The activities of ITU-BDT for Broadband Wireless Communications in Developing Countries

ITU/BDT Regional Seminar on Broadband Wireless Access (BWA) for rural and remote areas for Africa

Yaounde, 18-21 September 2006

R. Passerini, **ITU-BDT**

Summary

1)The digital divide problem

Table 5.1: Where the divides lie
Overview of the main forms of the digital divide affecting individuals and countries

For individuals	For countries
Socio-economic status	Development stage
Gender	Infrastructure
Age, life stage	Public policy
Language/ethnic status	Skills mix
Rural/urban location	Size of domestic market
Skills balance	Location relative to trading partners

Source: Adapted from *"How real is the Internet market in developing nations?"* by Madanmohan Rao, at http://www.isoc.org/oti.articles/0401/rao.html

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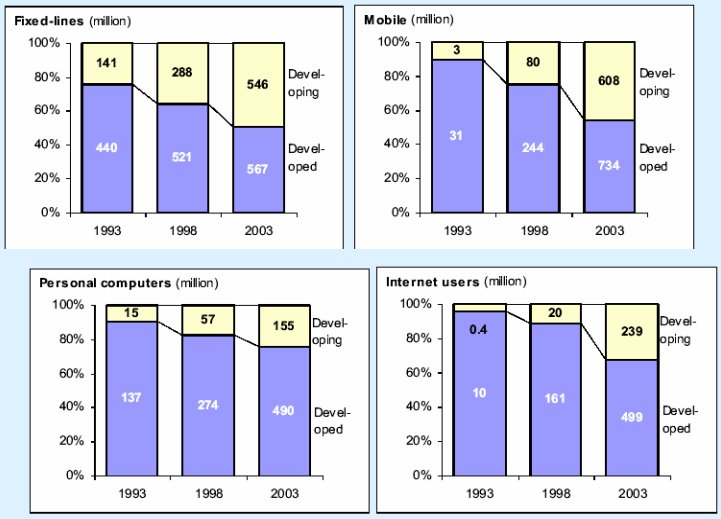
Figure 5.1: The shrinking digital divide
Percentage shares among developed and developing economies of fixed lines, mobile phones, personal computers and Internet users in 1993, 1998 and 2003



Source: ITU World Telecommunication Indicators Database

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The digital divide problem

In recent years, as information and communication technologies (ICT) have become the backbone of the global information economy, increasing attention has focused on the gap in access to ICTs between developed and developing countries.

This gap has come to be known as the **"digital divide":** it is multifaceted, with the gap in access to technologies affecting rural and remote populations, females, children, the elderly, those with health problems and disabilities, ethnic minorities, the illiterate and poorly educated and others both within and between nations.

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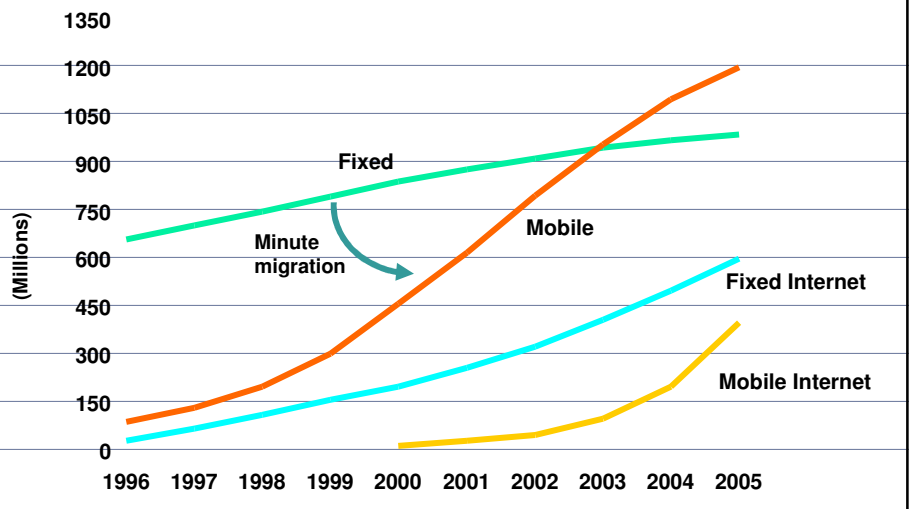
Subscriber Growth



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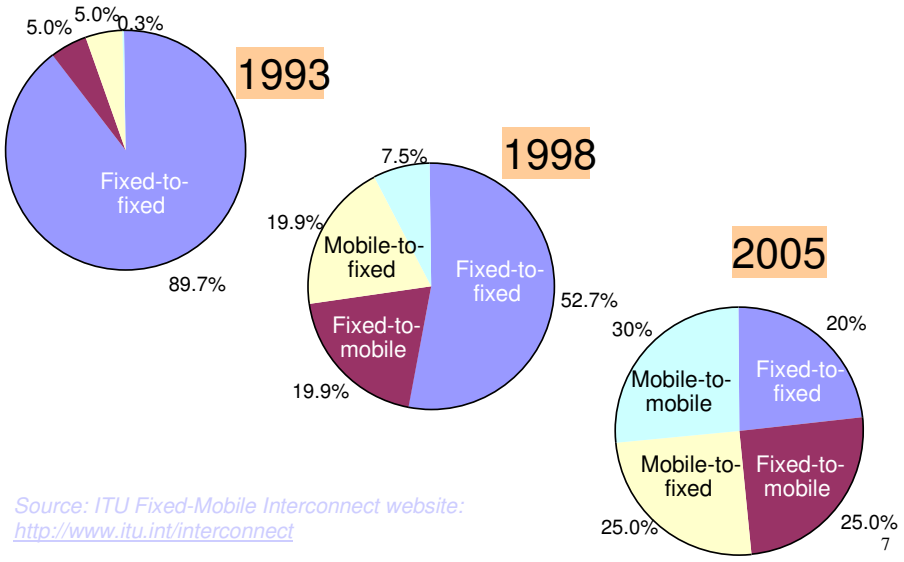
Calling opportunities worldwide



Source: ITU Fixed-Mobile Interconnect website: http://www.itu.int/interconnect

The digital divide problem

Notwithstanding the growth in mobile penetration, Broadband Wireless devices are a long way from being fully deployed in developed, **let alone developing areas of the world**.

Broadband Wireless could bring access to information and communication to huge numbers of the world's population who are currently without it.

Widening access to basic infrastructure should help to reduce the other forms of divide. **In this context, the Broadband Wireless should be seen for the future promise it holds especially in developing countries and in rural and remote areas of the developed world.**

Developed versus developing divides

Nevertheless, given that the developing world accounts for more than **80 per cent of global population**, there is still along way to go to reduce the divide. Even if national populations were growing at similar rates, and current ICT growth rates were sustained, it would take at least ten years for this gap to be reduced.

