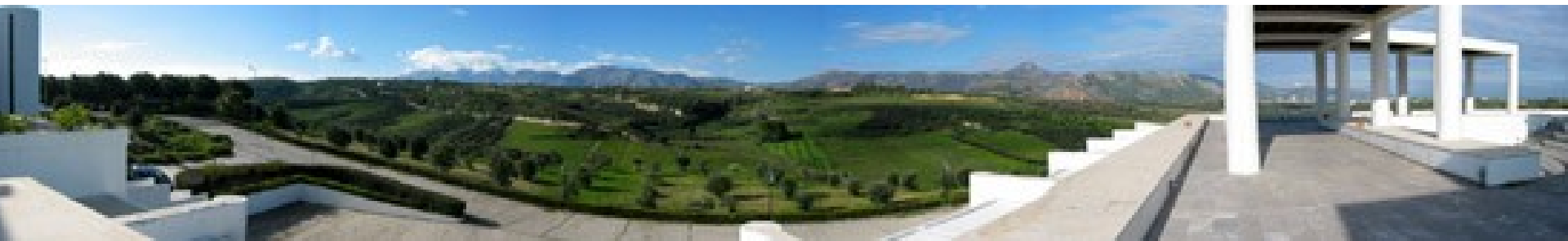




Lectures on ***Wireless Networks & Mobile Computing***
CS 439 & 539

Prof. Maria Papadopouli
University of Crete
ICS-FORTH
<http://www.ics.forth.gr/mobile>



Περιεχόμενα



Εισαγωγή στις θεμελιώδεις έννοιες σχετικά με τα παρακάτω:

- ασύρματα δίκτυα, τόσο στο φυσικό όσο και στο **MAC layer** (**radio propagation, channel, modulation**)
- **συστήματα εύρεσης θέσης** (positioning systems)
- ασύρματες τεχνολογίες (πχ **IEEE802.11**, WiMAX, UWB, Bluetooth, RF tags, sensors, LTE)
- αρχιτεκτονικές/μοντέλα πρόσβασης
 - στην πληροφορία (πχ mobile peer-to-peer systems, infostations) , και
 - ασύρματων δικτύων (πχ ad hoc, mesh, sensor, infrastructure networks),
- πρωτόκολλα δρομολόγησης σε ασύρματα δίκτυα (routing protocols)
- εποπτεία ασύρματων δικτύων και ανάλυση της απόδοσης τους
- quality of experience in VoIP and Video streaming services
- πρωτότυπες εφαρμογές & υπηρεσίες που χρησιμοποιούν mobile devices και βασίζονται στο crowd-sourcing & participatory μοντέλο
- **τηλεπικοινωνιακές αγορές και οικονομία δικτύων**

Short CV



Originally from Heraklio, Crete, Greece

- B.Sc. **University of Crete** (1992)
- M.Sc. **New York University** (1994)
- Ph.D. **Columbia University** (2002)

Ph.D. Thesis “Resource sharing in mobile wireless networks”

Advisor: Prof. Henning Schulzrinne

- Assistant Professor, **University of North Carolina at Chapel Hill** (2002-2006)
- Research Associate, **Foundation for Research & Technology-Hellas** (2004-)
- Associate Professor, **University of Crete** (2005-)
- Guest Full Professor, KTH Royal Institute of Technology (2011-2013)

Research interests:

wireless networks, measurements & modeling, mobile computing, positioning

Wireless access markets

Εισαγωγικά - Δομή



Δεν είναι ένα συνηθισμένο μάθημα!

Οι φοιτητές θα χρειαστεί να διαβάσουν από διάφορες πηγές:

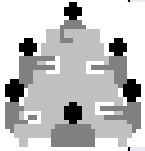
- Υλικό online (διαλέξεις, papers)
- Κεφάλαια βιβλίων

Περιλαμβάνει τόσο **θεωρητικές** όσο και **πρακτικές ασκήσεις**.

Θα γίνουν **διαλέξεις από τους φοιτητές**

Θα γίνουν διαλέξεις από τους μεταπτυχιακούς φοιτητές/βοηθούς και εργαστήρια

Αν έχουμε Erasmus φοιτητές, οι διαλέξεις θα γίνονται στα αγγλικά



- Ευριπίδης Τζαμούσης tzamusic@csd.uoc.gr
- Μαρια Πλακιά plakia@csd.uoc.gr



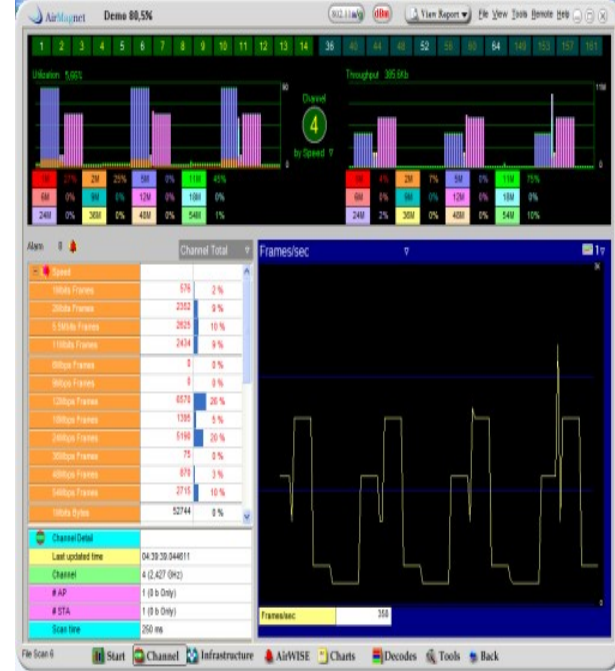
Project 1:

Εποπτεία ασύρματου δικτύου



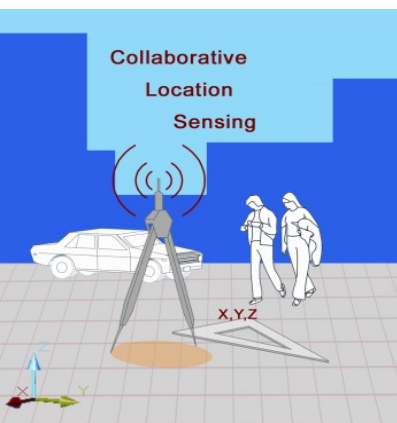
- Θα στήσετε testbed για την παρακολούθηση και την καταγραφή δεδομένων σχετικά με την κίνηση και την πρόσβαση χρηστών σε ένα ασύρματο δίκτυο.
- Θα εξοικειωθείτε με προγράμματα εποπτείας (π.χ., *tcpdump*, *wireshark*, *iwlist*, *snmp*, *syslogs*) καθώς επίσης και με την συλλογή δεδομένων.

Project 2: Στατιστική ανάλυση & επεξεργασία δικτυακών δεδομένων



- Δεδομένα που έχουν καταγραφεί σε ασύρματα δίκτυα με διάφορα προγράμματα εποπτείας δικτύων (Project 1), θα τα αναλύσετε στατιστικά με σκοπό την εξαγωγή συμπερασμάτων για το δίκτυο.
- Θα εξοικειωθείτε με *matlab* & απλές στατιστικές συναρτήσεις (πχ υπολογισμό mean, median, Cumulative Distribution Function, fitting κατανομών)

Project 3- Συστήματα εύρεσης θέσης



- Εξοικείωση με ανάλυση μετρήσεων signal-strength.
- Ανάλυση της fingerprinting μεθόδου και κάποιων που βασίζονται στην απόσταση

Research Projects (Examples)



- Analysis of the **quality-of-experience (QoE)** for various applications (systems project)
- Develop a crowd-sourcing screening tool for **autism spectrum disorder (ASD)** in children
- Develop a tool that **senses the user satisfaction while watching video using camera**
- Valuation of the **information fingerprint in the context of online shopping**
- Develop a **recommendation system** for video streaming service providers

Εισαγωγικά - Βαθμός



- Εργαστηριακές ασκήσεις **20%**
θα δοθεί κώδικας έτοιμος, πάνω στον οποίο θα υλοποιήσετε το project σας
Ομάδες 2-3 ατόμων ή ατομικά projects
Sharing of the infrastructure (e.g., Android phones)
- Τελικός (Final exam) **50%** (βαθμός > 4.5, για να περάσει κάποιος το μάθημα)
- Project & workshop **(30%)**

Large-scale Wireless Testbeds



Experimenting with
state-of-the-art wireless technologies

Wireless testbeds based on IEEE 802.11

- UNC campus (with **> 900 APs**, 20,000 users)
- Iraklion (area of **150 Km²**)
- **ambient technology space** at FORTH

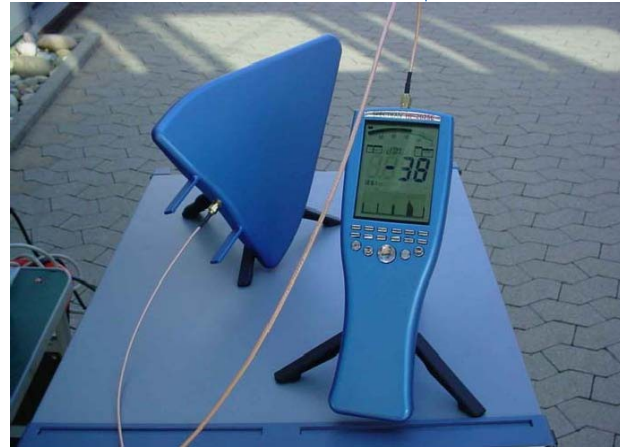


Telecommunications & Networks LAB

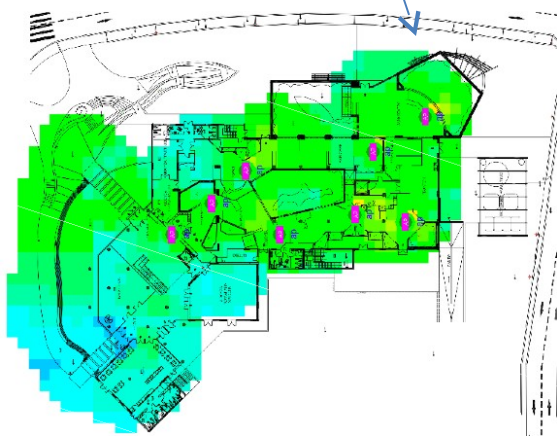
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Spectrum analyzers



