

# Architecture Agnostic PON Monitoring Solution using Optical Coding

Authors: **Habib Fathallah and Leslie A. Rusch**,

Centre d'Optique Photonique et Laser, Université Laval, Québec (Qc), G1V 4T8, Canada, E-mail: [hfabib@gel.ulaval.ca](mailto:hfabib@gel.ulaval.ca), [rusch@gel.ulaval.ca](mailto:rusch@gel.ulaval.ca)

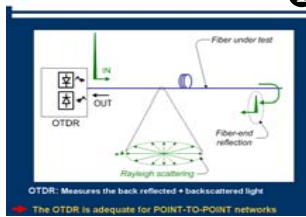
## Abstract:

We develop a novel network monitoring solution, suitable for all popular existing and emerging passive optical network (PONs) architectures. Our solution uses an optical coding technique inspired from the standard direct sequence-optical code division multiplexing (DS-OCDM) technology. We exploit passive devices and address various service provisioning and network maintenance challenges in PONs, alleviating their complexity and reducing their operational cost. In our analysis, we address the coding settings and develop network capacity curves. In addition, we elaborate architectural solutions allowing the technique to scale up from time-division multiplexing TDM-PONs to wavelength division multiplexing (WDM-PON) and TDM over WDM-PONs.

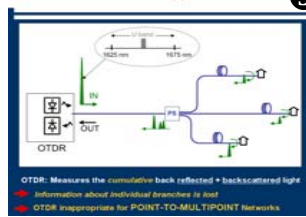
## Outline:

- PON growth & monitoring challenges
- Limits of OTDR & existing approaches
- Our Optical Coding (OC) approach
- Promised capacity & design issues
- OCDM monitoring for WDM & TDM/WDM PONs
- Summary and future work

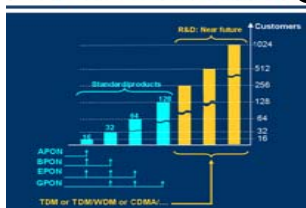
## Limits of the OTDR 1



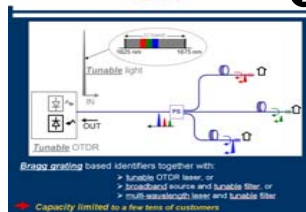
## Limits of the OTDR (2) 3



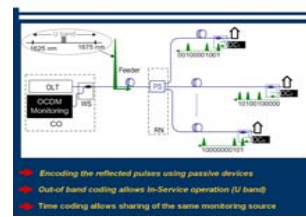
## PON growth & monitoring challenges 2



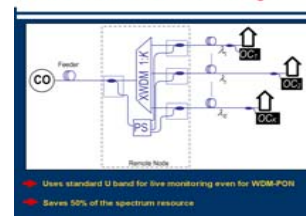
## Limits of existing approaches 4



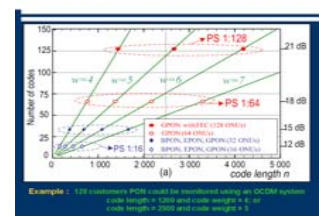
## Our approach: Optical Code division multiplexing (OCDM) 5



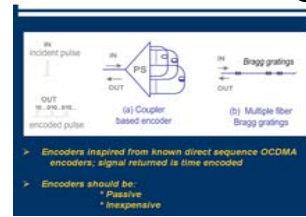
## WDM-PON: OCDM Monitoring 8



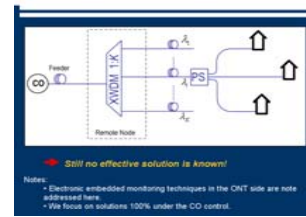
## Capacity: OCDM monitoring for standard FTTH-PONs 11



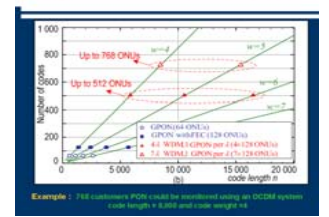
## Our Approach: Examples of encoders 6



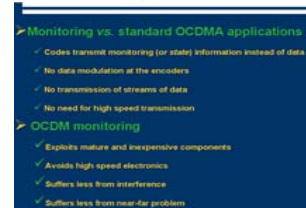
## TDM/WDM-PON: No solution exists yet! 9



## Capacity: OCDM monitoring for future high capacity PONs 12



## WDM-PON Monitoring: existing approach 7



## OCDM monitoring vs. data transmission 10

- **Monitoring vs. standard OCDMA applications**
  - ✓ Codes transmit monitoring (or status) information instead of data
  - ✓ No data modulation of the encoders
  - ✓ No transmission of streams of data
  - ✓ No need for high speed transmission
- **OCDM monitoring**
  - ✓ Exploits mature and inexpensive components
  - ✓ Avoids high speed electronics
  - ✓ Suffers less from interference
  - ✓ Suffers less from near-far problem

## Conclusion & future work 13

- **A novel OCDM based PON monitoring system**
  - ✓ Monitors high capacity PONs (100s to 1000s of clients)
  - ✓ Monitors TDM, WDM and TDM over WDM PONs
  - ✓ Exploits mature and inexpensive components
  - ✓ Avoids high speed electronics
- **Future Work**
  - ✓ Advanced performance study
  - ✓ Experimental demos