Hochschule Esslingen
University of Applied Sciences

IWT 2011 International Workshop on Telecommunications
May 3rd - 6th 2011 - Rio de Janeiro - Brazil

Communication in Transportation Systems

Optical and related Microwave Techniques

Otto Strobel

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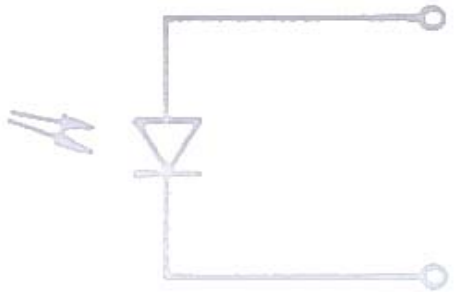
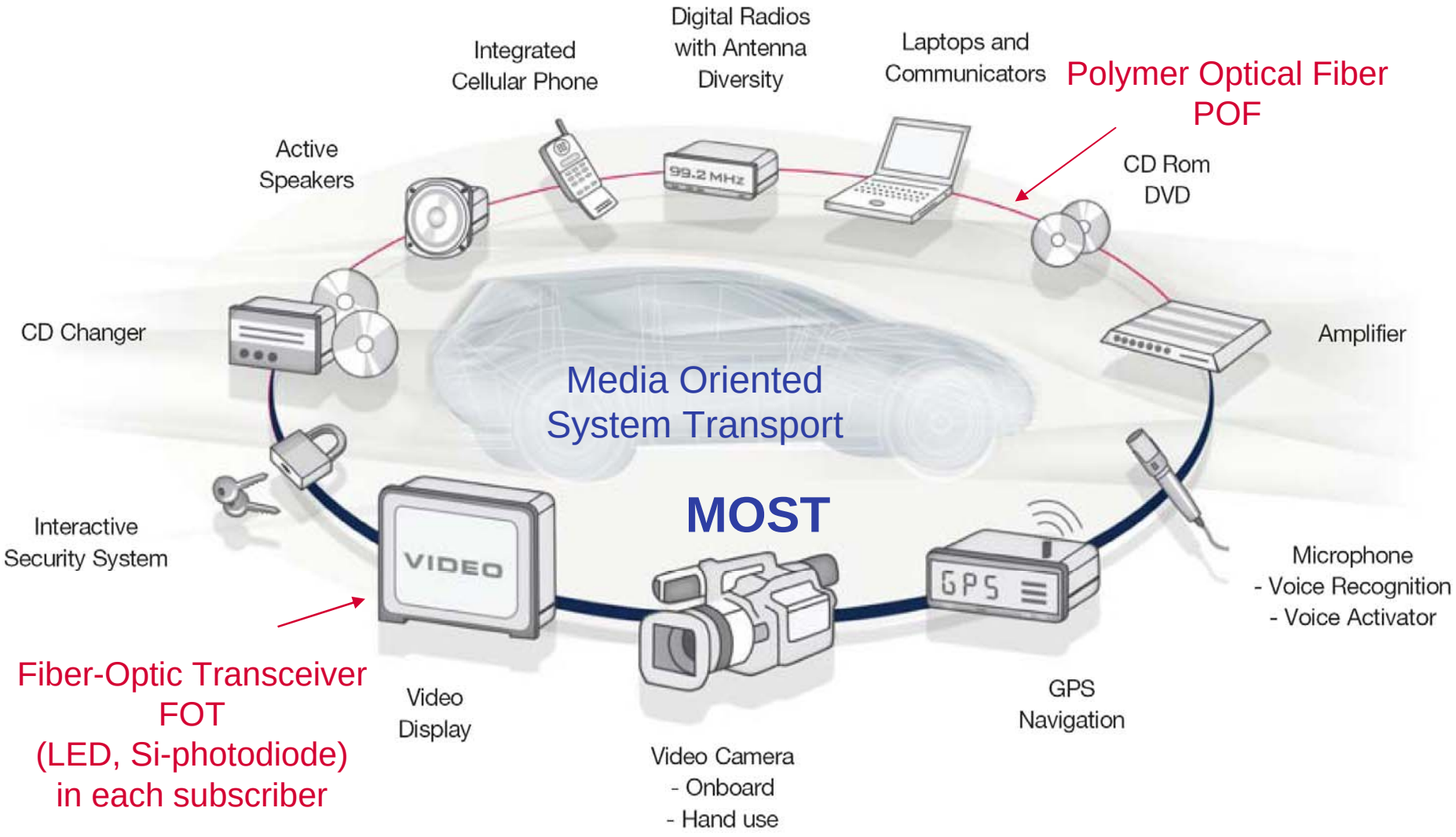


- Introduction to Automotive Systems
- Principle Considerations
  - Components for fiber-optic systems
- Future technologies for Automotive Systems
  - Alternative components to overcome conventional limitations
  - High speed optical data buses for automotive applications
  - Limits and future applications of high-speed automotive data buses in vehicles and airplanes
  - Optical wireless systems, Visible light communication (VLC)
  - Low cost automotive data buses
  - Radio over Fiber Systems (RoF)
  - 4G wireless CTS communication
  - Automobile Radio Vision System
  - Radiometric speed measurement

