

The Abdus Salam ICTP Aeronomy and Radiopropagation Laboratory (ARPL)



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ICTP mission

Founded in 1964, the Abdus Salam International Centre for Theoretical Physics (ICTP) operates under the aegis of UNESCO and IAEA and a seat agreement with the Government of Italy, to:

- * Foster the growth of advanced studies and research in physical and mathematical sciences, especially in developing countries;**
- * Develop high-level scientific programmes keeping in mind the needs of developing countries;**
- * Provide an international forum of scientific contact for scientists from all countries;**
- * Conduct research at the highest international standards.**



ICTP and the world of science

ICTP welcomes about 5,000 scientists each year. About 50% of the 100,000 scientists who have participated in ICTP research activities since the Centre's inception in 1964 are from developing countries.

Visitors have represented some 170 nations and 40 international organizations.



The Marie Curie Library


Fully computerized:

- **it houses one of the largest collections of specialized literature in physics and mathematics in Europe,**
- **covers an area of 3,200 square meters,**
- **has more than 66,000 books and 439 current print subscriptions,**
- **has a comfortable environment with 70 reading places is available to work or study.**

The Library give access to 3,600 e-journals and several leading scientific databases from 12 workstations located inside the Library, and all computers across campus.



Research fields

 **Applied physics (AP) [Includes the Aeronomy and Radiopropagation Laboratory]**

 **Condensed matter and statistical physics (CMSP)**

 **Earth system physics (ESP)**

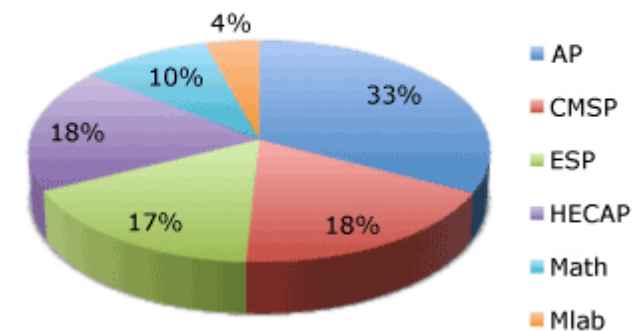
 **High energy, cosmology and astroparticle physics (HECAP)**

 **Mathematics (Math)**

 **ICTP-INFN Laboratory (Mlab)**



Visitor Participation by Field, 2008



ICTP Programmes

Diploma Programme

Sandwich Training Educational Programme

Associateship Scheme

Federation Arrangements

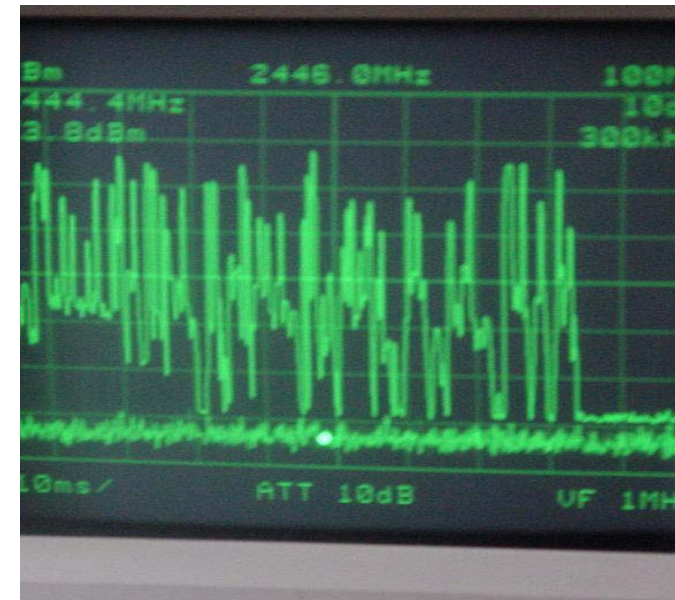
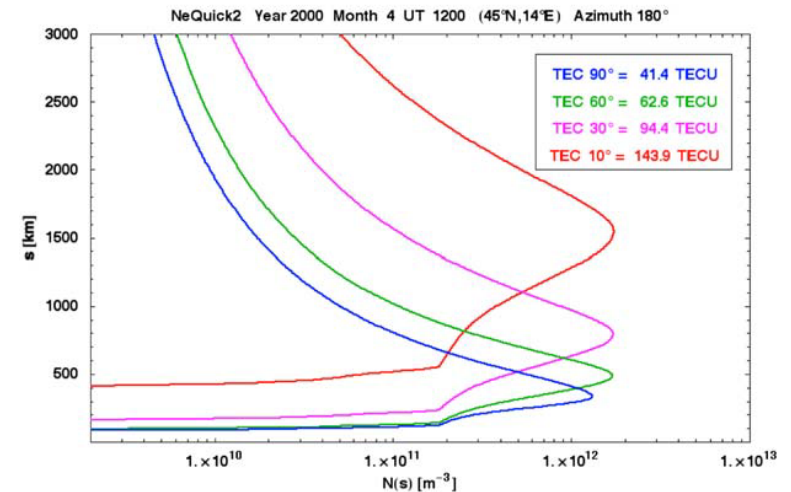
Training and Reserach in Italian Laboratory



