国　　际　　电　　信　　联　　盟

第20-2/2号课题

最后报告

ITU-D　　第2研究组　　第4研究期(2006-2010)

第20-2/2号课题:

对宽带通信接入技术的研究

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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词汇

3G	第3代移动通信
3GPP	第3代合作伙伴计划
3GPP2	第3代合作伙伴计划2
ADSL	不对称数字用户线
ANT	接入网传送场景
AP	接入点
APONs	异步无源光网络
ATM	异步传输模式
ATSC	高级电视制式委员会
BS	基站
BWA	宽带无线接入
CATV	共用天线电视
CCK	补码键控
CDMA	码分多址
CMTS	电缆调制解调器终端系统
CO	中心局
COFDM	编码正交频分复用
CPE	用户终端设备
CWDM	粗波分复用
DBS	卫星直播
DFS	动态频率选择
DMB-T	数字多媒体广播 — 地面
DRB	数字无线电广播
DSL	数字用户线
DSL ISDN	基于ISDN的数字用户线
DSP	数字信号处理
DSSS	直接序列扩谱
DVB	数字电视广播
DVB-H	数字电视广播 — 手持
DVB-T	数字电视广播 — 地面

DWDM	密集波分复用
DXC	数字交叉连接
EPON	以太网无源光网络
ETS	欧洲电信标准
ETSI	欧洲电信标准协会
FDD	频分双工
FHSS	跳频扩谱
FTTC	光纤到路边
FTTH	光纤到家
FTTP	光纤到户
FWA	固定无线接入
GoS	业务等级
GSO	对地静止轨道卫星
HDSL	高比特率数字用户线
HEO	高倾角椭圆轨道卫星
HFC	光纤同轴混合网
IEEE	电气和电子工程师协会
IETF	互联网工程任务组
IDU	室内单元
IMT-2000	国际移动通信
IMT-DS	国际移动通信直接扩谱
IMT-FT	国际移动通信频分时分多址
IMT-MC	国际移动通信多载波
IMT-SC	国际移动通信单载波
IMT-TD	国际移动通信时分
IMS	IP多媒体分系统
IP	互联网协议
ISDB-T	综合业务数字广播地面
ISDN	综合业务数字网
ITV	互动电视广播
LAN	局域网
LEO'S	低地球轨道卫星
MAC	媒体接入控制

MEOs	中地球轨道卫星
MEPG	移动图像专家组
MHP	多媒体家庭平台
NAC	网络接入控制
NTN	网络终接结点
NGSOs	非静止轨道卫星
NLOS	非视距
NRN	网络中继结点
ODU	室外单元
OFDM	正交频分复用
OFDMA	正交频分多址模式
OSI	开放系统互连
OSP	外部设备
P2MP	点对多点
P2P	点对点
PC	个人计算机
PDH	准同步数字系列
PDSN	分组数据业务结点
PHY	物理层
PONs	无源光网络
POTS	普通老式电话业务
PSTN	公共交换电话网
QAM	正交幅度调制
QoS	业务质量
QPSK	四相相移键控
ROW	通行权
RF	射频
RLAN	无线局域网
SDAF	依赖于卫星的适配功能
SHDSL	单对线高比特率数字用户线
SI-SAP	独立于卫星的业务接入点
SMEs	中小规模企业
SSMF	标准单模光纤

STs	卫星终端
STLs	演播室至发射台的链路
STM	同步传送模式
TCPAM	网格编码脉冲幅度调制
TDD	时分双工
TD-SCDMA	时分同步码分多址
TIA	电信工业联合会（美国）
TMN	电信管理网
UHF	超高频
USB	通用串行总线
UWB	超宽带
VL	甚高速率数字用户线
VHF	甚高频
VoIP	IP语音
VSAT	甚小孔径地球站
WAN	广域网
WCDMA	宽带码分多址
WCS	无线通信业务
WDM	波分复用
WEP	有效等效保密协议
Wi-Fi	无线相容认证
WiMAX	微波接入全球互通
WLAN	无线局域网
WLL	无线本地环路
WMAN	无线城域网
WPAN	无线个人接入网
ZWPF	零水峰光纤

内容提要

加强电信系统（能力）的最新趋势之一是宽带技术。许多人把宽带与特定的传输速率或某些业务和/或应用套餐，如数字用户环路(DSL)或无线局域网（WLAN）联系在一起。然而，由于宽带技术一直在变化之中，宽带的定义也在不断地演变。国际电信联盟（ITU）把宽带定义为比特率等于或高于256 kbps[1]。在发展中国家中移动通信的渗透率每增加1个百分点是与个人平均收入增加4.7个百分点相关联的。同样，在发展中国家中，互联网的渗透率增加1个百分点是与个人平均收入增加10.5个百分点相关联的[2]。当有许多宽带可选方案可以使用时，在发展中国家的这一内在联系内进行宽带研究是一个很有价值的课题。

宽带技术考虑了在网络上传输话音、电视和数据。引入宽带技术，包括但不限于数字用户线（DSL）、共用天线、光纤、卫星和固定和移动无线技术，已经有可能使传统的和新的电信形式在全世界成为现实。由于各个国家的物理基础设施和地形的差别非常大，在一种地理区域内工作得很好的技术可能在另一种地理区域内不能很好地工作。所以，确定最满足它的需求的技术是由每一个独立的地区的责任 — 不管这一地区是一个村庄也好、一个城市也好、一个省或一个国家也好都是这样。

本报告书目的在于给来自全世界发展中国家的决策者和工业部门的参加者提供有关影响宽带接入技术和应用的实际部署的技术因素、经济因素和发展因素的信息。该报告分为三部分：

a) 该报告的正文包括能够用来给端用户提供宽带接入的各种可用技术的简要梗概。

b) 各个附件包含有关宽带的一般问题的信息，主要集中于宽带的经济效益和社会效益，促进宽带接入技术和应用的部署和使用的策略，以及调查表(CA25/Doc,004)的分析，主要分析影响宽带部署的经济、技术和发展的因素。2006年已将一系列调查表分发给成员国。BDT对在ITU-D网站能够找到的回应进行了分析。在这些附件中还有几个国家的实践经验，它们描述了影响宽带技术部署和受部署宽带技术影响两个方面的技术、经济和社会的因素。对于本报告的实际应用而言，这些国家的经验是极其有用的，因为这些经验提供了许许多多的实际情况的例子，即许多国家和组织为了把宽带业务延伸到它们的各组成部分中去已经不得不实施各种有想象力的和创新精神的策略的实例。在研究本报告中所包含的各国经验的基础上，通过向面临提出宽带部署和接入的类似挑战的其它地区学习的方法，发展中国家将能够节省时间、经费和资源。

本报告中提到的国家和技术已经作了选择，因为在课题20-2/2的文稿中对它们作了详尽的说明或者在ITU有关宽带和其它公共媒体市场的报告中已经对它们作了重点介绍。为了进一步更新本报告，请其它国家和关注的各部门成员提供文稿。

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[1] 国际电联世界电信统计指标（2007年4月）

[2] 电信管理组2007

第20-2/2号课题

第1部分 — 技术矩阵

术语矩阵是一个通用术语，可以用不同的方式使用它。在这里，该术语包含一特定技术的简要描述的意思，介绍应用及开发的技术发展水平和有关的参考文献。

宽带通信技术可以粗略地分成有线技术和无线技术。有线技术包含传统的电话线、公用天线的线路和光纤线路。无线通信包括蜂窝技术和固定无线技术、像RLAN（无线局域网）和自由空间光那样的高速短距离技术和卫星传输技术。卫星网包括对地静止轨道卫星（GSOs）和非对地静止轨道卫星（N-GSOs）。后者包括低地球轨道卫星（LEOs）、中地球轨道卫星（MEOs）和高轨道卫星（HOSs）。高轨道卫星用于超出GSO轨道范围的特殊用途，它被看作高倾角椭圆轨道卫星（HEOs）。宽带使用有线技术或无线技术或其组合，给用户提供高速接入。

I.1 有线宽带接入技术

在广域网接入领域中，存在许多可供选择的有线技术，它们现在正在为取得市场份额和认可进行竞争。这些技术的可选方案源于广域网（WAN）和局域网（LAN）两种环境，而且包含许多技术，例如ISDN、ATM、交换以太网帧中继、用于在公用天线（CATV）电缆进行数据传输的几种技术和数字用户线技术家族。

I.1.1 DSL技术矩阵

新业务需要具有越来越高比特率的数字信号，引进新业务要求或者是采用先进技术来扩展现有用户环路的可用带宽，或者是用宽带传输媒体，例如用光纤/同轴电缆或无线传输来替代双绞线。

历史上，有线用户环路包含装在多芯市话电缆中的多对双绞线。多年来，一直在进行用户环路的研究，并且它用电缆类型、电缆长度、环路结构和噪声源来作出规定。利用DSL技术，可以将通常用于传输最高达4 kHz的话音信号的用户环路的频谱扩展到1100 kHz左右，供传输数字信号使用。替代现有的用户环路和同时开发数字信号处理技术要涉及大量费用，这影响了实现更好地利用可用带宽，从而传输更高比特率的数字用户环路（DSL）技术的发展。DSL技术使得数字信号能够与话音信号（POTS）共享用户环路。

典型的DSL系统如下：

— 高比特率数字用户线（HDSL）；

— 不对称数字用户线（ADSL）；

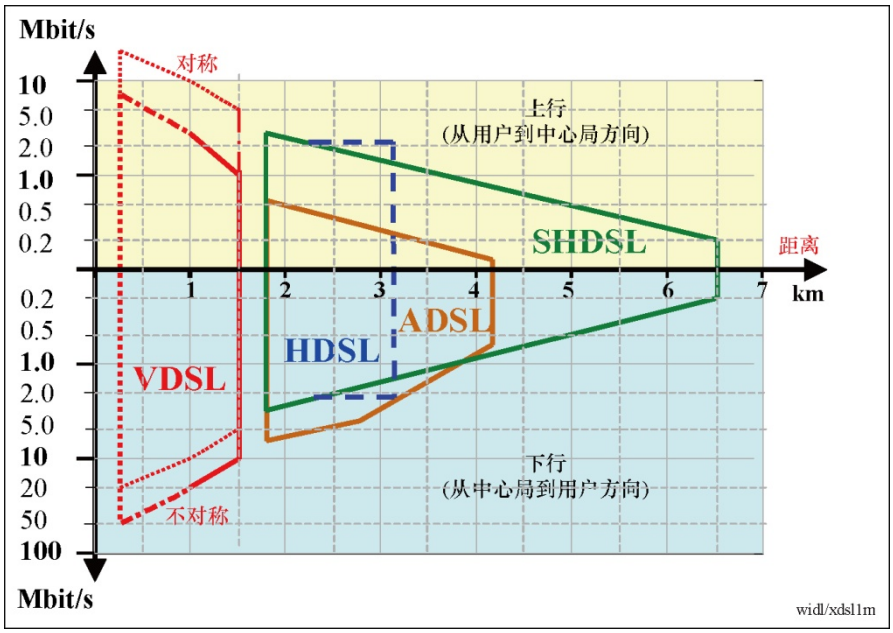
— 甚高速数字用户线（VDSL）；

— 单线对高速数字用户线（SHDSL）；

— 基于ISDN的数字用户线（DSL ISDN）。

图1表示了使用1对线（不使用任何中继器，即再生器）的系统的典型数据速率和相关的应用距离。

图 1 — 与各种 DSL 系统有关的距离



在该表中所显示的数值与许多参数有关，例如诸如线规、桥接抽头，干扰（包括线对之间的串话）、备余量等等。此外，由于不断地开发新技术，这些数值可能会改变。

HDSL已经是应用最广泛的DSL技术，它使用2对或3对铜双绞线。大多数实施方案提供1.5 Mbit/s(T1)或2 Mbit/s(E1)对称用户线，离中心局的最大距离3000 m。有再生器的情况下，这一距离可以延长。

近期，ADSL对居民、小办公室、家庭办公室市场提供宽带接入负有最大的责任。给从业务提供商到用户方向（下行）的通信流量分配了比从用户到业务提供商方向（上行）的通信流量更宽的带宽。这一带宽分配方案使得有可能同时实现普通的老式电话业务（POTS）或ISDN业务。有两种ADSL形式：使用1 MHz左右带宽的全速率型ADSL和使用1/2 MHz带宽的简化经济型ADSL（ADSL Lite）。全速率ADSL需要安装分离滤波器，而ADSL Lite工作时不需要分离滤波器或者只需要安装简化的直接插入的滤波器。

VDSL是设计用于更高的比特率和极短的用户环路距离。VDSL常常与光纤安装结合起来的，例如与光纤到路边结合起来的。借助于分离滤波器，有可能同时实现POT业务。

预料将来SHDSL会替代HDSL，因为SHDSL系统通常将在一对线上工作。可以使用2对线或/和再生器的方法来延长它的工作距离。使用先进的编码技术限制了带宽的要求，导致与其它DSL系统共存。

DSL技术家族提供各种各样的方案来实现和满足对现在的和将来的基础设施的不同的市场需求。在DSL这一方面，无论是一对线也好或是两对线也好，对称也好或不对称也好，速率自适应也好或是多信道应用也好，DSL技术是应对市场挑战的工具。市场需求和DSL技术两方面都仍然在演变之中。

除了速度以外，DSL系统提供了另一个主要益处：不间断的连接。因为DSL调制解调器使用无连接技术，与办分室的LAN 非常类似，用户的PC机总是与网络联机的。

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I.1.2 基本电缆矩阵

在某些国家中，有线电视的宽频带公用天线几乎普遍覆盖，公用天线连接为给居民和小型商业提供高速数据连接提供了一个强有力的平台。然而，必须把单向的电缆电视系统升级到现代的双向网络，以支持高级电信业务。

学习来自ITU-T第9研究组的“电缆电视入门”可以用作对电缆电视网的一个有用的引言。在ITU-D第2研究组第4分册的下列各节中可以找到有关电缆电视网的进一步的信息：

5.3.9 电缆电视分配

5.3.9.1 电缆电视系统的重要部件

5.3.9.2 光纤电缆混合的电缆系统

5.3.9.3 互动的双向电视业务

5.3.9.4 使用电缆系统的高速数据

电缆电视入门

最初，将电缆电视系统设计或用来将广播电视信号有效地传送到用户家中。为了保证消费者能够用他们用来接收无线广播电视信号的同一个电视机来得到电缆电视业务，电缆经营商在一个密封的公用天线的线路内重新产生一部分无线广播的射频（RF）频谱，并将其分配到各用户的家中。

传统的公用天线系统一般以330 MHz或450 MHz的容量进行工作，而现代的混合光纤/电缆（HFC）系统扩大到750 MHz或更多。

逻辑上来看，下行电视节目信号在50 MHz左右开始，等效于无线广播电视信号的第2频道。一般，将该频谱的5 MHz-42 MHz部分保留给来自用户家里的上行通信用。

例如，许多国家使用国家传输标准委员会（NTSC, 美国）的传输标准，标准电视频道占用6 MHz射频频谱。所以，传统的下行带宽为400 MHz的电缆系统能够承载60个模拟电视频道的等效容量，而现代的下行带宽为700 MHz的HFC系统的容量大约有110个频道。

电缆调制解调器接入网

为了在电缆网上传送数据业务，通常（在50-750 MHz频率范围内）分配一个电视频道给往家里的下行业务用，而用（5-42 MHz频带中）另一个频道载送上行信号。

头端的电缆调制解调器终端系统（*CMTS*）通过这些频道与位于用户家中的电缆调制解调器进行通信，以建立虚拟的局域网（LAN）连接。大多数电缆调制解调器是外部器件，它们通过外部的标准10Base-T以太网盒或内部的PCI或PCMCIA卡或通用串行总线（USB）连接与个人计算机（PC）相连接。

电缆调制解调器接入网在开放系统互连（OSI）参考模型的第1层（物理层）和第2层（媒体接入控制/逻辑链路控制层）上工作。所以，在电缆调制解调器平台上，能够将IP业务这样的第3层（网络）协议无缝地传递给端用户。

采用64 QAM(正交幅度调制)传输技术的条件下，单个下行6 MHz电视频道可以支持从电缆头端来的高达27 Mbit/s的下行数据吞吐量。使用256 QAM时，能够将速度提高到36 Mbit/s。使用16 QAM或QPSK（四相相移键控）调制技术，上行频道可以传送家里来的500 kbit/s到10 Mbit/s的上行数据吞吐量，具体的速率取决于为业务所分配的频谱量。当连接到一给定的网络段上的数据用户都共享这一上行和下行带宽时，一般在现代的HFC网络上连接500到2000个家庭。

除了速度外，电缆调制解调器提供了另一个关键的益处：不间断的连接。因为电缆调制解调器使用了无连接技术，与办公室的LAN很相似，用户的PC机总是与网络联机的。

电缆互联网传送

电缆运营商要进入高速互联网行业，必须做比简单地安装电缆调制解调器设备更多的工作。更确切地说，他们必须在它们服务的每一个社区建设一个先进的端到端的IP连网的基础设施，该设施要能够足以可靠地支持数万个数据用户。那要包含许多像互联网骨干连通那样的物品，路由器、服务器、网络管理工具以及安全和计费系统。实际上，电缆运营商面临建设一些世界上最大的“内部网”、严酷的工程和运行挑战的任务。

电缆运营商把注意力集中于提供高速内部网接入而不是互联网接入是由于一个简单的理由：网络连接速度只有像它的最慢的链路那样快。显然，若一个通过56 kbit/s线路连接到互联网的用户试图访问储存在一个网站服务器上的内容，则就失去了1 Mbit/s的电缆链路的优点。解决这一左右为难问题的方案是把内容推移到更靠近用户的地方，理想的方案是一直下到电缆头端。这是通过在本地服务器上记录或存储流行的互联网内容的复制品的方法来实现的，所以，当电缆调制解调器用户访问一个网站的网页时，他或她将被以最高速度路由到头端中的服务区，而不是被要求出行到拥挤的互联网上。

许多公司正在给电缆运营商进入高速互联网的需求提供综合的连网和系统集成业务。

共享网络平台的性能

与办公室的LAN非常相似，大多数电缆调制解调器系统依赖于共享接入平台。与电路交换电话网不一样，电路交换电话网中给呼叫者分配 — 专用的连接，而电缆调制解调器的用户在他们的在线会话期间不占用固定大小的带宽。而是他们与其它正在使用的用户共享该网络，并且只有当他们实际以快速的突发方式发送或接收数据时才使用网络的资源。所以，并不是200个电缆在线用户中的每一个都分配135 kbit/s，在需要下载他们的数据包的毫秒时间内，他们能够抢占全部可用带宽，速率可达每秒许多兆比特。

若由于使用者很多而确实出现了拥堵现象，电缆运营商有给数据业务增加更多带宽的灵活性。电缆运营商能够为高速数据分配一个附加的6 MHz电视频道，使得给用户的可用下行带宽增加一倍。增加带宽的另一可选方案是通过光纤线路更深入地铺设到许多邻居的方法将物理上的电缆网络作细分。这就减少了每一网络段所服务的家庭数目，因而给端用户的可用带宽量增加了。

I.1.3 光纤到户（FTTP）矩阵

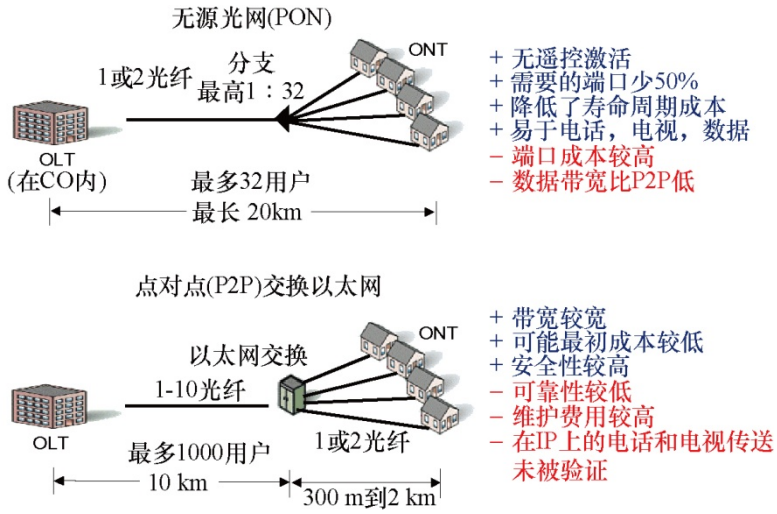
由于设备的费用和外部设备（OSP）部署费用都大大降低，FTTP正成为值得选用的接入网结构。几个美国最大的负责的电信公司早已宣布，计划将它们的Greenfield的部署变换到FTTP。同样，在由于性能劣化必须替换掉铜线设施的地方，铜线网改建的经济情况使得这些“褐式土地”（即有重新开发潜力的地区）的部署对利用FTTP有更大的吸引力。最后，由于将基于铜线的网络延伸到乡村消费者的范围所造成的巨大费用确定了它的距离极限，所以，对寻求给消费者提供话音、电视和数据业务“三重服务”的乡村业务提供商而言，FTTP快速成为所选择的接入网结构。

最初可以把FTTP接入网设备技术分为无源或有源解决方案。前者一般称为无源光网或PONs。有源解决方案有在现场部署的电子部件，并且一般能够有较高的带宽，而无源解决方案没有在现场部署的电子部件，并且节省了部署和运行的成本。

这些解决方案还可以进一步分为点对点（P2P）或点对多点（P2MP）两种方案。点对点方案在电信公司的中心局（CO）和/或头端及客户地点之间有一条直接的一对一的链路。而点对多点方案中，将来自电信公司中心局的信号被分开，并分别发送到多个客户的地点。一般，P2P解决方案有较高的带宽，而P2MP解决方案的部署和运行费用比较低。

最后，在有源和无源以及P2P和P2MP两个方面，都存在许多可用的网络协议可选方案，这些可选方案进一步区分产品供应。例如，在PON解决方案的空间以内，存在APON（和它的BPON变形）和EPON两种解决方案。APON解决方案基于传统的话音电话异步传送模式（ATM）协议，而EPON解决方案是基于广泛应用的基于IP的以太网协议。BPON/APON基于ITU-T G.983.3建议书，而且该建议书现在的版本在1490 nm上提供622 Mbit/s下行和在1310 nm上提供155 Mbit/s上行，这是通过1：32分支比（一个信号分给32个客户）实现的，并且在1550 nm上提供模拟电缆电视，BPON和APON由光纤解决方案的供货商，如阿尔卡特、日立和其它公司所提供。（由相同的供货商提供的）GPON标准的技术是基于ITU-T G.984.2标准，它也基于传统的ATM协议，但是有更高的传输速率，它在1490 nm上提供2422或1244 Mbit/s下行，在1310 nm上提供155、622、1244或2422 Mbit/s上行，它是通过1：64分支比实现的，而在1550 nm上提供模拟电缆电视。EPON解决方案基于IEEE802.3ah标准，这一标准是在2004年在第1英里任务组中的IEEE P802.3ah以太网项目所完成的，它利用IP供话音和数据两种业务使用。它在1490 nm上提供1000 Mbit/s下行，在1310 nm上提供1000 Mbit/s上行，使用1：32分支比，而在1550 nm上提供模拟电缆电视（供货商包括Alloptic、Calix、Flexlight和其它公司）。图2提供了FTTP体系结构上的可选方案的图形上的综述。

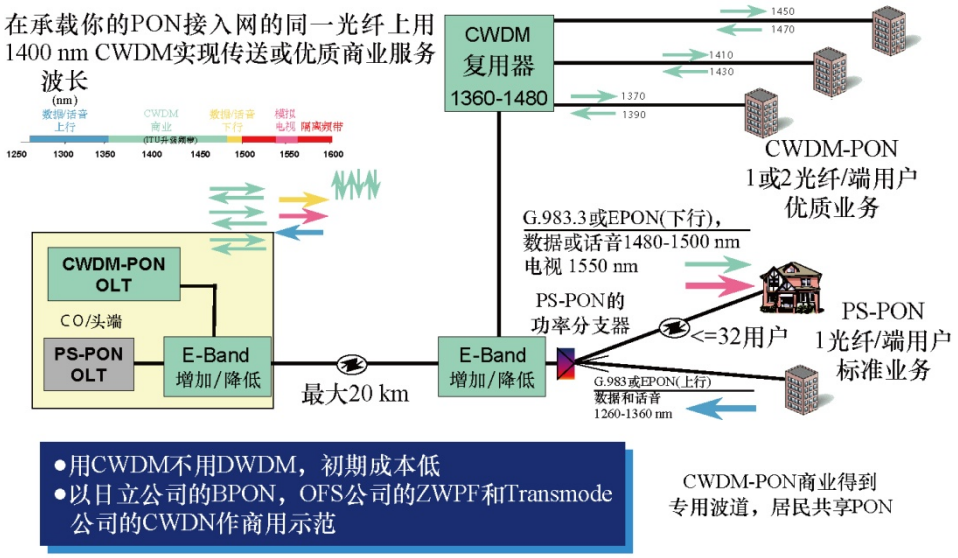
图 2 — FTTP 结构：PON 和 P2P



除了选择有源和有源光网以及APON、BPON、GPON、EPON以外，在外部线路设备解决方案方面有许多技术上的进展，这些进展可能大大影响与FTTP接入网部署相关的成本和效益。

适当地选择光纤可以大大降低部署网络的成本，方法是使电信公司有可能使FTTP接入网部件连同它的企业和边缘传送网部件都适应单一的光纤单元。今天的先进技术，零水峰光纤（ZWPF）正在替换过去的标准单模光纤（SSMF），它使得能够在完全相同的光纤上部署16光波道的粗波分复用（CWDM）边缘网，承载1：32或1：64分支的FTTP网络。与密分波分复用（DWDM）波道相比，CWDM波道的费用要降低60%，所以，这样的接入/边缘网部署不仅使电信公司能够在一个基础设施上部署两种网络，而且通过使用成本低得多的CWDM波道的方法提供了成本效益极高的大都市网络结构。图3显示了在PON结构上的这样一个CWDM和在同一个载送PON接入网的基础设施上提供网络传送业务或优质商业波长业务的益处。

图 3 — 零水峰光纤在 PON 的一网二用网络上实现粗波分复用（CWDM）



正象选择正确（ZWPF）的光纤能够提供一个网络的价格得到两个网络的效益一样，选择低损耗光纤和部件使电信公司有可能实现商用设备的额定距离加倍。这一范围的扩大意味着电信公司在一给定的外部线路设备投资下将能够为多达二倍的客户服务，这将保证电信公司能够接通它们的所有客户，而且这也将使电信公司能够通过提供更有效的分配/锁电光纤比的方法实现节省高达30 %的系统成本。

在某些情况下，在业务提供商和用户之间有许多对铜线可以应用。可以将这些线对组合在一起，即按照ITU-T G系列建议书的描述，把它们捆绑在一起，从而导致大大提供单个数据流的容量。两对线提供两倍的容量，三对线提供三倍的容量，最多可以捆绑32对铜线。在这些线对上的净荷是基于ATM的、基于以太网的或者包含使用时分反向复用的信号。

I.1.4 密集波分复用矩阵

在70年代早期，发明了在1300 nm附近的有低损耗窗口的低损耗光纤，这就使得在使用光致发射二极管和多模光纤的条件下，不经过再生，光信号就能够传输数十公里的距离。在1980年代，引入了单模光纤，单模光纤与多纵模（MLM）的激光器发射机连接在一起，能够传输约100 Mbit/s的数字信号。有了色散位移光纤和单纵模分配的反馈激光器（SLMFB）系统以后，中继器距离达100 km，传输速度达2.5 Gbit/s是切实可行的。在90年代，包含掺铒光纤放大器的再生器使得有可能在多个相邻的波长上同时进行传输，这样就产生了密集波分复用系统（DWDM）。技术上的进展使得有可能在同一光纤上传输两个波长，一个波在1310 nm窗口中，而另一个波在1550 nm窗口中，这样就产生了第一个波分复用（WDM）系统。然而，光频分复用系统继承了铜线频分复用系统有关的某些问题，例如每一再生段的长度的限制和大量连续的再生段。典型的DWDM传输系统最多提供32个波长，相邻波长之间的间隔为0.8 nm，相当于频率间隔100 GHz，每一波长承载2.5 Gbit/s，在约600 km距离内有6个再生段，从而总的传输能力达到80 Gbit/s。

与单波光纤传输相比较，DWDM有下列重要的优点：

- 色散效应比较小。对一给定的吞吐量而言，可以降低各个光波道的速率，因而降低了色度和极化的发散效应。结果，可以延长再生器之间的距离（尽管为了保持功率预算仍然需要光放大）和在安装在不理想安装线路设备上能够提高容量。
- 改善了可伸缩性。根据按波长付费的方法，加一个新的波长就可以简单地提高吞吐量。附加的波长不必都有相同的速率，所以提供了额外的灵活性。
- 放松了规格要求。DWDM放松了对为实现一系统对所需要的光电（O/E）部件的技术上的限制，因为这些部件只要求在最高的单个波长上实现，而不是在总吞吐量上实现。
- 单一光纤上全双工工作。

随着DWDM系统的出现，有许多可供选择的增加传输性能容量的方法，如改变每一对光纤的波长数目（间隔），每一波长的比特率，光的频带和距离（有或没有定时再生）。图4描述了影响预想的DWDM系统距离发展的参数。

- 比特率的增加受限于许多物理效应，诸如色散（这可能需要色散管理），极化模式发散（对现有的安装好的光纤是很重要的），光纤非线性（导致交叉相位调制和四波混频效应）导致产生更快的和更贵的电子部件（例如O/E转换）。
- 增加波长数目受限于可用的光总带宽（在光纤和放大器中）和波长之间的间距（导致稳定性问题、比特率限制和增强非线性效应）。
- 增加距离受限于放大器增益（取决于带宽和波长有关的增益），连续再生段的数目（取决于噪声和抖动的累积和再生器有或无再定时功能）。

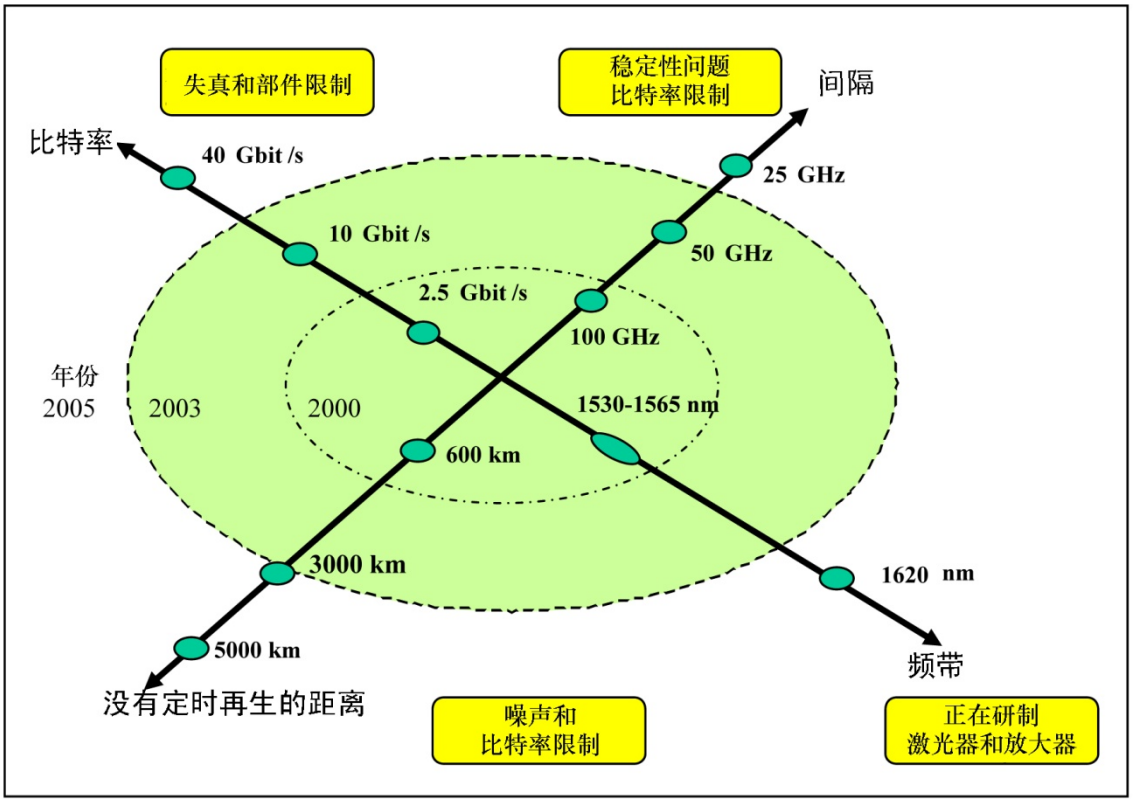
各个不同的参数是相互依存的，即增加一个参数的数值可能会减小另一参数的可接受的数值。

许多出版物介绍了大容量DWDM系统，例如：

- 在32个波长上的10 Gbit/s信号导致320 Gbit/s。为了达到光传输路径大于600 km，所报导的光传输段长为80-140 km。
- 在许多波长上的20 Gbit/s信号导致在一根光纤上的容量大于1 Tbit/s。
- 在有50 GHz间距的150个波长上的10 Gbit/s信号导致容量为1.5 Tbit/s。

对于这一系统，为了达到光传输段长100 km和光传输路径长400 km，必须要用色散补修光纤。

图 4 — DWDM 系统的发展



在正在发生的演变的过程中，在不远的将来将很可能会加上光交换设备，从无法重新构建的分插元件开始，再加上光保护自愈环，然后再加上光交叉连接，用于环的互联或作为网状光网络的基础。然而，物理上的局限性很可能将限制可以实现的光网络的规模，只能通过使用部分或全部光电子或光再生器来扩大光网络的规模。

I.1.5 同步数字系列矩阵

对更高的传输比特率、更灵活的信道处理以及更完善的管理要求日益增长的需求导致产生同步传输的概念。该概念最初是由美国Bellcore（贝尔通信研究所）提出的，称为SONET，即同步光网络。ITU已经进一步重新定义和将其原理通用化，以产生同步数字系列，即SDH。国际协作精神产生了一个全世界接受的SDH标准。SDH推广了准同步数字系列（PDH）的原则，同时规避了PDH的某些缺点，产生了下列推进因素：

- 不经过中间复用级就能够将64 kbit/s的数字话路或话路群加入SDH信号或从SDH信号中将它们取出，这样就得到了比较经济的分插设备。
- 不同复用级和属于不同系列（例如ETSI — 欧洲，ANSI — 美国）的准同步信号都能够映射到SDH信号中去，并作为SDH信号传输。
- 在同步数字交叉连接（DXC）中，能够交换数字64 kbit/s话路或话路群。

- 在DXC网络中的路由选择可以受命令控制，允许以灵活的方式选择路由，在同一物理网络上根据不同的逻辑网结构进行控制。在不同的时间上，可能出现不同的逻辑网络结构。
- DXC允许进行通信业务分类，例如，可以将进入的承载数据，话音和电视的混合体的数字信号进行变换，以便分开数据、话音和电视的数字信号。
- DXC允许通信业务打包，例如，可以将进来的有空闲时隙的数字信号与没有空闲时隙的数字信号组合起来，这样它就充分利用了传输媒体。
- DXC可以与电话交换机放在同一地点。在这一情况下，DXC处理稳定的基本业务负荷，而交换机负责业务高峰。这将比只用单一的电话交换机，增加交换机容量更经济一些。
- 最后但不是最不重要的是，SDH和DXC是已经具体设计了具有充裕的管理能力的电信管理网（TMN）的第一个设备类型。

SDH的基本单位是同步传送模块STM-1，它有19440 bits。STM-1每秒重复8000次，从而得到下列STM-N的比特率：

STM-1 155.52 Mbit/s

STM-4 622.08 Mbit/s

STM-16 2488.32 Mbit/s

STM-64 9953.28 Mbit/s

传送不同系列的PDH信号以及传送ATM信号的要求造成复杂的复用方案。正如下面所说明的那样，一个STM-1系统可以承载不同的PDH系统和一个ATM系统。

3×34或45 Mbit/s系统 84×1.5 Mbit/s系统

21×6 Mbit/s系统 1×140 Mbit/s系统

63×2 Mbit/s系统 1×ATM系统

4种基本的SDH复用器（MUX）已经标准化。

1) 用于从准同步信号（按照G.703建议书）变换到同步的STM-N信号的MUX。能够提供把一支路灵活的指配到STM-N帧的任何一个位置上。可以适合于在PDH环境中建立SDH链路。

2) 用于在各种不同的STM信号之间变换的MUX。能够将许多STM-1信号复用为更高的比特率。将VC-3/4灵活指配到STM-N上的任何一个位置是可能的。能够有效地使用光缆的容量。

3) MUX用于STM-N信号分出/插入准同步和同步信号，不经过整个信号的去复用和终结。能够从一个同步比特流中加入或分出单个话路或话路群。典型的应用是在自愈环结构中的插入/分出复用器。

4) 用于制式转换（互通）的MUX，它能够把VC-3s中的C-3负荷在基于USA（举例）和欧洲（举例）制式的网络之间的制式转换。

三种基本的数字交叉连接（DXC）已经标准化：

1) DXC交叉连接140 Mbit/s准同步信号或STM-1信号

2) DXC交叉连接2、34和140 Mbit/s准同步信号

3) DXC将1型和2型的功能组合在一起。

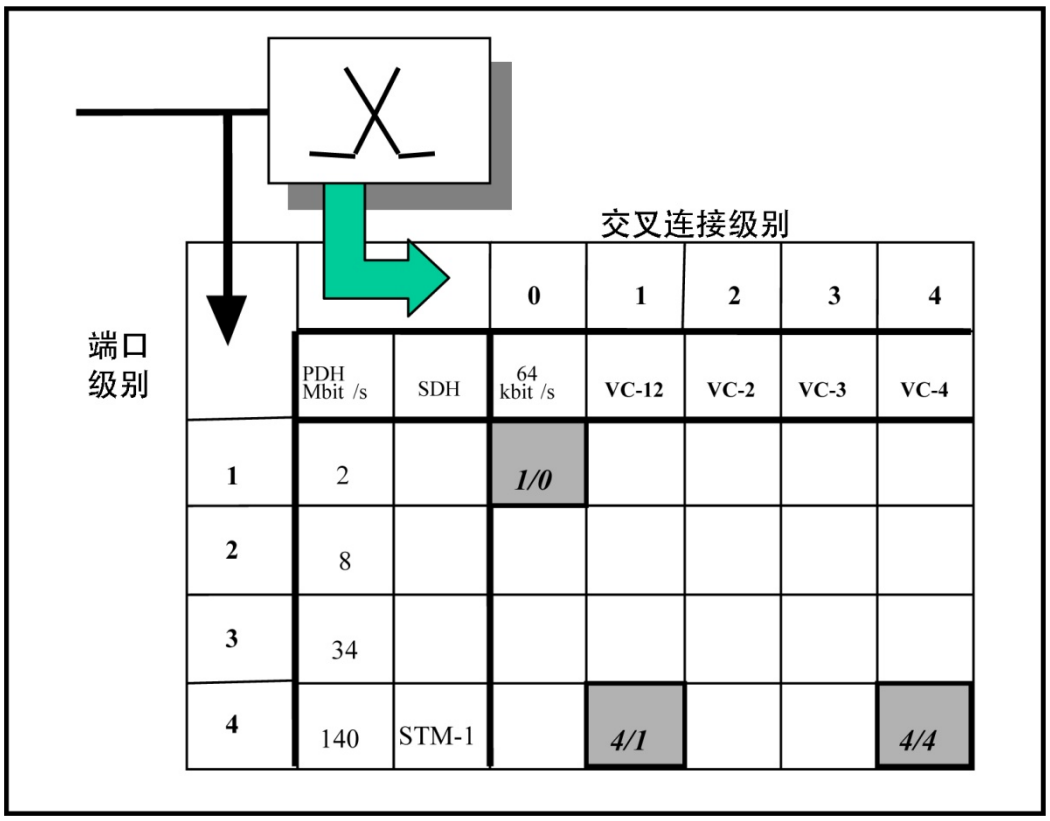
DXC用端口级别和交叉连接级别来表征，如图5中的实例所示。

DXC 1/0　端口级别2.048 Mbit/s和交叉连接级别64 kbit/s，用于（举例）64 kbit/s的租用线网络。

DXC 4/1　端口级别140 Mbit/s和交叉连接级别VC-12，用于（举例）2 Mbit/s的租用线网络。

DXC 4/4　端口级别140 Mbit/s或STM-1和交叉连接电平VC-4，用于（举例）网络保护，与DXC 4/1一起用于网络行政管理。

图 5 — 数字交叉连接设备的例子



SDH的重要应用是使用复用段共享保护（MS-SP）环。把每一STM-N链路的总净荷均等地分为工作容量和保护容量。业务是双向的：两个光纤环用于顺时针方向和两个光纤环用于逆时针方向。所有工作段共享保护容量。在链路发生故障的情况下，在与有故障的链路或结点相邻的结点上提供环回电路。典型的环参数是：每链路8个VC-4，切换时间小于50 ms和一个环最多16个结点。在现代网络结构中，串接使用多个环，每一环代表（举例）代表一网络层。使用上述各原则清除电缆故障和结点故障。在这一情况下，二个环通过二个结点连接利用了MS-SP环的优点，从而导致破坏安全的网络结构。

I.2 无线宽带接入技术

无线通信由已经出现的范围广泛的各种技术、业务和应用所组成，以满足不同的市场领域和用户环境的特殊需要。下列特性能够概括地表征不同的系统：

- 工作频率；
- 定义该系统的标准（在ITU中，使用建议书而不是标准）；
- 所支持的数据速率；
- 双向和单向传送机制；
- 移动性的程度；
- 所提供的内容和应用；
- 法规上的要求；和
- 成本。

对真正寻求高速接入或任何一种接入的许多发展中国家或地区而言，无线技术或许是最有可能的可行选择方案。相对于其它基础设施技术而言，无线技术有部署快和覆盖的地理范围相对比较广的优点。此外，它使得几乎没有或完全没有电信基础设施的国家能够“跳跃式”发展或者完全跳过建设固定有线的阶段和直接跨入互联网接入。由于无线技术的移动性和便携性，它们有刺激需求和鼓励新的接入方法和使用互联网的潜力。

I.2.1 无线局域网（RLAN）技术矩阵

RLAN系统正在进入世界上的所有市场。有几个宽带RLAN系统的主要标准（不一定在某些建议书中得到ITU认可），表1提供了这些标准的概貌。

因为笔记本计算机和手持计算设备的速度随时间稳定地提高，它们在有线网上能够在使用者之间提供互动的通信；然而，当连接时，这些设备中有几种要牺牲便携性。多媒体应用需要宽带通信设备，不仅是对有线终端而言的，而且也是对便携式和个人通信设备而言的。有线局域网标准能够传送高比特率的多媒体应用。为了保持便携性，将来的无线局域网将有必要传送更高的数据速率。宽带RLAN通常定义为能够提供大于10 Mbit/s数据吞吐量的那些RLAN。

系统结构

宽带RLAN几乎总是点对多点的结构。点对多点应用一般使用全向天线。多点的结构使用两种系统：

— 点对多点集中控制的系统（多个器件通过无线接口连接到中心设备或接入点）；

— 点对多点非集中控制的系统（在一个小区域内以特设网为基础进行多个设备之间的通信）。

在校园环境中，有时使用RLAN来实现大楼之间的固定点对点链路。点对点系统通常使用定向天线，定向天线的射束宽度窄，能够在距离比较远的各设备之间实现通信。这使得有可能通过频道重复使用来实现频带共享，并且与其它射频（RF）系统的干扰减至最小。

频谱要求

RLAN可以在无许可证或免许可证的频谱中工作，而且它在给用户提供高的服务质量的同时，经常必须允许邻近的未经协调的网络实现共存。对RLAN而言，某些国家早已按照免许可证的原则使用2.4 GHz频带中的83.5 MHz，而且世界无线电大会（WRC）在所使用的5 GHz频带中已经新划分了455 MHz频带供RLAN使用，但加了一些限制[3]。在5 GHz频带中，保护基本业务是一个义务。当多种接入技术可以使得一个单频信道要由几个结点使用时，以高的业务质量支持许多用户要求有足够多的信道可以使用，以保证接入到无线电资源，不受过长的排队时间等的限制。在同一频带中的各运营商中实现灵活共享无线电资源的一个技术是动态频率选择（DFS）（为了说明这一技术，见附件2）。

移动性

宽频带RLAN可能是伪固定的（像在台式计算机情况下那样，可以从一个地方搬运到另一个地方）或是可携带的（像膝上型或掌上型电脑情况下那样，例如，用带到办公室环境中的电池进行工作）。设备之间的相对速度保持低速。在仓库那类地方的应用中，可以使用RLAN来与最高速度为20 km/h的起重车进行联络。一般，RLAN设备不是设计成能在汽车速度或更高速度下使用的。

工作环境和接口的考虑事项

宽带RLAN主要部署在校园大楼内部、在大办公室、工厂、仓库中等地方。因为RLAN设备部署在建筑物内部，房屋的构件将衰减发射。

因为大楼内部工作的短距离特性和ITU无线电规则所加的功率限制，RLAN使用低功率电平。功率谱密度的要求是根据由一个圆所定义的单个RLAN的基本服务区来确定的，圆的半径在10 m到50 m之间。当需要更大的网络时，可以通过桥接或路由器功能逻辑上连接上多蜂窝RLAN，以便形成更大的网络，但不增大它们的复合功率谱密度。

为了达到上面所规定的覆盖区，假设在5 GHz工作频率范围内，RLAN需要的峰值功率谱密度约为12.5 mW/MHz。对数据传输而言，为了初始化和根据射频链路的质量估计控制发射功率，某些标准使用更高的功率谱密度。这一技术称为发射功率控制（TPC）。一般，所需要的功率谱密度与工作频率的平方成正比。大范围的平均功率谱密度将比峰值低得多。RLAN设备按时间共用频谱。激活率将随用途、应用的时间和一天中的时段而变化。

与IMT-2000的兼容性

RLAN能够与IMT-2000以及其它移动（蜂窝）网协调工作。虽然IMT-2000的能力提供了广泛的移动性的性能和成本效益好的广域覆盖，但是RLAN能够在特殊地区（热点）提供高质量的数据吞吐量能力，现在宽带RLAN能实现的数据速率可达54 Mbit/s[4]。

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[3] “*RLANS:ITU-R*的发展”，在2003年12月2日日内瓦举行的有关新技术和新业务的ITU-R WP8A研讨会上发表的。

[4] 详情请参阅第229号决议（WRC-03）。

动态频率选择

在动态频率选择（DFS）中，在所有的RLAN结点上，所有的无线电资源都可以使用。结点[一般指控制器结点或接入点(AP)]可以临时分配一个频道，而可以适用的频道的选择根据所检测到的干扰或某些质量标准（例如接收信号强度、*C/I*等）来完成。为了获得有关的质量标准，移动终端和接入点都以规定的时间间隔作测量，并将测量结果报告给作选择的实体。

为了以等概率利用所有的可用频道，配备了DFS。这就使得当一频道准备发射时，频道对结点的可用性最大化，而且保证当汇集了大量用户时，射频能量被均匀地散布在所有频道上。后面一个效应有利于与其它业务共用频率，这些业务可能对任一特定频道上的综合干扰比较灵敏，例如装在卫星上的接收机就比较灵敏。

TPC想要降低不必要的设备功率消耗，但是通过减小RLAN结点的干扰区域也促进了频谱重复使用。

大容量R-LAN系统的实例

加拿大通信研究中心已经开发出一套大容量R-LAN的实验系统，在正向（下行）上，它基于DVB-S的物理层技术；而在反向（上行）上，它基于802.11的物理层技术。它工作于5 GHz免许可证频带，而它的容量大是由于它的高的频率重复使用，这是由于它的基站玫瑰花瓣形辐射图的天线产生了24个电磁上相互隔离的微蜂窝（称为花瓣），4个频率在水平面中不断重复使用。在每一花瓣内，对用户而言，正向最大容量可以用到22 Mbit/s，而反向最大容量可以用到9 Mbit/s。该系统使用了识别无线电技术，监视正向和反向链路的工作频带并且自动调节系统的频率指配和等效全向辐射功率（e、i、r、p），在某种意义上看，它减轻或避免了对附近使用同一频率的其它系统的干扰。该系统加入了DFS作为它的识别无线电工作的组成部分。整个用户终端设备由一付面积18 cm×18 cm，厚2.5 cm的平面天线组成，并且它包含所有必需的电子部件。一般，系统工作使用大都市的光纤骨干网来传递它通过的大量无线通信业务流量。工作半径能够扩展到4.8 km，但是通常在视距（LOS）情况下约为1500 m，而在有阻挡的条件下就更近了，它提供各种TCP/IP业务，如点播电视、VoIP和互联网。

表 1 — 宽带 RLAN 应用的技术参数这些要求根据国家的法规和地区的法规

网络标准	IEEE项目 802.11a [(1)]	IEEE项目802.11		ETSI BRAN HIPERLAN1 ETS 300-652	ETSI BRAN HIPERLAN 2 [(1), (2)]	MMAC HSWA HiswANa[(1)]
		11b	11g			
接入方法	CSMA/CA	CSMA/CA，SSMA	CSMA/CA	TDMA/EY-NPMA	TDMA/TDD	TDMA/TDD
调制	64-QAM-OFDM 16-QAM-OFDM QPSD-OFDM BPSK-OFDM 52个子载波 （见图1）	CCK （8个复码片扩散）	64-QAM-OFDM 16-QAM-OFDM QPSD-OFDM BPSK-OFDM 52个子载波	GMSK/FSK	64-QAM-OFDM 16-QAM-OFDM QPSD-OFDM BPSK-OFDM 52个子载波 （见图1）	64-QAM-OFDM 16-QAM-OFDM QPSD-OFDM BPSK-OFDM 52个子载波 （见图1）
数据速率	6，9，12，18，24，36，48和54 Mbit/s	1，2，5.5，6，9，11，12，18，24，36，48和54 Mbit/s		23 Mbit/s（HBR） 1.4 Mbit/s（LBR）	6，9，12，18，27，36和54 Mbit/s	6，9，12，18，27，36和54 Mbit/s
频带	5 150-5 250 MHz 5725-5825 MHz 5250-5350 MHz[(3)]	2400-2438.5 MHz		5150到5300 MHz在某些国家中限制到5150-5250 MHz[(3)]	5150-5350和 5470-5725 MHz[(3)]	5150到5250 MHz[(3)]
频道配置	20 MHz频道间隔	25/30 MHz间隔3频道		23.5294 MHz（HBR） 在100 MHz内3频道和在150 MHz内5频道 1.4 MHz（LBR）	20 MHz频道间隔在200 MHz内8频道在255 MHz内11频道	20 MHz频道间隔在100 MHz内4频道

(1) 在IEEE802.11a和ETSI BRAN HIPERLAN2和HiSWANa之间，物理层的参数是共同的。

(2) WATM（无线ATM）和有QoS的高级IP想要在ETSIBRAN HIPERLAN 2物理传送上使用。

(3) 对5150-5250 MHz频带，应用无线电规则（RR）的第5.447款。

来源： ITU-R M.1450-2建议书；宽带无线局域网的特性；（ITU-R 第212/8号课题和ITU-R 第142/9号课题）。

宽带RLAN应用的技术参数（续完）

补充的 802.11 标准正由国家和/或地区组织批准[5]

标准	描 述
802.11d	补充 802.11 MAC（媒体接入控制）层，以考虑到法规的限制对不同国家是变化的，允许由固件版本选择确定设备的定位。
802.11e	补充MAC层，提供业务质量管理功能。 将应用于不同的物理层（802.11a、b和g）。
802.11f	在接入点之间的通信，以保证在多生产厂家环境下它们的互操作性，特别是涉及到漫游的地方。
802.11h	补充是为了符合欧洲有关5 GHz频带设备的法规（广泛应用于卫星通信）。提供动态频道选择和发射功率控制。
802.11i	补充MAC层，以便用提供对WEP（有线设备私密性）的一个可供选择的方案。使用802.1x和将使用AES（高级加密标准）加密。将被应用于802.11a、b和g。

I.2.2 固定宽带无线接入系统

I.2.2.1 IEEE802.16和ETSI HiperMAN 矩阵

IEEE 802.16和ETSI HiperMAN 都以宽带接入为目标，给固定和游牧应用的居民、SoHo（小型/家用办公室）、SME（中小企业）的用户提供无线DSL连接，主要用于不能由有线部署提供DSL连接的区域。

IEEE 802.16和IEEE802.16a

2003年，IEEE已经发布了802.16a标准[2]，它是IEEE 802.16[1]标准的修订版本，论述“关于2-11 GHz的媒体接入控制的修改和附加的物理层规范”。

IEEE 802.16空中接口的关键性能是媒体接入控制层（MAC），它规定了控制接入到无线电波的机理。IEEE 802.16 MAC是基于按需指配多址，其中，发射是根据优先级和可用度来确定时间的。这一设计是由支持电信运营级的有完善的QoS支持的到公共网络的最后一公里接入的需求所驱动的。该系统可以很容易支持一般的互联网型数据和实时数据，包括各种双向应用，如话音、电视会议或互动游戏。

802.16a标准为在2-11 GHz频带使用规定了三种物理层模式：

- SCa（单载波，对2-11 GHz）；
- 正交频分复用（OFDM），基于256点FFT（快速傅立叶变换）；对这一模式规定了附加的网孔拓扑；
- OFDMA，基于2千点的FFT；在上行/反向和下行/正向两种情况下都使用OFDMA。

这些模式是不能互操作的，并且遵循该标准的系统只可以使用其中的一个模式。

[5] ITU-R M.1450-2建议书“宽频带无线局域网的特性”，（课题ITU-R 212/8和ITU-R142/9）。

所有模式都提供下列性能：

- FDD和TDD都支持，包括在FDD模式中的半双工CPE;
- 高频谱效率和高数据速率，在20 MHz的频道内，最高达72 Mbit/s;
- 自适应调制，对OFDM和OFDMA模式，从QPSK 1/2比率到64 QAM 3/4比率，对SC（单载波）模式，甚至用更高的调制方式；
- 频道带宽范围广，1.25 MHz到28 MHz，在802.16REVd标准中要规定实际的互操作性的轮廓；
- 蜂窝半径大，使用定向的室外安装的天线时，在P-MP模式中，蜂窝半径大到50 km。

高级天线系统用的Hook技术

- 高安全业务加密的Hek（TEK）加密算法：
  - — 用128 bit 密钥的3-DES（类型1）；
  - — 用1024-bit 密钥的RSA。

更进一步的IEEE 802.16标准

到2003年末为止，802.16正在起草：

— 修订版（802.16 REVd），以改进现有的物理层（PHY）模式和规定互操作性轮廓；

— 改进版（P802.16e），以支持移动工作，即切换和功率节省；移动系统将使用由802.16REVd规定的改进的物理层模式；预计2004年秋完成。

将来的移动无线电系统将支持高数据速率、高移动性、大容量和高QoS。因为可用的频谱是受限的，高频谱效率是将来的移动无线电系统的一个主要挑战。而且，对不同的环境和应用（大都市、郊区和乡村地区），比特率和性能应该是可以升级的。

ETSI HiperMAN

ETSI BRAN HiperMAN已经产生了3个标准，早已被批准：

- TS 102 177，论述物理层；
- TS 102 178，论述数据链路层；
- TS 102 210，规定互操作性轮廓。

ETSI HiperMAN有一个两年的选择和改善过程：

- 作为基线，采用802.16和802.16a标准；这一选择考虑有与以前对802.16系统所描述的相同的性能；
- 选择了OFDM 256点FFT模式作为宽频带非视距工作条件下的最佳性能价格比的解决方案；
- 改进了OFDM模式，方法是加了上行/反向子频道配置COFDMN，16个子频道，使用专门的组群方法，以达到：
  - — 由于功率集中，上行链路系统增益大12 dB;
  - — 在蜂窝边缘处，每一子频道的宽带数据速率（在QPSK 1/2比率时，在3.5 MHz内150 kbit/s）；数据速率随子载波数减少而下降；
  - — 各种不同业务类型（IP和TDM）下的最大容量和低时延；
  - — 可靠地工作，频率分集，良好的高级天线系统（AAS）支持。

HiperMAN DLC层已经主要采用802.16MAC-OFDM模式。增补的HiperMAN DLC标准提供了上行链路子频道配置的支持和经改进的ARQ/BW请求/BW分配模式。

可以预料，IEEE 802.16 REVd（2004），OFDM部分将与ETSI HiperMAN密切合作。

ETSI HiperMAN更进一步的标准化

ETSI 现在正在起草四个新标准，以支持HiperMAN系统的互操作性：

- 数据链路控制层（DLC）的一致性测试 — 第1部分：PICS；
- 数据链路控制层（DLC）一致性试验 — 第2部分：测试序列结构和测试目的（TSS和TP）规范；
- 数据链路控制层（DLC）一致性试验 — 第3部分：抽象测试序列（ATS）；
- 网络管理：MIB。

ETSI PTCC（协议和测试能力中心）的专家领导了一致性试验工作。

预料将要产生互操作轮廓，以支持5.8 GHz的频道分配。

将来，ETSI BRAN也可能考虑移动应用。

部署实例

参考文献

[1] IEEE 802.16 Standard:Air Interface for Fixed Broadband Wireless Access Systems-2001.

