register of available stations, it is considered that it may be necessary to install filters in the 1 340 fixed satellite service (FSS) earth stations in the state capitals. In addition, another 229 stations that currently operate in the extended C band (range from 3 625 to 3 700 MHz) will need to vacate the band, as if they fail to do so, they will be subject to interference caused by 5G transmissions at 3.5 GHz.

Status of the migration process

GAISPI continues to participate in deliberations to free-up cities for 5G usage, including on the management of interference, and the distribution and installation of satellite broadcasting kits. Within the scope of the GAISPI group, it was decided that all municipalities that are part of the metropolitan area of all State capitals, the Federal District, and cities influenced by municipalities of more than 500 000 inhabitants, would migrate first, followed by a migration schedule for the remaining regions.

This decision was motivated by the logistical gains to be obtained in the process of distribution and installation of reception kits, as well as by a better use of migration communications. In this way,

GAISPI sought efficiency gains in the migration process and the best use of the financial resources contributed to the group.

It is important to emphasize that the implementation of all of the necessary actions to allow for 5G usage in a particular municipality, does not mean that the 3.5 GHz band will necessarily be available for immediate use. The migration progress in each city enables the GAISPI to evaluate, and make decisions on, the 3.5 GHz band availability, and on the possible anticipation of the release of the C band in other cities, provided that actions to mitigate interference in the fixed satellite service (FSS) receiving stations, are also completed.

As of August 2023, 1 712 municipalities, having completed the migration actions to mitigate interferences in satellite broadcasting services, were deemed ready, and have been permitted to provide 5G services. Further information and updated dashboard data can be found at <https://informacoes.anatel.gov.br/paineis/espectro-e-orbita/gaispi-liberacao-e-planejamento-3-5-ghz>.

Objectives of the public policy strategy

The main objectives of the current public policy strategy were two-fold, first, to allow for the usage of the 5G in the 3.5 GHz frequency band, and second, to allow the migration of the existing satellite services to a more advanced and interference-free digital broadcasting service.

Both actions are strategic to the Brazil context, as Brazil is a country large in territorial area that needs to rely on satellite services to extend coverage, both for broadcasting and for other services, including broadband Internet.

Annex 16 –Digital broadcasting needs in developing countries

A.16.1 Argentina

The role of information and communication technology (ICT) was reinforced during the Covid-19 pandemic, when connectivity became essential for citizens to continue with their jobs, education, communication and entertainment. Today without ICT, people risk being excluded from the digital economy. Providing connectivity to all of Argentina, involves thinking about various specific strategies that are integrated into a general strategy.

Through the Conectar Plan, the Government of Argentina have worked to deliver connectivity infrastructure to remote areas, so that every citizen can utilize digital technologies and take advantage of their full potential. Regarding the Conectar Plan, it stands out as a lesson learned, in that the Conectar Plan is a public policy sustained over time, and that transcends the different administrations that succeeded each other in the National Executive Branch. In this sense, the connectivity policy that is reflected in the Conectar Plan is a continuation of the various initiatives implemented by the National Government since 2010, when the Argentina Conectada Plan was formulated.

The adoption of a tailored approach for each region of the country, with due consideration of specific singularities, involved providing a digital solution to fit the needs of each region, and providing satellite or optical fibre solutions according to the specific characteristics of each region. For remote areas, satellite connectivity proved an effective solution to connect small towns and cities where the deployment of optical fibre would be difficult. One of the lessons learned from this experience is that it is important to diversify investments in connectivity technology to effectively connect the unconnected and to strategically allocate public resources.

In Argentina, the Conectar Plan, implemented by Arsat, a state state-owned telecommunications company, has contributed also to the transition from analogue to digital broadcasting through an open digital terrestrial television platform, called Open Digital Television (TDA), that constitutes a state policy that began in 2009, with the selection of the integrated services digital broadcasting – terrestrial (ISDB-T) standard. The Conectar Plan also comprises updating and recovering of all transmission stations, the renewal of the transmission platform to improve image quality, and strengthening of equipment to avoid transmission outages.

A.16.2 Côte d'Ivoire

The status of the digital terrestrial television (DTT) transition in Côte d'Ivoire is outlined in this section. A steering body was established in 2017, and DTT was officially launched 2019, followed by the launch of the campaign to switch off analogue television in Abidjan in 2021, and the cessation of transmissions with the old RTI antennas in the same year.

Côte d'Ivoire has been able to meet economic, social, and institutional challenges for the deployment of DTT, including Government investment of approximately XOF 30 billion. The national objective of switching off analogue transmissions before the end of December 2021, has been complied with.

State of needs in terms of digital broadcasting:

- According to the provisional results of a survey on DTT penetration from 2022, the adoption by households in Côte d'Ivoire of this technology remains a major challenge. Four major axes summarize the needs of the populations in this area:
- Improved content and diversity of programmes¹¹⁴.
- Improved communication and easier acquisition of free DTT¹¹⁵.
- Targeting of the most vulnerable populations¹¹⁶.
- The conquest of new markets¹¹⁷.

A.16.3 Guinea

The status of the DTT transition in Guinea is outlined in this section. Private broadcasters began transmissions in 2008, while transmission by the public broadcaster began in 2015, which allowed for the coverage of part of the Greater Conakry region and other areas. Licences were granted to four TV broadcasters and five cable distributors, and the digital dividends in both cases were released.

State of needs in terms of digital broadcasting:

¹¹⁴ It would be appropriate to increase the number of free-to-air channels available on the free DTT offer. Households without free DTT subscribers, particularly in urban areas, present the number of free DTT channels as an obstacle to its acquisition. An improvement in the diversity of programmes served by DTT is required. The analysis reveals that the improvement points of free DTT according to households are, among other things, the programming for youth and for early childhood, the programming of television series (african or "novelas") and sporting events.

¹¹⁵ Even though the overall awareness of DTT is very high, around 72.6 per cent, DTT offer has not yet entered the daily lives of the households surveyed. Only 4.4 per cent of households surveyed cite free DTT as a television offer, and only 1.2 per cent for Pay DTT. It is important to intensify communication on free DTT, in particular via television. It would be possible to broadcast commercials on the 7 channels already present simultaneously on free and pay DTT, or even on other popular satellite channels. Beyond that, an intensive campaign on social networks, for example with the intervention of influential personalities, could make it possible to increase market share. It would also be possible to present DTT as an additional offer to the offers that are already present in households. It will, therefore, be necessary to insist on DTT's uninterrupted character. Finally, it is important to facilitate the acquisition of DTT kits by households. Although this was not the main objective, the survey showed that only 33.5 per cent of the 50 households surveyed had a DTT point-of-sale in their immediate surroundings. Like the points-of-sale for satellite offers, or mobile money offers in telecommunications, it would be necessary to significantly increase the number of points-of-sale per household living area.

¹¹⁶ Analysis of the determinants of DTT makes it possible to understand that socio-economic categories of households (income level, housing amenities) and these categories serve as excellent explanatory factors for the adoption of free DTT. It would be interesting to carry out sustained local awareness campaigns in the geographical areas with the most poor or vulnerable households.

¹¹⁷ An intense promotion of DTT kits in collective public places such as hospitals, restaurants, and hotels would make it possible to anchor DTT in the daily lives of households.

- Improvement of the territory coverage by DTT¹¹⁸.
- Capacity building needs¹¹⁹.
- No current needs for new services and applications¹²⁰.

According to the Guinea case study¹²¹, the digital terrestrial television (DTT) project comprises 15 sites. Given that the country has 33 Prefectures, the 15 sites planned by this project will not cover all the territory. To achieve the objective of covering the rest of the country, Guinea must find ways to provide reception kits to families living in areas not covered by DTT.

