Data-Processing: Pooling Information Theory and Signal Processing into Networks

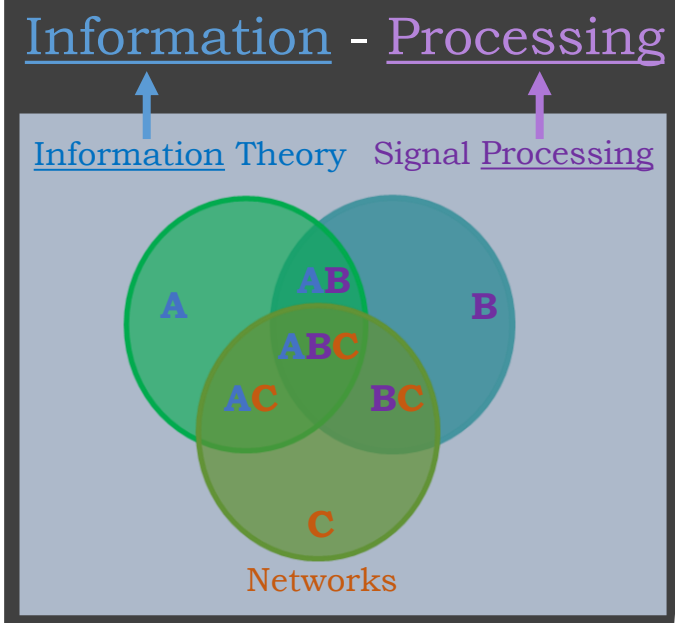
Alejandro Cohen

From theory to practice and back using information theory and signal processing

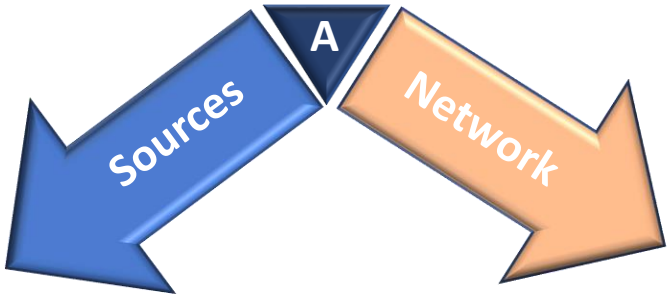
TECHNION
Israel Institute of Technology

Contents

Information - Processing



Why do we need Information-Processing?



Large volume of analog and digital data

Fast time-varying structure and link conditions

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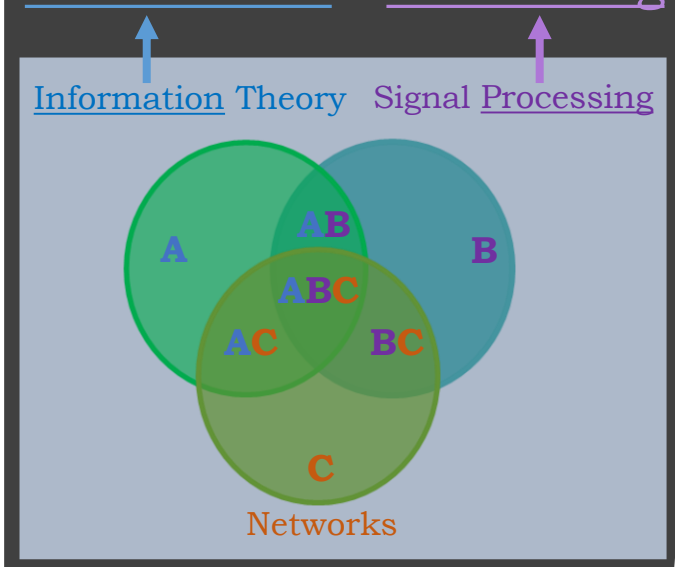

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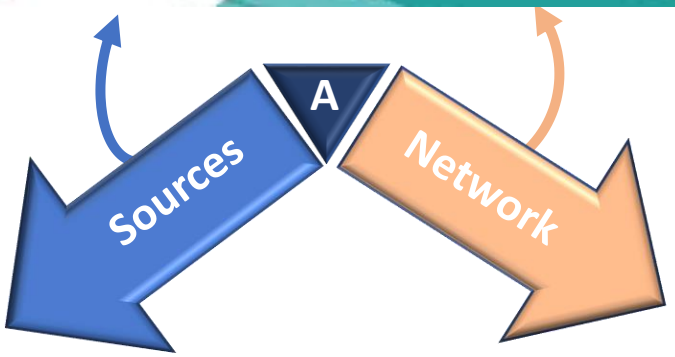


Large volume of analog and digital data

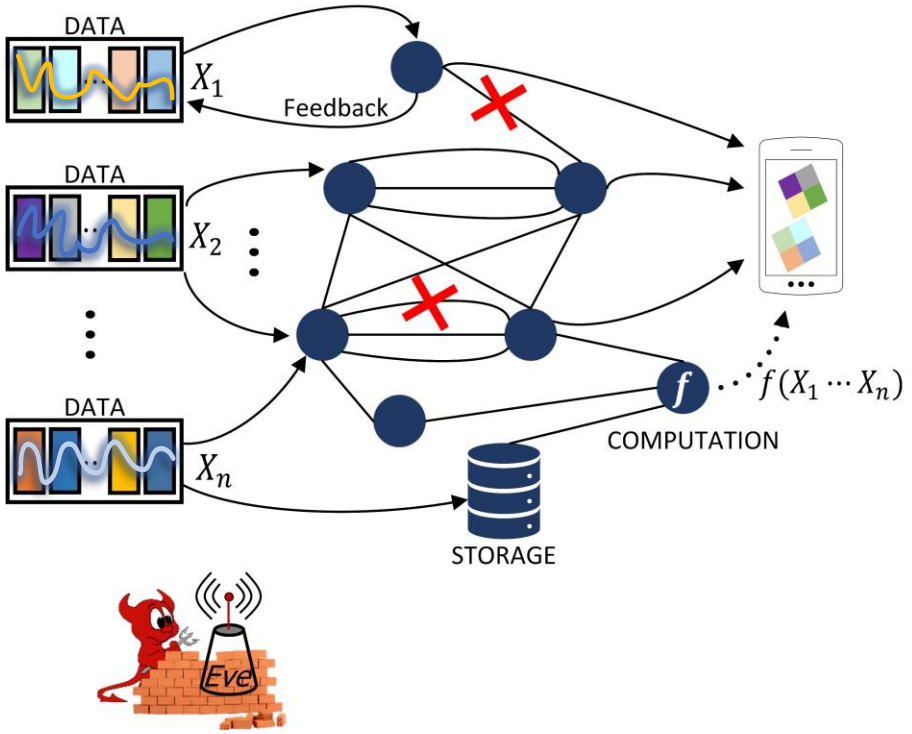
Fast time-varying structure and link conditions

