

ICTP-ITUBDT School on Wireless Networking for Development
The Abdus Salam International Centre for Theoretical Physics ICTP, Trieste (Italy), 5 to 23 February 2007

Radio for development

ICTP-ITUBDT School 2007

Ryszard Struzak

Aim: Introduction to the 2007 school

- Human development = evolution from a less advanced to more advanced stage ...
 - Trends, predictions, programme
 - Numerous predictions claim great success of new technologies
 - But many predictions made in the past have proved to be dramatically wrong, even when made by famous experts...
 - » “Heavier-than-air flying machines are impossible”
[Lord Kelvin, famous physicists, 1897]
 - » “There is no reason for any individual to have a computer in their home” [Ken Olsen, Founder & President of Digital Equipment Corporation, 1977]
 - » “Radio has no future” [Lord Kelvin, famous physicists, 1897]

- **Progress of humanity -- thanks to gathering and sharing information and knowledge**

See: World Bank, 1998, quoted after Sarah Cummings, Richard Heeks & Marleen Huysman: 'Knowledge and Learning in Online Networks in Development - A Social Capital Perspective' (2003); <http://www.sed.manchester.ac.uk/ldom/publications/wp/di/index.htm>



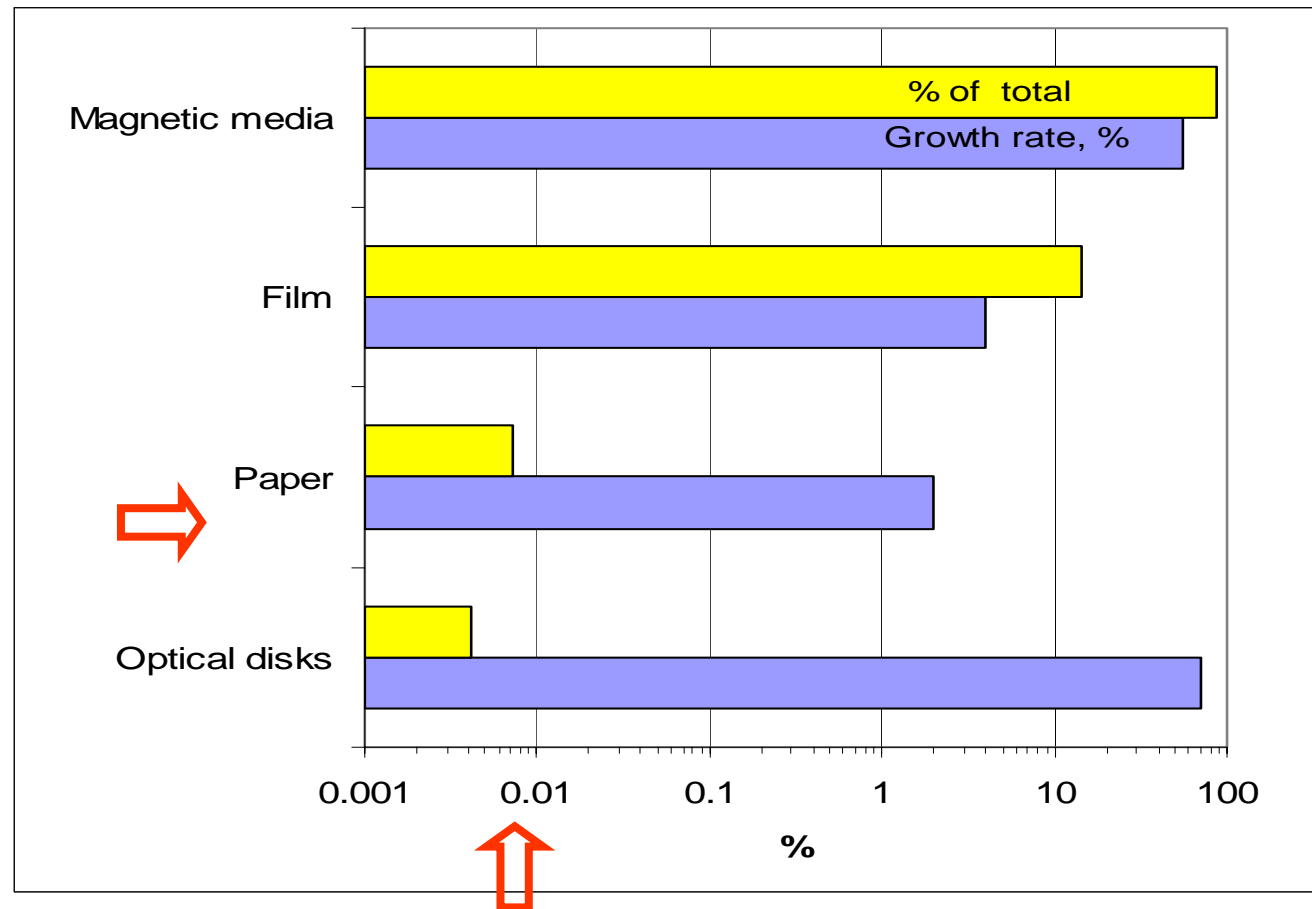
[human rights](#)



[Code of Hammurabi](#)

Information in the world

- **Production:**
~800Mb / person
(~10m bookshelf)
- **Storage:**
Print: <0.01% of
total information
stored
- **Transmission:**
Phone, radio, TV,
Internet – 3.5 x more
than stored
- **Effects:**
Politics
Culture
Quality of life
Safety/ security
Business ...

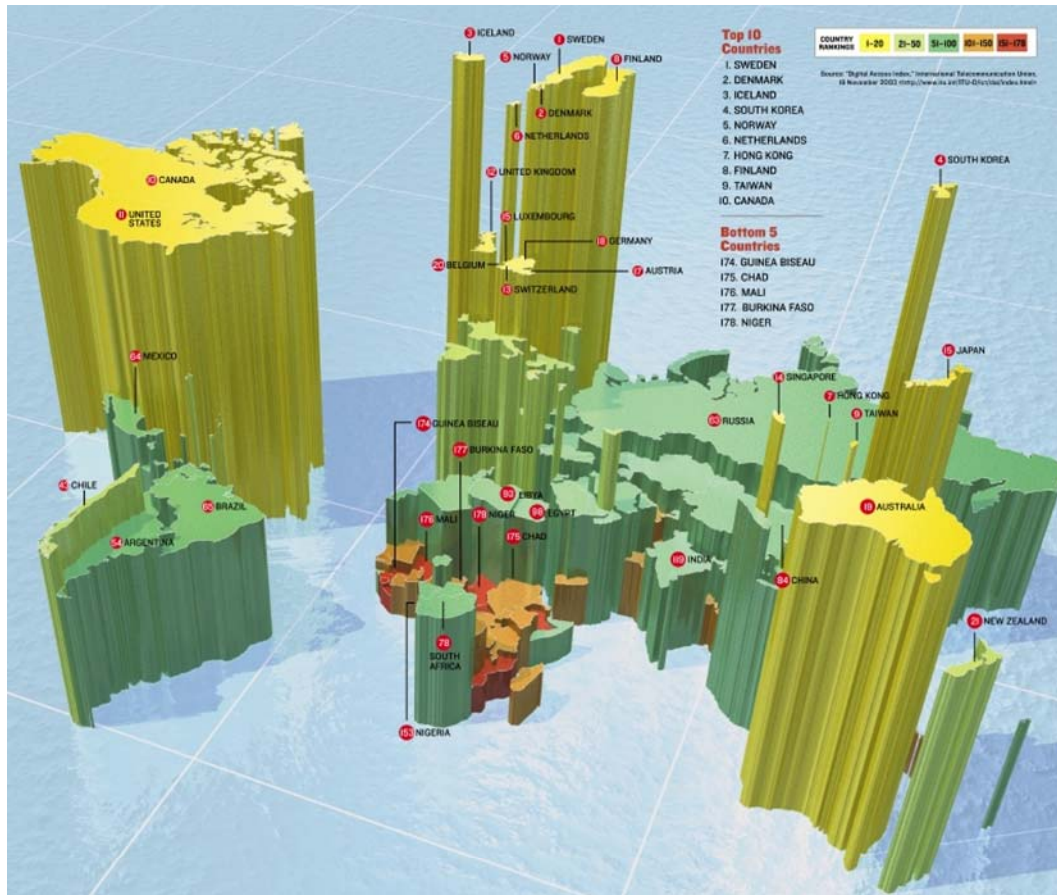


Lyman P, Varian HR: How Much Information?,
SIMS, University of California at Berkeley, 2000-
2003. <http://www2.sims.berkeley.edu/research/projects/how-much-info-2003/execsum.htm#summary>

Trends

- The amount of *new* information has doubled in about 3 years
 - » Stored on paper, film, magnetic, and optical media
- The next 3 years: more new information than has been produced over the *entire history of mankind*
 - » If that trend continues
 - » source: <http://www.sims.berkeley.edu/research/projects/how-much-info-2003/>
- Almost all information in **electronic** media
- What about *accessing* it?

