国　际　电　信　联　盟

第11-2/2号课题
最后报告

ITU-D　第2研究组　第4研究期(2006-2010)

第11-2/2号课题:

审议地面数字声音和电视广播技术和系统，包括成本/效益分析、数字地面系统与现有模拟网络的互操作性，以及从模拟地面技术向数字技术过渡的方法

ITU-D 研究组

2006 年世界电信发展大会（WTDC-06）根据第 2 号决议（2006 年，多哈），保留了两个研究组，并为它们确定了研究课题。WTDC-06 通过的第 1 号决议（2006 年，多哈）规定了研究组应遵循的工作程序。在 2006-2010 年期间，第 1 研究组受托开展电信发展战略和政策领域九个课题的研究工作。第 2 研究组受托开展电信业务及网络和信息通信技术应用的研发与管理领域十个课题的研究工作。

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鸣谢和前言

从模拟到数字地面广播的过渡是一个相当复杂而繁锁的过程，对整个广播链具有举足轻重的影响。虽然主管部门和广播机构将在实施过程中费劲周折，但过度将使广大受众获得模拟电视广播无法想像的更多娱乐和信息体验。过度关系到政府和国际、国家、区域及社区层面各种相关机构，其中包括监管机构、广播机构、广播工业、观众和听众，即现代社会的所有人。

ITU-D第11-2/2号研究课题职责范围甚广，不经过与全球广播专家的磋商并听取其建议，无法成功完成此报告。

的确，ITU-R第6研究组自始至终顶力相助，我们希望对ITU-R第6研究组IRT主席Christoph Dosch博士（德国）、ITU-R第6研究组副主任Oleg Gofaizen教授、乌克兰无线电广播电视研究所、ITU-R 6C工作组主席来自欧广联的的David Wood先生、美国CBS高级副总裁Joseph Flaherty博士和澳大利亚Free TV工程总监Roger Bunch先生给予的帮助和建议表示感谢。

我们还汲取了巴西、保加利亚、法国、德国、俄罗斯联邦主管部门、法国泰雷兹、DigiTAG、DVB、欧洲广播联盟和欧洲委员会以及Rohde和Schwarz均为本报告提供了宝贵的意见。

我们还要对欧洲广播联盟技术总监Lieven Vermaele先生、德国IRT频率管理处负责人Roland Brugger博士和英国BBC研发部高级研究工程师Richard Salmon先生的一贯支持表示感谢，通过分享知识和最新科研信息，进一步提高了本报告的价值。

本报告将作为ITU-R第6研究组可供使用或正在处理的出版物组成部分。

为此，应将以下ITU-R出版物作为补充资料：

- ITU-R BT.2140号报告“从模拟到数字地面广播的过度”
- 有关“数字地面电视广播（DTTB）实施”的手册
- 有关“数字电视信号编码和工作式接口”的手册。

值此之际，我荣幸地向本研究课题报告人俄联邦的Semen Lopato先生和本研究课题副报告人法国泰雷兹Philippe Mege先生以及ITU-D第2研究组各位尊敬的代表表示感谢，感谢他们富有成效的贡献以及赋予我们的信认。

我还要感谢本研究课题电信发展局联系人Izstvan Bozsoki先生和电信发展局秘书处为实现ITU-D第11-2/2号课题的目标给予的支持和帮助。

保加利亚索非亚

交通信息技术和通信部副部长顾问，

ITU-D第11-2/2号课题代理报告人

Petko Kantchev先生

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第11-2/2号课题

1 背景

卓越而又富于创造的人们已经将声音（音频）和电视数字广播概念化，并且开发了大量标准。

音频、视频和数据被数字化，并且被严格编码，然后进行广播，最后在用户终端处进行解码。这种新方法可以改进接收质量，允许增加广播频道的数量，或可作为一种选择，一旦模拟广播停止后还可使国家监管机构能够重新分配频谱，并可为其他运营商发放许可证。此外，此种新方式还做了切实的革新。由于对数字广播信号实施非常严格和可靠的编码，并采取了灵活应用数字广播频道的、高容量的长远策略，使得在音频、视频和数据的数字流之间进行重新分配成为可能。简言之，数字广播平台创造了有待进一步发掘的新机遇。

广播业务的数字化传播是通过CATV、地面广播网络和卫星广播网络而实现的，并且在世界上的很多国家都已经投入运营、或者处于测试阶段。最近，互联网和电信业务提供商也向终端用户传送了相同的广播业务。便携的手提式终端使声音和电视广播节目的接收也成为可能。

声音和电视广播链包括如下组件：

a) 投稿网络：交付各种输入材料用以制作节目；

b) 产品中心：组装并处理声音和电视节目；

c) 分发网络：将这些节目传送到发射网络；

d) 发射网络：将这些节目广播给听众和/或观众，以及最后；

e) 观众/听众的接收与播放终端。

上述广播链组件中的a)、b)、c)和d)可能完全由某个广播组织来运作，或者作为可选，上述任一组件可能转包给一个或多个专门的业务提供商。值得注意的是，广播链中的组件a)、b)、c)和d)，通常与节目的产品来源一起，全部置于某广播组织的整体预算中。

随着数字广播技术最近出现的进步，广播链中的a)、b)和c)部分在向数字技术演进的过程中也面临着复杂的挑战，并对听众/观众产生影响。

非常令人惊讶的是，我们发现广播公司所投入的全部基础设施的投资，可能比听众和观众为了能够让所有家庭都能够接收并播放广播节目而对接收和播放终端（见上述的组件e）所投入的基础设施投资要少。

我们相信，在作出任何关于转换到数字广播的策略决定时，如果不考虑广播链中的关键投资者–数百万听众和观众的兴趣和期望，那这种决定将是不公平的，也是有风险的。这样就可能会引出一些不可避免的问题，即为什么要强迫人们去购买机顶盒（STB），或者为什么仅仅是为了从模拟变为数字，就要让他们面对更新其接收/播放终端的难题。对这些关键投资者来说，真正的原因是不断增长的、令人感兴趣的高质量广播节目所产生的刺激。可能有如下假设，即到目前为止，在模拟广播技术领域所获得的进步可能非常适用于大多数观众/听众关于信息、娱乐和教育的一般需求。如果在从模拟到数字的转换过程中，不能提供有吸引力的内容和增值的创新业务，那么向数字广播的转换可能会被延迟。

很显然，主管部门/监管部门是这种转换的推动力。

广播公司将会认真地选择前景最光明、最经济的和预先规划好的数字广播转换策略。在接收/录制/播放终端进行了投资的普通公众，假设他们对更多更好的节目和服务的期望得以实现，并且适时的、可用的、支付得起的机顶盒（STB）和/或数字广播接收/录制/播放终端可以确保到数字广播的平滑过渡，那么他们将采纳向数字广播的转换策略。

一百二十多个国际电联成员，（其中有119个成员来自1区），已经参加了日内瓦的2006年区域性无线电通信大会（RRC-06），在这里，从模拟到数字的频率规划和转换方面已经在条约层面达成一致。

更广泛的国家层面的规划练习不仅在1区的国家而且已经在国际电联的2区和3区的其它一些国家中展开。

由于上面所述的原因，本报告将关注于上述组件d)和组件e)中从模拟到数字的转换。

目前，在多数发展中国家，还没有引入地面数字广播。那些已经批准了转换策略和计划，并且已经声明了地面模拟广播截止日期的工业发达国家的主管部门，对于转换至少有三个主要原因：

- 优化并更有效地使用频谱；
- 通过将频谱拍卖给新的ICT业务投标者而潜在地提高国家收入；
- 通过使用户接收到更广泛多样、有吸引力的节目（包括本地广播节目），并为质量优于模拟节目的广播业务提供创新业务和应用方面的补充（尤其是可能的交互式业务），重振广播业务市场。

在大多数发展中国家，必须提及的是：

- 发展中国家的社会/人口统计数据显示，即使在现代改进的技术平台，如DTTV的基础上引入更商业化的广播公司，其发展也是有限的；
- 在大多数发展中国家，并没有强大的市场力量来推动将空闲的频谱准备用于创新的ICT业务。

这就意味着在大多数发展中国家，商业化或许并不能成为引入数字广播的关键驱动力，而且还有一些重要的原因需要继续通过占有统治地位的模拟地面发射网络来进行广播。因此，对于大多数发展中国家而言，从模拟向地面数字广播的转换是可行的，但是并没有急迫的必要性。

另一方面，发展中国家的地面模拟广播的生命周期能够被再延长至少十年以上，这样随之而来的是由于技术的退化，将会不可避免地推动广播公司和听众/观众向数字广播进行转换。广播公司为了扩展当前模拟发射网络的人口覆盖以便实现他们的普遍服务义务，将会面临单位观众预算的高成本。尤其是，他们还将被迫继续对过时的和昂贵的发射技术进行投资（例如，模拟电视要广播一个单独的电视频道，需要大约四倍的频谱和很多倍的功率）。DTTV在连接数字鸿沟，以及在发展中国家创建信息社会中可能作出的贡献也不应当被忽视，尤其是考虑到DTTV能够作为教育、医疗、以及其他有社会价值的ICT服务和应用的基础，包括交互式服务等。

因此，数字广播将最终在发展中国家推进，其原因在于，广播公司和业务提供商将受到模拟技术和相关技术支持不断萎缩的负面影响。

因此，对主管部门、广播公司、股东以及其他感兴趣的参与者而言，确有一些重要的原因使他们需要调查为发展中国家的地面声音和电视广播引入数字技术的各种可能方式。

地面数字广播的标准由国际电联和全球、区域和国家标准制定组织/实体制定。

因此，值得注意的是“政治互通”这一概念其范围要远大于技术互通的概念。其中涵盖的问题包括因使用多种标准或多种技术造成的市场细分。潜在的难点在于多种选择同时存在：50Hz/60Hz；720/1080线；交织或递归；以及多种压缩方式。因此存在市场割裂的风险，并带来政治后果。这一点从2004年IBC市场研究公布的结果中便可略见端倪，当时它便呼吁在欧盟内部制定一个统一的标准。但是，在撰写此报告时已存在各式各样的国家、国际和行业规范，已经造成了混乱。

早期有关在1080i或720p内引入业务的决定不应防碍有意使用1080p的各方实施这一计划。例如，在一次欧洲27国会议上面临的挑战便是如何确保不同成员国广播公司所做的选择能够长期共存。

有关地面数字声音和电视广播技术、标准和系统演进，以及部分案例补充研究的简要概述可通过最新的ITU-R第BT.2140号报告“从模拟向数字广播过渡”获取：http://www.itu.int/publ/R-REP-BT.2140/en 。该报告概要描述了向数字过渡的可选方案以及途径，其案文由两部分组成。

- 第1部分 涉及有关向数字技术过渡的主要问题，介绍了遇到的主要困难和可能的解决方案。
- 第2部分 针对第1部分中的重要方面，提供更为详细的信息。

ITU-R第BT.2140号报告和有关ITU-D第11-2/2号研究课题的本报告旨在提供补充性信息，通过相关安排避免在两份报告之间产生重复。

ITU-R第BT.2140号报告中业已提供的有关地面数字声音广播的信息很充分，但是，本报告第9章言简意赅地介绍了优势、技术平台、实施方法、特殊功能和可行的过渡阶段信息。

此外，ITU-R第6研究组为编制《数字电视实施手册》成立了报告人组。该组将尽力避免与本报告产生重复。

2 引入地面数字广播的各种可能观念

观念1：让市场力量在引入数字广播中起到关键作用

在这种情况下，各级主管部门不得不全面推进对于新业务和相关应用的引入和许可证的颁发工作。这对付费电视业务和不希望通过卫星转播的小区域和地区性运营商具有吸引力。因此，这种方式不能通过强大的驱动力来控制，从而影响发展中国家的数字广播形态。大部分发展中国家的高收入人群将从这种数字广播业务中受益。

观念2：基于受控的市场启动策略而引入数字广播

由于目前并没有明确的市场业务需求，因此在一定时间内受管理的/强制性的转换将会是引入数字广播的一种有效手段。监管机构/主管部门应当对模拟DTTV广播的布署施加中止命令，并且为模拟广播宣布一个较早的且固定的截止日期。这种方式将加快数字广播的转换，并且将是一种较快的方法来提供对高级普遍服务的访问，其中教育、医疗和其他社会应用将是这些业务的主要组成部分。对消费者而言，使用受资助的接收终端将是一种激励和催化剂。此外，很重要的一点是，政府还必须为公众广播公司的转换成本的增加给予资助，因为现存的资金模式不足以涵盖转换到数字广播发射网络所需的巨大投资。

观念3：使用各种交付平台的组合分步骤地引入数字广播

一种可选择的方法（所谓“岛屿方式”）是，首先有计划地在大城市中引入新业务，然后将这些业务扩展到国家的其他部分。消费者的特征以及在这些区域内的可支配收入将引导其成为成功的由商业和广告收入驱动的广播模型，随之而来的是可以减轻扩展所需的资金负担。很显然，这样一种转换计划将考虑到当前的模拟广播公司的利益。因此，通过一种干预手段来保护当前的模拟业务是至关重要的。可以使用卫星技术将业务扩展到那些服务水平较低的农村区域。然后，信号可以被中继到社区观看中心或多功能社区中心。随着成本的降低，以及在大城市的成功推出（从财务角度），可以安装具备恰当信号反馈的DTTV发射机，从而提供本地覆盖。

在可能的情况下，计划中应当避免在某个给定区域内，同时通过模拟和数字发射网络进行广播，因为对广播公司而言这样的成本是非常高的。事实证明商业电视广播商对这一问题十分敏感。

3 转换策略的选择

目前，大多数发展中国家都面临着模拟向数字转换的挑战以及关于教育、医疗等具有高预算优先级事务之间的矛盾。然而，至关重要的是不能因为当前的预算限制或其他国家优先级事务，而忽略了创建信息社会的长远利益。

在大多数发展中国家，地面数字广播对于实现下述策略性目标而言是一种可行的方式：

- 实现国家的无线电通信目标，例如：使用远程教育技术解决方案；
- 通过DTTV的高级发射能力，提供将公众广播内容分发给所有居民（普遍服务）的方式；
- 通过DTTV的高级发射能力，为商业广播公司提供一种机会，将其附加的收入流最大化。

然而，大多数发展中国家目前并没有处于这样一种准备就绪状态，即可以很容易地满足数字广播的接入、提供和启动测试的条件。很显然，观念1的主要缺陷是很少或根本没有项目规划，从而使得这种观念不会被考虑得更深远。

因此，对于大多数发展中国家而言，可以走向积极的经济和社会发展的唯一可行方式是使用一种受控的市场启动策略，如上文观念2和/或观念3中所述。事实上，鉴于模拟业务有可能被提前取消和/或根据商用和/或普遍服务的目标进行重新配置，观念3更为迅捷和强力的演进方式将带来产生大量的节约，消除双重的运营发射成本。受管理的/强制性方式将提高规模效益，最明显之处是通过更深的市场渗透降低成本。

至关重要的是所有利益攸关方均理解并支持将这种最为恰当的、符合经济增长、普遍服务和最终创建信息社会等国家目标的战略。

此外，还建议主管部门中最高层监管机构要通过宣布一个开始日期，从而对数字广播的启动作出战略决策。这可以为设定务实而全面的计划提供充足的时间，从而考虑到财政、员工、技能、技术、社会、以及其他各种因素的影响和牵涉。这种决定应规定为视频和音频调制、信道编码和传输选择的标准，由此，成为在预期时间内引入数字广播的有效手段。此外，上述监管机构应颁布禁止为模拟广播颁发许可的命令并尽早宣布切断模拟DTTV广播的确定日期。

一旦DTTV业务令人青睐的内容唾手可得，对模拟业务的选择将逐渐缩减，从而推动消费者走向数字化。第一次启用到应当在所宣布的日期开始。然后，模拟广播就可能在转换期结束后被终止，同步广播阶段正是为现存发射机制定资金替代计划的时期，同时给消费者市场一个充足的时间来将新技术带入家庭。

针对能够以最低入门成本提供DTTV接入的基本数字电话接收机/机顶盒，可考虑给予国家补贴。

4 向DTTV的演进

数字广播运营必将产生巨大的变化，巨变不仅涉及广播产业链而且还将涉及各利益攸关方及其相互间的关系。

各国的立法应及早调整，以便能够适应向数字广播、专用内容、制作、多路复用，以及向大众和消费者转播。

所有权、融资、内容许可与频谱特性、管理和业务等方面亦需立法。

向DTTV广播过渡的国家战略应当制定并尽可能在最高层予以批准。广播产业链复杂而冗长-因此所有相关方间的有效合作至关重要。

由相关权能机构指定国家任务组，对此进行审议并就复杂的数字广播新环境提供正确的选择建议。

尽早做出详细的规划。

任命业务和覆盖质量责任经理，对质量问题给予特别关注。

最后，但很重要的是，具有吸引力的高级内容和以及接收的强健性是确保向数字广播成功过渡的两项关键因素。

从模拟向数字电视的转换策略由三个步骤组成，并且以如下内容为基础：

- 建立使用可用频率的新DTTV网络；且
- 存在已准备就绪、并且有能力在短时间内建立DTTV基础设施的组织。

这种方式还应确保当前模拟格式的广播和消费者接收终端在短时间内不会受到不良影响，同时还会有一段共存的时间，在这段时间内，节目将同时以模拟和数字格式进行发射。

应对现有国家立法予以修订，从而能够批准对地面数字网络的相关许可。为此，可采用下述建议：

阶段一：引入数字电视发射

- 对目前存在的规章制度进行审议，以确保它们可以反映出数字发射所隐含的问题。
- 不应当再颁发更多的模拟许可证。
- 允许当前的广播公司继续进行模拟发射，直至模拟广播的截止日期。
- 须向当前的广播公司分配特殊的频率信道，使其可以数字格式来提供联播。对广播公司而言，缺点是双倍的发射成本。
- 为新的业务保留特殊的信道，如移动DTTV广播业务。
- 应当发出倡议/意向书，看是否有运营商对商业DTTV网络的运营感兴趣/能够签署意向书。倡议的提出应当遵循一个判断，即在相应许可证下预先定义的可供分配频道和相关多路复用的数量。
- 为商用DTTV网络提供的频道许可证须收费。潜在的商业广播公司应当得到正式通知，告知其每频道每年的费用。
- 免费广播公司将在数字环境中与其他广播公司共用一个或多个频道，这样的广播公司不需要承担费用。
- 在对运营感兴趣的倡议发出后，对所收到的申请通过“选美”予以挑选。
- 复用和发射网络运营商遵循的规章制度与电子通信网络使用的规章制度相同。
- 数字广播的启动阶段应当在覆盖、接收质量和干扰方面得到严格监控。
- 应设立一个“利益攸关方”组来协调过渡过程。
- 应研究涉及广播链运营商的基础设施共用安排。
- 为商业DTTV网络颁发频率许可证应当满足在一定时间内覆盖全国的布署要求。

阶段二：联播阶段

- 在这一阶段须确定面向观众开始广播联播的日期。广播公司在联播阶段的费用加倍，因此，要采取合理措施缩短该阶段。
- 鼓励公众广播公司建立一个演进规划。应当与广播公司讨论，鼓励它们确立一个日期，至此，当前所有的免费模拟广播也使用数字传输。
- 现有的国家广播在可用的地面数字电视广播平台上应作为一种“必须承载”的义务予以提供，但对公共服务广播公司而言是免费的。

阶段三：模拟的切割（ACO）

须确定模拟广播的切割（最迟）日期。

在这一阶段，将关闭所有的地面模拟广播。在模拟广播切割之前，当前所有的广播公司都应转换到一个数字平台上，并且居民家庭须具备地面电视接收机或地面数字电视机顶盒（STB），在常规模拟电视接收机上进行接收。ACO须根据广播公司/监管机构所选择的转换方案以及市场对引入DTTV的总体反应予以确定。

为促进向大众提供DTTV/STB，政府可能采取的行动

为向大众提供DTTV接收机，政府可能采取下述措施：

1 在州或地方预算之外，为居民购买DTTV接收器给予长期的专项免息或低息（一年或更长）贷款。

2 准予政府为居民购买DTTV接收器而向私有银行提供专项贷款担保。

3 可以向最低收入群体的家庭提供固定金额的优惠卷或补贴，帮助其降低机顶盒或数字电视接收机的成本。

5 DTTV平台和网络

5.1 摘要介绍

地面数字音频广播（TDAB）（无线电）业务和无线电移动通信（UMTS）业务并未包括在DTTV这一术语之内，所以在此将不予以考虑。

规划地面数字电视时，需要在多路复用容量、覆盖质量和辐射特性之间平衡折衷。多路复用容量自身对服务质量十分重要（针对图像破坏和伪影等）。

多路复用的网络数据速率与多路复用内业务数量之间的关系由各个电视节目的数据速率来确定。

对可接收相关业务的人数（另一术语为“人口覆盖”）而言，覆盖质量十分重要。此参数被定义为在特定地点存在噪声和干扰的情况下，收到有用信号的比率。

人们或者是能够接收到电视节目信号或者在屏幕上什么也收不到－这与模拟电视广播不同，不存在在“可接受劣化”的情况下接收图像的可能性。

具有规定接收率的所有位置共同构成了覆盖区。发射机的辐射特性与传输成本相关。发射机的功率和天线的规范，无论是来自单一的发射电台还是来自单频网络（SFN），均可确定在特定位置接收时产生的场强。

在服务质量、潜在观众数量和传输成本自身之间折衷非常复杂，因为这期间要考虑多项互斥的因素。选择会受到操作、规则和技术因素的限制。

针对各类业务，折衷方案均不相同，从而产生了不同的辐射特性，抽样、压缩、调制和传输制式的不同选择，且发射站点和多路复用数量不同。

监管环境

基于市场的方式将越来越多地用于频率管理。这种方式可能会导致广播频谱的减少，并可能增加干扰电平。

相关频率规划须使广播传输按照规定的特性予以实施，从而保证没有干扰。规划的修改须得到相关邻国以及GE-06成员国的同意。

数字切换（DSO）是各国由模拟向数字电视过渡时使用的方法。在欧盟（EU）内部，建议各成员国于2012年前终止使用模拟电视。释放的频谱首先将用于原先使用模拟格式传输的数字电视业务。其它新业务，无论是否为广播性质的业务，均将在被称作“数字红利”的剩余频谱内予以授权。

数字红利

数字红利通常被理解为，因使用数字模式传送模拟电视业务而释放的频谱。

数字红利可用于广播业务，例如采用屋顶、室内或室外接收的地面数字电视业务，移动电视、HDTV和互动电视业务。但是，移动无线电通信业务亦可在UHF频段（790-862 MHz）的上半部分提供，且根据各国的频率规划，某些低功率应用亦可在无干扰无保护的前提下使用“白空间”。

2009年7月10日，欧洲委员会公布了一份题为“将数字机遇转化为欧洲的社会福祉和经济增长”的文件，于2009年9月4日之前向公众征询意见，参见本报告所附的附件6。意见征询旨在汇集所有利益攸关方的观点，征求他们对如何使用因模拟向地面数字电视（DTTV）过渡而释放的无线电频谱数字红利的看法。该委员会有意就数字红利进行通报，包括提出一项欧盟政策路线图的正式提案，并于2009年秋向欧洲议会和欧洲委员会提交。该委员会确定了两项紧急措施，促成在协调的技术框架范围内，以技术和业务中立为原则提供UHF 790-862 MHz频段（‘800 MHz’频段）。主要目标之一是通过对2012年1月1日后销售的所有DTTV接收机提供规定最低效率压缩标准（至少相当于MPEG-4）和确定DTTV接收机的阻抗标准，保证全欧DTTV接收机的高品质，从而提高用户体验水平。

对于地面数字电视业务，一旦实施之后，便有必要在业务要求发生变化时改变电台的特性。根据电台需要做出的变化及其特性，在征得相关邻国同意的情况下，可对《规划》进行修改。

发射电台的变化可能与下述内容相关：

- 可实现更佳覆盖的辐射特性；
- 通过DTTV系统不同的配置实现更好的覆盖或提供更多的容量；
- 通过改进的编码器、高级压缩系统（MPEG-4）、安装附加的多路复用装置或不同的系统，并在将来安装更多地先进系统，实现更好的覆盖或提供更多的容量；及
- 为改善和扩大覆盖增加更多站点。

目前正在讨论为不同类型的业务分割频段IV和V （用于大面积覆盖的数字电视、移动电视和移动无线电通信）。建立子频段会减少数字电视广播的容量，需要对数字电视《规划》做出修改。频谱容量的损失限制了未来的发展，且可能需要对现有业务的网络进行修改。

这些修改涉及：

- 因规划变更而改频；
- 提供容量更大的DTTV系统、经改进的压缩系统（MPEG-4）或在将来提供DVB-T2等更为先进的系统，为数据速率容量损耗提供补偿；和
- 改变辐射特性并安装新站点以补偿覆盖的损失。

在频段IV和V的某些部分提供移动通信业务可能会对数字广播产生干扰。

在不干扰不保护基础上可在所谓频谱“自空间”操作的低功率应用，对地面数字电视业务无直接影响，但前提是在任何情况下均可保障不会产生干扰。

网络

由于新业务、监管义务的引入或技术的改变，可能有必要对地面数字电视网进行调整。有些变化的成本很高，而另一些则因只需调整部分设备而仅会产生边际费用。大部分变化会影响到覆盖。

辐射特性

必须说明频率和各方位的最大辐射功率。天线的特性取决于频率。因此，同一站点发射的不同频率的覆盖会有所不同。在靠近发射站的位置，在垂直辐射方向可能会因零辐射信号（null）区产生覆盖问题。

压缩和传输制式

根据针对特定业务做出的折衷选择，可选择一个派生系统来支持相对较大的多路复用容量，但其要求的场强较高。此外亦可选择强健的派生系统，其需要的场强相对低，但会导致多路复用容量更加受限。

压缩系统编码器的质量在技术成熟之前将会不断改进。通过不断更新编码器软件或经常替换电视节目制作中心的主要编码器（贬值周期很短的耗材），可以更有效地使用多路复用容量。目前市场上已经开始提出一种改进型压缩系统（MPEG-4），大规模生产将继续降低零售成本。MPEG-4编码器与MPEG-2相比，有效增益明显提高。在巴西工作的ISDB-T制式，已从MPEG-4压缩系统的改进中获益。

DVB-H、T-DMB和ISDB-T是根据手持接收机移动电视的需求做出调整的传输制式。

DVB-T2预计将于2010年开始运营，并将改善多路复用容量，而这对HDTV而言尤其重要。

压缩或传输制式的改变对覆盖并无直接影响。

站点

相同网络中的补充站点用于改善或扩大覆盖。若干站点的功率分配（单频网络－SFN）提高了为便携、室内和大区域内移动接收提供覆盖的频谱效率。但是，SFN规划成本高昂且内容复杂，尤其是在各发射机的时间同步问题上，并且在有些情况下会因内部网络干扰产生覆盖问题（因从网络发射机接收到的信号超过“保护间隔”的时长而产生了自干扰，以及在密集SFN的某些位置接收到的等场强信号产生了所谓“0 dB回声”干扰）。

多路复用

更多的多路复用装置将提供额外的传输容量。这些多路复用装置可安装于现有站点，但也可组成新的网络或构成新网的组成部分。在发射机站点附近，有时可能会产生非共站传输干扰。

取得的实际经验

实际经验表明：

- 在本国和/或邻国还未关闭模拟电视的情况下，数字传输就可能会受限。如果广播公司在不同步不协调的情况下切换到另一制式，将会产生缺陷并面临巨大风险。
- SFN的改频可能很复杂，需要仔细的准备和详细的规划。
- DVB-H可能需要高密度的发射机网。值得注意的是，对于ISDB-T，移动电视的信号会与HDTV的信号多路复用。
- HDTV需要MPEG-4压缩。新的DVB-T2传输制式预计也将会采用MPEG-4。
- 国家决策将与接收机制造商进行密切协调，商讨如何以可接受的费用为公众及时提供足量的接收机/机顶盒。

消费者的关注点

由于新业务的引入或落实监管措施而产生网络的变化需要观众采取行动，从而能够接收新的业务或继续接收现有业务：

- 确定并广泛通报模拟电视的关闭日期（ACO）。向消费者提供信息，介绍应当购买的接收机/机顶盒以及具有吸引力的电视内容。
- 如果符合国家法律，至少应为低收入人口购买机顶盒提供补贴。
- 频率的变更，安装更多的站点和附加的多路复用装置，会强迫消费者重新调谐接收机。
- 频率、发射天线、DVB-T或ISDB-T的变化、SFN的改变以及非共站传输将会在某些地区产生覆盖问题。消费者可能需要部署经改进的天线，以接收一个或多个多路复用信号。
- 压缩系统（MPEG-2至MPEG-4）和传输系统的改变要求采购新的接收机，从而能够接收以此方法传输的业务。但是，在一段过渡期之后且不迟于2012年，所有接收机（至少在欧盟内部）均将能够接收新（MPEG-4）旧（MPEG-2）两种制式压缩系统。
- 压缩系统编码器的质量随着技术的成熟日益完善。通过更新编码器软件或经常更换电视节目制作中心的主编码器（高速折旧的消耗品），更高效地使用复用，或为观众带来更好的图像质量。
- 在安装新站的情况下，最佳信号将来自不同的方位，因此可能需要调整接收天线。
- 就网络的改变与消费者沟通，为消费者的行为提供帮助和信息必不可少且至关重要。电话服务和网站可提供详细的信息以及基于准确覆盖预测的建议，但这还不够。高效的个人咨询也不可或缺。
- 有效且快速的阴影区测量十分重要。
- 需要制定每次仅做一项变更的规则。
- 广告、提供多路复用和电传文件的信息频道，以及有关专用网站的信息能够为观众提供帮助。本地供应商可以提供信息并请大众访问网站或电话服务台。
- 专门根据需求，为给人们提供帮助而培训的“数字教父”，受到了大众的欢迎。

5.2 业务要求

本节的内容涉及能够促进地面数字电视网络演进的业务和应用。网络的演进有赖于：

- 为观众提供业务的选择。鉴于各国的条件不同，各国提供的业务很可能不一样。例如，市场经济国家很可能会把业务选择交到市场之手来操纵；
- 将为业务发展制定出框架的各项规则。规则反映出的是政治倾向，而这一点会因国家而异；
- 技术、发射和接收设备将促进新业务的推广，但也有其自身的限制。

因此，重要的是在考虑到业务要求和监管环境的前提下，做出正确的选择。

为成功地推广各项业务，市场参与方和监管方应就业务发展进行合作。所有的市场参与方（广播公司、内容提供商、多路复用和网络运营商、消费电子制造厂家）均对地面数字电视颇有兴趣，并应支持为网络演进做出的选择。

地面数字电视业务可根据接收的类型分类（屋顶、室内或室外、便携、移动与手持），也可按照内容类型分类（标准清晰度电视（SDTV）、高清晰度电视（HDTV）、互动电视和数据业务）。

在规划地面数字电视方面，应在下述内容间予以折衷：

- 多路复用容量；
- 覆盖质量；
- 辐射特性。

做出的折衷将在很大程度上决定地面电视网络的类型和网络可能发生的演进。

多路复用容量关系到业务的质量。多路复用中的网络数据速率和业务的数量决定了每个节目的数据速率。多路复用的容量受到了压缩和传输系统技术，以及DVB-T或ISDB-T选择的限制。

警告：数据速率低于4Mbits/s的节目可能会在观众的平面电视屏幕上显示出拖尾和伪影，使观众提出抱怨。如果家用平面电视的尺寸更大，则消费者的抱怨之声也会越高。最好避免出现这种情况！

覆盖质量对潜在观众的数量而言十分重要，用噪声和干扰条件下某位置接收有用信号的比率来表示。接收率可接受的各个位置共同构成了覆盖区。覆盖质量还取决于DTTV制式的选择，接收设备的特性、特别是接收天线和特定的接收条件。用覆盖面难以计算出模拟和数字辐射功率之间的确切关系。产生这一问题的主要原因是，在远离正常覆盖区的地方仍可接收广播模拟电视节目，但图像噪声大并具有模拟电视接收中所谓“故障弱化”的声音特性。但是，依靠应用编码和所用电视机质量的数字传输就不同了。当调制误差率（MER）达到一定值时，传送到电视屏幕上的图像将停滞或黑屏（所谓悬崖效应）。

辐射特性与传输成本相关。来自单一发射电台或单频网络（SFN）的发射机功率和天线规范，决定了接收位置产生的场强。辐射特性受到发射设备和发射电台设施的限制。事实说明，2 kW到2.5 kW DTTV（OFDM）发射机可以经常取代10 kW模拟电视发射机，因此，覆盖给定服务区所需要的发射机辐射功率低4-5倍。但应指出的是，模拟和数字地面电视发射机的参考不同，即同步脉冲峰值功率与平均功率不同。然而，在一些情况下，根据相关服务区的具体特点，由于数字电视的固有的“成功或失败”的接收原则（没有模拟电视的故障弱化可能性），同样覆盖区可能需要DTTV发射功率接近模拟发射功率。

应指出，一些DVB-T发射机可能比辐射功率输出相同的模拟发射机消耗更多的电网能源。

但是，按照概测法，现代DTTV发射机在电功率输入/射频（RF）功率输出方面比以往的发射机功率更高。此外，最近日趋显著的趋势是，DTTV发射机制造商正在投入大量研发资源以实现更高的DTTV发射功率。

简言之，数字地面电视发射网提供高于模拟的能效，因此是地面电视广播满足未来需求的更佳选择。

还应注意，与业已形成的模拟DTTV广播做法完全不同的是，任何待用数字DTTV发射机与故障备用普通数字发射机的辐射功率相同。

服务质量、潜在观众的数量和传输成本间的折衷是一项非常复杂的选择，主要由市场方面的考虑来确定。

屋顶和便携室内外接收

屋顶接收又称固定接收，其特性由安装于屋顶的固定方向接收天线决定。屋顶接收可被视作地面数字电视的基本要求。在大多数国家，几乎要求为屋顶接收提供全覆盖，至少是针对公共广播业务。在有些提供电视服务的地区，屋顶天线通常已消声灭迹。地方社区甚至要求撤除屋顶天线。最近在德国出现的事实表明，随着向DTTV的过渡，再次唤起了人们对此项业务的兴趣，屋顶天线又开始出现。在此关键时刻，值得注意的是DTTV有可能成为有线电视、卫星电视和IPTV的有力竞争对手，从而使市场更为均衡（德国约有5%的家庭使用地面模拟电视广播，而在向DTTV过渡之后，订户数量升至22%左右）。

使用简单天线进行室内室外接收是地面数字广播的一项重要特性。这种接收方式被移动便携接收。市场上出现了不同类型的室内或便携接收天线和便携接收装置，包括有源室内天线和与个人计算一同使用的地面数字电视接收机。由于接收高度低、建筑物的屏蔽、接收天线的方向性很差或根本不存在，便携接收的最低场强要求比屋顶接收要严格得多。在许多国家，通过网络的设计使人口密集地区的室内接收得到了优化。

SDTV的多路复用容量

为促使消费者购买地面数字电视（DTTV）的数字接收机，具备吸引力的广播节目套餐应包含20至30套流行的电视节目。为与卫星和有线电视媒体更好地竞争，这一数量也是必要的。仅个人感兴趣的高端服务，最好应通过宽带电视的点播业务提供。

欧洲广播联盟（EBU）在2006年世界无线电通信大会（RRC-06）之前就建议，为在常规传输显示技术的基础上提供可接受的视频质量，为各SDTV划分的数据容量应在3至4 Mbit/s（MPEG-2源编码）范围之内，具体视DVB-T派生系统和统计多路复用（如果使用）的情况而定。但对于澳大利亚在7MHz信道的64QAM复用DVB-T和23 Mbit/s容量的数据速率的情况下，2010年SDTV所选视频数据为4.3 Mbit/s。

实际上多路复用中有关电视节目数量的决定，在考虑到为电视节目划分的数据速率的基础上，通常有利于将这些电视节目纳入多路复用数据的容量之中。

但值得注意的是，随着平板电视数量的增加，业务质量的要求亦有所上升。研究显示，平板电视屏幕对伪影和拖尾更为敏感，其高质量图像要求的比特率比常规阴极射线管（CRT）高两倍。此外当前的趋势显示，与过去的老电视机相比，消费者购买的电视屏幕越来越大。因此，图像质量的主观下降对大屏幕而言将越来越明显，其原因在于编解码的伪影将变得越来越明显。因此做为一项基本原则，如果源编码为MPEG-4/AVC，则对业务质量要求而言，在统计多路复用范围内各SDTV节目使用4 Mbits/s的数据速率是适宜的，但如果源编码为MPEG-4/AVC，则在近期对业务质量的要求而言，在统计多路复用范围内各SDTV节目使用3 Mbits/s的数据速率是适宜的。

然而，源编码具有“移动目标”的特性，因此上述数据速率应被视作指示性数据。

覆盖质量

ITU-R BT.1368-7建议书推荐的规划标准被用作覆盖评估的参考标准，但是网络运营商通过会根据各国的情况对某些标准做出调整。需要定义的一项重要标准是可接受的覆盖质量。总体而言，针对屋顶接收，95%的覆盖率是可以接受的。对于便携接收，这一比例从70至95不等。应注意，低于95%的定位可能会导致用户提起投诉。

为评估覆盖质量，需要先进的网络规划软件工具、准确的发射机数据库以及地形和地物数据库。

覆盖区的地形、地貌和大小与各国的具体情况的关系十分密切。作为业务要求的组成部分，定义某些电视节目的覆盖区，应考虑规定的接收率，在必要的情况下还应考虑可接受较低率地区的面积和条件。

辐射特性

便携接收，特别是室内接收（通常接收高度为10米）所需的最低场强要远高于屋顶接收的最低场强。

与室外接收，特别是室内接收相关的辐射特性决定了实际上大面积的覆盖仅能通过辐射功率分配和使用单频网络来实现。

5.3 HDTV

高清晰度电视（HDTV）业务通过高质量的服务明显改善了观众的观看体验。对高清（HD）业务的需求驱动因素如下：

- 越来越多的家庭拥有了可接收高清节目的HDTV平板电视屏幕；
- 随着平板电视屏幕的增大，SDTV广播提供的业务质量明显下降；
- 出现了具备HD功能的新兴技术；

- 观看高质量体育节目和高清质量电影的愿望。

购买平板电视家庭的数量上升迅猛。约有30%的欧洲家庭拥有平板电视，且普及率有望在2010年达到87%。

几乎所有28寸或28寸以上的平板电视均可接收高清节目。鉴于有更多的家庭配备了能够接收高清节目的电视机，他们将能享受高清晰度电视业务。

HDTV的覆盖质量标准和辐射特性与屋顶接收和便携接收相似。第5.2.2.3和5.2.2.4节的考虑同样涉及HDTV。HDTV对大屏幕的平板电视最具吸引力。尽管大屏幕电视同时也可通过简单室内天线接收信号，在许多情况下，室内接收用于较低档次的电视机，通常其屏幕较小。

多路复用容量

对于HDTV，图像质量（业务质量）是主要目标，因此每个多路复用中的业务数量受到限制。真实，有限数量的HDTV广播节目可能会被观众接受。但是，将来把现有标准清晰度电视业务转化为高清质量而不增加多路复用的数量，将带来巨大挑战。

HDTV的容量要求使MPEG-2压缩格式不再适用，尽管从技术角度来看它仍可在单一多路复用内以MEPG-2的方式发射一套HDTV节目（澳大利亚便是如此，7MHz信道的DVB-T采用64QAM复用，数据速率容量为23Mbit/s，2001年为HDTV选择的视频数据速率为15.4Mbit/s）。美国等使用ATSC的国家亦可提供每频道一套HDTV节目。

对于HDTV，为了采用更为有效的压缩系统，需要使用一种新的、具备HD MPEG-4/AVC功能的接收机。下述方面对HDTV尤为重要：

- 采用MPEG-4/AVC压缩的HDTV可能需要高图像质量（业务质量）：720p扫描格式为10Mbits/s；1080i的扫描格式为 12 Mbits/s，且1080p的扫描格式为：20 Mbits/s。
- 每个多路复用至少应承载两套HDTV业务才能保障频谱使用的合理性并提供经济上可行的方案；
- 720p比1080i的频谱效率更高；根据内容不同，1080i需要的传输容量要高10-20%；
- 1080p可提供最佳的图像质量；它对大屏幕平板电视的显示屏（50英寸或以上）极为重要，可做为将来部署的方案选项之一。

DVB-T和DVB-T2的多路复用容量

现已为地面数字电视广播制定了第二代DVB-T2标准，在类似的接收条件下，比DVB-T的网络数据容量高30%至50%。此外，它还具有下述内在特性：

- 抵抗其它发射机干扰的能力更强，更好地实现频率多路复用；
- 更佳的SFN性能，相邻发射机间的距离至少为30%以上；
- 重点放在使用现有天线进行固定接收；
- 不需要与DVB-T信号的反向兼容；
- 与GE-06协议兼容；
- 早期用户产品于2009年年底推出。
- 大规模的DVB-T2接收机预计于2012年投放市场。

目前，DVB-T2正在英国进行高密度的测试。

下述表1（由IRT的R. Brugger博士,提供，《欧广联2008年预测》）展示了固定接收状态下每个多路复用中标准清晰度/高清晰度电视节目的数量：

- DVB-T（64QAM-2/3-1/32, 每个多路复用的总数据速率为24.1 Mbit/s），且
- DVB-T2（256 QAM-2/3-1/32，每个多路复用的总数据速率为35.2 Mbit/s）