[2] IEEE 802.16a Standard:Amendment2:Medium Access Control Modifications and Additional Physical Layer Specifications for 2-11 GHz-2003.

[3] IEEE L802.16-03/16:IEEE802.16 Liaison Letter to ITU-R:Appendix www.ieee802.org/16/liaison/docs/L80216-03_15.pdf

[4] ETSI TS 102 177 2003-09;Broadband Radio Access Networks(BRAN); HiperMAN; Physical (PHY)Layer.

[5] ETSI TS 102 178 2003-08;Broadband Radio Access Networks(BRAN);HiperMAN;Data Link Control(DLC)Layer.

[6] ETSI TS 102 210 2003-08;Broadband Radio Access Networks (BRAN);HiperMAN;System Profiles.

I.2.2.2 IMT-2000无线本地环路宽带接入

在当代市场中，无线蜂窝业务继续快速增长。大多数运营商或者已经启动或者正在部署利用IMT-2000技术的WLL系统的过程中。WLL系统也称为固定无线接入（FWA）系统。虽然IMT-2000技术主要是为提供移动通信考虑的，它们能够提供成本效益好的对固定宽带和有线技术的替代手段。

特别是使用基于IMT-2000的WLL系统能够大大降低运营商部署WLL网络所需要的先期投资，因为可以利用构成移动网的大多数标准的网络部件。这还加上了IMT-2000技术所显示出的高频谱效率和兼容性的优点。运营商能够或者完善它现有的移动网，以便提供WLL业务或者建设完全新的WLL系统。IMT-2000系统所提供的高度恢复能力使它们成为计划提供WLL业务的运营商的一个理想的选择。

虽然有许多其它的IMT-2000和非IMT-2000技术能够提供WLL业务，但是这一节将把精力集中在提供WLL业务的CDMA2000的自适应性和稳健性。

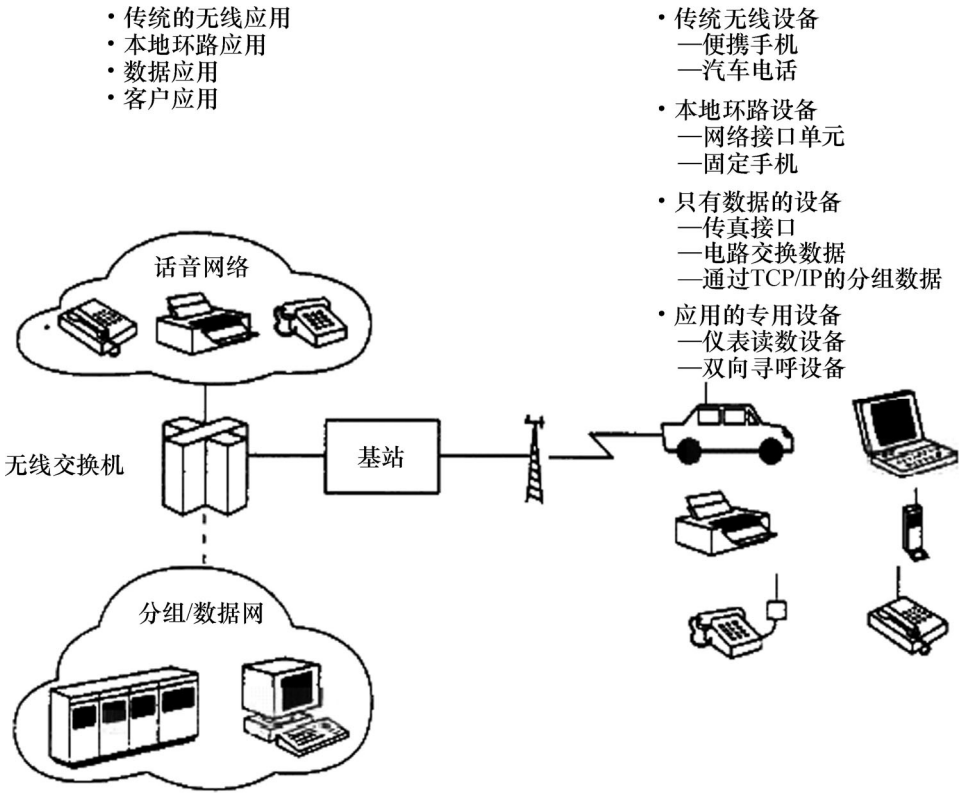
除了本报告的II.2.3.1节所列出的性能外，基于CDMA2000的WLL业务的关键性能如下：

- 利用多媒体域（MMD）和/或IP多媒体分系统（IMS）体系结构能够稳健地演变到全IP（3G和超3G）系统。
- 同时提供话音和高速数据业务。使用CDMA2000-1XEV-DO时，在DL上为3 Mbit/s和在UL上为1.8 Mbit/s。
- 集中式结构
  — 用声码器池、帧选择和功率控制算法，提供了重要的益处。
- 考虑了CDMA-1X和1X-EV载波混合使用。
- 给某些用户群和/或预定地理位置中的个别用户提供客户呼叫性能和收费率。
  — 公共账单和客户服务。
- 无线功能（OTAF）和软件的性能考虑到网络重新配置容易和灵活。
- 基于位置的业务
  — 多用户费率计划。
  — 分层次服务。
  — 每个用户的收益更高。
- 提供基于IP的位置业务和加密的包数据流。
- 提供最严格的受规章限制的转出要求。

基于CDMA2000的无线本地环路的应用如下：

基于CDMA2000的WLL系统支持各种各样的应用。运营商能够与现在的陆上线路业务提供商，如电缆电视提供商、电力公司和/或与无线运营商建立伙伴关系和提供不同应用的主办方。当能够从同一网络和软件平台支持这些应用时，可能需要特殊用途的手机。后面的图（图3）显示了能够使用基于CDMA2000的WLL系统来提供的各种各样的不同应用。这些WLL业务可以在CDMA2000系统工作的所有频带（如800 MHz、1900 MHz等）中工作。

图 3 — 使用 CDMA2000 的无线本地环路应用



WLL应用包含移动性基础设施的元件以及一些其它的补充的元件：

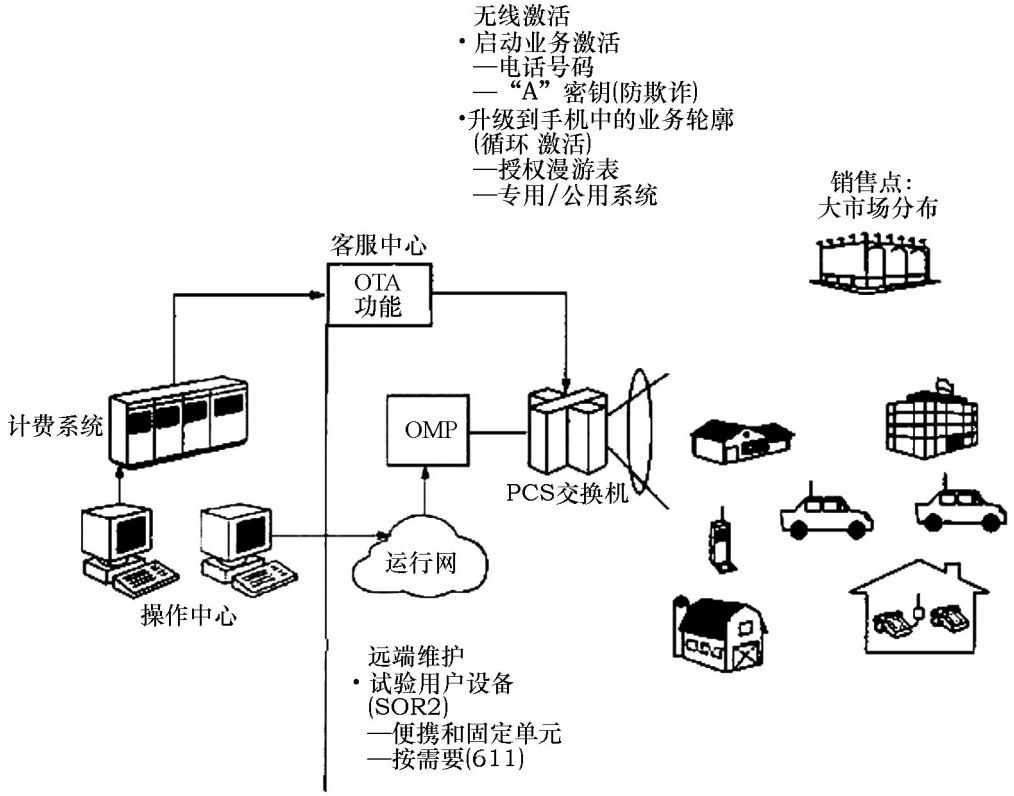
- 固定的用户设备（手机或用户终端设备（CPE））— 许多手机供应商正在制造与CDMA2000的基础设施相兼容的WLL用户单元。固定无线设备的可选方案现在包含传统的手机、全集成的无线台式单元、无线网络接口、无线付费电话、个人基站等。手机供应商也正在计划在用户单元中包含许多附加的性能，以改善用户的体验。
- 性能透明度 — 为了确定WLL设备的定位，该单元必须提供陆地线路的外观和提供对端用户透明的业务和性能。这些性能包括：
  - — 商业/居民的性能透明度
    - 协调的外观和感觉（拨号音）
    - 呼叫转接
    - 三方通话
    - 主叫线路限制
    - 呼叫等待和呼叫转移
  - — 工作透明度
    - 性能码
  - — 执行透明度
    - 语音消息/消息中心
    - 业务结点
    - 业务控制点。

预料将来要把附加的性能集成到WLL设备中去。

- 业务授权 — 在同时提供固定和移动业务中关键的性能之一是该网络区分固定和移动用户的能力，以供计费用。CDMA2000以稳健的方式提供这一能力。CDMA的专用网和用户区域性能实现公共网的分割。业务提供商通过使用网络ID能够区分开不同的业务等级并且用户付费与同一物理设备和地点的用户不同。当某用户从一个地区移动到另一地区时，只要加强网络（通过标明费率/付费区的器件上的标识）提醒该用户的能力，就能为考虑个人付费区作好准备。此外，在预定的区域以外，网络也提供了限制接入性能，即禁止发起、终止和切换呼叫。

  网络的另一重要性能是它提供了公共的计费和客户服务的能力，以便于WLL运营商的日常运行。图4显示了把基于CDMA2000的WLL的客户服务中心和计费中心汇集在一起的方式。

图 4 — 基于 CDMA 的 WLL 系统的集中客户服务和计费中心

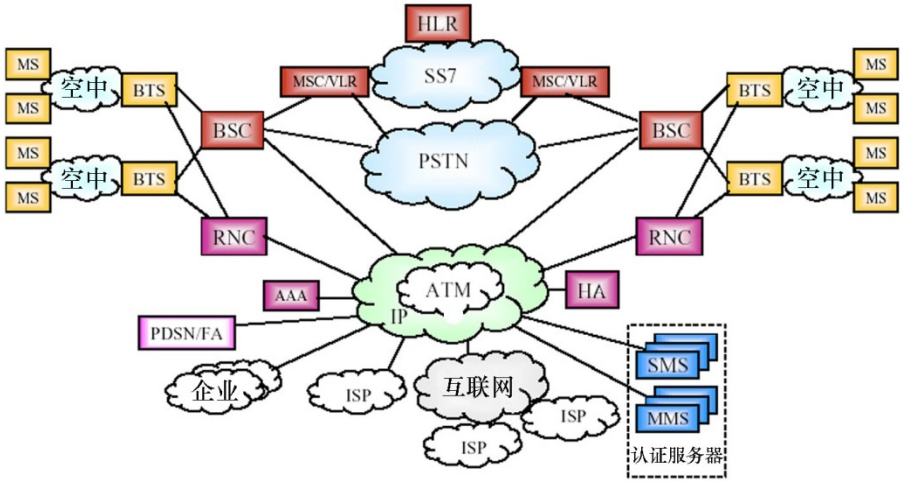


系统体系结构

CDMA2000-1XCDMA2000-1X-EV-DO WLL系统的无线接入网（RAN）和IP核心网[6]的典型系统结构如下：

[6] 关于CDMA2000系统的IP核心网的全部详情，请参阅TIA/EIA/IS-CDMA2000标准。

图 5 — 基于 CDMA2000 的 WLL 系统的典型 IP 核心网



甚于CDMA2000的WLL系统利用了分布式结构方式，它由基站（BS）、基站控制器（BSC）、归属代理（HA）和认证、授权和计费（AAA）以及其它有关接口组成。这是为提供移动性业务所使用的同一体系结构，所以，能够将固定业务应用综合到现有的基础设施中去。这一综合策略保护了业务提供商在基础设施、端用户和各种业务方面的投资。核心网各部分的简要描述如下：

- 基站收发信机系统（BTS）是一个实体，它在无线接口两端提供传输的能力。
- 基站控制器（BSC）是一个实体，它对一个或多个BTS提供控制和管理。
- 分组数据业务结点（PDSN）给无线接入网提供到IP核心网的接入。
- 认证、授权和计费（AAA）提供基于IP的认证、授权和计费功能。它还保持了与对等层实体有关的安全性。
- 归属代理（HA）提供了两个主要功能。它对用户现在的配属点（即现在发送和接收IP包要使用的IP地址）进行登记并转发往来于用户现在的配属点的IP包。
- 归属位置寄存器（HLR）存储用户的信息。
- CDMA2000 RAN提供通过7号信令系统（SS7）接口与PSTN的互连。

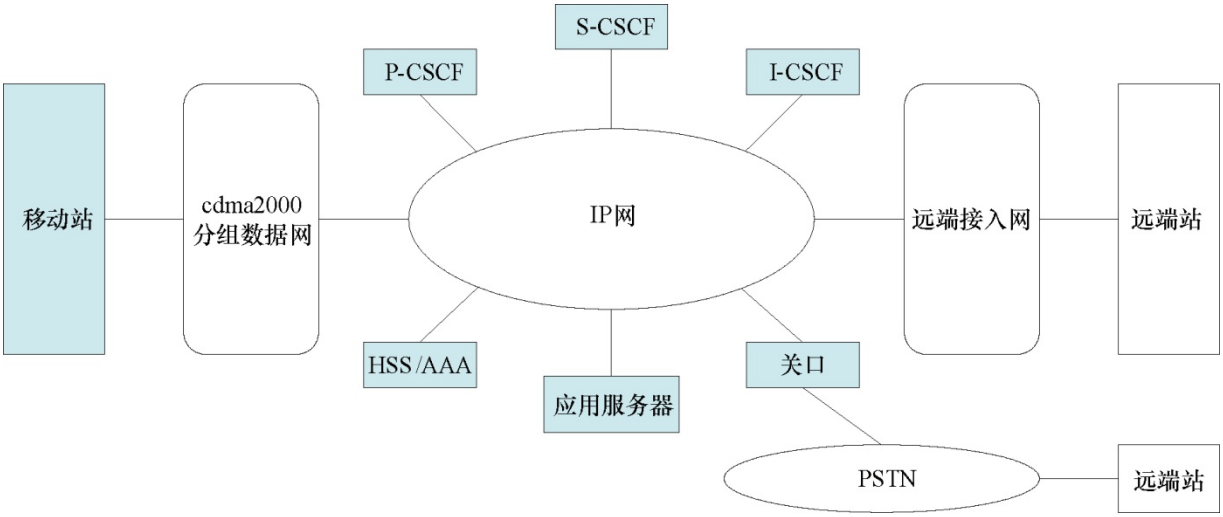
对使用CDMA2000作为WLL业务的运营商的主要益处是把该网络转移为全IP网络的能务，有时全IP网络称为超3G系统或下一代网络（NGN）。IP核心网有下列好处：

- 增强的话音和数据业务
  - — VoIP
  - — 高速数据传送
  - — 互联网接入

- 业务引进比较容易
- 标准协议和业务
- 跨技术漫游和互操作性。

运营商能够通过使用多媒体域（MMD）的体系结构[7]演变它的现有网络。转换是无缝的和稳健的，对现有业务的破坏最小。利用MMD体系结构的CDMA2000网络的典型例子概略介绍如下：

图 6 — MMD 体系结构概貌



MMD的功能实体是：

- AAA — 扩充HLR，以包含IP多媒体子系统的用户数据。
  - — 从呼叫状态控制功能（CSCF）的接入使用IETF协议（DIAMETER）。
- 呼叫会话控制功能（CSCF）— 提供呼叫控制功能。
  - — 代理CSCF
    - 移动通信的SIP代理服务器，起代表IMS内的UE的作用
    - 在移动和其它SIP服务器之间转发消息
  - — 服务CSCF
    - 在AAA（位置服务器）合作下的SIP寄存器
    - 所登记的端点的会话控制呼叫状态机制
    - 与业务控制用的业务平台互动，提供业务触发。
  - — 询问CSCF
    - 其它网络来的入口点
    - 分配或决定S-CSCF
    - 可能隐藏网络拓扑。

[7] 关于MMD的体系结构和功能体的完整描述请参阅适当的CDMA2000标准。

I.2.3 移动宽带无线接入系统

I.2.3.1 IMT-2000矩阵

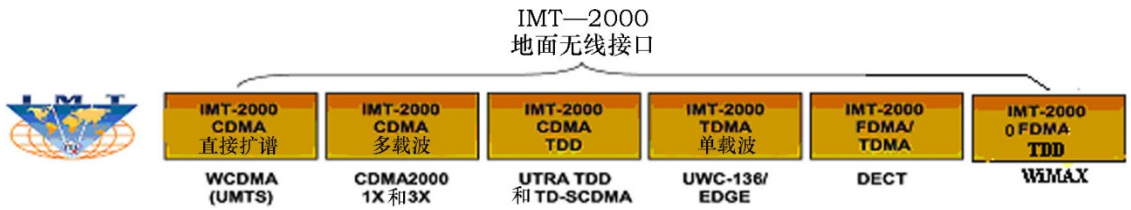
第3代无线解决方案（3G）是一种相对新的和创新的宽带接入解决方案，可以把它作为其它技术如光纤、数字用户线xDSL或电缆的替代技术加以研究。IMT-2000“国际移动通信”是国际电信联盟（ITU）为第3代（3G）移动通信业务和设备的全球协调的标准所使用的术语。IMT-2000视为分配被会聚在一起的固定、移动、话音、数据、互联网和多媒体应用的一个平台。IMT-2000可能提供比较高的“宽带”传输速率，对移动、便携和固定的应用传输速率分别为从144 kbit/s、500 kbit/s到2 Mbit/s。IMT-2000包括一灵活配套的五种地面无线接口，它们提供大容量话音应用和被增加的数据速率。IMT-2000目的在于在许多媒体（移动、卫星和固定）上提供各种应用的无缝传输，使得从运营商和消费者两方面的观点来看，这个平台是相当有用的。这一套技术想要在信息时代中满足一个较小的解除管制的竞争市场的需要，并且预料对发达国家和发展中国家，它都会成为总的经济增长的一个组成部分。

IMT-2000的关键性能如下[8]：

- 全世界设计的高度通用性；
- 在IMT-2000内和与固定网的业务兼容性；
- 高质量；
- 适合于全世界使用的小终端；
- 全世界漫游的能力；
- 高速数据；
- 在范围广泛的业务和终端内多媒体应用的能力。

IMT-2000是在ITU内部（ITU-R和ITU-T）和ITU外部（3GPP、3GPP2，IEEE，等）的许多实体互相协作的结果。IMT-2000包含了由ITU所简化的许多技术，即IMT-DS、IMT-MC、IMT-TD、IMT-SC、IMT-FT和IMT-OFDMA TDD WMAN。下面的图7是六个IMT-2000地面无线接口规范的标准。

图 7 — IMT-2000 地面无线电接口标准



基于码分多址（CDMA）的IMT-2000技术使用了频谱扩展技术，把语言打碎成小的数字化的片断并把它们编码，以便识别出每一呼叫。所以，大量用户能够共享同一频带频谱和大大增加系统容量。换句话说，CDMA使得无线业务运营商有可能把更多的数字信号挤压进一特定的无线网络部分中去。

[8] 国际电联关于IMT-2000的定义。

OFDMA技术已经成为普遍认可的移动通信朝4G演进的一个可选方案。基于OFDMA的IMT-2000技术提供高数据速率的能力和支持许多新技术，如先进的天线技术，以使得该网络的覆盖和所支持的用户数最大化。在非视距（non-LOS）条件下，OFDMA提供了多径干扰的容忍能力，以便在各种各样的工作环境和使用模型下，包括完全移动性的情况下，提供普遍存在的宽频带覆盖。

通用的IMT-2000技术的名称包括CDMA2000，WCDMA和TD-SCDMA，它们的规范在许多ITU建议书中作了规定，最值得注意的是ITU-RM.1457建议书和ITU-T Q.174x系列建议书，它们分别描述IMT-2000的无线接口和核心网。

现在商用的IMT-2000技术的最大数据速率达到2 Mbit/s，而将来的IMT-2000版本的最高数据速率将达到3.1 Mbit/s，甚至更高。由于IMT-2000的技术得到的高数据速率能够有几种应用给乡村社会提供实质性的利益。这些应用的例子包括电子医疗服务、电子商务、电子政务、位置定位和紧急帮助。此外，在比较低的频带中部署的IMT-2000技术对乡村地区的覆盖提供了很大好处。

自2000年以来，已有50多个国家（半数是发展中国家）开办IMT-2000技术[9]，许多国家准许运营商利用现有的移动通信频谱转移它们现有的网络。许多国家也已经为地面的IMT-2000网络发放了附加频谱的许可证。CDMA2000和WCDMA已经是IMT-2000商业运行中所使用的主要技术。

现在，有几个运营商正在基于WiMAX的IMT-2000技术[10]方面进行投资。消费者正在利用IMT-2000作为用于固定、便携和/或移动环境中的宽带的一个传输媒体。

IMT-2000也以稳健的方式提供宽带业务；最初是为用户提供中低速率数据而开发的，现在这些技术除了提供高质量的话音外，还能够提供最高达2 Mbit/s的数据速率。通过利用商用IMT-2000系统提供宽带业务，运营商在商业IMT-2000蜂窝市场中能够从创新的重要步伐上得到好处，包括增强的宽带数据业务、频谱效应改善（自适应天线、先进的调制和编码技术）、网络安全增强和归入这些技术的其它特性；所有这些将对提高和改善宽带用户的体验起重要的作用。而且，运营商通过利用IMT-2000技术能够对经济规模有重大影响，这将会降低与该网络有关的资本费用和运行费用。

随着新要求和新技术的出现，IMT-2000技术在这些标准内和支持该标准两个方面的扩充将使IMT-2000技术能够进一步满足宽带用户将来的需要。

例如，IMT-2000技术所应用的基于分组交换IP的核心网为增加支持宽带应用的新性能和技术提供了一个开放的和高效的平台。当宽带数据速率的需求增长时，所有这些都将进一步促进和减轻多媒体和宽带的内容分配给用户的工作。

在其它宽带技术中，IMT-2000技术有一个重要的情况，其中IMT-2000技术不仅在固定或便携环境中能够提供宽带业务，而且在移动环境中也能够继续提供这些业务。该技术的关键性能，如移动性、重叠网的能力、设计的高度共性，终端尺寸小、全世界漫游的能力等等都使该技术能够给正在从一个地方（固定或移动）移动到另一地方的用户提供宽带业务。此外，今天，IMT-2000技术能够提供安全可靠的宽带数据业务，远远超过今天的陆地移动无线技术和某些固定无线接入技术的数据业务能力。

重要的是要注意到在任一特定时间上，在单个跨越各种不同网络工作的设备中，可能呈现不同的技术，如RLAN、短距离连接的系统和IMT-2000。例如，个人数字助理（PDA）可能包含多种无线接口，使它能够与便携式终端（个人域）、专用或公用RLAN（中等域）或广域业务提供商如移动（蜂窝）网（广域）进行通信。

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[9] www.3gtoday.com/operators flash.html

[10] http://www.wimaxforum.org/resources/documents/marketing/casestudies

I.2.3.1.1 IMT-2000的卫星和地面组成部分

通常，IMT-2000的卫星和地面部分是互为补充的，给任何一个组成部分不可能经济地服务的区域提供业务覆盖。每一个组成部分都有特殊的优点和局限性。卫星组成部分能够给可能不在地面组成部分的实用范围内的区域提供覆盖；这一卫星部分特别适用于农村和边远地区，特别是对发展中国家更是如此。此外，在提供这一互补的卫星覆盖的问题上，在人口比较密集的区域中，卫星部分可能首先覆盖，以后再要求由地面部分提供覆盖。卫星系统也能够提供多播层，作为地面移动网的补充。所以，可能要用两种方式考虑演进的方法：一是增加IMT-2000的陆上部分，另一个是作为对IMT-2000地面部分的一个预报器。

现在有六个卫星系统通过它们的无线接口被定为IMT-2000家族的一部分（见ITU-R M.1455-2和ITU-R M.1457-3建议书），并且可以预料，每一系统相互间都是独立运作的。所有卫星都企图为地区的、多地区的或全球的服务区提供覆盖，所以，可能有几颗卫星就能在任一国家中提供服务。

有许多演变的方案，特别是ITU-R正在进一步研究下列各方面的问题：

- 预计IMT-2000的地面部分的基础设施的大量发展对IMT-2000移动卫星系统的实施和演变的效应。
- 最初在网络级上比在其它级上更可能有共性。IMT-2000将在什么级别上评价一个系统？
- 无论使用哪一种移动网（卫星或地面），能够在许多系统上提供话音和数据业务的双模用户终端的影响和实用性。
- 作为对2007年下一次世界无线电大会议程1.19项的回应，ITU-R正在研究在乡村地区、人口稀少的地区等将卫星用于互联网应用的问题。

I.2.3.1.2 IMT-2000的业务增强

可以预料，IMT-2000的标准、技术和业务也将进一步演变。下面是现在正在开发的这样的业务增强的几个例子。

早就在研究UMTS进一步演变的问题。UMTS无线接入技术将加以提高，以支持下行链路和上行链路的高速分组数据接入，使得能够以高达14.2 Mbit/s的速率进行传输。用同一方式，与GPRS相比，EDGE提高了频谱效率；与IMT-2000CDMA直接扩谱相比，HSDPA提高了频谱效率。更高的频谱效率和更高的传输速率不仅能够实现新的应用种类，而且由于HSDPA提供的容量高了一倍以上，也就能够支持更多的用户接入该网络。为了真正提供高数据速率和很高的用户密度，如在会议中心将会出现的那种用户密度，将要有其它一些补充的技术，包括无线局域网（W-LAN）在内，将来它们将弥补IMT-2000技术的不足，理论上提供的比特率高达54 Mbit/s。虽然公用的WLAN网络也将独立于移动网进行部署，但是，移动运营商有许多固有的有利条件，这些有利条件来自提供移动性管理、用户管理、高的安全性和漫游的能力。

另一个增强是IP多媒体分系统（IMS）。通过使用IP多媒体呼叫控制的方法，这系统能够使得实时的、个人对个人的业务（如话音电话或可视电话）有可能与信息和数据业务共同由分组交换技术来提供。它使得有可能在多个用户和设备之间同时建立电信业务和信息业务以及授权的通信会话的集成和互动。

也在考虑CDMA2000的进一步演变的问题。例如，同时包含新的可选择模式声码器（SMV）和天线分集技术的情况下，CDMA20001X可以提供的话音容量几乎是IS-95系统的三倍[11]。

[11] “SMV Capacity Increases”, Andy Dejaco，高通公司，CDG-C11-2000-1016010，2000年10月16日。

CDMA2000 1xEV-DO是对CDMA2000的增强，它主要对数据业务优化，并实现以更高的速度进行数据传输。CDMA20001xEV-DO的空中接口是按与CDMA20001X网络有完全互操作性来进行设计的，在一个载波的频带宽度为1.25 MHz的情况下，它提供的峰值数速率为在正向链路中高达3.1 Mbit/s，而在反向链路中为1.8 Mbit/s。此外，现在CDMA2000 1xEV-DO能够提供多播/广播（点对多点）、点对点的话音、数据和多媒体内容。CDMA2000 1xEV-DO使得运营商有一个经济的可选方案，以便能够以可以负担的成本传递各种各样的IMT-2000的数据业务。早已商用部署的1xEV-DO系统[12]实现了许多先进性能的无线通信系统设计。1xEV-DO的容量大是由于有了16-QAM这样的高阶

调制方案、动态链路自适应、自适应调制、增加冗余度、多用户分集、接收分集、turbo编码和其它信道控制机制[13]。

CDMA2000 1xEV-DO是对IMT-2000 CDMA多载波系统的增强，它将CDMA2000 1X和CDMA2000 1xEV-DO系统组合起来。所以，它提供了一个可选方案，或者是提供更高话音容量的CDMA2000 1X系统或者是提供更高数据容量的CDMA2000 1xEV-DO系统或者甚至在单个1.25 MHz载波内，提供高容量的话音和数据均衡的混合。

正好像IMT-2000的IP多媒体分系统（IMS）那样，直接扩谱能够实现由分组交换技术所提供的实时、个人对个人的业务，如话音电话或可视电话，IMT-2000多载波中的多媒体域（MMD）也这样，用公共的分组交换IP核心网，对用户实现分配一整套多媒体和数据集中应用，诸如VoIP、点对点和图像、话音、音乐内容、电视等的多播分配。所有这些给希望用同一无线平台给多个用户和设备提供许多应用和业务的组合运营商提供了许多益处和能力。

ITU-D课题18/2对现有的系统向IMT-2000过渡已经有了已准备好的一套严密的方针。

I.2.3.1.3 CDMA2000和EVDO

I) 引言

现在，CDMA2000技术在83个国家中，有超过193个运营商提供给3.45亿以上用户使用[14]。CDMA2000代表了部分IMT-2000标准家族，包括CDMA2000 1X和CDMA2000 1xEV-DO技术[15]。CDMA2000 1xEV-DO的版本0传送的数据峰值速率为2.4 Mbit/s，而平均速率为300-600 kbit/s。

现在可以商用的CDMA2000 1xEV-DO修订版A在正向链路上提供峰值数据速率3.1 Mbit/s，在反向链路上提供峰值数据速率1.8 Mbit/s。修订本A影响了CDMA的IP体系结构和引入了增强措施，以支持对等待时间敏感的和带宽集中的应用，如IP电话（VoIP）和即时多媒体传信（IMM），并且它使运营商能够以较低的成本和跨越多个网络提供综合的话音、数据和电视业务。EV-DO修订版A的硬件是可以商用的并且它与CDMA2000 1X和与EV-DO版本0可以反向兼容。

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[12] 到2003年5月1日为止，包括三大洲的运营机构，例如：SK Telecom（韩国）、KTF（韩国）、 Monet Mobile（美国）、Giro（巴西）。来源：www.3gtoday.com

[13] "*CDMA/HDR: a bandwidth efficient high speed wireless data service for nomadic users*", Bender, P., Black, P., Grob, M., Padovani, R., Sindhushyana, N., Viterbi, S., Communications Magazine, IEEE , Volume: 38 Issue: 7, July 2000. Page(s):70-77

[14] www.cdg.org as of March 2007 and World Cellular Information Services (WCIS), https://wcis.emc-database.com/pub/emcdata.nsf/WCIS%20main3.

[15] CDMA2000 1xEV-DO, or CDMA2000 1xEvolution-Data Optimized is often referred to as EV-DO. The 3rd Generation Partnership Project 2, www.3gpp2.org, has the responsibility for standardizing the CDMA2000-based members of the IMT-2000 family. 3GPP2 has standardized both Revision 0 and Revision A of this technology as IS-856.

1xEV-DO的修订版B将考虑最多聚合15个1.25 MHz载波，以便当可以获得比较大的带宽时，甚至提供更大的数据吞吐量。CDMA2000 EV-DO修订版B标准支持下行链路每一频道最高4.9 Mbit/s，对一三个频道组合在一起时，下行链路的数据速率高达14.7 Mbps。通过多载波和64-QAM的调制方案，修订版B标准能够使下行链路吞吐量增加到73.5 Mbps，上行链路增加到27 Mbps。CDMA2000EV-DO修订版B的技术也能够大大提高网络的能力和改善性能。高通公司QUALCOMM预计，第1个商用的EV-DO修订版B的产品将是2007年末可以得到的数据调制解调器，其后很快可以得到附加的无线设备。

II) 标准的信息

IMT-2000技术规范在大量ITU建议书中作出了规定，最值得注意的是ITU-R M.1457建议书和ITU-T Q.174x系列建议书，这些建议书分别描述IMT-2000标准家族的无线接口和核心网。ITU-2000是ITU内部（ITU-R和ITU-T）和ITU外部（3GPP、3GPP2，等）的许多实体互相合作的结果。

III) EV-DO的能力：

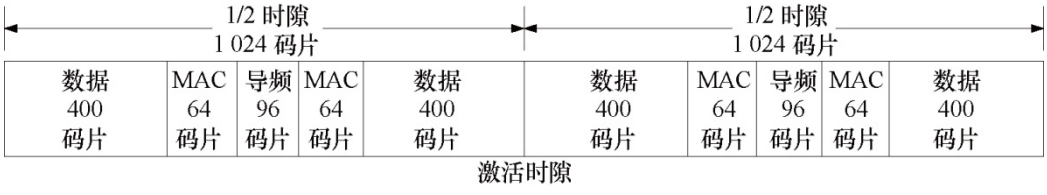
EV-DO标准家族提供如下关键能力/性能

- 全QoS和有效支持各种各样的分组数据应用，如对VoIP、可视电话、无线游戏、蜂窝一按通，广播/多播
- 可反向兼容的多载波支持，最大20 MHz
- 广播/多播
- 灵活的双工
- 混合频率重复使用

1xEV-DO版本0

如在IS-95和IS-2000系统中一样，1xEV-DO版本0的载波分配1.25 MHz带宽，使用1.2288 Mcps的直接序列（DS）扩谱。下行链路传输的基本定时单元是1.66……ms的时隙，它包含导频信道和MAC信道和包含业务或控制信道的数据部分，如图1所示。与一帧为20 ms的IS-2000不一样，在1xEV-DO版本0中1帧是26.66 ms。

图 8 — 1xEV-DO 版本 0 下行链路时隙结构



导频信道以满功率发射，每半个时隙96个码片，不仅提供业务信道和MAC信道的同步解调用的基准，而且也提供无线信道状态的1200 Hz取样。MAC信道由一个反向激活（RA）信道和负责反向功率控制（PRC）的信道组成。从一特定扇区来的RA信道提供1 bit，反馈给所有能够接收那个扇区正向链路的所有终端，指示出它的上行链路负载是否超过门限。业务信道在一个时间上给单个用户发送。1xEV-DO版本0使用-TDM下行链路，而不是在IS-2000系统的CDM下行链路。用于传输到接入终端的接入网所使用的业务信道数据速率由上行链路上的接入终端所发出的数据速率控制（DRC）消息所决定。H-ARQ和多载波用户分集的组合改善了在各种不同信道条件下的性能，前者造成在快衰落信道中的容量增加，而后者造成慢衰落信道中的容量增加。

1xEV-DO版本0中的上行链路与IS-2000中类似，主要差别是使用随机分布速率控制，通过直接测量热噪声升高（RoT）实现。上行链路的MAC信道协议确定每一接入终端所使用的规则和利用反馈控制条件下的一种分布算法。

1xEV-DO修订版A

由CDMA2000 1xEV-DO修订版A所提供的关键增强如下：

- 上行链路物理层有混合ARQ（H-ARQ）支持、高阶调制（QPSK和8-PSK）、更高的峰值数据速率（1.8 Mbps）和更细的速率量化。
- 上行链路MAC层有受竞争管理的多流QoS支持、对每一数字流的网络全面频谱效率控制和等待时间权衡以及更稳健的干扰控制机制，使得系统能够以更高的热噪声升高（RoT）或负荷来工作。
- 下行链路物理层有更高的峰值数据速率（3.1 Mbps）、更细的速率量化和短的包。短包造成传输时延减小和下行链路资源利用更好。
- 下行链路MAC层有包分多址（PDMA）、传输时延减小和无缝自适应服务器选择。传输时延减小是通过允许向报告零速率DRC的终端传输来实现的，而无缝自适应服务器选择消除了由于服务器改变引起的传输时延。使用PDMA以后，接入网能够使用同一个物理层包将数据传输到多个用户，所以，不仅改善了物理层的打包效率，而且也改善了传输等待时间。
- 对要求“即时连接”的应用，通过使用更短的包间间隔时间（它能够在快速建立连接和终端电池寿命最大化之间合理权衡）和更高速率的接入信道来快速建立连接。

下行链路

在DO Rev.A下行链路中对物理层和MAC层的关键增强如下：

- 短包，即128-bit、256-bit和512-bit
- 更高的峰值数据速率（3.1Mbps）和更细的速率量化
- 对传输格式的DRC指数的一个对多个映射
- 通过使用多用户包的包分多址
- 无缝自适应服务器选择

使用多用户包，即使用同一物理层的包将数据发送到多个用户终端的方法，能够实现链路（或打包）效率有实质性的改善。这一技术能够支持大量低速率的、对时延敏感的应用。下行链路调度程序使用机会调度不间断地为单个用户包服务，以便尽可能使用多用户分集。

上行链路

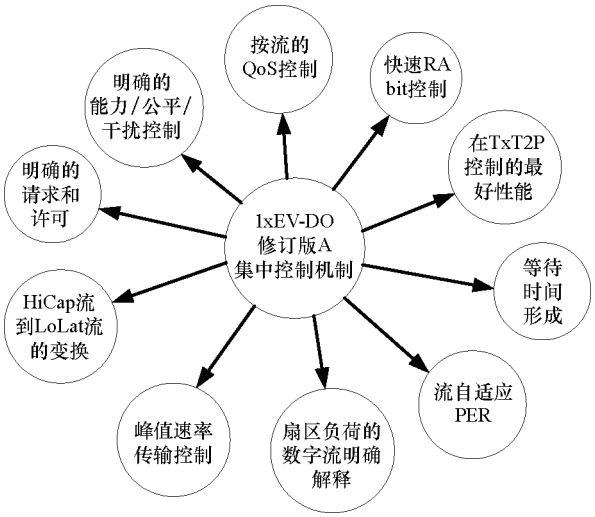
在DO Rev.A中对上行链路中的物理层的关键增强如下：

- 物理层H-ARQ
- 更高的数据速率（峰值数据速率1.8 Mbp/1.25 MHz）和更细的速率量化
- 用最小的信令开销进行综合集中控制

综合集中控制

1xEV-DO修订版A除了1xEV-DO版本0所提供的以外，还提供了供集中控制用的几种接入网机制。图9说明了在DO Rev.A中的集中控制机制。

图 9 — 在 1xEV-DO 修订版 A 的上行链路集中化控制机制



1×EV-DO修订版B（多载波EV-DO）

多载波EV-DO可与1**x**EV-DO修订版A反向兼容。为了多载波工作需要更新的终端时，基于1**x**EV-DO版本0或1**x**EV-DO修订版A的单载波终端可以在支持多载波工作的已演进的EV-DO网络上工作。1**x**EV-DO修订版B给端用户提供了更丰富的业务和改善了的用户体验，同时降低了运营商每bit的成本。多载波EV-DO规定了带宽高达20 MHz的系统，每一载波带宽1.25 MHz，终端支持一个或多个载波。运营商通过软件升级能够把基于多载波EV-DO的业务传递给1**x**EV-DO修订版A的信道卡。多载波设备可以在用1**x**（IS-2000）或1**x**EV-DO的单载波模式中或在用二个或更多EV-DO修订版A载波的多载波工作模式中工作。多载波EV-DO设备可能支持非邻近的CDMA信道工作，以使得由信道频率选择和各载波上的负荷均衡所得到的好处最大化。

基本概念

在多载波EV-DO中引进的基本概念如下：

1 通过多链路无线链路协议（ML-RLP）实现信道集合

1 对称和非对称工作模式

2 自适应负荷均衡

3 灵活的双工载波指配

4 终端电池寿命改进（通话时间和待机时间延长）

I.2.3.1.4 WCDMA和HSPA矩阵

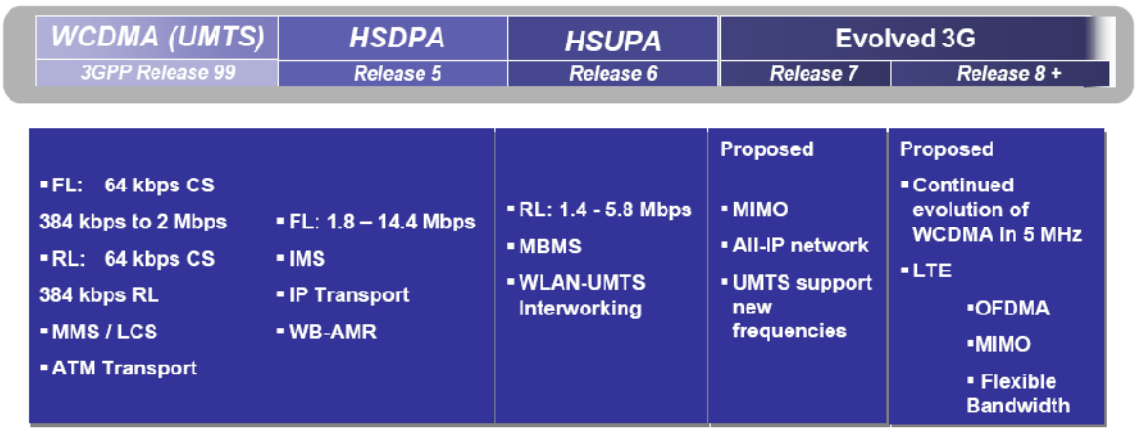
I) 引言

WCDMA技术是ITUIMT-2000标准家族的组成部分，而且现在，在59个国家中有超过134个运营商给1亿以上的用户提供了WCDMA技术[16]。WCDMA版本99下行链路理论上传递的最高速率刚好超过2 Mbps。虽然准确的吞吐量取决于运营选择的信道可用带宽、设备的能力和该网络中激活的用户数，但是，在商用网络中用户能够得到的峰值吞吐量的速率为350 kbps。下行链路的网络速度为384 kbps。在比较新部署的网络中，上行链路网络吞吐量的速率也为384 kbps，而用户可以达到的峰值速率为350 kbps。

在北美、欧洲、澳大利亚、日本、韩国、菲律宾、南非和中东中的大多数WCDMA网络已经启动HSDPA升级，以便提供全无线宽带的经验[17]。全球移动通信供应商联合会（GSA）的定期调查确认，在67个国家中，有147个网络运营商已经投入WCDMA-HSDPA系统，其中，在54个国家中的100个网络已经开办宽带无线接入业务。有200个以上的有HSDPA功能的设备，其中用于电话的超过80个。[18]

WCDMA是在保持反向兼容性的同时，提高移动宽带能力的一个已建立的比较好的演进路径。下面的图在提供关键增强的列表的同时，说明了WCDMA的演进轨迹。

图 10 — WCDMA 的演进轨迹



高速分组接入（HSPA）与3GPP标准的版本5和6中WCDMA无线接口的改进有关系。HSPA+与版本7和8中WCDMA无线接口的改进有关系。正向链路或下行链路被称为高速下行链路分组接入（HSDPA），而反向链路或上行链路被 称为高速上行链路分组接入（HSUPA）。HSDPA实现了下行链路数据传输速度高达14.4 Mbps。HSUPA实现上行链路数据传输速度高达5.76 Mbps。HSDPA和HSUPA都能在WCDMA网络的标准5 MHz载波内实现。HSPA+将增强VoIP这样的实时业务的容量和提供MIMO和反向兼容性。HSPA+在下行链路上提供14-42 Mbps的峰值数据速率，而在上行链路上，峰值数据速率高达11 Mbps，与先进性能的实施情况有关系。

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[16] World Cellular Information Services (WCIS), https://wcis.emc-database.com/pub/emcdata.nsf/WCIS%20main3 as of November 2006.

[17] Global mobile Suppliers Association at www.gsacom.com.

[18] Ibid.

II) 标准的信息

IMT-2000技术规范在大量ITU建议书中作出了规定，最值得注意的是ITU-R M.1457建议书和ITU-TQ.174x系列建议书，这些建议书分别描述了IMT-2000标准家族的无线接口和无线网。ITU-2000是在ITU内部（ITU-R和ITU-T）和ITU外部（3GPP、3GPP2等）的许多实体互相合作的结果。

III) WCDMA/HSPA的能力

WCDMA版本99

- 增加容量
  - 话音的容量性能明显增强。在使用AMR声码器（7.95到12.2 kbps）的条件下，在5 MHz的WCDMA版本99频道中，在GoS为2%时，估计话音容量约为70-100个用户[19]。
  - 下行链路和上行链路的扇区吞吐量显著增加。
- 更高的数据速率
  - WCDMA版本99的下行链路和上行链路的最高分组数据速率都为384 kbps。
    - WCDMA版本99的系统使用可变的扩谱率，规定了各种不同数据速率的信道。扩谱率越低，数据信道的速度越高。
  - WCDMA版本99的技术规定了电路交换的数据信道，提供恒定数据速率64 kbps。
- 通过QoS，增强业务和应用
  - 对现有的应用，在端用户的体验中有明显改善，
  - 电路交换可视电话，
  - 话音和数据同时的应用成为现实。
- 反向兼容
  - 重用GPRS核心网结点
  - 支持系统间（WCDMA-GSM）的切换

高速下行链路分组接入（HSDPA）

HSDPA是给移动宽带运营商提供增强下行链路的数据性能的一种技术，它能实现先进的数据业务。这一技术现在已被全世界的许多运营商广泛使用，它将下行链路中的高性能数据和增加系统容量得到的高峰值数据速率结合起来，把很短的等待时间性能与优越的链路预算及覆盖以及蜂窝边缘的高性能容量结合起来。

HSDPA是一个新的下行链路高速数据信道，它是作为版本5对WCDMA技术的增强部分引进的，作为常规的版本99WCDMA频道上面的一个重迭频道。版本5的载波被设计成同时支持HSDPA和R99的用户或者能够随意地部署在它自己的专用载波上。

虽然现在可以用的商用峰值数据速率在3.6 Mbps到7.2 Mbps的范围以内，但是在单个频道内，HSDPA提供的峰值数据速率为14.4 Mbps。HSDPA大大改善了3G端用户的数据体验，在下行链路中，它的数据容量超过版本99的百分之三百，而且与GPRS和EDGE技术相比，性能要高许多倍。

HSDPA把WCDMA提高到一个新的性能水平，由于它等待时间更短，时延更短和网络响应时间更快以QoS更好，它能够支持更丰富的宽带应用。

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[19] “Comparing HSDPA vs R99 Capacity v7”, QUALCOMM Internal Paper: Thomas Klingenbrunn, Jan 2005

由于HSDPA是可以与版本99技术反向兼容，它给运营商提供了平滑转移和灵活部署的可选方案。HSDPA的部署可以随所希望的网络投资而改变。

从版本99升级到HSDPA要在NodeB(3G基站)和RNC的功能方面都有少许改变。现在NodeB能够实现以前由RNC（R99）所实现的功能，它提供以下性能：

- 更快的反应时间，这是由于更有效的链路自适应和调度，NodeB的工作将能够有比较短的环路时延的缘故。
- 由于快速调度，使得能更有效地利用资源。
- HSDPA加入了H-ARQ，改善了重传效率。

下面是被加入的新的先进技术。在HSDPA中性能大大增强是由于加入到该技术的设计方案中的下列新的先进概念和技术：

- 新的高速物理信道
  - HSPDA模式引入了新的高速数据信道，被称为高速物理下行链路共享信道（HS-PDSCH），在时域上，将它指配给用户。在一个5 MHz WCDMA无线频道中工作的这些信道中有15个信道。在时间和码两个域中（HS-DSCH信道）指配资源。
- 快速链路自适应，更高级的调制和编码
  - HSDPA支持更高级的调制方案，包括QPSK和16QAM。16-QAM提高了数据吞吐量，而QPSK可在各种不利条件使用。
  - HSDPA使用的编码率从R＝1/3到R＝1。
  - 根据接收信号和信道环境的不同，给HSDPA用户分配一适当的调制和编码方案，以使得所传递的数据速率最大化。选择和自适应更新最佳的调制方式和编码率的过程称为快速链路自适应。
- 快速调度
  - 在快信道质量信息反馈和较短的TTI时隙的基础上，使得在HSDPA中使得有可能更快地调度资源。在保证用户之间的公平性的条件下，以最好的瞬时无线条件给用户分配业务资源。在调度程序确保每一用户得到最低水平的数据吞吐量服务的同时，调度程序很可能以更好的瞬时信号质量来选择用户。这一资源分配法被称为比例公共调度。
- 多用户分集
  - 因为不同用户的信道条件是不同的，每一用户在它处于理想无线条件下时得到服务。这一方法大大有助于使扇区吞吐量最大化，在那里该网络实现了有意义的用户分集和高得多的频谱效率，即系统有更多的用户时，所得到的扇区吞吐量将比用户比较少时要更高一些。
- 通过混合ARQ快速重发
  - 混合自动重发请求（ARQ）是将被重复的数据传输组合起来的过程，以提高成功解码的概率。这一技术是通过NodeB中的MAC层机制与调度及链路自适应技术一起来实施的。这一过程有助于以最最好的方式对基站上的实时无线电波条件的变化作出最好的响应，以便使总的数据吞吐量最大化和使时延最小化。
- 较短的传输时间间隔（TTI）帧
  - HSDPA首次引进了具有很短的TTI（2 ms）的分组数据帧，这一TTI比版本99WCDMA所用的10到20 ms的间隔要短得多。把分配给不同用户的分组数据在短短的2 ms TTI内，指配给这些信道中的一个或多个信道。然后，每2 ms重新调整网络如何把用户指配给不同的HS-PDSCH的方法。结果是为了更快重传和更严格地控制资源分配，在一短时间内指配资源。

高速上行链路分路接入（HSUPA）

HSUPA是在版本6中标准化的，它把HSDPA的好处推广到上行链路。HSUPA引进了一新的物理信道，称为增强的专用信道（E-DCH），它实际上引进了一整套增强措施来优化上行链路的性能。HSUPA加入了与在HSDPA中相类似的概念和原则，包括以下方面：

- 快速上行链路调度
- 使用混合ARQ上行链路达到快速和有效的重传
- 上行链路用更短的TTI帧

上行链路的新模式实现了大大增强的性能，包括提高吞吐量、减小等待时间和提高频谱效率。启动HSUPA对NodeB，只要求物理层和MAC层改变，而对RNC，只要求MAC层改变。

HSUPA模式将提供高得多的峰值数据速率，高达5.76 Mbps，几乎使上行链路蜂窝容量加倍，与版本99相比，等待时间减小达85%，并实现了大大改善用户的数据速率。附加技术，如干扰抵消和4-Rx接收分集使HSUPA系统的蜂窝容量几乎提高了400%。

HSUPA也大大减小了分组的时延。短的TTI、快速调度和快速混合ARQ的组合与下行链路类似，用来减小等待时间。HSUPA提供了改进的QoS控制，它考虑了更好的利用上行链路系统的资源。HSUPA实现了在NodeB上的空中链路资源的严格控制和上行链路更新的快速调度，这些与下行链路中的HSDPA非常相似。

HSUPA的UE（用户单元）与版本99和HSDPA反向兼容，用同一载波能够支持HSUPA、HSDPA和版本99。

具有增强上行链路性能的HSUPA再加上HSDPA模式一起在提供对移动宽带业务提供最好的支持方面把WCDMA技术引到一个新的水平。HSDPA和HSUPA的组合定名为HSPA，它对时延敏感的应用如VoIP、可视电话和其它游戏应用提供了更好的支持。对上行链路的密集应用，如发送文件和传送电视和图像消息的应用，HSPA提供了大大改善的用户体验。

由于HSUPA所带来的在上行链路中性能的新的增强提供了更好的链路预算，从而再转化为在市区和乡村应用中用更大的蜂窝来扩大覆盖。

I.2.3.1.5 WiMAX

2007年10月18日，ITU无线电通信全会作出了一个全球性的重要决议，在IMT-2000成套标准中纳入由WiMAX而来的技术。这一协议为给固定和移动设备使用各种各样的话音、数据和多媒体业务铺平了道路。值得注意的是它开启了移动互联网满足城乡两个市场需求的大门。ITU无线电通信全会（RA-07）正式认可了源自IEEE802.16的技术，将它作为第六种地面的IMT-2000无线接口。自从多年前采纳了最初的五种接口作为全球使用的3G无线电标准组成部分以后，这是对IMT-2000的首次增加，并将大大推动IMT-2000能力的技术状态[20]。

IEEE802.16标准，或者称为WiMAX（微波接入全世界互操作性，公司），从实现大众市场采用的成本的观点来看，它在全IP的无线网络上实现了真正的宽带速度。WiMAX有传递真正的宽带速率的能力，有助于使普遍连接的幻想成为现实。现在，全世界有超过475个商用WiMAX网络。已经为固定、游牧和移动应用开发了WiMAX标准。WiMAX提供了宽带和移动性两方面的组合。WiMAX使业务能力加四倍。

移动WiMAX是以OFDMA（正交频分多址）技术为基础的，在吞吐量、等待时间、频谱效率和先进天线支持方面是有利的，最后，它能够提供比今天的广域无线技术更高的性能。许多下一代4G无线技术很可能利用OFDMA和全IP网作为传递成本效益好的无线数据业务的一个理想工具。

[20] http://www.itu.int/newsroom/press_releases/2007/30.html

用户通过WiMAX网络能够得到能够负担得起的无线宽带业务。WiMAX论坛（www.wimaxforum.org）有500个以上成员，全球正在部署经WiMAX认证的产品。WiMAX将是宽带市场中的竞争者，所以，降低了与消费者有关的成本。使用WiMAX的应用包括医疗、教育、电子政务、电子商务、安全等。2006年1月，WiMAX论坛发布了第一个无线宽带网产品，现在有112个经认证的产品。从不同的供应商可以得到经过认证的移动WiMAX产品。WiMAX作为一种先进的宽带无线技术能够同时在发达国家和发展中国家中应用，给解决今天对许多国家（包括发展中国家）有破坏性的数字鸿沟问题提供了一个机会。

WiMAX标准：要考虑下面两个WiMAX标准

— IEEE802.16-2004/ETSI Hiperman（2004年6月完成的 — 支持固定和游牧应用）

— IEEE802.16e-2005（2005年12月完成 — 固定、游牧和移动应用）

ITU已经认可和ETSI已经协调的WiMAX标准如下：

- IEEE802.16-2004标准，在ITU-R F.1763建议书中认可
- IEEE802.16-2005标准（也称为IEEE802.16e），ITU-R M.1801建议书中认可

IEEE802.16-2004标准（固定、游牧）：依据IEEE802.16-2004空中接口标准的固定WiMAX已经证明是对电缆和DSL业务的一种成本效益好的固定无线替代系统。

这是以IEEE802.16标准的802.16-2004版本和以ETSI Hiper MAN为基础的。它使用正交频分复用（OFDM）技术和支持在视距（LOS）和非视距（NLOS）环境中的固定和游牧接入。WiMAX论坛最初的轮廓是在3.5 GHz和5.8 GHz频带中。

IEEE802.16e标准（移动WiMAX）：2005年12月，IEEE批准了修订IEEE802.16-2004标准的IEEE802.16e。这一修订版给该标准增加了支持移动性所必需的性能和属性的内容。IEEE802.16e标准支持固定、游牧和移动业务。

为了改善非视距环境中的多径性能，移动WiMAX空中接口采用正交频分多址（OFDMA）。将OFDMA引入IEEE802.16e修订版，以支持频道宽度可以扩大或缩小。

