

---

# **Introduction and technological Fundamentals**

# Contents - Introduction & technological Fundamentals

---

- Introduction
- Radio Channel Properties (Radio Propagation)
- Basic Transmission Techniques
- Basic Antenna Concepts
- Cellular Principle

---

# **Introduction and technological Fundamentals Introduction**

# Contents - Fundamentals - Introduction

---

- Mobility Types
- History of wireless Communication
- Types of wireless Communication Systems
- General Architecture of cellular Mobile Networks
- Handover and Roaming
- Frequency Ranges of wireless Communication Systems

# Mobility Types

---

## Device Mobility

- fixed assignment of user  $\leftrightarrow$  device; coupled user and device mobility
- device stays connected to the network despite of mobility
- requires wireless connection (radio link) between device and network
- example: cellular phone

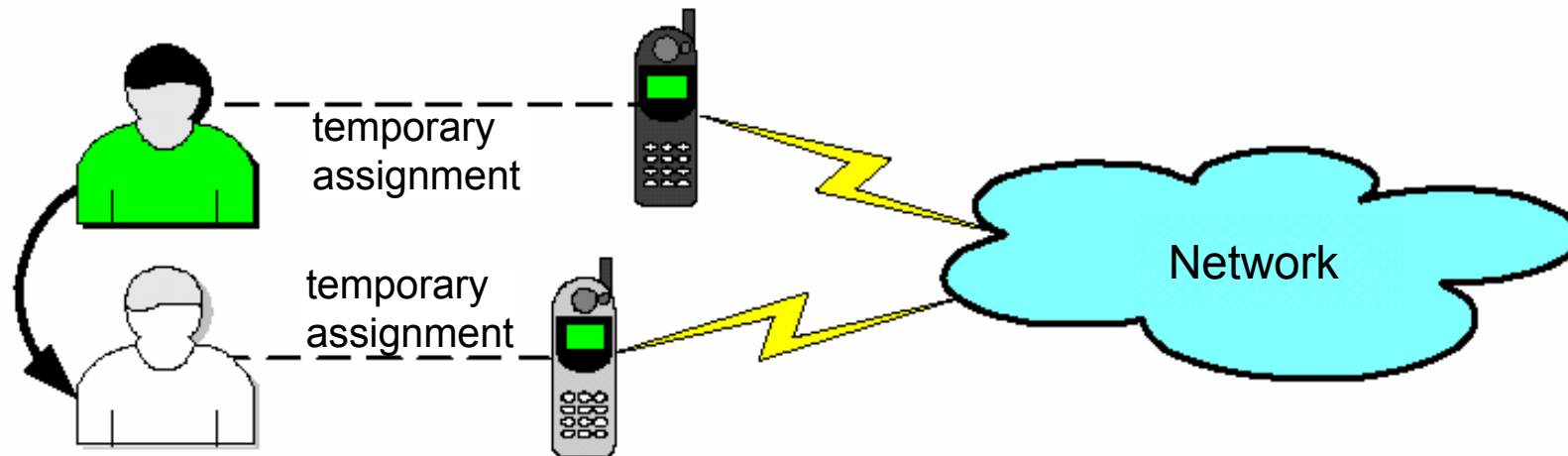


# Mobility Types

---

## User Mobility

- temporary assignment of user  $\leftrightarrow$  device; decoupled user and device mobility
- user changes the device when moving
- requires user identification (e.g. via PIN or smartcard) each time when changing the device
- example: user uses different cellular phones with his SIM-card