表 1

HDTV的频谱要求

HD需要和可用的数据速率

每个复用的节目数量－固定接收

（每个复用的可用数据速率/每个节目要求的数据速率）

		固定复用			统计复用			统计复用（未来）		
格式	源编码	所需数据速率	DVB-T	[illegible]	[illegible]	DVB-T	DVB-T2	所需数据速率	DVB-T	DVB-T2
SD	MPG-2	4	6.0	[illegible]	[illegible]	8.0	11.7	3	[illegible]	[illegible]
SD	MPEG-4/AVC	3	8.0	[illegible]	[illegible]	9.6	14.1	[illegible]	[illegible]	23.5
HD-720p	MPEG-4/AVC	10	2.4	3.5	8	3.0	4.4	5	4.8	7.0
HD-1080i	MPEG-4/AVC	12	2.0	[illegible]	[illegible]	2.4	3.5	6	4.0	5.9

7 标清节目

3 - 4 高清节目

Started in France: 3D高清节目

5 - 6 高清节目

(DVB-T-64QAM-2/3-1/32: 24.1 Mbit/s; DVB-T2-256QAM-2/3-1/32: 35.2 Mbit/s)

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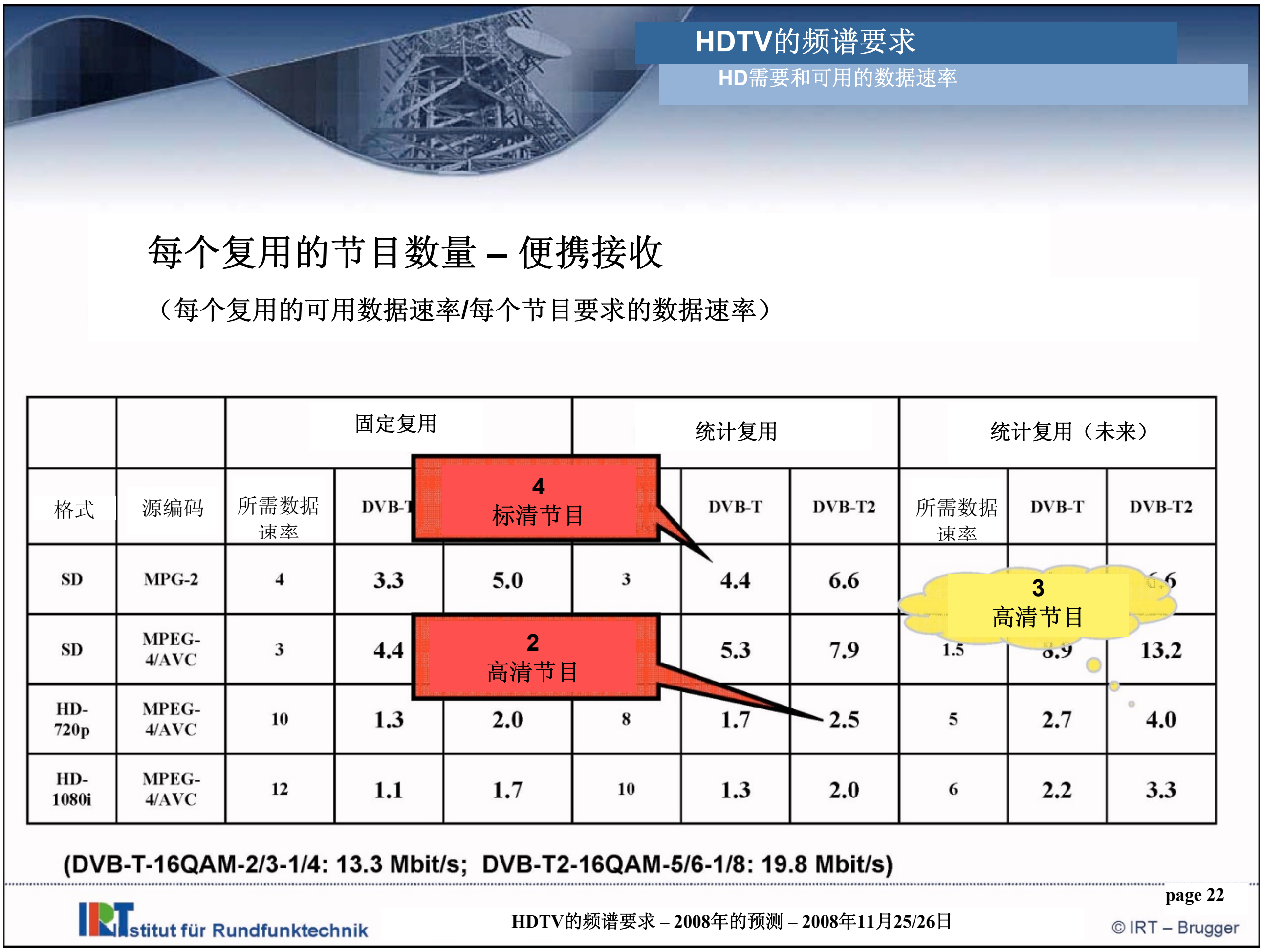
下述表2（由IRT的R. Brugger博士提供，《欧广联2008年预测》）展示了便携接收状态下每个多路复用中标准清晰度/高清晰度电视节目的数量：

- DVB-T（16QAM-2/3-1/4, 每个多路复用的总数据速率为13.3 Mbit/s），且
- DVB-T2（16QAM-5/6-1/8每个多路复用的总数据速率为19.8 Mbit/s）

表 2



		固定复用			统计复用			统计复用（未来）		
格式	源编码	所需数据速率	DVB-T	[illegible]	[illegible]	DVB-T	DVB-T2	所需数据速率	DVB-T	DVB-T2
SD	MPG-2	4	3.3	5.0	3	4.4	6.6	[illegible]	[illegible]	6.6
SD	MPEG-4/AVC	3	4.4	[illegible]	[illegible]	5.3	7.9	1.5	8.9	13.2
HD-720p	MPEG-4/AVC	10	1.3	2.0	8	1.7	2.5	5	2.7	4.0
HD-1080i	MPEG-4/AVC	12	1.1	1.7	10	1.3	2.0	6	2.2	3.3

在最近的研究中，R. Bruger和A. Gbenga-llori (trev_2009-Q4_Spectrum_Brugger.pdf) 认真研究了数字地面电视为未来广播应用提供平台的潜力。高清电视（HD）已被看作所有未来电视应用的标准。研究评估了应用统计复用、新来源编码技术（MPEG-4）和新信道编码技术（DVB-T2）在一个复用中可容纳的节目数量并审议了GE-06协议带来的可能性。

此外，可得出的结论是，广播公司要想得益于向MPEG-4和/或DVB-T2的过渡，前提是他们使用这些提高频率使用效率的技术能够提供更高品质（HD）和/或更多数量的节目。

为此，必须将现有广播频谱继续用于广播。否则，减少广播频谱在近期内就会对DTTV平台的竞争造成严重影响。

ISDB-T多路复用容量

ISDB-T包含13个OFDM单元。一个OFDM单元对应的频谱带宽为B/14 MHz（B是指地面电视频道的带宽：6、7或8 MHz）。因此一个单元占用带宽6/14 MHz（428.57 kHz）、7/14 MHz（500 kHz）或8/14 MHz（571.29 kHz）。电视广播使用13个单元，传输带宽约为5.6 MHz、6.5 MHz或7.4 MHz。

ISDB-T有三种载波间隔不同的发射模式，用于处理各类条件。例如由网络配置确定的可变保护间隔，以及移动接收过程中出现的多普勒频移。在第1种模式中，一个单元包括108个载波，第2和第3种模式分别有2倍和4倍数量的载波。

实时的交织时长取决于数字信号阶段确定的参数以及保护间隔的时长，因此下表3中所述参数值是恰当的。

表 3：ISDB-T 系统的基本参数

传输参数	模式1	模式2	模式3
单元的数量	13		
带宽	5.57 MHz （6M*） 6.50 MHz （7M*） 7.43 MHz （8M*）	5.57 MHz （6M*） 6.50 MHz （7M*） 7.43 MHz （8M*）	5.57 MHz （6M*） 6.50 MHz （7M*） 7.43 MHz （8M*）
载波间隔	3.968 kHz （6M*） 4.629 kHz （7M*） 5.271 kHz （8M*）	1.948 kHz （6M*） 2.361 kHz （7M*） 2.645 kHz （8M*）	0.992 kHz （6M*） 1.157 kHz （7M*） 1.322 kHz （8M*）
载波的数量	1405	2809	5617
有源符号的时长	252µs （6M*） 216µs （7M*） 189µs （8M*）	504µs （6M*） 432µs （7M*） 378µs （8M*）	1008µs （6M*） 864µs （7M*） 756µs （8M*）
保护间隔的时长	有源符号时长的1/4、1/8、1/16、1/32		
载波调制	QPSK、16-QAM、64-QAM、DQPSK		
每帧符号的数量	204		
时间交织的时长	0, 0.1s、0.2s、0.4s		
内码	卷积编码（1/2、2/3、 3/4、5/6、7/8）		
外码	RS（204,188）		
信息比特率	3.65-23.2 Mbit/s （6M*） 4.26-27.1 Mbit/s （7M*） 4.87-31.0 Mbit/s （8M*）		
分层传输	最多3层（A、B、C层）		

*) 地面电视频道的带宽。

以频道内频段划分实现的分层传输使同时固定接收节目与手持接收节目成为可能。“分层传输”是指频道编码的三个要素，即调制方案、卷积纠错码的码率和时间交织时长，能够独立选择。时间和频率的交织分别在其各自的分层数据单元中进行。

如上所述，频谱中最小的分层单元为一个OFDM单元。如图1所示，可对包括13个OFDM单元和最多三层（A、B和C层）的电视频道进行单元设置。如果OFDM信号只用一层发射，则使用A层。如果信号发射使用两层，中心“包裹（rugged）”的一层为A层，外层为B层。如果使用三层发射，则中心“包裹”的一层为A，中间层为B层，最外层为C。考虑到接收机的信道选择操作，按这些方式分层的频谱必须遵守分层安排的规则。此外，对于仅使用单层业务的手持接收机，可为其设置单一的中心层，供部分接收用。在这种情况下，中心部分为A层。在整个频段使用这种方法称为ISDB-T。

图 1

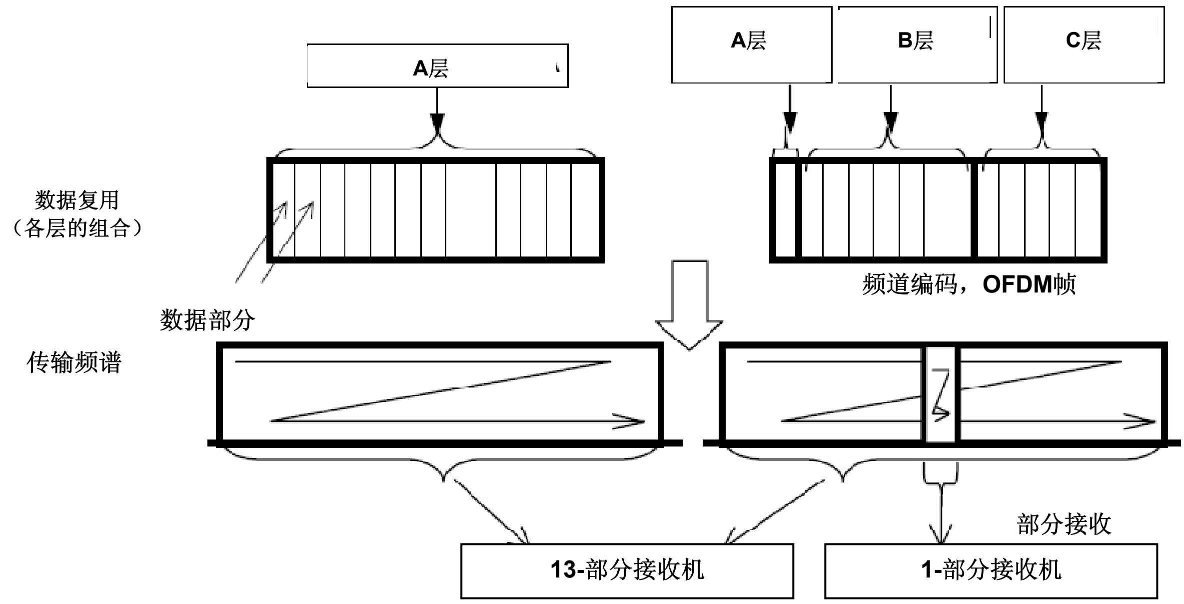


表4描述的是所有13个部分的总数据速率，在考虑到广播公司定义的ISDB-T参数的基础上，可供固定和便携接收之用：

表 4：总数据速率

载波调制	卷积码	发射的TSP数量（模式1/2/3）	数据速率 (Mbit/s)			
			保护比：1/4	保护比：1/8	保护比：1/16	保护比：1/32
DQPSK QPSK	1/2	156/312/624	3,651	4,056	4,295	4,425
	2/3	208/416/832	4,868	5,409	5,727	5,900
	3/4	234/468/936	5,476	6,085	6,443	6,638
	5/6	260/520/1040	6,085	6,761	7,159	7,376
	7/8	273/546/1092	6,389	7,099	7,517	7,744
16QAM	1/2	312/624/1248	7,302	8,113	8,590	8,851
	2/3	416/832/1664	9,736	10,818	11,454	11,801
	3/4	468/936/1872	10,953	12,170	12,886	13,276
	5/6	520/1040/2080	12,170	13,522	14,318	14,752
	7/8	546/1092/2184	12,779	14,198	15,034	15,489
64QAM	1/2	468/936/1872	10,953	12,170	12,886	13,276
	2/3	624/1248/2496	14,604	16,227	17,181	17,702
	3/4	702/1404/2808	16,430	18,255	19,329	19,915
	5/6	780/1560/3120	18,255	20,284	21,477	22,128
	7/8	819/1638/3276	19,168	21,298	22,551	23,234

注 – 本表所示为总数据速率的示例，描述了所有13个部分的同类参数。请注意，在分层传输期间，根据分层参数配置的不同分层传输会产生变化。

有关ISDB-T多路复用的详细信息，请参见ITU-R BT-1306-3建议书（C制式）和下述标准：

ARIB标准ARIB-STD B-31 版本1.6 – 地面数字广播的发射系统，11月/2005。可通过下述网址获取：http://www.arib.or.jp/english/html/overview/doc/6-STD-B31v1_6-E2.pdf。

巴西标准ABNT NBR 15601 – 地面数字电视 – 传输系统，12月/2007。可通过下述网址获取：http://www.abnt.org.br/tvdigital/norma_eua/ABNTNBR15601_2007Ing_2008.pdf。

5.4 移动电视

移动电视有不同的含义。其中一种数字电视信号移动接收是指接收来自屋顶或室内接收DTTV网络的数字电视信号。此外，它亦可指移动电视手持装置的电视接收。后一种得到了很高程度的重视，尽管人们也对此表示担忧。这究竟是一种电信运营商拥有的网络通信服务，还是由广播网络运营商网络提供的广播业务？或者它是一种集两者于一身的新方式？警告：考虑到为DVB-H 运营商颁发许可证，对原有申请者的商务规划进行详细研究可能十分有益（最近德国发生的许可证撤消，引发了一系列应由国家许可机构回答的问题）。

移动电视存在几种制式。

本报告将仅针对DVB-T、DVB-H、T-DMB和ISDB-T。从网络规划的角度来看，T-DMB和DAB-IP没有区别。

第5.2节的考虑亦适用于DVB-T或ISDB-T制式的移动接收。

DVB-H和T-DMB各有千秋。主要区别在于为该系统指配的带宽和频段。为了在T-DMB中发射与DVB-H内相同数量的业务，可能需要更多的DMB多路复用。系统间的取舍主要是频段和频道所用光栅问题。

在ISDB-T中，移动电视节目使用OFDM信号中的一部分传输（见上文中的图1）。用于此目的的部分为中心部分，但目前已经开始讨论将13个部分中的某一部分用于不完全接收。这使广播公司能够发射13个独立的移动电视频道，付费电视的商业模式也成为可能。

如果一个移动电视频道在中心部分传输，则接收机必须对信号进行解码并解调此部分的OFDM信号。此应用称为“1-seg”或“1-seg技术”。

鉴于带宽的限制，各种1-seg的传输均仅能够处理低清晰度的、针对移动装置的节目播放。

手持装置可用于室内和室外，无论是静止的位置还是高速运行中的汽车与火车。相对波长而言，接收天线的尺寸很小，且许多装置使用内置天线。但是，这些内在特性将提出很高的最低强制要求。

多路复用容量

手持装置的屏幕很小，且DVB-H、T-DMB和ISDB-T使用了先进的压缩系统（MPEG-4/AVC）。因此，各节目选择的数据速率较低。鉴于接收条件十分苛刻，大多数运营商倾向于选择强健的系统参数，从而限制了净比特率。在这种情况下，DVB-H多路复用可容纳10至15套节目。做法5和做法6中介绍了T-DMB多路复用的电视业务的数量。

移动应用的ISDB-T，将针OFDM的一个部分计算多路复用容量。下文表5介绍了在考虑到ISDB-T参数的情况下，单一部分的数据速率（由广播公司定义）：

表 5: 单一部分的数据速率

载波调制	卷积码	发射的TSP数量[1]（模式1/2/3）	数据速率 (Mbit/s)[2]			
			保护比：1/4	保护比：1/8	保护比：1/16	保护比：1/32
DQPSK QPSK	1/2	12/24/48	280.85	312.06	330.42	340.43
	2/3	16/32/64	374.47	416.08	440.56	453.91
	3/4	18/36/72	421.28	468.09	495.63	510.65
	5/6	20/40/80	468.09	520.10	550.70	567.39
	7/8	21/42/84	491.50	546.11	578.23	595.76
16QAM	1/2	24/48/96	561.71	624.13	660.84	680.87
	2/3	32/64/128	748.95	832.17	881.12	907.82
	3/4	36/72/144	842.57	936.19	991.26	1021.30
	5/6	40/80/160	936.19	1040.21	1101.40	1134.78
	7/8	42/84/168	983.00	1092.22	1156.47	1191.52
64QAM	1/2	36/72/144	842.57	936.19	991.26	1021.30
	2/3	48/96/192	1123.43	1248.26	1321.68	1361.74
	3/4	54/108/216	1263.86	1404.29	1486.90	1531.95
	5/6	60/120/240	1404.29	1560.32	1652.11	1702.17
	7/8	63/126/252	1474.50	1638.34	1734.71	1787.28

[1] 表示每帧传输的TSP数量。

[2] 表示发射参数每个部分的数据速率（比特）：TSPs transmitted × 188 (bytes/TSP) × 8 (bits/byte) × 1/frame length.

数据速率（比特）：发射的TSP数量×188（字节/TSP）×8（比特/字节）×1/帧长

有关ISDB-T多路复用的详细信息，请参见ITU-R BT-1306-3建议书（C制式）以及下述标准和链接：http://www.arib.or.jp/english/html/overview/doc/6-STD-B31v1_6-E2.pdf或http://www.abnt.org.br/tvdigital/norma_eua/ABNTNBR15601_2007Ing_2008.pdf。

ARIB标准ARIB-STD B-31版本1.6 -地面数字广播的发射系统，11月/2005。可通过下述网址获取：http://www.arib.or.jp/english/html/overview/doc/6-STD-B31v1_6-E2.pdf。

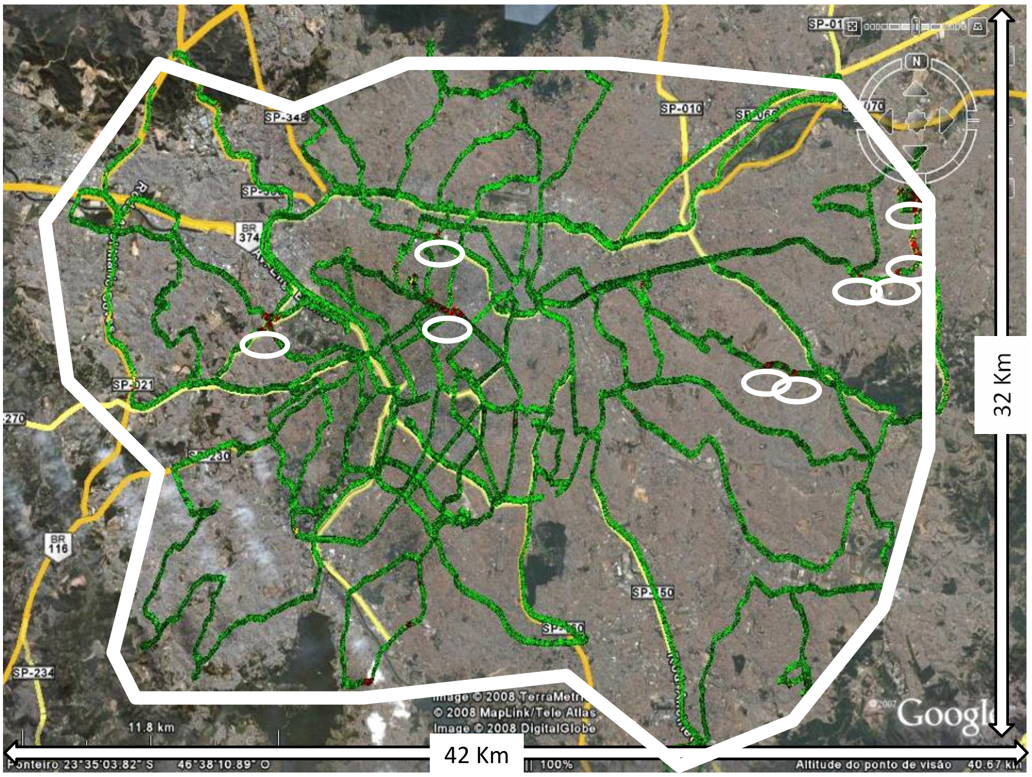
巴西标准ABNT NBR 15601 – 地面数字电视 – 传输系统，12月/2007。可通过下述网址获取：http://www.abnt.org.br/tvdigital/norma_eua/ABNTNBR15601_2007Ing_2008.pdf。

覆盖质量

移动和手持接收需要高覆盖质量。手持便携接收的定位率通常为95%，移动车辆内的手持接收的定位率为99%。

ITU-R **6A/99-E**号文件（http://www.itu.int/md/R07-WP6A-C-0099/en）阐述了巴西实地移动测试的情况。例如在圣保罗市，实地移动测试的结果如下图2所示。测试使用了331个测试点，其中258个在室外73个在室内。圣保罗是巴西最大的城市，市中多个部分高楼密布，与纽约和东京的地形相仿。移动信号从单一的电台发射。此参考电台水平EIRP为130 kW且总EIRP约为200kW，天线为全向天线。在所述图1中，绿点表示移动信号良好的接收，红点表示质量差的接收点，其中大部分是在隧道内。使用黑白文本辨认时，白色等高线显示高质量的移动信号，但一些小白圈处表明信号质量不佳。

图 2：模式 3 中的 ISDB-T 移动性能，保护间隔为 1/16 调制方式为 QPSK，码率为 1/2，采用时间交织



图例：

小圈：圈内信号不良（多数在隧道内）

白色等值线：信号质量好。

辐射特性

即使使用强健的派生系统，鉴于接收天线的性能很差且接收条件不良，场强的要求仍然很高（室内、室外，有外部天线的车载和无外部天线的车载）。最苛刻的接收条件如下：

- 在III频段；16QAM且移动车内的手持接收与外装天线接收机无连接；
- 在IV和V频段（加上某些国家的1.5 GHz）；16QAM和手持室内接收。

实际操作中，网络实施始于城市周边的高功率发射机，用于为城市地区提供覆盖。根据要求，将安装发射机光栅密度较高的单频网络，用以改善覆盖。有关DVB-H和T-DMB网络的更多信息，请参见欧广联Tech 3327。ISDB-T的详细信息请参见ITU-R 1368-7建议书 -《VHF/UHF 频段地面数字电视业务的规划标准》。

5.5 互动电视和数据业务

多路复用容量通常被用于视频和相关的声音业务。有时可能还包括一系列无线电节目。此外，多路复用可能还包括用于下述各类业务的数据：

- 电子节目指南
- 服务信息
- 互动业务
- 图文电视
- 系统软件更新（SSU）

在不同情况下，为上述业务划分的数据速率差异很大。

互动业务

现有两种类型的互动电视业务：

- 本地互动业务，其信息存贮于接收机内（例如图文电视）；
- 远程互动业务，通过返回频道将信息发送给节目提供商。此信息可包括对某一节目的响应（例如投票）或对某些节目的请求（视频点播或按次付费节目）。

远程互动电视被视作数字电视的一项重要特性由来以久，但在许多国家远程互动电视应用都受到限制。远程互动业务需要一个返回路径。如果返回路径是通过有线或移动电信系统提供，则互动业务对地面数字电视网没有直接影响。现已制定了带内返回路径系统，即所谓“DVB-RCT”，但仍未出现商业应用。但是，本地互动十分流行。文字电视广播（ITU-R BT.653-3）仍将是数字电视业务中的一项重要组成部分。

基本互动业务，例如图文电视，可与标准DVB-T接收机共用。更为先进的互动业务，接收机除操作系统外应当配备所谓中间件，如多媒体家用平台（MHP）Ginga（详情见ITU-T H.76建议书和ITU-D 2/229号文件）及多媒体和超媒体信息编码专家组（MHEG）系统。

许多国家均为消费者提供了DVB-T/ IPTV机顶盒与硬盘组合应用。最为流行的节目可以通过地面数字电视网不占用空中信道接收，而IPTV网络提供补充信息、点播节目和特别节目。选择的节目可以自动下载至硬盘。通过这种方式，可以提供远程互动业务。为了显示并选择存贮的节目，各个节目均伴有元数据。

互动多媒体业务

互动DTTV将成为一种有生命力的媒体，能够为发展中国家观众提供具有现代信息通信特色的社会服务。这一服务可通过将多媒体数据流（包括网络和网络类的业务数据）纳入电视广播数字流得以实现。上述业务的接收可利用数字电视广播机顶盒及电视机屏幕上显示的数据。相同的机顶盒及其软件支持返回路径所有的线路既可以是PSTN线路（基于内置拨号调制解调器）、xDSL，也可以是基于DOCSIS标准（自带调制解调器或通过以太网接口与机顶盒相连的外部DOCSIS调制解调器）之上的家用电缆线路HFC（混合光纤电缆）。

增强型电视和互动电视原则上均属于新电视广播业务，只能通过数字广播提供。增强型电视的概念计划使用加密信号付费业务，要求用户使用智能卡和有条件的接入系统。向专门运营商租用设备，可为套餐用户提供互动业务。此外，免费接收大众节目套餐（国家和地区）仍存在可能性。

增强型电视计划使用伪互动（本地内置接收机）DTTV业务，不提供返回路径频道。这包括各类信息业务和参考材料，例如电视－新闻、气象预报、收视率、广告频道等。在向数字广播过渡的过程中，此类业务可立即提供给缺少电话的居民区，以及仍可为全面互动业务提供返回路径频道的地区。

在电话充分普及的地区，可通过PSTN线路在返回路径的基础之上部署互动系统。返回频道可支持各类电子应用（商务、政务、就业、卫生、教育、农业、社会调查、收视率、虚拟CD、网络游戏等）。与此同时，还可提供基于专用DTTV频道的高数据速率接入。为此，电视观众在此情况下可能不需要PC，其功能将通过数字广播机顶盒实现：网页可通过屏幕显示，在对网页上的文字和图像对象进行重新格式编排和比例重调之后，根据“carrousel”原则将其显示在标准清晰度电视机的屏幕之上。网络浏览器的操作是使用无绳键盘。由于互联网频道随时可用，连接无须额外的时间。实际上，此业务是生活质量的一项新要素，因为电视业已成为一种强大的信息媒介，集最先进的信息技术于一身，在无须购买个人计算机的前提下使所有人融入全球化的信息基础设施，而不论其年龄与社会地位如何。数字电视广播机顶盒支持互联网接入和电子邮件功能。

在下一阶段的数字电视广播系统部署中，可通过无线返回频道，将互动业务拓展到PSTN尚未普及的边远农村。

基于数字电视广播的集成互动式多用途信息系统

上述电子应用可形成一种集成互动式多用途信息系统，在单一用户界面（浏览器）和统一互动平台的基础上实施。这样，广播运营商可能会成为服务系统的提供商，在相应信息服务数据组合中心的基础上为公司和个人提供服务，包括专用服务器和将上述业务附加于电视广播信号之上的装置。服务器软件代表一种多功能的软件包，其中特别包括计费模块、与其它银行付费系统互操作的模块，广告管理、收视调查和返回（互动）频道数据处理等。此系统（浏览器）软件的用户部分安装于数字广播机顶盒内。

此类系统通过对条件接入系统征收订购费（通过机顶盒智能卡实现）获得额外的收入。但是，互动信息系统运营商最重要的收入来源仍是广告商的付费。互动系统的广告与模拟广播的传统线性广播区别很大。其主要区别在于目标的特质（不同的用户群收到不同的广告）以及采集观众信息的内置功能（收视调查）。实际上机顶盒可支持下述功能：

1 为用户指配一个消费索引。当用户切换至该系统时，屏幕上将显示一个调查问卷。其内容包括用户的社会地位、年龄、性别、收入、感兴趣的领域、感兴趣的商品和服务等（此类调查可定期重复，例如每年重复一次，以便在发生变更的情况下做出更改）。索引被发送至运营商的服务器，进一步用于确定向此用户发送的广告材料。

2 电视节目的收视调查（对观众数量的调查）。机顶盒将记录每次电视频道间的切换，并记录下各频道的观看时间。定期将观看数据转发至运营商的服务器。此功能能够计算电视节目的精确收视时间而非收视率的统计。

3 广告收视调查。用户通过机顶盒购买的商品和服务（支持电子商务功能）均被记录，所购商品和服务类型的信息被发送至运营商的服务器，并由服务器对所购商品和服务与之前向用户所发广告间的关联做出分析。此功能有助于评估广告材料的有效性。

互动信息系统可对电视公司（节目收视调查）和广告商（由于目标收视率的提高，效率大幅提升）均提供至关重要的数据。

5.6 业务拓展和网络演进摘要

业务拓展

通常，无论采用完全免费（FTA）的形式还是FTA与按次付费电视结合的形式，地面数字电视均很受欢迎。

随着平板电视在家庭中的普及，对高质量视频的需求也随之出现。

将来，HDTV预计将成为家庭电视的标准。有些国家已经开始了HDTV传送。有线电视、卫星电视和IPTV比数字地面网的限制更少，更适于传输最高业务质量的HDTV。地面数字网可能还将提供HDTV（SDTV主要针对一般电视、家庭娱乐节目和手持设备）。

移动电视的消费需求仍需证实。

互动电视，特别是通过PVR或IPTV网络（TV Anytime）使用点播和时移业务的重要性越来越大。创新互动应用亦将在DTTV上部署。随着家庭网络的发展，针对集成媒体装置和互动数据业务的消费需求预计仍会增长。这将造成对线性（直播）广播需求的下降，而内容下载的需求将会上升。

由于数字有线电视、IPTV和卫星电视平台所提供的业务，地面数字电视网将面临越来越激烈的竞争。但地面数字电视是传播有限数量节目的一种高性价比的方式，可实现近乎全面的覆盖。在具备条件的情况下，可通过IPTV网络补充提供附加内容和特殊节目。

业务和网络的演进

针对地面数字电视网络的各项业务，应在下述三种独立参数之中做出基本选择：多路复用容量、覆盖质量和辐射特性。选择会对发射网络产生重大影响。

针对使用屋顶天线实施固定接收的电视业务，需要中等的场强电平。选择通常是针对高覆盖率的广袤区域，使用相对较高的多路复用网络数据速率。

使用小天线在室内和室外以便携方式接收的电视业务，需要比屋顶接收更高的场强。通常会选用更为强健的DVB-T 派生系统，与屋顶接收相比，多路复用网络数据速率较低，可达到中高覆盖率且发射网络密度更大。业务通常以城市为目标。

MPEG-4/AVC是各国的首选，特别是能够提高SDTV和HDTV的频谱效率（ HDTV要求每个多路复用具备高网络数据速率）。目前先进的DVB-T2传输系统已经部署，首批接收机预计将于2010年上市。

移动电视需要很高的场强电平，很可能选用强健的DVB-T、ISDB-T或其它派生系统，因此其每个多路复用的网络比特率是有限的。DVB-H、T-DMB和ISDB-T等移动电视系统采用MPEG4压缩。此种方式要求有高覆盖率。通常此网络在城市附近有高功率发射机，并使用SFN发射机予以补充。

互动电视可使用很大一部分多路复用容量。对于远程互动，则需要使用PSTN或无线通信系统的返回路径。

5.7 监管环境

有关频谱使用的监管决定由国家监管机构根据国际条约、标准和建议书做出。为此，各国主管部门将在世界层面上与国际电信联盟（ITU）等国际组织合作，同时还将与相关区域性组织一同努力（例如亚太电信组织（APT）、欧洲邮电主管部门会议（CEPT）、美洲国家电信委员会（CITEL）等）。

在欧盟（EU）内部，欧洲委员会（EC）的频谱政策对各国主管部门十分重要。

地面数字电视的传输使用III（174-230 MHz）和IV/V（470-862 MHz）频段。此外，如果与ISDB-T制式的做法不同，移动电视并不与HDTV或SDTV信号一同传输，则移动电视亦可使用此频段（1452- 1479.5 MHz）的一部分。

以下各节将阐述关于使用分配给广播业务的这些频段的主要国际监管规则。

《无线电规则》中的业务划分

国际电联《无线电规则》是国际电联各成员国间达成的一项契约，由世界无线电通信大会（WRC）定期进行审议。上次WRC（WRC-07）于2007年召开，下一次将于2012年举行。《无线电规则》阐述了如何使用频段并规定了使用这些频段的规则。

最近出现以业务和技术中立的方式进行频谱监管的趋势。可能会导致若干业务频段的重新划分，以及对广播、移动和固定业务等现有国际电联定义的重新审议。对于广播等不仅只具有经济价值，同时还有文化和社会价值的业务而言，频谱管理的市场化方式令人十分忧虑。这种方式可能会导致技术特性差异极大的业务使用相同的频段。防止产生不可接受的干扰需要仔细斟酌。

频段划分

III（174-230 MHz）频段在1区被划分给了广播业务，而在有些国家则划分给了移动业务。与过去的一二十年不同，没有人对在III频段开展无线电移动通信业务感兴趣。

IV和V（470-862 MHz）频段被划分给了广播业务，且根据 WRC-07的决定，自2015年6月17日起在1区内将790-862 MHz （61至69电视频道）频率范围划分给移动业务。

此日期与《GE-06协议》中规定的模拟/数字广播过渡期相对应。但是，包括22个欧洲国家在内的65个国家在WRC-07之后立即允许移动无线电业务在此频段上操作，但前提是邻国的广播业务（或根据《无线电规则》使用此频段的其它业务）能够得到保护。

应当注意的是，在移动业务划分内，国际移动电信（IMT）业务已被确定为潜在用户之一。IMT业务包括IMT 2000 （3G技术、UMTS、CDMA 2000、WiMAX） 和IMT高级业务（4G）。在WRC-07期间，各国主管部门决定将IMT 2000和IMT高级业务并入同一范围。

WRC-07同意，应保护GE-06中的广播业务免受移动业务的干扰，且拟在790-862 MHz频段内开展移动业务的国家应在实施之前与邻国进行协调。此外，WRC-07呼吁国际电联研究790-862 MHz频率范围内移动与广播业务间的兼容性（ITU JTG 5-6）。这些研究的结果将在WRC-12上做介绍。

此外，IV和V频段还被划分给了下述其它业务：

- 某些国家的射电天文（36频道）；
- 某些欧洲国家的无线电导航业务（645-862 MHz）；
- 790-862 MHz内的固定通信业务；
- 在某些国家，如果广播和移动业务能够得到保护，可将其用于广播辅助业务（例如无线电麦克峰）。

1452-1492 MHz频段被划分给了广播和卫星广播业务，且根据《无线电规则》，其使用仅限于数字音频广播。

频率规划

对大部分广播频段而言，均已制定了先验性的频率规划，例如《GE-06协议》。成功频率规划的主要条件如下：

- 相关国家公平地接入各频段；
- 避免不可接收的干扰；和
- 为未来的部署提供灵活性。

频率规划规定了参与国在传输多路复用方面的权利，并对其技术特性加以详细描述：

- 落实协议的程序；
- 规划中规定的频段规划修改程序；
- 工作传输通知的程序。

III、IV和V频段

《GE-06协议》规定了广播和非广播业务如何使用III、IV和V频段。III频段计划用于数字广播（T-DAB）和数字电视（DVB-T）。GE-06的成果经常用“层”来表述。在GE-06 中并未对“层”做出定义，但一般被理解为在一个地区接收到的频道数量。大多数国家在III频段实现了三个T-DAB和一个DVB-T“层”。几乎所有欧洲国家均采用III频段的一条7 MHz频道。IV和V频段计划使用8 MHz频道的DVB-T。大部分国家在IV和V频段实现了七或八个DVB-T“层”。

《GE-06协议》的程序使灵活应用该规划成为可能。

这方面的主要条款如下：

- 规划条目可供与其规定特性不同的广播传输使用，但前提是不得超出在大量测量点处计算出的规划条目干扰场强；即所谓遵从性检查；
- 规划条目可用于不同的广播或移动业务应用，但前提是在《无线电规则》规划内该频段被划分给了相关业务，且未超出规划条目中规定的功率密度限值。
- 在可能会受影响的各国达成一致后，规划条目可以做出修改。必须指出的是，修改过程可能耗时很长，因为各方达成一致有可能需要很长一段时间。如果在2 ¼ 年后仍未达成必要的协议，则建议的修改将流产。

《GE-06协议》包含两项频率规划，即模拟电视规划和数字广播规划。这两项规划并不相互兼容。过渡期后，模拟电视规划将不复存在，模拟电视传输也不再受保护。此过渡期将于2015年6月17日结束。但是，在一些非洲和阿拉伯国家，III频段的模拟电视在2020年6月17日之前一直受保护。

5.8 数字转换（DSO）

数字转换（DSO）是一项耗时多年的复杂进程。各国政府需要对模拟电视向数字电视转换采取一项明确并得到所有相关机构支持的战略。此项战略中应当包括的部分要素如下：

- 模拟系统关闭的日期；
- 过渡期间与邻国就数字电视的频段进行协调；
- 地面数字电视的许可程序；
- 有关终止模拟电视许可证的协议；
- 联播的规定；
- 为确保能够及时得到充足的数字接收设备，与消费设备制造商达成的协议；
- 为使低收入家庭有能力购买数字机顶盒/接收机而做出的规定；和
- 为通知大众而开展沟通活动。

地面数字电视的推广方式和完成此项进程所需的时间取决于市场，且各国情况差异很大。在联播期间，究竟何时在特定地区同时提供数字和模拟广播业务，很大程度上取决于采用的转换策略。在实际操作中，联播期从零至十四年不等。

模拟电视关闭之后，频谱将可用于新业务。

频谱的释放通常被称作“数字红利”。

模拟的关闭

有些国家的政府通过贷款或特许、对机顶盒给予补贴、临时削减广播公司许可证费的方式促进数字转换。例如，针对那些欧盟认为其违反了国家补贴原则的成员国，已经就数字转换资助工作开展了调查。总之，欧盟成员国在不倾向于某个特定交付平台的基础上，可能提供资金援助（坚持技术中立的原则）。

颁发许可证

各国主管部门的立法起草要考虑到国际电联的协议以及一些区域性协议（在欧盟成员国之间为CEPT协议和欧盟政策与指令）。在国家立法的基础上，将为数字电视颁发许可证。地面数字电视颁发许可证的程序差异很大。在一些国家，许可证被颁发给网络运营商，而在其它一些国家，许可证被授予内容提供商、多路复用运营商和网络运营商。申请者的选择有时是基于拍卖，有时采用竞赛（“选美比赛”）的方式。在大多数情况下，公共广播传输的许可是按照优先级来确定的。许可证费用有很大不同，有些情况下费用应能够补偿监管机构颁发许可证进程的费用，另一些情况则是在费用涉及相关频谱市场价值的前提下，采用频谱“行政定价”。

5.9 数字红利

“数字红利”存在多种解释。但是，对欧盟各国而言，欧洲委员会及其顾问机构“无线电频谱政策组（RSPG）”的定义相关性最强。根据RSPG的定义，数字红利是指在现有模拟电视业务之上，以数字形式在VHF（III频段：174-230 MHz）和UHF（IV和V频段：470–862 MHz）频段提供的频谱。

欧洲委员会在其通告“下次2006年国际电联区域性无线电通信大会欧盟有关数字转换频谱策略的工作重点”中确定了三个范围：

1） 改善地面广播业务所需频谱：例如技术水平更高的业务（以HDTV为典型），更多的节目和/或收视体验的改善（例如：体育节目的多角度拍摄，独立的新闻流和其它准互动方式）；

2） “融合”广播业务所需的无线电资源，预计主要为传统广播和移动通信业务的“结合”；

3） 为不属于广播系列应用的新“用途”划分的频率。其中有些潜在的频谱红利新“用途”属于还未面市的未来业务与应用，此外还包括未在这些频段工作的现有业务与应用（例如，3G业务的扩展，短距离无线电“宽带”应用）。

在大多数国家，模拟电视业务可纳入一个DVB-T或ISDB-T多路复用。但是，使用DVB-T或ISDB-T的强健调制方式提供五套或更多模拟电视业务的国家，可能需要两套DVB-T或ISDB-T复用，以数字SDTV格式广播现有的模拟电视业务。

