Mobile Networking

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History, Definitions, Applications, and Future,…

INTRODUCTION TO MOBILE NETWORKING I

Contents

- Wireless and Mobile History
- Spectrum Allocation
- Mobile Devices

Definitions and History!

WIRELESS VS. MOBILE

Wireless vs Mobile

- Aspects of mobility:
  - *user mobility*: users communicate "anytime, anywhere, with anyone"
  - *device portability*: devices can be connected anytime, anywhere to the network

- Wireless vs. Mobile

Wireless	Mobile	Examples
✗	✗	stationary computer (desktop)
✗	✓	Cable-Internet laptop in a hotel
✓	✗	wireless LANs in historic buildings
✓	✓	smart phone

- The demand for mobile communication creates the need for integration of wireless networks or mobility mechanisms into existing fixed networks:
  1. Telephone network ➔ cellular telephony (e.g., GSM, UMTS, LTE)
  2. Local area networks ➔ Wireless LANs (e.g., IEEE 802.11 or "WiFi")
  3. Internet ➔ Mobile IP

History of Wireless Communication

- **Many people in History used light for communication**
  - heliographs, flags („semaphore“), ...
  - 150 BC smoke signals for communication (Greece)
  - 1794, optical telegraph, Claude Chappe
- **Electromagnetic waves are of special importance:**
  - 1831 Faraday demonstrates electromagnetic induction
  - J. Maxwell (1831-79): theory of electromagnetic Fields, wave equations (1864)
  - H. Hertz (1857-94): demonstrates with an experiment the wave character of electrical transmission through space (1886)

History of Wireless Communication

- **1895 Guglielmo Marconi**
  - first demonstration of wireless telegraphy
  - long wave transmission, high transmission power necessary (> 200kw)
- **1907 Commercial transatlantic connections**
  - huge base stations (30 to 100m high antennas)
- **1915 Wireless voice transmission New York - San Francisco**
- **1920 Discovery of short waves by Marconi**
  - reflection at the ionosphere
  - smaller sender and receiver, possible due to the invention of the vacuum tube (1906, Lee DeForest and Robert von Lieben)

History of Wireless Communication

- 1928 Many TV broadcast trials (across Atlantic, color TV, TV news)
- 1933 Frequency modulation (E. H. Armstrong)
- 1946 First public mobile telephone service in 25 US cities (1 antenna per city…)
- 1976 Bell Mobile Phone service for NY city
- 1979 NMT at 450MHz (Scandinavian countries)
- 1982 Start of GSM-specification
  - goal: pan-European digital mobile phone system with roaming

History of Wireless Communication

- 1983 Start of the American AMPS (Advanced Mobile Phone System, analog)
- 1984 CT-1 standard (Europe) for cordless telephones
- 1992 First deployment of GSM
- 2002 First deployment of UMTS
- 2010 - 2013 LTE standards mature, first trials

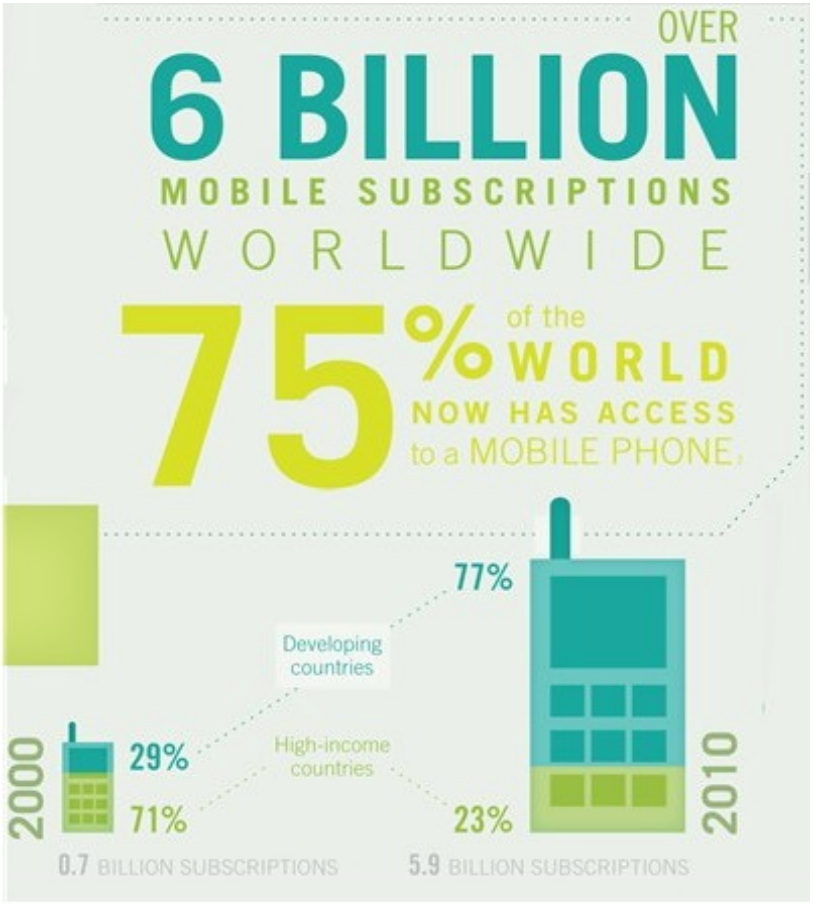
Wireless vs. Fixed networks: A Brief Comparison

