FSO-based relaying/backhauling architecture

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Shou-Sheu Lin, Chang-Lung Hsiao and Wern-Ho Sheen	Voice:	+886-3-5914061
CCL/ITRI	Fax:	+886-3-5820371
3F, Bldg. 14, 195 Sec. 4, Chung Hsing Rd. Chutung, HsinChu, Taiwan 310, R.O.C.	E-mail:	sslin@itri.org.tw

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Purpose:

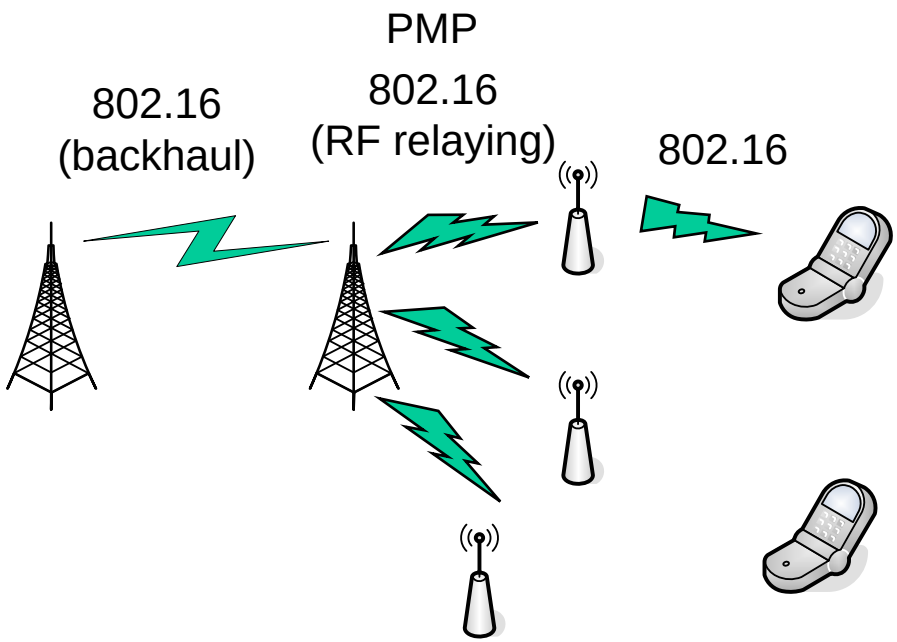
Propose a low cost and high throughput relaying/backhauling architecture based on free space optics (FSO)

Outline

- RF relaying
- RoF (Radio over Fiber) relaying
- Proposed FSO(Free Space Optics) relaying and backhauling
- Summary

RF relaying

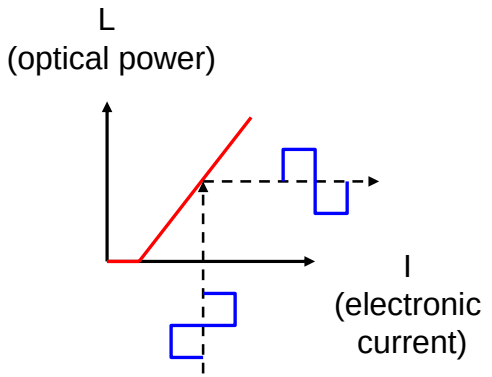
- Relaying solutions
  - AF: Amplify-and-Forward
  - DF: Decode-and-Forward
- Benefits:
  - Coverage extension
  - Increase capacity
  - Provide uniform data rate coverage
- Problem
  - Intra- and inter-cell inference by relay stations
  - Costly RF relaying equipments



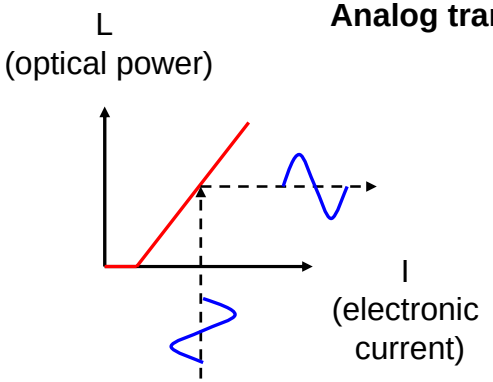
Basics of optical communication

- Principle of optical communication:
  - Transmitter:
    - Direct modulation: LED, LD (FP, DFB laser)
    - External modulator: MZM, EAM
  - Receiver:
    - DD: PIN, APD diode
- Applications
  - Digital transmission
    - Optical backbone
  - Analog transmission
    - CATV, RoF

