



Optical Wireless Networks with Topology Control

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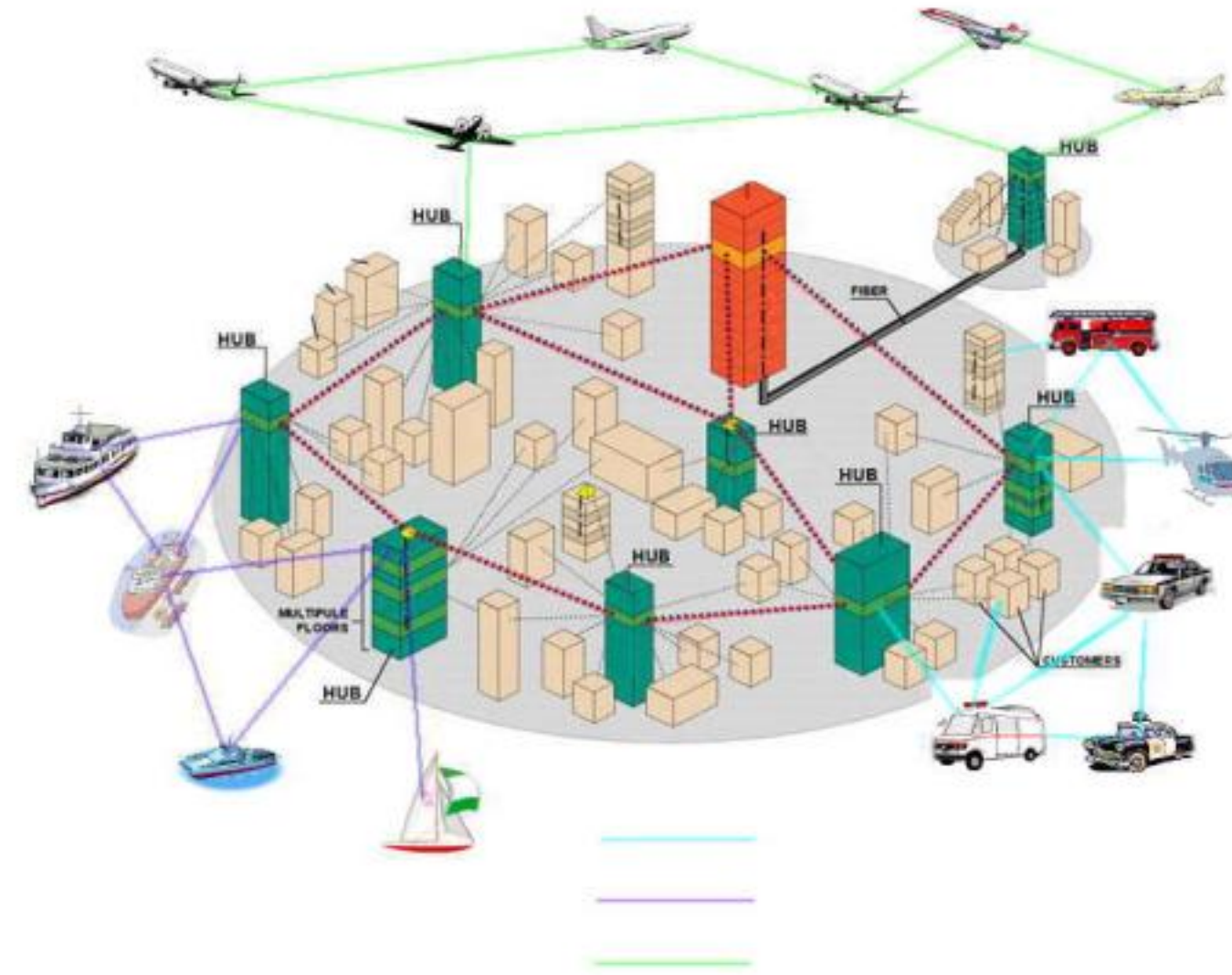
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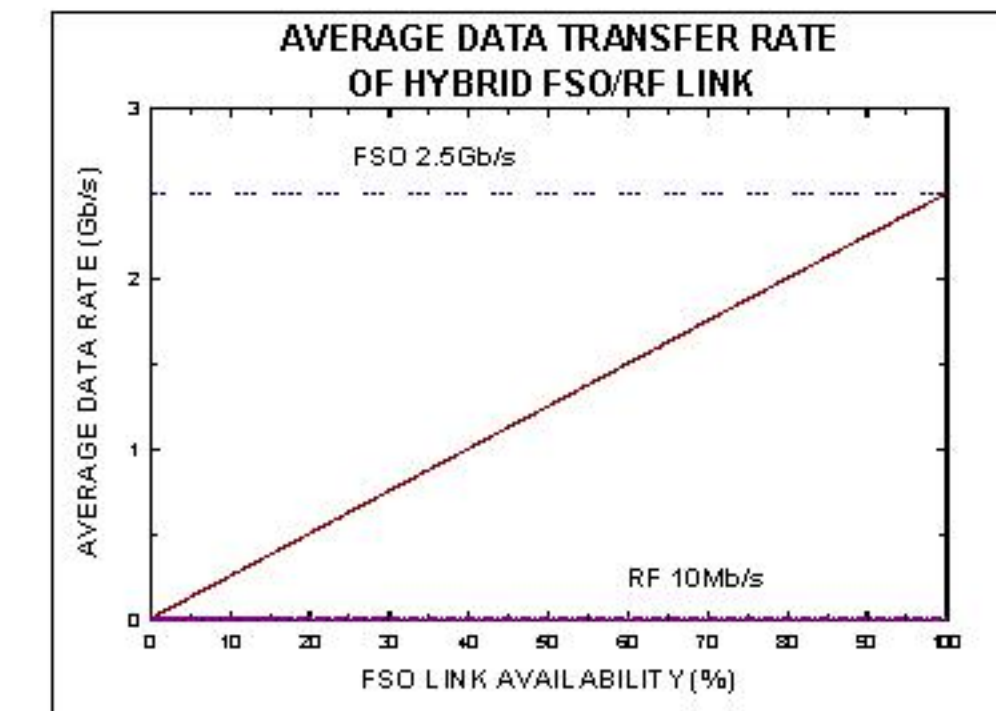


