Intent and Context-Aware Optical Networks

PROJECT INTRODUCTION

The ICON project is redefining the future of optical networks by making the fibre sensing an integral part of the network.
ICON introduces a new paradigm in network operation: a network that understands user intent (a sensing application), senses physical events to create the context (environment surrounding the network infrastructure), and automatically adapt its operation to ensure optimal performance, resilience, and energy efficiency.
By merging communication, environmental sensing, AI-driven interpretation, and digital twins, ICON supports a future, where Europe's optical networks can react to threats to network infrastructure, earthquakes, traffic patterns, and fluctuating demands — in real time.

ICON OBJECTIVES

- Develop a portfolio of highly flexible physical layer sensing solutions
- Develop a library of signal processing, context creation, data compression algorithms to interpret and correlate heterogenous data
- Develop an intelligent sensing controller, including data lake and DT functions, compatible with SDN controller and NMS
- Investigate, validate and optimise the ICON JC&S functions
- Max. impact through dissemination and standardization in optical communication, sensing and JC&S.

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Sensing & Communication

The ICON project is working towards:

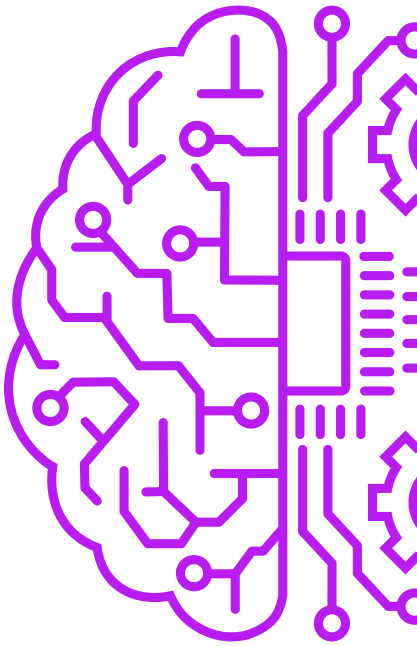
- A scalable, intelligent sensing controller enabling real-time context awareness.
- A digital twin framework supporting autonomous operation and predictive maintenance.
- Validated use cases in terrestrial, subsea, and smart-city contexts.
- Contributions to standardisation, ensuring alignment with future optical network architectures.
- A roadmap for industrial exploitation, strengthening Europe's leadership in photonics and smart connectivity.

Key Results

- Launched a shared technical vision and aligned work
- Defined system architecture and interfaces between communication, sensing, and AI components.
- Initiated experimental planning for optical sensing validation
- Published initial scientific contributions and participated in international conferences.
- Engaged with clustering networks and other projects

ICON PROGRESS

TECHNICAL UPDATES FROM FIRST 12 MONTHS



System & Architecture Design

Defined the reference network architecture integrating sensing and digital twin
Early requirements captured for sensing devices, control, and automation

Sensing Technologies - Early progress

Design of initial fibre-sensing concepts (e.g., OTDR-based sensing)
Review of state-of-the-art and performance targets for environmental context-awareness

Intent-Based & Digital Twin Control (Initial Steps)

Baseline development of the intent interpreter functionalities
Digital twin data structure and interactions drafted with partners

Dissemination and Communication

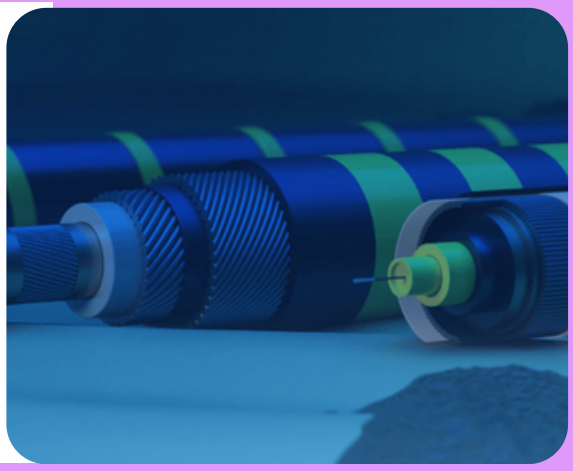
ICON visual identity created (website under development)
Early stakeholder mapping and planning of outreach actions

04.

ICON Use Cases Explained

Subsea Monitoring and Resilience

Using undersea optical cables as distributed sensors to detect temperature variations, strain, and seismic events — enhancing cable protection and ocean observation



Urban Network Intelligence

Employing context-aware networks in metropolitan areas to monitor vibrations, traffic flows, and infrastructure conditions, supporting smart city applications.

