High Speed and Low Cost One-to-Many VLC Using Polymer-Dispersed Liquid Crystals

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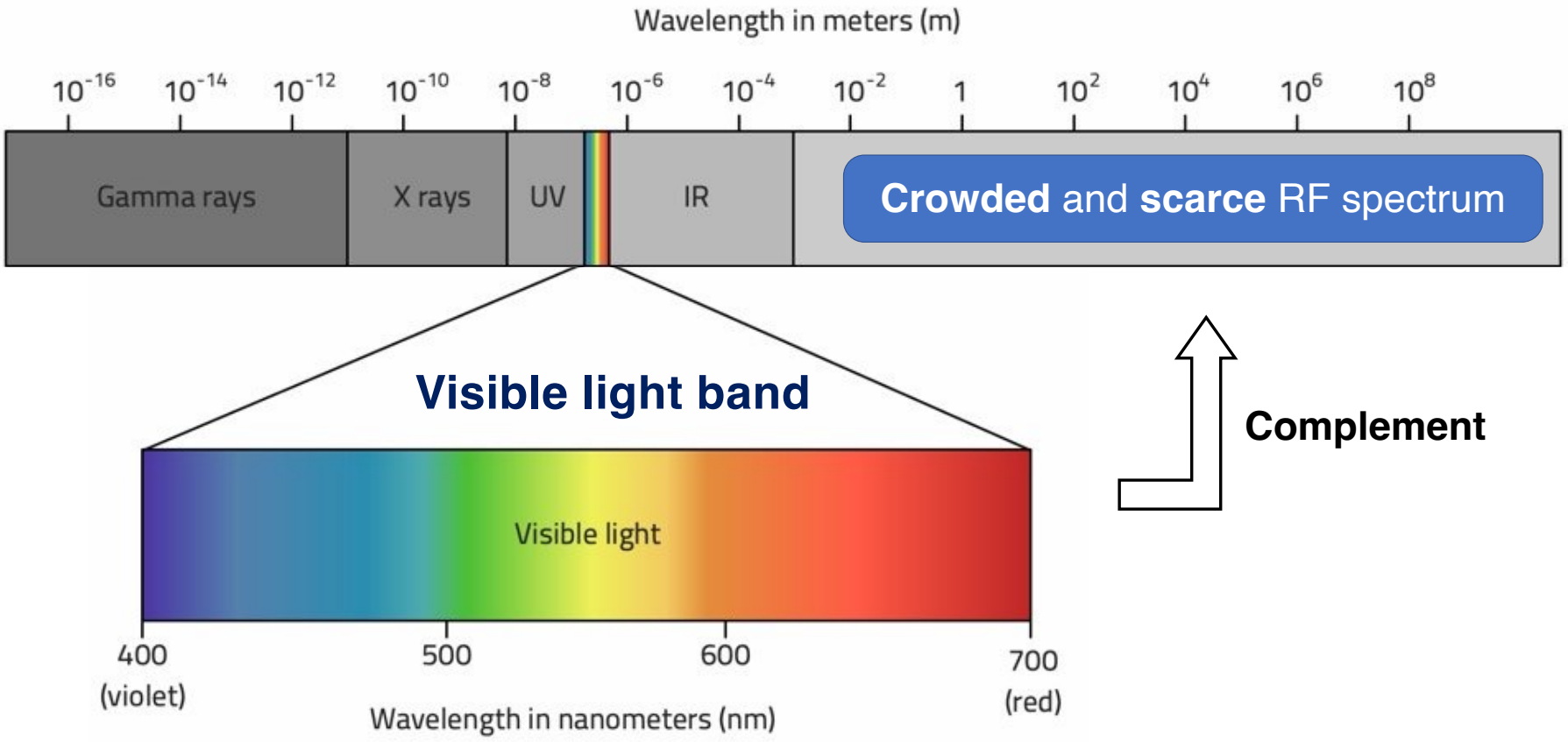
Outline

- **Background and Motivation**
- Compressive Sensing and Hierarchical Coding
- System Design
- Evaluation
- Conclusion

From Radio Frequency to Visible Light

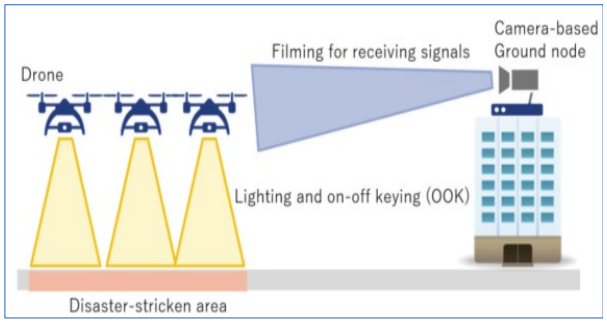


From Radio Frequency to Visible Light

VLC v.s RF

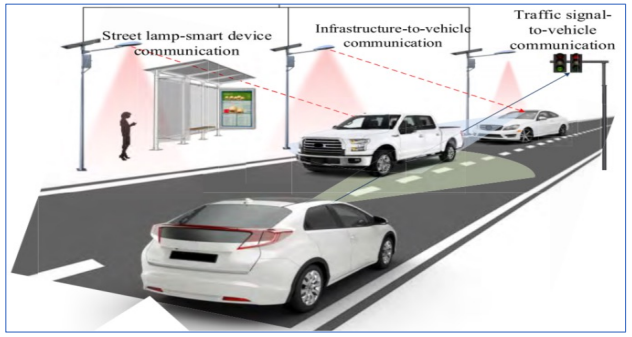
- Not regulated and license-free
- Extremely rich spectrum
- Widely-deployed infrastructure
- Energy efficient

