ICTP-ITU-URSI School on Wireless Networking for Development
The Abdus Salam International Centre for Theoretical Physics ICTP, Trieste (Italy), 6 to 24 February 2006

Radio for development: The ICTP-ITU-URSI School 2006

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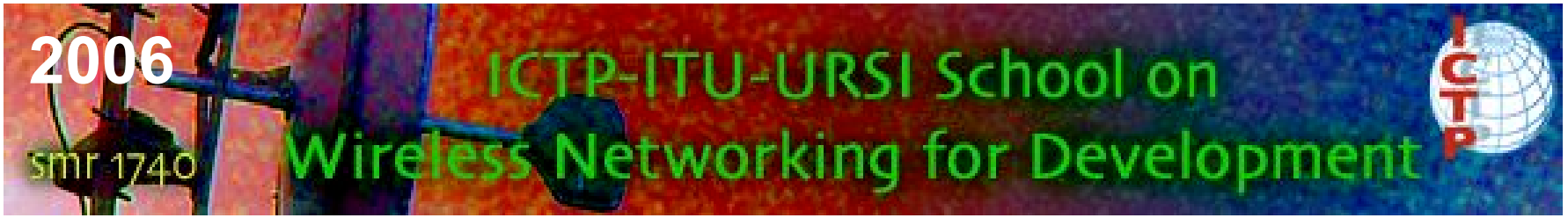


- Human development = progress: evolution from a less advanced to more advanced stage ...
- Knowledge is central to development*
  - » Since the Stone Age, the progress of humanity has been possible thanks to gathering & sharing knowledge and applying it to solve problems

  *) *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/idpm/publications/wp/di/index.htm*
- Teaching, learning, information sharing - central to knowledge dissemination; only humans can do it
  - » *J Delors: Learning: the treasure within; Report to UNESCO of the International Commission on Education in the Twenty-first Century, UNESCO 1996*

Where does knowledge reside?

- Then: human memory → writings
- Now:
  - Paper, film, magnetic/ optical media
  - Information infrastructures – local, regional, national, and global
- Access to knowledge = access to information & information infrastructures

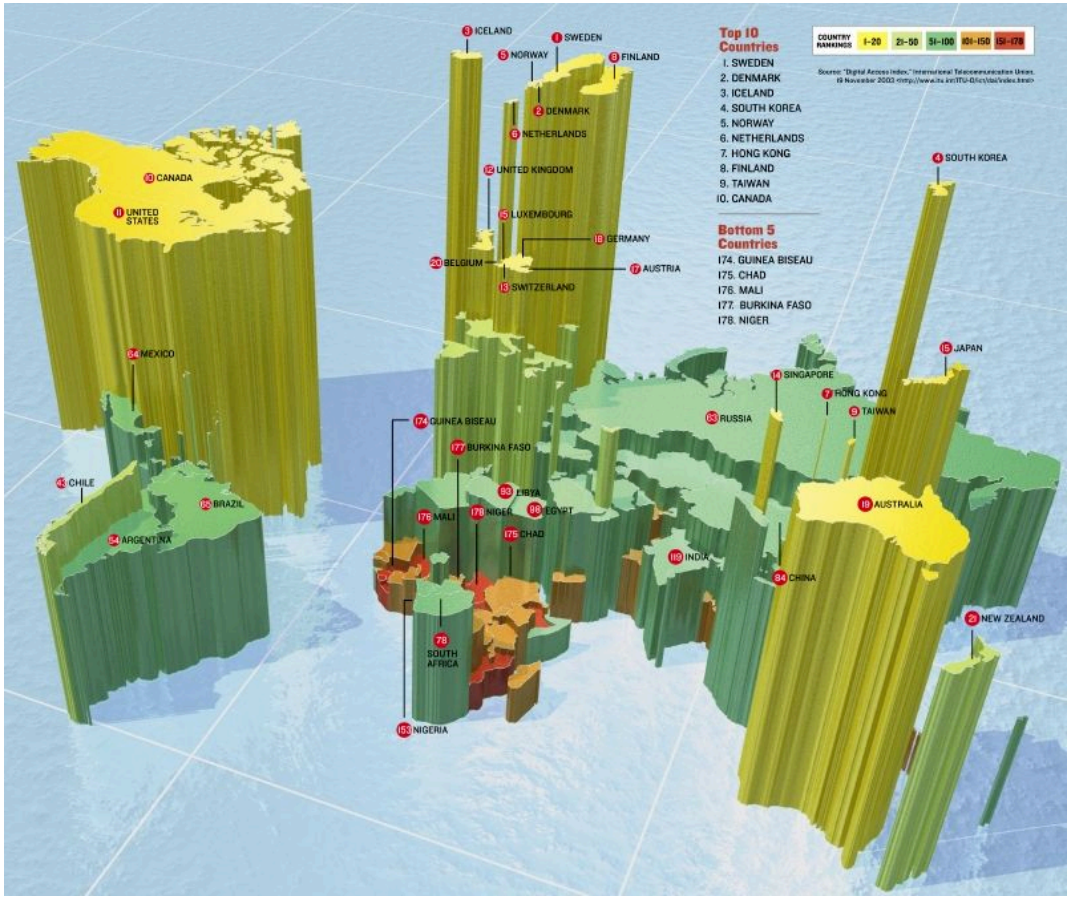
How much information?