<http://www.ictp.it/pages/mission/statistics.html>

ARPL: two sections

- **Aeronomy and Radiopropagation:**
research and training in ionospheric physics with emphasis on satellite positioning and navigation
- **Wireless Networking:**
research and training in wireless ICT for Development (ICT4D)



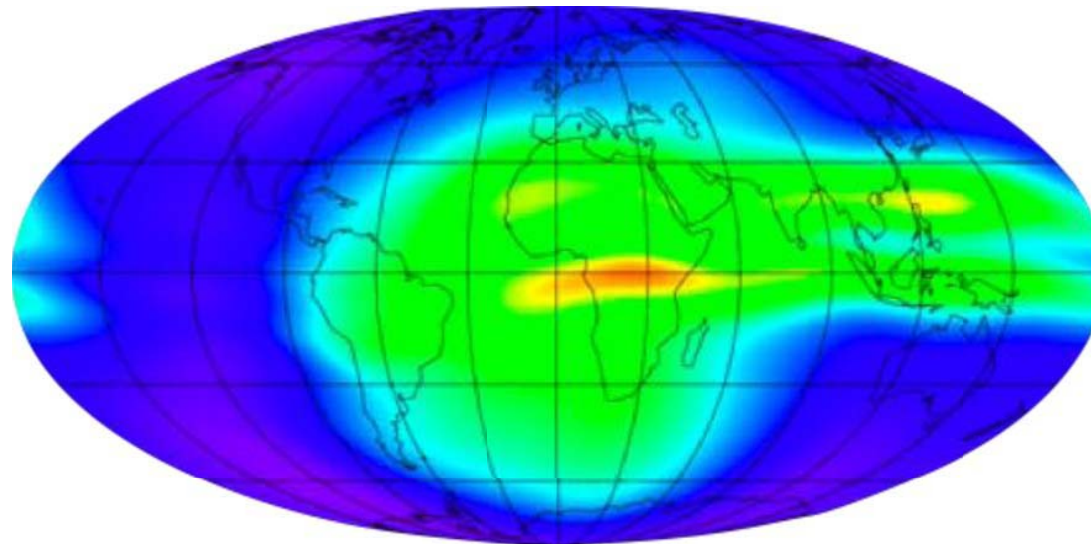
Aeronomy: models

- ◆ an advanced 4D ionospheric electron density model: *NeQuick*
- ◆ simulation of ionospheric effects on satellite navigation systems (EGNOS, Galileo)
- ◆ data assimilation in models



NeQuick* has been adopted to compute ionospheric correction in the future European Satellite Positioning System *GALILEO

***NeQuick* has been proposed by ESA as ITU-R recommendation for TEC calculations**



NeQuick and IRI

Taking into account results like those shown in the figure the IRI in its last version, IRI-2007, adopted the NeQuick new formulation as the default option for its topside:
http://omniweb.gsfc.nasa.gov/vitmo/iri_vitmo.html

Bilitza and Reinisch (2008) consider the new NeQuick topside electron density profile “*the most mature of the different proposals for the IRI topside*”.