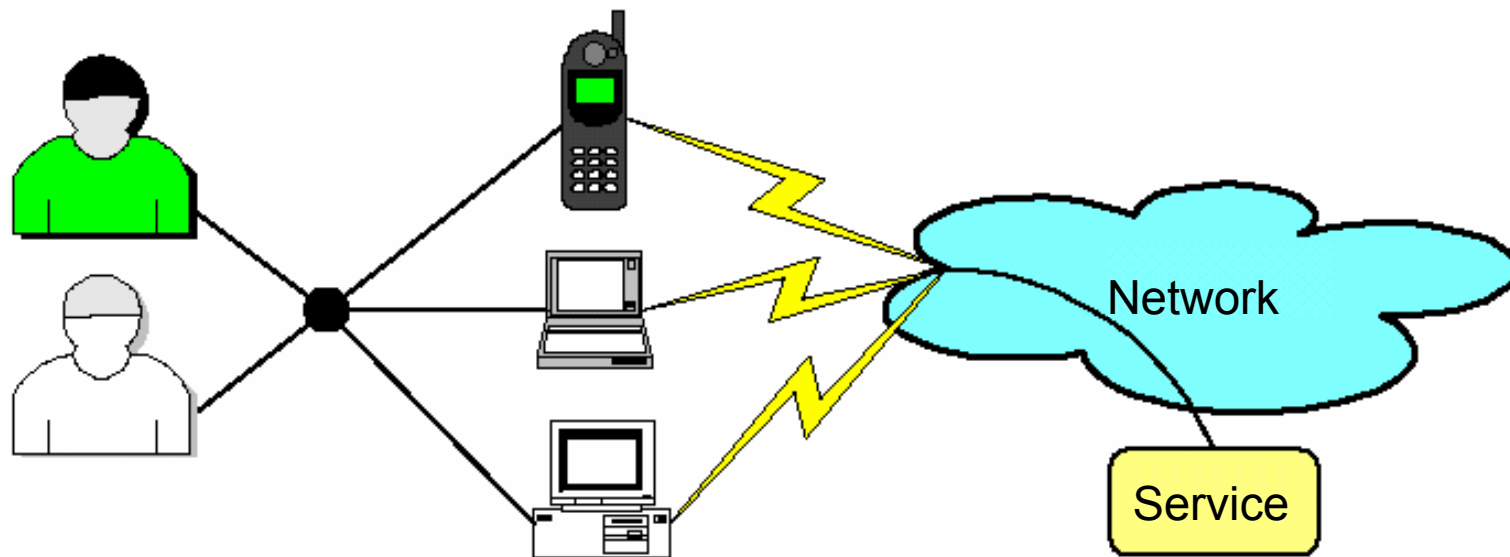


# Mobility Types

---

## Service Mobility

- user has access to a service independently of his location and the device he uses
- example: global access to private e-mail account



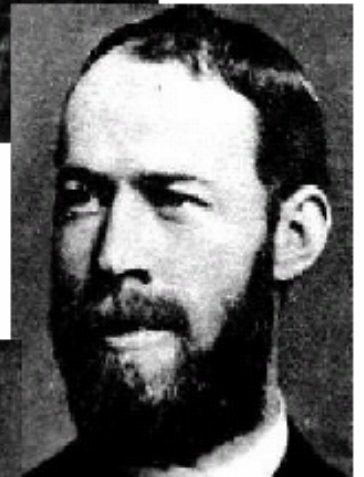
# History of wireless Communication

---

1831 Michael Faraday demonstrated the electromagnetic induction



1886 Heinrich Hertz demonstrated the free space propagation of electromagnetic waves in space (induction of sparks over the distance of 20m)



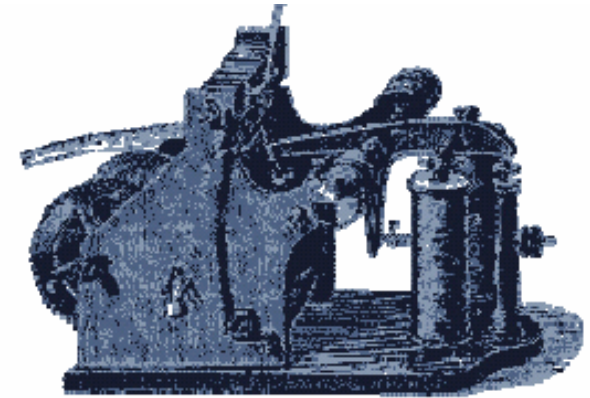
1896 Gulielmo Marconi demonstrated the first wireless telegraph





