High Speed Visible Light Communication in Real-time

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- Total budget: 2 billion €

- Approx. 80% raised through contract research
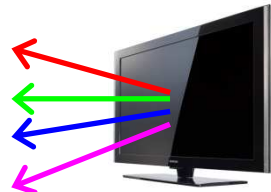
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Research Areas

- Information and Communication Technology
- Life Sciences
- Microelectronics
- Surface Technology and Photonics
- Production
- Materials and Components
- Defense and Security

Outline
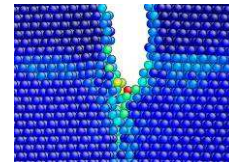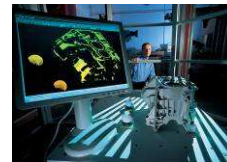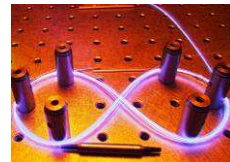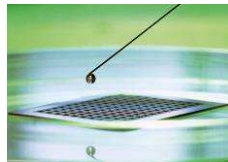
- Classification of Optical Wireless

- Field of Applications

- Application Directions

- Current Projects

- Market Situation

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Transmitter / Receiver		Very low speed, dominated by the transmitter	Low speed, dominated by the receiver		
			Medium speed	High speed	Ultra high speed

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Attractive Application Fields

High Speed

High Speed

IT Security

Hospitals
(RF-sensitive)

Private
Households
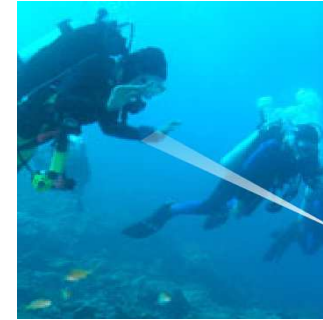
Underwater
Communications

High Speed

High Speed

Mechanical
Engineering

Tradeshows,
Museums

Advertising,
Messaging

In-flight
Entertainment

Application Directions

Data
Broad-
casting

Bidirecti-
onal Link

Low-
Speed

High-
Speed

Point-to-Point Bidirectional VLC-Link
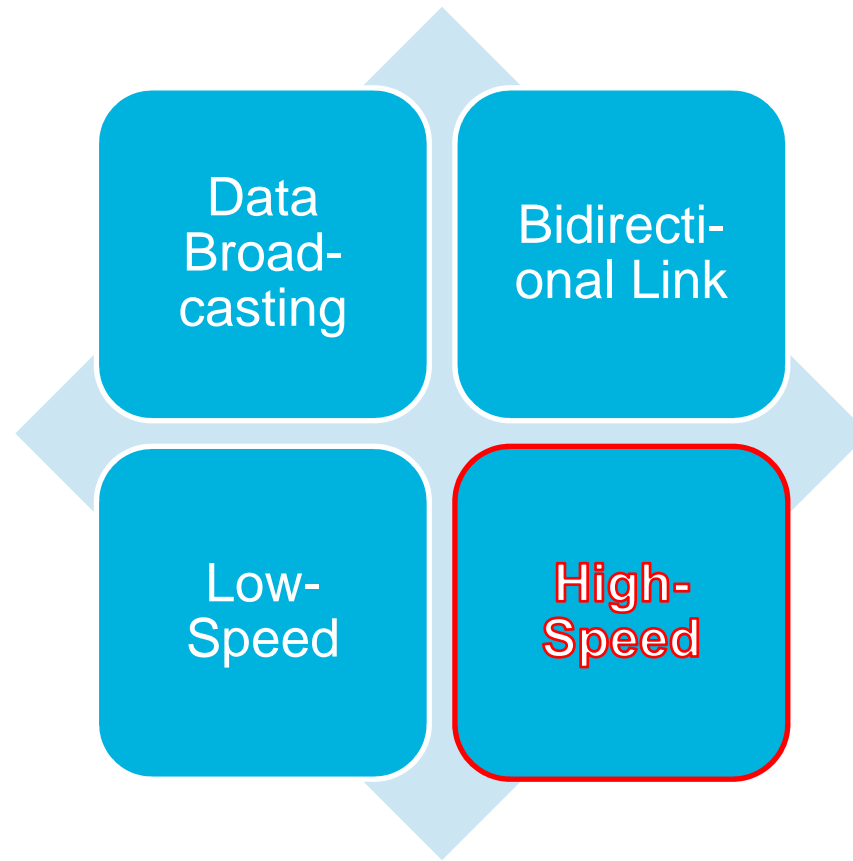
- **Bidirectional link**