- Average: ~800 MB per person per year
  - » Worldwide average, recent few years. It would take ~10m of books to store it on paper (formatted)
- >90% on electronic/magnetic media
- ~0.01% on paper !
  - » http://www.sims.berkeley.edu/research/projects/how-much-info-2003/
- Future: almost all information in electronic format, accessible only through ICT infrastructures (if the trend continues)

Trend

- The amount of new information has about doubled in 3 years
  - » Information stored on paper, film, magnetic, and optical media
- The next 3 years will see 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/
- 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

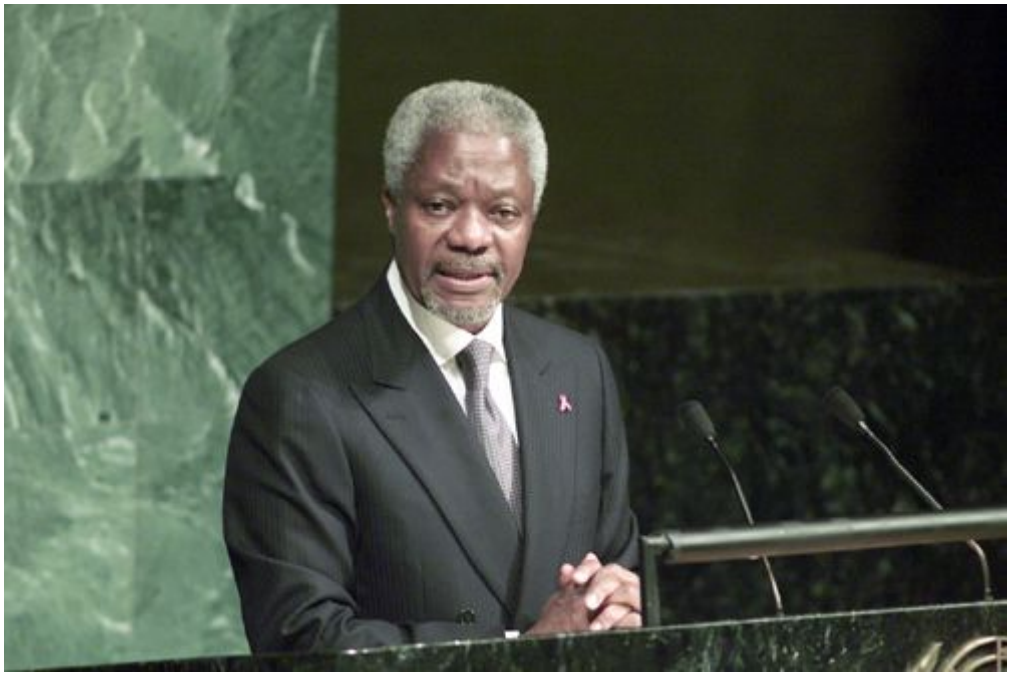
http://www.itu.int/ITU-D/ict/dai/

http://www.spectrum.ieee.org/WEBONLY/resource/feb04/0204bmapf1.pdf http://www.internetworldstats.com/list3.htm