Access to IT infrastructures



Map of relative ability of individuals to access IT infrastructures:
Digital Access Index (DAI)

Prepared by ITU for WSIS 2003

<http://www.itu.int/ITU-D/ict/dai/>

<http://www.spectrum.ieee.org/WEBONLY/resource/feb04/0204bmapf1.pdf>

<http://www.internetworldstats.com/list3.htm>

Urban-Rural digital divide





Kofi Annan



Yoshio Utsumi

We Must Close The Digital Gap...

Kofi Annan: We, The Peoples: The Role of the UN
in the 21-st Century. Millennium Report (2000)

UN Secretary General, Report 2000 (<http://www.un.org/millennium/sg/report/full.htm>)

Humanitarian viewpoint

„We, the representatives of the peoples of the world, assembled in Geneva from 10-12 December 2003 for the first phase of the World Summit on the Information Society, declare our common desire and commitment to build a people-centered, *inclusive* and development-oriented Information Society, where *everyone* can create, *access*, utilize and share information and knowledge, enabling individuals, communities and peoples to achieve their full potential in promoting their *sustainable development* and improving their quality of life...”

[World Summit on the Information Society, Declaration of Principles, <http://www.itu.int/wsis/docs/geneva/official/dop.html>]

Business viewpoint

- ICT-related businesses must continue
 - » To keep jobs & profits
- Profitable markets approach **saturation**
- Conclusion
 - Equipment Manufacturers, Service Providers, Contents Creators must invent:
 - » New markets
 - » New services/ applications
 - » New business models/ technologies

Challenge of the 21st Century

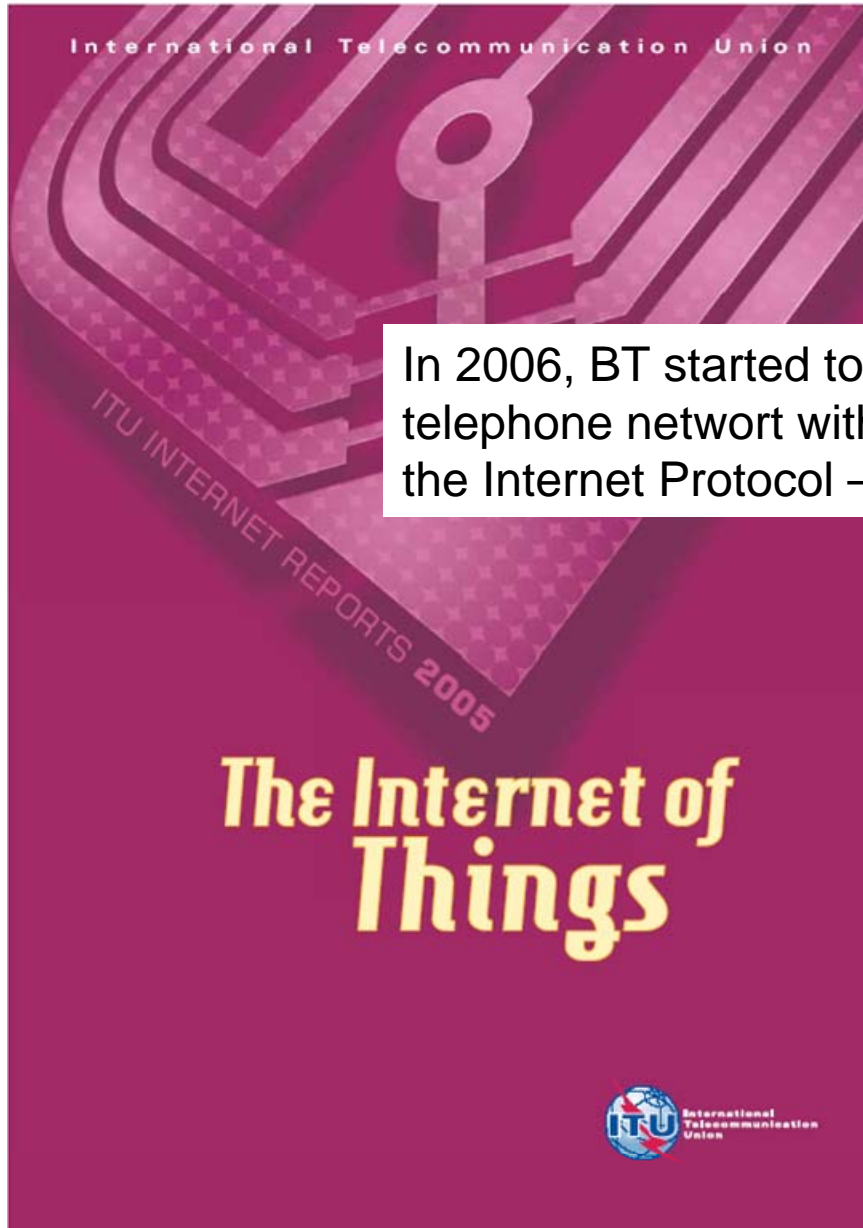
- Access to modern information infrastructure in rural, remote, and under-developed regions
 - Market mechanism failing
 - Government programs failing
 - International assistance failing
 - Barriers:
 - » Lacking finances, good organization, sufficient education, existing communication infrastructure, legal regulations, etc.

Towards ubiquitous network society

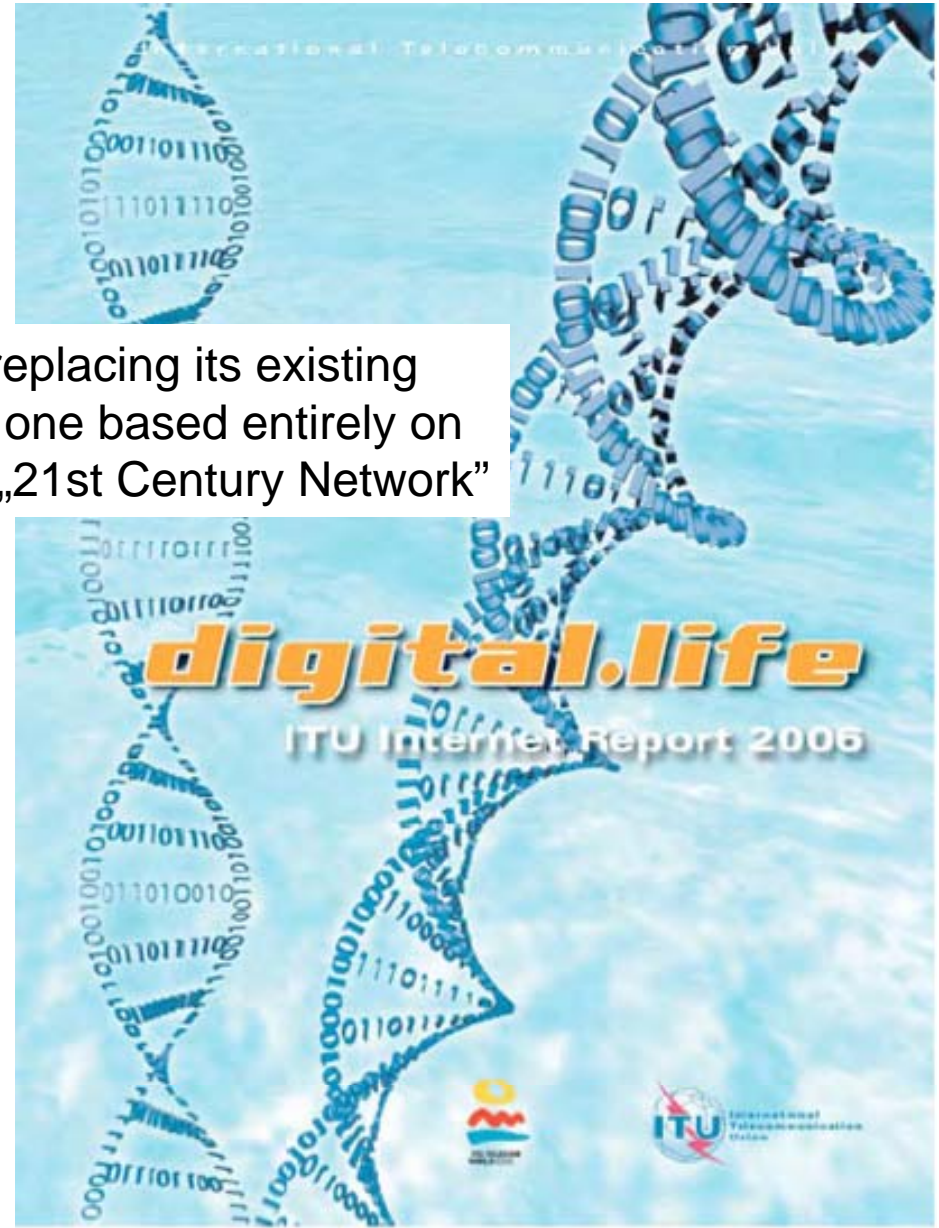
Japan & Korea programs: from e-services to u-services

