New Optical Codes Alleviating Synchronization in Optical Coding PON Monitoring System

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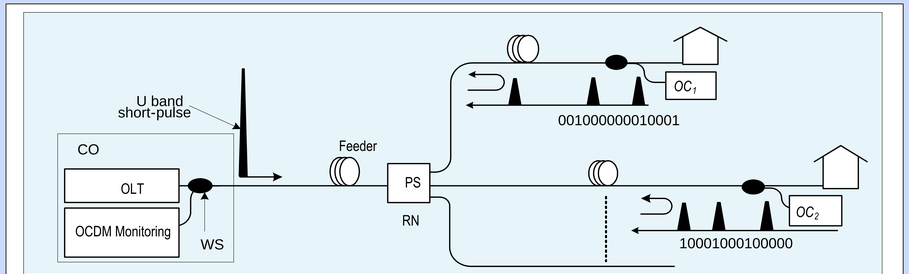
1- Abstract:

We propose a new optical coding structure for Passive Optical Networks (PONs) monitoring that dramatically reduces the overall system cost. Our analysis demonstrates that this technique increases the monitoring system performance, promises a high SNR and supports a high number of users. In fact, our solution exploits only two Bragg gratings, written for the same wavelength, connected together making an optical cavity. We demonstrate that the family of codes, appropriate for the new coding structure, simlifies the synchronization function of the central office (CO) monitoring receiver. This allows the monitoring system to automatically determine the customer's distances to the CO without a prior knowledge of the network.

2- Outline:

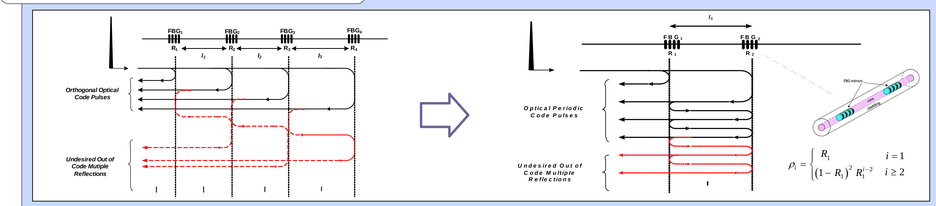
- Optical Coding Monitoring System
- Limits of Actual Optical Codes
- Coding Mirrors based on Optical Cavity
- Coding Mirrors Design
- Coding Performance (Auto-Correlation & Cross-correlation)
- Signal to Noise Ratio

3- PON Monitoring System Approach



❶ Our Approach: Optical Coding PON Monitoring System

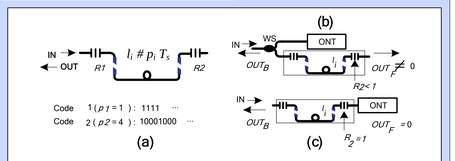
4- Limits of Actual Codes:



❷ Orthogonal Optical Coding Encoder Structure (w=4)

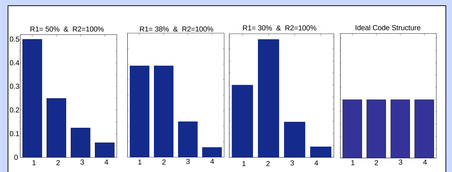
❸ Our Approach: Periodic Optical coding based on Optical Cavity

5- Coding Mirrors:

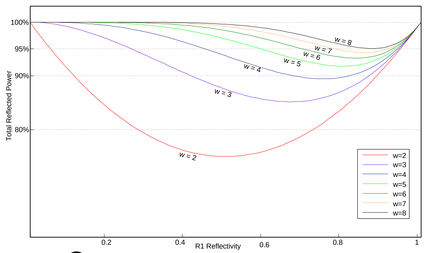


❹ (a) Proposed Coding Mirrors Structure, (b) & (c) Other Solutions

6- Code Structure:

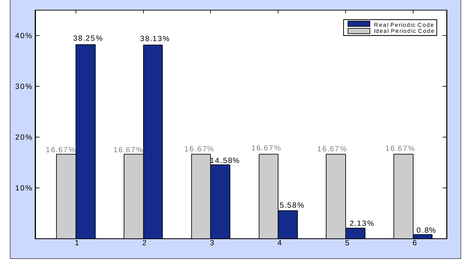


❺ SubOptimal and Ideal Code Structure



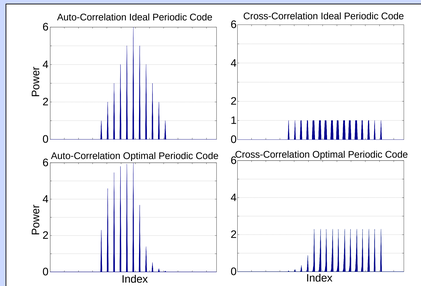
❻ Total Reflected Code Power

7- Code Pulses:

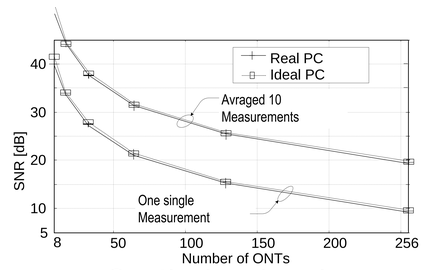


❼ Code Structure: Ideal and Optimal Cases

8- Performance:



❽ Auto-Correlation and Cross-Correlation (Ideal vs Optimal)

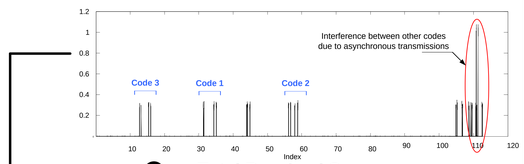


❾ Signal to Noise Ration

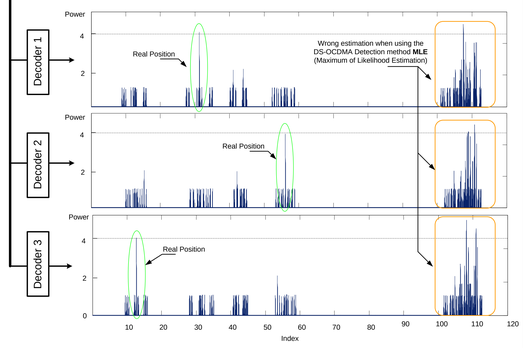
$$SNR = \frac{\mu_{SIG}^2}{\sigma_n^2} = \frac{\mu_{SIG}^2}{\sigma_{TH}^2 + \sigma_b^2 + \sigma_{SH}^2 + \sigma_{RN}^2}$$

9- Detection Technique:

High Sensitivity of OOC λ_c=2 to user's interference caused by Asynchronous Transmissions



❿. a Total Received Sequence



❿. b Decoded Sequences

10- Conclusion

The use of OOC for The PON Monitoring System have some limits:

- For each ONT we need a special encoder
- With λ_c=1, the Code Length is too high which need a longer encoder based on FBGs.
- With λ_c=2, synchronization's problem

Our Approach: New Code Structure and Improving Detection Technique to increase the System Synchronization:

- Periodic Code Structure with λ_c=1,
- Higher immunity face to interference and better synchronization scheme.
- Detection based not only on **MLE** (Maximum Likelihood Estimation) but also on the «**detection of the Auto-Correlation Pattern**».

Due to the unique and Symetric structure of Periodic Codes Auto-Correlation, it's use this factor to increase the synchronization of the PON Monitoring System and.