# History of wireless Communication

---



- 1907 commercial transatlantic telegraph service
- 1915 wireless speech transmission between New York and San Francisco
- 1926 wireless telephone service at Hamburg - Berlin railway line
- 1928 wireless TV transmission field trials
- 1958 first PLMN ("A-Netz") in Germany
- 1972 second PLMN ("B-Netz") in Germany
- 1979 first products with infrared communication
- 1982 start of the GSM specification
- 1986 third PLMN ("C-Netz") in Germany

# History of wireless Communication

---

- 1991 DECT standard for cordless telephones
- 1992 start of GSM900 (fourth PLMN, "D-Netz") in Germany
- 1994 start of GSM1800 ("E-Netz") in Germany  
IrDa infrared standard finished
- 1995 FIR standard for fast infrared transmission (up to 4 MBit/s)
- 1996 HIPERLAN wireless LAN (up to 23,5 MBit/s)  
start of the Wireless ATM specification
- 1997 IEEE 802.11 wireless LAN (up to 2 MBit/s)
- 1998 start of the UMTS specification  
HomeRF wireless LAN (up to 10 MBit/s)

# History of wireless Communication

---

- 1999 IEEE 802.11a wireless LAN (up to 54 MBit/s)  
start of WAP (Wireless Application Protocol)  
VFIR fast infrared transmission (up to 16 MBit/s)  
Bluetooth 1.0 standard finished  
start of i-mode in Japan
- 2000 UMTS license auction in Germany  
higher GSM data rates enabled by HSCSD and GPRS  
HIPERLAN/2 wireless LAN (up to 54 MBit/s)  
first Bluetooth 1.0 devices
- 2001 GPRS full coverage in Germany
- 2002 start of i-mode in Germany