Large volume of data challenges

Sources

Network

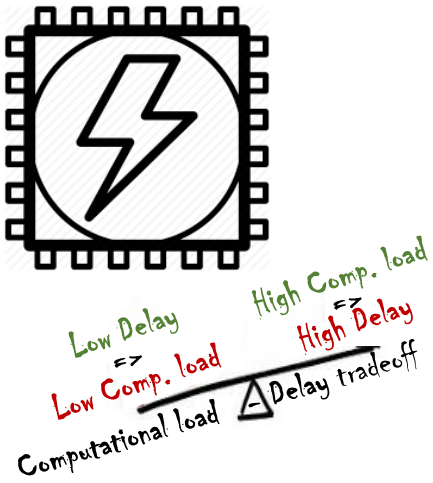
- Data across different locations
- Real-time delivery
- Computation and tasks
- Security

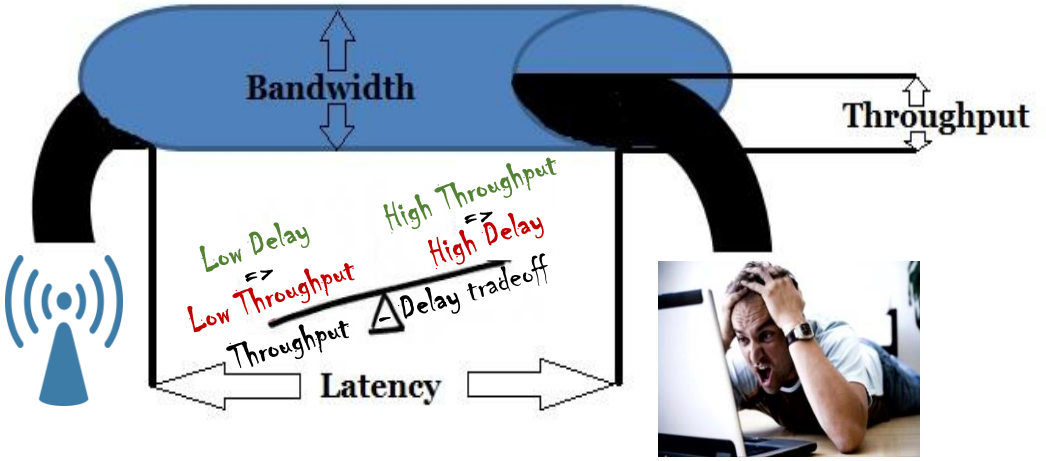


Data-Rate/Computation and In-order Delay challenges

Sources

Network





Considering new applications, it becomes challenging to close/bridge the trade-off between data-rate/computation and in-order delivery delay!

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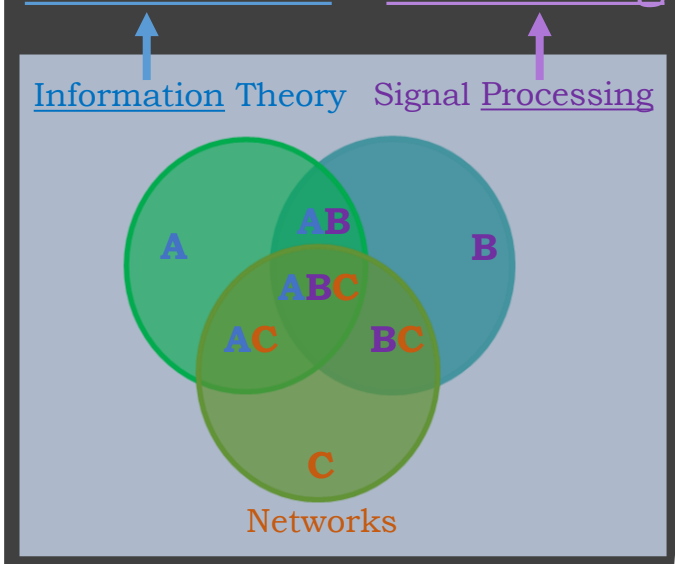

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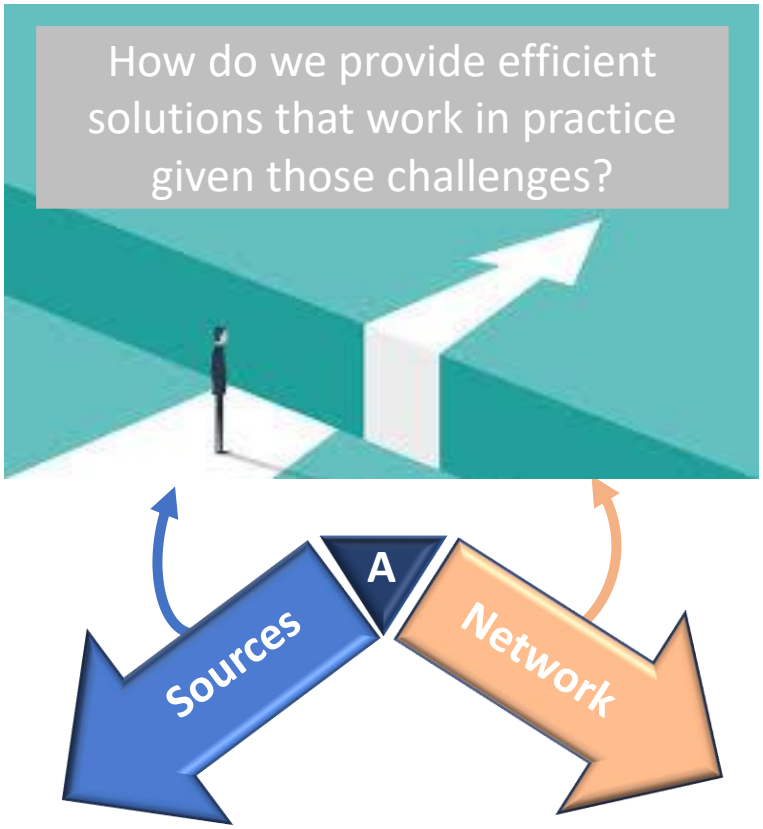