But in reality, **developing country populations are growing faster than developed ones,** and they have a much higher percentage of their population under the age of 15. In reality, therefore, it will take **much longer to bridge the digital divide**.

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Developed versus developing divides

Furthermore, given that more than a billion of the world's developing country population lives on less than USD 2 per day, well below the generally accepted minimum level of income needed for ownership and use of ICTs, it is likely that the fundamental nature of the divide will persist unless there is profound change in basic socio-economic conditions.

BROADBAND WIRELESS, TOOL FOR BRIDGING THE DIGITAL DIVIDE: It may help speed up this process, by making ICT access more affordable and easier to deploy.
The current shift from circuit-switched to IP-based networks, and from fixed-lines to wireless, associated with the development of the portable Internet, **is likely to have a Positive effect , especially given that mobile is overtaking fixed even more decisively in developing countries than in developed ones.**

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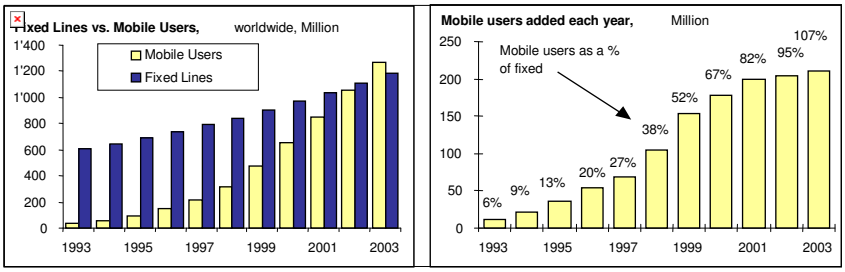
Deploying Wireless Broadband infrastructure

-Mobile Infrastructure

- Fixed Wireless Access (FWA) Infrastructure

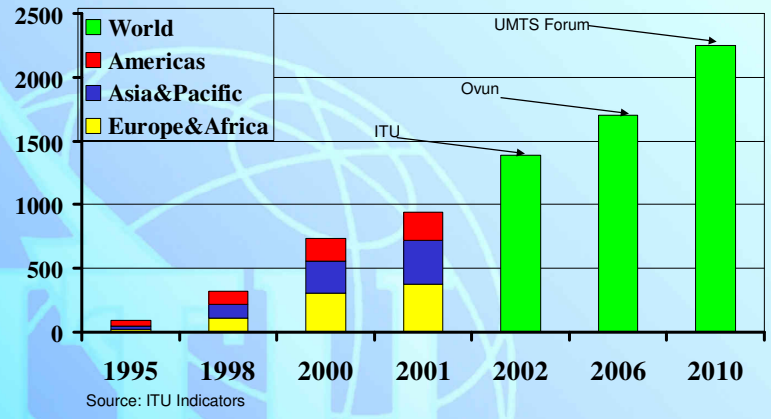
2) The growth of mobile cellular services

1993-1999 actual, with forecasts to 2003.



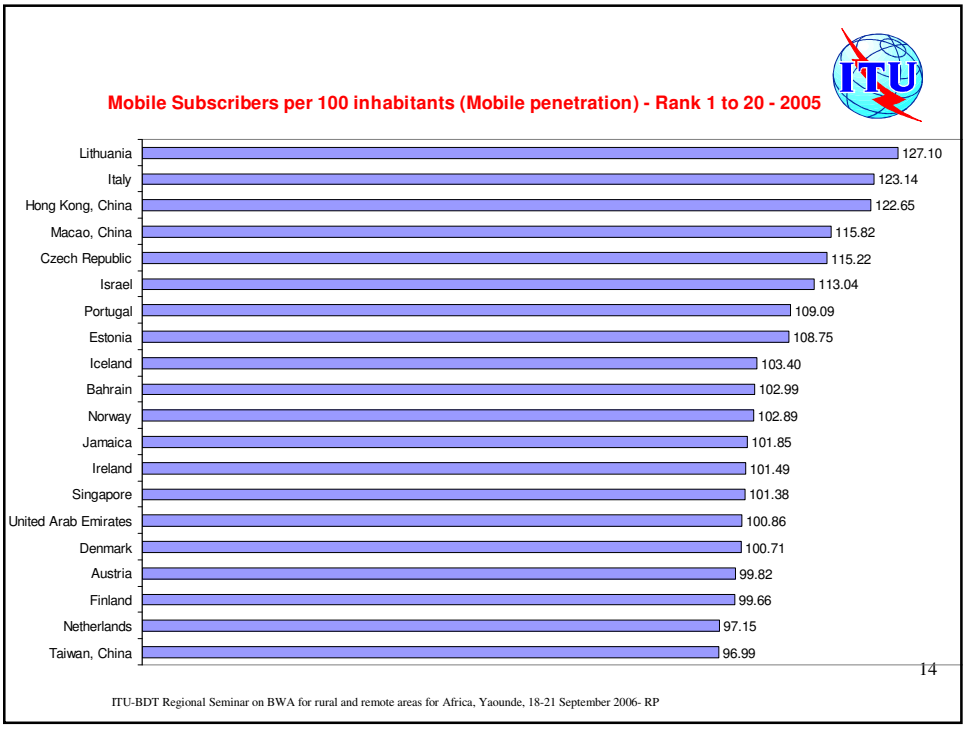
Source: ***ITU World Telecommunication Indicators Database and ITU forecasts in Trends in Telecommunications Reform, 2000 -2001: Interconnection Regulation .***

Trends – Mobile Growth (worldwide)

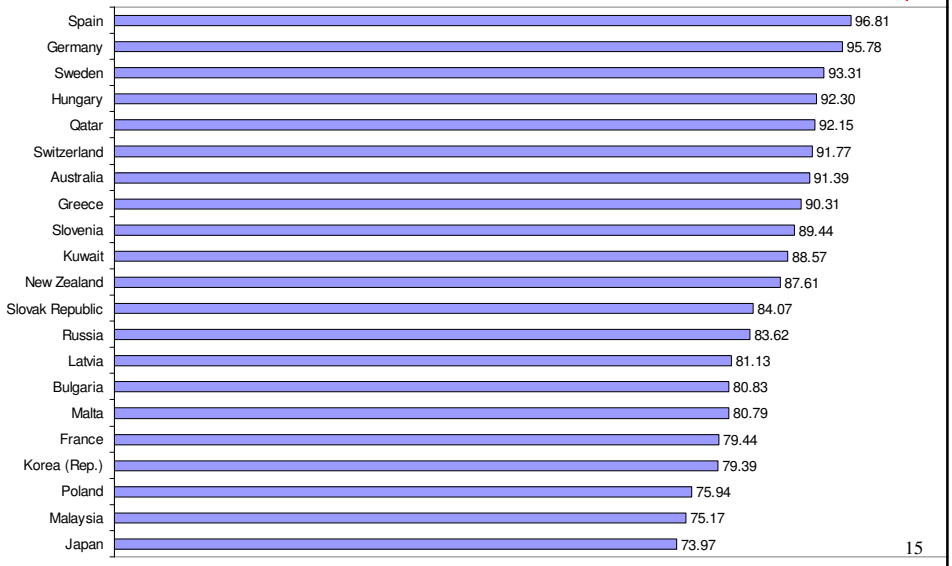


Source: ITU Indicators

Number of mobile subscribers already greater than fixed



Mobile subscribers per 100 inhabitants (Mobile penetration) - Rank 21 to 41 - 2005