Data Sharing



Drone Communication

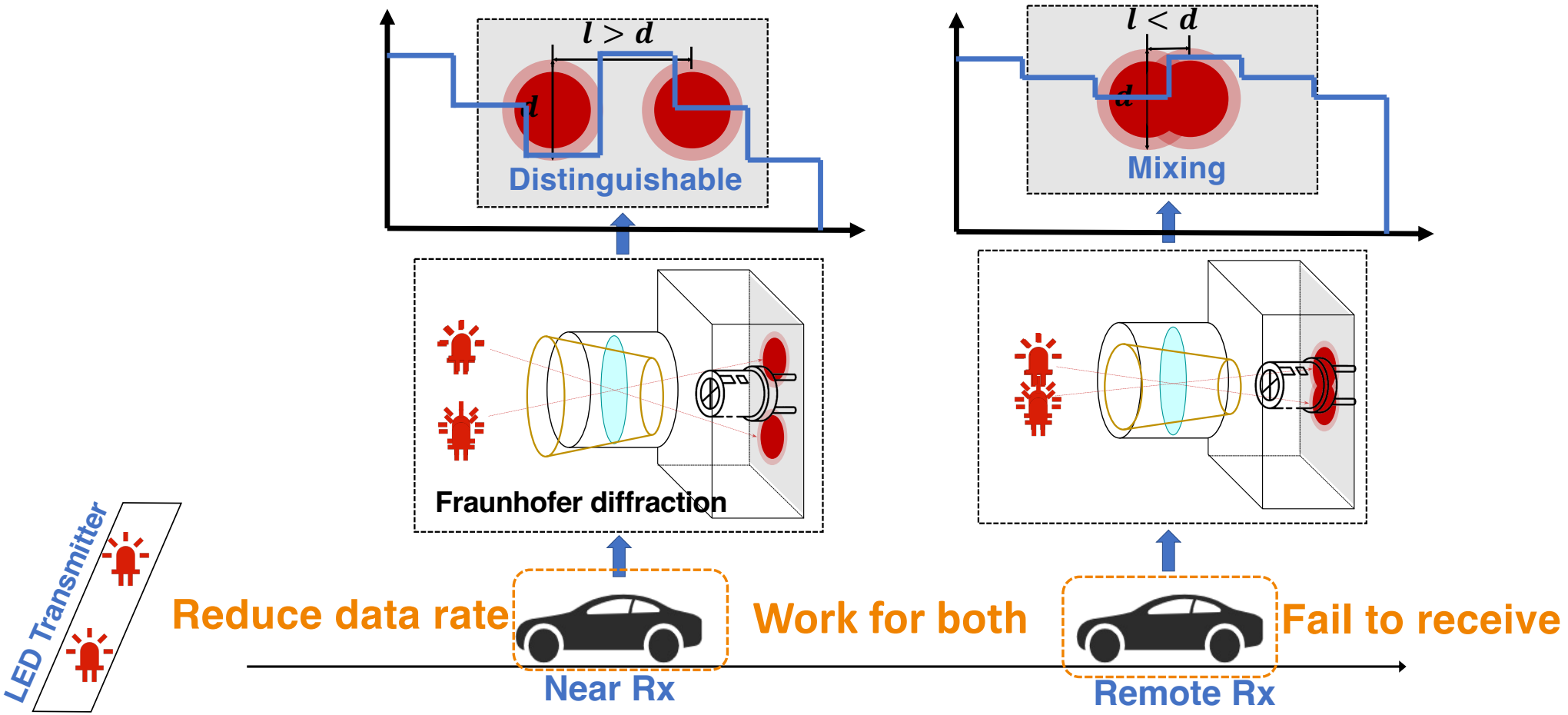
Indoor Positioning



V2X Communication

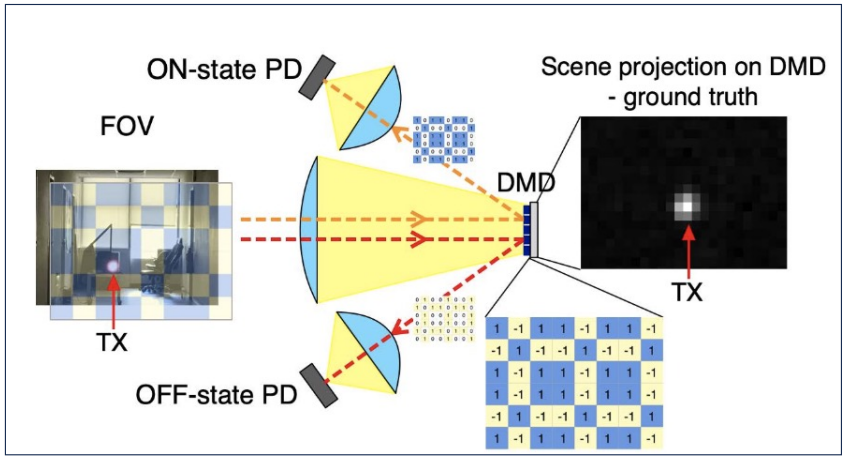
Limitation in One-to-Many Communication

➢**Distance** limits the performance in one-to-many communication.