What are access barriers?

- Physical
  - Lacking libraries, computers, telecommunications, transportation
- Education
  - Read/write illiteracy, computer illiteracy, language
- Legal/ regulatory/ organizational
  - Intellectual property rights
- Financial
- Other

Humanitarian viewpoint



- 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)

Business viewpoint

- Business is ruled by profit
  - ICT is a big industry that must grow to keep workplaces and profits
  - Wealthy markets approach saturation
  - Chance for poor regions:
    - 80% of the world population reside in poor/ rural regions
    - Potential large markets for Equipment Manufacturers & Providers, Service Providers, Contents Creators & providers

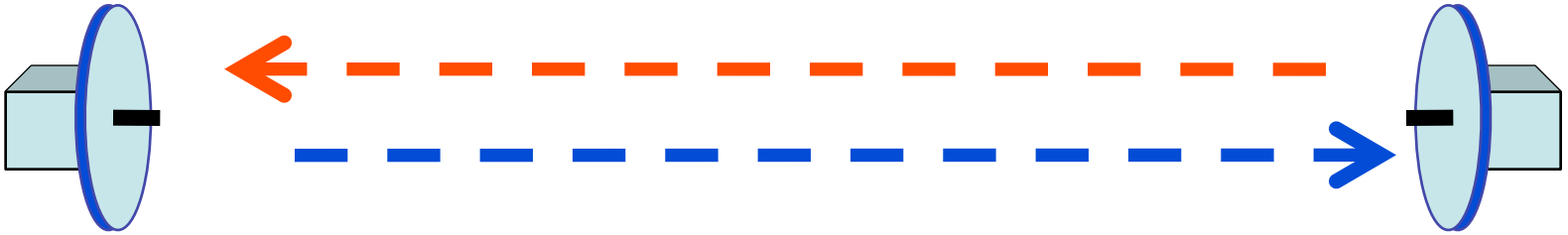
Challenge

- Assuring universal access to information infrastructure in all rural, remote, and under-developed regions over the world is an enormous challenge of the 21st century
- Your participation in this ICTP school will contribute towards that goal

- The School program is focused on innovative solutions in design and implementation of 2.4 GHz low-cost wireless local area networks (WLANs) not only interconnecting computers, but also offering data, audio, and video communications.
- Much of the school time is devoted to hands-on sessions on antenna and WLAN building, installation, testing and measurements.

The school focus: why radio?

- Because radio is unique access technology to local & global information infrastructures
  - Most future telecommunication devices will be wireless: mobile or transportable
    - » J Zander, SL Kim: Radio resource management for wireless networks; Artech House 2001, p. 315
  - Radio is priceless in emergency situations when other communications fail
  - Radio is cheapest in sparsely-populated/ remote regions with no pre-existing wired/ cabled telecommunication infrastructure
    - » The recent tsunami, hurricane, and earthquake disasters around the world evidenced the role of radiocommunications
      R Struzak: Emergency Telecommunications with and in the Field; UN OCHA 2000



Radio waves carry information to fixed & mobile users at no cost

- Ubiquitous - accessible at any place, any time…*
- Free; no right-of-way
- Fast: ~300’000 km/s
- Deployment cost & time
- Indestructible - no theft, snow, wind, flood, earthquake, tornado, trees…
- No cable production/ transport/ maintenance…

*Over the Earth’s surface

The school focus: why practice?