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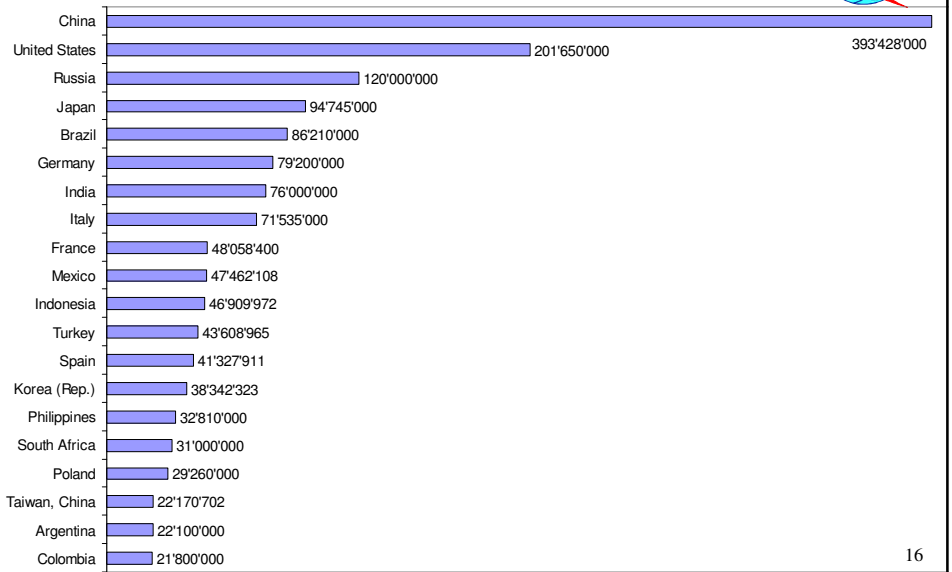
Total mobile subscribers 2005



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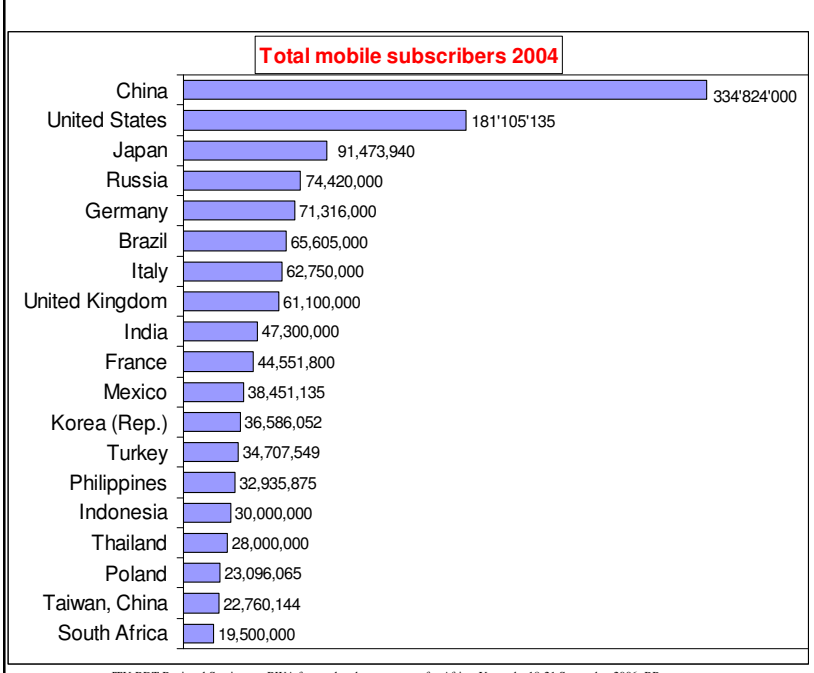

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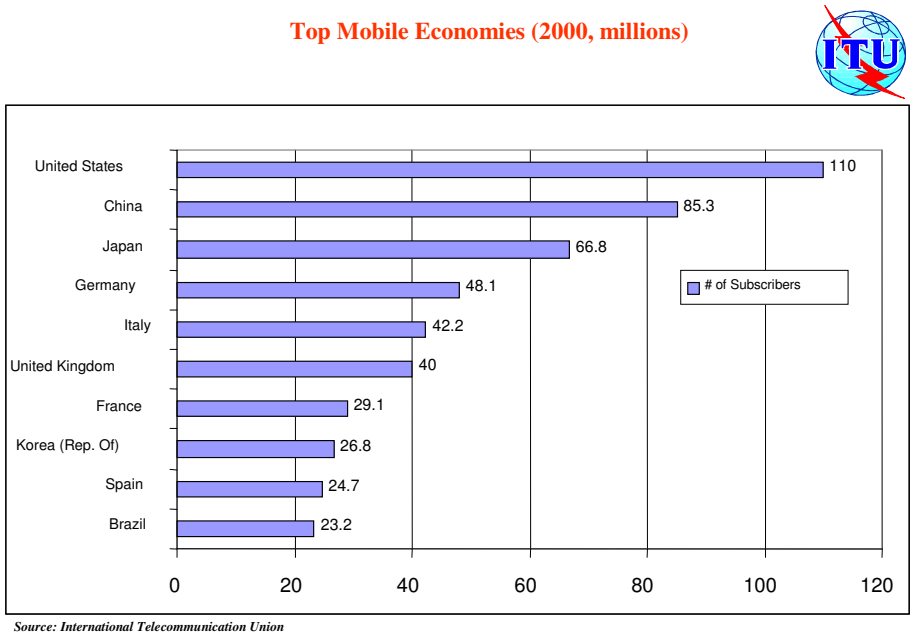