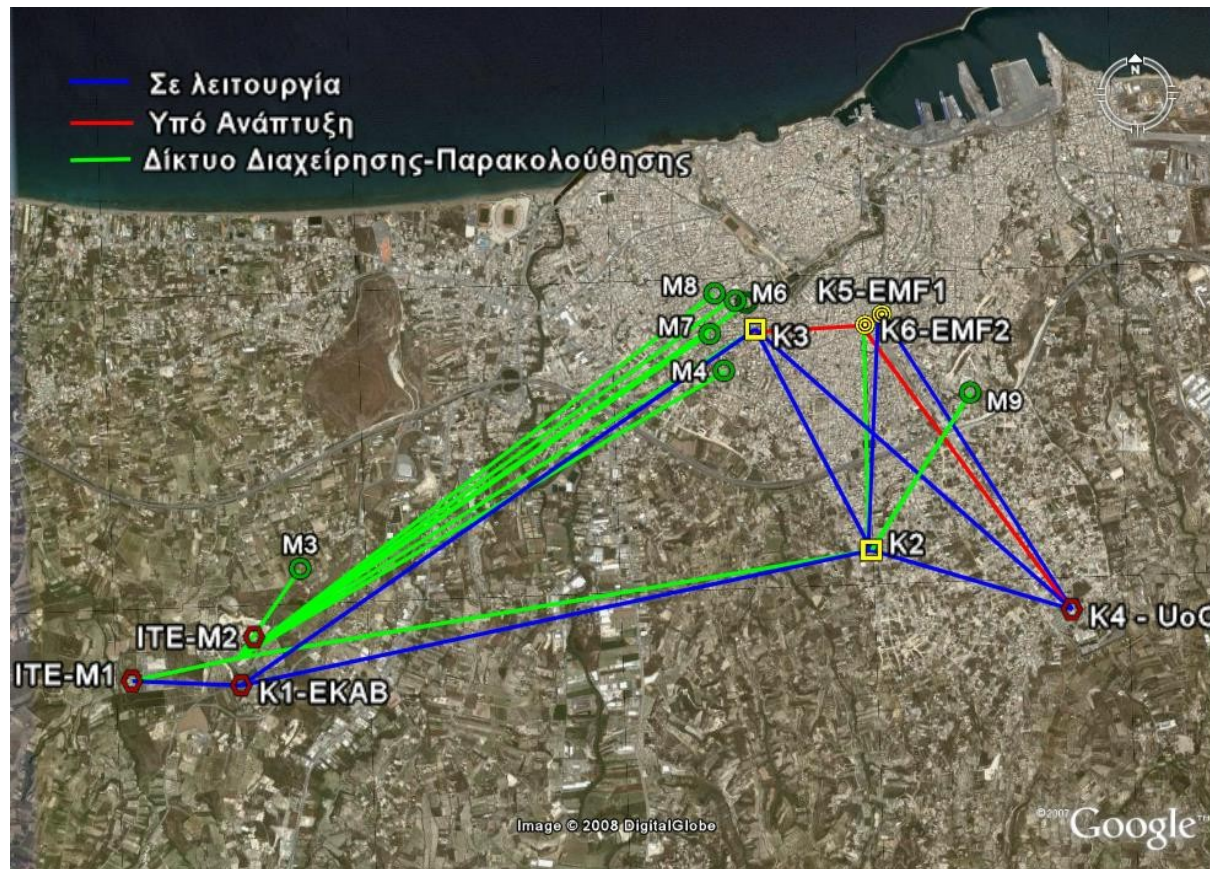
Airmagnet survey & planner



AMS
airmagnet
analyzers



Wireless Mesh Testbed @ Heraklion



- Deployed by ICS-FORTH
- The green line indicates the management/monitoring network, the blue line indicates the operational network, while the red line shows the under-development part of the network

Agenda



- **Introduction on Mobile Computing & Wireless Networks**
- Wireless Networks - Physical Layer
- IEEE 802.11 MAC
- Wireless Network Measurements & Modeling
- Location Sensing
- Performance of VoIP over wireless networks
- Mobile Peer-to-Peer computing

General Objectives



- Build some background on wireless networks, IEEE802.11, positioning, mobile computing
- Explore some research projects and possibly research collaborations

Wireless Networks & Mobile Computing



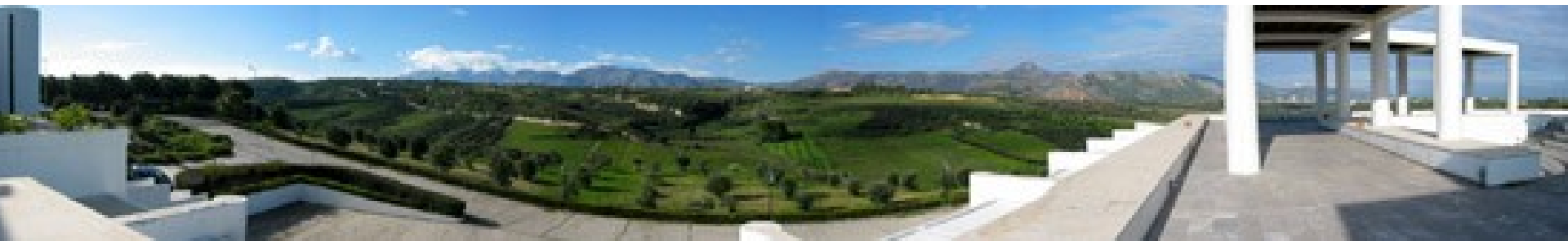
Lecture on *Introduction on Mobile Computing*

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Profound technologies



**“ The most profound technologies are those that disappear.
They weave themselves into the fabric of everyday life until
they are indistinguishable from it.”**

Mark Weiser, 1991

Weiser's vision



- The creation of environments saturated with computing and communication capability yet gracefully integrated with human users
- After two decades of hardware progress, many critical elements of pervasive computing that were exotic in 1991 are now viable commercial products: handheld and wearable computers, wireless LANs, and devices to sense and control appliances
- Well-positioned to begin the quest for Weiser's vision

Constraints in Pervasive Computing



The most precious resource in a computer system is no longer its processor, memory, disk or network. Rather, it is a resource not subject to Moore's law:

User Attention

Today's systems distract a user in many explicit & implicit ways, thereby reducing his/her effectiveness.