MOST Bus for Automotive Applications



MOST Physical Layer Components

Device

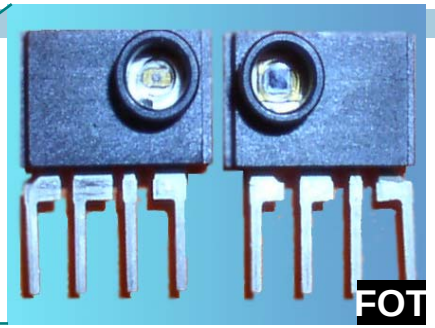
Pigtail is integrated in ECU

Function:
MOST Device e.g.:
CD-Player, Amplifier

Connector

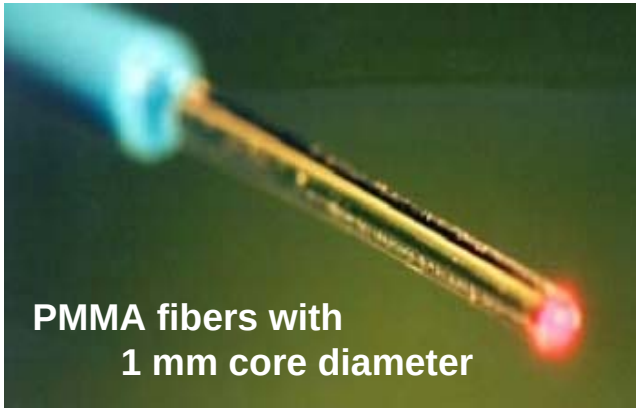
FOT is integrated

Function:
Represents the interface to the fiber

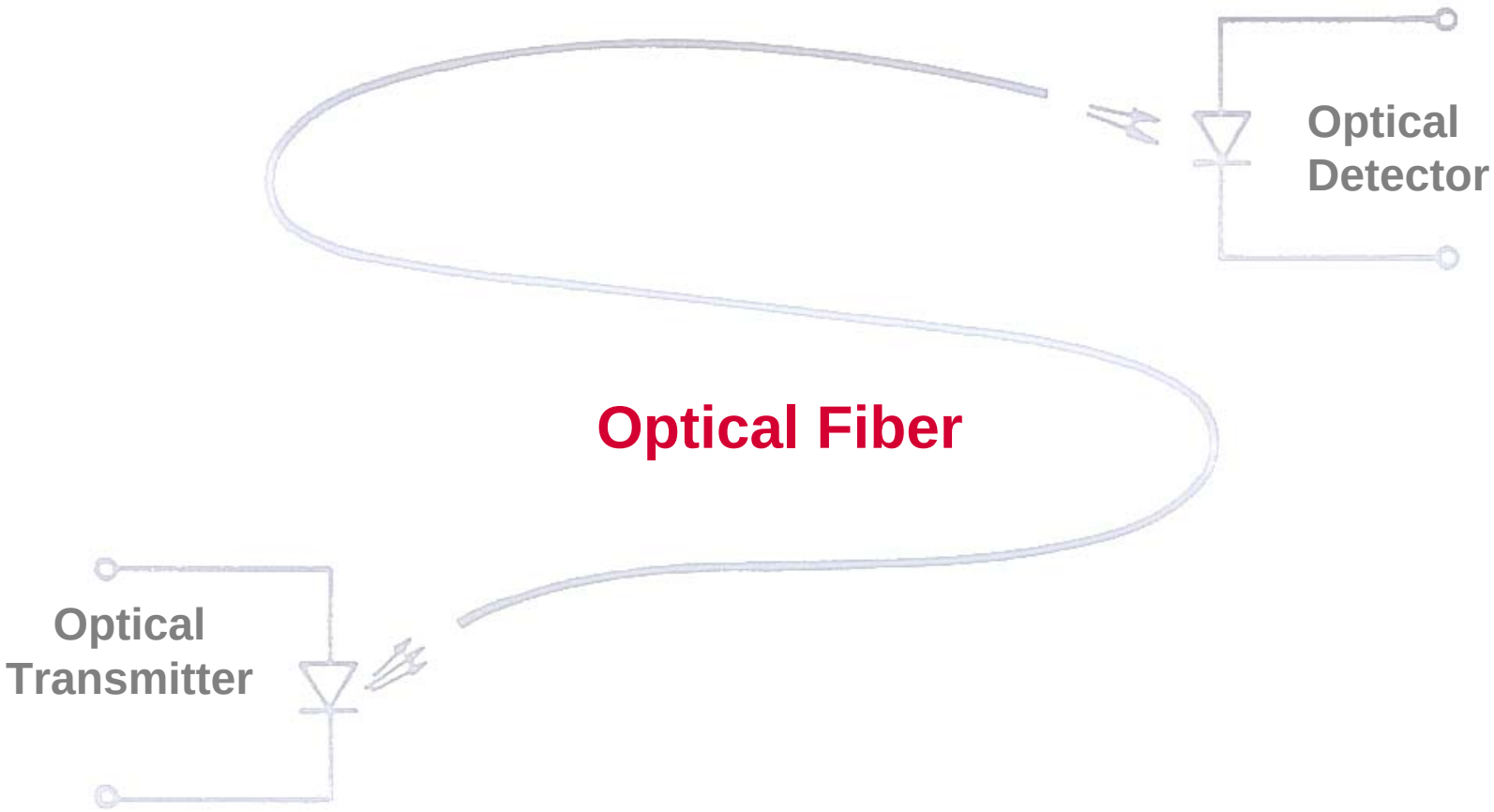


Component

Consists of two devices:
Fiber optical
Transmitter & Receiver



Principle Considerations



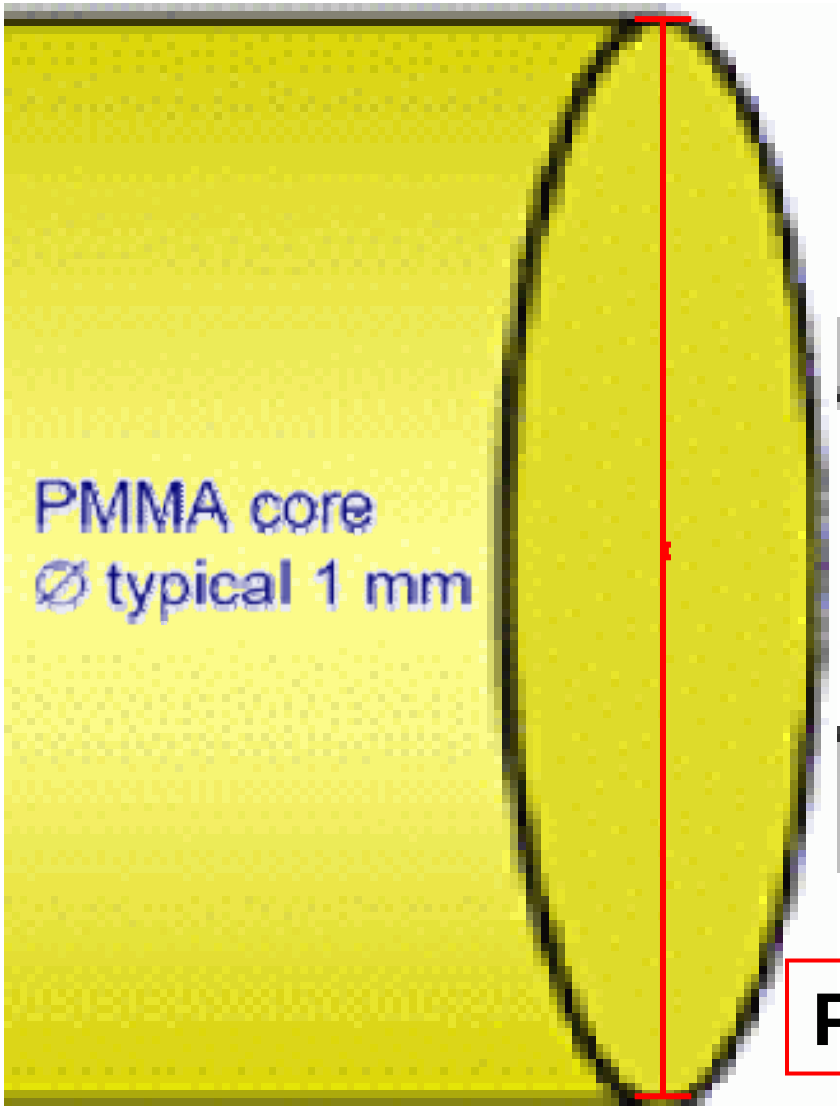
Advantages of Fiber-Optic Systems

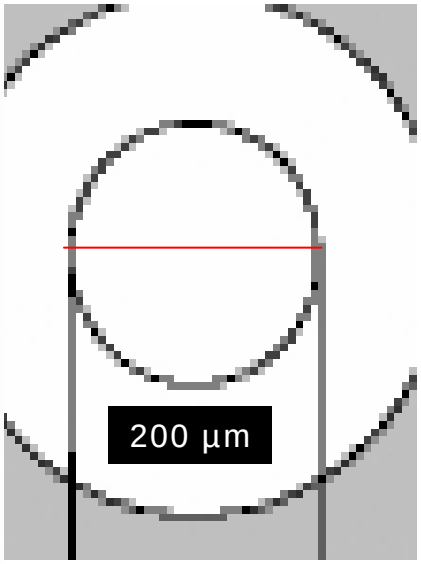
- Low attenuation
- High bandwidth
- Low weight and small size
- Non-sensitivity against electromagnetic interference
- Electrical isolation
- Low crosstalk

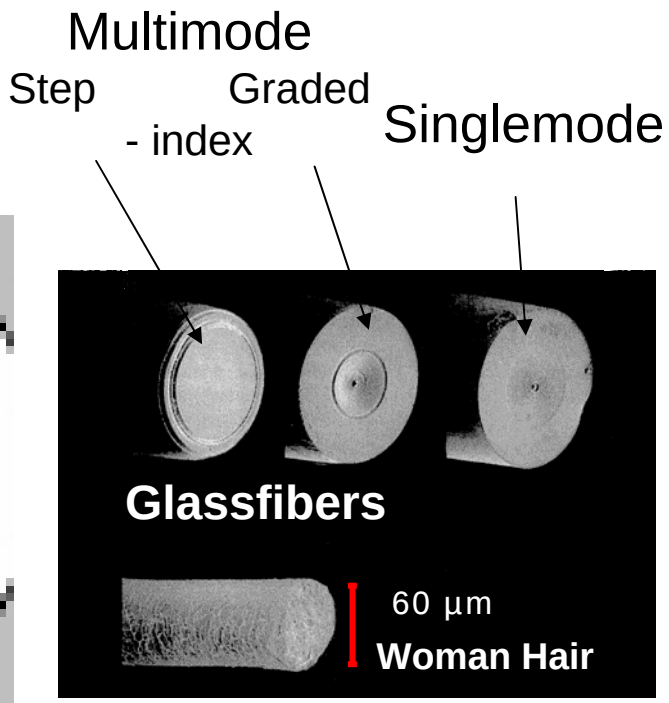
Transmission capacity = Bandwidth-length product:

$$B \cdot L = Max!$$

Different Fiber Types

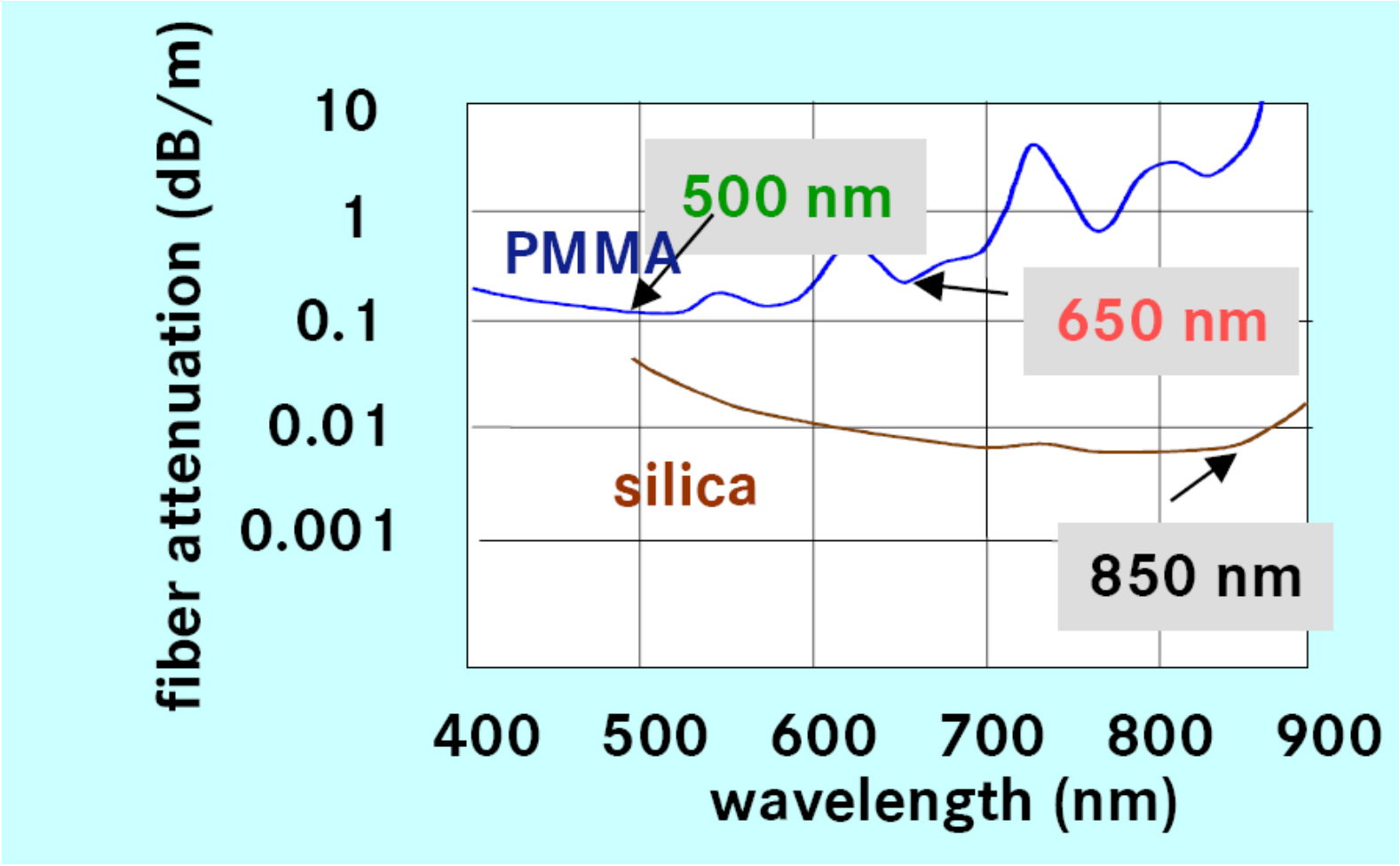






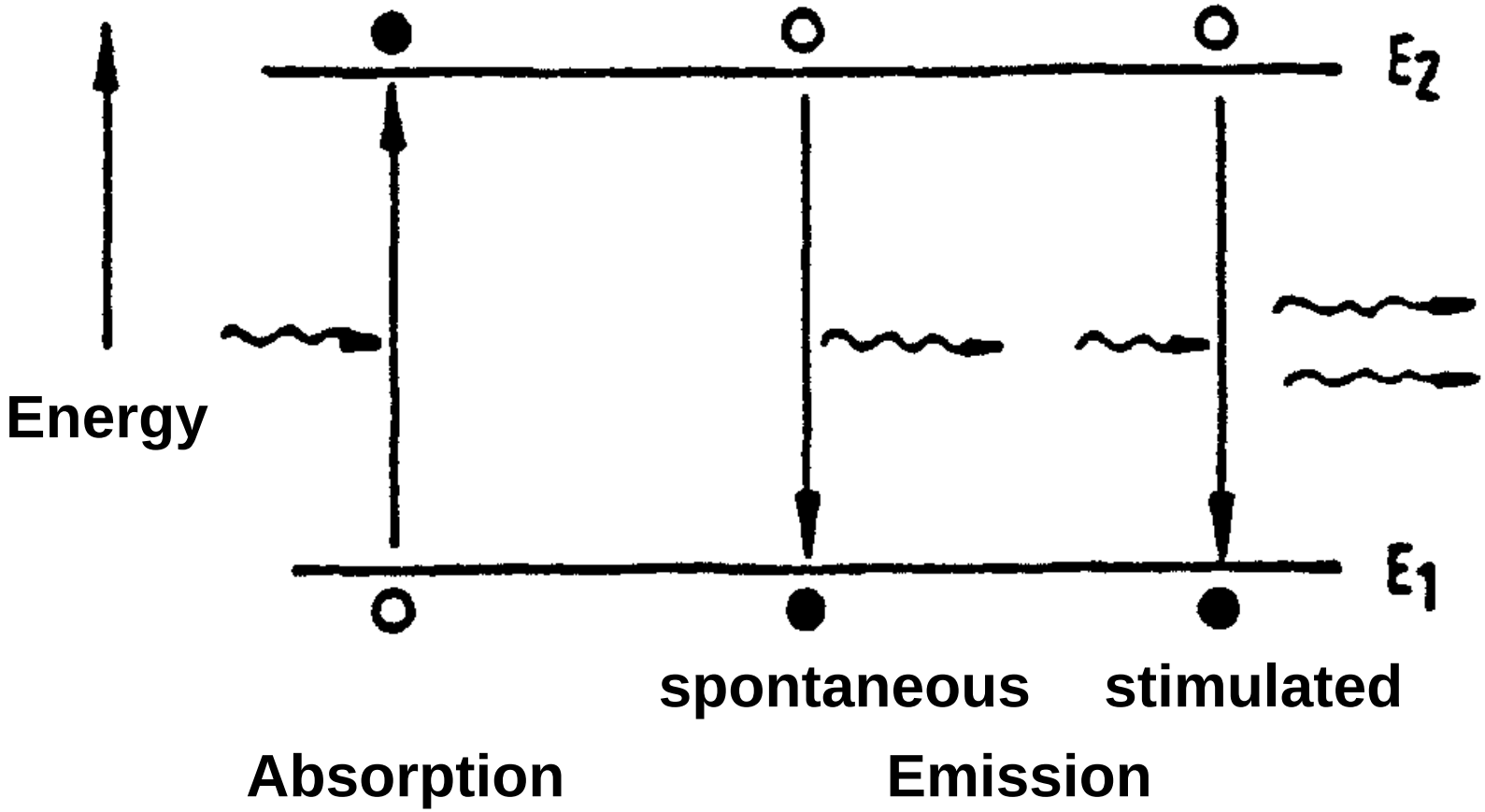
Polymer- PCS- and Glasfibers

Spectral Attenuation of different Fibers

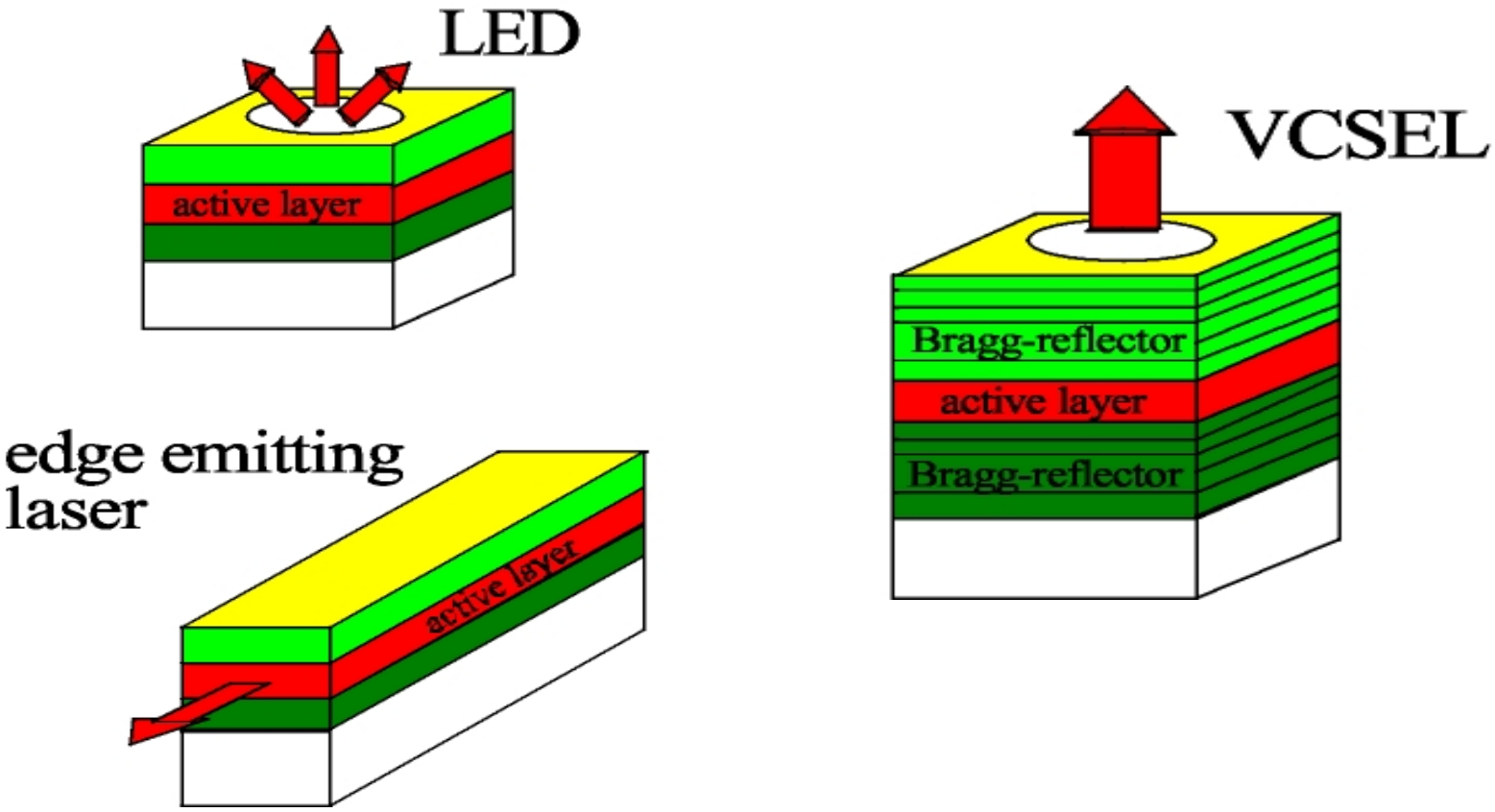


Absorption and Emission

$$E_2 - E_1 = \Delta E = h \cdot f = \frac{h \cdot c}{\lambda}$$



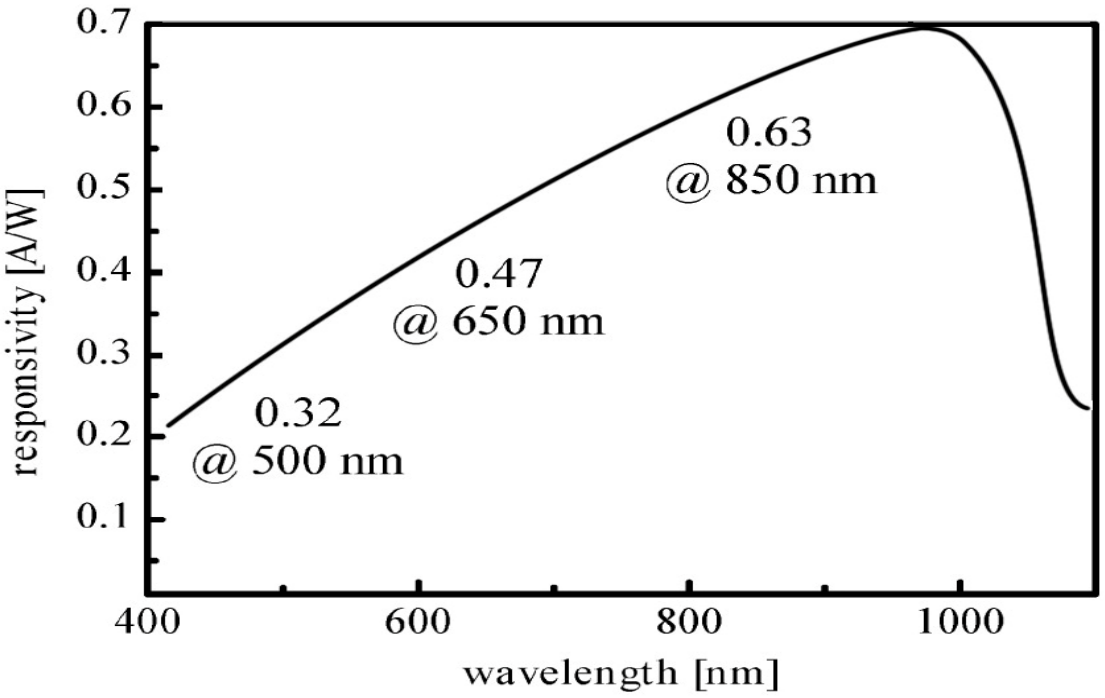
Light Sources for Fiber-Optic Systems



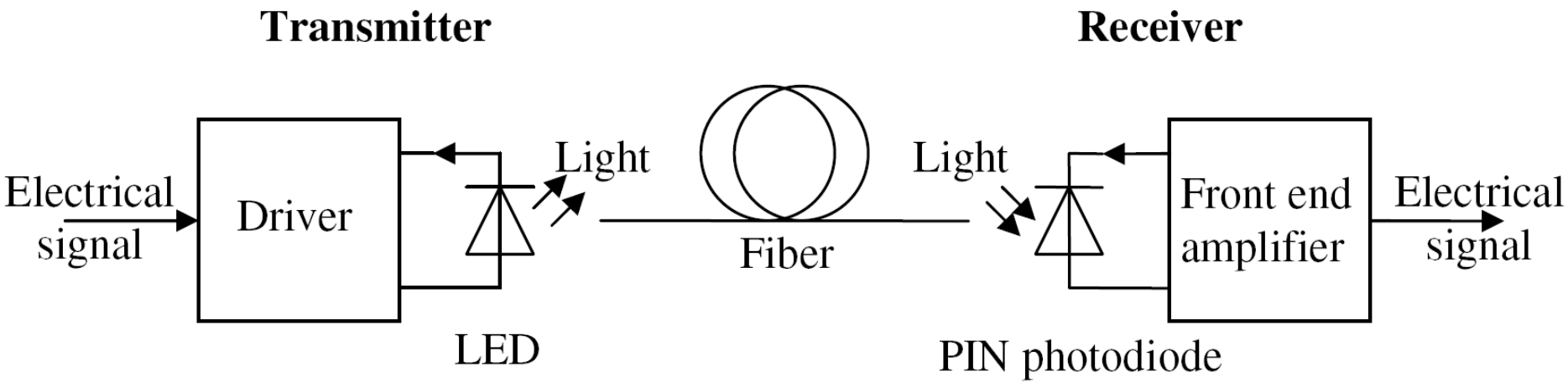
Demands on Optical Detectors

- **High sensibility**
- **Low noise**
- **Small size**
- **High bandwidth**

Spectral responsitivity of a Si pin-Photodiode

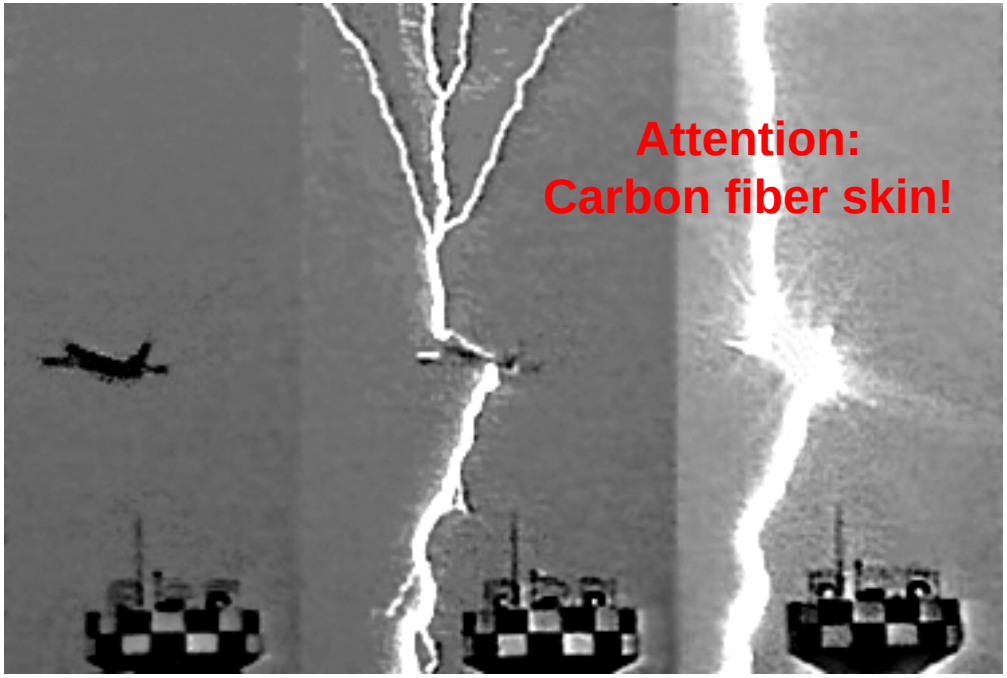


System Integration