  - Light Source:
    any high-power LED
    (arbitrary color)

  - Data rates:
    up to 1 Gbit/s

  - I/O: Ethernet RJ45

Data Broad-casting	Bidirecti-onal Link
Low-Speed	High-Speed

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10/19/2015   8

Current Projects: SODALES/XHAUL
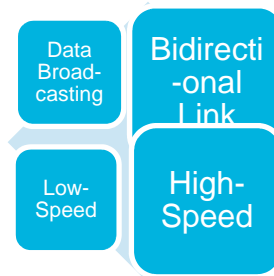
- **Low cost optical wireless link for the backhaul of Wi-Fi and LTE**

  - Bidirectional data exchange

  - Improved link robustness due to rate adaptation

  - Very high availability at short distances

  - No active tracking needed

  - 500 Mbit/s @ 100 m

Current Peojects: Island of Mainau
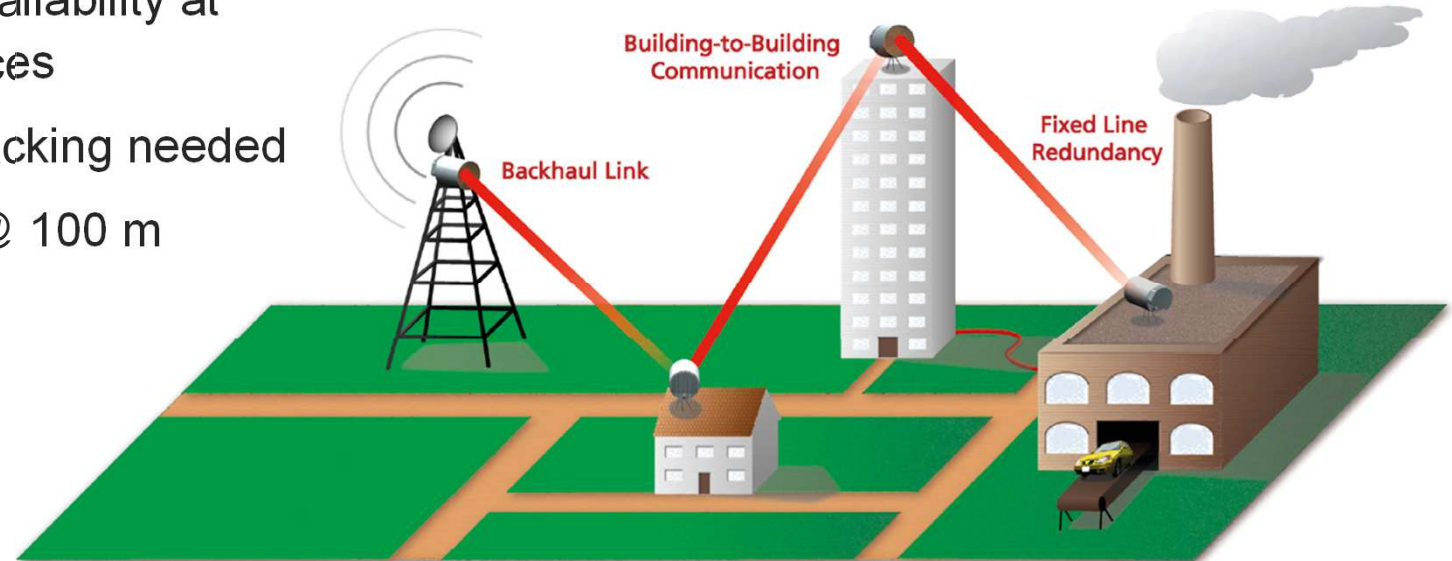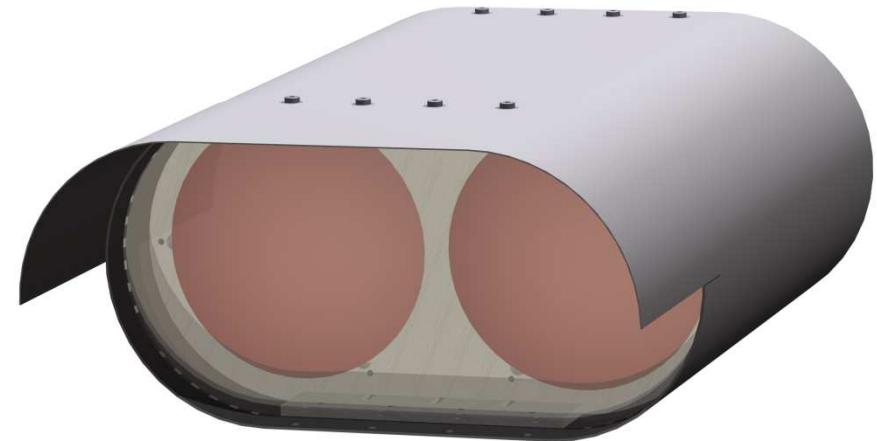
- **Conference room with Li-Fi**

