

"Quantum Communication Sensing and Measurement in Space" Keck Institute For Space Studies June 28th, 2012



Implementing a Near-Optimal Optical Receiver for Interplanetary Communications

Tim Rambo

Advisor: Prem Kumar

Center for Photonic Communication and Computing EECS Department, Northwestern University



 Spatial Encoding Joint Detection Receiver (JDR)

Temporal Encoding JDR





Overview









• Spatial Encoding Joint Detection Receiver (JDR)

Temporal Encoding JDR

Ultrafast Coherent All-Optical Switching

• Receiver Architecture

Photon Information Efficiency (PIE)

Performance of the BPSK Hadamard code with the Green Machine JDR: exceed the single-symbol receiver PIE

ol of Engineering and Applied Science

JDR architecture which improves \$inqubendefsigency for low-light level signals.

Ovoidetectorsate/signalbeathspointers1

No feed-forward required

Approaching The Holevo Limit

Approaching The Holevo Limit

Non-uniform phase accumulation over channels

Overlap of spatial modes after long propagation distance

Uniform Phase Accumulation,

For Sufficiently Small Blocks of Temporally Encoded Data

ΛΛΛΛΛΛΛ,

- Overview
- Spatial Encoding Joint Detection Receiver (JDR)

Temporal Encoding JDR

Ultrafast Coherent All-Optical Switching

Receiver Architecture

Bitwise Binary Switch

Selecting individual temporal modes

$$\begin{array}{c} \text{In}_{0} \longrightarrow \mathbf{S}^{(n)} \longrightarrow \text{Out}_{0} \\ \text{In}_{1} \longrightarrow \mathbf{C}^{(t)} \longrightarrow \text{Out}_{1} \end{array}$$

C(t): alters switching behavior

1 detector, *N* switches, *N* beamsplitters

Requirements for switching device		
low loss	low in-band noise	high speed

• Spatial Encoding Joint Detection Receiver (JDR)

Temporal Encoding JDR

Ultrafast Coherent All-Optical Switching

• Receiver Architecture

28 June 2012, Slide # 16

S⁽¹⁾

All-Optical Coherent Switch

Switch Properties

• Spatial Encoding Joint Detection Receiver (JDR)

Temporal Encoding JDR

Ultrafast Coherent All-Optical Switching

Receiver Architecture

28 June 2012, Slide # 19

Bitwise Optical Switching

The temporal JDR...

can be constructed from these optical switches

Acknowledgements

Special Thanks To:

Prem Kumar

Joe Altepeter

Neal Oza

Thanks For Listening