- There are many textbooks on microwave radio networking (theory)
- Opportunities are rare to make practical exercises
  - » Trainings offered by equipment manufacturers are product/ contract-oriented

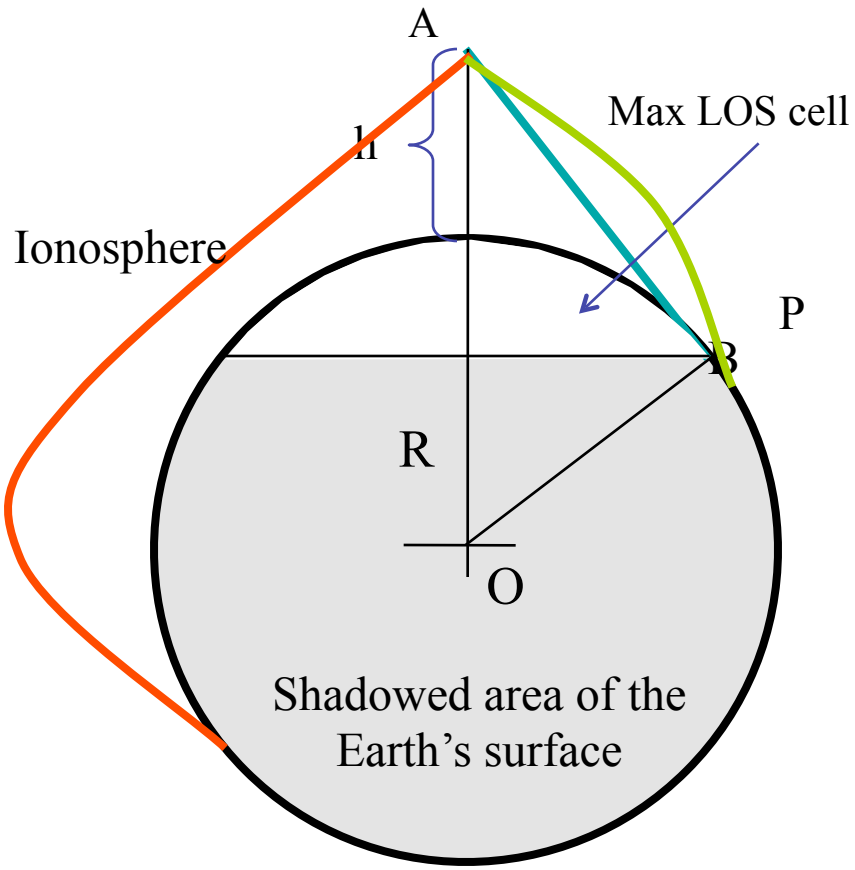
School focus: why WiFi?

WiFi stays for "Wireless Fidelity", a set of IEEE 802.11 standards for microwave radio access technology or wireless local area networks (WLAN)

- Inexpensive, “off-the-shelf” equipment
- Uses free frequency bands: no need for individual license
- Widespread, proven technology
- Promises communications at speeds up to 11 Mbps within rooms; extendable up to ~25 km

- Developing nations should leapfrog the digital gap using fiber optic cable and terrestrial wireless technology, WiFi and WiMAX
  - » Patrick Gelsinger (INTEL Senior Vice President and Chief Technology Officer), quoted after Larry Press, "Wireless Internet connectivity for developing nations," *First Monday,* volume 8, number 9 (September 2003), at http://www.firstmonday.org/issues/issue8_9/press/index.html#note4.
  - » See http://www.ieee802.org/16/ and http://www.ieee802.org/20/.

