

# T-Systems Nova Technologiezentrum

Radio services using Long-,  
Medium- and Short wave  
spectrum (9 kHz to 30 MHz)

Dipl. Ing. Wendelin Reuter

Spectrum Management of Deutsche Telekom AG

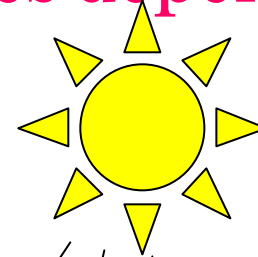
T-Systems Nova, Technologiezentrum Darmstadt

Tel. +49 6151 83-2461

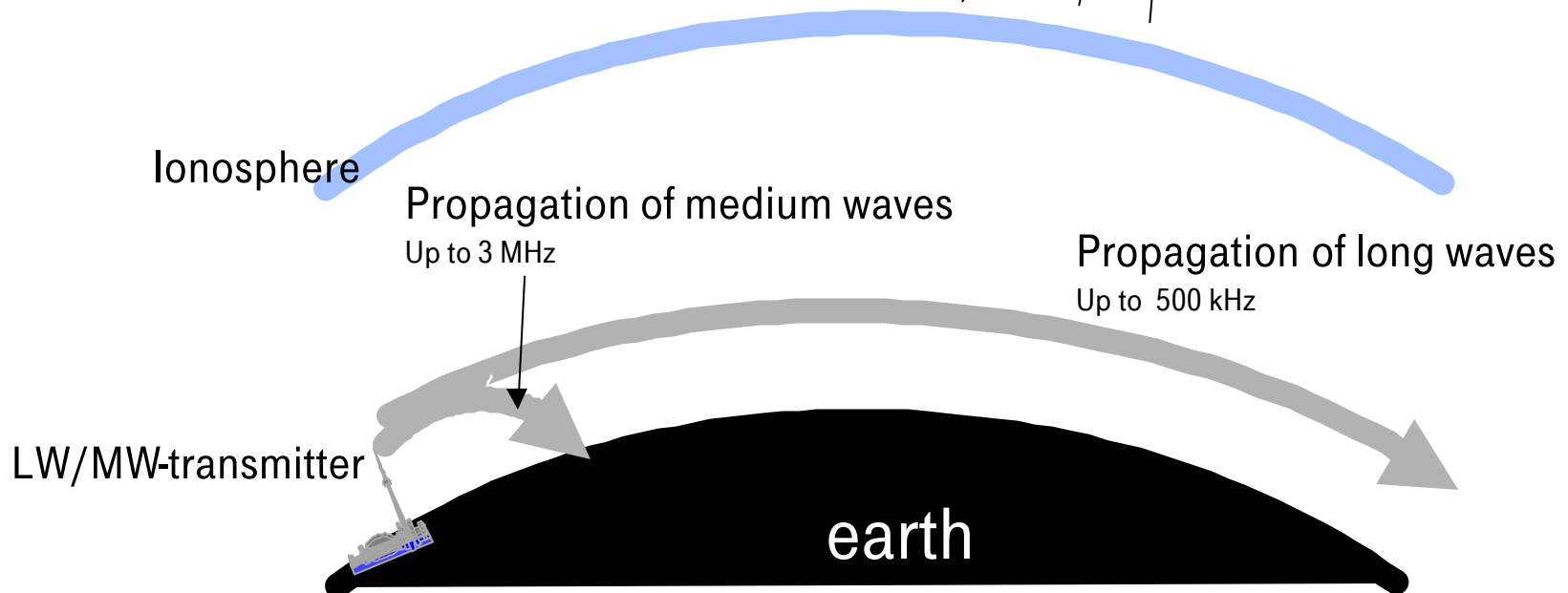
wendelin.reuter@t-systems.com

# Propagation of radio waves depending on frequency (1)

Frequencies up to 3 MHz (long and medium wave):  
Bending of the radio waves along the curvature of the earth