1. portable internet
2. mobile television
3. home networking
4. vehicle-based information systems
5. radio-frequency identification (RFID) technology,
6. W-CDMA mobile telephony,
7. digital television broadcasting,
8. Voice Over Internet Protocol (VoIP) services.

EU: i2010



In 2006, BT started to replacing its existing telephone network with one based entirely on the Internet Protocol – „21st Century Network”



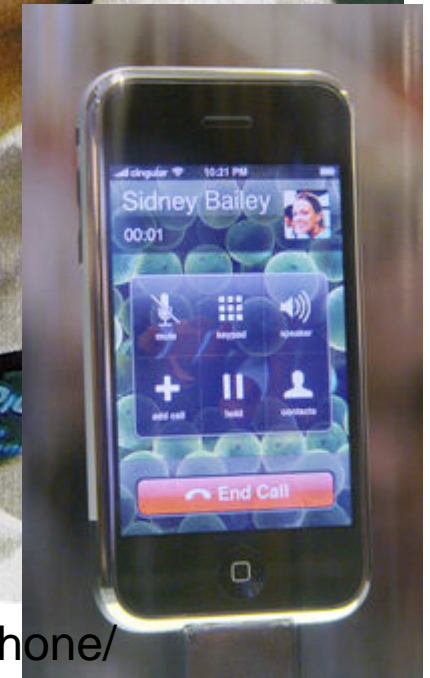
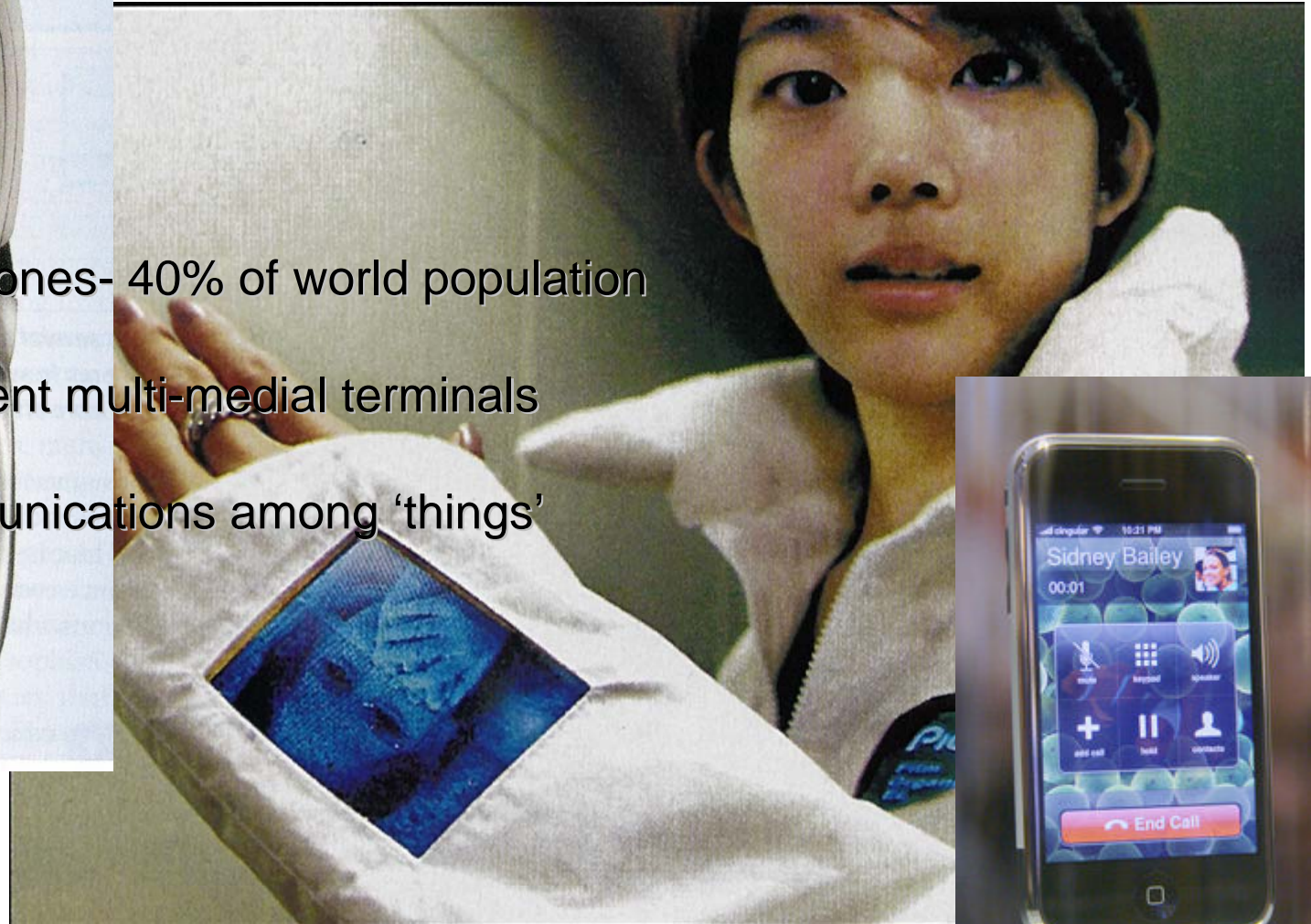
Trends



Cellphones- 40% of world population

Intelligent multi-medial terminals

Communications among 'things'



<http://www.apple.com/iphone/>



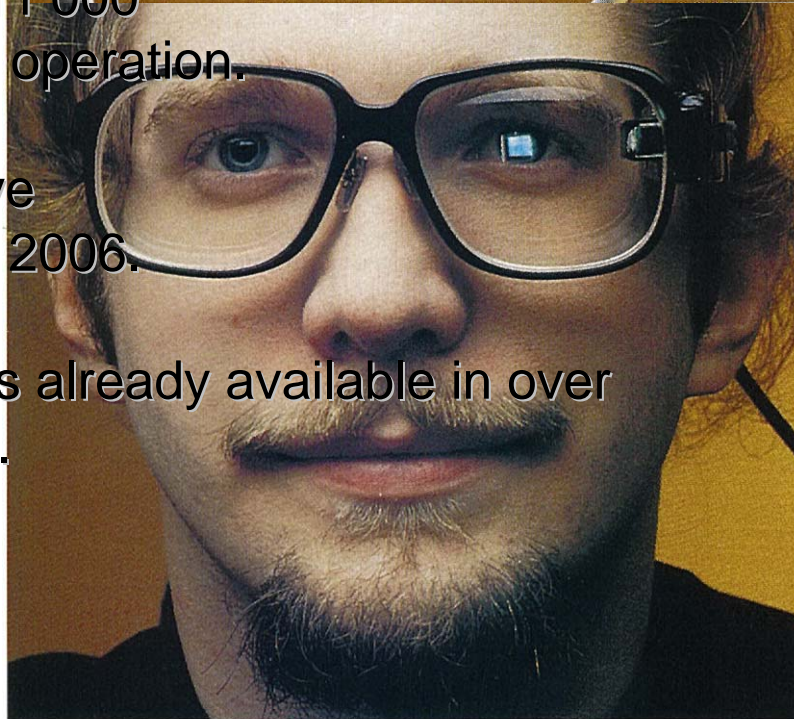
The world's first commercial mobile TV service using DVB-H technology was launched in Italy on 5th June, 2006, just ahead of the FIFA World Cup.