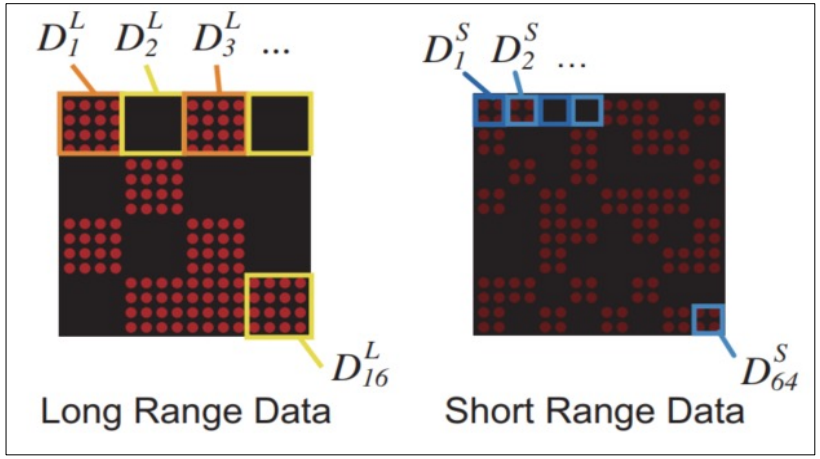
Motivation

- **RayTrack @ MobiSys'2021**
- Digital Micro-mirror Devices (DMD)
- ≈ 1500$, > 10kHz



High-speed but high-cost

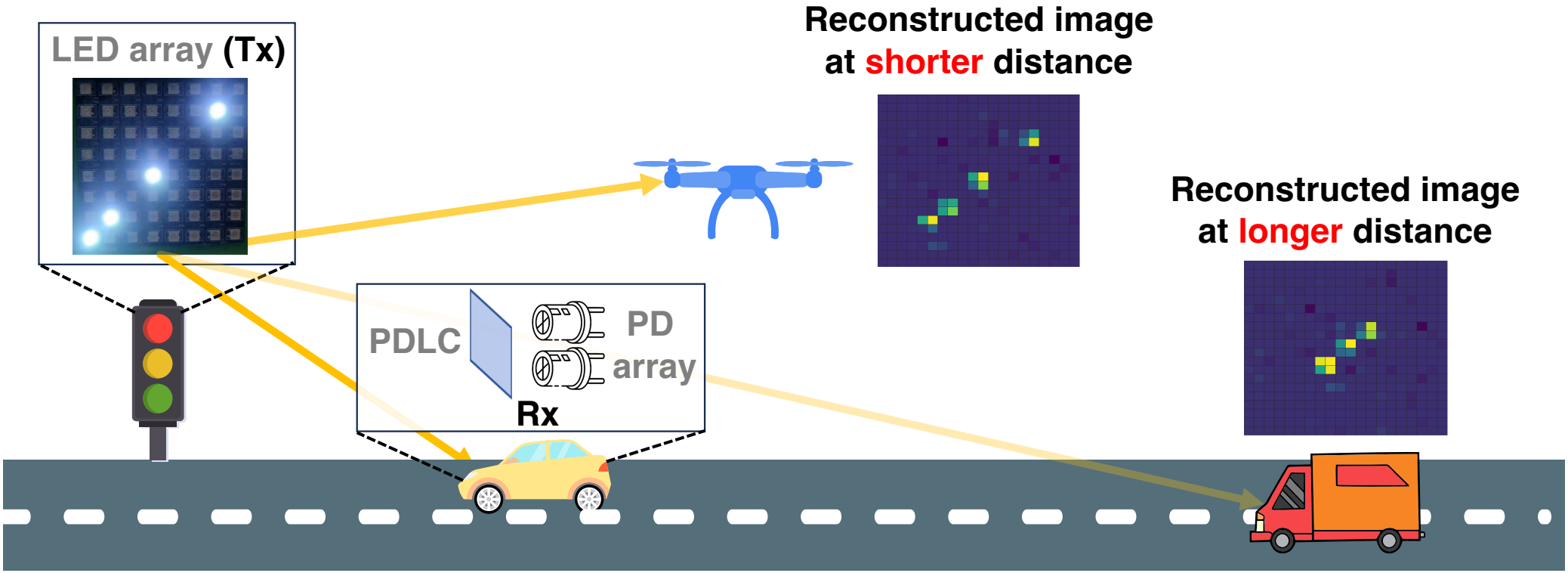
- **Overlay Coding @ IEEE ITSC'2011**
- Camera as receiver
- Block-based coding



Low-cost but low-speed

Our Proposal

- *Low-cost* **Polymer-Dispersed Liquid Crystals (PDLC)**
- *High-speed* **Compressive Sensing (CS)**



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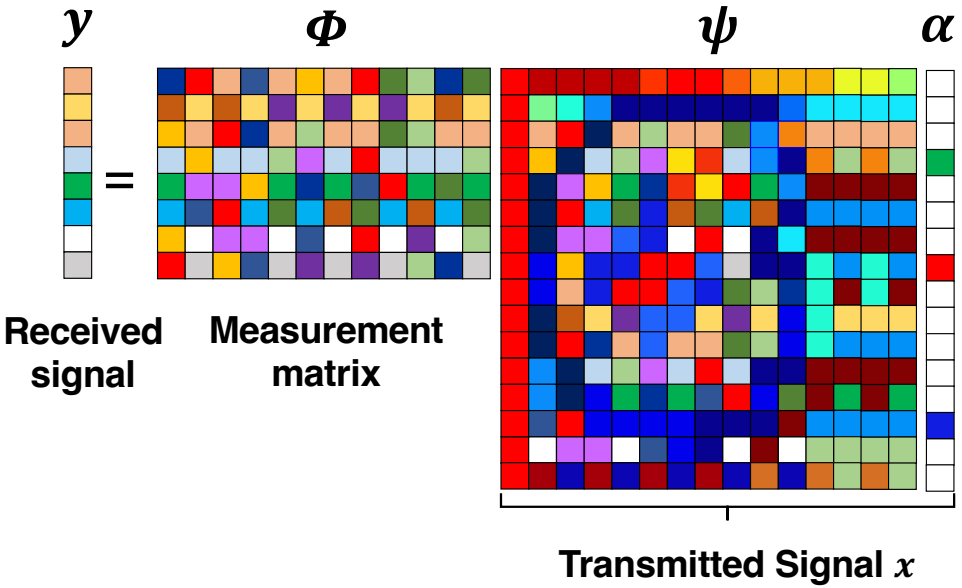
PDLC as the Measurement Matrix

