Atmospheric Mitigation Techniques for Freespace Optical Communication

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MITRE Sponsored Research

MITRE Technology Program

Problem

- Growing bandwidth demands of DoD applications fuel the need for freespace optical communication (FSOC)
- Atmospheric variability and terminal mobility impose limitations on optical communication
- Current FSOC terminals do not address variable link conditions and fail to maximize both system availability and throughput
- Next-generation FSOC terminals must dynamically react to changing atmospheric conditions in order to optimize overall system performance

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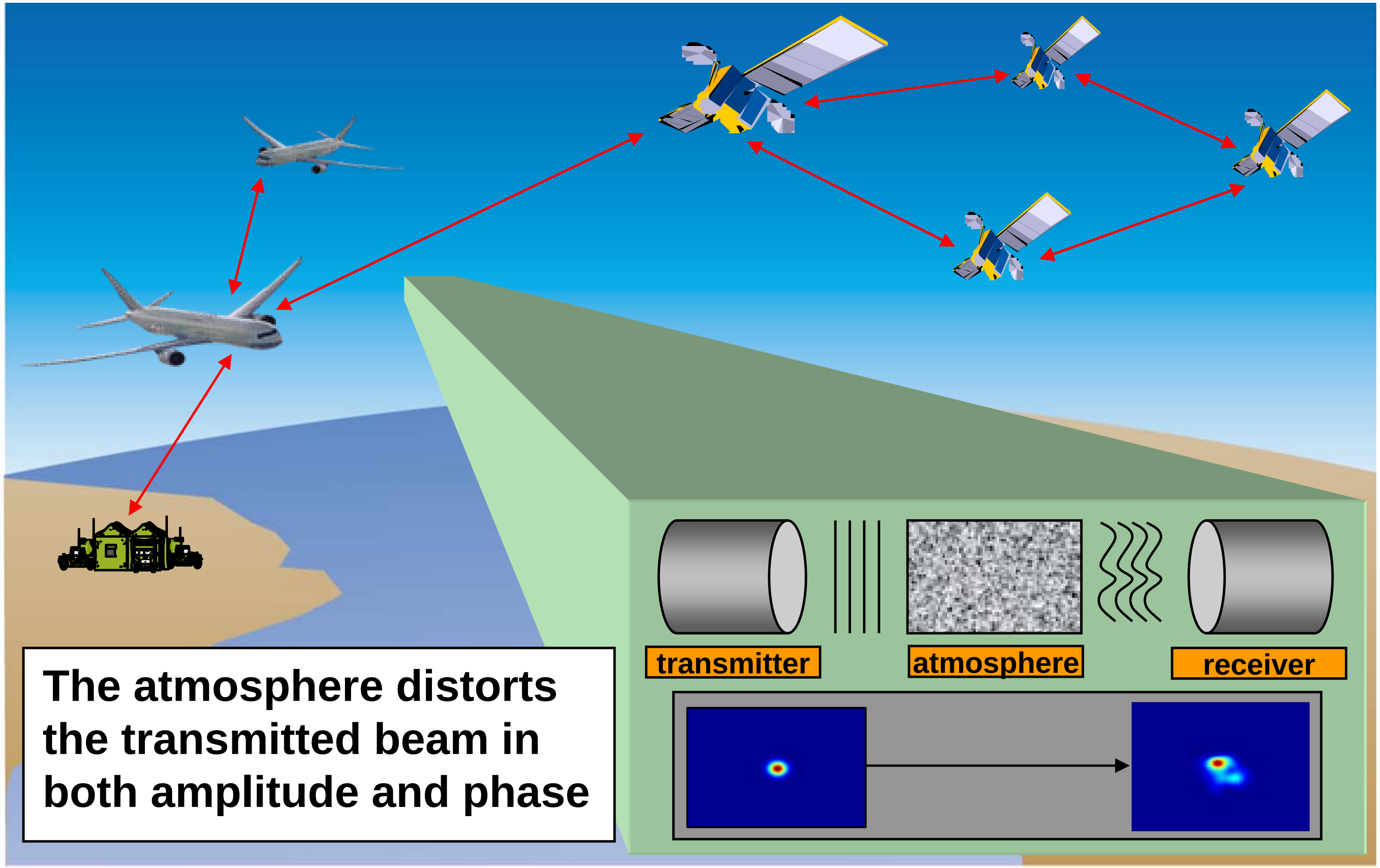
Background


transmitter
atmosphere
receiver
The atmosphere distorts the transmitted beam in both amplitude and phase

Objective

Build a freespace optical communication terminal that will dynamically optimize performance under varying link conditions