移动WiMAX是对动态移动无线电信道进行优化的，提供对切换和漫游的支持。它使用正交频分多址（OFDMA）和利用子信道配置的多载波调制技术。

WiMAX论坛中的移动技术组（MTG）正在开发移动WiMAX系统的轮廓，它规定了IEEE标准的强制实现的性能和可选的性能，它是建立一个移动WiMAX相兼容的空中接口所必要的，空中接口可以由WiMAX论坛进行认证。移动WiMAX系统轮廓使得移动系统能够根据通用的基本性能集来构建，所以保证了终端和基站的基本功能可以完全互通。基站轮廓的某些要素是作为可选项规定的，以便为根据具体的使用场景进行部署提供附加的灵活性，这些场景可能需要不同的配置，或者是按容量优化的，或者是按覆盖优化的。

Wave-1版本的移动WiMAX轮廓包括5、7、8.75和10 MHz的信道带宽，用于在2.3 GHz、2.5 GHz、3.3 GHz和3.5 GHz频带中的全世界要有许可证的频谱分配。

Wave-2版本移动WiMAX轮廓将包含如MIMO和射束成形这样的关键的先进性能。这些和其它增补的性能改善了链路余量、信道吞吐量并增补了支持附加宽带业务的其它性能增强。

移动WiMAX（IEEE802.16e）的基本性能

高数据速率：MIMO天线技术和灵活的子信道配置方案及先进的编码和调制技术使得在10 MHz信道内，若DL/UL比为3：1，则WiMAX技术能够支持下行链路（DL）扇区峰值数据速率高达46 Mbps；若DL/UL比为1：1，则WiMAX技术能够支持上行链路（UL）扇区峰值数据速率高达14 Mbps。

业务质量（QoS）：IEEE802.16e MAC体系结构的基本前提是QoS。它定义了能够映射到Diffserv（区分服务）码点或MPLS（多协议标签交换）的流标签的业务流，能够实现端对端的基于IP的QoS。此外，子信道配置和基于MAP的信令方案为在逐帧基础上的空中接口上的空间、频率和时间资源的最佳调度提供了一个灵活的机制。由于有了高的数据速率和灵活的调度，能够更好地加强QoS。与基于优先权的QoS方案相反，这一方法能够在逐个客户的基础上，对各种各样的业务类型提供有保证的业务水平，包括承诺的和峰值信息速率、等待时间和抖动。

伸缩性：尽管经济日益全球化，全世界无线宽带的频谱资源的分配仍然是非常不相同的。所以，把移动WiMAX技术设计成可调整的，能够在不同的信道配置中工作，以符合全世界各种各样的要求，这是为在比较长的时期内着手实现频谱协调化而进行的努力。这也使得不同的经济体对它们具体的地理需要，能够实现移动WiMAX技术的多方面的优点，如在乡村环境中，提供可以负担得起的互联网接入，而在大城市和郊区，要提高移动宽带接入的容量。

切换和漫游：在802.16e为移动接入作的修订中，支持切换是另一个重要的补充。当在跨越蜂窝边界移动时保持连接的能力是移动性的先决条件，它作为一个要求纳入802.16e系统轮廓中。802.16e WiMAX支持不同类型的切换，从硬切换到软切换，并且由运营商在它们之中进行选择。在802.16-2004和802.16e WiMAX中都能实施跨业务提供商的漫游能力，但是它们对便携和移动接入有特殊价值。

移动性支持：802.16e的产品对移动性进行优化，并将支持切换。支持功率节省和睡眠模式将延长移动用户设备的电池寿命。

更好的室内覆盖：它通过子信道和AAS来实现，对固定和移动应用都是有利的，因为用户经常在室内，或者不在视距以内。

在管理频谱资源中更大的灵活性：子信道配置还带来了使用网络智能按需要给用户设备分配资源的能力。事实上，这导致更有效的使用频谱，得到更高的吞吐量和更好的室内覆盖，而且在某些情况下，降低了部署成本。这对只有有限频谱的运营商是特别有价值的。

对多径干扰和自身干扰的容忍度：在下行链路（DL）和上行链路（UL）两个方向上都有子信道正交性。

时分双工（TDD）：由于它在支持不对称业务中有很好的效率和由于它的信道的互易性有效地支持先进的天线系统，它是为最初的移动WiMAX轮廓确定的。

混合的自动重发请求（H-ARQ）：在高移动性的情况下，随快速改变的路径条件提供更高的稳健性。

频率选择调度和子信道配置：有多种排列的可选方案，在逐次连接的基础上，给移动WiMAX提供根据相对信号强度来优化连接质量的能力。

电源保护管理：为了保证依靠电池工作的手持或便携设备在睡眠和空闲模式中电源高效工作。多播和广播业务（MBS）：将DVB-H和3GPPE-UTRA的性能组合起来。

先进的天线系统（AAS）：借助于子信道配置和信道互易性的支持实现各种各样的先进天线系统，包括MIMO、射束成形，空时编码（STC）和空间复用（SM）。

部分频率重用：控制同频道干扰（CCI），以便支持通用的频率重用，而频谱效率的降低最小。

宽带增值业务：包括数据、电视业务以及VoIP。

普通覆盖：在各种各样的人口调查环境中的非视距条件下。

安全性：EAP鉴权，用AES-CCM加密，CMAC鉴权，X.509认证，密钥捆绑，互相鉴权，器件和用户鉴权。

实时应用：低等待时间和QoS。

互通：移动WiMAX网络将能够与其它技术互通，并且支持像IMS那样的新兴体系结构，使得运营商能够跨越多种有线和无线接口做同样的可以用的应用和业务。

附加的WiMAX的好处包括它的开放标准步骤和健康的生态系统。数百家公司已经致力于开发该技术。广大的工业界参与和全世界采用将保证经济规模，从而有助于推动低成本的签约费，和能够在发达市场和新兴市场两个市场中使用各种各样的宽带移动业务。

I.2.3.2 IEEE802.16-2000（2k）OFDMA模式 — 移动扩充矩阵

这是ETSI EN-301958(DVB-RCT，DVB-T在全世界广泛使用)利用2k FFT的一个外延。2k OFDMA支持移动和固定两种工作方式，在802.16REVd标准下，尽管还没有为任一个ITU-R建议书所认可。

OFDMA将FDMA和TDMA的接入方案与扩谱的概念结合起来。OFDMA用给每一用户指配多个子信道和多个时隙的方法，在用户中分配带宽（BW）资源。为了达到频率分集效果，子载波在整个频谱上伪随机散布。

2K OFDMA具有将来可能出现的移动IP系统所需要的如下所有代表当代技术水平的性能：

- 高的子信道数目 — 80（处理增益系数19 dB）
- 短的开销 — 最大15%
- 大的FFT规模 — 高的频率选择性，能够支持长的时延扩散；对大蜂窝和低频率工作，宽的带宽容量（2.5-28 MHz）和很高的吞吐量（峰值4 bit/(s*Hz)）。
- 支持新的天线方案，像MIMO、STC、AAS（自适应天线系统）和正规的MRC（最大比例合成）天线分集
- 短环回时延的短帧和所有ITU的移动性等级（包含250 km）
- 自适应的高效编码方案（Turbo方案）
- 短时延的ARQ方案
- 自适应的调制和编码率（QPSK、16QAM、64QAM和5/6、3/4、2/3、1/2、1/3、1/4、1/6、1/8、1/12），它能够扩展范围和在SNR为负值（− 5dB）下进行工作
- QoS支持（几个等级），利用子载波的小粒度（6字节）
- 自适应子信道控制
- 覆盖缺口的快速傅立叶变换
- 高效节电模式
- 正向和反向APC（自适应功率控制）
- 包含移动IP的高效切换
- 物理层中的软切换（HO）能力（宏分集）
- 在第2层以上的平滑切换（不丢包）
- 像电视/声音那样，向整个网络广播信息用的单频网络
- 为把广播和电信网络和应用汇合在一起的广播。

系统性能

在重用1（所有的扇区和蜂窝都用相同频率）时，若使用SISO（单进单出）或开环MIMO（多进多出）解决方案，每扇区容量为0.7-1.1 bit（1/Hz）。在6扇区情况下，蜂窝的容量可提高到6 bit(1/Hz)，而在会聚多于24扇区的情况下，预计的容量为18 bit(1/Hz)/蜂窝。在覆盖优于95%的许多条件下，包括ITU-R的车载条件、对数 — 正态10 dB衰落和瑞利衰落条件下，能够达到这一性能。

蜂窝的规模与现在的蜂窝系统类似（指在不同的场景和发射功率方面，但数据速率更高），对市区、郊区和乡村，包括室外到室内，使用小的和大的蜂窝半径。2k OFDMA支持所有其它的系统要求 — 安全性和IP模式。在固定工作中，若在用户侧使用是向天线，距离可延伸到50 km，系统容量可以增加到4倍。

I.2.3.3 大容量空分多址（HC-SDMA）无线接口技术和iBurstTM宽带无线技术矩阵

I.2.3.3.1 HC-SDMA概要

HC-SDMA是由电信工业解决方案联盟（ATIS），以前的T1委员会开发的新的ANSI（美国国家标准化协会）标准，它遵循联盟的宽带无线互联网接入（WWINA）的要求并且在早已在几个大陆上商用的iBurst宽带无线系统中得到体现。在经过商用验证的技术的基础上，HC-SDMA标准规定了广域移动宽带iBurst系统的无线接口，提供高速、宽范围和高基站容量的组合。iBurst系统是一端到端的，基于标准的全IP的用于无线数据和VoIP的解决方案，所采用的设备是可以从主要生产厂家买到的。现在市场上可以买到的端用户设备包括PCMCIA卡和台式单元。PCMCIA卡供笔记本电脑和PDA用户用，而台式单元是供家庭和小的商业用途用。现在用的路由器和接入点也可以与台式单元直接连接。今天，iBurst解决方案给每用户提供的数据速率超过1 Mbit/s。iBurst基站在不成对的频谱中工作，在5 MHz内，提供的网络可用吞吐量为20 Mbit/s，而在10 MHz内，为40 Mbit/s。iBurst系统已在澳大利亚和南非进行商业部署。在美洲、亚洲、欧洲和非洲，该系统还有几个试验性部署。

HC-SDMA标准利用时分复用（TDD）和自适应天线（AA）技术，和最新技术水平的空间处理算法一起，产生了一个世界上频谱效率最高的移动通信系统。该系统只用单个（不成对的）对移动业务要许可证的5 MHz频带频谱就能够提供移动宽带业务。iBurst设计成在低于3 GHz的要许可证的频谱中工作，提供完全的移动性和广域覆盖，这一点最适用于移动应用。因为该系统以TDD技术为基础，不需要由适当的频带空隙或双工频率间隔分隔开的对称的成对频带，所以，对不同的频带，iBurst能够比较容易重新划分频带。

I.2.3.3.2 HC-SDMA无线接口描述

HC-SDMA无线接口的主要接口如下：

- TDD/TDMA，625 kHz信道间隔
- 每用户的峰值数据速率，下行链路最高16 Mbit/s，上行链路5.5 Mbit/s[21]
- 频谱效率4 bit/s/Hz/蜂窝（在5 MHz内20 Mbit/s）
- 下行链路/上行链路吞吐量不对称性3：1
- 分层次调制和信道编码用于链路质量自适应
- 为了在覆盖区内实现无误码链路的前向纠错（FEC）和自动重发请求（ARQ）
- 按需分配带宽，动态资源分配

[21] 通过载波聚合达到的峰值速率。现在可以买到的PCMCIA和台式调制解调器支持单载波，与下行链路每用户峰值速率1 Mbit/s，上行链路峰值速率345 kbit/s相对应。预计2005年末可以买到载波聚合调制解调器。

- 用来提高信号质量、资源管理和碰撞解决的自适应天线空间处理
- 移动性（切换）支持
- 内置空中接口业务质量（QoS）支持。

空中接口切换

端到端IP会话的切换是在无线电网络中从一个蜂窝切换到另一个反映新的提供业务的蜂窝并与重新选择端用户的IP会话的路由相结合的结果。由HC-SDMA空中接口所支持的一种承载工具是点对点协议（PPP），它在IP业务提供商和端用户设备（如膝上型电脑）之间将IP数据封装起来。（IETF RFC 1661等的）PPP是一种低开销 — 每-IP包1到2字节 — 的隧道协议，有利之处是IP设备几乎普遍能买到并且在业务提供商的网络中普遍部署了用于PPP终结、配置、计费、额定值等等的设备。PPP还有隔离传送网中IP会话的优点，所以，像社团的VPN中所使用的那样，容许重叠地址空间。现在空中接口所支持的一种切换是3GPP2为微移动性所使用的少量的简单IP模型（参见3GPP2 P.S0001-B，“无线IP网标准”），必要时，由移动IP（参见IETF RFC 2002等）补充，例如当切换到不相似的像802.11这样的接入网时。

HC-SDMA空中接口的先连接后切断的切换方案是受用户终端（UT）控制的。每一UT监视从周围的基站（BS）来的广播信道，根据信号功率和其它因素排好候选者次序。UT能够完成这些测量以及登记候选的新的服务基站，同时，用它当时服务的基站切换业务信道（TCH）的数据。对用户数据的切换是先连接后切断，TCH的数据改道到成功登记后的新的服务基站。

自适应天线（AA）技术

HC-SDMA标准的核心是自适应天线（空间处理）技术，它显著地提高了无线电频谱利用效率并导致无线网络的容量、覆盖和业务质量的极大改善。

AA技术通过干扰管理和改善信号质量来产生这些重要的利益。典型的基站使用一付天线或一对天线，与它的用户进行通信。配备自适应天线的基站使用一个小的天线群（即“天线阵”）和非常高级的信号处理方法，大大降低了基站所辐射的额外能量的量。同时，信号处理使得基站能够有选择地“收听”它的用户的信号，从而减轻了该网络中其它用户所呈现的干扰效应。天线阵还在信号功率上提供增益，因而，在基站和用户终端所辐射的总功率量相同的情况下，提高了无线电链路的质量。链路质量改善转变为更高的数据速率，工作范围扩大和用户终端上的电池寿命更长。

用了AA技术后，消除了蜂窝间的干扰，所以，网络中的每一蜂窝可以使用同一频率分配。事实上，AA技术用把能量只指向需要它的地方的方法，甚至能够使系统在一给定的蜂窝内，多次重复使用一个频率分配。

HC-SDMA无线接口的频谱效率

频谱效率是无线系统用一给定的无线频谱量传送信息，（即“数据业务”）的能力的量度。在蜂窝无线电系统中，以 bit/s/Hz/蜂窝来衡量频谱效率。许多因素对系统的频谱效率有影响，其中包括调制格式、空中接口“开销”（用户数据以外的信令信息）、多址方法和使用模型。这些因素对该单位 bits/s/Hz的各个维都有影响。出现“每蜂窝”的维度似乎令人惊奇，但是，在蜂窝网中的一特定的蜂窝基站的吞吐量几乎总是大大低于孤立的单个蜂窝的吞吐量。原因是网络中产生的自干扰，要求运营商分块分配频率，这些频块在空间上隔开一个或多个蜂窝。这一间隔用重复使用系数来表示，数值较低代表频谱效率更高的系统。

HC-SDMA系统的频谱效率在下面计算中说明：

- 625 kHz载波
- 每载波三个时隙
- 每时隙用户数据速率475 kbit/s
- 有效的频率重复使用模式1/2

它将产生如下频谱效率：

（3时隙×475 kbit/s/时隙）/625 kHz/0.5=4.28 bit/s/Hz/蜂窝

无线电系统的容量和经济学

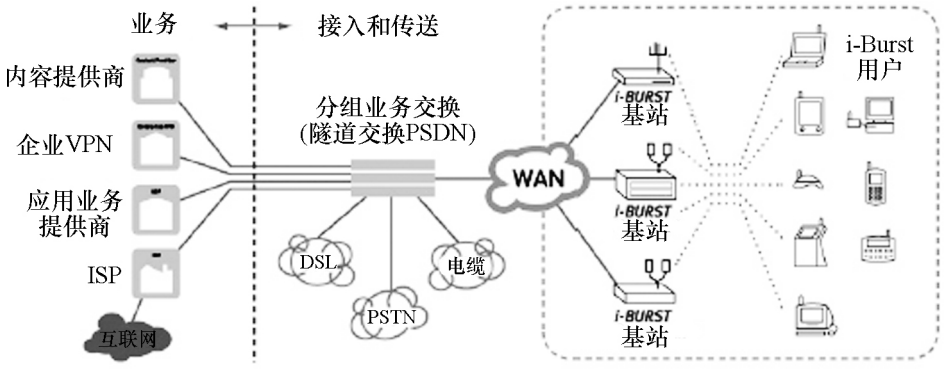
HC-SDMA系统的频谱效率4 bit/s/Hz/蜂窝意味着，与其它技术将会需要的数值相比，HC-SDMA无线电网络能够用少得多的基站和少得多的频谱来支持一给定的客户基数，所以，大大降低了所需资金和运行成本。例如，用10 MHz的可用频谱，每一HC-SDMA基站将提供40 Mbit/s的接入容量。AA技术在链路质量或信号强度方面的改善大致上转变为HC-SDMA系统的工作距离加倍（或面积的四倍）。

I.2.3.3.3 iBurst网络的体系结构

公共的接入和传送网的体系结构

图11表示了公共的接入和传送的iBurst网络，它使得几个业务提供商能够同时给它们的相关用户提供优质的业务。接入和传送运营商的独立的商业单元本身可以是那些业务提供商之一。

图 11 — 公共的接入和传送网



接入和传送运营商汇集各种各样的“最后1公里”接入技术并再将端用户会话切换到适当的业务提供商。这一方案的关键是分组业务交换（PSS），它起一个汇合点的作用和选择用户会话路由的交换盘的作用。一般，根据在PPP鉴权期间由该用户所提供的构成用户名作出切换的决定。例如，在“joe@aol.com”中的联机将使用户的会话引向AOL（美国在线）的网址并要求对用户“joe”鉴权，而在“mary@hercompany.com”中的联机将造成用户的会话连接到hercompany（她的公司）的网址，多半是为社团的VPN接入，并请求对用户“mary”进行鉴权。在主要的ISP和电信公司的网络中，广泛使用PSS技术。除了将来自各种各样的媒体的用户会话汇集起来以外，PSS以统一的格式将这些会话递交给业务提供商的网络，业务提供商不必为每一接入类别保留不同内容和业务库。

I.2.3.3.4 iBurst协议栈

iBurst系统在业务提供商和它们的客户之间实现通过PPP的端对端的IP连接，这与有线接入领域中的主流业务模型相一致。从图12中的左边移动到右边，我们能够看到，用户的PPP会话是由各种不同的媒体和协议承载的。

图 12 — iBurst 用户数据网的部件和协议栈

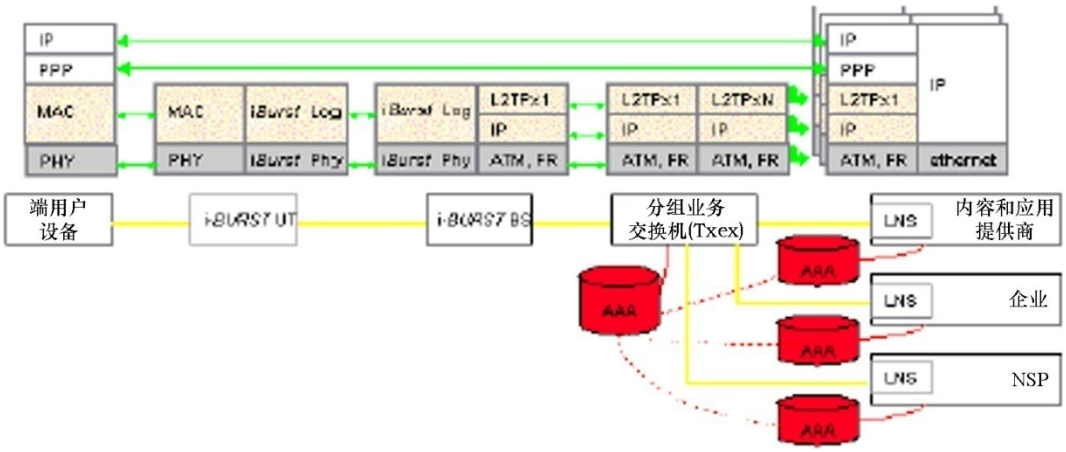


图12也表示了在接入和传送域和业务域之间的鉴权、授权、计费（AAA）服务器和AAA连接。

I.2.3.3.5 iBurst网络业务提供

移动业务提供

移动连通是通过iBurst接入卡提供的。当连接到如膝上电脑或PDA这样的移动设备时，只要该设备保持在网络覆盖区内，它提供移动的连通。

固定/便携业务提供

iBurst接入桥以主要的固定模式提供连通。该设备看起来与传统的调制解调器相似。它有一个电源连接头，一小的加长天线和一些端口。端口能够通过以太网或USB连通。这提供了固定宽带连接的益处，又加上了便携性，只要简单地拔下电源插头就可以断开业务，并且只要把它移动到一个新的位置，再给iBurst接入桥加上电，就能够重新连通。可以将iBurst接入桥连接到单个计算机供接入用或者它附属于局域网或无线网，供在家中或办公室中的几个设备之间共享接入用。

Arraycomm是一个注册商标，而iBurst是Arraycomm公司的一个商标。

I.2.4 宽带接入作为互动式数字电视广播的可能解决方案

用于互动式数字电视广播（iTV）的宽带无线接入有如下主要特性：

- 大的数据容量：每一个5、6、7或8 MHz频道高达20 Mbit/s（遵循ITU-R BT.1306建议书的ASTC、DVB、DMB-T、ISDB-T）。
- 大覆盖。

A 互动电视

- 宽带接入技术对互动电视应用是很重要的。
- 通常认为互动电视系统是一个固件包，它将电视业务提供商与具有两条通信信道 —广播和互动 — 的观众连接起来。在ETSI制定的欧洲电信标准（ETS 300 800-ETS 300 802）中给出了互动电视系统的最直观的通用化的框图。
- 在互动电视系统中，电视信号在网络适配器中与互调业务提供商的数据相混合，并通过传送设施进入互动电视端用户的终端。在该终端中，包含电视、声音和数据的内容被解码，并在普通的电视机屏幕上显示出来，但有了以图形菜单、询问进入域等形式的扩充。
- 借助于遥控盘或通过借助于无线的键盘输入数据，端用户能够选择菜单的项目。
- 互动电视用户终端（一般称为机顶盒或STB）将普通电视机转变为智能电视机，它在该平台中处于中心位置。所有所谓的STB通常分为三类：广播电视STB、增强电视STB和高级业务STB。最后那一类STB与多媒体台式PC机相似。它们的计算能力大了许多倍，并且它们通常有一个记录电视信息和数据的硬盘。
- 传送协议现在由ETSI开发，这样的协议的试验正在进行中。

B 电视宽带的基本技术

已经确定分类的无线接入网的主要类型如下：

- WPAN个人无线接入网用于在一工作站的框架内的各设备的无线连接。蓝牙就是这样的技术的一个例子。
- WLAN无线局域网。它们的主要标志是为在一大楼内部的信息资源提供接入手段。它们的第2个重要用途是把在公共场所（如旅馆、飞机场、咖啡店）的商业社团接入点（热点）以及在像研讨会、展览会等这样的事件期间的临时网络的机构组织起来。WLAN无线局域网标准是以IEEE 802.11标准为基础的。这样的网络也被称为Wi-Fi（无线相容认证）。
- 无线接入分布式无线网和城域网WMAN和WiMAX（IEEE 802.16）。
- MMDS（微波多点分配业务）是宽带无线接入的可选方案和电缆网要面对的方案。

B.1 WiMAX在无线接入技术中的特殊地位

与其它类型的网络不一样，分布式网络无线接入（其它名称是BWA,WiMAX）是大都市规模的网络WMAX（无线城市接入网）、地区规模和运营商级的网络。该等级的网络主要是为其它用户类别设计的，譬如说，就它们解决的任务而言，它与Wi-Fi是完全不同的。

分布式网络技术（不像WLAN、Wi-Fi）从一开始就使用无碰撞的接入方法，它能够给客户提供具有固定时延（最小抖动）的固定的数据传输信道，这对大楼的运营商级网络来说是一个必不可少的要求。

设备标准化

直到现在，大楼的WMAN网络的设备是按设备生产厂家的某些有专利商标的协议来工作的，它们不是标准化的或者是不可兼容的。2004年夏季，IEEE 802.16标准的最终版本出版了，并且不同生产厂家的设备经过了鉴定认证，开辟了各生产厂家的宽带无线接入设备标准化的道路。

IEEE 802.16标准

IEEE 802.16标准是为分布式无线网（无线接入）设计的第一个标准（标准群）。

该标准是为构建大都市规模的无线网来设计的，它为用户提供现在通过电缆可以接入的所有类型的现代业务。它是为无线MAN，宽带无线接入等级的无线系统的第一个标准。

该标准对基站和用户设备做了描述。

标准 802.16 群的比较表

标准	802.16	802.16a
批准日期	2001年12月	2003年1月
频率范围，GHz	10-66	2-11
工作条件	直接视野	无直接视野时工作的可能性
传输比特率，Mbit/s	32-134	1.0-75
调制	QAM, 一个载波	QAM, 一个载波 OFDM, 256子载波 OFDM, 2 048子载波
蜂窝半径，km	2-5	4-6

该标准的最初版本包含的频率范围为10-66 GHz，它是单载波模式（单载波SC —— 一个子载波）工作的。在该频带中特殊的无线电波传播模式使系统的工作受直接视界范围的极限所限制。

在典型的城市环境中，它只能连接约一半用户。按惯例，其余的50%用户不存在直接视距的条件。这促使开发标准802.16的增补版本，涉及2-11 GHz频带。除了单频工作外，在下述的基础上，重视使用正交频分复用（OFDM）和多址（正交频分多址，OFDMA）。

同时传输256个子载波的OFDM模式使得同时接收直接信号和反射信号成为可能或者在直接视界极限以外的反射信号上工作。

2004年，IEEE协会批准了802.16-2004标准，替代以前的802.16、802.16a和802.16REVd版本。

现在，WiMAX联盟开辟了一条道路，根据最终标准802.16-2004制定所设计的规范，以保证不同生产厂家所提供的设备的兼容性。

所以，WiMAX技术是一个运营商级的技术，给全体居民提供多媒体宽带无线接入的高质量业务。

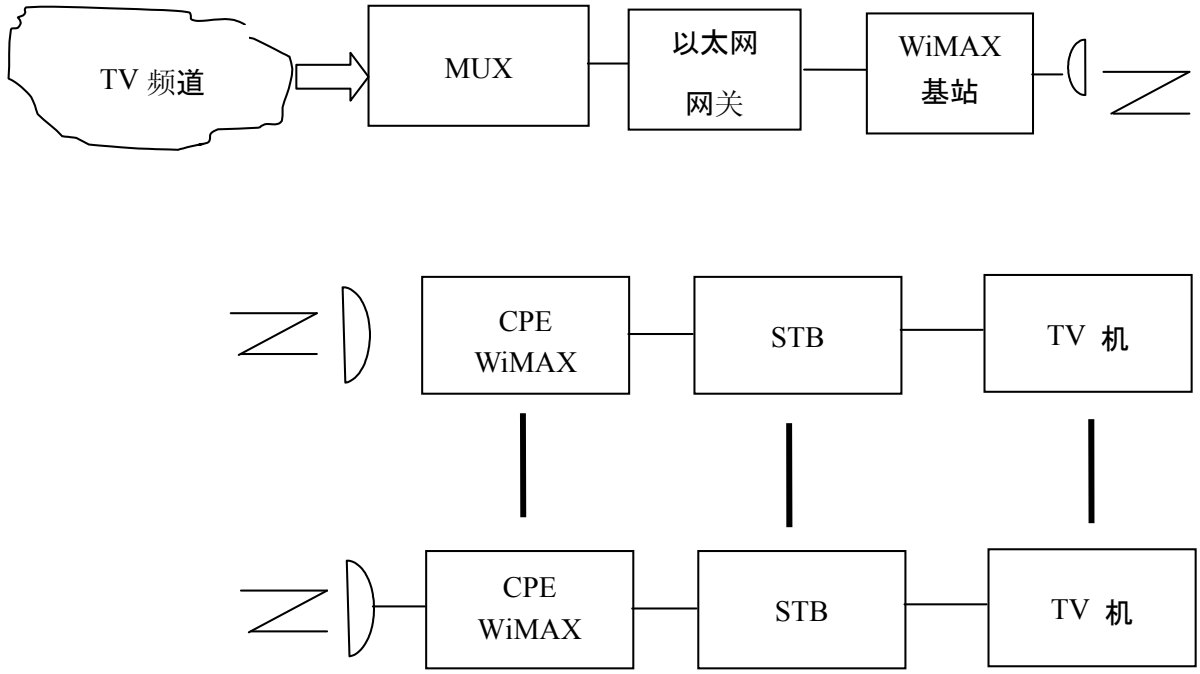
表征现代无线接入发展趋势的特性是多业务性和由此而来的宽带性。

从理论上看，现代的用户对通过如SDH或以太网这样的电缆连接现在可以接入的任何一种业务都不应该感到有任何约束。假设按照WiMAX来鉴定的最新系统将使宽带接入网的运营商能够给用户提供如IP和E1这样的业务，因而，能够替代ADSL接入的基础设施和所分配的线路。

以WiMAX技术为基础的互动电视。

图13给出了以WiMAX为基础的互动电视的方框图

图 13 — 基于 WiMAX 的互动电视方框图



主要设备组成

1) 基站设备
   - 带N型接头的外部无线电模块，用于通过功分器在几个天线中的切换。
   - 带基站控制器的内部网络处理模块，它控制所有基站设备部件和用户设备。
   - 在WiMAX硬件入口处的形成彩式信号的DVB设备和一个DVB以太网网关。

2) 用户设备
   - 带集成天线的外部收发信机模块或带N型接头的外部收发信机，用于一副天线中的切换，以保证用一单独天线情况下得到最大覆盖。
   - 有互动电池机顶盒功能的内部模块和与用户的电视机相连接的必要接口。
   - 从基站能有直接视界的最简单情况下，可以使用有内置天线的单块结构。

B.2 MMDS技术

- **定义**

多年来，MMDS（微波多点分配业务）已经广泛铺开作为经典的电缆网的一个替代方案。在经典的电缆网中，分配网是由同轴电缆或光缆构成的。

在西半球，现在已经部署了许多MMDS系统，提供到互联网的接入、提供互动电视和其它用无线接入技术的宽带业务。世界上有几家公司生产了能够给安装了MMDS的收发信机天线的覆盖区内的任何远方的用户提供高速接入到互联网的设备。

根据美国组织所作的研究结果，部分大众消费者对宽带接入业务的需求正在增长。到2006年为止，预计仅在美国，MMDS系统用户的数目达到90万（在2000年，这一数值刚好为2万）。

欧洲的DVB项目除了卫星、电缆和地面网络外，还包含MMDS系统（2.5-2.7 GHz）。

- **互动的数字MMDS**

在传统的MMDS中，电视频道的数目受限于频带2500-2700 MHz的相当窄的带宽，即只有200 MHz带宽。例如，在俄罗斯的D标准（每一频道8 MHz）情况下，最多可容纳25个频道。在数字DVB标准情况下，在每一电视频道的频带中，电视节目广播能够传输5到7个数字节目。在数字MMDS中，采用DVB-C电缆数字电视，使用64 QAM调制系统。为了接收数字节目，每一MMDS用户应该安装好一个数字电缆机顶盒。这是数字MMDS系统的唯一缺点，而它们有如下优点：

1) 大量频道（多于150个）。

2) 高质量的声音和图像。

3) 由DVB标准设想的附加业务：立体声、和/或多通道声音、电子响导、自动调谐、根据目录选择频道、图文电视、消去副标题等。

4) 在一个系统中同时广播模拟和数字节目的可能性。

- **互动的数字MMDS**

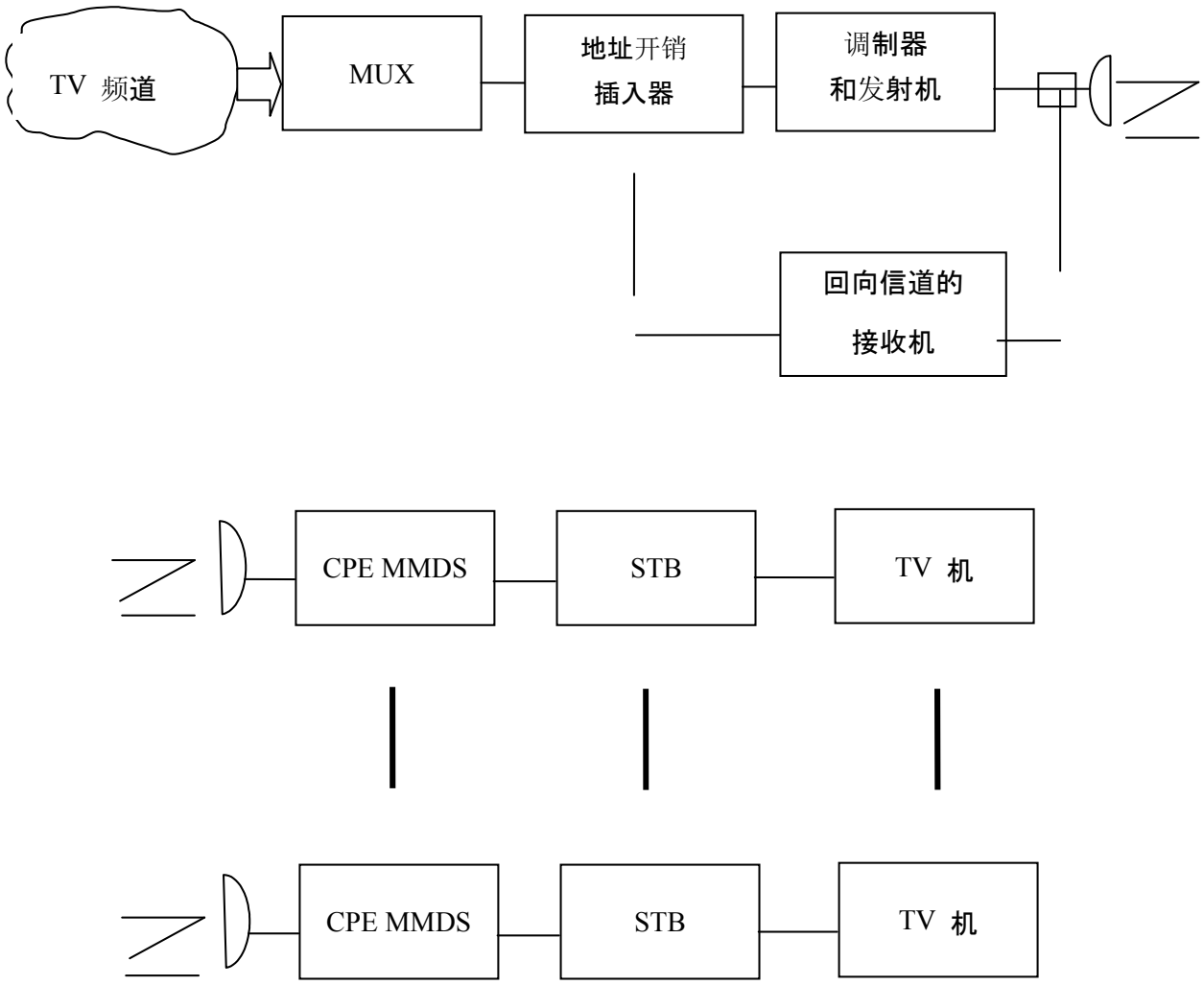
可以用MMDS系统来组织互动数字电视广播。为此，应该为用户出发的业务安排一个回向信道（“呼叫信道”）。在互动MMDS的用户上，而不是在带变频器的接收天线上安装用户的收发信机。

为了组织回向信道，使用QPSK调制的MMDS回向信道。回向信道的容量比正向信道小，但是，要以较低的发射机功率保证更远的传输距离。在这一情况下，把接收机和QPSK调制器安装在分配结点上。还可以通过将业务区分为多个扇区的方法增加用户数。

- **数字MMDS设备的主要部件**

以数字MMDS为基础的互动电视方框图示于图14。

图 14 — 以数字 MMDS 为基础的互动电视方框图



设备配套

数字MMDS系统设备配套包含如下组成部分：

- 调制器；
- 发射机（或对N频段，一组发射机）；
- 频道相加器；
- 网络管理系统；
- 自动或人工预定系统；

- 宽带转发器（如有需要）；
- 天线；
- 在MMDS发射机入口处的用来形成数字信号的DVB设备。

为了在MMDS发射机输入口形成数字信号，需要DVB设备，它应该实现如下功能：

- 接入来自卫星的数字节目（解调）；
- 已编码节目的解码（解扰）；
- 形成电视演播室的模拟信号的数字流输出（MPEG-2编码）；
- 形成来自不同来源的各种不同的数据流节目的自己的数字流输出（复用和去复用）；
- DVB业务信息（频道表、调整表等）的再生；
- 数字电视节目的解码（解扰）— 组织付费电视；
- 形成提供给发射机的数据流的射频信号（调制）输出。

用户设备

数字互动MMDS的整套用户设备由内部的、一般的台式部件（具有一内置的对付费内容进行解码的系统的电缆DVB-C数字终端）和外部的发射机模块 — 带天线的用户收发信机所组成。为了管理互动应用，必须有互动电视机顶盒。

I.3 卫星系统矩阵

I.3.1 通过卫星的宽带接入

能够实现的宽带和业务被日益视为全世界经济增长的推动力。然而，只有地面网络无法把宽带信号传递到所有居民区。当一些国家对有可能用于宽带部署的一大批技术和解决方案进行评估时，应该把卫星传送的宽带看作任何一种宽带策略的重要组成部分。除了回程的解决方案外，基于卫星的宽带业务给成本效益好的连通提供了延伸到最边远地区的机会。在那些地区，地面（有线和天线）的业务无法得到或者部署费用相当昂贵。

消费者越来越多地选择卫星作为互联网和宽带接入的解决方案。因为通过卫星能够直接发送和接收数据，不需要电话连接或任何一种陆上线路连接。现在，卫星为固定宽带提供的传送速率在200 kbps到5 mbps的范围内，而为移动宽带提供的传送速率在200 kbps到500 kbps的范围内。

基于卫星的宽带业务提供了如下面这样的许多益处，特别是对发展中国家更有利：

- 对全球的每一个角落提供普遍覆盖；
- 成本效益好和易于安装的解决方案，甚至对边远和乡村地区也是如此；
- 不需要基础设施投资；
- 支持大量的端用户人口；
- 能够实现大型网络部署；
- 固定和移动应用；和
- 为影响地面基础设施的紧急情况提供可靠的和备用的服务。

由于它们独特的地区覆盖和全球覆盖，卫星能够利用现有的卫星资源和基础设施提供直接的互联网和宽带的连通。这给按市场需要扩大业务服务区、即时和方便地覆盖乡村以及市区提供了灵活性和能力。

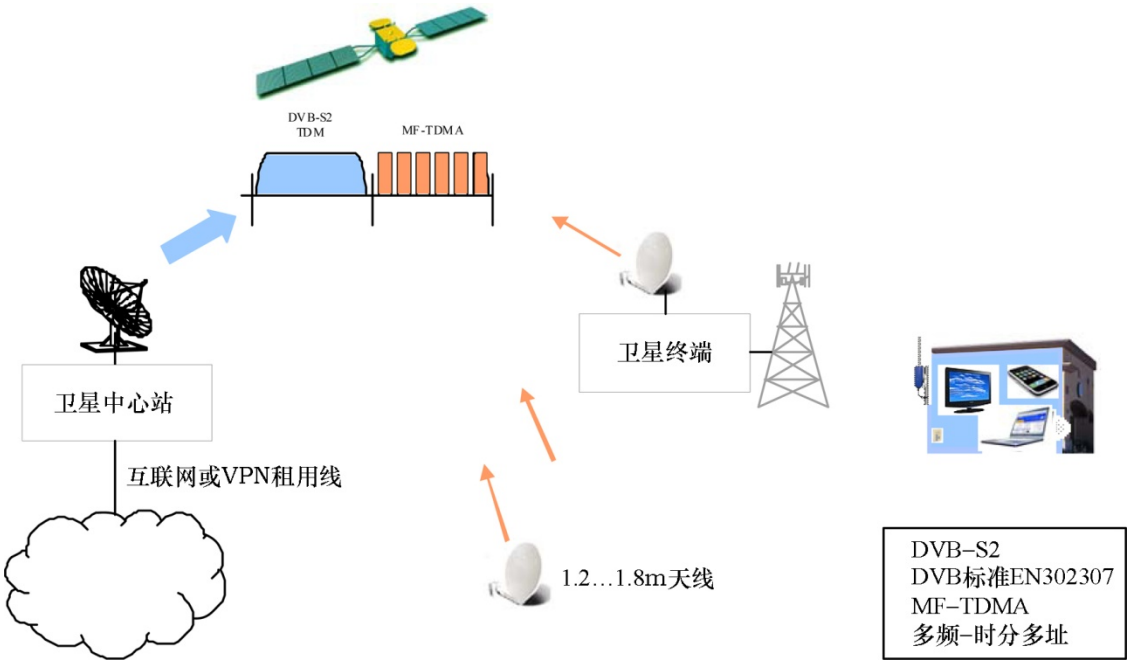
对发展中地区特别重要的是不需要巨大的资本投入或范围广泛的建设计划就可能提供端用户和社团的连通。一旦卫星系统投入运行，用易于使用和安装的终端就能够将连通进一步延伸到用户的位置。当用户数增加时，规模经济使设备更便宜，使得卫星成为一个更有竞争力的解决方案。用更高的pfd（功率通量密度）电平能够实现用小天线提供的高密度服务，它甚至为成本效率更好的连通提供了机会。而且，基于卫星的回程频道在扩大全世界移动电话网的工作范围和覆盖方面起着日益重要的作用，特别是在发展中的市场中更是如此。技术的进步已经导致价格效益更好的和更稳健的卫星解决方案，使卫星回程通道成为移动网部署的一个整体组成部分。当政府寻求保证为所有公民提供连通时，对只有基于光纤或地面电路的移动宽带技术不是一种经济可用的解决方案的地区来说，卫星回程通道将继续在提供连通方面起作用。

利用卫星回程通道扩大宽带业务在覆盖、成本、安全和备用电路方面提供了许多益处。对地静止轨道（GSO）卫星能够为一个大的地区提供回程业务，在基础设施方面只有最低的支出。卫星回程通道的解决方案使运营商能够把基站定在将给公民提供最多利益的位置上，几乎不必查询地面基础设施的位置的资料。

卫星回程通道的使用也为连通提供了备用通道。光纤骨干网的毁坏可能造成地面基站被从主要网络上切断，卫星回程提供的额外的分集将保证使连通保持不中断，即使出现地面基础设施的情况连通也不会中断。

卫星回程网的例子如图15所示。

图 15 — 卫星回程网实例



此外，可以将卫星技术与地面解决方案组合起来使用。为了架设全球数字鸿沟的桥梁，现在有了比Wi-Fi更有希望的互联网的技术。WiFi能够给位于“热点”、即无线互联网接入点覆盖的地区的用户提供无线互联网连接。

WiFi和卫星的组合可能为农村社区、乡村部落和山区及海岛村庄的居民提供经济的共享服务。卫星连接将互联网的数字流带到村庄，而WiFi接入点将那个连通延伸到家庭、学校和公共建筑物。通过付定金或其它联合付费计划，用户将共同负担设备和连接两个方面的费用。

为了利用卫星通信，应该考虑到法规问题。由于全世界的地理、政治和经济环境有差别，采用一个方案适合所有宽带接入的政策是不可能的。鼓励采用使消费者的选择最大化和认可各宽带部署可行方案有不同的容量和技术特性的政策。国家的频谱分配、发许可证的框架和通用的业务方案都应该考虑到卫星起的作用，并且要考虑到制定法规的决策可能会怎样促进或阻碍卫星宽带技术的发展和卫星回程把覆盖延伸到边缘地区的解决方案的使用。

除了把卫星宽带解决方案考虑进去以外，考虑部署宽带无线接入（BWA）解决方案的国家，特别是在从卫星回程增值得到利益的那些区域中的国家应该采取步骤，以保证卫星和地面网能够在无干扰的环境中工作。例如，按照无线电规则NO.4.3，为了在最易受降雨衰落影响的国家（热带地区）中，为BWA提供安全的卫星回程通道，应该保护分配给固定卫星业务（FSS）的频带3400-4200 MHz的频谱，以避免来自其它业务的有害干扰。这一保护措施可能包含对进入该频带的新用户的强制性的内部的和跨边界的协调要求，以及保持国家频谱用户的最新登记，与ITU的MIFR（国际频率登记总表）一起使用，以便知道该频带的新进入者的所有卫星地球站的位置。通过促进达到无干扰的工作环境，发展中国家能够保证卫星业务可以在通过回程通道将网络延伸到边远和乡村地区方面继续起作用。

卫星通信的固有特性，即它们的覆盖范围宽、工作的广播模式和多播特性，能够提供高速互联网连接和多媒体远距离连接。

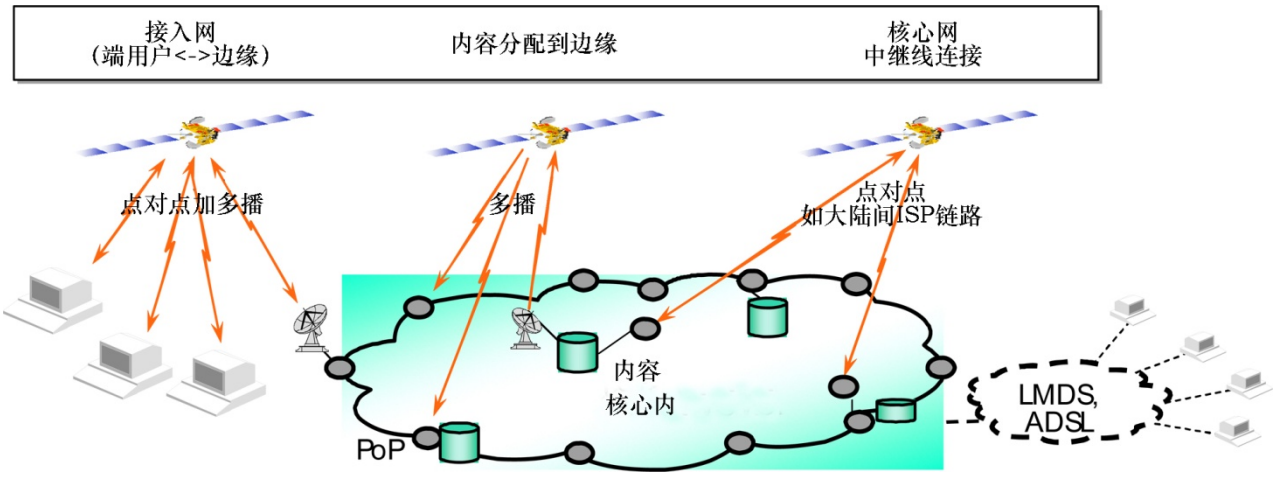
下面的图（图16）给出了能够提供高速互联网业务的全部场景的概貌。必须记住，整个网络能够致力于许多单独的家庭以及许多比较集中的家庭和与其它电信网相互连接的问题，想要努力达到规模经济，供分散的用户或在业务很稀少的路由上使用。以无缝的方式与地面网互联将使由卫星系统提供的全球宽带卫星业务取得成功。

a) 网络体系结构

可以将全球宽带卫星业务分为三种主要场景，如图13所示：

- 接入网，为端用户提供业务；
- 分配网，把内容分配给边缘地区；
- 核心网，提供中继线服务。

图 16 — 全球宽带卫星网场景

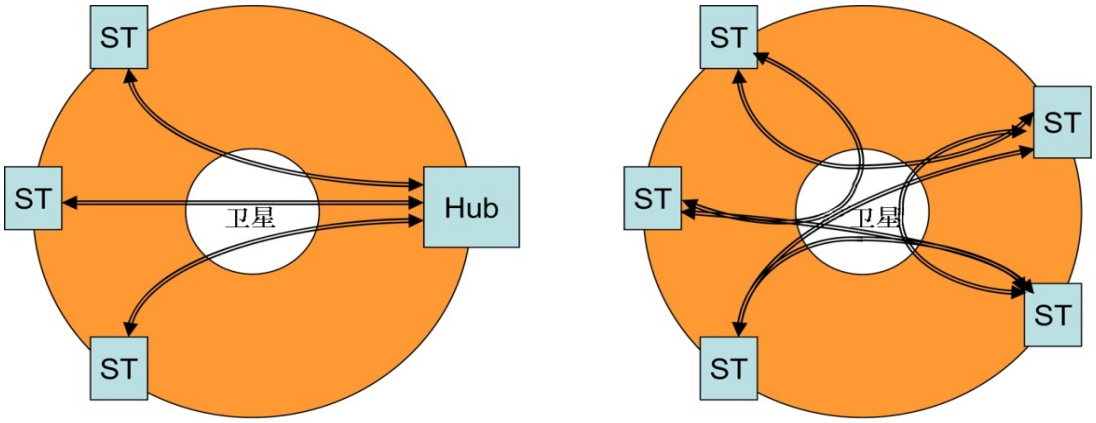


现在的工作把注意力集中在使用GSO卫星和固定卫星终端情况下接入网的场景。

如图17所示，该网络可能使用星形拓扑或网孔形拓扑。

- 当中心站（或互联网接入点）和多个远端站之间的链路成星形配置时，就被定义为星形拓扑。一个远端站只能在它和中心站之间建立直达链路，不能与其它远端站建立直达链路。
- 当各个站之间的链路成网孔形配置时，就被定义成网孔形拓扑。在这种情况下，任何一个站都可以与任一个其它的站建立直达链路。可以把星形拓扑看作网孔形拓扑的一个特殊情况。

图 17 — 星形和网孔形拓扑



注 — 用在远端站之间通过中心站建立直达电路的方法，可以使用星形拓扑提供网孔形连接。

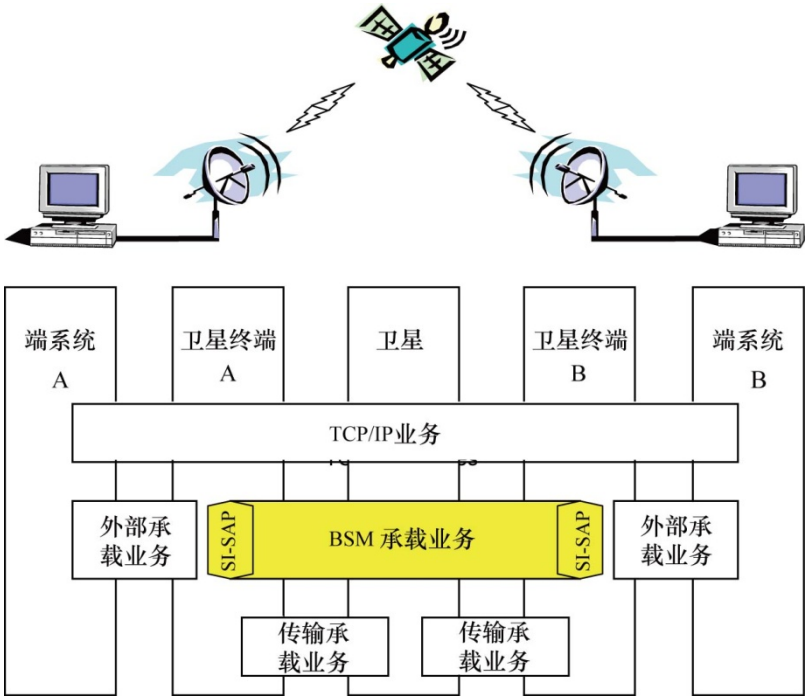
全球宽带卫星系统网络可以使用非再生的或再生的卫星体系结构。

- 非再生体系结构称为单个结构，通常称为“弯管”结构。这种结构不能在卫星中端接任何一层空中接口协议栈。卫星简单地把信号透明地传递给馈送链路。
- 再生体系结构是在卫星中提供许多附加功能的各种各样的其它结构。在这些体系结构中，卫星的功能是在卫星中端接空中接口协议栈的一层或多层。

b) 业务体系结构

如图18所示，宽带卫星媒体（BSM）的体系结构把传送层分为上部和下部。上部包含标准的IP业务，而下部包含全球宽带卫星系统的承载业务和在其下面的无线传输承载业务。

图 18 — 全球宽带卫星业务体系结构



为了把对所有卫星系统都共有的业务与对一给定的卫星技术所特有的业务区分开来，该业务体系结构规定了一个独立于卫星的业务接入点（SI-SAP）作为这些上层和下层之间的接口，这一接口相当于全球宽带卫星系统承载业务的端点，如图18所示。

c) 协议体系结构

全球宽带卫星系统确定了三组协议：

- IETF网络协议；
- 独立于卫星系统的适配全球宽带卫星系统协议；和
- 依赖于卫星技术的协议。

全球宽带卫星系统协议的体系结构独立于卫星的业务接入点接口SI-SAP接口，该接口位于IP网络层和较低的层之间，它们分别直接在该接口的上面和下面，该体系结构规定了两个适配层，以保持与该接口有关的全球宽带卫星系统的各种功能，如图19所示。

图 19 — 全球宽带卫星系统协议体系结构

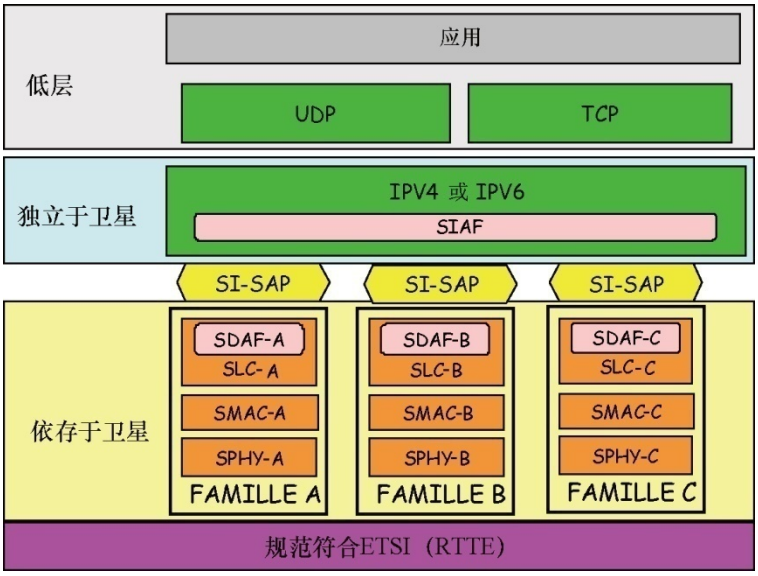
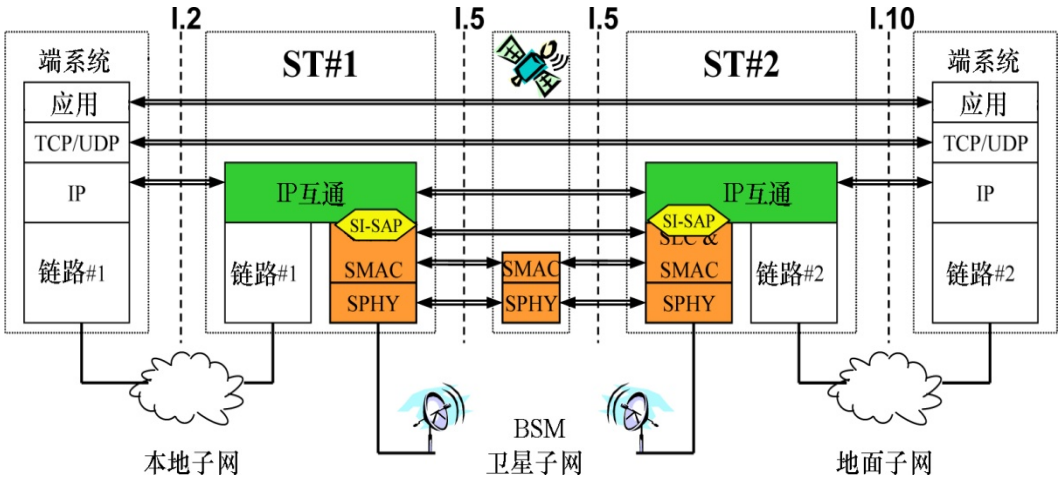


图19表示了全球宽带卫星系统的体系结构如何支持独立于卫星的低层协议的多种可选择的协议族。每一族相应于不同的卫星技术，包括透明的和再生的两种卫星和网孔和星形两种拓扑。每一独立于卫星的低层协议族能够以不同的方法支持这些通用的SI-SAP功能。每一族规定了独立于卫星的适配功能（SDAF）用它来提供SI-SAP接口的映射。

SI-SAP规定了独立于卫星的接口，实际可以使用它来跨越所有BSMS实施方案提供同一种业务。现在的工作把注意力集中在整套IP协议的互通方面，如图20所示。

图 20 — IP 互通



I.3.2 甚小孔径终端（VSAT）网络矩阵

在乡村地区实现的VSAT卫星网络通常在10-20 GHz频带内工作。

VSAT网络有类似星形的拓扑，有多个远端站，它们用FDMA/TDMA DAMA接入方案通过主中站进行通信。

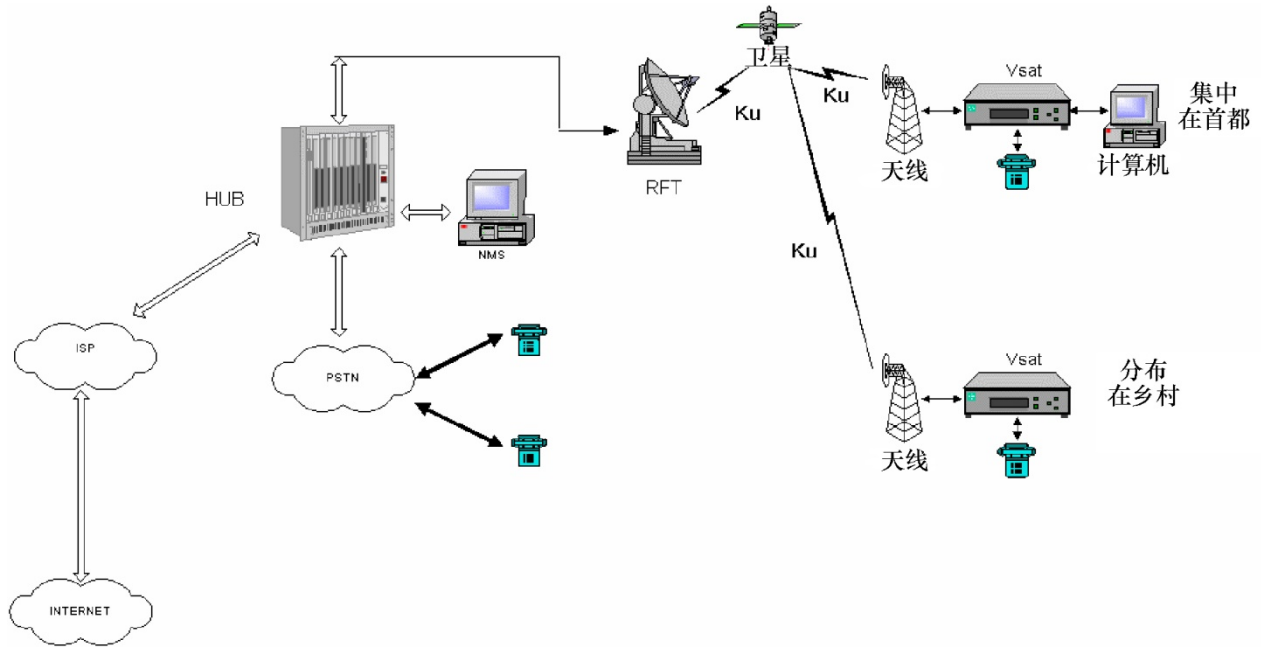
从中心站到远端站（外向 — 下行 — 正向）的载波采用QPSK调制，现在的数据传输速率为256 kbit/s，而从远端站到中心站（内向 — 上行 — 反向）的载波采用MSK调制，传输数据速率为38.4 kbit/s。通常，还提供以太网端口，以便与其它设备相接口。

VSAT网络的主要组成部分如下：

i）多个远端站，ii）结点站（中心站），iii）预付费分系统[22]，iv）网络管理系统。

图21显示了VSAT网络的简要方框图。

图 21 – VSAT 网络的简要方框图



远端站基本上由两个模块组成：外部单元（室外单元 — ODU）和内部单元（室内单元 — IDU）组成。包括VSAT，但电源分系统和保护分系统除外。

[22] 预付费系统使用带编解码器（PIN）的卡作呼叫。运营商必须有适当的卡分配计划以及必须保证对使用该业务的乡村居民进行适当培训。在预付费卡的背面可以找到呼叫步骤，并且在电话亭里面可以找到呼叫步骤的布告，而且运营商要对用户进行培训，使它们能够正确地使用公用电话和互联网接入（如有必要）。

外部单元（ODU）由天线和射频部件组成，它们能在内部单元和卫星之间进行通信。它的某些部件包括：

i) 天线，尺寸变化范围1.2到1.8 m[23]，ii) 高功率变频器，功率变化范围500 mw-1 w[24]，iii) 低噪声变频器模块。

所提供的业务[25]可能包括下列业务：i) 话音，ii) 传真（3类），iii) 免呼叫到应急中心，和，iv) 乡村行政中心中的互联网接入，速率600 Baud。

[23] 天线的尺寸与许多因素（地理位置、卫星覆盖、降水大小、要求的数据速率等）有关。根据情况不同，用直径更大的天线来改善系统的性能。

[24] 在秘鲁丛林中的某个城市中用1W的功率主要是由于卫星的覆盖和降水的大小引起的。

[25] 现在，乡村地区的运营商所提供的所有业务都是通过预付费平台运作的，但互联网除外，直到今天为止，互联网业务是免费提供的。

ANNEX I

General Broadband Matters

I.1 Social and Economic Benefits of Broadband in Telecommunications

Broadband is extending greater access to the information society, at a lower cost, to more people worldwide. Furthermore, broadband is delivering multiple applications (voice over IP telephony, Internet applications, television/video applications and audio applications) over a single network.[26] For developing countries, access to the internet helps to provide previously unattainable services such as e-learning cheap telecommunications and medical know-how, and broadband has the potential to make these benefits even more achievable by bringing down costs and increasing the quantities of information exchanged. The Internet Report "The Birth of Broadband"[27] identifies some of the ways that broadband is impacting societies around the world:

- The sharing of knowledge is enhanced by ensuring equitable access to the Internet, which is considered as a source of information for educational, scientific, economic, social, political and cultural activities.[28]
- Broadband is becoming a more significant tool that is accessible to all for the attainment of truly pervasive telecommunications. This goes some way towards the fulfilment of access to knowledge for all as a basic human right – a goal that has been evoked in a number of regional and international declarations and that forms one of the main tenets of the Principles developed as part of the United Nations World Summit on the Information Society (WSIS).[29]
- The development of broadband is also bringing about a paradigm shift in levels of informatization, and therefore, accountability, particularly in government processes. Wider public access to government information, and the opening up of information on public networks, underscores a commitment to democracy and good governance.