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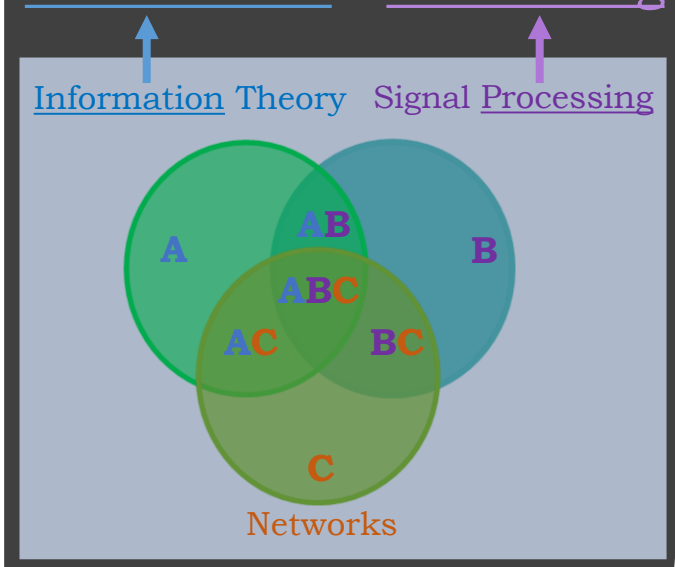
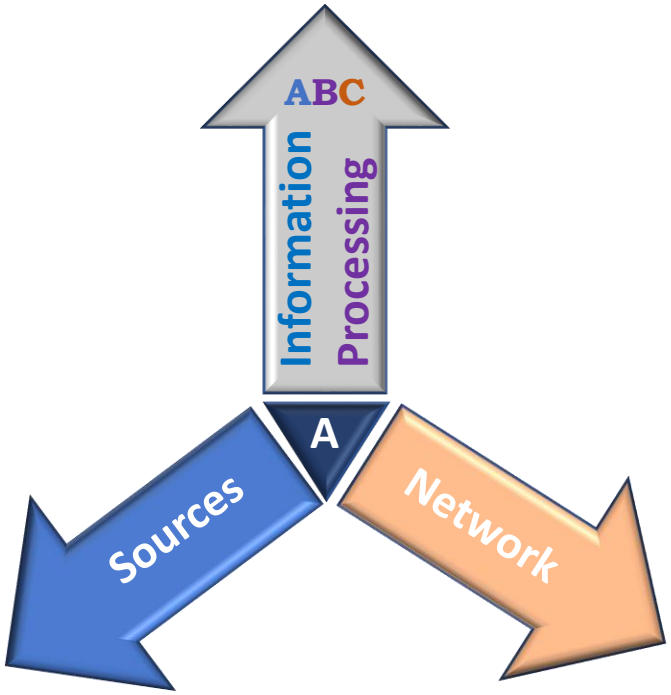


Why do we need Information-Processing?

Joint efficient solutions which consider the available resources and the specific application



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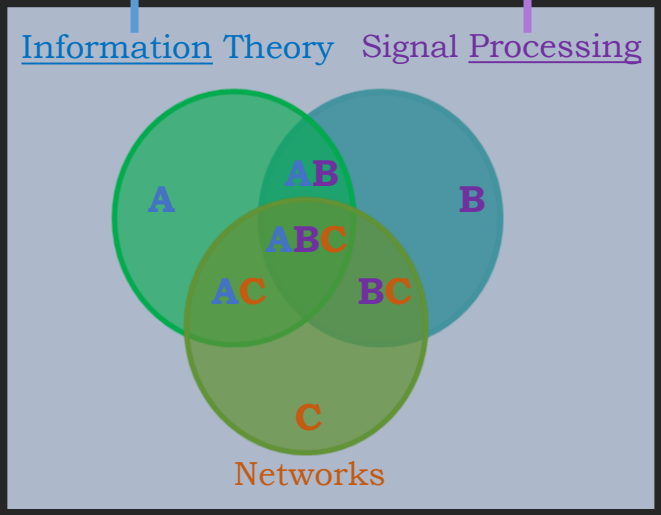
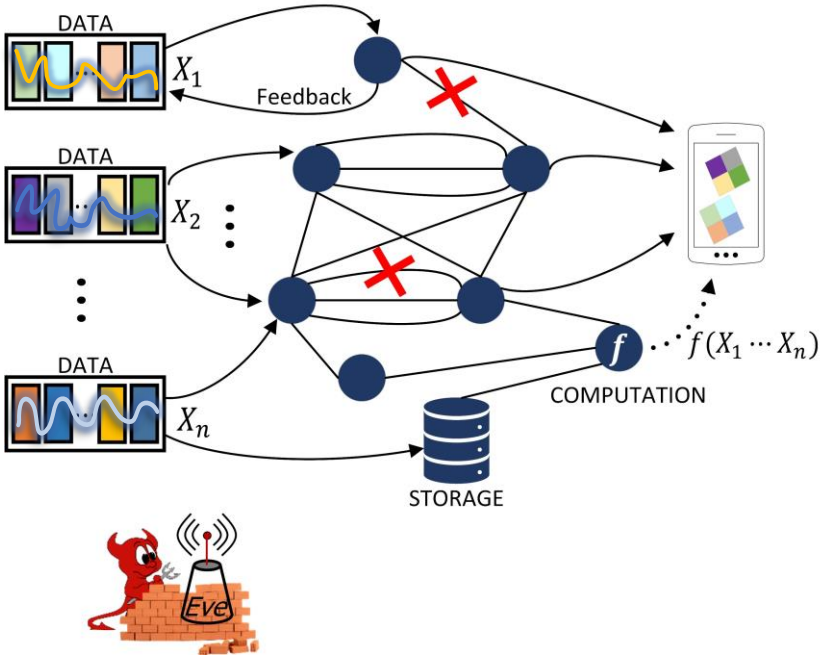
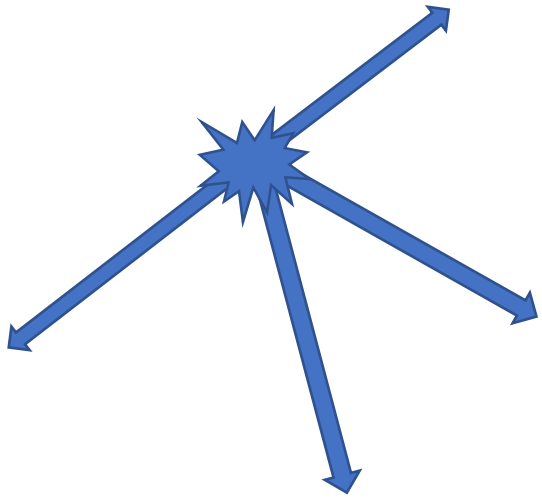


