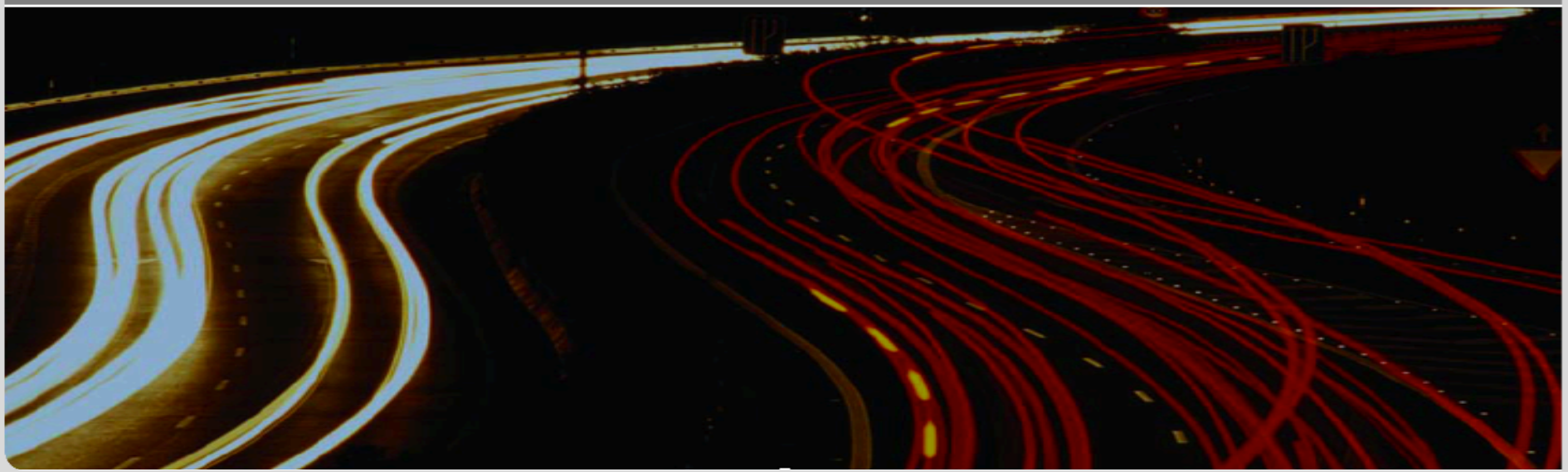
Karlsruhe Institute of Technology

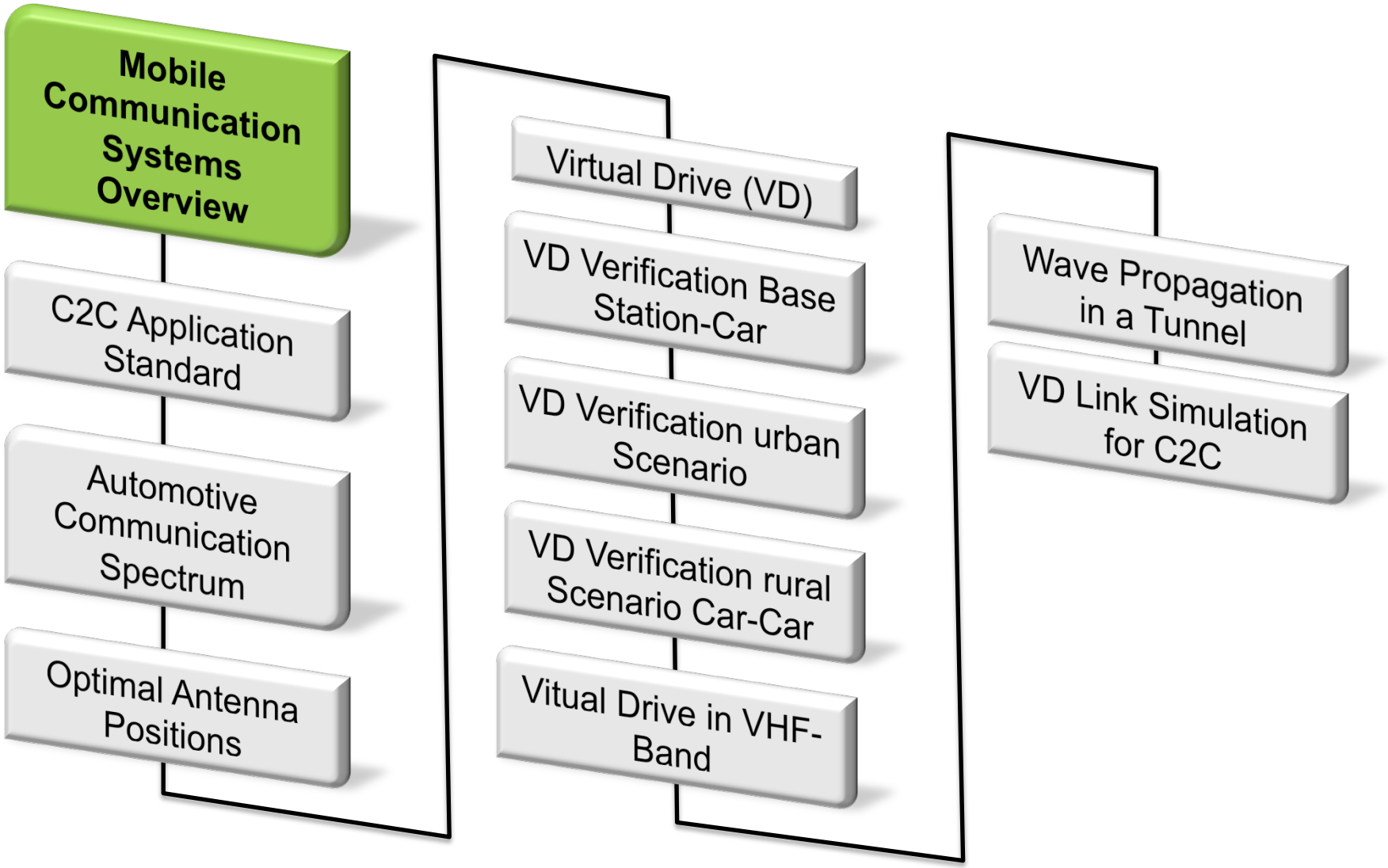
Mobile Communication Systems Overview

Prof. Dr.-Ing. Dr. h.c. Dr.-Ing. E.h. mult. Werner Wiesbeck

Institut für Hochfrequenztechnik und Elektronik



Presentation Overview



Dawn of the Communication Age –Key Figures

James Clerk Maxwell
(1831 - 1879)

- Maxwell's equations (1864)