In addition to its impact on social issues, broadband is considered an accelerator of economic development. With broadband access, it is very common that worker productivity increases. Broadband creates opportunities for bundling services together and enables telecommunication operators to offer more services to consumers at lower prices, creating added efficiencies in both time and money. In addition, new or offshoot industries are created as a result of broadband. As telecommunication broadband penetration rates grow, there will be resulting demand for computer and home network equipment, as well as wireless handheld devices and other equipment that facilitate broadband use. The economic benefits of broadband also can be attributed to indirect factors, including "increased e-commerce applications, reductions in commuting, increased consumption of entertainment, Internet telephony and savings in healthcare as a result reducing the cost of sophisticated telemedicine"[30]. For the distribution enterprise sector, the economic benefits result from efficiencies in the distribution of goods, services and information. Thus, the economic benefits of broadband transcend from both direct and indirect sources.

In the United States, for example, several studies have been released detailing the prevailing economic benefits of broadband deployment. A July 2001 study conducted in the U.S. by Robert Crandall and Charles Jackson has estimated the benefit of broadband to the United States to be upwards of USD 500 billion per

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[26] ITU Internet Reports: "*Birth of Broadband*"; International Telecommunication Union; September 2003. This publication has been compiled by the ITU General Secretariat.

[27] ITU Internet Reports: "*Birth of Broadband*"; International Telecommunication Union; September 2003.

[28] See: www.itu.int/osg/spu/ni/promotebroadband/PB03-PromoteBroadband.doc

[29] WSIS Declaration of Principles, www.itu.int/wsis

[30] Ben Mackin. "*The value of Widespread Broadband*", Entrepreneur.com, August 13, 2002.

year within the next fifteen to twenty-five years, if broadband were to become nationally available.[31] In addition, the Corporation for Network Initiatives in California (CENIC) projects the benefits of broadband for the state to be quite substantial. California's "One Gigabit or Bust" broadband initiative promises to add 2 million jobs and an estimated USD 376 billion growth in gross state product (GSP) by 2010. This would equate to a 17 per cent increase in GDP per capita, as opposed to a mere 3 per cent increase without expanded broadband deployment.[32]

Many countries and governments around the world may be concerned about the expenses of deploying broadband networks; however, with economic incentives and a favourable regulatory policy, it may be done both cost effectively and efficiently. Potential fiscal incentives for broadband build-out, such as tax credits, grants, subsidized or low-interest loans, support for research and development on broadband technologies – particularly for rural and underserved areas – can make broadband network deployment a reality.[33]

I.2 Broadband Applications in Telecommunications

With the advent of broadband technologies, a myriad of applications become possible or are enhanced beyond their current capabilities limited only to dial-up Internet access. Some of the applications include:

- E-Health
- E-Working
- E-Government
- E-Agriculture
- E- Learning
- Public Safety
- Applications for persons with disabilities
- Utility applications
- Small business assistance
- Information gathering
- E-Tourism
- E-Commerce
- Entertainment

While this is not an exhaustive list, these applications are some of the most important for broadband use. The next section describes some of the most commonly used broadband applications and provides real-life examples of how broadband has been used globally to facilitate these services.

I.2.1 E-Health

E-Health (also referred to as telemedicine) has been touted as one of the primary applications made possible by broadband technology. E-Health refers not only to making diagnoses and treating patients using high-speed telecommunication access with two-way voice, video and data transmission, but it can also refer to the ability of consumers to purchase medical supplies or prescription drugs online.

Broadband deployment has led to revolutionary developments in the medical field. E-Health allows patients that are either too elderly, too sick or those in rural or remote areas too far away from medical facilities to "see" a doctor and receive medical attention using medical equipment and digital imagery technology. Thus, e-health enables improved access and better quality medical care to those who cannot visit a doctor in person, as well as offers early diagnosis and medical treatment. E-health also facilitates medical training for

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[31] Robert Crandall and Charles Jackson. "The $500 Billion Opportunity: The Potential Economic Benefits of Widespread Diffusion of Broadband Internet Access", Criterion Economics, L.L.C., Washington D.C., July 2001.

[32] Corporation for Education Initiative in California. www.cenic.org

[33] "Broadband Bringing Home the Bits". Washington D.C., National Academy Press, 2002, p. 168.

persons that can help doctors and patients in the diagnosis process from afar. While not only reducing transportation costs, it encourages the sharing of scarce resources for medical care.

Internationally, there are many examples where e-health has had a significant societal impact. The beauty of e-mail is that, with the appropriate technology, it can be performed anywhere. The following are just a few examples of where and how e-health, using broadband technology, has been employed.

- Tele-radiology in Canada's Buchanan Memorial Hospital used broadband telecommunication technology to help diagnose a problem in a patient over 270 kilometers away, thus allowing for proper patient care without the patient having to be moved.[34]
- Using telecommunication satellite broadband technology, several patients in a remote area in Canada were treated by a dermatologist that was over 900 miles away. Had the technology not been available, those patients would have had to wait several months until the specialist could make it out to this remote area.[35]
- In Ontario, the Canadian Hearing Society has planned several projects using broadband technology in an interactive, broadband technology to support education, employment and telecommunication opportunities for people who are blind and hard of hearing.[36]
- In Russia, the E-health Foundation of Russia is focused on using broadband technology to conduct e-health consultations between Russia and other countries in Europe and North America, as well as within Russia's vast borders.[37]
- The Medical Informatics and Technology Applications Consortium (MedITAC[38]) has made several successful trips to Ecuador in recent years. Teams of medical and technical personnel have completed many projects in Ecuador, including electronic transmission of pre-operative patient data; installation of Electronic Medical Record (EMR) in Ecuador; training of collaborators in entering, exporting, and importing data; transmission of text files from remote villages to larger cities using high frequency radio; and transmission of live hernia surgery from a mobile surgical truck with images from a laparoscopic camera, while surgeons in Richmond identified key instructions.[39]
- In Turkey, MedITAC sent two people to Turkey with Physicians for Peace (based in Norfolk, Virginia, USA) to assemble a multimedia course on landmine victim rehabilitation. The Physicians for Peace mission focused on developing an on-site multimedia curriculum that can be used for landmine relief efforts anywhere in the world.[40]
- In Uzbekistan the Teleconsultation System for the Republican Centre of Emergency Medicine is one of the largest medical centres in Tashkent, the nation's capital. The principle long-term e-health goal of the centre is to connect via broadband, the primary Emergency Centre with the National Research Centre of Surgery and all 12 regional branches of the Emergency Centre. Initially, e-health transmissions will be based on store-and-forward Internet technology. Later, when the country's telecommunication infrastructure has been upgraded to ISDN, videoconference facilities are also to be implemented. The system will be focused on teleradiology.

For more information on applications for telemedicine and e-health applications, please see the ongoing work under Question 14-1/2, "Application of telecommunications in health care."[41]

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[34] Canadian Broadband Taskforce Report, "*Networking the Nation for Broadband Access*", 2001, p. 29.

[35] Canadian Broadband Taskforce Report, "*Networking the Nation for Broadband Access*", 2001.

[36] Canadian Broadband Taskforce Report, "*Networking the Nation for Broadband Access*", 2001, p. 20.

[37] www.meditac.com/MedITAC/Projects/projects_main.cfm

[38] Stands for The Medical Informatics and Technology Applications Consortium, which has its headquarters on the Medical Campus of the U.S. Virginia Commonwealth University.

[39] www.meditac.com/MedITAC/Projects/projects_main.cfm

[40] www.meditac.com/MedITAC/Projects/projects_main.cfm

[41] www.itu.int/ITU-D/webdocuments/list_new.asp?question=Q14-1/2&lang=en&period=2002

1.2.2 E-Working

The ability to work – either work from home or from another location, such as a telecentre that is outside of a person's regular office – is an important telecommunication broadband application using such technology. E-Working can contribute to time and cost savings for both employers and employees, as well as enable persons with disabilities or others that are physically challenged to work. While E-Working is generally thought to mean "working from home," it is not limited to this. It also refers to using virtual or satellite offices to work. In a virtual office, employees may share a reduced office space at a nearby employer facility, use the same facilities on a rotating basis, or participate in a fee-based telework centre arrangement.[42]

Many people believe that E-Working can significantly change their lives. By using broadband technology for teleworking, people spend more time working and less time commuting to and from work. This becomes particularly important both in high-density areas where traffic and traffic-related pollution are both very high, as well as in remote areas that force workers to travel great distances to get to their jobs. E-Working also can improve employee productivity by reducing the number of distractions that people encounter at the office. This is because it can help eliminate competing priorities and interruptions.[43]

For many companies, teleworking results in significant advantages for both employers and employees, and it can be a low-cost employee benefit provided by companies. E-Working can contribute to reduced office space rental and parking expenses, as well as save on business travel due to the reduced need to travel to physically attend meetings. It also can provide workers the needed flexibility that may induce well-qualified people, who otherwise may not want to work in particular jobs or areas, to accept certain jobs.

E-Working using broadband technology also can facilitate group projects and collaborative projects with professionals in different locations. This helps maximize efficiencies and sometimes-scarce economic and professional resources. With the assistance of videoconferencing, as well as streaming audio and video facilities, teleworking enables employees to collaborate on projects more easily, reduces the need for face-to-face meetings, and therefore reduces the necessity to travel, while accomplishing the same goal of "seeing" people or presentations in real-time.

E-Working may also assist persons with disabilities who currently are underemployed or unemployed due to communication difficulties or trouble with transportation to an office outside of the home or other facility. Because the high connection speeds and the facilitation of two-way voice, video and data transmission, broadband enables the presentation of information in multiple formats, such as audio, video, and captioning, which are well-suited for those with certain disabilities. Thus, broadband technology opens up a range of telecommunication choices that help present information in the most appropriate format for peoples' needs.[44]

Another advantage of using broadband to facilitate teleworking is that it can improve employee retention rates, thereby reducing recruitment costs and other costs, such as advertising, interviewing, and training, that are associated with hiring new employees. It also can reduce absenteeism because it allows people flexibility to balance work and home-related activities more easily, thereby reducing the need for people to take time off from work or use sick leave to accomplish the same goals. Overall, E-Working can be a substantial time- and money-saving application for many different industries.

Companies, both large and small, can reap the benefits of E-Working. A subsidiary of a large multinational company, Siemens Enterprise Networks, has realized substantial savings by promoting teleworking which became a mainstream part of the business model in 1996. By mid-2002, 20 per cent of the 3 000 employees were dedicated full-time E-Workers, and 40 per cent were mobile workers.[45] E-Working enabled the company to decrease office space by 35 per cent nationwide and annual real estate savings have been over USD 3 million in the 3 000-person subsidiary alone.

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[42] Positively Broadband Campaign, "Anytime, anyplace, anywhere: Broadband and the Changing Face of Work", July 2002, p. 5.

[43] Positively Broadband Campaign, "Anytime, anyplace, anywhere: Broadband and the Changing Face of Work", July 2002, p. 5.

[44] Positively Broadband Campaign, "Anytime, anyplace, anywhere: Broadband and the Changing Face of Work", July 2002, p. 5.

[45] Siemens Enterprise Networks – Facts on Teleworking Products and Practices Press Release, 2001.

Many smaller companies and individuals have reaped the rewards of E-Working, as well. In order to assist smaller companies in rural U.S. communities, the United States Government is actively promoting the benefits of E-Working in the United States through the Farm Security and Rural Investment Act of 2002 which was signed into law on May 13, 2002. The law provides grants of USD 500 000 each to rural communities to establish telework sites. Grants will be awarded to non-profit organizations, educational institutions, and Native American tribes. The law also authorizes the U.S. Secretary of Agriculture to establish and operate a national rural E-Work institute. This institute will conduct outreach to rural communities and rural workers; develop innovative, market-driven telework projects and joint ventures with the private sector that employ workers in rural areas in jobs that promote economic self-sufficiency; support private sector businesses that are transitioning to telework; and support and assist telework projects and individuals at the State and local level.

I.2.3 E-Government

As an entity that primarily provides services to others, government is in a prime position to reap the benefits of broadband technologies. Governments can use broadband to help transform legacy systems into customer-friendly systems and create a public-centered service for such public.

E-Government applications can help citizens solve problems. E-Government allows citizens to get information on basic government services to allow citizens to fill out electronic forms and get information through self-service online. With more citizens accessing and using services online, the more expensive paper, voice and face-to-face transactions are likely to shrink, lowering the cost of providing services.[46] This also allows government agencies greater ability to concentrate on providing improved quality of service or expanding the quantity of services they provide.

Broadband allows interaction with the government to be more convenient for citizens because it reduces the time necessary to get information. It can obviate the need to make phone calls or visit government offices during business hours because tasks can be performed at the citizen's convenience. In addition, those who work long hours or shift work, the elderly and those with mobility problems or other disabilities have the same opportunities as others to get the information they need.[47]

Examples of some of the services that can be provided using E-Government include: renewing a driver's licenses; registering to vote and voting; one-stop shopping for government services without having to know which government agency handles specific functions; ordering birth, death, marriage certificates; filing and paying taxes; and obtaining business licenses.[48] Other services include filing for financial aid, as well as filing applications for certain government housing, education and other programs.

Broadband technology -enabled E-Government is a win-win for both citizens and the government itself. Within government, broadband can lead to improved task management, as well as less waste, fraud and abuse. Many internal government transactions can be handled online, including travel reimbursements, changes of address, pension fund modifications, etc.[49] Broadband technology also can enable government to save money on mailing, printing and handling costs. Overall, electronic service delivery can change human resource management patterns and improve organizational performance.[50]

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[46] Andrew Leigh and Robert Atkinson, "*Breaking Down Bureaucratic Barriers – The Next Phase of Digital Government*," Progressive Policy Institute, November 2001.

[47] Andrew Leigh and Robert Atkinson, "*Breaking Down Bureaucratic Barriers – The Next Phase of Digital Government*," Progressive Policy Institute, November 2001.

[48] M. Cook, "*What Citizens Want from E-Government*", Center for Technology in Government, University of Albany/SUNY, www.ctg.albany.edu/resources/htmlrpt/e-government/what_citizens_want.html

[49] Leigh Atkinson, "Breaking Down the Bureaucratic Barriers: The Next Phase of Digital Government", November 2001, p. 7.

[50] S. Cohen. and W. Eimicke, "*The Use of the Internet in Government Service Delivery*", PWC Endowment for the Business of Government, 2001. See www.endowment.pwcglobal.com

There are many examples of countries that have employed broadband technology to create E-Government applications.[51] The following are just a few:

- In the Dhar district in central India, the Gyandoot Project has established community-owned, technologically innovative and sustainable information kiosks in a poverty-stricken, tribal dominated rural area of Madhya Pradesh. Information kiosks have connectivity through local exchanges on optical fibre or UHF links. Citizens can use the kiosks to obtain Agriculture Produce Auction Centre Rates; get copies of land records; conduct online registration to obtain income/caste/domicile certificates; file an online public grievance redress; conduct auctions for land, agricultural machinery, equipment, and other durable commodities; and obtain updated information regarding beneficiaries of social security pension, rural development schemes and information regarding government grants given to village committees and public distributions.[52]
- In Brazil, the state government of Bahia has created Citizen Assistance Service Centres (SAC), using broadband technology, that bring together federal, state, and municipal agencies in a single location to offer the e-services that citizens most frequently need and use. The centres have been placed in convenient public locations, such as shopping malls and major public transportation hubs.

  They offer citizens significant time savings, while also delivering services with greater courtesy and professionalism. A further benefit has been a reduction in the overhead expenses of government since, in many instances, agencies pay much lower rents for space in the SAC than for the properties they previously rented to interact with the public.[53]
- The Department of Revenue in Karnataka, India, has computerized 20 million records of land ownership of 6.7 million farmers in the state. Previously, farmers had to seek out the village accountant to get a copy of the Record of Rights, Tenancy and Crops (RTC) – a document needed for many tasks such as obtaining bank loans. Currently, for a small fee, a printed copy of the RTC can be obtained online at a computerized land record kiosks (Bhoomi centres) in 140 *taluk* offices. In the next phase, all the *taluk* databases are to be uploaded to a web-enabled central database. RTCs would then be available online at Internet kiosks connected through broadband technologies, which are likely to be set up in rural areas.[54]
- A European Commission study, carried out in April 2002,[55] on E-Government in Europe shows clear progress. Since the measurement in October 2001, the availability and interactivity of public services on the Internet rose by 10 per cent to reach 55 per cent. The study was part of the European Commission's "Benchmarking eEurope" initiative and measured twenty basic public services in the 15 EU Member States, plus Iceland, Norway and Switzerland. In this study, a representative sample of more than 10 000 public service providers in the 18 countries was assessed. The survey found that the overall degree of online availability of public services in the countries through broadband technologies was 55 per cent, compared to 45 per cent in October 2001. The categories of public services that were most prevalent included income-generating services, such as taxes and social contributions (79 per cent), followed by registration services, such as registration of cars and new

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[51] See: www.digitalopportunity.org/cgin/index.cgi?root=2822&url=http%3A%2F%2Fwww1%2Eworldbank%2Eorg%2Fpublicsector%2Fegov%2Fservdel%2Ehtm for other examples.

[52] See: www.digitalopportunity.org/cgiin/index.cgi?root=2822&url=http%3A%2F%2Fwww1%2Eworldbank%2Eorg%2Fpublicsector%2Fegov%2Fservdel%2Ehtm

[53] See: www.digitalopportunity.org/cgibin/index.cgi?root=2822&url=http%3A%2F%2Fwww1%2Eworldbank%2Eorg%2Fpublicsector%2Fegov%2Fservdel%2Ehtm

[54] See: www.digitalopportunity.org/cgibin/index.cgi?root=2822&url=http%3A%2F%2Fwww1%2Eworldbank%2Eorg%2Fpublicsector%2Fegov%2Fservdel%2Ehtm

[55] See: europa.eu.int/rapid/start/cgi/file.tmp_Foot 1

companies, and social security. Services related to documents and permits, such as drivers' licenses and passports, were the least developed on the web (41 per cent).[56]

- By 2003, the Japanese Government's E-Government Program was expected to result in nearly all applications and procedures being available online.[57] The government would like to deploy public Local Access Networks (LANs) that connect schools, libraries, community centres and city halls across the country by 2005.
- In Canada, the city of Yellowknife now offers many government services online. Citizens can register businesses, obtain lottery licenses, pay parking tickets, book public facilities and find information about local laws. Through a project called CityNET, the city is preparing to offer citizens information through an interactive computerized phone system and an interactive version of cable television.[58]
- In the UK, the www.ukonline.gov.uk portal was created to provide a single access point to UK Government information and services. It was launched in early December 2000 and contains applications and features, such as:

  a) "Quickfind" – a powerful search engine that guides users directly to the right information, allowing people to cut through the maze of government.

  b) "Do It Online" – access to useful online transactions, such as applying for a passport, buying a TV license, paying bills, notifying others of changes of address and filling in self-assessment tax returns.

  c) "Newsroom" – providing an easy way to keep in touch with government news, announcements and advices.

  e) "CitizenSpace" – a section to make it easy for people to find out about government plans and contribute to the formulation of new policies on which the public is invited to comment.

  f) "Easy Access" pages, which give simpler access to the portal for those who are visually impaired or have low reading skills.[59]

I.2.4 E-Agriculture

Agriculture is another ideal candidate for reaping the benefits broadband technology. Broadband access creates a link between buyers and sellers, simplifies pricing determination, offers risk management and forward pricing opportunities and can facilitate improved farm productivity and environmental protection. Broadband also makes possible electronic exchange trading of agricultural commodities, and it enables farmers the ability to conduct better production management, inventory control and better marketing techniques for their commodities and products – both domestically and internationally.

Because of the geographical separation between farmers and their markets, the fact that there are far more buyers than sellers, as well as the fact that commodities are often perishable and fungible by time, broadband can play an important role in bringing farmers and their markets together more quickly and getting products to market more quickly and efficiently.

Broadband technology also can provide farmers with an easier ability to earn "off-farm income." Because the economics of farming do not allow many farmers to live off the proceeds of farming alone, many farmers need to find additional work to supplement their income. Broadband access can give them an opportunity to use their skills to work from home and not leave the farm.

The economic benefits of using broadband in the agricultural sector are significant. "According to Morgan Stanley Dean Witter, B2B e-market opportunity (in the United States) for non-equipment agricultural inputs

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[56] "Online public services: Europe making progress on eGovernment", EC Website, Brussels, June 20, 2002.

[57] TISP workshop, OECD, Shinichiro Sakata, Deputy Director General for Information and Communications Policy, Ministry of Public Management, Home Affairs and P & T, Japan, December 2001.

[58] Canadian BB Taskforce Report, "*Networking the Nation for Broadband Access*", 2001, p. 20.

[59] UK Online Strategy Action Plan Report: www.e-envoy.gov.uk/oee/oee.nsf/sections/index/$file/index.htm

such as seeds, chemicals, fertilizers and veterinary supplies alone could be USD 34 billion. Moreover, on the farmers' marketing side, efficient B2B e-commerce structures could cut marketing costs by about five cents per bushel for wheat, oilseeds, and feed grains."[60]

In addition, broadband networks can provide the agricultural community with many additional advantages. For example, broadband enables the creation of "Virtual Enterprise Zones" (VEZs). These are electronic markets for citizens and businesses that could reap benefits from government assistance. With broadband technology, more rural areas could immediately join existing VEZs or create new VEZs. Precision agriculture is another application made possible by broadband technology. With this, broadband can be used for yield monitoring, soil sample analysis and access to satellite imagery for weather patterns. The information can be stored off-site and analyzed by off-site experts and then relayed back to the farm.

Other applications, such as distance agriculture education and technical services via broadband technology, can assist with crop planning, pest management, input management of goods and equipment servicing. Tele-veterinary applications are also possible with broadband technology. Because of the high cost of door-to-door veterinary services and because many farmers often perform their own routine veterinary care, broadband can deliver more accurate information on health problems in animals and more vital information on insects more quickly. Virtual livestock auctions also are made possible with broadband technology because the potential number of buyers seeing animals increases without having to transport animals from location to location. Furthermore, broadband technology can assist farmers with distributing scarce resources efficiently and effectively in times of draught or crisis by enabling farmers to transmit information quickly about product stockpiles.

An additional application of broadband technology in the agricultural sector is using broadband connections to track the identity of agricultural commodities and products. In other words, broadband connections can be used to track the production and distribution chain of various commodities and products. This can be particularly useful when products need to be recalled for health and safety concerns. In addition, broadband technology can play a role in protecting national security because it can make food tampering less effective by using product tracking to expose potential culprits.

In Canada, broadband telecommunication networks are being used to assist with farm management and electronic livestock auctions. In fact, over 60 per cent of the beef cattle sold in Quebec are now sold at electronic auctions. The selling cost for producers of grain-fed calves has dropped from CAD 11 to CAD 4 a head, thus increasing profit margins, and the animals do not have to be shipped twice – first to the auction site and then to the slaughterhouse.[61]

In a major step towards improving rural connectivity in Maharashtra, India, the state government has planned an integrated agricultural project using wireless in local loop (WLL) technology to provide extensive and dynamic information to farmers through internet and video-conferencing. Two pilot locations, at Baramati and Pabal, will have one WLL centre each. The proposed project will extend Internet access to surrounding villages within a 25 km radius. The villages in the vicinity of the WLL centres would be provided with Internet kiosks from where farmers can browse agriculture-related websites, download information on various agro technologies, get meteorological information as well as disaster prevention management plan, pest incidents and remedies. Similarly, farmers will be able to access global and country-wide market information, various government schemes, facilities, agro-processing and marketing information, communicate directly with scientists and other farmers and utilize e-commerce in agriculture.[62]

One example of an agriculture portal is Agmarket, an Indian agriculture website that aims to establish a nation-wide information network for speedy collection and dissemination of market information for its efficient utilization.[63] Agmarket offers computerized data on market fees, market charges, total arrivals, arrivals by agencies, prices (variety wise / quality wise), storage, dispatches with destination, mode of

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[60] "The Importance of Next Generation Internet Access to Agriculture and Rural America", World Perspectives, Inc., April 13, 2000, p. 2-3.

[61] Canadian Broadband Taskforce Report, "*Networking the Nation for Broadband Access*", p. 22.

[62] "***Maharashtra draws up plan for WLL-versed villages***", *The Economic Times*, 21st April'03, www.economictimes.com

[63] www.agmarknet.nic.in/

transportation, costs, sold and unsold stocks, sources of supply with destination, method of sale and payment. It also ensures the flow of regular and reliable data to producers, traders and consumers to derive maximum benefit of their sales and purchases.

In the United States, the "Freedom to E-File Act" directs the U.S. Department of Agriculture (USDA) to make its programs accessible via the Internet. USDA officials estimate that up to two million farms could save, at minimum, the one-hour drive from the farm to government office building to fill out forms."[64] In addition, the 2002 U.S. Farm Bill included a specific section on the promotion of rural broadband telecommunication access. Section 601 states that the loans and loans guarantees should be provided to aid in the construction, improvement and acquisition of facilities and equipment for broadband telecommunication service in eligible rural communities. Up to USD 20 million will be made available for each of fiscal years 2002 through 2005, and USD 10 million each for fiscal years 2006 and 2007.

I.2.5 E-Learning

E-Learning is one of the most widely touted applications of broadband technology. Broadband technology enables students of all ages and from any geographic location to take advantage of educational opportunities in schools, universities and other kinds of educational institutions. Broadband can provide students the opportunity to see and interact with professors in real-time, collaborate on group projects when participants are located in different geographic locations, and give the poor, underprivileged, or disabled technology the opportunity to learn a multitude of subjects without the burden of costly and time-consuming travel to educational institutions. Many nations and localities have used broadband technology to provide distance-learning opportunities for their citizens. Below are several examples to illustrate some successful examples.

In Denmark, Sektornett[65], which was established in 1993, is an electronic network for primary, lower and upper secondary schools, vocational schools and institutes of higher education. In addition to Internet access, a number of services are offered, primarily high-security Sektornett manager training at schools and technical support. By 2002, there were more than 3 000 institutions on the Sektornett. Nearly all upper secondary schools, higher preparatory courses, adult education centres, vocational schools and institutes of higher education are now connected through broadband technology.

Also in Denmark, the Research Network (Forskningsnettet) was established in 1997 for the purpose of interconnecting Danish research institutions using high-speed transmission of text, sound, images and video. The Research Network supports applications such as videoconferencing, distance education and telemedicine.[66]

A virtual university in Pakistan is providing students with an opportunity to learn computer skills. The USD 40 million project provides distance learning using the television, video conferencing and Internet, and it is intended to train nearly 60,000 computer science graduates so that they can help develop an information technology industry in Pakistan. In order to control costs and make the program affordable, educational centres are being set up where students can view the courses and access the Internet.[67]

The Cisco Networking Academy Program evolved out of internal Cisco efforts to meet the training needs of students and teachers in schools being "wired", having telecommunication networks installed, and being connected to the Internet. The Academy program focuses on training students in the skills necessary to design, implement and operate computer networks. It utilizes web-based learning to facilitate rapid evolution and dissemination of up-to-date curricula. It can also provide widespread availability of information on the strategy and the programs that support it. Currently, the Networking Academy program includes partnerships with many organizations, in addition to ITU, has been established in almost 8 500 locations in over 130 countries, including 28 of the UN's officially designated Least Developed Countries.[68]

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[64] "The Importance of Next Generation Internet Access to Agriculture and Rural America", World Perspectives, Inc., April 13, 2000, p. 6.

[65] www.fsk.dk/fsk/publ/2001/broadband/fromhardware.doc

[66] www.fsk.dk/cgi-bin/theme-overview.cgi

[67] Alfred Hermida "*Teaching Goes Virtual in Pakistan*", BBC News Online, May 13, 2002.

[68] World Telecommunications Development Conference.

I.2.6 E-Tourism

Broadband enables people to "visit" tourist spots without having to travel long distances to see attractions in person. Broadband technology connections (video application in particular) can enable people to view art treasures, exhibits, historical landmarks and other types of tourist attractions. In addition, broadband technology can assist fans of sporting and other major events, like the World Cup or the Olympics, to "see" the events as they would in person in real time. This is particularly useful for events that may be too far to travel to and where significant time-zone differences may not enable real-time viewing of these events.

I.2.7 E-Commerce

Electronic Commerce (E-Commerce) is the term associated with buying and selling products and services over electronic systems such as the Internet and other computer networks. Recently, with widespread Internet usage, e-commerce has grown extraordinarily. E-commerce has become a general concept given the wide variety of applications that it enables including mobile banking, ticketing, coupons, payments and money transfers. E-commerce has witnessed steady growth, especially with the launch of high profile device launches including smartphones.

There has been a growth in sophisticated mobile web applications that resemble the full web experience equivalent to PC-based online shopping. Mobile banking in particular has proven to be extremely relevant in developing countries where banks seek to provide convenient services to bankers but face poor banking infrastructure (including poor fixed broadband network infrastructure).

The following are a few examples illustrating e-commerce applications that would operate productively through a broadband connection:[69]

- Launched in 2007, Pay-Buy Mobile, a MNO (Mobile Network Operator) worked with the GSM Association (GSMA) to use mobile phones to make fast, secure payments in a retail environment using wireless technology. The GSMA has been working with a variety of key stakeholder groups including operators, financial institutions and handset and point-of-sale device vendors.
- In January 2008, U.S. Bank, MasterCard and Nokia introduced a mobile payments pilot program in Spokane, Washington. Programme participants received a new Nokia 6131 mobile phone equipped with MasterCard PayPass payment functionality, which allows them to pay for purchases with a tap of their mobile phone, instead of sliding a card through a magnetic stripe reader, handing it over to the cashier, or fumbling for cash and coins.
- In late 2008 it was announced that a mobile payment pilot in South America is being launched in Guatemala by Visa with Banco Industrial and Banco Uno. The trial will last for six months. 200 Visa customers will have their credit card details placed on to their mobile phones and will be able to make small value purchases at hundreds of merchants by tapping their devices against Vivotech VivoPay in 5000 payment readers.
- India's Bharti Airtel chairs the GSMA's Mobile Money Transfer steering committee, and Western Union agreed with the GSMA in October 2007 to develop a commercial and technical framework that mobile operators can use to deploy services that enable consumers to send and receive low-denomination, high frequency money transfers using their mobile phones.
- MoneyBoxAfrica is an initiative from Nigeria's leading technology focused investment and financing institution, Integrated Capital Services. The service is based on Paybox's Mobiliser Platform and the Money Mobiliser product. The service targets the 80% of Nigerians who are unbanked or under banked. MoneyBox is a new savings and payment service based on scratch cards and e-pins and enabled by any mobile phone. IT offers a fast, safe, secure and reliable cash-like way to remotely save, spend and transfer money. With MoneyBox, one can open an account, save money, pay utility bills, buy insurance, send money to friends and relatives, withdraw money at agent locations, banks or ATMs, get access to credit and make investments. MoneyBox offers

[69] "Mobile Commerce – Prospects for Payments, Ticketing, Coupons and Banking 2008 – 2013" – Juniper Research.

banking functions at agent locations by providing deposit, transfer and withdrawal services unrestricted by location or proximity to a bank.

- In April 2008, Etisalat announced the start of a pilot service for Mobile Money Transfer from the UAE to India. The service enables Indian expatriates in the UAE to transfer money to their relatives back home through Idea Cellular, with Tata Communications to the central hub for the service. HSBC India is the banking channel for the funds transfer in India with Mashreq the banking partner in the UAE. Customers enrolling for Mobile Money Transfer service are provided with a mobile wallet which can be loaded by transferring money from a partner bank account. The money transfer is a simple menu driven process. Transactions are secured using a PIN.

I.2.8 E-Environment

E-environment[70] is defined as a) The use and promotion of ICTs as an instrument for environmental protection and the sustainable use of natural resources; b) The initiation of actions and implementation of projects and programs for sustainable production and consumption and the environmentally safe disposal and recycling of discarded hardware and components used in ICTs, and c) The establishment of monitoring systems, using ICTs, to forecast and monitor the impact of natural and man-made disasters, particularly in developing countries, LDCs and small economies.

The contribution of ICTs for dealing with environmental issues can be broken into categories such as[71]:

- Environmental observation
- Environmental analysis
- Environmental planning
- Environmental management and protection
- Impact and Mitigating effects of ICT utilization
- Environmental capacity building

The effect of broadband and related applications on the environment:

Similar to several recent studies, a study in the USA[72] "investigated the use of advanced technologies, including broadband services and telecommunications technologies and their specific effects on energy use and the environment" and indicated that there are significant savings that broadband technologies can bring in terms of reduced green house gas (GHG) emissions. The study concluded that the greatest potential for GHG reductions over the coming 10 years in the USA would come from the use of e-Commerce, followed by telecommuting, teleconferencing and paper reduction. "If the green house reductions noted in this study were converted into energy saved, we forecast that IT applications could save 555 million barrels of oil a year, or roughly 11 per cent of the oil imported into the USA today".

Similarly, a study on the role of ICTs and broadband on GHG emissions and climate change commissioned by Telstra, the incumbent Australian telecommunications operator, stated that according to a survey of Australian business, their ICT use amounts to 7.9 Megatons of CO_2, amounting to roughly 1.4% of national emissions. Telstra has recently launched the "Smarter, greener, together" website after reviewing a study showing that the telecommunications industry is capable of helping Australia reduce its yearly carbon emissions by approximately 5%, amounting to roughly 27 million carbon tons by the beginning of 2015.

Many reports have shown how broadband usage and (ICT) can have a huge environmental impact by reducing energy consumption and greenhouse gas emissions.

A November 2008 report by GeSI, the Global e-Sustainability Initiative, estimates that ICT can reduce emissions in the U.S. by up to 22 percent by 2020 through environmentally friendly practices such as smart logistics, smart buildings, a smart power grid and reducing travel through videoconferencing and tele-work.

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[70] Derived from the text in the Geneva Plan of Action (2003) from the World Summit on the Information Society (WSIS) Action Line C7: E-environment (http://www.itu.int.wsis/docs/geneva/official/poa.html#c7-20).

[71] ITU.2008. ICTs for e-Environment – Guidelines for Developing Countries, with a Focus on Climate Change.

[72] Fuhr, J.P. and Pociask, S.B. 2007. *Broadband services: economic and environmental benefits.* The American Consumer Institute.

The assessment of smart grid has many implications including broadband since broadband equipment contributes to electricity consumption. A 2007 American Consumer Institute (ACI) study found major reductions are possible over 10 years:

- Telecommuting reduces office space and car commutes, saving 588 million tons of emissions;
- Widespread teleconferencing could eliminate one-tenth of all flights, saving 200 million tons;
- E-commerce will reduce warehousing and long- distance shipping, saving 206 million tons.

The GeSI and ACI studies show how widespread adoption of high-speed broadband service could reduce up to 36 percent of U.S. oil imports each year and eliminate a billion tons of greenhouse gas emissions in 10 years.

An additional study by GeSI[73] indicates that while there is expected ICT and broadband growth in developed markets, the most significant growth will occur in developing countries. Currently 1 out 10 people in China owns a PC. This is expected to increase to 7 out of 10 by 2020, comparable to the PC ownership in the United States today. In approximately 12 years, half the Chinese population will a phone and half of all households will have broadband access.

By 2020, almost a third of the global population will own a PC, half will own a mobile phone and one in 20 households will have a broadband connection. These statistics are indicative of a parallel increase of mobile phones, chargers, internet protocol TV (IPTV) boxes, home broadband routers and telecom infrastructure in the coming years. The telecoms devices (excluding infrastructure) global footprint was 18 Million Tons CO_2 ($MtCO_2$) in 2002 and is expected to increase almost threefold to 51 $MtCO_2$ by 2020,[74] driven mainly by increases in the use of broadband modems/routers and IPTV boxes. Telecom infrastructure growth is attributed to an increased demand for telecom devices, broadband and mobile accounts, video and game sharing and other peer-to-peer content exchange. The telecoms infrastructure footprint, including ongoing energy use and carbon embodied in the infrastructure, was 133 $MtCO_2$ in 2002 and expected to more than double to 299 $MtCO_2$ by 2020.[75]

The OECD is currently[76]:

- Developing a framework for analysis of ICTs and environmental challenges. The aim is to comprehensively model environmental effects of ICT production, use and their application across industry sectors.
- Analyzing existing indicators and statistics on the relationship between ICTs and the environment with the aim of improving availability and comparability of official statistics.
- Identifying priority areas for policy action including life cycle analysis of ICT products and impact assessments of smart ICT applications. This work covers the potential of sensor-based technologies and broadband networks to monitor and address climate change and facilitate energy efficiency across all sectors of the economy.

In a recent paper[77], the OECD notes that governments can encourage the usage of Green ICTs by enforcing rules that can be voluntary Codes of Conduct (CoC) or mandatory national laws. “For example, the EC has formulated two CoCs fo relevance for Green ICT: In the *EU Codes of Conduct for Broadband Equipment*, companies must commit to reduce energy consumption of broadband equipment (EC, 2008a). The *EU Codes of Conduct for Data Centers* sets energy efficiency goals and measures standards for data centre providers (EC, 2008b).”

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[73] SMART 2020: Enabling the Low Carbon Economy in the Information Age.

[74] “Energy Usage of Mobile Telephone Services in Germany”, Schaefer C., C. Weber and A. Voss (2003), Volume 28, Issue 5, pp 411 – 410.

[75] “Energy Usage of Mobile Telephone Services in Germany”, Schaefer C., C. Weber and A. Voss (2003), Volume 28, Issue 5, pp 411 – 410.

[76] http://www.oecd.org/document/30/0,3343,en_2649_34223_42906974_1_1_1_1,00.html

[77] OECD – “Toward Green ICT Strategies Assessing Policies and Programs on ICT and Environment”, May 2009.

The following example illustrates an E-environment application using broadband:

- Coral disease, bleaching, climate change and pollution are harming the health of the Great Barrier Reef which stretches for thousands of square kilometers. In order to monitor and measure the health of the various factors damaging the reef, data needed to be collected and transferred back to research facilities, a challenge when dealing with over 70 kilometers offshore with no fixed line infrastructure. Telstra, Australia's 3G operator offered a solution that could transmit data from remote offshore locations that was scalable, cost-effective, fast and secure. Sensor buoys containing 3G modems were placed at various locations on the Great Barrier Reef to capture data in real-time and proceed to transmit it back to land. The signal connects to a fixed line IP metropolitan area network on the 3G network via a wireless port. The data is then relayed back to a research center for analysis. By bolting the 3G modem onto a sensor buoy, it can be deployed in less than a day.

I.2.9 Telecommunications for Public Safety, for Disaster Prevention and Disaster Relief

The use of broadband technology to support public safety initiatives, disaster prevention and disaster relief are increasingly important applications. Since 11 September 2001, U.S. public safety officials and members of the international telecommunications community have focused on the uses of broadband technologies to effectively protect public safety and security in the event of another similar terrorist attack. The ability to roll out and quickly deploy broadband wireless links in order to provide essential telecommunication connectivity to public safety agency was recognized by the entire nation.

Broadband technology can be used in a variety of ways to assist with public safety protection. Some of these applications include: biometrics screening at designated entry points into a country or locality and at sensitive facilities; enhancing remote surveillance of borders, airports, ports, and train stations to complement local surveillance; restoring public services and public confidence by enabling public officials and their staffs to telework in the event of damage to or destruction of normal work spaces; providing remote access to information systems necessary for either public or private business activities in the event of bio-chemical threats, attacks or quarantines; marshalling geographically dispersed medical expertise and support at crisis scenes; and supporting or replacing letter mail services with high capacity electronic service in the event of a disruption caused by destruction, contamination or quarantine of mail facilities.

Moreover, broadband telecommunication networks, and particularly wireless networks, can assist police, fire and specialized law enforcement members in many situations. Large data and image files can be quickly and wirelessly transferred, enabling images and fingerprints of wanted or missing persons, video clips of robberies, maps and layouts to be downloaded into police vehicle mobile computers as they leave their precincts. The same technology also can allow wireless uploads of videos, images and reports from the police vehicle to the command centre, enable command centres to employ full motion video for remote-controlled robotics in terrorist and other highly dangerous operations, and monitor officers or suspects in high risk situations to allow on-scene decision making and assistance based on video transmissions.[78]

In addition, broadband networks can supplement conventional circuit-switched wireline and wireless telephony services with survivable, dynamically routed Voice-over-Internet Protocol (VoIP) applications capable of TV-quality videoconferencing and other applications. Broadband also can assist federal and local officials taking part in safety training to do so more cost effectively – enabling training without the expense of the travel associated with going to seminars, etc.

Broadband technology can be particularly useful in times of crisis or before, during and after disasters. With broadband technology, individuals can instantaneously alert family and friends about a person's status. Broadband connections using position location technology, particularly in rural and remote regions, can assist rescuers in recovering victims of accidents or natural disasters. Broadband, particularly wireless or satellite broadband, can assist first-responders in receiving area maps, provide videos on situations like how to pry open a rail passenger door or how to safely shut off electrical power in a facility expectation of a

[78] Motorola. "4.9 GHz Allocation to Public Safety: Motorola White Paper for Submission to FCC", July 31, 2001.

disaster and it can enable all involved responders from numerous agencies to view the same image and data and assist before, during and after the disaster.[79]

Broadband technology also can be used to facilitate mobile robotics. In such cases, robots can be used to help rescue people from hazardous areas, conduct automated inspections of non-accessible areas, and assist with hazardous material, bomb disposal and landmine clearing.

Firefighting is critical field that can use broadband technology very effectively. Broadband technology can help reduce personal risk to firefighters' lives. Using a multitude of detectors, a firefighter's vital signs, as well as high-resolution signals from both visible light and infrared sensitive cameras, can help off-site managers make decisions that can save lives. In addition, the technology can provide accurate three-dimensional positioning used to determine the exact location of a firefighter inside a burning facility.

In January 2001, two international standards development organizations, the Telecommunications Industry Association (TIA) and the European Telecommunications Standards Institute (ETSI), finalized the first international standardization partnership project agreement involving users and organizations from the public protection, disaster response and civil defense sectors (also known as PPDR). The partnership, called Project MESA[80] (Mobility for Emergency and Safety Applications), brings together users, industry and researchers to facilitate advanced, dependable, secure, efficient, effective and interoperable equipment specifications and service applications that are primarily involved with public safety-oriented broadband telecommunication needs. The result of this Public Safety-oriented activity will be harmonized specifications for broadband terrestrial mobility applications and services, driven by common scenarios and spectrum allocations. MESA deliverables are being transposed, as necessary, into regional standards involving next-generation mobile broadband technology for public safety, security and emergency response (before, during and after the disaster) professionals. With the recently Tsunami disaster, this application becomes more than a necessity.

I.2.10 Small Business Applications

For small business owners, broadband technology can assist entrepreneurs with the ability to obtain information about how to establish a small business, apply for permits and licenses online, enable business owners to conduct Internet market research, advertise their products and services and correspond with customers and suppliers more easily. Broadband technology also can enable small business owners to find supplies and purchase materials faster and without the need to spend excessive time and money travelling to various locations to accomplish the same goals.

I.2.11 Entertainment Applications

Many people have used broadband to further personal hobbies, browse the Internet for fun, play games, gamble, and download music, videos and movies. In addition, position location technology, combined with broadband, can enable people to obtain restaurant information, local area maps, and museum and tourist information.

I.2.12 Information Gathering

One of the most popular applications for which broadband technology is used is to access and search for information. The always-on, high-speed broadband telecommunication connection allows users to access more information faster than with slower narrow-band connections. Thus, broadband technology can encourage more people to search for more information online and improve their ability to learn new things.

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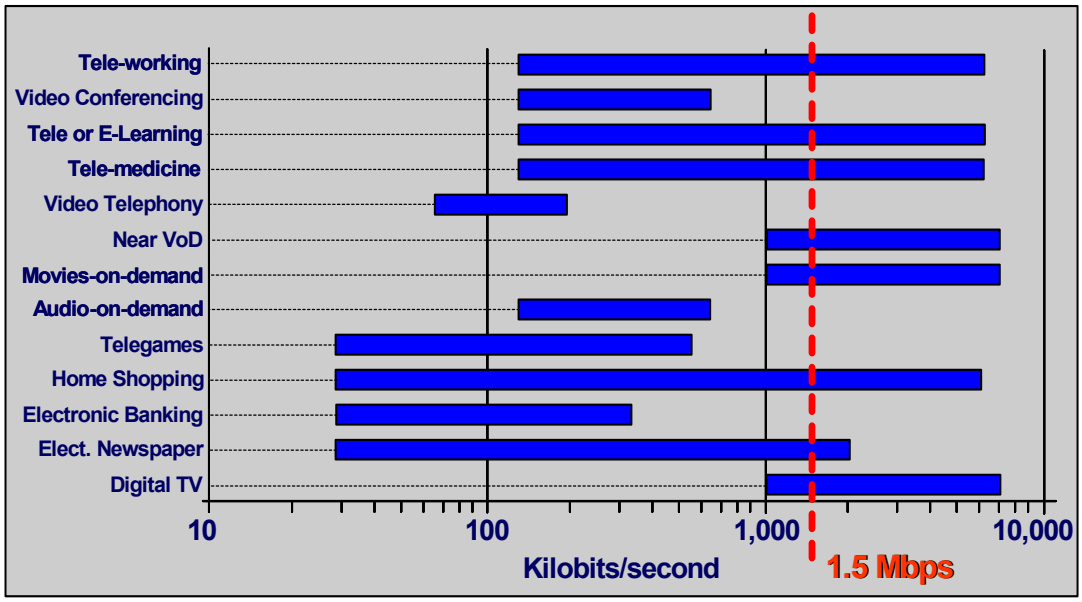
[79] Motorola. "4.9 GHz Allocation to Public Safety: Motorola White Paper for Submission to FCC", July 31, 2001.

[80] See: www.projectmesa.org/

I.2.13 Capacity Requirements for Selected Applications

While telecommunication bandwidth requirements are subject to change based on technological advancements, the chart provides a general idea of the necessary speeds to perform a variety of applications, many of which are discussed in this Report in great detail.

"Capacity: Required bit rate capacity per application"[81]



NOTE – Depending on a variety of compression or other techniques, the speeds mentioned in the above table may change.

I.3 Broadband Technology Deployment

Potential factors negatively affecting the widespread deployment of broadband access technologies are numerous. Not only do operators face extreme difficulties in installing a network, but acquiring customers and running a profitable business are additional challenges. Attempts at deploying and providing a profitable broadband telecommunication service are difficult for a number of reasons including:

- expensive access technology
- lack of awareness of broadband access technologies
- lack of regulatory framework conducive to network build out and deployment
- continued monopolies and low levels of competition
- lack of competition in the last mile
- state subsidies that produce market distortion
- excessive cross-ownership between telephone and cable TV networks as this reduces the potential for inter-modal competition
- environment with little or no basic infrastructure such as electricity and roads
- high maintenance and operational costs, including security, administrative and labour costs
- high equipment prices

[81] Chouinard, Gerald; "*Rural & Remote Broadband Access (RRBA)*", Communications Research Center of Canada, www.crc.ca/broadband/

- the imposition of excessive caps on volume that could be downloaded within a flat rate
- lack of technical personnel in area of service
- difficulty in dealing with subscribers with bad debt problems
- poor distribution, sales and customer service presence in area of coverage
- low usage and average revenue per subscriber
- small potential markets
- lack of localized content and applications in national languages besides English
- theft of infrastructure equipment such as cables

I.3.1 Analysis of Broadband Access Questionnaire: Main Findings

A questionnaire was distributed following the Second Rapporteur's Group meeting for Question 20/2: Examination of access technologies for broadband communications questionnaire in March 2003. The questionnaire requested Member States, Sector Members, relevant organizations and industry to identify relevant wireless and wireline broadband access technologies and their attributes. The questionnaire also aimed to identify economic, technical and development factors influencing the effective deployment and accessibility of broadband access technologies and applications. Below represents the summarized results of the responses received by the ITU-D Secretariat by June 2003. An external expert was contracted by BDT to conduct the analysis. By mid-June 2003, fifty-five responses were received from forty-nine countries from the six ITU regions.

Main Findings

The questionnaire was organised into several sections and the main findings from these sections can be summarised in brief, as follows:

Section	Main findings
Technology	The current dominant technology for delivering broadband services over wire line networks is DSL, closely followed by more traditional E1/T1, fibre and cable connections. (NOTE – Cable-TV is ahead of DSL in North-America because of a few years lead in the market.) Satellite, fixed wireless, IMT-2000, and wireless local area networks are leading solutions used to deliver wireless broadband solutions especially where wireline solutions are inappropriate. Other solutions include ISDN, Ethernet, laser free space optics and GPRS.
Competition	Only four countries did not permit competition in Internet services. 28 countries have competition in the local loop and 21 do not. 10 respondent countries did not have competition between differing broadband technologies. There is no regionally dominant technology – broadband solutions vary from country to country depending on operator offerings, local economics and historic investment.
Access	There are huge differences between developed and developing nations when viewing access to broadband services on a business, household and rural telephone subscriber basis. Many developing (and some developed) countries estimate that rural subscriber access to broadband, if it exists at all, is often measured in fractions of a few per cent of the potential subscriber base.
Pricing and usage	Despite the variance in size and nature of the economies of those countries which responded to the question there is a general convergence on the average price for Internet dial up accounts across ITU-D six Regions. However broadband prices show a marked variation between these Regions especially in terms of large bandwidth capacity based services with average broadband access costs being five times as high in the Africa region than in Europe. Unlimited usage plans offered by operators did not show a marked regional bias but rather were governed by the domestic situation facing individual operators. Pricing and Usage models varied between operators, technologies and regions though broad models were identified.
Barriers to broadband deployment	Deployment costs are the single largest barrier followed by lack of demand for broadband service applications. Of the issues limiting the spread of broadband identified by respondents, the most common was that the monthly associated fee was too high. High monthly fees, high installation costs and lack of personal computers when combined result in insufficient demand to justify infrastructure costs and make the business case for deploying broadband services more difficult. The majority of respondent countries do not provide loans or support to enable broadband deployment.
Quality of Service	Average downstream speeds for DSL, cable and wireless vary based on technology constraints and pricing usage model employed.
Miscellaneous	The fastest growing broadband technology area was identified as Wireless, with business applications (e.g. email and access to corporate extranets) as the main adoption driver though personal use (web browsing etc) was a close secondary driver in both developed and developing countries.

