



ECOC 2026 – HOT & EMERGING TOPICS

An overview from the ECOC 2026 Technical Programme Committee

The following research directions were highlighted by the ECOC 2026 subcommittee chairs. The overview is organised into four technical domains, followed by well-attended workshops and a glossary of AI-interconnect terminology.

1 Optical devices & circuits

- **Multi-band fibre amplification.**
- **CPO-ready fibre technologies.** Fibres supporting co-packaged optics (CPO), including hollow-core fibres (HCF).
- **Data centre light sources.** O-band lasers and 1060 nm VCSELs dominate for data centre applications.
- **Advanced packaging & heterogeneous integration.** Co- and near-packaged optics (optical engine in the package), dense 2D optical I/O and fibre coupling, wafer-scale integration of materials. The targets are sub-pJ/bit links and higher shoreline bandwidth density.
- **AI interconnects driving silicon photonics.** Scale-up, scale-out and scale-across requirements are pushing 200 to 400 Gb/s per lane on silicon photonics. Heterogeneous integration of functional materials onto silicon, including lithium niobate/tantalate, ferroelectric oxides, PZT, electro-optic polymers and III-V or germanium-based materials, offers promising routes toward high-speed and energy-efficient modulation.
- **Parallel and DWDM architectures.** Wider-and-slower parallel and DWDM architectures are being explored, enabled by integrated optical frequency combs, generated through the Kerr effect or mode-locked lasers, from a single compact optical pump source.
- **Integrated photonic computing and processing.** Micro-rings, AWGR and MZI-mesh based tensor cores, photonic neural networks and reservoir-computing-based equalizers are being demonstrated on the same integration platforms used for transceivers.

2 Optical transmission & signal processing

- **Hollow-core fibre systems.** From system-level transmission lab demos to field trials, with record reach/capacity and growing focus on long-haul use cases.
- **Wideband and multi-band transmission.** Capacity scaling beyond C+L into S/E/O-bands as well as T-band (1 μm), enabled by new amplification schemes (YDFA), E/O devices, and hollow-core fibres.
- **Subsea optical fibre sensing.** Earthquake detection and longitudinal power monitoring. A similar trend towards sensing is also seen in passive optical networks (PONs).
- **Optical signal processing** (optical FIR filters, optical DACs, etc.).
- **Coherent PON evolution.** In PONs, the increasing demand for higher bit rates per wavelength is pointing towards the adoption of coherent technologies.

3 Optical networks

- **HCF-based data centre interconnects.** C-band HCF is a promising technology for high-speed data centre interconnects and new services. There is discussion about relevant practical aspects such as the impact of intermodal interference and the need of predictive OSNR models.
- **Fast integrated optical circuit switching** (ns-scale, low loss) is emerging as a complement to reduce switching-fabric power.

- **Agentic network automation.** Network automation is evolving beyond conventional AI-assisted SDN towards agentic architectures based on multiple collaborative AI agents. These agents can autonomously reason, plan and coordinate actions across different network domains and control functions, paving the way towards more adaptive, intent-driven and self-operating optical networks.
- **Distributed AI infrastructure.** The rapid growth of distributed AI training and inference is making the network a critical component of the AI infrastructure. High-capacity, low-latency and increasingly adaptive optical connectivity within and between data centres (DCN/DCI) will be essential to efficiently interconnect distributed AI compute resources, driving tighter co-design and joint optimization of computing and optical networking.
- **Programmable 6G and edge networking.** Dynamic and programmable optical networks for highly variable 6G/edge traffic.
- **Optical architectures for AI scaling.** Optical technology-based solutions for supporting scale-up/out/scale-across architectures for AI-based data centres. This has become a very active research topic, driving discussions on the appropriate transceiver and switching technologies needed to support the increasingly demanding traffic workload generated by AI applications, while also ensuring long-term scalability and sustainability.

4 Free-space optics, microwave & quantum photonics

- **Free-space and underwater optical links.** The main challenges being addressed are atmospheric effects, particularly turbulence mitigation and pointing techniques.
- **Integrated free-space photonics.** Photonic integrated circuits and metasurface devices for free-space optical communication.
- **Machine learning for optical links.** Machine learning and neural networks to improve free-space optical communication system performance.
- **Integrated sensing and communication (ISAC)** in free-space optical communication.
- **Entanglement-based quantum communication.** Quantum communication beyond simple prepare-and-measure protocols. Generation and distribution of photonic entanglement, which is a more challenging task than the transmission of quantum states of individual physical systems.
- **Free-space and satellite quantum links.** Quantum communication protocols in free-space scenarios, including satellite links. This effort builds on current progress in free-space optical communications, but faces numerous challenges resulting from variable channel parameters.
- **Analogue radio-over-fibre (ARoF) for 6G fronthaul.** Increasing radio bandwidths and distributed antenna architectures are driving renewed interest in ARoF, particularly for simplifying remote radio units and centralizing signal processing while avoiding the scaling limitations of digital fronthaul.
- **Photonics-assisted sub-THz/THz.** These systems are moving towards higher capacity, longer transmission distances, and ISAC. Recent demonstrations show rapid progress towards practical high-capacity sub-THz/THz wireless links, while the same photonic technologies are increasingly being explored for integrated communication, localization, and sensing in future 6G systems.
- **Long-range distributed acoustic sensing (DAS).** While DAS has so far primarily been limited to distances up to 100 km, recent experiments demonstrate various approaches extending DAS sensing to thousands of km. This enables sensing of distant tsunamis and earthquakes.

5 Most-attended Workshops & Special Symposia

Sessions attracting strong attendance reflected particularly high interest in AI connectivity, optical architectures and energy efficiency.

- Meeting diverse AI connectivity needs: architectural choices for next-generation pluggable transceivers.
- Can fast narrow channels keep rising without limit or will slow and wide become the winner?
- Winning interconnects for AI: scale-up & scale-out technology paths.
- How can we overcome the power wall across optical communication systems - from AI clusters to submarine networks?
- Light sources for next-generation optical communication systems for AI data centres.

6 AI interconnects — terminology at a glance

Based on the classification by **Selina Farwell**.

Term	Typical scope	Plain-language meaning
Scale-within	Inside an ASIC, package or tightly coupled system.	Co-design optics and compute at the chip/package level to move data efficiently within the system.
Scale-up	Within a server or rack.	Connect processors closely so they behave like a larger, tightly coupled compute system.
Scale-out	Across racks within one data centre.	Add more servers or racks and connect them through the data centre network.
Scale-across	Between data centres or sites.	Connect separate facilities into a larger AI cluster, with distance, latency and power constraints shaping the design.
Scale-beyond	Data centres plus edge or other distributed compute locations.	Extend workloads across a wider distributed environment, potentially placing compute near users or data. The term is still evolving and isn't a settled next rung in a distance hierarchy.

Acknowledgements

We thank all [ECOC TPC members](#) and especially the subcommittee chairs for their outstanding work for ECOC's 2026 edition and for contributing to this document. If you have questions or concerns, please contact us at tpc-chairs@ecoc2026.org.

Robert Halir & Ivana Gasulla | ECOC 2026 TPC co-chairs