- Postulation of electromagnetic waves
- Propagation with the speed of light

Heinrich Hertz
(1857 - 1894)

- Proof of electromagnetic waves (1887/88)
- Proof of light propagation speed
- Transmitter, antennas, receiver

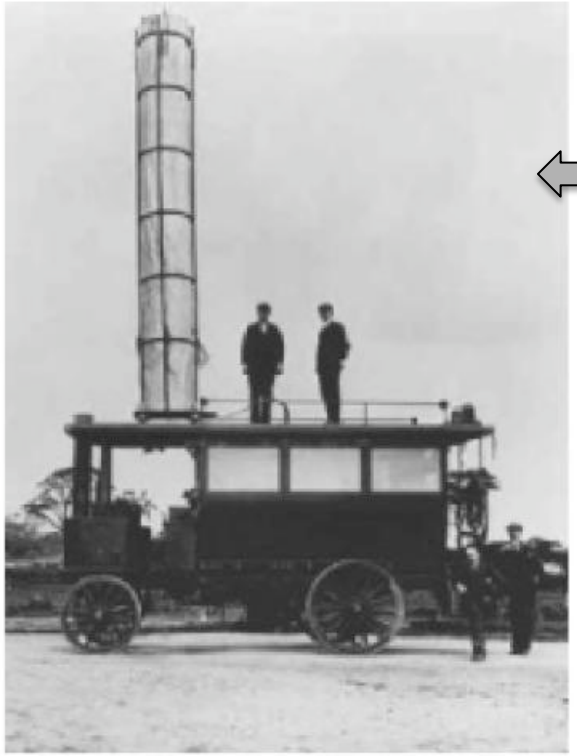
Guglielmo Marconi
(1874 - 1937)

Ferdinand Braun
(1850 - 1918)

- First wireless com. system 1895
- Trans-Atlantic communication (1901)