Additional and detailed information on the broadband questionnaire are given in Annex II: Analysis of the replies to the questionnaire.

I.3.2 Gender Issues Surrounding Broadband Technology Deployment

Advanced telecommunications technologies such as broadband, when democratically employed, constitute powerful instruments that can contribute to securing the advances in human rights, such as fuller participation of women in all spheres of activity. Nonetheless, access to these technologies may be unequal in different geographic regions and social groups. This is in part a result of women's economic position within their households and communities. This inequality contributes to increasing the gap between those who have access to abundant information resources and those who are deprived of this access, thus

reinforcing the marginalization that already exists in terms of development and technical resources. In this context broadband technology, because it promises the delivery of information at lower cost, has the potential to erode financial constraints and narrow the gendered digital divide.

Women in particular, tend to be under-represented in terms of access to these technologies, and especially women from developing countries and from marginalized groups. Ironically, women from these social groups are precisely those who make up the work force that produces computer components, in working conditions that are often damaging to their health; similarly, women in low-grade technical and service jobs also make up the largest group of computer users, while many others have lost their jobs to increasing automation. In contrast, women are less present than men in fields such as computer systems administration and in technical development. They are also proportionally under-represented as users of broadband technologies.

Many women's organizations have come to appreciate the importance for their work of creating and participating in regional and world- wide information exchange fora that enable them to share ideas, proposals, documents and information. Broadband technologies can help make this exchange of information possible. Many portals or exchange networks have arisen on diverse issues of concern to women. For example, women's networks and organisations at the national and regional levels are promoting applications related toe-health, agriculture, distance learning and e-commerce, etc. More specifically, some women's organizations have noted that certain applications, such as telemedicine-health, while virtually reducing distances, can speed up access to health care and increase the health and economic well-being of women in poor communities.

E-commerce applications also positively impact on the welfare of women across economic backgrounds. For example, in Cameroon ASAFE uses ICTs as a tool through which to address the needs of disadvantaged women in the urban and rural sectors by building the capacities of small women-owned businesses. Similarly, SEWA (Self-Employed Women's Association) in India works with women involved in micro enterprises and craft production to market their products internationally. There is increasing recognition that the development of such telecommunication networks will contribute to advancing the cause of gender equality and to promoting greater participation in worldwide fora and decision-making processes.

Many women and women's organizations are therefore eager to access and appropriate this technology. Nonetheless, they often face obstacles that make this endeavour more difficult for them. Such obstacles include: less access to resources (financial and technological), reduced access to training and technical assistance or non-gender sensitive methodologies, social and cultural barriers for women and girls to access technology, educational short- comings, misconceptions about technology and its use, language barriers, etc. Special efforts are required to overcome these problems.

One such organization in the US, Women in Cable & Telecommunications (WICT). Since its founding in 1979, WICT has remained steadfast in its resolve to advance the position and influence of women in technology through proven leadership programs and services at both the national and local level. WICT embraces a spirit of collaboration within its organization and throughout the industry. They partner with cable and telecommunications industry leaders to provide leadership programs and services, and challenge these companies to create professional advancement opportunities for women.[82]

Another organization, Women'sNet, is developing a pilot Women's Online Resource Centre (WORC), an information community building project.[83] WORC will be the place to find gender-related training materials relevant to individuals and organizations active in the struggle for gender justice. It is intended to serve as an online clearinghouse for gender-aware training materials in the area of ICT training, as well as a range of other fields for which there is an expressed need. The goal of WORC is to promote the inclusion of gender analysis in ICT and other areas of training, with a view towards enhancing the quality of training in support of gender justice available at global, regional, and local levels. The Association of Progressive Communications (APC) is an international network of civil society organisations dedicated to empowering

[82] www.wict.org

[83] www.womensnet.org.za

and supporting groups and individuals working for peace, human rights, development and protection of the environment through the strategic use of information and communication technologies.

Gender Experience: Broadband adoption is booming in the US with women leading the way

According to figures from Nielsen/NetRatings, as of May 2003, nearly 40 million internet users in the US now connect via broadband networks, up 49 per cent in the last year.[84] The fastest adopters are women, seniors, students and affluent social groups. Women outpace men in broadband adoption slightly at 51 per cent versus 48 per cent. There are still more men (20.1 million) who access the internet via broadband than women (18.9 million), and there continues to be more females (37.8 million) who access the internet via narrowband than males (31.8 million).[85]

I.3.3 Access to Broadband Services for Persons with Disabilities

An estimated 10 percent of the world's population (around 650 million people) is living with a disability, representing a significant communication challenge.[86] The ITU is committed to addressing this issue. This year, the World Telecommunication and Information Society Day (WTISD) adopted the theme: "Connecting Persons with Disabilities: ICT Opportunities for All" to address the special requirements of persons with disabilities. Furthermore, the World Summit on the Information Society (WSIS), through the Geneva Plan of Action, urged Member States to address the special requirements of persons with disabilities in their national e-strategies and encouraged the design and production of ICT equipment and services suited to their needs, including adherence to the Universal Design Principle and use of assistive technologies. Additionally, the Doha Plan of Action endorsed the Tunis Commitment of building ICT capacity for all, including people with disabilities, through the promotion of universal, ubiquitous, equitable and affordable access to ICT. Increased accessibility through the effort of policy makers, regulators, operators and industry would not only ensure an inclusive information society but would also enable Member States to meet their obligations under Article 9 of the UN Convention on the Rights of Persons with Disabilities (CRPD) adopted by the United Nations General Assembly in December 2006.

Access to broadband for persons with disabilities is vitally important for successful integration into society. Without the speed of broadband there are many problems in providing accessibility features such as real time captioning over the web for meetings and conferences. Examples are Video IP relay services for deaf or voiceless persons require the inclusion of sign language as well as real time text. Without broadband, there would be great difficulty in participating in distance learning and video conferencing. Persons with disabilities require applications and services in real time without delay. The ITU Recommendation "Total Conversation (Real Time Text, Video and Voice)" over the internet would suffer delay and errors if broadband were not deployed. The lack of real time services and the expenses associated with broadband impacts all levels of society – but especially persons with disabilities.

Persons with disabilities in developing countries may not have the income to support using the internet or may lack access altogether. This would prevent them from benefiting to modern broadband enabled applications related to e-commerce, e-heath, e-medicine, e-emergency and e-disaster preparedness and relief. Therefore the speed of broadband and accuracy without delay is especially important for persons with disabilities.

I.3.4 Strategies for Promoting Broadband Deployment

Economies that have been successful in facilitating broadband access technologies have several factors in common such as: measures to inform the public about the advantage of broadband technologies effective use of broadband through applications and content, an environment that fosters broadband innovation, a competitive market structure that keeps prices low, and government policies and programs that focus on the broadband technology environment.

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[84] "*Broadband Adoption is Booming in the US*", www.onlinepublishingnews.com/htm/n_olpn20030620.538206.htm

[85] ibid.

[86] http://www.itu.int/themes/accessibility/

Two viable methods for promoting broadband include connecting schools and using community access centres to give users access to broadband without the vast fixed costs of wiring to homes. Economies must also make best use of the existing networks since financial resources to build new networks may be scarce.

Other countries have addressed broadband through government initiatives including e-government, e-health, and e-learning applications. Projects include initiatives that focus on teaching teachers how to interact and deliver material via computers and broadband connections.

Establishing an appropriate regulatory framework is also essential to promoting the deployment and market adoption of high-speed data applications. Effective strategies of promoting broadband technology demand and supply as well as the importance of technology flexibility and universal access policies are further described below.

I.3.4.1 Promotion of broadband applications[87]

There is no single method of promoting broadband applications. Promotion strategies and policies will prove most effective when various initiatives and projects are incorporated simultaneously, encompassing all stakeholder groups, and adjusted to contextual and environmental factors. Some central reasons for promoting broadband applications include:

- Benefits to users: increased speeds and always-on nature of broadband technology enables the exchange of richer content, facilitates improved, expanded and more rapid telecommunication, and allows the sharing of a connection with multiple users.
- Benefits to the economy: broadband connectivity encourages innovation, stimulates growth in an economy, and attracts foreign investment.
- Returns on investment: broadband technology holds the promise of new applications and services that will attract users and help recover infrastructure development costs.

Promoting Broadband Demand

In general, there are certain actions that a particular country or region can follow in order to foster a more conducive environment for broadband deployment and expansion. A successful broadband application economy can emerge if the following actions are taken:

Keep the public informed about broadband technology and applications

It is important to make users aware of the benefits that broadband technology and its application can provide. Both governments and the private sector can play an active role in marketing the benefits of broadband. Users should be made aware of the advantages to be gained by adopting key broadband technologies and integrating them into their daily lives. Business and government cultures can also embrace and encourage ideas such as E-working and online transactions.

Promote technological innovation

It is important to promote policies and incentives which serve to foster the development of broadband content and applications. Economies must offer an environment that fosters broadband development by giving careful consideration to intellectual property rights, support for sectors that participate in developing new, high-bandwidth applications, methods for diffusing technology, and measures to ensure security for users.

Support broadband usage with compelling applications and content

The types of applications that are available across countries make a big difference in the adoption rates for broadband technology. Applications that have been meshed into successful broadband economies include IP telephony, video chat, audio over broadband and online gaming. Furthermore, application developers must take into consideration the need for content in multiple languages.

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[87] ITU/SPU, "*Promoting Broadband*" Background Paper, April 2003.

Create a competitive market environment

Open and fair competition in broadband will help drive down prices to an affordable rate, thus stimulating greater demand. While other mechanisms, such as subsidies, grants, and regulatory measures help to foster the development of broadband technology, a truly competitive market will be the key stimulus for increased demand. Consumers will only adopt broadband when they can justify its cost in terms of the value it adds.

Promoting Broadband Applications Supply

A broadband application economy, which affectively promotes broadband supply, can be characterized by:

a) *Competition*

Multiple providers offering multiple broadband technologies is key to driving prices down and increasing the broadband options available to users. Furthermore open access policies can help promote service competition. It is also beneficial to have players in the market that are capable of rivalling the incumbent operator.

b) *Maximum utility of current networks and new network investment*

Existing networks must be utilized to their full extent alongside new network investment. Innovative broadband networks such as wireless, satellite, railway and electrical can be used to supply broadband applications. Schools, hospitals, and community access centres can serve as initial broadband anchors in areas, eventually becoming the network access points from which future networks.

I.3.4.2 Flexibility

Establishing an appropriate regulatory framework is essential to promoting the deployment and market adoption of high-speed data applications. The convergence of services, such as data and voice should not lead to additional unnecessary regulations. The importance of technology flexibility is further described below.

Importance of Technology Flexibility

Technology flexibility (also known as technology neutrality or operator choice) is an important aspect in promoting broadband deployment. Technological flexibility in the policy arena means that policies and incentives do not create a preference for any specific technology platforms or modes of providing broadband applications (e.g. satellite, wireline, wireless, etc). Also within a given platform or mode of providing a service, technology neutral policies and incentives do not create a preference for any specific technology products or standards – e.g., circuit- or packet-switched networks, various mobile or cellular telecommunications standards, etc. If possible, it is important that service providers have the flexibility to independently choose the most suitable technology based on commercial and competitive considerations. A transparent regulatory framework, in which the market selects the most appropriate technologies for deployment, may encourage competition, spur innovation and accelerate the deployment of advanced services.

I.3.4.3 Universal Access

A transparent universal access policy aims to promote the availability of quality services at just, reasonable, and affordable rates, increase access to advanced telecommunications services and to advance the availability of such services to all consumers, including those in low income, rural, insular, and high cost areas. It is important that countries continually evaluate their universal access strategies in the face of technological advances and changing market conditions in order to maximize the size, scope, variety and efficiency of telecommunication networks. It is also important that universal access policies encourage the availability of affordable education and health and safety applications to citizens, businesses and government.

Universal access policies that are competitively neutral do not favour any one participant or group of participants. As no one technological solution is necessarily appropriate for an entire country or region, the variety of available technology platforms gives new and innovative alternatives to expanding access to services in developing countries.

I.3.4.4 Public Role in Promoting Broadband

a) Government programs that serve to accelerate broadband supply

Several government sponsored programs at the local, national and regional levels have been successful at increasing the overall supply of broadband. Specifically, governments can invest directly in broadband infrastructure as well as provide tax credits, low-interest loans and subsidies to the industry players looking to provide broadband networks in underdeveloped areas. It is important that in promoting development of broadband "for all" to avoid any direct or cross-subsidy by the country which would give an unfair advantage to some market stakeholders. Governments are invited to assist with the provision of broadband infrastructure and services in areas that are not served by the public sector due to unfavourable market conditions.

b) Public institutions as effective anchors for broadband demand

In areas where individual household connections are not yet viable, schools, hospitals, and community access centres can be utilized to offer broadband connections. The network can then expand incrementally from these key points as the technology and economy allows. Wireless broadband also offers a viable community economic alternative to fixed line solutions such as broadband via DSL or cable modem.

c) Government participation at all levels

National, regional and city-wide initiatives and community participation projects have been successful in expanding access. In some cases, governments have chosen to provide, or to subsidize, infrastructure to stimulate the economic development of a particular area.

d) Best Practice Guidelines for the Promotion of Low-Cost Broadband and Internet Connectivity

In December 2004 the Best Practice Guidelines for the Promotion of Low-Cost Broadband and Internet Connectivity were produced at the Global Symposium for Regulators (organized by the ITU-D on a yearly basis). These guidelines describe what the foundation for an enabling regulatory regime should be and how governments can help to stimulate growth in the telecommunications market for broadband applications. (Full guidelines can be found in Annex IV.) Some of these are as follows:

- "We encourage political support at the highest government levels with such support expressed in national or regional policy goals. These include an effective, separate regulator insulated from political interference, a transparent regulatory process, and adoption and enforcement of clear rules."
- "We encourage regulators to set policies to stimulate competition among various technologies and industry segments that will lead to the development and deployment of broadband capacity. This includes addressing barriers or bottlenecks that may exist with regard to access to essential facilities on a non-discriminatory basis."
- "We encourage regulators to allocate adequate radio spectrum to facilitate the use of modern, cost effective broadband radiocommunications technologies. We further encourage innovative approaches to managing the spectrum resource such as the ability to share spectrum or allocating on a license-exempt non-interference basis."
- "We urge regulators to conduct periodic public consultations with stakeholders to inform the regulatory decision-making process."
- "We recommend that regulators carefully consider how to minimize licensing hurdles."
- "We encourage regulators to provide a clear regulatory strategy for the private sector in order to reduce uncertainty and risk, and remove any disincentives to investment."

ANNEX II

Technology Matrices (Standardization in Progress)

II.1 Canopy Solution for Fixed Broadband Wireless Access Matrix

For many businesses, domestically and, especially, internationally, reasonably priced broadband is not readily available, sometimes not at any price. The expense of building out new DSL networks, re-working or conditioning the lines that exist, or converting existing cable plants to carry two-way traffic might be expensive. This section provides information on BWA technology characteristics which make this broadband approach accessible.

The majority of the world is still unable to receive reliable high-speed data and/or voice connections. The promising access medium to meet this need, broadband wireless access (BWA), accounts for less than five per cent of the total broadband access connections.

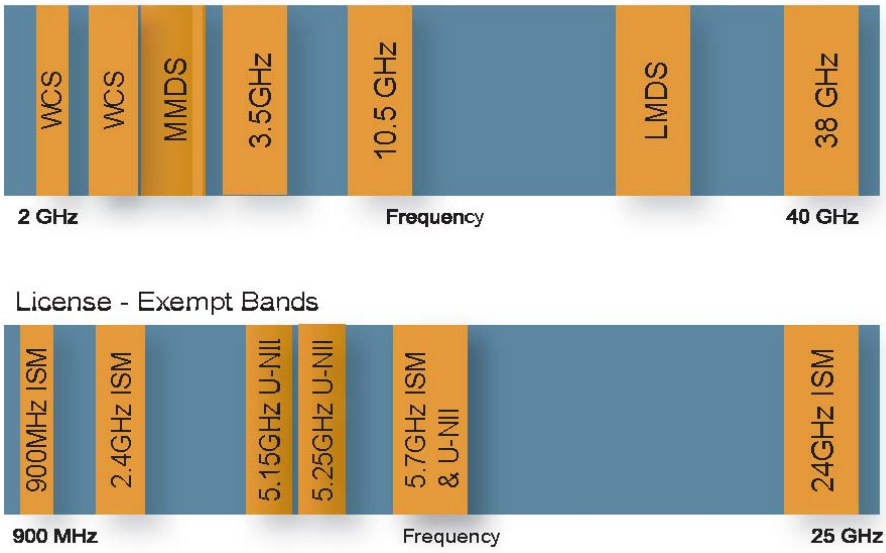
Nevertheless, BWA is developing new approaches to solving the issues that had previously stalled its growth. A big issue for service providers, for example, has been the lack of ability to avoid RF interference. This has resulted in higher costs due to additional equipment and an inability to meet service agreements with their customers.

The key challenge to making BWA ubiquitous broadband access is interference. Customers must be assured that the technology chosen is hassle-free and always available. With BWA, the number one threat is interference.

When licensed bands are designated for BWA, typically a limited number per region are granted. On the surface, this means that BWA will only be deployed in those places where the license fee can be recouped and only by a few players. Such a situation effectively reduces the number of potential competitors and, hence, reduces options available to the end customer, freezing out competing BWA options. The rules should be designed to allow multiple networks to co-exist with minimal interference, enabling multiple operators to serve a given geographic region. The bands below in Figure 22 are examples of such use on a national level in a few countries.

Broadband Wireless Frequencies Licensed Bands

Figure 22 – Global Frequency Bands



The overriding design goal of the Canopy technology has been to deliver an interference robust simple-to-use BWA system. Interference lies at the heart of the reliability design challenge, and interference in the license-exempt bands can be a much greater factor than that faced by licensed band systems.

To that end, it is critical that BWA solutions designed for the license-exempt bands address this issue head on. It is also clear that in order to do so, proper design at a very detailed level must be accommodated in the core of the product. Solid, reliable BWA networks do not happen by chance; they are a result of keeping a focus on the issues and delivering the right solutions.

The BWA Canopy solution has the following characteristics:

– Access Method: TDD/TDMA
– Modulation: High Index BFSK (Optimized for interference rejection)
– Data Rate: 10 and 20 Mbit/s (signalling rate)
– Frequency Band: 2 400-2 483.5 MHz, 5 250-5 350 MHz, 5 725-5 850 MHz
– Channelization: 3 non-overlapping channels at 2 400-2 483.5 MHz (18 overlapping channels)
– 3 non-overlapping channels at 5 250-5 350 MHz (11 overlapping channels)
– 6 non-overlapping channels at 5 725-5 850 MHz (22 overlapping channels)
– Network Standard: IPV4, UDP, TCP, ICMP, Telnet, HTTP, FTP, SNMP
– Transmitter power: Meets FCC ISM/UNII EIRP limits.

The interference effectiveness of Canopy is accomplished by:

- Employing BFSK for modulation. With this modulation the C/I ratio necessary to operate properly with an error rate of $1 \times 10–4$ bits per second is only 3 dB; i.e. the wanted signal needs to be only 3 dB higher in power than the unwanted interferers. A system operating with 16 QAM at these levels would require a C/I ratio of roughly 12 to 14 dB.
- Deploying networks in a cellular topology; the performance of the antenna in rejecting unwanted signals from behind is an important feature. The Canopy system, with its integrated antennas at the AP, has a front-to-back ratio of 20 dB. Coupled with the excellent C/I ratio, this means a Canopy AP receiving a signal at threshold (the weakest signal it can still detect) can be hit with an interfering signal from behind, either internal or external, on the order of –60 dBm and still support connections at an acceptable error rate.
- Delivering tight synchronization across potentially hundreds of square miles. With the Canopy system, designed for large scale, dense network deployments, TDD synchronization is a critical requirement. This has been solved with the use of a GPS signal. These precise satellite signals are used for timing and, ultimately, transmit/receive synchronization, thus tying all sectors in a Canopy network to the same "clock".

Recognizing the dilemma of combining TCP/IP with wireless networks and the attendant error rates, the Canopy system solves the problem with a feature called Automatic Retransmission request or ARQ. ARQ actually inspects the RDPs that come into the receiving SM and looks for errors. If an error is detected, the SM (or AP) will send a request to the sending entity to re-send the RDP.

II.1.1 *Airstar*: A Multi-Service Broadband Fixed Wireless Access System

Summary of the "*airstar*™" system

airstar™ is a point-to-multipoint fixed wireless access system specially designed for residential, Small Offices/Home Offices (SOHO) and Small and Medium-sized Enterprise (SME) users in urban, suburban and rural areas.

airstar™ is a high capacity solution for service providers that effectively handles applications ranging from toll-quality voice and data transmission to mobile base station backhaul on a single platform. Operating in the 3.5, 10, 26 and 28 GHz frequency bands, the system uses an ATM/TDMA/FDD air interface with dynamic bandwidth allocation delivering a high level of Quality of Service (QoS) for voice and data.

airstar™ is a field proven solution: more than 80 systems have been deployed in 37 countries and are in operation for now more than 5 years.

Applications

The ***airstar***™ system is a high flexible platform that supports multiple applications.

- 2G/3G mobile backhaul.

  Mobile operators upgrading to 3G technologies face significant increases in the capacity requirements of their transmission networks, as well as a need to migrate from TDM to ATM and IP. The system provides the transmission link to backhaul 2G and 3G mobile base stations from a single customer premises equipment. In addition, the native ATM air interface provides a future-proof backhaul infrastructure solution for supporting future 3G mobile services.

- Access for Small and Medium-sized Enterprises (SMEs).

  Given the large variety of equipment and applications within a typical SME, delivering multiple services is an essential part of any service provider's business case. The system enables the delivery of E1/T1-based voice, Internet access, virtual private network (VPN), and Frame Relay services from a single Customer Premise Equipment (CPE).

- Multi-tenant unit access.

  In residential multi-dwelling units, the system provides scalable and versatile solution for multi-tenant unit access and enables the delivery of Internet access and toll-quality voice or VoIP services.

- Wireless local loop backhaul.

  At 3.5 and 10.5 GHz, it provides backhaul links up to 20 Kms, enabling remote towns and villages to be served with the wireless local loop and backhauled to a larger city for connection to the Public Switched telephone Network (PSTN).

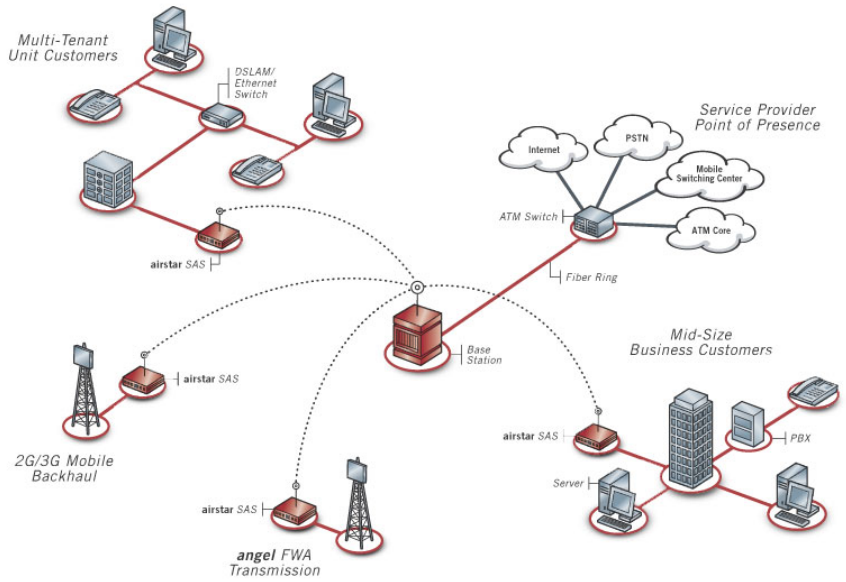
- Wi-Fi hotspot backhaul.

  The system also provides backhaul for Wi-Fi hotspots using the CPE 10/100 Mbit/s Ethernet interface. All backhaul links are aggregated over the airlink and delivered on a single ATM network connection at the base station. The ATM QoS implemented on the airlink guarantees the necessary bandwidth for Wi-Fi hotspots.

Architecture

Figure 23 represents an example of the Architecture of "***airstar***™" system.

Figure 23 – Airstar™ Architecture



Main features and benefits

- **Service flexibility**

The platform efficiently supports the following voice and data services, enabling service providers to offer personalized solutions to their customers:

Voice Services:

– ***E1 Lease Line*** – Both unstructured and structured modes are supported. For structured E1s, only provisioned time slots are carried over the air.

– ***PRI-ISDN*** – with dynamic bandwidth allocation on a call by call basis.

– ***Voice over IP/FR/DSL*** – with statistical multiplexing gain and differentiated QoS to enable POTS and BRI-ISDN services.

Data Services:

Dynamic Bandwidth Allocation is provided for all data services.

– ***Internet Access*** – Without the need for external router

– ***LAN to LAN Interconnection*** – Through bridged Ethernet or a Frame Relay service

– ***Frame Relay*** – Over E1 or X.21/V.35 Serial interfaces

– ***VLAN*** – For providing IP services to dozens of end customers while maintaining individualized QoS.

Unique Service Offerings via Wireless

– ***4xE1 Leased Line*** – For an AirStar CPE, the incremental cost per customer is less than 20% for providing 2xE1 per building or 4xE1 per building.

– ***8 Mbit/s IP Service*** – With the 3000 Series SAS-XP, the AirStar system can deliver near wirespeed throughput on the SAS Ethernet interface.

• The Wireless + ATM benefits

Quick to deploy	High speed switching and transport
Low initial costs	One network for all traffic types
Flexible and scaleable	Bandwidth sharing of services
Easy to maintain	Simple network management
	Long architecture lifetime

• Service level agreement

The platform enables service providers to reserve bandwidth for their different customers according to the service level agreement they have purchased.

• Service availability equivalent to fibre

Features such as base station redundancy and error correction algorithms are combined to achieve a high level of reliability. This allows the system to provide up to 99.999% availability.

• Ease of deployment

CPE configurations can be pre-provisioned prior to installation to accelerate the deployment.

• Efficient spectrum utilization

The system features dynamic bandwidth allocation to enable dynamic bandwidth sharing over the airlink for the delivery of bandwidth-on-demand applications such as voice and Internet traffic.

"*Airstar*™" technical characteristics

• Access method: TDMA

• Modulation: 4 or 16 QAM

• Frequency bands:
  – 3.5, 10, 26 and 28 GHz with Frequency Division Duplex (FDD) channel arrangement
  – multiple frequencies can be deployed from the same base station platform, and aggregated onto a single network interface.

• Base station capacity:
  – A single base station can cover 40 km2 at 26 to 28 GHz, and up to 400 km2 at 3.5 and 10.5 GHz, enabling hundreds or thousands of potential customers to be addressed from a single base station.
  – up to 28 Mbit/s of capacity per radio channel
  – from 2 to 12 sectors (48 at 10 GHz)
  – a total capacity of 384 E1s or 1½ STM-4s with only 28 MHz of available spectrum.
  – capacity is provisioned based on average utilization rather than peak utilization as is the case with fibre enabling a wireless base station configured for an STM-1 to provide the same effective capacity as an STM-4 fibre ring.

• Subscriber Access System:
  – User Interface: E1/T1 lines, 10/100BaseT port, Serial Port
  – Radio Interface: TNC connector for coax cable carrying transmit and receive IF signals, radio DC power, reference clock signal and telemetry control channel.

• Environmental specifications:
  – Indoor equipment operating temperature: 0°C to +40°C
  – Outdoor equipment operating temperature: – 33°C to + 55°C

- Power:
  - all system components operate from a nominal – 48 VDC source.
- Typical Power consumption:
  - Subscriber Access System: 38 W (– 48 VDC)
- Network management:
  - A scalable carrier-class suite of tools that allows operators to easily manage their networks.

II.1.2 *angel*: A Non-Line-Of-Sight Broadband Fixed Wireless Access System

angel™ is a point-to-multipoint fixed wireless access system specially designed for residential, Small Offices/Home Offices (SOHO) and Small and Medium-sized Enterprise (SME) users in urban, suburban and rural areas.

It is the first and only field-proven access network solution to use Non-Line-Of-Sight (NLOS) Orthogonal Frequency Division Multiplexing (OFDM) technology to deliver carrier-class voice and data services up to 1 Mbit/s per subscriber on a single platform.

Therefore it is a natural evolutionary path to WiMax using also NLOS – OFDM technology.

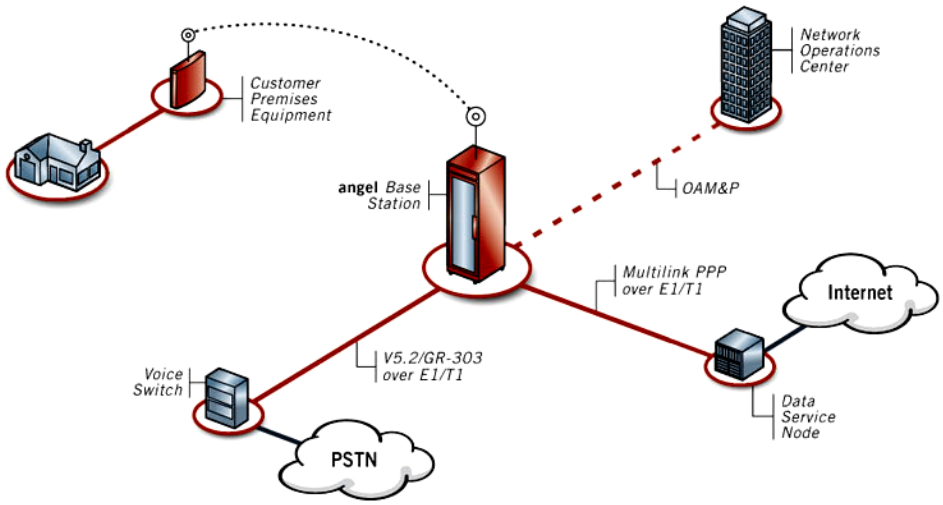
Over 100 000 subscriber lines connected to over 500 base stations are commercially operational today in the US as well as in the world.

Operating in the 2.3 and 3.5 GHz frequency bands, NLOS technology provides up to 95% predictability of coverage and penetration in a given cell, while, thanks to OFDM, layouts can range from 1 to 30 km radius cells, resulting in reduced operational and installation costs .

Architecture

Figure 24 represents an example of the Architecture of angel.

Figure 24 – Angel Architecture



Main features and benefits

- **Non-line-of-sight technology to maximize coverage and revenues**

  OFDM technology enables angel to provide 95% predictability of coverage in a given cell, which ensures high installation success rates and controls deployment costs. Thanks to this NLOS

technology there is no requirement for a direct, unobstructed view of the base antenna. More customers can be served and precise alignment of the Customer Premise Equipment (CPE) antenna with the base antenna is unnecessary. High base station antennas are not required, allowing deployments in markets that have zoning restrictions on tower heights.

- **High spectral efficiency**

  The net spectral efficiency of the system is 3.4 bit/s/Hz. For maximum spectral efficiency, the system adapts its modulation to the channel conditions it supports. The maximum throughput is typically available even at the edge of the cell, which enables the system to offer high data rates in smaller 1 MHz channels. Because frequencies can be re-used in adjacent cells, operators can deploy hundreds of base stations in a city or region using only 4 MHz of spectrum.

- **Flexible services**

  The system enables operators to significantly enhance their revenues by providing a variety of voice and broadband data services to subscribers. As well as providing carrier-class voice that is equal to the quality and reliability of wireline service, the system supports revenue generating CLASS services, such as Call Waiting, Call ID, Three-way Calling and Voicemail.

  Broadband data connectivity provides Internet access for multiple IP devices from a single subscriber unit, without impacting voice traffic. It also provides broadband data support for PCs and IP devices and enables subscribers to use standard modem and fax protocols for interoperability with legacy devices.

- **Grade of Service levels**

  Service providers can offer multiple Grade Of Services (GOS) that can be customized to meet residential, SOHO or small business customers' unique needs. The data channel can be partitioned into as many as four sub-channels, called "service grades". Each service grade utilizes a portion of the available channel and can be tailored to the size that the operator chooses. Each subscriber is provisioned a maximum data rate (such as 64 kbit/s or 128 kbit/s, up to 1 Mbit/s), and is assigned to one of the grades. Thus, rigid, simple Grades of service enable operators to easily develop data "products" that can be targeted to specific segments of their diverse subscriber base. For example, a channel could be divided between business and residential subscriber "products".

- **V90 over Data IP**

  A unique MAC architecture and voice coding enables the system to transmit modem traffic over packet data portion of the wireless channel. While traditional modem solutions use precious bandwidth even during idle periods, the angelTM solution frees that bandwidth for other modem and data subscribers. The amount of bandwidth used for a voice call and a modem are virtually identical. This means that the voice capacity of the airlink remains constant, regardless of modem usage. Constant capacity is imperative for the delivery of reliable voice service.

Technical characteristics

- Access method:
  - Access method:cteristicswidth for other modem and data subscribers. The amount of bandwidth used for a voice call and a modem are virtually identity of coverage in a given cell.
- Modulation: 64-, 16-, 8-QAM, and QPSK:
  - Modulation: 64-, 16-, 8-QAM, and QPSK:r modem and data subscribers. The amount of bandwidth used for a voice call and a modem are virtually identity of coverage
  - Modulation: 64-, 1annel (NAC/HCC) is always QPSK modulated for robustness.
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  - Modulation: 64-, 1annel (NAC/HCC) is always QPSK modulated for robustness.ount of bandink-by-link basis if necessary.

- Frequency bands:
  - Frequency bands: 1annel (NAC/HCC) is always QPSK modulated for robustness.ount of bandink-by-li
- Base station capacity:
  - Base s3 600 Voice lines or up to 12 Mbit/s of data per Base Station using as little as a single 4 MHz pair of frequency blocks.
  - Up to 4 sectors with cell radius of up to 30 km.
  - Channels can be configured to support voice-centric, data-centric or combined voice and data networks.
- Customer Premise equipment (CPE):
  - Installation without line-of-sight between the base station and the CPE.
  - Data rate:
    - Over 3 Mbit/s symmetric data rate (aggregate).
    - Up to 1 Mbit/s downstream, 256 kbit/s upstream per Customer Premise Equipment.
    - Ethernet data interface.
  - Voice capacity:
    - 1 to 6 POTS per CPE.
    - 312 active calls per base station.
  - Fax, V90, CLASS services, dial-tone from the V5.2 switch.
  - IP access: Up to 5 IP addresses per CPE.
  - Battery back-up.
- Power consumption: all lines active:
  - Base station: 2000 W, 176-264 VAC or – 48 VDC.
  - Subscriber Integrated terminal (SSU 4000): 25W, 85-264 VAC or 176-264 VAC.
- Environmental specifications:
  - Indoor equipment operating temperature: –5°C to +50°C (Base station ABS 3000).
  - Outdoor equipment operating temperature: –40°C to +60°C (Single Subs. Unit).
- Network management:
  - A scalable carrier-class suite of tools that allows operators to easily manage their Fixed Wireless Access network.

II.1.3 *SR 500-ip*: A Broadband Fixed Wireless Access System for Remote Areas

Brief description of the SR 500-*ip* system

SR 500-*ip* is a broadband, high-capacity wireless access system for operators and service providers serving rural and remote areas. It is the first point-to-multipoint (PMP) microwave system to economically combine highly scalable voice capacity with broadband Internet access. With **SR 500-*ip***, service providers can evolve their rural networks to offer leading edge services such as ADSL at 1.5 Mbit/s, while preserving scarce spectrum resources through efficient handling of voice traffic. **SR 500-*ip*** makes broadband access in low-teledensity areas a reality and enables service providers to comply with universal access initiatives at the lowest cost. With ADSL capability it is the ideal solution to bring broadband Internet and voice services to rural communities. It can also overlay or replace legacy access networks to add capacity or provide broadband Internet access.

Architecture

As a packet-based PMP microwave access system with network repeater capability, the system can be configured in star, branched or linear network topologies, see Figure 25.

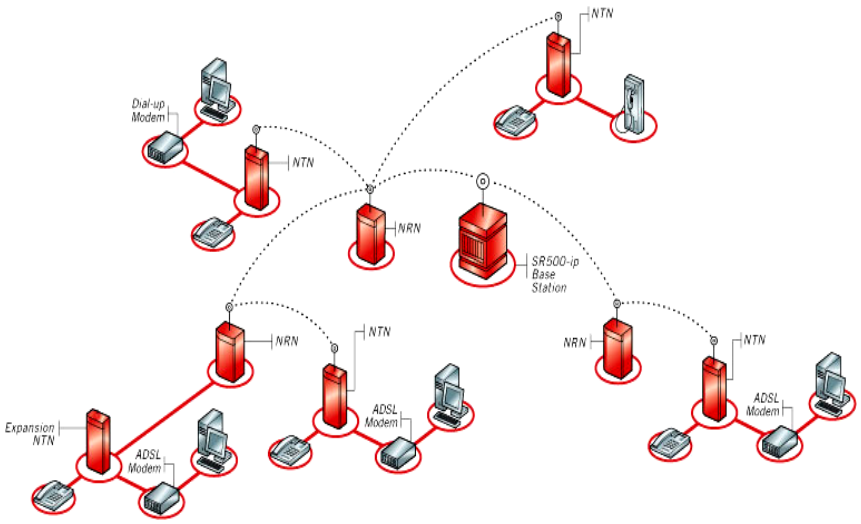
The base station (BS) provides the network interfaces to connect to the core network, and communicates will all remote radio nodes. Network interfaces are PPP over Ethernet for Internet services and V 5.2 over E1 for voice-band services. The base station can accommodate up to two 4 Mbit/s air links for a total system bandwidth of 8 Mbit/s.

The Network Termination Node (NTN) provides the subscriber interfaces. The NTN is a multi-line, multi-service, outdoor unit that serve a large number of subscribers through copper loops. Subscribers connect to the network using a 2-wire equipment, including ADSL modems, standard or payphone sets, as well as V90 modem and faxes. Subscriber capacity can be increased using an extension cabinet that is cabled directly to the main NTN.

The Network Repeater Node (NRN) is an outdoor unit that is used when line-of-sight between the **SR 500-*ip*** Base Station and NTN is compromised by rough terrain, man-made objects or distance. The NRN can also provide subscriber services using an expansion cabinet.

The system is centrally managed by insight NMS, which handles all operation, administration, maintenance and provisioning (OAM&P) and support over-the-air software downloads.

Figure 25 – Architecture of SR 500-ip



Main features and benefits

- **Wide Area Coverage**

  The system offers log-range microwave links and network repeaters to ensure coverage in difficult to reach areas spread over hundred of kilometres.

- **Broadband IP access**

  The system enables service providers to meet universal Internet access mandates and promote development in rural communities.

- **Advance services**

  With full CLASS support, transparency to fax and V90 modem traffic and payphone support, the system enables service providers to maximize voice service revenue. Flexible dial-up and ADSL interfaces offer service provider a choice of high-speed Internet solutions.

- **Future proof**

  Based on a packet switch architecture, the system is a long-term solution for IP-based services that reduces operators' technical and financial risk. With such a system, service providers will have access to future IP-based subscriber services while maintaining network stability.

- **Low cost of ownership**

  The system offers high capacity and linear scalability, which results in decreased costs on hardware and support. Standard interfaces facilitate network integration, while minimal infrastructure requirements reduce capital costs. In addition, SR 500-ip is centrally managed by insight Network Management System (NMS) to maximize staff productivity and reduce travels to remote locations.

- **High availability and field-proven reliability**

  SR 500-ip builds on the technology of SR 500, the most widely deployed rural wireless access system in the world. Reliable in-service performance ensures subscriber satisfaction and preserves revenues streams while minimizing maintenance expenses.

Technical characteristics

- General
  - Capacity: up to 2 air links / 8 Mbit/s per base station
  - Frequency bands: 1.5, 2.5, 3.5, 10.5 GHz
  - Access method: TDMA
  - Duplexing technique: FDD
  - V5.2 PSTN interface: Complies with ITU-T recommendation G.965
  - IP interface: PPPoE over 10Base-T
- NTN Services and Capacity

– Voice:	2-wire VF	48 lines
–	Payphone: standards and prepay (12 or 16 KHz) services	All 2-wire 48 lines
– Dial-up Internet:	V.90 modem support (up to 56 kbit/s)	48 lines
– Broadband Internet:	2-wire ADSL, always-on, bandwidth-on-demand	5 lines

- Power
  - Base station –48 VDC
  - Network repeater node: –48 VDC
  - Network termination node: –48 VDC or 120/240 VAC (+/– 12 VDC optional).
- Power consumption:

–	Radio Base station: 110 W (average DC per sector 1.5 GHz, 30 dBm, all trunks busy)
– Network Repeater:	59 W (average DC at 1.5 GHz, 30 dBm, 25% traffic load)
– Termination node:	43 W (average DC at 1.5 GHz, 30 dBm, 10% traffic load)

- Environmental specifications:
  - Radio Base station (Indoor) operating temperature: 0°C to + 45°C, forced air cooling
  - Repeater and termination nodes (Outdoor) operating temperature: –40°C to + 55°C
- Standards Compliance:
  - Ethernet: IEE 802.3, 10Base-T
  - V 5.2 PSTN: ITU-T G.965
  - Voice: ITU-T G.711(PCM voice coding), G.726 ADPCM 32 kbit/s voice coding A-law and μ-law, G.165 echo cancellation.
  - ADSL: ITU-T G.992.2
  - Safety: IEC 60950
  - EMI/EMC: ETSI EN 300 385
  - Environment: ETSI EN 300 01.

Technology Section Conclusion

A similarity of services and applications across different systems is beneficial to users, and this has stimulated the current trend towards convergence. Furthermore, a broadly similar user experience across different systems leads to a large-scale take-up of products and services, common applications and content and an ease and efficiency of use. However, such convergence should not preclude opportunities for competitive innovation. Access to a service or an application may be performed using one system or may be performed using multiple systems simultaneously (e.g. a digital broadcast channel and a return channel using IMT-2000).

The increasing prevalence of IP-based applications is a key driver for this convergence and facilitates the establishment of relationships between previously separate platforms. What form these relationships will take depends on market requirements, but they might include, for example, hardware integration within a device, network interworking, common access, authentication, accounting, common man-machine interfaces, portals, roaming and handover between systems.

ANNEX III

Country Experiences

III.1 Africa

III.1.1 Deployment of Broadband Wireless Access in Mali, Africa

Mali is a landlocked country in western sub-Saharan Africa with 80 per cent of the more than 11 million people living in rural areas. The country experiences extreme climate changes, very arid to a heavy rainy season. It also is very hot and humid. The cost of bandwidth in this country is very high and traditional hard-wire solutions for delivering high-speed Internet often leads to higher support costs and disgruntled customers, both of which can affect the bottom line. It also makes the availability of Internet service to residential customers almost non-existent. Afribone Mali began installing Motorola's Canopy 5.8 GigaHertz radios in 2003 for business and non-government offices. By deploying Motorola's Canopy solution, Afribone Mali SA was able to increase quality of service, keep customers satisfied, and reduce radio frequency cable problems. Afribone is now working on sharing bandwidth with other companies.

III.1.2 Deployment of Mobile Broadband Wireless Access in South Africa

Wireless Business Solutions (WBS) is a dynamic South African company established to provide mobile data network services to meet corporate, government and domestic requirements. It was licensed by SATRA in 1997, to provide National Mobile Data Services and is South Africa's fourth Telecommunication licensee. WBS has deployed a wireless packet switching network with 700 point-to-multipoint radio base stations. This network currently supports over 8 000 radios with which WBS has been providing a service to Uthingo, for the data telecommunications of their Lotto terminals to the Host system. A VSAT network is used to backhaul the traffic from the base stations to the Network Host.

Having gained knowledge and success by being the backbone network behind the National Lottery and providing nationwide wireless data services covering 95% of the population, WBS is rolling out a commercial mobile wireless broadband data network using iBurst technology (see Section II.2.3.3.3). This network will provide customers with high-speed access to the Internet and corporate information wherever and whenever they want. By using the iBurst system, WBS intends to unshackle broadband and to liberate data telecommunications in the same way the mobile phone liberated voice telephony. WBS operates as a wholesale provider of iBurst connectivity, concentrating on its strengths of establishing and managing the infrastructure. It will rely on its channel partners to disseminate the service to the community. This will be the second implementation of iBurst in the world following the successful launch in Australia by Personal Broadband Australia early in 2004.

III.2 Americas

III.2.1 Brazil

1) Introduction

Recent poll shows that Brazil has reached 10 million broadband accesses[88]. Considering that Brazil has a population around 180 million inhabitants living in 45 million homes[89], it's noticeable that this kind of Internet access hasn't spread much in Brazil. This is true, even knowing that Brazil had a 48% growth in the amount of access in relation to the first half of 2007, as suggested by the research.

Data available on the National Telecommunication Agency – Anatel's web site show that, by the first half of 2008, more than 50% of access in Brazil had transfer rates up to 512 kbps[90]. Less than 10% is at 2 Mbps and

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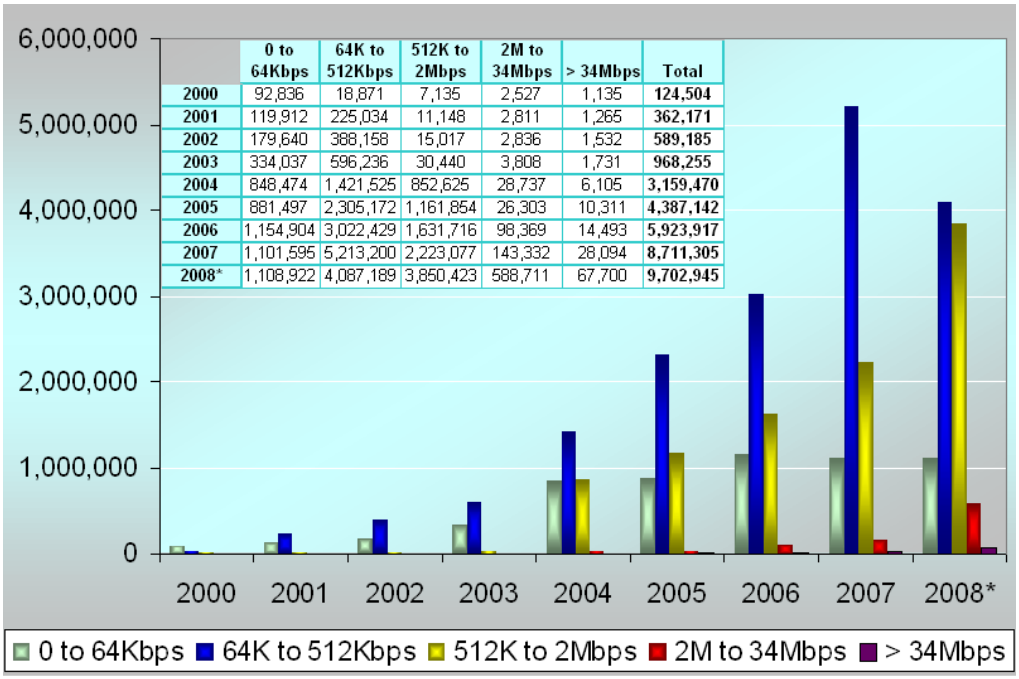
[88] *Barômetro Cisco Banda Larga*, 10th Edition, 2008, August 20.

[89] Demographic Census conducted by the *Instituto Brasileiro de Geografia e Estatística*, available at www.ibge.gov.br

[90] *Sistema de Coleta de Informações* – SICI, available at http://sistemas.anatel.gov.br/sici

above, as shown in Figure 1. Therefore, few Brazilians are taking advantage of new applications available on the web (that requires high rates, like streaming video and voice and file exchange).

Access evolution for various transfer rates.



	0 to 64Kbps	64K to 512Kbps	512K to 2Mbps	2M to 34Mbps	> 34Mbps	Total
2000	92,836	18,871	7,135	2,527	1,135	**124,504**
2001	119,912	225,034	11,148	2,811	1,265	**362,171**
2002	179,640	388,158	15,017	2,836	1,532	**589,185**
2003	334,037	596,236	30,440	3,808	1,731	**968,255**
2004	848,474	1,421,525	852,625	28,737	6,105	**3,159,470**
2005	881,497	2,305,172	1,161,854	26,303	10,311	**4,387,142**
2006	1,154,904	3,022,429	1,631,716	98,369	14,493	**5,923,917**
2007	1,101,595	5,213,200	2,223,077	143,332	28,094	**8,711,305**
2008*	1,108,922	4,087,189	3,850,423	588,711	67,700	**9,702,945**

Although Brazil has been experiencing a sharp growth in the amount of broadband access points over the last years, there is still a digital divide scenario present. This paper has the goal of describing some of the broadband access technologies that are reverting this situation. Also, it aims to present actions continuously taken by the Brazilian Government and by the companies acting in the country with means to promote the development and use of these technologies.

Current Broadband access scenario in Brazil

I) Wireless Access

Brazilian regulation defines telephony processes as those that permit communication between determined fixed points, with voice and other signals, making use of transmission technique modes 3.1 kHz-voice or 7 kHz-audio or up to 64 kbit/s unrestricted, by wire, radioelectricity, optical means or any other kind of electromagnetic signals[91]. Therefore, as Brazil does not define a specific lower boundary rate for broadband access, for the purposes of this study, broadband shall be understood as the service that offers capacity of transmission, emission and reception of multimedia information, using any means, with transfer rate above 64 kbps (56kbps, discarding less significant bit).

In Brazil, wireless technologies capable of delivering broadband access and currently in use are the ones based on: Institute of Electrical and Electronics Engineers – IEEE 802.11 'b' and 'g' (Wireless Fidelity – Wi-Fi), 802.16 (Fixed Worldwide Interoperability for Microwave Access –WiMax), Multipoint Multichannel Distribution System – MMDS, Direct To Home – DTH, High-Speed Downlink Packet Access – HSDPA, Enhanced Data rates for GSM Evolution – EDGE, Fixed Wireless Access – FWA, amongst others[92].

[91] Regulamento do Serviço Telefônico Fixo Comutado, approved by Resolution nº 426; 2005, December 9.

[92] Ibid.

II) Wired Access

Wired access capable of delivering rate above 64kbps and currently in use in Brazil are: G.992 family (Asymmetric Digital Subscriber Line – ADSL, ADSL2/2+), Hybrid Fiber Cable – HFC, Cable Modem, Fiber To The Home – FTTH, Power Line Communication – PLC[93]. Those last two on an experimental state.

III) Number of Access Points

Consulting broadband access data available at Anatel's website (www.anatel.gov.br) and the demographic data available at the Brazilian Geographical and Statistical Institute – IBGE's website (www.ibge.gov.br), it's possible to obtain some statistics about broadband penetration in Brazil.

If all Brazilians could use the Internet at the present scenario (180 million inhabitants and 10 million access points), each 18 inhabitants should share the same broadband access point [3]. This is not a high mean, considering that approximately 23% of the Brazilian population has already access the Internet, while the world average rate is around 21%[94].

But, the majority of the population is concentrated in the southeast region (São Paulo and Rio de Janeiro mostly). Regions like the north (Amazonas, Acre, Rondônia etc) and the northeast (Maranhão, Piauí etc) have a less dense population. This means that those regions are less economically attractive for telecommunication companies. Therefore, the number of broadband access points tends to be unequally distributed throughout the Brazilian territory. For example, the State of São Paulo has a mean value of 11 inhabitants sharing the same broadband access point, while the State of Maranhão has a mean value of 118 inhabitants/access points[95].

2) Technologies

Regulatory strategies for promotion of broadband access technologies amongst less populated areas and small and home offices

The reduction of prices of radio equipment operating in some frequency bands has allowed the emergence of small providers of broadband access, offering telecommunications services where the main operators do not provide them. In these locations, considered, in generally, as being less economically attractive for big companies due to high cost of deployment of a new network, there are a growing number of small offices trying to absorb this demand for broadband access.

I) Regulations applied

The use of radiofrequency ranges 2,400-2,483.5 MHz and 5,725-5,850 MHz are free of charge if the equipments, certified as of Limited Radiation Equipments, operate under several conditions established by Brazilian Regulations. Brazil defines Limited Radiation Radiocommunication Equipments as those that use radiofrequencies for several applications in which emission creates an electromagnetic field bounded by Brazilian law[96].

However, this legislation imposes some restrictions depending on the coverage of the telecommunication service: restricted or collective. Collective interest services are those that must be provided to any interested person on a non-discriminatory basis, satisfying the interests of the community. Restricted interest services are those designed for personal use or provided to certain groups of users, selected by the provider through criteria established by itself[97].

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93 Ibid.

94 Regulamento sobre o Uso de Equipamentos de Radiocomunicação de Radiação Restrita, approved by Resolution n° 506; 2008, first of July.

95 *Sistema de Coleta de Informações* – SICI, available at http://sistemas.anatel.gov.br/sici

96 Regulamento sobre o Uso de Equipamentos de Radiocomunicação de Radiação Restrita, approved by Resolution n° 506; 2008, first of July.

97 *Regulamento dos Serviços de Telecomunicações*, approved by Resolution n° 73; 1998, November 25.

When the telecommunication activity, using radio communication stations, surpasses the limits of a building or property and these stations operate at frequency ranges 2.400-2.483,5 MHz or 5.725-5.850 MHz using Spread Spectrum or other Digital Modulation technology, the following rules are applied:

i) When the operation of these stations is associated with the rendering of collective interest telecommunications services, an authorization for the provision of the corresponding service is required. The licensing of stations is also required if these stations are intended to:

   a) interconnect with the network of another telecommunication service provider; or

   b) interconnect with another station of the same network and that other station operates with at least one equipament that is not classified as of Limited Radiation.

ii) When the operation of these stations serves as support for telecommunications network designed to support restricted interest services, no telecommunication service authorization is required. However, if these stations operate in accordance with subparagraphs "a" or "b" of item I above, they must be registered in the database of the Brazilian National Telecommunications Agency – Anatel. In this case, no licensing is necessary.

   Especially for the 2.4 GHz band, all stations, including terminals, have to be licensed, regardless of coverage of the telecommunications service, if the equipment operates with e.i.r.p higher than 400 mW and at locations with population greater than 500,000 inhabitants.

II) Main Users

In Brazil the bands mentioned above are intended primarily for providing broadband access in less populated areas and for private networks. Small and home offices offer broadband access using those radiofrequency bands in locations poorly supplied with access points and with little bandwidth available from large companies. This kind of telecommunication service depends on an authorization of the Brazilian Government and on licensing of the radio stations in accordance with Brazilian Regulation[98].

To promote digital inclusion and universal access to broadband services, Anatel has understood that municipal governments could provide their own network and offer the community a telecommunication service, always free of charge, limited to the municipality area [99].

3) Proposal

The Brazilian administration is open to contributions from other countries in order to exchange experiences on the best practices in the matter, and would like to suggest further discussions to examine how other countries are dealing with the challenges of increasing broadband access through new technologies.

III.2.2 Canada

1) Broadband for Rural and Northern Development Pilot Programme

Canada is taking steps to provide broadband Internet access for all Canadian communities, including those in rural and northern communities. The *Broadband for Rural and Northern Development* Pilot Programme aims to fulfil this commitment through partnership with local communities, the provinces, territories and the private sector.

The programme is being delivered through two rounds of business plan development funding, followed by two rounds of implementation funding. In a recent announcement (October 2003) by the Government of Canada, it was stated that a total of 33 organizations have been selected to receive financial assistance from the Department of Industry (Industry Canada) in deploying broadband or high-capacity Internet to their communities. These organizations, representing an estimated 768 First Nations, northern and rural communities across Canada, will have access to funds from the Broadband for Rural and Northern Development Pilot Programme's first round of implementation funding. The deadline for submission of business plans to compete for the second round of implementation funds was November 2003, and the results

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[98] *Lei Geral de Telecomunicações*, federal law n° 9,472; 1997, July 16.

[99] *Ato 66,195*; 2007, July 27.

were announced in April 2004. The business plans selected for implementation funding were based on the following criteria: level of community engagement, assessment of community need, experience and/or ability in project management, technology and implementation, and sustainability of business plan. For more information, visit: www.broadband.gc.ca.