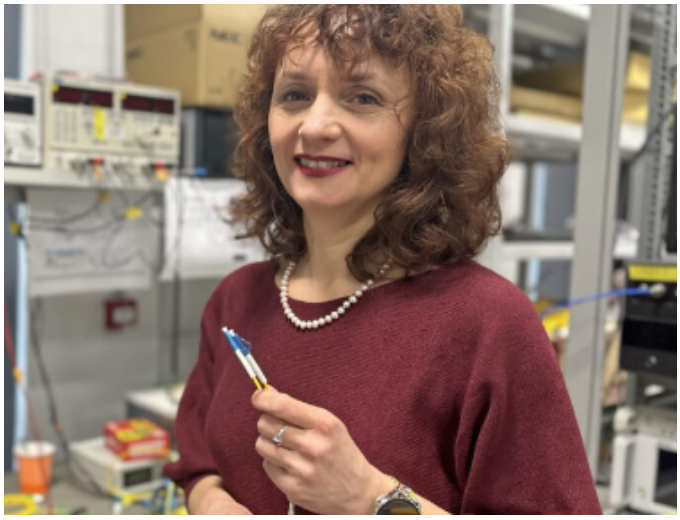
Infrastructure Health and Energy Efficiency

Integrating optical sensing for predictive maintenance and energy optimisation in large-scale telecom infrastructures.

DISSEMINATION & COMMUNICATION

UPDATES ON ACTIVITIES PERFORMED

>> FIRST PROJECT PRESS RELEASES



“New €5 million project will transform fibre optic cables into active sensors, safeguarding networks from damage.”
ICON Press Release, CONNECT Research Ireland Centre, March 18, 2025, Ireland.
Our coordinator, Dr Aleksandra Kaszubowska said:
“ICON represents a bold step forward in how we conceptualise and implement optical networks. By incorporating sensing capabilities, we are moving beyond traditional communication paradigms to develop systems that are more intelligent, efficient, and adaptive.

Kick-off Meeting – March 2025, Dublin (TCD)

The project officially launched with a successful kick-off meeting hosted by Trinity College Dublin, where consortium members gathered to set the foundation for this ambitious and innovative journey.

ICON NEWS

2nd Consortium Meeting – October 2025, Copenhagen (DTU)

The second consortium meeting focused on:
Organisation of an integrated communication and sensing (ICAS) workshop in Estonia in May 2026, bringing together partners, students, industry, and government representatives.

The next plenary meeting will take place in Estonia together with the workshop, maximizing collaboration and impact.

Partners also explored participation in upcoming events, including the ICTON conference taking place in Prague in July, where ICON will organize a dedicated session on ICAS.

Dataset collection and publication, to support research activities and future machine learning challenges.

ICON NEWS

The ICON project and certain results were further presented at scientific conferences by project partners

>> EUROPEAN CONFERENCE OONDM 2025 – Optical Network Design and Modelling

ICON Project will co-organise the Optical Communication and Sensing (OCandS) Roadmap Workshop — a strategic session exploring the integration of communication networks and sensing technologies.

This workshop will examine the 2024 edition of the IEEE International Network Generations Roadmap (INGR) optics chapter, addressing how optical communication systems — including submarine, metro, and access networks — can evolve into large-scale platforms for environmental and infrastructure sensing.

The Workshop, co-organised in May 2025 by the ICON Project and the IEEE INGR Optics Chapter.
Moderated by Aleksandra Kaszubowska - Trinity College Dublin, the workshop brought together experts from research and industry, including Dan Kilper- Trinity College Dublin, Achim Autenrieth - Adtran, Marianna Hovsepyan - Open Fiber, Emanuele Virgillito - Politecnico di Torino, and STEINAR BJØRNSTAD-Tampnet .
The panel addressed how sensing data can strengthen network resilience, detect seismic activity, prevent infrastructure damage, and improve security.
Discussions also highlighted the challenge of managing high-resolution sensing data and the opportunities for innovation in hybrid communication-sensing systems.

ICON NEWS

25th International Conference on Transparent Optical Networks (ICTON 2025).

Presented ICON Project results, some key areas of research were highlighted:

Simultaneous Distributed Acoustic Sensing (DAS) and 200 Gbps transmission:

Advanced optical network security monitoring.

