[R12]

Title	**Large Capacity Centralized Monitoring Solution for Next Generation Fiber-to-the-X Gigabit TDM/WDM Passive Optical Networks**
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Summary:
Fibre-to-the-home (FTTH) is the evolving solution for the last/first mile telecom bottleneck. Fibre-to-the-X (FTTX) is more general acronym that means fibre-to-the-everywhere; where X is H for home, C for curb or cabinet, B for business or building, N for node or neighbourhood, D for desk etc. FTTX becomes the keystone of next generation wireless and wired broadband communications networks. Extensive FTTH deployments have been carried out in North America and Japan over recent years. The demand for FTTH services is growing at 80% per year compared to 3% for DSL in Japan. Saudi Telecom Company (STC), the largest telecom service provider in Saudi Arabia, undertook a number of pilot projects of Gigabit passive optical network (GPON) FTTH. GPON FTTH technology will enable advanced multimedia triple play services (i.e., for TV, PC and telephones) including IP telephony, video-on-demand, personalized TV, super fast internet and data services.
The number of customers sharing the same fibre currently ranges from 16 to 32; existing GPON attains 64, and near term industry forecast predicts 128 of time division multiplexing (TDM) customers. Next generation passive optical networks will overlay TDM over wavelength division multiplexing (TDM/WDM) Industrial and academic laboratories already report 1024 customers sharing the same fibre by means of time division multiplexing together with wavelength division multiplexing of passive optical networks (TDM/WDM-PON). The combination of TDM and WDM theoretically scales up the capacity to many thousands of customers. The need remains for centralized monitoring of these complex optical network infrastructures, and many technologic challenges remain. Indeed, no known product, nor technology, offers a serious solution for high capacity PONs supporting more than 8 customers per fibre.
In this project, we propose to develop an alpha prototype of a monitoring system for an FTTH-PON supporting the surveillance and the administration of up to 128 TDM customers per wavelength. TDM over WDM testing will also be achieved in order to proof the scalability of our approach to thousands of customers. We have examined the capacity of our solution via simulation, and found a monitoring capacity of hundreds of customers per fibre. Our main objective is to achieve the monitoring of 128 TDM customers and prove the scalability of our solution to next-generation high capacity TDM over WDM PON systems.
Key features of our new coding technology include its simplicity, the maturity of the components (exploits of the shelf components), low cost components, and its inherent ability to allow centralized monitoring, thus giving telecom service providers full information and control of their networking infrastructure. Alternative solutions have only achieved a very early research state, are impractical, and lack supervisory and troubleshooting information that is crucial to service providers. These solutions, based on placing supervisory modules in customers' equipment, do not provide the operator full control of their network.
Our alpha prototype of an FTTH Optical Coding Monitoring System (OCMS) will include one central office monitoring equipment (COME), 128 coding modules (CM), two high capacity passive splitters based optical remote nodes, and one network emulator module (NEM). The later should allow us the emulation of 256 TDM modules and more. The COME prototype should support up to 128 FTTH TDM customers in addition to including the capability of WDM monitoring. This number easily exceeds by more than 10 times any competing approach, while reducing system complexity and cost. Our solution of high capacity In-Service FTTH monitoring and surveillance equipment uses a simple and mature optical coding technology that calls

on only one wavelength inside the standard U band (1625 to 1675 in compliance with ITU-T L.41).
Our prototype will be developed as a modular platform that could emulate in laboratory, different communication problems that could occur in a real network GPON FTTH network over next generation WDM-PON network. These problems include service interruption or degradation, accidental fibre or cable breaks, customer disconnection, connection malfunctions, degradation of a connector, splice or fusion, abnormal bending of a fibre, etc.
We are already quite advanced in theoretical and simulation analysis of our novel technology in addition to initial proof of concept for 16 TDM customers. The main purpose of this proposal is to build the system prototype for advanced TDM over WDM architecture passive optical network that is the ultimate next generation of FTTX technology. The projected advanced alpha prototype consist on an integration of the whole system composed of multiple shelves including the COME, the passive distribution network modules (fibres, remote nodes and distribution boxes), and the coding modules (CMs). Note that the project will also enjoy good collaboration with center of Optics Photonics and Laser in Laval university group in Canada.

Objectives:

The main objective of this project is to build an alpha prototype of an FTTH Optical Coding Monitoring System (OCMS) that supports up to 128 TDM customers sharing a single fibre. This system includes:

(a) A Central Office Monitoring Equipment (COME) for high capacity fibre-to-the-home-passive optical networks (FTTH-PON) supporting 128 customers. This number easily exceeds more than 10 times any competing technology approach while reducing the system complexity and cost. The first versions of the prototype could use common wavelength region (C band around 1550 nm). The final demonstrator should be built on the standard U band (1625 to 1675 in compliance with ITU-T L.41). The ultimate performance measurement would be the probability of fault detection and the probability of false alarm of the system in different distributions and capacity scenarios.

(b) Design of 128 coding modules, manufactured and packaged corresponding to our specifications. The encoders of the first experiments could also be made on the C band range but the final demonstration should be made on the U band. At least two different architectures of coding modules will be considered.

(c) Mount a hybrid WDM/TDM remote node that allows 128 fibre connections in addition to spare connections on other wavelengths.

(d) Develop a Network Emulator Equipment (NEM): This equipment allows generating a signal that emulates an arbitrary distribution of network. Using this equipment we could evaluate the performance of our system for any possible distribution of an FFTX system. The NEM saves a huge time and investment for the demonstration and experimentation.

(e) Emulate a system composed of 256 coding modules for hypothetic 256 TDM customers network and evaluate its performance. For these emulated hypothetic cases, we will be able to measure the signal to noise ratio, the detection probability and false alarm probability of different.