

**Ph.D. in Information Technology
Thesis Defense**

March 30th, 2026

At 11:00 a.m.

Emilio Gatti Conference Room- Building 20

Xiaohui ZHAO – XXXVIII Cycle

**MULTI-BAND ADAPTIVE OPTICAL AMPLIFICATION FOR ULTRA-HIGH-
THROUGHPUT FIBER-OPTIC TRANSMISSION SYSTEMS**

Supervisor: Prof. Massimo Tornatore

Abstract:

This doctoral dissertation investigates multiband adaptive optical amplification techniques for enabling ultra-high-throughput fiber-optic transmission systems. Driven by the rapid growth of global data traffic and emerging data-intensive applications, the work explores ultra-wideband (UWB) transmission across the S, C, and L bands as a scalable approach to significantly increase per-fiber capacity without requiring new fiber deployment. The research presents a systematic experimental characterization of multiband optical amplifiers—including erbium-doped, semiconductor, and bismuth-doped fiber amplifiers—to assess their performance and suitability for UWB systems. It further analyzes nonlinear impairments introduced by semiconductor optical amplifiers and demonstrates low-complexity digital pre-distortion techniques to extend the achievable power budget. Building on these findings, the dissertation experimentally demonstrates state-of-the-art unrepeated multiband transmission systems achieving real-time throughputs up to 67.2 Tb/s in C+L bands over 100 km spans and 59.2 Tb/s over 201.6 km spans. Finally, laboratory experiments and field trials validate S+C+L UWB transmission over deployed infrastructure, achieving record throughputs up to 200.5 Tb/s in controlled experiments and 158.4 Tb/s in operational networks, while providing new insights into physical impairments such as inter-channel stimulated Raman scattering in multiband wavelength-division multiplexing systems. These results demonstrate the feasibility and practical potential of adaptive multiband amplification architectures for future ultra-high-capacity optical communication networks.

PhD Committee

Dr. Mëmëdhe Ibrahim, **Politecnico di Milano**

Prof. Francesco Da Ros, **Danmarks Tekniske Universitet**

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