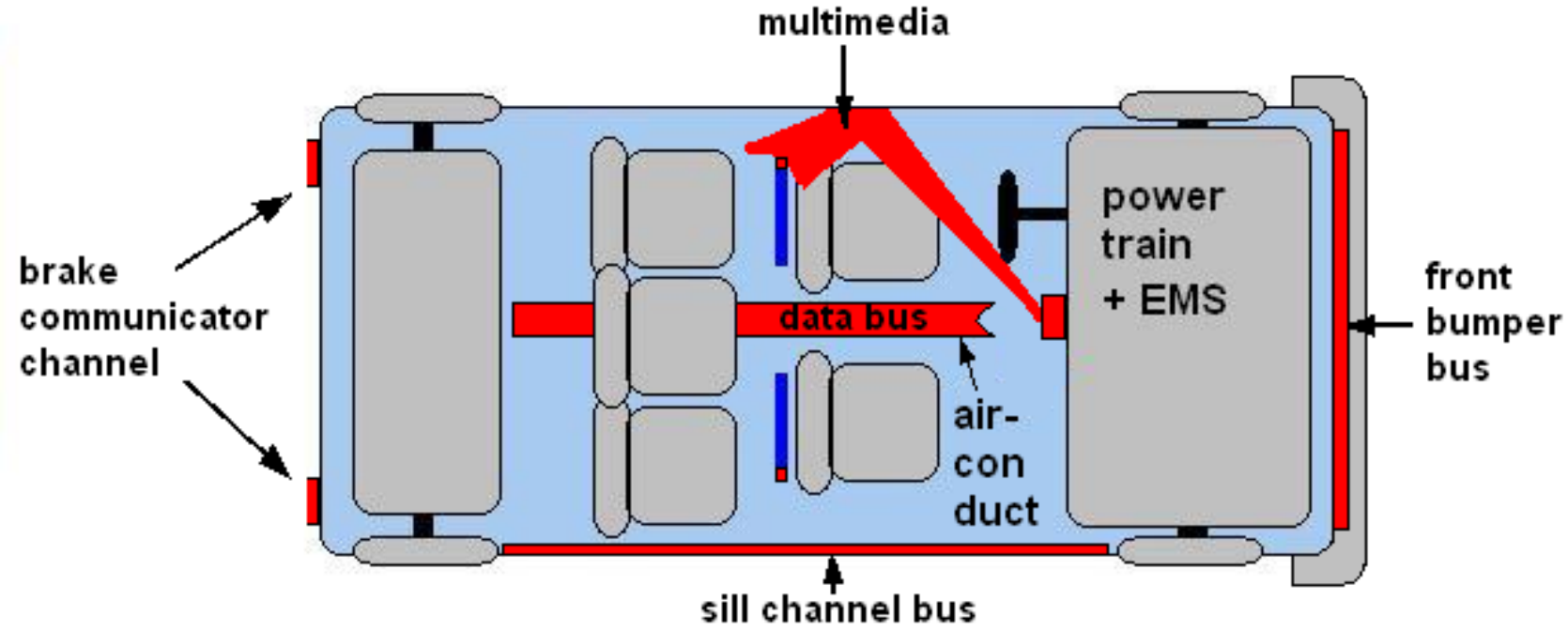
Lightning Strike

- Nowadays aircrafts have a metal fuselage
  - Faraday's cage effect
    - good passive lightning protection granted
  - heavy, high fuel consumption
- Future aircrafts are using more and more carbon fiber fuselage
  - less weight
  - less fuel consumption
  - less/no Faraday's cage effect
    - more protections needed



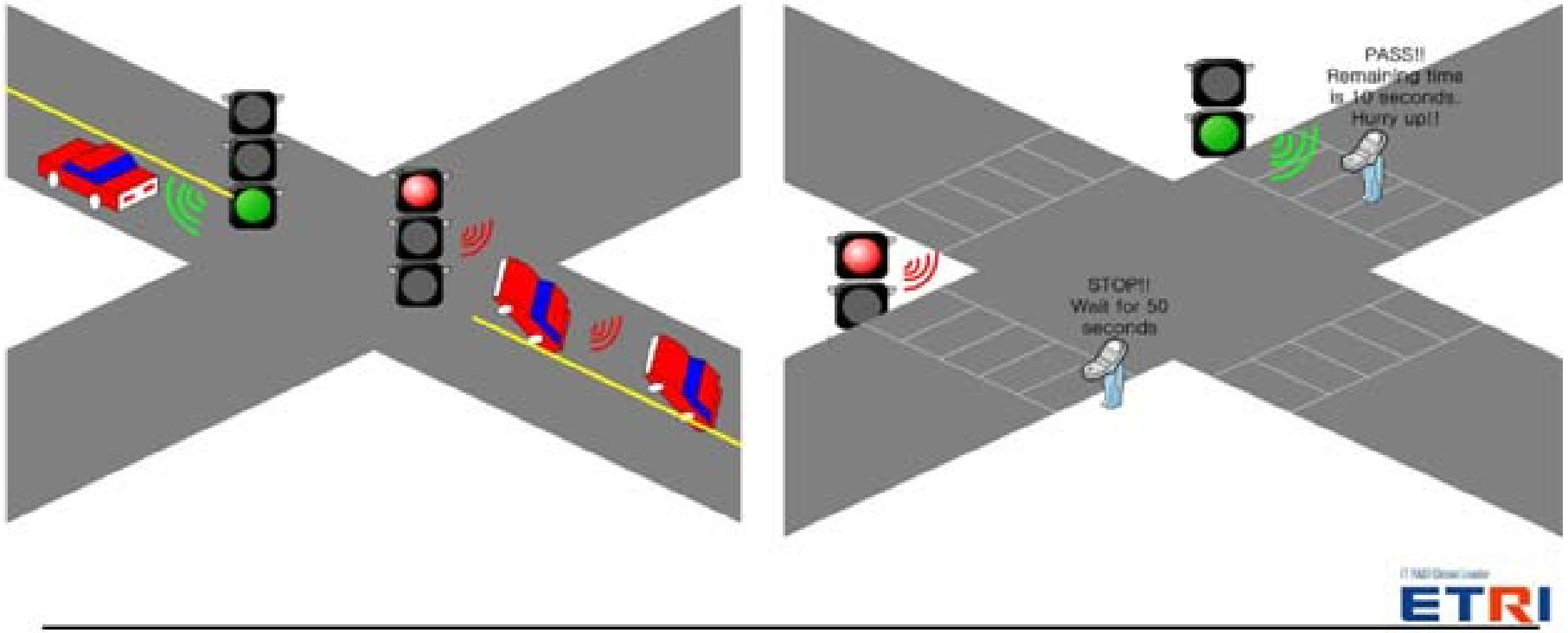
Optical wireless channels

Optical wireless channels for multimedia distribution, vehicle control, and external communication



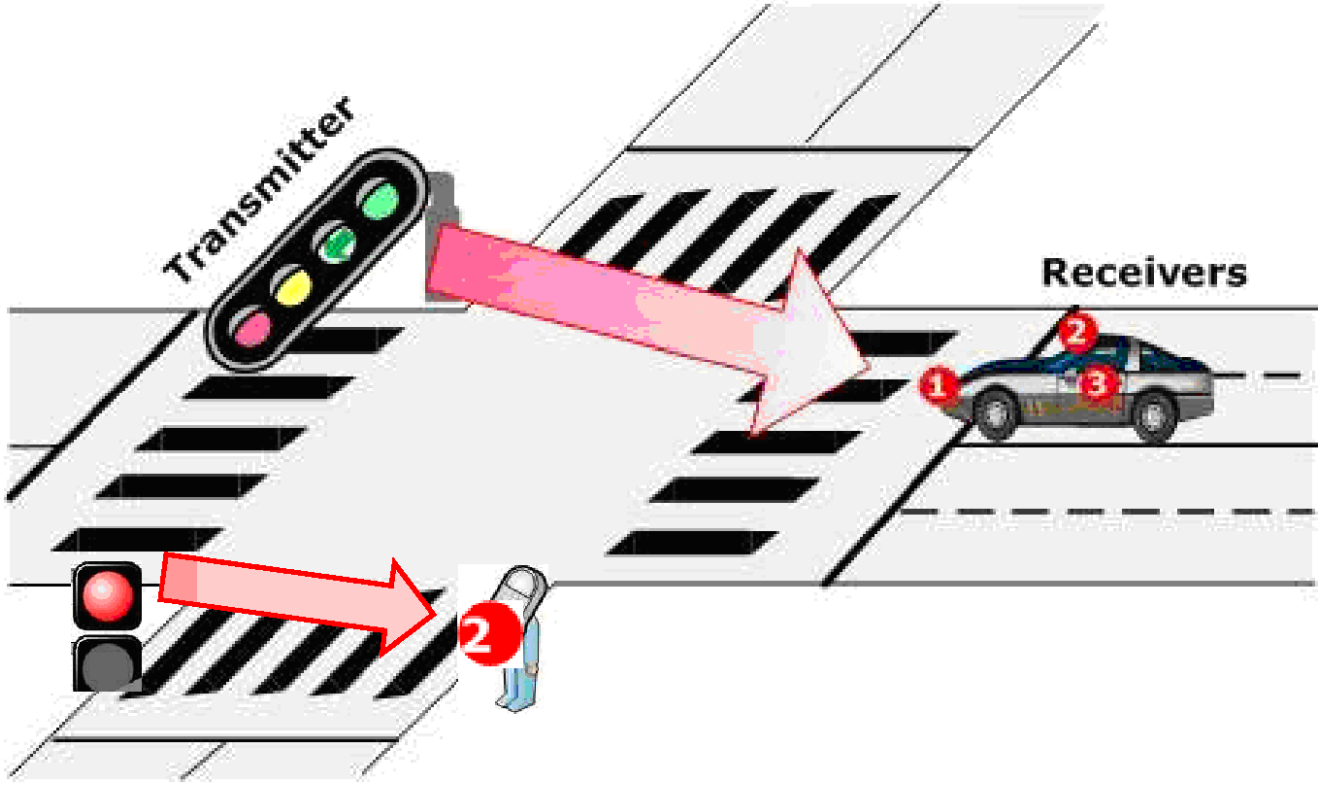
We.C3.2 14:30Optical wireless with application in automotives (*Invited*) *R.J. Green*