- **Higher data loss-rates due notably to interferences**
  - emissions of e.g., engines, lightning, other wireless networks, micro-wave ovens
- **Restrictive regulations of frequencies**
  - Usage of frequencies has to be coordinated, useful frequencies are almost all occupied (or at least reserved)
- **Lower transmission rates**
  - From a few kbit/s (e.g., GSM) to a 100s of Mbit/s (e.g. WLAN)

Wireless vs. Fixed networks: A Brief Comparison

- **Lower security (higher vulnerability)**
- **Higher jitter**
- **Radio link permanently shared →** need of sophisticated MAC
- **Fluctuating quality of the radio links**
- **Unknown and variable access points →** authentication procedures
- **Unknown location of the mobile station →** mobility management

Worldwide Mobile Subscribers



Source: Maximizing Mobile, ICT, World Bank, July 2012

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A brief history and Consequences

SPECTRUM ALLOCATION

Spectrum Allocation

All ships should be equipped with a wireless telegraph

Regulation of radio broadcasting is started by the U.S. Department of Commerce

1910

1912

1912

"**Unsinkable**" Titanic ocean liner sinks

The Californian passenger ship (10 miles away Titanic) missed Titanic SOS:
It was asked by Titanic wireless operator to "shut up", because it was "interfering" with Titanic messages.

Spectrum Allocation

Comité Consultatif International pour la Radio (**CCIR**)

1927

1934

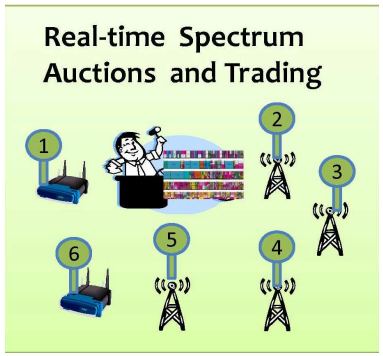
FCC in USA (Command and control model)

CCIR merged to form **ITU-R**

1934

Spectrum Allocation

FCC authorizes **unlicensed band** (maximum power 1 watt)