THE LAST MILE PROBLEM – HOW TO PROVIDE HIGH DATA RATE CONNECTIVITY

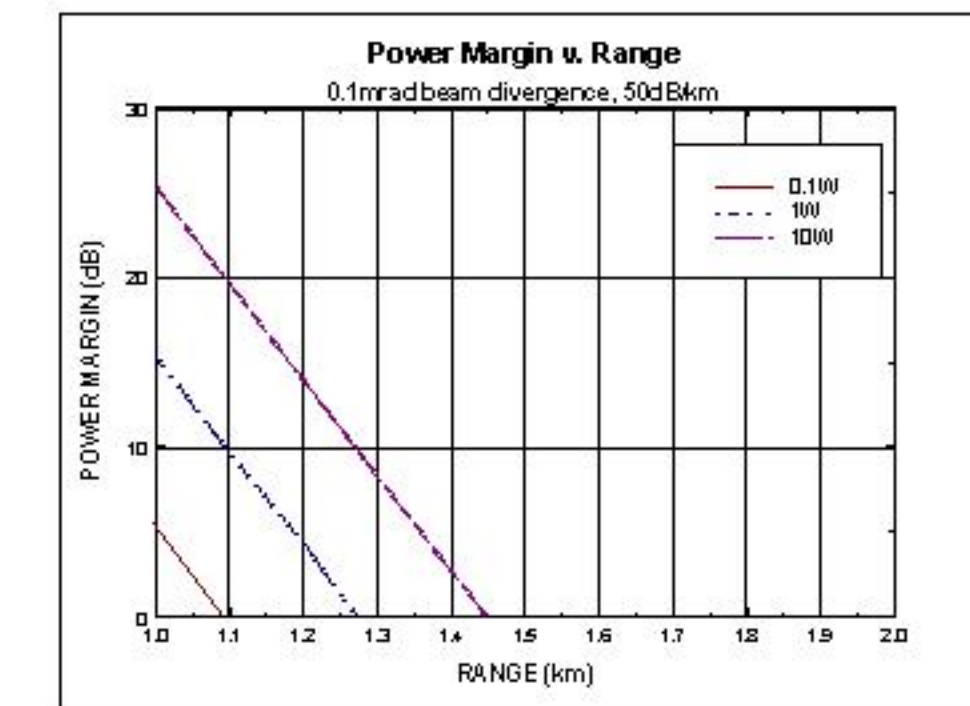
- Must be cost effective – optical fiber installation can cost \$1M per mile, fiber-to-the-home >\$1,000 per installation
- Easy to install and uninstall – optical wireless installation requires no digging
- Compatible with existing technologies – existing optical wireless systems installed at the University of Maryland are seamlessly connected to the campus communications network
- Must provide more capability and reliability than competing technologies – optical wireless reliability >99.99% over ranges up to 300m
- Provide network extendability
- Fixed and mobile Platforms