Aeronomy: radio occultations

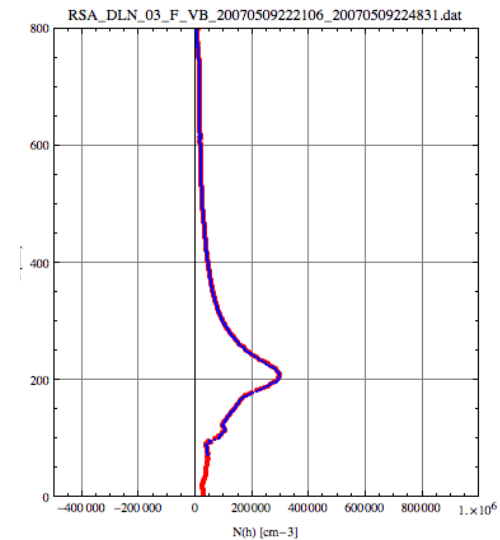
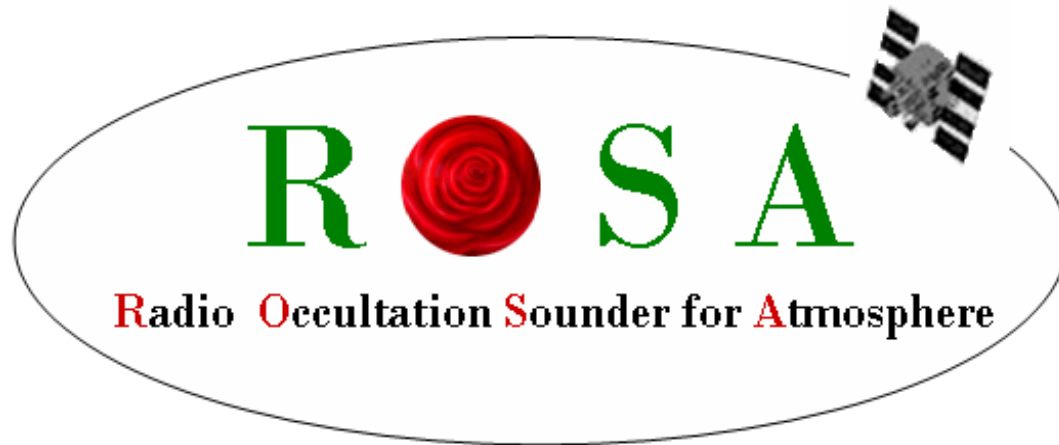
- ◆ *radio occultation data inversion techniques* are used to derive the vertical electron density profile of the ionosphere from satellite measurements.

- ◆ the advantage is to get such profiles where measurements from ground stations are not available (e.g. in Africa or over the oceans).



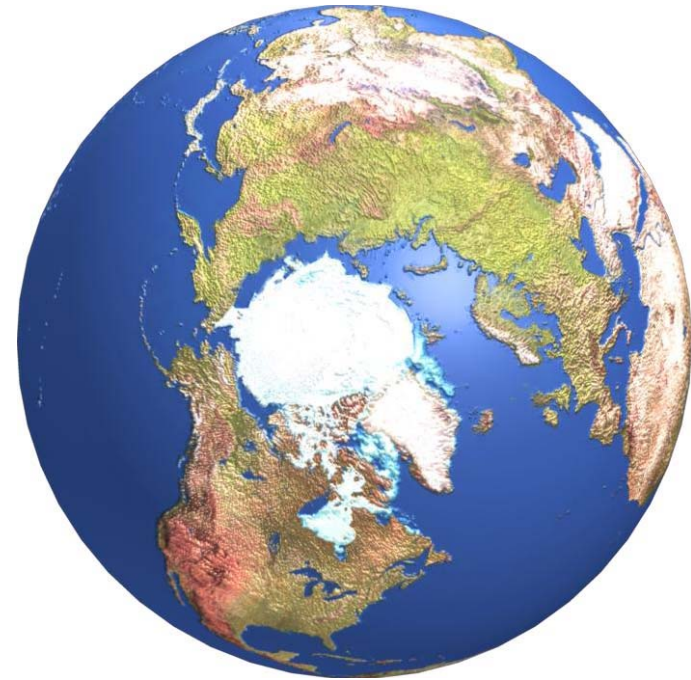
ARPL participates in the ASI project *ROSA* (*Radio Occultation Sounder of the Atmosphere*)