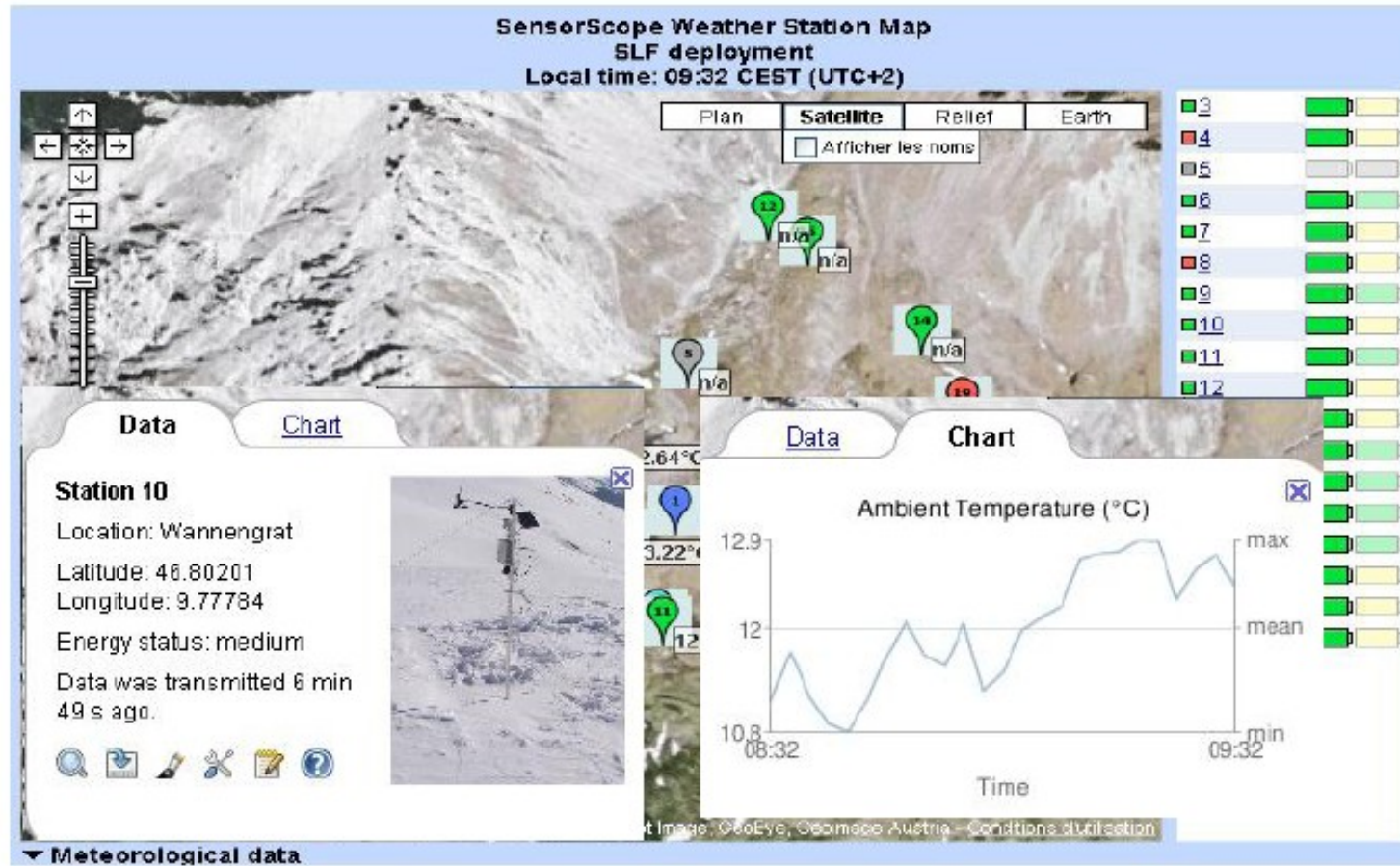
- Understand the quality-of-experience (QoE) for a service
it is not just a simple set of QoS metrics (e.g., bandwidth, delay, packet loss)
- Define the user utility function!

