Comparison of semiconducting and superconducting hardware for optoelectronic neuromorphic systems

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Abstract

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Differences between neural and digital optical communi-

- neural: mux/demux not required
- neural: high power optical signals not necessary (nor tolerable)
- neural: not point to point, one to many
- neural: asynchronous, no clock, no phase-locked loop, no clock recovery on receive
- neural: 1s and 0s not equally common; signals are sparse
- neural: TIA + limiting amplifier + decision circuit likely uses too much power
- neural: noise is more tolerable, decision circuit still potentially useful
- neural: speed can be much lower, as demonstrated by biology
- neural: with lower light levels, light-source driver circuits don't need to deliver as much current
- multi-chip partitioning required for digital due to high speed and sensitivity to timing jitter, multi-chip not tolerable for neural (cannot have multiple chips for each neuron) Tx and Rx amplifiers cannot remain in isolation ([1] pg. 5)
- neural: bits are not sampled on a clock

other notes:

- in conventional optical communication systems, package parasitics limit speed. optoelectronic integration crucial for overcoming this limitation ([1] pg. 5)
- for long time constants, semiconductors can augment RC by op amp gain: $RC \to (1+A)RC$, where A is the op amp gain, which can be enormous, like 300,000. thus, essentially arbitrarily long time constants can be achieved. the price is power.
- regarding subthreshold oscillations, RLC behavior in semiconductors can be achieved with op amps. in this case, there is no inductor, and that role is played by the active op amp. the price is power

14 Acknowledgements

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A Appendix One

Appendix One

References

[1] B. Razavi. *Design of Integrated Circuits for Optical Communications*. Wiley, second edition, 2012.