Reliable Data Acquisition



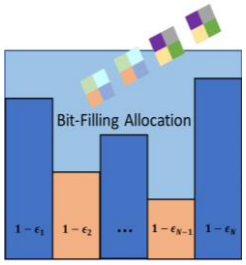
Data Acquisition for Tasks

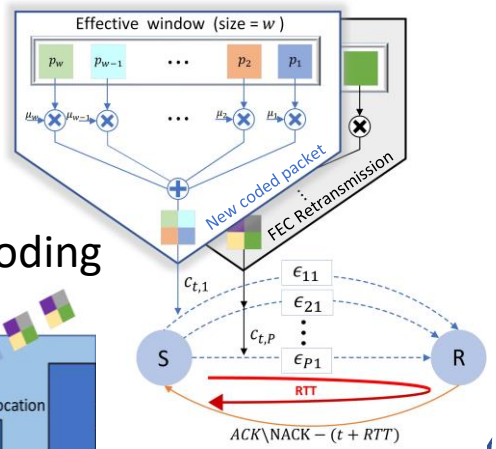
Reliable Data Acquisition

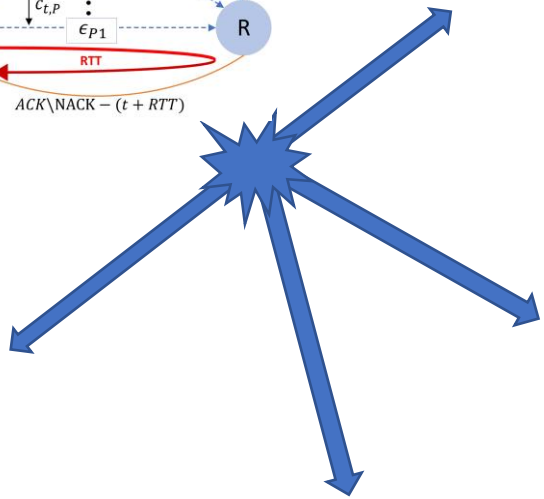


Reliable Data Acquisition

Adaptive Causal Network Coding







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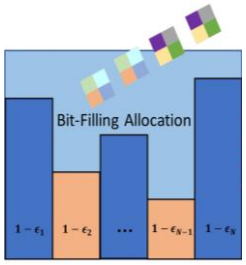
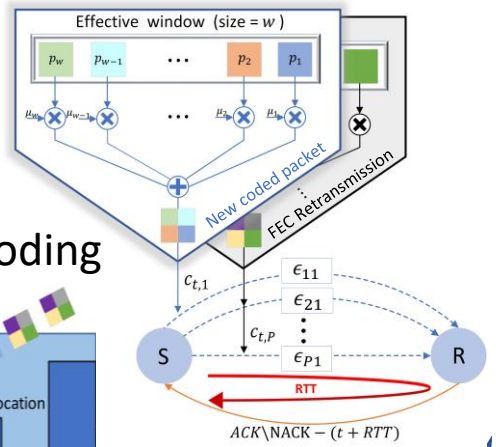
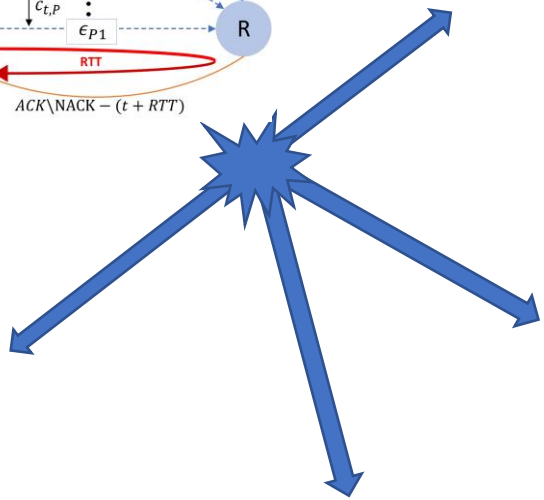
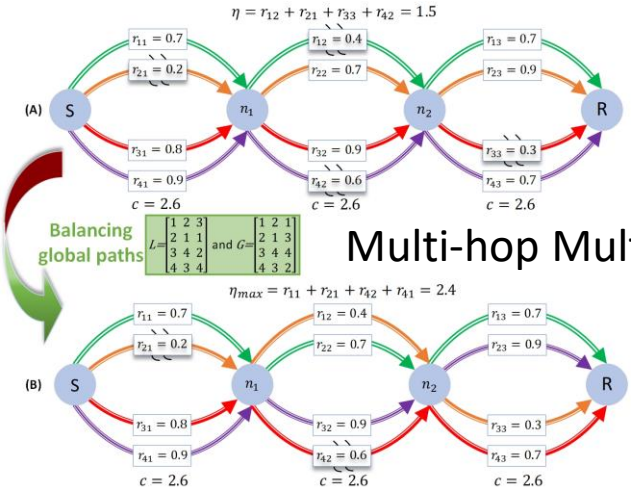