Pervasive computing – Smart spaces



- Pervasive computing is the **method of enhancing computer use** by making many computers available throughout the **physical environment** but **effectively invisible to the user**.
- Pervasive computing spaces involve **autonomous networked heterogeneous** systems operating with **minimum human intervention**

Monitoring the environment



Source: Joao Da Silva's talk at Enisa, July 20th, 2008

Tagged products



Source: Joao Da Silva's talk at Enisa, July 20th, 2008

A new Wave of Visualisation and Search Devices



Source: Joao Da Silva's talk at Enisa, July 20th, 2008

3D: the next frontier

- ❖ Multiplicity of Virtual World Platforms, 60 M users estimate
- ❖ Confluence of trends: social networks, user generated content, immersive experience, rich media
- ❖ 3D pioneered through Games
- ❖ A possible approach to information overload
- ❖ New business perspectives

Level of Interaction ↑



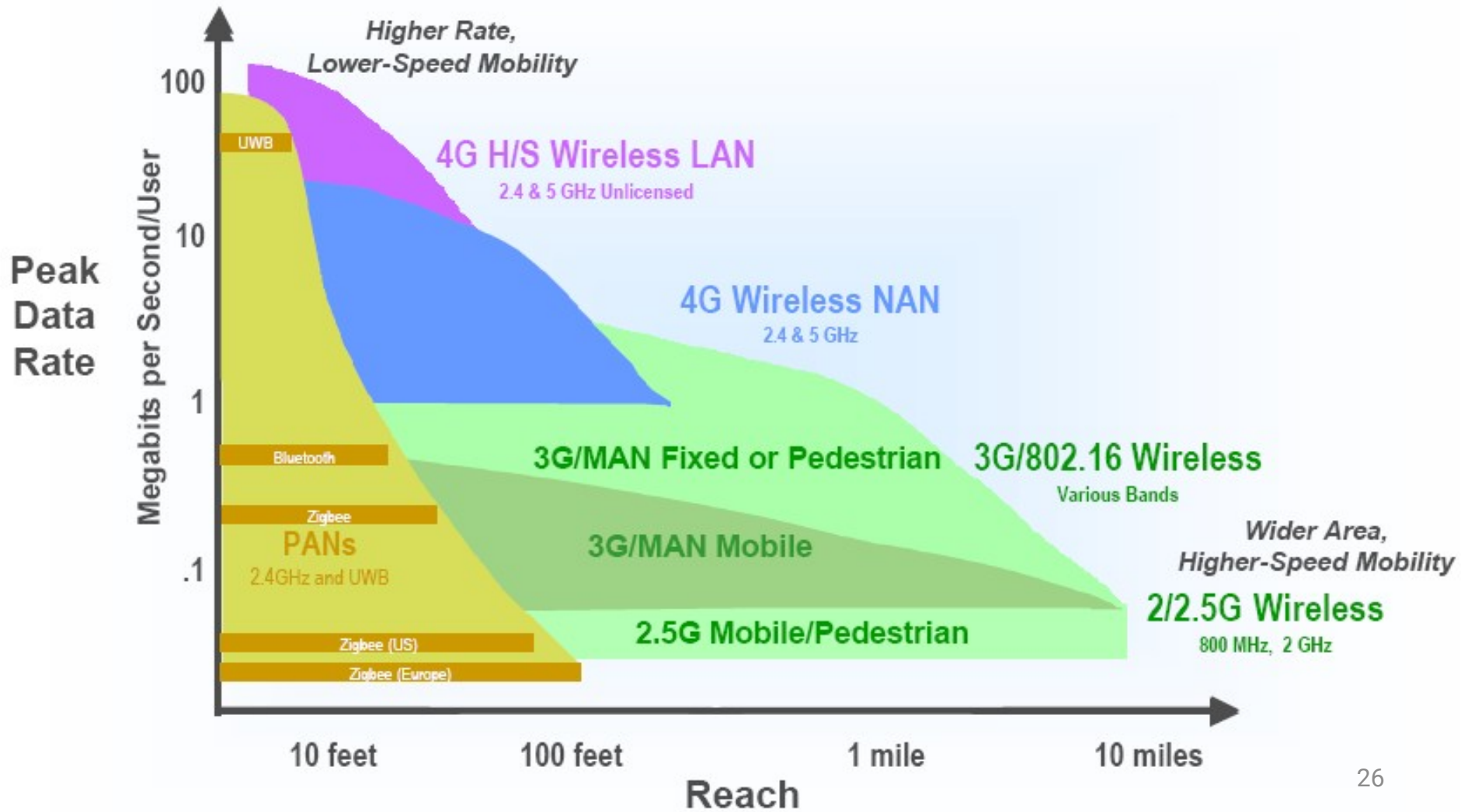
Source: Joao Da Silva's talk at Enisa, July 20th, 2008

