DIEMOUNT SOLUTIONS

# Optical freespace communication (OFC) with POF feeder lines

Hans Kragl

DieMount GmbH
Giesserweg 3
38855 Wernigerode

www.diemount.com

## FGT 5.4.1 Meeting, Oldenburg, May 12th, 2006

# Overview

1. **Broadband data access for everybody?**
2. **Optical freespace communication (OFC)**
3. **Idea: from POF simplex to OFC simplex with POF feeder line**
4. **Technical approaches**
   - simplex OFC systems
   - duplex OFC systems
5. **Comparison: Simplex and duplex OFC systems**
6. **Next steps**

# Broadband data access for everybody?

**Telecom operators will introduce broadband access networks first:**

- for well funded customers,
- at places with a high customer density (large cities),
- a high number of customers per access line (multiple dwelling units).

**I.e., customers:**

- outside economic centers (from rural regions in Europe to developing countries),
- living in small villages and
- living in single-family houses

**will be served with broadband access at last.**

# Optical freespace communication

**Optical freespace communication systems allow**

- to bridge up to 8km transmission distance (@1.55µm wavelength),
- provide high bandwidth (2.5Gbit/s and more),
- don‘t require licences,
- offer easy installation,
- offer reliabilities of more than 99%, if system margin sufficiently high.

**But:**

Commercially available systems today cost 4˙000 to more than 25˙000 Euro. This price is too high for:

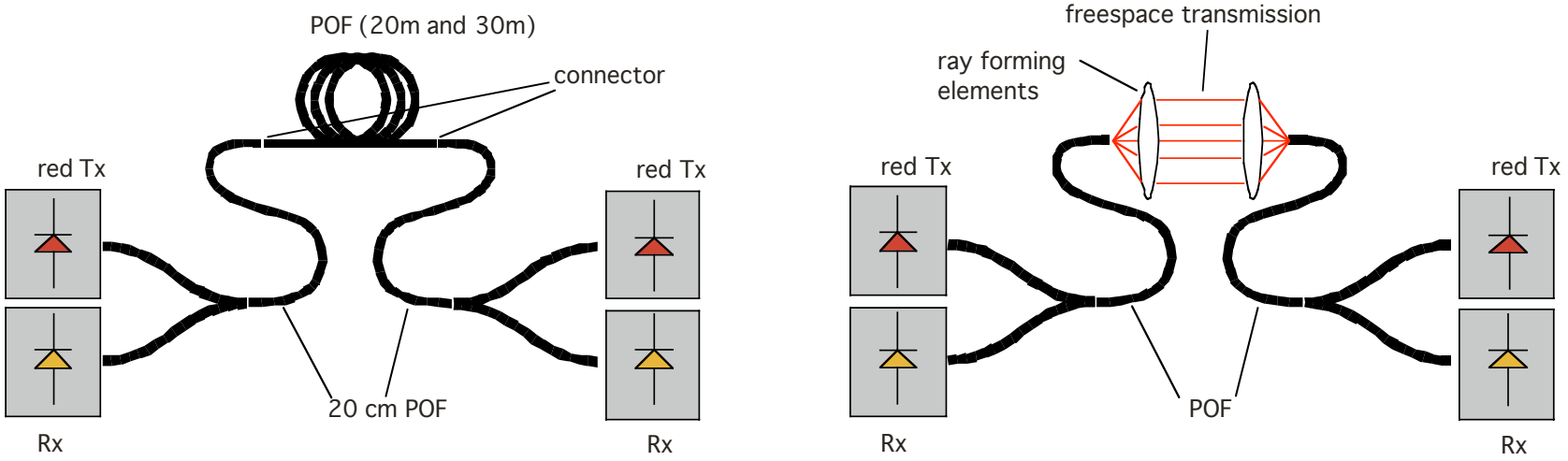
- private persons, i.e. not professional applications and
- developing countries.

**Idea:**

Is it possible to use low cost POF mediaconverters for optical freespace communication?