Number of forums and standards bodies work on frequency allocation

1985

1994

Now

FCC begins using **spectrum auctions (game theory)**

ETSI World Class Standards

وزارت ارتباطات و فناوری اطلاعات
سازمان تنظیم مقررات و ارتباطات رادیویی

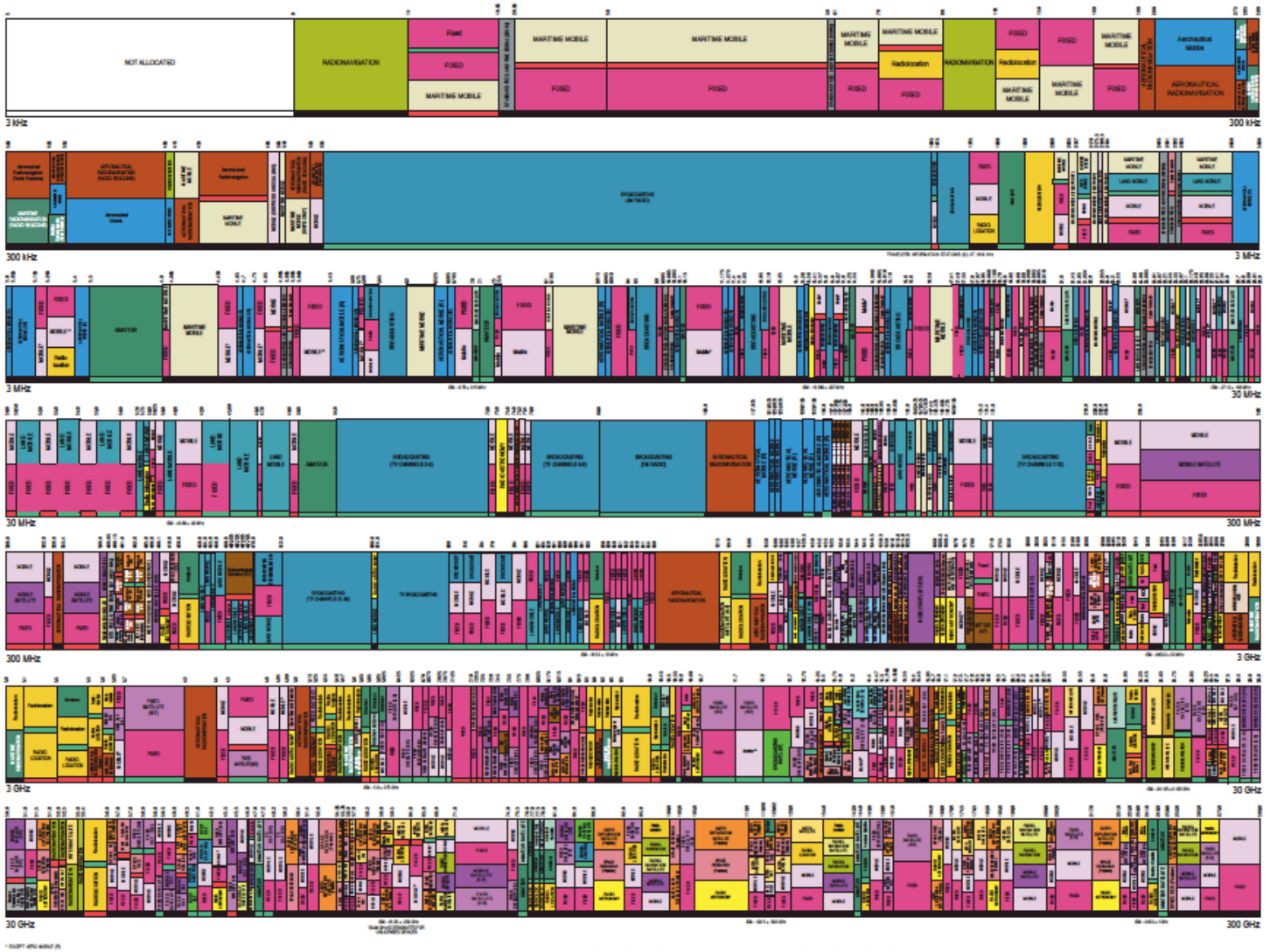
FEDERAL COMMUNICATIONS COMMISSION

Ofcom

FCC Allocation Chart

UNITED STATES FREQUENCY ALLOCATIONS

THE RADIO SPECTRUM



RADIO SERVICES COLOR LEGEND

ACTIVITY CODE

ALLOCATION USAGE DESIGNATION

SERVICE	EXAMPLE	DESCRIPTION
Primary	FIXED	Capital Letters
Secondary	Mobile	1st Capital with lower case letters

U.S. DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
Office of Spectrum Management