  - Multiple access points

  - Bidirectional optical wireless LAN

  - Compatible with light dimming
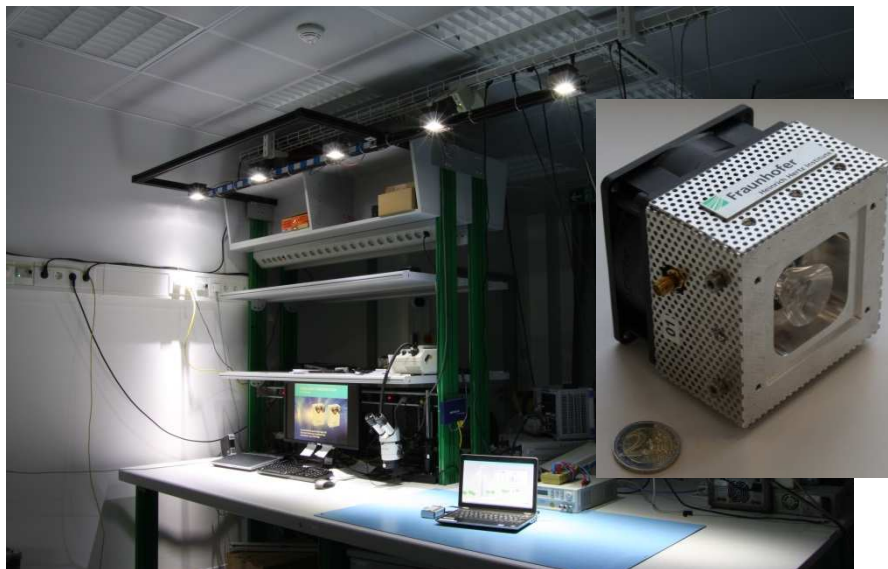
- Phase 1: Optical wireless hotspots

- Phase 2: Multiuser multi-cell

Current Projects: OWICELLS
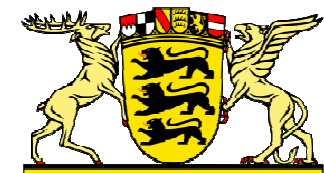
- **Optical wireless field in industry**

  - M2M Communication with very high-speed (1 Gbs) and low latency (<1ms)