3 Italia, the mobile network operator, claimed to have signed up 111'000 users in the first six weeks of operation.

The operator is aiming to have 500'000 clients by the end of 2006.

The rapidly-growing service is already available in over 2'000 Italian towns and cities.

Source: Digital Life. ITU Internet Report 2006



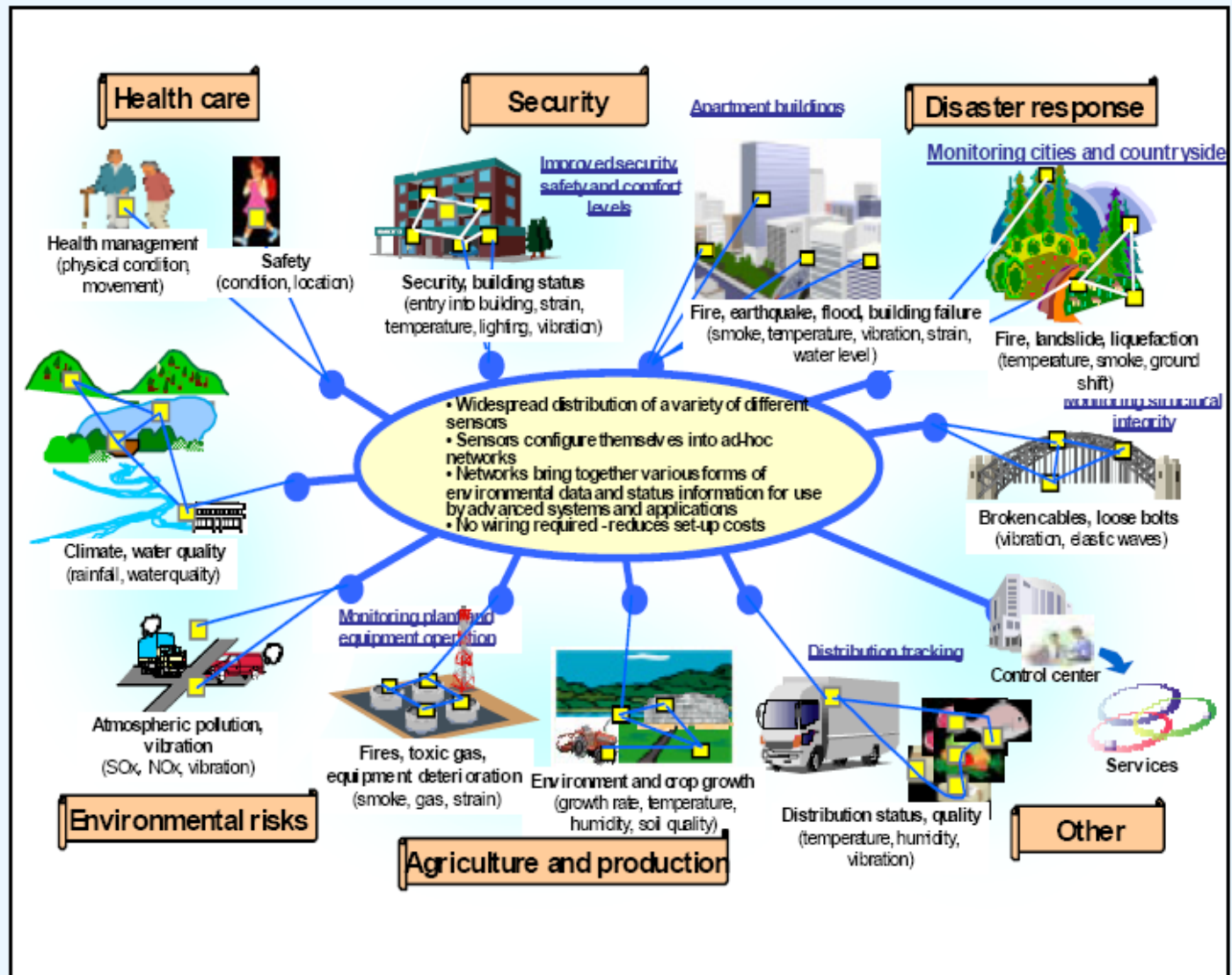
Brain-computer interfaces:
IEEE Computer Jan 2007 p.17

Figure 2.4: Smart people, smart home
Technology for intelligent living



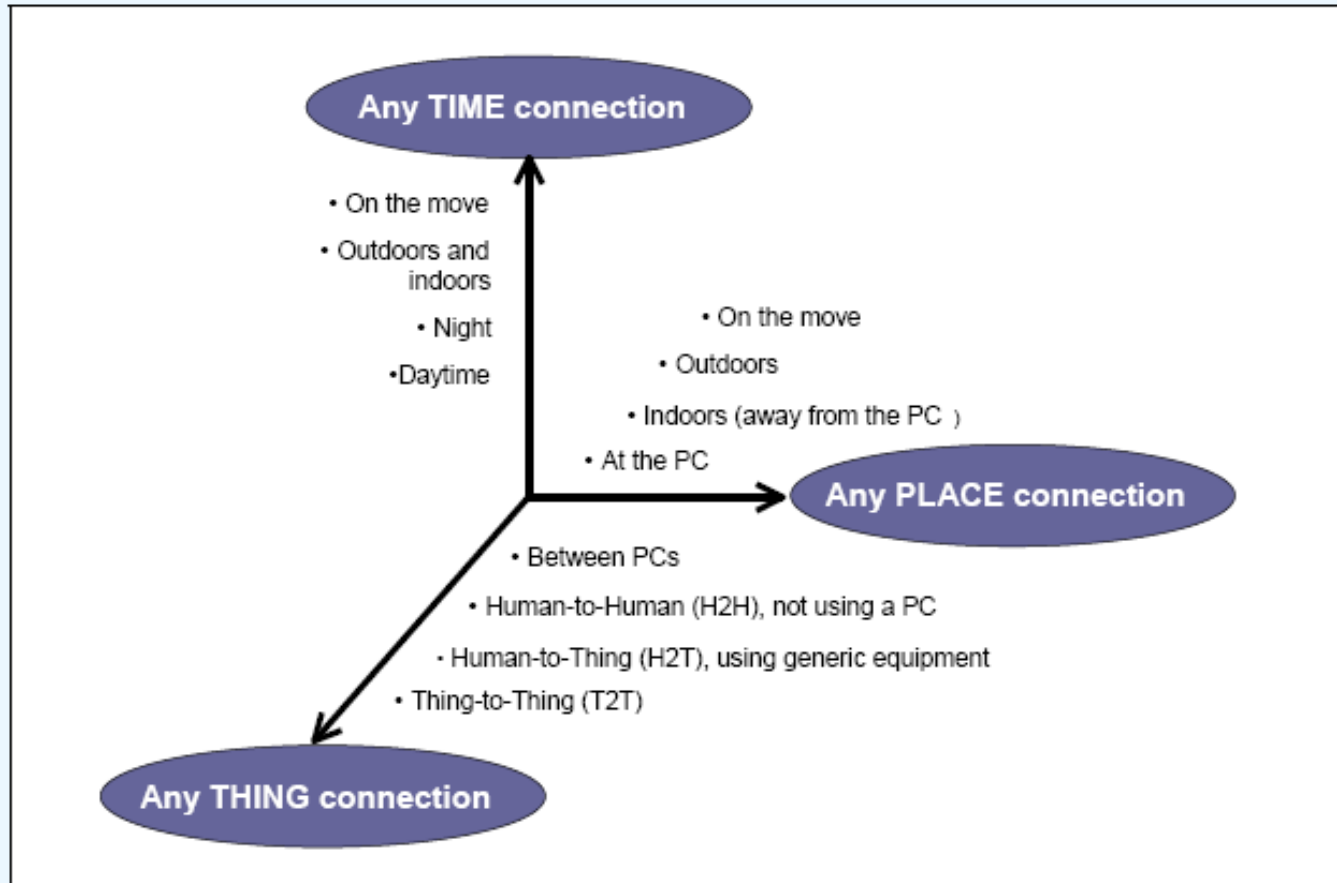
Sources: ITU, adapted from Line9

Figure 2.3: The wide reach of sensor networks
A Japanese vision of ubiquitous sensor networks



Source: Ministry of Internal Affairs and Communications (Japan)