为了成功地推广DVB-T或ISDB-T，需要提供比现有模拟电视节目更多的多路复用。但是，根据RSPG的定义，无须以数字格式发射模拟业务的复用属于数字红利的范畴。

5.10 网络的变化

鉴于上文第5.2（业务）、5.3（监管环境）和5.4（数字红利）所述发展状况，可能需要对地面电视网络做些改动。

网络的变化可能会涉及下述一个或多个网络要素：

- 辐射特性；
- DTTV系统；
- 发射站点；和
- 多路复用器。

发射电台和网络部署

a) 发射站点

在维护或发射机故障时使用n+1配置的预留（备用）发射机。此时，应对预留发射机做出调整，使其与所替换的发射机功能相一致。

另一种经常使用的备用配置是在每台发射机上安装备份单元，例如双驱。射频功率放大器在固态发射机的情况下，因存在一系列放大器的并行操作，所以配有内置冗余。一些情况下，天线被分为两个部分，每部分均由天线电缆供电。这样，天线安装部分可以在电台仍然工作的情况下关闭，尽管其辐射功率会有所下降。

b) 发射机网络

地面数字电视的发射机网络大体包含下述部分：

- 中央复用器的核心；
- 中央监测和操作中心；
- 分配链路（无线电中继、光纤）；
- 主发射机；
- 填入发射机。

发射机即可作为多频网络（MFN）也可作为单频网络 （SFN）或者二者的结合体进行操作。后者可包括一批主站作为MFN，并将一批低功率的电台作为SFN。在SFN内，覆盖是通过若干电台的功率分配来实现的。SFN的总功率小于使用一部电台覆盖类似区域所需的功率。此外，通过同时接收多个有用信号，接收率亦有改善。SFN的操作复杂，特别是在发射机时间同步方面，且其成本更高。

在MFN配置中，可在每个站点广播本地节目，且由于无需很长的保护间隔，其比特率更高。

填入式发射机通常由主发射机以非占空的方式馈给，并在不同频率将信号转发（MFN）。在SFN内，亦可以非占空的方式馈给填入式发射机，并在相同的频率上转发，但必须小心确保入局信号与出局信号间留有充分的间隔。有时很难保障充分的间隔，此时SFN内的填入式发射机将使用与主流发射机（通过无线电中继或光纤链路）相同的方式馈给。

5.10.1 辐射特性

改变的原因

发射电台辐射特性的改变原因有很多，例如：

- 新业务的引入；
- 子频段和保护频段的引入；
- 操作方面的原因；
- 覆盖的改善。

在电视网的推出时间紧迫的情况下，可能会因操作的原因改变数字电视台的特性。取得所需的当地规划许可证或使发射机达到所需功率电平，并非总能如愿。因此，有必要临时安装一些功率或天线高度受限的装置甚至是电台。

此外，天线装置还有可能无法满足新数字发射机的功率要求，且需要对天线进行更换。

最终，电台的覆盖可能无法令人满意或因邻国推出数字电视台所产生的干扰而变得无法令人满意。因此，可能需要安装功率更强的发射机或经改进的天线。

频率

改变频率需要重新调谐发射机和天线滤波器。对于SFN，其所有发射机均须改频且最好同时改频。天线方向图与频率相关，会因使用新频率而不同。

此外，新频率可能要求对其它方向加以限制，除非这些方向由经国际协议批准的原频率使用。为了遵守这些限制，可能需要降低最大辐射功率。如果新频率在频段的另一部分，其传输特性会有所不同。

因此，改频很可能会造成覆盖范围的变动，在有些地区会带来覆盖问题。在这些情况下，必须通告相关地区的观众，并及时通知他们改善接收的方法。

功率

在相关国际规划（GE-06）和本地规划许可证允许的情况下，可用不同方式提高辐射功率。

天线

a) 水平辐射方向图

天线方向图受天线的设计与建造以及频率的影响。基本辐射单元是使用双极安排的面板。一般而言，发射天线包含几层面板。一层内面板的数量取决于支持结构和所需的辐射方向图。天线杆顶的非方向性天线通常每层有四个面板。

在整个频段内，新设计的天线结构其辐射特性有大幅改进。

b) 垂直辐射方向图

垂直辐射方向图对发射机附近的覆盖特别有用。层次增多会导致天线增益的上升，但同时也会使发射站附近的接收产生更多的问题。如果站点在城区，有些网络运营商将不安装八层以上的天线。在多层的情况下，必要的零信号区填补只能通过增加增益来实现。

即使不改变层数，更换天线几乎总会改变垂直方向图中的“零信号区”，造成位置上的移动，并使低场强部分靠近发射机。

发射机附近的高场强区也是令人担心的问题。在最大场强出现在发射机附近的区域，场强可能会大至对消费者和专业设备产生干扰的程度。在十分靠近天线处可能会危胁到健康。各国对电磁兼容性的规定和场强限制不同，因此可能有必要对辐射功率加以限制。

垂直天线辐射方向图的主波束应指向覆盖区（但不要超出）。特别是在天线很高或覆盖区相对较小的情况下，波束倾角是必要的。此波束倾角还有更多的优势，即水平方向的辐射功率更低，因此对其它传输的干扰更小。

c) 极化

与垂直极化相比，水平极化会产生更少的接收备份镜像（延迟信号反射）。 因此，模拟电视的大部分天线均为水平极化。尽管备份镜像对数字电视不是问题，但由于目前存在大量的水平极化屋顶天线，且人们希望对现有传输设施尽量加以重复利用，因此大多数国家选用了水平极化的方式。如果在低高度进行接收十分重要且接收天线主要采用水平极化的方式，例如室内和移动电视的接收，则可采用垂直极化的方式。

d) 操作方面

如果需要安装新天线或天线合路器，则改装天线的成本很高。通常针对天线的施工需在高处实施。由于天气条件的限制，天线维护与施工仅能够在适当的季节进行。天线杆上的空间有限。对于新天线，高度与孔径间要做出折衷。某些情况下，在另一天线移除之前，可能需要安装一个较小孔径（因此增益较小）的临时天线。如果较低的增益无法通过更高的发射机功率予以补偿，则覆盖范围会缩小。

事实表明，在工作条件恶劣的高天线/塔顶端操作时，可能会出现安装差错。建议使用安装有专业器材的直升机对天线辐射特性进行测量，验证水平和垂直辐射的方向图（不足一小时便可）。做为一项首要原则，在启用相关DTTV发射机前，必须对两种方向图进行验证。仅仅是BBC模拟广播网，直升机天线验证测量就检测出了30%左右的差错。

对模拟电视广播的覆盖区而言这会产生可接受的劣化，但对DTTV广播而言此类差错是不能接受的－此种施工上的疏忽将在覆盖区产生漏洞－不可避免的会引发观众的抗议。

e) 天线高度

增加天线的高度通常是一种有效的改善覆盖的方法。这种方式可以扩大覆盖区，但在水平方向之外，对其它业务区的干扰场强在可接受的限度之内。然而增加天线的高度并非小事，由于实际问题和监管方面的原因，可能无法实施。

此外，出于节约资金的考虑，许多国家的现有传输装置主要用于数字电视且无法增加天线的高度。但是，有些国家使用了更为密集的数字电视网（例如SFN），以改善室内和移动接收。

在这些情况下，每个发射机的覆盖区要比模拟电视的覆盖区小，因此天线高度可以更低。针对天线高度很大且覆盖区相对小的情况，应注意垂直辐射方向图的零信号区，并需提供充分的波束倾角。

5.10.2 DTTV制式

DTTV压缩或传输系统的选择取决于提供的业务。这些要求可能会随着时间而变化。如果复用的数量减少或无法扩大，且对广播业务的要求超出了可用频段的容量，则可能有必要采用更为高效的压缩和传输系统。如果IV和V频段被分割且规定的业务的频谱不足，则这一点更是至关重要。

可选方案

DVB-T可选用2k或8k的快速傅利叶变换（FFT），三类载波调制和五种码率，总共有120种可能变化。

通过恰当地选择调制方式和码率，可以产生一种强健的派生系统，不仅所需场强低且比特率亦不高。

另外，也可选择高多路复用容量，但这种情况需要高场强。保护频带对单频网络很重要。

此外，还可以选择非分层调制或分层调制。对于后一种情况，还可在调制参数间做出选择。

这些考虑同样适用于ISDB-T系统。

改变DVB-T、ISDB-T或其它派生系统是对发射机的一种简单调整。最低网络比特率的发射机将确定网络的多路复用容量，因此网络内所有发射机通常被调整至相同的DVB-T、ISDB-T或其它派生系统。MPEG传输流的比特率和发射机的入局信号，不得超过DVB-T、ISDB-T或其它派生系统的比特率（针对这些系统，对发射机做出了调整）。

DVB-T2使用最高阶群256QAM，将总数据速率提高至每个OFDM小区8比特，从而提高了频谱效率以及针对某特定码率的传输容量。类似的考虑适用于上述DVB-T。

FFT的尺寸

2k和8k变量是指数字信号中OFDM子载波的数量。目前有仅使用8k的趋势。2k在移动接收方面有优势，因为2k时因多普勒效应产生的干扰是8k时速度的四倍。无论保护频带（对SFN操作很重要）如何，其时间仅为8k时的四分之一。DVB-H和ISDB-T制式使用折衷的4k速率。

载波调制和码率（DVB-T和ISDB-T）

对于便携接收，特别是室内接收，场强的要求特别苛刻，且趋势是使用相对低码率的（2/3或1/2）。对于屋顶接收，通常使用64 QAM和相对高的码率（2/3或3/4）。如第2.2节所述，必须在多路复用容量、覆盖质量和有用场强间做出折衷。在实际操作中，做出了不同的折衷：16QAM亦被用于为屋顶接收规划的网络，并将64QAM用于为室内接收规划的网络。存在为小区域广播大量业务的情况，且7/8码率的64QAM被用于提供31.6 Mb/s的业务。

分层调制（DVB-T和ISDB-T）

分层调制实际上很少使用。它允许使用一台发射机传（一个频率）输两路独立的复用，但传输的质量不同且会占用部分开销容量。高优先级的复用可用于向广袤地区的室内接收广播有限数量的主要业务等操作。低优先级的复用可用于向发射机附近的室内接收广播大量业务，但在乡村用于屋顶接收。

压缩和复用

编码和复用在一个中心点操作，是传输链中相对昂贵的部分。改变或改善压缩或复用系统对发射台和覆盖没有直接影响。统计复用经常被使用，并与每项业务的恒定比特率做对比。在保证画面质量的同时增加多路复用的容量。

编码机的升级

经验显示，在技术成熟之前编码机的效率会逐年提高。相同压缩系统的编码器升级与更新将在复用中产生更多的业务，或在业务数量相同的前提下提高质量。

使用MPEG-4

MPEG-4是一种面向未来的压缩系统，又称ITU-T H.264建议中称为MPEG-4/AVC（MPEG-4/AVC第10部分）。与MPEG-2相比，MPEG-4的编码效率要高至少1.5倍。使用MPEG-4在复用中提供更多业务时还可得到另外一个优势，即统计复用。需要充足的接收机HDTV业务于2008年始于欧洲的地面网络，此业务使用MPEG-4。

传输系统

调制和差错编码在数字电视发射机的驱动器中进行。可能已经为不同的传输系统配备了发射机。如果还未配备，则改变传输系统，例如用DVB-T2 或 DVB-H 替换DVB-T 需要进行软件更改或更换发射机中的驱动器模块。传输系统的改变对网络只有很小的直接影响。但是，安装了新系统的业务可能会有不同的要求（例如：移动电视）并需要充足的接收机。

地面HDTV传输使用了MPEG-4压缩，例如巴西使用的ISDB-T制式便是基于MPEG-4。

当HDTV的推广将与DVB-T/MPEG-4同时开始时，如果要求在大型平板电视屏幕上显示重要信息，则多路复用中不得容纳两个以上的HDTV业务。对于中型尺寸的屏幕，当观看距离是屏幕高度的三倍时，可在多路复用中提供三种HDTV业务。

预计近年来MPEG4编码器将会不断改进（正如MPEG2编码器那样）。

如果DTTV的推广将于2010年或之后实施，则可以考虑使用经改进的DVB-T2制式。

在现有业务中引入新的传输系统，必须在不会造成业务中断的前提下，通过现有系统与新系统并行传输来实现。所有接收机均装备了新系统之后，可将老系统关闭并将复用用于新业务。在某一日期之后，规定只能出售可同时接收新旧两种制式的设备之时，此进程方有可能缩短。然而，这一进程可能需要许多年才能完成。

由于IV和V频段的频谱已被划分给了其它非广播业务，造成并行操作DVB-T2等制式无复用可用，则可考虑使用下述方法之一：

- 在GE-06程序的基础上寻找新频率；这些频率在部分情况下可能会受限；
- 将某一复用内的业务移至另一复用，释放该复用。利用更加成熟的MPEG-2技术的优势，使用容量更高的派生DVB-T，在释放复用中引入基于最领先技术（如统计复用、DVB-T2/MPEG4）新的HDTV业务。

发射站点

总体而言，电视网络的推出始于主要电视台，以人口密集的地区为目标，即所谓“岛屿原则”。此后，通过对网络的扩容再覆盖人口密度较低的地区，通过加站的方式提高覆盖。

在山区和城市安装一批填入式接收机，目的就是为了解决镜像产生的接收问题。对于数字电视，镜像并不是一个问题。因此，多数情况下地面数字电视网需要更少的填充站。

扩大覆盖

主要人口聚集区被相对较少的台站覆盖后，从每位居民的人均成本来看每个新增台站均很昂贵。公共广播公司有义务提供全面覆盖，并需要将其节目尽量覆盖全国。有些国家普遍覆盖的义务并不仅限于地面电视，农村地区也可接受卫星电视。没有公共服务使命的商业广播公司可能不愿覆盖整个国家，并将地面网络限制在人口密集的地区。

总之，现有站点将得到重复利用。数字电视的投资成本可被限制在数字发射机（通常功率更低）替代模拟发射机以及重新使用原本为模拟电视安装的天线所产生的费用之上。根据规划条目的特性，与模拟电视相比天线方向图对数字电视而言并非最佳，例如当数字电视的功率限制面向不同方向时（方向角或方位角）。

对于SFN，其内部发射机间的距离特别需要注意。如果在某个接收点，SFN内两发射机间的相对时延超出了保护频带的长度，SFN可能会产生自干扰。

覆盖的改善

在覆盖区内，由于地形、建筑物、森林等原因，接收率可能勉强符合要求或在可接受限值之下。覆盖预测的准确性受到限制；有些接收不良的地区仅在观众投诉后才被发现。通过详细的地形和地物数据以及久经测试的传播测试方法，在某些情况下可以实现将覆盖预测精度达到几dB的范围。良好的接收是一种统计特性，并取决于多种变量，其中包括在1%的时间内超出的干扰场强值。记载有所有有用发射机和潜在干扰发射机数据的精确数据库也是一个前提。即使预测的覆盖范围能够符合标准，仍有可能收到投诉。

在进行覆盖预测时，总是假设观众使用符合频率规划标准的接收设备。第5.7节涉及接收设备以及如何在接收站点改进接收。

如果要求室内接收或移动接收，上述功率在一台发射机的情况下可能不足以覆盖很大的区域，例如屋顶接收便是如此。可能有必要使用SFN进行功率分配。如果SFN的密度变大，在某些位置收到等场强的两个或多个信号的可能性增加，即所谓零dB回波。如果信号的强度相同，DVB-T或ISDB-T接收机在这些情况下的灵敏度会下降，其范围在5至10 dB（针对64QAM2/3的情况）。如果时间差很小（< 0.5 μs），接收机同步还会出现其它问题。

零dB回波能够影响相对大的区域，特别是在平坦的地形上。如果使用了密集的SFN，重要的是使规划软件考虑到零dB回波。通过恰当的网络规划，零dB回波区可降至最低或被转移至人口较少的地区。

复用

例如根据《GE-06协议》，大部分国家在IV和V频段有权使用七个或八个DVB-T"层"并在III频段使用一个DVB-T"层"。GE-06中对"层"进行了定义，但通常可将其理解为某一地区能够接收到的频道数量。在多数国家，目前的许可证还未覆盖《GE-06协议》提供的所有"层"。在下述情况下可为更多"层"授权：

- 模拟电视已经关闭（包括邻国的模拟电视）且对"层"的限制已经取消；
- 已针对新广播业务或其它非广播业务做出了决定；
- 新技术的成熟度已可供布置；和
- 市场的要求更为明确。

现在有一种趋势，将地面数字电视集中在IV和V频段，并使用DAB家族的系统将III频段用于广播和多媒体业务。

公共站点的使用

将公共站点用于现有和新复用的传输在于能够对现有设施，例如：分配链路、发射机所在建筑、天线杆、天线和预留发射机，加以利用。此外，目前已经进行了大量投资：公路、高压电源、备用电源、水、为站点划拨的土地、建筑物和人员。

在对广播站点进行施工和安装时，最好将未来的扩容考虑进去。后来对链路、建筑、天线杆和天线进行修改通常价格要昂贵许多。

不同网络运营商使用同一站点时，公共站点的使用可能很复杂。

使用建筑物和天线杆的有限空间必须制定优先级规则。天线合路器和天线的共用也需要有明确的责任、费用与维护协议。从经济和操作的角度来看，天线共用存在优势；但它并不总能提供最佳覆盖。

将更多复用应用于不同网络时，站点的共用只有部分的可能性。如果要求高密度的电视网，则需建更多站点，且站点处的天线可能过高或与要求的极化不同。

使用不同的站点

在下述情况下需要不同网络拓扑：

- 几家运营商使用相同的频段；
- 部分复用使用高密度网络。

非共站电台，以及有用信道或图像信道两侧的第一、第二或第三相邻信道的使用会产生相邻信道干扰。

非共站电台既可以是广播电台，也可以是移动基站。甚至移动终端也可在很短的距离内造成相邻信道干扰。

相信信道干扰是一种地方性问题。相邻信道干扰有许多可能的解决方案。

如果涉及不同的网络运营商，则会出现谁将为这些规定埋单的问题。

6 经济方面

广播链在各个层面均很独特。概念、结构和部署的差异是如此之大，几乎无法找到“孪生”兄弟。没有完全相同的电视制作中心、制作/转播网、复用/传输网。技术选择和方案的种类各异，使广播链上的各个元件均有其独特的设计、规划和成本。价格信息总是保密的，且合同的签署要经过冗长的协商。大规模交货、长期业务关系等因素将会得到优惠。规划、保障、安装与测试、人员培训、售后服务等将对签署合同的总价产生影响。即使有成本信息，也只有存在具体环境时才有价值。

尽管本研究课题被授权开展研究，但此报告无法提供成本影响问题的答案。

有关商业模式、成本与融资、风险因素评估、成本/效益问题的分析的信息，有利于建立支撑环境，可由电信发展部门开展的实际研究提供，同时为国际电联成员向数字时代过渡提供帮助。

提供这些国家案例研究非常有益于评估所发生的成本并对成本效益和风险予以分析。

数字转换的成本影响

数字转换将影响大多数家庭并为消费者带来无法回避费用。此外，它还将为非本国电视业用户带来费用。此还包括升级社区电视接收系统的费用，这些系统被用于公寓、饭店、住宅区的保健中心和家庭护理。对于广播公司和复用运营商，存在部署数字网络的资本投资成本和落实广播许可规定的数字转换所产生相关成本。商用业务广播公司还将制定战略，通过扩大对复合节目业务的选择和接入，应对收入方面的负面影响。

消费者的费用

数字转换过程中，希望继续接收电视服务且仍未切换至数字电视的家庭，至少需要购买一个机顶盒。

目前，接收DTTV业务的机顶盒的价格在70美元左右。转换之后价格预计还会继续下降。但是，除机顶盒/接收机的费用之外，选用DTTV的消费者还可能面临其它费用。

有两个或多个电视机的家庭需要为所有的电视机购买设备，才能在切换后使用这些电视。如果他们不选用集成数字电视（内置数字调谐器），其成本将包括机顶盒。成本还将包括VCR和新室内天线的补充电缆；

使用录像机的家庭或许还需要购买额外的SCART电缆。

如果拥有录像机的家庭需要录制其调谐电视频道之外的频道，则需更换其录像机（或针对录像机购买另一机顶盒）。

选用DTTV（第一台或其后的电视机）可能需要为数字转换更换天线。新室外天线的价格会根据需求和区域性差异而变化。其范围在150至600美元之间。

公寓区内的家庭，为弥补数字接收系统更新的费用，可能需要支付额外的服务费。

在数字转换的准备期间和启动之后，随着国家开始落实数字转换规划，DTTV设备的价格预计会因规模效益而下降。数字电视不断上升的需求，为卫星和有线基本业务的廉价接入打开了方便之门。

国外用户的成本

许多商家使用模拟网络的广播电视业务。为能够在数字转换后继续接收电视业务，接收设备以及相关系统需要进行升级。在某些情况下，需在正常更新周期前，就提前更新设备。

由于位置和在建筑物的地点所限，其效率不如公共电视天线系统，因此此系统可取代个人天线。公共电视系统的数字电视业务更新成本取决于多项因素，例如建筑物的类型、位置，以及业务和住户是希望仅将系统更新为DTTV还是希望投资建设一个全新的、能够提供卫星或有线业务的系统。尽管费用存在差别，但针对条件良好的系统，其费用在1200 – 2000美元之间。

公共服务广播公司的成本

实现数字转换的进程将会对公共服务广播公司产生一系列影响：

- 它们需要与传输网络公司签定合同（作为复用运营商或间接通过其它复用运营商），部署并配置DTTV网络，通过承载公共服务频道的复用提高DTTV覆盖，以使覆盖范围与现有模拟覆盖相匹配；
- 数字腾飞将在很大程度上影响未来的网络广告收入。

成本/效益分析的基本内容

成本/效益分析要针对各发展中国家单独分析，并考虑到基础设施、经济、社会、人口、技术和其它各方面的因素，同时以相关数据库为基础。此外，可使用各国主管部门和相关利益攸关方成本/效益分析专家感兴趣的一些公共方法。

7 观众的利益

在网络发生某些变化之后，观众可能有必要采取措施，从而能够接收新业务或改进后的业务，亦或继续使用现有业务。

外部因素会造成接收质量下降。这些因素包括启用新数字电视业务时干扰电平的上升，相同频段内其它业务产生的本地干扰。

应当指出，如果接收质量下降，即使接收质量仍保持在认可标准之上，观众仍可能会遇到接收问题。大多数情况下，观众可采取措施改善接收质量，但广播业必须提供信息和相关协助。

改善接收的方法

接收装置中对实现高质量接收至关重要的要素包括：

- 接收天线的位置；
- 接收天线的方向性和接收天线的增益；
- 天线电缆的损耗；
- 天线和接收机间的匹配；
- 接收机的灵敏度；和
- 接收机的选择性。

接收机的特性取决于其设计和实施。一般而言，接收机符合EICTA规范。尽管有些特性，例如选择性等在将来会改善，但观众无法对接收机进行改进。为改善接收，要注意天线特别是其位置、方向性和增益。这些特性均与频率相关。有源天线、天线放大器和分集接收亦有助于接收。

天线位置

接收天线的高度是一项十分重要的因素。原则上讲，屋顶天线应置于本地的地物上方。将天线置于屋内的高点、更高的楼层或室外，能够改善室内接收。甚至是室外安装的小尺寸天线，例如3米高，与室内接收相比都可使接收率大幅改善。

场强的分配可划分为宏观变化和微观变化。宏观变化涉及小范围区域，例如100x100米的范围，且对此类地区有位置概率要求。微观变化与接收位置相关，其范围是几个波长，主要因附近物体反射产生的多径效应造成。接收天线应位于场强最大的位置。但是，微观变化取决于频率，如果必须接收多个频率且平均场强值接近要求的最小值时，可能很难找到最佳位置。屋顶天线的位置在安装时便已确定，选择受到屋顶建筑的限制。便携天线原则上可置于各频道的最佳位置。但是，如果每选择一次频道就需要改变天线的位置，对收看电视的乐趣会有不良影响。

方向性和增益

有效天线孔径是波长与半波双机增益比的函数。甚小天线，例如手持接收设备的内置天线，增益很低。另一方面，方向性屋顶天线尺寸很大且增益也很高。

实际上，屋顶或便携天线特性很差，特别是当方向性与增益为频率的函数时。如果能够提供有关接收天线的全面信息，对公众将十分有益。

使用增益更佳的天线可改善接收。对于屋顶接收，可通过配置更多要素的天线实现更好的方向性和增益，并用天线放大器补偿电缆损耗。

通过小型指向天线获取更大增益的方法，可改善便携接收。或者，有源天线可实现更低噪声值并更好地与接收机匹配。

通过拉杆天线，手持接收在某些位置的接收将会得到改善。

分集接收

通过天线的方向性，移动和便携接收可大幅改善。手持电视装置太小，无法容纳一个以上的天线。天线分集系统降低了快衰落的影响，包括两个或更多的天线和一个专用接收机。天线输出使用某种权重因子合路，并使用标准解码算法解码。与单一天线接收相比，天线分集应用具有下述优势：

- 所需场强更低（6至8dB）；
- 更高速率下提供更好的接收；
- 人员在天线附近移动时接收问题更少；
- 接收若干复用时问题更少；且
- 便携接收天线更容易找到最佳位置。

尽管具有这些优势，但分集天线接收设备并未广泛提供。

重新调谐接收机

变频或新频率投入使用后，需要重新调谐接收机。有些接收机在待机模式下实施背景扫描，因此会针对新频率自动调整。但是，大多数接收机的重新调谐均是通过菜单人工启动自动频率搜索功能实现的。经验表明，重新调谐对许多观众都殊非易事，他们必须采取下述行动：

第一步

- 进入菜单
- 选择“安装”
- 执行“重新设置缺省值”

第二步

- 进入菜单
- 选择“安装”
- 执行“自动搜索发射机”

采取这两项步骤之后，可能有必要恢复优选的频道顺序，删除不喜欢的频道。

对公布、通知和变频的实施而言，良好的沟通是重中之重。

更换消费者的电视接收设备

当各国决定改善其系统时，有必要使用新接收设备：

- 新压缩系统（例如：MPEG-4）；
- 新传输系统（例如：DVB-T2；DVB-H）；
- 新电视制式（例如：HDTV）。

对于巴西的ISDB-T，面向未来的系统业已将MPEG-4和HDTV全面融入其中。因此，此类接收机的更换完全没有必要。

现在电子装置的置换周期很短。一般而言，假设数字接收设备的替换周期在六年以上。但是，与模拟电视的情况相似，更换下来的机顶盒或集成数字电视接收机将继续被用在其它房间或娱乐场所。此外，数字电视接收调谐器还被用于其它装置，例如家用录像机（PVR）和个人计算机（PC）。

集成有新压缩或传输系统的接收设备，其价格很可能会高于使用成熟技术的相应设备。强迫观众更新接收设备并不可取，只有能够提供有吸引力的新业务时才会为人们所接受。

沟通

必须通知观众有关接收的可能性，网络的变化以及可能对其接收产生的影响和他们须采取的行动。

下述工具可用于与观众间的交流：

- 网站；
- 电话服务台；
- 广告；
- 通过本地经销商传递信息；
- 采用复用技术的信息频道；
- 图文电视。

8 有关向DTTV过渡的结论与建议

地面数字电视网在III、IV和V频段的演进将得益于多种业务选择的助力，业务种类包括HDTV、移动电视、互动和数据业务，以及便携接收。根据当地的需求，各国提供的业务种类亦不相同。

有关SDTV和HDTV的战略决策将在未来30年左右的时间内塑造DTTV广播，因此应在模拟业务关闭日之前早做筹划。截止日期之后，III、IV和V频段可重新分配给其它业务且在1区的部分国家将不再用于广播。各国主管部门可能会面对“现有或更新的”两难境地，特别是针对HDTV广播的推广，而广播公司应当意识到这种可能性。

a) 广播业必须齐心协力

每种业务均有必要在下述方面做出选择，例如接收的类型（屋顶、室内、室外、移动、手持）、覆盖的区域和使用的制式（DVB-T、DVB-H、DMB、ISDB-T及其它）。需要在多路复用容量、覆盖质量和辐射特性之间进行折衷；折衷的内容涉及业务质量、潜在观众的数量和传输成本。此外，需要就网络的类型做出选择（使用现有站点和/或新站点，或者是补充站点、SFN与MFN）。

广播公司和/或网络运营商应当讨论这一问题，并在恰当的时机，与接收机制造商达成协议，以确保足量及时地提供各类接收机。

b) 需要明确定义的监管框架

III、IV和V的使用通过国际电联《无线电规则》和《GE-06协议》等国际协议进行严格监管。欧洲委员会就数字红利的使用提出了明确的政策，倾向于市场主导的方式进行划分。

存在将部分IV和V频段用于移动通信系统（UMTS）等非广播业务的可能性。在上次国际电联世界无线电通信大会（WRC-07）上，许多国家同意为此类业务开放61至69频道。但目前正在对数字广播与非广播业务间的兼容性开展研究，因为人们十分担心广播业务与双向传输混用所产生的后果。

这些研究的结果，请参见WRC-07的议项17。该议项将于2012年的下次世界无线电通信大会（WRC-12）上做介绍。

c) 广播界需仔细跟踪"数字红利"应用的进展

各国主管部门决定将某子频段为特定业务预留需要进行重新规划，并会改变对现有和规划业务的限制。应对此类进展严密跟踪，并对给成本和覆盖带来的影响做出分析。此外，只要没有关于使用频道61至69的明确国家决策，则应尽量避免在这些频道内提供地面数字电视业务。

在IV和V频段使用低功率或无需许可证的应用十分引人关注，应予以仔细跟进，防止对地面数字广播业务产生干扰。

d) 需要告知观众网络发生的变化

引入新业务或对网络进行修改十分复杂，需要仔细的筹备。

可能需要改变辐射特性、系统变量和压缩或传输系统，且可能需要安装额外的发射站点和额外的复用。网络的大部分变化将对观众产生影响，并涉及其接收电视节目的能力。此外，由于频率范围的设计或其方位角的原因，现有接收天线可能不适用于新业务。

与大众进行良好的沟通，让其为网络变化做好准备至关重要。大部分的网络改变至少会影响到部分家庭，且可能会对所有家庭产生影响。为判断网络变化对相关地区的影响，并通知大众其有机会接收新节目或仍然接收现有节目，准确的覆盖预测不可或缺。

e) 通过改进的接收天线改善接收

无论是屋顶、室内还是手持接收，在接收地点使用更好的接收天线均可改善接收效果。可伸展的天线能够改善手持接收的效果，而所谓"有源"天线最适用于室内接收，且使用天线放大器和更高方向性与增益的天线可改善屋顶接收。在DTTV接收机天线输出连接器中加入可开关5V电源，将有利于有源天线的使用。

f) 为将来仔细规划

替换发射天线时，新天线的调制解调器设计通常有更好的频率特性。

单频网络（SFN）是一种有效的方法，可为便携（室内）和大范围移动接收提供覆盖。但是，SFN的规划很复杂并需要特别小心避免产生自我干扰和所谓"0 dB回声"干扰。

如果将来要引入更多的复用，宜应在发射机的构造、天线和电源的设计和布局中考虑预留额外的空间和容量。此后的网络扩容存在高成本的风险，因为现有设备将被放弃并替换。

将来网络需要演进来满足各市场的业务需求。广播业应担负起确保所有利益攸关方均为应对此挑战做好准备的职责。

9 数字音频广播（DTAB）的引入：优点、技术平台、可能的实施方法、独特的功能、演进的阶段

9.1 DTAB的优势

对听众而言，数字广播承诺改进接收并提供更好的音频质量，而数字传输系统有潜力提供范围多样、比模拟时代更为高级的广播业务。越来越多的国家在选用恰当的DTAB标准用于部署，并将精力集中于颇具吸引力的标准制定方面，例如：DRM和DAB+（比如：后者的频谱效率要比DAB高两至三倍）。

这一强大的新技术浪潮支持丰富的多媒体感受，通过文字、图像和补充数据业务等形式为商业广播公司的广告和赞助提供了更多的机会。

与模拟音频广播相比，地面数字声音广播（DTAB）的核心优势在于数字广播提供数据业务的能力。此类数据承载能力可被用于提供下述业务：

- 新闻；
- 本地信息（在一条广播数据流内为不同地区提供不同的数据）；
- 气象信息，特别是有关农业气象条件的专项数据，包括本地气象条件的更新；
- 就业辅助数据（在一条广播数据流内为不同团体提供不同数据）；
- 市场数据/更新（在一条广播数据流内提供不同地方市场的现行价格数据）；
- 业务信息包括本地业务条件的更新；
- 财务报告/更新；
- 各类订购数据业务。

9.2 DTAB的部署

DTAB已部署于一些国家（如澳大利亚、德国、意大利、韩国、新加坡、瑞士；英国和美国等国家已有九百万DAB收音机。）。在瑞典，DTAB完全取代了FM模拟广播，FM模拟广播已完全关闭。法国做出一项规定，自2012年起，每辆新车必须配备该国通过的T-DAM数字标准数字收音机（DAB的一种）。

但是，德国和瑞士的商用广播业于2009年7月拒绝了在其国内投资开发DAB数字广播系统以取代现有模拟AM/FM发射的建议。他们反对TDAB的理由是，基于欧洲已引用DAB广播的国家的经验，所需的巨额投资与漫长的财务回报不成比例。德国和瑞士商用广播业警告指出，淘汰FM技术将导致收入减少，投资下降，创业风险提高和公司就业人数的缩减，由此导致各国媒体话音多样性的缩水。

从广义而言，考虑到当前的金融危机，很难说服广播链中的最大投资商以及监管机构、公众和商业广播公司做出在近期向数字广播进行大规模转换的风险性决策。“逐步过渡”策略可能是一种明智的做法，在DTTV完全关闭后再开始在世界范围内大规模开展模拟声音广播向数字地面音频广播的过渡。在此方面，国际电联成员国可以考虑在适当时间内重新计划《日内瓦84规划》，就像根据《日内瓦06规划和协议》向数字地面电视过渡时重新计划《日内瓦61和日内瓦89规划》一样。

对于发展中国家，DTAB可成为一种为大众提供数据业务的可行方式。DTAB的使用在电视广播不能覆盖的地区或接收质量很低的地区增长迅猛。除了接收机的便携性与传统模拟声音广播的移动接收之外，DTAB的内在优势还包括：更高的数据业务接收容量、逐步降低的接收机价格（目前还不够低，但随着DTAB接收的产量将会迅速下降）。

9.3 DTAB技术

请参见ITU-R BT-2140报告（http://www.itu.int/publ/R-REP-BT.2140/en）中有关DTAB标准的详细信息。

下表展示了各类技术的频段范围和频道宽度。

此技术使用的频谱		
技术	**业务要求**	**优选频段**
Eureka 147（DAB）和DAB+	宽带 – 复用 每个集合为1.5 MHz频道	VHF频段III*, L-频段
DRM	窄带 9-18 kHz每频道	MF, HF
IBOC（HD无线电） - AM - FM	窄带 20 kHz每频道 200 kHz每频道	MF VHF频段 II
ISDB-TSB	宽带 – 复用 0.4 or 1.3 MHz每频道	VHF 频段II和III, UHF
DVB-T	宽带 – 复用 7 MHz每频道	VHF频段III, UHF

*) 注：一些欧洲国家使用DVB-T和DAB的混合复用。

不同数字广播技术设计使用不同的频段，以实现特定的性能。例如，IBOC系统专门设计用来在现有广播公司现行许可频谱划分内提供数字广播能力，因此使用MF-AM 频段和/或VHF的频段 II 广播频谱。DRM计划用于提供极宽覆盖范围的数字广播业务，因此在MF-AM和HF频段以使用已划分给大范围覆盖业务的部分频谱。

9.4 DTAB实施的方法

为实施数字广播，各国监管机构已采取了一系列方法。这些方法反映出了一些因素，其中有许多是特别针对某一国家，例如广播市场的结构、技术或频谱的限制；特别是引入数字广播的政策和战略、公众对此做出的反应等。

实施DTAB的可行方法主要有三个：

全面转换

“全面转换”方法谋求通过对现有模拟广播业务进行数字转换，使现有的全部广播公司必须转型，以便在数据接收机启动的某一时点关闭模拟业务。此方法基于数字广播将作为模拟广播的首要替代技术的假设，很可能涉及模拟广播数字频谱在指定关闭日期后的退还。

“全面转换”需要充足的频谱以容纳所有的现行模拟广播业务从一开始就使用数字格式（或尽快）转向数字化。

市场方案

根据落实数字广播的“市场方案”，对广播业务的监管程度很低，主要领域涉及品味和道德和其它与内容相关的要求、技术标准、频谱划分和干扰水平管理。最基本的问题是很可能通过拍卖或选美的方式，批准可用的频谱，且对提供某特定类别的服务没有要求。对现有模拟业务向数字业务的转换没有具体要求和义务。

受控推广

“受控推广”方案介于全面转换与市场方案之间。此类方法的假设是数字广播将与模拟业务共存一段时间，其长度超出了合理的政策制定范畴。尽管在数字推广初期可能无法预见对模拟业务的全面复制，但更长远的目标就是要确保将来在做出关闭模拟业务的决定之后，可在某一时间对任一模拟业务进行数字化转换。很可能在自愿的基础上，为那些有意复制模拟业务的老牌模拟广播公司优先提供数字容量，并推动新型创新业务的开发。

“受控推广”方案可更好地解决当前有限频谱产生的限制，并在频谱可用之后提供未来的频率（例如，模拟电视频谱的最终退还）。

非商业公共广播公司在数字广播中的职能将受政府采用的、实施模式的影响。

“全面转换”的模式致力于将现有业务数字化。当前的频谱瓶颈可能会限制非商业广播公司的潜力，在可用容量被大量用于提供联播服务的情况下，无法充分利用数字平台带来的机遇。

在“受控推广”方案中，为非商业广播公司从模拟向数字化过渡提供更大的灵活性。

9.5 选择方法

在选择方案之前，需要认真考虑一系列问题，其中包括：

- 及早实施数字广播业务是否符合大众的利益
- 选择数字广播技术和划分用于提供业务的频谱时，哪些是最为重要的因素
- 应将数字广播视作补充技术还是后续技术
- 对数字广播从开始和在规定期限内的监管程度
- 老牌商业、社区、地区、国家及其它广播公司的职能
- 提供新业务的范围以及新业务提供商的参与。

9.6 DTAB的具体功能

与模拟音频广播完全不同，DTAB涉及一批独立的音频和数据广播流。因此，与现有模拟广播业务不同，部分广播提供商将通过单一的传输设施提供广播业务。广播节目的复用提供使听众更加平等，同时取消了社区广播方案。

颁发许可证

DTAB通过单一频道复用提供大部分不同业务的能力，为业务规划带来了新的可能性，特别是将复用运营商引入了无线电广播价值链。后者意味着具备了将内容与承载分开的机遇，即采用双层许可证机制，将许可内容提供商的授权与复用运营商的授权分割开来。在采用此种许可证的情况下，复用运营商将有能够管理数据业务间的比特率容量，即可以灵活地对市场需求做出响应。但与此同时亦应保护内容提供商的利益，即无论是谁控制多路复用容量，内容许可证都将为被许可方提供多路复用容量的接入。对那些提供具有社会价值、与信息社会内容相关的提供商而言，例如：播放公共广播节目（国家服务）的公司，尤其应保障此类接入。下述方案均可行：

- 颁发内容许可证，且保证此类许可证对多路复用容量的接入权。例如，内容许可证可在某许可区内提供128 kbit/s容量的有保障接入，且得到授权的内容提供商有权就使用更低或更高的划分进行磋商。这就需要有足量的复用来容纳所有得到授权的服务以及各个国家级的广播公司。可以考虑划分专门的复用，用于传送国家和其它非商业服务。此接入权亦可通过要求得到复用操作授权的各方根据第三方接入方案操作来实现。
- 为复用许可证持有方规定“必须承载”的义务，要求其提供最小数量的某些特定类别的服务。此类义务可以针对所有复用许可证的持有方，或根据本地需求的条件逐案确定。此类复用许可证的价格反映出的是对商业灵活性和提供服务所得利益的限制。

频谱划分

对于地面数字广播，似乎业务将通过复用操作提供。因此频谱的划分可能会涉及一批业务而不是单一业务。单独的运营商可得到或购买对比特率容量的使用权。

DTAB业务和联播

在数字广播的早期阶段，（在没有规定话务的情况下），数字广播的内容很可能与模拟业务进行联播。但从中期来看，消费者可从数字平台内容的差异中获益，特别是客户设备使听众能够在同一装置上使用模拟业务的情况下。

到目前为止，没有证据表明具有针对数字广播业务的国家监管框架，要求或禁止提供联播。相反，大多数国家在不同程度上混合使用模拟联播和独特的数字业务。

如果某主管部门选择DTAB的全面转换方式，组播的要求可能是恰当的。其目的是防止不想立即转用数字业务的听众，因主要模拟内容向数字的转换而处于不利地位，从而出现数字鸿沟。但对于计划将数字与模拟业务在一定时期内共存的模式而言，联播要求会给广播公司带来很重的财务负担，造成有限频谱的低效使用，限制新业务的部署潜力，从而无法吸引消费者接纳数字广播业务。

DTAB平台为广播公司提供一系列新业务提供了机会，这些业务包括补充音频流、数据业务和潜在的视频业务。在国际上，数字广播的普及通常伴随着相应的监管措施，以实现这些新业务与数字广播平台仍致力于提供音频娱乐节目之间的平衡。

复用可被限制在，例如仅使用10%的多路复用容量提供与节目相关的数据业务，而另外10%可用于提供与节目无关的辅助数据业务。

9.7 向数字地面音频广播演进的阶段

第一阶段：DTAB的推广

- 应对现有规定重新审议，确保其能够反映出DTAB的影响，特别是将内容提供商与复用运营商分开的双层许可证制，
- 将为现有广播公司划分专用频道，供其以数字格式进行联播。
- 将为公共节目（国家服务）广播公司和其它非商业广播公司划分专用的多路复用或多路复用容量，以便为与信息社会相关的内容提供支持。

- 复用将被限制在使用固定比例的多路复用容量之上，提供与节目相关的数据业务和与节目无关的辅助数据业务。
- 在确定了内容许可证持有者必须提供的多路复用容量保障最低数据流之后将征集应用程序。
- 商用DTAB网对频道的使用应付初装费和年许可费。应将每个频道预期的年费告知广播公司。
- 在DTAB的起始阶段应密切监视其覆盖、接收质量和干扰。
- 将建立一个协调过渡进程的利益攸关方组。
- 须研究有关基础设施共用可能性的国家法律。

第二阶段：联播期

对于DTAB的“全面转换”方案，公共业务广播联播的开始日期应确定，从而

- 鼓励公共业务广播公司制定一项演进规划。将与广播公司一同探讨，鼓励确定一个日期，使当前所有免费的广播业务亦能通过数字格式传播给听众。
- 在任何可用的DTAB平台上，国家公共业务广播公司必须传送并免费播放。

第三阶段：关闭模拟业务

在向DTAB的“全面转换”方法中，应当规定模拟广播的关闭日期（最迟日期）并事先通知听众。

此阶段涉及关闭所有地面模拟音频广播。在模拟广播关闭之前，所有目前的广播公司均应过渡到数字平台。因此，所需时间取决于广播公司选择的过渡选项，以及市场对DTAB的全面提供做出的反应。

10 其它影响

从模拟向数字的转换将会引发针对整个广播业务链内从业人员的密集培训。

此外，急需对大学、学院及学校的课程进行调整，因为这些学校的毕业生很可能会在广播产业链供职，而这就需要他们的技能能够适应不断变化的数字环境。

11 最常使用的术语和缩略语清单：

720p/50	SMPTE 296M-2001和欧广联Tech3299规定的720行HDTV格式，每行像素1280，每秒50帧逐行扫描。
720p/50-60	1280水平像素x 720纵列HDTV图像格式，每秒50或60帧逐行扫描。
1080i/25	SMPTE 274和ITU-R BT.709-5规定的1080行HDTV格式，每行像素1920，每秒25帧或50字段交织扫描。
1080i/25-30	水平像素x 1080纵列HDTV图像格式，每秒25或30帧或50或60字段交织扫描。
1080p/50	SMPTE 274和ITU-R BT.709-5规定的1080行HDTV格式，每行像素1920，每秒50帧逐行扫描。
BMC	欧广播技术管理委员会
ACO	模拟关闭
BER	误码率
CA	有条件接入
CATV	有线电视
CCD	光电偶合器

CMOS	互补金属氧化物半导体
CRT	阴极射线管
DAB-IP	DAB – 互联网协议
DCT	离散余弦变换
DSO	数字转换
DTAB	数字地面音频广播
DTTV	数字地面电视
DV	（索尼）数字视频压缩格式
DVB	数字视频广播（标准名称）http://www.dvb.org/
DVB-H	数字视频广播 – 手持（标准名称）
DVB-T	DVB – 地面
DVB-T2	利用先进的调制和前向纠错技术的最新地面传输系统，比DVB-T性能超出30-50%。
DVI	数字界面
EBU	欧洲广播联盟
EPG	电子节目引导
FTA	免费广播
GE-06	GE-06协议，2006年，日内瓦
GoP	图片组
HD	高清
HDCP	高带宽数字内容保护
HDMI	高清多媒体界面
HDTV	高清电视
ICT	信息通信技术
ISDB-T	综合业务数字广播 – 地面
ITU	国际电信联盟 http://www.itu.int
ITU-T H.262	与MPEG-2相同
ITU-T H.264/AVC	与MPEG-4第10部分相同
LCD	液晶显示
MC	多频道
MER	调制误差率
MHEG	多媒体和超媒体专家组 – 多媒体演示标准
MHP	多媒体家用平台
MISO	多输入单输出- 智能天线技术，在来源（发射机）使用多个天线。目的地（接收机）只有一部天线。综合利用天线以减少错误并优化数据速率。MISO是若干智能天线技术之一，其它技术为MIMO（多输入，多输出）和SIMO（单输入，多输出）
MPEG	运动图像专家组http://www.chiariglione.org/mpeg/
MPEG-2	运动图像专家组 – 2（标准名称）
MPEG-4	运动图像专家组 – 4（标准名称）
MPEG-4/AVC	指2003年的ISO/IEC 14496-10，信息技术 – 先进的视频编码：视频信号编解码器，亦称为AVC，在技术上与ITU-T H.264标准相同。14496-10，日内瓦：ISO/IEC。

MUX	复用器
OLED	有机发光器件（二极管）
OpenTV	提供包括EPG、HD、VoD、PVR和家庭联网等多种高级应用的互动电视技术。
PDP	等离子显示板
RF	射频
SD	标清
SDTI	序列数据传送接口
SDTV	标清电视
SMPTE	运动图像和电视工程师学会（美国）
UHF	特高频
VHF	甚高频

12 推荐查询更多信息的网站

在以下网站中可以查阅更加全面而宝贵的信息：

DigiTAG： http://www.digitag.org

DVB：http://www.dvb.org

欧广联技术网站：http://tech.ebu.ch

法国监管机构CSA：http://www.csa.fr

英国监管机构OFCOM: http://www.ofcom.org.uk

Annex 1

European Membership Case Study

EUROPEAN COMMISSION
Information Society and Media Directorate-General

Electronic Communications Policy
Implementation of Regulatory Framework (I)

Brussels, 14 January 2009
DG INFSO/B2
COCOM09-01

COMMUNICATIONS COMMITTEE

Working Document

Subject: **Information from Member States on switchover to digital TV**

This is a Committee working document which does not necessarily reflect the official position of the Commission. No inferences should be drawn from this document as to the precise form or content of future measures to be submitted by the Commission. The Commission accepts no responsibility or liability whatsoever with regard to any information or data referred to in this document.