Source: International Telecommunication Union

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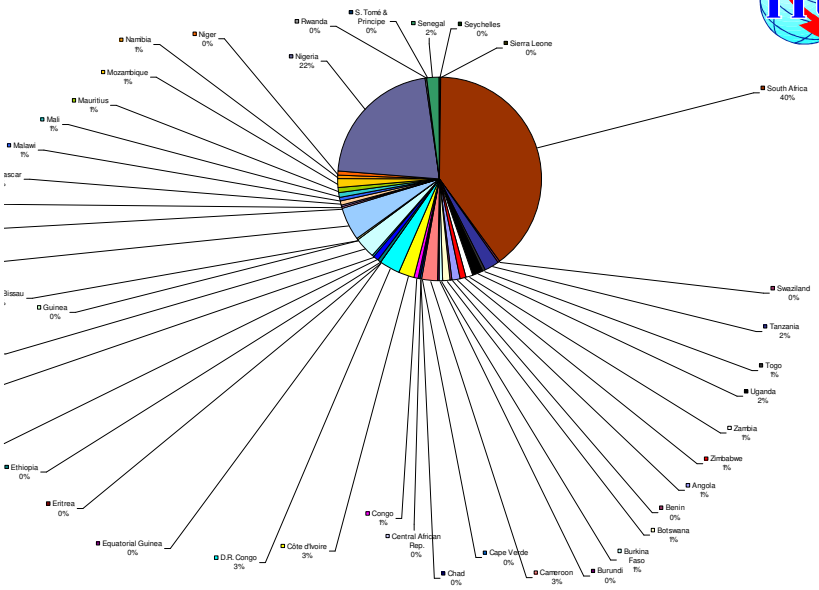
Cellular subscribers - Africa Region (2005)



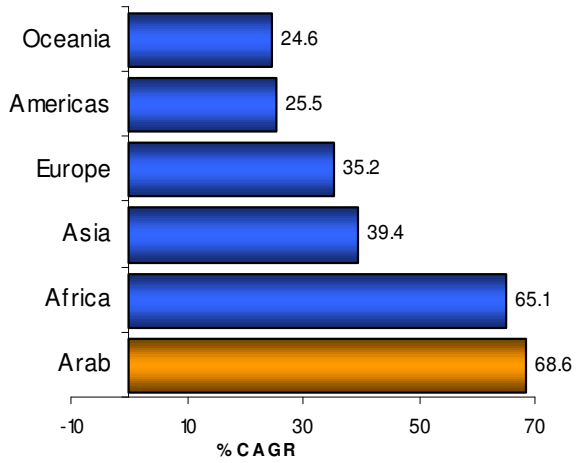
African Countries: Mobile Cellular Subscribers 2005 (Source: ITU)

		(k) 2000	*(k)* 2005	*CAGR (%)* 2000-05	*Per 100 inhabitants* 2005	*As % of total telephone subscribers* 2005
1	Angola	25.8	1'094.1	111.6	6.86	92.1
2	Benin	55.5	386.7	62.5	5.33	-
3	Botswana	200.0	823.1	32.7	46.63	86.2
4	Burkina Faso	25.2	572.2	86.7	4.33	85.5
5	Burundi	16.3	153.0	56.5	2.03	-
6	Cameroon	103.3	2'259.0	85.3	13.84	-
7	Cape Verde	19.7	81.7	32.9	16.12	53.4
8	Central Afr. Rep.	5.0	60.0	86.4	1.53	85.7
9	Chad	5.5	210.0	107.2	2.15	-
10	Congo	70.0	490.0	47.6	12.25	-
11	Côte d'Ivoire	473.0	2'190.0	35.9	12.06	-
12	D.R. Congo	15.0	2'746.0	183.5	4.77	99.6
13	Equatorial Guinea	5.0	96.9	80.9	19.26	90.6
14	Eritrea	-	40.4	-	0.92	51.7
15	Ethiopia	17.8	410.6	87.4	0.53	40.2
16	Gabon	120.0	649.8	40.2	46.95	94.3
17	Gambia	5.6	247.5	113.3	16.31	84.9
18	Ghana	130.0	2'842.4	85.3	12.85	89.8
19	Guinea	42.1	189.0	35.0	2.36	-
20	Guinea-Bissau	-	67.0	-	5.01	-
21	Kenya	127.4	4'612.0	105.0	13.46	94.2
22	Lesotho	21.6	245.1	62.5	13.65	83.6

African Countries: Mobile Cellular Subscribers 2005 (Source: ITU)

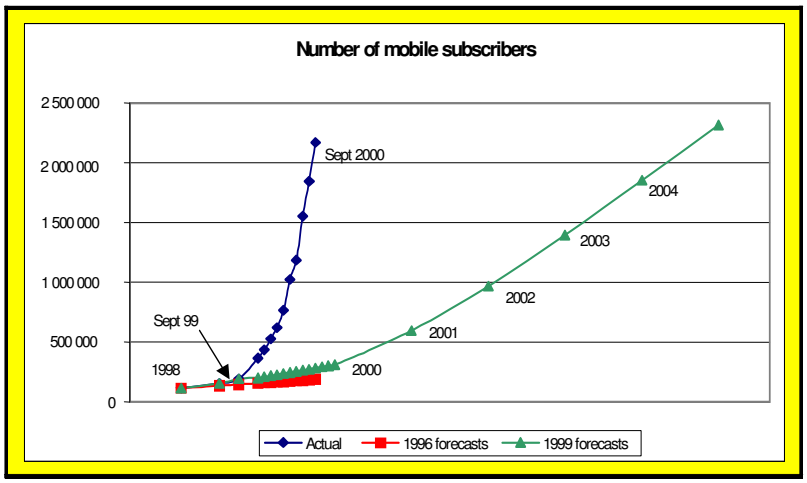
		(k) 2000	*(k)* 2005	*CAGR (%)* 2000-05	*Per 100 inhabitants* 2005	*As % of total telephone subscribers* 2005
23	Liberia	1.5	160.0	154.5	4.87	-
24	Madagascar	63.1	504.7	51.6	2.71	88.3
25	Malawi	49.0	429.3	54.4	3.33	80.7
26	Mali	10.4	869.6	142.4	7.66	92.1
27	Mauritius	180.0	713.3	31.7	57.29	66.5
28	Mozambique	51.1	1'220.0	88.6	6.16	-
29	Namibia	82.0	495.0	43.3	24.37	-
30	Niger	2.1	299.9	170.9	2.15	92.6
31	Nigeria	30.0	18'587.0	261.8	14.13	93.8
32	Rwanda	39.0	290.0	49.4	3.21	-
33	S. Tomé & Principe	-	12.0	-	7.67	-
34	Senegal	250.3	1'730.1	47.2	14.84	86.6
35	Seychelles	26.0	57.0	17.0	70.68	72.7
36	Sierra Leone	11.9	113.2	111.7	2.21	-
37	South Africa	8'339.0	33'960.0	32.4	71.60	87.8
38	Swaziland	33.0	200.0	43.4	19.36	85.1
39	Tanzania	110.5	1'942.0	104.7	5.16	92.9
40	Togo	50.0	443.6	54.7	7.22	88.3
41	Uganda	126.9	1'525.1	64.4	5.29	93.8
42	Zambia	98.9	946.6	57.1	8.11	90.9
43	Zimbabwe	266.4	699.0	21.3	5.87	68.1