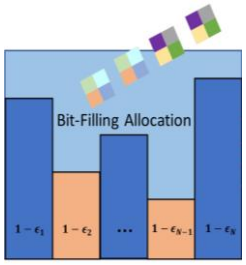


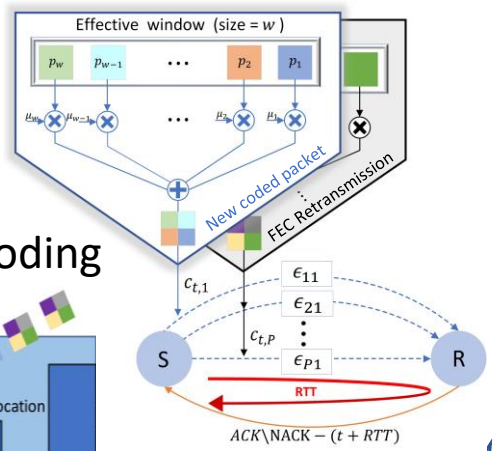


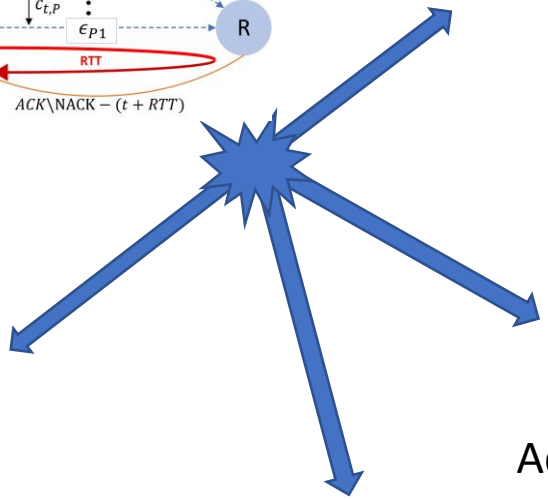
Multi-hop Multipath

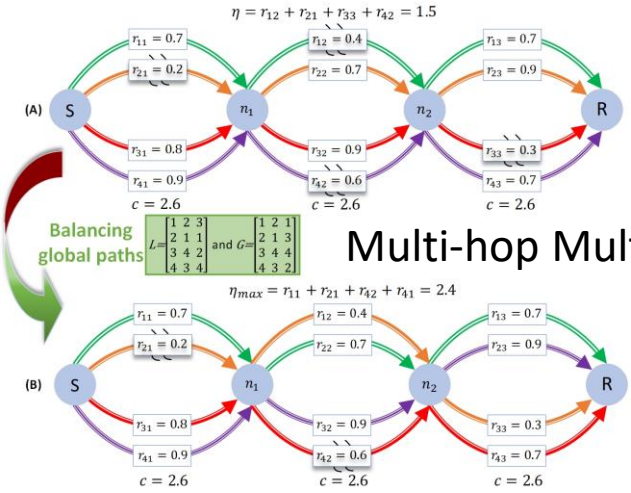
Reliable Data Acquisition

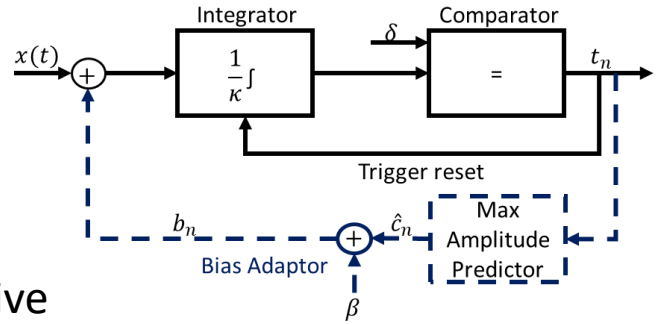
Adaptive Causal
Network Coding







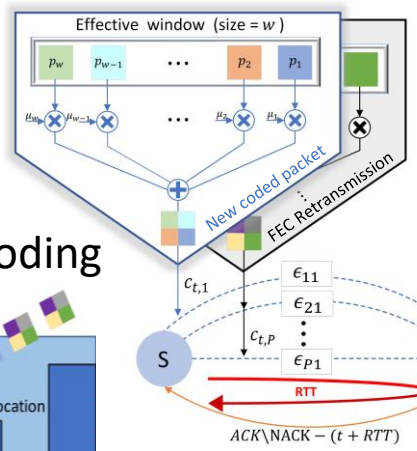


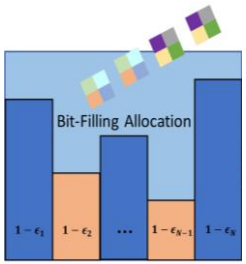


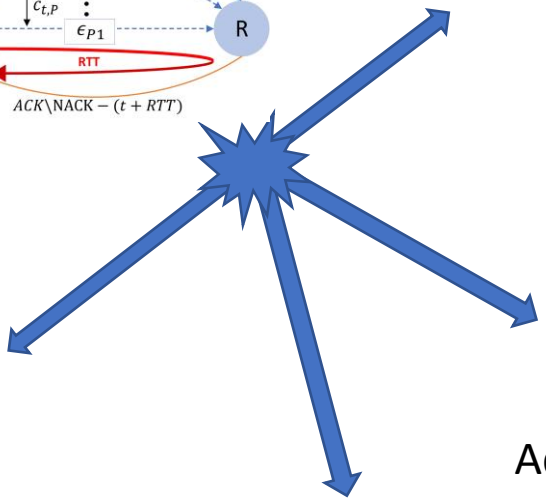
Adaptive
Time Encoding Machine Sampler

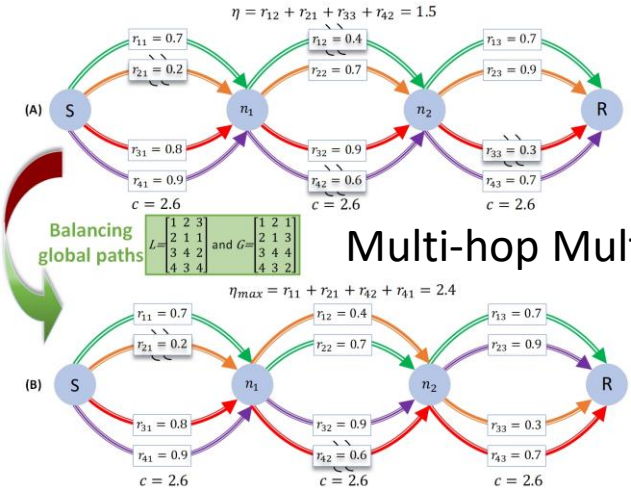
Reliable Data Acquisition

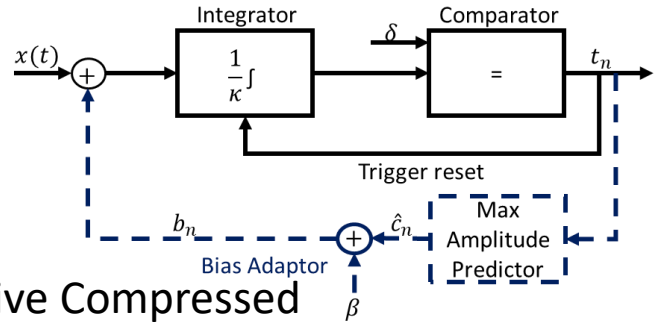
Adaptive Causal Network Coding



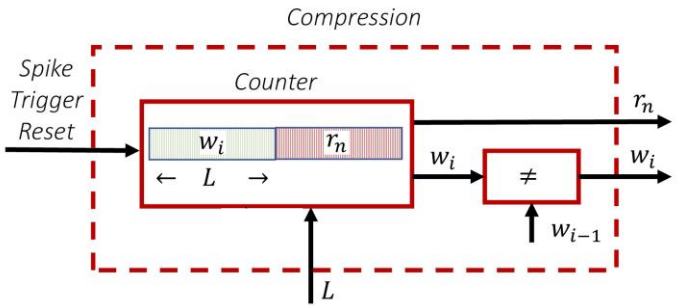








Adaptive Compressed Time Encoding Machine Sampler