- **Understand communication impacts caused by the atmospheric channel via simulation tools coupled with direct measurements**
- **Implement advanced modulation formats, rate and modulation agile transceivers, and adaptive mitigation techniques to optimize overall performance**
- **Test terminal designs in a realistic fading environment**

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Activities

- ***Wave-Optic Simulator***: Create system design tools to investigate communication performance under varying link conditions for arbitrary link topologies

- ***Advanced Modulation Techniques***: Develop rate and modulation adjustable transceivers to optimize system performance under slowly varying link conditions by trading available margin for throughput

- ***Acquisition and Tracking Testbed***: Investigate the performance of various acquisition and tracking techniques when subjected to a turbulence induced fading environment

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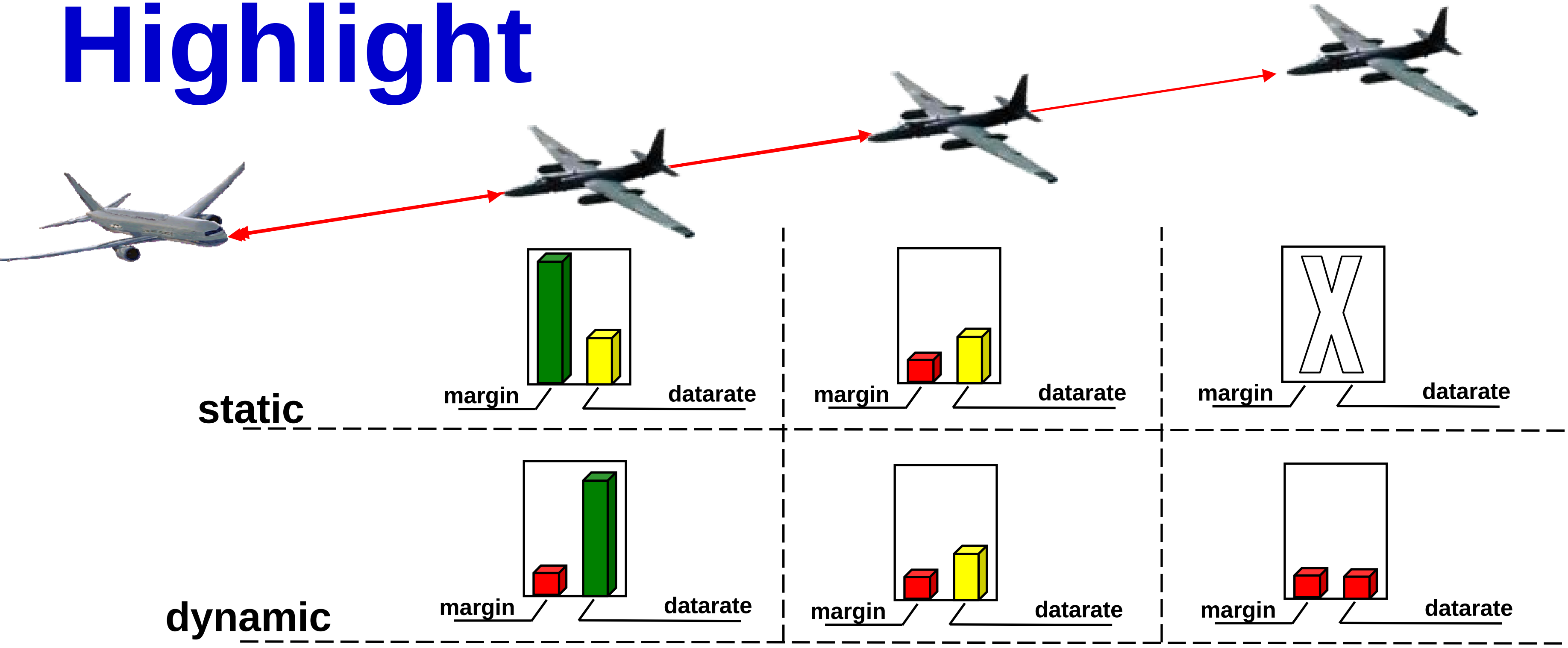
Highlight



- Convert excess margin into increased link capacity or vice versa
- Aggressively fight to maintain link connectivity
- Allow for system flexibility as flight conditions or mission objectives change