Regional Mobile Growth: Compound Annual Growth Rate (CAGR) in mobile subscribers (%), 1998- 2003



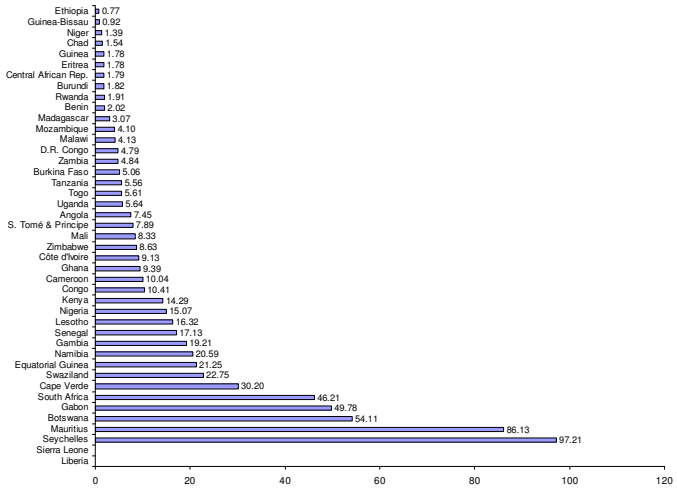
CAGR: Compound Annual Growth Rate. The year over year growth rate applied to an investment or other part of a company's activities over a multiple-year period. The formula for calculating CAGR is (Current Value/Base Value)^(1/# of years) - 1.

Growth of Moroccan mobile subscribers

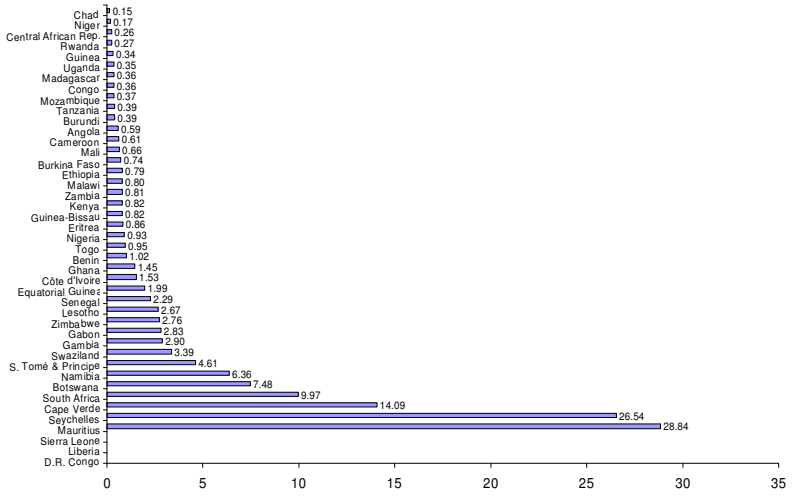


Source: ITU Effective Regulation: Moroccan Case Study.

Total telephone subscribers (fixed and mobile) per 100 inhabitants for Africa Region (2005)



Main Telephone Lines (Fixed) per 100 inhabitants - Africa Region (2005)



Mobile Market in the Middle East

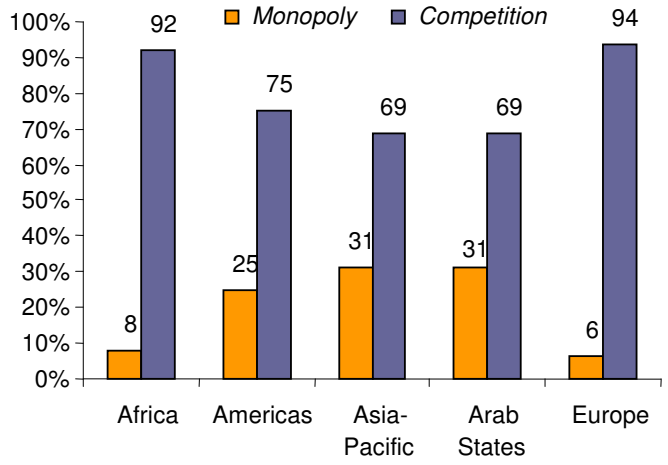
Middle East represents approximately 2% of the global mobile market and a Rapid growth is forecast for the region with a wide range of different market conditions

There is generally a higher mobile than fixed penetration in most countries and with the wide acceptance of pre-paid mobile services this trend is rapidly increasing. However, internet penetration levels are quite low, except in the wealthier states such as Bahrain, Kuwait and UAE, and so the development of mobile data services in most countries will be quite slow, and therefore voice services will be the primary source of operator revenue for many years.

A number of the countries with low mobile penetration levels have recently awarded a second mobile operator license, e.g. Saudi Arabia and Oman, or are planning to license a second operator, e.g. Iran, which will clearly result in a rapid increase in mobile users in these countries. Oman currently has a mobile penetration of over 25% and Oman Mobile offers GSM/GPRS services throughout Oman. A second GSM operator (Nawras) started service on March 16th 2005.

Operators in both Bahrain and UAE have recently launched UMTS (IMT-DS), and Multi-media Messaging Services (MMS), based largely on GPRS and eventually also on EDGE, are available in a number of Middle Eastern countries.

Competition Cellular mobile services



Source: ITU World Telecommunication Regulatory Database.

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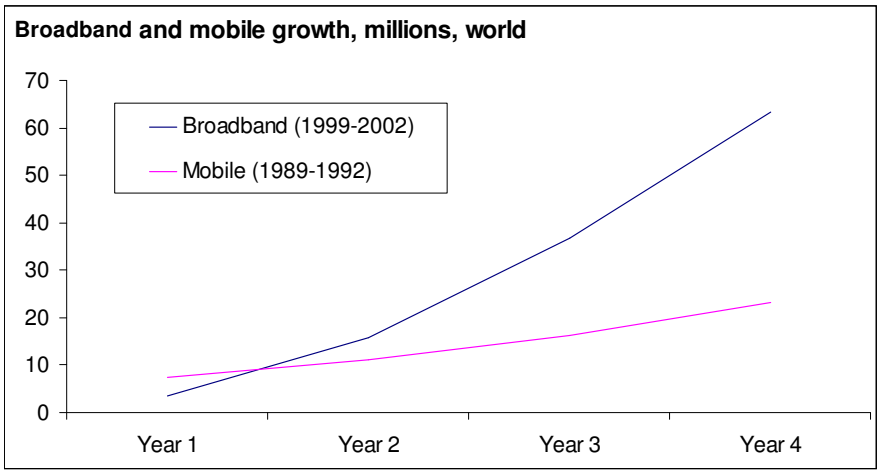
3) Growth of broadband