ICON NEWS

ECOC 2025

Our coordinator Dr. Aleksandra Kaszubowska-Anandarajah, from Trinity College Dublin, was invited as a speaker at the Women in Photonics Workshop at ECOC 2025, alongside Qian Li (Peking University Shenzhen Graduate School, China) and Christina Lim (University of Melbourne, Australia).

PUBLICATIONS

JOURNAL ARTICLES

High-Resolution FBG Strain Sensing With Dual-Comb Interrogation and Optimized Signal Processing

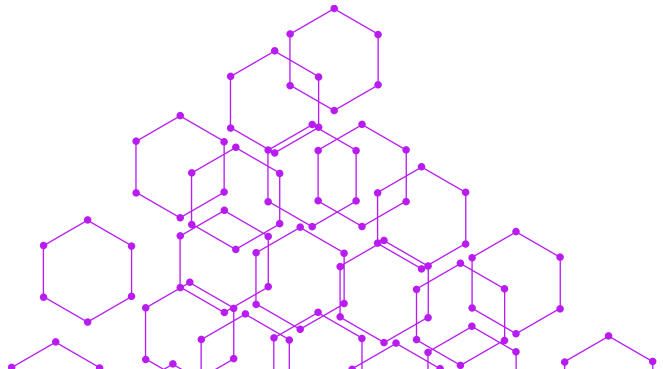
Authors: Malhar A. Nagar, Minghao Wei, Conor McArdle, Aleksandra Kaszubowska-Anandarajah, Prince M. Anandarajah, Davide Janner

Publisher link: https://ieeexplore.ieee.org/document/10998942

ITU-T G.681: the first distributed fiber optic sensing standard for in-service terrestrial optical networks

Authors: Yoshifumi Wakisaka, Gabriele Di Rosa, Qirui Fan, Etienne Rochat, André Sandmann, Xiang Liu, Jun Shan Wey

Publisher link: https://opg.optica.org/jocn/abstract.cfm?uri=jocn-18-4-B1



PUBLICATIONS

CONFERENCE PUBLICATIONS

Correlation-Enhanced Distributed Fiber Optic Sensing

Authors: André Sandmann, Florian Azendorf
Conference: Optica Advanced Photonics Congress (SPPCom) 2025

DOI: https://doi.org/10.1364/SPPCOM.2025.SpW4E.3
Repository link: https://zenodo.org/records/16993697

Exploring Telemetry Collection Interval and Continuity in a Six-Month Study of a Pan-European Network

Authors: Kaida Kaeval, Torm Järvelill, Hendrik J. Kerm, Jasper Müller, Carlos Natalino
Conference: OFC 2025

Publisher link: https://opg.optica.org/abstract.cfm?uri=OFC-2025-W2A.32
Repository link: https://data.taltech.ee/records/6z40w-5rg63

PUBLICATIONS

CONFERENCE PUBLICATIONS

Field Trial of Vibration Sensing on an Operational Telecom Fibre Network using Phase-OTDR

Authors: Vishal Chandraprakash Rai et al.
Conference: ECOC 2025

Publisher link:
https://ieeexplore.ieee.org/document/11263065

Intent and Context Aware Optical Networks

Authors: Aleksandra Kaszubowska-Anandarajah et al.
Conference: ICTON 2025

DOI: https://doi.org/10.1109/ICTON67126.2025.11125334

Proposal and Simulation of External Laser Phase Noise Reduction Using Telecommunication-Grade Devices

Authors: Pablo Roberto Castro Ayala, Michael Eiselt, André Sandmann, Bernhard Schmauss
Conference: OECC 2025

DOI: https://doi.org/10.23919/OECC/PSC62146.2025.11110037
Repository link: https://zenodo.org/records/17018151

PUBLICATIONS

CONFERENCE PUBLICATIONS

Vendor Neutrality Drivers and Hindrances – Optical Spectrum as a Service in Disaggregated and Open Networks

Authors: Kaida Kaeval, Torm Järvelill, Hendrik J. Kerm, Jasper Müller, Carlos Natalino
Conference: ECOC 2025
Publisher link:
https://ieeexplore.ieee.org/document/11263188

State of Polarization Sensing – Correlating Across Cable Sections

Authors: Steinar Bjørnstad, Jostein Gjesdal, Anders Tysdal
Conference: SubOptic 2025

Publisher link:
https://www.tampnet.com/hubfs/State%20of%20Polarization%20Sensing%20-%20Correlation%20Across%20Cable%20Sections-1.pdf?hsLang=en

PROJECT CONTACT DETAILS
ONLINE PRESENCE OF THE PROJECT

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