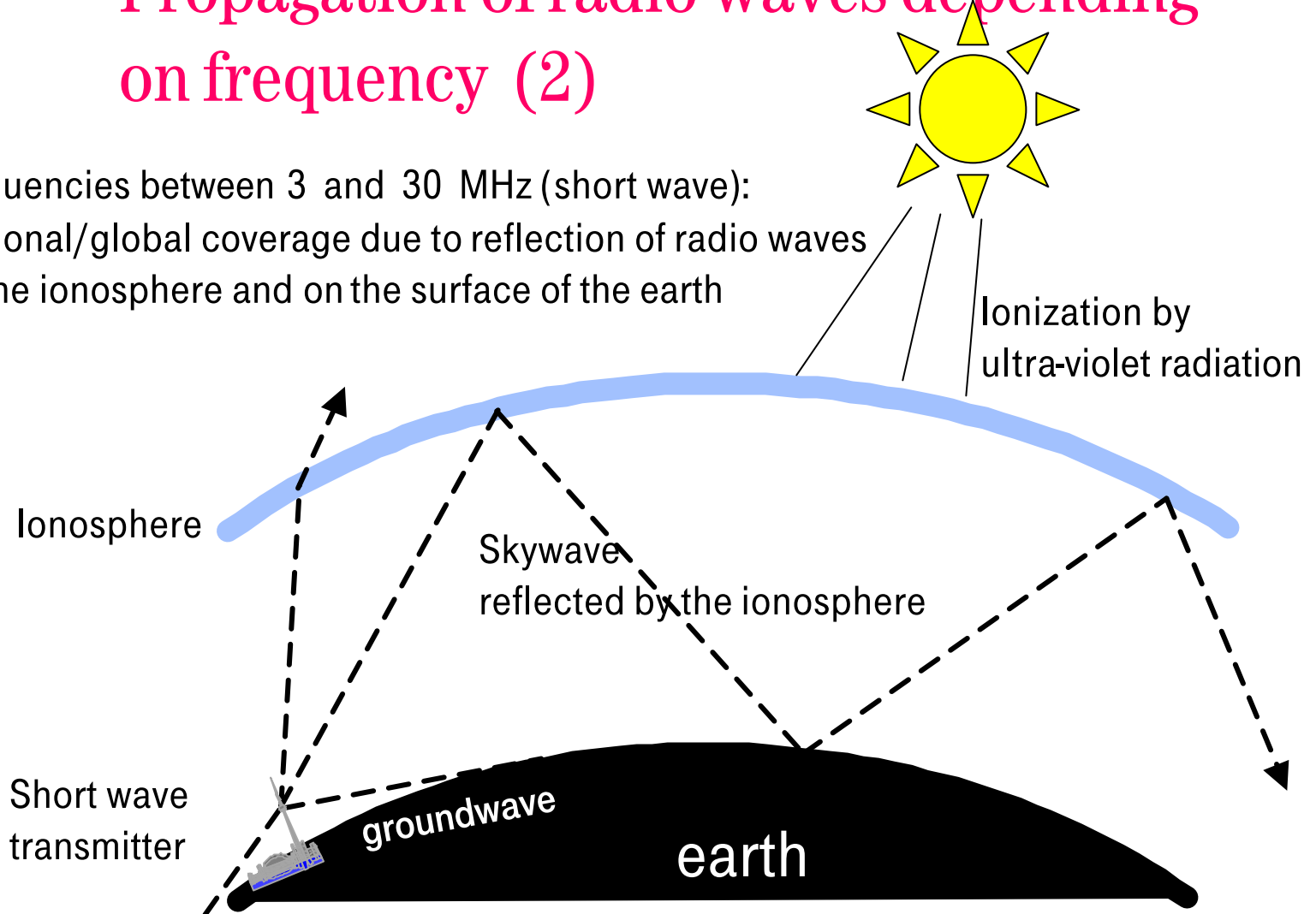


Ionization by  
ultra-violet radiation



# Propagation of radio waves depending on frequency (2)

Frequencies between 3 and 30 MHz (short wave):  
Regional/global coverage due to reflection of radio waves on the ionosphere and on the surface of the earth