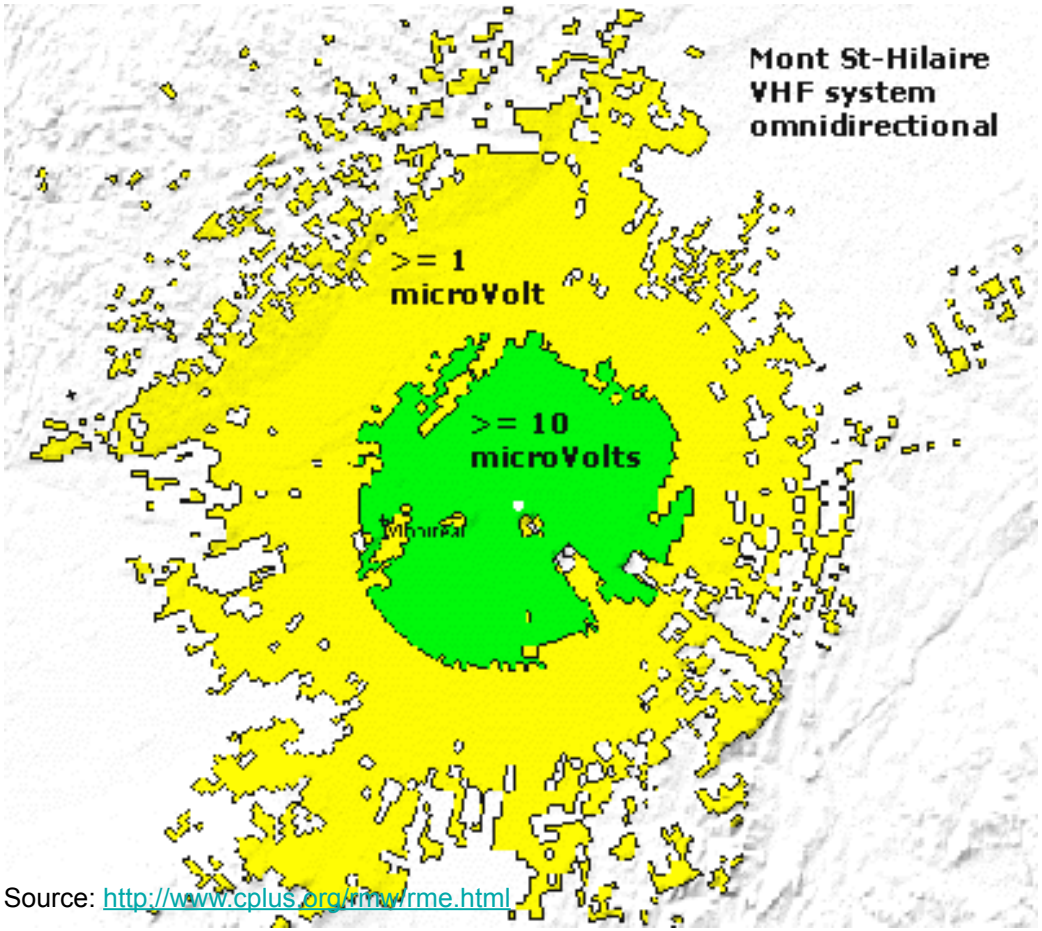
Evolution



- Terrestrial radio
  - Microwave LOS
  - HF ionospheric
- Satellite radio
  - LEO, GEO, MEO
- Stratospheric radio

LOS = Line-Of-Sight

Terrestrial radio coverage



Source: http://www.cplus.org/rmw/rme.html

- Microwave terrestrial LOS systems suffer from terrain obstacles
- Short-wave systems are narrow-band and suffer from fading