Visible Light Communication (VLC)



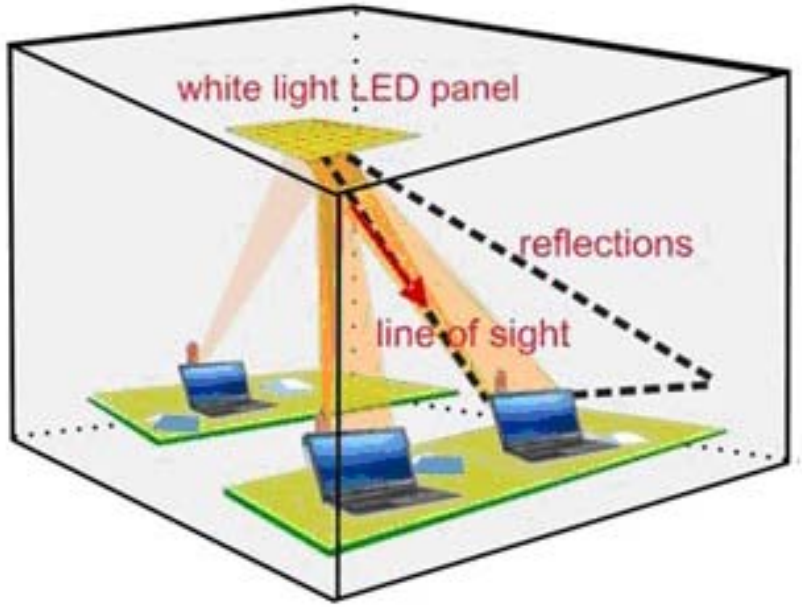
Myunghee Son, Electronics and Telecommunications Research Institute, ETRI, Korea

Visible Light Communication (VLC)



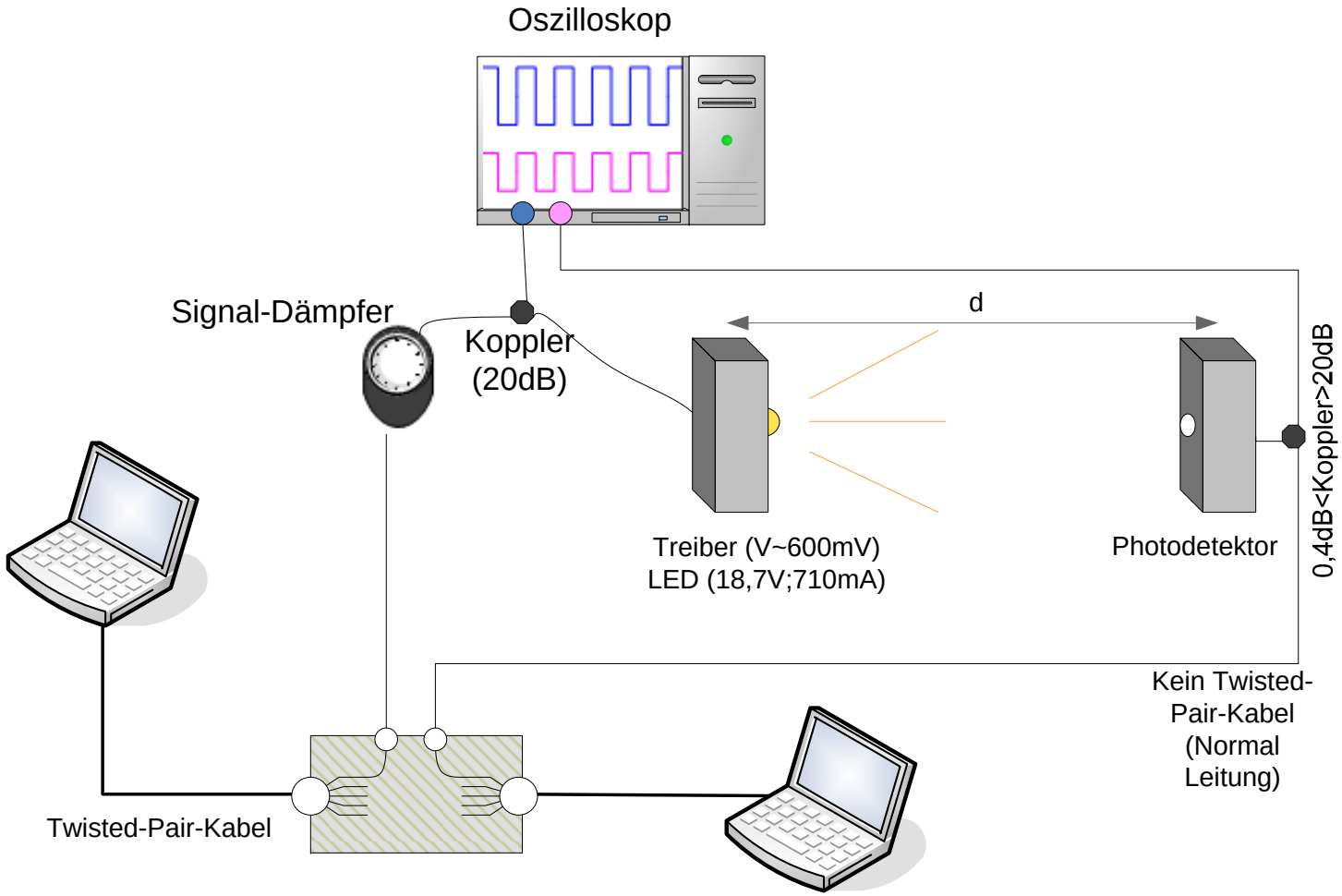
Myunghee Son, Electronics and Telecommunications Research Institute, ETRI, Korea

VLC broadcasting by use of an LED array

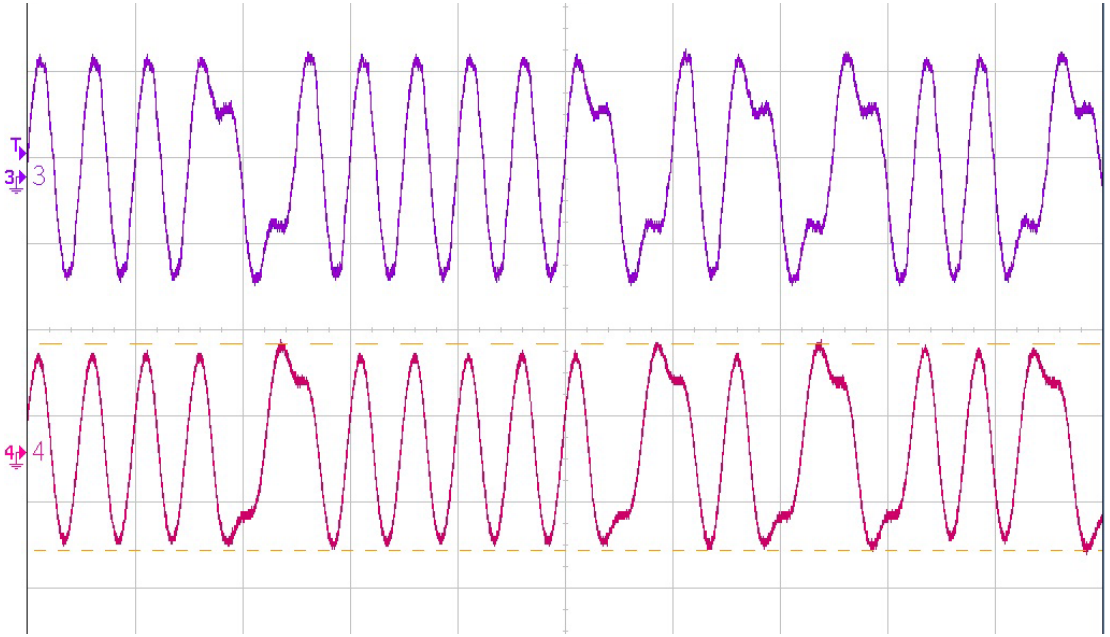


VLC broadcasting with an array of LEDs
on the ceiling used for lighting as well as data communication