Information on switchover to digital TV in EU Member States

Information on roll-out dates of DTTV and switch-off dates for analogue terrestrial TV was first published in a Commission services' working document as an Annex to the 2005 Communication on accelerating the transition from analogue to digital broadcasting[1]. Part 2 of the current document provides a synthesis of updated information from Member States regarding roll out of digital terrestrial TV[2]. Updated information on switch off of analogue terrestrial TV is displayed in Part 3.

All Member States have updated their information in summer/autumn 2008.

This document will be published on the Commission's website at
ec.europa.eu/information_society/policy/ecomm/current/broadcasting/switchover/national_plans/index_en.htm

The Commission has asked the Member States to report on switchover and has provided a checklist of items that could be included in published national switchover plans[3]. These plans have also been published on the Commission's website at the same address (see Part 4).

Roll out of Digital Terrestrial TV in Member States

Country	Date	Other details
AT	Started 26.10.2006	MUX A: 87% coverage of population by the end of 2007; 91% by the end of 2008; 95% by 2010 MUX B: 81 % by the end of 2007 (unchanged since) MUX C (regional): 16 licenses issued in November and December 2008; services to be launched soon. MUX D (DVB-H): four main cities covered since June 2008; 50% coverage of the population at the end of 2008
BE	Flanders: fully rolled out since mid 2004 Wallonia and Brussels capital area: fully rolled out since end 2006	90% coverage of BE by end 2006 80% coverage of Wallonia and Brussels capital area
BG	Digital TV broad-casting started on 26.05.2003 in Sofia – one multiplex, maxi-mum six programs	2 single frequency transmitters operating in TV channel 64, 6 TV programs; covering the Sofia region.
CY	2010	The Republic of Cyprus has decided to grant two nationwide licenses for DTTV network/multiplex operators. One license will be granted to the public broadcaster in order to use 1 MUX to transmit its programs. The second license will be auctioned. It will include two MUXes during the switchover period and five MUXes after the switch off. These processes are currently underway and it is expected that both licenses will be granted by 2009. The roll out of DTTV and availability of services will commence as soon as possible and no later than 2010.

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1 Commission services working document Annex to the 2005 Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions on accelerating the transition from analogue to digital broadcasting {COM(2005)204 }

2 This document covers only regular permanent broadcasts. It does not cover information about transitory and pilot test broadcasts.

3 See Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions on the transition from analogue to digital broadcasting (from digital 'switchover' to analogue 'switch-off'){COM(2003)541}

Country	Date	Other details
CZ	Launch of DTT services started in October 2005.	Started (21 October 2005) in Prague and Brno and their near surrounding areas. Two networks have been gradually put into operation on temporary basis prior to preparation and approval of a national switchover plan. One of them has reached approximately 40% penetration of population covering Prague, Brno, Ostrava, Plzen, Domazlice, Usti nad Labem and their surroundings. Since May 2008 switchover development in the Czech republic has been based on the national switchover plan approved by the government.
DK	Launch of service April 2006	Public Service: MUX 1 launched in 2006 with outdoor coverage in the whole country and partial indoor coverage. MUX 2 to be launched by 1 November 2009. A commercial gatekeeper has been appointed to launch MUX 3-5 at the latest by 1 November 2009 and MUX 6, including DVB-H, by 1 November 2010. MUX 6 will be used for testing and research 1 November 2009 until 31 October 2010.
DE	DVB-T: coverage: 95 percent of population with public broadcasting and 60 percent of population with private broadcasting in addition.	May 2008 termination of DMB-services on all sites.
EE	Regular DTT broadcasts started 2004	MUX 1 carries 7 freeview channels (two public - ETV, ETV2 & five commercial – Kanal2, TV3, TV6, K11, Kalev Sport) and covers 99% of territory from August 2008. MUX 2 & 3 are dedicated for pay services, including the first local digital pay channel Neljas TV, coverage is more than 90% of the territory.
EL	Since January 2006, one MUX of the national broadcasting organisation is operated and offers four programs of DTT[4]	The national level coverage is roughly 50% of the population and 30% of the geographic cover. Up to end of the current year, it is forecast that the above percentages will be increased up to 60% and 40% respectively.
ES	Since 2000	Coverage 85% of population currently, 88% by July 2008, 90% by December 2008, 93% by July 2009 and 98% for PSB(RTVE) before 3 April 2010.

4 The Greek Administration has issued the new Broadcasting Law (3592/19-07-07 OFFICIAL JOURNAL OF THE HELLENIC REPUBLIC 161) and therefore it has been harmonised with the Directives 2002/21/[EC], 2002/22/[EC] and 2002/77/[EC], at the part that they concern the provision of radio-television services. The aim was the plurality and objectiveness of the information, and the equality of the transmission of the information and news to be guaranteed.

Based on the above mentioned Law, the Administration has the appropriate vehicle to proceed in licensing of DTT and digital radio. Besides, the Administration has determined the process and the terms to proceed from analogue to digital broadcasting.

It is foreseen also, that by the end of 2008, a nation wide digital frequency plan will be available and it will be the appropriate tool for the DTT realization.

With regard to the current situation, a MUX of the national broadcasting organisation is in operation, which offers four programs of DTT.

<table>
<tr><th>Country</th><th>Date</th><th>Other details</th></tr>
<tr><td>FR</td><td>Started on 31 March 2005</td><td>Coverage 50% of population by September 2005, 65 % by October 2006, 85% by 2007, 95% by 2011</td></tr>
<tr><td>HU</td><td>From 2008</td><td>Government accepted the National Digital Switchover Strategy in March 2007.
misc.meh.hu/letoltheto/english_kormhat.pdf
misc.meh.hu/letoltheto/english_DAS.pdf
Parliament accepted the act on the rules of broadcasting and digital switchover in June 2007.
www.meh.hu/misc/letoltheto/eng_2007_74_tv_das.pdf
The national Communications Authority entered into a contract with Antenna Hungaria Zrt. on 5 September 2008. The contract includes the following conditions for coverage:</td></tr>
<tr><td></td><td></td><td><table>
<tr><td>year Multiplex coverage %</td><td>2008</td><td>2009</td><td>2010</td><td>2011</td><td>2012</td><td>2013</td></tr>
<tr><td>A</td><td>59</td><td>88</td><td>95</td><td>96</td><td></td><td></td></tr>
<tr><td>B (in that case DVB-T)</td><td>20</td><td>45</td><td>65</td><td>85</td><td>94</td><td></td></tr>
<tr><td>B (in that case DVB-H)</td><td>16</td><td>30</td><td></td><td></td><td>50</td><td></td></tr>
<tr><td>C</td><td>59</td><td>88</td><td>95</td><td>96</td><td></td><td></td></tr>
<tr><td>D</td><td></td><td></td><td></td><td></td><td>96</td><td>97</td></tr>
<tr><td>E</td><td></td><td></td><td></td><td></td><td>95</td><td>96</td></tr>
</table></td></tr>
<tr><td>IE</td><td>DTT services launch in Q3 2009.</td><td>The Broadcasting (Amendment) Act 2007 has provided for the development of DTT services in Ireland.</td></tr>
<tr><td>IT</td><td>Since second quarter 2008.</td><td>2 Public Services Coverage >70% of population (DVB_T)
3 Private Services Coverage >70% of population (DVB_T)
4 Private Services Coverage >50% of population (DVB_T)
2 Private Services Coverage >70% of population (DVB_H)</td></tr>
<tr><td>LT</td><td>30 June 2006</td><td>Start in Vilnius, by end 2007 in the five biggest cities, by beginning of 2009 one network should cover 95% of the territory. At the beginning of 2008, four digital TV networks were in operation. The completion of networks is scheduled for the end of 2010.</td></tr>
<tr><td>LU</td><td>DTTV start on 31 August 2006
Complete switch-off of analogue TV on 31 August 2006</td><td>Currently one VHF TV channel has been converted as well as two UHF TV channels.</td></tr>
<tr><td>LV</td><td>Since 2007 digital terrestrial broadcasting started in test mode.</td><td>Planned to introduce digital terrestrial TV in steps by regions</td></tr>
<tr><td>MT</td><td>Commercial operations started 2005. Nationwide coverage achieved.</td><td>The process leading to award of spectrum for the purposes of general interest objectives is currently underway.</td></tr>
</table>

Country	Date	Other details
NL	Available since 2003 in the western parts of NL. From 11 December 2006 PSB available in the whole country.	KPN provides mobile TV over DVB-H since 05 June 2008.
PL	Launch of service is expected in 2009. Tender will be announced in the near future.	The National Switchover Strategy is currently under review process.
PT	Launch of service until the end of August 2009	MUX A (FTA) Licence granted in December 2008.
RO	Not yet started	Pilot transmissions in Bucharest (started March 2006) and in Sibiu (since November 2006). Implementation strategy to be finalised by the end of 2008.
FI	Available since 2001/2002; full network rollout autumn 2004 to autumn 2005	Coverage 99,9% (Aug 2005)
SE	since 1999/2000;	Multiplex 1 carrying the PSB channels covers 99,8% of permanent households. Multiplexes 2-4 cover 98% of households. A fifth multiplex covers approximately 70 %, but is planned to be extended. A sixth multiplex is planned to start transmitting by the end of 2008. Licenses have been issued for the sixth multiplex requiring transmissions with MPEG 4.
SI	Roll out 2006-2010	MUX A: 80% coverage of population by the end of 2008; 95% by 2010 MUX B: 70% coverage of population by 06/2010 MUX C: used for HDTV only; a public tender planed for 2009
SK	Full switch-off: end of 2012	The selection procedure is still running in Slovak Republic. The invitation for tender was published on 20 August 2008 together with the deadline for submission offers which is 20 November 2008. This is common selection procedure for MUX1 and MUX2. It is expected to issue the licenses after evaluating all submitted offers not later then in 1st Q of 2009. Expected coverage of the all citizens of the Slovak Republic is 45% as minimum after one year after issuing of the license for MUX1 (channels above 60). Switch-off of analogue transmitters using frequencies for digital MUX2: on 31 December 2011 at the latest Switch-off of analogue transmitters using frequencies for digital public multiplex (MUX3): on 31 December 2011 at the latest Switch-off of remaining analogue transmitters: on 31 December 2012 at the latest
UK	Since 1998	87% of households have digital TV [March 2008]

Switch off dates of Analogue Terrestrial TV in Member States

Country	Date	Other details
AT	End of 2010 envisaged (full switch-off)	Main high power analogue transmitters already switched off. Low power transponders are in the process of being switched over to digital.
BE	November 2008 in Flanders November 2011 in Wallonia and Brussels capital area	
BG	2012	Start of DBV-T – mid 2008, analogue switch-off 2012 according to the Plan of Introduction of DBV-T in the Republic of Bulgaria, adopted by a decision of the Council of Ministers on 31 January 2008. For the successful realisation of the transition to digitisation, a package of regulatory measures, amendments of and supplements to the Bulgarian legislation are needed namely the Electronic communications Act and the Radio and television Act. Both are in a discussion process in the Bulgarian Parliament.
CY	1/07/2011	All analogue transmissions will be switched off, nationwide, on the 1 July 2011.
CZ	June 2012	The first region Domazlice was switched-off on 31 August 2007 as an experimental measure prior to approval of a national switchover plan. The national switchover plan was approved by the Czech government on 28 April 2008 and came into force on 15 May 2008 (*www.ctu.cz/cs/download/sb051-08.pdf*). The switchover plan determines ASO in details, sets 11 geographical areas which will be digitised step by step due to lack of accessible spectrum, conditions for analogue TV transmitters switching off etc. According to the plan – the network for PSB will cover 95% of population to 31 December 2010, – by 11 November 2011 the main phase of ASO will be completed i.e. analogue transmitters switched off (except for two regions) and DTT network coverage of population will be the same as previously provided by analogue terrestrial television, in the final stage four DTT networks in operation, four MUX receivable countrywide (coverage 70-95 % of population), full analogue switch-off in June 2012.
DE	End of 2008	Commenced in Berlin in 2003; will be continued through specific areas and completed before end of 2008[5]
DK	End of October 2009	Nationwide switch off

[5] See www.ueberallfernsehen.de/

Country	Date	Other details
EE	1 July 2010	The first region – the island Ruhnu was switched off on 31.03.2008. Nationwide switch off will be held on 01.07.2010
EL	after 2010	2012 may be feasible
ES	3 April 2010	The first area (Soria) to be switched off in July 2008. Gradual switch off the analogue transmitters from 30 June 2009 in accordance with the transition plan. Target PSB (RTVE) coverage: 98%
FI	31 Aug 2007	
FR	30 Nov 2011	Gradual switch off from 2009, depending on the coverage of digital TV and the rate of equipped households
HU	End of 2011	Gradual switch off of the analogue transmitters. The possibilities for earlier switch off of the analogue systems are investigated.
IE	No decision yet.	
IT	According to a new law the switch off at national level is postponed to 31 December 2012.	Switch-off by technical areas, in eight half-year periods. Sardegna is the first region to be totally switched-off, from 15 to 31 October 2008. The second region, Valle D'Aosta, will be switched-off in the 1st half of 2009.
LT	29 October 2012.	Resolution No. 970 issued by the Government of the Republic of Lithuania on 24 September 2008.
LU	31 August 2006	One analogue VHF channel and two analogue UHF channels have been switched off on 31 August 2006.
LV	1 December 2011	Regulations issued by the Cabinet of Ministers on 2 September 2008. Switch-off by regions, finished 1 December 2011 The strategy for the introduction of DTT services in Latvia was approved on 11 October 2006 by the Latvian Cabinet.
MT	31 December 2010	Nationwide coverage
NL	11 December 2006	'Big bang' switchover from analogue to digital terrestrial television in one night. Only PSBs were concerned, no commercial broadcasters were operational in analogue terrestrial TV.
PL	2015 (final date)	Earlier date possible according to the market situation.
PT	No decision yet	2010-2012 (tentative)
RO	31 December 2012 (current assessment)	Implementation strategy to be finalised and adopted by the end of 2008
SE	October/December 2007	The last analogue terrestrial transmissions were switched off in October 2007. The switchover was carried out during a period of two years on a regional basis.
SI	End of 2010 or earlier	Gradual switch off local areas when similar penetration as by analogue terrestrial broadcasting coverage is reached.

Country	Date	Other details
SK	end 2012	Gradual switch-off of the transmitters in accordance with the national strategy. There is a plan to switch off all analogue TV transmitters before 31 December 2012. This is in accordance with the Slovak technical plan for transition from analogue to digital TV transmission.
UK	2012	Switch-off by region, from 2nd half 2008 to 2nd half 2012[6]

Detailed information on Member States' switchover plans

Member States information on their switchover plans is published on the Commission's website at

ec.europa.eu/information_society/policy/ecomm/current/broadcasting/switchover/national_plans/index_en.htm.

6 For details see www.digitaluk.co.uk/when

Annex 2

The Brazilian Case Study

The digital terrestrial television broadcasting channel planning and the deployment of the DTTB in Brazil.

1 Introduction

This chapter presents the work that has been conducted by the National Telecommunications Agency (Agência Nacional de Telecomunicações - Anatel) related to channel planning regarding the introduction of the Digital Terrestrial Television Broadcasting (DTTB) in Brazil and the stages for its deployment. The text consolidates three contributions (RGQ11-1/2/93-E, 95-E and 185-E) submitted by the Brazilian Administration to the Rapporteur's Group on Question 11-1/2 during the meetings held on September 8th 2003 and May 31st 2004, both in Geneva. The Rapporteur´s Group Meeting of September 2003 "proposed that the contributions of Brazil should be documented on the ITU Web site as a case study on the introduction of digital terrestrial TV broadcasting"(2/REP/012-E). This proposal was approved in the Plenary Session of the Study Group 2 on September 11th 2003. As a result of these decisions, this Annex presents the methodology, the results and the current work Anatel is undertaking on the completion of the DTTB channel planning. In addition, it is important to observe that the country's channel planning is not related to any specific DTTB standard, since it contemplates the particularities of each existing DTTB standards.

2 Methodology applied for digital terrestrial television channel planning and its respective results

This section describes the methodology applied by Brazil to prepare its channel planning for the deployment of the DTTB in the country and its results. The applied methodology is independent of the DTTB standard adopted. A working group under the coordination of Anatel and representatives from the Brazilian TV networks has been working on digital terrestrial television channel planning since 1999.

2.1 Digital television channel planning strategy

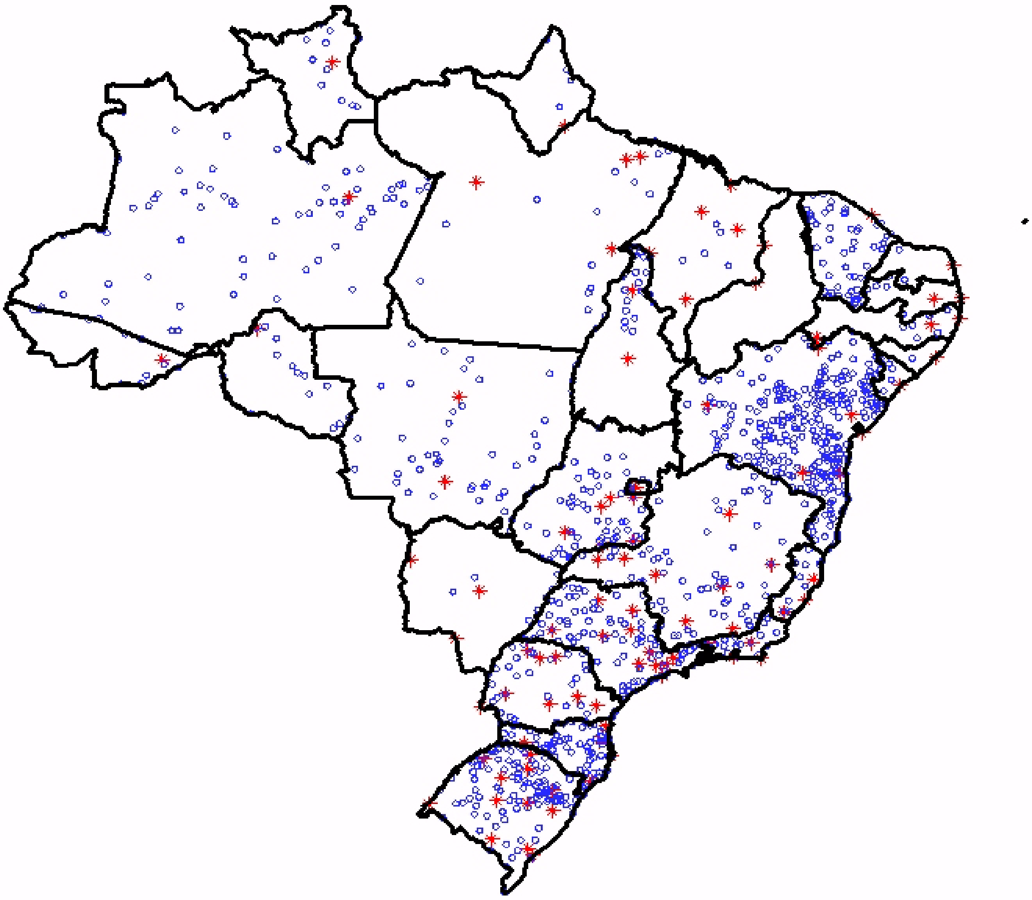
When it comes to coverage, Brazilian TV networks present quite different characteristics among themselves. They can be either regional networks or national networks, which encompass regional networks, or eventually independent full TV station with strict local penetration. Figure 1 indicates the distribution of full TV stations (in stars) and relay stations (in circles) of a particular Brazilian network with distributed generation and national penetration.

The preparation of the Basic Plan for DTTB began in September 1999. Since then, specific premises have been established. They are as follows:

- digital television will replace existing analogue TV by using UHF (channels 14 to 69) frequency bands;
- the main objective of channel planning is to assure that digital television stations will have service areas similar to their corresponding analogue stations service areas;
- during the initial phase called the 'transition period', analogue and digital channels will perform simultaneous broadcast (simulcasting);
- digital television planning will be carried out in three phases: "Phase 1" only for those cities where active full TV stations are in place and, in a later stage; "Phase 2" for those cities whose population is over one hundred thousand inhabitants with only television relay stations; and "Phase 3" for

others cities with television relay stations; whenever is possible, digital stations will have to operate on the maximum power of its class[7].

Figure 1: Network with distributed generation and national penetration (Phases 1 and 2)



Because of the preparation for the Basic Plan for Digital Television Channel Distribution (PBTVD[8]), Anatel has suspended, from October 1999 to April 2005, allocation of new analogue channels, and changes of the technical characteristics in the existing channels in regions of Brazil under heavy spectrum usage. From February 2002 to April 2005, the same policy was applied to the remaining regions. After the publication of the PBTVD, item 1.3.3, Anatel resumed activities on the analogue channels allotment plan, proceeding with the inclusion of new analogue channels. It's important to observe that PBTVD will continue to use the frequency band currently allocated to analogue transmission.

[7] Brazilian TV Stations are classified into Special, A, B or C Class according to the ERP (Effective Radiated Power) that they are authorized to transmit by Anatel. The ERP limits for each class are defined in the national technical regulation for television broadcasting.

[8] Basic Plan for Digital Television Channel Distribution (PBTVD) is the official name designated for the Digital Television Allotment Plan in Brazil.

2.2 Phases of digital television channel planning

The channel plan studies were divided in three phases. The first phase focused on making digital channels available to broadcast simultaneously with a specific and already existing analogue channels, those authorized to provide television service on municipalities where at least one generator station covers.

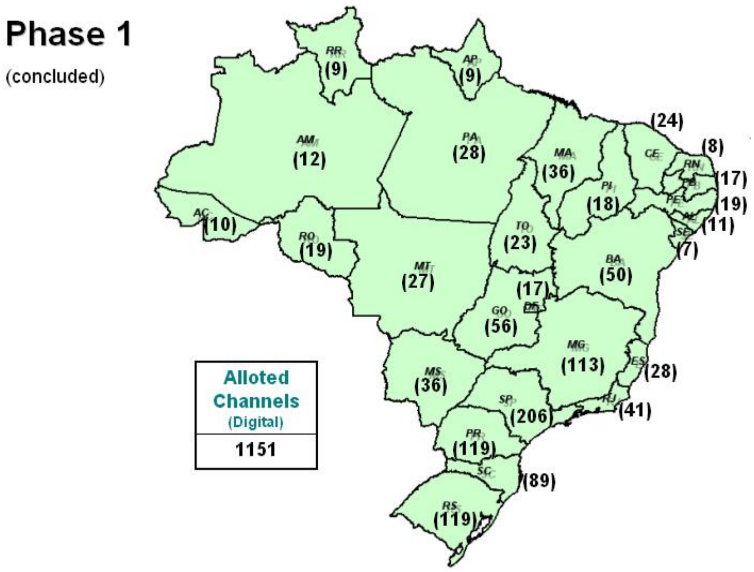
The second phase focused on the availability of digital channels for simulcasting in municipalities with population above one hundred thousand inhabitants and that are covered only by relay stations. This phase also included a review of the first phase, in order to meet the demand in all municipalities to which authorizations to install new television operating networks were granted after the beginning of the first phase.

In the year of 2006, Brazilian government initiated the third phase of digital channel planning studies. This phase deadline is June 2011. It includes the allotment of digital channels for the relay stations on the remaining cities and a digital channel revision on the previous phases allotment plan.

2.3. Channel planning results

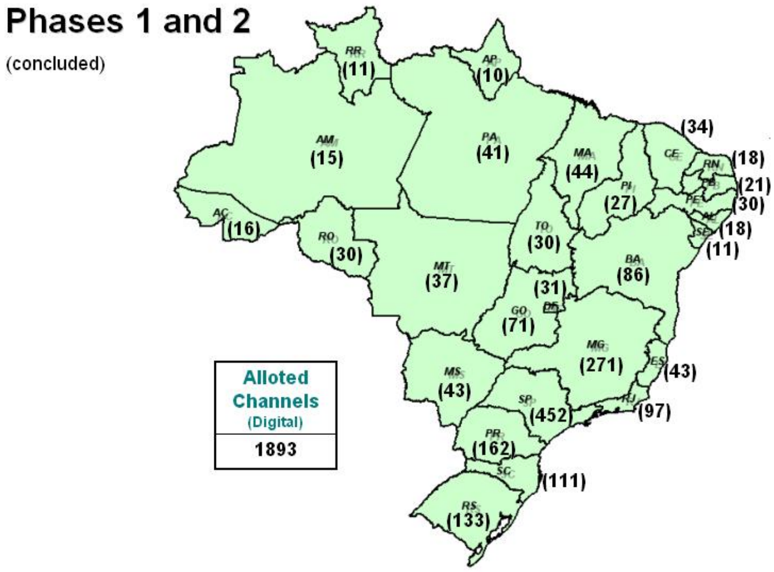
The first phase, concluded in September 2002, made available 1 151 digital channels in 164 municipalities, as presented in Fig. 2.

Figure 2: Digital channels available after Phase 1



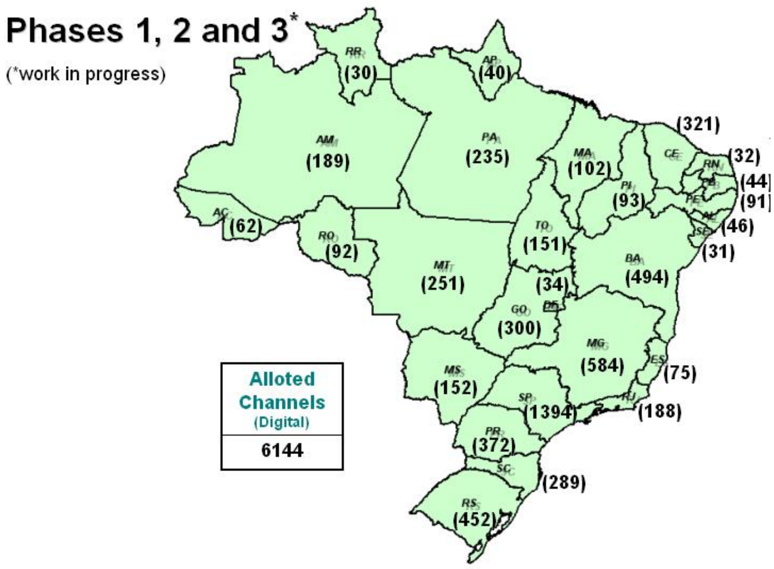
The second phase, concluded in March 2003, made further allocation of 742 digital channels in 132 municipalities. As a result of the conclusion of both Phases 1 and 2, 1893 channels were made available for the introduction of Digital Terrestrial Television Broadcasting (DTTB) in Brazil as presented in Fig. 3.

Figure 3: Results obtained after the conclusion of Phase 2 – Digital channels



After the conclusion of the third phase, which is currently in progress, it's planned to have 6 144 digital channels in Brazil, as presented in Fig. 4.

Figure 4: Digital channels allotted after the conclusion of Phase 3



The Basic Plan for Digital Television Channel Distribution (PBTVD) has been successful in assuring that the service areas of digital television stations is similar to its related analogue stations. The PBTVD encompasses 296 Brazilian municipalities, whose total population is approximately 110 million inhabitants. These municipalities are covered either by a generator television station service (main broadcasting transmitting stations – primary service) or if their population is over one hundred thousand inhabitants and at least by one operating relay-station (known also as repeater-components of the secondary rebroadcasting service) in the city. Only in service analogue channels were taken into account for the channel planning. Therefore, up to August 2008, 2 157 digital channels have been made available by the National Telecommunications Agency (Agência Nacional de Telecomunicações - Anatel) and there will be more than 6 100 digital channels in Brazil until 2013. Thus, more than 12 200 channels, analogue or digital, will be available during the "simulcast" period from 2013 to 2016.

3 Legislation and Regulatory adjustments for the deployment of Digital TV in Brazil

In order to deploy the Brazilian System of Digital TV (SBTVD), adjustments to the legislation and to the regulatory framework were needed. This process had five important stages, as listed below.

3.1 Phase 1: Creation of the Brazilian System of Digital Television (SBTVD)

The creation of the Brazilian System of Digital TV (SBTVD), was initiated by the Decree 4.901, of 26 of November of 2003, which:

– Established the aims of the Brazilian System of Digital Television (SBTVD).

– Created the Development Committee of the SBTVD with the scope of studying and elaborating a report[9] with proposals for:

 1 The definition of the reference model for the Brazilian system of digital television.
 2 The standard of television to be adopted in the Country.
 3 The form of exploitation of the digital television service
 4 The period and framework of the transition from analogue to digital system.

– Created an Advisory Committee and a Steering Group, which jointly compose the SBTVD, along with the Development Committee.

3.2 Phase 2: Digital Technology updates in regulatory documentation

The Phase 2, which was based on digital technology updates in the regulatory framework, was approved by Anatel Resolution N. 398, on April 7th 2005[10]. This Regulatory document presents technical aspects of sounds and video broadcasting and television retransmission, with the purpose of:

– Ensuring the quality of the signal in the coverage area.

– Preventing harmful interferences over currently authorized, and already installed, telecommunication stations.

– Establishing the technical criteria of viability projects designing, especially those regarding to inclusions in channel allotment plans, and modifications on technical installations.

The revision of the technical regulation for television broadcasting also included the procedure for calculation of viability involving channels of Digital TV[11] and the adoption of Recommendation UIT-R P.1546[12].

3.3 Phase 3: Creation of Basic Plan for Digital Channel Distribution (PBTVD)

The Phase 3 startup occurred with the publication of Anatel Resolution 407, on June 10th 2005[13]. This document approved the Brazilian Digital Television Channel Allotment Plan, officially named as Basic Plan

9 sbtvd.cpqd.com.br/cmp_tvdigital/divulgacao/anexos/ 76_146_Modelo_Ref_PD301236A0002A_RT_08_A.pdf

10 www.anatel.gov.br/Portal/documentos/biblioteca/resolucao/2005/res_398_2005.pdf

11 www.anatel.gov.br/Portal/documentos/biblioteca/resolucao/2005/anexo_res_398_2005.pdf

12 www.anatel.gov.br/Portal/documentos/biblioteca/resolucao/2005/anexoii_res_398_2005.pdf

13 www.anatel.gov.br/Portal/documentos/biblioteca/resolucao/2005/res_407_2005.pdf

for Digital Channel Distribution - PBTVD[14], referred to in item 1.2.3, Fig. 33. It also allocated, considering the guidelines discussed on item 1.2.1, 1893 digital television channels in 306 localities. In sum, in 2005, the Basic Plan of Distribution of Television Channels (PBTV) contained a total of 473 generator TV stations (analogue stations), 9845 relay TV stations and 1207 stations in cities where its populations were more than one hundred thousand inhabitants

3.4 Phase 4: Definition of the Digital Terrestrial Television system and the transition period guidelines

The Phase 4 started with the Decree No 5,820, on June 29th 2006[15], defining that the SBTVD-T would adopt, as a base, the standard of signals desigatned by ISDB-T (Integrated Services Digital Broadcasting-Terrestrial), also incorporating the technological innovations approved by the Development Committee. Beyond those definitions, the document presented the guidelines for the transition period from analogue to digital TV. The Decree also laid down the following points:

- Creation of the SBTVD Forum[16];
- Made possible:
- Simultaneous fixed, mobile and portable transmission.
- Interactivity.
- High Definition (HDTV) and Standard Definition Television (SDTV).
- Defined the assigned of one digital channel for each existing analogue channel, regarding the transition period. The preference is for the digital channel allocation in the UHF band (channels 14-59), rather than in the VHF band - high (channels 7 - 13).
- Deployment sequence, first starting with the TV stations.
- Established that, after signing the assignment contract, the installation projects must be submitted by the broadcasting companies to the Ministry of Communications within 6 months. Afterwards, the digital transmissions should start within 18 months.
- Defined that, after July 1st 2013, only digital technology television channels will be granted by the Ministry of Communication for television broadcasting.
- Defined the date of June 29th 2016 as the switch-off date of analogue transmission.

Creation of 4 (four) digital public channels for the national Government.

3.5 Phase 5: Establishment of conditions for assignment contract of the additional channel for the digital and analogue simultaneous transmission

The Ministry of Communication (MC) ordinance Nº 652[17], which has been published on the 10th of October, 2006, initiated Phase 5 by establishing the assignment contract conditions for the additional channel, which shall be used during the digital and analogue simultaneous transmission period (Simulcast). It has also included the schedule for the transition, as defined below:

- The assignment contract will observe the PBTVD.
- The digital channel will have to:
  I Provide the same coverage as its analogue counterpart;
  II Provide efficient management of the analogue and digital transmissions;
  III Prevent interferences.

[14] www.anatel.gov.br/Portal/documentos/biblioteca/resolucao/2005/anexo_res_407_2005.pdf

[15] www.planalto.gov.br/ccivil/_Ato2004-2006/2006/Decreto/D5820.htm

[16] www.forumsbtvd.org.br

[17] www.mc.gov.br/sites/600/695/00001879.pdf

Figure 5: Transition period in Brazil (analogue to digital television)

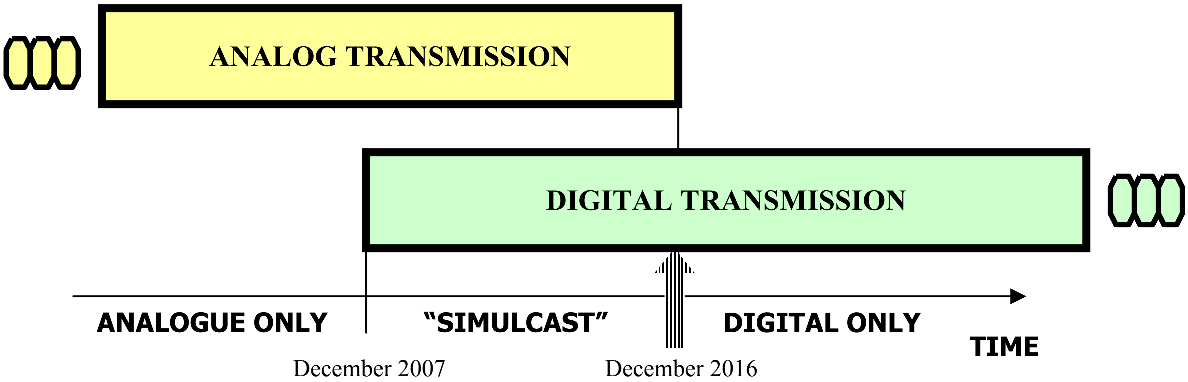


Table 1 presents the planning phases for assignment contracts of additional channels and the schedule for their commercial deployment[18]

According to the plan, migration priority is given to generator TV stations and, later, to the relay stations located in Federal and State Capitals. The signing of assignment contracts by relay station operators in the remaining cities will take place at the last stage.

After the assignment contract is signed, the TV Broadcaster may start to test and then commercially deploys the system.

[18] www.forumsbtvd.org.br/cronograma.php

Table 1: Schedule for the assignment contract and commercial deployment of Digital TV

Phase of planning (Item 1.2.3)	Station TV type	Cities (Group)	Assignment contract schedule	Commercial deployment schedule
Phase 1	TV stations	São Paulo (SP)	Up to 12/29/2006	12/29/2007
Phase 1	TV stations	Belo Horizonte, Brasília, Rio de Janeiro, Salvador e Fortaleza (G1)	Up to 11/30/2007	Up to 01/31/2010
Phase 1	TV stations	Belém, Curitiba, Goiânia, Manaus, Porto Alegre e Recife (G2)	Up to 03/31/2008	Up to 05/31/2010
Phase 1	TV stations	Campo Grande, Cuiabá, João Pessoa, Maceió, Natal, São Luis e Teresina (G3)	Up to 07/31/2008	Up to 09/31/2010
Phase 1	TV stations	Aracaju, Boa Vista, Florianópolis, Macapá, Palmas, Porto Velho, Rio Branco e Vitória (G4)	Up to 11/30/2008	Up to 01/31/2011
Phase 1	TV stations	Other Cities with TV Stations (G5)	Up to 03/31/2009	Up to 05/31/2011
Phase 2	Relay stations	Cities of the Groups SP, G1, G2, G3, G4 (Capitals and Federal District)	Up to 04/30/2009	Up to 06/31/2011
Phases 2 and 3	Relay stations	Other Cities with Relay Stations	Up to 04/30/2011	Up to 06/30/2013

4 The Brazilian Digital Television System (SBTVD) Forum

After the release of Presidential Decree 5,820, the role of private organizations in the development of DTT was intensified, mainly because of the SBTVD Forum.