More information on the overall strategy and implementation progress can be found in Annex 13 of this Final Report.

A.16.4 Senegal

The status of the DTT transition in Senegal is outlined in this section. A national strategy was established following concertation among all stakeholders. This national strategy comprised technical, economic, legal, and audiovisual dimensions. The implementation began in 2014. After the creation of the Senegal Broadcasting Company (TDS), as sole operator responsible for carrying out the distribution activity, and for the technical and commercial operation of the DTT infrastructure. The national strategy implementation currently comprises 23 sites spread across the country. These 23 sites cover most of the national territory with 31 transmitters (including four transmitters in the capital and two in each of the bigger cities. Dakar, the capital, has 80 channels on four multiplexes) and following the switch-off of some of the analogue broadcasting of TV channels, a coverage of approximately 70 per cent of the demographic is ensured.

State of needs in terms of digital broadcasting:

- A direct to home (DTH) satellite offer, in addition to terrestrial broadcasting to cover the territory.
- Integrated decoder options, including DTT, satellite and Internet service offers.
- Mobile television services (smartphones and tablets).
- Video-on-demand and catch-up TV offers.
- Interactive and transactional programmes, such as banking, games, and education programmes.
- Access to more regional and local content.

¹¹⁸ The country needs technical and financial assistance to densify the network that will be deployed by the current DTT migration project in place, financed jointly by the development and investment banks of France (BPI France) and the CEDEAO (BIDC). The 15 sites and the two multiplexes planned by the referred project are insufficient to cover the 33 prefectures with the DTT network.

¹¹⁹ The country needs support in terms of capacity building in the audiovisual field, especially the personnel of all the stakeholders, including the regulator, the ministries involved, as well as the staff of radio and TV broadcasters. The country also needs support for the development of legal texts in the matter.

¹²⁰ The needs relating to the evolution of audiovisual technology for the country are, for the moment, future innovations, since digital technology is not yet very developed in the country.

¹²¹ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0250/> from Guinea.

- Thematic television channels, such as the "Télé Ecole" school/education channel that was established during the COVID crisis.

A.16.5 Brazil

The status of the DTT transition in Brazil is outlined in this section. A DTT standard was adopted in 2006 and initial transmissions began in 2007. Between 2016 and 2018, analogue transmissions were switched-off in all state capitals and other major cities to allow for a Fourth Generation IMT advanced system operating in the 700 MHz band. Since 2021, a new phase is being carried out to complete the digital switchover in all locations where analogue TV is still in operation. A deadline was set for the end of 2023, based on a projection of the expected lifespan of existing household analogue TV sets¹²².

State of needs in terms of digital broadcasting:

- Completion of the digital switchover and shutdown of the last remaining analogue TV stations in remote areas and municipalities.
- Evolution of the digital television offer with the development of the TV3.0 standard¹²³.

A.16.6 Bosnia and Herzegovina:

The status of the DTT transition in Bosnia and Herzegovina is outlined in this section. In 2007, the Broadcasting Sector Policy was established, followed in 2009, by the strategy for transition from analogue to digital terrestrial broadcasting and by Rule 90/2018 on the provision of electronic communications network management services in digital terrestrial broadcasting. Transmissions started with the implementation of both public and commercial broadcasting multiplexes, the latter successfully implemented by 2021.

State of needs in terms of digital broadcasting:

- Complete the process of transition to digital terrestrial broadcasting;
- Implement new services, such as OTT, digital platforms, video sharing platforms. Special attention to be paid to the regulatory response to the new broadcasting landscape, and to the changes in consumers habits;
- Adaptation to the European Union regulatory provisions, such as the Digital Service Act (DSA), and the Digital Market Act (DMA), and due attention to the discussions on the Fair Share initiative by the European Telecommunications Network Operators Association (ETNO).

¹²² In the first phase, 1 379 municipalities, comprising 129.6 million people, completed the analogue switch-off, including all state capitals, metropolitan areas, and other areas where the analogue switch off was required to clear the 700 MHz band, corresponding to 62.6 per cent of the Brazilian population. The second phase comprised 2 896 municipalities, some of these already having partially digitized transmissions, and others having analogue TV only (1 639 municipalities).

¹²³ Following the take-up of the deployment and the innovations incorporated and planned to be included to the digital television standards and systems, the SBTVD established the TV3.0 Project, aimed at incorporating the latest evolutions into the Brazil digital television system, including personalized content, app-based TV experience, UHD/HDR video, immersive audio, enhanced accessibility features, advanced emergency warning system, IP-based technologies and frequency reuse.

Annex 17 – Case studies of digital radio broadcasting implementations

A.17.1 Brazil case study

As is the case for a digital television transition, a digital radio broadcasting migration also involves planning and coordination. One example of such a migration was implemented in Brazil. Discussions about the adoption of digital radio began in 2007, and the National Telecommunications Agency (Anatel), the telecommunications regulator, and the Ministry of Communications (MCom) began coordinated testing, with the broadcast industry, of HD radio and digital rights management (DRM) systems. In 2010, the Brazilian Digital Radio System (SBRD)¹²⁴ was instituted through Ordinance No. 290/2010, which defined the usage of the digital radio system for MW and FM.

In 2012, with the objective of assisting in the implementation of digital technology into the audio broadcasting system, the Digital Radio Advisory Council¹²⁵ was established to advise the Minister in the implementation planning of the Brazilian Digital Radio System (SBRD).

The Digital Radio Advisory Council was made up of representatives of civil society, of Federal Government, including Anatel and the Ministry, of the broadcasting sector (commercial, educational, community and public actors), of industry (reception, transmission and audiovisual actors), of academic institutions; and of advertisers. The Ministry of Communications was in charge of the coordination of the council. Council sub-groups were also created:

- CCRD1: A thematic commission addressing policy;
- CCRD2: A thematic committee addressing technological innovation;
- CCRD3: A thematic committee addressing test analysis and monitoring.

In Brazil, the general consensus was that the tests had to be directed to in band on channel (IBOC) systems, which use the same band as analogue systems. This was because the interested parties felt at the time that IBOC systems were easier and cheaper to deploy as they could be activated with the same physical structure as analogue stations using adjacent channels. Additionally, it was the view of the Ministry and ABERT (Associação Brasileira de Emissoras de Rádio e TV) that the systems were recommended to be deployed in both FM and AM and would have minimal financial impact on broadcasters.

Recently, discussions have been underway to allocate spectrum that could allow simulcast transmissions on both digital and analogue radio systems. However, the deployment of digital radio in Brazil remains under discussion, and one of the reasons for this is that analogue radio is still very popular, and consequently some initiatives were carried out to expand the usage of the FM band, which has a better service quality. This case study is presented below.

Broadcasting transition – AM-FM migration in Brazil

The adaptation of authorizations for amplitude modulation (AM) radio service stations, operating in medium wave (MW) radio licences, to migrate to frequency modulation (FM) radio service stations, is a successful example of public policy employed to prioritize small radio stations in Brazil.

¹²⁴ SBRD – Sistema Brasileiro de Rádio Digital, in Portuguese.

¹²⁵ CCRD – Comitê Consultivo do Rádio Digital, in Portuguese.

The migration aimed to strengthen both the broadcasting sector, and small AM radio stations in Brazil, impacted by the abandonment of audiences in face of increased interference and noise, especially in urban areas. The migration of the AM radio services to FM radio services allowed improved audio and transmission quality, in addition to enabling the transmission of programming onto mobile phones, with an immediate increase in audiences and revenues. Currently, of the 1 781 AM radio station authorizations, approximately 1 720 stations have requested the migration to FM.