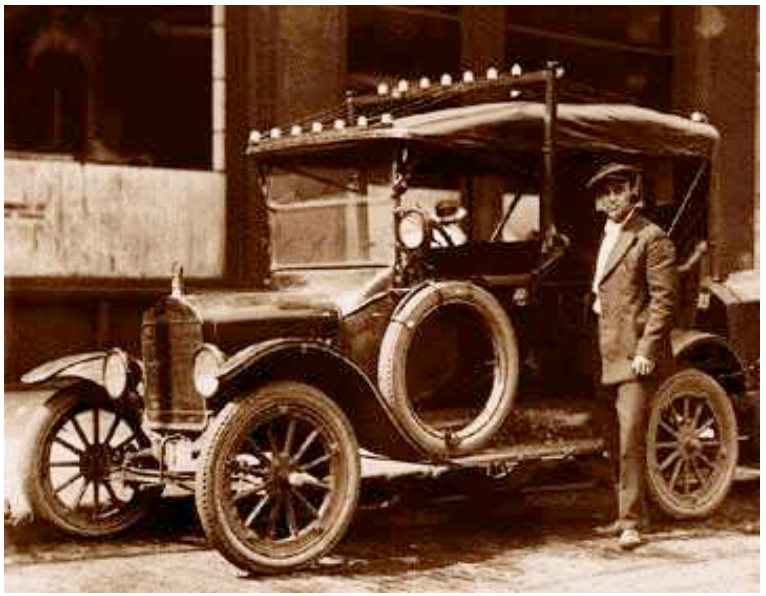
- Nobel Prize together (1909)

Historical Vehicle Antennas



Marconi pictured with a Thornycroft steam bus
- Firecracker antenna for “low frequencies”
- for demonstrating AM receive 1897

Detroid 1924 Clotheline antenna
Patrolman stands by one of the city's first radio-dispatched police cars, a Ford Model T.
System working at around 2 MHz



C2C Communication - First Approaches

Source: Daimler

First Radios (1920th)

(Both photographs by General Photographic Service, N. Y. C.)

A loop antenna in front of the wind screen and a receiver set on the dashboard

Commercial systems available around 1930 (in the USA)
In Germany from1932 on
(Blaupunkt Autoradio AS5)

“Clipper” Antenna 1937

Horizontal rod antenna for radio reception

First Car Telefon Service in Germany

- 1952 A-Net
- Taxi in Bremen/Germany
- 16 kg /15.000 DM (3 VW Beetle)

C2X-Communication Applications

… Commercial Infrastructure

… Satellite

… Cellular Infrastructure

Car-to-…

…Public Roadside Infrastructure

… Private Infrastructure

…Mobile

…Car

..... Based on Different Technologies

… Commercial Infrastructure

… Cellular Infrastructure

GSM

… Co… Infrastructure

…Public Roadside Infrastructure

WLAN
(IEEE802.11a/b/g/n/ac)

DSRC
(IEEE802.11p)

