High capacity asynchronous OCDMA system with advanced modulation technique

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Outline

- Background
- DPSK-OCDMA experiment
- CSK-OCDMA experiment
- Summary

Background

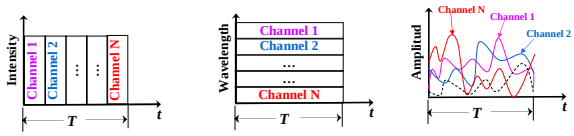
The last mile problem

Bandwidth requirement for next-generation services (ethernet, video, voice and etc.)

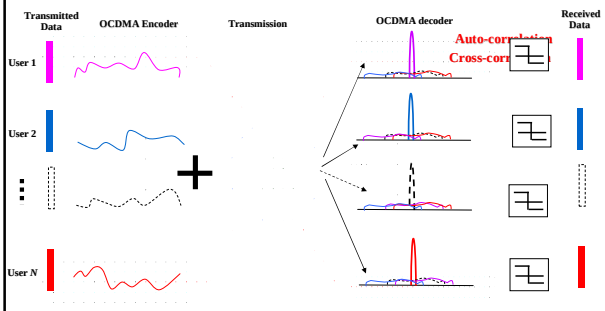
Optical access

Promising for future last mile networks.

TDMA	*SCMA*	*WDMA*	*OCDMA*
Time-Division-Multiple-Access	Sub-Carrier-Multiple-Access	Wavelength-Division-Multiple-Access	Code-Division-Multiple-Access



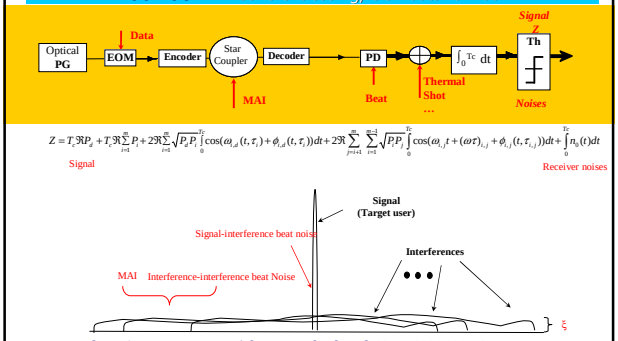
Working principle



Features and advantages of OCDMA

- All optical processing
- Fully asynchronous transmission
- Low-latency access
- Dynamic allocation of bandwidth
- Protocol transparency
- Decentralized architecture
- Soft capacity on demand
- Physical layer QoS Control
- Potential confidentiality

OOK-OCDMA: Coherent coding, OOK data format



$$Z = T_c \Re P_d + T_c^2 \Re \sum_{i=1}^{m} P_i + 2\Re \sum_{i=1}^{m} \sqrt{P_d P_i} \int_0^{T_c} \cos(\omega_{i,d}(t,\tau_i) + \phi_{i,d}(t,\tau_i))dt + 2\Re \sum_{j=i+1}^{m} \sum_{i=1}^{m-1} \sqrt{P_i P_j} \int_0^{T_c} \cos(\omega_{i,j} t + (\omega\tau)_{i,j} + \phi_{i,j}(t,\tau_{i,j}))dt + \int_0^{T_c} n_0(t)dt$$

Signal — Receiver noises

* X. Wang and K. Kitayama, *IEEE J. Lightwave Technol.*, Vol. 22, pp.2226-2235, 2004

Issues with OOK-OCDMA

a. MAI and beat noise

Data-rate detection in presence of MAI and beat noises

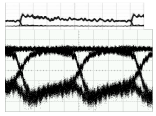
Noise tolerance enhancement

b. Vulnerable confidentiality

Eavesdropper

Data-rate power detection

Break without code information



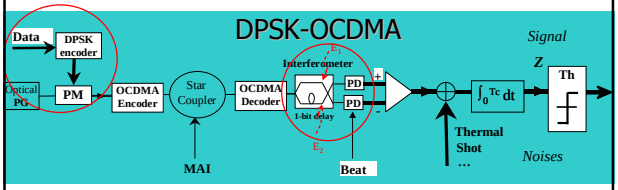
C. K estimation and dynamic Th setting Requirement

Complexity and cost

Advanced modulation format (DPSK, CSK)