Extended FM range

To meet the spectrum requirements for migration, the Brazilian National Telecommunications Agency (Anatel) made available channels in the currently allocated band for FM radio (88-108 MHz). However, it was found to be technically unfeasible to include new channels in some high-spectrum occupancy regions. Consequently, in 2019, Anatel completed a revision of its technical regulations for audio broadcasting to extend the FM band down to 76 MHz, thus adding 60 new channels. The extended FM band (76-88 MHz) in Brazil will be entirely available after the analogue TV switch-off, foreseen to be completed by the end of 2023.

In 2021, the MERCOSUR (Southern Common Market) administrations achieved consensus on establishing the technical parameters for coordinating FM channels within the extended FM band (76-88 MHz). These parameters included protection ratios, which were determined based on sharing studies conducted by the Brazil administration, encompassing both analogue TV and FM stations. The approval of these technical parameters paved the way for commencing frequency coordination procedures among the administrations of the MERCOSUR Member States.

In 2022, Brazil led discussions within the Inter-American Telecommunication Commission (CITEL) to develop Recommendation [PCC.II/REC. 66 \(XXXIX-22\)](#), which recommends that CITEL Member States evaluate the use of the extended FM frequency band (76-88 MHz) for the provision of FM audio broadcasting services. The Recommendation also states the importance of administrations establishing bilateral or multilateral frequency coordination agreements in the extended FM band, in order to guarantee interference-free operation, and that administrations should consider taking actions to facilitate the production of receivers capable of tuning into stations in the 76-108 MHz band.

Milestones of the migration

- In May 2010, the National Telecommunications Agency published a study on the technical feasibility of migrating from AM radio to the FM band, using television channels 5 and 6 in Santa Catarina State;
- After discussions with broadcasters, on 07 November 2013, the migration decree, [Decree No. 8.139/2013](#) was published;
- On 12 March 2014, the Ministry of Communications published an ordinance that regulated the migration of AM radio to the FM band (Ordinance No. 127/2014);
- On 25 August 2014, the Ministry of Communications issued the first authorizations for the radio migration, followed by Ordinance No. 6 467/2014 which defined the prices for migrating from AM to FM radio, published on 24 November 2015;
- On 23 May 2017, the Ministry of Science, Technology, Innovations and Communications regulated how the medium wave channels would fall back to the Brazil's Federal Government (Ordinance No. 2771/17);

- On 25 January 2018, [Decree 9.270/2018](#) opened a new period of 180 days for the remaining broadcasters to present the request for migration from AM radio service to FM;
- In February 2020, Anatel published [Resolution 721/220](#) which included technical parameters to extend the FM band to 76-88 MHz;
- In October 2021, the Mercosur Sub-Working Group no. 1 "Communications" approved the revision of the technical rules that are applied for frequency coordination of FM audio broadcasting stations in border zones to include the FM extended band ([Resolution 47/2011](#)); and
- In April 2022, the Inter-American Telecommunication Commission (CITEL) published Recommendation [PCC.II/REC. 66 \(XXXIX-22\)](#), which recommends that CITEL Member States evaluate the use of the 76-88 MHz frequency band for the provision of FM audio broadcasting services.

Objectives of the public policy

The migration from AM to FM, aimed at increasing audio and transmission quality for small radio stations throughout Brazil. However, other objectives were also achieved with this policy, including reinvigorating the FM market and increasing content availability and competition.

FM technology has proven to be still attractive to the broadcasting industry in Brazil, which was not the case for AM radio stations which became less attractive due to interference. With the migration from AM to FM, several new radio stations could be included in the radio station range of many urban areas, adding increased options and a more diverse programming set, which is beneficial for the public.

Another important achievement is the more efficient use of spectrum, delivered through the use of television channels 5 and 6 that were released following the analogue television switch-off (ASO), enabling effective service delivery with radio broadcasting. New usages are also under discussion, such as use of the same spectrum freed by the ASO to speed up the transition from analogue to digital radio broadcasting in Brazil, with the possibility of allocating simulcast channels, as was the case for television. However, this option is still under discussion in Brazil.

For more information on digital radio transition and adoption, refer to Chapter 4, section 4.2.7, of the Final Report on ITU-D Question 2/1 for the 2017-2021 study period, available at <https://www.itu.int/hub/publication/D-STG-SG01.02.2-2021/>.

A.17.2 DAB and DAB+ technologies adoption

The level of adoption of digital radio varies from country to country. Norway stands out as the sole country to have discontinued FM transmissions and fully transitioned to digital audio broadcasting (DAB) technology in national radio broadcasting.

A number of countries such as Hungary, Portugal, Ireland, and Romania introduced DAB+, but after several years' experience, they each ceased DAB broadcasting and shut down the receiver network.

Other countries maintain both analogue FM and DAB systems, with the two coexisting rather than replacing one another. In most countries DAB and FM operate concurrently, with some stations expanding their coverage areas across different networks.

Some countries have official DAB+ multiplexes, and there are 30 of these worldwide, while in 28 countries, DAB+ exists as a pilot project.¹²⁶

Population coverage percentages of DAB+ signals in European Union countries are high, ranging from 42 per cent in France at the bottom of the European Union table, to Italy at 86 per cent, Germany at 98 per cent, the United Kingdom at 97 per cent, and Denmark at the top of the table with 99.9 per cent (data from WorldDAB).

In the case of Bosnia and Herzegovina¹²⁷, the regulator for electronic communications began the process of introducing digital radio by issuing a public call for a DAB multiplex with specified conditions regarding coverage and deadlines to provide the services. However, as is the case in many other countries, Bosnia and Herzegovina is considering the profitability of this investment, and the real level of interest among users and radio broadcasters for this form of broadcasting, given that current estimates suggest that a relatively low number of citizens own DAB receivers. For this reason it is anticipated that the simultaneous broadcast of FM and DAB radio will persist into the foreseeable future.

The future of digital audio broadcasting (DAB) presents both opportunities and challenges, especially in the face of competition from other radio platforms and streaming services. As FM radio remains one of the last remaining analogue technologies, its limitations necessitate a shift to digital platforms. Younger audiences often view traditional radio as outdated, favouring alternatives such as YouTube, Spotify, and podcasts. However, fully transitioning to streaming services faces obstacles such as limited mobile network coverage, high data costs, and capacity issues. Policymakers should consider several factors when deciding upon DAB implementation, including its growing rate of adoption due to the superior sound quality and additional features of DAB, the influence of regulatory support and the influence of content diversity on user interest, as well as potential innovations such as interactive features, and smart device integration. Despite competition, the strengths of DAB in terms of broadcast reliability, spectrum efficiency, and localized content can help it to remain relevant. The future of DAB in developing countries will depend on economic development, technological advancements, regulatory support, and evolving user preferences.

i) DAB+ in Norway

Despite the switchover from traditional FM to DAB+ digital radio in Norway in 2017,¹²⁸ the initiative can be seen as an effort towards a form of NextGen FM.

DAB+ offers better sound quality, increased channel capacity, and increasingly efficient data services. The components of NextGen FM could be inspired by successful switchovers in other countries.¹²⁹

ITU has been studying this topic.¹³⁰

Hybrid radio

A hybrid radio is a device that allows you to receive broadcasts from radio stations via:

- digital audio broadcasting (DAB) or HD FM broadcasting, and/or
- Internet (IP) streams.

¹²⁶ <https://www.worlddab.org/countries>

¹²⁷ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0214/> from Bosnia and Herzegovina.