# History of wireless Communication

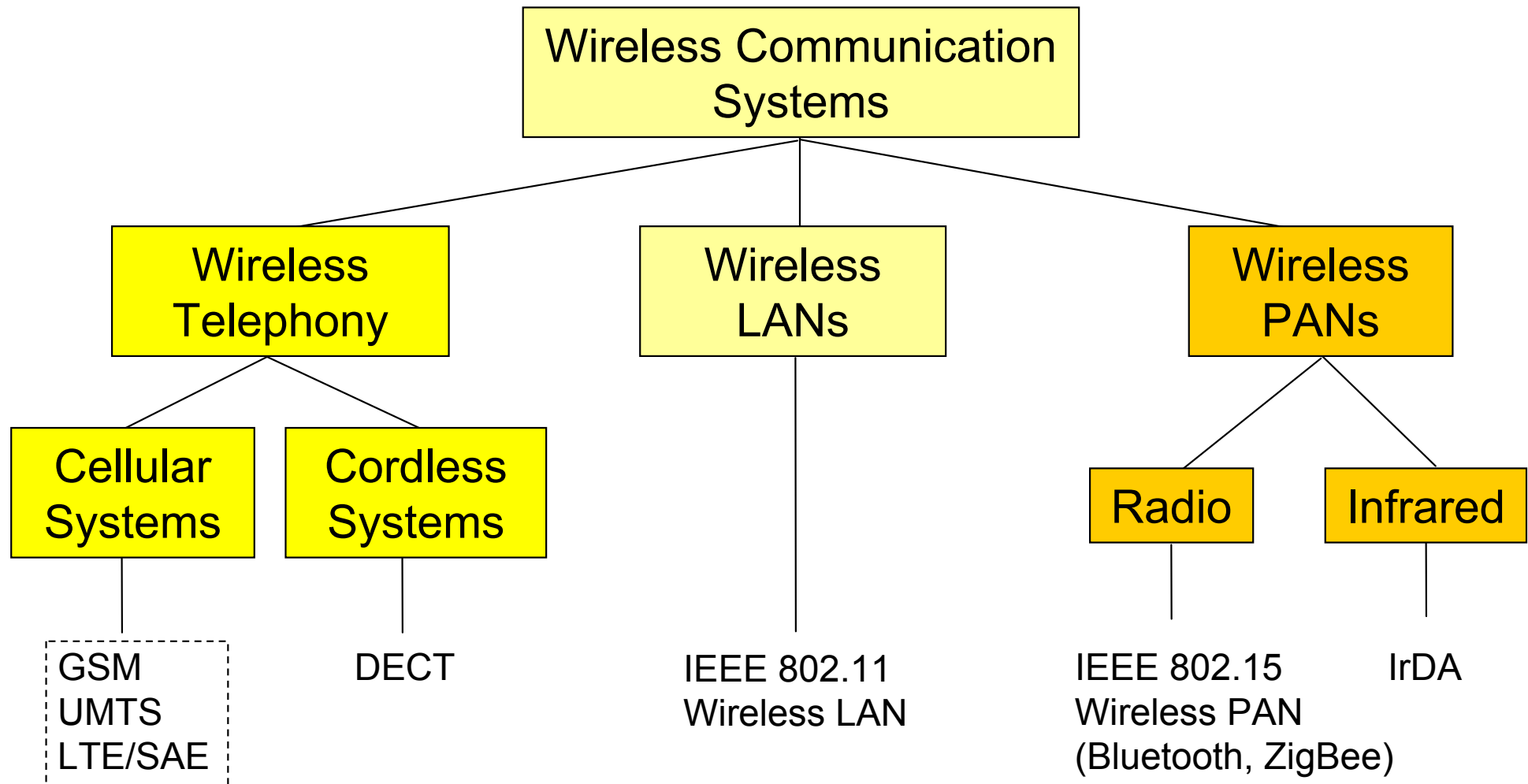
---

2004 start of UMTS (3G) in Germany

2011 start of LTE (4G) in Germany

# Types of wireless Communication Systems

---



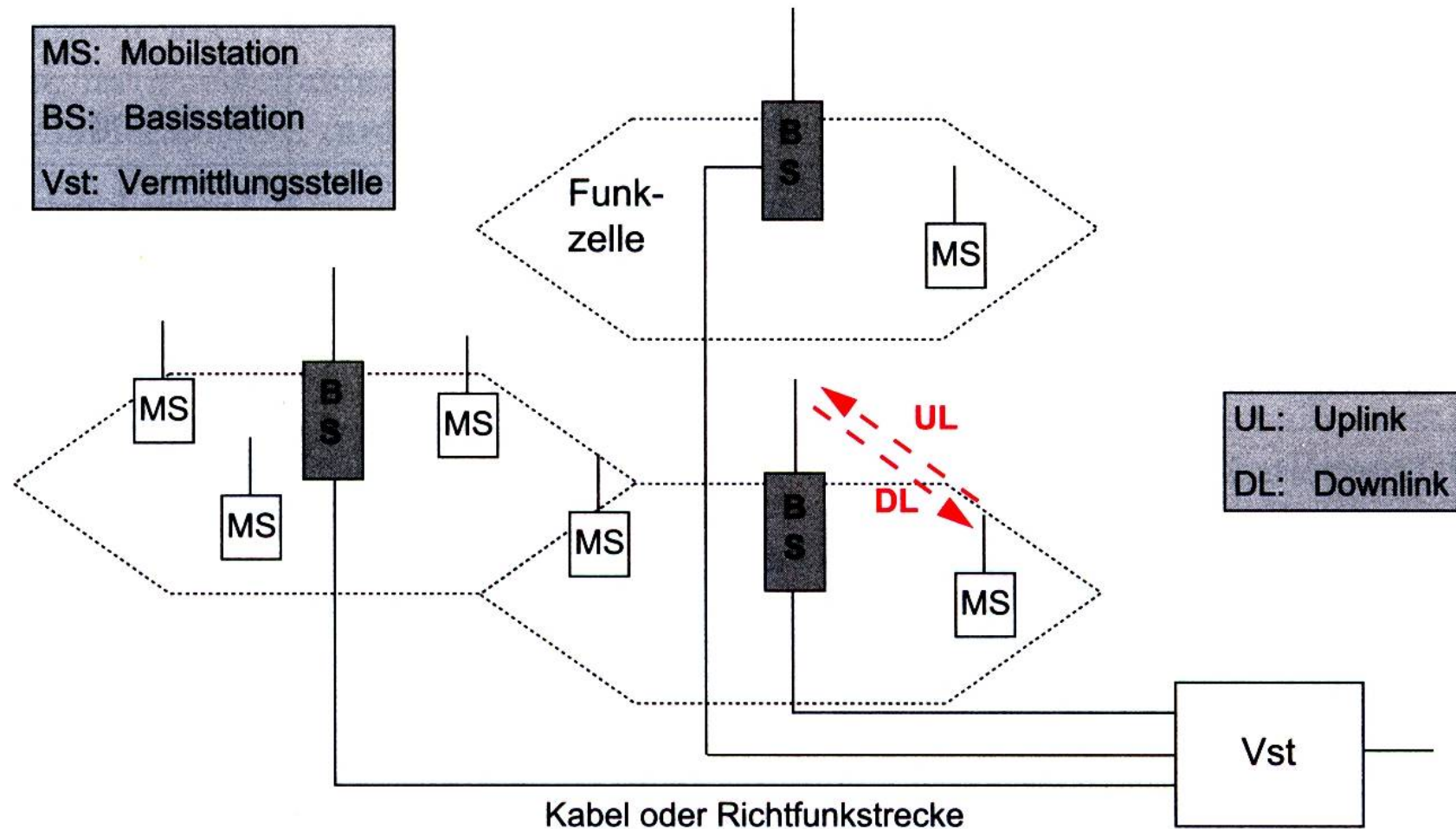
# Types of wireless Communication Systems

---

## **Further types:**

- Satellite Systems
  - for (unidirectional) broadcast transmission with large area coverage
- Radio Link Systems
  - for stationary point-to-point transmission
- Terrestrial Broadcast Systems
  - for (unidirectional ) terrestrial broadcast transmission
- Trunked Radio Systems
  - for private mobile radio (e.g. taxis) and special mobile radio (police, firefighters)
  - in Europe: TETRA (Trans-European Trunked Radio)