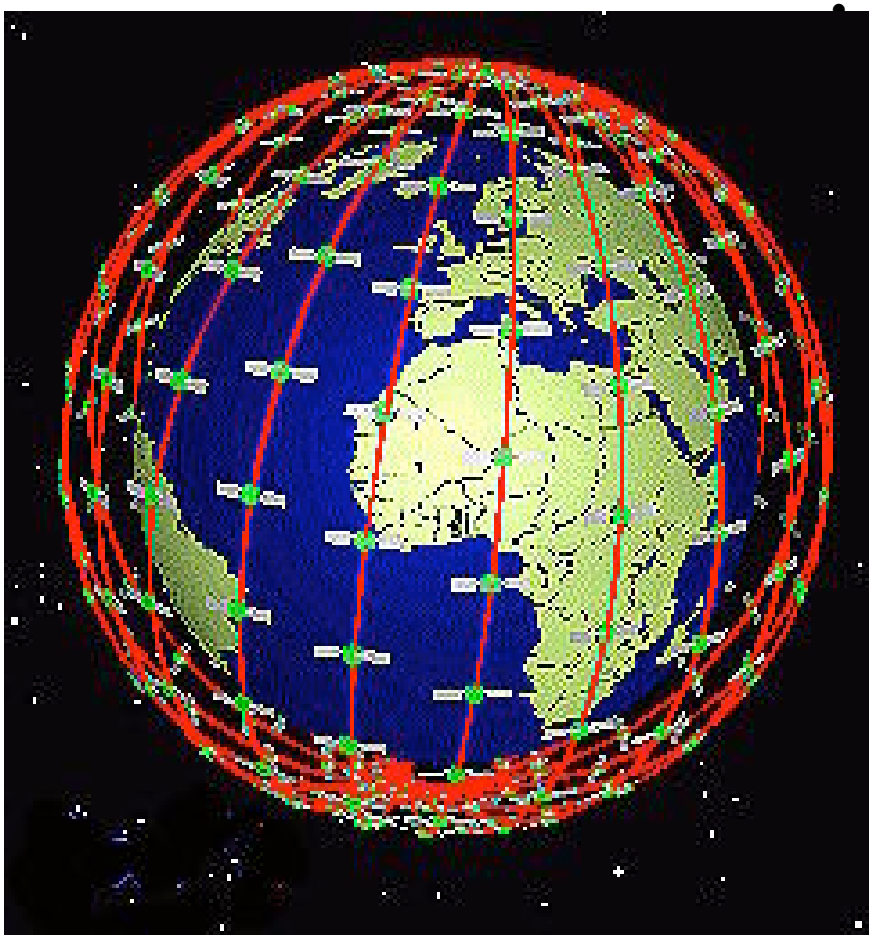
GEO satellites

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

Source: ESA - (Ariane 5)

- 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
  - » See the Global VSAT Forum, [http://www.gvf.org/].