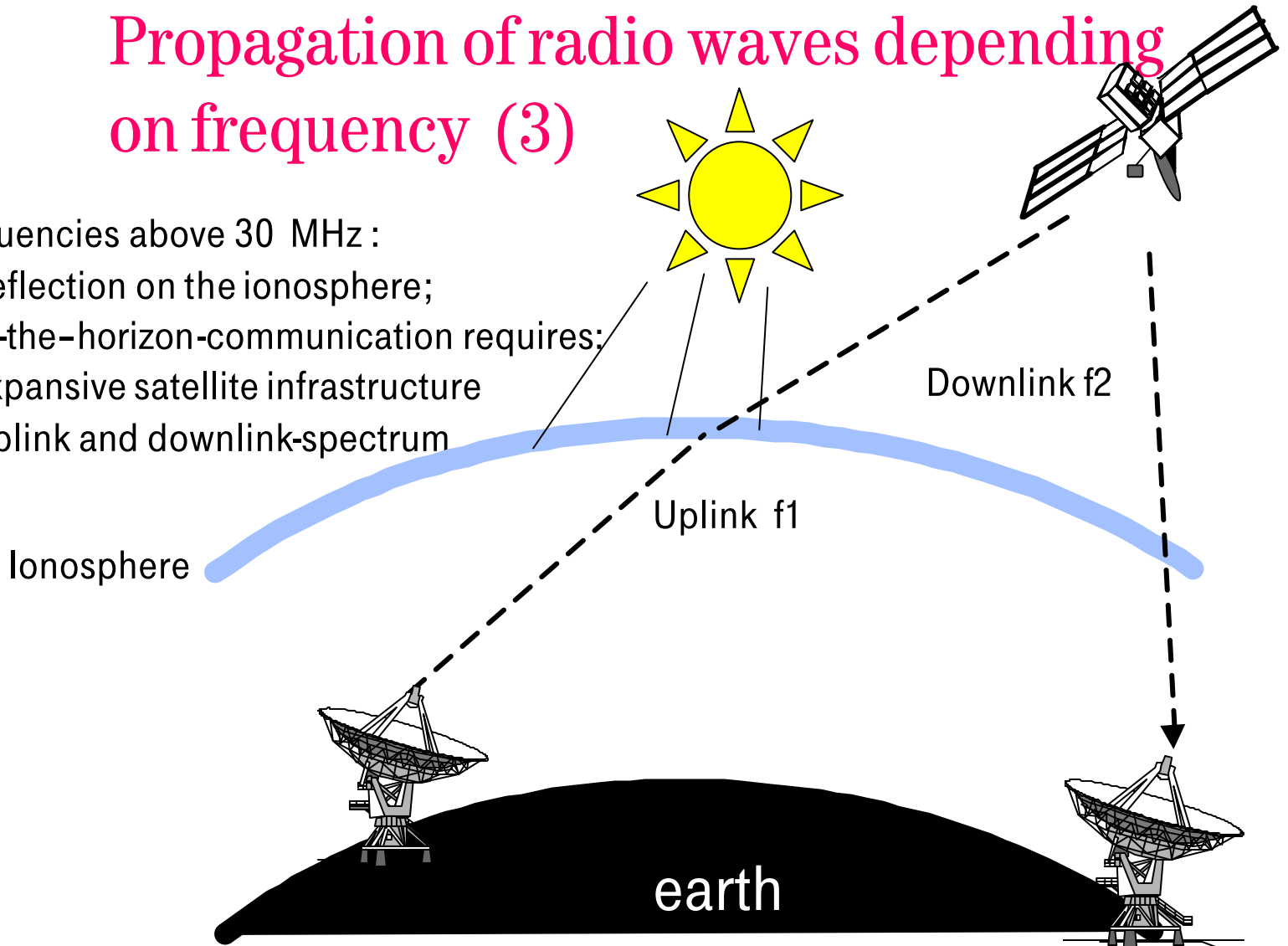
# Propagation of radio waves depending on frequency (3)

Frequencies above 30 MHz :

No reflection on the ionosphere;

Over-the-horizon-communication requires:

- expansive satellite infrastructure
- Uplink and downlink-spectrum

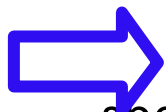


# International Telecommunication Convention + Radio Regulations (1)

The frequency range 9 kHz to 30 MHz - due to its excellent and unique propagation conditions (reflection on the ionosphere) - is

- especially valuable to some radio services but is also
- much more vulnerable to interference

than the frequency spectrum above 30 MHz.



The spectrum below 30 MHz can not be compared with the spectrum between 30 MHz and 275 GHz !

# International Telecommunication Convention + Radio Regulations (2)

## Radio Regulations S4.11:

Member states \* recognise that among frequencies which have long-distance propagation characteristics, **those in the bands between 5 MHz and 30 MHz are particularly useful for long distance communications**; they agree to make every possible effort to reserve these bands for such communications....

\* more than 180 states, which have signed the International Telecommunication Convention and the “Radio Regulations”

# International Telecommunication Convention + Radio Regulations (3)

Radio Regulations      S15.12 §8

”Administrations shall take all practicable and necessary steps to ensure that **the operation of electrical apparatus or installations of any kind, including power and telecommunication distribution networks, .....does not cause harmful interference to a radiocommunication service** and, in particular, to the radionavigation or any safety service operating in accordance with the provisions of these regulations.”

