Next Generation Optical Access PON Evolution

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A passive optical network (PON) features a point-to-multi-point (P2MP) architecture to provide broadband access. The P2MP architecture has become the most popular solution for FTTx deployment among operators. As full services are provisioned by the massive deployment of PON networks worldwide, operators expect more from PONs. These include improved bandwidths and service support capabilities as well as enhanced performance of access nodes and supportive equipment over their existing PON networks. The direction of PON evolution is a key issue for the telecom industry. Next-generation PONs are divided into two phases: NG-PON1 and NG-PON2. Mid-term upgrades in PON networks are defined as NG-PON1, while NG-PON2 is a long-term solution in PON evolution. This short course will discuss the various flavors of PON, design principles and prospective technologies within the framework of NG-PON recommendations.

The various topics to be covered during the short course are as follows:

- Overview of system concepts/technologies with potential of meeting the requirements of next-generation optical access. Key requirements include residential peak data rates of ≥1 Gb/s, support for 256 to 1024 customers per feeder fibre, support for 20 to 40 km passive reach, and support for 60 to 90 km extended reach with protection path.

- The main system concepts of FTTH are PON based on time division multiplexing (TDM) and active optical networks (AON). As a natural starting point of next-generation systems, firstly, higher bit-rate alternatives will be discussed. For TDM-PON this includes options based on higher rate on-off keying as well as variants based on advanced modulation and coherent detection.

- Wavelength division multiplexing (WDM) offers another avenue for increasing capacity in optical networks. WDM-PON concepts are categorized based on optical network unit (ONU) design i.e. tunable lasers, reflective lasers or reflective lasers employing wavelength reuse. Advantages of WDM-PON include long reach and large per customer sustainable bandwidth. A drawback is the limited fan-out, limiting the number of customers per feeder fibre.

- An alternative avenue for increased capacity is orthogonal frequency division multiplexing (OFDM) which is based on data transmission over several densely spaced subcarriers. The OFDM format, with its tolerance to chromatic dispersion, offers long reach and large resource flexibility but presents challenges with respect to key

components. Several variants of OFDM-PON will be presented based on either intensity modulation or electric field modulation.

- Code Division Multiplexing (CDM) offers yet another technology relevant for next generation optical access. Different CDM implementation options and fan-out possibilities will be discussed with focus on coherent optical CDM using one-dimensional code words.

- Hybrid concepts are motivated by the fact that each of the aforementioned pure system concepts individually may have difficulties of cost-effectively fulfilling more stringent next generation requirements. Hence, hybrid concepts have been proposed that combine advantages of different concepts. Typically the advantages that are exploited are the increased overall capacity of WDM and the efficient resource sharing of TDM, OFDM and CDM.

- Ultra-dense WDM, which can be seen as a two stage WDM system will also be presented.

- Key components for the identified system concepts like wavelength selective components, tunable lasers, reflective transmitters, reflective semi-conductor optical amplifiers, reflective electro-absorption modulators, coherent receivers, burst mode receivers, different methods for dispersion compensation, passive wavelength selective devices such as thin film filter-based WDM components, fibre Bragg grating-based WDM components, etched diffraction grating-based WDM components and arrayed waveguide grating-based WDM components etc. will be presented

- Finally, comparative performance table will be discussed in the form of a table where the main system variants are compared against each other with respect to key system aspects.

Brief bio of Anand SRIVASTAVA

* Dr. Anand Srivastava has joined IIT Mandi as Professor in Feb'12. Prior to this, he was with Alcatel Lucent India as solution architect for access and core networks. Before joining Alcatel Lucent he had a long stint (~ 20 years) in CDOT (Telecom Technology Center of Govt of India) where he was Director and member of CDOT board. In CDOT he was responsible for conceptualization, development and national level deployment of state-of-the-art telecom products in the areas of Telecom Security Systems, Network Management System, Intelligent Netwoks, Operations Support Systems, Access networks and Core Optical network products.

He received his Master's and Ph. D. degrees in Electrical Engineering from I.I.T, Delhi. His research work was in the area of Optical Code Divison Multiplex Access (OCDMA) systems.

He has also represented India in Study Group 15 for various optical networking standards meetings in ITU Geneva.