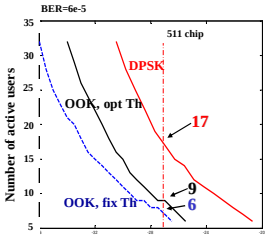
DPSK-OCDMA experiment

DPSK-OCDMA: Coherent coding, Differential–phase-shift-keying data format



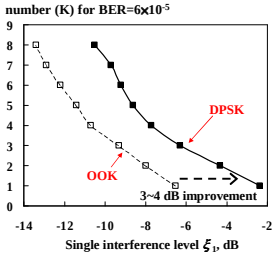
Performance improvement of DPSK-OCDMA

Theory



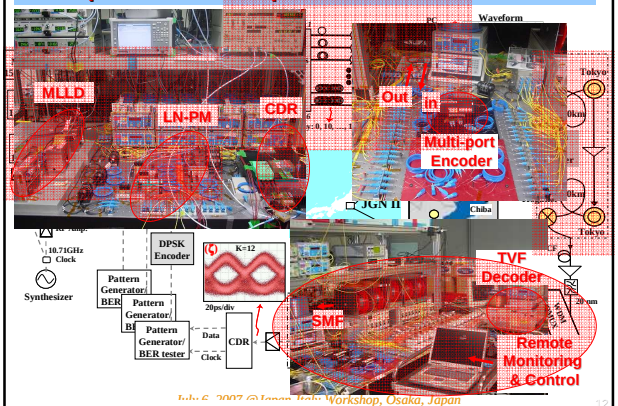
Experiment

Maximum interference number (K) for BER=6x10^{-5}



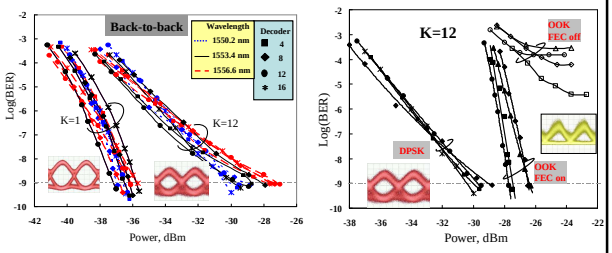
* X. Wang et al, *IEEE PTL*, Vol. 18, pp.826-828, 2006

Experimental set up of WDM/DPSK-OCDMA



* X. Wang, et al, OFC'06 postdeadline, PDP44, 2006

Back-to-back BER performance



Spectral efficiency (η) ≈ 0.32 bit/s/Hz

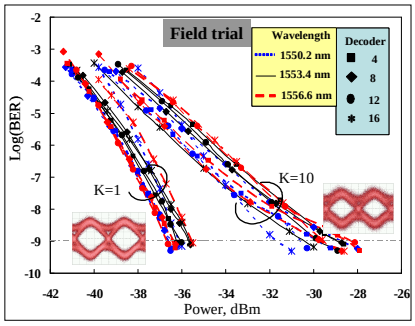
Field transmission BER performance

Asynchronous environment

- Balanced power
- Random delay
- Random bit phase
- Random polarization state

Worst-case scenario

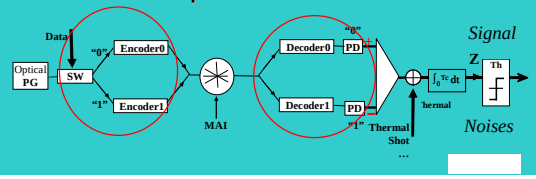
η ≈ 0.27 bit/s/Hz



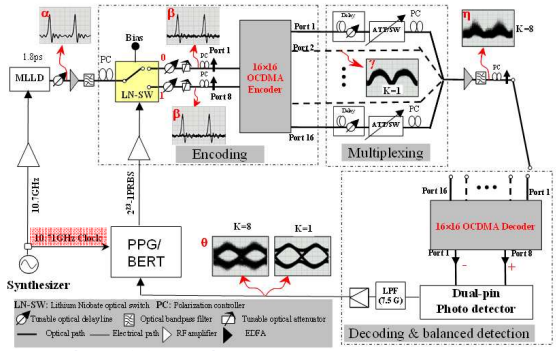
CSK-OCDMA experiment

CSK-OCDMA: Coherent coding, Code-shift-keying data format

Proposed scheme

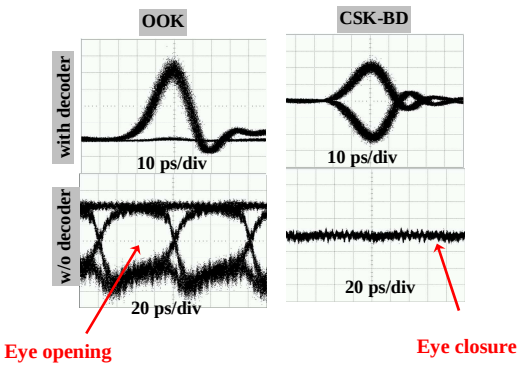


Experimental setup

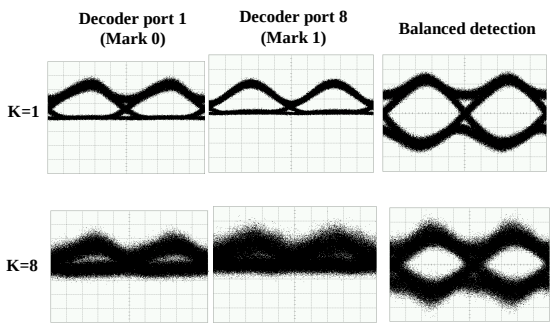


* X. Wang et al, *IEEE JSTQE*, September 2007.

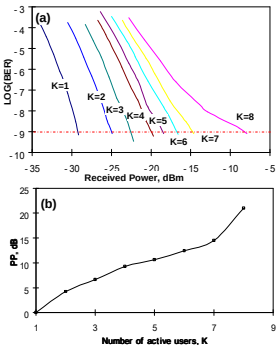
Enhanced confidentiality

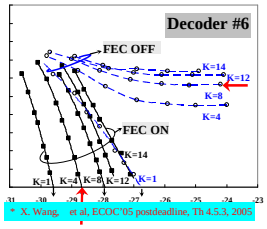


Enhanced multi-user capability



BER performance





* X. Wang, et al, ECOC'05 postdeadline, Th 4.5.3, 2005

Summary

- Novel OCDMA schemes with DPSK and CSK data format have been proposed and experimentally demonstrated using multi-port E/D
- Performance improvement over OOK-OCDMA
  - (1) Improved receiver sensitivity;
  - (2) Better tolerance to beat noise and MAI noise;
  - (3) No need for optical thresholding;
  - (4) No need for dynamic threshold level setting;
  - (5) Enhanced confidentiality
- High capacity asynchronous OCDMA experiments with DPSK and CSK data format

Thank you !