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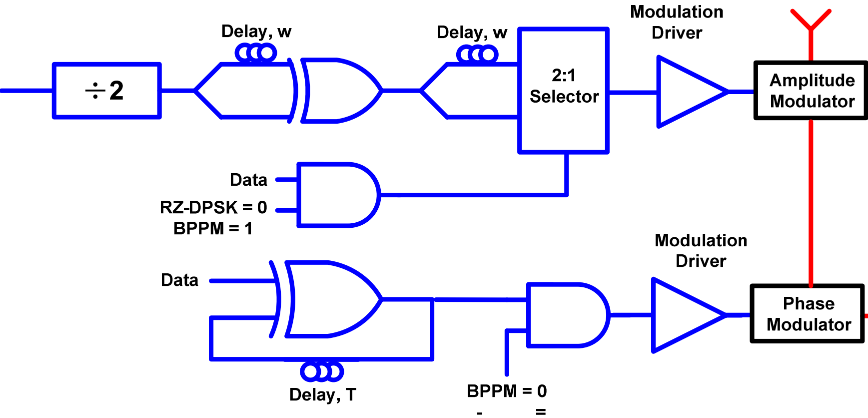
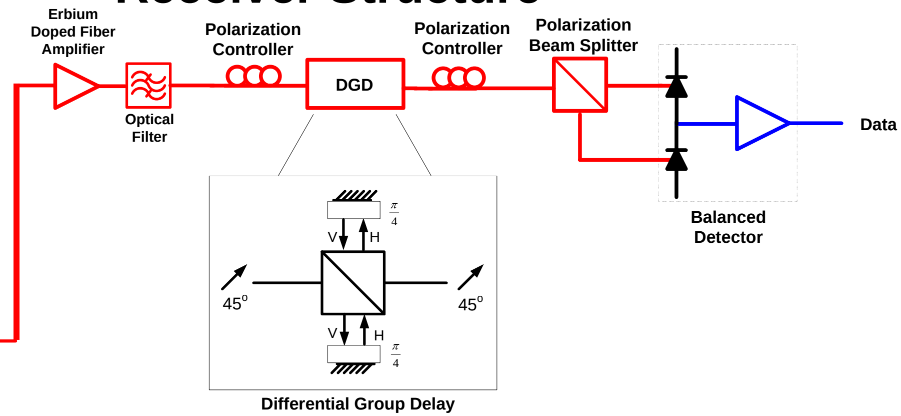
Demonstration

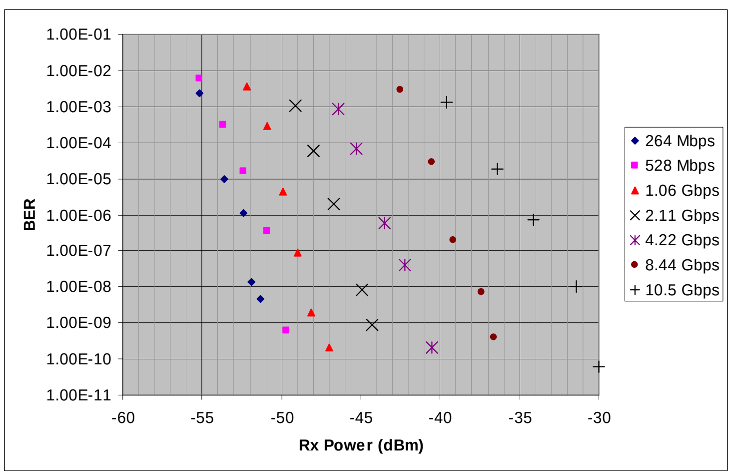
Transmitter Structure

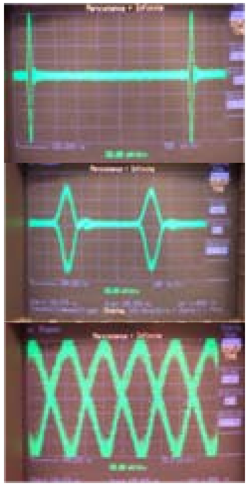


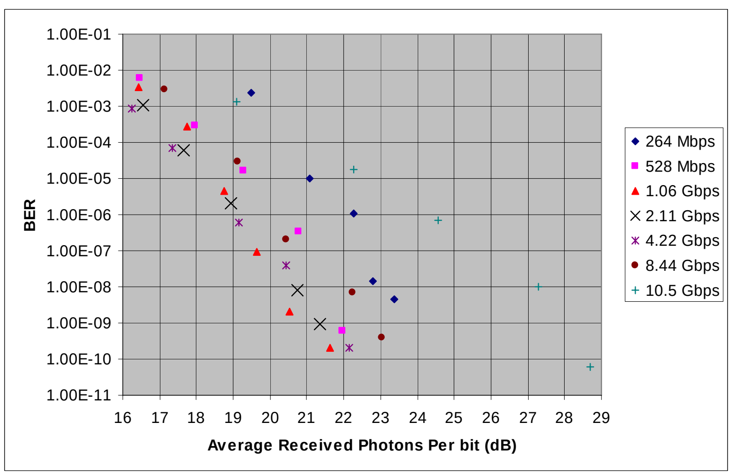
Receiver Structure



Variable Rate RZ-DPSK Bit Error Rate Performance Graphs and Eye Diagrams







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Impacts

- Expand the practicality and usability of freespace optical communication (FSOC)
- Provide a solid baseline to identify key enabling technologies for future needs
- Contribute to risk reduction and technology maturation efforts for current and envisioned lasercom programs
- Develop an in-house optical testbed for future ventures and directly funded work programs in FSOC