2) National Satellite Initiative

An announcement was made by the Government of Canada (October 2003) to provide funding, over a period of 10 years, for the provision of broadband access to remote communities over satellite channels. Some 400 communities were initially identified for this programme. The objective of the National Satellite Initiative is to acquire satellite capacity (and possibly) some satellite ground infrastructure to provide remote broadband connectivity to rural, remote or isolated communities. This will bring broadband access to the remote communities at a cost that is comparable to that in the southern urban areas. Services that will be supported by this programme will principally be telehealth, e-business, distance learning and access to the Internet. This programme includes two C-band (4-6 GHz) public benefit transponders managed by Industry Canada (the first one became available in 2002 and the second one in 2003), Ka-band (20-30 GHz) satellite transmission capacity on the ANIK-F2 satellite (to be launched in mid-2004) as service credit to the Canadian Space Agency, and further satellite transmission capacity to be purchased on the open market.

3) Promoting Broadband: The Case of Canada

Under the New Initiatives programme of the Office of the Secretary General of the ITU, a series of Telecommunication Case Studies were produced. One of the cases studied was an examination of Canada's experience in promoting broadband. The study, prepared by Eric Lie, Project Manager, International Telecommunication Union, is entitled "Promoting Broadband: The Case of Canada".

The report of this study provides comprehensive information on the country's background, an overview of the origins of the Internet in Canada, the distribution of Internet and broadband infrastructure in the country and the demographics of Internet and broadband usage, the broadband market, the regulatory environment, and main strategies and initiatives that have been put in place by communities and governments to promote broadband. For more information, visit: www.itu.int/osg/spu/ni/promotebroadband/casestudies/canada.doc.

4) Fixed wireless access systems in the 900 MHz range

In Canada, the band 953-960 MHz is shared by Studio-to-Transmitter Links (STLs) and fixed wireless access systems on a geographical basis.

The operation of STLs had been limited to the band 956-960 MHz. With the introduction of digital radio broadcasting (DRB), there was a need for additional spectrum for STLs in the band 953-956 MHz, particularly in urban areas where there may be a large number of AM, FM and potential DRB stations. The deployment of these STLs will not be extensive in rural areas. The spectrum in these areas could be utilized by other radio applications to ensure efficient use of the frequency spectrum. In this regard and with the objectives of making information and knowledge-based infrastructure available to all Canadians, the band 953-960 MHz was also designated for radio services such as fixed wireless access systems (FWAs) that could be deployed outside of the areas of intense use of STLs.

In order to facilitate sharing between STLs and FWAs on a geographical basis, certain criteria were used including the establishment of geographical zones to give priority access to STLs where the future use of STLs could be most intense. As well, as a general practice, the provision of new STL licences begins from the upper frequency limit of the band 953-960 MHz, whereas the provision of new FWA licences begins from the lower frequency limit of the band.

The band 953-960 MHz is divided into 55 RF channels with 125 kHz spacing between centre frequencies. For FWA applications, a minimum of five contiguous 125 kHz channels are necessary. The transmitter power delivered to the antenna input is limited to 5 watts per RF carrier. Specific spectrum mask and FWA subscriber antenna characteristics also apply. For more information, visit:

www.strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/vwGeneratedInterE/sf01613e.html and
www.strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/vwGeneratedInterE/sf02144e.html.

5) Subscriber radio systems in the 1.4 GHz range

Fixed wireless systems in the 1 427-1 525 GHz bands are deployed in many rural areas of Canada to provide access to voice and data services. These systems are based on point-to-multipoint TDMA/FDD technology using 3.5 MHz channel bandwidth to provide a payload capacity of 4 Mbits/s per central station equipment, and up to 28 Mbits/s per system (7 central stations).

A typical system consists of central stations, repeaters, and terminal stations that can be configured in radial, branched, or linear topology with a maximum range of up to 720 km.

A typical central station has capacities of 400 to 600 subscribers depending on the grade-of-service objective and type of data service, which could be $n \times 64$ kbit/s dedicated lines.

Some systems also have integrated sub-systems that operate in the radio frequency band of 950 MHz.

6) Wireless communication systems in the 2.3 GHz and 3.5 GHz range

A spectrum auction took place in Canada in early 2004 for the Auction of Spectrum Licences in the 2 300 MHz and 3 500 MHz bands. Five licences in each of 172 service areas across most of Canada, totalling 848 licences, were auctioned for companies to provide innovative wireless services, such as high-speed Internet. In each service area, one WCS licence will be available, totalling 15+15 MHz in the band 2 305-2 320/2 345-2 360 MHz. Four licences will be available in the band 3 475-3 650 MHz in each service area, three licences of 25+25 MHz plus one licence of just 25 MHz. The purpose of this licensing process was to facilitate the growth of Wireless Communications Services (WCS) in the 2 300 MHz band and Fixed Wireless Access (FWA) in the 3 500 MHz band in both rural and urban areas, as well as to facilitate the implementation of new and innovative services.

Equipment in these bands is typically capable of providing data rates from 64 kbit/s to 1.5 Mbit/s or more to each subscriber.

Many of these products are also capable of providing traditional telephone services. Where there is a direct line-of-sight from the base to the subscriber station, these systems may be capable of providing service at ranges of 20 km or more. Some of these systems are also capable of operating without a clear line-of-sight, albeit at significantly reduced ranges. For further information: www://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/vwGeneratedInterE/sf05472e.html.

7) 2.4 GHz and 5 GHz wireless access systems including radio local area networks

Wireless access systems deployed in 2.4 GHz and 5 GHz (5 250-5 350 MHz, or 5 470-5 825 MHz) are increasingly being used in urban areas for local area network connections as well as hot spot applications. However, many of these systems are also being used in rural areas. For example, in the band 5 725-5 825 MHz, some companies deploy point-to-point or point-to-multipoint systems in rural parts of Canada with e.i.r.p. as high as 4 Watts (consistent with Canada's domestic technical rules).

In other cases, companies are taking advantage of using 2.4 GHz and 5 GHz technologies to form a comprehensive network that provides the transmission range necessary to reach some of the rural communities. In particular, in one case, 2.4 GHz systems are being used as the last mile connection to homes and offices, while the access points are interconnected using the 5 GHz IEEE 802.11a technology. The 5 GHz transit links are part of a self-configuring wireless mesh network. This enables a wireless backhaul network to be deployed quickly with increased network reliability and at reduced infrastructure costs.

8) Research and development efforts in Canada

To support the government of Canada's priorities for connecting Canadians, the Communications Research Centre (CRC), an agency of Industry Canada, established an R&D programme called the Rural and Remote Broadband Access (RRBA) Programme. The Programme began in April 2002 and will run until March 2007. The RRBA Programme's mandate is to conduct innovative R&D on technologies and systems that will facilitate rural and remote access to interactive broadband multimedia services.

The RRBA Programme focuses on finding technological solutions in areas of satellite communications, terrestrial wireless, fibre optics, etc., that can extend broadband services to rural and remote areas in a cost

effective manner; especially where there is currently little interest by the private industry because of the perceived small return on investment. Proof-of-concept systems and subsystems will be developed with the participation of public- and private-sector partners to demonstrate the feasibility and advantages of broadband access in rural and remote areas. Collaborative demonstrations of broadband applications will also be conducted. Participation in international standards activities will take place with the aim of lowering the costs of broadband equipment through harmonized operating rules and large-volume manufacturing.

A number of critical issues have been identified by the programme; these include equipment cost, flexibility, reach, spectrum availability and interference, standardization and potential international markets. This results in the need to support a variety of R&D projects dealing with:

– Terrestrial wireless technologies such as WiFi, WiMax and other similar technologies for transport and "last mile" access.
– Wireless broadband access using frequencies below 1 GHz for better reach in rural and remote areas due to better propagation characteristics.
– Broadcast transmission technologies such as the use of DTV and an adequate wireless return channel for broadband access.
– Satellite broadband access technologies, especially related to low cost bidirectional Ka-band (20-30 GHz) terminals.
– Other broadband technologies such as distribution of RF signals over optical fibre and application of Software Defined Radio to flexible broadband access terminal.

More details are available from the programme website: http://www.crc.ca/broadband.

9) Nemiah Valley, British Columbia, Canada[100]

The Nemiah Aboriginal Wilderness Reserve, in isolated mountain-rimmed Nemiah Valley in central British Columbia, Canada is the homeland of the Xeni Gwet'in (pronounced "Awney Gwateen") Native American Indian community. Within the Reserve, the community government prohibits construction of paved roads, electric power and telephone pole lines, and commercial logging. To replace the sole narrowband radio-telephone link then available to community government and residents, the Canadian and British Columbia governments two years ago jointly funded deployment of wireless medium-speed Internet access (including feeder/backhaul) to the medical clinic, the school, the community and tourist office (www.xnigwetin.com), and to several clusters of residences. Telus Communications deployed by helicopter solar-plus-battery-powered broadband wireless equipment that included one 40-mile, 3.5 GHz feeder/backhaul link, and four 950 MHz Mbit/s "WL500" multi-sector, point-to-multipoint fixed-access links. The government and many residents now enjoy Internet services plus multi-channel fax and voice applications. Telus Communications' mobile business recently announced a USD 20 million expansion to bring high-speed mobile voice and data communications to 90% of Canadian communities.[101]

10) Wi-Fi in Ontario Canada"[102]

In rural and remote areas where population density prohibits the cost-effective use of wireline broadband distribution, inexpensive wireless solutions have been used to create broadband access networks of sufficient size to achieve the economies necessary to sustain the network. Being scaleable, portable, and easy to deploy, fixed wireless in particular has proven to be a popular technology choice for a number of demand aggregation community initiatives such as those in Leeds and Grenville Country, South Dundas and Simcoe County in Ontario.

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[100] Loi, Linda and Kreig, Andrew, "*International Wireless Broadband Success Stories*", WCAI, July 2003.

[101] "TELUS Mobility's Heartland Expansion brings digital wireless phone and data service to small and remote communities in British Columbia", Canada English Newswire, July 16th, 2003.

[102] ITU/SPU, Reynolds, Tad, "*Promoting Broadband*", Background Paper, 2003. www.itu.int/osg/spu/ni/promotebroadband/PB03-PromotingBroadband.pdf

Although still in a nascent state of deployment, cooperative solutions based on "Wi-Fi" technology present a possible avenue through which high-speed network access can be deployed at low cost. 44 Informal Internet access-sharing cooperatives, grounded in websites, at which information on participating is exchanged and provided, have already sprung up in a number of cities in Canada. Examples include cooperatives such as the Waterloo Wireless project, whose users have attempted to create a mesh of uninterrupted connectivity via a dense clustering of nodes, or "hot spots", and the BC Wireless project which, alongside the usual node maps and do-it-yourself deployment instructions, has declared an interest in using high-gain antennae to create point-to-point intercity links that would cobble together community networks into an interconnected system 45. Current attempts in Canada to extend Wi-Fi networking to the 10 km and even 20 km range on a point-to-point basis indicate the possible extension of Wi-Fi as an alternative means for remote community-dwellers to aggregate demand and share backbone connectivity. Stretching the reach of "Wi-Fi" technology in a point-to-multipoint arrangement is also being investigated by CRC. One appealing approach is to down-convert "Wi-Fi" transmission to lower frequencies in the UHF range to take advantage of better RF propagation characteristics (see subsection 8).

Conclusion

A number of programmes and initiatives are being carried out in Canada to deliver wireless broadband connections to Canadians in rural and remote communities. Government programmes such as the *Broadband for Rural and Northern Development* Pilot Programme and the *National Satellite Initiative* are only two of the many programmes that Canada has initiated to promote broadband connections in rural communities. A number of frequency bands are currently being used, in Canada, for broadband transmission to rural areas including the 900 MHz, 1.4 GHz, 2.3 GHz, 2.4 GHz, 3.5 GHz and 5 GHz bands. Nonetheless, a number of issues including cost, climate and propagation (the need for spectrum with propagation characteristics more suitable for rural areas) can be challenging in the deployment of systems in rural areas.

III.2.3 Ecuador

Broadband Wireless Point-to-Point Enterprise Network, Banco del Pichincha, Machala Zone, Ecuador

The Banco Del Pichincha, the largest bank in Ecuador, has established 200 branch offices spread across Ecuador. To interconnect these, the bank has deployed an extensive private network, containing many wireless links. The bank stipulates that each link be available 365 days of the year, 24 hours per day, with reliability at least 99.96%. For many critical links, the bank has deployed "VIP 110-24" broadband wireless links offered by Wi-LAN. Installed in 2001, these wireless links now have demonstrated reliability exceeding that stipulation. The VIP 110-24 product incorporates routers, are called "anypoint-to-multipoint", or "VINE" routers, which have enabled Banco Del Pichincha to adopt a deployment approach wherein any endpoint or repeater node already in the network can become the centre of one or more point-to-multipoint branches. This approach minimizes up-front costs for its evolving network.

III.2.4 Mexico

Fixed Wireless Access, Mexico City, Mexico

Mexico City, containing 20 million residents, is one of the densest, largest urban markets in the world. Fast Internet access (Mbit/s) has not been readily available within much of the metropolitan area. MVS Comunicaciones, for many years a principal deliverer of TV programming throughout the metropolitan area and the nation, now is delivering high speed fixed wireless Internet access within the city, across 220 sq. miles encompassing approximately 10 million of its residents, and including its central business district. Within Mexico City, many prospective customers are located down in high-building street canyons or mountain-ridge canyons, and many behind extensive foliage, thus not within wireless line-of-sight of current and prospective base stations. Hence MVS sought a NLOS wireless technology effective in demanding terrain. It deployed the MMDS-band 2.5-2.686 GHz broadband NLOS wireless equipment. Within forthcoming months, the MVS Mexico City network likely will become the world's largest NLOS network.

III.2.5 Peru

"USE OF VSAT SYSTEMS FOR TELECOMMUNICATIONS SERVICE RENDERING IN RURAL AREAS IN PERU"

Introduction

In August 1998, the Guidelines for Telecommunications Market Opening in Peru were approved through the Supreme Act No. 20-98-MTC, which defined the universal access as a group of essential telecommunications services to promote the development and integration of the furthermost areas in Perú.

Additionally, the following universal access goals were defined until the year 2003:

- The installation of 5 000 public telephones in an equal number of rural towns lacking this service, capable of transmitting voice, fax and data at a low speed, as well as making free calls to emergency centres.
- The installation of Internet access in 500 rural district capitals[103] comprised in the 5 000 towns previously mentioned.

The Telecommunications Private Investment Supervising Organization (OSIPTEL) through the Telecommunications Investment Fund (FITEL) designed a series of projects under these guidelines, which aimed at providing fixed telephone services through public telephones and Internet access in district capitals.

FITEL called for International Public Bids, in which participating bidders committed themselves to oversee: i) installation, ii) operation and iii) maintenance of specific services utilizing the most efficient technology to allow them to comply with technical specifications.

Peru has particular characteristics that include a great geographic unevenness. Rural operators in charge of selecting the most adequate technology to comply with technical requirements took this into consideration. In the end, satellite technology through the implementation of VSAT networks was chosen by participating bidders.

This document presents a general perspective of the deployment of VSAT networks in Peru through FITEL.

Description of the VSAT network

The VSAT satellite network implemented in Peru's rural areas operates in the band 10-20 GHz, with a 11,7 to 12,2 GHz up-link and a 14 a 14,5 GHz down link, utilizing a PAS-1R satellite.

The VSAT network has a star-like topology, with multiple remote stations that communicate through a Main Hub with a FDMA/TDMA DAMA access scheme.

Current data transmission speed reaches 256 kbit/s for the carrier from the Hub to the remote stations (Outbound – up link), with QPSK and 38,4 kbit/s modulation for the carrier from the remote stations to the Hub (Inbound – down link) with a MSK modulation. Additionally, a LAN Ethernet port is included which can reach speeds of up to 10 Mbit/s.

Among the VSAT network's main components we can mention the following: i) multiple remote stations, ii) nodal station (Hub), iii) prepayment[104] subsystem, iv) network management system. Figure 26 shows the simplified diagram of the VSAT network.

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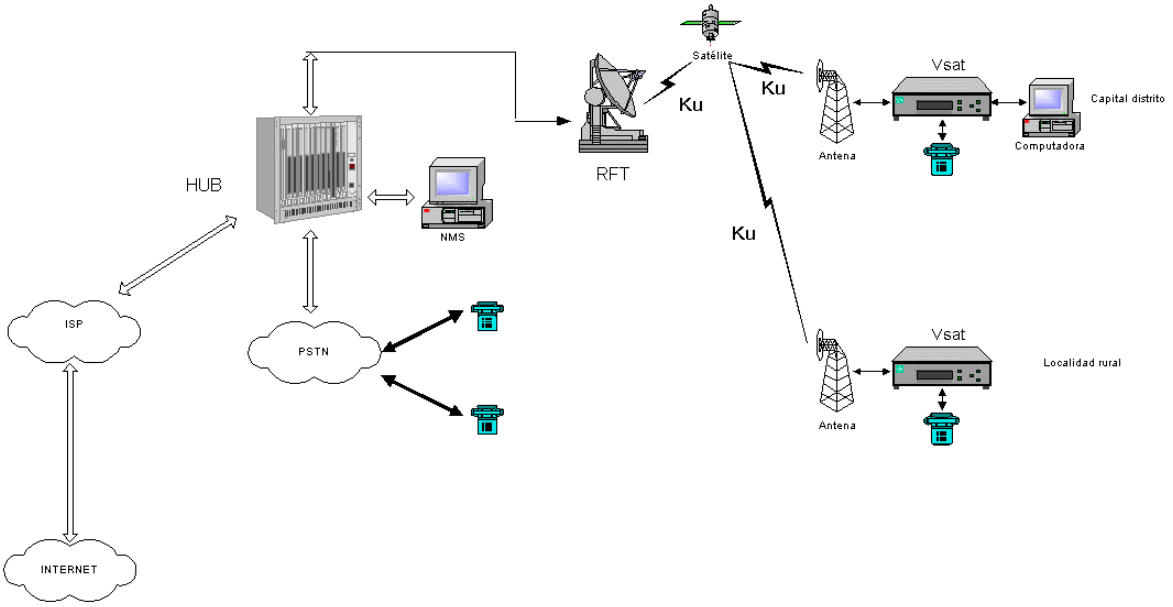
[103] According to the definition of the IT and Statistics National Institute, district is the smallest territorial division in the country. It is generally subdivided into urban and rural areas.

[104] The prepayment system uses cards with codes (PIN) to make calls. It is necessary for the operator to have an adequate card distribution plan, as web as ensuring adequate training for the rural population to use the service. The procedure to make a call can be found in the back of the prepayment cards, and a procedure poster can be found inside the telephone booths, and also the operator trains users on the proper use of the public telephone and Internet access (if necessary).

Figure 26 – Simplified scheme of the VSAT network



Remote stations are constituted basically by two modules: the external unit (Outdoor Unit – ODU) and the internal unit (Indoor Unit – IDU), that includes the VSAT. Apart from the energy subsystem and protection subsystem.

The external unit (ODU) is comprised of the antenna and radio frequency elements that enable communication between the internal unit (IDU) and the satellite. Some of its components include: i) an antenna that varies in size from 1,2 to 1,8m[105], ii) a high potency converter, with potency that varies from 500 mW to 1 W[106] and iii) low noise converter block.

Services[107] currently being provided include the following: i) voice, ii) fax (Group 3) low speed data, iii) free calls to emergency centres and iv) Internet access in rural district capitals at a speed of 9 600 Bauds.

Rural operators

As a result of the International Public Bids the subprojects have been awarded to two operators: Gilat To Home Peru S.A. (formerly named Global Village Telecom.) and Rural Telecom. S.A.C. Table 2 shows the distribution of subprojects per rural operator.

[105] The size of the antenna depends on many factors (geographic location, satellite coverage, precipitation levels, speed of data requested, etc). Depending on the case, antennas with a greater diameter are used to improve the system's performance.

[106] 1W of power in some towns in the Peruvian jungle mainly due to the satellite's coverage and precipitation levels).

[107] Currently, all services rendered by rural operators run through prepayment platforms, except for Internet access, which is being provided freely to this date.

III.2.6 United States

1) Fibre to the Home Rural Community Project, Grant County, Washington, US[108]

The Grant County Public Utility District (GCPUD) is building fibre-to-the-home (FTTH) in a rural community in Washington State. According to the GCPUD, FTTH is assisting small business, educational institutions, medical facilities and others where other telecom services are offered in a limited capacity. In March 2000, Washington State passed a state law that allowed public utilities to build fibre-optic networks. As of March 2003, more than 10 000 meters were passed, and more than 9 200 homes were passed by the fibre build-out in Grant County. The Grant County Public Utility District had a 43 per cent penetration rate, with about 4 000 subscribers, as of March 2003. Nearly 100 per cent of the homes have Internet access. And, nineteen ISPs, two video companies, one telephone company and one security company are providing high-speed voice, video and data applications. As a result of its broadband buildout, the economic impact has been significant.

- Over 100 new jobs have been created as a result of the network, creating a USD 9 million economic benefit for the region.
- As a result of the network, 25% of people with access have purchased a new computer or related equipment, 72% of people with access have purchased goods or services online and 62% believe that broadband access improves their children's education.
- A local chemical plant has reduced executive visits to Sweden from once a month to twice a year because of video conferencing.
- Point-of-service entities, like gas stations, have decreased credit card processing time.
- Farmers are using the applications to track the market prices of their products and do livestock and crop research.
- County schools are using the FTTH connection for distance learning, distributing programming, financial aid information and advising information.
- Medical facilities are transmitting more medical information to doctors and patients faster.
- GCPUD also estimated that every 300 new employees attracted to the region as a result of the FTTH networks would translate into USD 72 million for the local economy because of the multiplier effect of consumer spending.

High Speed Satellite Broadband Service for Medical Purpose, Columbia, South Carolina, US[109]

On July 1, 2002, Hughes Network Systems, Inc. (HNS), the Advanced Technology Institute (ATI), and the Columbia Eye Clinic launched a high-speed, satellite broadband service linking medical professionals at the Columbia Eye Clinic with patients at Beaufort-Jasper-Hampton Community Health Centre in Ridgeland, South Carolina. The service allows clinic experts to screen the eyes of patients over 100 miles away for diabetic retinopathy. In the coming years, they plan to screen patients in other parts of South Carolina and then expand to screenings for glaucoma and other anterior segment diseases. Broadband access will facilitate the collection of epidemiological data and aid in patient education.

2) Municipal Fibre Optic Network, Kutztown, Pennsylvania, US[110]

The city of Kutztown, Pennsylvania built Pennsylvania's first municipal fibre-optic network. It is a USD 4.6 million project, which the city began building in 2001. The network has created competition for high-speed Internet access, cable TV and telephone service in Kutztown. Kutztown is one of only a handful

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[108] Donna Keegan. "Great Needs: Fiber-to-the-home drives development in Grant County, Wash", Opastco Roundtable, July/ August 2002, pp. 50-51.

[109] "Healthcare Groups and Broadband Satellite Provider Collaborate to Help Save Eyesight in Rural South Carolina", HNS Press Release, July 1, 2002.

[110] "Wired in Kutztown – Municipality sells Internet, cable TV and phone service through its own lines", Christian Berg, The Morning Call (online), August 4, 2002.

of US cities to run fibre to every home and business. The network offers speeds up to 100 megabytes per second. The network provides residents the ability to monitor home security, pay water and sewer bills and track their electricity use. Officials also envision video-on-demand and music-on-demand, distance learning and e-health as applications to be deployed using the new fibre-optic network. In addition, the network will provide Kutztown's electric utility the ability to automatically detect the location of power outages and equipment failures. It also will let the utility use automated meter reading technology. That will eliminate the need for time-consuming manual checks of the borough's several thousand electric meters each month.

3) Point-to-point Wireless Broadband Program Turtle Mountain & Fort Berthold, ND & Fort Peck, MT, US[111]

Fast Internet access (Mbit/s) has become available within but few of the U.S. Native American Indian Reservations. To accelerate availability, the U.S. National Science Foundation, through its EDUCAUSE (www.educause.edu) affiliate and AN-MSI project (www.an-msi.org), recently funded deployment of wireless fast Internet access to community colleges at several reservations, including necessary feeder/backhaul. At three, including Fort Peck Community College (MT), the Fort Berthold Community College (ND), and the Turtle Mountain Community College (ND), the AN-MSI project, led by Dandin Group CEO Dewayne Hendricks, deployed U-NII band (5 GHz) "Canopy" broadband wireless equipment offered by Motorola, both 20 Mbit/s feeder/backhaul links and 10 Mbit/s access links. Each network soon will be extended to more community sites, perhaps then households.

4) Example of Fixed Broadband Wireless Implementation in the United States

The city of Forth Wayne, Indiana, is the second largest city in the state of Indiana. The local government and private sector of this city concluded that it was necessary to establish a regional capability to provide businesses and residents in the metro area access to high-speed broadband services at reasonable cost as such a capability was essential to economic development. It was considered that ubiquitous broadband deployment would bring valuable services to businesses and consumers, stimulate economic activity, improve local productivity, and improve education.

This was accomplished through the Indiana Data Centre. The criteria for the technology to implement this were: 1) No public financing, but use of public facilities; 2) digital structure; 3) Always on and ubiquitous, 4) able to evolve new users; 5) able to address interference issues.

After much evaluation of alternative technology solutions, the Motorola Canopy product was selected. This BWA concept:

- Uses a cellular-like concept with more access points close to the ground.
- Mitigates interference in unlicensed bands.
- Provides a modular design for expanding the system with ease of installation (one day).
- Very cost effective.
- Scaleable bandwidth on demand up to 2 Mbit/s.

III.3 Asia

III.3.1 Australia

1) "Networking the Nation" Broadband Program and Regional Mobile Phone Program

Also in Australia, the government took a step toward creating demand for broadband-delivered applications through its "Networking the Nation" program. Part of the overall Commonwealth of Australia's National Broadband Strategy, the Networking the Nation Program Australia program that provided nearly AUUSD 180 million Australian dollars to non-profit organizations to support activities and projects designed

[111] Courtesy of Motorola and Linda Loi, WCAI.

to address a range of telecommunications needs in rural, regional and remote Australia.[112] It included a strategy for deploying public Internet access, videoconferencing facilities to the general public and female health facilities, training, building parts of a new telecom backbone, helping municipal and county councils provide government services, and providing money for community telecommunications centres that will assist people with disabilities to access the Internet.[113]

Another initiative by the Australian government designed to improve the level of telecommunications services in rural and regional Australia is the Regional Mobile Phone Program. This AUUSD 50.5 million program provided AUUSD 20.4 million improved 3rd Generation CDMA mobile voice and high-speed data coverage to 31 towns that currently have inadequate coverage and to 24 towns that have no existing coverage. Other mobile phone coverage provided under the USD 50.5 million Regional Mobile Phone program includes:

- spot coverage for selected regional highways;
- funding to improve mobile phone coverage in the south west of Western Australia under the Wireless West project; and
- a satellite mobile phone handset subsidy scheme.

2) Telstra's Broadband Acceleration Program, Australia

Telstra, a major telecommunications operator in Australia, has established a broadband policy which allocated up to AUUSD 30 million in cash and bandwidth to accelerate the development of technology that will stimulate broadband growth in Australia.[114] Under the deal, Telstra will contribute AUUSD 10 million in cash, AUUSD 20 million in bandwidth, and it has committed to match equivalent industry contributions to the program with further support of up to AUUSD 15 million over five years. The goal of the Telstra Broadband Strategy is to stimulate and accelerate the development of new and innovative applications, tools or technologies with wide appeal for broadband delivery to Australian businesses and consumers. This in turn will stimulate subscriber growth and ultimately mean more revenues for Telstra resulting in a win-win situation for both consumers and the private sector.[115]

3) "Reach for the Clouds" Broadband Program, Melbourne, Australia

In Melbourne, a local initiative of GreenPC, called "Reach For The Clouds," aims to deliver to each of 770 homes in the low-income housing project called Atherton Gardens a refurbished computer completely free of charge and the chance to get online. All of Atherton Gardens has been wired with an ADSL broadband system. Residents are able to use e-mail and a community intranet service free, but they pay to connect to the web. The project is using refurbished computers to enable a whole community to access the web. The project's aims are to provide all residents with free access to a PC in their own home, establish a local community computer network (Intranet), provide access to Internet telecommunications (Internet), train residents in computer use, enable community management of the network and establish social enterprise opportunities. If successful, GreenPC will deploy similar networks in Melbourne's 13 other poor housing developments.

4) Personal Broadband Australia

In March 2001 the Australian Communications Authority (ACA) conducted an auction of 2 GHz (3G) licenses covering all major cities in Australia and applying for 15 years from October 2002. ACA's 2 GHz spectrum allocation was consistent with the ITU's recommended frequency arrangement for spectrum

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[112] See: www.dcita.gov.au/Article/0,,0_1-2_3-4_106337,00.html and www.newconnections.gov.au/download/0,6183,4_113958,00.doc for more information.

[113] OECD Report, "Broadband Infrastructure Deployment: The Role of Government Assistance", November 14, 2001.

[114] "*Telstra Sets Up Broadband Fund*", www.dialelectronics.com.au/articles/8f/0c00e78f.asp, June 21, 2002.

[115] See: www.broadbandfund.telstra.com/about_home.htm for more information, as well as a list of funded projects.

identified for IMT-2000[116] and adhered to their technology neutral spectrum policy that allows Australian licensees to deploy any technology that meets the adopted emissions and coexistence requirements. The ACA awarded five licenses as a result of this auction, including a license to CKW Wireless which was established in February 2001 with the objective to roll out the iBurst™ technology across Australia. By June 2002, CKW had been renamed *Personal Broadband Australia* (PBA) and formed into a consortium partnership that includes Ozemail, Vodafone, Crown Castle, TCI, UT Starcom as well as the shareholders. After a one-year trial that was successfully completed in November 2003, a "soft launch" was initiated in December 2004 and the fully commercial iBurst service was launched on March 19, 2004.

PBA is delivering a new paradigm for access to the Internet and corporate information where people are able to rely on secure high-speed connectivity wherever they are and whenever they want. Not only does this greatly enhance the utility of many existing data applications, it enables the development of exciting new applications that could not exist until iBurst came into existence. PBA is a network builder and service provider. Its iBurst network offers the first commercially available service of its kind in the world. Based on patented technology from ArrayComm and using equipment supplied by Kyocera Corporation, the iBurst network uses state of the art High Capacity-Spatial Diversity Multiple Access (HC-SDMA) technology that is being standardized by the Alliance of Telecommunications Industry Solutions (ATIS), an ANSI-accredited standards development organization. HC-SDMA systems make far more efficient use of radio spectrum than previously developed mobile radio telecommunications systems, allowing each radio node to provide up to 1 Mbit/s broadband service to thousands of users simultaneously. With PBA's iBurst service subscribers can maintain their connection whether moving between rooms or between suburbs – the network supports seamless handover between radio nodes at vehicular speeds, thereby providing a fully mobile service.

PBA is a wholesale provider of iBurst connectivity, concentrating on its strengths of establishing and managing its network infrastructure. It re-sells its service via selected Channel Partners who are specialists in the provision of ISP and mobile services. PBA is positioned to be the market leader for mobile broadband Internet services in Australia. With its unique iBurst technology, PBA is able to offer connectivity to the Internet or corporate data at a cost and quality that has previously only been available though fixed connections.

III.3.2 Bangladesh: Access technologies for broadband telecommunications

Foreword

Bangladesh is a developing country situated in south-east Asia, where telecommunication is one of the booming sectors. Being a densely populated country, Bangladesh has the advantages of greater coverage. Bangladeshi people are very enthusiastic to know about the recent developments in any sectors especially in telecommunication. They try to adopt new technologies when rolled out.

Infrastructure

The infrastructure for accessing broadband technology in Bangladesh is not satisfactory though more than 75% people lives in the rural and remote areas. The city dwellers are getting the advantages of all the latest technologies but the rural people are deprived still. It is not possible for a country to move ahead, leaving this large number of rural people unconnected. Bangladesh has 6 Mobile operators and 13 PSTN operators. Among them 5 (five) mobile operators uses GSM technology and 1 (one) uses CDMA technology. The BTS coverage area of the different operators is more than 90% of Bangladesh.

Technologies

It will be better if Bangladesh goes for air interface technologies like Broadband wireless Access (BWA) and Third Generation (3G) network. At present, most of the mobile operators are ready to migrate to 3G technology. The existing mobile operators in Bangladesh use 2.5G networks. It will not be a tough job for

[116] See ITU-R Recommendation M.1036, "Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications-2000 (IMT-2000) in the bands 806-960 MHz, 1 710-2 025 MHz, 2 110-2 200 MHz and 2 500-2 690 MHz".

the operators to migrate their existing 2.5G network to 3G. Operators just need to have an overlay on the existing 2.5G network. Bangladesh Telecommunication Regulatory Commission (BTRC) has already started working on 3G licensing guidelines. BTRC will issue the 3G license(s) to the operators after the completion of 3G guidelines. A new access technology which is suitable in Bangladeshi context is Broadband Wireless Access (BWA) or WiMAX. BTRC has already awarded 4 (four) BWA licenses and they have already started working to meet the roll out obligations. Wi-Fi is another access technology used in Bangladesh which is cheaper then WiMax and it is becoming popular day by day. People can easily use this technology because most of the latest communication devices are Wi-Fi enabled. At present the metropolitan cities and towns in our country are cluttered with hazardous overhead optical fibre / cables. Use of multiple optical fibre / wired networks in the same area by the multiple ANS operators causing duplication of effort using national resources. Therefore, to de-clutter the city areas and towns, minimizing the duplication of national resources, the license of Nationwide Telecommunication Transmission Network has been awarded to 1 (one) company. The incumbent operator Bangladesh Telecommunications Company Limited (BTCL) has started providing DSL service in Bangladesh.Bangladesh will continue to work to develop the access technologies for broadband telecommunications, especially for the rural people. ITU can help Bangladesh in this regard.

III.3.3 China: The Development of Broadband Services and Applications in China

Broadband Service Development in China

Vigorously driven by such leading Chinese broadband operators as China Telecom and China Netcom, the Chinese broadband service market is progressing from the phase of market cultivation to one of rapid expansion. According to statistics provided by China's Information Industry Ministry, there were only 3.34 million broadband subscribers in the entire telecom market in 2002.

A year later, however, the figure had shot up to 11.15 million, and a further 6.58 million new subscribers were added in the first six months of 2004, bringing the total up to 17.73 million (source: www.mii.gov.cn/mii/hyzw/tongji/yb/tongjiyuebao200406.htm), with some 80 per cent of them being ADSL subscribers.

Thanks to the strong impetus given by China Telecom, China Netcom and other broadband operators, the Chinese broadband market is rapidly entering a period of fast growth, as evidenced by:

– the broadband subscriber base having topped the ten million mark by the end of 2003;
– China's Internet international gateway bandwidth having reached 27 GB in 2003;
– the gradual spread of broadband applications, including numerous varieties of high-capacity video software, gaming applications, etc.;
– the diligent efforts on the part of Internet application suppliers and operators in search of a cooperative mechanism, which have led to the mushrooming of businesses specialized in broadband application content, the emergence of an eco-chain for the broadband Internet industry, and considerable progress in the quest for an operating model for value-added network services.

The subscriber base explosion has fuelled the expansion of the broadband equipment market, where operators have found incentives to engage in volume procurement that has resulted in constant cost-cutting. The price per ADSL line has fallen consistently, from as high as 1 800 RMB yuan (about USD 200) in 2000 to 1 000 RMB yuan (about USD 120) in the second half of 2001, and thereafter to 600 RMB yuan (USD 72) in the first half of 2002, 550 RMB yuan (USD 66) in the second half of 2002, 430 RMB yuan (USD 52) in the first half of 2003, and finally to as low as 320 RMB yuan (USD 39) in the second half of the same year. The low price of broadband equipment has led to a significant reduction in the operating costs of the operators, leaving room for them to cut prices and thus further whet the appetite of consumers. It is evident that the Chinese broadband subscriber base has embarked on a period of self-sustainable growth.

According to a report by the Academy of Telecommunication Research under the Information Industry Ministry of China, the number of subscribers nationwide is expected to reach 51.15 to 58.40 million in 2006, representing a 358 to 423 per cent increase over the 2003 figure.

Table 1 – Forecast of Chinese broadband subscriber growth in the period 2004-2006 in millions

		2004	2005	2006
Optimistic estimate	Broadband access users	25.28	40.79	58.40
	Annual growth rate	107%	61%	43%
Conservative estimate	Broadband access users	23.19	36.32	51.15
	Annual growth rate	90%	57%	41%

Source: Academy of Telecommunication Research under the Information Industry Ministry of China.

Broadband application development in China

Several years of stiff competition in the Chinese broadband market have brought home to operators the fact that the key driver for broadband service development is the application side rather than access alone, and that it is therefore imperative to put in place an integrated broadband industrial chain model to enable sound and sustainable development of the broadband market. Out of the competition and consolidation that took place in both 2003 and 2004, there emerged in the Chinese broadband market a broadband value chain composed of equipment suppliers, telecom operators, value-added service providers and content suppliers.

During 2003 and 2004, the Chinese broadband industrial chain made good progress with China Telecom's "ChinaVNet", China Netcom's "TTZX" and other broadband brands and operating models introduced and brought into operation, and with the broadband market shifting its focus from increasing access to developing broadband applications. The consolidation of the broadband industrial chain implemented by both China Telecom and China Netcom, two leading suppliers in the Chinese broadband market, will have a decisive impact on the development of that market.

- **China Telecom's "ChinaVNet"**

As a nationally unified application service brand and a charging model for information and application services, ChinaVNet (www.chinavnet.com/chpage/c1/), by making use of a mutually beneficial model, helps value-added Internet service providers, content providers and telecom operators achieve their business value together.

By taking full advantage of its subscriber, network and application support platform resources as well as its sales network, customer service and promotion channels, China Telecom hopes to create a friendly ecosystem for Internet industry development, develop a new business model for Internet services and provide its Internet users with a rich array of content and information application services by consolidating the content and applications from its partners, with a view to bringing benefit to all parties concerned, namely users, ChinaVNet partners and China Telecom itself.

Aiming to be at the same time entertaining, informative and of practical use, ChinaVNet's content and applications cover a wide range of trades and sectors, including entertainment, education, securities, consulting, e-commerce, public services, business applications, etc. Advocating the concept of "sharing resources, drawing on each other's strengths and working for the common good", and adhering to the principle of "openness" and "consolidation", ChinaVNet has created a win-win business model through which the service providers and a host of other partners who make up the links in the industrial chain are able to fulfil their own business targets. Meanwhile, China Telecom has also made publicly available its resources, such as its network, subscriber base, charging channel, extensive sales network, customer care and promotion channels, and has provided service providers with such services as user authentication, authorization and fee collection on their behalf. Moreover, China Telecom will do all it can to deliver to service providers a package of convenient services including, among others, network access, IDC, media distribution network and media exchange.

Since China Telecom declared it ready for commercial use on 15 September 2003, ChinaVNet has been commissioned in Guangdong, Zhejiang, Jiangsu and other provinces and municipalities. By the end of December 2003, China Telecom had become the largest operator in the domestic broadband market, with a total of 7.35 million broadband subscribers of whom nearly 3 million were registered ChinaVNet subscribers. Over 260 partners have entered into contract with ChinaVNet. Of the 263 SP partners nation-wide, 28 work directly with ChinaVNet's national centre. In 2004, ChinaVNet will access more than 100 SPs via its national centre platform and give priority to the launch of four product lines, namely broadband entertainment, online gaming, instant communications and enterprise applications, to which end it will build the largest broadband entertainment platform, online movie supermarket and music library in China, establish a unified online gaming prepaid credit system in an endeavour to bring under its coverage 80 online games from operators including the top 40 online operators in China by the end of 2004, and intensify efforts to develop services such as instant communications, e-mail, online anti-virus protection and distance learning.

- **China Netcom's China Byte**

As a countermeasure in response to China Telecom's ChinaVNet, China Netcom joined forces with a number of investment companies to set up the China Byte Corporation in Beijing in February 2004. "TTZX", a broadband portal built through meticulous effort on the part of China Netcom, went into operation at the same time, marking the initial move by China Netcom towards broadening its value-added broadband service strategy. The TTZX website targets ordinary Internet users and delivers specialized broadband information services through a TV-channel-like mechanism with unique content that is "TV-centric, entertaining, family-based and high in quality". What TTZX aims to achieve is, first, to address the needs of ordinary consumers and home users; second, to develop a service and specialized content delivery system that is as easy to operate as TV channels, in order to facilitate user network access; and third, to supply an ever-increasing number of broadband multimedia video services.

China Byte is a limited liability company incorporated by China Netcom, IDG and a number of other world-renowned investment companies, mainly providing such services as Internet content, broadband content, game channels billed to calling parties, the channel-based China Netcom broadband portal and value-added telecommunications.

The China Byte Corporation will offer three categories of service, namely broadband portal, value-added voice services (such as the nationwide voice service mainly accessed by a centralized number 116XX, telephone commerce, calling centre and telephone information inquiry service, etc.) and value-added wireless services (mainly SMS and meeting coordination services), of which the voice services and the broadband portal will be launched first. China Byte will adopt the same operating approach as China Mobile's "Montenet" and will partner with numerous SPs across the country in an effort to supply a massive amount of multimedia information in addition to the narrow-band information already delivered, thereby fully reflecting its business concept of giving overriding importance to the application side in rendering content service.

Following the principle of taking on projects on a selective basis, China Netcom has been diligently looking for a cooperation model of benefit to all. Apart from TTZX, it has explored other ways of cooperation in its search for still greater breakthroughs in broadband applications.

Cooperation model 1: In the light of the market situation and service capabilities, China Netcom is engaged in further development of the already consolidated software, modem and other products from user-end equipment suppliers in order to provide a better quality of service to broadband access users. In conjunction with well-established computer and terminal vendors, China Netcom has started to develop simple network access terminals to lower the access threshold for users. As a result, China Netcom and its partners have introduced co-branded computers with embedded broadband access capabilities, bundling the sales of terminal equipment with that of broadband services.

Cooperation model 2: China Netcom cooperates extensively with the outside world and gives full consideration to user needs in its development, upgrading and management of content channels.

Cooperation model 3: By creating an industrial chain, China Netcom and the provincial communications companies will jointly build a centralized network service platform to provide access, authentication and

billing services to other enterprises, and to promote bundled sales of terminals and broadband services in cooperation with ICPs/ISPs and terminal manufacturers.

III.4 Europe

III.4.1 eEurope Action Plan 2005

The eEurope initiative was first proposed by DG INFSO (Direction Générale – Information Society) at the end of 1999 and endorsed by the European Council in Feira in June 2000. The main objective of eEurope is an ambitious one: to bring every citizen, school and business online and to exploit the potential of the new economy for growth, employment, and inclusion. The first eEurope Action Plan, 2000-2002, had three aims: a cheaper, faster, more secure Internet; investment in people and skills, and greater use of the Internet. It consisted of 64 objectives and nearly all were successfully reached by the end of 2002.

The second stage is the **eEurope 2005 Action Plan**, which was endorsed by the European Council in Seville, 2002. The eEurope 2005 objective is that Europe should have modern online public services (e.g. E-Government, eLearning, eHealth) and a dynamic eBusiness environment. As an enabler for these, there needs to be widespread availability of **broadband access** at competitive prices and a secure information infrastructure.

eEurope 2005 objectives

The objective of the new Action Plan is to provide a favourable environment for private investment and for the creation of new jobs, to boost productivity, to modernise public services, and to give everyone the opportunity to play a role in a global Information Society. eEurope 2005 aims to stimulate secure services, applications and content based on a widely available broadband infrastructure.

The challenges of eEurope 2005

The Information Society has a vast untapped potential for improving productivity and quality of life. This potential is growing due to the technological developments of broadband and multi-platform access, i.e. the possibility of connecting to the Internet via other means than the PC, such as digital TV and 3G mobile phones. These developments are creating significant economic and social opportunities. New services, applications and content will create new markets and provide the means to increase productivity and, as a direct result, growth and employment throughout the economy. They will also provide citizens with more convenient access to information and communication tools.

The targets of eEurope 2005

eEurope 2005 applies a number of measures to address both sides of the equation simultaneously. On the demand side, actions on eGovernment, eHealth, eLearning and eBusiness are designed to foster the development of new service. In addition to providing better and cheaper services to citizens, public authorities can use their purchasing power to aggregate demand and provide a crucial pull for new networks. On the supply side, actions on broadband and security should advance the roll-out of infrastructure.

One of the key areas covered by eEurope 2003 is broadband:

Currently, the most common way to access the Internet is through dial-up connections, a narrowband service, which uses the existing local telephone network and is mostly charged on the basis of time. The main challenge ahead is to accelerate the transition from communications based on narrowband networks to communications based on broadband networks, providing high-speed and always-on access to the Internet. While large corporations have completed their transition to broadband, the focus must now be on the mass market to ensure that broadband becomes available to all homes and SMEs.

Broadband stimulates the use of the Internet and enables the usage of rich applications and services. Its benefits spill over to the areas of e-business, e-learning, e-health and e-government, improving the functionality and performance of those services, and further extending the use of the Internet. As such, it is considered the crucial infrastructure for realising the productivity gains that a more effective use of the Internet can deliver.

To reach everybody, broadband policy must also take into account the potential of the emerging alternative communication platforms such as 3G and digital TV. This multiplies the channels through which people can access broadband and benefit from it, contributing to the achievement of an Information Society for all.

Measures taken under the eEurope 2005 Action

The eEurope action plan is based on two groups of measures which reinforce each other. On the one hand, it aims to stimulate services, applications and content, covering both online public services and e-business. On the other hand it addresses underlying broadband infrastructure and security matters.

(see www.europa.eu.int/information_society/eeurope/index_en.htm)

heEurope Action Plan Implementation in Spain: Program "Internet Rural"

In March of 2002, the European Council of Barcelona put together a strategic plan for the development of an Information Society throughout Europe by the year 2005. In June of 2002 the plan of action for eEurope was approved and at this time the program "Internet Rural" was established. The goal of this project was to install a series of public internet access points that would permit all citizens within their given regions to access the internet, preferably using a broadband connection.

The objectives of project Internet Rural are to establish the following:

- Connectivity to broadband internet services
- Centrally located public access points
- Installation and maintenance services
- Central command and control centre
- Service portals for rural areas
- Optional extensions for connectivity
- Financial Resources.

A simulation of "Internet Rural" was conducted based on the following criteria:

- Simulation was carried out in municipalities that are not covered by ADSL or Cable
- To guarantee the coverage of no less than 40% of the population that does not have present access to Broadband Internet
- This study and the above criteria were established for municipalities of 1 200 inhabitants or greater. In the event that municipalities were smaller, such as 800 or 500 inhabitants, expectations were lowered with regards to the 40% or more coverage target.

The total impact of the program is summarized in the following figure 27:

Figure 27

	Present State Without DSL	**Implementation of the Program**	**% Implemented**	**Final State Without Access to Broadband**
Population	5.177.305	3.808.231	73.56%	1.369.074
Municipalities	6.414	1.853	28.89%	4.561

III.4.2 Ireland

South West Regional Authority Broadband, Ireland[117]

The South West Region of Ireland comprises an area of 12 100 sq. kilometres and has a population of 580 000 people, over half of whom live in the City of Cork and its immediate environs. As with many modern economies, a high level of the region's commercial and industrial activity is centered in the regional capital and it's Metropolitan Area. The agricultural economy is under pressure and the sector no longer provides a means of sustainable livelihood for many farmers, particularly those in the more remote areas. In regions such as these telecom companies have concentrated on the core populated areas since they provide the best commercial or financial returns.

The South West Regional Authority (SWRA) has twenty four elected representatives and has responsibility to promote the coordinated delivery of Public Services in the region. In the course of its work in the development of the Information Society, the SWRA recognized that even with completely free market operations, telecommunications providers are not likely to be prepared to bring broadband to marginalized areas since the chances of profitability are slim. They also realized that financial incentives to attract new market entrants are also not always successful, particularly when the rural market is small. These were the circumstances which moved the South West Regional Authority to try and do something for itself – something different.

Its research pointed to the slow rollout of DSL technology only planned for towns with a population in excess of 6 000 persons.

Since the majority of towns in South West Ireland have populations far less than 6 000, the SWRA further looked at the growing preference for wireless around the globe, and the availability of broadband from satellites. The SWRA decided to try and combine both, with an intelligent interface. In late 2002, the Regional Authority made a proposal to the European Space Agency to undertake a research program relating to the combined usage of Satellite and wireless technologies, the results of which would be of value to many regions experiencing difficulties in getting broadband to remote towns. This proposal was accepted and the SWRA began work on the South West Broadband Project, in February, 2003.

The proposal was to test satellite as a means of accessing broadband, to validate the technology across a range of field trials in areas of e-government, business support, e-Medicine and Distant Education. SWRA was fortunate to receive many offers from major players in the satellite and wireless communications field to participate in the program. Fourteen field trials are now operational and satellite technology is used in conjunction with wireless local area networks to provide broadband access.

A principal economic advantage of its program is that typically a satellite/ wireless system can be installed in just a few days and the total cost of creating a satellite fed wireless LAN is of the order of € 25 000. The SWRA contrasted the rollout of this technology with that of fibre where the cost of laying a plastic duct is of the order of € 150 000 per kilometer and then further substantial costs are involved in providing the fibre, lighting it and then making the "last mile" connection to users. The economics of SWRA's approach are such that the annual cost, including installation, of operating a satellite/wireless local area network, can be as low as € 20 000 per annum. On this basis with a total of 40 customers, connection charges can be as low as € 25 per month for home users and € 60 per month for small businesses.

The SWRA market approach is one of product and service sustainability, on a not for profit basis, reinvesting revenues from the service into the rollout of Satellite and Wireless Broadband to even smaller communities. The SWRA has also adopted a highly inclusive approach with local communities, who will partner with them in each town, to develop and agree on terms and conditions of service, in consultation with local community representatives. The Local Authorities in the region are also partners and provide premises for housing the equipment. The success of the broadband program undertaken by the South West Regional Authority has led the agency to seek its own telecom operator license and one of its main conclusions is

[117] McAleer, John, "*Local communities providing broadband for themselves*", www.swra.ie/broadband, jmcaleer@swra.ie, June 2003.

"think about doing it for yourselves" and advises any interested partners to speak to them for more information.

III.4.3 Norway

1) eNorway Action Plan

Also in Norway, according to the eNorway Action Plan, the government's goal is that broadband is available on the market in all regions of Norway. Primary schools, public libraries and local authority administrative services shall be given the option of broadband connection at a competitive price during the course of 2005.

By the end of 2003, all colleges of secondary education shall also be offered an equivalent scheme[118]. A key priority of the government also will be to stimulate broadband rollout in Norwegian municipalities for use by local authorities. The public sector's extended use of broadband communication is supposed to significantly contribute to a well-functioning broadband services market, making the broadband services more available for small and medium-size enterprises, as well as consumers.[119]

2) Modalen Project, Norway

In Norway, the Modalen Project, which was started in 2000-2001 by a consortium of information technology companies in Modalen, Norway, provides Internet through broadband networks. Because the closest major city to Modalen is over an hour away, the project's intent was to provide every family, company, public department, organization, school and institution in the 400-person city access to broadband technology using the TV set as its user interface. As a result of the project, a May 2001 Gallup poll showed that Internet access on the job, at home and at school was higher in Modalen than in the rest of Norway, and Modalen residents were online more than the rest of Norway.[120]

III.4.4 Sweden

Sweden has a long and strong tradition in IT and Telecommunication. It was an early user and a leader in fibre optics in the end of 80:ies and beginning of the 90:ies very much depending on efforts made by Ericsson and Telia in cooperation with University Research. Sweden was early in using PC :s at home and has today one of the highest PC penetrations per capita in the world.

In mobile communication Sweden was one of the early adopters together with the other Nordic countries and Ericsson together with Nokia from Finland are among the leading suppliers in mobile system and terminals. During the 90:ies the government took a number of steps to deregulate the market in telecommunication and Sweden is today one of the most deregulated countries in the world with the market supervised by the regulating authority PTS (Post och Telestyrelsen).

The situation in Sweden today is characterized by a fierce competition in the broadband marketplace, 20% of the private households have got broadband and the biggest operator is TeliaSonera with a market share of 42%. TeliaSonera uses dominantly DSL and has almost monopoly on the cupper access network but must by law offer it to its competitors. The second largest operator is Bredbandbolaget with 23% and the biggest FTTH network in Sweden. In the enterprise sector TeliaSonera, Song Network and Telenor are the major players. Sweden has more than 200 operators, the majority of them are owned by communities or their energy companies serving the local city region. The major access technologies are DSL (market share of 55%) and FTTH, (almost 20%, based on LAN and Ethernet technology). In connection with the government supported broadband program a separation exists between the role of being a network owner and a service provider i.e. an end user can choose between many different service providers and vice verse.

Sweden is on the threshold to introduce a multi service converged network offering Internet, telephony and TV, triple play, all based on IP. Some DSL operators include VoIP in their service package today and are

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[118] See: www.odin.dep.no/archive/nhdvedlegg/01/03/eNorw040.pdf.

[119] See: www.hoykom.net.

[120] Norwegian Gallup Presentation, OECD workshop on broadband, December 5, 2001.

even discussing TV, the TV operators on the other hands that today offers normal TV and Internet access have started to implement VoIP over their coaxial network.

FTTH access with triple play services is available for some small scale commercial operations.

Broadband access is in Sweden a cornerstone for implementing 24 h e-governance services, to be able to rationalize the health sector by e-health, to offer remote education and to strengthen the local democracy and access to local information.

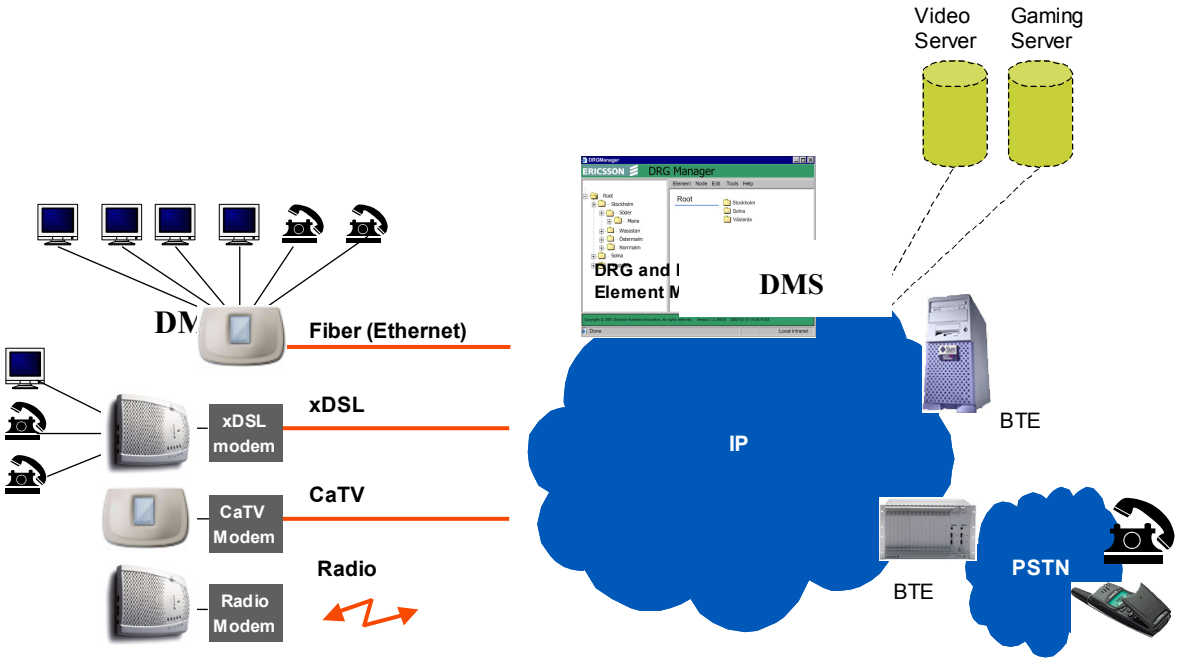
The introduction of triple play has opened up a market for companies developing IP based Set Top Boxes and Home Gateways as spin off from Ericsson and Telia research activities. As example 42 networks together with Ericsson developed an end-to-end broadband access solution for the connection of various types of subscriber equipment to the Internet.

The move to a broadband network based on IP that is a convergence between Internet, Telecommunication and Broadcasting creates of course a number of challenges for the research community. To verify the service and infrastructure requirements various testbeds with real end users have been implemented in Sweden. As example the research institute Acreo's national broadband testbed involves more than 15 vendors, more than 15 operators, more than 10 universities and a number of public authorities.

As an example of a broadband installation in the north of Stockholm Sollentuna Energy provides a network with more than 12 000 installed broadband access terminals. Examples of current services are: Internet (with 4 ISP:s), TV (up to 18 channels), movies (video on demand), Intranet for local information and broadband telephony.