Time →

New networking paradigms for efficient search and sharing mechanisms



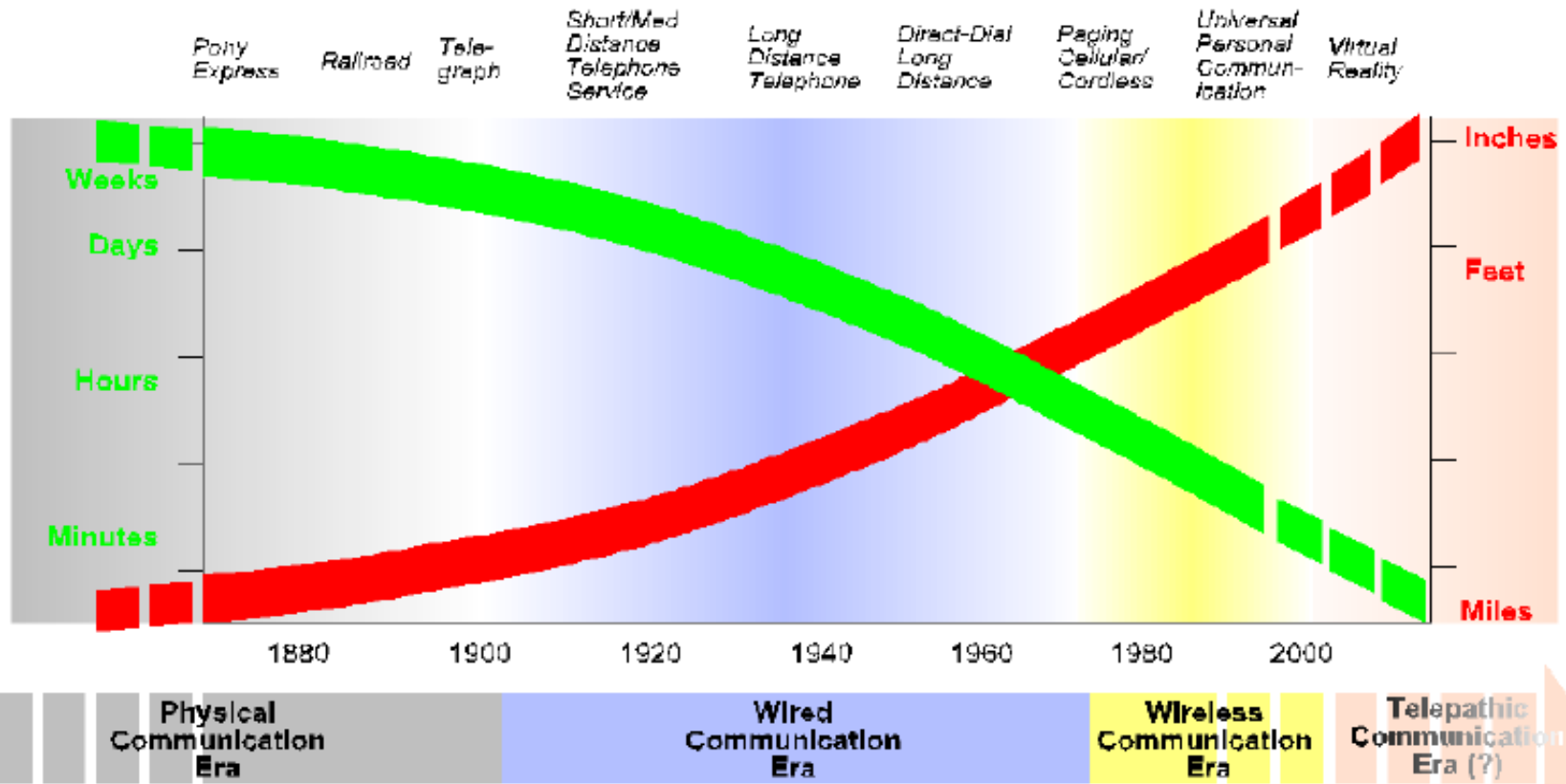
Source: Joao Da Silva's talk at Enisa, July 20th, 2008



Info "Half-Life" & "Inconvenience Threshold"

"Half-Life" of Perceived Personal Information Value

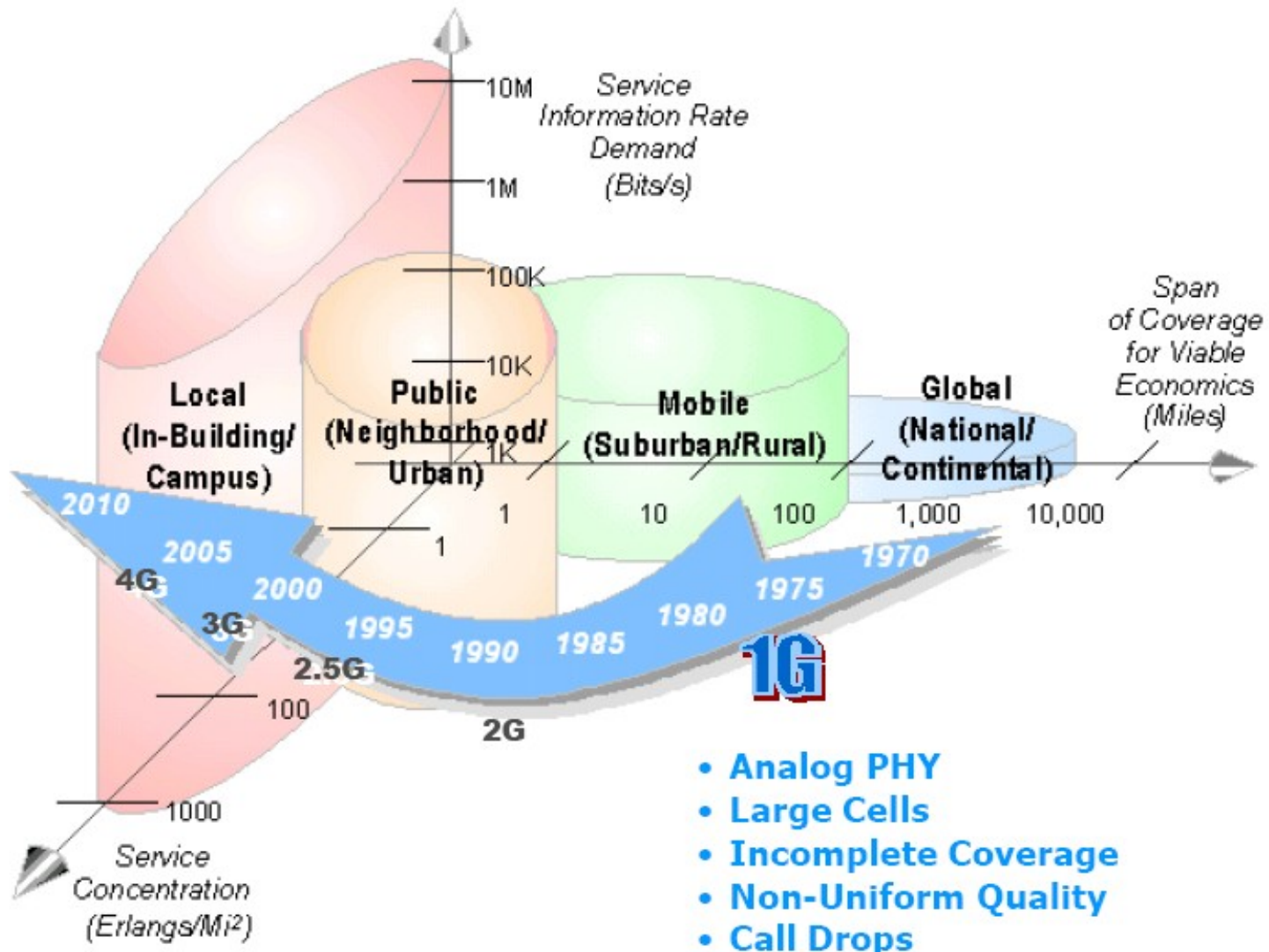
"Inconvenience Threshold" Travel Distance to Obtain Valuable Information