The Forum is a nonprofit entity, whose main objectives are supporting and fostering the development and implementation of best practices to the Brazilian digital television broadcasting success. The most important participants of broadcasting, reception-and-transmission-equipment-manufacturing, and software industries are part of this Forum.

The Forum’s main tasks are: to identify and harmonize the system’s requirements; to define and manage the technical specifications; to promote and coordinate technical cooperation among television broadcasters, transmission-and-reception-equipment manufacturers, the software industry, and research-and-education institutions; to propose solutions to matters related to intellectual property aspects of the Brazilian DTT system; to propose and develop solutions to matters related to the development of human resources; and to support and promote the Brazilian standard in the country and overseas.

Besides the private sector, federal government representatives also participate in the Forum. And such participation is considered very important, since it allows those representatives to closely follow the discussions taking place, while strengthening the relationship between forum members and public regulators.

4.1 Objectives

The Forum of Brazil’s Terrestrial Digital TV Broadcasting System was formally instated in December 2006. The Forum’s mission is to help and encourage the installation or improvement of the digital sound and video transmission and receiving system in Brazil, promoting standards and quality that meet the demands of the users.

The purpose of this Forum is to propose voluntary or mandatory technical norms, standards, and regulations for Brazil's terrestrial digital television broadcasting system, and, in addition, to promote representation, relations, and integration with other national and international institutions.

4.2 Structure and Composition

There are three membership categories: Full Members, Effective Members, and Observers. The Full Members, who have the right to vote and the obligation to pay annual dues, belong to the following sectors:

a) Broadcasting stations.

b) Manufacturers of receivers or transmitting equipment.

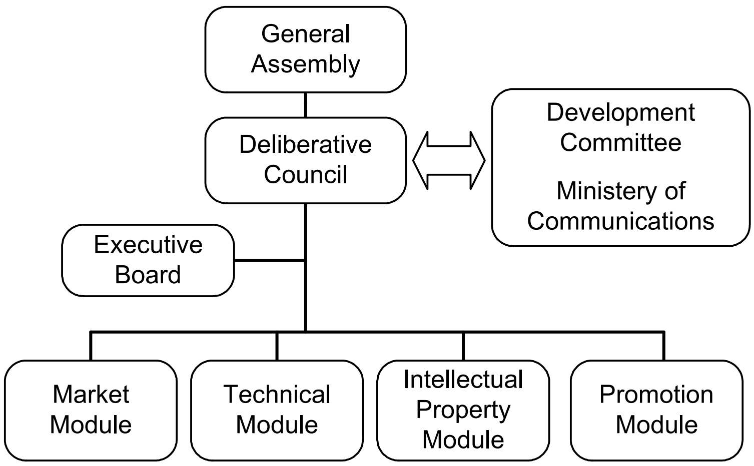
c) Software industry.

d) Teaching and research institutions that carry out activities directly involving Brazil's digital TV system.

Effective Members come from sectors that are different from those mentioned previously, but they must also pay annual fees dues. The Observer Members are those who, when formally invited by the Council, accept to enter the Forum, without any voting rights and without the obligation to pay annual fees dues.

The Deliberative Council is comprised of 13 councilor members elected by the General Assembly. The Council shall be able to draw up general policies of action, strategies, and priorities, adopt the results of the work, and refer them to the Development Committee of the Federal Government.

Figure 6: Brazilian digital TV Forum



4.3 Modules Assignments

The Forum is comprised of four modules that address different aspects of the Digital TV implementation task.

Market Module

The Market Module must identify the needs, wishes, and opportunities of the market, defining functional requirements, time limits for availability, and costs, and coordinating the relationship between the various sectors represented in the Forum.

This module checks conformity with the technical specifications and requirements that are drawn up and analyzes and proposes solutions to issues related to planning the implementation of terrestrial digital television.

Technical Module

The Technical Module coordinates the efforts relative to the technical specifications of Brazil's digital TV system and research and development activities, identifies specification needs, and defines the availability of technical solutions referring to the generation, distribution, and reception of the digital TV system, including high definition, standard definition, mobility, portability, data services, interactivity, content protection, and conditional access.

This module also coordinates the efforts to harmonize technical specifications with other national and international institutions.

Intellectual Property Module

The Intellectual Property Module must coordinate efforts in the search of solutions regarding intellectual property, drawing up policies and practices to be adopted among the members and proposing the legal advise on these issues to the competent institutions.

This module also helps and monitors the negotiation of royalties linked to the incorporation of technologies along with their holders and informs the council about the costs involved in the techniques being adopted or incorporated.

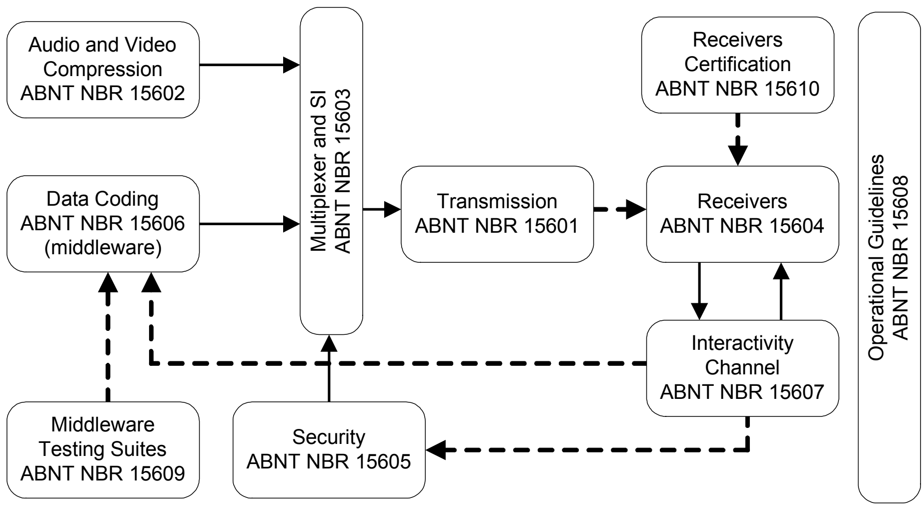
Promotion Module

The Promotion Module coordinates efforts to promote, distribute, and disseminate Brazil's system. This module must promote seminars and courses; publish newspapers, bulletins, and other carriers of information. The Promotion Module is also responsible for organizing the common activities of broadcasters and industries aimed at increasing the awareness about the advantages of the Digital TV system.

4.4 Outline of the Technical Standards

Standardization activities, performed by the Technical Module, are divided among eight subgroups of specialist volunteer members, which work in the sectors of the broadcasters, consumer electronics, transmitters and software industries and universities. The working groups are organized as below.

Figure 7: Brazilian standardization structure



The standards for the digital terrestrial television, showed in the Fig. 37, are listed below:[19]

– ABNT NBR 15601:2007 – Transmission system
– ABNT NBR 15602:2007 – Video coding, audio coding and multiplexing
– ABNT NBR 15603:2007 – Multiplexing and service information (SI)
– ABNT NBR 15604:2007 – Receivers
– ABNT NBR 15605:2007 – Security issues (under approval)
– ABNT NBR 15606:2007 – Data coding and transmission specification (partial)
– ABNT NBR 15607:2007 – Interactive channel (partial)
– ABNT NBR 15608:2007 – Operational guidelines
– ABNT NBR 15609:2007 – Middleware test suit (internal working document)
– ABNT NBR 15610:2007 – Tests for receivers (internal working document).

5 Current Status of the DTTV deployment

On December 2nd, 2007, the first official implementations of the Brazilian DTTV system began commercial operations in the city of São Paulo and, by mid-2008, there were already 10 commercial broadcasters operating in this city. Although tests were already being conducted since May, 2007, the government chose the December date as the official date of the system launch.

According to the schedule established by the government, all analog TV broadcasters must also be transmitting digital until 2013. Furthermore, the switch-off of the analog systems is schedule to take place in 2016.However, in 2008, the actual deployment of DTTV transmissions in Brazil was moving ahead of the schedule. Stimulated by the increasing interest in the new technology, many broadcasters have been investing earlier than required by law and have been starting digital transmissions sooner than expected. The accelerated implementation was also due to the tax-reduction incentives offered by the government, and to the new applications made possible by the DTTV system, such as portable reception.

[19] www.abnt.org.br/tvdigital/TVDIGITAL.html

In the first six months after the official commercial launch, DTTV transmissions in Brazil is a reality in São Paulo, Rio de Janeiro, Belo Horizonte and Goiânia, and 10 other cities were scheduled to get digital broadcasting yet in 2008. By the third quarter of this year, DTTV signals already covered over 21 million people, and were expected to reach 30 major cities and state capitals by the end of 2009.

The robustness of DTTV signals, as well as the superior video and audio quality provided by the technology, represents a big step forward in the technical quality on content access of lower income population. The market penetration of television devices in Brazil and its close relationship with the general population are clues to enable us to devise the huge market that DTTV will offer in the next few years.

5.1 DTTV market in 2008

In the third quarter of 2008, there were already over 30 different DTTV receivers available in the market, with functionalities and designs aimed to different economic segments and user preferences. Among those models, there could be found portable reception devices (1-Seg), including portable TVs, computer USB tuners and cell phones. For fixed reception, consumers could choose between standard definition and high definition devices, although all broadcasters have been transmitting in high definition (1080i). There were already over 50 h a week of original HDTV programming, and a growing demand from viewers.

Since the commercial start of DTTV in Brazil, consumers were able to see a significant fall in the prices of reception devices, with the proliferation of additional manufacturers and models. As an example, by the third quarter of 2008, portable one-seg receivers for computers could be found for prices around US$ 100, while high-definition fixed-reception set-top devices could be found in the US$ 180 to US$ 300 price range. It was not unusual to find special offers to lower income consumers that split the price of the receiver in up to 12 monthly instalments.

By that same time, the industry had already provided many solutions for the high-end DTTV market, such as full-HD displays with integrated digital tuners. Many manufacturers offered displays with integrated receivers, with sizes ranging from 32 to 52 inches, for a price to the consumer starting at around US$ 1.500.

Since the beginning of transmissions, market prices for DTTV receivers have been falling gradually, as the market moves from the early adopters to the ordinary consumers. That expected movement has been regarded by broadcasters and industry as proof of the successful introduction of DTTV. It’s a trend that is expected to intensify with the beginning of transmissions in other cities. As of mid-2008, manufacturers have been preparing for Christmas, when a surge in demand for reception devices is expected. The general expectations are that the demand for DTTV receivers and integrated TVs will grow steadily over the following years.

6 Conclusion

The opinion of the majority of the concerned entities is that the introduction of digital TV in Brazil has been very successful. The better images and sound quality, the portable TV with in-band “one-seg” technology, the future interactivity with the user and the digital convergence are the most evident benefits of the new technology. Nonetheless, keeping terrestrial television a free and open service, providing ways for the social inclusion of a growing number of citizens, as well as offering them an important mean of entertainment, education and cultural integration, at local, regional, and national levels, are not less important objectives for system that has been prepared to serve a vast country such as Brazil, both in territorial and demographic senses.

One of the first steps on the transition process was the development of the Digital Television Channel Plan, conducted by the National Telecommunications Agency (Agência Nacional de Telecomunicações - Anatel) since 1999. At the end of the channel planning process, not later than 2013, it is expected that more than 6 100 digital channels have been assigned. In the full “simulcast” period, from 2013 to 2016, more than 12 200 analogue and digital channels are supposed to be in operation. This fact illustrates the magnitude of the task that has been assigned to Anatel, and that has been so far successfully executed by the Agency.

An important cornerstone of the successful introduction of the digital terrestrial TV in Brazil was the creation of the Brazilian Digital Television System Forum, or SBTVD Forum, in 2006. The Forum, whose members are TV network operators, equipment manufacturers, the software industry, education and research institutions, plus some other invited institutions and individuals, has had an important role in supporting and fostering the development and implementation of digital television in the country. It is also responsible for defining the best practices for the deployment of the system. By working close with the Japanese experts on the ISDB-T standards, the Forum has created a vast knowledge base about the implementation of DTT, and has contributed to the formation of a large number of professionals with competence on the subject.

Annex 3

Case Study for the schedule of introduction of DTTV in France

1 Preamble

The **Conseil Supérieur de l'audiovisuel (CSA)**, which is the French regulator for audiovisual, was established by Decree No. 89-518 of 26 July 1989 on the organization and functioning of CSA (www.csa.fr). CSA issues licences for private TV and radio broadcasting over terrestrial radio relay, and agreements are established for such licences. Television and radio broadcasting over frequencies that are not assigned by CSA (cable, satellite, ADSL, Internet, telephone, etc.) also comes under CSA's responsibility (agreement or declaration).

With responsibility for the procedures for deploying digital television over all French territory in fixed terrestrial (DTT) and mobile terrestrial (PMT) form, CSA has established a detailed schedule in order to ensure that the deployment of digital terrestrial television (DTT) is completed by 30 November 2011 for all French people in accordance with the legislation in force. That legislation deals with around 13 000 frequencies assigned to around 4 000 transmitters.

Note: French territory includes entities in Regions 1, 2 and 3 as defined by the ITU-R Radio Regulations (international treaty).

2 Schedule for digital terrestrial television (DTTV)

31 March 2005: Commencement of deployment of DTTV (17 sites).

10 May 2006: 50% of the population of Metropolitan France are covered by DTTV. Adoption of a list of new stations licensed for 31 March 2007, i.e. 115 sites before the end of 2007, which should result in 66% coverage of Metropolitan France by October 2006 and 70% in March 2007, with an objective of 85% by the end of 2007.

4 January 2007: Programme adopted by CSA for 2007 for the opening of 37 new zones that should allow 80-85% of the population to be covered by the end of 2007.

22 July 2007: CSA establishes the conditions governing the introduction and deployment of DTTV (DVB-T).

11 December 2007: Consultation of the different players potentially involved in DTTV further to Law 2007-309 of 5 March 2007 on the modernization of audiovisual broadcasting and television of the future.

15 April 2008: Contribution by CSA for the establishment of a national plan for discontinuing analogue broadcasting and changing over to all-digital. Further to the consultation of potential DTTV players launched on 11/12/07, CSA received 80 contributions. Based on those contributions and its own studies, CSA adopted an opinion which it transmitted to the Prime Minister. In summary, discontinuation of analogue TV must take place gradually based on geographical zones, with the guarantee of continuity of service without programme loss for TV viewers.

July 2008

– 23.2% of homes are equipped with **HDTV** (high resolution image transmitted by ad hoc equipment: HD-DTTV/MPEG-4 adapter, Blu-Ray reader, etc.); studies foresee extensive spread, with 51% in 2010 and 93.2% in 2017. CSA has authorized three HD channels at the end of 2007 and two HD channels in 2008. Industrialists have decided to ensure the widespread use of the MPEG-4 standard as from the end of 2012.

– 22 July 2008: Programme for the extension of DTTV in 2009; first phase: 71 new DTTV zones for the summer of 2009 at the latest. By the end of 2009, around 92% of the population of Metropolitan France should have DTTV coverage.

October 2008

– On 1 October, CSA posted **DTTV coverage interactive digital maps** on its website to allow TV viewers to visualize the coverage of each DTTV channel. Those maps will be updated regularly with the bringing into service of new transmitters.

– Under Articles 99 and 105 of Law 2007.309 of 5 March 2007 on the modernization of audiovisual, the **Digital TV Observatory** (OTVnu) was set up by the government at the end of 2007 under the auspices of CSA to **measure the level of TV equipment in French homes**. The Observatory published its first results on 2 October. At the end of the first quarter of 2008 and based on 25 284 000 homes equipped with TV sets, regarding the deployment of digital TV (DTTV, satellite, ADSL, cable): 58.7% of homes have at least one digital access, 30% of those homes are entirely digital and 53.7% possess at least two TV sets; 8 million homes, or 31.7%, have at least a DTTV adapter. The percentage of the population with digital TV coverage as at 31 March 2008 was 83.3%. In addition, with regard to analogue TV reception: 70.1% have digital access on at least one of their sets and 29.1% receive analogue TV only. In summary:

Digital access: 31.7% wireless access with DTTV adapter (8 million), 14.6% digital satellite through subscription (3.69 million), 13.2% ADSL (3.35 million), 6% digital cable through subscription (1.5 million). Free digital satellite is not covered by this study, but it is estimated that 500 000 households use this means of reception.

Digital and analogue access: 31.7% DTTV (8 million), 33.8% other digital access (8.54 million), 29.1% analogue terrestrial wireless access (7.35 million), 8.5% analogue cable (2.15 million). It is estimated that 1.5 million households receive analogue TV free via satellite.

– Action No. 20 of the plan FRANCE NUMERIQUE 2012 (www.francenumerique2012.fr) recommends that resources be made available for the new TV services. This means setting France the objective, by 30 November 2011, of 13 multiplexes: 11 for DTTV (simple or high definition) with a coverage of 95% of the population, and 2 for PMT with a coverage of 70% of the population.

25 November 2008: DTTV extension continues with the opening of 77 new transmitters on dates set between 30 November and 19 December 2008. The 77 new zones will add to the 55 localities already brought into service in 2008, thus by the end of 2008 nearly 53 million people, or almost 87% of the population of Metropolitan France, will have DTTV coverage.

8 December 2008: CSA opinion on the future schedule for the changeover to all-digital.

More up to date information could be found via trev_2009-Q4_Spectrum_Brugger.pdf (reference Section 2.1)

3 Schedule for terrestrial mobile television (PMT)

The first tests for the different terrestrial PMT standards commenced in 2005, followed by testing of the chosen DVB-H standard in 2006 and 2007; that testing is continuing.

17 January 2007: Public consultation by CVSA regarding arrangements for the launch of PMT.

14 June 2007: Analysis by CSA of the 47 contributions received following the consultation of 17/1/07.

6 November 2007: Pursuant to Article 30-1 of the law of 30/9/86, CSA launched a call for candidacies for PMT (with possible interactivity) with national coverage for **a multiplex** of 16 channels with 3 reserved for the public service.

1 April 2008: Issue of call for candidacies for the PMT interactive services further to the consultation of 6/11/07.

27 May 2008: From the 36 receivable files submitted further to the consultation of 6/11/07, **CSA retained 13 candidates for PMT.**

28 July 2008: CSA foresees the commercial launch of PMT **in the first quarter of 2009.**

6 November 2008: Analysis of the 15 contributions received for **interactive PMT**. The resources foreseen comprise six blocks of 20 kbits/s for the services under Article 30-7 of Law 86-1067: access for electronic communication to the public allowing simultaneous reception by an entire segment of the public (ESG, traffic, weather, etc.). In addition, for the data associated with the programme (Push, VoD, Music, etc.), 10 kbits/s, modifiable as required, are planned.

NOTE: The Council of Europe set up the **European Audiovisual Observatory** in 1992 (www.obs.coe.int). In its communication of 15/10/08, the Observatory estimated that in 2008 a total of 6 500 TV channels are available in the 27 countries of the EU and 2 candidate countries (Croatia and Turkey). The Observatory's MAVISE database set up in 2007 at the initiative of the European Commission through its Directorate General Communication (mavise.ubs.coe.int) contained, as at 15/10/08: 4 663 listed channels, of which 381 are national terrestrial (analogue or digital), 2 473 use cable, satellite and IPTV, and 1 809 are regional or local. MAVISE, to which access is free, is continuously updated and in December 2008 contained 5 157 TV channels, 4 000 TV companies, and channel offers from over 150 packages. It may be noted that the Observatory's PERSKY database contains the directory of TV channels in Europe.

Annex 4

EBU HDTV Receiver Requirements
EBU Tech 3333

EBU Committee First Issued Revised Re-issued

DMC 2009

Keywords: HDTV Receiver, Set-top-box, Functional Requirements

1 Scope

This document represents the minimum HDTV receiver requirements of EBU members (the broadcasting organisations) and has been discussed in detail with DIGITALEUROPE (EICTA) representatives. Media industries developing stand-alone receiver (set-top boxes - STB or integrated receiver decoders - IRDs) or receivers with integrated digital televisions (iDTVs) are encouraged to comply with this set of requirements in order to allow interoperability between EBU Members' broadcasts and the receiver device.

Note 1: EBU Members may require additions or changes to these requirements to meet particular national demands (e.g. language).

Note 2: The sections on Audio of this document received substantial contribution from EBU project P/Loud and D/MAE; the sections on LAN/Networking and CE-HTML have been provided in cooperation with the EBU project D/CH.

2 Normative references

The technical requirements or specifications contained in this document refer to standards developed by standard-settings organisations such as DVB; ETSI; DIGITALEUROPE, MPEG; ISO; CEI and CEN. In particular:

– EBU Tech 3299 EBU Tech 3325
– ETSI TS 101 154 v1.9.1 ETSI EN 300 421 v1.1.2 (DVB-S)
– ETSI TS 102 323 v1.3.1 ETSI TS 102 366 v1.2.1
– ETSI EN 300 429 v1.2.1 (DVB-C) ETSI EN 300 744 v1.6.1 (DVB-T)
– ETSI EN 300 468 v1.10.1 ETSI EN 302 755 v1.1.1 (DVB-T2)
– ETSI EN 300 743 v1.3.1 (DVB subtitling) ISO/IEC 14496-3
– ETSI EN 302 307 v1.1.2 (DVB-S2) ISO/IEC 14496-10 (2005)
– ETSI TR 101 211 v1.8.1 ITU-R Rec. BT 601
– ETSI TS 102 114 v1.2.1 ITU-R BS.775
– IEC62216-1 IEC 60169-24
– ITU-R Rec. BT 709 Dolby Technical Bulletin Number 11
– IEC 60169-2 DLNA Guidelines 1.5
– CEA-861-D HDMI 1.3a
– DVB TM-GBS0275

3 Informative references

HDready (1080p) DIGITALEUROPE HDTV (1080p) www.digitaleurope.org www.swisstxt.ch >Download > Multimedia Solutions >Teletext - recommendations for the minimum functions of teletext decoders

4 Video

4.1 Image formats

The following image sampling structures shall be supported (see TS 101 154 V1.9.1, which defines further formats beyond those listed here).

– 1920 x 1080, interlaced, 25 frame/s (50 fields)
– 1920 x 1080, progressive, 25 frame/s
– 1440 x 1080, interlaced, 25 frame/s (50 fields)
– 1440 x 1080, progressive, 25 frame/s
– 1280 x 1080, interlaced, 25 frame/s (50 fields)
– 1280 x 1080, progressive, 25 frame/s
– 1280 x 720, progressive, 50 frame/s
– 1280 x 720, progressive, 25 frame/s (carried as 720p/50 with pic_struct=7) (frame doubling). (See ISO/IEC 14496-10).

Note: receiver supporting IP streaming (e.g. Hybrid Receiver), should support native 720p/25.

– 960 x 720, progressive, 50 frame/s
– 720 x 576, interlaced, 25 frame/s (50 fields)
– 704 x 576, interlaced, 25 frame/s (50 fields)
– 544 x 576, interlaced, 25 frame/s (50 fields)
– 480 x 576, interlaced, 25 frame/s (50 fields)

The following Profiles shall be supported:

– MPEG-2: MP@ML;
– MPEG-4 - H.264/AVC: MP@L3, MP@L4.0; HP@L4.0

The receiver shall be able to decode the SVC baseline layer (see TS 101 154 v1.9.1) 1080p/50 & SVC (**): The receiver shall not crash when 1080p/50 is received either as H.264/AVC or SVC. The receiver shall not crash when any other image format with SVC is received. *

Note: It is expected that new compression/sampling formats or elementary streams with the same coding format and higher levels, such as 1080p/50, will be broadcasted in the future. Current receivers should be designed such that they exploit available information from (P)SI and elementary streams in a way that they safely detect such situations and behave in a stable way in the presence of such signals, e.g. by presenting information to the user through the GUI.*

*Note**: DVB TM-AVC has approved the addition of HP@L4.2 and SVC (includes the 1920x1080p/50-60 image format) to TS 101 154 V1.9.1.*

4.2 Random Access Points

Receivers must support random access points of maximum 5 seconds (see ETSI TS 101 154).

4.3 Overscan

An IDTV receiver shall utilize the appropriate overscan flag as defined by ISO/IEC 14496-10 (2005).

A STB receiver shall convey the flag to the display through the AVI_infoframe (HDMI).

Note: see EBU Tech 3325 as background information on overscan.

4.4 Scaling between HD and SD

SD to HD up-scaling shall use the centre 702x576 pixels unless this would cause misalignment of SD video and graphics.

HD to SD down-scaling shall use the whole HD image to the centre 702x576 SD image format.

4.5 Video Display Characteristics

4.5.1 Frame Cropping information

Shall only be used to crop 1088 to 1080 lines. If there is no crop information the receiver shall discard the bottom 8 lines of a frame.

4.5.2 Format switching

The receiver shall not crash and must continue operation after format switching (event-based and channel-hopping). Disturbance/distortions to the image should be minimal (e.g. freeze or black frame duration <= RAP, depending on GOP length).

4.5.3 Output format

The default output resolution is HD resolution (either 720p/50 or 1080i/25).

A mode shall be available that allows the output to follow the input format.

It shall be possible to manually switch between 720p/50 and 1080i/25.

Enhanced receivers may also allow switching the output to 1080p/50.

4.5.4 Active Format Descriptor (AFD)

(See EN 2216-1, chapter 6.4.3). It is recommended that receivers with HDMI output provide at least one of the following methods of processing aspect ratio and AFD information for video output on HDMI:

- Provide a reformatting function for the video to match the aspect ratio of the display based on AFD, aspect ratio and user preference as per section 6.4.3.5, EN 2216-1 for 16:9 displays) of the E-Book.

  Support for scaling to 4:3 aspect ratio for HDMI is optional (since consumer HD displays are 16:9). Aspect ratio signalling in the HDMI AVI Infoframe bits R0 - R3, M0, M1 (see CEA-861) shall be set in accordance with the properties of the video on the output.
- Pass the video to the HDMI output unprocessed with respect to AFD and aspect ratio scaling, and pass AFD and aspect-ratio signalling in the video to the HDMI output as part of the AVI Infoframe bits R0 - R3, M0, M1 (see CEA-861).

Note: HD broadcasts are always in 16:9 aspect ratio.

4.5.5 Colorimetry

A receiver shall signal the appropriate colour space to the display via the HDMI AVI Infoframe. The default colour space shall comply with ITU-R Rec. BT 709-5.

When converting SD to HD, a receiver should apply a colour transformation from ITU-R BT. 601 colourspace to ITU-R BT.709-5 colourspace. The colourspace shall be signalled via the HDMI interface.

4.6 Decoding compliance

4.6.1 Minimum bit-rate (e.g. static pictures)

The receiver shall respect MPEG timing models in ES buffer occupancy. The minimum bit-rate is defined by the shortest syntax according to ISO/IEC 14496-10 for a uniform sequence with maximum redundancy.

5 Audio

HD IRD shall fulfil the minimum decoding requirements for standard definition (SD) according to ETSI TS 101 154. For audio, the HD receiver shall provide at least one stereo decoder MPEG-1 Level 2. The receiver should support audio bitrates of up to 192 kbit/s per single audio channel and up to 384 kbit/s for two-channel stereo. In the case of transmitted stereo, the HD receiver shall support linear PCM at the digital output interface. In the case of a transmitted 5.1 audio signal, the HD receiver shall provide a downmix of the multichannel audio signal. The HD receiver shall provide support for 5-channel plus LFE (Low Frequency Effects), i.e. 5.1-channel surround sound corresponding to the loudspeaker layout described in ITU-R BS.775. In the case of simulcast, i.e. transmitted stereo and 5.1 audio signal, the HD receiver shall provide the transmitted stereo at its analogue and digital stereo output interface.

In this document the following notation is used:

– **System A**: Dolby Digital Plus or E-AC-3 (DD+) transcoded to Dolby Digital or AC-3 (DD)

– **System B:** HE AAC transcoded to DD or DTS

The audio may be carried by **System A** and/or by **System B**, as determined for the relevant network.

– **Both System A and System B** shall be supported for networks where there is no mandatory operator acceptance of IRDs.

– **Either System A or System B** may be required for networks where an operator is in charge of specifying the functionality of the IRDs and ensuring that the minimum requirements are met.

In addition to these requirements for mono/stereo output, HD IRD shall provide outputs for multichannel audio, as in Table 1 below:

TABLE 1: Audio Requirements for System A and System B

Status Comment

DD streams at all bitrates and fs=48 kHz according to ETSI TS 102 366 v1.2.1

Mandatory

Decoding

DD+ from 32 kbit/s to 3024 kbit/s and fs=48 kHz= according to ETSI TS 102 366 v1.2.1. Other samples rates may be required by local specifications

Mandatory

Transcoding

DD+ to DD according to ETSI TS 102 366 v1.2.1

Mandatory At fixed rate of 640 kbit/s

Metadata

A complete set of Dolby metadata

Mandatory The HD IRD shall use metadata, where provided by the broadcaster, to control for example the stereo down-mix from multi-channel audio, and shall use it, or pass it through, when providing bitstream output of Dolby Digital.

Examples of metadata parameters of use are down-mix coefficients, "dialnorm", compression modes, etc.

Pass-through of native DD and DD+ bitstreams

Mandatory In order to guarantee compatibility with legacy multichannel audio receivers, the following mechanism should be implemented. If an HDMI sink device indicates in its E-EDID structure that Dolby Digital decoding is supported, but Dolby Digital Plus decoding is not supported, the IRD shall transcode Dolby Digital Plus streams to Dolby Digital prior to HDMI transmission.

System A

HDMI Audio output

DD+ transcoded to DD according to ETSI TS 102 366 v1.2.1

Mandatory Fixed bit-rate of 640 kbit/s

PCM stereo from the decoded or downmixed bitstream

Mandatory When an HDMI Sink device indicates in its E-EDID structure that it only supports Basic Audio (i.e. two-channel L-PCM from the original stereo signal or from a stereo down-mix from the multi-channel signal), then the HDMI output will provide Basic Audio. This feature would then take precedence over the requirement of DD, DD+ and HE AAC multi-channel in the table above whenever the Sink device indicates that only Basic Audio is supported. The volume control settings of the HD IRD shall not influence the audio playback level on this interface.

PCM MCA from the decoded bitstream

Optional The volume control settings of the HD IRD shall not influence the audio playback level on this interface.

Pass-through of DTS bitstream

Not applicable

DD+ transcoded to DD according to ETSI TS 102 366 v1.2.1

Mandatory Fixed bit-rate of 640 kbit/s

PCM stereo from the decoded or downmixed bitstream

Mandatory The volume control settings of the HD IRD shall not influence the audio playback level on this interface.

Pass-through of DD bitstream

Mandatory

S/PDIF

Audio output

Pass-through of DTS bitstream

Not applicable

Status Comment

HE AAC Level 2 (mono, stereo) at fs=48 kHz according to ISO/IEC 14496- 3 and as constrained by ETSI TS 101 154 v1.8.1

Mandatory

System B

Decoding

HE AAC Level 4 (MCA up to 5.1) at fs=48 kHz according to ISO/IEC 14496-3 and as constrained by ETSI TS 101 154 v1.8.1

Mandatory

Transcoding

HE AAC Level 4 (MCA up to 5.1) at fs=48 kHz according to ISO/IEC 14496-3 and as constrained by ETSI TS 101 154 to DD according to ETSI TS 102 366 v1.2.1 or DTS according to ETSI TS 102 114 v1.2.1.

Mandatory If DD, at fixed rate of 640 kbit/s. In the case of DTS, fixed bit-rate of 1509 kbit/s

Dynamic Range Compression parameters according to ISO/IEC 14496-3 and “Transmission of MPEG -4

Ancillary Data" as specified in Annex C of ETSI TS 101 154 v.1.8.1

Programme Reference Level according to ISO/IEC 14496- 3 etadata

Mixdown parameters according to ISO/IEC 14496- 3 and "Transmission of MPEG -4 Ancillary Data" as specified in Annex C of ETSI TS 101 154 v.1.8.1

Pass-through of native HE AAC bitstreams

Optional

MCA HE AAC bitstream transcoded to DD according to ETSI TS 102 366 v1.2.1 or DTS according to ETSI TS 102 114 v1.2.1.

Mandatory For DD, a fixed bit rate of 640 kbit/s. For DTS, a fixed bit-rate of 1509 kbit/s.

If an HDMI sink device indicates in its E-EDID structure that DD or DTS is supported, but HE AAC decoding is not supported, the IRD shall transcode HE AAC streams to DD or DTS prior to HDMI transmission.

PCM stereo from the decoded or downmixed tstream

Mandatory When an HDMI Sink device indicates in its E-EDID structure that it only supports Basic Audio (i.e. two-channel L-PCM from the original stereo signal or from a stereo down-mix from the multi-channel signal), then the HDMI output will provide Basic Audio. This feature would then take precedence over the requirement of DD, DD+, HE AAC multi-channel and DTS in the table above whenever the Sink device indicates that only Basic Audio is supported.

The volume control settings of the HD IRD shall not influence the audio playback level on this interface.

PCM MCA from the decoded bitstream

Optional The volume control settings of the HD IRD shall not influence the audio playback level on this interface.

HDMI Audio output

Pass-through of DTS bitstream

Optional

S/PDIF

Audio

PCM stereo from the decoded or downmixed bitstream

Mandatory The volume control settings of the HD IRD shall not influence the audio playback level on this interface.

Status Comment

MCA HE AAC bitstream transcoded to DD or DTS

Mandatory For DD, a fixed bit rate of 640 kbit/s. For DTS, a fixed bit-rate of 1509 kbit/s

Pass-through of DTS bitstream

Optional

Audio Stream Mixing

Optional

Audio Description

Mandatory

Mandatory only for Broadcast-Mix according to DVB EN 300 468 v1.10.1 (supplementary audio descriptor). The receiver should provide a separate audio output (headphone socket preferred) which is switchable to audio= description and which is separately adjustable (if headphone). According to the needs of the users, the receiver mix audio description shall be available at the digital output interface. The receiver mix audio description is described in TS 101 154 V1.9.1 Annex E. An alternative is provided by the DD+ stream mixing, which is implemented as part of DD+

Adjustment of video/ audio delay

Mandatory The HD IRD shall support the possibility to adjust the audio-delay on the S/PDIF output (if available) from 0 to 250 ms and it should be adjustable in 10 ms steps.

Audio handling when changing service or audio format

Mandatory The HD IRD should gracefully handle change of service or audio format at the audio outputs without significant disturbances to the end user. The HD IRD shall not store volume control settings for individual TV or Radio channels independently.

Internal digital audio reference level

Mandatory The HD IRD shall have an internal digital audio reference level equivalent to the Dolby dialogue normalization reference level of –31 dBFS (equivalent to –20 dBFS Leq for the analogue outputs). The HD IRD shall adjust the output level of all audio decoders to match the internal reference level so that perceived programme loudness is consistent for all audio-coding schemes. For HD IRD featuring DD and DD+, this should be consistent with Dolby Technical Bulletin 11: Requirement Updates for DD and DD+ in DVB Products. HD IRD featuring DD or DD+ decoding shall include the PCM Level Control feature described therein.

For example, for MPEG -1 Layer 2 audio streams that have an average loudness of about -20 dBLeq, the IRD shall apply an attenuation of 11 dB for the digital output to match the internal reference level. For information HE AAC has a reference level of -31.75 dBFS. It shall be possible to change the applied gain reduction for the

MPEG Layer 2 audio according to future loudness standardization by means of a downloadable software update.

Lip Sync

Mandatory HD IRDs shall not introduce a differential delay of more than 5ms between audio and video. An IRD shall support HDMI v1.3 including "Auto-LipSync". The receiver/player should delay the audio on the analogue output (intended for amplifiers) and S/PDIF output by the corresponding amount of time, which is needed to compensate for the different decoding delay of audio and video. Section "Adjusment of video/audio delay" specifies the accuracy required. This delay shall not be applied to audio conveyed through HDMI (even if the audio is decoded and mixed down to stereo PCM).

Miscell-aneous Require-ments

Radio Services

Mandatory Support of the codecs mentioned above.

6 SI and PSI

6.1 Multiple video compression

The receiver shall present the H.264/AVC video if there is a choice between AVC and MPEG-2 in the PMT.

6.2 Logical channel number

The receiver shall interpret the HD simulcast and logical channel number descriptors according to IEC62216 (2009 version). The decision to interpret the presence of a HD_Simulcast_LCN as a substitution depends on quality reception condition and is made only at the scanning step. LCN conflicts shall be handled gracefully by the receiver.

6.3 HD_simulcast_LCN

The receiver should ensure that the quality of the HD service is good enough (e.g. BER after viterbi is quasi error free e.g. 10-7) before taking a switch.

6.4 Linkage descriptor

Receivers shall interpret linkage descriptors with link types of service replacement service (in the SDT) as described in DIGITALEUROPE's draft 'E-book' (rev end 2008) and event simulcast (in the EIT) as described in document EN 300 468 V1.10.1. This specification is currently under finalisation.

Note on event simulcast: broadcasters must ensure that the SD- and HD-events are temporally aligned.

6.5 Service type (content)

Use of 0x0A, 0x16, 0x19, 0x03, 0x0c*, 0x01, 0x02 service types.

Note: platform dependent

6.6 DVB FTA_Content_Management_Descriptor

If the descriptor is available it shall be supported according to the EN 300 468 V1.10.1 and the parameters settings as defined in this document. In the case of absence no restrictions shall apply. Further information can be found in section 9.7.

6.7 EPG

Receivers shall support EIT p/f and schedule, carried in EIT actual and EIT other tables, and shall expose the information to the viewer. Recorders should support CRIDs (TV-Anytime - see document ETSI TS 102 323 v1.3.1, chapter 12) and use them to provide advanced recording functionalities such as series linking, trailer recording and conflict resolution.

6.8 Dynamic switching PMT

Dynamic switching PMT shall be supported. The maximum switching time should not be longer as a manually initiated channel change.

6.9 Dynamic changes of service_names in SDT

Dynamic changes of service_names in SDT shall be supported.

6.10 Service_move_descriptor

Depending on service changings within one platform (i.e. DVB-C) the service_move_descriptor shall be supported.

6.11 Event_id

The receiver shall support automatic PVR recordings by using the EIT actual as trigger (see also 7.7.2).

Note: This functionality requires that the EIT transitions be timely aligned to the event boundaries.

7 Access Services

Receivers shall not simultaneously interpret txt-subtitles and DVB subtitles. The receiver shall give priority to DVB Subtitles.

7.1 DVB Subtitles

DVB-subtitling to EN 300 743 V1.3.1 is mandatory. Different languages shall be selectable. The default is the preferred language at installation. It is mandatory to be able to select or deselect subtitles and for this choice to be maintained across channel changes.

7.2 HD-DVB Subtitles

Mandatory (EN 300 743 V1.3.1). Different languages shall be selectable. Default is preferred language selected at installation. It is mandatory to be able to select or deselect subtitles and for this choice to be maintained across channel changes.

7.3 Clean Audio

Shall be compliant with TS 101 154 V1.9.1 (draft).

7.4 Teletext Subtitles

Mandatory (Teletext-Subtitle EN 300472, internal decoder), and the STB shall render the graphics.

Note: There is no teletext via HDMI.

7.5 RDS/Radio/Radio text plus

Optional DVB TM-GBS0275.

7.6 Hard of Hearing

The receiver shall detect 'normal' DVB Subtitles (component_type=0x14) and Teletext subtitles (component_type=0x02) and when labelled as 'hard of hearing' with component_type=0x24 for DVB Subtitles or teletext_type=0x05 for teletext subtitles. This shall be accessed as a user choice in the subtitling menu. If 'hard of hearing' content is available in both DVB Subtitling and Teletext, only the DVB Subtitling shall be displayed. In case of 'hard of hearing' subtitling mode is selected and no 'hard of hearing' pages are received, the receiver shall use 'normal' subtitling from the same selected language. In case of 'normal' subtitling mode is selected and no 'normal' pages are received, the receiver shall use 'hard of hearing' subtitling from the same selected language.

7.7 Control of recording devices

7.7.1 Source is HDTV Set Top Box

The Set top box should toggle the SCART pin 8 to signal an external recorder when to start and stop recording an event. It shall be possible to have a choice between a time based recording or a recording based on the value of the event_id.

7.7.2 HDTV PVRs

It shall be possible to have a choice between a time based recording or a recording based on the value of the event_id.

8 VBI

8.1 Teletext Services

Mandatory: V1.5. Recommended V2.5.

Recommendation: HD appropriate graphics-generator, decoder memory capacity for a minimum of 10 Teletext pages. The Memory should in all cases store the (4) TOP or FLOF (as appropriate) "colour-linked" pages. If the service does not carry one of these page access methods the previous, the next, the next "nn0" (e.g. page number 240, if currently showing 234) and the next "n00" (e.g. page number 300, if currently showing 234) page number. Teletext should be re-inserted into the baseband video signals on the SCART interface of the STB.

8.2 Wide Screen Signalling (WSS)

Mandatory on all analogue outputs on a STB. The information for the AFD needs to be transformed into WSS for the analogue output on SCART.

Note: This requires that broadcaster AFD does not preclude the translation into WSS

8.3 Signalling over SCART

VCR (2nd SCART).

If there is a second SCART, only DVB and teletext subtitling shall be presented, and not OSD.

9 Content Management

9.1 Common Interface (CI)

Mandatory for STB size receiver and IDTV with screen-size bigger than 30 cm diagonal, optional two CI slots. Optional for small receivers such as USB-sticks or plug-in PC cards. Not required if CI+ implemented.

9.2 CI+

Recommended one CI+ slot, optional two CI+ slots.

9.3 Analogue HDTV/SDTV component output

If Y Pb Pr outputs are available then the receiver shall support the DVB FTA_Content_Management_Descriptor information as specified in section 9.7.

9.4 HDCP on HDMI

Shall be controlled by the DVB FTA_Content_Management_Descriptor information as specified in section 9.7.