Reliable Data Acquisition

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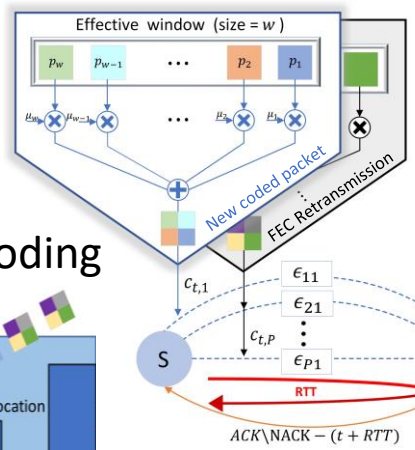
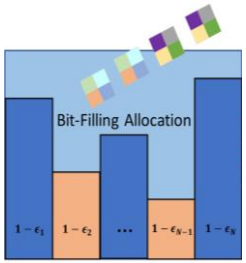
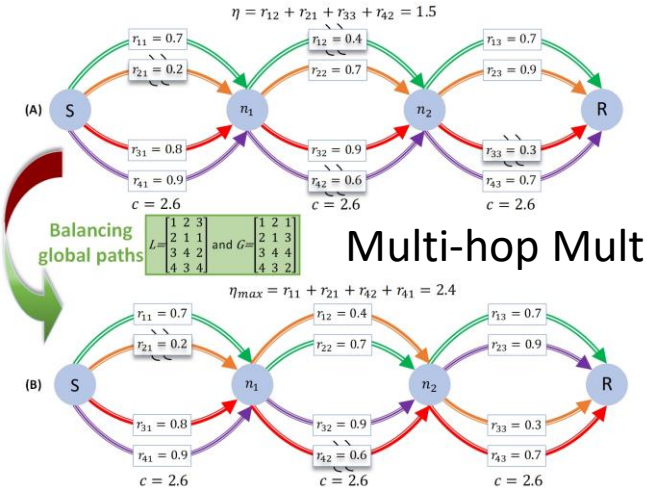
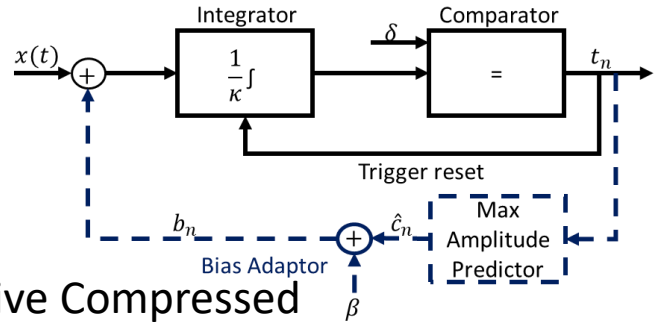
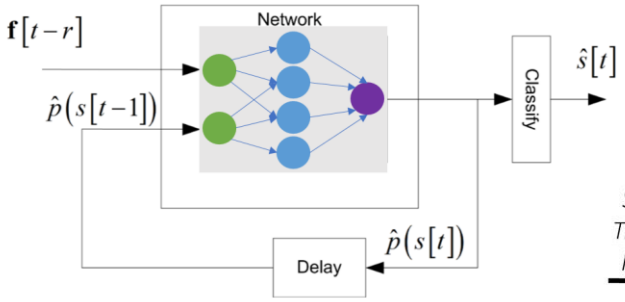








DeepNP - Noise Prediction



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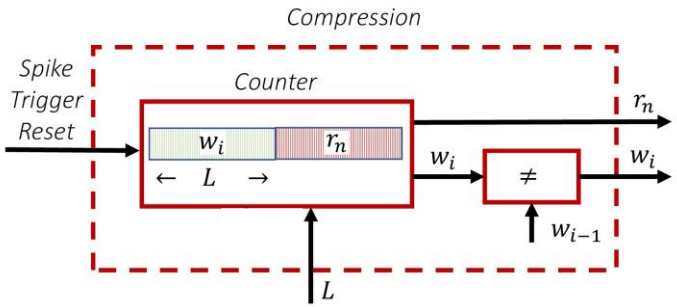

Data Acquisition for Tasks

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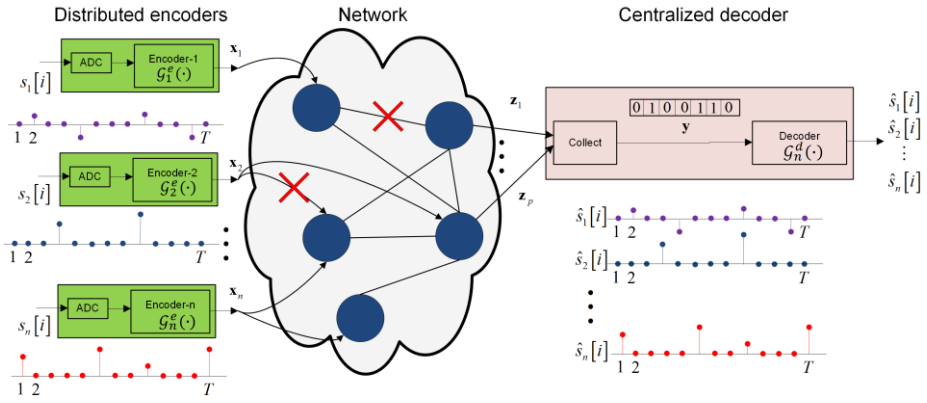
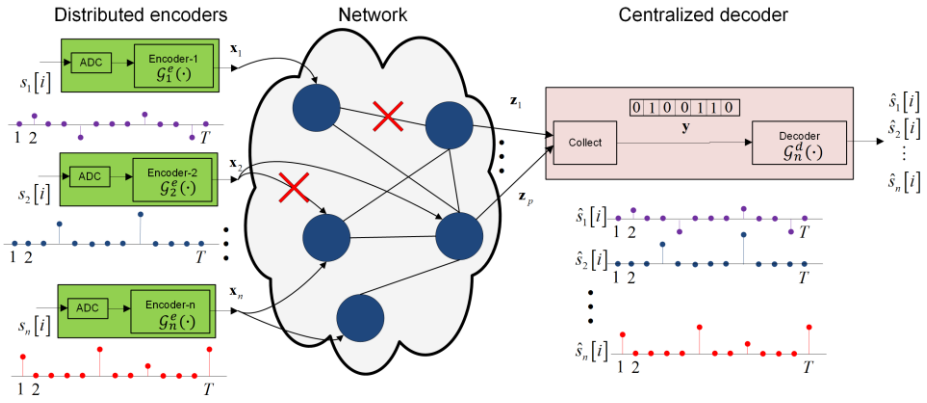


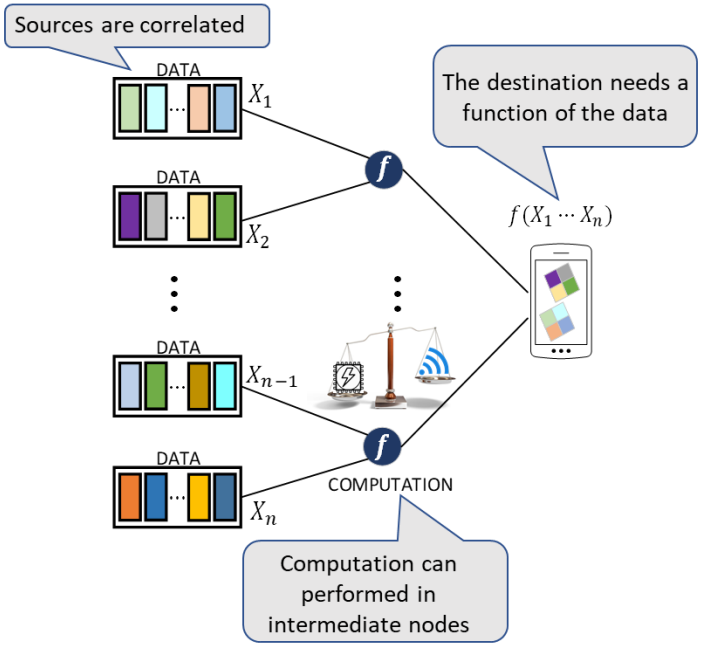
Serial Quantization for
Representing Sparse Signals

