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Channel Equalization of Space Division Multiplexing Based on Optical MIMO


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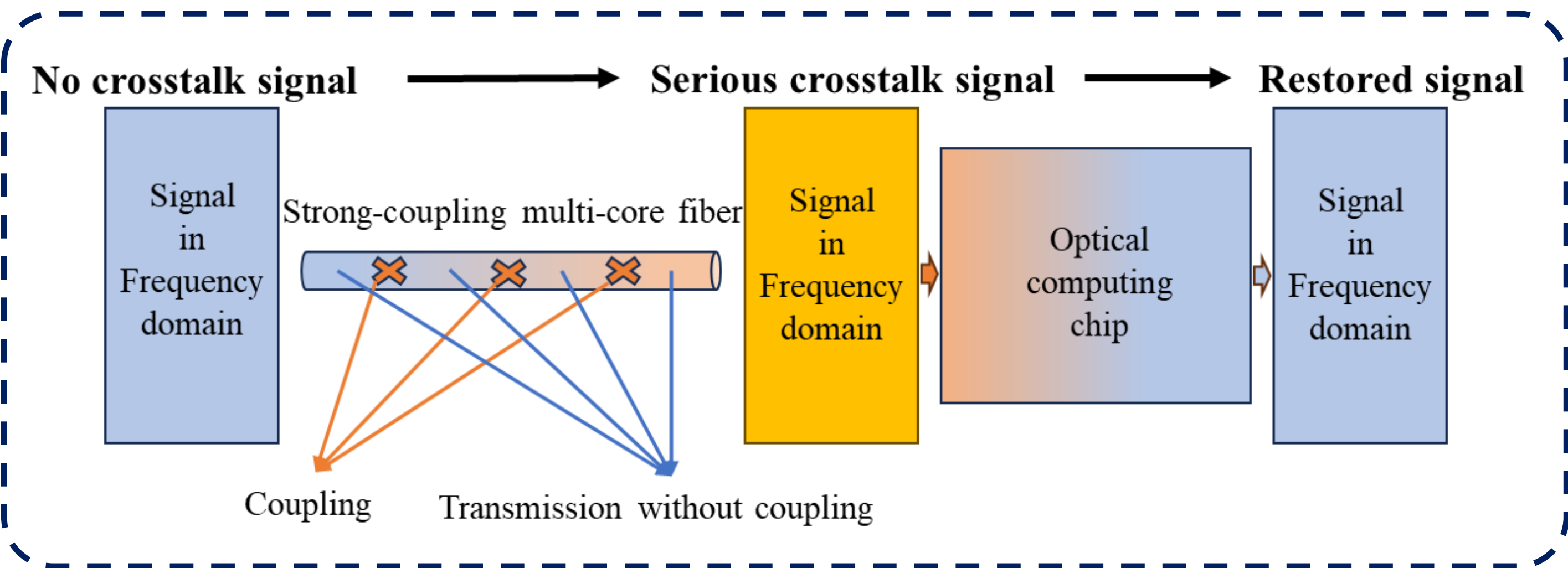


Introduction

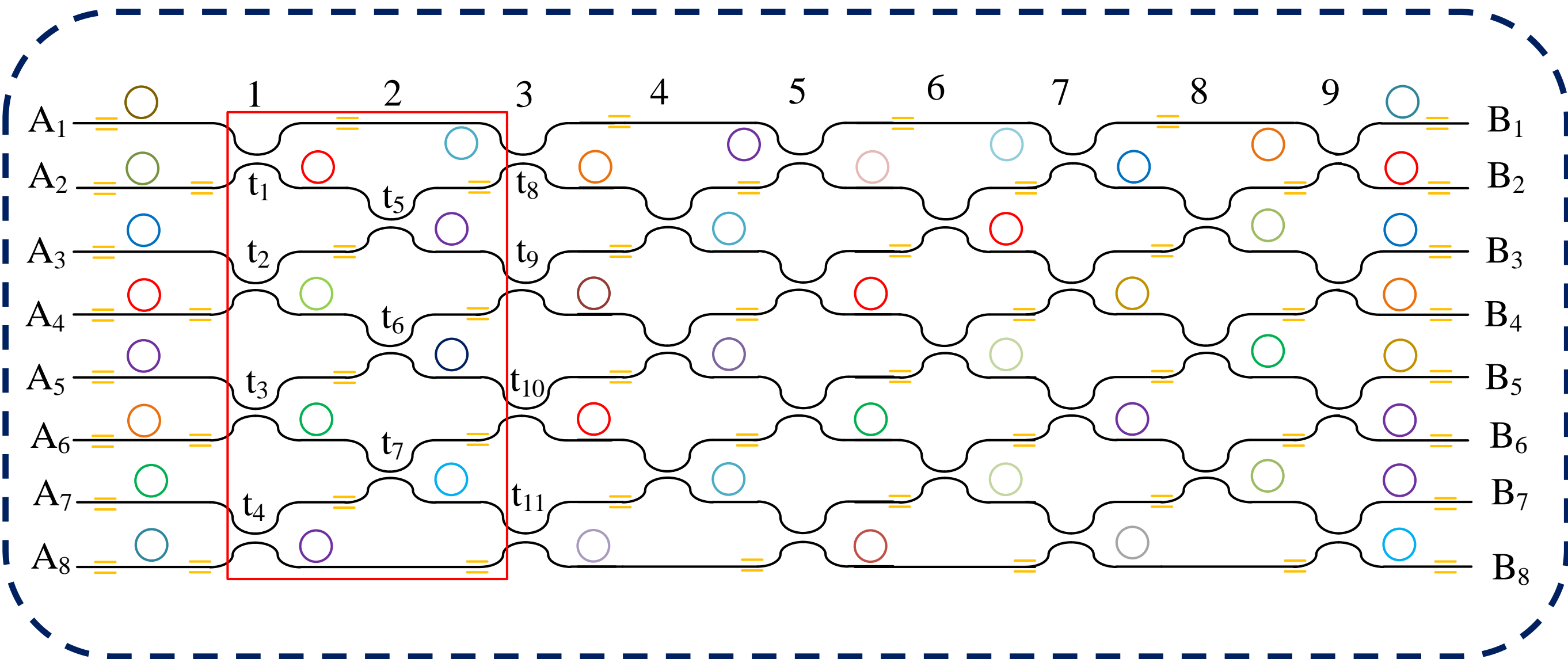
- The transmission capacity of single-mode fiber approaches the Shannon limit.
- The digital signal processing technology based on the electric chip is difficult to achieve channel equalization in long-distance and large-capacity multi-core optical fiber transmission system.
- Several reported optical chip architectures based on Mach Zehnder interferometer (MZI) and phase shifter (PS) have been used to achieve channel equalization without differential-mode group delay (DMGD), which can not be applied in practical fiber-optic communication.