# General Architecture of cellular Mobile Networks



# Handover and Roaming

---

- **Handover**

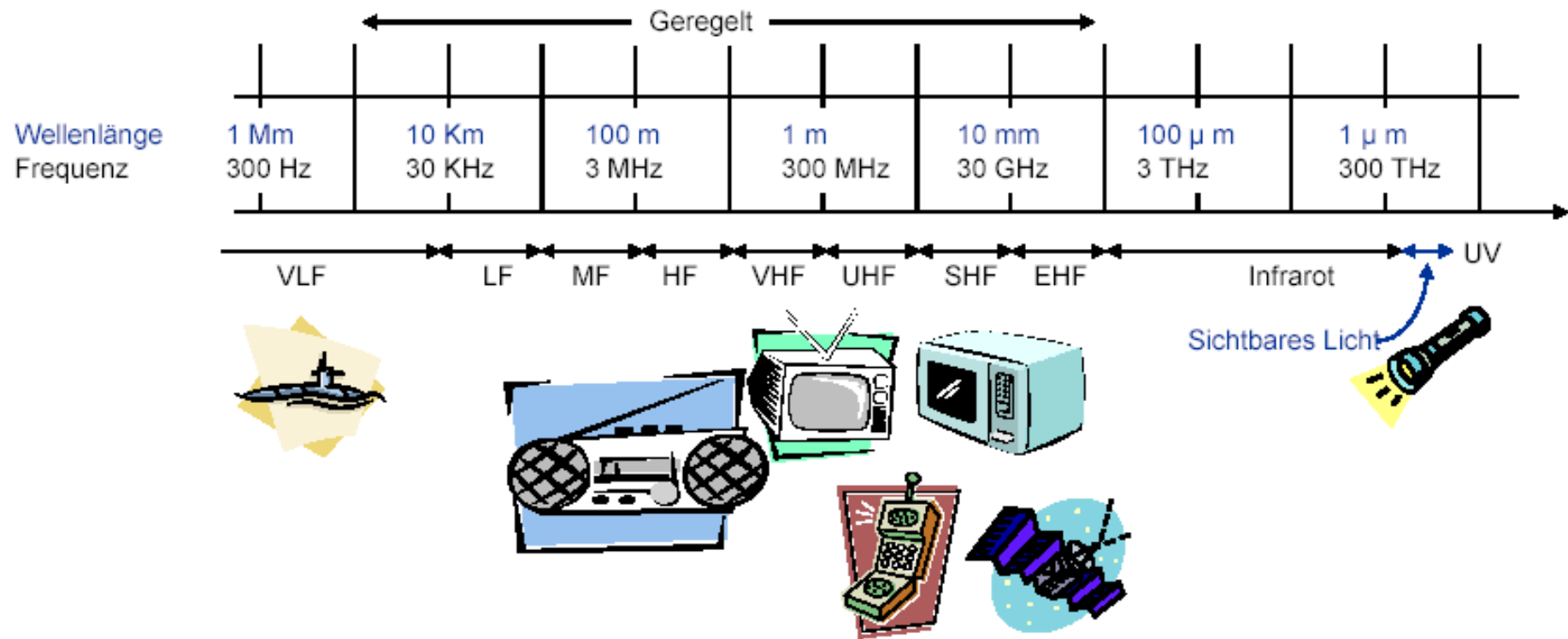
- when changing the cell (due to the user movement) any active connection has to be maintained by suitable mechanisms
- the procedures for updating the connection are called handover procedures

- **Roaming**

- a mobile user can initiate or receive calls irrespectively of his current location
- this property is called roaming
- roaming variants:
  - roaming within the network of one operator
  - national roaming: roaming between networks of different operators in one country (example: roaming between T-Mobile and o2 in the first years of operation of the o2 network)
  - international roaming: roaming beyond country borders



# Frequency Ranges of wireless Communication Systems



# Frequency Ranges of wireless Communication Systems

	Frequenzband [MHz]	System	Rubrik
ISM-Bänder (Industrial Scientific Medical) sind teilweise freigegeben	890-915	GSM (GSM 900)	Mobilfunk
	935-960	GSM (GSM 900)	
	1227,6	GPS	Positions- bestimmung
	1575,42	GPS	
	1710-1785	GSM (DCS 1800)	Mobilfunk
	1805-1880	GSM (DCS 1800)	
	1880-1900	DECT	Schnurlos-Telefonie
	1900-1920	UMTS (UTRA-TDD)	Mobilfunk
	1920-1980	UMTS (UTRA-FDD)	
	2010-2025	UMTS (UTRA-TDD)	
	2110-2170	UMTS (UTRA-FDD)	
	2400-2483,5	WLAN 802.11b, HomeRF, Bluetooth	drahtlose lokale Netze
	5120-5300	HIPERLAN/1	
	5150-5250	WLAN 802.11a	
	5150-5350	HIPERLAN/2	
	5470-5725	HIPERLAN/2	
	5725-5825	WLAN 802.11a	