# Radio for long distance communication

Radio systems that shall offer a greater range than 100 km need

- To use the frequency range below 30 MHz or
- must use satellite systems.
  
- Radio services below 30 MHz:
  - Narrowband
    - Not depending on infrastructure, no investments for infrastructure necessary
    - Not vulnerable to intentional destruction (military conflict, terrorism) or destruction by natural disasters
  
- Satellite services:
  - Broadband
    - Depending on infrastructure, high investments
    - Vulnerable to intentional destruction (military conflict)



# Longwave radio services (up to 500 kHz)

## Facts

- nationwide coverage with a single longwave transmitter (range approx. 1000 km)
- no shading by buildings and mountains (inhouse-reception)
- small and cheap receivers, small internal antennas
- high reliability due to modern modulation schemes
- expansive transmitter sites, very big transmitter antennas, low antenna efficiency

## ■ Broadcasting Service 148 - 283 kHz

European wide coverage with a single transmitter

Analogue: limited audio quality

- **T** Digitalisation of broadcasting; DRM, high audio quality, increased economy, additional data

Receivers being operated within DSL-structures 

# Longwave radio services (up to 500 kHz)

- Navigational Service SAFETY !
  - Non Directional Beacons (NDB) for maritime and aeronautical use
  - LORAN-navigation
  - Military applications
  
- Maritime Mobile Service SAFETY !
  - International emergency frequency 500 kHz
  - Communication with vessels
  - Military maritime Service (e.g. communication with submarines)
  
- Fixed Service
  - Telekom-Service „Distribution of data to special subscribers“ ■ ■ T  
(Control of electric networks, differential GPS-service)
  - Military Fixed Service
  - ■ T National standard and time transmissions (Germany: „DCF 77“)

# Medium wave services (500 kHz to 3 MHz)

## Facts

- no shading by buildings and mountains (inhouse-reception)
- small and cheap receivers, small internal antennas
- smaller ranges compared to long wave (range approx. 300 km)
- regional coverage with a single transmitter
- increase in range at night

## ■ Broadcasting service (526 - 1606 kHz)

Regional coverage with a single transmitter



Digitalisation of broadcasting; DRM, high audio quality, increased economy, additional data

Receivers being operated within DSL-structures



## ■ Maritime Mobile service

International emergency frequency 2182 kHz

Communication with vessels

Military applications

**SAFETY !**

# Medium wave services (500 kHz to 3 MHz)

- Fixed Service
  - Public security services
  - Military applications
- Navigational Service
  - positioning systems
  - Military applications
- Amateur Service 1,8 MHz
  - Low signal service, high transmitter fieldstrength
  - Receivers being operated within DSL-structures



# Shortwave services (3 bis 30 MHz)

## Facts

- regional or global range with a single transmitter (range depending on time of day, season, solar cycle)
- long distance communication with low power
- little shading by mountains or houses (Inhouse-reception)
- only narrow band transmissions possible
- limited sound quality with AM-transmissions
- Ongoing digitalisation of broadcasting; DRM, high audio quality, increased economy, additional data (RDS)

## ■ Broadcasting Service

Broadcasting bands 4/6/7/9/11/13/15/17/19/21 und 26 MHz

European wide/global coverage with a single transmitter ■ ■ T ■

Receivers being operated within DSL/PLC-structures

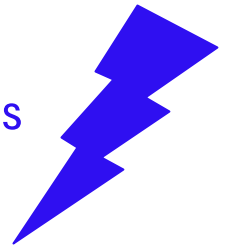
Digitalisation of broadcasting; DRM, high audio quality

■ ■ T ■ increased economy, additional data



# Shortwave services (3 to 30 MHz)

- **Aeronautical Mobile Service** SAFETY !
  - R(route) = civil air traffic control
  - OR(off-route) = military air traffic control
  
- **Maritime Mobile Service** SAFETY !
  - Civil and military applications
  - Communication with vessels
  
- **Mobile Service**
  - Tactical military radio (Bundeswehr and NATO)
  
- **Amateur Service**
  - 3,5/7/10/14/18/21/24/28 MHz
  - Low signal service, high transmitter fieldstrength
  - Receivers being operated within DSL/PLC-structures



# Shortwave services (3 to 30 MHz)

## ■ Fixed Service

Public security services,

Military applications

German foreign ministry service, communication with German embassies worldwide

Communication of foreign governments with embassies in Germany

## ■ National Intelligence Agencies

Special civil and military radio monitoring services

„50% of intelligence material gathered is obtained by monitoring radio stations of interest in the range below 30 MHz“