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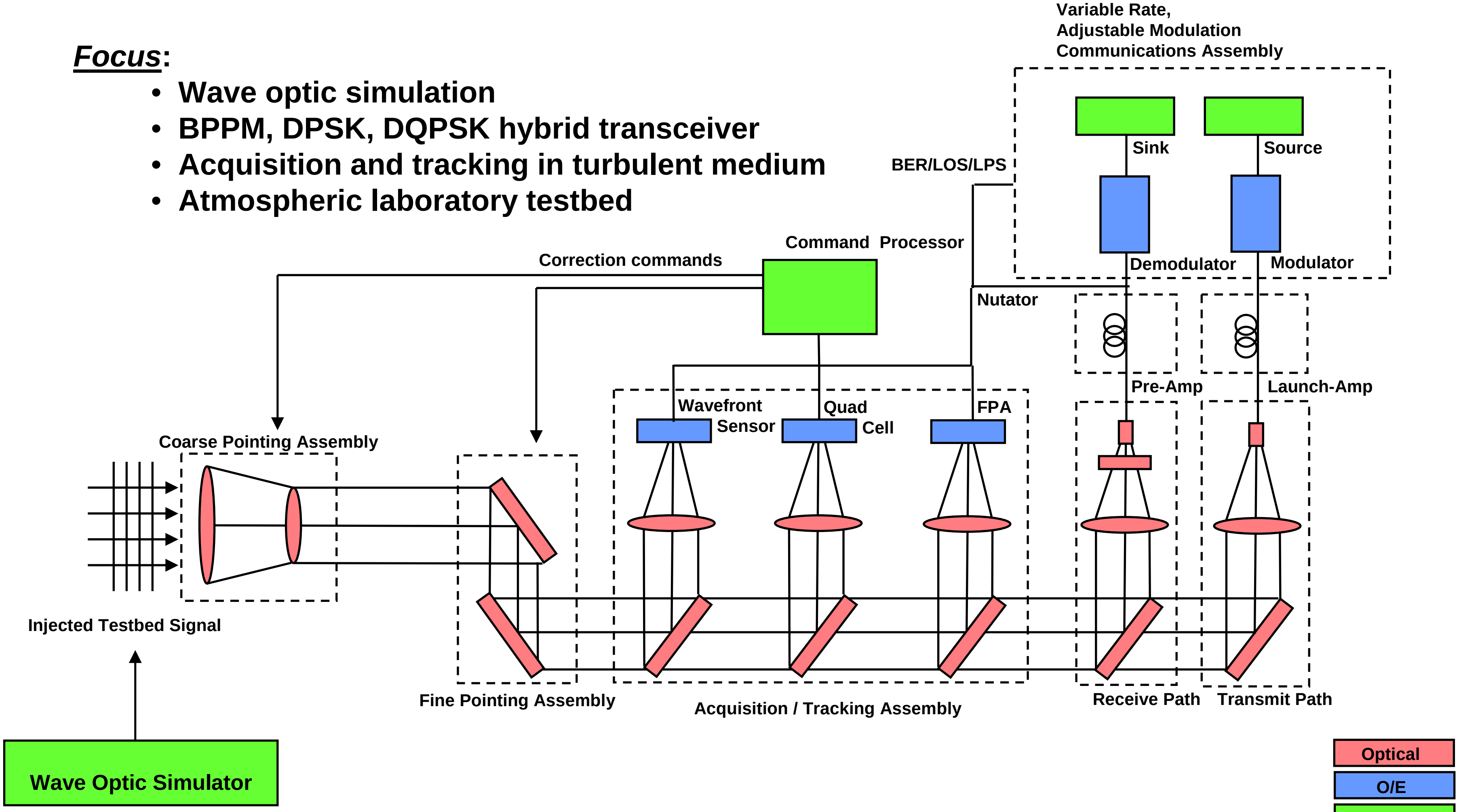
Future Plans

Focus:

- Wave optic simulation
- BPPM, DPSK, DQPSK hybrid transceiver
- Acquisition and tracking in turbulent medium
- Atmospheric laboratory testbed



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