We propose a novel optical chip architecture for signal processing with differential group delay, which consists of MZI, PS and micro-ring resonator. The channel equalization can be realized in the strongly-coupled fiber link with length of 1000km and DMGD of 158ps.

Optical computing architecture



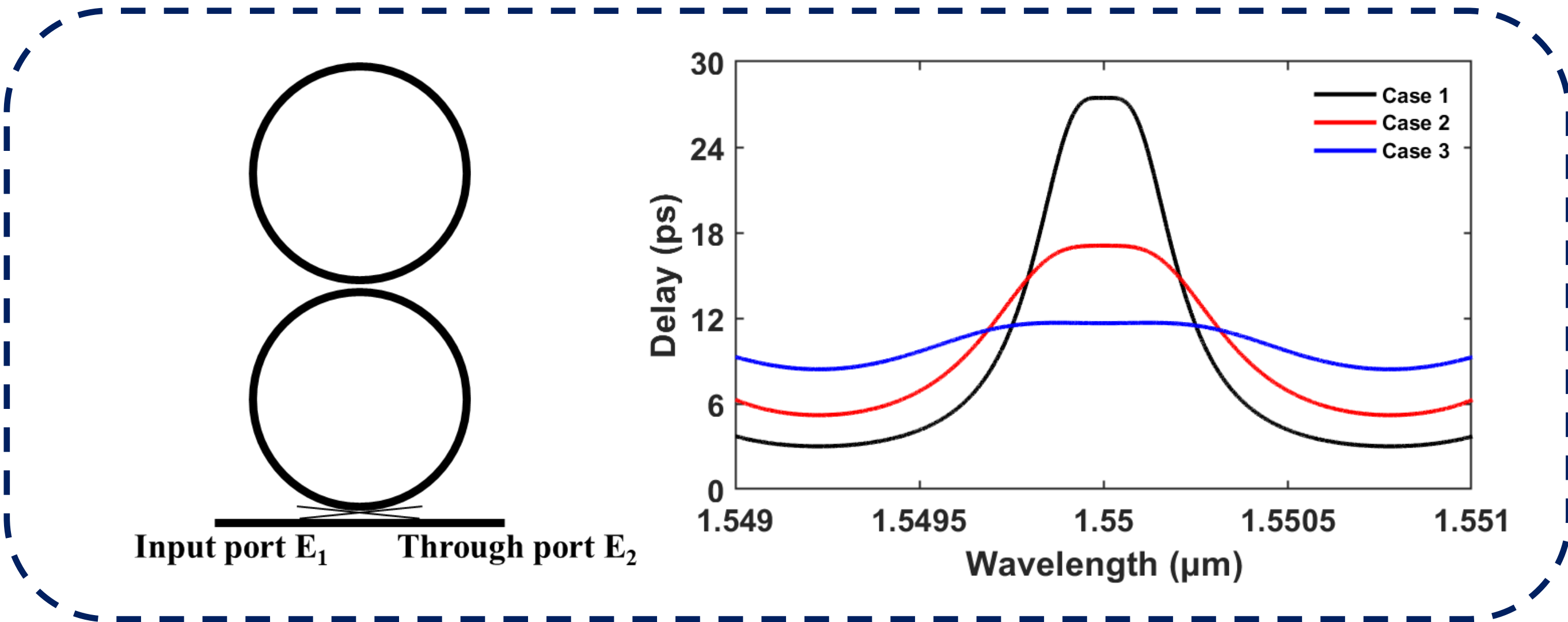
Schematic of the transmission system based on our optical computing chip.