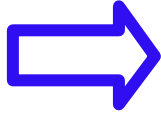
# The future of Broadcasting below 30 MHz:

## The DRM-Standard

- Technical features
  - High quality sound broadcasting
  - Cheap receivers, no external antennas required
  - Additional data (similar to RDS)
  - more convenience for users (system tunes to the optimum frequency)
- Economical/political implications
  - European operators are the spearhead of DRM- development
  - Replacement of 3 billion receivers worldwide
  - Upgrading of approx. 10 000 transmitters
  - Enhancement of broadcasting infrastructures and economy
  - High quality Pan-European broadcasting services possible on long-, medium- and shortwave
  - Reception of foreign European radio stations everytime, everywhere in high quality

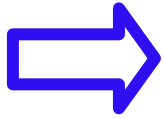


# Legal status of radio services in Germany (1)

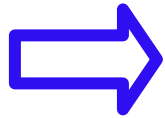


- Legal obligation according to the „Telecommunications Act“ (§44, §45 und §48)  
„.....to ensure effective and **interference-free** use of frequencies.....“
- Right to claim protection for radio services according to international conventions  
Obligation to protect radio services according to the **International Telecommunication Convention** and the **Radio Regulations**  
Bilateral or regional agreements concerning radio services  
EMC - Directive
- Radio services are operated to fulfil international agreements  
Security of naval and air traffic  
Military agreements (e.g. NATO)  
Bilateral diplomatic agreements (e.g. communication from foreign governments to embassies)

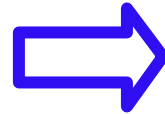
# Legal status of radio services in Germany (2)



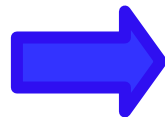
Legal claim of operators to be supplied with unpolluted spectrum enabling radio services to „operate as intended“



Legal obligation of the German administration to protect spectrum as a very limited resource



Safeguarding of the investments made by operators



Example PLC:

„Intended use versus pollution by unwanted emissions“

The priorities are clear and must not be discussed

# Radio services using Long-, Medium- and Short wave spectrum (9 kHz to 30 MHz)

Thank you for your attention !

Wendelin Reuter

Spectrum Management of Deutsche Telekom

# Comparison of ranges covered by radio depending on frequencies used

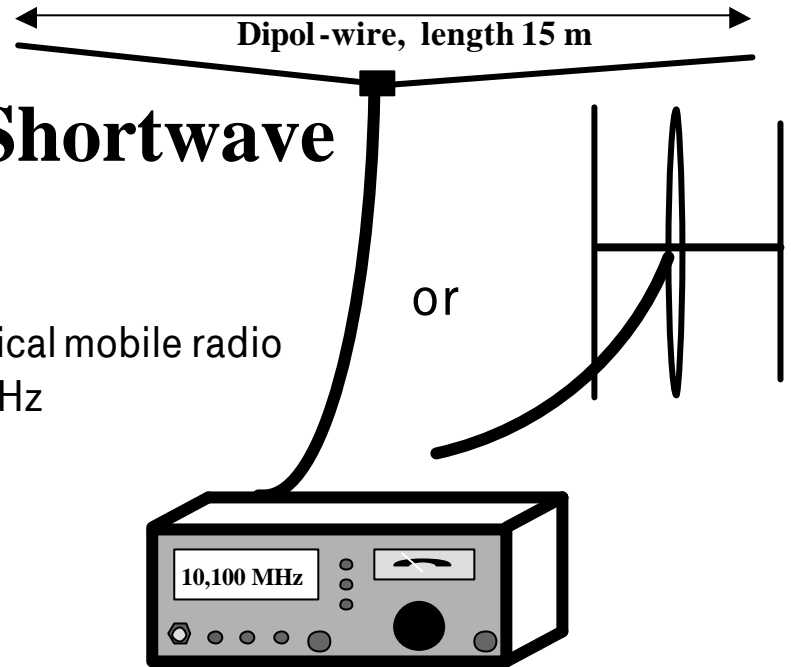
**UHF**



GSM 900 MHz, 2 watts  
digital modulation  
range max. 15 km

**Shortwave**

Example:  
Aeronautical mobile radio  
10,100 MHz



example 10 MHz, 2 watts  
analogue or digital modulation  
range up to 20.000 km

depending on frequency band, time of day and year