DIEMOUNT SOLUTIONS

# Idea: from POF simplex to OFC simplex

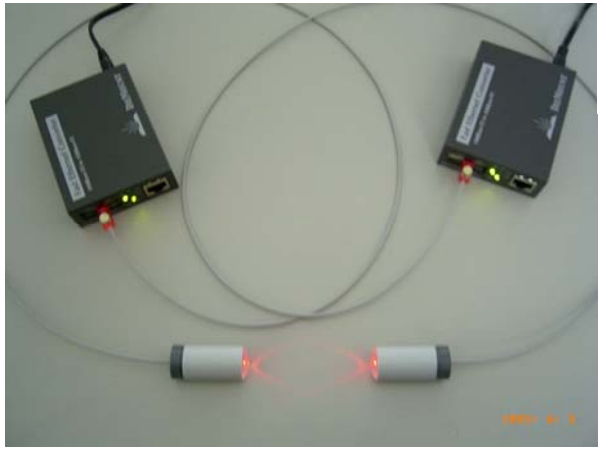



- optical header comprises passive optics,
- POF serves as feeder line to optical header,
- installation very easy, because one optical axis only,
- visible light (650nm) allows to find focus and install by „eye“,
- anti reflection at POF endface easily feasible.

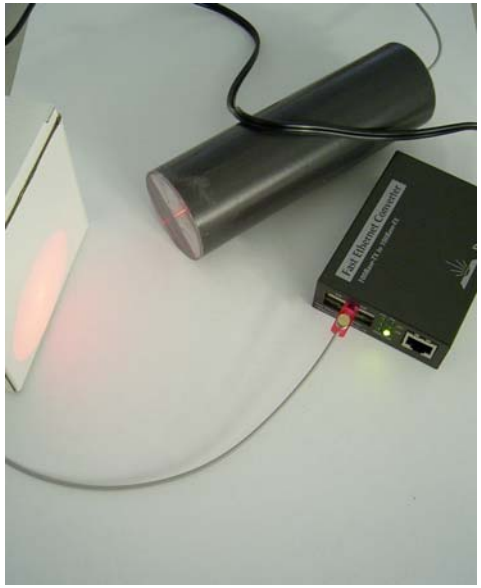
**Cost:**

A standard simplex media converter set + a fresnell lens in the optical header.

# OFC test systems with POF feeder line



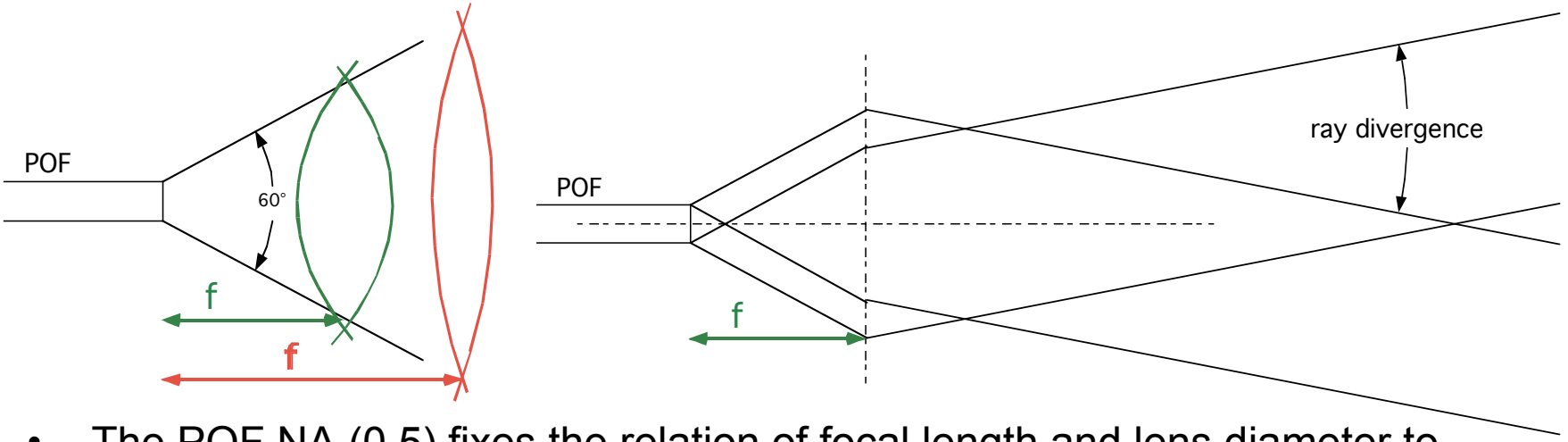
d = 18mmØ, f = 30mm, D = 1m
**App.: rotary data joints**