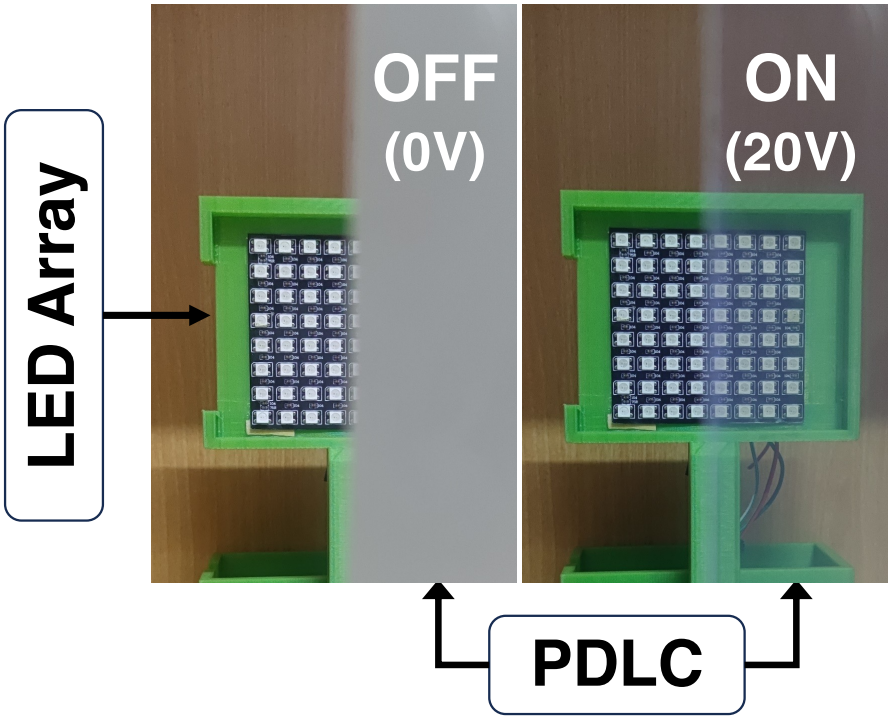
➢Compressive Sensing



$$y = \Phi x = \Phi\, \psi\alpha$$

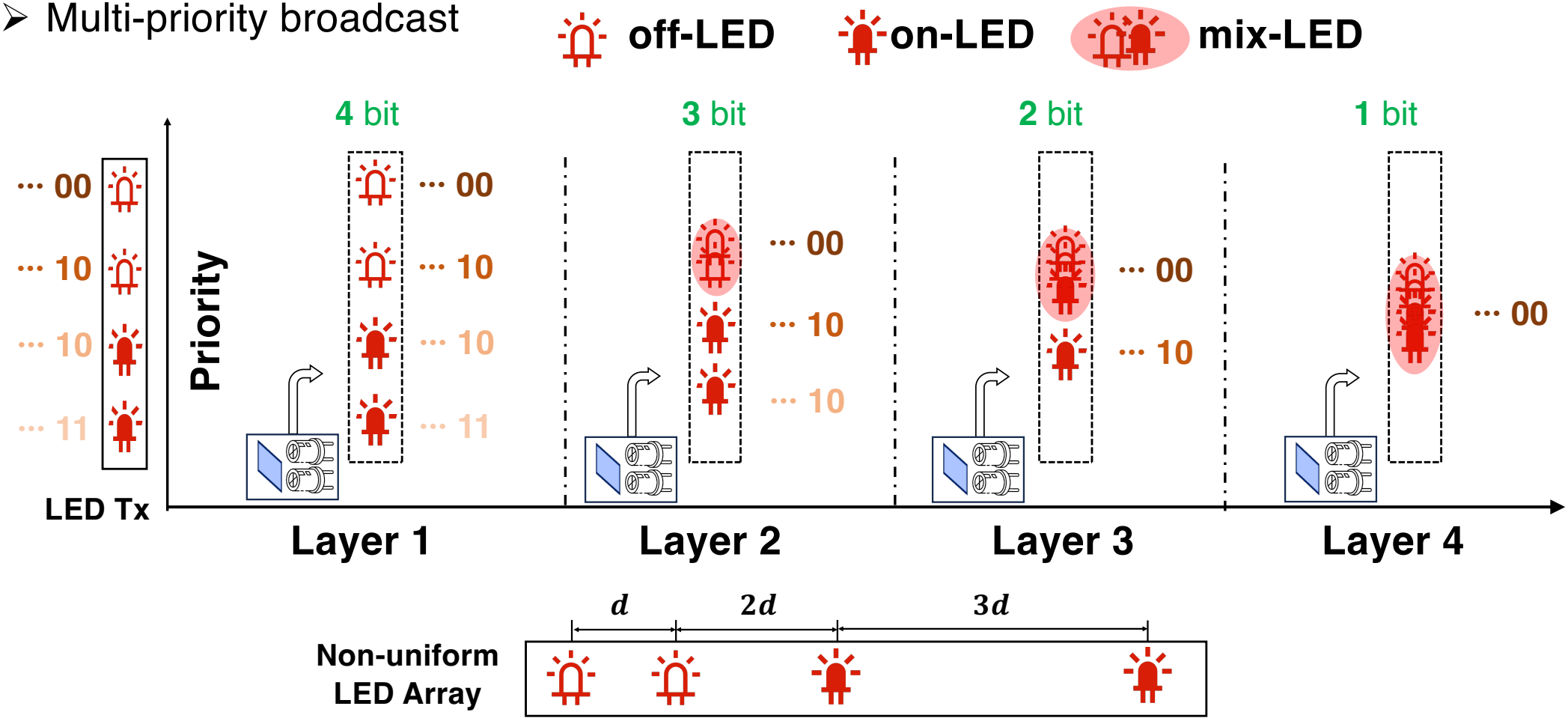
$$min||\alpha||_1 \;\; s.t. \;\; y = \Phi\psi\alpha$$