- ⬭ Optical Accespoint
- — Fieldbus
- — Optical Link

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Market Situation
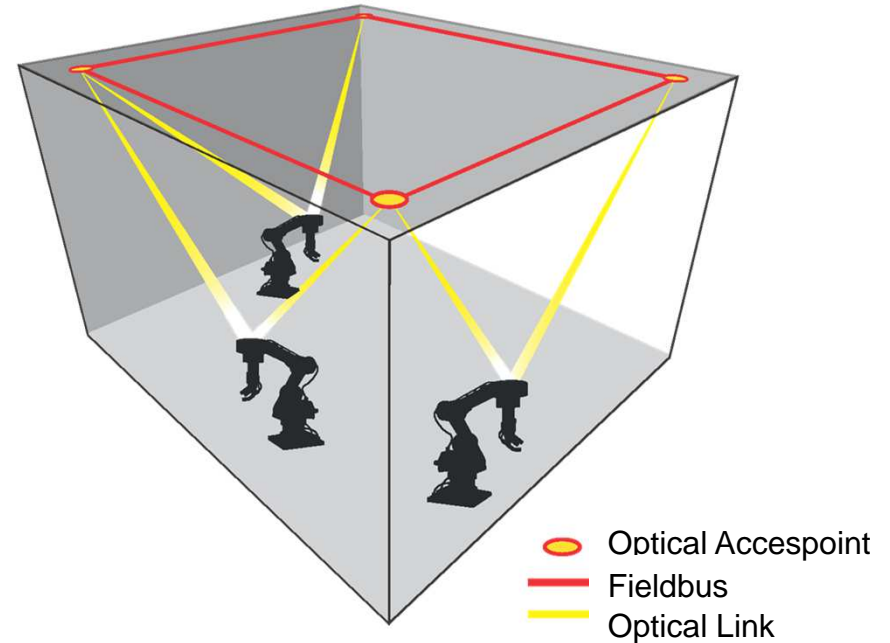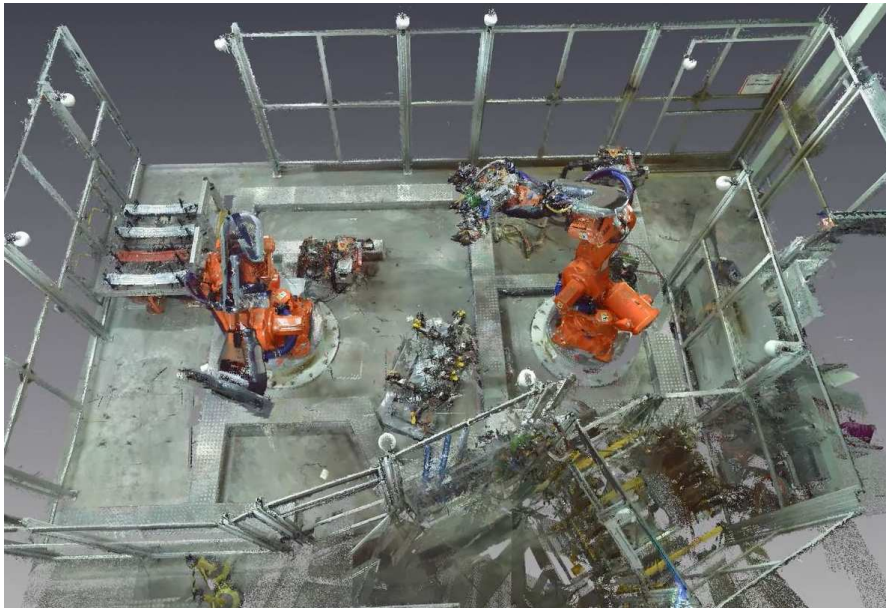
- **Combining light and communications promises a future mass market**

  - But there is a long way to go

  - Low-speed applications (indoor navigation, messaging) will appear first

  - High-speed applications will probably follow

- **Next steps for high speed**

  - Reduced form factor

  - Smaller analog driver, reduced energy consumption for battery-powered uplink

  - Bidirectional multi-user and multi-cell capabilities, low latency

  - IEEE 802.15.7r1 standard aims to support these new features

New optical wireless standard

- **Optical Camera Communications (OCC) for low speed**
  - Using cameras in handsets or specific cameras in cars
  - Low-speed communications with angular resolution (via pixels)
  - High-density scenarios (e.g. traffic jam), localization using data base

- **Many world records show potential for very high speed**
  - Up to 5 Gb/s short distance so far using RGBY LEDs
  - Several 100 Mb/s single color in wide beams at 2-3 m distance
  - Short-range mobile scenarios

- **IEEE 802.15.7r1 standardisation is ongoing**
  - Efficient use of the available optical bandwidth
  - High data rates (1 Mbit/s to 10 Gbit/s)
  - Enhanced mobility support by adaptive transmission, handover, localization
  - Call for Proposals was recently published