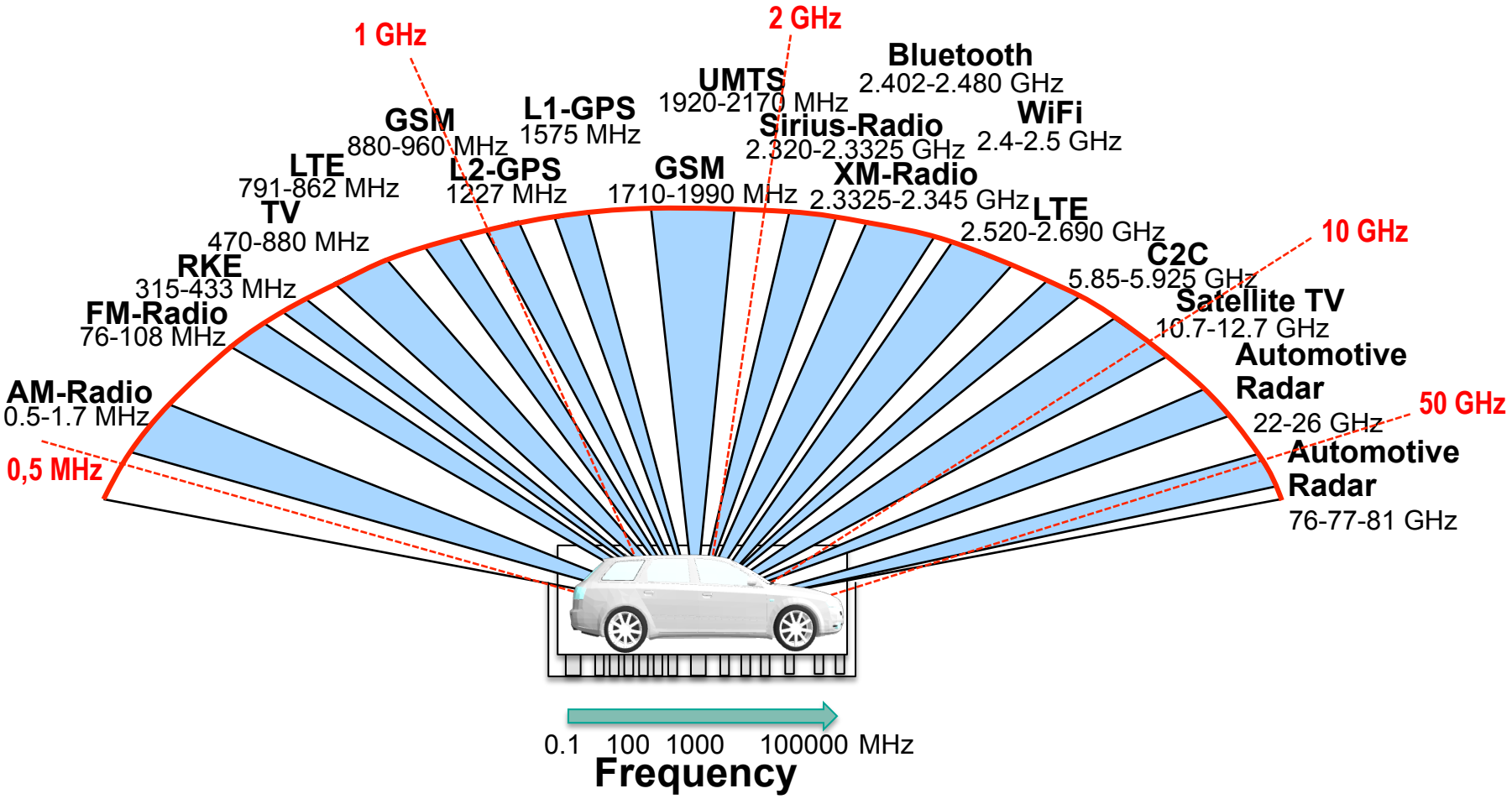
… Private Infrastructure

…Mobile (CE)