➢Polymer-Dispersed Liquid Crystals

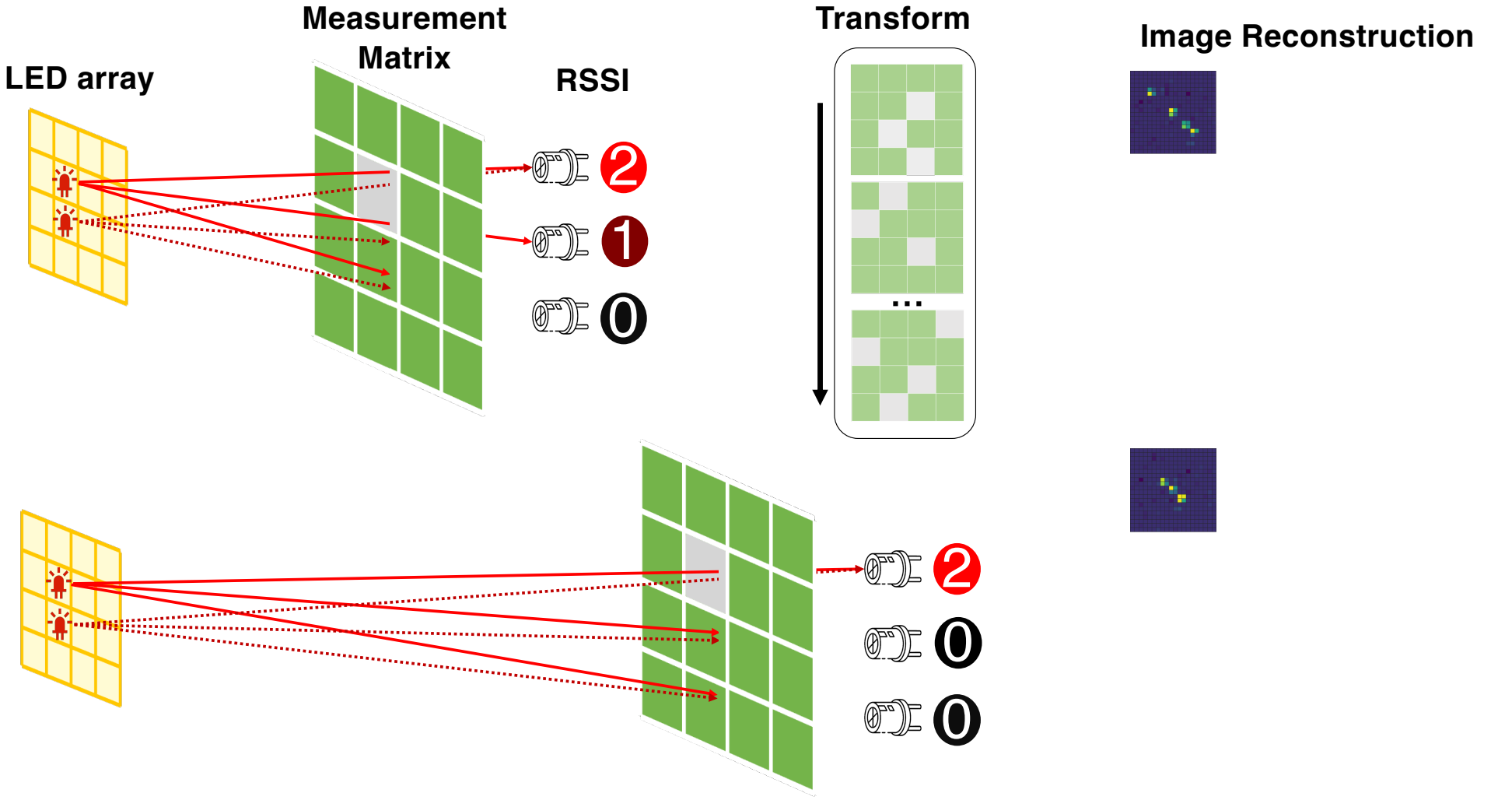


Hierarchical Coding

➢ Multi-priority broadcast



CS + Hierarchical Coding



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