Source: ITU World Telecommunication Indicators Database

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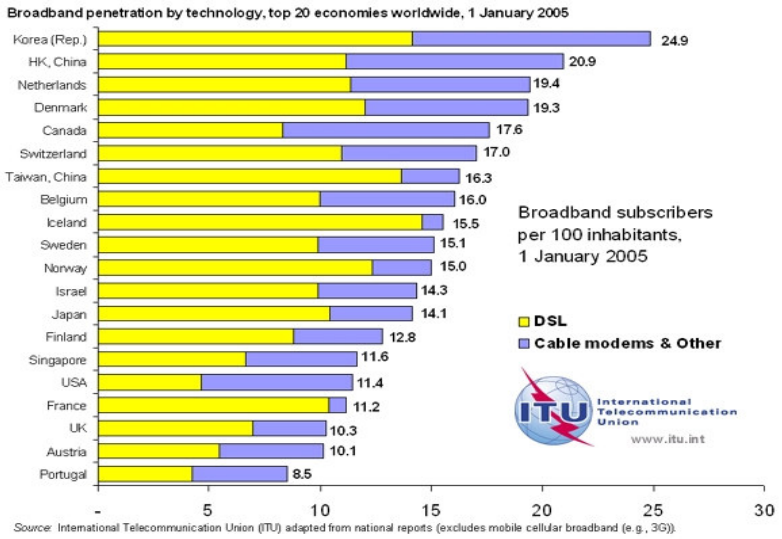
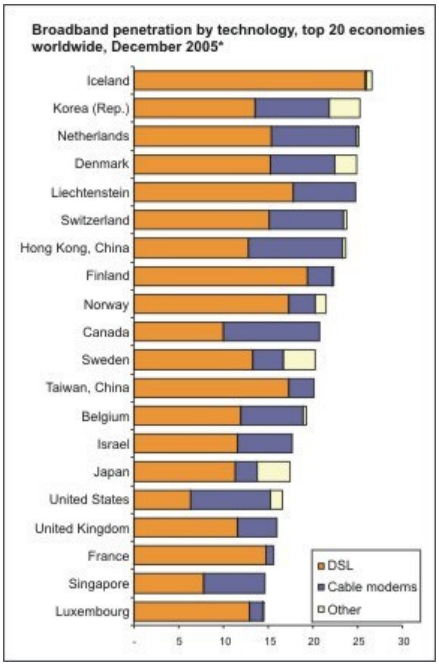
Broadband penetration, 2004





The road to BWA

Need
Market
Technology

- Spectrum & regulations
- Radio interface standards
- Sharing and interworking

3) Wireless Broadband Technologies

Figure 2.2: Portable Internet technologies, by range
The portable Internet will involve a wide range of technologies for different speed and mobility needs

Portable Internet technologies

Long range	Medium range	Short range
• IMT-2000 (3G)	• WLAN	• Bluetooth
• WiMax - IEEE 802.16	➢ Wi-Fi - IEEE 802.11b	• RFID
• IEEE 802.20	➢ IEEE 802.11a	• ZigBee
• HiperMAN	➢ IEEE 802.11g	
• Satellite	➢ IEEE 802.11i	
• HAPS/LAPS	• Free space optics	
• LMDS	• HiperLAN2	
• MMDS	• Ultra wideband	

Source: ITU

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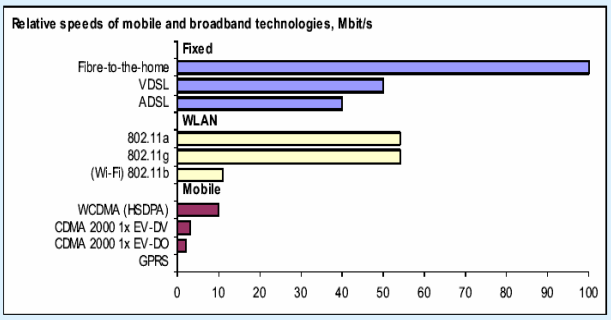
Broadband Technologies

Figure 2.1: Relative speeds of mobile and broadband technologies
Fixed connections are among the fastest connections available; WLAN technologies offer high-speed connectivity within a very small area of mobility and IMT-2000 (3G) technologies offer the lowest speeds with the highest degree of mobility



Source: ITU

3a) Deploying Wireless Broadband infrastructure

Technologies for narrowing the gap: IMT-2000

Existing 2G and 2.5G cellular networks provide a platform for slow-speed and medium-speed Internet access, as well as for voice. **But for higher speeds, advanced wireless technologies and techniques provide a platform for high-speed data access using Internet Protocol (IP).**

For developing economies, one of the most promising technologies may be WiMAX (IEEE 802.16), which offers high-speed connectivity over a range of up to 50 kilometres

Cellular mobile: IMT-2000 or third-generation (3G) mobile technologies

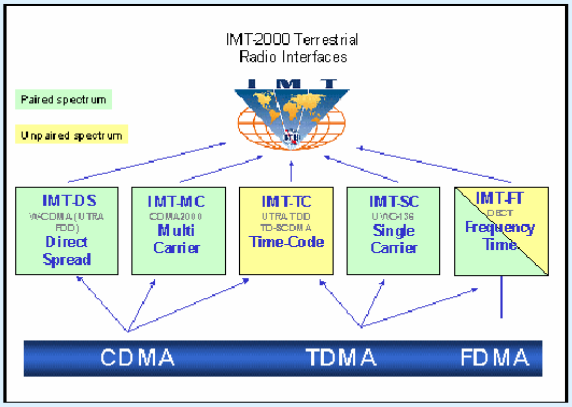
The number of mobile phone users in the world overtook the total number of fixed line subscribers in 2002.

With this tremendous **growth of mobile communications comes the possibility that the world's vast mobile networks can offer the most promising method of delivering the portable Internet to users.**

The great majority of the world is still using second-generation mobile networks, but IMT-2000 (3G) networks have begun to make their impact: there were 118 million 3G users in the world by mid-2004.

Box 2.3: IMT-2000 (3G) and beyond
Looking towards the next generation of networks

The IMT-2000 project harmonized the standards for third-generation networks with three different access technologies using five different radio interfaces (see graphic below). However, even as network operators proceed with rolling out IMT-2000 networks, work in also proceeding to develop faster, higher capacity networks for future mobile connectivity, known as "Systems beyond IMT-2000" or 4G. The World Telecommunications Standardization Assembly (Montreal, 2000) created a Special Study Group (SSG) to study of four questions regarding network signalling and protocols that can enable next-generation mobile services. Future work on Systems beyond IMT-2000 will help ensure that mobile networks will provide fast data access and reliable multimedia transmission at high mobile speeds.