Each communication technology advance has shortened the useful life of information and increased the need to obtain new information more rapidly regardless of the situation or location...

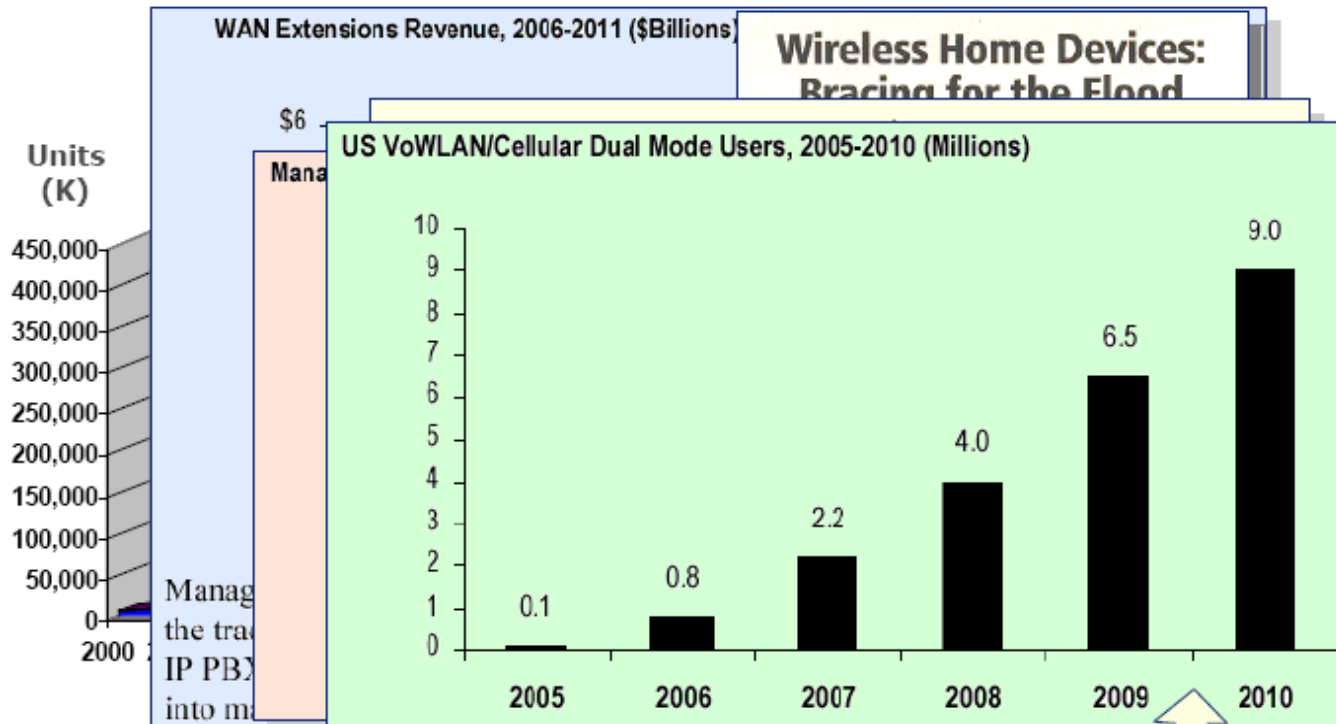


Mobility Evolution – 1G





Device Presence: Unlocking the Value of “Chip Radios”



- 100K+ hotspots worldwide, CAGR of 45% (JiWire)
- 90% of airports to offer Wi-Fi by 2008 (Airports Council International)
- 269M broadband homes worldwide in 2009 (IDC)
- 72% of companies to deploy Voice over Wi-Fi by 2009 (Infonetics)
- 100 million consumer mobile VOIP users in 2011
- The PC industry will ship more than two times as many mobile VOIP devices per year as the Telecom industry in 2011.