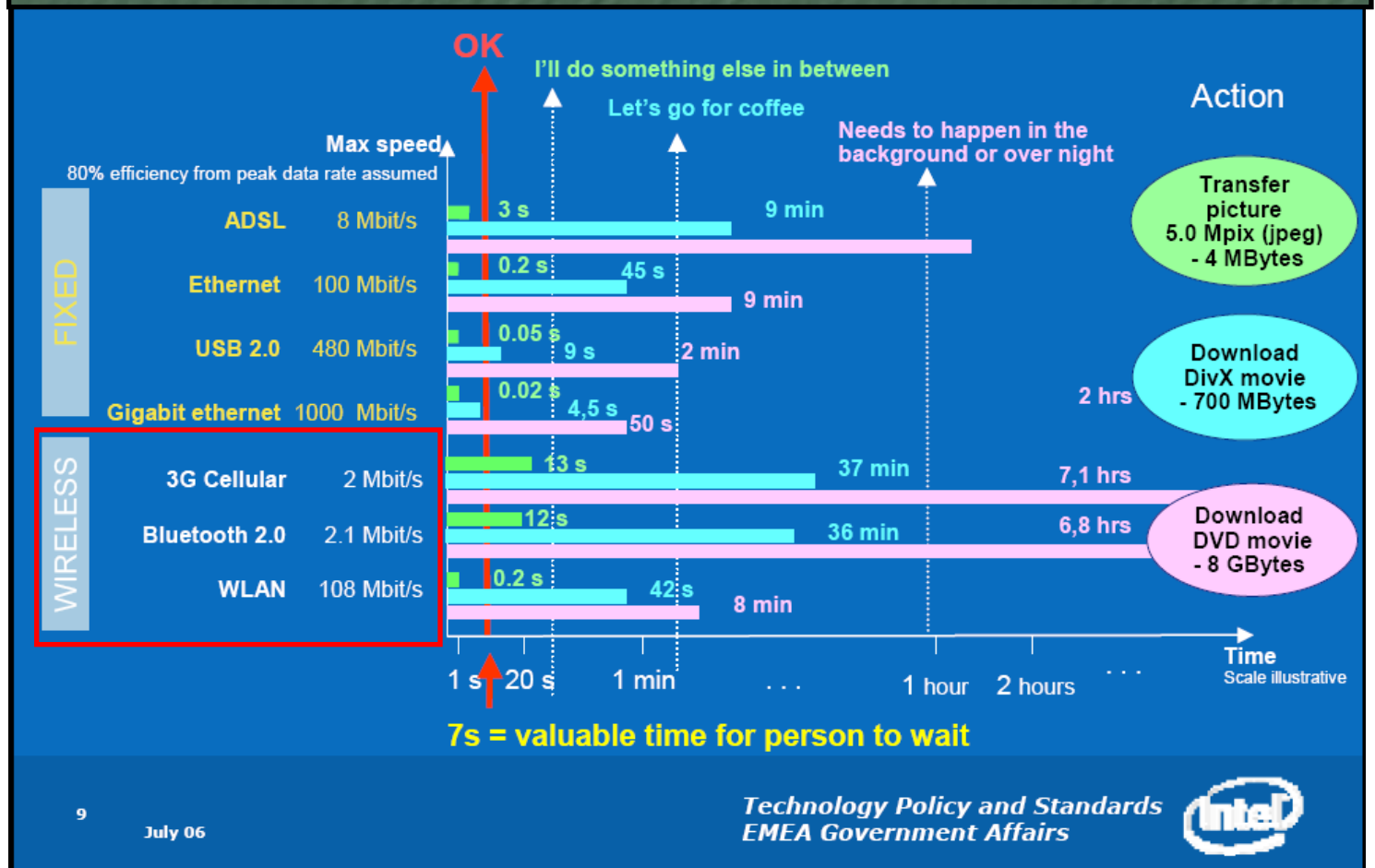
Figure 1.2: Introducing a new dimension to the telecommunication environment
Connecting Things



Source: ITU, adapted from the Nomura Research Institute, "Ubiquitous Networking: Business Opportunities and Strategic Issues", August 2004

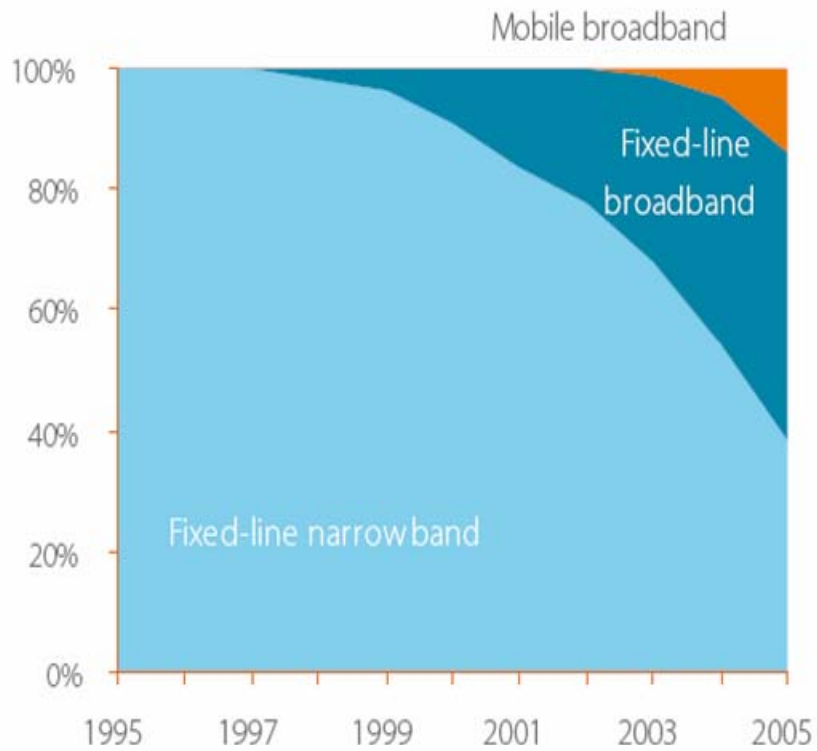
New directions in networking technologies in emerging economies – Connectivity in emerging regions:
IEEE Communications Magazine Jan 2007 p. 96

Why broadband?