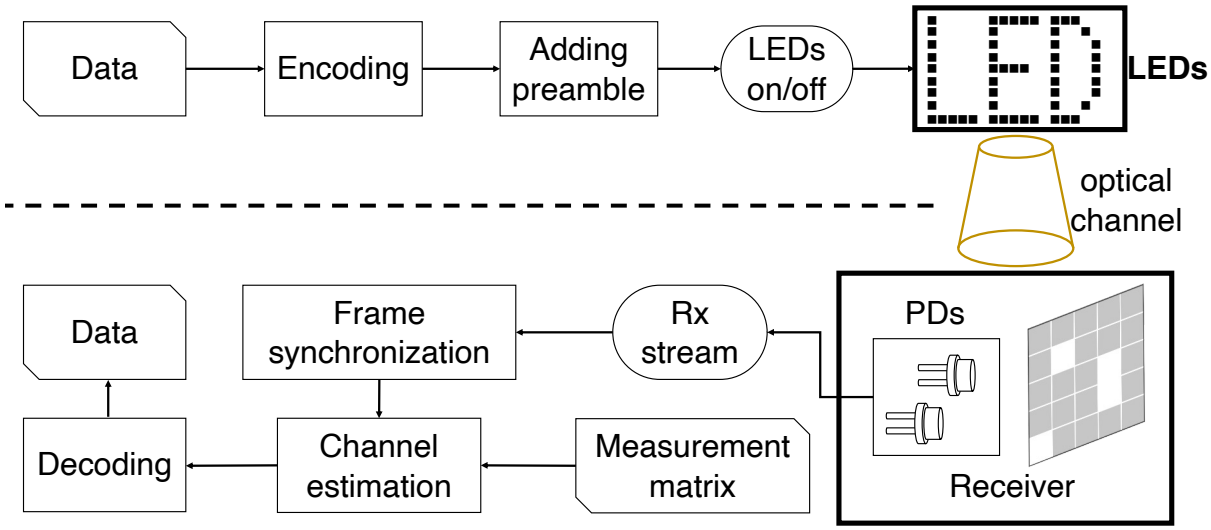
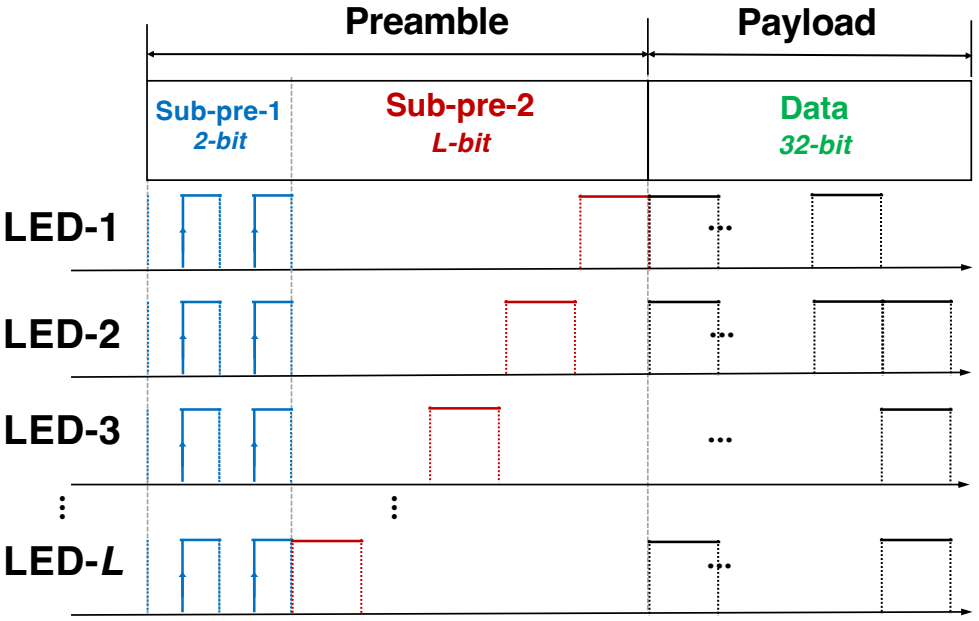
System Overview





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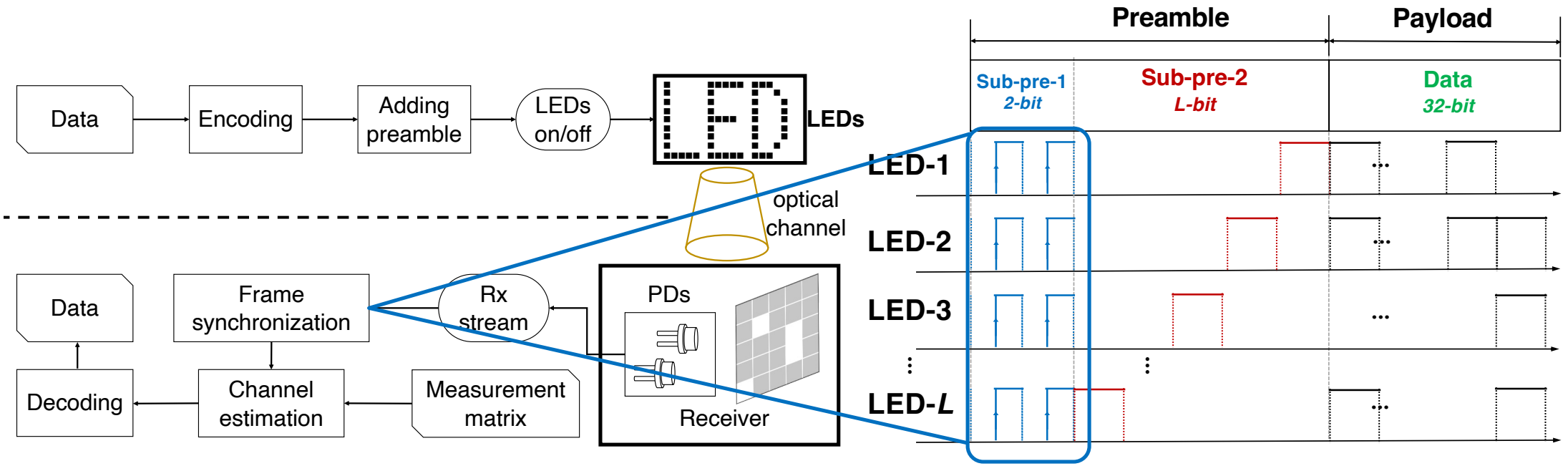