¹²⁸ <https://insight.npaconseil.com/techno-equipements/lexemple-reussi-de-la-transition-vers-la-radio-numerique-en-norvege/> (in French)

¹²⁹ https://www.tecnonews.info/tecnonewsworld/norway_makes_history_with_radio_s_first_digital_switchover

¹³⁰ <https://www.itu.int/en/ITU-R/terrestrial/workshops/SRME-19/Documents/Workshop/SRME-19-DigitalRadio.pdf>

The purpose of a hybrid radio is to provide a seamless broadcast service anywhere. When one transmission method becomes unavailable or weak, it is superseded by another.

The beauty of using a hybrid radio in an automotive context is that connection to the radio station can be maintained despite changing conditions.

For example, during a long-distance drive, a listener may travel out of the range of the FM signal of a station. If the vehicle is equipped with a hybrid radio, the hybrid radio will find another way of receiving that station and select it automatically, so that the listener can continue listening without interruption.¹³¹

According to the European Broadcasting Union "The introduction of digital and hybrid services can reinstate and fortify the role of radio as the backbone of audio consumption in the years to come."¹³²

ii) DAB+ in Senegal

Within the framework of the development of broadcasting services in Senegal and following the adoption of DAB/DAB+ standards by the international community, Senegal launched a pilot project for digital terrestrial radio (DTR). This pilot project began in May 2022, in Dakar, with broadcast tests on channels 10A and 10C.

Faced with the saturation of the FM band in some regions, Senegal undertook this DTR pilot project using the DAB+ standard to explore alternatives to frequency modulation (FM) broadcasting and to meet the growing needs of radio promoters.

DAB+ is a digital broadcasting technology that allows more stations to be broadcasted on the same frequency channel through digital compression, thus providing audio quality that is superior to that of analogue FM. In addition, the DAB platform provides access to rich multimedia content (text, images, video), and is more energy efficient, contributing to its reputation as a 'green' technology. By reducing the number of transmitters required, DAB+ also reduces non-ionizing electromagnetic radiation.

Digital terrestrial radio pilot project objectives

Senegal officially launched the pilot project on 10 May 2024, with the following objectives to:

- decongest the FM band;
- respond to the shortage of frequencies;
- promote technological innovation;
- solve interference problems;
- promote test coverage, quality of service (QoS), and user experience (QoE);
- analyse the costs and availability of receivers;
- study the CAPEX and OPEX per station.

For the evaluation of this experimental phase, a measurement protocol was defined, including coverage mapping, key performance indicators (KPIs), evaluation of receivers (portable, fixed, DAB+ USB sticks), field measurements and benchmarking with international standards.

¹³¹ <https://developers.radioplayer.org/use-cases/hybrid/>

¹³² <https://tech.ebu.ch/groups/radio>

Selection of radios

The criteria for selecting the radios for this experiment are based on:

- the status of radio stations (public, community, commercial, foreign);
- geographical proximity (Dakar, regions);
- collection media (encoder/decoder, Internet streaming, satellite);
- recording techniques (mono, stereo).

A total of 32 radio stations were selected to participate in the pilot phase.

DAB+ station coverage

The stream of each radio programme is transmitted at a bit rate of 64 Kbit/s with EEP3-A protection level. The field tests, carried out using a SANGEAN receiver, made it possible to capture 32 flows along the Kayar-Toubab Dialaw axis in the direction of Dakar.

During the last quarter, a quality of service (QoS) monitoring plan was developed, using the Audemat FM/DAB+ MC-6 tool, in order to exhaustively map the signals received over the entire Dakar region.

Implementation schedule

In terms of the implementation schedule, the following steps are considered:

- Drafting and signing of a protocol between the regulatory authority and the national broadcasting company. This protocol must define the objectives of the pilot project by specifying a matrix of responsibilities between the stakeholders.
- Overall evaluation of the pilot project: A complete analysis of the results obtained, highlighting performance indicators such as:
 - The benefit/cost ratio of infrastructure.
 - The benefit/cost ratio of receiver kits.
- Consultation between stakeholders: The establishment of a national committee to coordinate efforts and ensure synergy in the implementation of the project.
- Recommendations on the business model and next steps:
 - Development of recommendations on the business model to be adopted.
 - Definition of the next steps, with a key decision to be made between scaling up ("Go") or a paradigm shift ("Not Go"), depending on the results obtained.
- National policy and strategy:
 - Definition of a national strategy aimed at diversifying the offer of services.
 - Promotion of social inclusion and territorial equity to ensure that digital broadcasting is accessible to all segments of the population, including in the most remote areas of the country.

These steps are intended to ensure an efficient transition to digital broadcasting, while taking into account the specific features and national priorities for the development of audiovisual services.

Status of implementation

This pilot project is an opportunity to present the technical details of the solution, including a collection network (32 channels), a head-end (32 encoder/decoders), a distribution network (two + one transmitters each of 600 W) and a supervision system (two computers with software).

In terms of receiving terminals, 99 fixed receivers, 99 mobile receivers, 99 handheld receivers and 99 DAB+ USB keys were acquired. This equipment was distributed to institutional players, radio publishers, training institutes, and the general public in order to conduct qualitative and quantitative tests.

Unfortunately, these types of receivers are only available in specialist technical equipment stores. In addition, most cars are not yet equipped with DAB+ receivers to switch between digital radio and FM signals via a selector.

For this reason, many countries maintain both analogue and digital FM DAB+ systems, with the two co-existing, rather than replacing each other. As a result, most countries are simultaneously operating DAB+ and FM, with some stations extending their coverage areas across different networks.

In accordance with Article 4 of the Geneva 06 Agreement, Senegal has initiated international coordination for the notification of frequencies to ITU, with a view to their publication and recording in the ITU international register.

Senegal is the first West African country to be tested for DAB+ since June 2022.

In terms of steering, it is crucial to re-examine the importance of technical coordination, the organization of test broadcasts, the introduction of DAB multiplexes, opportunities for programme enrichment, parallel FM/DAB broadcasting, regulatory adjustments, and equipment adaptation in the automotive industry.

To this end, a dedicated national committee should be set up to deal with these issues properly, in order to avoid the pitfalls encountered previously in the implementation of digital terrestrial radio (DTR).

General guidelines

The future of digital terrestrial broadcasting (DTB) in Senegal presents both opportunities and challenges, particularly in the face of the rise of streaming platforms. The optimization of the FM band is essential in order to compensate for the current saturation, and to accommodate new services.

FM radio broadcasting is one of the last remaining analogue technologies still in use in the current digital era. In Africa, the saturation of the FM spectrum limits the available space for new programmes and services, necessitating the development of new digital radio platforms.

While many alternatives such as YouTube, Spotify, Deezer, and various podcasts offer options for listening to music and audio content, it is pertinent to wonder about the future of radio in its traditional form.

It has been noted that the transition to streaming-only services faces several challenges, including insufficient coverage with new generations of mobile networks, high costs associated with using mobile data, and capacity limitations.

For a successful implementation of DTR, the following recommendations are proposed:

- **Adoption:** Encourage the adoption of DTR because of its sound quality, diversity of available stations and additional capabilities.
- **Market dynamics:** Foster high user engagement through regulatory support and diversity of content.
- **Innovation and interactivity:** Integrate innovations to improve the user experience, such as personalized content recommendations.
- **Internet connectivity:** Consider the transition to digital platforms, while taking into account the challenges of network coverage and mobile data costs.
- The success of DTR depends on regulatory support, innovation in content, and user preferences. To this end, Senegal could consider creating a **national committee** responsible for defining strategies for migrating to digital technologies and promoting their adoption.