Data Acquisition for Tasks



Serial Quantization for Representing Sparse Signals

How to Distribute Computation in Networks



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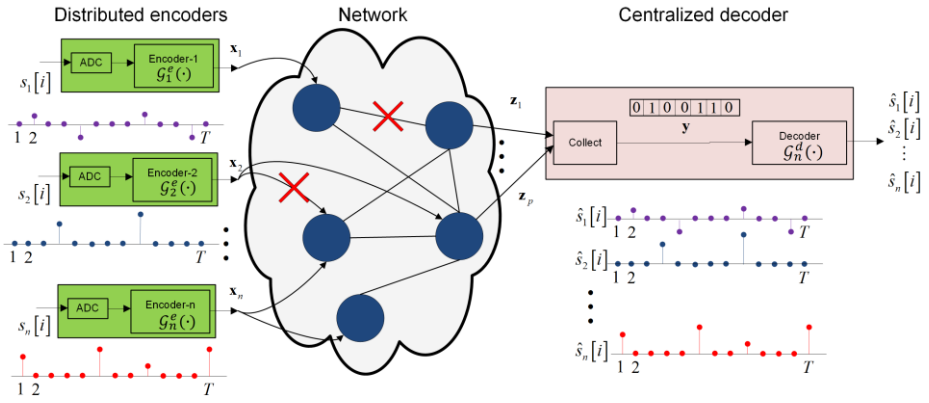

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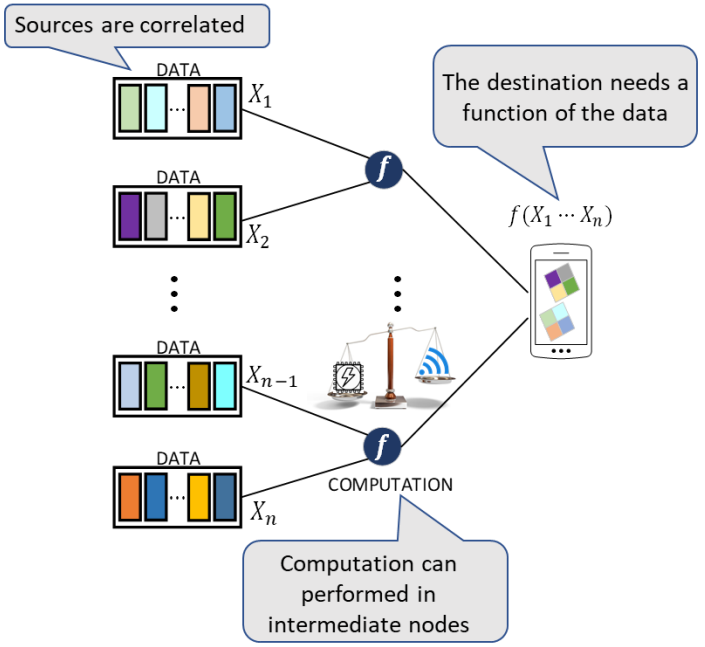
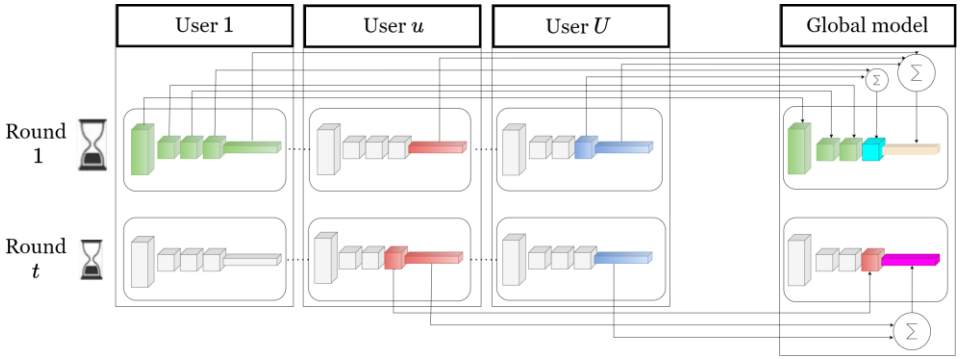


Stragglers-Aware Low-Latency Synchronous Federated Learning



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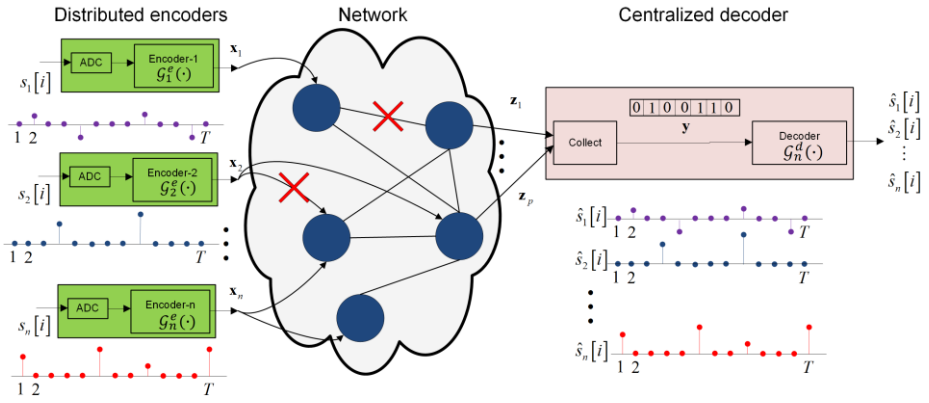