ARPL has developed a software to extract ionospheric and atmospheric information from satellite radio-occultation data



Aeronomy: collaborations

- ◆ Europe: *Italy, Austria, Spain, Russia*
- ◆ Africa: *Nigeria, Ivory Coast, Egypt, Ethiopia, Zambia*
- ◆ Americas: *USA, Argentina, Cuba*



ARPL has a partnership with the Boston College (USA), to provide instrumentation to build distributed observatories in Africa and foster local research in GNSS science and applications in Africa



The Partnership



The **ICTP** promotes advanced studies and scientific research in developing countries through schools, colleges, workshops and other training activities both at ICTP and in other countries. In particular the **Aeronomy and Radiopropagation Laboratory** has been concerned with ionospheric research of interest to the European Navigation Satellite programs and GNSS ionospheric related science and applications for a number of years, involving scientists from developing countries particularly from South America and Africa.

Boston College is an American Jesuit University with a dedication to international outreach programs that address societal needs. Through the **Institute for Scientific Research**, Boston College conducts research programs that include GNSS for scientific exploration and practical applications. It has also been involved in international programs related to GNSS studies. These studies have included scientists from developing countries in South America, Asia and from Africa.

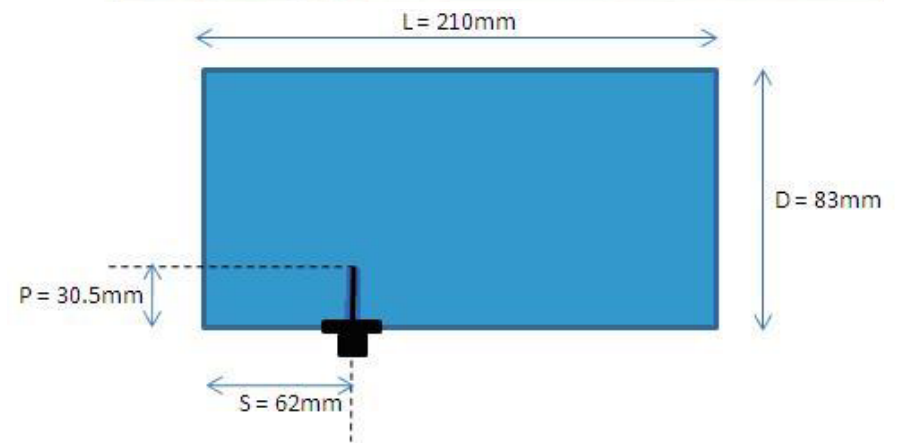


Wireless Networking Unit

Training

Wireless long
distance

Wireless Sensors
Networks



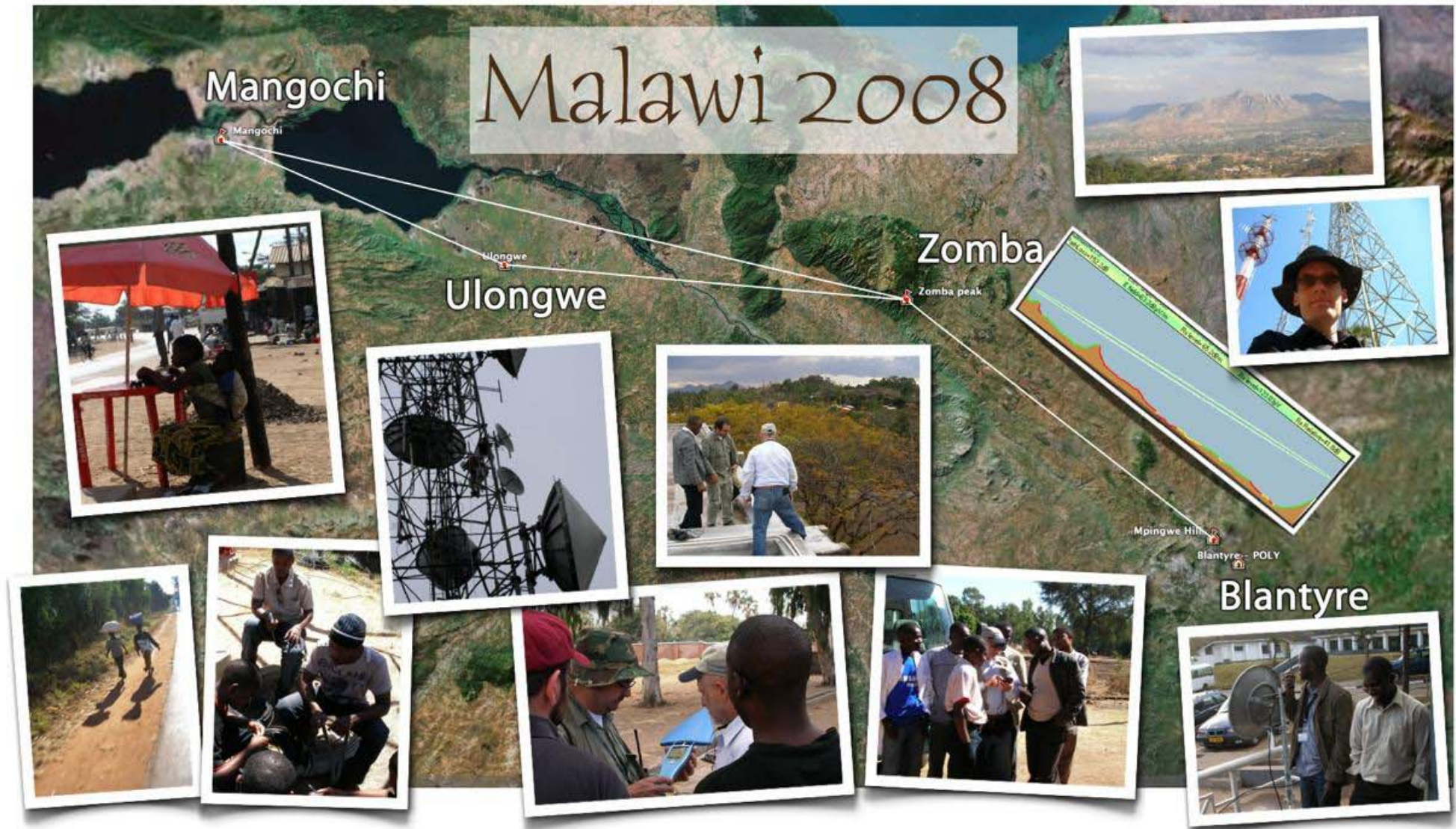
Wireless: ICTP-ITU lab

- ✦ a joint *ICTP–ITU/BDT Technology Observatory and Training Unit for Developing Countries* was created in 2007, following many years of collaboration with the ITU/BDT
- ✦ in 15 years, over 1200 expert have been trained (*in more than 50 activities at ICTP and abroad*)



Wireless: long distance Wi-Fi

- ✦ **project in Malawi (*Polytechnic of Blantyre, College of Medicine; funded by Regione FVG*)**
- ✦ **project in Venice lagoon (*for MOSE; funded by Consorzio Venezia Nuova*)**
- ✦ **research (*testbed link: 130km*)**
- ✦ **training**



Connecting hospitals across 150km with low-cost wireless

Wireless: training kit

- ✦ it's a *“WiFi-course-in-a-box”*, ready to be integrated into various academic curricula in Developing Countries
- ✦ the kit consists of low-cost hardware for laboratory and hands-on exercises, lecture notes, videos, teacher's and student's guides for intensive 2-weeks courses in wireless networking (*up to 40 students*)

