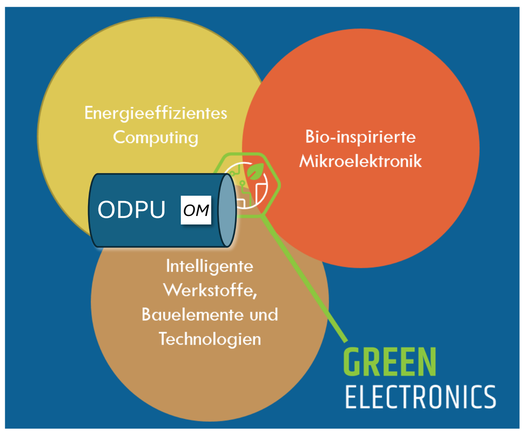
Optical Computing in Data Processing Applications



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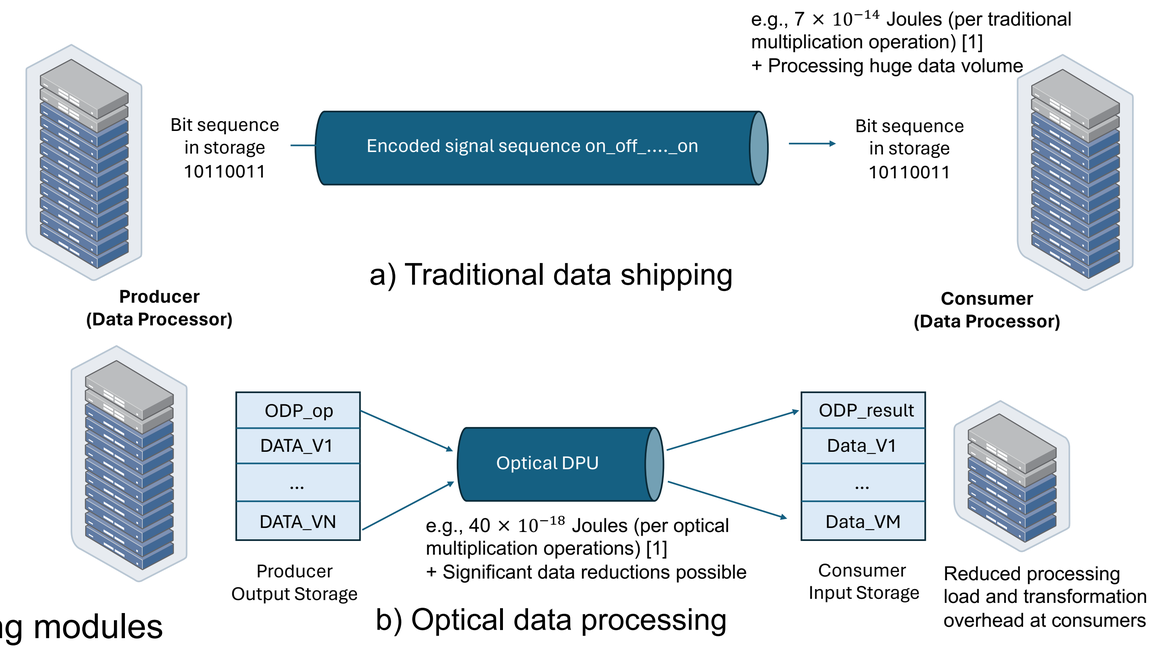
Motivation / Relevance for ISGE

Motivation

- Nowadays substantial amount of energy is spent on *Data Processing*
- Data movements is a significant cost factor for energy due to
  - Separation of data movement and processing
  - Overhead in digital / analog transformations
- **Optical processing: huge potential to collocating computation and transfer for higher energy efficiency!**
- ***Passive optical modules (OM)* enable analog optical data processing for data correlation and analytics**
- Requires appropriate computational/programming models



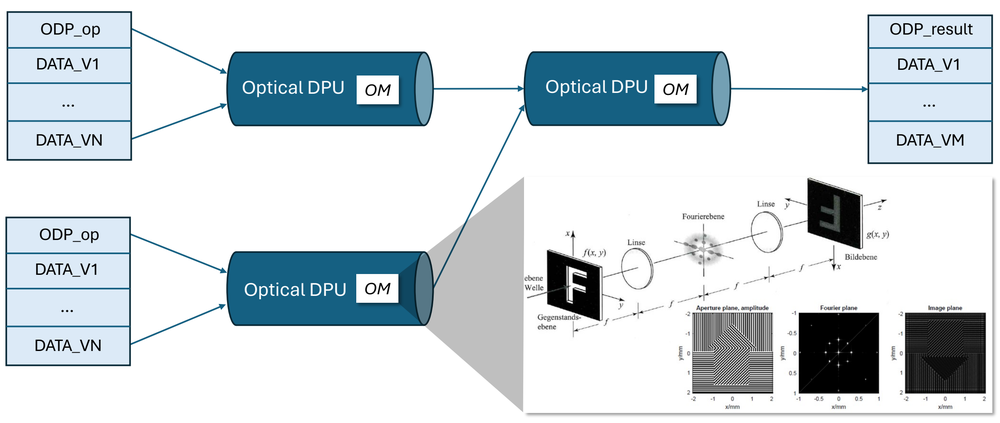
Research Goal

- Research methods for building and composing analog optical data processing modules to enable energy-efficient data processing pipelines

Approach and Research Questions

Approach

- Benefit from processing capability of optical communication channels
- Research methods for interconnecting *Optical DPU* to support data processing pipelines



Envisioned Data Processing Pipeline

Research Questions

- Computational expressiveness:
  - Suitable data processing operations?
- Integration:
  - How fabricating and integrating passive optical modules (OM)?
  - Implication to computing architectures, such as processing pipelines, in-memory computing architectures
  - Technological building blocks, connectors, networks, etc.?
- Programming model:
  - Efficient support for data processing paradigms, e.g., with stream processing or map reduce?
- Energy efficiency:
  - Gain in terms of energy efficiency?
  - What is the influence of properties of specific data processing applications?

Work Program

WP1 Physical Foundations of ODP:

- Assessment of the physical scope
- Integrated ODP modules with transmission capabilities
- Integration possibilities into data processing pipelines

WP2 ODP Computing Model:

- Performance model of ODP modules
- Optimized numerical interfaces
- Prototyping of limited functionality for experimental demonstration

WP3 Adoption to Stream Processing Systems:

- Data analytics use case for modeling concrete operators for data processing
- Used to evaluate and enhance the expressiveness of ODP computing model and corresponding mechanisms.

WP4 Evaluation

- Basic energy model based on physical measurements
- MATLAB model for complex ODP
- Analysis with workloads in the domain of stream processing systems

References / Work of the research teams

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Work Plan / Funding

Applied Funding

- One doctoral researcher (4 years)
- 5000€ / Annum travel and publication costs

	24		25				26				27				28	
Work Package **Quartal**	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
WP1: Physical Foundations of ODP	■	■	■	■	■	■	■	■								
WP2: ODP Computing Model			■	■	■	■	■	■	■	■	■	■				
WP3: Adoption to Stream Processing Systems					■	■	■	■	■	■	■	■	■	■		
WP4: Evaluation									■	■	■	■	■	■	■	■