Digital transmission

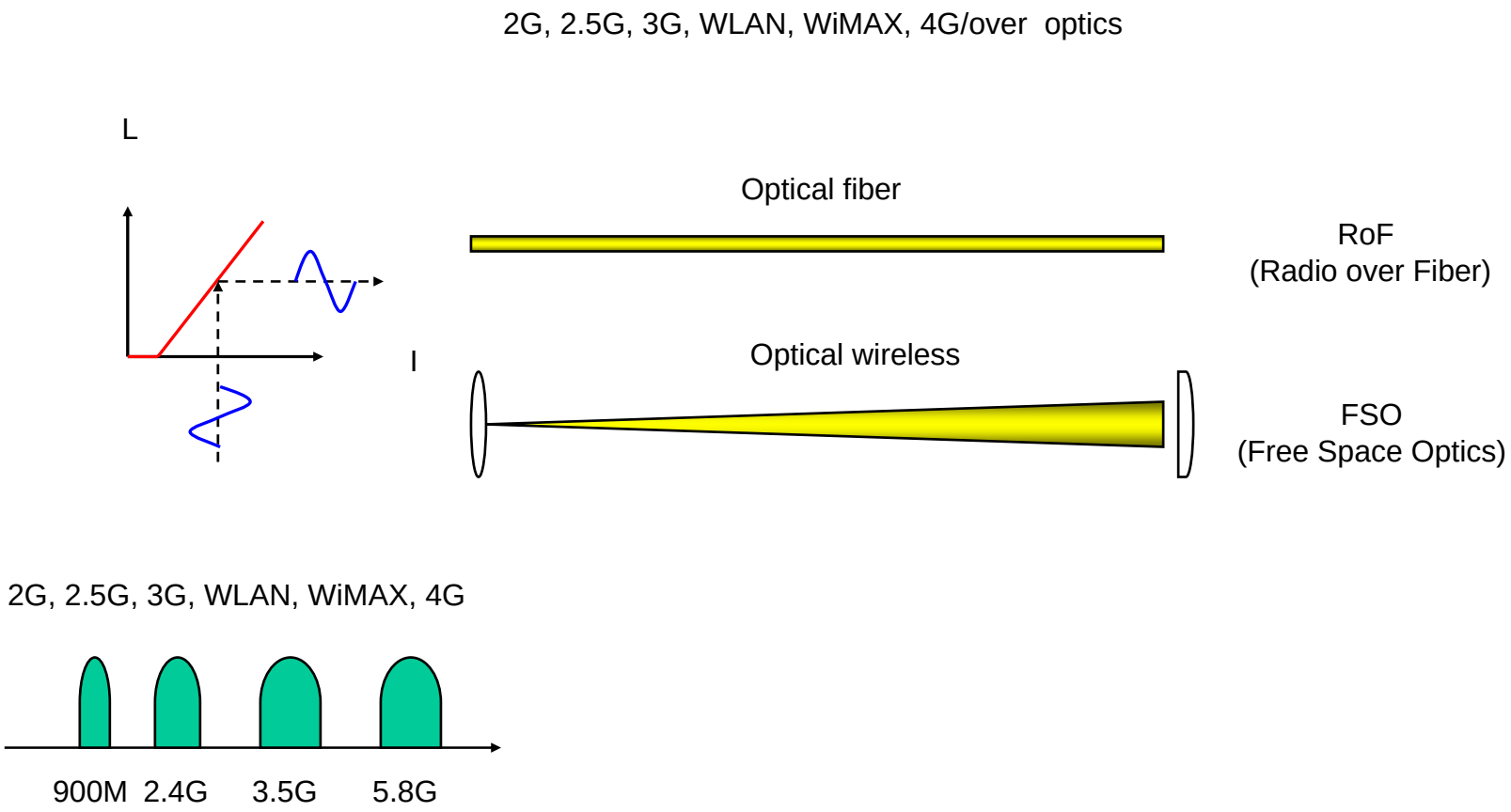


Analog transmission



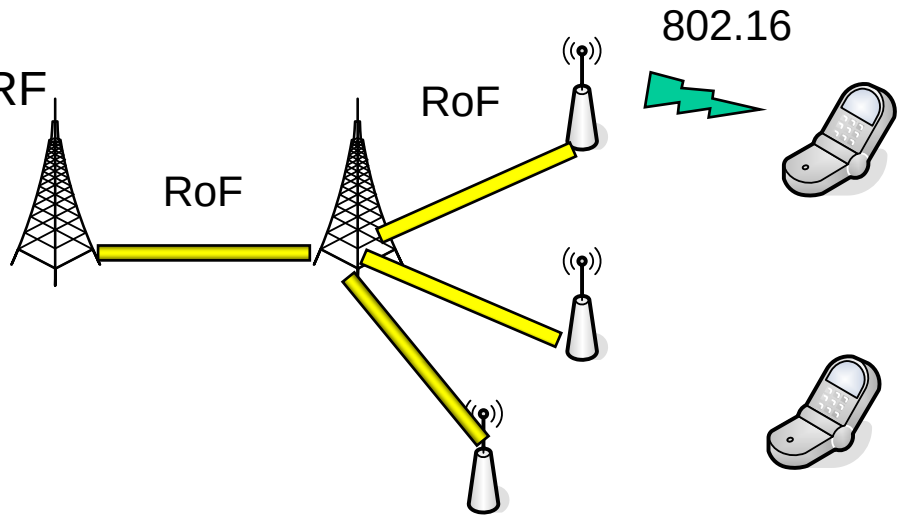
Optical relaying

- Subcarrier Modulation (SCM) for RF signal relaying by analog transmission



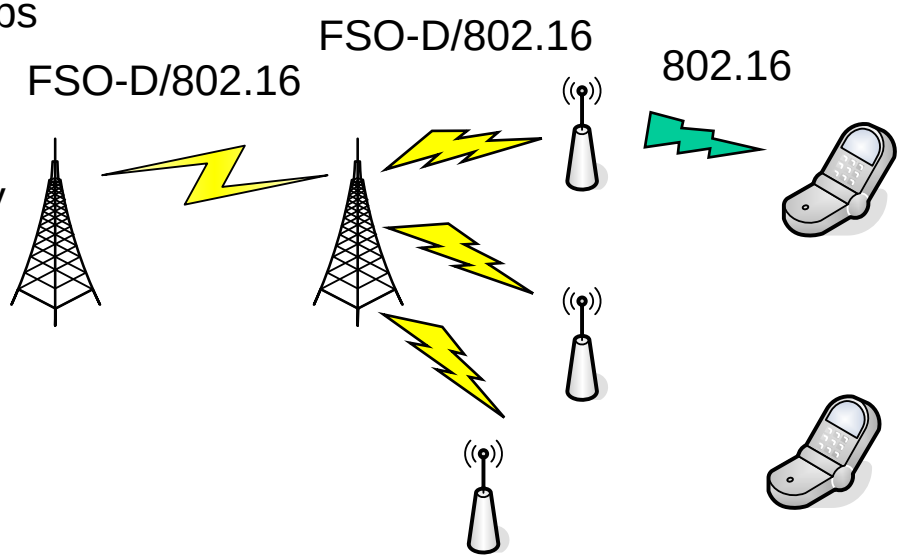
RoF relaying

- Pros:
  - Higher capacity than RF relaying
  - Lower equipment cost than RF relaying
  - Better radio resource reuse
- Cons:
  - High installation engineering cost



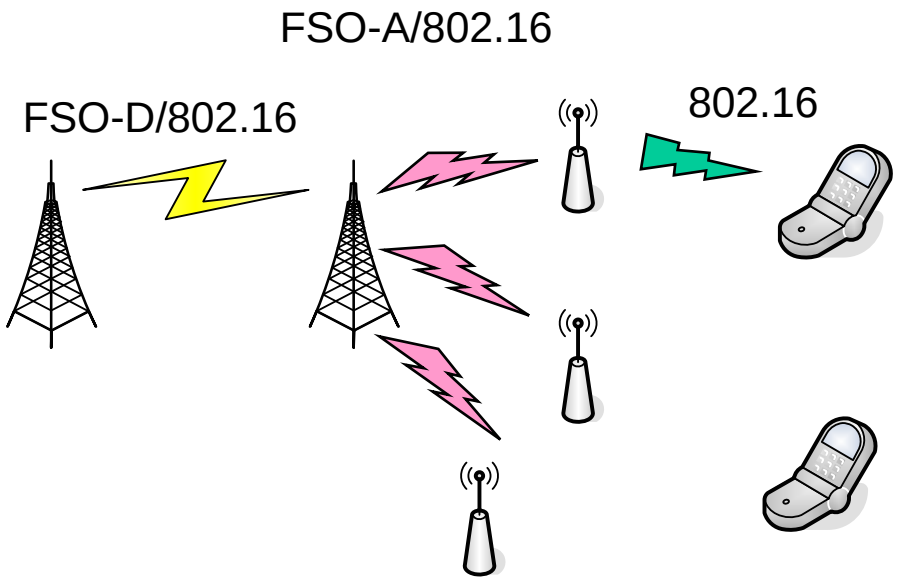
Proposed hybrid digital FSO/RF relaying

- Features of Digital FSO (FSO-D):
  - Long distance, high bandwidth, less power (e.g. throughput: 1Gps for 4km)
  - Like a directional antenna with very large antenna gain (dBi)
  - Low interference/noise immunity
- Pros:
  - Combine the advantage of RF and RoF relaying
  - High throughput yet low installation cost
  - 10 times backhaul capacity than RF backhaul
- Cons:
  - Sensitive to weather condition (Fog), but this could be solved by hybrid FSO/RF system @ 99.999% reliability



Proposed hybrid analog FSO/RF relaying

- Features of of Analog FSO (FSO-A):
  - Signal transparency: without format conversion compared to digital FSO
  - Multi-standard radio frequency over FSO
- Pros:
  - Combine the advantage of RF and RoF relaying
  - High throughput yet low installation cost
  - Easy to migration to 4G network
- Cons/Difficulties:
  - Linearity of laser diode
  - Up/down convert maybe needed
  - Products not available yet



Summary

- A hybrid digital FSO/RF architecture is proposed for improving the capacity/throughput of relaying network and backhaul system
- A hybrid analog FSO/RF architecture is proposed for improving the capacity/throughput of relaying network
- A novel analog FSO concept is proposed to support multi-standard wireless over FSO to accelerate the deployment of next generation broadband wireless access system

References

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