VLC broadcasting experimental setup



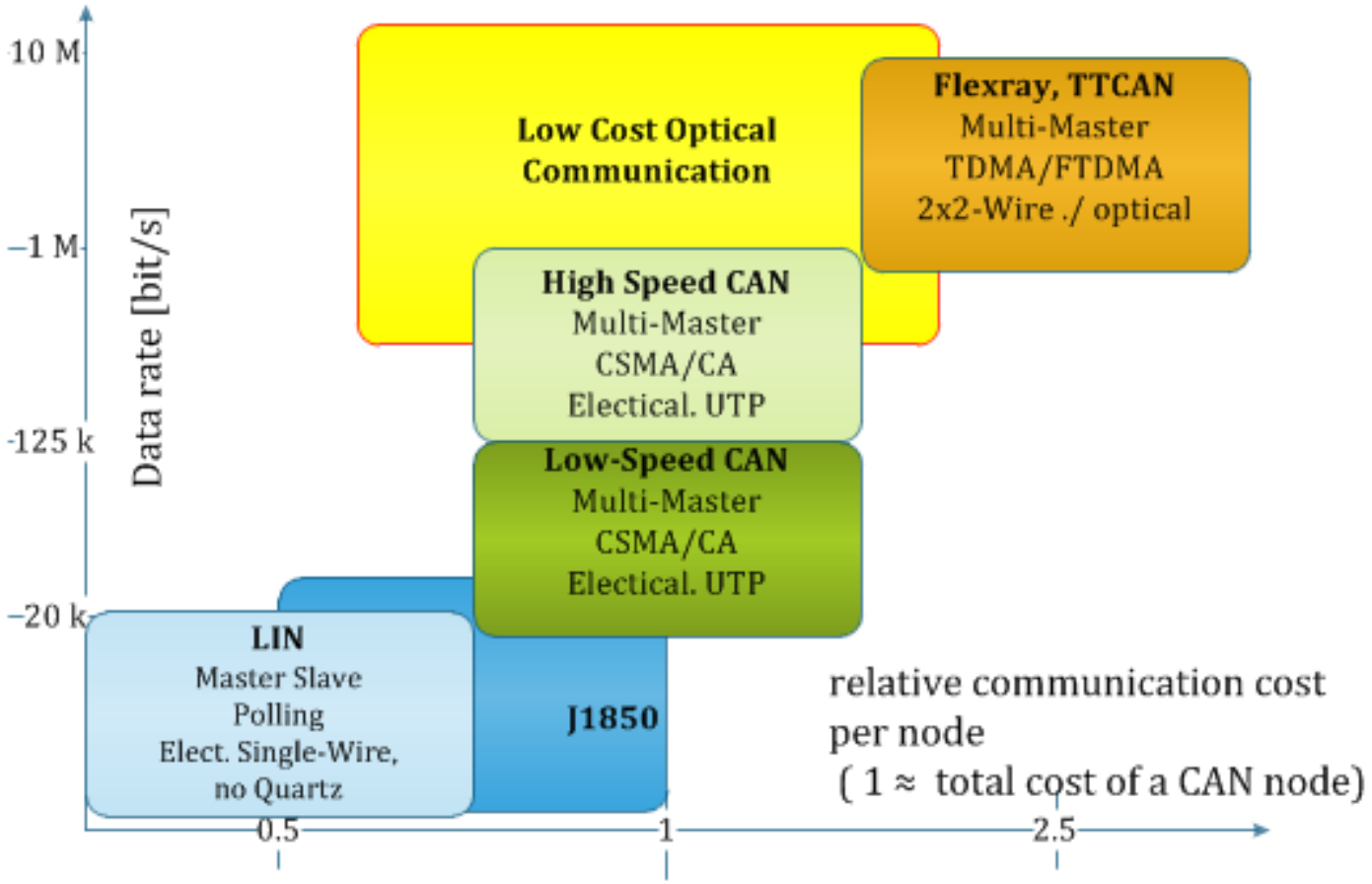
10 Mbitps Ethernet signal



Transmitter signal

Receiver signal

Low cost optical bus solution

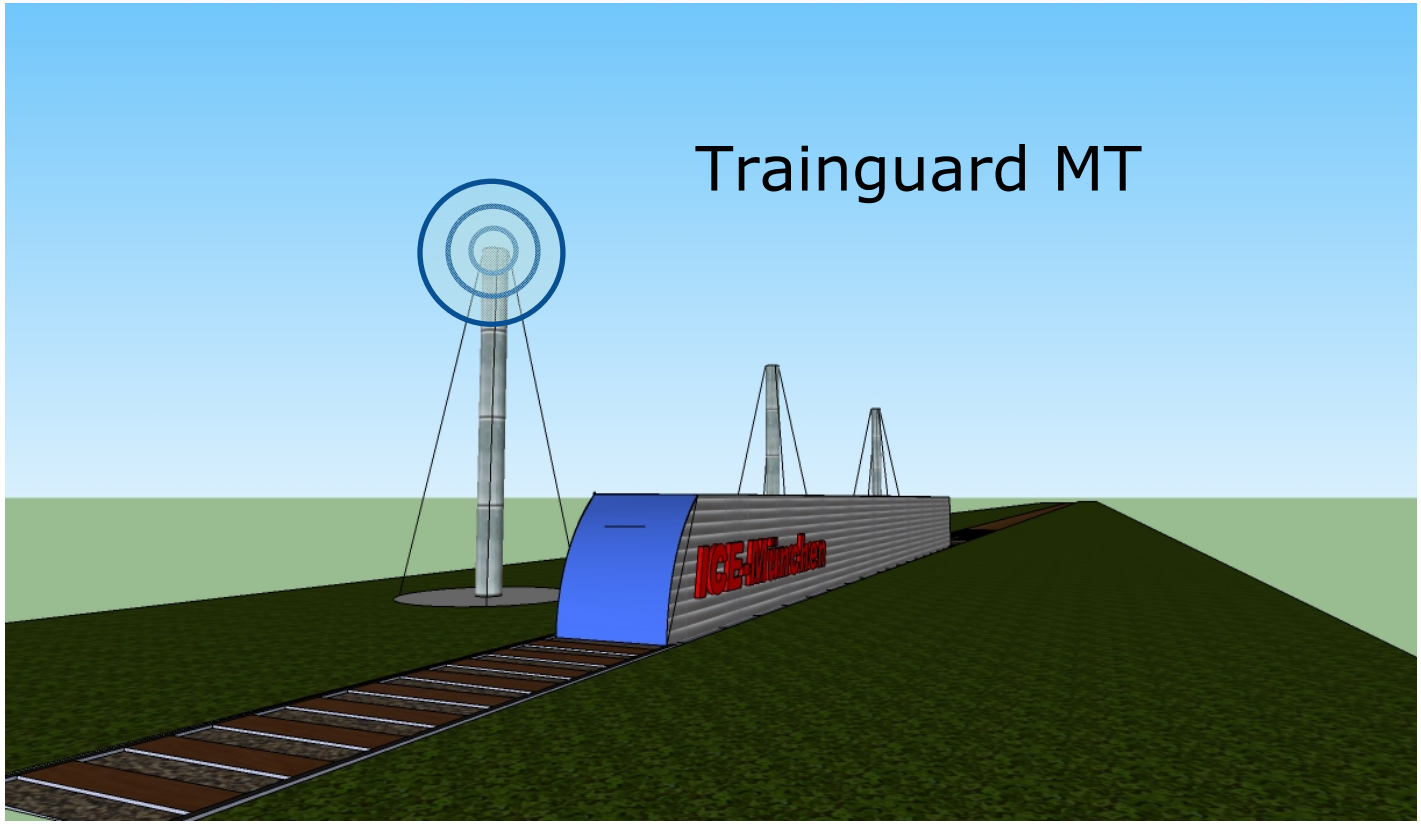


Data rate versus cost for various automotive real-time networks

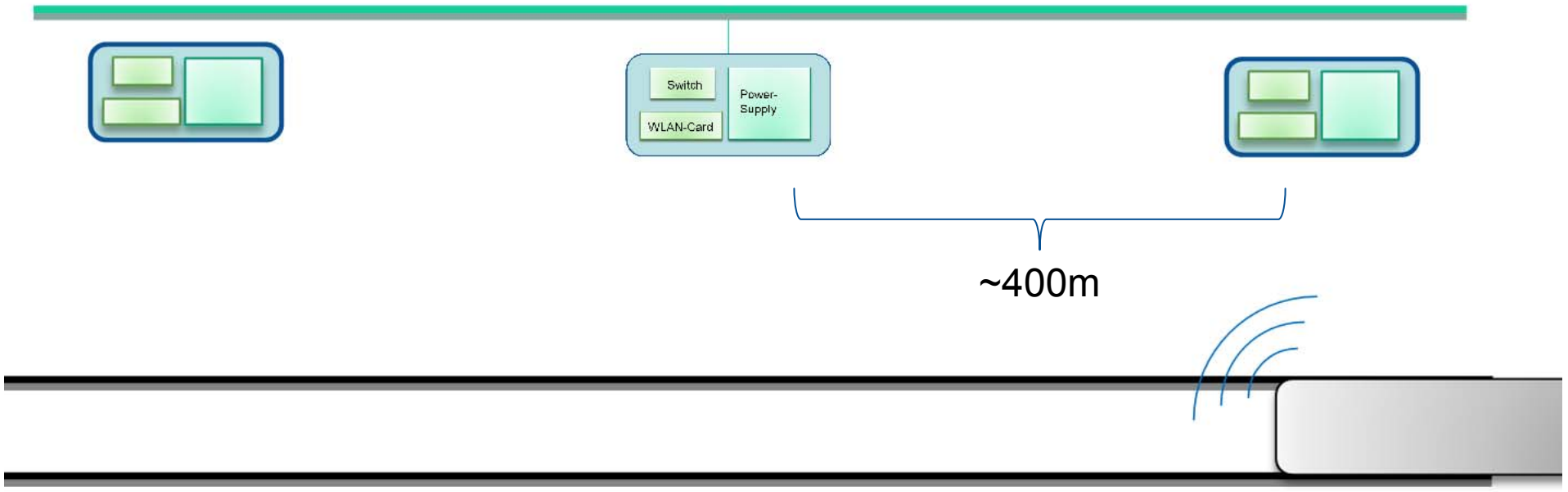
Optical bus application for glow plug control

Controlled glow plugs visualized in a Graphic User Interface (GUI)