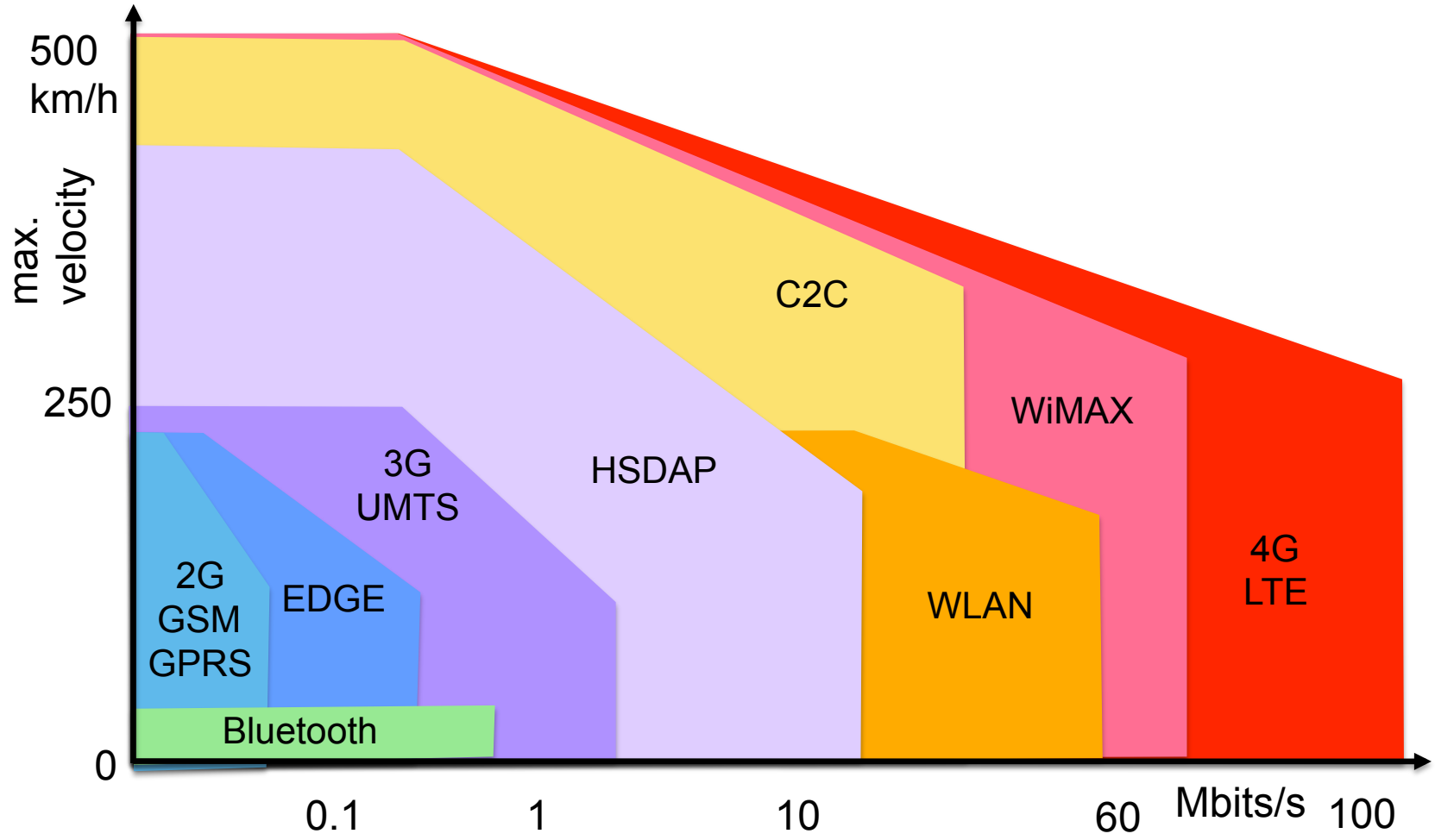
…Car

Courtesy Bosch

Frequencies and Applications in Vehicles



Data Rates of Wireless Communication Standards

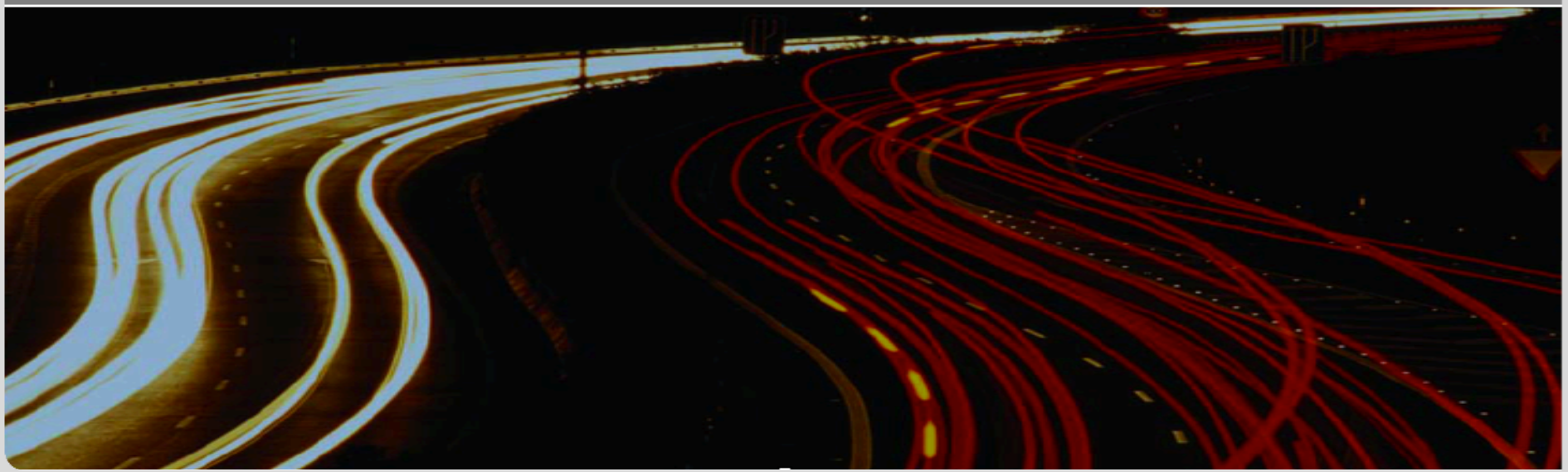