9.5 HDCP switchable (via menu in STB)

It shall be possible to enable and disable HDCP for content with no usage restrictions through a user set-up menu. See section 9.7.

9.6 USB, LAN access to audio/video data

Shall be controlled by the DVB FTA_Content_Management_Descriptor information as specified in section 9.7.

9.7 FTA content management according to signalling by FTA content management descriptor

For SDTV broadcasts no restrictions shall apply.

Note: This section follows the principles of ETSI EN 300 468 V1.10.1; however further definitions are made for the management of HD content.

The FTA content management descriptor provides a means of defining the content management policy for an item of content delivered as part of a free-to-air (FTA) DVB Service.

9.7.1 Semantics for the FTA content management descriptor

The content management descriptor is defined in EN 300 468 V1.10.1 Section 6.2.18.

9.7.2 Fundamental requirements for HD content management

The interpretation on how to apply the functionalities of the content management descriptor is currently under discussion. This document will be updated in due time.

10 System Software Update

DVB-SSU Simple profile mandatory (enhanced profile is strongly recommended). Default settings for automatic SW update: active in both stand-by and operate mode. The receiver should support data rates from at least 10 kbit/s*. User shall be able to disable/shift/cancel. The receiver should allow for an alternative software update (e.g. via USB).

**Note:* This data rate is used in the French markets; however users should be aware that this low data rate will require longer down-load times. Consequently higher date rates should be applied in broadcasting and should be supported by the receivers.*

Informative note: typical data rates are in the area of 50 kbit/s to 150 kbit/s.

11 API

The receiver should be able to support the different API (e.g. MHP, MHEG, CE-HTML, etc.) from their hardware structure in markets where these services are available. See also appendix A.

12 RF & Channel

12.1 DVB-S

Tuner/demodulator characteristics in accordance with ETSI EN 300 421 v1.1.2. The receiver shall support symbol rates on the incoming carrier in the range 7.5 Mbaud to 30 Mbaud. The receiver shall accept input signals with a level in the range -25 to -60 dBm.

12.2 DVB-S2

RF/IF characteristics as in ETSI EN 302 307 v1.1.2.

12.3 DVB-C

Tuner/demodulator characteristics in accordance with ETSI EN 300 429 1.2.1. RF frequency range from 110 – 862 MHz. National demands may require an extended frequency range.

Receiver performance: Return loss > 7 dB, Noise figure < 10 dB.

The bit error rate before Reed Solomon decoding is used as the quality criterion. The receiver shall have a BER performance better than- 10-4 for the C/N ratios specified below for all specified input levels:

QAM: C/N:

256 - 32.5 dB

128 - 29.5 dB

64 - 26.5 dB

16 - 20.5 dB

12.4 DVB-T

Tuner/demodulator characteristics in accordance with EN 300 744 v1.6.1. Receiver performance as in ETSI EN 62216-1 - E-book 2008 update. DVB-T additions are referenced in the relevant E-book sections.

12.4.1 VHF/UHF S Band, 230 – 470 MHz.

Optional. (ref. E-Book 12.2)

12.4.2 C/N performance

The values given in EN 300 744 v1.6.1, (Annex A1, Table 1; reproduced here for convenience) should perform in the same way or better.

Table 2: Required C/N for non-hierarchical transmission to achieve a BER = 2x10-4 after the Viterbi decoder C/N performance (dB)

Modulation Code rate Gaussian channel Ricean channel

QPSK ½ 3.5 4.1

QPSK 2/3 5.3 6.1

QPSK ¾ 6.3 7.2

QPSK 5/6 7.3 8.5

QPSK 7/8 7.9 9.2

16-QAM ½ 9.3 9.8

16-QAM 2/3 11.4 12.1

16-QAM ¾ 12.6 13.4

16-QAM 5/6 13.8 14.8

16-QAM 7/8 14.4 15.7

64-QAM ½ 13.8 14.3

64-QAM 2/3 16.7 17.3

64-QAM 3/4 18.2 18.9

64-QAM 5/6 19.4 20.4

64-QAM 7/8 20.2 21.3

12.4.3 Noise Figure

Better than 7 dB. (ref E-Book 12.7.3).

12.5 DVB-T2

Work in progress (16/12/2008). Tuner/demodulator characteristics in accordance with ETSI EN 302 755 1.1.1.

13 Connectors and Interfacing

13.1 DVB-T and DVB-T2

IEC 60169-2, 75 Ohm antenna socket.

Mandatory: inline power supply for antenna, DC 5V, 30mA (these are recommended values).

13.2 DVB-C

IEC 60169-2, 75 Ohm antenna socket.

13.3 DVB-S/S2

IEC 60169-24, 75 Ohm antenna socket.

13.4 Connectors for iDTV

Mandatory: S/PDIF (either optical or electrical), HDMI input, Common Interface.

Recommended: Ethernet port.

Optional: headphone audio output (i.e. audio description), SCART input (RGB/CVBS), SCART output.

13.5 Connectors for STB

Mandatory: S/PDIF (either optical or electrical), HDMI output, Common Interface, SCART output (RGB/CVBS), SCART input-output for VCR and loop-through to the SCART output.

Recommended: Ethernet port.

Optional: Y Pb Pr, RF loop-through for DVB-C, DVB-T and DVB-T2, headphone audio output (i.e. audio description).

13.6 Remote control

A remote control is mandatory.

13.7 HDMI

13.7.1 Video

Receivers shall provide an output of signals in YCbCr 4:2:2 format and the coding range as specified in ITU-R BT.601 (SDTV) and ITU-R BT.709-5 (HDTV) with a resolution of at least 8 bit. The appropriate colour space needs to be signalled to the display. The HDMI AVI Info frame (CEA-861-D Table 7) shall be supported.

13.7.2 Audio

The receiver shall support multichannel PCM and bitstream outputs over HDMI.

13.8 HDMI control data

CEC shall support, as a minimum, system audio, stand-by, and one-touch play.

13.9 USB connector

Optional. It shall follow the FTA-descriptor specified in this document.

13.10 Removable Media (USB-Connector)

Optional (It shall follow the DVB_FTA_descriptor as specified in this document).

13.11 LAN-Access (Fast Ethernet, Wireless LAN or Powerline)

Access to a private local area network is optional. An integrated wired or wireless IP-based Interface shall be compliant to Fast Ethernet (IEEE 802.3u) and/or WLAN (802.11g and better). Wirelesses interface support should be WiFi certified. A Powerline interface should support HomePlug-AV including band-stop filtering to minimize RF-interference with radio-services and wireless transmitters in the home.

13.12 Home Networking

Access to Home Networking is optional. The following describes the receiver behaviour when Home Networking is supported:

For the integration in a Home Network (HN), the receiver shall support home networking compliant to DLNA Guidelines 1.5 or higher using UPnP-AV, exposing recorded and live content to the HN as a Digital Media Server (DLNA-DMS) (*).

The receiver shall be able of carrying on the IP interface at least one broadcast service (live or prerecorded) in real time in the original encoding format and resolution. The IP interface should be able to accommodate traffic from the access network as well from the HN at the same time.

The receiver should expose the programme/service guide received on the delivery network on the HN including the option of scheduling recordings by the user (**).

The receiver should provide a Digital Media Player (DLNA-DMP) for the selection, control and rendering of live and stored content from a Digital Media Server (DMS). The Renderer (DLNA-DMR) is part of the Digital Media Player (DLNA-DMP) and should be able to be discovered and controlled by other UPnP Control points in the HN.

Any Digital Rights Management (DRM) and/or Conditional Access (CA) that are integrated in the receiver should support exposing both secure and non-secure content to the HN by following the rules of DVB-CPCM including the DVB FTA_Content_Management Descriptor.

(*) If DLNA Media Profiles are other than those used in the access network, transcoding may not be required.

(**) The exposure on the HN of the programme/service guide should be in accordance with UPnP and/or HTML.

14 Usability

In general it is recommended that internationally agreed icon labelling be applied, instead of textual descriptions.

14.1 Stand-by mode

Mandatory.

14.2 Power Consumption in stand-by mode.

See EU regulations on power consumption.

14.2 Power Switch-Off

It is recommended that STB and IDTV have a physical power-switch.

14.3 Channel change time

Not significantly more than RAP period.

14.4 HDCP control by user

Mandatory. See 9.5.

14.5 Component descriptor display

Mandatory for subtitles and audio descriptions, and audio channels (i.e. different languages). Display of image format changes should be manually selectable.

14.6 Means of selecting an alternate language

Mandatory - see above.

14.7 User controls

The standby, channel, menu, volume and arrow-keys buttons on the device shall be easily accessible to the user.

14.8 Remote control

Buttons should have consistent labelling, using internationally agreed icons wherever possible.

14.8.1 Remote Control Buttons

The following table lists the major functions and buttons preferred on the remote control.

Table 3: Remote Control Button Functions Button function Requirement Comments

Aspect ratio adjustment Optional, for use with SD

Audio description on/off Mandatory, Including sound indicator.

Easily to be identified (i.e. finger sensitive) or on the corner position.

Audio mute Mandatory With icon.

Audio volume up/down Mandatory. May also control the volume of other equipment when configured appropriately.

Back (menu navigation) Mandatory.

Channel up/down Mandatory.

Cursor (menu navigation) Mandatory. up/down/left/right

Exit to video Mandatory.

Guide Mandatory.

Help Recommended

Info Mandatory.

Menu Mandatory.

Numeric, 0 - 9 Mandatory.

OK Mandatory. In centre of cursor keys

On/Stand-by Mandatory.

Picture-in-picture Optional.

Radio/TV select Mandatory.

Subtitling on/off Mandatory, Should cover all channels over channel changing.

Text applications colour keys Mandatory.

Text/TV Mandatory.

Video format Optional, Recommended.

It would be preferable to mechanically protect the less frequently needed remote control buttons by some sort of flap or cover, or alternatively to access their functions in the graphic menu structure.

14.8.2 Audible feedback for buttons on the remote control

It is recommended that the receiver should generate audible tones to provide feedback that a remote control button press has been acknowledged. The user should be able to turn these tones on or off, as desired, in the receiver.

14.9 Display functionalities

14.9.1 Alphanumeric

Optional but recommended for radio services.

14.9.2 Event Name

Optional but recommended.

Appendix A (informative): Signalling for CE-HTML

A.1. Signalling and Application lifecycle

Interactive services related to one or more services are signalled in a DVB-AIT which is carried in the same MPEG-2 TS as the corresponding service(s). HTML-applications shall be started and stopped according to DVB-AIT signalling. Basic lifecycle rules:

- Signalling of applications on broadcasting services is done via broadcast DVB-AIT or SD&S.
- Only those applications signalled in the AIT are allowed to run in the context of the corresponding service (embedding of video, …)
- When an application tunes to a service and is included in its AIT then the tuning is performed and the application remains active. If the new service signals an autostart application then this application is not started.
- When an application tunes to a service and is not included in its AIT then the tuning is performed and the application is killed. If the new service signals an autostart application then this application is started.
- When an application running on a service starts another application which is not signalled in the AIT of this service then the application is started but the service context has to be cancelled (logical tuning to a "null" or "default service"). The new application can then via tuning put itself into a new service context (if not signalled on the new service it will be killed).

A.2. Transport protocols for HTML applications

Interactive services related to one or more services are signalled in a DVB-AIT, which is carried in the same MPEG-2 TS as the corresponding service(s). Standard DVB-AIT signalling is used for transmitting the related URLs via the broadcast channel.

A.2.1 Bidirectional IP connection

For bidirectional IP communication channels standard http and https protocols are used to carry applications.

A.2.2 DSM-CC via Broadcast channel

DSM-CC implementation is required.

Note: IPTV networks will not use the DSM-CC carousel mechanism within the MPEG-2 TS for the transport of any application or data. Only http requests on web servers via the IP interaction channel will be used to load data. The only exception is the carriage of DSM-CC stream events, which will be used for transmitting time critical information via the MPEG-2 TS.

A.3. HTML profile

The HTML profile used by the services is based Open IPTV Forum Declarative Application Environment (DAE) specification based on the CE-HTML standard (ANSI/CEA-2014.A) plus the additions defined by the Open IPTV Forum. The minimum requirements for the browser are given by a compliance list that is still under discussion and will be published later. Scalable Vector Graphics will not be used for the time being.

Annex 5

Matters Related to Consumers' Digital TV Receivers

Annex 5 - Part A
Maximizing the Quality of SDTV in the Flat-Panel Environment

5.A.1 The changing environment

With television screen sizes becoming progressively larger in the home, defects in the transmitted picture quality are becoming more and more noticeable - and also more annoying - for the viewer. Display technology is changing from the CRT to LCD or PDP flat-panel displays. These types of displays - particularly PDP - mask the picture impairments to a lesser extent than CRTs and thus, compared to CRT displays, are apparent "magnifiers" of the impairments. Television is moving to an age where high picture quality is becoming more important.

Many ITU Members have broadcast in PAL or SECAM for the last 40 years; in recent years, digital broadcasts have used the MPEG-2 video compression system. The picture quality delivered in an MPEG-2 channel depends on many factors but a limiting factor is the channel data rate. Most European broadcasters for example use bitrates of 2.5 - 5.0 Mbit/s. But, for a number of reasons, there are circumstances where the programme's inherent picture quality cannot be delivered satisfactorily to viewers using flat-panel displays.

Broadcasters need to review the ways in which they make and deliver television programmes in the light of these new large home displays - indeed, at some stage sooner rather than later, broadcasters will need to improve the picture quality that is delivered to viewers using flat-panel displays.

This Chapter, based on EBU Technical Information I39-2004 [3], describes the steps that broadcasters should take to improve picture quality in the standard-definition TV (SDTV) environment. Of course, in responding to the new age of large displays, some broadcasters may decide to introduce high-definition TV (HDTV) services. This scenario indeed is most far-sighted. However, it is not the subject of this Chapter. The issues associated with a change to HD delivery will be considered later in this Report.

Studies conducted within the EBU have suggested that, in an MPEG-2 SDTV channel (with available encoders and decoders), the more critical kinds of scene content must be delivered at a data ate of 8 - 10 Mbit/s if they are to be reproduced with good "conventional" quality on largescreen flat panels. It is to be noted that in the case of HDTV, a data rate of 15 - 22 Mbit/s is required for good quality TV using MPEG-2 compression – depending on the scanning format used and the acceptable level of degradation relative to the uncompressed HD picture quality. This is a rule of thumb for ensuring high quality for all types of content produced for digital delivery in the flat-panel age, even though such high data rates will not be required for some types of picture content found in average programmes.

If data rates adequately higher than those used today are possible for SDTV broadcasting, a major part of the potential limitation on flat-panel quality is removed. This is the step that will have most effect on critical content impairments. But whether the data rates can be raised or not, there are other steps that can be taken to make the best of the prevailing situation. There are "good practice" steps that are worth taking, whatever the available data rate limit. It is these steps that are the subject of this Annex. In time, practical experience will be gained by Members on which data rates and measures are needed to optimize picture quality on flat-panel home displays, which can then be shared with others. In the meantime, broadcasters should evaluate the extent to which they can adopt the measures suggested in this article. Furthermore, they should consider setting organization-wide picture-quality targets for digital television. Having such a benchmark will make it possible for broadcasters to evaluate the costs of making the necessary improvements, and allow them to plan the appropriate measures needed to achieve these improvements.

5.A.2 Recommendations for best practice:

1) Thorough research on relative performance should be done before buying MPEG encoders. It will be a good investment. The state of the art needs to be reviewed frequently.

2) If the service is a green field with no legacy MPEG-2 receivers to serve, consider, as most Broadcasters do, using codecs more modern one like MPEG-4/AVC instead of MPEG-2. Make buying the encoder the last thing you do before the service starts.

3) Check if the picture quality limits, due to the delivery mechanism, match the quality limits possible in programme production. If the delivery mechanism is a significant constraint on quality transparency across the chain, programme makers may be wasting their investments in programme production. Broadcasters' public service mission calls for technical quality, which does justice to the high programme quality.

4) Take great care in the broadcasting chain to ensure end-to-end high-quality 4:2:2 signals, and never allow the signal to be PAL or SECAM coded.

5) If possible, preserve 10 rather than 8 bit/sample values for the components in the 4:2:2 signals flowing through the programme production and broadcasting chain.

6) Explain to production staff what kind of production grammar (shot composition, framing and style) will lead to poor quality on large flat panels. Encourage and train them to avoid high entropy unless you can use higher broadcast data rates.

7) Encourage flat-panel receiver manufacturers to develop high-quality standards conversion and scaling electronics, and advise the viewing public about which are the best flat-panel receiver types.

8) For mainstream television programme production in compressed form, use no less than 50 Mbit/s component signals.

9) Do not trans-code between different analogue or digital compression schemes, and use signal exchange technologies such as SDTI and File Transfer which handle compressed signals in their native form.

10) If noise reduction is required it should be introduced before encoding. However, noise reducers should be used with caution after a careful consideration of the options here-after.

11) Set clear organizational broadcast quality goals, and use the professional skills of your staff to keep to them.

5.A.3 Options for optimizing SDTV picture quality in a flat-panel environment

5.A.3.1 The way compression systems work

Before outlining the measures in more detail, it is useful to review the way that digital compression systems work. While yesterday's analogue compression system –"interlacing" - applied itself in exactly the same way to *any kind* of scene content, digital compression systems *adapt themselves* to the scene content. This makes them much more efficient, but also it makes describing the way they perform more complex, and identifying ways to optimize the quality is more complex as well. Nevertheless, worthwhile good-practice elements can be identified if care is taken.

The key element of picture content that affects the way compression systems perform is the degree of detail and movement in the scene (sometimes called ***entropy***). It is mainly this that determines how taxing the scene is for the compression system. Scenes with less detail and movement are "easier" to compress, in the sense that the input is more closely reproduced at the output, but the reverse is true for scenes with a lot of detail and movement - particularly over the whole picture, rather than in just parts of it. The point where "easy to compress" become "difficult to compress" is determined by the delivery data rate (bitrate) limit. When the scene is difficult to compress, the compression system introduces impairments of its own ("artefacts") in the picture.

Programme-makers need to understand the different types of scene content and they way they behave in compression systems.

The most difficult or taxing scenes to compress are those containing high detail and movement over the whole scene. The most taxing or "stressful" type of content is usually material shot originally with video cameras, showing scenes which have an elaborate "canvas". This usually means sports events or light entertainment. These are the kinds of programme that will look worse on the new large displays, because the compressionprocess will introduce its own impairments into the picture - unless the data rate is high enough.

The easiest or least taxing scenes to compress are usually, but not always, cartoons or those shot on celluloid film at 24 pictures per second. This usually means fiction/drama or documentary material. Movie material will usually look “good” on large displays at low bitrates, because the compression process is least likely to introduce artefacts of its own - though film grain can make compression more difficult if it is present, as explained later. The higher the field or frame rate, the higher the entropy. For the same camera shot, 50 Hz interlaced television scenes are easier to compress than 60 Hz interlaced scenes.

Unfortunately “noise” or “grain” in a picture, which may be unintended and unwanted, can also be interpreted as entropy by an encoder, and can thus “stress” the encoder and lead to impairments. The encoder has no way of knowing whether detail is desirable or undesirable, so noise or grain contribute to the overall entropy of the picture. Noisy pictures whose wanted content is “noise-like” may be masked by unwanted picture noise, causing impairments in desirable parts of the picture. ***“Clean” pictures always win twice - they are better to look at, and they are easier to compress.***

Apart from noise itself, creating a PAL or SECAM analogue picture leaves a certain technical “footprint” on the picture. This footprint can pass unnoticed when a viewer first sees the picture, but it can also be interpreted by the digital compression system as more entropy. For PAL, the footprint takes the form of fringes around objects. Thus, PAL pictures can be “stressful” for compression systems. Note also that analogue PAL broadcasts can look poor on flat-panel displays.

5.A.3.2 The need for "headroom"

It is inevitable that television signals will have to go through a number of processes before they reach the viewer in his/her home. Thus, when deciding on the *adequacy* of a set of technical parameters for a television signal, it is important to remember that the full desired picture quality must be available *at the end* of the broadcast chain (and not just at an earlier point). For system-wide adequacy, a safety factor (i.e. ***headroom***) should therefore be added at other points in the chain - to allow the signals to undergo further processing while still “protecting” the chosen parameter values.

The precautions mentioned below should ensure that the picture quality is protected during the many stages of processing that the signals may have to endure, before reaching the viewer’s large flat-panel display.

5.A.3.3 The role of sound

The perceived quality of a television programme is influenced by the presence or absence of sound, and by the sound quality itself. The presence of sound appears to have a distracting effect on viewers’ perception of the picture quality. So, if broadcasters take care with the sound then, within the limits of home equipment, this should positively help with the image perception too.

5.A.4 Quality and Impairment factors

Picture quality is considered to be made up of a range of ***quality factors*** which affect perception of the quality. These are elements such as “colorimetry”, “motion portrayal” (picture rate and scanning format), contrast range, and others. It is the combination of these various elements which defines the perceived picture quality.

In addition, for convenience, there is a range of ***impairment factors*** which also can contribute to picture quality. They are similar to quality factors, but the term is used for impairments added by compression systems or coding. They include elements such as “quantization Noise”, “static or dynamic Ringing” (mosquito noise), “temporal Flicker” and “blockiness”. Sometimes non-technical analogies are used to describe these elements - for example, the “heat haze” and the “ice cube” effects. These impairments mostly arise when the bitrate is too low for the degree of detail and movement contained in the scene.

Quality factors include those which increase the potential entropy - definition and motion portrayal. At the same time, these very same elements can induce impairment factors to “kick in”, because the compression system becomes over-stressed. The process of optimizing the end-to-end broadcast chain is often a case of finding the best balance between these two contrasting factors.

5.A.5 The Broadcasters' objectives

Broadcasters will always want to deliver their material at the lowest possible bitrates they can successfully use. Channel data rate is a precious resource which can be used to provide more multimedia services or more programme channels within a multiplex. However, broadcasters must develop an end-to-end strategy which uses the lowest bitrate that is consistent with acceptable picture quality, or with other constraints.

To optimize the broadcast chain in a 576/50 (conventional quality) transmission environment, broadcasters need to do two things:

a) they must deliver (to the final MPEG-2/MPEG-4 encoder) pictures which have the *minimum entropy* possible, taking into account the programme-maker's intention and the impact the pictures will have.

b) they must use MPEG-2/MPEG-4 encoding arrangements that will result in a minimum of *coding artefacts* being introduced into critical high-entropy content.

Suggestions for a) are considered in the Section immediately below, titled "*Production and contribution arrangements to maximize quality"*. Suggestions for b) are considered in a later Section titled "*Delivery channel arrangements to maximize quality*".

A further Section below, "*Receiver arrangements to maximize quality*", looks at ways in which the receiver manufacturers can improve the perceived picture quality, by designing certain features into the receiver.

While these points can be discussed separately for convenience, always remember that the broadcast chain *as a whole* needs to be considered. The measures taken in production and delivery need to be proportional. ***There is no reason to take special care in production - if poor arrangements are used for encoding, and vice versa.***

5.A.6 Production and contribution arrangements to maximize quality

5.A.6.1 Quality is more than technical parameter values alone

The perceived technical quality of a television picture is not based purely on the technical fidelity of the picture, and the lack of impairments in it. Our impression of picture quality is also determined by our interest in the scene. This means that picture quality is influenced by the professional skills of the cameraman and editor in shot-framing and scene composition.

The "quality factors" of the scene (as described earlier) are also influenced by the professional skills of the cameraman and editor. They are responsible for elements such as colour balance, colorimetry, lighting and the effects of contrast and noise. Control and care not only reflect on the impact of the pictures ... but also upon the entropy of the pictures.

5.A.6.2 Capture

Production staff need to keep in mind the final delivered picture quality. There are two main areas to consider here. The first is the impact that shot composition, framing and style (sometimes called "production grammar"), as well as lighting and camera settings may have on the picture entropy. The second is the influence that production techniques may have on noise or grain levels in the picture.

Production "grammar" influences, among other things, how much visible detail and movement there is in the picture. Camera pans and zooms over *detailed* areas should be avoided if possible, obviously depending on the context of the production. Camera tracking is (for our technical purposes) better than panning. Shooting with lens settings that lead to short depths of field . i.e. with low detail in the background and, hence, lower entropy - may reduce the encoding artefacts in the received pictures.

Production lighting, camera settings and types of equipment can influence the noise level in the picture. Low lighting with high gain settings should be avoided. Although it may not be noticeable to the naked eye, the signal-to-noise ratio is degraded - there is less "headroom" in the signal.

To improve picture sharpness, the camera processing introduces "aperture correction" and/or "contour/detail" correction which amounts to boosting the high frequency end of the spectrum. By improving picture sharpness, it also makes the signal- to-noise ratio worse. In addition, the ′thickness” of the “contours” is magnified and hence is more unnatural when viewed on a large flat-panel display, at a shorter viewing distance in the home. Aperture/contouring correction should be used with caution in any camera. In low-cost cameras (i.e. DV camcorders), the correction circuits are often not as well designed as they could be (to lower costs), and their use should be avoided. In these cases it is better to apply any indispensable “peaking/sharpening” tweaks using subsequent high-quality processing equipment.

Since aperture and detail correction also corrects for (a lack of) “lens sharpness”, the best possible lenses should be used to minimize the need for these corrections.

5.A.6.3 Processing

Pure production with no compression, in accordance with ITU-R Rec. BT.601-6, will produce the best quality for delivering to the encoder. However, this may well be impractical.

Nevertheless, 4:2:2 sampling structures should be used throughout the production process.

The use of helper signals such as “MOLE” [4] - which carry information on the first application of compression “coding decisions” along the production chain - could in principle be useful for maintaining quality in production. In practice, we have not been able to identify any organization which has been able to successfully apply them. These technologies are arguably most useful when very high levels of compression are used, rather than the low levels usually used for production. Furthermore, it is difficult to pass the MOLE signal entirely error-free through the production process.

In the production chain, multiple decoding and recoding of compressed signals must be avoided. Compressed video should be carried throughout production in its “native” compressed form (i.e. as it first emerged from the camcorder).

For real-time transfer via the existing SDI infrastructure, the Serial Data Transport Interface (SDTI.SMPTE standard 305) should be used.

For file transfer, the MXF file format should be used as it provides standardized methods of mapping native compressed (and uncompressed) Video and Audio .essence. (e.g. DV/DV-based, MPEG-2 Long GoP, D10 etc).

Compression in mainstream television production to not less than 50 Mbit/s, as explained in EBU Technical Text D84-1999 [5], should be used.

When higher compression rates and low data rates are necessary for high-content-value news contributions, a long GoP should be used. Compression systems like MPEG-4, that are more efficient than MPEG-2 for news feeds should be considered.

If multiple cascaded (concatenated) codecs cannot be avoided in the overall chain, then at least similar encoding and decoding devices should be used to minimize the quality loss.

For file transfer of programme material in non-real time, the original or native compression system should be used at 50 Mbit/s or higher, I-frame only.

Broadcasters are converting to file/server-based systems and, although ever larger storage is possible, these do not have infinite data capacity and some form of compression will still be needed. The bitrate of the compressed signal should not be below 50 Mbit/s. Do not use editing/storage equipment that has its own internal compression scheme that is different from the “native” one used in the capture camcorder.

It may be absolutely necessary to use noise reduction. If so, this should be performed before the first compression process. Noise reduction should not be introduced in the middle of a series of concatenated compression systems.

5.A.6.4 HD production for conventional-quality television

HD production which is down-converted to 576/50/i gives very good quality, particularly if the HD is progressively scanned (e.g. 720p/1080p), but also if the HD is interlaced (e.g. 1080i). This is a very effective future-proof way of preparing high-quality 576/50/i material. There are additional benefits because the material can be archived at HD resolution and used in future years when there are HD broadcast services. Material captured using cameras operating on an interlaced standard includes spatio-temporal aliasing virtually “burnt in” to the picture. If 1080i material is down-converted to 576i, much of the burnt-in alias is lost and, consequently, the signal is cleaner and easier to compress in the 576i signal domain. If the production is 720p/1080/p originated, the alias is absent, so the 576i signal produced can be even cleaner than that sourced from 1080i.

Broadcasters who make HD productions are advised to produce the material in the same format as the production format. Although it might not be practical to archive a 720p/1080p or 1080i signal in base-band uncompressed form, a compressed data rate at 720p/1080p or 1080i should be chosen that will still provide sufficient quality headroom for future repurposing and post productions. Further studies on this subject are required.

5.A.6.5 Wide aspect ratio

The use of aspect ratio should ideally be controlled in such a way that the best quality result is obtained, although the scope for using different aspect ratios will depend on the organization’s broadcast policy. However, whatever arrangements are used for shoot and protect areas, 16:9 productions should be shot in the 16:9 production format (“anamorphic 16:9”) and not as a letter-box inside the 4:3 production format.

Semi-professional (consumer, or even “prosumer”) cameras normally provide only 4:3 aspect ratio sensors but some of them utilize in-built signal manipulation to give the 16:9 aspect ratio. Experience has shown that these internal camera manipulations should not be used. If needed for wider aspect ratios in post-production, a high-quality professional converter should be used to extract the area of interest.

5.A.6.6 PAL/SECAM signals

Do not use video signals that have been analogue composite-coded at some point. The quality headroom is already lost, and nothing can be done to retrieve it. Furthermore, PAL coding adds unwanted artefacts to the picture (sub-carrier fringing effects, and luminance/chrominance cross effects) which can consume compressed data rate because they are interpreted as valuable picture entropy.

5.A.6.7 Primary distribution

The input to primary distribution should use MPEG-2/MPEG-4 MP@ML encoding for transmission. It is important that encoders of a very high quality perform this encoding process, and that the highest possible data rate is used. Statistical multiplexing should be used if more than two programmes are being distributed in the same stream.

5.A.6.8 The final quality check

Production or technical staff should always check on a large-screen display during production, a version of their programme which is compressed to the level used for broadcasting. This is the only way to be sure about the picture quality. This care will pay off in the long term. This check is probably not needed if broadcast data rates of 8 - 10 Mbit/s are being used for broadcasting.

5.A.7 Delivery channel arrangements to maximize quality

5.A.7.1 Choosing an MPEG encoder

The MPEG compression family is arranged specifically to allow encoders to evolve and improve. Only the form of the MPEG-2/MPEG-4 decoder signal is specified, and as long as the signal received conforms to that, the encoder can be as simple or sophisticated as it needs. The system is also intended to be “asymmetric” in the sense that the decoder system is simple, and complexity is loaded into the encoder.

There are a range of technologies available for pre-processing and post-processing in MPEG-2/MPEG-4 encoders. Pre-processing algorithms essentially filter the image before or during compression. This improves the performance by simplifying the image content. Post-processing algorithms identify and attenuate artifacts that were introduced into the encoder.

Noise and other high entropy elements "stress" the encoder and generate impairments, but over-application of pre-processing, denoising and filtering will blur the picture. The best quality will be obtained by finding the optimum balance between them.

More effective pre-processors and noise reducers are obtained by "loop filters" and de-blocking processors within the encoder and the decoder. Indeed these techniques are included in more recent codecs such as ITU-T Rec. H-264 (MPEG-4).

However, they are not included in the MPEG-2 system which is used today for digital broadcasting at conventional quality. Noise reducers and pre-processors can be used in MPEG-2 systems before the encoder. They can be separate from the encoder or controlled by it. In the first case, the user can adjust the weight of the pre-processor and noise reducer to obtain the best picture quality during the set-up stage, even changing them scene by scene.

This cannot usually be done "live" in real time. In the second case, the encoder selects the weight of the preprocessor and noise reducer by measures such as "buffer fullness" (which is related to entropy). The second approach could be more effective than the first because changes can automatically be made at small time intervals, but this may cause resolution pumping as an unwanted side effect.

Nowadays the performance of MPEG-2/MPEG-4 commercial encoders has improved dramatically and this trend is ongoing. Thus, the MPEG-2/MPEG-4 encoder should be the last item of equipment to buy when starting digital broadcasting. The very latest models should be used, and the encoder should be periodically replaced to take advantage of recent improved performance and should be considered as "expendable" investment in the broadcast chain.

The performance of MPEG-2/MPEG-4 encoders also varies significantly from manufacturer to manufacturer. Variations in the performance of equipment available at any given time can be as much as 30%. Users should evaluate all available encoders, either with their own tests or based on reports of the experience of others. As a rule of thumb, the same type of MPEG-2/MPEG-4 encoder used across the broadcast chain provides better overall quality than a mixture of types. It is worth noting that "two-pass" MPEG-2 encoders offer higher encoding efficiency than "single-pass" encoders, but they suffer higher encoding delay. They can be up to 20% more quality efficient than single-pass encoders, and should be used where the delay is not important.

Statistical multiplexing increases effective encoding performance. The gain is higher in multiplexes of many programmes, but it is still useful in multiplexes of only three or four programme channels. The unchecked application of statistical multiplexing can lead to impairments when particular combinations of content entropies occur. To reduce the effects on premium content, different priority levels can be applied to different programme channels. In this case, a request for data rate from a high-priority channel will be satisfied before requests from low-priority channels.

5.A.7.2 Using new compression systems

If a "green field" service is to be launched, then one of the new more efficient compression systems should be chosen like ***MPEG-4 Part 10*** (also known as ITU-T Rec. H.264 and MPEG-4/AVC) as significantly more quality-efficient than MPEG-2 at conventional quality levels. Tests made by the RAI in Italy suggest that savings of 50% could be made at conventional (SDTV) quality, even with the early implementations of MPEG-4 Part10. Increasing number of broadcasters wish to use the new algorithms, and indeed they encourage more manufacturers to make receivers/set top boxes using them. As a rule of the thumb the European countries without the legacy problemme of early MPEG-2 adoption have decided to choose the MPEG-4 as future proof choice.

It is to be noted that the license costs of using this system needs to be checked by potential users.

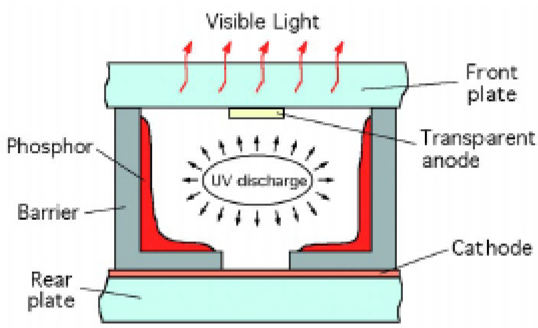
5.A.8 Receiver arrangements to maximize quality

5.A.8.1 Flat-panel technologies

Plasma Display Panel (PDP)

The advantage of the PDP was to have been ease and cheapness of manufacture, as compared to LCD, since it could take advantage of printing, rather than photo-lithography, in its production processes. It has not turned out this simple though, and the benefits of scale are now being felt in new LCD plants which could turn the panel-cost balance on its head.

The PDP manufacturers have invested a lot of money in their factories, and not surprisingly are still confident, in public at least, that there is a good market for their products. Due to high panel costs, these displays initially found a niche as public data displays in airports and railway stations, but have been found to suffer from a lack of brightness when viewed in natural light. Often, when displaying basically static or repetitive information, they exhibit image-sticking and phosphor burn-in.



The heart of a plasma display panel (PDP) is the discharge cell. Sandwiched between two sheets of glass, constrained by barriers, the cell has an anode and cathode. A plasma discharge in the low-pressure helium/xenon gas mixture in the cell generates ultra-violet radiation, converted to red, green or blue visible light by a conventional phosphor. The PDP is therefore self-emissive, but the form of construction leads to a relatively heavy and fragile panel.

A major problem for PDPs has been motion portrayal, with colour fringing becoming visible due to the pulsewidth-modulated greyscale. There is also a difficult trade-off to be made between panel lifetime, and the settings for brightness and contrast. High brightness reduces lifetime but makes the display attractive at the point of sale. Improved contrast can also only be achieved at the cost of reducing the brightness.

The historic advantage of PDPs over LCDs was the ease of making a large panel. Higher resolution was harder but now full HD 1080 i/p resolution large screens PDPs are widely available for sale at affordable prices. Recently PDPs offer1080-line resolution at most sizes an same production facility can make number of panels simultaneously from a single sheet of glass, thus cutting the costs.

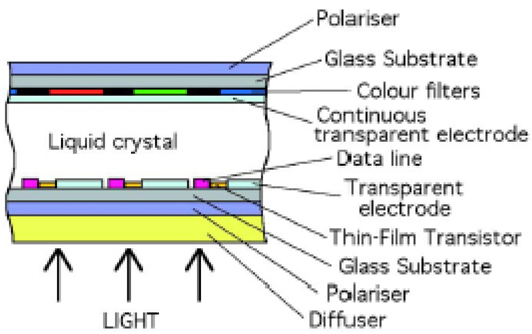
The typical contrast ratio claimed was around 8000:1 accompanied by very good colorimetry with life expectancy around 20000 hours. Very latest models on the market are with 1000000:1 dynamic contrast ratio. Power consumption varies between 350 W and 500 W for 107 cm PDP.

Innovative plasma display technologies enhance further image quality (more colors and gradations), and bring greater energy savings, thinner dimensions, larger screens, new materials and processing technologies, new discharge gas and cell design technologies and double the luminance efficiency with lifetime expanded around 100000 hours. Recently developed 100 Hz, 200Hz, or even better 600 Hz motion portrayal panels are great for good film motion and sports quality reception.

Nowadays plasma panel manufacturers are finding it hard to justify investment in current financial crisis (Pioneer who had already absorbed NEC and Fujitsu/Hitachi are pulling out of plasma panel manufacturing leaving Panasonic as the only Japanese plasma panel manufacturer). Nevertheless Panasonic has made an investment required to bring the next generation of Plasma displays on the market and the Neo PPDs have brought a substantial cut in power consumption with thinner and lighter panels, all increasingly important factors to counter the climate change.

Liquid Crystal Displays (LCD)

LCD technology has the inherent ability to more readily provide displays of higher resolution.



The TFT-LCD basically consists of a layer of liquid crystal sandwiched between polarizing sheets. When a voltage is applied across the electrodes, the polarisation of light passing through the panel is altered, and hence the transmission of the cell can be varied. A colour display is achieved by adding filters, so that a triplet of cells is used for each pixel of red, green and blue. It is, in direct view designs, a transmissive technology, requiring a back-light.

Many of the LCD TVs seen in shops are far from ideal in picture quality. Five years ago, LCD was not seen as a serious contender for the large-screen television market. This was not just due to the yield problems of making the larger sizes, but also due to motion blur caused by slow response speeds, poor colorimetry and viewing angles, as well as higher costs. However, these drawbacks are now being overcome.

Colorimetry improvements have proved relatively simple to implement.

LCD picture quality can now surpass PDP for the first time. Motion blur is greatly improved by a variety of proprietary techniques which aim to speed the transitions between grey levels by modifying drive voltages during the transition. LCDs with higher than 175° angles of view are common practice today. Cheaper LED backlights leading to wider color gamut, now a significant part of the cost of a large display, have been developed, while most common type before was Cold Cathode Fluorescent Lamp (CCFL).

LCD technology is dominating the flat-panel market in terms of volume, with prices falling rapidly following a vast ramp-up of production volumes in different parts of the world - huge resources have been invested into mass production resulting in 47 new fabs built only in the last 2 years before 2009. For example Sharp simultaneously make eight LCD panels at 57-inch size from a single substrate of 2.8mx3m. Towards this end Sharp has invested 3.2bn US$ and this investment has created the last Japanese LCD panel manufacturing facility operational since March 2009. In the future investment in new manufacturing LCD capacity will be through partnerships outside Japan.

LCDs now account for the vast majority of desktop PC screens. Larger screen sizes use up surplus production capacity. With the 42-inch market becoming increasingly competitive, manufacturers are introducing models in 46-47 inch range-to bridge the gap below 50 inches. The inexorable rise in average screen size appears set to continue, which really is the main driver for broadcasters to invest further in HDTV.

LCD may not be the ideal technology for television, but nowadays it is unstoppable. All display sizes and all resolutions can be made and drive circuits are easier than PDP. LCD's have long life around 40000 hours being limited by the backlight's endurance. Generally there is no "burn-in" effect. Contrast ratio in latest LCD TVs achieved is 80000:1, with luminosity around 550 cd/m2, no large area "flicker" and are of relatively light weight. Power consumption of LCD's is as a rule of the thumb one half of that of the PDP's (250 W for 107 cm screen size). However there are some remaining problems such as the natural S-curve transfer characteristic which even after correction results in "stretch of blacks" (causing increased visibility of "noise in blacks"' and of coding artefacts- sometimes dealt with by "clipping" the blacks) as well as the “blur” and ”combing” during the de-interlacing, however most new display types are inherently “progressive”. Motion portrayal is another remaining problem, but recently developed 100 Hz or even better 200 Hz panels are big things for good film motion and sports quality reception.

Organic Light Emitting Diodes (OLED)

Samsung has produced in the fall of 2008 a 102 cm size flat screen on Organic Light Emitting Diodes (OLED) new technology incorporated into HDTV receiving set with breath taking contrast ratio of 3000000:1. Recently during this year Samsung has made available for sale in the market 117 cm diagonal 40 % thiner and 40 % less power consumption HDTV LED receiver sets with 1000000:1 contrast ratio and motion portrayals of 100Hz and 200Hz. Furthermore Samsung has hinted for 50-inch version end of year 2009, but this company does not expect OLED to become a mainstream product for 4-5 years. Remaining problems of this promising more efficient technology are the display lifetime, the good blue emitter plus the uniformity and low panel production yields, leading to HDTV receiver’s price for consumer around three times higher than the LCD type same size. It is estimated that the OLED technology will move up to larger display sizes and that it might have a noticeable impact on the TV industry within next 5-10 years and challenge LCD/PDP technology.

