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OCDMA: A practical Solution Path to New-Generation Symmetric-Bandwidth Access System

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***Abstract* — With current mature optical device technology, OCDMA now deserves revisit. In this talk, recent progress of OCDMA using ultra-long code, super-structured fiber Bragg grating en/decoder and optical thesholder for New-Generation (NwGN) FTTH system will be presented.**

I. INTRODUCTION

Optical code division multiple access (OCDMA) has been proposed in mid '70s, followed by experimental demonstrations in ’80s. Despite of its unique characteristics such as fully asynchronous multiple access capability, soft-capacity-on-demand as well as low latency of data transmission, OCDMA has long been remaining outside the mainstream of telecom multiplexing technologies. With current mature optical device technology, OCDMA now deserves revisit not only for a powerful alternative for New-Generation FTTH access systems.

In this talk, at first, a gigabit-symmetric OCDMA over WDM PON is presented. It can provide the gigabit symmetry, that is, a gigabit- or even multi-gigabits-per-second both in up- and downlinks, to meet customers’ demands for peer-to-peer applications as well as HDTV broadcasting [1].

II. GIGABIT-SYMMETRIC OCDMA SYSTEM

In OCDMA PON, the users are assigned with different optical codes as the signatures and share common transmission medium. The optical encoding and decoding are performed all in optical domain, and hence OCDMA can support full asynchronous transmission mode with very low latency without using any complex electrical equipment.

A number of different OCDMA schemes have been proposed. In *incoherent* OCDMA using unipolar (0,1) code, the coding is performed on optical power basis, while in *coherent* OCDMA, it is performed on field amplitude basis. Another is by processing dimension. Coherent OCDMA is superior to incoherent OCDMA in overall performance as it works with bipolar (-1, +1) codes, as it has a larger code sets size and better correlation property, compared to unipolar code. It is more practical in terms of available user number, BER performance, and frequency efficiency. However, the beat noise is the most critical issue for coherent OCDMA. Lower the cross correlation level by using longer OC maybe an effective way to mitigate it.

We have achieved a record long 511-chip, 640-Gchip/s bipolar optical code (OC) by super-structured (SS) FBG. The chip length of the grating and the total length are 0.156 mm and 80mm, respectively, which corresponds to the chip rate of 640Gchip/s with the duration of the generated optical code of about 800ps.

III. OCDMA OVER WDM PON

A solution path to the scalable gigabit-symmetric FTTH system would be OCDMA over WDM PON. OCDMA channels can be overlaid on N WDM grids. On each WDM grid, M users can be accommodated by individually assigning each user with a different OC_m (m=1,...,M). Note that the same code sequence OC_m can be reused on all the WDM channels. The total number of users which can be accommodated becomes N x M. It has been shown that the power penalty due to the WDM crosstalk can be suppressed as small as 2dB for 200GHz interval, but it can be made negligible for 400GHz interval. From the economical viewpoint, OCDMA over WDM PON is currently considered to be viable, because the FBG en/decoder is a passive device, and it should be potentially of low-cost. The ultrashort pulse laser is an expensive mode-locked laser diode, but a loop-back scheme implemented by placing a single ultrashort pulse laser in OLT will allow a number of users to share the light source for the uplink. This will drive down the system cost while improving the system reliability.

IV. CONCLUSION

It has been shown that OCDMA is capable of providing a gigabit- or even multi-gigabit-per-second for each user both in the up- and downlinks, and scalable OCDMA over WDM PON could be one of the most promising NwGN FTTH systems.

REFERENCES

[1] K. Kitayama, X. Wang, and N. Wada, “OCDMA over WDM PON: A solution path to gigabit-symmetric FTTH,” *IEEE J.* Lightwave Technol., vol.24, No.4, pp.1654-1662, 2006.