In short, the future of DAB+ will depend on such factors as economic development, technological advances, regulatory support, content innovation, and user preferences.

Despite competition from other platforms, digital terrestrial radio (DTR) can leverage its strengths in terms of delivery reliability, spectrum efficiency, and localized content to remain a relevant and attractive choice for radio enthusiasts.

Annex 18 – Case studies of spectrum planning for digital broadcasting, including interference mitigation

A.18.1 Spectrum monitoring in Argentina

The policy adopted by Argentina for the administration and management of the radio frequency spectrum not only defines the provision of telecommunications services, but also impacts companies that develop services and solutions relying on this resource, even if they are not necessarily licensed for information and communication technology (ICT) services. The future of innovation in production processes is tied to the advancement and promotion of high-capacity wireless network deployment, a key element in boosting the productive matrix of the nation.

Within the ICT sector, the spectrum is one of the most relevant resources for the provision of mobile telecommunications services. The management of spectrum resources in Argentina has gone through different phases throughout history, depending on the socio-economic and productive model proposed by each government administration. These phases ranged from extraction and concessions to private entities (both national and foreign), to models of public exploitation.

However, in 2021, Argentina introduced a domestically developed platform for the technical verification of electromagnetic emissions in the radio frequency spectrum. This reversed the previous logic, where spectrum management was carried out by international third-parties, or through technological solutions provided by foreign companies, thus concluding the cycle of sovereignty over the management of the natural resource initiated in 2004.

The recently acquired technological solution, called the iSpectrum App, is entirely local and the result of collaborative efforts between the public and private sectors, which flourished thanks to policies promoting the development of the knowledge economy.

The iSpectrum App is a flexible solution that simplifies and automates radio frequency spectrum monitoring activities. Currently focused on terrestrial services with minimal connectivity and hardware requirements, it has the ability to control and manage equipment independently of the manufacturer, including digital receivers, measuring equipment, and peripheral accessories such as uninterruptible power supply (UPS), global positioning system (GPS), antenna switches, routers, and PCs, among others. These features facilitated the deployment, adaptation, reuse, and capacity expansion of existing equipment in the national technical emission verification system (SNCTE) of the communications regulatory authority. Work is currently underway to incorporate the monitoring of satellite services, coverage planning (4G/5G/FM/DTT/satellite), signal localization, and automated measurements using unmanned aerial vehicle (UAV) systems.

Argentina has made progress in solving historical problems such as the technological obsolescence of its radio emissions verification system, and its dependence on the global oligopoly of hardware manufacturers. It has also addressed current challenges, such as the lack of foreign exchange to acquire international goods and services, operational difficulties in having highly qualified human capital, and long-term projections, positioning itself with its capabilities at the forefront of mobile technology evolution.

The Government of Argentina considered the effective and efficient use of public resources by deciding to nationalize the management of the radio frequency spectrum in 2004, with the aim of prioritizing the development of individuals and society. In this way, the public value chain is promoted, creating opportunities for local companies and workers, that can serve as a model for other countries.

A.18.2 Interference mitigation strategies in Brazil

An example of policies implemented to mitigate interference is that of Brazil¹³³. This case study highlights the satellite broadcasting policy adopted in Brazil to extend the coverage of television broadcasting to remote and rural areas, as well as suburban areas without optimal digital terrestrial television (DTT) coverage. The initiative was also targeted at solving the problem of interference caused by the 5G networks of neighbouring countries/stations using the 3.5 GHz frequency band, to satellite broadcasting services in the C band using the same band (3.5 GHz).

The solution that was proposed was to migrate existing satellite broadcasting technologies in the C-band, to another frequency band, the Ku-band. This led to the need to provide appropriate digital receivers to low-income populations and has also promoted the extension of digital satellite broadcasting coverage in these areas.

In addition to the main objective of avoiding interferences, other specific objectives include, to allow the use of 5G in the 3.5 GHz frequency band and, to facilitate the migration of existing analogue satellite services to a digital broadcasting service exempt from interference.

As part of the transition to digital satellite broadcasting, two entities were created. One for monitoring the implementation of solutions to interference problems in the frequency band 3 625-3 700 MHz (GAISPI¹³⁴), and the other for the management of the 3.5 GHz band (EAF – Siga Antenado¹³⁵). These entities are operational and have created communication channels to inform beneficiaries of reception kits about the procedures to obtain and install the reception kits. Both entities, GAISPI and EAF, are responsible for the equipment included in the kits, the acquisition and distribution costs, and the scheduling of activities.

The migration process is expected to continue until 2025, and so there will be a simulcast period of transmissions in the current band (C-band) and in the new band (Ku-band), followed by the discontinuation of transmissions in the C-band. After the end of the simulcast period, only households that have received kits or purchased new devices will be able to continue watching satellite TV in digital.

The GAISPI and EAF entities are also responsible for organizing awareness and information campaigns to update the registration of terrestrial stations of the fixed-satellite service operating in the C band, both for the correction of data, such as geographical coordinates, and for the creation of new listings, mainly from reception stations. More information can be found in Annex 15 of this Final Report.

A.18.3 Case study on eliminating harmful interference in Bosnia and Herzegovina

In Bosnia and Herzegovina¹³⁶, the transition from analogue to digital broadcasting services began in 2006, with the aim not only of complying with the Geneva Agreement GE-06, which defined 17 June 2015, as the end of the transition period, but also to benefit from an efficient use of the frequency range and to offer a better quality of television broadcasting with advanced services to its citizens.

Unfortunately, the project was delayed, leading to interference with neighbouring countries that have completed their digitization process and advanced in the introduction of new technologies, especially for 5G deployment.

According to the frequency allocation plan, the UHF and VHF spectrum is divided into respective groups of very high frequency (VHF) and ultra-high frequency (UHF) channels: VHF 5-12 channels

¹³³ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0143/> from Brazil.

¹³⁴ GAISPI - Monitoring Group for the Implementation of Solutions to Interference Problems in the Frequency range of 3,625 to 3,700 MHz.

¹³⁵ 3.5 GHz Band Administering Entity (EAF).

¹³⁶ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0201/> from Bosnia and Herzegovina.

(used by public broadcasters) and UHF 21-69 channels (for all broadcasters). The UHF TV channels frequencies band should be reassigned from broadcasting to mobile services (digital dividend) and is further divided into 3 blocks of channels, as follows:

21-48	49-60	61-69
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Each country is required to comply with ratified international agreements and take immediate steps to eliminate interference from television channels that no longer have the right to broadcast analogue signals. This was the case when Croatia filed a complaint against Bosnia and Herzegovina in April 2021, regarding interference in the 700 MHz frequency range (attributed to 5G technology) from analogue broadcasting in Bosnia and Herzegovina.

Bosnia and Herzegovina quickly reacted by implementing several actions, including the granting of multiplexes for commercial broadcasting. In its proceedings, the Bosnia regulator informed the competent institutions and licensees of the request received from Croatia. In this regard, meetings were held with representatives of broadcasters, during which a schedule for the shutdown of the analogue signal was set, from 01 July to 31 December 2021. It should be noted that 171 transmitters from 26 television stations throughout the country were affected by the shutdown of analogue broadcasting.

At the time of receipt of the application from Croatia, Bosnia and Herzegovina had only one multiplex (MUX A) in operation, intended for public service broadcasting, with a capacity of 19.9 Mbit/s, due to technical limitations imposed by the DVB-T technology.

It was clear that under existing conditions it was possible to broadcast six TV program streams (three public HD 720p HD programmes, at 4 Mbit/s each and 12 Mbit/s total, and three commercial SD programmes, at 2 Mbit/s each and 6 Mbps total) in each region. Through further analysis, it was confirmed that, under the existing conditions, and given the available multiplexes in each region, it was not possible to broadcast the 26 program streams affected by the analogue shutdown in compliance with the complaint received, without compromising the operation of public broadcasting services.