Fast Growth of Wireless Use



- Social networking (e.g., micro-blogging)
- Multimedia downloads (e.g., Hulu, YouTube)
- Gaming (Xbox Live)
- 2D video conferencing
- File sharing & collaboration
- Cloud storage

Next generation applications

- Immersive video conferencing
- 3D Telemedicine
- Virtual & Augmented reality
- Assistive Technology

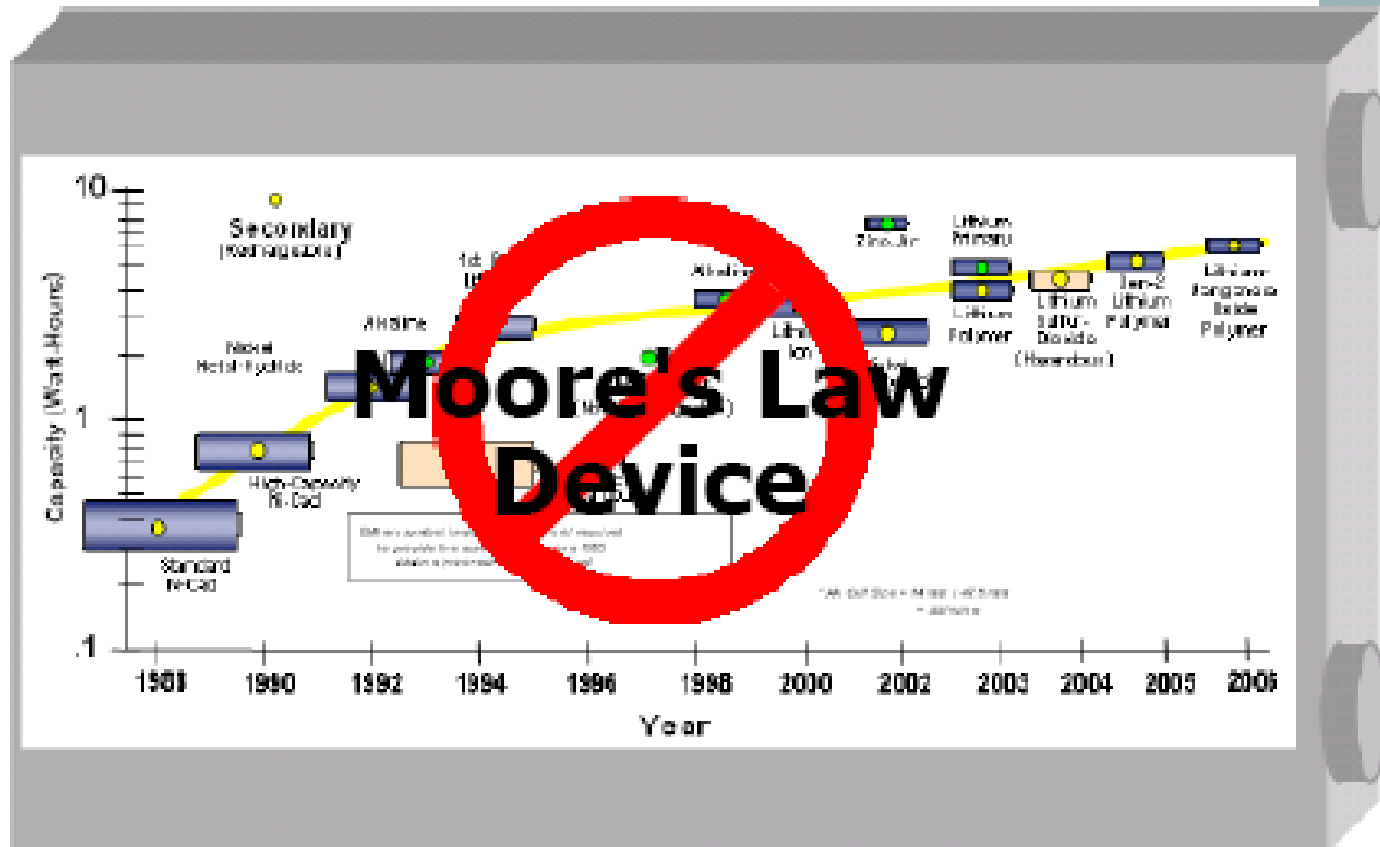
○ Rapid increase in the multimedia mobile Internet traffic

Fast Growth of Wireless Use (2/2)



- Video driving rapid growth in mobile Internet traffic
- Expected to rise 66x by 2013 (Cisco Visual Networking Index-Mobile Data traffic Forecast)

Energy constrains



Rechargeable Battery Capacity Trends

Wireless Networks



- Are ***extremely complex***
- Have been used for **many different purposes**
- Have their own distinct characteristics due to ***radio propagation*** characteristics & ***mobility***
 - wireless channels can be **highly asymmetric** & **time varying**

Multiple Access Techniques



- **Frequency Division Multiple Access (FDMA)**
 - Each device is allocated a **fixed frequency**
 - Multiple devices share the available radio spectrum by using different frequencies
- **Code Division Multiple Access (CDMA)**
- **Direct Sequence Spread Spectrum (DSSS)**
- **Frequency Hopping (FH)**
- **Orthogonal Frequency Division Multiplexing (OFDM)**