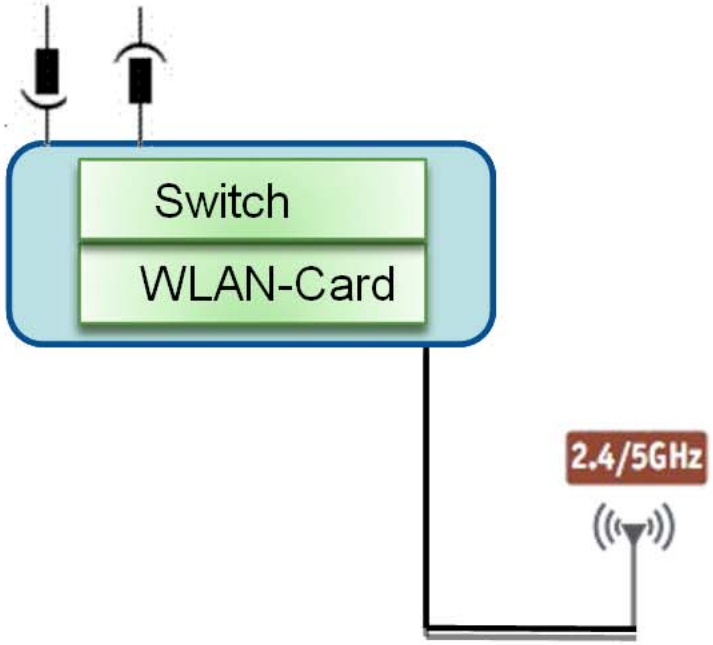
WLAN reduction due to fiber propagation



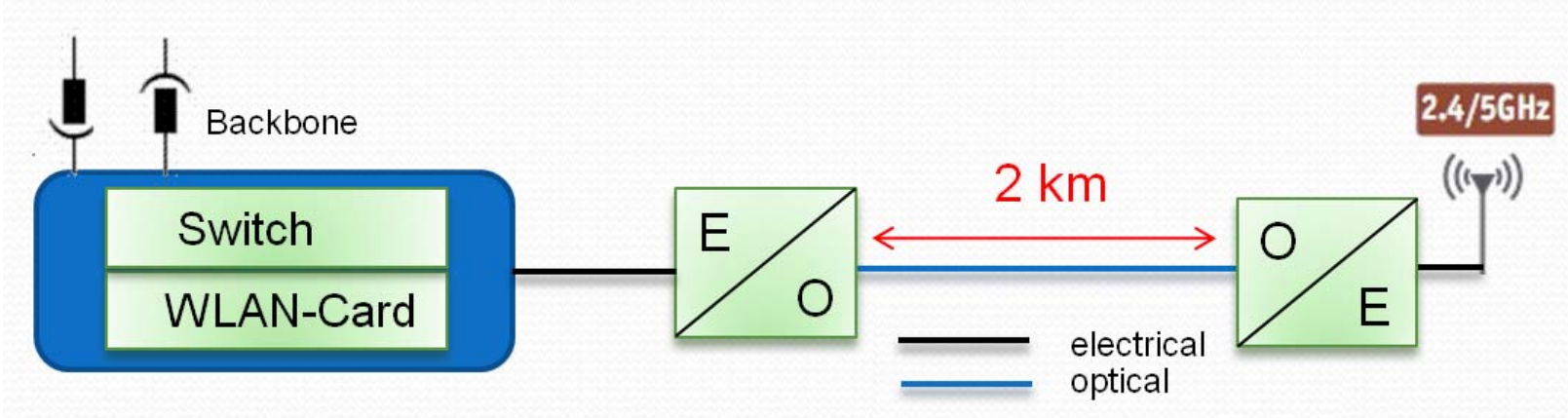
Topology



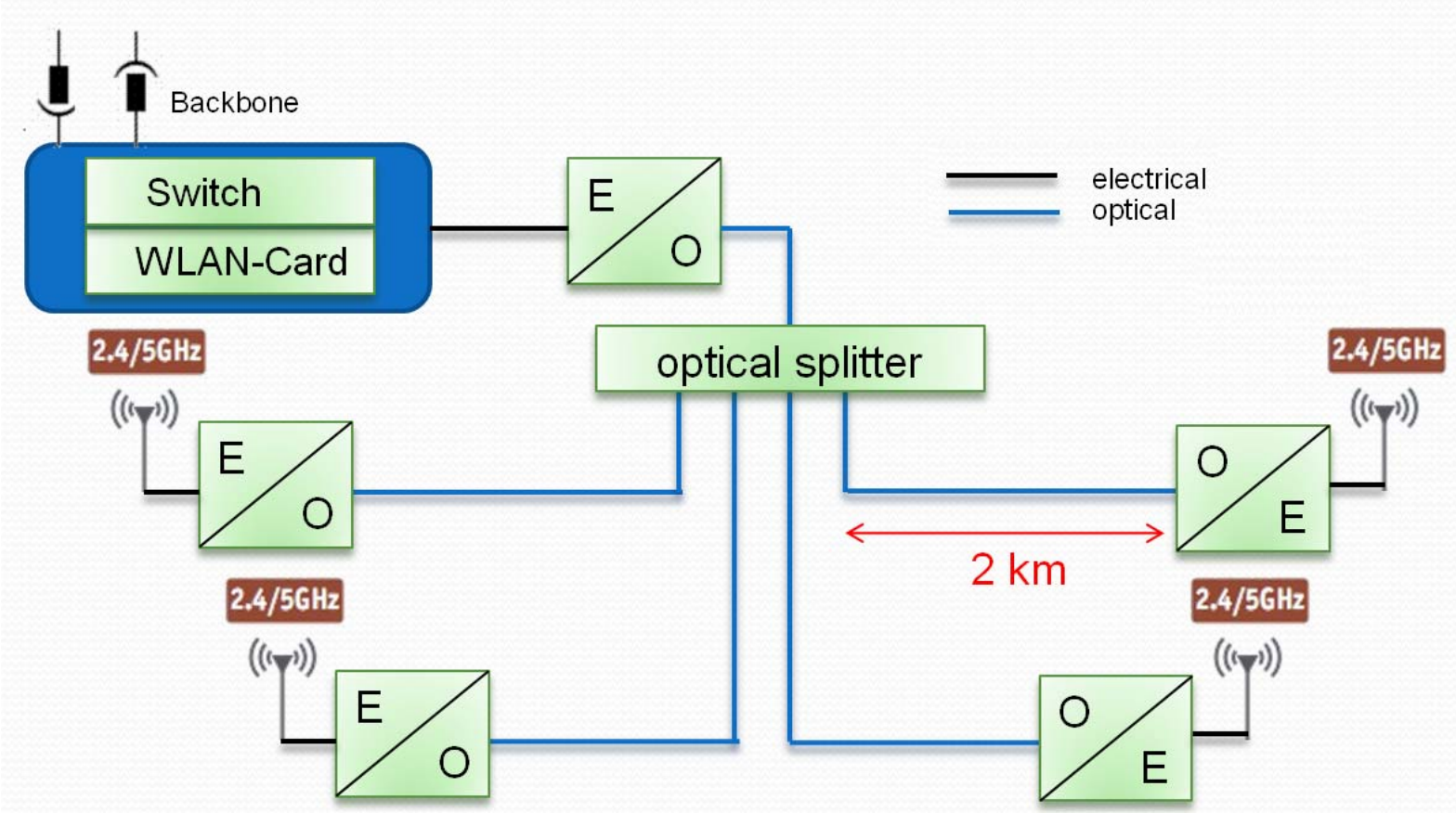
Scenario details



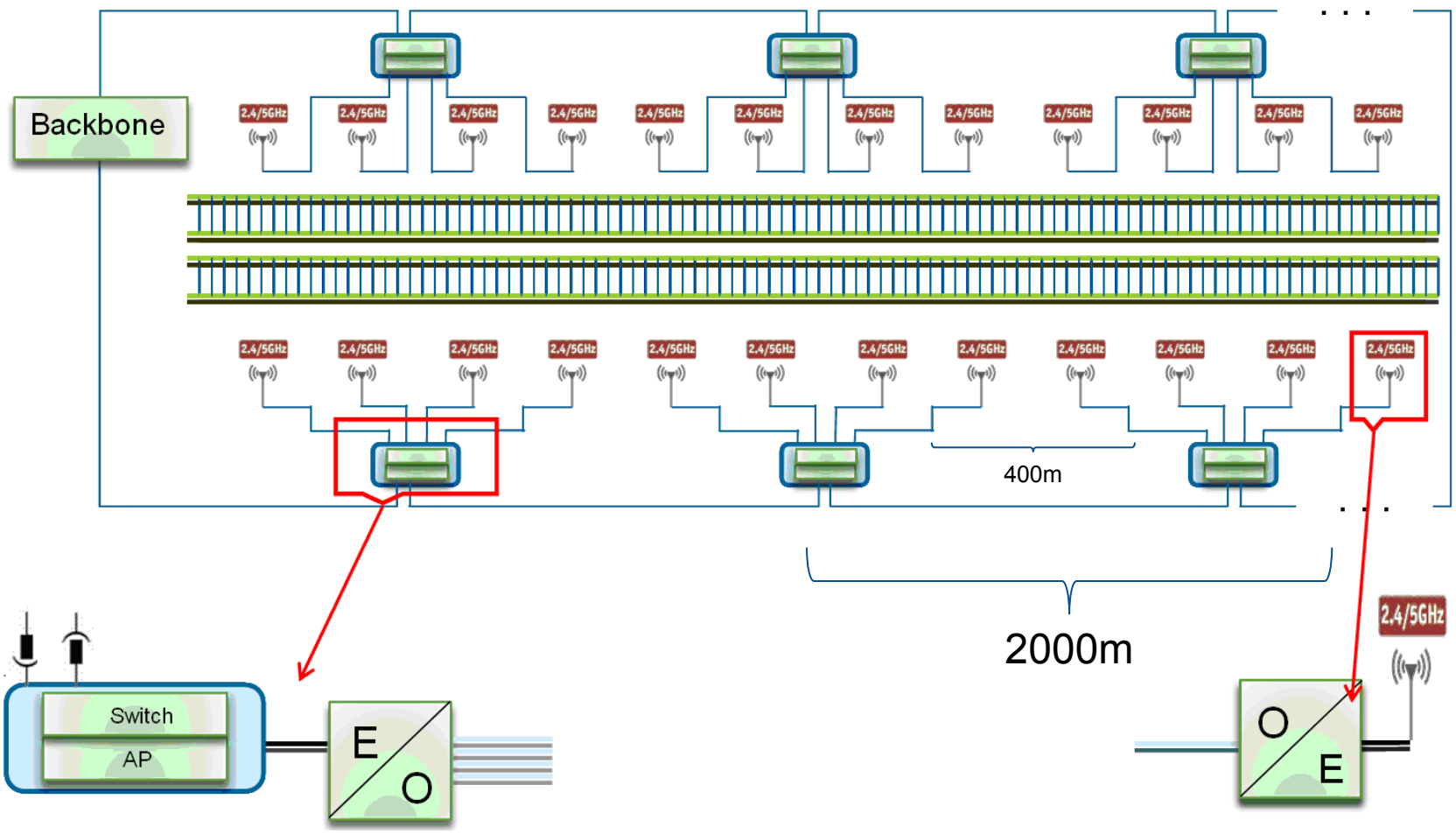
Scenario details



Scenario



Scenario details



4G wireless CTS communication

10 Mbps up to a speed of the car of 140 km/h

CTS Application for internet radio, watch movies, check e-mails and book online airline tickets for Passengers and drivers

Signal quality investigation

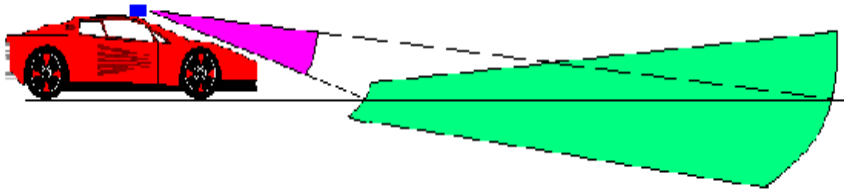
CINR (Carrier to Interference and Noise Ratio)
RSSI (Received Signal Strength Indication).

Table 2. CINR and RSSI at different speeds.

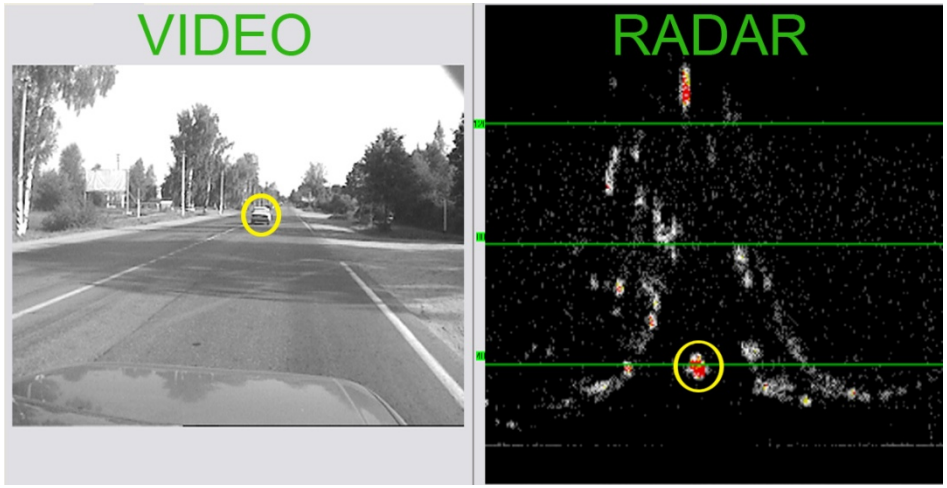
Speed (km/h)	CINR (dB)	RSSI (dBm)
30	30…21	-48…-62
60	28…16	-41…-65
80	30…20	-52…-55
100	20…8	-62…-80
120	31…12	-46…-69
130-140	28…9	-48…-75

Automobile Radio Vision System (ARVS)

ARVS is a small-sized, all-weather, information-measuring system – a new generation of panoramic radar systems.