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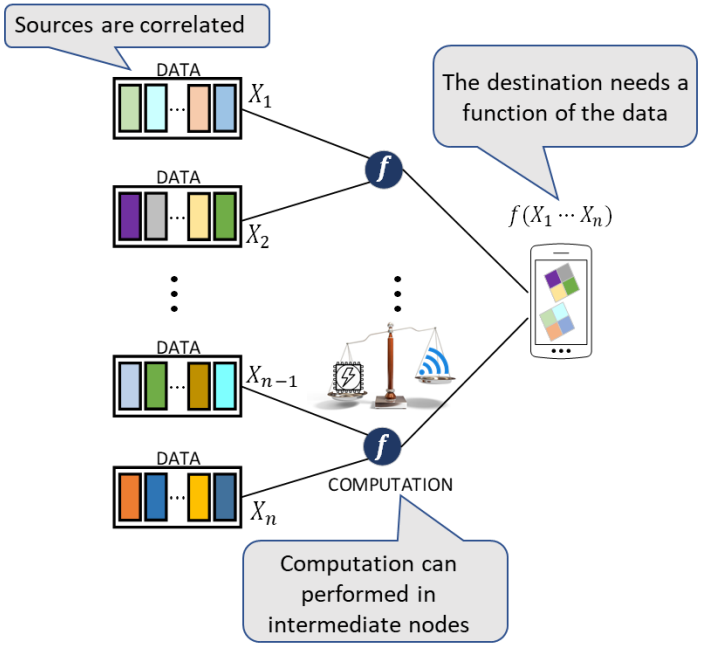
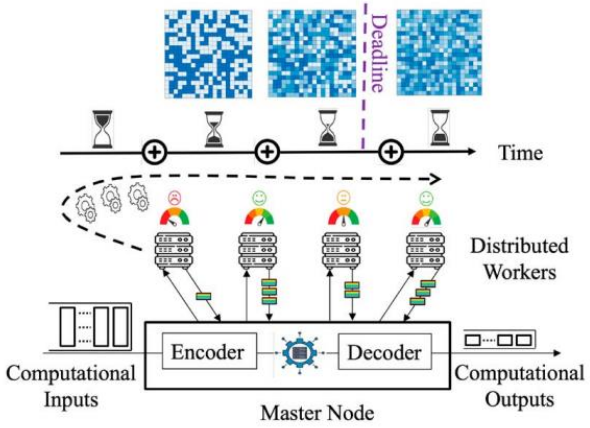
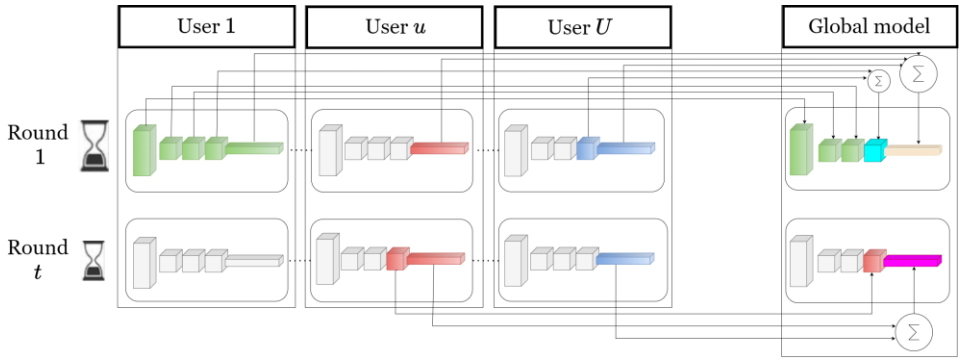


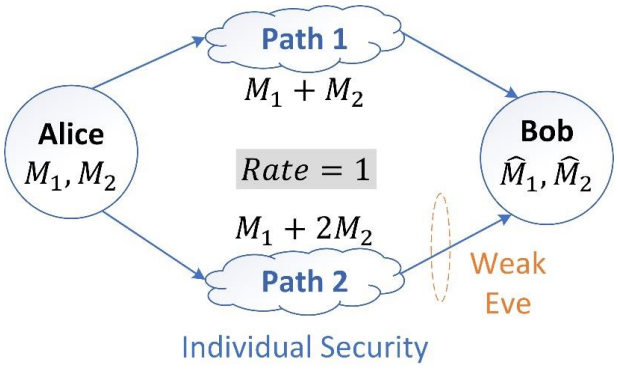


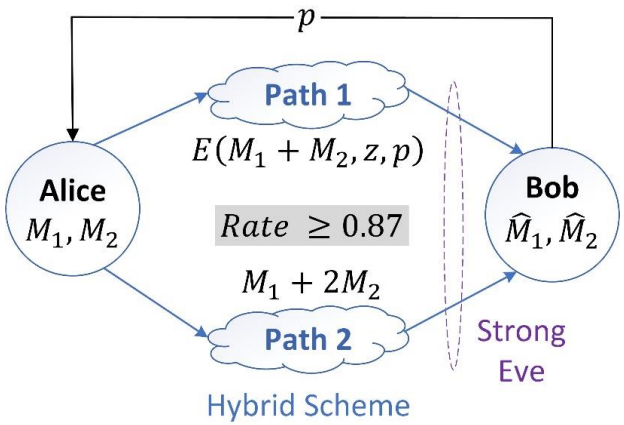
Stream Iterative Distributed Coded Computing for Learning Applications

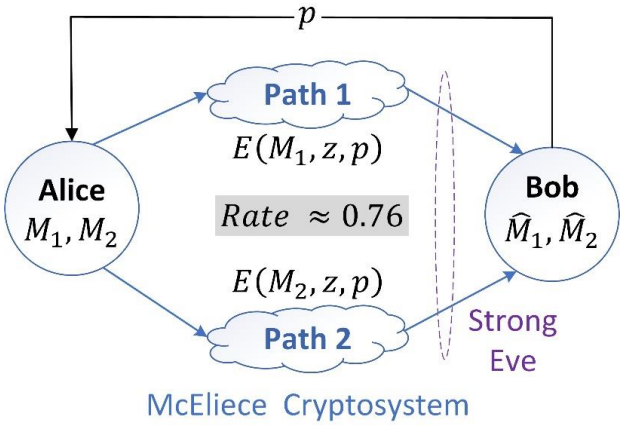
Stragglers-Aware Low-Latency Synchronous Federated Learning



Post-Quantum Security





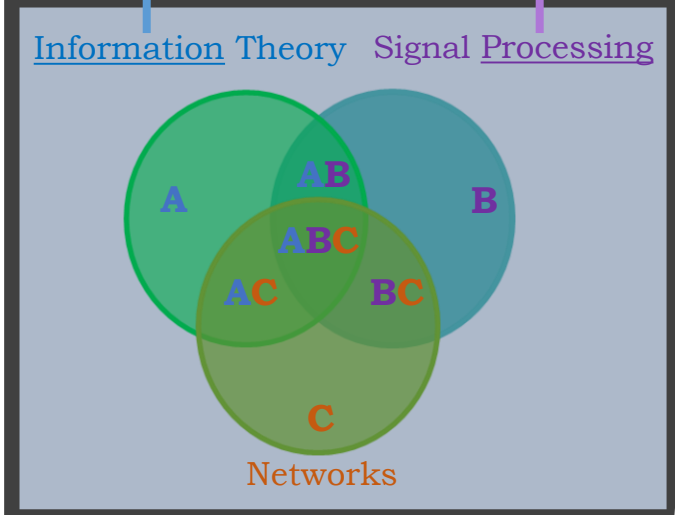


	Ind. Sec. Code	HUNCC	McEliece Cryp.
Encrypted paths	0	c	l
Information rate	$R_{IS} = 1$	$(cR_C + (l-c)R_{IS})/l$	$R_C < 1$
Public-key size	0	p_C	p_C
Ind. comp. secrecy	0	$\min\{c, 1\} \cdot b$	b
Ind. secrecy	$(l-w)/l$	$(l-w)/l$	0

* In the original McEliece Cryptosystem the rate $R_C \approx 0.5$

Questions?

Information - Processing



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Research directions:

- Design efficient data acquisition methods for tasks
- Characterize fundamental limits and provide practical reliable solutions for delay and data-rate/computation guarantee
- Provide security and privacy in advanced data acquisition systems
- Understanding the tradeoffs between computation and communication
- Limits of adaptive sampling and compression
- Novel approaches to extract data from noise

Why do we need Information-Processing?

https://sites.google.com/view/alejandrocohen/