d = 45mmØ, f = 150mm, D = 6m
**App.: drag chain links**

d = 390mmØ, f = 270mm, D = 100 - 150m
**App.: house to house link**

# Physical aspects of „POF-Simplex OFC“




- The POF NA (0.5) fixes the relation of focal length and lens diameter to 1.15. Smaller lenses cause losses, larger lenses are useless.
- The lens focal length f and the large POF diameter of 1mm define ray divergence to: arctan(1mm/ f [mm]).
- **Consequences:**
  - large lenses are necessary for long distances (small ray divergence)
  - large, but low cost lenses are fresnell lenses
  - fresnell have limited optical quality.

**With a power budget of 14dB (standard simplex POF system) simplex POF OFC systems allow to bridge up to 150m maximum only.**

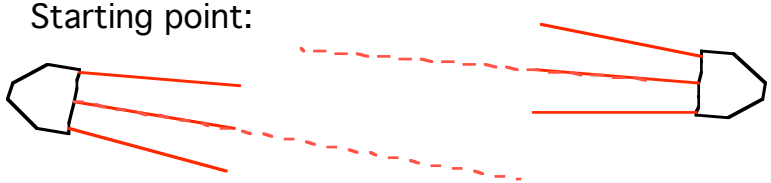
# „Version 1.1“ system

d = 260mm x 260mm, f = 200mm,
available low cost Fresnell lens

**Transmission distance: 50m (+x?) with a LED based 14dB power budget simplex system**

## Alignment procedure:

Starting point:



First step:

Second and final step:

# Duplex POF OFC system

**Duplex POF OFC systems overcome the problem of large, high quality lenses due to tiny laser radiation apertures.**

**But they require:**

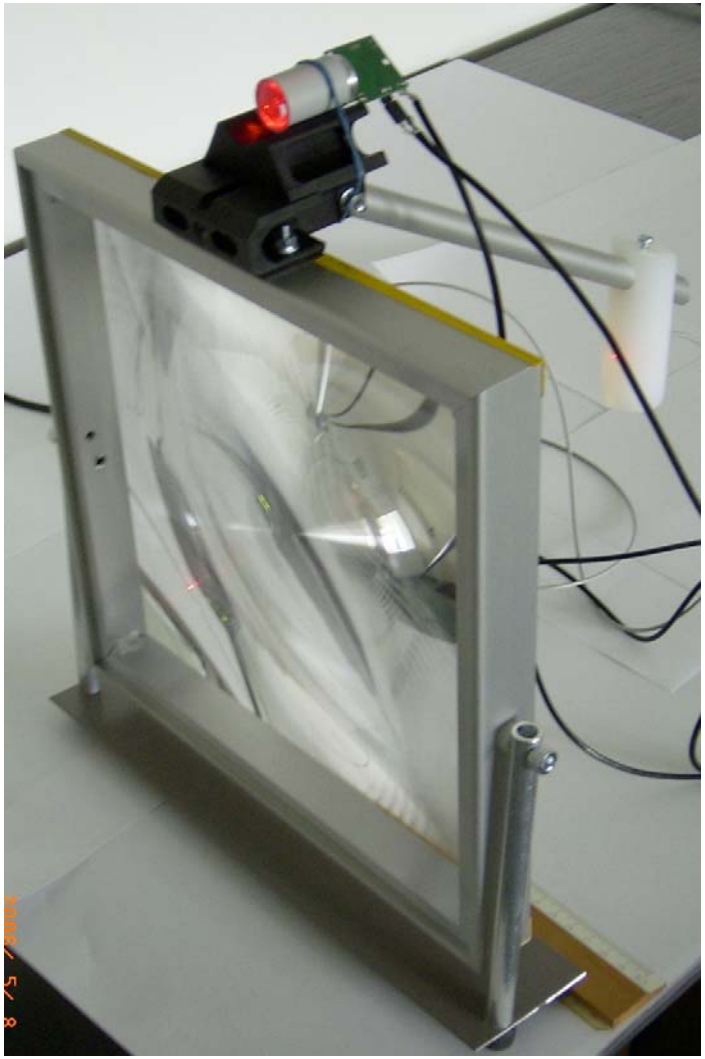
- an active optical header comprising a laser diode,
- the alignment of two optical axis,
- 2 feeder cables: POF (receiver) and coax (data laser driver).