LEO satellites



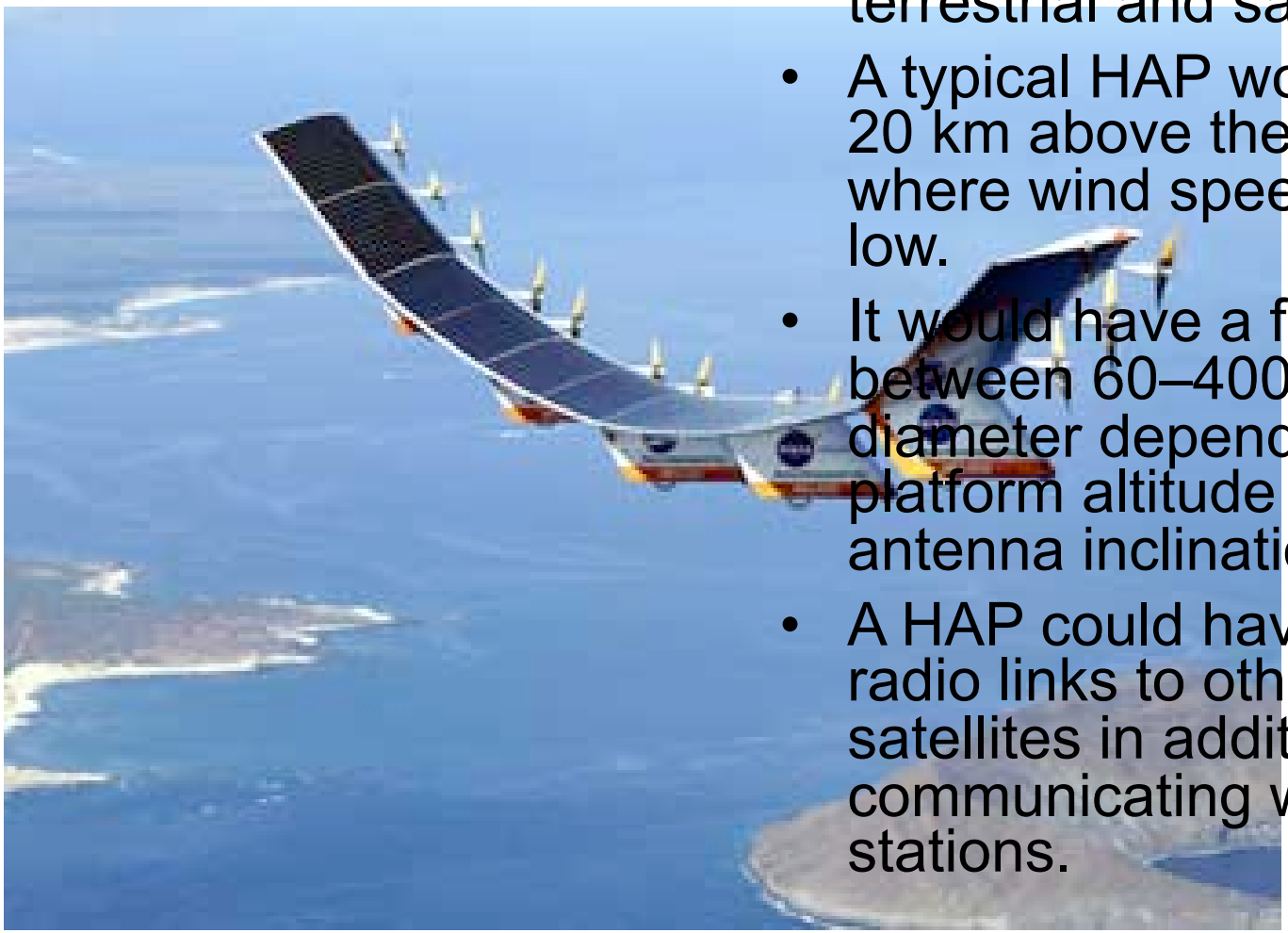
Source: This image was generated using Satellite Constellation Visualizer, at http://sourceforge.net/projects/savi/.

- 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

 (Source: Orbital Science Corp., 1998)

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.)

- The HAPS proponents promise services much cheaper that the terrestrial and satellite systems
- A number of R&D projects under way, but no HAP station has been in operation yet
    - » *R Struzak:* Mobile telecommunications via stratosphere; http://www.intercomms.net/AUG03/content/struzak1.php http://www.capanina.org/; http://www.capanina.org/news.php (videos)
    - – There will be a short film on HAPS

Other perspectives

- 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

Warning…

- 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 experts with impeccable credentials...

"Heavier-than-air flying machines are impossible" [*Lord Kelvin, famous physicists,* 1897]

"Radio has no future" [*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*]

Concluding remarks

- Access technology is only one of several “divides” that exist in the world
- Digital divide is a manifestation of poverty – it is meaningless for those who lack safe water, adequate nutrition, basic education, or other essentials…
- Technology alone can not bridge the digital gap, but can facilitate its closing

- The 2006 School aim is to contribute to closing the digital gap and to advancing scientific development in academic and research institutions in Developing Countries
- I hope you, the participants, will take a leading role here and I wish you every success in this endeavor

Lecturers & Instructors

- C Cap
- R Flickenger
- C Fonda
- J Grassberger
- T Krag
- W Luther
- E Pietrosemoli
- G Repici
- R Struzak
- M Zennaro

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- This project was possible thanks to collaboration of a number of organizations and individuals

Any question ?

Thank you for your attention