ARVS is intended for prevention collisions with obstacles and drive of the car in conditions of absence or the limited optical visibility (a fog, a snow, a rain, could, a dust, etc.)

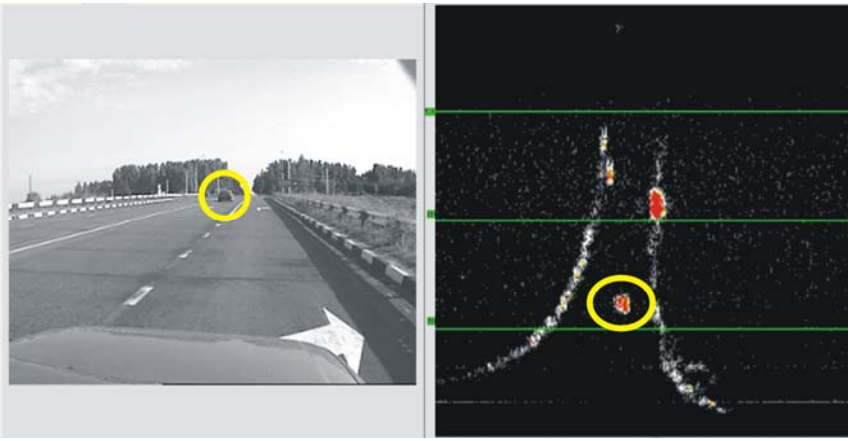


ARVS forms for driver the dynamical image of all participants of movement, obstacles, borders and roadsides of road.

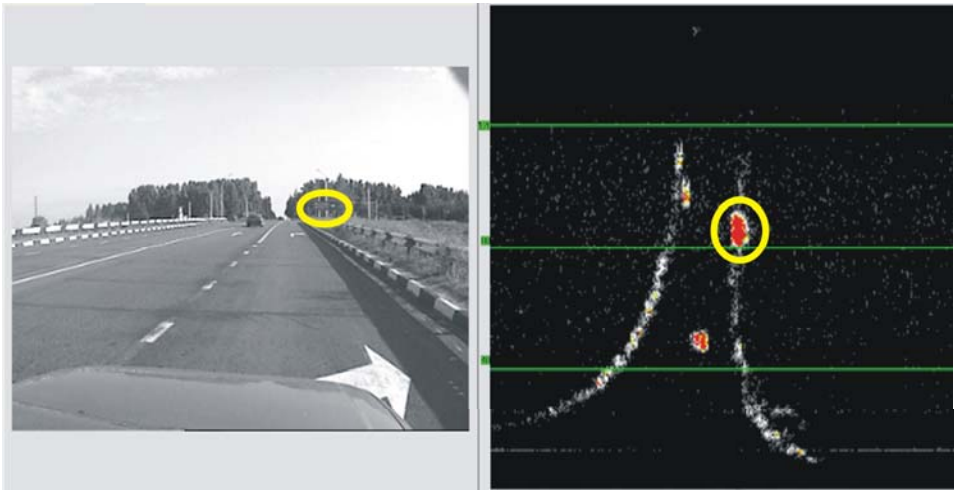
Andrey Ananenkov, Anton Konovaltsev, Vladimir Nujdin, Vladimir Rastorguev*, Pavel Sokolov – "Algorithms of Processing of Radar Images in Radio Vision Systems of the Car", Proceeding of International Conference on Transparent Optical Networks – ICTON-MW'09, Angers, France, December 10-12th, 2009. IEEE explore, Digital library **E-ISBN:** 978-1-4244-5746-5, **Print ISBN:** 978-1-4244-5745-8, **Digital Object Identifier:** 10.1109/ICTONMW.2009.5385559

The real radar images

The vehicle



The traffic sign



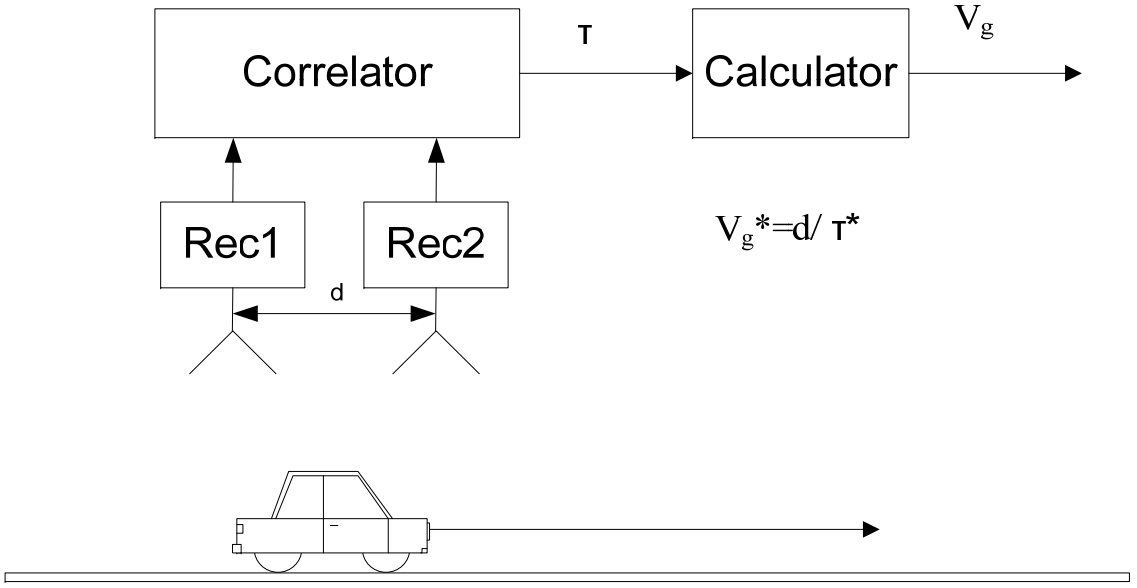
Andrey Ananenkov, Anton Konovaltsev, Vladimir Nujdin, Vladimir Rastorguev*, Pavel Sokolov – “Characteristics of Radar Images in Radio Vision Systems of the Automobile”, Proceeding of International Conference on Transparent Optical Networks – ICTON-MW’08, Marrakech, Morocco, December 11-13th, 2008. - IEEE Catalog Number: CFP0833D-CDR, ISBN: 978-1-4244-3485-5, Library of Congress: 2008910892

TASKS OF SPEED MEASUREMENT OF VEHICLES

Stationary - the remote measurement of vehicle speed

Mobile – the measurement of speed on board the vehicle

Principle of action of speed sensor

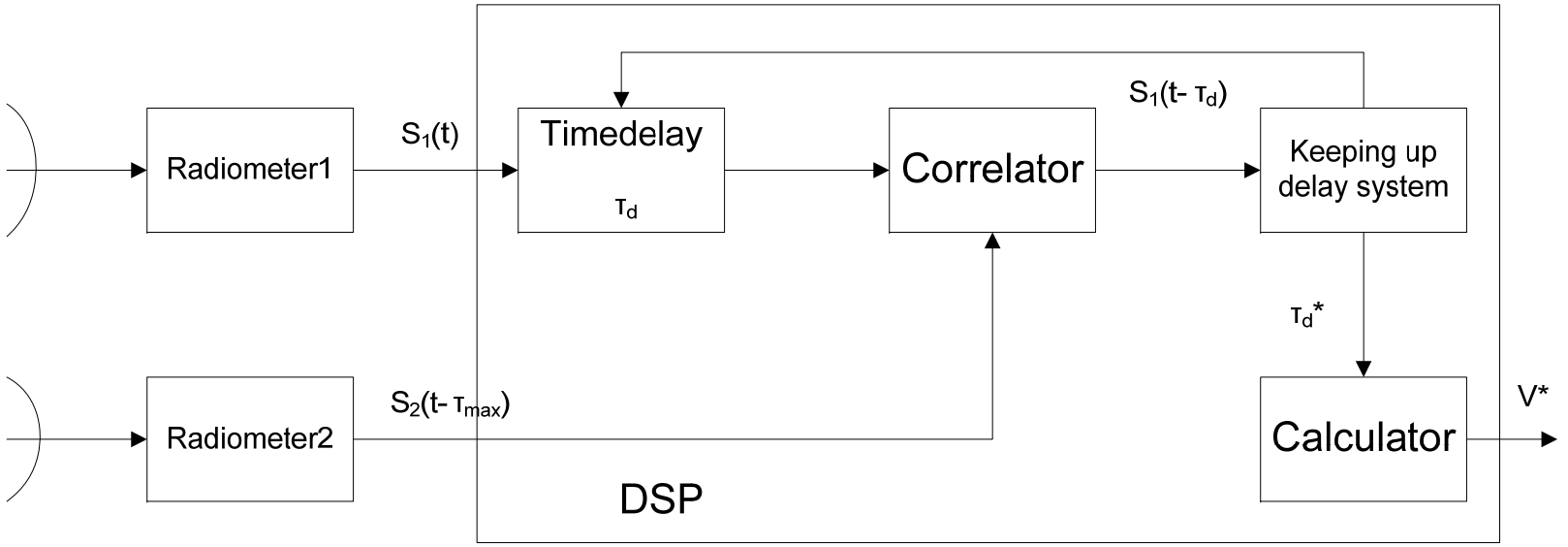


Vladimir Rastorguev, Victor Shnajder – "Radiometric sensor of movement speed of vehicles", Proceeding of 12th International Conference on Transparent Optical Networks – ICTON'2010, Munich, Germany, June 27 - July 1, 2010. IEEE Catalog Number: CFP10485-USB, **Print ISBN:** 978-1-4244-7797-5 **Digital Object Identifier:** 10.1109/ICTON.2010.5549089 .

Speed sensor of correlation type (SSCT)

Exploitation of moving body radiation (Transmitter)
from UV(200 nm) to Microwave area (50 cm)

Receiver: Microwave antenna 8 mm to 30 mm
corresponding roughly 40 GHz to 10 GHz (Radar area)



Esslingen University of Appl. Sciences in cooperation with

MBtech Mercedes-Benz technology

SIEMENS

DIEHL Aerospace

BOSCH

Fraunhofer Heinrich Hertz Institute

My R&D student group

Uwe Strauß
Jan Lubkoll
Daniel Seibl
Chandan Viraktamath
Saba Kakavand
Andreas Kruspel
Werner Weinzierl
Egor Mosyagin
Christian Betz

Otto Strobel