In view of this and the fact that MUX A was allocated to public broadcasting services, it was requested that commercial television stations should contact public broadcasting services, to negotiate entry into MUX A in accordance with available technical capacity, explicitly emphasizing that consent would be given for any agreement reached. In the meantime, the process of setting up the multiplex for commercial television channels began, and this multiplex is now fully operational. As a result, there are now two fully operational multiplex operators in Bosnia and Herzegovina: MUX A for public broadcasting and MUX D for commercial broadcasting.

In addition, it can be noted that the programming of the 26 television channels, the subject of the application from Croatia, was also included in the offer of almost all cable operators in Bosnia and Herzegovina, with coverage of up to 90 per cent of all households in the country, a fact that facilitated the analogue switch-off.

A.18.4 Interference mitigation policies in Senegal

Interference is a major problem for radiocommunications because it interferes with signal transmission. The broadcasting service in the VHF/UHF bands, which is a significant user of the radio spectrum in West Africa, is increasingly confronted with interference issues arising from the rapid technological evolution which has created an increasing demand for spectrum in these bands.

The proliferation of broadcasting stations has increased the volume of harmful interference, not only between the broadcasting stations themselves, but also with other radiocommunication services.

In addition, the ending of simulcast has not yet been effected in all West African countries. This could lead to interference between neighbouring countries. Indeed, some countries have already

deployed 4G mobile networks in some digital dividend frequency bands, while analogue TV continues to operate in others.

According to the Radio Regulations (RR) of the International Telecommunication Union (ITU), there are three types of interference:

- **Permissible interference:** Observed or predicted interference that meets the interference levels and quantitative sharing criteria set out in the Regulations, or in ITU-R Recommendations or in special agreements, the possibility of which is provided for in the Regulations (RR Article 1.167).
- **Accepted interference:** Interference, greater than that defined as permissible, which has been agreed upon between two or more administrations without prejudice to other administrations (RR Article 1.168).
- **Harmful interference:** Interference which endangers the functioning of a radio-navigation service, or of other safety services, or seriously degrades, obstructs, or repeatedly interrupts the functioning of a radiocommunication service operating in accordance with the Radio Regulations (RR Article 1.169).

Interference is regularly reported by administrations, the main causes of which are:

- **Unauthorized transmissions.**
- **Lack of coordination:** Harmful interference caused by the use of uncoordinated frequencies.
- **Failure to comply with technical operating characteristics:** transmission power, frequency tolerances, antenna orientation.
- **Unnecessary transmissions:** Harmful interference caused by the transmission of superfluous signals.

This issue of interference is crucial, and is the subject of ongoing study by ITU and administrations.

Subregional approach to mitigating interference

Within the framework of interference prevention and management, Senegal, Gambia, Guinea, Guinea-Bissau, Mali, Mauritania, and Cabo Verde adopted in August 2009, a Coordination Framework document for coordination and sharing of frequencies at borders with the participation of 21 telecommunication operators.

The main objectives of this coordination framework agreement are to:

- harmonize the use of frequencies in neighbouring countries;
- guard against harmful interference in border areas; and to
- propose provisions for frequency sharing and coordination in specific frequency bands.

Note: The border zone/coordination zone is the area adjacent to the border of two countries, 15 km deep inside each country.

The Coordination Framework document was updated at several meetings between 2013 and 2020.

The legal and regulatory framework of the Coordination Framework document refers to Article 6 of the "RR special agreements". The document is composed of five general provisions and seven technical annexes.

- In practice, the coordination procedure is based exclusively on the principle of equitable access to frequency resources. In addition to the overall framework provided by the coordination framework document, bilateral agreements were signed with bordering countries providing further details on trunking channels and emission thresholds.

Thus, channels have been defined and allocated to countries in the different border areas, and this new plan is being implemented by the national operators.

Monitoring missions are carried out in response to complaints or annually. Monitoring missions provide an opportunity to verify compliance with the allocated channels as well as compliance with the emission thresholds set. For example, Senegal and Mauritania regularly carry out joint monitoring missions to verify the effectiveness of the bilateral agreement and take corrective measures if necessary.

There are many interference issues in border areas, especially for mobile communication services. The coordination framework document and the bilateral agreements focus, at this stage, mainly on these services rather than on broadcasting. The development of DTT in the countries of this subregion is not yet sufficiently advanced.

However, this established coordination framework may contribute to the resolution and prevention of future interference conflicts related to the widespread deployment of DTT at different rates.

Annex 19 – Case studies of digital dividend usage

A.19.1 Italy case study

This case study considers the approach taken by Italy, following discussions at European level, concerning the release of the 700 MHz frequency band and the reorganisation of digital terrestrial television. Figure A.19.1 shows the approach taken by Italy in the release the 700 MHz frequency band. Coordination at the European level and thorough planning were key components in the approach of Italy.