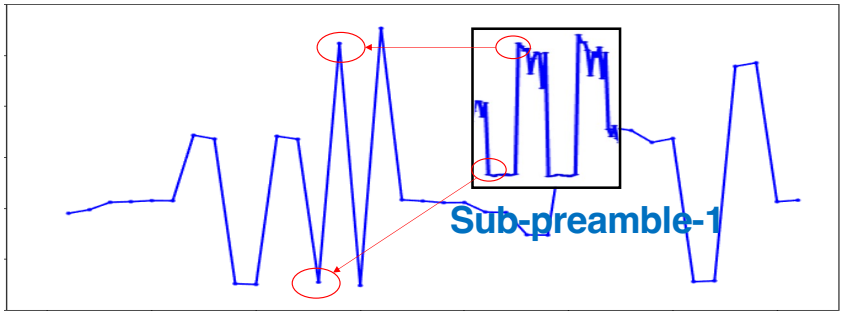

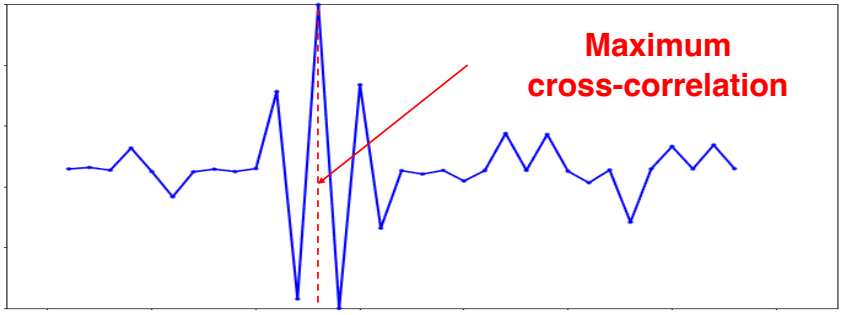

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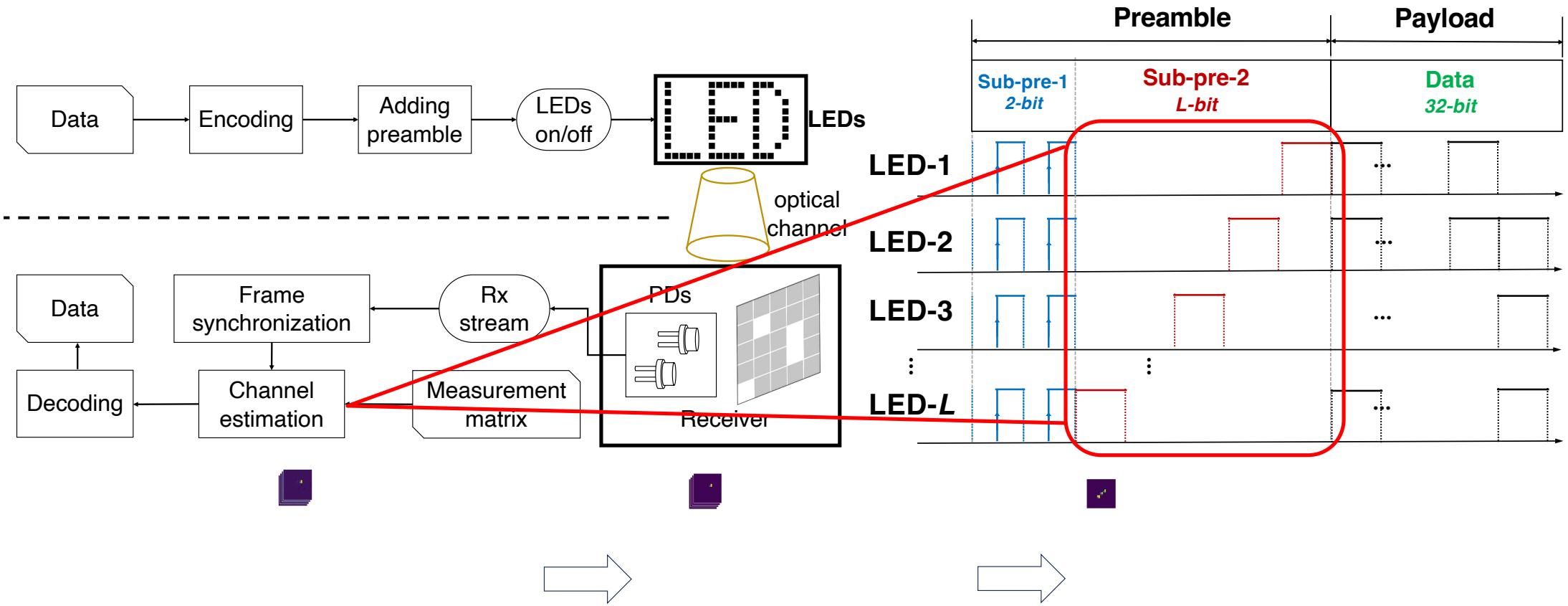
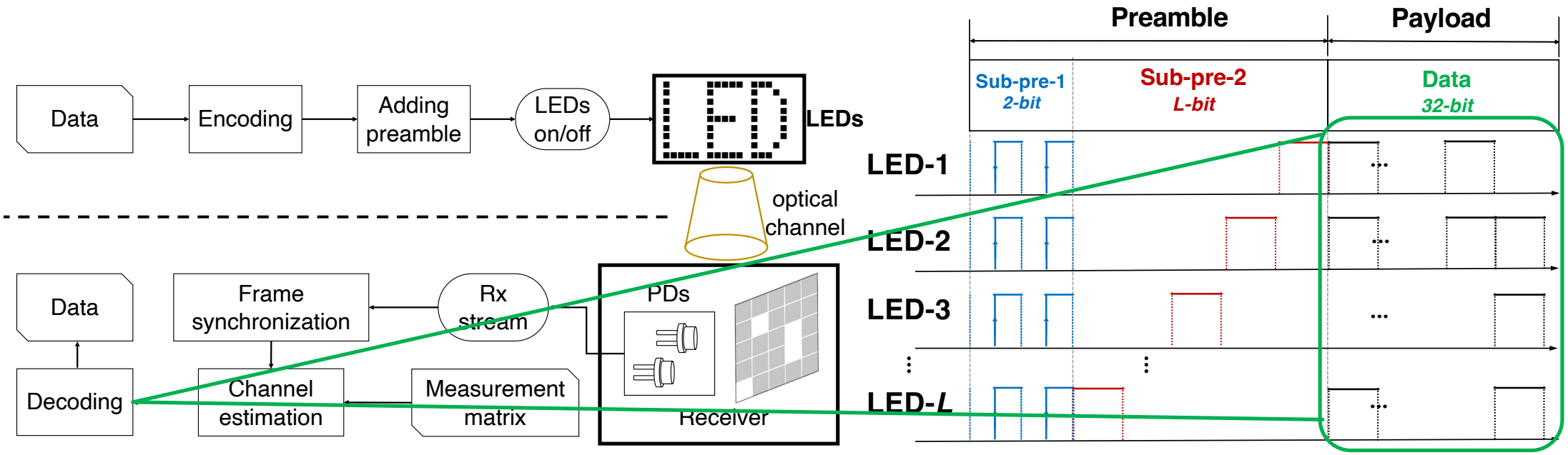
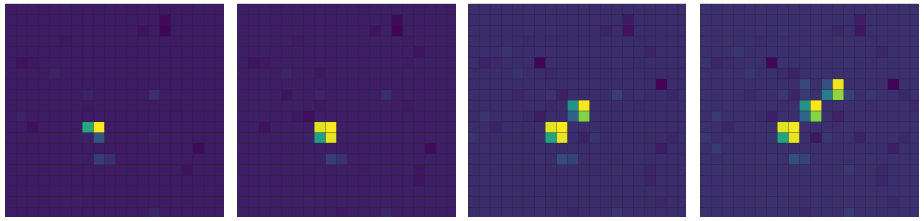