5.A.8.2 Energy Consumption and Environmental Aspects

The said unprecedented TV industry developments have led to production of 6.6 TV receivers with total of 2350 square inches of flat panel displays per second during the year 2008 leading to use of 74 million square inches of special TV-glass by the single manufacturer Philips alone. All this is supplemented by impressive quantity of electronics, enclosures and so on.

Consumer Electronics (CE) represent 16% of the household electricity bill, with TV receivers accounting for the biggest part (40 %). It is estimated that by year 2010 the CE products will be the single largest part of household electricity consumption. Therefore introducing energy efficiency improvements of household appliances will represent substantial cost-effective investments to reduce society’s CO2 emissions originating from home electricity use. Estimates show that TV receivers will consume more than 30 Terra Watt Hours during 2030. Every effort will be made to optimize the energy consumption and appropriate regulations/specifications will be imposed leading to balancing the technological push with ecology requirements. It is worth noting that during the year 2007 the LCD TV was twice more energy efficient than CRT TV produced during the year 1999 for the same 32” size. Clearly, the Climate Change dilemma itself will enforce much stricter environmental friendly standards and key innovations in the broadcasting industry.

Obligations for both the Minimum Ecodesign Requirements on Power On/ Standby consumption of TV receivers and the Labeling of Energy Efficiency Class evolving every two years (from 1 to 10 based on Energy Efficiency Index) will be imposed by the European Commission to be applicable within European Union.

5.A.8.3 TV Screen size progress

The average CRT screen size before the demise of CRT was 28”. The display manufacturers and broadcasters have conducted extensive surveys to establish the size of flat-screen displays that consumers are likely to purchase.

The advent of flat screen TV’s is leading to larger screen sizes in households – most popular LCD size is already 32” and by the year 2010 the size is expected to move up to 42” diagonal. Predictions stipulate that the average TV screen size will be of 60”diagonal in the year 2015 – inclusive 1080 i/p. No doubt-consumer flat-panels are becoming a key driver for HDTV. Furthermore, professional HDTV screen needs will be met by piggybacking on the consumer market for panels as it was done for CRT’s. The steady reduction of consumer prices for both PDP’s and LCD’s at narrow competitive range encourage the viewers – the biggest investor in the broadcasting chain – to acquire large flat screen TV’s with expectations to enjoy attractive programmes delivered at home of real HDTV quality.

5.A.8.4 Display pre-processing

The pre-processing of video signals for display on these new panels is a major challenge. Traditional TV manufacturers have never needed to de-interlace interlaced broadcasts, as a CRT can display an interlace signal directly. Similarly, image scaling/resolution changes are accommodated by adjusting the scan size with a CRT. In the case of the new displays, with fixed rasters addressed sequentially, the TV manufacturers need to incorporate de-interlacing and scaling technologies. These technologies are well understood in the professional broadcast environment, but less so by the consumer electronics and PC industries.

There are several chipsets available that claim to do everything necessary. Experience suggests that many of the scaling chips are characterized by poor de-interlacing, and insufficient taps on their scaling filters. They have features to partially mask these shortcomings, but are used with inadequate additional memory. The best way of mapping a picture to such a display is to transmit the signal in a progressive format, pixel mapped to the display. This is one of the reasons for the suggestion in EBU Technical Texts I34/I35 [1][2] that progressive scanning should be used for new HD services. For legacy 576/50/i broadcasting, we were obliged to use interlace scanning, and do the best we can with it.

On a digital flat-panel, the overscan used systematically for CRT displays might be seen as redundant, since the edge of the picture is clearly defined. However, there may be a case for a few pixels overscan:

i) to allow easy scaling ratios,

ii) to mask archive programme content which was not made with a totally "clean aperture" (microphones in shot etc.), and

iii) to cope with unwanted incursions into frame during live programming today.

Another area where most currently-available panels are inadequate is in the presentation of film-mode material carried on an interlaced format (sometimes known as PSF - Progressive Segmented Frame). The pre-processing in nearly all current displays fails to treat film-mode material as such. Instead, it applies a de-interlacer to the signal, thus degrading a signal which, by the progressive nature of flat-panel devices, should in practice be easier to scale and display. ***The broadcast signal should flag "film mode", when appropriate.***

Presentation of pictures with coding artefacts would be improved by adaptive pre-processing that is able to distinguish between picture features and coding-block edges. Better interlace-to-progressive conversion, using two- or three-field spatio-temporal filtering, would also improve the picture quality of currently broadcast pictures.

To scale an image to a particular raster size, the scaling filters need to be carefully chosen to obtain the best final image quality. Therefore the scaling chips should include pre-selected filters, with an adequate number of taps, for the common conversion ratios that they are likely to encounter. A "one size fits all" filter design will not produce the best image quality when scaling from, for example, 720 to 768, if it is optimized for scaling from 1080 to 768.

5.A.8.5 Physical interfaces between equipment and display screen

Digital interfaces, such as DVI and HDMI, offer the possibility of making transparent the transfer of picture data to the display screen. Experience of panels with digital inputs suggests that this will enable the panel to display a clean signal (so much so that coding artefacts become more prominent). The mechanism for this is the lack of an optical output filter on the flat-panel display, compared to the Gaussian spread and hence filtering effect of the CRT spot. This could be mitigated by having many more pixels on the screen than in the source, and appropriate up-conversion filters. This would smooth block boundaries, as well as effectively providing extra bit depth in the display by means of spatial dithering, provided the processing were done to an adequate bit depth.

HDMI - the High-Definition Multimedia Interface [6] - specifies a means of conveying uncompressed digital video and multichannel audio. It can support data rates up to 5 Gbit/s, and video from standard definition, through the enhanced progressive formats to HDTV at 720p, 1080i and even 1080p at 60 Hz and lower, including 50 Hz. This is an appropriate interface for digital connections to flat-panel displays.

Included in the HDMI is HDCP (High-bandwidth Digital Content Protection) [7] to prevent piracy of the uncompressed digital signal. The system encrypts the signal before it leaves the "source" (e.g. the set-top box) and the "sink" (e.g. the display) then decrypts the signal to allow it to be watched. HDCP is a link encryption system. The first products incorporating HDMI interfaces are now available.

The DVI (Digital Visual Interface) [8] is the predecessor of HDMI. It is increasingly used on computers and display products, and uses very similar technology to HDMI, but lacks the audio capability. There is a measure of electrical compatibility between the two, enabling adaptors to be used between the different connectors. The connectivity will be lost if a DVI/HDMI-capable "source" with HDCP enabled does not sense an HDCP-enabled DVI/ HDMI "sink" at the other end. Hence most display manufacturers who are targeting Home Entertainment and Television systems now implement HDCP functionality to their DVI/HDMI interfaces to avoid complaints about picture quality of content.

The advantage of HDMI over DVI will be cable length. Usually limited to about 2m for DVI, 15m (and beyond) should be possible over HDMI.

5.A.9 References:

[1] EBU Technical Information I34-2002: **The potential impact of flat panel displays on broadcast delivery of television.** www.ebu.ch/en/technical/publications/ott/index.php

[2] EBU Technical Information I35-2003: **Further considerations on the impact of Flat Panel home displays on the broadcasting chain.** www.ebu.ch/en/technical/publications/ott/index.php

[3] EBU Technical Information I39-2004: **Maximising the quality of conventional quality television in the flat panel environment - first edition.**

www.ebu.ch/en/technical/publications/ott/index.php

[4] Nick Wells: **Transparent concatenation of MPEG compression** EBU Technical Review No. 275, Spring 1998

[5] EBU Technical Statement D84-1999: **Use of 50 Mbit/s MPEG compression in television programme production.** www.ebu.ch/en/technical/publications/ott/index.php

[6] **High-Definition Multimedia Interface** HDMI Licensing, LLC. www.hdmi.org

[7] **High-bandwidth Digital Content Protection** Digital Content Protection, LLC. www.digital-cp.com

[8] Digital Visual Interface Digital Display Working Group. www.ddwg.org/dvi.html

5.A.10 EBU guidelines for Consumer Flat Panel Displays (FPDs)

5.A.10.1 Scope

This document describes the requirements of the EBU as to how broadcast programmes should be displayed on modern (non-CRT) consumer television sets. It lists the main technical parameters as well as relevant measurement methods. In addition this document recommends an EBU default parameter set.

Any characterization of a display's performance that references this EBU document shall have been undertaken in full accordance with the measurement procedures outlined below.

5.A.10.2 Background

The diversity of consumer flat panel displays (FPDs) that are currently available has raised concerns over the way that television images are presented to the viewer. Standards for television image capture are aimed at a display with the characteristics typical of a cathode ray tube (CRT). All television programmes produced today in standard definition (SDTV), as well as in high definition (HDTV), comply with these standards. The same is true of all earlier television programmes now stored in broadcasters' archives around the world.

Broadcasters have an obligation towards programme producers to present their productions without distorting their creative intent. Therefore it is essential that manufacturers of consumer television sets should design their displays such that their image rendition adequately reflects the creative values intended by the programme director.

5.A.10.3 Main technical parameters

5.A.10.3a Luminance

On displays of up to 50-inch diagonal, small-area peak white should be adjustable to least 200 cd/m^2 without excessive flare. On larger displays, a lower peak luminance is advisable in most domestic environments. However, more important than the actual peak luminance achieved is the shape of the electro-optical transfer function (EOTF) when set to a realistic peak luminance (the EOTF is defined in section 5d; its gamma value is specified in section 4a).

5.A.10.3b Black level

With a luma signal at black level the luminance level measured from the screen should be adjustable to be below 1 cd/m^2, such that it can match a range of home viewing conditions.

5.A.10.3c Contrast

The contrast obtained will depend on the settings of 3a and 3b, above, which indicates a simultaneous contrast of at least 200:1 (see also section 5c). The contrast figures quoted by a manufacturer should be both the full-screen contrast and the simultaneous contrast, measured as defined below.

5.A.10.3d Frame rate presentation

The display should present images at the frame rate of the source where possible, or at some integer multiple thereof. 60 Hz presentations of 50 Hz input signals and 3:2 pull-down should be avoided.

Television pictures are produced as YC_BC_R digital components with a coding range as defined in ITU-R BT.601 (SDTV) and ITU-R BT.709 (HDTV), i.e. the coding range digital 16 to 235 (8-bit) or digital 64 to 940 (*A5.11.3e. Digital interface (DVI or HDMI) coding range.*

10-bit). Consumer displays with an 8-bit digital interface such as DVI [10] or HDMI [11] shall correctly operate in the 8-bit coding range of digital 16 to 235 for YC_BC_R digital components.

Note 1: HDMI 1.3 allows greater bit depth (deep colour mode). Earlier versions allow increased bit depth when using YC_BC_R 4:2:2 pixel encoding.

Note 2: RGB SDTV and HDTV video signals shall be coded with the video coding range as specified in CEA-861-D [12]

5.A.10.3f HDMI AVI InfoFrame

Because sources (e.g. Set Top Boxes) are expected to set the following bits within the HDMI AVI InfoFrame (described in CEA-861-D [12] Table 7), these should be correctly interpreted by the HDMI input of the display:

Data	Bits	Explanation	CEA-861-D reference [12]
Active Format Info Present	A0	Idicates that Active Format Info is valid	Table 8, AVI InfoFrame Data Byte 1
Bar Info	B1..B0	Provides information about letterbox/ pillarbox when active format information alone is not sufficient	Table 8, Data Byte 1
Scan Information	S1..S0	e.g. display is not to apply overscan	Table 8, Data Byte 1
Colorimetry	C1..C0	e.g. BT.470-2 or BT.709	Table 9, Data Byte 2

Picture Aspect Ratio	M1..M0	e.g. 4:3, 16:9	Table 9, Data Byte 2
Active Format Aspect Ratio	R3..R0	Indicates area of interest within the picture	Table 9, Data Byte 2
RGB Quantisation Range	Q1..Q0	e.g. limited range (16-235)	Table 11, Data Byte 3

The following AVI InfoFrame data may be used to assist input synchronisation:

Pixel encoding	Y1..Y0	e.g. YCbCr 4:2:2, RGB 4:4:4, etc.	Table 8, Data Byte 1
Video Format Ident Code	VIC6..VIC0	e.g. 1080p/50, 1080i/25, 720p/50, 576i/25	Table 3, Data Byte 4

5.A.10.4 Recommended "EBU default" settings

5.A.10.4a Display gamma

The electro-optical transfer function should be a power law (commonly referred to as "Gamma"). The default value of display gamma that is required to match the television programme producer's intent is 2.35 in a "dim-surround" environment [6], as per the measurements reported in section 4.2 in [5]. See also Annex A for further information.

5.A.10.4b Colour primaries and gamut

The colours produced by red, green and blue signals, with each of the others turned off, should be within the EBU tolerance boxes in EBU Tech 3273 [13]. The difference between the gamuts of ITU-R BT.709-5 [2] (HDTV) and EBU (SDTV) [14] systems is so small as to be negligible.

5.A.10.4c Colour temperature

Whilst television pictures are produced in the studio assuming a display with D65 [3] reference white colour, it is acknowledged that many consumer displays are set up for much higher colour temperatures.

To change current broadcast practice would result in an unwanted and undesirable change to the look of the pictures, and so it is proposed that the current status quo be accepted, namely that broadcasters produce pictures for a white point of D65. Consumer displays may actually be set to a white of significantly higher colour temperature, but should always contain a user-selectable setting that conforms to D65. This setting should be clearly indicated and is part of the EBU default conditions.

5.A.10.5 Measurement methods required to characterise the display

5.A.10.5a Luminance

The 100% luminance level is measured on a white patch occupying the central 13.13% part of the picture, both horizontally and vertically, using the test signal described in section 3.5 of EBU Tech 3273 [13] and in ITU-R Rec.BT.815-1 [7]. The measurement should be taken perpendicular to the centre of the screen.

5.A.10.5b Black level

Black level is measured in a dark room, on the black patches in the test signal described in 5a, above. Care must be taken to avoid veiling glare in the measurement instrument, by the use of a mask or a frustrum, as described in EBU Tech 3325 [1].

5.A.10.5c Simultaneous and full screen contrast

Simultaneous contrast is the ratio of the measurements in 5a and 5b, above.

The expression "Full screen contrast" has created confusion within the industry as it is used with different meanings. For the purpose of reporting contrast measurements on flat panel displays, the EBU defines full screen contrast as follows:

Full screen contrast is the ratio of the luminance of a white patch occupying 10% of the width and 10% of the height (i.e. 1% of the screen area) in the centre of a black screen to the luminance measured from a completely black screen (with the set switched on) in a dark room. This is sometimes known as "Full screen (1% patch) contrast".

5.A.10.5d Electro-optical transfer function (Gamma)

The electro-optical transfer function (EOTF) is a definition of how the light output (luminance L_R, L_G and L_B) is related to the broadcast *R*', *G*' and *B*' signals thus:

$$L_X = L_{X0} + s\left(\frac{X' - X_0'}{r}\right)^{\gamma}$$

where:

L_X is L_R, L_G or L_B

L_{X0} is the residual light output at 'black' (this is a combination of the residual light output of the display with the effect of the ambient room lighting),

s is a scaling factor related to peak light output, X' is R', G' or B',

X_0' is the electrical signal representing the effective black level, and

γ is the display gamma, which is specified in section 4a.

The value of r will depend on the coding range (for example, analogue voltage, or 8- or 10-bit digital coding) of the television signals.

Measurements of gamma are made by the method defined in EBU Tech 3273 [13]; see also BBC RD 1991/6 [4].

The EBU would prefer consumer displays to avoid applying overscan on any HD input format (1080p, 1080i, 720p).

However, if a small degree of overscan is unavoidable, it should match the clean aperture, as defined by SMPTE 274-2005 Annex E.4 [8] and SMPTE 296M-2001 Annex A.4 [9].

Further information about overscan is provided in Annex B

5.A.10.7 References

[1] **EBU Tech 3325**: **Methods of measurement of the performance of studio monitors (in preparation)**

[2] ITU-R Rec.BT.709-5: Basic Parameter Values for the HDTV Standard for the Studio and for International Programme Exchange (2002)

[3] CIE (Commission Internationale de l'Eclairage) Standard S 014-2/E (2006): Colorimetry - Part 2: CIE Standard Illuminants

[4] Roberts, A.: Methods of measuring and calculating display transfer characteristics (Gamma)

BBC Research Department Report RD 1991/6.

[5] Roberts, A.: Measurements of display transfer characteristics using test pictures. BBC Research Department Report RD 1992/13.

[6] Hunt, R.W.G: "Corresponding colour reproduction" in *The reproduction of colour*, ed. 6, pp. 173, Wiley & Son, 2004.

[7] ITU-R Rec.BT.815-1: Specification of a signal for measurement of the contrast ratio of displays

[8] SMPTE 274M-2005: Annex E.4 in 1920 x 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates

[9] SMPTE 296M-2001: Annex A.4 in 1280 x 720 Progressive Image Sample Structure — Analog and Digital Representation and Analog Interface

[10] Digital Display Working Group, 1999-last update, digital visual interface [Homepage of Digital Display Working Group], [Online]. Available: www.ddwg.org/ [June, 20, 2005]

[11] HDMI, 2007-last update, high-definition multimedia interface [Homepage of HDMI], [Online]. Available: www.hdmi.org [March 14, 2007]

[12] CEA 861 –D: A DTV Profile for Uncompressed High Speed Digital Interfaces (2006)

[13] EBU Tech 3273: Methods of Measurement of the Colorimetric Performance of Studio Monitors (1993)

[14] EBU Tech 3213-E: Standard for Chromaticity Tolerances for Studio Monitors (1975)

5.A.10.8 Attachments (Annexes)

5.A.10.8.1 Annex A: Gamma

Television has evolved to give pleasing results in a viewing environment described by colour scientists as ‘dim surround’ [6].

This outcome includes three invariant components:

– the requirement to match luminance level coding (whether analogue or digital) to the approximately logarithmic characteristic of the human vision system by means of an appropriate nonlinear coding or “perceptual” coding of level. Such a characteristic has the effect of equalizing the visibility over the tone scale of quantizing in a digital signal, or noise in an analogue one. A linear or other non-perceptual based characteristic would require greater dynamic range (bandwidth or bit rate) for the same perceptual quality, with adverse economic consequences;

– the immovable legacy effect of the CRT gamma characteristic on which the entire television system was empirically founded. This legacy consists of both archived content and world-wide consumer display populations;

– gamma is also the characteristic which coding schemes such as MPEG-2 and MPEG4-AVC are designed to match, and any other characteristic will be less than ideal in terms of artefact and noise visibility, to the extent that much of the impairment seen these days on transmitted television material, when viewed on flat screen displays, is caused by the failure of the display to adhere closely to a gamma characteristic, particularly near black.

It has been found that the end-to-end or “system” gamma for images captured in nominal daylight conditions, adapted for the dim-surround consumer viewing environment is approximately 1.2, i.e. definitely not linear.

The system gamma can be expressed as:

System gamma = camera encoding gamma (OETF[1]) x display gamma (EOTF[2])

It has been found from measurement techniques, progressively refined over several decades, that a correctly designed CRT display has an EOTF gamma of approximately 2.35 [5]. This is part of the “immovable legacy effect” of the CRT.

Therefore our system gamma equation is rewritten as

[1] OETF: Opto-electrical transfer function

[2] EOTF: Electro-optical transfer function

System gamma = 1.2 = OETF gamma x 2.35

Therefore OETF (camera) gamma = 0.51.

Since a pure gamma curve would require infinite gain to be applied to camera signals near black, resulting in unacceptable noise; in practice this curve is modified to consist of a small linear region near black in combination with a reduced gamma curve of 0.45 [2]. Note however, that a “best fit” single power law curve for this characteristic comes out as 0.51, the same as in the calculation above. From the above, since the consumer viewing environment does not, in general, change, and the OETF gamma cannot change (for compatibility reasons and for the continuation of an optimal perceptual coding characteristic), the EOTF gamma must also remain at 2.35, regardless of which new physical display device is used to implement it.

5.A.10.8.2 Annex B: Issues concerning overscan

The CRT has historically applied overscan of around 5% at each edge. This was required because of the difficulty of aligning the scan geometry at the edges of a screen. Edge artefacts on analogue TV content (and digitised versions of this) have been masked by the presence of overscan in the display.

In the modern all-digital environment, it is expected that edge artefacts are well contained.

Overscan has been applied on early flat panel displays to mimic the appearance of the image on CRTs.

There is an inevitable move towards the broadcast signal containing essential content to the edge of the screen. The consumer should be able to see this complete image, rather than only 80% of the image area.

If the display has greater resolution than the incoming signal, scaling is needed. This scaling should not be confused with overscan.

If a display is a close match to the resolution of the incoming signal, one-to-one pixel mapping will always provide a better picture than scaling by a small percentage.

For SDTV the legacy of the installed base of consumer CRT displays, and the legacy of archive content may prevent any change to existing broadcasting practices for some years to come.

Annex 5 - Part B
HDTV and Progressing Scanning Approach

The advent of flat screen TV’s is leading to larger screen sizes in households – most popular LCD size is already 32” and by the year 2010 the size is expected to move up to 42” diagonal. Predictions stipulate that the average TV screen size will be of 60”diagonal in the year 2015 and full strength HDTV 1080p would be preferred by consumers.

Progressive scanning is being presented to the public as a major improvement in the quality by receiver industry.

No any more doubt-consumer flat-panels are becoming de-facto one of the key drivers for HDTV. The steady reduction of tumbling consumer prices for both PDPs and LCDs at narrow competitive range encourage the viewers – the biggest investor in the broadcasting chain – to acquire large flat screen TV’s with expectations to enjoy attractive programmes delivered at home of real HDTV quality.

Furthermore, professional HDTV screen needs will be met by piggybacking on the consumer market for panels as it was done for CRT’s.

Single world-wide HD video disc progressive scanning format “Blu-Ray Disc” is available on the market as from the year 2008. It is backwards compatible with the DVD and CD formats. The “Blu-Ray Disc” format’s playing and personal recording devices are exposing consumers to a quality that is far superior to standard digital terrestrial television broadcast transmissions. “Blu-Ray Disc” player tumbling consumer prices have made the “Blu-Ray Disc” very popular too. Furthermore within less than two years packaged media on HD Blu-Ray discs, such as movies, will dominate the market.

Satellite broadcasting, a leading HDTV delivery system for many households of the world, is increasing bandwidth to better serve viewers with flat panel sets. Cable Television distribution networks also introduce the HDTV innovation. IPTV is providing attractive HDTV content exclusively on pay per view basis. Telco’s are also providing HDTV content via VDSL and optical cable directly to households.

Digital terrestrial HDTV broadcasting service is offered to viewers of Australia, Brazil, Canada, China, France, Japan, Korea (Republic of), New Zealand, Singapore, USA. Extensive digital terrestrial HDTV broadcasting testing is on the way in Croatia, Finland, UK.

5.B.1 What if the core display was a 1080p display?

A question considered by the B/TQE Group of EBU in 2004 was: If the world watched video content on 1080p displays, and 1080p DVDs were widely used, would 720p broadcasts look inadequate?

The BBC research, based on series of tests with 170 viewers seems to suggest that if they are at the 2.7 m representative viewing distance for 30-40 inch screen flat panel displays, they would not notice the difference between 720p and 1080p content on the 1080p display, because the eye would already be saturated with detail by the 720p content. But if they watched at closer range (or alternatively at bigger screen), they *would* notice the difference.

But it did seem clear to the said experts group that if: (i) the manufacturers decided to make receivers capable of handling progressive formats up to and including 1080p; (ii) the majority of displays were 1080p and (iii) there were 1080p DVDs in the public hands, then this is what the terrestrial broadcasters would have to deliver.

As already indicated, all the above-mentioned three preconditions of the EBU B/TQE experts group will be fully met as from the year 2010 and will be exceeded by far in the year 2015 with 60 inch average screen size.

Another issue which remains to be explored concerns the extent to which a given progressive input signal can be fully explored in practice by a given flat-panel display. If the three colour primary points are not spatially coincident (as they are not in practice), it may be that to fully exploit a given signal resolution, a higher resolution panel is needed to avoid spatial aliasing effects. In other words, it may be that a 1080p panel is needed in order to fully use the 720p delivery format. At the year 2004, however, the evidence before B/TQE suggested that the best delivery format would be 720p.

Warning to TV Broadcasters: Today, a professional HDTV programme can be produced in any of over 40 different capture/recording formats and converting between them always has shortcomings!!

On 3 of March 2006 Dr. J. A. Flaherty, Senior Vice President Technology, CBS Broadcasting Inc. has stated:

<<Today, Europe needs a more direct path to full HDTV terrestrial broadcasting. Suitable spectrum for terrestrial broadcasting 1920/1080/16:9/24p, 25p, and 50i&p HDTV must be found, even at some sacrifice of today’s lesser TV services. Otherwise, Europe’s terrestrial broadcasters, starved for spectrum, and thus without HDTV, will, in time, cede their audiences and their future to the worlds’ alternative HDTV media. European terrestrial broadcasting deserves a better future, and only Europe can make that future happen. Today, Europe has a new birth of HDTV opportunity in its “Challenge of Choice”. Europe needs to adopt full quality high definition for both production and emission and not adopt another evolutionary SDTV or Enhanced1280/720p system on the way to final HDTV**. *Tempus fugit*. European terrestrial broadcasters must become HDTV broadcasters.**>>

5.B.2 Interlaced/Progressive Scanning dilemma

The legacy question here is whether what you already have can be made to work. Interlace scanning can work well with advanced compression and progressive displays – it is just less efficient in transmission, needs complex standards-conversion in the flat-panel display, and has less motion-portrayal quality potential.

It may or may not be most cost-effective to use progressive scanning for programme production, or a mix of interlace and progressive. It may be that interlace production equipment will be cheaper for today. But by specifying a progressive delivery channel, we keep all the production options open, and make ourselves as future-proof as technology allows.

5.B.3 Arguments for progressive scanning

5.B.3.1 Coding gain

In simple terms, anything an interlaced analogue bandwidth-compression system can do in series with a digital compression system, a content-adaptive digital compression system alone can do better, working on the "original" progressive signal.

Thus, one of the advantages of progressive scanning is that we can compress video in a content-adaptive way, rather than partly in a simple systematic way. A system such as interlace never cares what is best for the particular content being seen, or the bitrate available in the channel. ***In the twenty-first century there are better ways to reduce bandwidth than to use interlaced scanning.***

Taken overall, the application of digital adaptive compression must be more "quality efficient" than using interlaced scanning. There must be a "coding gain" associated with progressive scanning and adaptive compression, when compared to using interlace scanning and then adaptive compression.

Quantifying precisely how much this is, or will be, is difficult because it depends on the scene content. It cannot be done in terms of a set of a small number of subjective evaluation results; it has to be seen as the long-term result for the channel efficiency. In practice it seems that most of the coding gain of progressive scanning in a MC hybrid DCT environment comes from the improvement in the effectiveness of the motion compensation stages of compression.

Tests with the ITU-T Rec. H.264 compression system widely known as MPEG-4 AVC Part 10, have established that it compresses progressive images "better" than they compress interlace images. The bitrate required to deliver a "good" quality 720p/50 image has been found to be less than that required to deliver 1080i (interlace) for material which is "critical but not unduly so".

5.B.3.2 Avoidance of display up-conversion

New LCD, plasma and non-CRT-based projection technologies are different from the CRT technology they replace. It is relatively easy to convert a progressive delivered image to an interlaced form, but it's much more difficult to convert an interlaced image to progressive form to suit it to the new displays**.**

If you have a choice about whether to broadcast a signal which does, or does not, need de-interlacing in the receiver, all the arguments found support broadcasting a signal that does not need de-interlacing:

1) Firstly because creating whole pictures for a progressive display from an interlace signal is no simple task. Essentially you need different conversion algorithms in the receiver for when the picture is static and for when it is moving. It is complex because you are trying to compensate for information which is not there. Once the upper segment of the vertical/temporal spectrum is taken away by the interlacing, it cannot be recuperated. Certainly there has been much research and development of consumer interlace-to-progressive conversion by the large receiver manufacturers. But, even so, the progress – especially for HD resolution – is not matching its original promise. On sale is seen only equipment with simple "motion adaptive" designs, without motion compensation. While good for still images and for film mode, these methods are less good for television moving images. In television, our core business is moving images.

2) Secondly, if you must have a de-interlacer, it is better to do something once with expensive and complex equipment at the studio output, than to do it a thousand times less well using low-cost equipment in each and every receiver across the land. EBU Group B/TQE assessed de-interlacers that are common in the domestic display environment and found they generally contributed impairment and limited the final quality of an HD-delivered image. However, professional conversion equipment of very good performance has been developed and good de-interlacers are available from a range of manufacturers for studio use.

From all this, the said EBU Group concluded that conversion from interlace to progressive should not be carried out at the receiver if we can avoid it.

5.B.3.3 Improvements in motion portrayal

Though the EBU B/TQE group has not investigated the best forms for HD production those broadcasters in the United States who are using 720p/60 progressive scanning have informed the said group that the greatest reason for their using it is because of motion portrayal for sports content. When there is much movement, progressive scanning looks better, and indeed slow motion replay looks better.

History has taught broadcasters that sport was the major reason for people to buy colour television receivers in the sixties and seventies. For HD, sport will be a “killer” incentive to move to HD. There is every reason to take particular care of sports content for public service broadcasting where it is critical content.

Whether or not progressive scanning is used for production, the choice of progressive scanning for the delivery channel is an advantage. If we choose an interlace delivery channel, we are locked out of fully seeing the advantages of progressive production – they cannot be carried forward to the public. Having a progressive delivery channel allows us the option of using progressive production or not, as circumstances dictate, and this seems the responsible approach.

5.B.3.4 The future broadcast chain will begin and end with progressive scanning

Current picture sources are fundamentally “progressive”. The CCD/CMOS at the heart of each camera converts the optical image into electrical form with charges from all the rows of CCD elements transferred into a storage device at the same instant. “Interlaced” or “progressive” images are formed when the signal is “read” out of the chip: indeed, the interlaced signal is formed by discarding information.

We can also note that much electronic graphic programme material is generated in progressive form to avoid the twitter or flicker of fine detail.

Objectively, we will have a broadcast chain which begins and ends with progressive scanning and, given that you have the choice, one can see the use of interlace as an un-necessary limitation on quality built into the chain.

5.B.3.5 Establishing the optimum progressive format

The above experiences led the EBU Technical Committee to recommend that Europe's best interests are served by a progressive delivery channel, of which two are specified by the SMPTE – 720p/50 and 1080p/50.

To reach conclusions on whether one or the other, or both, should be recommended, the B/TQE group went back to first principles to establish what HD brings to the viewer.

Deciding on a proposition for an HD format is not purely a matter of simply citing who uses which system, or drawing three dimensional diagrams of the responses of different scanning formats.

There are too many variables to take into account and, unless actually related to real equipment, these diagrams are misleading.

An appraisal was needed to be done based on the results of controlled tests with real equipment and real people.

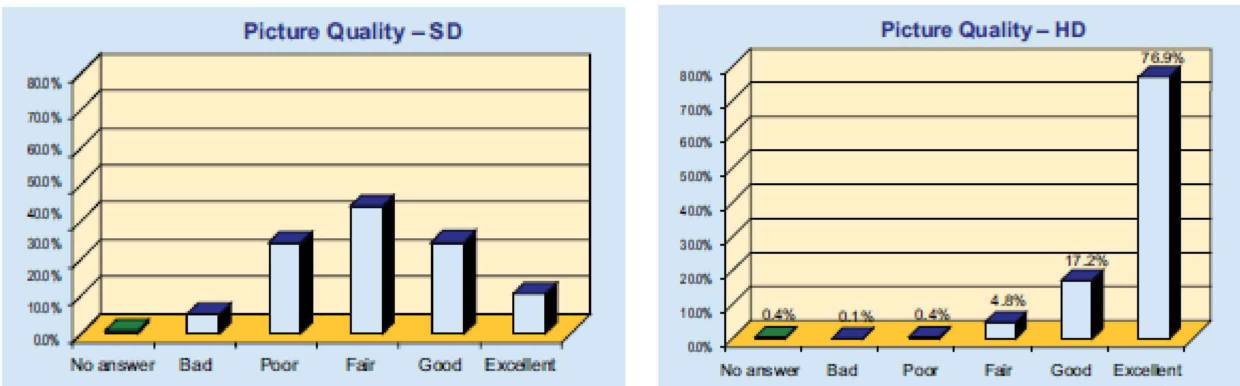
5.B.4 How much quality do we gain with HD?

Overall, of course, the SD image falls short of the equivalent HD-delivered image. For a general idea of the difference, *Fig. 1* shows a comparison made in the year 2004 in Sweden between SD delivered with MPEG-2, and HD delivered using a more advanced coding method. The shots were sections of a complex moving sequence. This was not a scientific test, but it was simply to show the general impact of the order of difference.

Figure 1: Comparing standard-definition and HD images

Fig. 2 shows how SD and HD have been compared by a large population sample in tests in Sweden. In this case, very good quality standard-definition DVDs were compared with HD Digital VHS on adjacent screens. The results showed that the SD picture quality was generally "fair" whilst the HD picture quality was judged as "excellent". If they are seen together, there is about two quality grades difference between HD and SD.

Figure 2: Comparison of SD and HD assessments



This suggests that the critical factor for the viewer's perception of quality is the "context". If the viewer can experience both HD pictures and SD pictures, he or she will evaluate the SD pictures as two grades worse than the HD pictures.

As HD DVDs and HD-capable displays are becoming popular, the viewer will experience this "context", and this in turn will lead to growing pressure on broadcasters to provide matching HD quality.

5.B.5 The balance between requirements for detail and spectrum efficiency

B/TQE believed that a judgment on the optimum delivery format needs to take into account both the requirement to saturate the eye with detail in representative circumstances, and the need to provide the lowest possible delivery bitrates for spectrum efficiency.

The European terrestrial airwaves, in particular, are highly congested and all broadcasters arguably need to be as spectrum-efficient as possible but without annoying rtefacts. There is no doubt that whatever the compression system used, the delivery bitrate for a 1080p/50 signal would be higher than for a 720p/50 signal. If a 720p/50 delivery signal is adequate, it is argued, it would be responsible to use it, rather than use a higher scanning format that provides detail which will not be noticed on smaller screens. This is not to say, however, that 1080p/50 should not be used for programme production, where headroom could be an advantage – but this is the subject of another study.

This choice of the 720p/50 format, rather than 1080p/50, with an advanced compression system would decrease the risk of compression artefacts for practical bitrates. If we choose the lower of the two scanning formats, for a given delivery bitrate, we have a higher chance of providing artefact-free delivery.

A demonstration, conducted by EBU at IBC 2006, was not intended to be a formal scientific subjective evaluation of three HDTV formats, but rather a first-hand look at the qualitative differences in the formats, in as fair and controlled feasible environment.

In the presentation of uncompressed sequences, the delegates reported difficulties in seeing difference between the three formats – even at a viewing distance of 3h. But when the compressed images were shown, the viewers did notice differences in the visibility of compression artefacts. Depending on the viewing distance and scene content, the artefacts became visible to a greater or lesser extent and, with few exceptions, the following were reported:

i) The 720p/50 format showed better image quality than the 1080i/25 format for all sequences and for all bitrates;

ii) With decreasing bitrate in the compressed domain, the difference between the 720p/50 and 1080i/25 format became more marked;

iii) The 1080p/50 format was rated equal or better than 720p/50 for the higher bitrates. However, 720p/50 was rated better than 1080p/50 at the lower bitrates.

Annex 5 - Part C
Status of HDTV Delivery Technology

5.C.1 System considerations

5.C.1.1 HD scanning formats

The EBU has identified and specified, in EBU document Tech 3299 (ITU-R Rec. BT.709-5), **four HDTV production formats**: 720p/50, 1080p/25, 1080i/25, and 1080p/50. The 1080i/25 and the 720p/50 formats can also be used for broadcasting, or other forms of secondary distribution, whereas 1080p/25 is currently a production format only. However, for distribution, 1080p/25 can either be mapped into 1080i/25 as 1080psf/25 (**p**rogressive **s**egmented **f**rame, psf) or converted to 720p/50 by spatial down conversion combined with frame repetition.

The 1080p/50 is termed a "3rd generation" HDTV format, which some broadcasters believe may be used in future both for production and distribution purposes.

EBU studies suggest that, if the final quality seen by the modern HDTV viewer is taken into account, the most "quality-efficient" broadcast format of these four, seen on current HDTV consumer displays, is the 720p/50 format. The 1080p/50 is quality-efficient and can be compressed to bitrates comparable to 1080i/25. No technical advantages have been identified to date for the 1080i/25 format in the current broadcast environment, though there were advantages in the past in the all-CRT-based display environment.

Almost all HDTV displays sold in Europe today are flat-panel matrix displays, requiring incoming interlaced TV signals to be deinterlaced. The progressive format is thus the natural match to current HDTV displaysSome broadcasters in Europe are however choosing the production format 1080i/25 for other than technical reasons. This may be when, for example, older legacy equipment only supports 1080i/25, or when productions are commissioned in, or the customer may require, 1080i/25. Both are understandable reasons. *But it is now technically understood that the interlaced footprint in the HDTV signal cannot be removed with standards converters*. Consequently a chain with a progressive signal generated from an interlaced source will always have a potentially impaired quality compared to a full progressive chain.

As a rule of thumb, for interlaced production, it is better to use one high quality professional de-interlacer at the playout point, rather than placing the burden of de-interlacing on the many (and less effective) consumer devices in the home. An additional advantage is that broadcast encoders can operate moderately more efficiently in terms of bitrate requirements with progressive signals derived from interlaced than with interlaced HDTV.

EBU tests suggest that, all other elements being equal, the advantage for 720p/50 broadcasting applies whether the viewer's display is one of the widespread Wide-XGA-panels (1366x768 pixel, also called HD-Ready) or a newer panel with 1920x1080 pixel (HD Ready 1080p), up to a diagonal size of about 52 inch. However taking into account that average screen size predicted for year 2015 will be 60 inch this suggestion may not be future-proof, therefore 1080p delivery would be better solution for the nearest future.

HDTV broadcast encoder manufacturers usually provide optional signal processing functionalities which process the baseband input video signal. This normally includes selectable input filters that reduce the horizontal resolution of the video signals, in order to reduce the required bitrate in distribution, but with some quality trade-off.

Often this horizontal down-filtering is expressed as the number of pixels per line. Having lower horizontal resolution reduces the “criticality” of the scene (a function of the entropy of the picture, which relates to how difficult the picture is to compress without artifacts) and thus makes compression easier. If a scene shows visible compression artefacts such as “blocking”, lowering the horizontal resolution can reduce these, though the sharpness potential of the image falls also.

It is worth noting that recent formats from Sony (XDCAMHD 422) and Panasonic (AVC-I) and GVG/Thomson (Infinity J2K) do not use horizontal down-sampling for either 1080i/25 or 720p/50.

The HDTV baseband environment can be seen as comprising a number of quality format/levels, given that the compression system and bitrate are chosen to transparently deliver the original signal.

Though it is by no means a complete indicator of quality, a major indicator of quality of a moving picture system is its luminance-sampling rate. This is used below to classify scanning formats. There are several factors in addition to horizontal resolution that relate to subjectively perceived picture quality, so the luminance sampling rate should not be taken as a singular or linear measure of potential quality:

Scanning raster Luminance sampling Rate

1920x1080p/50 148.5 MHz

1920x1080i/25 74.25 MHz

1920x1080p/25 74.25 MHz

1280x720p/50 74.25 MHz

Equivalent luminance sampling rate with subsampling

1440x1080i/25 54 MHz

960x720p/50 54 MHz

1280x1080i/25 48 MHz

960x1080i/25 36 MHz

The lower the level above that is used, the lower the bitrate needed to produce “artefact free” images, for a given scanning algorithm, but also the lower the potential detail in the picture - which is important for the HDTV experience.

SDTV quality signals (720x576i/25, 13.5 MHz luminance sampling rate) can be “up-converted” to any of the formats by the broadcaster prior to broadcasting. The quality available to the viewer in this case can be better that the quality obtained from up-conversion in the viewer's HDTV receiver, and may be improved in quality compared to normally seen SDTV - but is not “HDTV. This can become even more apparent to the viewer if he has the possibility of ”zapping” between SD-up-converted and native HDTV channels.

To avoid double up-conversion, once in the studio and once in the receiver, if an HDTV format is broadcast, it is best if 576i/25 source material is converted only once to 720p/50, using the best possible converter in the studio.

The 1080p/50 format will provide higher quality headroom for programme production, and will make a major contribution to programme production in the years ahead, when 1080p/50 production equipment becomes readily available. Today, however, no complete IT-based studio infrastructure is available yet for this format, but TV production manufacturers will fill in this temporary gap in the next couple of years.

The 1080p/25 format is an excellent format for programme production where motion portrayal is not critical, as is often the case with drama (movie-look type programmes). This format fits into a 1080i/25 delivery channel as segmented frames (1080psf/25), and can provide very high picture quality for viewers with 1920x1080 displays (given that there is no overscan, but one by one pixel mapping, though which is not very often the case today), and a modest quality advantage for viewers with WideXGA (1366x768) displays.

There may be a case for using any or all of the four formats, 1080p/50, 720p/50, 1080p/25,and 1080i/25 for programme production, and one or combination of the formats 1080p/50, 1080i/25 and 720p/50 for distribution. Broadcasters need to make informed decisions on formats, rather than decisions based solely on the advice of equipment manfacturers, who may be influenced by their own product line availability.

To respond to Members' needs, the EBU has asked production equipment manufacturers to make production equipment which is “agile”, and can support any of the three 74.25 MHz formats. If possible, the equipment should also support the 1080p/50 format (EBU R115). The information available at Spring 2008 is that current new generation mainstream HD production equipment made by most or all manufacturers can support any of the 74.25 MHz formats.