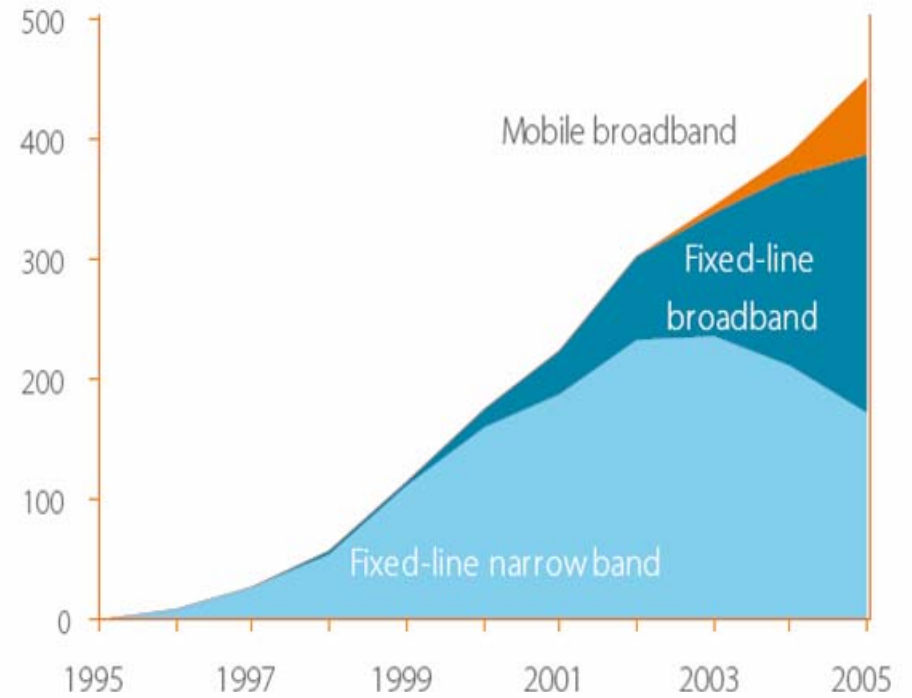


Source: Ch Legutko 2006

Internet subscribers worldwide, in %

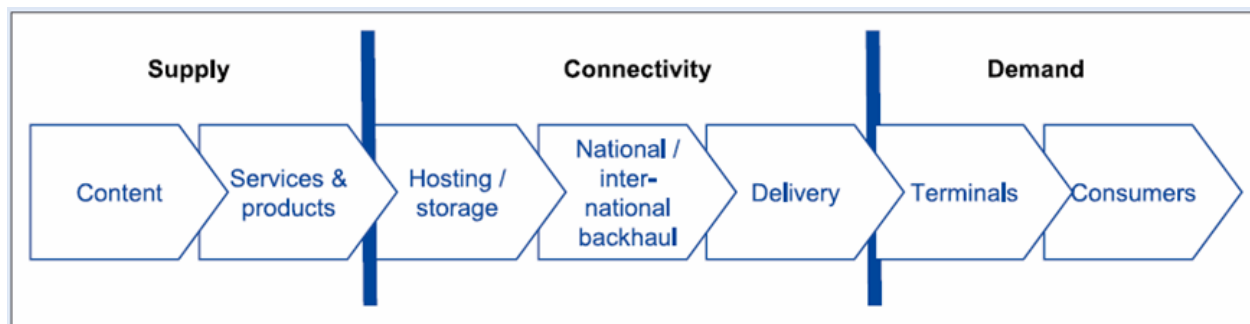


Internet subscribers worldwide, in millions



Source: Digital life ITU Internet Report 2006

Information dissemination value chain



- Internet perceived as being oriented towards *urban* population
- Insufficient content/ services relevant to rural life
- Migration of youths to cities/ computer illiteracy of the elderly
- Intellectual property rights
 - ‘Content is the king, access is the key’

Problems

- Lacking:
 - Widely supported vision
 - Local leaders
 - Viable business models
 - Efficient management/ organization
 - Stable & enforced laws & regulations
 - Human & material resources

Solutions

- Needed:
 - new ideas,
 - new business models,
 - new technologies,
 - new (qualified) people ...
- Critical:
 - involvement of *young* generation and *local communities*

Hope in young people

- ICTP approach:
 - initiate a self-developing process
 - teach teachers that
 - disseminate further the aware-ness
 - disseminate further know-how
 - generate demand,
 - augment other programs
 - activate market forces

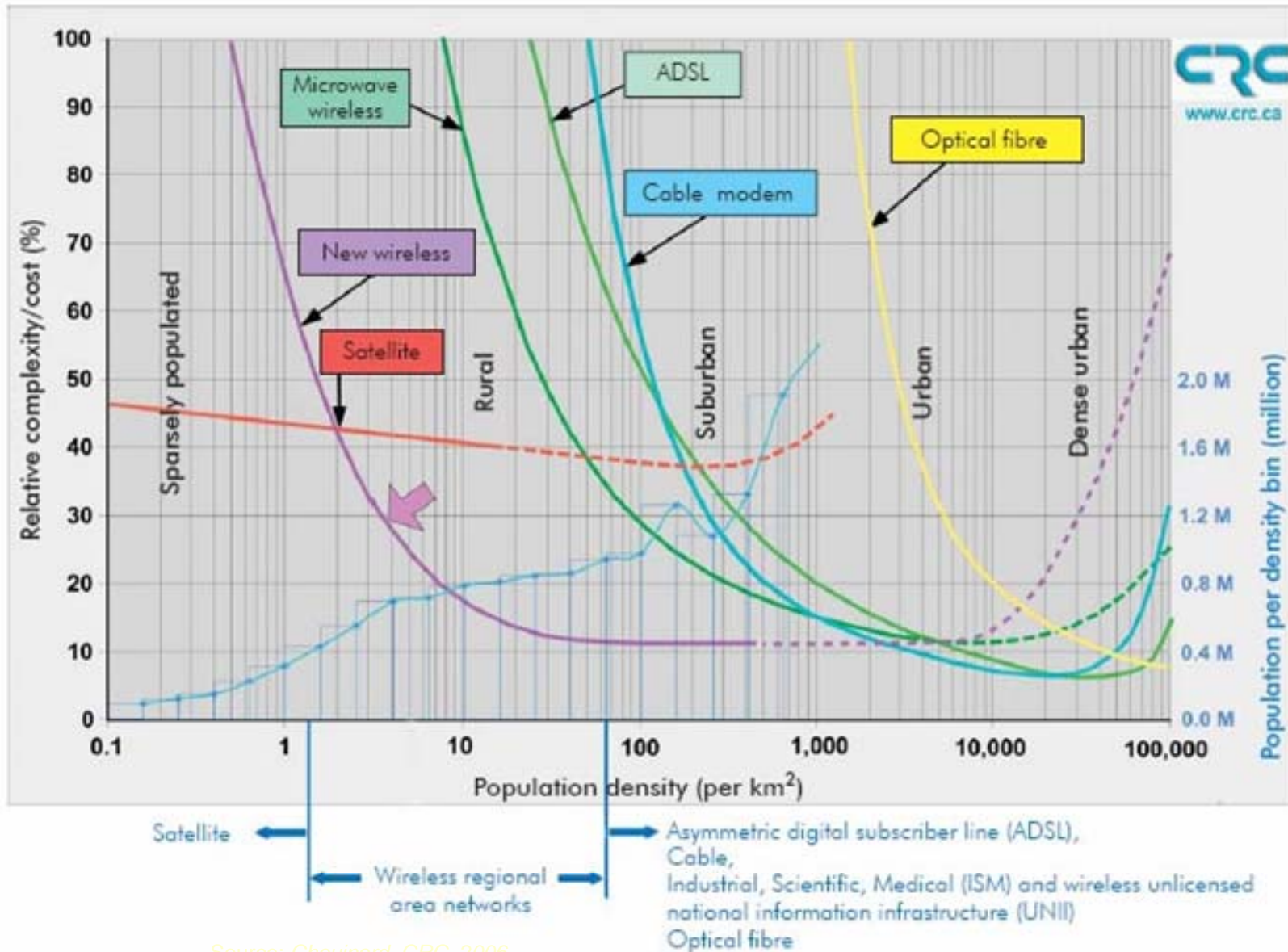
Focus on radio

Radio waves carry information from/to fixed and mobile users with the speed of light...



- Deployment time & cost (emergency situations!)
- Ubiquitous - any place, any time, at no cost ...
- Free; no right-of-way
- Indestructible (theft, snow, wind, flood, earthquake, tornado, trees...)
- No cable (production/ transport/ maintenance...)
- Easy to setup, upgrade & expand
- Often the most cost-effective -- ideal for the “last mile” solution
- Future-proof (most of future applications - mobile/ transportable)

Figure 1 — Suitable broadband access technologies as a function of population density



