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EMERGING AND SELECTED TOPICS IN CIRCUITS AND SYSTEMS

Call for PAPERS

Energy-efficient optical communications, optical integrated circuits, and signal processing

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Rationale, motivation, and scope

With the further development of AI technology and modern communication technology, the increasing computational power requires the collaboration of multiple cards simultaneously, placing higher demands on high-speed real-time communication. Fiber optic communication, with its extremely high bandwidth, holds the potential to meet the data transfer needs of data centers. As data rates continue to increase, DSP algorithms become more complex and require greater processing power, which in turn raises system power consumption and poses significant challenges for thermal management and heat dissipation in transceivers. Work related to "low-power short-distance optical fiber transmission research" is expected to become a trend in the next generation of communication research.

- **Ultra-high bandwidth, low-power digital signal processing circuits design:** The continuous increase in bandwidth makes high-order modulation the preferred mode of optical fiber transmission. The extremely high bandwidth exacerbates the phenomenon of ISI (intersymbol interference), and high-order modulation increases the system's sensitivity to ISI. Additionally, with the increase in sampling rates, the phenomenon of frequency offset jitter cannot be ignored. At the circuit level, to meet the requirements of balanced real-time performance, corresponding circuits need to be expanded, leading to a dramatic increase in area and power consumption due to high parallel processing. In recent years, researchers have proposed simplified DSP architectures tailored for data centers, implementing them in analog circuitry to achieve power consumption reduction. Additionally, various breakthrough DFE circuit structures have been introduced to overcome time constraints by breaking the loop, offering crucial research value for high-bandwidth transmission.
- **Silicon Photonics:** Due to the advantages of high integration density and compatibility with CMOS technology, Silicon photonics is widely researched in communication for High-Performance Computing (HPC), data center switches, and chiplets. Silicon photonic devices and circuits find extensive use in areas like microwave photonics, quantum photonics, machine learning, and optical communication. There is still significant exploration space for improving integration density, increasing modulator bandwidth, reducing optical losses, mitigating coupling losses, etc. Regarding co-packaging, there remains substantial exploration space in integrated methods and packaging platforms, etc.
- **Opto-electronics hybrid integration:** To achieve low-power consumption characteristics to satisfy short-distance optical fiber transmission applications, opto-electronics hybrid integration is a feasible way.

Redesign and optimization of key components in the system are extensively discussed to balance the transmission performance and power consumption. In optoelectronics hybrid integration, silicon photonics integration is regarded as the power-efficient candidate, while a new integration scheme still needs to be explored.

- **DSP for new coherent-lite architecture:** System architecture, either intensity modulation-direct detection or coherent detection will face high power-consumption challenges, especially from the robust DSP. In IM/DD, the complexity of equalizers is increased sharply with the fiber chromatic dispersion and nonlinear impairments, how to effectively reduce the complexity of equalizers to meet low power consumption needs further investigation. In coherent detection, traditional DSP needs to be tailored or redesigned to better serve the new coherent-lite architecture.
- **Hybrid optical/electrical design:** Optical signal processing will significantly reduce the area and power consumption requirement of DSP, while it is not flexible and robust enough to totally compensate for signal distortions in the transmission link. Hybrid optical/electrical equalization might be a good solution to balance the system performance and power consumption, large power consumption functional units can be achieved through analog optical signal processing, while functional units with high flexibility and accuracy requirements can be realized with digital electrical signal processing. It might provide a feasible solution to pave the way for the next generation beyond 800G/1.6T optical interconnection.

Topics of interest

Topics of interest to this special issue include, but are not limited to:

- High Precision Low Complexity Equalization Circuit Design,
- Low Power Feedforward Digital CDR Circuit Design,
- Real-time Frequency Offset Circuit Design,
- Stable High Precision Phase Offset Recovery Circuit Design,
- High power efficient hybrid optical/electrical equalization,
- Low latency coded modulation scheme for optical interconnection,
- Opto-electronics hybrid integration and new enabling key optical components,
- Low computation complexity CD and nonlinearity equalization in IM/DD short-reach commutation,
- Coherent-lite and related new DSP architectures,
- Integration on silicon photonic chips,
- Optical interconnection,
- Reconfigurable photonic integrated devices and circuits,
- Photonic neural networks,
- Integration of electrical and photonic integrated circuits,
- Optical computing,
- Silicon photonics for inter-chip communication in advanced packaging.

Submission procedure

Prospective authors are invited to submit their papers following the instructions provided on the IEEE JETCAS website: https://ieee-cas.org/publication/JETCAS/manuscript-submission-guide. The submitted manuscripts should not have been previously published, nor should they be currently under consideration for publication elsewhere. The IEEE JETCAS submission site is https://ieee.atyponrex.com/journal/jetcas.

Important dates

- **Manuscript submissions due (extended):** **June 23, 2025**
- **First round of reviews completed:** **July 27, 2025**
- **Revised manuscripts due:** **Sep. 01, 2025**
- **Second round of reviews completed:** **Sep. 22, 2025**
- **Final manuscripts due:** **Oct. 13, 2025**

Request for information

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