In 2005 the consumer equipment manufacturers association, EICTA, supported and encouraged by the EBU, agreed labels that can be used for HDTV displays and for HDTV receivers. These are the “HD-ready”, and “HDTV 1080” labels. These labels mean that receivers and displays are able to interpret and display the 720p/50 and the 1080i/25 format, as well as SDTV. Displays with the highest market penetration today are compliant with the “HD-Ready” or “HD-Ready-1080p”/” HDTV-1080p” specification of EICTA (see www.eicta.org/ for more details of these and other labels) with market share of large screen “HDTV-1080p” steadily growing.

Several manufacturers are already making available 1920x1080 displays. Until recently, they have attached one of the many proprietary labels that are not clearly defined. However their meaning for the public was limited to indicating that those displays use a native 1920x1080 panel. It is neither an indicator of one-to-one pixel mapping (i.e. no overscan), nor of the signal formats accepted (e.g. 1080p24/25/50/60 for Blu-Ray) at its interfaces. These non-specified labels confused consumers and the industry, and should be avoided. Fortunately, in Autumn 2007 EICTA agreed new and defined labels for 1080p displays (“HD-Ready 1080p”) and for integrated receiver-displays (“HDTV - 1080p”). This is a welcome move, and these labels should supersede the earlier labels.

Whilst the EICTA/Digital Europe HD-ready logo had found widespread acceptance as a guarantee that a TV set would display an HD signal when the broadcasts started, the next step - the HD-ready 1080p logo – appears not to have achieved the same acceptance until second quarter of 2009, which is rather unfortunate. Whilst a manufacturer’s own “Full-HD” logo indicates that the display has indeed got 1080 lines of pixels, it does not go as far as to guarantee that the TV will be compatible with 1080p50 signals from a set-top box or 1080p60 from games machine.

EBU has produced publicly available EBU Tech 3307 “Service requirements for Free-to-Air High definition Receivers” in June 2005. and EBU Tech 3333 “HDTV receiver requirements’ publicly available at www.ebu.ch.

Broadcasters can broadcast either 720p/50 or 1080i/25, or the horizontally downsampled versions of them, as well as SDTV, in the knowledge that all HDTV ready receivers will be able to decode and display them (provided any conditions needed for copy protection and conditional access needed have been met by the viewer). Future-proof option of broadcasting 1080p/50 should also be considered.

It is reasonable for broadcasters to inform their viewers about the quality they have provided in their services. This is a sensitive issue, because many broadcasts today use “sub-sampling” prior to broadcasting, to allow a lower delivery bitrate at the expense of some loss of detail in the picture***. Strictly speaking, services that are not based on a 74.25 MHz luminance sample rate should not technically be labelled as “HDTV”.***

5.C.2 Distribution options

Broadcasters have to decide which delivery media to use for their HDTV services.

5.C.2.1 Broadband

The linear/non-linear medium of broadband (both wired and wireless) is available in some parts of Europe. However it should be noted that high-quality (unimpaired) HDTV-services need high data rates that can currently only be met by VDSL- technology. The more widespread ADSL2+ technology can be used, but with some drawbacks in quality and Quality of Service (QoS), related to error transmission time.

FTTH (Fibre to the Home) networks are being deployed in many countries providing a much higher data rate (100 Mbit/s) into the viewers home, using IP protocol. These services can provide ‘transparent’ quality for HDTV, provided the networks are managed to avoid packet loss for video services.

Broadband networks usually offer a certain bitrate that is not so large compared with digital satellite, terrestrial, and cable capacities. In addition, zapping times and other quality of service parameters can be dependent on the number of broadband streams simultaneously watched by the viewers. Only few European broadband networks today have the capacity to deliver a single channel of HDTV without impairment - that is with the bitrates of 12 Mbit/s or higher needed.

It is possible to deliver HDTV on the Internet by downloading or streaming. Peer-to-peer networks could deliver such services, but work remains to be done to establish the practicality of doing so.

Introducing HDTV in the terrestrial frequency bands is less straightforward, mainly because terrestrial radio frequency spectrum is scarce resource.

5.C.2.3 Satellite delivery

The digital satellite transponder is essentially a container that can carry digital signals of any form, and there is considerable airwave capacity available in DTH bands. Satellites have generally adequate data capacities for HDTV channels, though current satellite bands are filling up.

The DVB-S2 digital multiplex capacity will be typically about 50 Mbit/s. If this is used as a single statistical multiplex of HDTV services with diverse types of content, with mature encoders, the multiplex should be able to accommodate three to five HDTV MPEG-4 AVC channels.

5.C.2.4 Terrestrial delivery

As a rule of the thumb, frequency planning for the digital terrestrial television environment is based on using the same channel widths that are used today for analogue television broadcasting. This means that any digital terrestrial television (DTTV) service, including HDTV terrestrial services, will be based on conventional radio frequency TV channels, with the consequent limitation on the size of digital multiplexes.

The DVB-T digital terrestrial television system (DTTV) is essentially a “container” with a capacity of between 12 Mbit/s and 24 Mbit/s, depending on the error protection level and modulation scheme used, for a 7/8 MHz (Band III) or 8 MHz (Bands IV and V) channel.

Work was accomplished by the DVB Project on a new digital terrestrial TV broadcasting format, DVB-T2. The draft specification of this is freely available on the DVB website. DVB-T2 offers, in its first profile, a 50% gain in channel capacity compared to DVB-T. Though there are many parameters affecting bitrate capacity, a typical maximum channel capacity for DVB-T2 may be 36 Mbit/s. DVB-T2 receivers however will not be available before 2010.

5.C.3 Accommodation of HDTV in the ITU RRC-06 (GE-06 Agreement and Plan)

Introduction

The purpose of this Section is to assess the potential of the GE06 Plan to accommodate HDTV services. In a recent study carried out for the EBU Technical Committee it is considered that in the future all TV programmes will be in HD quality and that a minimum of 20 to 25 HDTV programmes will need to be provided on the terrestrial platform in order to make it attractive for the viewers.

The GE06 digital broadcasting plan allows for implementation of HDTV services, i.e. using DVB-T. However, not all DVB-T plan entries offer the same opportunity for HDTV, primarily because of different Reference Planning Configurations (RPCs) or system variants used to establish the GE06 Plan. Nevertheless, the GE06 Plan permits a significant degree of flexibility in the implementation of transmission networks that may be used in favour of HDTV.

By using advanced transmission systems, such as DVB-T2, it is possible to provide a higher transmission capacity than DVB-T without changes to the GE06 Plan. It is worth noting that the GE06 Agreement allows only DVB-T and T-DAB entries to be recorded in the Plan. However, other digital television systems, such as DVB-H and DVB-T2 can be implemented using the 'envelope concept'.

Data rate capacity required to deliver HDTV

One element of choice for HDTV broadcasting (or for HDTV delivery by other means) will be the data rate used for delivering the compressed HDTV video signal. This is a critical factor that affects both the quality the viewer experiences as well as the transmission costs.

The digital transmission capacity needed to deliver HDTV depends on a number of factors, such as:

- The type of compression used: legacy MPEG-2 or ITU-T H.264/AVC (MPEG-4 Part 10) also referred as MPEG-4.
- The HDTV scanning format used.
- The degree to which picture impairments are acceptable.
- Whether the compression has to be done as the programme unfolds –"on the fly"- or not.
- There may or may not be time for several passes through the encoder for quality optimization scene-by-scene. At least some broadcast material will always demand "real time" encoding because the material is live.
- Whether the HDTV signal is part of a "statistical multiplex".
- The performance of the particular manufacturer's encoding equipment.
- The type and size of the display and viewing distance at home.
- Predominant type of content.

All European broadcasters that have to date announced future plans to broadcast HDTV on the terrestrial platform will use MPEG-4 compression.

The EBU has identified and specified4 four HDTV production formats: 720p/50, 1080p/25, 1080i/25, and 1080p/50. The 1080i/25 and the 720p/50 formats can also be used for broadcasting, or other forms of secondary distribution, whereas 1080p/25 is currently a production format only. The 1080p/50 is defined as "3rd generation" HDTV format, which may be used in future both for production and distribution.

Recent EBU tests of stand-alone MPEG-4 encoders of different vendors have suggested the following minimum fixed bitrates in order achieve an HDTV image quality providing a significantly better quality perception compared to good quality SDTV of 6 Mbit/s MPEG-2 for a wide range, including critical content:

- For the 1080i/25 HDTV format and horizontal sub-sampling to 1440 samples a minimum bitrate of 12 Mbit/s is recommended,
- For the 1080i/25 HDTV format and no horizontal sub-sampling a minimum bitrate of 12 - 14 Mbit/s is recommended,

• For the 720p/50 HDTV format and no horizontal sub-sampling a minimum bitrate of 10 Mbit/s is recommended.

The choice of bitrate for HDTV needs to take into account a number of conflicting factors, and there will be a need for trade-off of advantages and disadvantages.

For various reasons, administrations or broadcasters may decide to launch HD at a level of quality beneath the above recommendations. These reasons may be due to strategic decision, or the requirement to respect a given time schedule. Whilst the quality of such HD services may be less than recommended several broadcasters consider that they are providing or will provide a significantly better offering than SD. Nevertheless, it should not prevent a broadcaster to look for further improvements of the quality as they become available (more spectrum, better compression, statistical multiplexing and so on...).

Whatever bit rate is employed, there will always be less risk of compression artefacts if 720p/50 is used rather than 1080i/25, and thus there will be advantages in using 720p/50 for terrestrial HDTV broadcasting, until the 1080p/50 standard eventually becomes available (EBU Recommendation R 124).

The bit rate used for current HDTV services is constrained by commercially available encoder performance, which is constantly evolving (moving target).

In practice a range of bitrates is currently used for HDTV broadcasting, including, for example, about 13 Mbit/s by the SRG for their 720p/50 service in Switzerland. In Germany, since July 2008, ARTE has transmitted a 720p/50 satellite service with a video data rate of 12 Mbit/s. In Belgium, HDTV services are available in cable and over IP, 720p/50 and 1080i/25, depending on the programme, and with a bit rate of about 9 Mbit/s.

In France TF1, France 2, Canal+, ARTE and M6 are offering terrestrial HDTV services in the 720p/50 and 1080i/25 format. One HD multiplex uses 64 QAM ¾ GI 1/8 over SFN with 3 HD programmes in the statistical multiplex with an average video bit rate of 7.3 Mbit/s per programme.

MPEG-4 advanced video coding transmissions will benefit from statistical multiplexing. In a large statistical multiplex, with mature encoders, future HD services may be able to operate with an average bit rate of about 8-10 Mbit/s. In a standalone service, up to 16 Mbit/s will be needed, depending on the development of encoders in the future. In a small statistical multiplex, the bit rate needed will lie between the said two values.

Finally, when calculating the overall bitrate budget for an HDTV service, additional capacity needs to be added to the video bitrate for 5.1 surround sound (about 0.5 Mbit/s with the DD system and 0.25 with DD+ or HE-AAC) and about 2 Mbits/s for interactive multimedia services (MHP, OpenTV, MHEG).

Features of the GE-06 Plan

The GE-06 Plan covers the frequency band 174 - 230 MHz (Band III - arranged into seven or eight channels with 8 or 7 MHz bandwidth, respectively, depending on the country,) and the frequency band 470 - 862 MHz (Bands IV/V - subdivided into 49 channels, each with 8 MHz bandwidth).

Whilst large number of combinations of DVB-T system variants and the reception modes (fixed, portable and mobile reception) are possible, their use would make the frequency planning extremely complicated. Furthermore, not all of these combinations are used in practice.

In order to simplify the Conference planning process a limited number of Reference Planning Configurations (RPCs) was defined representing, in an approximate way, the most common types of coverage. As a result, for each GE06 Plan entry an associated RPC (mainly as allotments), or a chosen combination of system variant and reception modes, are recorded in the Plan. In the implementation phase, broadcasters or delivery network operators have the freedom to choose a system variant that best fits the real coverage requirements, while taking account of the recorded RPC of the corresponding digital entry in the Plan.

The three following RPCs have been defined for DVB-T:

• RPC1 - for fixed roof-level reception

• RPC2 - for portable outdoor, lower coverage quality portable indoor, or mobile reception

• RPC3 - for higher coverage quality for portable indoor reception

Some examples of typical implementation parameters corresponding to these three RPCs are shown in the table below. Other system variants may be implemented under certain conditions.

Reference planning configuration	RPC1	RPC2					RPC3
Reception mode	Fixed	Portable outdoor		Mobile		Portable indoor	Portable indoor
Modulation	64-QAM	16-QAM	64-QAM	QPSK	16-QAM	16-QAM	16-QAM
Code rate	3/4	2/3	2/3	2/3	½	2/3	2/3
Location probability for planning	95%	95%	95%	99%	99%	70%	95%
Max. net bit rate* (Mbit/s)	27.14	16.09	24.13	8.04	12.06	16.09	16.09

* Source: EBU BPN005 - Terrestrial Digital Television: Planning and Implementation Considerations,

Third issue, Summer 2001

It is not obvious from GE-06 how the Plan entries will be used in practice, since national objectives for DTTV are different across the 120 countries of the GE-06 Plan. The total capacity available in the GE-06 Plan is often expressed in the number of multiplexes ('layers') that could be provided over the whole national territory. One layer represents a set of channels that can be used to provide one full, or partial, nationwide coverage.

For most countries this is equivalent to:

• three T-DAB layers in Band III,
• one DVB-T layer in Band III, and
• seven to eight DVB-T layers in Bands IV/V.

It is up to the national administrations to decide how this capacity will be used. Some of the Plan entries are likely to be used to provide nationwide coverage while the other entries will be used for regional or local coverage.

The number of multiplexes that can be achieved in practice sometimes exceeds the capacity that is theoretically available in the GE-06 Plan. In most cases this will be at the expense of accepting higher levels of interference that may result in reduced coverage or lower quality of service. Moreover, variations in the overall coverage that can be achieved by a given country arise due to the different situations that occur within the area of this Plan; for example geographical size, proximity and number of neighbouring countries, type of reception mode adopted (fixed or portable).

For the purpose of this Report the theoretical capacity available in the GE-06 Plan will be used.

5.C.4 Assumptions on the technology evolution

There are important developments taking place that would provide for a significant increase in the transmission capacity on the terrestrial platform. These relate to improvements in coding (compression) and transmission system as follows:

• **MPEG-4** is an improved video and audio coding compression standard. This is expected to operate at up to double the efficiency of the coding standard MPEG-2 that is currently used for most of the digital terrestrial transmissions. This means that a DTTV multiplex could carry up to twice as many services using MPEG-4 as can currently be achieved using MPEG-2, whilst maintaining similar picture quality.

• **DVB-T2** is a new transmission standard. Early estimates of performance of the baseline specification suggest 30 to 50% bitrate capacity gain for a typical application for the same reception conditions.

It has been estimated that the introduction of these two innovations could, if combined, increase the capacity of a multiplex by up to 160% for fixed reception although some experts consider 100% to be a more realistic estimate. It is also assumed that the capacity gain in the case of portable or mobile reception will be similar to that of fixed reception.

Furthermore, as a trade off, implementation of new DTTV systems such as DVB-T2 may:

• require different approaches concerning network planning and may also have an impact on the frequency planning. In particular, if GE06 Plan entries are to be used for DVB-T2 instead of DVB-T the conditions for such substitution need to be determined and the implications in terms of interference, protection requirements and coverage parameters have to be investigated.

• induce extra cost for the broadcaster - transmitter, aerial if multiple input single output antennas (MISO), and new set up boxes and HDTV receivers availability for the viewers which should be taken into account at the time of the considered introduction of DVB-T2 but dully taking into account other available digital terrestrial television platforms.

5.C.5 Conclusions

An entry to GE-06 Plan is submitted and implemented as one DVB-T multiplex transmitted over a corresponding coverage area. This applies to both assignments and allotments. Allotments are normally converted into a single assignment or a set of assignments that operate as an SFN.

A DVB-T multiplex is essentially a “container” with a given bitrate capacity, which in practice ranges between 8 Mbit/s (QPSK, 2/3) and 27 Mbit/s (64 QAM, 3/4). Whilst the choice of the system variant is in some cases constrained by the RPC recorded in the Plan, there is the possibility for the Plan to be modified to include a different system variant.

In principle, the container (multiplex) can be used to deliver any picture quality, including HDTV providing that the services fit into the available channel capacity and are receivable at an adequate bit error rate.

One HD programme currently requires a fixed bit rate of 10-20 Mbit/s depending on the format and compression method used (e.g. MPEG-2 or MPEG-4). If statistical multiplex is applied an average bit rate of 7-8 Mbit/s per programme can be achieved (e.g. if 3 HD services are multiplexed together in a DVB-T multiplex with around 24 Mbit/s). Careful design of the production chain and high quality MPEG-4 encoders in combination with statistical multiplexing and horizontal sub-sampling will allow that these bitrates provide perceptible improvements over state-of-the-art MPEG-2 based SDTV services on DTTV. Consequently, one GE-06-based DTTV multiplex can theoretically carry one to three HD programmes for fixed reception and maximum of one or two HD programme for the more robust system variants that allow for portable or mobile reception. Some system variants do not have sufficient capacity for HDTV.

In the future, with the expected future improvements of video coding, it is assumed that HD fixed bit rate requirements will be reduced to 8-10 Mbit/s per programme. There will also be advances in the transmission system such as DVB-T2. The GE-06 Agreement allows for implementation of DVB-T2 *under the envelope concept*; i.e. provided that it does not cause more interference nor require higher protection that the original Plan entry. This may restrict the choice of DVB-T2 system variants available for such implementation and will need further investigation.

By combining the expected advances in the transmission systems and using statistical multiplexing it should be possible to aggregate up to 4 or 5 HDTV programmes per multiplex for fixed reception, or 2 to 3 HDTV programmes in a multiplex for portable or mobile reception.

This leads to the conclusion that the maximum capacity currently available in the GE-06 Plan in terms of number of programmes is as follows:

	Fixed Reception		Portable Reception	
	UHF Bands IV/V	**VHF Band III**	**UHF Bands IV/V**	**VHF Band III**
DVB-T	7-24	1-3	7-16	1-2
DVB-T2	21-40	4-5	14-24	2-3

The figures in the table above are based on the following assumptions:

- most countries have 7-8 layers in UHF and 1 layer in VHF in the GE-06 Plan,
- all DVB-T Plan entries will be used to provide HDTV services, and
- the performance MPEG-4 encoders, which are continuously evolving (moving target), are sufficiently advanced by the time of DVB-T2 implementation.

It should be understood that these conditions may not always be applicable in practice. The above-mentioned maximum bitrates for DVB-T can only be achieved with MFNs or SFNs using short guard intervals, otherwise the actual net bitrates are less than the stated above.

It should be noted that many European countries may not be able to launch a full HDTV offering on the terrestrial platform until they and their neighbours have completed analogue switch-off.

Mr. R. Brugger and Ms. A. Gbenga-llori, IRT, Munich, Germany have published the outcome of their study "Spectrum Usage and requirements for future terrestrial broadcasting applications" in the EBU Technical Review, 2009 Q4. There-in, they have assumed the HDTV as future standard for all TV applications and they have assessed the number of TV programmes that could be accommodated in given multiplex when applying both the MPEG-4 source coding techniques and the DVB-T2 channel coding techniques. Based on those assumptions and taking into account latest status-quo of technology development, they have investigated the possibilities available within GE-06 Agreement and Plan as well as the potential of digital terrestrial television to provide a compettive platform for future broadcasting applications.

The concise up to date information in this article [Hyperlink A] may provide a realistic framework for conceptual elaboration of strategy, policy and plans for the transition to DTTV broadcasting and deserves thourough consideration and analysis not only by the TV Broadcasters but also by competent Regulatory and Policy Making Authorities.

5.C.6 Licence Fees for MPEG-4/AVC

A factor affecting decisions on the use of technologies is the licensing costs of using them. Broadcasters expressed concern about these charges, and MPEG-LA also offered the option of a one-time fee of $2500 per professional encoder. In 2008, there are two options for free to air broadcasters:

- one payment of $2,500 per encoder
- Payment of $10,000 each year for any number of encoders per legal entity.

The less expensive option depends on the way the individual broadcaster operates.

5.C.7 Interactivity services and Teletext

Broadcasters may also want to add interactivity to their HD broadcast services.

Teletext already allows for limited local interactivity (with SDTV resolution only), whereas the DVB developed system, the Multimedia Home Platform MHP (and other systems) can provide the full range of interactive content (declarative and procedural). The MHEG API used in the UK currently provides for declarative content.

The MHP 1.1.3 specification has been extended to support HDTV, i.e. the resolutions of 1280x720 and 960x540 as mandatory formats, and 1920x1080 as an optional format in addition to an SD resolution of 720x576.

Both mandatory resolutions of 1280x720 and 960x540 are 'exclusive', which means that applications can only use one of these resolutions at a given time. In most cases, a broadcaster will need to align the resolution of the HD MHP graphics plane with the resolution of the video content. Where several applications share a graphics plane, these need to agree on the same resolution.

If unbound applications provided by a network operator are active at the same time as applications provided by a broadcaster, the parties need to agree on a graphics resolution that is commonly used by their applications.

At the current time however, the EBU Technical Committee has withdrawn its recommendation for MHP because of lack of information on licensing, and is developing requirements for future systems.

5.C.8 Dynamic switching of HD and SD resolutions

The display (or other downstream device) following the receiver, whether connected through analogue or digital (HDMI) interfaces, needs to follow resolution changes without picture break up, frame roll or freezing, and without on-screen display indications, unless a fixed output format is configured at the receiver output. The use of such fixed output format is less advantageous for overall signal quality.

Dynamic switching between SD and HD

The new DVB guidelines for receiver implementation, ETSI TS 101 154, identify four separate categories of receivers in the 50 Hz world:

- Receivers based on MPEG-2 and supporting SDTV,
- Receivers based on MPEG-2 and supporting HDTV,
- Receivers based on MPEG-4 H.264/AVC and supporting SDTV
- Receivers based on MPEG-4 H.264/AVC and supporting HDTV

These categories are not mandatory backwards compatible, and at least in principle, receivers could be made that are capable of decoding MPEG-4/AVC in HDTV, but do not support either SDTV, or MPEG-2 services in either resolution. However, most receivers in free-to-air markets will support both HD and SD resolutions, and often MPEG-4/AVC and MPEG-2 video coding. A requirement to support more than one of these categories should be specified in receiver guidelines.

Where a receiver supports more than one category, the broadcaster might wish to dynamically switch between an HDTV and SDTV event by event in order to optimize the use of a broadcast channel. Receivers should follow such changes without any action by the user, without any onscreen indication, and with a minimum of service interruption comparable to a channel change.

Since such near-seamless dynamic switching is not explicitly specified by DVB, a broadcaster who wishes to do so should make this an explicit requirement, and might also decide to provide test signals on air to check this feature. This approach would help to establish a receiver population supporting all these operational modes, even if such features are not used from the start of any HD broadcast services.

Dynamic switching of HD resolution and HD formats

In the same way as switching between HD and SD resolutions, a broadcaster might wish to dynamically change the horizontal resolution, e.g. between 1920 and 1440 pixels, for a give vertical resolution, or might wish to change between 1080i and 720p formats. Such switching could help to avoid cascaded conversion processes in a broadcast chain.

In the same way as for dynamic switching between SD and HD, it is recommended that prior to regular services using this feature, test signals are provided on air, and inclusion of such features in the related receiver specifications. Further studies are required to cope with the 1080p option.

Dynamic switching of channels and transponders

It may be useful for broadcasters to be able to provide HD versions of programmes on a different channel to SDTV versions, and to trigger set top boxes to switch to HD versions of programmes when they are available. This approach is used by TPS in France, and uses signalling in the DVB-SI, in "private data" to signal the existence of an HDTV version of a programme, and its location (transponder, multiplex, SI). If such a feature was valuable to several broadcasters, a standard could be developed.

Signalling of aspect ratio

MPEG-4/AVC signals include the "pixel" aspect ratio as an optional parameter in the bit-stream, whereas for MPEG-2 signals, the aspect ratio is mandatory information.

At the time of writing this report, not all AVC encoders include this optional information, and there is also a minor inconsistency between the ISO/IEC MPEG-4/AVC specification and the corresponding DVB document.

However it is recommended that all professional broadcast encoders should include this information in the broadcast stream..

5.C.9 Broadcast issues

5.C.9.1 Encoder performance

Encoders for MPEG-4 H.264/AVC have been developed by several established broadcast equipment manufacturers, but also by manufacturers generally known for Internet applications, or from the merging IPTV market.

For head-end implementation, most encoders already provide both DVB-ASI and IP/Ethernet interfaces, as typical interfaces for these areas.

Current quality of H.264 compared to MPEG-2

The quality of MPEG-4 H.264/AVC encoders has improved significantly in recent years. The results of the evaluation are given in separate reports available for each manufacturer, to EBU members only.

Preliminary conclusions on encoder quality

The following initial conclusions can be drawn from this evaluation:

- Coding efficiency has significantly improved. Practical broadcast implementations of MPEG-4 H.264/AVC now show a clear advantage over established MPEG-2 encoders.
- Some implementations of MPEG-4 H.264/AVC encoders now allow a saving of about 40-50% bitrate (depending on content criticality) compared to MPEG-2.
- 1080i/25 is generally more difficult to compress than 720p/50. The advantage of 720p/50 over 1080i/25 varies for different implementations. Current, but ongoing, investigations indicate about 20% bitrate savings for critical content with 720p/50.

5.C.9.2 Delay issues between audio and video "lipsync"

In HDTV systems using sophisticated compression and scaling, the major sound vision synchronisation issue is the extent to which the sound runs ahead of the vision due to the image processing, which causes a delay, which in turn can be much greater that the delay caused by the audio processing.

The human senses are much more sensitive to sound ahead of the picture than to sound behind the picture, because having sound arriving later than the image is quite normal when we converse with people who are far away. Unfortunately, sound running ahead of the image, to which we are particularly sensitive, is the usual form of lack of synchronisation in HDTV broadcasting.

The situation is complex because the delay in the display itself can depend on whether the incoming picture is interlaced or progressively scanned, because of the need to deinterlace the interlaced image in the display.

The threshold of perception of sound running ahead of the picture in critical conditions is very small - about 10ms, and the threshold for sound running after the picture is about 20ms. In normal circumstances however it is considered that for SDTV these requirements can be relaxed to 40ms and 60ms for the end-to-end chain (EBU R37).

To apportion this to different parts of the broadcast chain is somewhat arbitrary, but ideally, the delay should be arranged in the encoder/decoder combination to be less than 5ms, to allow maximum freedom for delay in production and home display.

5.C.9.3 Quality requirements for broadcasting

Bitrates should be chosen such that there are acceptable (just perceptible or imperceptible, for virtually all average programmes) compression artefacts at 3H viewing distance, on scenes which are "critical for advanced compression systems but not unduly so", on a given target display (up to 50"). This means using scenes that have high entropy (scenes full of non identical detail and non uniform movement) but which could still be conceivably part of a normal programme.

For an HDTV service to have a public value, it is necessary to provide and maintain high quality, and the presence of artefacts must not diminish the value of the high definition. The service must be essentially artefact free, in order to provide the added value compared to an SDTV service.

The bitrate needed depends on many factors, explained earlier.

5.C.9.4 Receiver Content Protection

Information on the current Content protection options is given in the Appendix below.

5.C.9.5 General conclusions on HDTV delivery

In principle, the highest quality for the viewer will result if the highest quality is used for programme production, and the most efficient format used for compression for broadcasting, bearing in mind viewer's display capabilities.

The highest quality HDTV today can be provided for normal viewers using display sizes up to about 50 inch, if programme production is in the 1920x1080p/50 format, and broadcasting is in the 1280x720p/50 format.

If 1920x1080p/50 format production is not available (as is the case today), the highest viewer picture quality will be achieved for scenes with motion critical content originating from 1280x720p/50 programme production and by1280x720p/50 delivery. This will deliver the best quality for "events" HDTV television, and the best trade-off between bitrate required and quality delivered to households.

If 1920x1080p/50 format production is not available, and the programme content has very little movement (i.e. with movies), than the highest potential viewer quality will be achieved for viewers with 1920x1080p/25 production and 1920x1080psf/25 delivery. This format will deliver the best quality for "drama".

If 1440 or 1920x1080i/25 programme production is used, conversion to 720p/50 for broadcasting will not significantly improve the picture quality, because the efficiency gains of progressive scanning for compression will not be available, although professional standards converters can improve quality. The viewed picture may be slightly better because of the improved sophistication of the interlace-to-progressive conversion. It is better to use professional, high quality interlaced to-progressive converters at the broadcaster's premises than to place the de-interlacing task on consumer displays or set-top boxes.

5.C.10 Appendix: Digital HDTV broadcast security elements

The current situation suggests that EBU members have **different circumstances and different needs** for HDTV broadcast security. A number of different scenarios will therefore need to exist among EBU members.

- A 'common EBU position' may amount to an acknowledgment that different scenarios exist, which may each suite different members best, depending on their local circumstances
- There are five different scenarios in use by different broadcasters in different countries.

The elements determining broadcast security

There are two main elements of the broadcasting path to consider:

- the signal on the broadcast path **from the transmitter (e.g. via satellite) to the receiver** in the home, which is usually a set top box.
- the signal on the path in the home **from the set top box to the display**.

The signals in each case can be "in-the-clear" or "scrambled". If the signal is "scrambled" the picture will not be viewable unless it is "descrambled".

For the first element of the broadcasting path, e.g. from a satellite to the receiver in the home, "**geolocation**" (limiting coverage to certain geographical areas) may be applied to limit coverage.

Broadcast coverage areas can, in principle, be limited by two means:

- The first may be called '**physical geolocation**'. In this case the coverage beam or a combination of the coverage beam and the error correction system used on the satellite delivery path are arranged to ensure that only viewers in a given area can watch the broadcast. This may or may not be possible depending on factors such as which satellite beams are available. This is done, for example, by the BBC and ITV in the UK to constrain coverage of their digital satellite services to the United Kingdom.
- The second may be called '**electronic geolocation**'. In this case, the broadcast signal is scrambled and is only available to those who have a receiver that accepts smart cards, and have a particular smart card. This is done, for example, for SDTV services by the SRG in Switzerland, who provide the necessary smart card only to those who have paid the annual broadcast license, and are normally resident in Switzerland. There are scrambling methods available, such as the DVB algorithm, but there is no EBU recommended scrambling method specifically for this application.

The reason geolocation is applied to broadcasting is usually because rights have not been obtained for viewers outside a constrained area.

For the second element of the broadcasting path, the path from the set top box to the display, "**content protection**" may be applied to prevent copying and redistribution of the signal.

If simply signalling that the material should not be copied is not enough, the signal on the link can be scrambled (though with a new system which is separate from that used on the broadcast path). The signal will be viewable on the display if it is an "authorized" display (subject to authentication or revocation between STB and Display), because it will contain the descrambler. There is a standardized method of scrambling and descrambling on this link called '**HDCP**' (High Bandwidth Digital Content Protection).

The HDCP scrambling can be set to be 'on' or 'off' by default, which will be the status of the equipped devices when purchased. It is possible in principle to switch either at any time, or per content. This requires, however, that broadcasters insert a flag in their signal to activate or deactivate the appropriate mode, respectful of the original default mode. This flag however requires a particular protected transport that is usually not available for free-to-air FTA broadcasts.

The DVB Project has developed a signalling system that can be used to switch the HDCP scrambling on and off. This DVB signalling is intended for use in general for Content Protection and Copy Management (DVB-CPCM). It contains a flag called "Do Not Scramble" that could be used to control HDCP. This signalling could be implemented and used before consumer electronic product implement the DVB-CPCM solution in integrated form as a whole.

The total broadcast security system is defined by the **combination of methods used on the two parts of the signal path**. There is a link between the two elements to the extent that security may need to be balanced in both parts - both high and both low. However, there may be circumstances when this does not apply.

Scenario 1: Free to Air Scrambled (FTA/S) with HDCP default set to "on" in the set top box or receiver

1.1 The digital HDTV signal over the broadcast path is scrambled. The purpose is not to enable payment systems, it is usually to ensure that only viewers in given geographical areas are able to watch the programmes ("geolocation") when and if viewing rights restrictions call for it.

1.2 The digital HDTV signals can only be received on "authorized" receivers, in the sense that the receivers conform to a specification that includes a descrambling process and the receiver needs a smart card.

1.3 Part of the descrambler is included in a smart card that needs to be inserted into the receiver. Smart cards can be available at no cost to the user at the point of sale of the receiver or in some other convenient way, but only in geographically authorized locations.

They could be made available subject to proof of payment of a TV license.

1.4 There are several elements of additional costs associated with this scenario, compared to a free to air unscrambled scenario. The set top boxes need additional complexity and they will cost more. The smart cards have to be made and provided. Broadcasters have an additional burden associated with the scrambling process.

1.5 The burden of the additional costs to be born by the viewer can be light to the extent than volume production of receivers inevitably reduces the cost of features in a receiver. The cost of the set top box is determined more by the volume made than by the cost of the components in it.

1.6 The burden of the costs to be born by the broadcaster in the arrangements for the smart card is large if born by a single broadcaster, and could have a significant impact. The burden of costs would be reduced if born collectively by a group of broadcasters. A smart card system has been in operation in Japan and the cost of management of the smart card has proved to be higher than anticipated revocation is per device and not per content. This is one of the drawbacks of HDCP "on" by default.

1.7 The scrambling between the set top box and the display is set to "on" unless otherwise instructed. Authorized displays (e.g. those which have the "HD ready"'label) are able to descramble the signal and display it. Older displays which do not have an HDCP-descrambler built in (and thus no HD-ready label) are not able to display the digital signal, but may be able to see a marginally inferior analogue HDTV picture.

1.8 Programmes that need to be scrambled for "geolocation" reasons are likely also to be subject to restrictions on copying and transfer to other media such as Internet. Once the obligation of distributing content within a geographical area has been fulfilled there may however be no reason why content could not remain in the clear after acquisition within the home.

1.9 If broadcasters use HDCP actively this will mean they have the responsibility of distributing the 'black list' of devices which should not be served because they are known to allow piracy in some way - the so-called "revocation list". Furthermore, if a device is on the revocation list because of its insertion by a Pay TV operator, the same revocation will apply to free to air services, whatever the public service mission of the operator of the free to air services.

Scenario 2: Free to Air Unscrambled (FTA) with HDCP default set to "off"

2.1 The digital HDTV signal over the broadcast path is in the clear. Other means of physical geolocation may be used.

2.2 The digital HDTV signals can be received on any receiver, and no smart card is needed.

2.3 Old HDTV and new HD-ready displays are able to view the digital HDTV signal.

2.4 Given that a signalling system is standardized in the DVB family of standards, and that receivers recognize it, it will be possible for the broadcaster to switch the HDCP scrambling off remotely. This could be important if there are set top boxes on the market which have HDCP enabled by default and if manufacturers are obliged to implement HDCP devices with this switching function.

2.5 This configuration prevents revocation from impeding reception.

Scenario 3: Free to Air Unscrambled (FTA) with HDCP default set to "on"

3.1 The digital HDTV signal over the broadcast path is in the clear. Other means of physical geolocation may be used.

3.2 The digital HDTV signals can be received on any receiver, and no smart card is needed.

3.3 The scrambling between the set top box and the display is set to "on" unless otherwise instructed. Authorized displays, those that have the "HD ready" label and thus have an HDCP descrambler, are able to descramble the signal and show it to the viewer. Other devices that are not authorized cannot. This acts as a deterrent to the redistribution of the programme. Older displays which do not have the HD-ready label are not able to display the digital HDTV signals, but may be able to see a marginally inferior analogue HDTV signal, although the trend is to abandon such analogue interfaces on the mid to long term.

3.4 If all devices are HDCP compatible, free-to-air programmes would flow transparently to the display. If the device is shared with other service providers such as Pay TV broadcasters with stronger security constraints, and if Pay TV broadcasters were required by content providers to revoke certain devices, the screen would go also black for FTA content as HDCP scrambling 'on' if this is required for some content by the owners.

Scenario 4: PayTV Scrambled with HDCP default set to "on"

This is the most likely scenario for Pay TV services.

As mentioned above, the use of revocation per device may have repercussions for the reception of FTA content.

Scenario 5: PayTV Scrambled with HDCP default set to "off"

This is the second scenario for Pay TV services. The digital HDTV signal over the broadcast path is scrambled but the default setting of HDCP scrambling between the set top box and the display is set to "off".

Pay TV services use their proprietary scrambling systems on the broadcast path to switch HDCP scrambling "on" if this is required for some content by the owners.

Current situation in Europe

Available information obtained suggests that:

France Television believes that Scenario 1 is necessary for the French environment, including public service broadcasting. The dominant factor is the critical need for content that is only available if there is guaranteed geolocation and copy control.

ARD, ZDF, and SRG believe that Scenario 2 is necessary for their environments in Switzerland and Germany. The dominant factor is the national policy for public service broadcasting to be in clear.

The BBC and ITV believe that Scenario 3 is necessary for the UK environment. The dominant factor is a combination of the national policy for public service broadcasting to be in clear, coupled with the wish to take some steps to deter redistribution of content. Though not "watertight" measures, they would act as a deterrent to unauthorized redistribution.

Scenario 5 is used by Premiere for Pay TV services, and 4 is used by Sky Italia and Sky UK for Pay TV services, and by Canal plus/TPS for Pay TV services. The reason for the different approaches has not been established.

Annex 6

European Commission Launches Public Consultation on Digital Dividend

On July 10, 2009 the European Commission published for public consultation until September 4, 2009 a document on *"transforming the digital opportunity into social benefits and economic growth in Europe"*.

The consultation is aimed at collecting views from all interested stakeholders on the use of the digital dividend radio spectrum released from the transition from analogue to digital terrestrial television (DTT).

The Commission intends to adopt a communication on the digital dividend, including an official proposal for an EU policy roadmap, to be submitted to the European Parliament and Council in autumn 2009.

The Commission also identifies two urgent measures to facilitate the process of making the UHF 790-862 MHz band ('800 MHz band') available on a technology and service neutral basis as quickly as possible within a harmonised technical framework.

A. Background

The policy debate on the use of the digital dividend dates back to 2005 when a commission communication set January 1, 2012 as the recommended deadline for the EU-wide transition to DTT (see EU Media Tracker 11).

In its 2007 communication on *"reaping the full benefits of the digital dividend in Europe: a common approach to the use of the spectrum released by the digital switchover"* the Commission proposed an approach based on different 'clusters' in the UHF band (470-872 MHz) which would be subject to different degrees of spectrum management coordination at the EU level. These clusters would be the sub-bands for: digital terrestrial broadcasting; mobile multimedia (including mobile TV); and fixed wireless/mobile broadband (see EU Media Tracker 12).

A number of follow-up initiatives were then promoted by the Commission to further analyse the economic, technical and policy implications of the proposed approach, including:

- launch of a comprehensive study assessing the economic and social impact of the different uses of the digital dividend and the potential benefits resulting from EU coordination;
- technical studies under the auspices of the European Conference of Postal and Telecommunications Administrations (CEPT) to identify technical solutions to interference challenges; and
- extensive consultations with main stakeholders.

Consensus on the approach and a call for swift action on the digital dividend also came from the Radio Spectrum Working Group (RSWG) and the European Regulators Group (ERG) in May 2009 (see EU Media Flash 31/2009).

NB. For an overview on the analogue switch-off dates and the use of the digital dividend in the EU Member States, see Table 18 in the WE Telecom Cross-Country Analysis and Table 15 in the CEE Telecom Cross-Country Analysis, and Table 2 in the WE Media Cross-Country Analysis.

B. EU roadmap for mid- and long-term action

Considering the broad consensus on the need for a harmonised approach to the digital dividend, the Commission suggests the envisaged coordination could be achieved by agreeing on a shared EU roadmap which would define the process and milestones for implementing a set of strategic actions at the EU level.

In practical terms, the roadmap could be incorporated into the wider multi-annual spectrum action programme to be adopted by the European Parliament and Council in early 2010, as foreseen in the reformed regulatory framework for electronic communications (see EU Telecoms Tracker 1).

A summary of the main actions under consideration is presented in the table below.

Objective	Proposed measures
1. Improve consumers' experience by ensuring high quality standards for DTT receivers across Europe	• Ensure availability of compression standards of defined minimum efficiency (at least as the MPEG-4) on all DTT receivers sold after Jan. 1, 2012. • Set standards for the ability of DTT receivers to resist interference.
2. Increase the size of the digital dividend by spectrum efficiency gains	• Foster collaboration between Member States to share future broadcasting network deployment plans (e.g. migration to MPEG-4 or DVB-T2) in order to increase efficiency. • Encourage the deployment of Single Frequency Networks (SFN). NB In short, DTT networks can be implemented by using Multi Frequency Network (MFN) technology, SFN or a mix of these two technologies. On SFN all transmitters of the network use of the same frequency channel to provide a common coverage for same content. On MFN each transmitter uses different frequency channel and has its own coverage area to carry either same or different content. • Support research on *"frequency agile mobile communications systems"*. (The consultation document does not specify in clear terms what this would mean in practice).
3. Make the 800 MHz band swiftly available under harmonised technical conditions	• Accelerate the switchover process in all Member States. • Make concrete steps towards EU-level technical harmonisation. NB For more details see C.2. below.
4. Adopt a common position on the use of *"white spaces"*	Invite Member States to cooperate with the Commission to assess the possibility to open up the *"white spaces"* (i.e. the unused spectrum between broadcasting coverage areas) in their respective countries.

5. Ensure continuity and development of wireless microphone applications	Develop a migration path for current secondary users of UHF spectrum, with possible mandate to be given to CEPT. NB The issue of wireless microphones has recently arisen e.g. in Germany where users were protesting against the proposals to make the 790-862 MHz band available for wireless broadband services (see Big Five Update June 2009).
6. Facilitate cross-border coordination with non-EU countries	Assist Member States in their negotiations with non-EU neighbouring countries.
7. Address future challenges	Establish mechanism to monitor external developments affecting the roadmap.

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