Source: Chouinard, CRC, 2006

Focus on WiFi 2.4 GHz

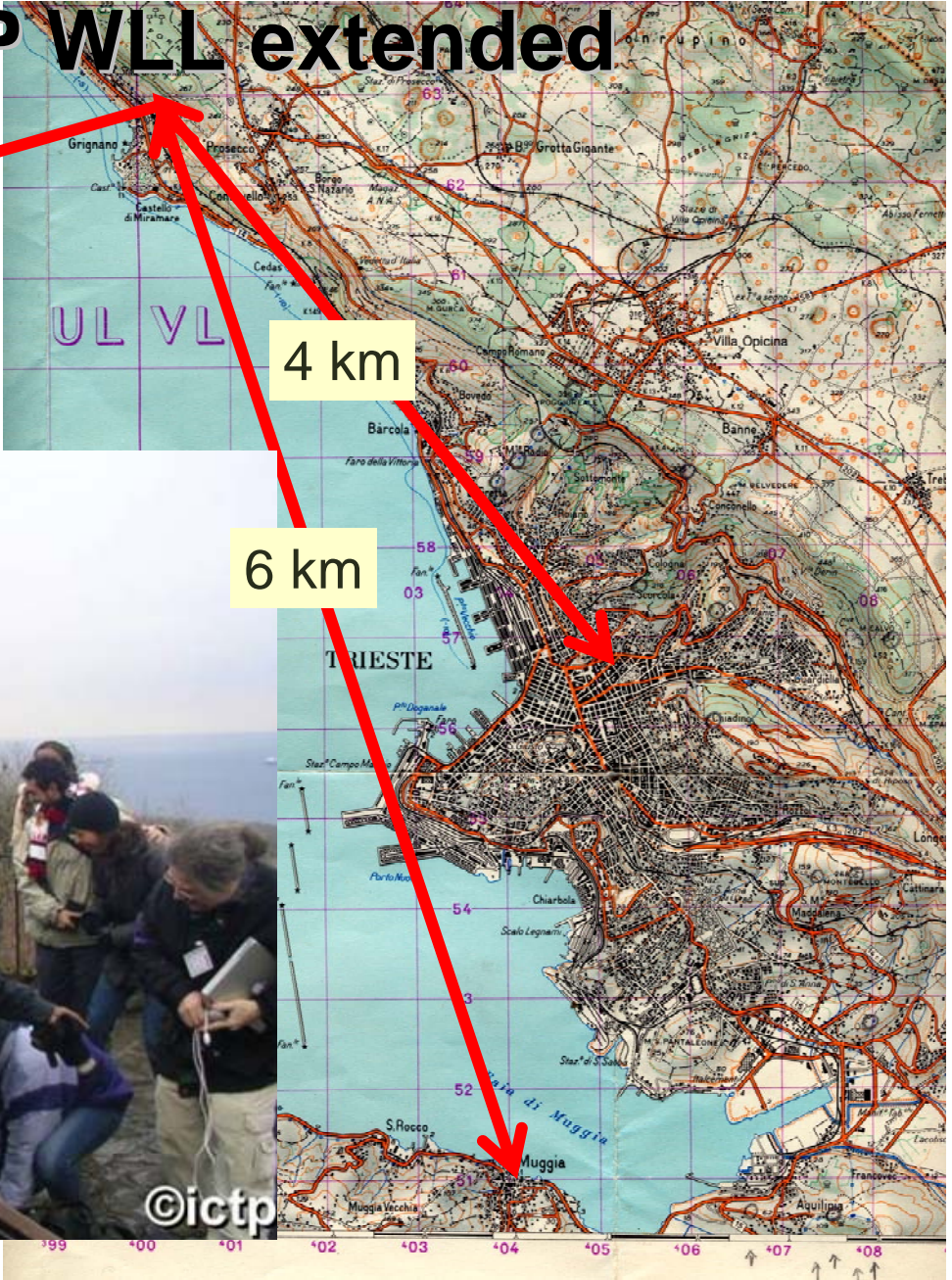
- [IEEE 802.11 wireless local area networks \(WLAN\)](#)
 - innovative implementations of wireless local area networks (WLANs) for data, audio, and video communications, interconnecting computers and sensor networks
 - Inexpensive, “off-the-shelf” equipment
 - Uses free frequency bands: no need for individual license
 - Widespread, proven technology
 - Promises communications at speeds up to 11 to 54 Mbps within rooms; extendable up to few km distance
 - » Record distance: 279 km achieved in 2006 by Ermanno Pietrosemoli, Carlo Fonda i Javier Triviño (lecturers at our school)
http://www.wilac.net/descargas/documentos/EnlaceAguila_Baul_EN.pdf

Example: ICTP WLL extended

25 km

4 km

6 km



©ictp

Focus on hands-on sessions

Basic theory + experiments

- Radio

- antennas, cables, WLAN building, installation, testing and measurements

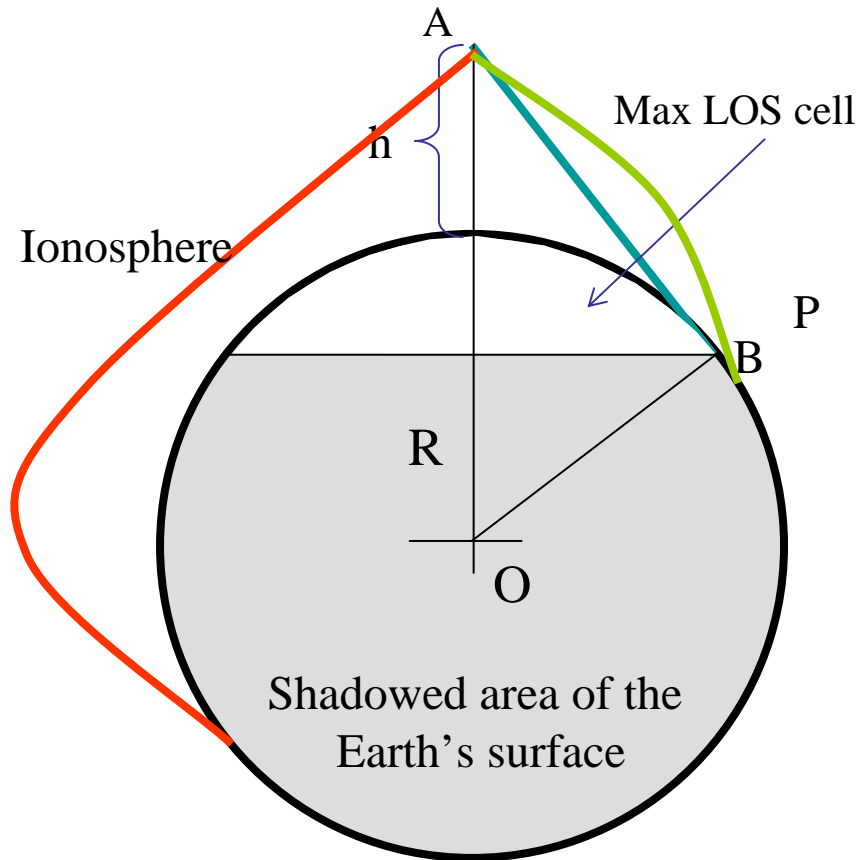
- IP

- Free software, Free frequencies

- There are many textbooks on microwave radio networking (theory)
- Opportunities are rare to make extensive practical exercises
- Training offered by companies are oriented towards specific-product and/or contract



Evolution



LOS = Line-Of-Sight

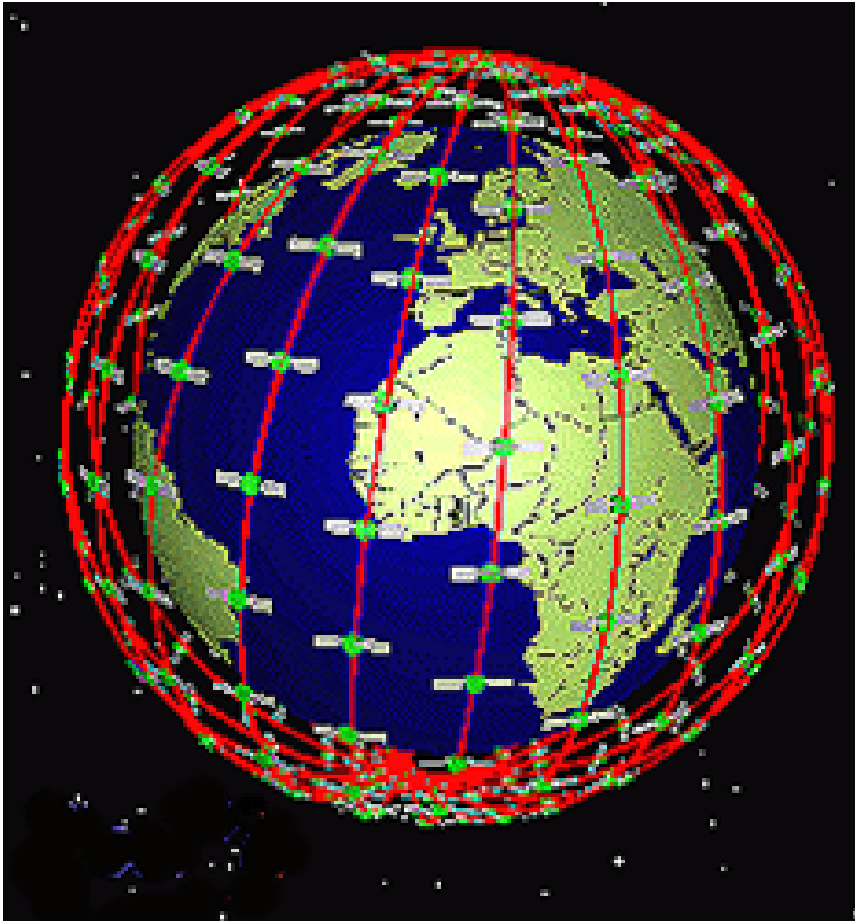
- Terrestrial radio
 - HF ionospheric
 - Microwave LOS
- Satellite radio
 - LEO, GEO, MEO
 - Very small aperture terminals (VSAT) are the cheapest GEO satellite terminals
 - There are more than 500,000 VSAT systems operating in more than 120 countries
 - » [<http://www.gvf.org/>]
- Stratospheric radio

GEO satellites



- GEO-satellite based services are cheaper than terrestrial when cost is shared by many users
- But they are expensive and impractical for some applications due to latency

LEO satellites



Source: This image was generated using Satellite Constellation Visualizer, at <http://sourceforge.net/projects/savi/>.