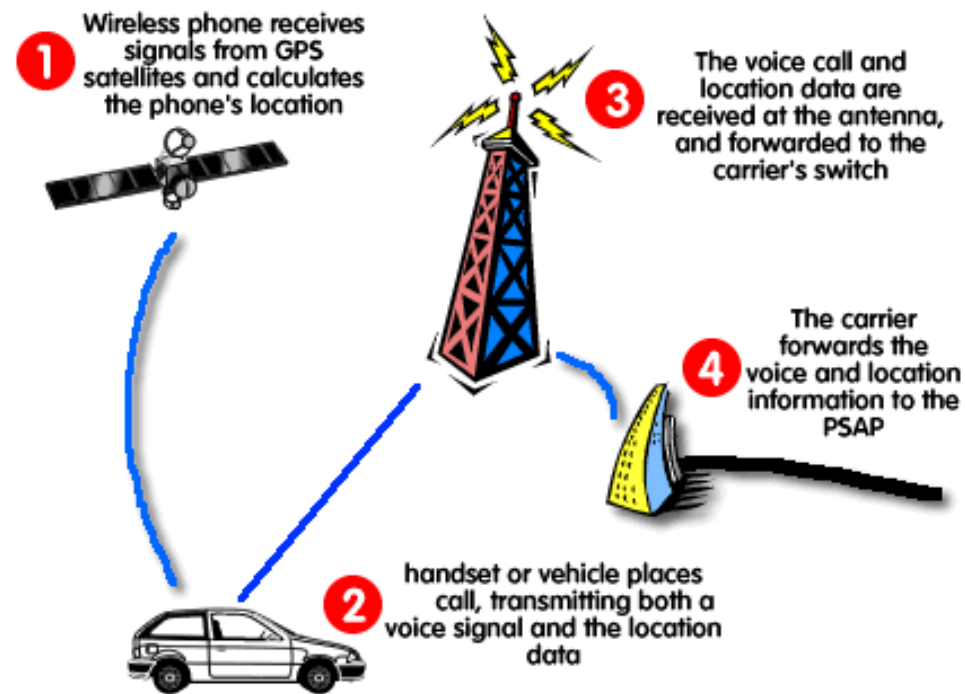


Wireless: WSN

- ✦ **Wireless Sensor Networks are considered the big revolution in both ICT and environmental sciences**
- ✦ **research in WSN is carried out at ARPL in collaboration with other institutions worldwide and with the involvement of researchers from Developing Countries.**



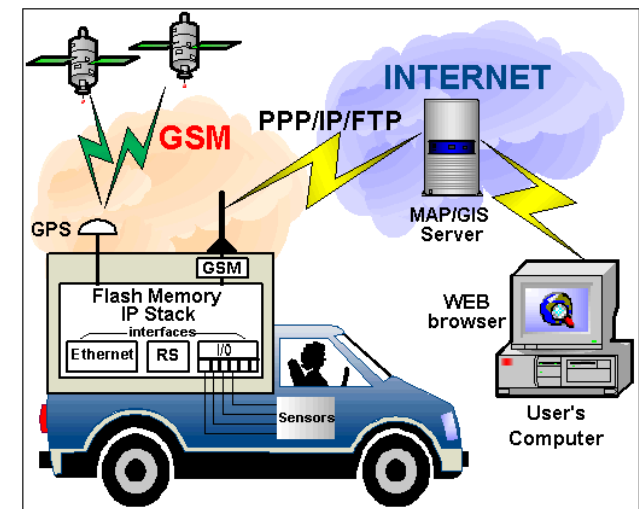
ARPL: moving forward



Positioning and Connectivity

There is a clear link between connectivity (including Bluetooth, Wi-Fi or cellular network) and positioning (location).

- *Positioning or location-based systems extend the reach of ICT out into the physical world – be it across a campus, the city streets or into remote wilderness.*
- *Users with mobile displays move through the world.*
- *Sensors capture information about their current context, including their location, and this is used to deliver information that changes according to where and when they are.*



*We at the ARPL are working towards the merging together of these two technologies:
POSITIONING and WIRELESS ICT*

POSITIONING

- *new-gen advanced ionospheric models*
- *multiple-sources data assimilation in models for low-latitude regions*
- *GNSS science and application in D.C.*

WIRELESS ICT4D

- *advanced long distance low-cost wireless*
- *WSN and environmental monitoring*
- *disaster communications*

**Thank you
for your attention!**