Sampling points **Filter and segmentation** **Channel estimation**

System Overview





L2: 100 100 110 111

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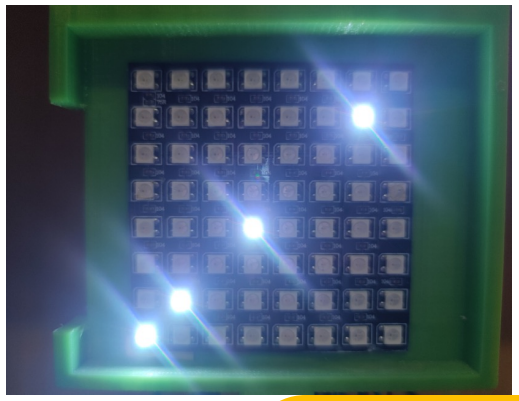
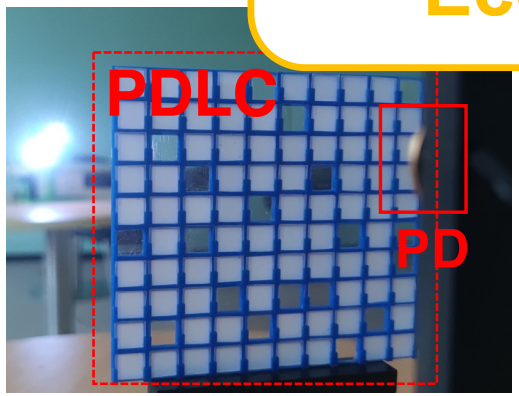
Experiments



Trans



Receiver

Cost and Power Consumption

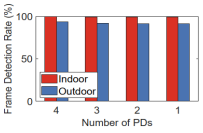
	Cost	Power	Num
DMD	$\geq \$80$	$5W$	1
			m^2

Economical & Energy-efficient

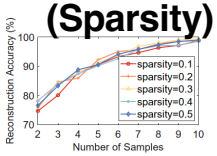
	Sample	Power	Num
Camera	$50Hz$	$> \$15$	1
PD	$10kHz$	$\$9$	4

Experiments

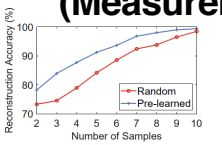
- **Frame detection accuracy**



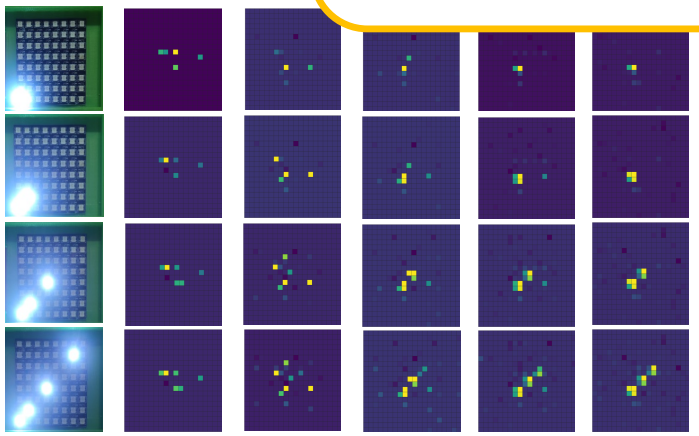
- **Image reconstruction accuracy (Sparsity)**

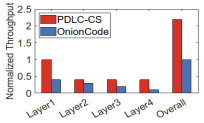


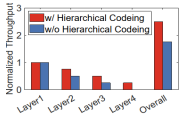
- **Image reconstruction accuracy (Measurement Matrix)**



High Flexibility & High Throughput







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Conclusion

High Speed and Low Cost One-to-Many VLC Using PDLCs

- A power-efficient and low-cost measurement matrix is designed using PDLCs, which are widely employed.
- A hierarchical coding scheme with multiple priorities is implemented using PD-based VLC, resulting in120% increase in communication throughput.
- Specific experiments are designed to evaluate the impact of configurations and different algorithms on the system's performance.

Thank you!