Long term stability aspect:

**Novel 650nm EELD promise a MTTF of 100˙000 h (10 years).**

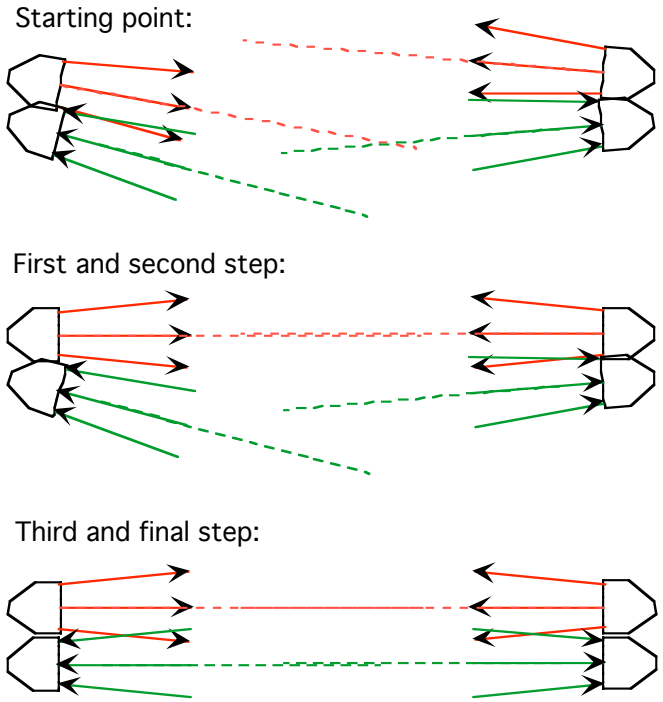
Failure:= 20% loss of optical power.

# POF-Duplex OFC



**Transmission distance: >300m with a 650nm EELD based 30dB power budget duplex system**

## Alignment procedure:



# Installation: POF duplex system

First OFC installation at aspericon GmbH, Jena.

The link is used to bridge an about 100m long public place between two company buildings.

DIEMOUNT SOLUTIONS

# Comparison:

| ***System:*** | ***Light source:*** | ***Relia-bility:*** | ***Installation:*** | ***Transmission distance:*** |
|---|---|---|---|---|
| Simplex f=200mm | red 650nm LED | high | very easy | 50m |
| Simplex f=200mm | 780nm VCSEL | high | medium | 100m |
| Duplex f=200mm | 650nm EELD | ? 100˙000h MTTF (?) | medium to easy | >300m (up to 1km?) |
| Simplex f=200mm | 650nm EELD | ? 100˙000h MTTF (?) | very easy | >150m (?) |

# Next steps

**An EELD based simplex OFC system promises:**

- very easy installation,
- a completely passive optical header that allows to place, active electronics far away from the header,
- an estimated maximum transmission distance of >150m,
- a very affordable price due to POF media converter technology,
- upgrade from Fast Ethernet to Gb/s Ethenet no serious problem (first Gb/s POF transceivers?).

**Next steps:**

- Design an optical simplex transceiver comprising EELD.
- Start of long term life tests.
- Use demountable LD-modules to overcome the potential (!?) problem with limited EELD lifetime.