- Low earth orbit (LEO) satellites overcome the latency and cost problems of GEO satellites
At any point on the earth, a single LEO satellite is visible during a short time period
That allows for store and forward applications like e-mail, but excludes interactive applications.
Continuous service can be assured by a satellite constellation in which every point on earth is visible to at least one satellite at all times (plus inter-satellite communication links).
But it is a very expensive solution.

- For further reading see e.g.: R Struzak: Satellite industries at the turn of the century; <http://www.intercomms.net/AUG03/content/struzak2.php>
- For store-and-forward email see e.g. <http://www.vita.org/programs/communication.htm>

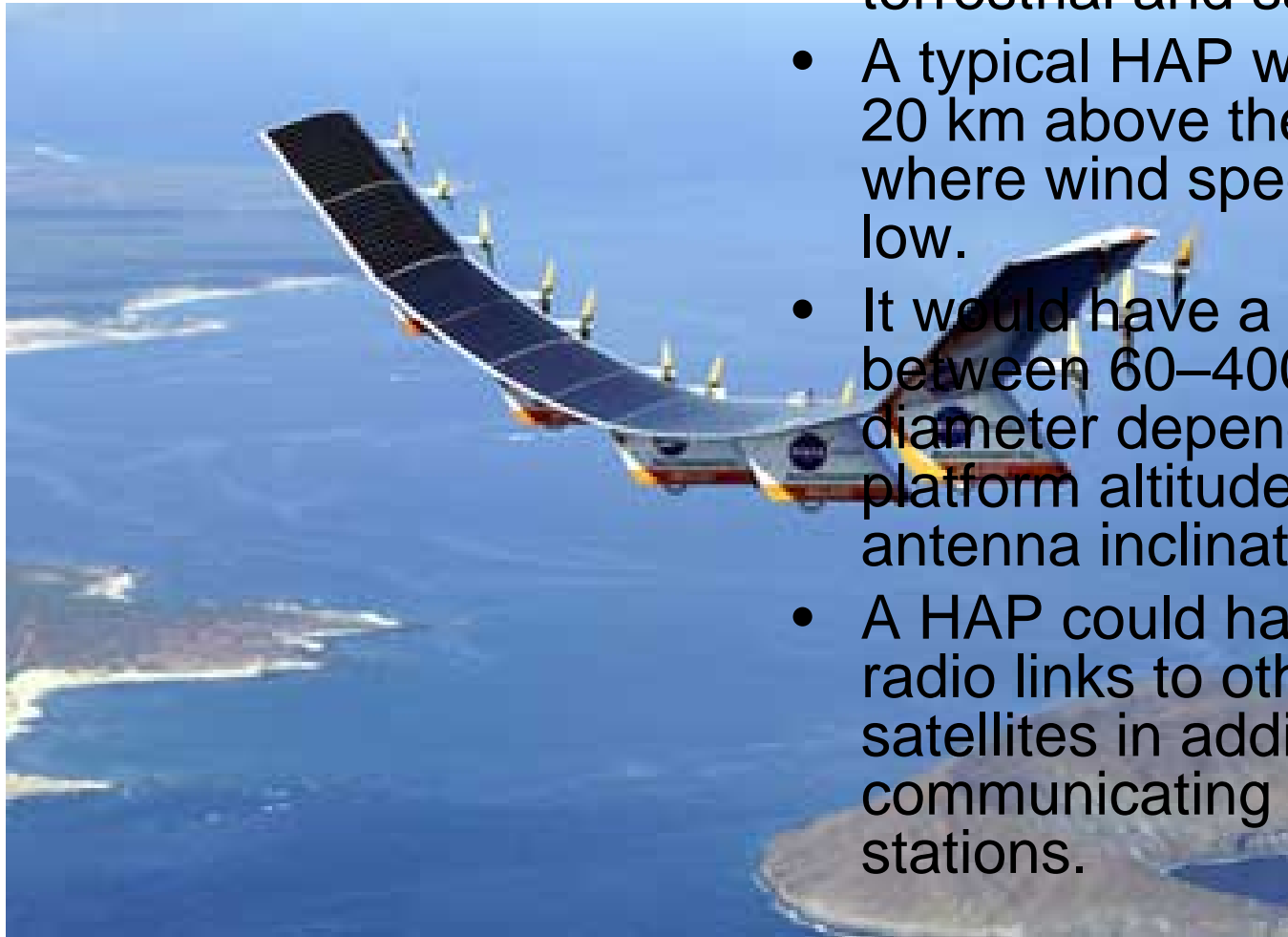
Launch of LEO (Teledesic) satellite



R Struzak

(Source: Orbital Science Corp., 1998) 34

HAPS



- HAPS are one alternative to terrestrial and satellite links.
- A typical HAP would fly about 20 km above the ground, where wind speed is relatively low.
- It would have a footprint between 60–400 kilometers in diameter depending upon platform altitude and ground antenna inclination.
- A HAP could have optical or radio links to other HAPs or to satellites in addition to communicating with ground stations.

Radio-controlled, solar-powered Helios prototype during its test flight over the Hawaiian Islands on 14 July 2001. (NASA Dryden Flight Research Centre Photo Collection. Courtesy of NASA.)

Other perspectives

- SDR
- Ultra-wideband technology (UWB) that promises cheap communications below levels of existing signal environment
- Broadband power-line telecommunications use existing wires and cables
 - Note: The school program is limited – it does not include detailed discussion of these and other promising technologies

Concluding remarks

- Access technology is only one of several „gaps” or “divides”
 - Digital divide is meaningless for those who lack safe water, adequate nutrition, basic education, or other essentials...
- Technology alone can not bridge the gap, but can facilitate its narrowing
- I hope this school will help you to take a leading role in closing the digital gap and in advancing scientific development in your institutions
- I wish you every success

Any question ?

Thank you for your attention



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Important notes

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s youthful exuberance.
 's most frequent and enthusiastic visitors—first s
 as co-director of the ICTP schools on digital rad
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IL PERSONAGGIO

La storia di uno scienziato che insegna dall'89 ai corsi di radiocomunicazioni

Struzak, un veterano all'Ictp



Tra le tante invenzioni l'uso delle lattine di olio per sostituire le antenne nei paesi sottosviluppati che collegano villaggi, università e ospedali

governativi e ricercatori accademici.
 Perché tanta enfasi sull'Africa, professor Struzak? -Perché - risponde - è il continente che ha più bisogno di collegarsi con il resto del mondo. E poi noi europei dobbiamo aiutare l'Africa anche perché portiamo la responsabilità di un passato coloniale. Da una grande soddisfazione vedere questi giovani che vengono ai nostri corsi imparare un sacco di cose che potranno poi applicare nei paesi d'origi-

Struzak

Abdus Salam ti
 d'accordo sul rae
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 di sviluppo.

INTERNATIONAL Herald Tribune

Wireless: The tin-can antenna offers a boon for third world

Elisabetta Povoledo International Herald Tribune
 WEDNESDAY, MARCH 1, 2006

TRIESTE, Italy A physics research institute here is using a low-cost but effective tool to bolster communications in developing countries: the tin-can antenna.

Made from a can (the best are those used for seed oil, their creators say), a screw-on connector and a short brass wire, the "cantenna" is promoted by researchers as a cheap and efficient tool to amplify access to information and communication technologies in some of the world's poorest and often most remote areas. Cantennas work like regular antennas but cost around €2, or \$2.40, to build, while those purchased in a store can cost several hundred euros. They are directional antennas and can be used for short- to medium-distance point-to-point links. They can also be used as feeders for parabolic dishes. That means that by aligning a series of cantennas, it is possible to receive signals from a distant receiver using one or more repeaters, which send, amplify and redirect radio waves, and send signals to remote areas.

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WIRELESS COMMUNICATIONS

Developing countries receive training in Trieste

New wireless technologies, often employing "free" unlicensed radio spectrum, can provide affordable broadband Internet access and voice service to the developing world if matched by supportive public policies and business approaches. Eighty young scientists, engineers, and lecturers, mostly from universities in developing countries, were in Trieste (Italy) from 7 February to 4 March 2005 to get a hands-on experience in developing low-cost and reliable technologies. They were selected from among 300 candidates from around the world to attend a course on "radio-based computer networking for research and training in developing countries. The three-week course was held within the scope of a cooperation agreement signed in February 2004 between the ITU Telecommunication Development Bureau (BDT) and the Abdus Salam International Centre for Theoretical Physics (ICTP).

Rob Fickenger