Typical broadband access installations are based on a 42 Networks broadband access solution providing end-to-end quality, security, simplicity and management. Ericsson's end-to-end broadband solutions enable operators and service providers to build a base for Fast Internet, Video on demand, telephony (VoIP) and other broadband services. The portfolio consists of 3 parts: the Digital Residential Gateway (DRG), the Broadband Telephony Enabler (BTE) and Device Management System (DMS), as illustrated in Figure 28.

Figure 28 – 42 Networks Managed Broadband Telephony Solution



Digital Residential Gateway (DRG)

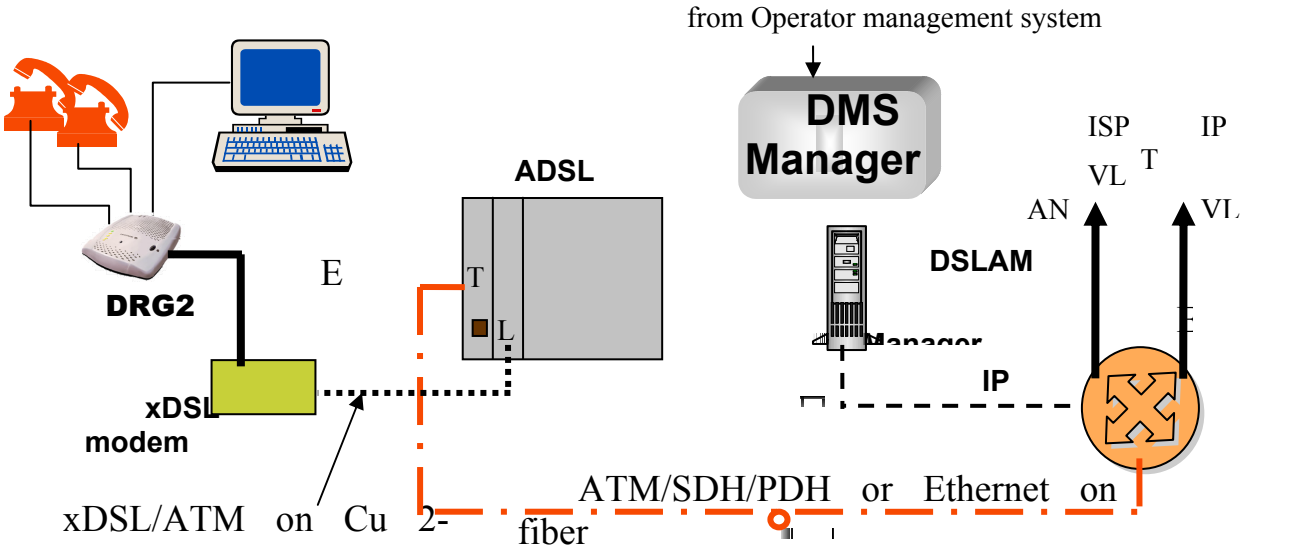
Digital Residential Gateway (DRG) units can be connected to the IP-network either with modems (e.g. for xDSL, CaTV or Radio transmission) or optical/electrical converters for single or multimode fibres (e.g. for Ethernet connection). DRG units allow end users to continue with their existing analog phones or fax machines, while calling with high quality over an IP-Network. To each telephony port up to 5 telephone sets can be connected in tandem. By connecting a set top box to one of the Ethernet ports e.g. Video on Demand can be delivered simultaneously with telephony and fast Internet. The ports also give the end user possibility of connecting several computers and printers to the unit. DRG units with built-in optical/electrical converters allow fibre To The Home/SoHo installations.

For various applications a number of different DRG versions of plug-and-play units have been developed with up to four Ethernet ports and two telephone ports suitable for the connection with Unshielded Twisted Pairs (up to 100 m) or multimode fibres (up to 2 000 m) or single mode fibres (up to 15 000 m).

The DRG Element Manager enables an operator or service provider to manage and configure up to 200 000 installed DRG units remotely. An operator can set parameters regarding e.g. VLAN, IP-telephony and packet filter using SNMPv1 messages as well as initiate remote software updates.

The residential network in Figure 29 is connected across copper wire to a Digital Subscriber Line Access Multiplexer (DSLAM) using an Ethernet connection between the xDSL modem and the DRG22 unit. The Exchange terminal (ET) signals are transmitted on a fibre net to the IP router and Virtual LAN. The operators management system controls the DRG and DSLAM managers to secure end-to–end management.

Figure 29 – Example of DRG implementation



The Broadband Telephone Enabler (BTE) is the central component in an end-to-end VoIP solution, consisting of a carrier class Gatekeeper, Gateway and Element Manager. The solution is based on the most common standards today. Some of the outstanding facilities are scalability, capacity, redundancy and range of services.

A number of Ericsson/42 Networks solutions can be integrated with the end-to-en VoIP solution product portfolio, including Public Ethernet equipment, active and passive equipment for fibre networks and Ethernet xDSL Access solutions.

The DRG and BTE Systems together with the DRG/BTE Element Managers are one of the few solutions for broadband telephony and services on the market focusing on the network aspects to achieve a high level of security, high quality of service (QoS) and a business case based on remote management and software updates of the Customer Premises Equipment (CPE).

III.4.5 Israel: 802.16 Deployment in Rural Areas

IEEE 802.16a is a high capacity standard utilizing OFDM/OFDMA technology on both the Upstream/return and Downstream/forward, with the potential of delivery of a high aggregated data rate in excess of 18 Mbit/s on a channel of 8 MHz bandwidth (average of 2.2 bit/(s*Hz)). Compared to known advanced generation system in stationary applications (2 Mbit/s), IEEE 802.16a has tenfold capacity which can be shared by a large community of users, spread over a wide geographical area, ideally used in rural areas or in highly populated areas.

The system is a highly adaptive system, employing different modulation schemes (nQAMs) and error correction codes (Viterbi, RS and Turbo Codes) with different coding rates. Dynamic resource allocation ensures optimal allocation of the required bandwidth, which fits current user application. The system can support a wide range of telecommunication applications, such as fast internet, video conferencing, VoIP, e-commerce, VoD, etc. The following contribution describes a typical multi-phase deployment of the infra-structure for developing countries, where the laid down infrastructure – of Base Stations (BS) and networking among Base Stations– is optimised to keep infrastructure cost to a minimum level, while supplying IP telephony and reliable Internet services. In addition, the design is modular and scalable in order to allow multiplication of the deployment to additional areas without resorting to any changes, on the system level design and/or the frequency planning.

Basic assumptions for rural deployment:

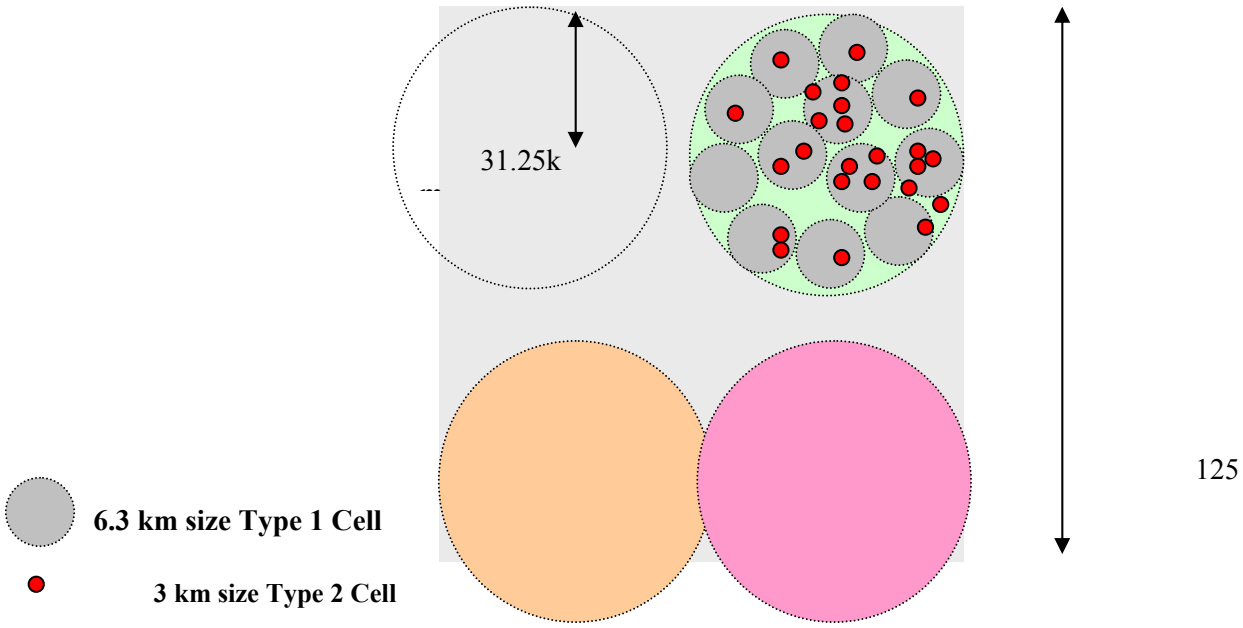
- Deployment in a typical rural area in low populated where 100-200 people live per sq. km (20-40 households), a penetration rate of 80%, and 25% of the subscribers (households) are active in the same time (4-8 households per sq. km).
- Suppose that the total area of coverage extends over 125 km by 125 km divided into four 62.5 km radius areas. Initial launch will start in one of the four areas.
- The Infrastructure should support an initial launch for 31 250 active households (in two phases).
- The Infrastructure should be scalable to support up to 125 000 households in the four regions. Data rate allocated for each household is 128 kbit/s.
- In Phase-1, 15 625 households in one area will be serviced by 31 Base Stations (providing full tele-communication services); each deployed in a cell of 6.3 km radius. Four channels in the 2.4-2.6 GHz band (each 8 MHz bandwidth) will be needed for the Downlink, and an additional 4 channels (8 MHz each) on the Uplink.
- In Phase-2, Additional Base Stations will be deployed in the same region to extend services to additional 15 625 households and to support full symmetric services, within certain parts of the coverage area; each one of them will cover a 3 km radius.
- The CPE (Customer Premises Equipment) supplied to subscribers will have to use out-door directional antenna;
- A minimum data rate between 128 kbit/s will be committed at peak hours;
- An average data rate between 160 to 425 kbit/s will be delivered at off-peak hours;
- Up to 18 Mbit/s burst peak rate will be achieved in some CPE's.

System Description

The deployment is designed to start with one out of four areas, assume a gradual growth of subscribers community, starting with the initial launch of 15 625, followed by successive deployments of Base Stations, to cope with the increase of the number of subscribers (Households), where more than one user is expected in some percentage of households.

The area is divided into four large regions with comparable area size. The area spans an area of 125×125 km, which when divided into four regions we get a region extending to a radius of 31.25 km.

Figure 30 – Typical deployment in rural and sub-urban areas



System Deployment considerations

Optimal design – to achieve a full coverage of one of the areas and keep number of the Base Station to a minimum – is based on cellular approach where the Base Stations are installed in cells of 6.3 km radius. Total number of Base Stations needed to achieve full coverage of one area serving 31 250 users is 62 BSs (assuming 25% active households in the same time).

Each Base station is comprised of two parts from the spectrum partition and services provided point of view as described below:

Part 1 – The first deployment of Base Stations in one of the four areas will target 15 650 households. The aggregated data rate achievable on DL or UL is 64 Mbit/s, which is shared among 500 subscribers (households). Total number of subscribers with the deployment of 31 BSs can reach 15 625 households.

Part 2 – A second phase of BSs deployment will be followed to extend system capacity for the delivery of symmetric services to additional subscribers in the same region. The second tier of BSs will be based on same type of Base Station. Each BS is deployed in a denser network of cells, each 3 km radius. Deployment of additional BSs, within the larger cells of 6.3 km radius will also support delivery of 64 Mbit/s/Base Station.

Assuming average simultaneous usage of 25%, a data rate of 128 kbit/s can be committed, subscribers with favourable link budget will be able to enjoy data rates 2.5 times faster, and by utilizing statistical multiplexing techniques the factor can grow to 20 times faster.

Design Consideration

- Frequency band: 2.4-2.6 GHz
- BST transmit power: 37 dBm
- BST Tx, Rx Antenna gain: 16 dBi
- CPE Transmit power: 23 dBm
- CPE Tx, Rx Antenna gain: 18 dB
- UL, DL propagation model: near LOS

- DL, UL aggregated data rate: 18 Mbit/s
- No diversity is attempted on BS or CPE

Economical Aspect

BWA system based on IEEE 802.16a has a potential for deployment in rural or underserved areas, for delivery of a wide range of telecommunication services. An initial investment of less than 350 USD/ household will be required for the supply of CPE`s and deploying infrastructure for the first 31 250 subscribers in one area (rural, suburban), the Return on Investment (ROI) is estimated to be less than 2 years. This calculation does not take into account expenses such as: spectrum license cost, and the cost of the equipment needed to supply the services such as routers, gateways, switches and intra-cell networking equipment.

III.5 Asia Pacific

III.5.1 Niue: Wi-Fi in Niue, South Pacific

The South Pacific island of Niue is about 100 square miles, has 1 750 residents, and its economy suffers from the typical Pacific island problems of geographic isolation, few resources, and a small population. Tourism is an import source of revenue and until recently, has declined severely. Additionally, the island in recent years has suffered a serious loss of population because of its economic downturn. In an effort to revive its tourism, economy, and population the tiny island of Niue has launched the world's first nationwide WiFi Internet access service. After introducing free email service to Niue in 1997, The Internet Users Society of Niue launched free Internet access service for the island in 1999. The group was initially set up to fund the high cost of satellite-based Internet connections on the remote island. However, WiFi was chosen as a better fit for the island, where harsh weather conditions of rain, lightning, salt water, and high humidity causes major problems with satellite and underground copper lines.

The Internet Users Society of Niue built a comprehensive network that includes solar-powered repeaters in coconut trees to give everyone on the island and its visitors' open and free Internet access. Full Internet access from all parts of the island was an important aspect of the tourist revival scheme. A substantial portion of Niue's tourism comes from visiting yacht traffic during the non-cyclone season. The vast wireless coverage created an even more attractive proposition for visitors. Yachts with onboard computer equipment are able to park in the harbour and access full Internet services from their vessels, free of charge. In addition, consultants and other visitors who carry laptops with WiFi capabilities are also able to connect. Through wireless broadband connectivity, Niue has become an extremely diverse communications technology home, and in turn, the island has been able to attract and generate more tourism and investment.

ANNEX IV

Definition of the Question

Question 20-2/2 – Examination of access technologies for broadband communications

This study should include an economic analysis of the factors affecting the deployment of various broadband access-technologies. The study should also include an examination of the benefits of using broadband technologies taking into account the gender perspective.

1 Statement of problem or situation

During the Study Period 1998-2002, Study Group 2 Question 12-1/2 analysed broadband communications over traditional copper wire, or digital subscriber line (DSLN), principally because of its ability to leverage existing investments made by telecommunication administrations. Given the rapid advancement of telecommunications technologies since 1998, other broadband access technologies, wired and wireless, have become available that provide similar or improved performance to DSL. Broadband technologies permit the deployment of applications, such as e-health, distance learning, e-government, tele-working, public safety, national security, Internet access, and intranet access.

The ITU-D can play a role in assisting Member States and Sector Members in understanding the appropriateness of different technologies available for broadband access communications. The ITU-D can also assist Member States and Sector Members in analyzing the economic issues involved in deploying broadband access technologies, including the integration of these access network solutions with existing or future network infrastructure.

2 Question or issue proposed for study

Identify the technical, economic, and development factors influencing the effective deployment of broadband wired and wireless access technologies and applications, with a focus on technologies and/or standards recognized or under study by the other two ITU sectors

3 Expectet Output

Taking into account the expected results from ITU-T and ITU-R, there will be a set of best-practices guidelines for implementing wired and wireless broadband technologies in developing countries. The guidelines will need to take into consideration the economic and technical factors that are affecting broadband deployment, assess the requirements of developing countries for broadband implementation and focus more on the experiences of developing countries rather than developed countries as was the case from the last study period of Question 20-1/2.

a) Analysis of the economic, technical, regulatory and development factors influencing the effective deployment of broadband access technologies. This will also include an assessment of the demand for these technologies and applications in developing countries.

b) A matrix of different broadband access technologies, both wired and wireless, terrestrial high-altitude systems, including stratospheric-based and satellite. Yearly updating of the technology matrices will be necessary, including an update of the output report of the last study period by the year 2009.

4 Timing

The work of the revised Question will commence after WTDC-06 and continue until the next ITU-D study period.

Proposers

Developed and developing countries.

6 Sources of Input

1) Collection of the requirements of developing Member States through a questionnaire.

2) An assessment of developing countries' experience with broadband access technologies, using the same questionnaire referred to above.

3) An update of ITU-T and ITU-R outputs relevant to broadband access technologies.

4) Contributions of concerned industry on the development of broadband access technologies for both wired and wireless.

5) Contributions on economic factors relevant to the deployment of wired and wireless broadband technologies, this might include information on tariffs, equipment costs, interconnection charges, licensing fees for wireless applications, etc.

7 Target audience

Target audience	Developed countries	Developing countries	Least developed countries (LDCs)
Telecom policy-makers	No	Yes	Yes
Telecom regulators	No	Yes	Yes
Service providers	No	Yes	Yes
Manufacturers	Yes	Yes	Yes

a) Target audience

Users of the output will be manufacturers, operators, regulatory agencies and service providers in developing countries and LDCs.

b) Proposed methods for the implementation of the results

To be decided during the study period.

8 Proposed methods of handling the Question

Within Study Group 2.

9 Coordination

The ITU-D rapporteur group dealing with this Question should coordinate closely with:

9.1 ITU-T Study Groups 13, 15, 16 and 19.

9.2 ITU-R Study Groups 4, 6, 8 and 9.

9.3 Other relevant Questions in ITU-D study groups.

In addition, the rapporteur group should take into consideration any relevant progress on agenda item 19 of the World Radiocommunication Conference (WRC-07) relating to “global broadband satellite systems”.

10 Other relevant information

As may become apparent within the life of this Question.

ANNEX V

Analysis of the replies to the questionnaire

Action required

Participants are invited to send their comments to BDT Secretariat **by January 2004 at the latest**. After inclusion of the comments received, the analysis will be finalised and put on the Study Group Web site.

Action demandée

Les participants sont invités à envoyer leurs commentaires au Secrétariat du BDT **au plus tard à la fin du mois de janvier 2004**. Après l'insertion des commentaires reçus, l'analyse sera définitivement mise au point et affichée sur le site web de la Commission d'études.

Acción requerida

Se invita a los participantes a que envíen sus comentarios a la Secretaría de la BDT **en enero de 2004 a más tardar**. Una vez incluidos los comentarios que se reciban se hará el correspondiente análisis, que se comunicará en el sitio web de la Comisión de Estudio.

Abstract

The contribution is the draft analysis of the replies to the Questionnaire sent on broadband communications. It has been prepared by a BDT external expert[121].

CONTENTS OF ANNEX V

List of Tables

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List of Figures

Introduction

In March, 2003, a questionnaire was distributed by ITU-D circular letter CA/25 following the Rapporteur's Group meeting for Question 20/2: Examination of access technologies for broadband communications questionnaire on march 3rd 2003 (see appendix of Annex 2). The questionnaire requested Member States, Sector Members, relevant organizations and industry to identify relevant wireless and wireline broadband access technologies and their attributes. The questionnaire also aimed to identify economic, technical and development factors influencing the effective deployment and accessibility of broadband access technologies and applications. This report represents the summarized results of the responses received by the ITU by June 2003.

By mid June 2003 fifty-five responses were received from forty-nine countries from the five ITU regions. Table 1, below gives a list of countries and indicates using parenthesis which countries responded with more than once.

Table 1 – Respondent Countries

Africa	Americas	Asia-Pacific	Arab States	Europe
Chad	Barbados	Israel (2)	Egypt	Armenia
Côte d'Ivoire (2)	Bolivia	Japan (2)	United Arab Emirates	Belarus
Ethiopia	Brazil	Korea (Rep.)		Belgium
Malawi	Canada	Maldives		Bosnia
Mauritius	Chile	Myanmar		Bulgaria
Nigeria	Costa Rica	Nepal		Denmark
South Africa	Dominican Rep.	Pakistan		Estonia
Uganda	Ecuador	Philippines (3)		Hungary
	Guyana	Sri Lanka		Lithuania
	Honduras	Thailand		Malta
	Mexico	Tonga		Norway
		China		Poland
		India		Portugal
				Spain
				Switzerland (2)

Methodology

In terms of workflow, MySql Server was used as a data repository for questionnaire responses and ToolMagic's MySQL Tools along with Microsoft Access were used to extract and summarise data with Microsoft Excel being used for graph generation and numeric analysis and the final report written in Microsoft Word.

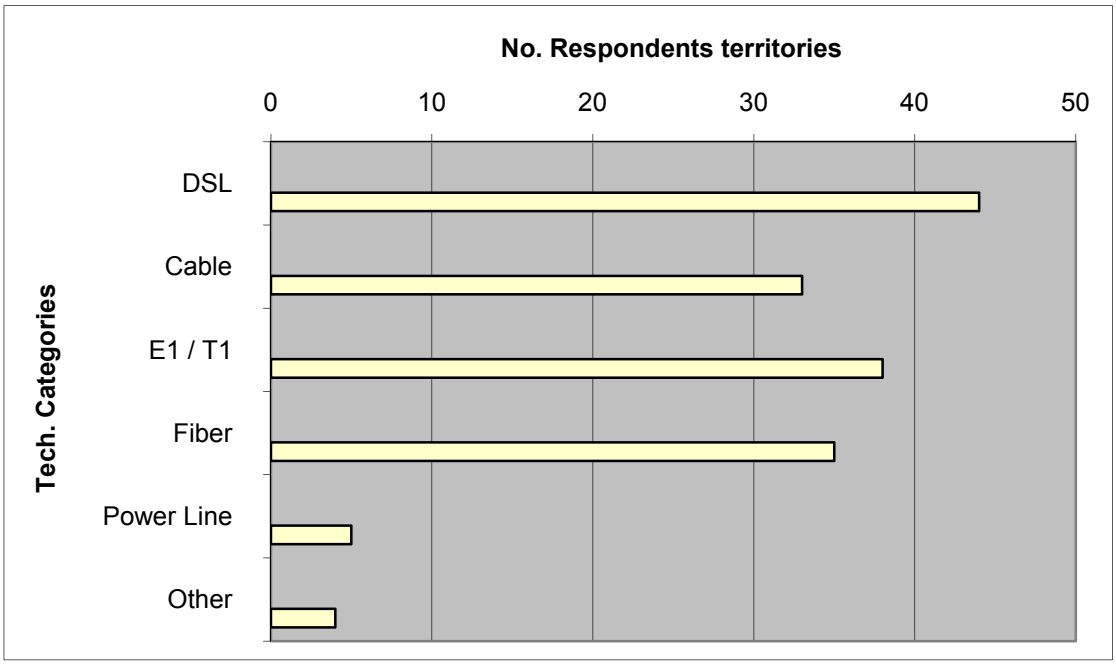
This report follows the overall structure of the questionnaire and summarises the findings as reported by questionnaire respondents. For the purpose of this report where more than one response for a member state was received, the data was merged during data analysis for the given territory where appropriate or in the case of conflicting information, data supplied with verifiable cited data sources, was selected. As a result, for the purpose of this report, the term respondent is used to indicate the information provided by a responding territory, rather than the individual responding organization.

Where provided data seemingly in response to ambiguity or misinterpretation of a given question is noted in the report text in order to facilitate discussion during the relevant Study Group meeting.

Technology

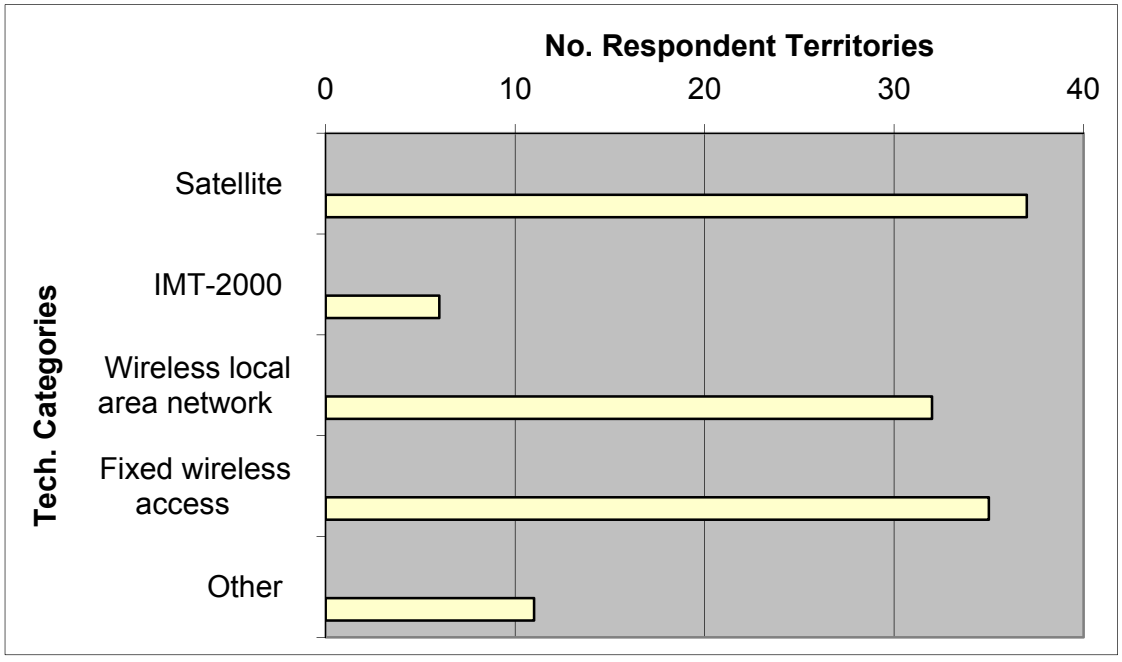
The technology section of the questionnaire aimed to discover which broadband technologies are in use to deliver broadband-based services. As can be clearly seen from Figure 1 below, the current dominant technology for delivering broadband services over wire line networks is DSL, closely followed by more traditional E1/T1 (E1 interface provides a 2 048 kbit/s access rate, T1 interface provides a 1 544 kbit/s access rate, see also ITU-T Recommendations G.703 and G.704 Interface for WAN analysis), fibre and cable connections.

Figure 1 – Wireline Technologies utilized to provide broadband services



Wireless technologies are widely used to deliver broadband services in developing countries with satellite, fixed wireless and wireless local area networks are used to overcome barriers where wireline solutions are inappropriate, as indicated in Figure 2 below:

Figure 2 – Wireless technologies utilized to provide broadband services



A number of countries employed technology solutions other than DSL, Cable, E1/T1, fibre and power line for wireline based solutions to deliver broadband services. Other technologies used in delivering wireline solutions included ISDN, ATM.

For alternates to the main wireless technologies of satellite, IMT-2000 or wireless LAN some respondents were using developments such as laser free space optics used in both South Africa and Canada, general packet radio service (GPRS) in Estonia and spread spectrum solutions in Ecuador. Table 2, provides a summary of the other technologies reported by questionnaire respondents:

Table 2 – Other technologies employed by respondent countries to deliver broadband service

Country	WIRELESS_OTHER_DESC
Armenia	802.11b Radio Ethernet
Belarus	GPRS, IMT-MC-450
Bolivia	MMDS (Multipoint multi-channel distribution systems), LMDS (local multipoint distribution systems)
Brazil	Multipoint multi-channel distribution systems (MMDS) are currently used and local multipoint distribution systems are in network roll out focused on the delivery of broadband services.
Canada	Optional Free Space (Laser), used by companies in some urban centres.
Ecuador	Spread Spectrum (A communication technique that spreads a signal bandwidth over a wide range of frequencies for transmission and then de-spreads it to the original data bandwidth at the receiver.)
Estonia	GPRS
Ethiopia	Fibre based access in Addis Ababa and major Cities
Korea (Rep.)	CDMA 1X (according to our, Korean, definition, it belongs to 2.5G and not to 3G IMT-2000)
South Africa	Free Space Optics (Laser)
Sri Lanka	Point to point Microware

Competition

The competition section of the questionnaire aimed to assess the degree of competition for Internet services, in local loop provision, among different broadband technologies and how many operators offer high speed internet, DSL, cable, wireless, etc.

Of the respondent countries only four countries did not permit competition in Internet services, namely:

Ethiopia, Costa Rica, the Philippines and the United Arab Emirates.

As shown in Table 3, twenty-eight of the respondent countries have competition in the local loop.

Table 3 – Respondent countries with competition in local loop

• Chad	• Japan
• Nigeria	• Korea (Rep.)
• South Africa	• Myanmar
• Uganda	• Sri Lanka
• Bolivia	• Thailand
• Brazil	• Tonga
• Canada	• Belgium
• Chile	• Bulgaria
• Dominican Rep.	• Denmark
• Ecuador	• Malta
• Guyana	• Norway
• Mexico	• Portugal
• China	• Spain
• India	• Switzerland

While as shown in Table 4, the following twenty one countries do not:

Table 4 – Respondent countries without competition in the local loop

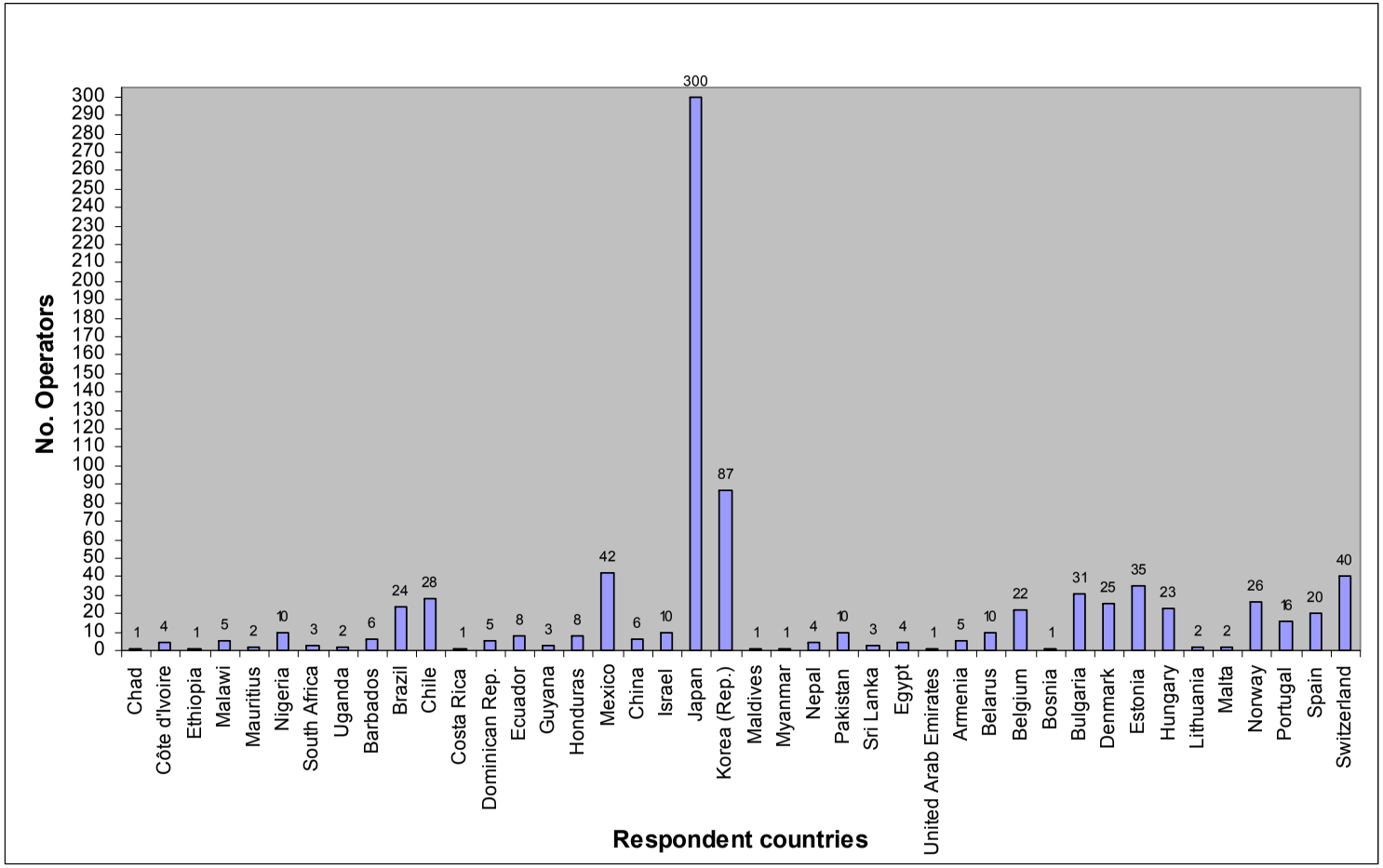
• Côte d'Ivoire	• Philippines
• Ethiopia	• Egypt
• Malawi	• United Arab Emirates
• Mauritius	• Armenia
• Barbados	• Belarus
• Costa Rica	• Bosnia
• Honduras	• Estonia
• Israel	• Hungary
• Maldives	• Lithuania
• Nepal	• Poland
• Pakistan	

Thirty-nine of the respondent territories have competition between different broadband technologies with only the following ten respondent countries having no competition:

• Ethiopia	• Maldives
• Malawi	• Nepal
• Barbados	• Philippines
• Costa Rica	• United Arab Emirates
• India	• Bosnia

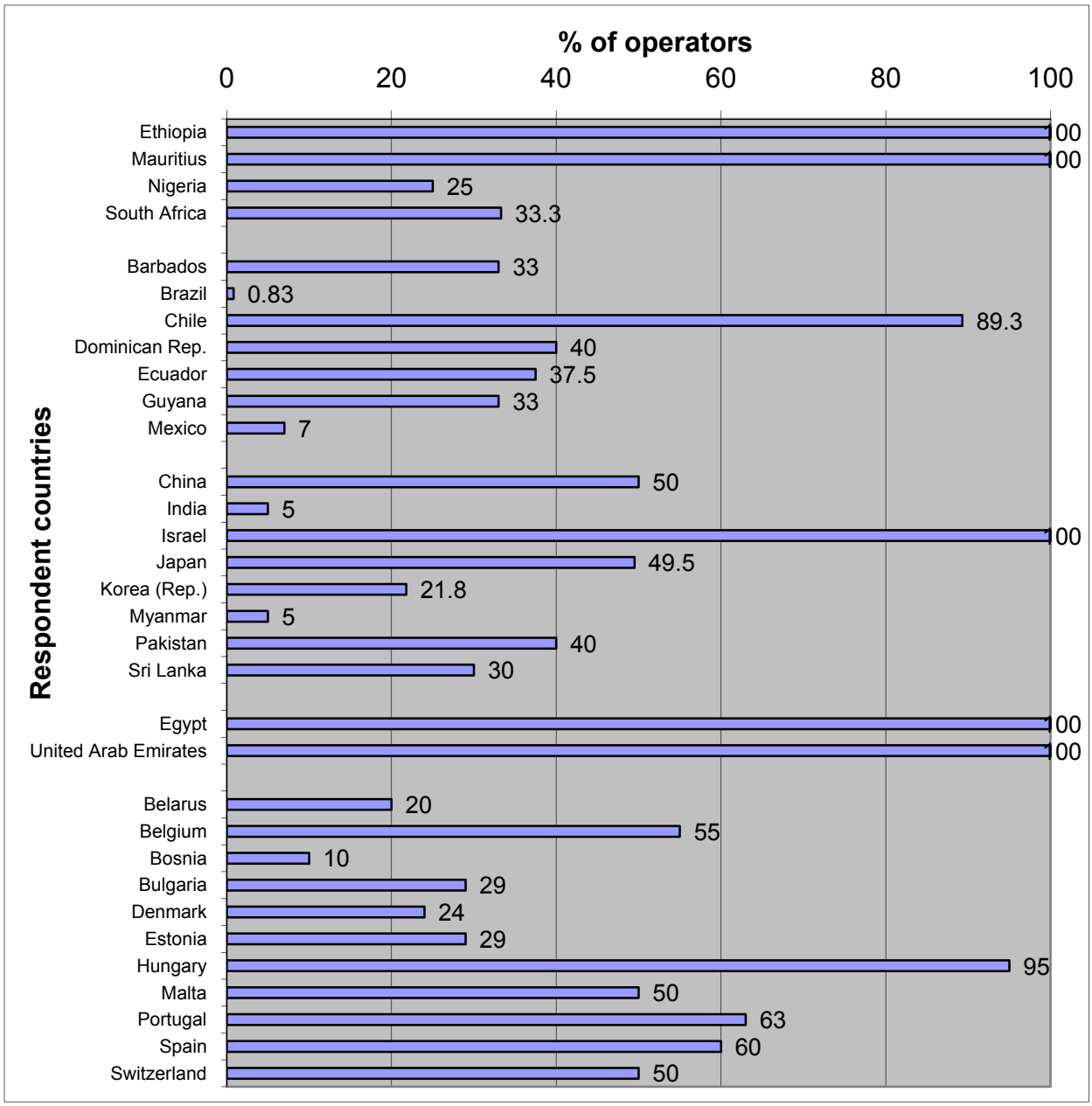
The following (Figure. 3) graph shows the number of operators offering high speed Internet:

Figure 3 – No. Operators offering high speed internet services



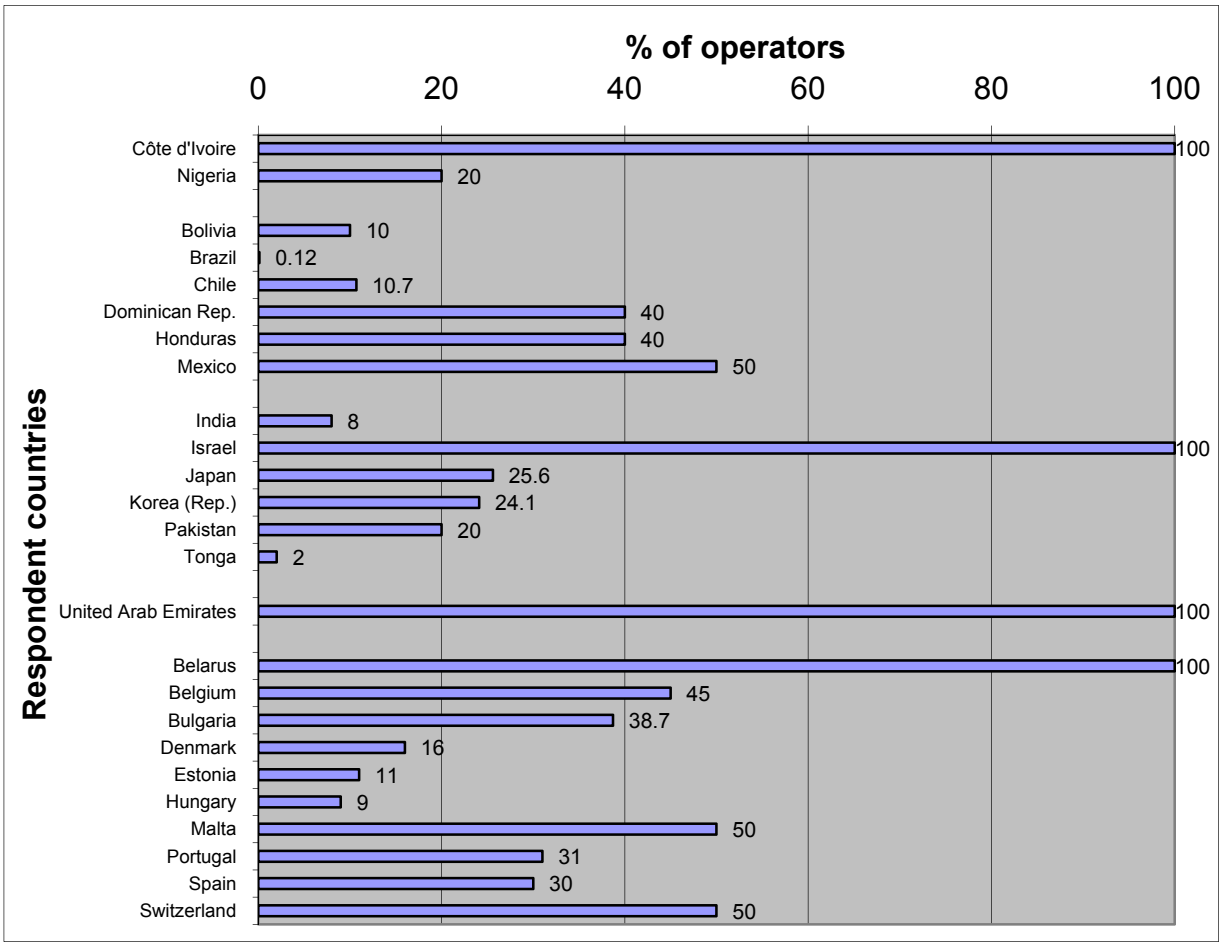
The following set of graphs shows the percentage of operators offering DSL, cable modem and wireless broadband-based services.

Figure 4 – Percentage of Operators offering DSL connections[122]



[122] In the case of Ethiopia – there is only one ISP – ETC. there is no competition in the provision of Internet services and since ETC offers DSL and HDSL, the resultant percentage of operators offering DSL is 100%. It should be noted that this figure does not imply coverage or 100% of access to DSL based services.

Figure 5 – Percentage of operators offering cable connections

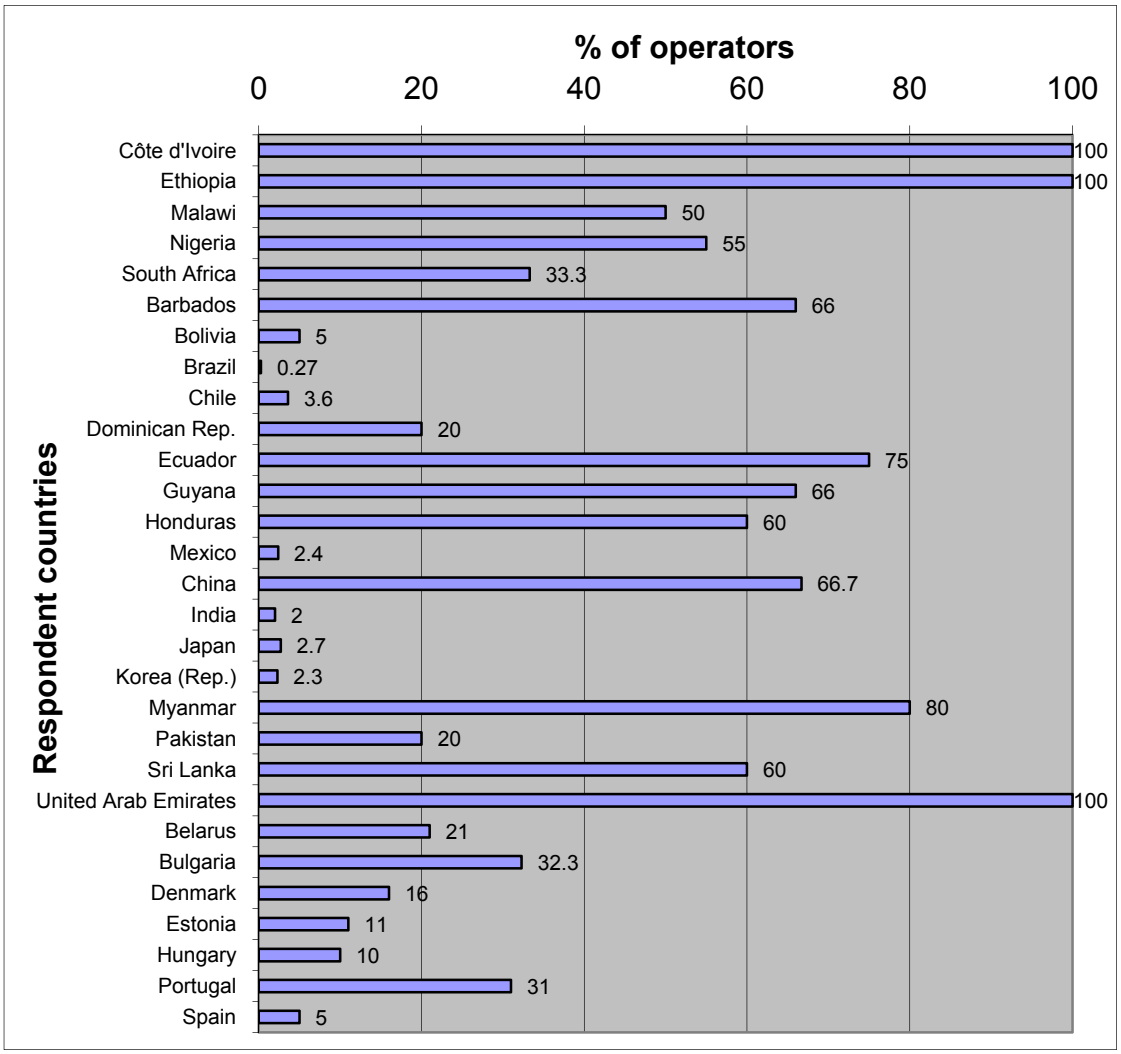


NOTE – Brazil's response of 0.12% does not show on the scale used for this document.

On analysis of the responses received it became apparent that there might have been some confusion on in the responses for the number of operators offering cable-based services. A number of respondents reported that cable technologies were not used in their countries to deliver broadband services but did indicate that a percentage of operators offered cable based services. As a result of this seeming contradiction those companies that indicated that cable technologies were not used, have not been included in the above (Figure 5) graph.[123]

[123] This is the case for Ethiopia and Egypt. In the case Cote d'Ivoire it is not apparent if all operators offer cable services; Africa Online offer cable services to businesses while AfNet offer fixed line services – the figure for Cote d'Ivoire awaits further confirmation.

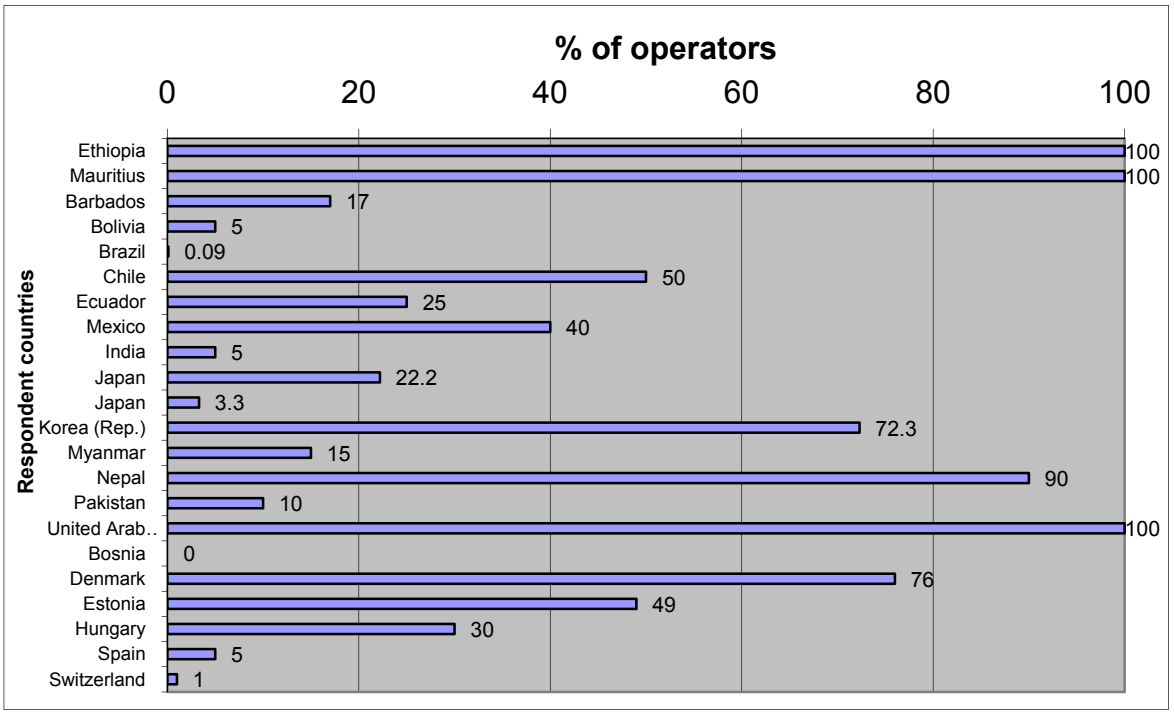
Figure 6a – Percentage of operators offering wireless connections



The percentage of operators offering other broadband access technologies such satellite, GPSR and optic fibre based networks, is shown in the following graph.[124]

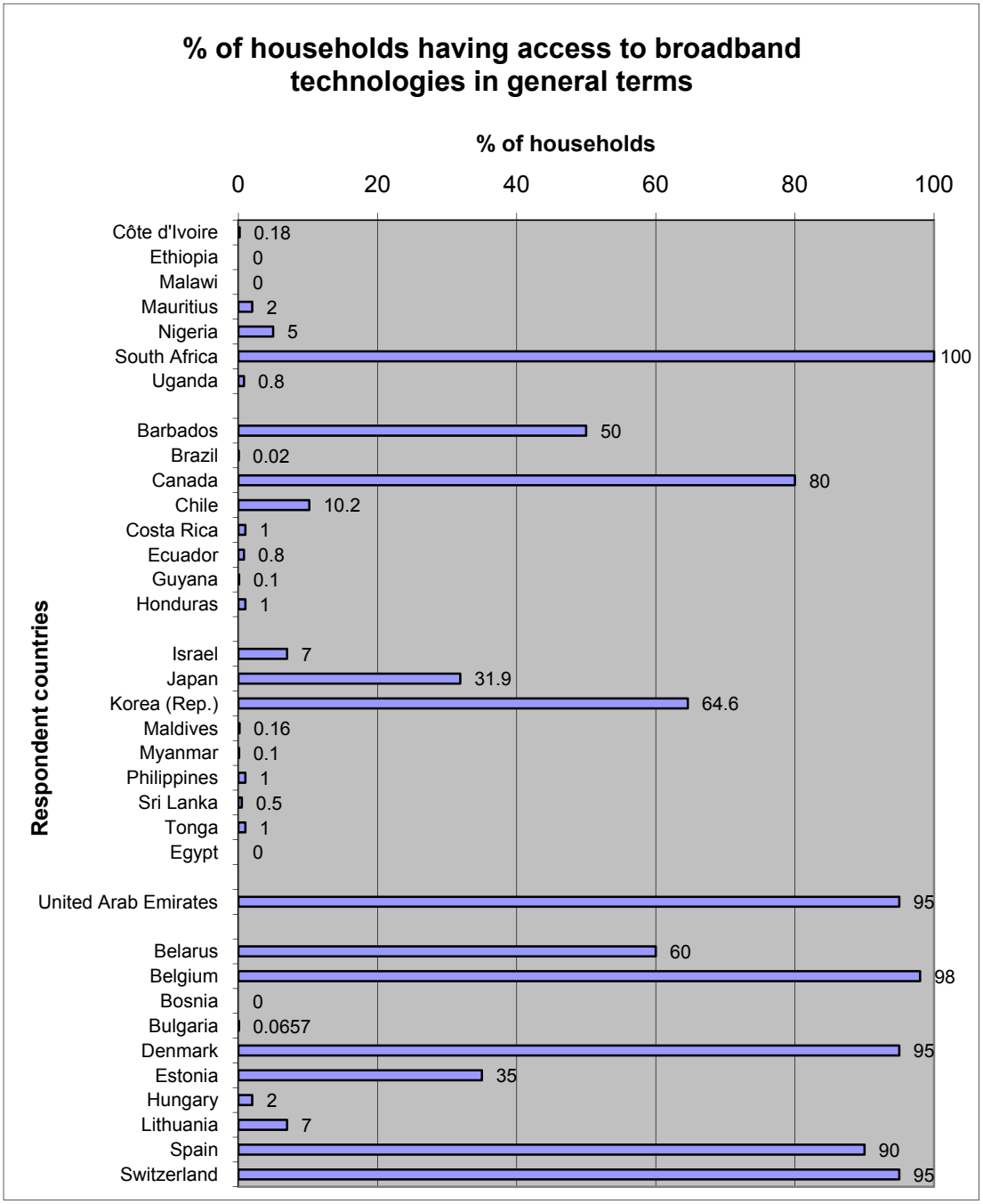
[124] In the case of Ethiopia – there is only one ISP – ETC. there is no competition in the provision of Internet services and since ETC offers DSL and HDSL, the resultant percentage of operators offering DSL is 100%. It should be noted that this figure does not imply coverage or 100% of access to DSL based services.

Figure 6b – Percentage of operators offering other broadband connection technologies



Access

The Access section of the questionnaire sought data on the percentage of access to broadband technologies by households and businesses and rural telephone subscribers and whether or not gender barriers existed to accessing services delivered with these technologies. The situation in regard to accessing broadband technologies was well illustrated by respondents when considering the overall percentage of households that have general access. The following graph shows highlights the differences in access that exists between countries.



However, the graph itself maybe misleading since the original question was possibly misinterpreted by some respondents. The question was interpreted by some respondents as meaning the percentage of households having general access to broadband i.e. via home, public access point (school, post office etc) or commercial point (cyber-café or telecentres) leading to figures such as 100% for South Africa or 95% for Switzerland. Other respondents interpreted the question as the number of individual households that have access (i.e. in the home) to broadband technologies. This was echoed in the figure of 10% for Switzerland supplied by the respondent from OFCOM. For the purpose of this document, the wider interpretation of the question was used (and hence in the case of Switzerland, the data supplied by SwissCom was used rather than that supplied by OFCOM), with this caveat attached that original question may have been misinterpreted by respondents and the data may not best represent the access situation in some countries.

