

Title	Experimental Prototype of Optical Code Division Multiplexing based Passive Optical Network for next generation Fibre-to-the-X/home (FTTX/H) system.
Team	<ul style="list-style-type: none"> • Dr. Habib Fathallah, Associate Professor, Electrical Engineering Department, King Saud University. • Dr. Ridha Djemal, Electrical Engineering Department, King Saud University.
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Summary:

Optical fibre communication technology is well established in long-haul, transoceanic, national and metropolitan networks. Presently, the access segment is the emerging market and Fiber-to-the-X/home (FTTX/H) is one among its most promising solutions. Hence, the FTTX/H market is still in its infancy, and requires innovative enhancement and upgrades to keep cost per subscriber to an absolute minimum, and to keep the fiber infrastructure simple, scalable and easy to maintain. FTTX, where means everywhere, includes the backhaul infrastructure of existing and emerging wireless networks. Passive optical networks (PONS) combined with time division multiple access (TDMA) are the solutions offered in today's marketplace for FTTX/H, with per client bit rates on the order of tens of megabits per second.

Our project examines a migration path that takes the PONs of today to much greater per client throughput (155 up to 1 Gb/s) without costly upgrades of the network infrastructure. Our solution exploits novel hybrid implementation of optical code division multiple access (OCDMA) over the existing TDM-PON infrastructure. For instance, while this more complex to implement, OCDMA allows multiple clients to share a single optical channel by assigning a unique code to each client. Moreover, OCDMA provides a coding gain for the transmitted data bits allowing this to have more energy, hence more performance or relaxed power/loss budget constraint.

Our system will be compatible with current FTTX-PON architecture; however our solution enjoys a much higher number of customers per fiber, clear migration path to bit rates up to ten times greater than current rates. This project will implement a stand-alone prototype of optical transponder pairs that can be field deployed over an installed network for further testing and vetting of this technology for commercial exploitation. In our novel implementation of OCDMA we consider implementing the encoding and decoding in the electronics instead of optics. We consider that the access network speed, electronics could do the required coding/decoding functions with a lower cost than optics while meeting better performance. By developing standalone transmission and reception equipments we could eventually make field test experimental measurements in real network infrastructure.

In a second phase of this project, we will also consider the prototyping of our optical CDMA technology over wavelength division multiplexing (WDM) PON infrastructure. Combining OCDMA together with WDM promises a network capacity of hundreds to a thousand of customers per fiber.

Objectives:

Typical bandwidth in existing FTTH market solutions offers 20-40 Mb/s per customer. The aggregate bit rate is up to 2.5 Gb/s that service up to 64 customers in Gigabit PON (GPON) standard and up to 1.25 Gb/s for Ethernet PON (EPON) standard. In special cases, these standards could allow up to 100 Mb/s per customer in expense of much lower number of customers.

In this project, we will investigate the migration to 622 Mb/s up to 1Gb/s and more per client that exploits the PON infrastructure with changes only to the line terminal equipment at the customer premises and at the central office. The use of our optical code division multiple access (OCDMA) technology promises a low cost

solution due to use of: 1) all electronic instead of optical coding and decoding; 2) natural and incremental migration of existing TDM based FTTX/H to OCDMA based FTTX/H; and (3) the use of standard of the shelf components and optoelectronic devices.

The ultimate objective of this project is the development of a standalone prototype of Optical CDMA based FTTX/H network that:

- (1) Accommodates the number of 16 to 32 customers to communicate at a maximum bit rate of 1 Gb/s, each of which implements programmable electronic coding for optical CDMA network. The number could be increased 128 and 256 if much lower bit per customer is required. Service providers benefit from this easy tradeoff between the bandwidth and number of customers.
- (2) Develop an innovative programmable Burst Mode OCDMA transponder (transmitter+ receiver) where reconfigurable coding and decoding is achieved electronically in the transmission and reception sides.
- (3) Develop an FPGA based optical network terminal (ONT) that is the unit to be placed at the customer location.
- (4) Develop an FPGA based optical line terminal (OLT) that supports all the network codes and implement advanced signal processing techniques in order to assign codes and reduce the interference.
- (5) Experience OCDMA over WDM network configurations making tradeoffs between the numbers of customers; reach distance, bandwidth for customers, service quality.
- (6) Study the advantages in terms of capacity, quality of service, multiple bit rates, of our novel OCDMA system compared to existing TDM system due to the bursty traffic nature of access networks.
- (7) Possibly performing field test demonstration on real network infrastructure belonging to our private local partner.