Figure A.19.1: Release of the 700 MHz frequency band in Italy

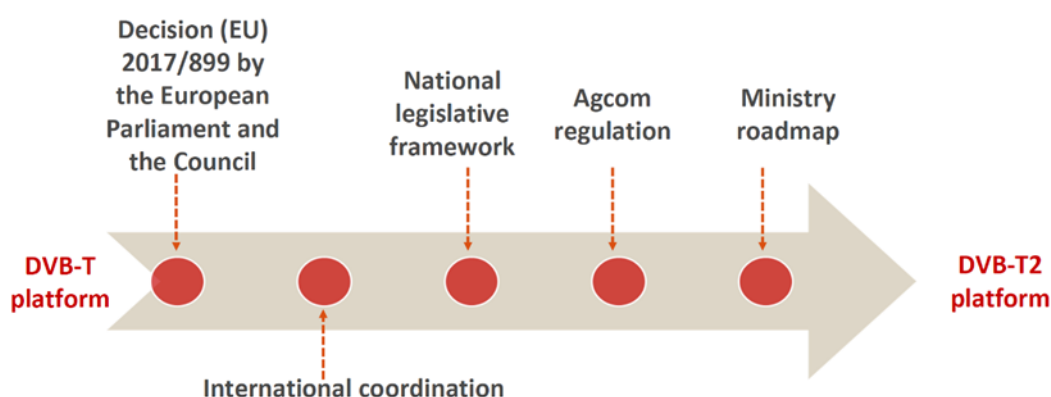


Figure A.19.2: Roadmap for DTT move from 700 MHz to lower frequency bands

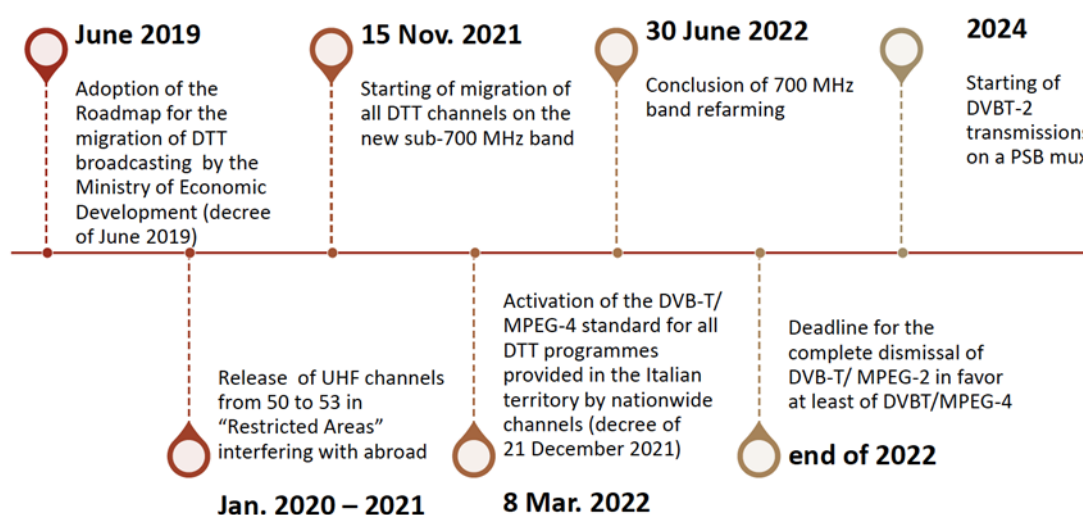
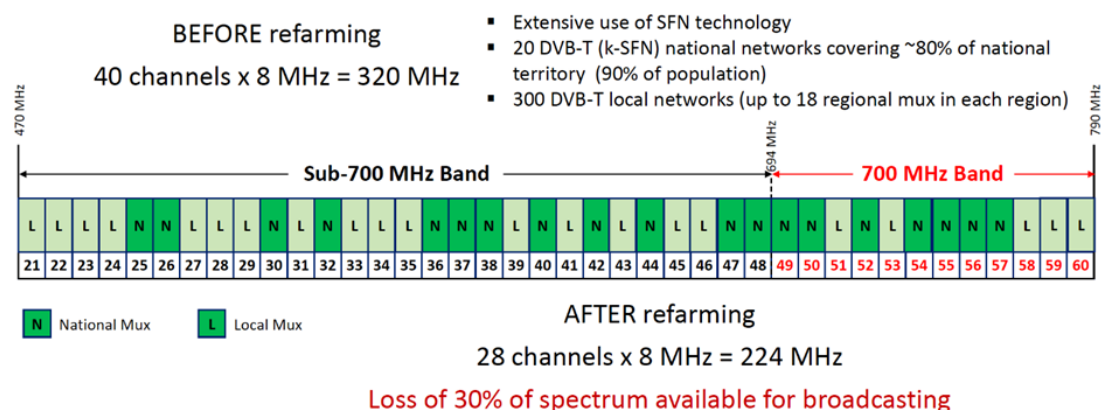


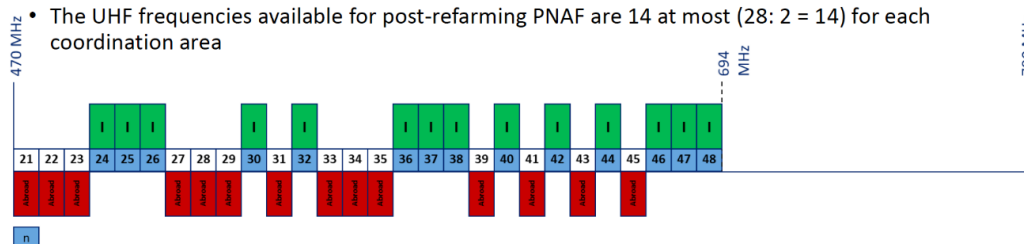
Figure A.19.2 shows the roadmap for the migration of DTT from the 700 MHz band to lower frequency bands allowing for the use of mobile services providing voice and data communications in the 700 MHz band.

An important task that needed to be accomplished was the mitigating of interferences with neighbouring countries and the refarming the frequency bands to accommodate the channels in the 700 MHz. Figure A.19.3 shows the impact in terms of the number of channels available after this refarming exercise.

Figure A.19.3: Impacts on frequency allocation after the release of the 700 MHz band



- Before the refarming of the 700 MHz band.
 - Considering:
 - the total amount of channels available in the sub-700 MHz band (28 channels)
 - the constraints deriving from the rules of international coordination (equitable access)
 - the constraints deriving from the 2018 Budget Law
 - The UHF frequencies available for post-refarming PNAF are 14 at most ($28:2 = 14$) for each coordination area



- After the refarming of the 700 MHz band.

In order to make possible the reallocation of stations a series of actions were planned and implemented:

- Exclusive use of coordinated frequencies assigned to Italy;
- Extensive use of single frequency networks (SFNs);
- Adoption of the most efficient coding techniques (such as high efficiency video coding) and transmission standards;
- Assignment of nationwide and local/regional multiplexes.

Another key aspect to the success of the replanning was the policy and regulatory actions taken (Decision no. 129/19/CONS approved 18 April 2019), such as:

- National and local DTT operators had to progressively release frequencies in the 700 MHz band, migrating to the sub-700 MHz band.

- Different policy approaches at national and local level, since market exit mechanisms were envisaged only for the local sector:
- Cost refunding mechanism for the change of technologies from DVB-T to DVB-T2 for the national TV broadcasting company;
- Compensation mechanism for the withdrawal of the usage rights for the local operators;
- Rules establishing the conversion of existing DVB-T spectrum usage rights into rights of use of transmission capacity of the national DVB-T2 MUX and awarding of spectrum to operators.

The funding scheme is presented in the table below:

Entities	2020	2021	2022
National broadcasters	EUR 24.1 million	EUR 24.1 million	EUR 228.1 million
Local broadcasters	EUR 230.3 million	EUR 73.9 million	

An aspect which is worth highlighting is the competitive procedure for auctioning additional spectrum made available following the removal of the reservation of transmission capacity in favour of local broadcasting (Decision no. 564/20/CONS).

Some of the lessons learned from the overall replanning and reallocation exercise include:

- The reorganization process of broadcasting following the release of the 700 MHz band had a significant impact on the entire broadcasting sector.
- A number of investments were made by operators and by the State to manage the transition, due to the high DTT penetration in the country and the large number of DTT households that needed to be migrated.
- DVB-T2 rights of use of spectrum with a ten-year duration, were assigned to network operators starting from 2019.
- The full transition to DVB-T2 was expected to start from 2024.
- During the transitional period, local and national networks (reduced from 20 to 12 networks) operated in DVB-T. This resulted in a shortage of capacity available to audiovisual media service providers.
- The requests for high quality video services (in UHD or HD formats) made bandwidth availability even more critical.
- The full transition to the next stage of DTT technology (DVB-T2, MPEG4/HEVC, HDTV/UHDTV (4k) is ongoing but the TV renovation cycle needs to be completed.
- The impact of reorganization on local broadcasting, moving from a vertical integration model to a horizontal entry model, is yet to be assessed.
- Currently and for the foreseeable future DTT is the main TV distribution platform in Italy.

A.19.2 Brazil case study

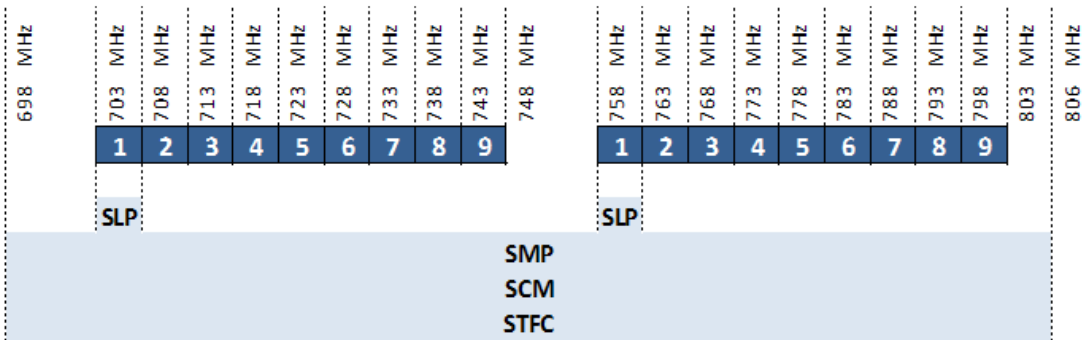
In 2013, Brazil approved the reallocation of the 700 MHz band to fixed and mobile services to provide voice and data communications¹³⁷.