Note: For acronyms, see Glossary.
Source: ITU

IMT-2000 Will provide

- Simultaneous transfer of speech, data, text, pictures, audio and video
- High-speed, mobile access to Internet
- Entertainment on demand (movies, Music..)
- Video-conferencing
- Mobile-commerce
- Travel information (roads, flights, trains,…)

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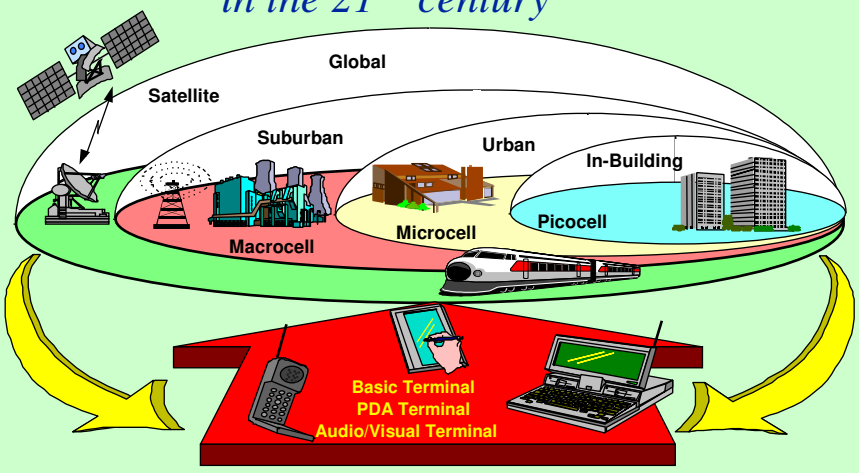
IMT-2000

The ITU vision of global wireless access in the 21 st century



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3b) Technologies for narrowing the gap: Fixed Wireless Access (FWA)

IMT-2000 technologies will cover the highly mobile **but lower speed portions of the portable Internet while fixed wireless technology will fill the niche of high-speed, long distance, but stationary connectivity.**

However, **fixed wireless connections are currently being promoted as replacements for wired broadband connections**.

The key role of **fixed wireless technologies in the portable Internet will probably remain as a cost-effective high-speed backhaul connection to a city, village, or even a community access centre.**

Technologies for narrowing the gap: Fixed Wireless Access (FWA)

Fixed wireless systems have been slow to gain ground when compared with traditional, wired high-speed connections.

However, **a new set of technologies is promising to change wireless adoption the same way Wi-Fi has changed localized Internet access. Two promising new developments, WiMAX, IEEE 802.16 and IEEE 802.20 are competing to become the new standard for fixed wireless.**

In fact, both are promising something that previous fixed wireless technologies have not allowed, that is to say **mobility (Regulatory aspect, Technical aspects).**

Technologies for narrowing the gap: Fixed Wireless Access

In addition to the wide geographical range, **WiMAX also promises to be relatively quick, easy and cheap to install.** A particular advantage with WiMAX is that the main investment burden falls on users rather than network or service providers, or the government.

Start-up costs are thus much lower and investment burden is more widely shared. WiMAX networks are characterised by relatively low sunk costs and networks can grow "organically", as more users join the network. **The spectrum costs for WiMAX are also likely to be much lower than for IMT-2000.**

Fixed-wireless as a formula for low-cost Internet access

Fixed Wireless Access is and option that can ensure greater user affordability, particularly by virtue of low-cost installation and roll-out, and the use of licence-exempt frequencies.

Fixed wireless systems use a small, inexpensive microwave antenna that is attached to a local radio network at the customer premises and their provision costs are far less than digging up the earth to install copper-based cables. **They can be employed as an efficient and cost-effective method for bypassing the last-mile of the existing telecommunication network.**

Fixed-wireless as a formula for low-cost Internet access

They are also cheaper to install in countries with rugged terrain—as long as line of sight is available. Along with low-cost equipment and installation, the relative lack of regulation over the supply of fixed wireless also presents a considerable cost advantage.

However, for developing countries in particular, the potential loss of revenues received by the incumbent operator and resulting loss of taxes, is an issue that needs to be taken into consideration.

Fixed wireless systems have been deployed in a number of countries, each addressing particular needs and requirements

WLAN (Wireless Local Area Networks)

Fixed-line broadband connections offer the fastest speeds but are confined to wired connections.

However, a subset of wireless technologies, WLANs, is expanding the reach of broadband in the **100-metre range.**

The WLAN market is currently dominated by one technological standard, **IEEE 802.11b (commonly known as Wi-Fi),** though several new variations are quickly gaining popularity.

WLAN (Wireless Local Area Networks)

Table 2.1: Wi-Fi ranges
The various ranges of Wi-Fi in different environments

	Range	
Environment	**Maximum**	**at 11Mbit/s**
Outdoors / open space with standard antenna	225-300 m	45-100 m
Office / light industrial setting	75 - 100 m	30-45 m
Residential setting	40-60 m	20-25 m

Source: The Wi-Fi Alliance at: http://www.weca.net

Wi-Fi: Cheap, unregulated and unlicensed broadband

The advantages of **Wi-Fi for increasing wireless access** include the fact that it can be built from the bottom up, **by small and local entrepreneurs.** Each telecommunication operator can provide services within the local community simply **by purchasing the basic radio equipment and transmitting on these unlicensed frequencies.**

The model is relatively inexpensive, responsive to local needs and realities, able to grow organically and fully scalable. It can also create employment, especially where the provision of Wi-Fi service is combined with sale of other services (e.g. mobile prepaid recharges, photocopying, etc.). As the number of local providers increases, so does the overall capacity of the network. Each new operator increases the number of pathways between any two points.

Wi-Fi: Cheap, unregulated and unlicensed broadband

However, there are a number of **constraints with WLANs, most notably the small cell size, which may not be appropriate in rural areas.** Furthermore, while WLANs may be cheap to roll-out, **installing and operating conditional access and billing systems may be more expensive.**

For these reasons, it is more likely that **WLANs would be used in developing countries not as a standalone service, but in conjunction with another technology,** like WiMAX, DSL or Very Small Aperture Terminals (VSATs).

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4) Wired vs Wireless Broadband technologies

- At the present time, **wired broadband technologies can transport much more data than wireless technologies.**
- Fibre optic technologies are currently capable of 10 Gbit/s over one wavelength, and fibre should be able to support multiple wavelengths.
- **Wireless technologies, available to consumers, have recently been shown to reach 54 Mbit/s but only over short distances, and still with nearly 200 times less bandwidth than a single fibre strand.**

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Wired vs Wireless Broadband technologies

The vastly superior speeds of wired connections mean they will continue to play a key role in providing high-bandwidth applications. Wired connections, where they are available, will be a vital element for high volume and low-cost data transportation.

