

Contents

Curriculum vitæ	4
Introduction	5
1 Thesis Overview	6
1.1 Scope and Research Motivation	6
1.2 Thesis Objectives	6
1.3 Relation to Author's Publications and Contribution	6
2 Fibre Optic Sensors Background	8
2.1 Background and Preliminaries	8
2.1.1 Laser Diode Spectral Linewidth	8
2.1.2 Coherence Length	8
2.1.3 Polarization of the Light	8
2.2 Distributed Fibre Optic Sensors	8
2.2.1 Interferometric Sensors	9
2.2.2 Reflectometry-based Sensors	10
2.3 Data and Non-data Services	12
2.3.1 Accurate Time	12
2.3.2 High-speed Data	13
3 Assessment of Suitability of Fibre Optic Sensing Techniques for Use in Data Networks	14
3.1 Photonics Services Description	14
3.1.1 Accurate Time Transmission	14
3.1.2 High-speed Data Systems	15
3.1.3 Sensing System	15
3.2 Simultaneous Transmission of the High-power Φ -OTDR, Standard Data, Accurate Time and Their Possible Interaction	16
3.2.1 Experimental Setup and Results	17
3.2.2 Conclusions	20
3.3 Sensitivity Comparison of an Interferometry and Polarization Methods	21
3.3.1 Experimental Setup	21
3.3.2 Results and Discussion	22
3.3.3 Conclusions	24
4 Novel Systems Based on Interferometric and Reflectometric Principles for Efficient Distributed Sensing	25
4.1 Φ -OTDR Signal Amplification	25
4.1.1 Pulse Signal Amplification with a Low Repetition Rate by Standard Telecommunication EDFA	25
4.1.2 Pulse Signal Amplification by Raman Amplifier	27
4.1.3 Remote Amplification of a Pulse Signal	28
4.1.4 Conclusion	30
4.2 Novel Method of Measurement of Polarization Transient Effects Caused by Mechanical Stress on Optical fibre	30
4.2.1 Methodology	30
4.2.2 Results and Discussion	31
4.2.3 Conclusion	31
4.3 Distributed Fibre Optic Sensing System Based on Dual Mach-Zehnder Interferometer Using Frequency Shift	31
4.3.1 Scheme and Principle of the Invention	33
5 Conclusion	34
Bibliography	35