October 2003

Results of Spectrum Allocation: Two Main Players

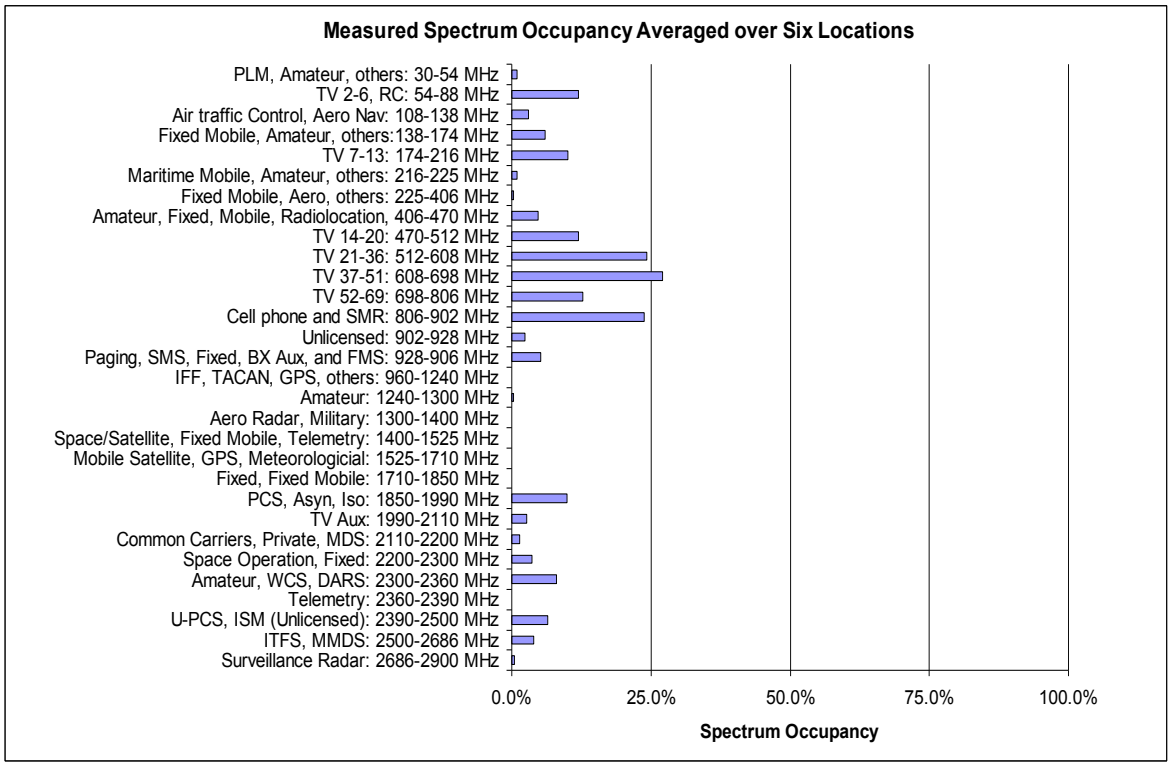
1. **Operators in Licensed Bands ($100 billion to buy spectrum in Europe)**

2. **Unlicensed Band users**

(i.e., industrial, scientific and medical [ISM] radio bands, Microwave oven, WiFi, …)


Efficiency of Spectrum Allocation

©Shared spectrum company report, August 2005



Locations:

1) New York city
2) Riverbend Park, Great Falls, VA
3) Tysons Corner, VA
4) NSF Roof, Arlington, VA
5) NRAO, Greenbank, WV
6) SSC Roof, Vienna, VA

The licensed spectrum is rarely utilized continuously across time and space

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Performance and evolution

MOBILE DEVICES

Smart Devices, Smart Life: NEST

Smart Devices, Smart Life:
Apple Pay (Near Field Communication)

Your wallet. Without the wallet.

One touch to pay with Touch ID. Now paying in stores happens in one natural motion — there's no need to open an app or even wake your display thanks to the innovative Near Field Communication antenna in iPhone 6. To pay, just hold your iPhone near the contactless reader with your finger on Touch ID. You don't even have to look at the screen to know your payment information was successfully sent. A subtle vibration and beep lets you know.

An easier way to pay.

More secure payments.

Mobile devices

Wireless sensors
- Limited proc. power
- Small battery

Laptop
- functionally eq. to desktop
- standard applications

Mobile phones
- voice, data
- web access
- location based services

RFID tag
- A few thousands of logical gates
- Responds only to the RFID reader requests (no battery)

Pager
- receive only
- tiny displays
- simple text messages

Tablets
- Light weight
- High resolution display
- High speed data communication

Performance

Smart Phones/Tablets

Quad band GSM
(850, 900, 1800, 1900 MHz)

GPRS/EDGE

Tri band UMTS/HSDPA
(850, 1900, 2100 MHz)

LTE

GPS + accelerometers

WiFi (802.11b/g/a/n/ac)

Bluetooth