Transfer Rate for Hybrid OWL/RF Link



Penetration through 50dB/km Obscuration



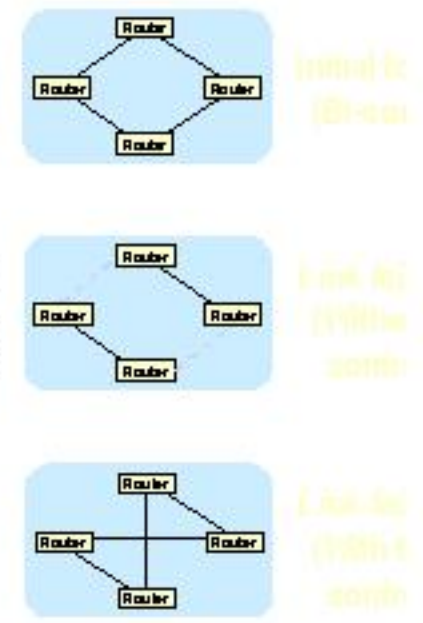
Optical Wireless Links offer Enormous Data Rates and can Penetrate Severe Obscuration over Moderate Ranges

NEW APPROACHES - OPTICAL NETWORKING AND TOPOLOGY CONTROL

- Active beam alignment and tracking at the physical layer
- Rapid Reconfigurability
 - Based on physical, environmental, link state, and network factors
- Point-to-point and omnidirectional transmitters are possible
- Networking over short ranges through diffuse reflection

Topology Control for Optical Wireless Networks

Dynamically Select and Configure Physical Network



- Assured Connectivity Over Unreliable Links
- Topology control enables links to be re-formed to create a suitable topology