Institut für Hochfrequenztechnik
und Elektronik

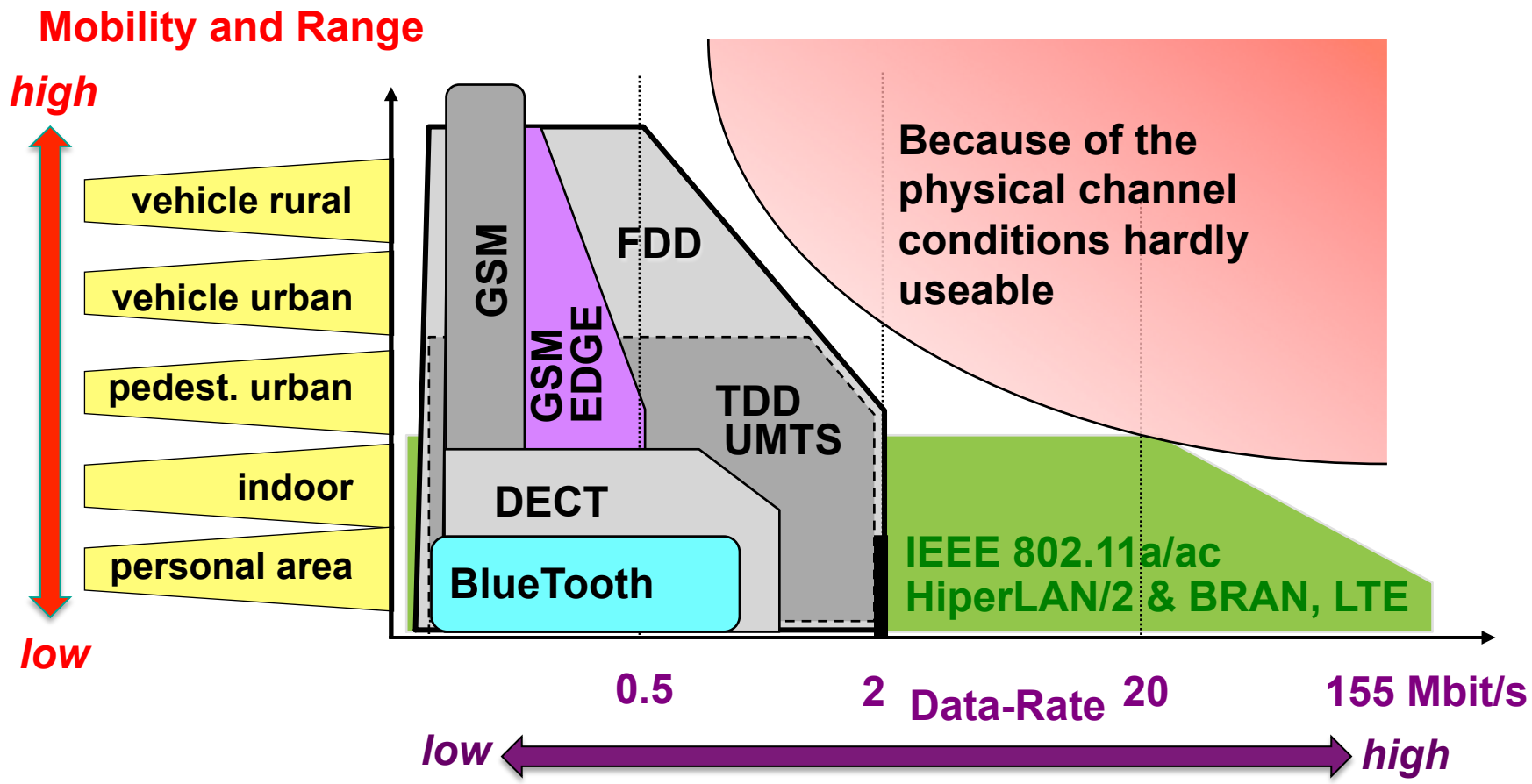
Karlsruhe Institute of Technology

Future Trends, Next Generation, Mobile Networks

Institut für Hochfrequenztechnik und Elektronik