Schematic of “Clements” optical computing cells based on MZI, PS and micro-ring resonator (222 parameters). The intersections represent MZIs, yellow rectangles represent PSs, and the red circles represent cascade double-ring resonators(CDRRs).

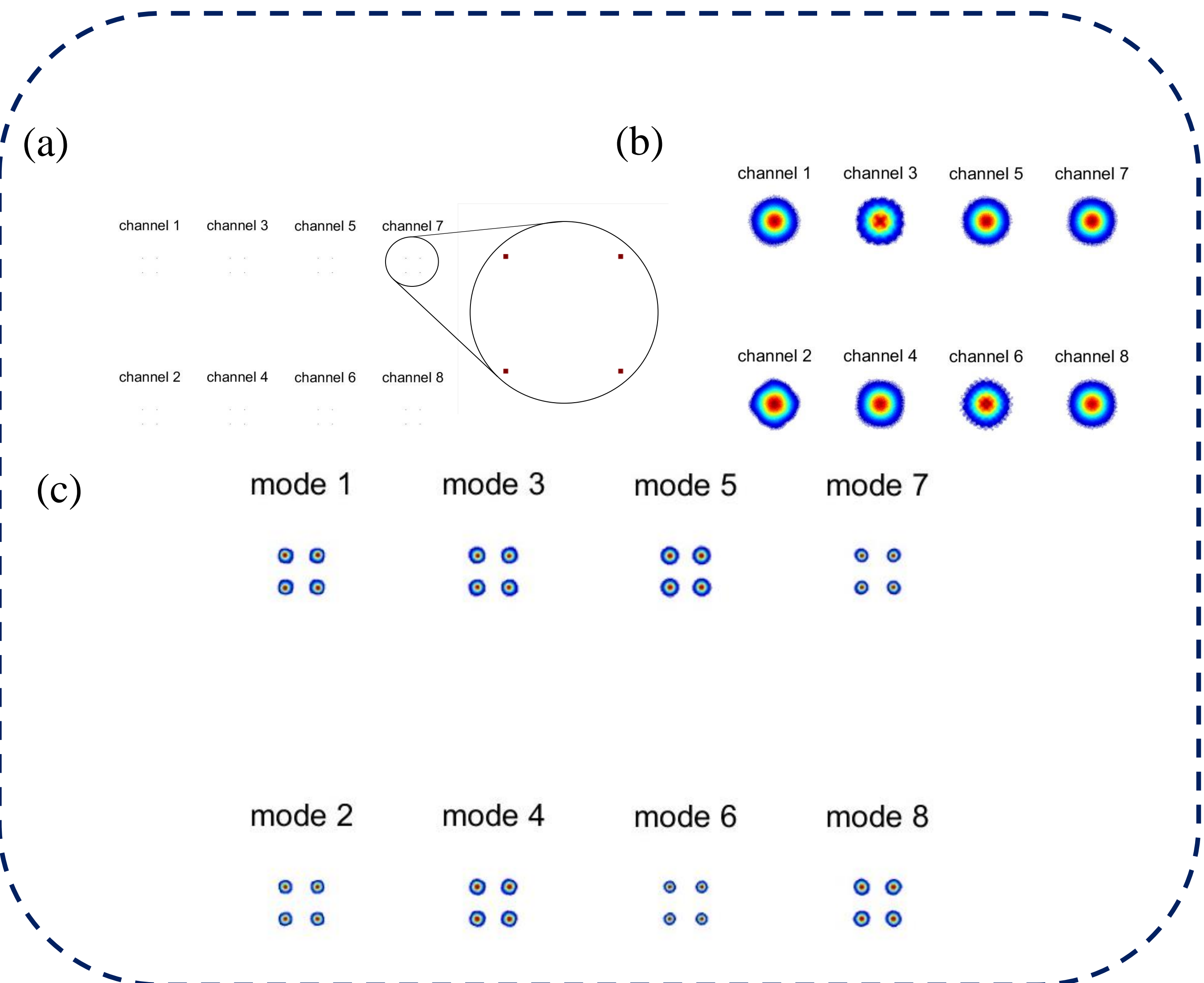
Results

- Optimization results of the maximum delay-bandwidth-product of a CDRRs



The 27 ps delay is obtained by CDRRs optimized with multi-population genetic algorithm.

- The results of channel equalization



Signal Constellation Diagram. (a) Input signal. (b) Crosstalk signal after 1000 km transmission. (c) The result of channel equalization by the “Clements” optical chip.

- Optimization method

NadamWs algorithm, which combines Gaussian Noise, NAG, conjugate gradient algorithm, and parallel computation to jump the local optimal solution and accelerate the convergence, is an efficient algorithm based on Adam algorithm.

Conclusion

- A novel optical computing architectures, which are composed of MZI, phase shifter and micro-ring resonator, are proposed to deal with crosstalk signal with DMGD.
- We have simulated channel equalization with a 1000 km strongly-coupled multi-core optical fiber link with DMGD of 158 ps.