For the foreseeable future, **wired and wireless technologies are likely to be complementary**, at least in the urban markets of the developed world

On the other hand, **wireless technologies may offer an effective way for countries without extensive fixed-line infrastructure to catch up**, and possibly "leapfrog" over other countries in terms of total connectivity.

Wired vs Wireless Broadband technologies

Residences subscribe to broadband via a fixed connection but then share the connection within the house or apartment via Wi-Fi. Businesses using WLANs almost always rely on wired infrastructure to reach their ISP.

Therefore, **instead of Wi-Fi competing against fixed-line broadband infrastructure, the two work together as complementary technologies.** Fixed broadband connections become more cost effective and attractive to users when they can be shared and Wi-Fi makes this possible.

Wired vs Wireless Broadband technologies

The second area of possible competition of newer portable Internet technologies is **with third generation (3G or IMT-2000) mobile.** As of mid 2004, there were around 118 million 3G subscribers worldwide (compared with around 58 million a year earlier).

Some of the functionality that 3G offers is very similar to that which could be potentially offered by Broadband technologies, **though 3G may still be preferred for use in fast moving vehicles.**

Furthermore, **although 3G may offer better coverage**, the start-up costs of providing nationwide coverage for **3G are likely to be much higher than a hybrid Broadband Wireless solution based on a WiMAX backbone and a Wi-Fi local loop.** The main difference affecting the cost is the size of cells (much smaller for 3G than for WiMAX) and the requirement for cell-handover in a 3G network.

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Wired vs Wireless Broadband technologies

The high costs of acquiring licences and rolling out the network are part of the reason why 3G has been slow to arrive

But the main area of competition relates to tariff structures (see pricing discussion below). Mobile operators approach the provision of Internet services from the starting point of per-minute voice tariffs, **whereas Wireless Internet service providers approach it from the starting point of "always-on", flat-rate Internet tariffs.** In any like-for-like competition, flat-rate tariffs are always likely to be preferred in the marketplace over per-minute pricing strategies.

This is one of the reasons why 3G service providers, notably in Japan are moving towards flat-rate tariffs.

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Results of WTDC-06 related to IMT-2000

The recent ITU World Telecommunication Development Conference WTDC-02 (Istanbul, 18-27 March 2002), approved the following texts related to IMT-2000:

- **Resolution 43** (WTDC-06): Assistance for implementing IMT-2000

-**Question 18/2**: Strategy for migration of mobile networks to IMT-2000 and beyond

-**Programme 2, point 1.4**: Mobile terrestrial communications

ITU-BDT Broadband Activities

Developing Regions

•Growing demand for Broadband

•Lack of Wireline infrastructure needed to meet the growing demand for Broadband

•BWA, economical and easy to install, is a good high-performance solution to address the needs of these Regions

•Availability of Broadband Services in Rural and Remote areas can address a variety of challenges posed by the distance

ITU-D Broadband Activities Presentation Agenda

- ITU-D Introduction
- Question 20-1/2: Broadband Access Technology
- Results of Questionnaire: Factors affecting broadband deployment
- Strategies to Promote Broadband
- Invitation to Participate

ITU-D Study Group 2 Question 20-1/2
Broadband Access Technologies

•**Approved at World Telecommunications Development Conference 2002:**
  –Identify the technical, economic, and development factors influencing the effective deployment of broadband access technologies and applications.

•**Technology Scope:**
  –All broadband technologies- as inclusive as contributions permit.

•**Draft Report (finalized July 2005) currently available on ITU-D website:**
  – **3 sections: 1) General broadband matters; 2) Technology Matrices, 3) Country experiences**
  –**General broadband matters:**
    •Social and Economic Benefits of Broadband
    •Broadband Applications
    •Broadband Deployment
    •Strategies to Promote Broadband Development
  –**Technology Descriptions:**
    •Wireline: DSL, Cable, Fiber to the Home, Powerline, etc
    •Wireless: Satellite, FWA, WLAN, IMT-2000, etc.
    •Non-Standardized Technologies

Conclusions: Strategies to Promote Broadband (1/2)

In order to promote demand for broadband deployment, governments and businesses private sector can aim to:

- Increase broadband availability in schools, and other public centers (increases awareness of broadband benefits).
- Educate users on successful applications such as IP telephony, video chat, audio over broadband.
- Promote teleworking, e-health, e-learning, and e-government transactions (such as filing of tax forms and other administrative procedures).
- Encourage content development in local languages.
- Ensure regulatory environment protects intellectual property rights and user security.
- A competitive market structure is vital to sustain low prices in order to attract consumers.
- Support for research and development on broadband technologies and applications.

Conclusions: Strategies to Promote Broadband (2/2)

In order to promote broadband supply, governments and businesses can aim to:

- Create incentives for competition both among providers of the same broadband technologies, and between providers of different broadband technologies.
- Establish policies that allow service providers the flexibility to independently choose technologies based on commercial and competitive considerations.
- Promote use of existing infrastructure to enable broadband rollout while at the same time encouraging new investment
- Utilize schools, hospitals, and community access centers as effective anchors for broadband demand in areas where individual household connections are not yet viable.
- Consider wireless broadband as a viable community alternative to fixed line solutions such as broadband via DSL or cable modem.
- Participate at all levels: national, regional and city-wide initiatives and community participation projects have been successful in expanding access.
- Particularly for rural and underserved areas, consider potential economic incentives for broadband build-out such as tax credits, grants for community planning efforts, subsidized or low-interest loans.

The concept of Universal Service in the EU

- **A safety net**

  - for those whose financial resources or geographical location do not allow them to have the basic services that are already available to, and used by, the great majority of citizens.

The Current Scope of Universal Service

- **Connection to the public telephone network at a fixed location**
  - *capable of supplying functional Internet access, taking into account prevailing technologies used by majority of subscribers and technological feasibility*
- **Access to publicly available telephone services**
- **Directories and directory enquiry services, public pay telephones, special measures for disabled users**

Test for possible inclusion of mobile

Recital 25 & Annex V of US Directive

- are **mobile** services available to, and used by, a majority of consumers ?

  YES

- does the lack of availability or non-use by a minority of consumers result in social exclusion for those that cannot afford them?

  NO

Conclusion on mobile

"The competitive provision of mobile communications has resulted in consumers already having widespread affordable access to mobile communications.

The conditions for including mobile communications within the scope of universal service are therefore not fulfilled."

Test for possible inclusion of broadband

Recital 25 & Annex V of US Directive

• are **broadband** services available to, and used by, a majority of consumers ?

NO

Conclusion

- Considering that both Mobile and Broadband can bridge the digital divide such conclusions should be carefully re-considered in the case of Developing Countries