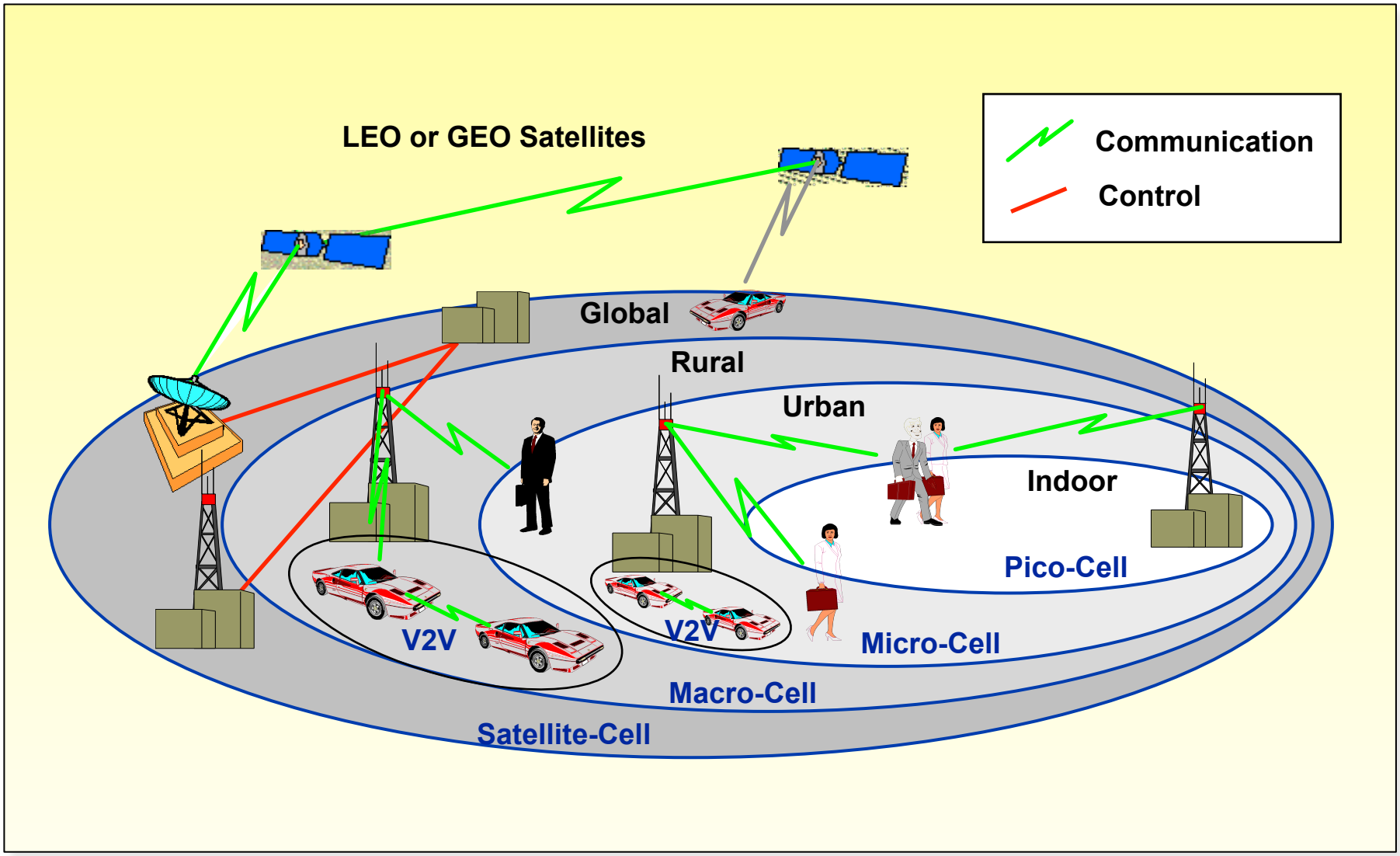


Radio Technologies Trade-Off: Mobility/Data-Rate



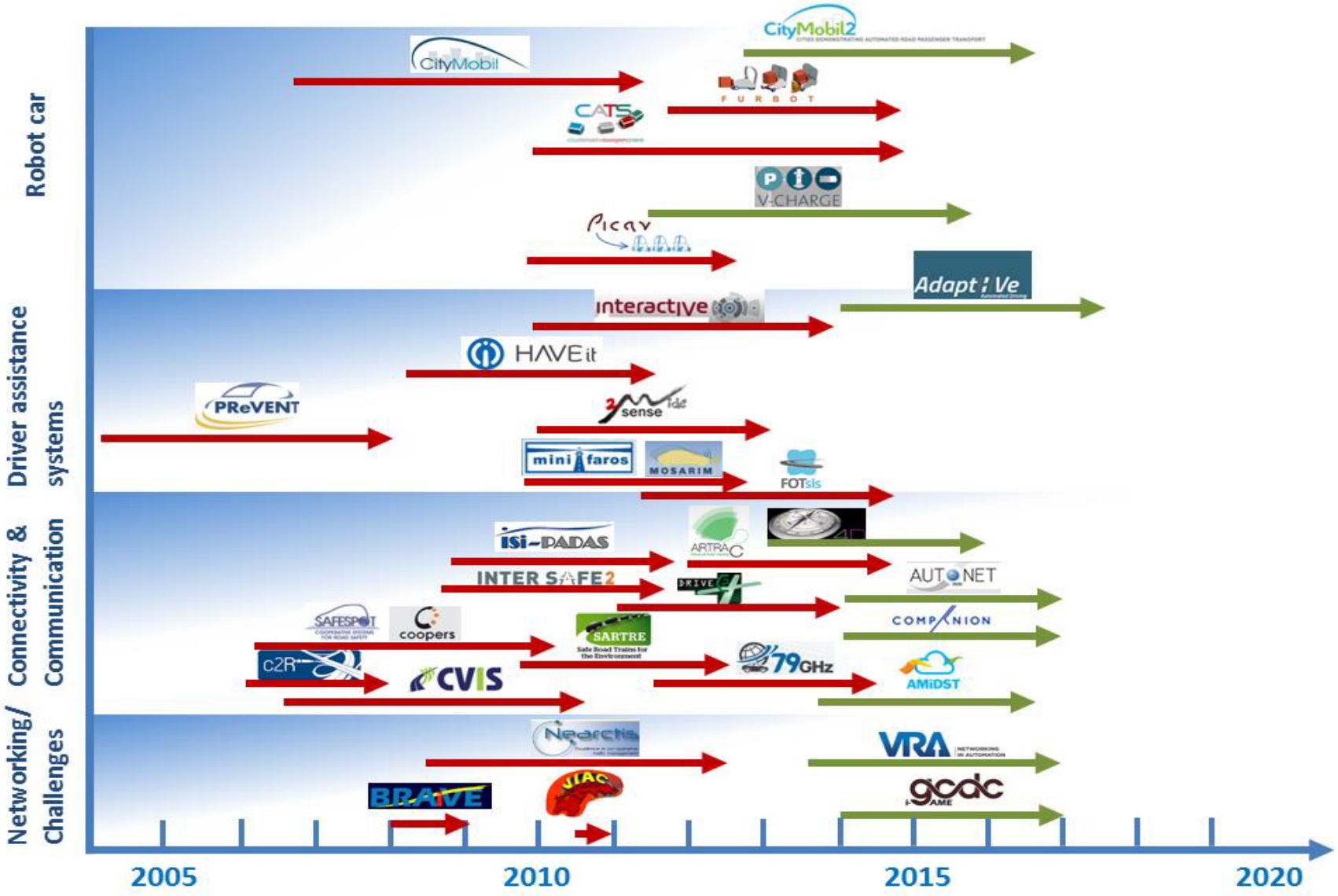
The different radio access technologies have to be optimized for different application areas

Cell Types of Future Communication Systems



Institut für Hochfrequenztechnik
und Elektronik

European Projects for Automated Driving



Autonomous Driving, Communication?