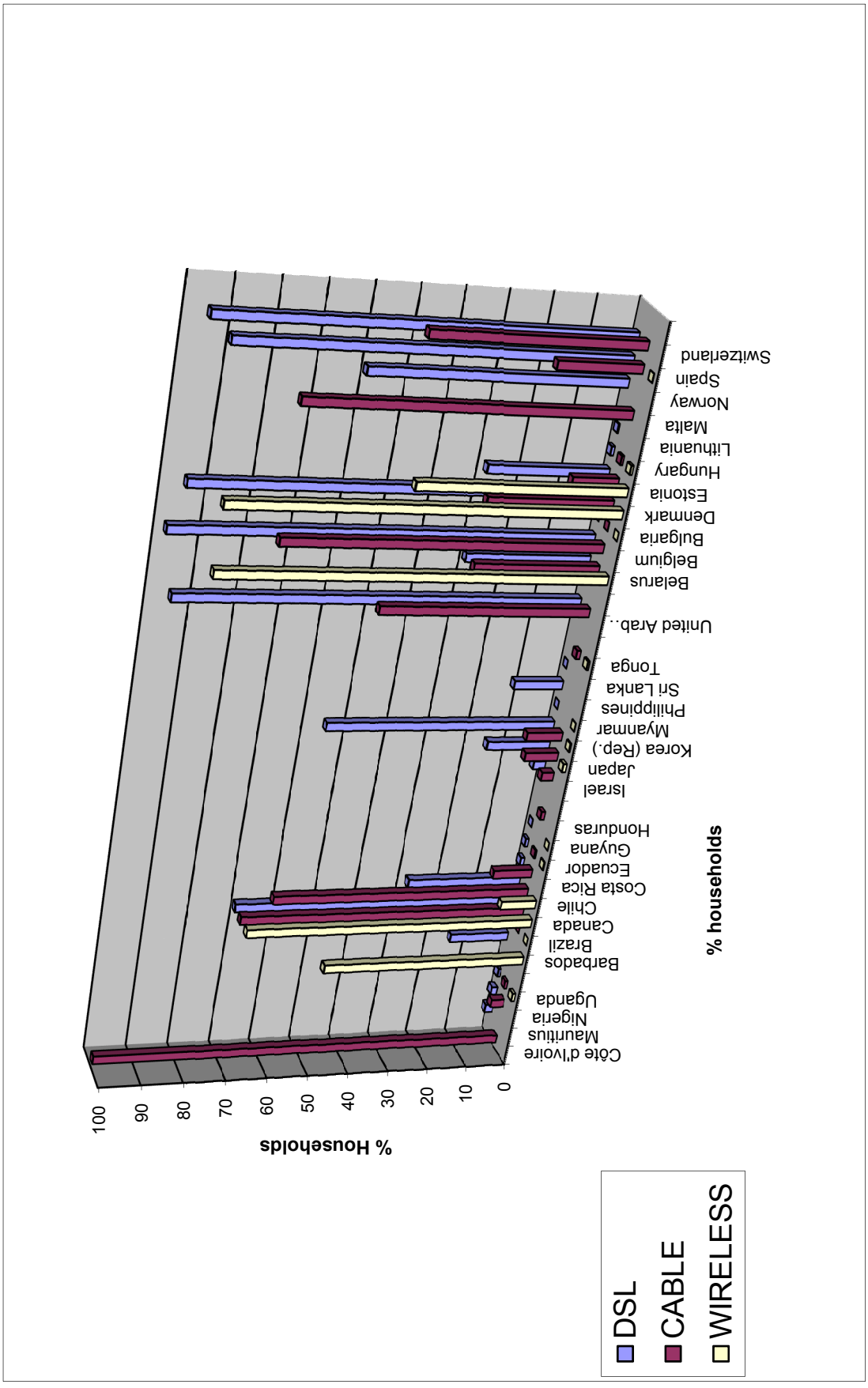
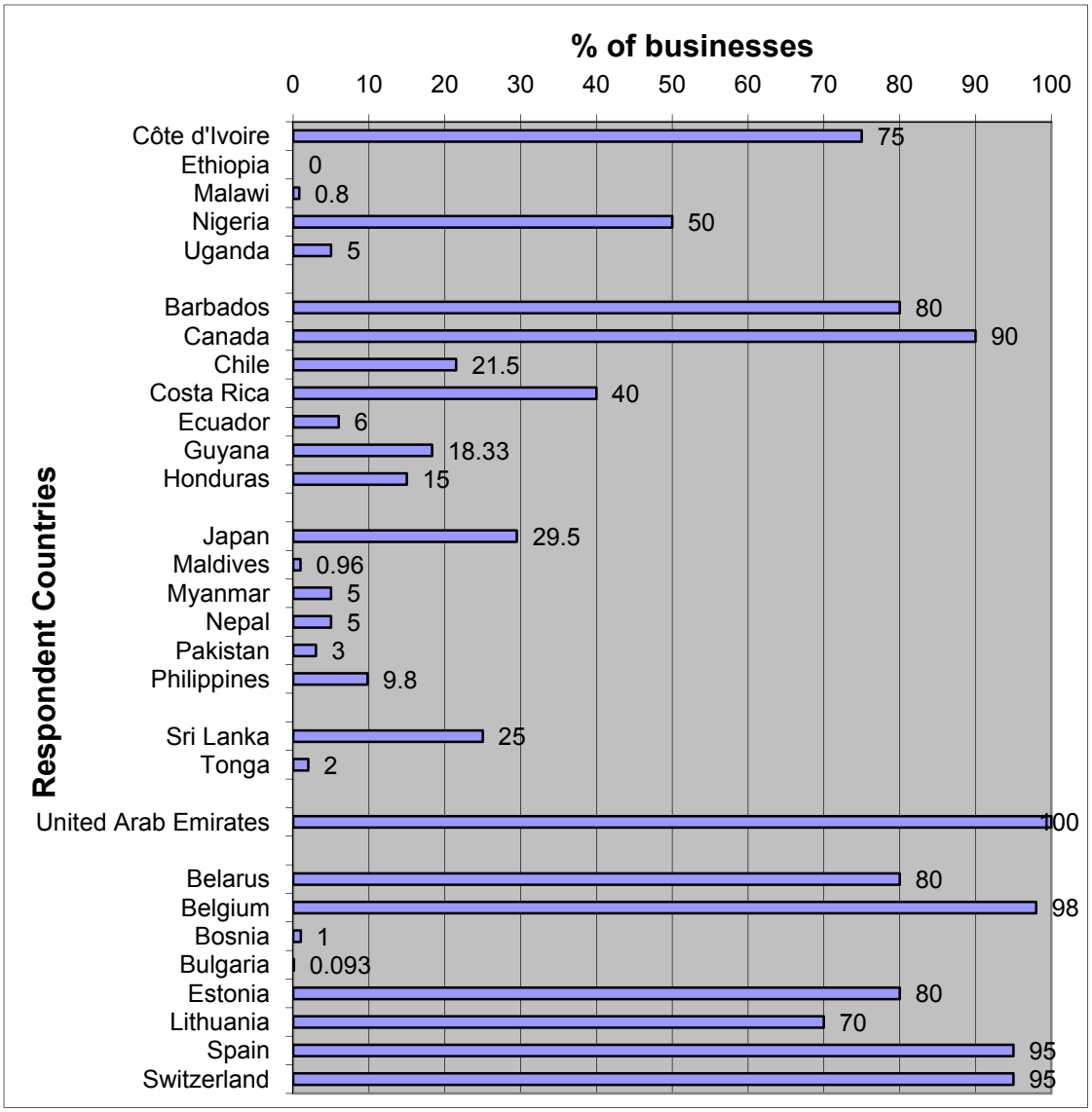


Figure 7 – Percentage of households with access to DSL, Cable and Wireless

The situation shown in the previous graph depicting the percentage of households with access to DSL, cable or wireless technologies reinforces the access situation to broadband-based services. Many of the countries shown have only a fraction of 1 per cent of the households in the country with access to one or another of the three main broadband technologies. Some other countries – primarily developed ones, are well served with access via DSL, cable or wireless – or in some cases where local technology competition exists, the option to select between which technology best meets current need.

Business applications are one of the main drivers of adoption of broadband services. The following graph (Figure 8) indicates the percentage of businesses in respondent countries that have access to some form of broadband technology.

Figure 8 – Percentage of businesses with access to broadband technologies



Business access to individual broadband technologies, illustrated by the following graph, echoes this structure and illustrates the larger role of wireless access for businesses in comparison with the household based access. Meanwhile the rural telephone subscribers access to broadband-based services graph, illustrates the differential in access problems facing developing and developed countries. As the graph clearly shows, in countries such as Chile, Ecuador, Myanmar, Sri Lanka and Tonga only a minute fraction of the rural population has access to broadband technologies. A number of countries including Côte d'Ivoire, Malawi, Nigeria, South Africa, Honduras, Bosnia and Hungary stated that **no** rural telephone subscribers had access to broadband technologies.

Figure 9 – Percentage of businesses with access to DSL, Cable or Wireless technologies

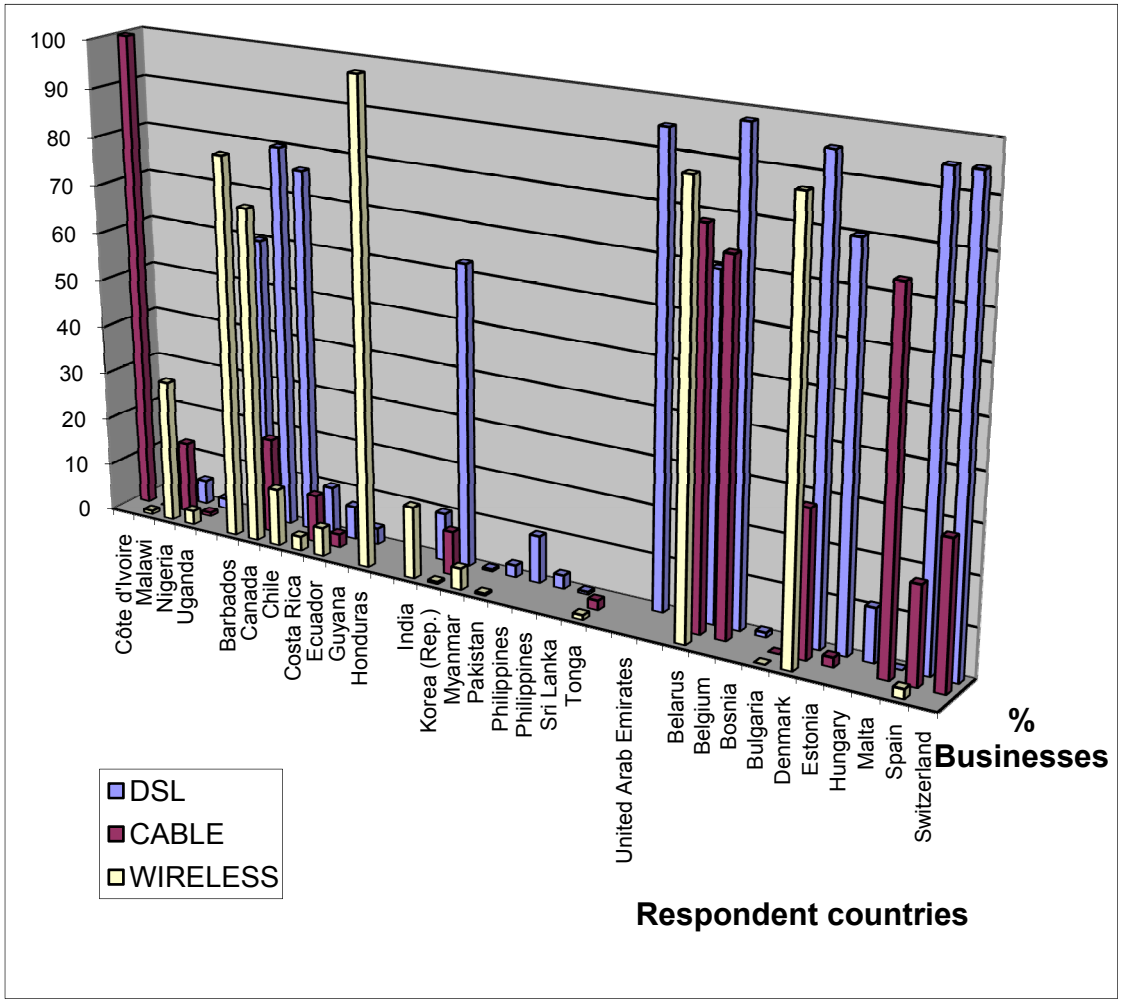
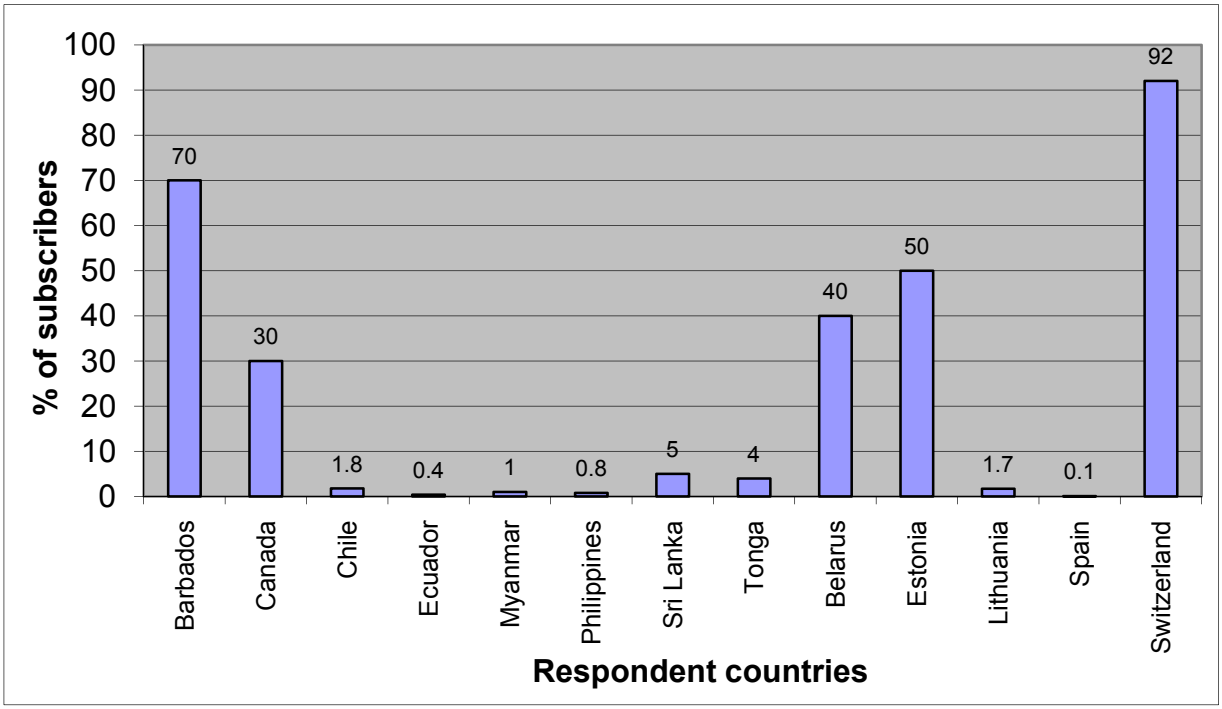


Figure 10 – Percentage of rural telephone subscribers with access to broadband technologies



Only six countries reported that there were gender barriers to broadband access, though the barriers they describe (given in Table 5 below) are also general barriers to the adoption of broad band.

Table 5 – Gender barriers to adoption of broadband

Country	Are there gender barriers to broadband access?	Description of barrier
Chad	YES	Lack of awareness and the cost of computer training
Guyana	YES	The issue of affordability arises. Due to Guyana's economic situation, residential customers in particular would have no choice but to utilize their resources on immediate essentials rather than access to luxuries such as broadband
Philippines	YES	Economical. The economic condition leads to market being price sensitive hence, DSL affordability becoming a barrier to broadband access. In the provincial areas market is very price sensitive
Sri Lanka	YES	Infrastructure facilities
Thailand	YES	
Bosnia	YES	Economical

Service pricing and usage

The service and pricing section of the questionnaire sought to establish average price for Internet dial up, average monthly price for broadband service (including Internet access) and whether or not operators offer unlimited usage plans as well as the most common usage/pricing plan for broadband services. Table 6 below, indicates the average prices for both dial up and broadband services on an ITU regional basis. As can be seen despite the variance in size and nature of the economies of those countries which respondent to the question there is a general convergence on the average price for Internet dial up accounts across ITU regions, however broadband prices show a marked variation between regions especially in terms of large bandwidth capacity based services.

Table 6 – Average prices for both dial up and broadband services on an ITU regional basis

Region	Average Price for Internet Dial Up access (USD per minute)	Average Price for Internet Dial Up access (USD per month)	Broadband average price (USD) per month	
			Between	In Excess and depending on the bit rate
Africa	0.03	24.08	1 011.17	19 731.96
Americas	0.02	19.69	177.36	496.28
Asia-Pacific	0.38	13.50	130.46	299.51
Arab States**	0.005	NA	64.52	189.76
Europe	0.02		227.21	364.78

** It should be noted that only two countries for the Arab States region, Eqypt and the United Arab Emirates provided pricing data and no data was provided for monthly dial up costs.

Intra-regional variations in pricing models are also common. In the case of Europe the high estimated average monthly costs of broadband access in Armenia (1 000)*[125] and Belarus (1 200) raised the average broadband price dramatically, without their inclusion the average service price in Europe for broadband services was just USD 146.98. This figure is in stark contrast to Africa's average pricing of USD 1011.17 that is also driven to a higher overall average rate as a result of Ethiopia's higher than average broadband access cost of USD 3 780 per month.

Given that only two Arab State countries answered the question, the figures are possibly misleading for the region as a whole and should certainly not be taken as illustrative of the broadband situation in the Arab States overall.

Further while dial up access is standardized means of Internet access –broadband access includes a variety of technologies ranging from ISDN through to ADSL and dedicated fibre, with ISDN and ADSL or cable typically forming the lower average cost of broadband access and dedicated fibre the basis for high end service pricing.

Unlimited usage plans offered by operators did not show a marked regional bias but rather were governed by the domestic situation facing individual operators. Of the 49 countries that responded to the question, only nine countries did not offer some form of unlimited usage plan, these are:

Chad, Ethiopia, Costa Rica, Dominican Rep., Israel, Maldives, Philippines, Egypt, Bosnia.

Table 7 below describes the most common usage-pricing plans for broadband on an ITU regional basis:

[125] Armenia's figure for excess cost of USD 20 000 was left from the table and is due for verification. If the figure was included then excess costs for Europe would be USD 2 419.80 per month.

Table 7 – Common Usage pricing models

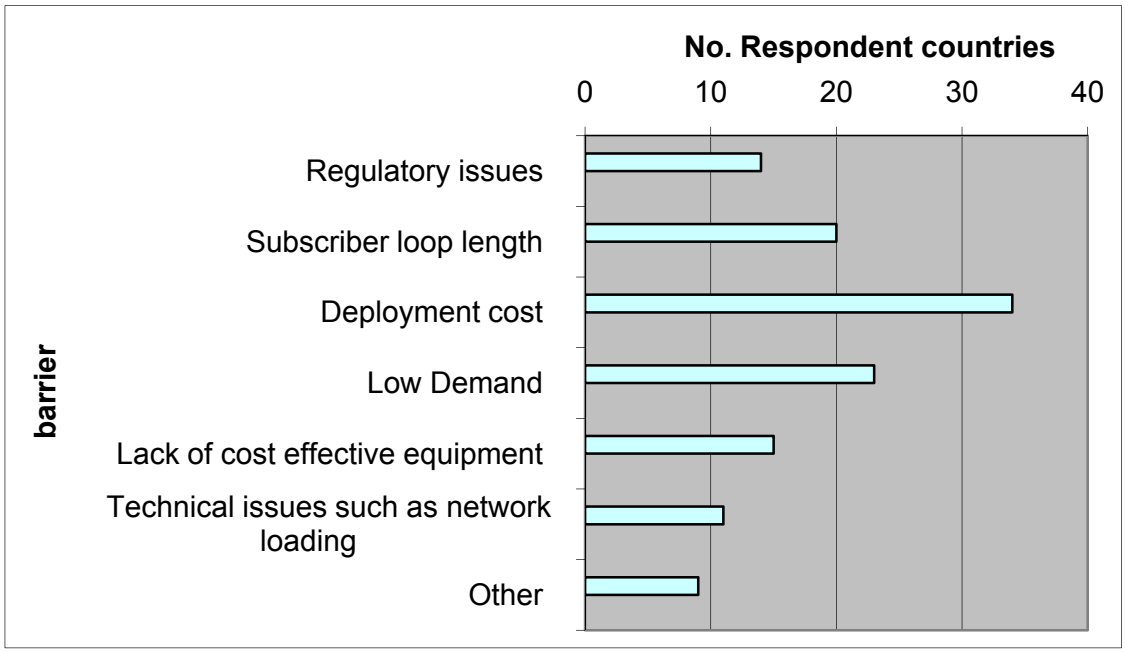
Région	Common Usage pricing plan
Africa	Common usage-pricing plans reported by the African respondents included: 1. Time, bandwidth and distance consideration 2. Flat rate, monthly rental, for given bandwidth 3. Per data unit (price per gigabit of transfer capacity).
Americas	In the America's region most models were based on the concept of unlimited access at a fixed rate such as 64 or 128 kbit/s for a fixed monthly fee. Where available ASDL is also offered on this model for a fixed monthly fee. In some countries a fixed monthly price plan is established with bandwidth usage limited to a set transfer threshold, for instance data transfer up to 10/15 Gigabytes, if data transfer exceeds this agreed limit then excess charges are then applied.
Arab States	In the case of Egypt, a fixed fee per minute is charged for access. In the case of the United Arab Emirates a fixed fee per month was charged and differed if the charge was for residential or business connection
Asia	Pricing plans varied including: Fixed dial up access costs based price per minute but packaged and presented as a combination of paid hours and with X number of additional bonus free hours. Other models include monthly fixed fees linked with specified data transfer limits (e.g. 1 GB per month). If the data transfer rate is exceeded than an excess charge is applied. Another model (where available) employs a monthly fixed fee for unlimited access e.g. ADSL based access. Where this model was operational but customer bandwidth requirements exceeded those offered via ADSL, the speed and nature of service requirement (e.g. E1/T1) would dictate the price of the agreement.
Europe	In Europe the most common usage plan is unlimited usage time with a flat fixed monthly payment This is used widely for DSL based connections. Following this are models for a monthly price plan with limited usage to a set threshold, for instance data transfer up to 10/15 Gigabytes with excess charges then being applied of traffic exceeding this threshold.

Barriers to Broadband Access Deployment

This section of the questionnaire sought to identify what are the major barriers to the deployment of broadband services, as well as thee the major cost issues limiting the spread of broadband, the financial (if any) assistance and the difficulties in raising finances for broadband build out facing operators.

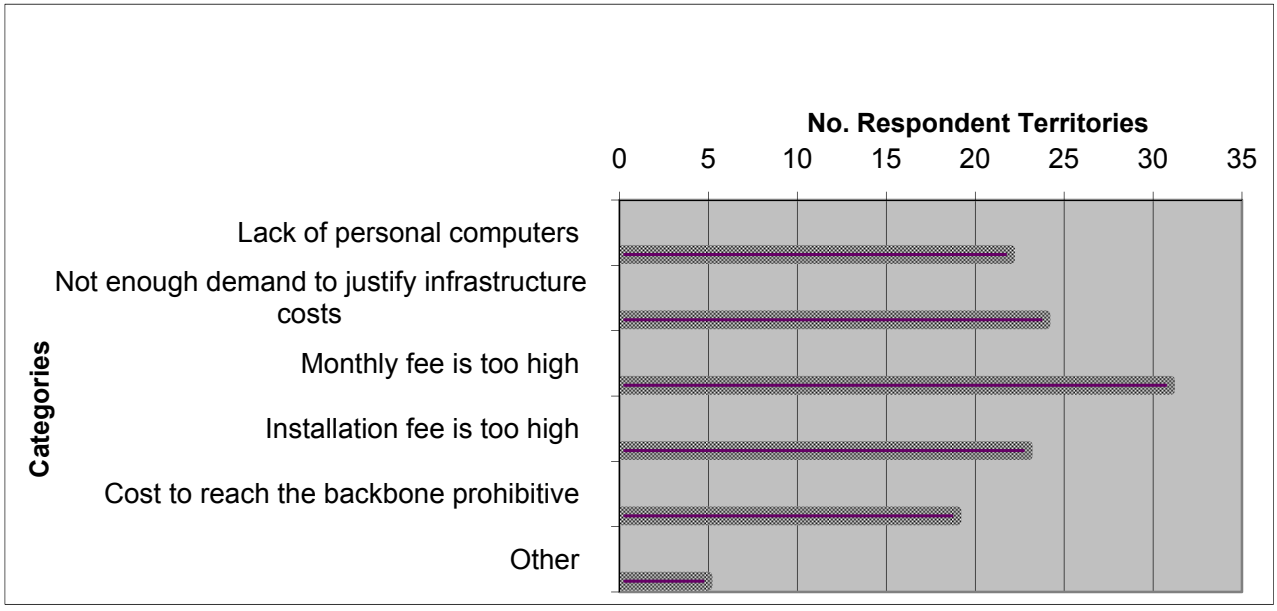
Figure 11, below, shows the major barrier to widely deploying broadband services, is the deployment cost of technologies.

Figure 11 – Major barriers to broadband access deployment



In addition to deployment costs, lack of demand for broadband services seemingly undermines any business case for investigating means to reduce deployments costs and overcome problems such as the subscriber loop length – which is a technical hurdle for the introduction of technologies such as DSL. Of the issues limiting the spread of broadband identified by respondents, the most common was that the monthly associated fee was too high as indicated in Figure 12.

Figure 12 – Major cost issues limiting the spread of broadband



High monthly fees, high installation costs and lack of access to personal computers when combined can result in insufficient demand to justify infrastructure costs and make the business case for deploying broadband services more difficult. Other reasons identified include relatively low levels of education and computer literacy and the respondent from Malta identified the cost of acquiring content in local languages.

Some thirty one countries did not have any form of loans or other financial assistance available to enable operators to provide broad band to the last mile and these are listed in Table 8:

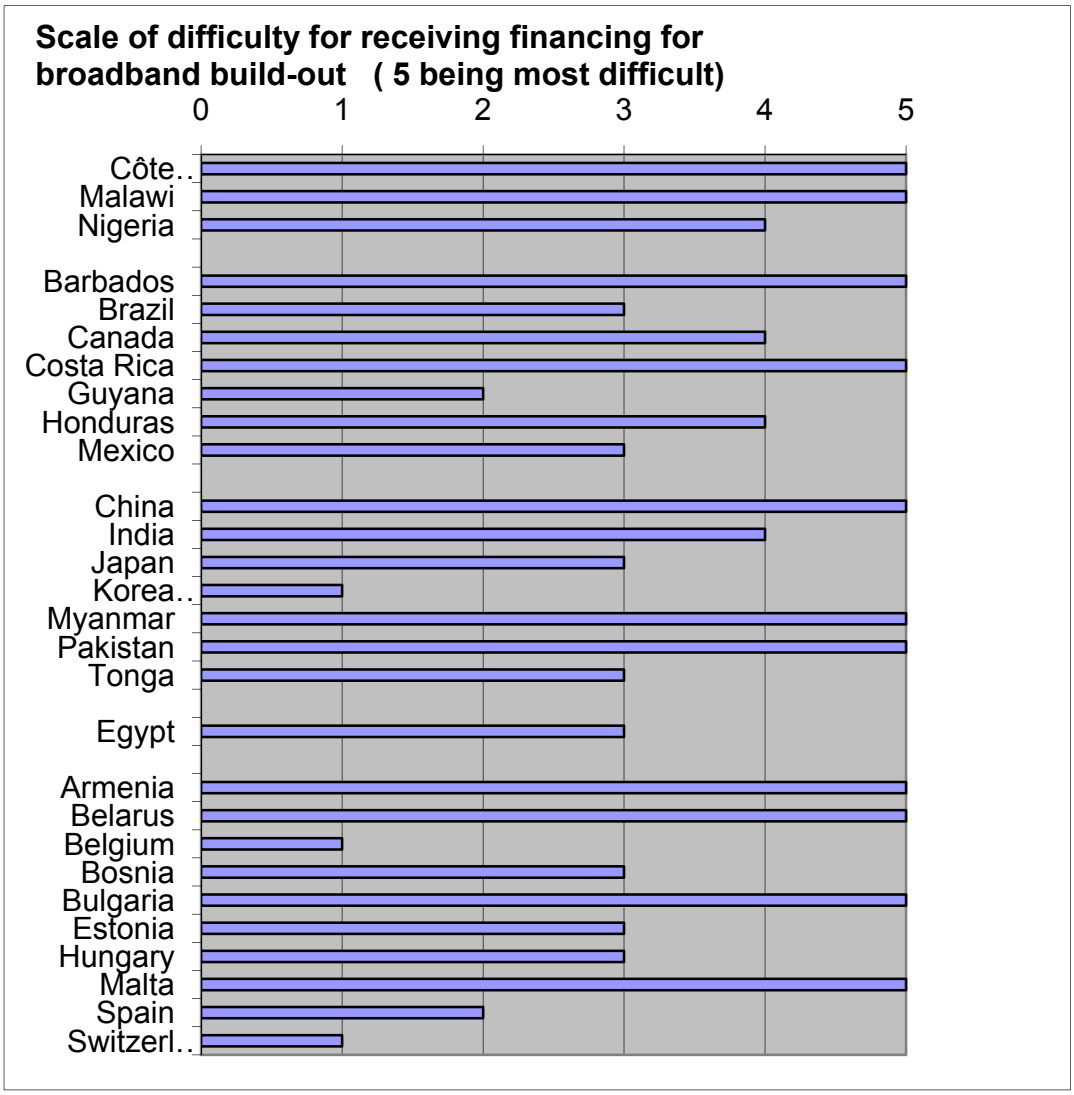
Table 8 – Countries without loans or financial assistance for the deployment of broadband services

Africa	Americas	Arab States	Asia	Europe
Chad	Barbados		China	Armenia
Côte d'Ivoire	Brazil		Israel	Belarus
Ethiopia	Chile		Korea (Rep.)	Belgium
Malawi	Costa Rica		Maldives	Bulgaria
Mauritius	Ecuador		Myanmar	Estonia
South Africa	Guyana		Nepal	Lithuania
	Honduras		Pakistan	Norway
			Sri Lanka	Poland
				Spain
				Switzerland

While 12 countries offered loans and other forms of financial assistance to encourage the expansion of broadband services including: Nigeria, Uganda, Canada, Dominican Rep., Mexico, India, Japan, Tonga, Egypt, Bosnia, Denmark, Hungary; how these loans are facilitated differs widely from country to country. Canada and Mexico, Japan and Egypt all offer government based loans for broadband development schemes. In Uganda offers only private loans are available to operators, where as in Nigeria loans for operators are available as a result of UNDP and WorldBank programmes in addition to private lenders. In Denmark incentives take the form of tax exemptions for data communication related developments and in Hungary corporate tax reductions and direct state subsidies are available for developing broadband-based services. Some developing countries also qualify for international aid – such as loans and grants from USAID.

The difficulties facing operators in raising financing for broadband build-out is illustrated in the following graph – where questionnaire respondents rated the difficulties in raising finance on a scale of one to five with five being the most difficult. Unsurprisingly those countries with large rural areas, and dispersed rural populations are among those that face the greatest difficulties in raising finances for broadband build-out.

Figure 13 – Scale of difficulty for financing broadband services



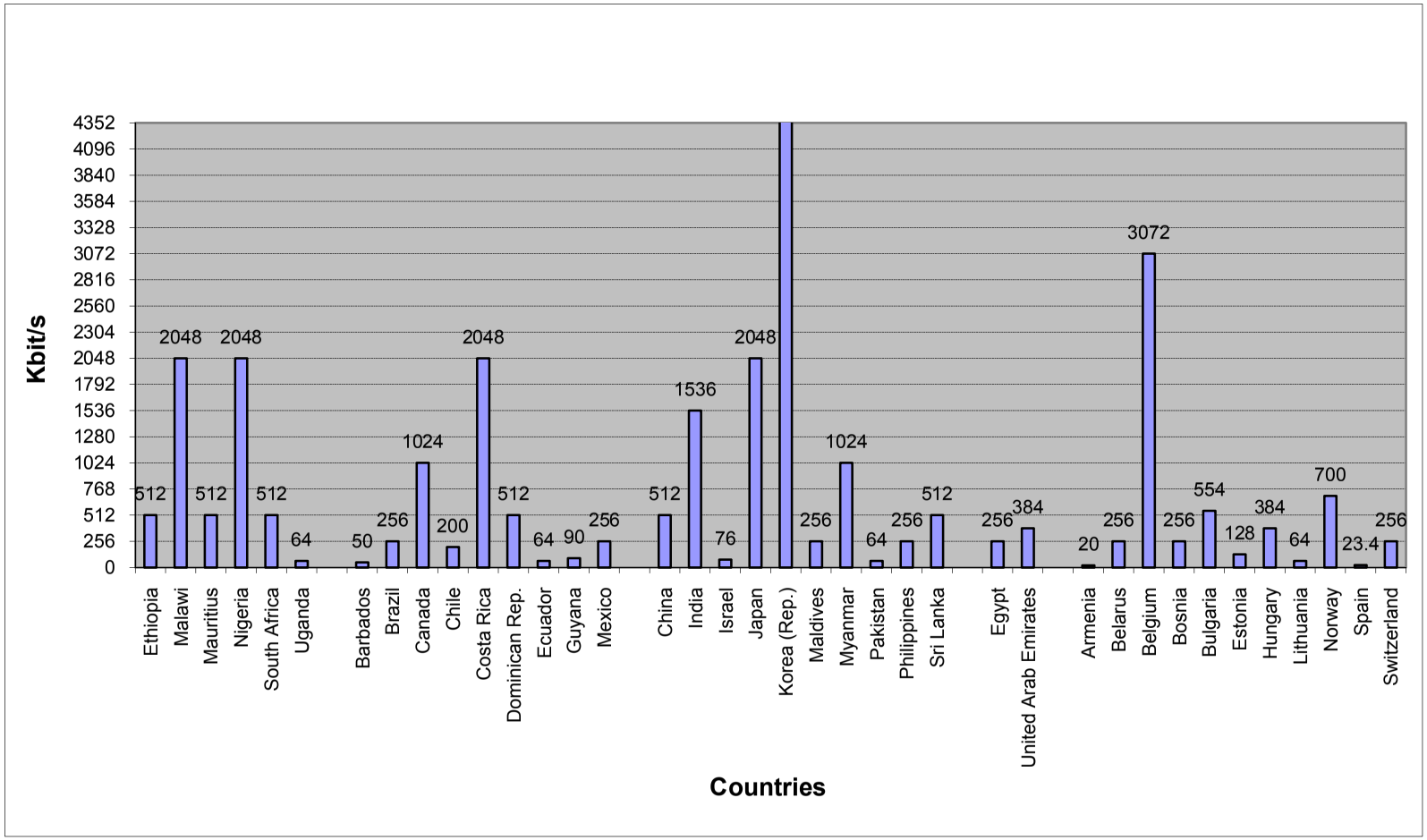
Quality of Service

In the questionnaire the quality of service section sought to establish the average speeds of downstream data for DSL, cable, wireless and other technologies employed to deliver broadband services. In most cases responses gave a range of speeds e.g. DSL may vary from 384 kbit/s downstream for residential and 512 for business. In some cases the reasons for the different capacities stated were not provided or were not clear given the mixed usage-pricing models that are used in differing countries. As a result the lowest average speed indicated was used for the graphs and purposes of comparisons. This means that in the case of some countries such as Japan the average downstream speed is shown as 2 Mbit/s rather than the 10 to 1 000 Mbit/s that is available over specialist fibre networks available to businesses. For the purposes of the graphs, the respondent countries are alphabetically grouped in terms of their ITU regional groupings of Africa, Americas, Arab States, Asia-Pacific and Europe.

In addition to DSL, cable and wireless a number of other technologies are used to deliver downstream broadband services. In Ethiopia the school-net, health-net, gov-net services and a DDN service that supports dedicated, and frame relay service connection for Internet access and enterprise wide LAN, etc offers speed up to 45 Mbit/s. In Barbados fixed wireless connections are used to deliver speeds of 128 kbit/s and a number of countries use satellite-based services – in Canada these offer access speeds of 500 kbit/s, while in

Myanmar broadband satellite (IPSTAR) offers connection speeds up to 1 218 kbit/s. In Estonia general packet radio services (GPRS) are used to deliver connection speeds of the 30 kbit/s. Finally fibre is used in a Japan (up to 100 Mbit/s for FFTH), 10 Mbit/s in Norway and 2 Mbit/s in Egypt. The following graphs illustrate the average downstream data for DSL, Cable and wireless based broadband services at an average distance of two to four kilometers**.**

Figure 14 – Average speed of downstream data for DSL



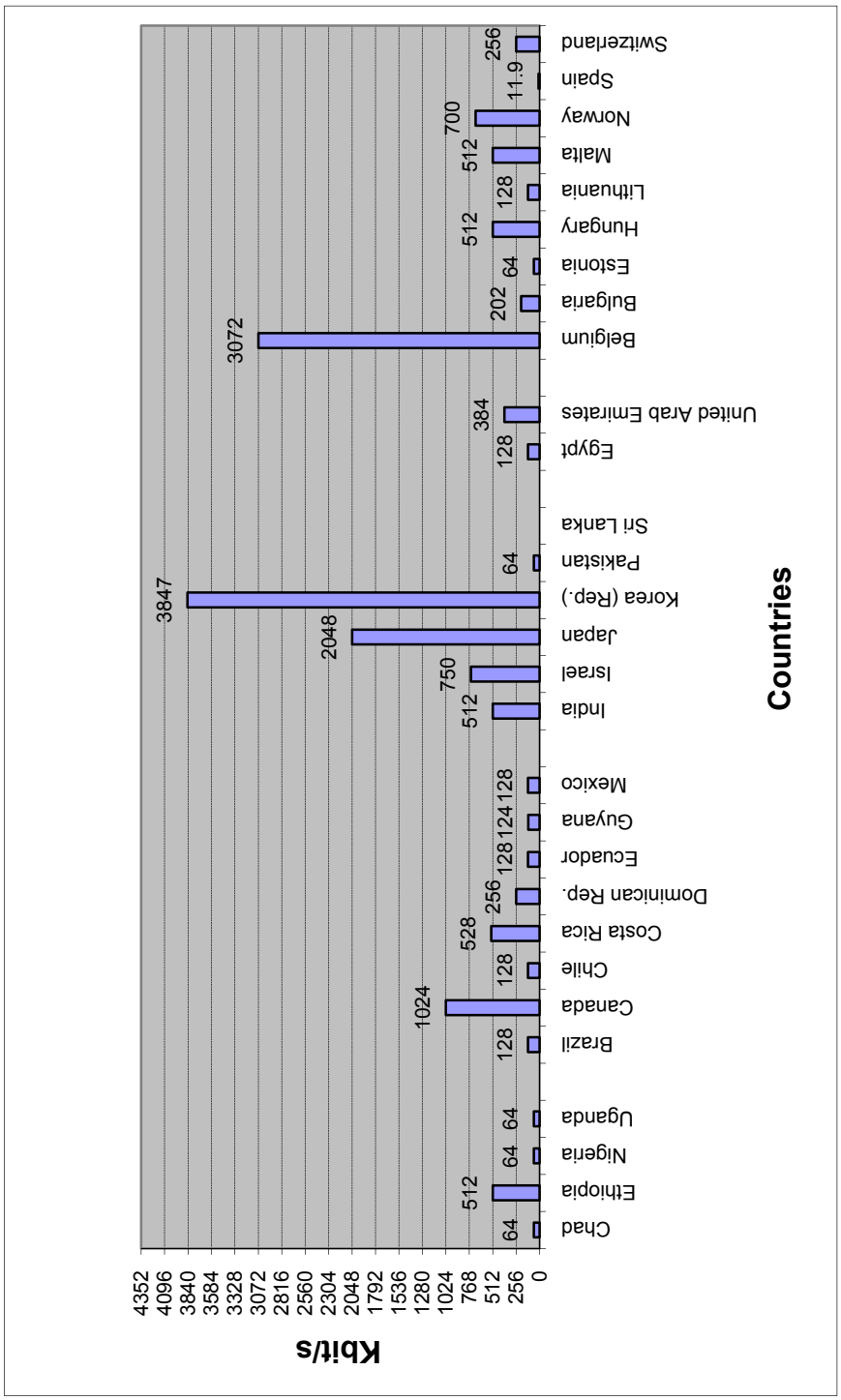


Figure 15 – Average speed of downstream data for Cable

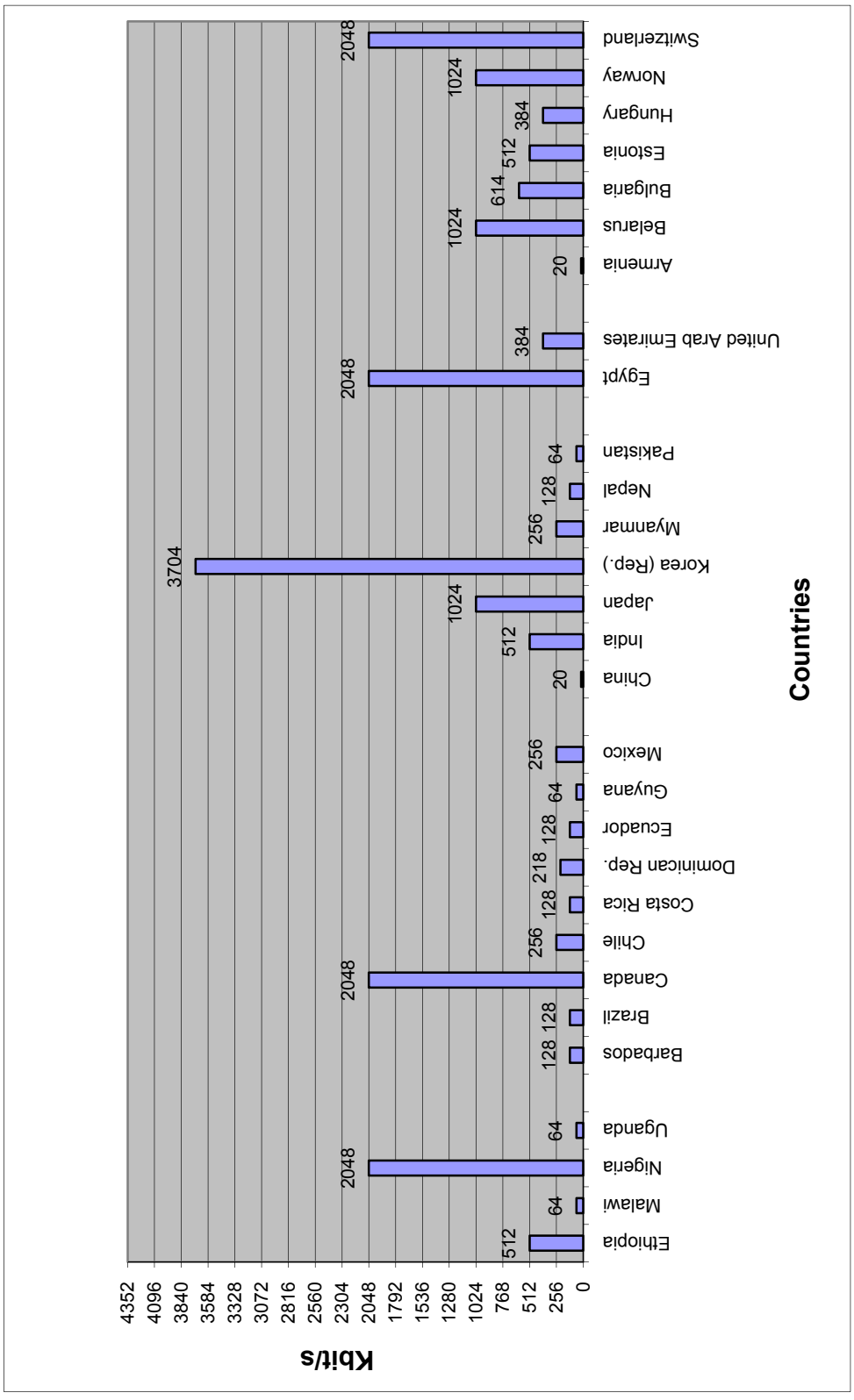


Figure 16 – Average speed of downstream data for wireless based services

Miscellaneous

The miscellaneous section of the questionnaire sought information on public access points to broadband services, fastest growing broadband technologies and those applications areas that broadband services are being used for. Seventeen respondent countries offered free access to broadband services through public centres such schools, libraries, hospitals, government office buildings and telecentres etc. These countries are:

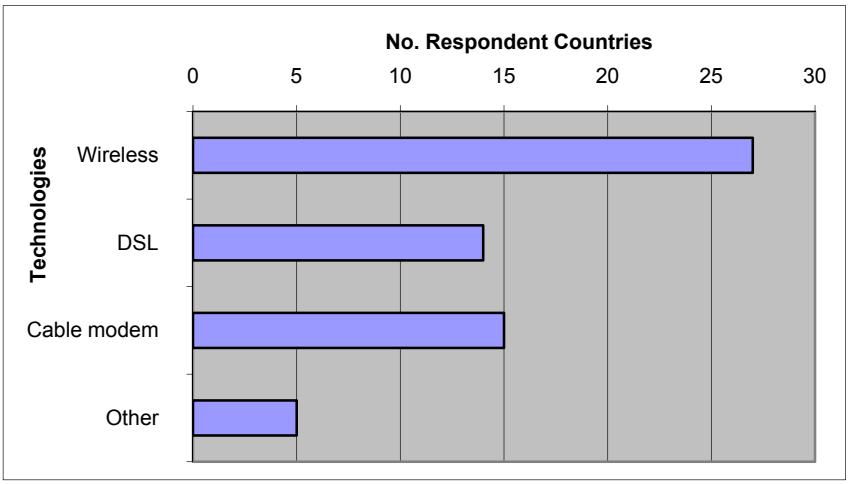
- Côte d'Ivoire
- Canada
- Chile
- Dominican Rep.
- Israel
- Japan
- Korea (Rep.)
- Myanmar
- Belgium
- Denmark
- Hungary
- Lithuania
- Malta
- Norway
- Poland
- Spain
- Switzerland

A further seven countries offered access to broadband services through public centres via a special pricing agreement, these were:

- Nigeria
- Uganda
- China
- Maldives
- Thailand
- Tonga
- Belarus

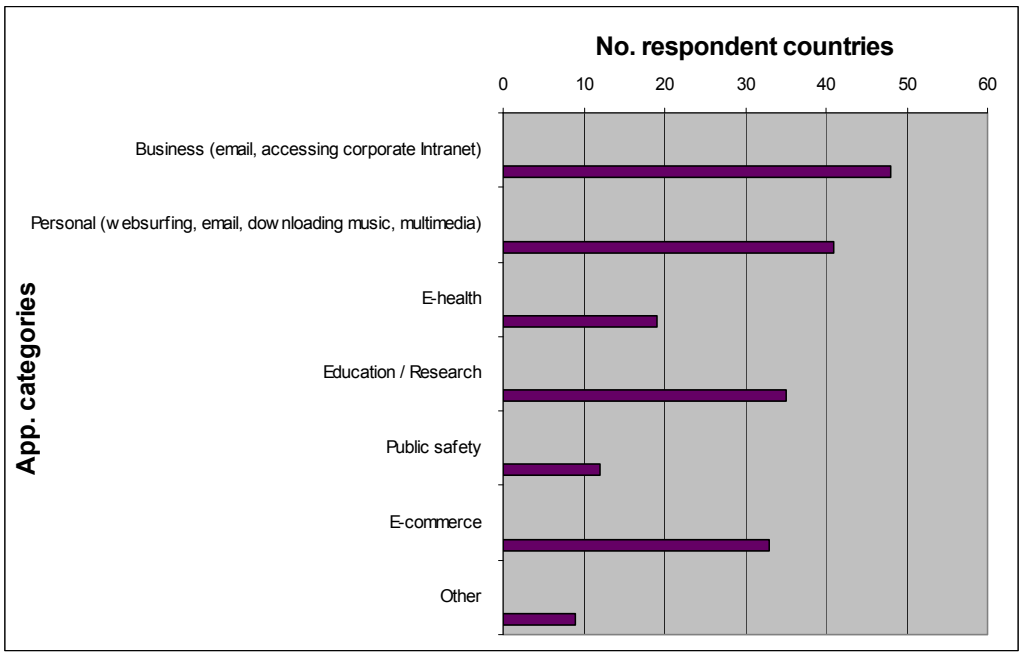
Finally Guyana, Sri Lanka, Armenia and Estonia offered access to broadband services through public centres but at standard market prices. The fastest growing broadband technology identified by respondents (as shown in the following graph) was wireless. A number of countries such as Belarus, Estonia, Ethiopia and the Philippines selected more than technology and reflects their current marketplace, in that no one technology has reached a dominant market position or serves diverse needs.

Figure 17 – Fastest growing broadband technologies



Broadband-based services are used in a number of application areas, with the main drivers being business (for accessing email, corporate intranets etc) and personal information access (web browsing, downloading music and multimedia etc). When examining the regional basis for these applications – the proportions are roughly the same business use is the primary driver in both developed and developing countries, while personal use is also a major driver for broadband services in both developed and developing countries. The respondent countries that were exceptions to this were Malawi, Guyana, Honduras, Nepal, Thailand, Armenia, Bosnia where business applications were the sole main application driver.

Figure 18 – Application categories that broadband is used for



In Nigeria, Canada, and Demark E- government services were identified as other application areas for broadband services; Whilst Japan and Korea both mentioned IP telephony applications being used and Korea also identified both games and video on demand as the basis for entertainment applications.

ANNEX VI

Broadband Questionnaire

DEADLINE FOR THE REPLIES: **30 May 2003**

Given Name

Family Name

Your Title

Organization / Main activity

Telephone/Fax (with area code)

Country

City

Business Address

E-Mail

Any queries or requests for further information regarding this questionnaire should be addressed to:

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INTRODUCTION

Purpose

1) To assess the current status of broadband access technologies.

2) To analyse broadband access technologies including the following dimensions: demographics, gender, geographic, technical and economic factors; market structures for delivery of broadband access service.

Output expected from the replies

The central output will consist of conclusions drawn from the data collected to include in the final report to assist ITU-D Members with the development of broadband access technologies. This research will generate information on the technical, economic and development factors having an impact on the deployment of broadband access technologies in developing countries. At the end of the study period, a final and complete report will be created on *Broadband Access Technologies*. The present questionnaire is designed to provide extensive, consistent background data for the overall study, to be complemented, as necessary, in the yearly work plans.

Technology

What wireline technologies are utilized to provide broadband services:

____ DSL

____ Cable

____ E1/T1

____ Fibre

____ Power Line

____ Other (please describe)

What wireless technologies are utilized to provide broadband services?

____ Satellite

____ IMT-2000

____ Wireless local area network

____ Fixed wireless access

____ Other (please describe)

Competition

Is competition permitted in Internet services? (YES/ NO)

Is there competition in the local loop? (YES/ NO)

Is there competition among differing broadband technologies? (ex. DSL, cable, broadband wireless)

(YES / NO)

How many operators offer high-speed Internet service? _____

Percentage of operators offering DSL broadband service _____

Percentage of operators offering cable modem broadband service _____

Percentage of operators offering wireless broadband service _____

Percentage of operators offering other broadband service _____

Access

Approximately what percentage of households have access to broadband access technologies in general? _____

Percentage of households with access to DSL broadband service _____

Percentage of households with access to cable modem broadband service _____

Percentage of households with access to wireless broadband services _____

Approximately what percentage of businesses have access to broadband access technologies in general? _____

Percentage of businesses with access to DSL broadband service_____

Percentage of businesses with access to cable modem broadband service_____

Percentage of businesses with access to wireless broadband services _____

What percentage of rural telephone subscribers have access to broadband technologies? _____

Are there any gender barriers to broadband access (i.e. political, economic, social, etc.)? (YES/NO)

If so, please describe.

Pricing and Usage

What is the average price[126] for Internet dial up access (please specify per time unit or data unit)? _____

What is the average monthly price for broadband service (including Internet access)?

between 64-500 kbit/s _____

in excess of 500 kbit/s _____

Do operators offer unlimited usage plans? (YES/NO)?

Describe the most common usage/pricing plan for broadband. (Please specify per time unit or data unit)

Barriers to Broadband Access Deployment

What are the major barriers to the deployment of broadband service? (mark all that apply)

____Regulatory issues

____Subscriber loop length

____Deployment cost

____Low demand

____Lack of cost-effective equipment

____Technical issues such as network loading

____Other (please describe)

What are the major cost issues limiting the spread of broadband? (mark all that apply)

____Lack of personal computers

____Not enough demand to justify infrastructure costs

____Monthly fee is too high

____Installation fee is too high

---

[126] Preferably in US.

____Cost to reach the backbone prohibitive

____Other (please describe)

Are there affordable loans/other financial assistance for operators to provide broadband to last-mile customers? (YES/NO)

If yes, please describe (government, private, other organizations).

How difficult (scale of 1-5; 5 being the most difficult) is it to receive financing for broadband buildout?

Quality of Service

What are the average speeds of downstream data for DSL? _____

What are the average speeds of downstream data for cable broadband? _____

What are the average speeds of downstream data for wireless broadband service? _____

What are the average speeds of downstream data for other broadband services? (Please describe which service)? _____

Miscellaneous

1) Do public centres (schools, libraries, hospitals, government office building complexes, telecentres, etc) offer broadband service? (YES/NO)

   If yes, are the services generally free of charge? (YES/NO)

   If services are not free, is there a special price? (YES/NO)

2) Which broadband technology is growing the most quickly? (wireless, DSL, cable modem or other)

   For which applications is broadband service used? (mark all that apply)

   _____ Business (email, accessing corporate Intranet)

   _____ Personal (websurfing, email, downloading music, multimedia)

   _____ e-health

   _____ Education/research

   _____ Public safety

   _____ e-commerce

   _____ Other (please describe)

ANNEX VII

Other ITU Sector Relevant Study Groups, Questions and Recommendations

Listing of appropriate Questions and relevant Recommendations to be studied in other ITU sectors.

In ITU-T Study Group 9, which deals with integrated broadband cable networks and television and sound transmission. The following Questions and their relevant recommendations are to be followed:

Question 6/9 – Conditional access methods and practices for digital cable distribution to the home

Question 12/9 – Cable Television delivery of advanced multimedia digital services and applications that use Internet Protocols (IP) and/or packet-based data

Question 13/9 – Voice and Video IP Applications over cable television networks

In ITU-T Study Group 15 which covers optical and other transport networks, the following Questions and relevant associated

Recommendations will be covered:

Question 1/15 – Access network transport

This question maintains a comprehensive standards overview that is updated on a regular basis and can be found at the following website address: www.itu.int/ITU-T/studygroups/com15/lead.html

Question 2/15 – Optical systems for access networks

In ITU-T Study Group 16, which is the lead group on multimedia services, systems and terminals, the following Questions and relevant associated Recommendations will be covered:

Question C/16 – Multimedia applications and services

Question 2/16 – Multimedia over packet networks using H.323 Systems

In ITU-R Study Groups 4, 5 and 6, relevant questions and associated recommendations will be followed. Additional information on ITU-R terrestrial fixed and mobile wireless access information can be found at the following website: www.itu.int/ITU-R/study-groups/was/itu/index.html.

ANNEX VIII

Best Practice Guidelines for the Promotion of Low-Cost Broadband and Internet Connectivity

We, the regulators participating in the 2004 Global Symposium for Regulators, have identified and proposed best practice guidelines to achieve low-cost broadband and Internet connectivity. Our goal is the creation of national regulatory frameworks that are flexible and enable competition between various service providers using multiple transport and technology options. We believe the best practices outlined below will help bring social and economic benefits to the world's citizens.

An enabling regulatory regime that encourages broadband deployment and Internet connectivity

1) We encourage political support at the highest government levels with such support expressed in national or regional policy goals. These include an effective, separate regulator insulated from political interference, a transparent regulatory process, and adoption and enforcement of clear rules.

2) We believe that competition in as many areas of the value chain as possible provides the strongest basis for ensuring maximum innovation in products and prices and for driving efficiency.

3) We encourage regulators to set policies to stimulate competition among various technologies and industry segments that will lead to the development and deployment of broadband capacity. This includes addressing barriers or bottlenecks that may exist with regard to access to essential facilities on a non-discriminatory basis.

4) We believe that the primary objective of regulation should be to secure fair and reasonable access for competitive broadband services, including Internet connectivity.

5) We encourage the maintenance of transparent, non-discriminatory market policies in order to attract investment.

6) We encourage regulators to adopt policies that are technology neutral and do not favor one technology over another.

7) We encourage regulators to take into consideration the convergence of platforms and services and that they regularly reassess regulatory regimes to ensure consistency and to eliminate unfair market advantages or unnecessary regulatory burdens.

8) We encourage regulators to allocate adequate spectrum to facilitate the use of modern, cost effective broadband radiocommunications technologies. We further encourage innovative approaches to managing the spectrum resource such as the ability to share spectrum or allocating on a license-exempt non-interference basis.

9) We urge regulators to conduct periodic public consultations with stakeholders to inform the regulatory decision-making process.

10) We recommend that regulators carefully consider how to minimize licensing hurdles.

11) We encourage the development of a regulatory framework that permits ISPs and broadband providers to set up their own last mile.

12) We encourage regulators to provide a clear regulatory strategy for the private sector in order to reduce uncertainty and risk, and remove any disincentives to investment.

Innovative Regulatory Policies Must Be Developed To Promote Universal Access

1) We recommend that the promotion of access to low cost broadband interconnectivity should be integrated from "grass-roots" efforts to identify local needs all the way through the "tree-tops" of international law. Governments, business and non-governmental organizations should be involved.

2) We recommend that regulators adopt regulatory frameworks that support applications such as e-education and e-government.

3) We encourage each country to adopt policies to increase access to the Internet and broadband services based on their own market structure and that such policies reflect diversity in culture, language and social interests.

4) We encourage regulators to work with stakeholders to expand coverage and use of broadband through multi-stakeholder partnerships. In addition, complementary government initiatives that promote financially sustainable programs may also be appropriate, especially in filling in the market gap that may exist in some countries.

5) We encourage regulators to adopt regulatory regimes that facilitate the use of all transport mechanisms, whether wireline, power line, cable, wireless, including wi-fi, or satellite.

6) We encourage regulators to explore programs that encourage public access to broadband and Internet services to schools, libraries and other community centres.

7) We encourage regulators to implement harmonized spectrum allocations consistent with the outcome of ITU Radiocommunication Conference process and each country's national interest. Participation in this well-established framework will facilitate low-cost deployment of equipment internationally and promote low-cost broadband and Internet connectivity through economies of scale and competition among broadband vendors and service providers.

Broadband is an Enabler

1) Regulation should be directed at improving the long term interests of citizens. Broadband can contribute to this by improving and enabling education, information, and increased efficiency. It can reduce costs, overcome distance, open up markets, enhance understanding and create employment.

2) We encourage regulators to educate and inform consumers about the services that are available to them and how to utilize them so that the entire population benefits.

3) We urge regulators to work with other government entities, industry, consumer groups, and other stakeholders to ensure consumers have access to the information they need about broadband and Internet services.

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