IEEE 802.15.7r1 Roadmap

Photonic Networks and Systems

2015 | 2016 | 2017 | 2018

- CFA Issued
- CFA Responses
- Finalize TRD and Release CFP
- Hear CFP Proposals
- Proposal mergers & Draft D0
- Draft D1 & LB1
- Draft D2 & LB2
- Draft D3 & SB1
- Draft D4 & SB2
- 15.7r1 to SA for publication
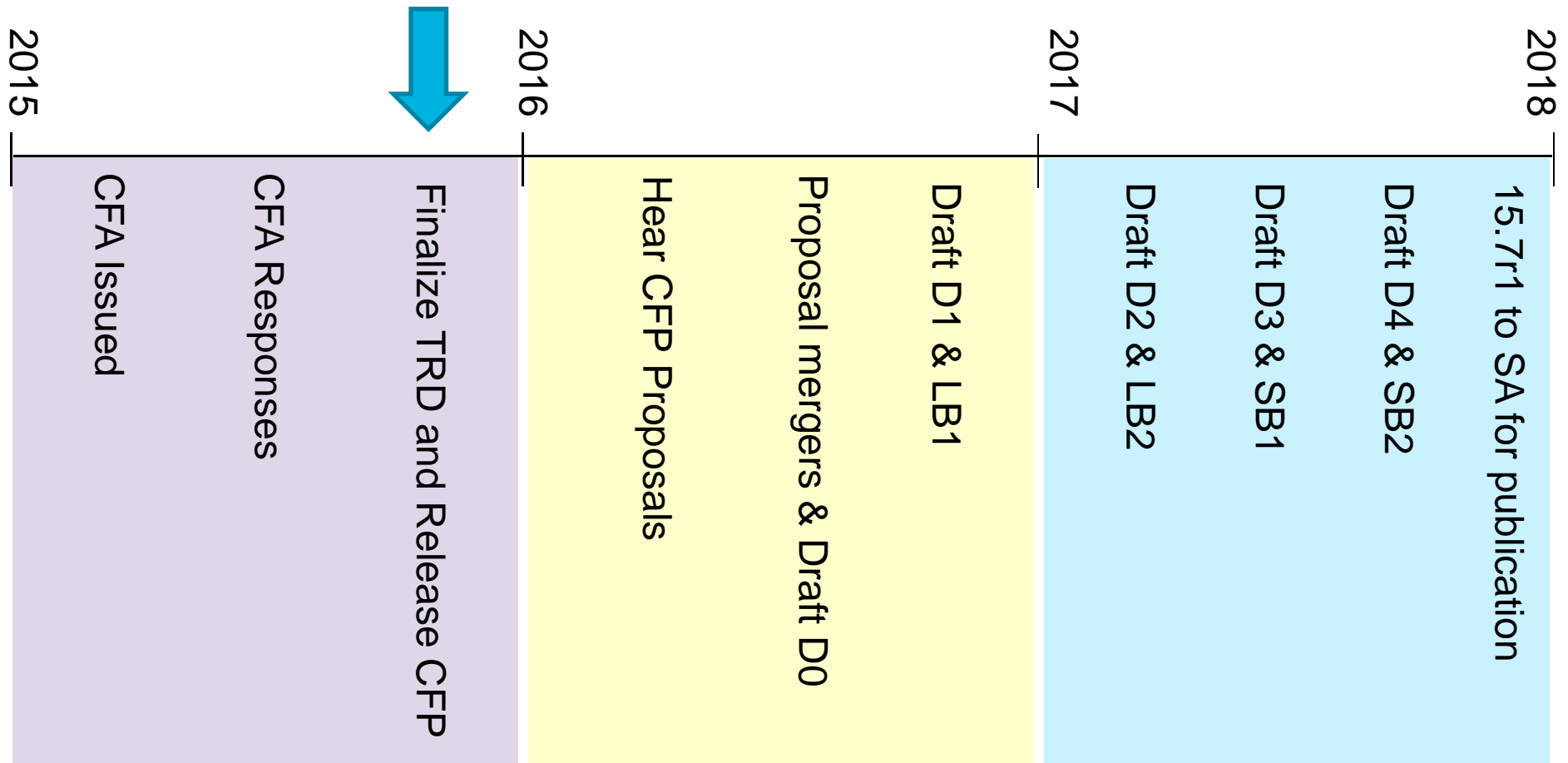
- Intent for proposal due Nov. 1, 2015, proposal due on Jan, 10

Conclusions

- **Combining light and communications promises a future mass market**

  - New wireless technology, complementary besides radio

- **R&D focus in HHI is on high-speed concepts <u>in real-time</u>**

  - 1 Gbit/s per wavelength with only 2 ms latency was recently demonstrated

  - Future applications: Wireless backhaul, conference rooms, manufacturing

  - HHI actively supports the ongoing IEEE 802.15.7r1 standardization
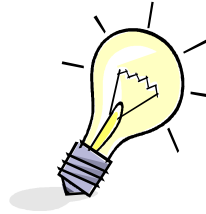
Thank you very much for your attention.

I am looking forward to answer your questions!

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