The band allocation was established to comply with frequency division duplexing (FDD), and the band was divided into nine 5 + 5 MHz sub-bands. The use of time division duplexing (TDD) could be authorized on these sub-bands, if technically feasible. Finally, it was decided that the first 5 + 5 MHz sub-band would not be used for 4G services, so this sub-band was consequently allocated for public safety applications. The allocation of the 700 MHz band is shown in Figure A.19.4.

To ensure fair competition, a spectrum cap of 10 + 10 MHz was also established for the first round of the auction. For any remaining spectrum, the cap could be increased to 20 + 20 MHz for the second round of the auction. For small cities, the spectrum cap could also be increased to optimize investments, for example with the usage of shared infrastructure between all companies that bought the rights for the spectrum in those cities.

The auction established three national bands of 10 + 10 MHz, and one band of the same size for specific regions. For the second round, the remaining spectrum needed to be sold in smaller chunks of 5 + 5 MHz. Figure A.19.5 shows the 700 MHz band auction areas and the auction method employed.

Figure A.19.4: Frequency allocation of the 700 MHz band in Brazil

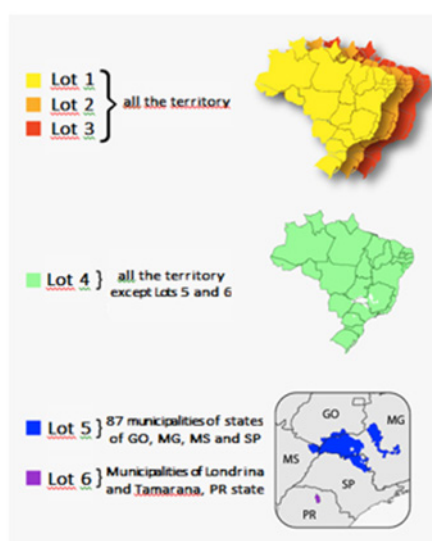


¹³⁷ Anatel Resolution no. 757, November 8, 2022. Available at: <https://informacoes.anatel.gov.br/legislacao/resolucoes/2022/1760-resolucao-757>

Figure A.19.5: Brazilian 700 MHz band auction areas



Brazilian 700MHz Band auction rounds



Currently, the 700 MHz band is completely freed-up and ready to be used by mobile services all over Brazil.

Annex 20 – Question 2/1 Lessons learned

Web	Received	Source	Title
1/364	2024-09-20	Senegal	Digital dividend and prospects for the development of broadcasting in Africa

1. Adopt single frequency network (SFN) configuration instead of multi-frequency network (MFN) configuration to maximize the efficient use of frequencies.
2. Allocate part of the revenues generated by the sale of 4G and 5G licences to financing the transition to DTT and audiovisual content production, taking into account that these frequencies were originally intended for broadcasting.
3. To encourage the participation of broadcasters in the work of ITU, particularly World Radiocommunication Conferences (WRCs), in order to defend the interests of broadcasting in frequency management.

Web	Received	Source	Title
1/337	2024-09-18	Korea (Rep. of)	Migration from DTV to UHD TV – Enhancing viewers' experience for OTA media content delivery

- Government support, in the form of policies, incentives, and spectrum allocation, plays a key role in enabling the adoption of new technology.
- Collaboration among broadcasters, manufacturers, and other stakeholders ensures that the technology is deployed efficiently.
- A focus on both consumer education and high-quality content can increase public awareness and accelerate the adoption of new broadcasting standards.

Web	Received	Source	Title
1/201	2023-10-09	Bosnia and Herzegovina	Analogue TV interference in the 700 MHz band

Delay in the process of the transition from analogue to digital broadcasting inevitably causes interference problems with neighbouring countries who have completed their digitalization process and advanced in the introduction of new technologies. Every country is obligated to comply with ratified international agreements and take immediate steps to eliminate interference from TV stations that no longer have the right to broadcast uninterrupted analogue signals.

In the case of Bosnia and Herzegovina, even though the Ministry of Communications and Transport had the main responsibility for carrying out the process of digitalization, the regulatory agency played the crucial role as an initiator and a partner in almost all activities of this process. It is of utmost importance that the regulator acts in accordance with its legal responsibilities and competencies laid down by the law to remove obstacles for industry growth and to ensure the country respects ratified international agreements.

Web	Received	Source	Title
1/153 +Ann.1	2023-09-07	Korea (Republic of)	Case studies utilizing TV platform to enable inclusive communication

Through two projects, it has been proved that TV is one of the most impactful platforms for delivering social values to deaf people. The two projects, funded by Government, are just starting point, as AI-based sign language translation technology is still in early stage. There was a proof of concept (PoC) project by two leading TV manufacturers to implement avatar sign language on their user guide. As the technology evolves, we can expect all contents on TV to be automatically translated into avatar sign language. To make this happen, there should be strong support from Government on AI training datasets (parallel corpus of sign language and spoken language) and on an effective translation engine.

Web	Received	Source	Title
1/48	2022-10-13	Bhutan (Kingdom of)	Strategies: Deployment of broadband in Bhutan

In order to operate and manage the network, it is necessary to involve stakeholders in ensuring reliable and available service anytime.

Government needs to provide subsidies/incentives to telecommunication operators in development of ICT Infrastructures.

Government developed infrastructure (fibre-optic network) and leased to telecommunication operators and a demand aggregation project reduced tariffs to make it affordable for communities.

Web	Received	Source	Title
SG1RGQ/115	2023-04-25	South Africa (Republic of)	Sharing experience from South Africa on the licensing process for international mobile telecommunications (IMT) in respect of the provision of mobile broadband wireless access services for urban and rural areas using the complementary bands, IMT700, IMT800, IMT2600 AND IMT3500

- The auction is a significant milestone that could lead to lower communication costs, expanded network reach to rural and outlying areas, improved network quality and enhanced competition.
- The regulatory authority has social obligations for telecommunications operators to connect 18 520 schools, 5 731 clinics and hospitals, 8 241 traditional authority offices, 949 libraries and a number of government services centres.
- While the revenue collected from the auction will go to the public treasury to support national priorities, the allocation of the high-demand spectrum will speed up the roll-out of new technologies, such as fifth-generation (5G) mobile, reduce the cost of mobile data and ensure greater Internet connectivity.
- The allocation of the spectrum will also enable the roll-out of 5G networks, which will accelerate the process towards universal connectivity, and the deployment of the digital technologies and services that are driving the fourth industrial revolution.

Web	Received	Source	Title
SG1RGQ/14 (Rev.1)	2023-02-20	Cameroon (Republic of)	Update on the process of migration from analogue to digital broadcasting and outlook

Lessons learned and suggested best-practices (if appropriate):

In Cameroon the process of migration from analogue to digital broadcasting currently faces several difficulties of a general nature:

- the problem of the division of responsibilities in the conduct of the migration process;
- the fact that the project is burdened by the need to take into account issues associated with radio production, TV production, and radio broadcasting as part of the rehabilitation of CRTV;
- the repeated modifications that the project has undergone in response to a variety of demands;
- funding difficulties.

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ISBN: 978-92-61-41025-4



9 789261 410254

瑞士出版
日内瓦，2025

图片鸣谢: Adobe Stock