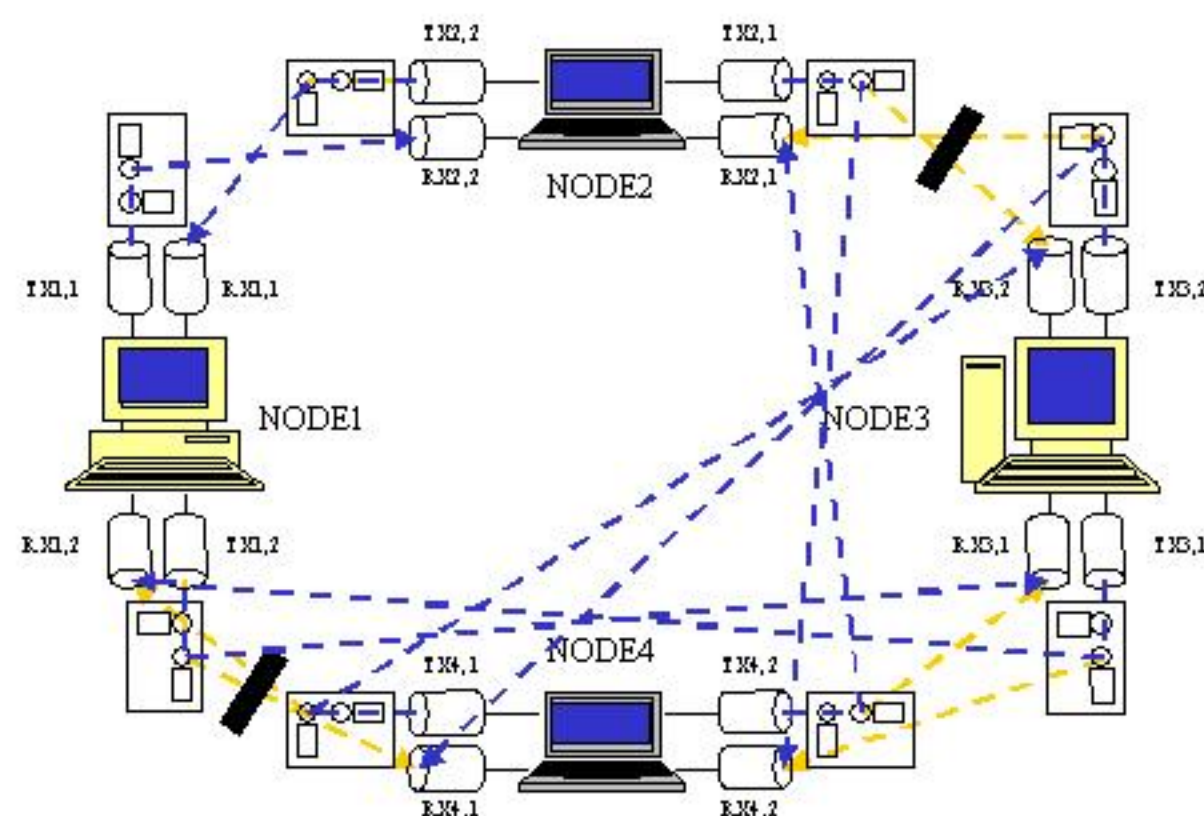
Solution Approach for Topology Selection

- Three main solution components
 - Discovery of potential neighbors at each setting of power, antenna direction, network service (QoS) choice using RF or optical "probes"
 - Distribution of potential neighbor information to other nodes so that each has the global potential topologies database
 - Execution of heuristic algorithm to choose best possible topology by:
 - searching the space,
 - evaluating the candidate topologies and
 - adjusting the transmit power/intensity, laser beam direction, etc.

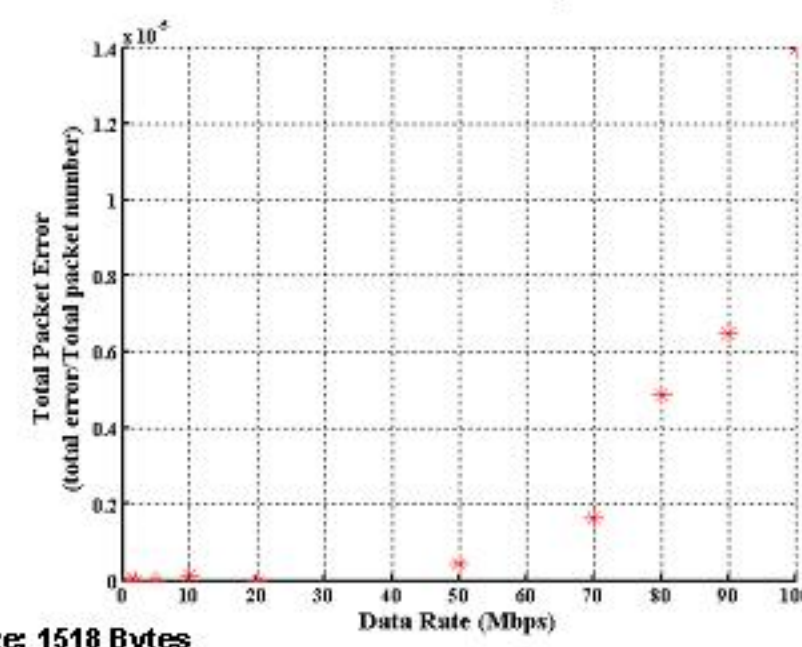
Optical Wireless Transceiver



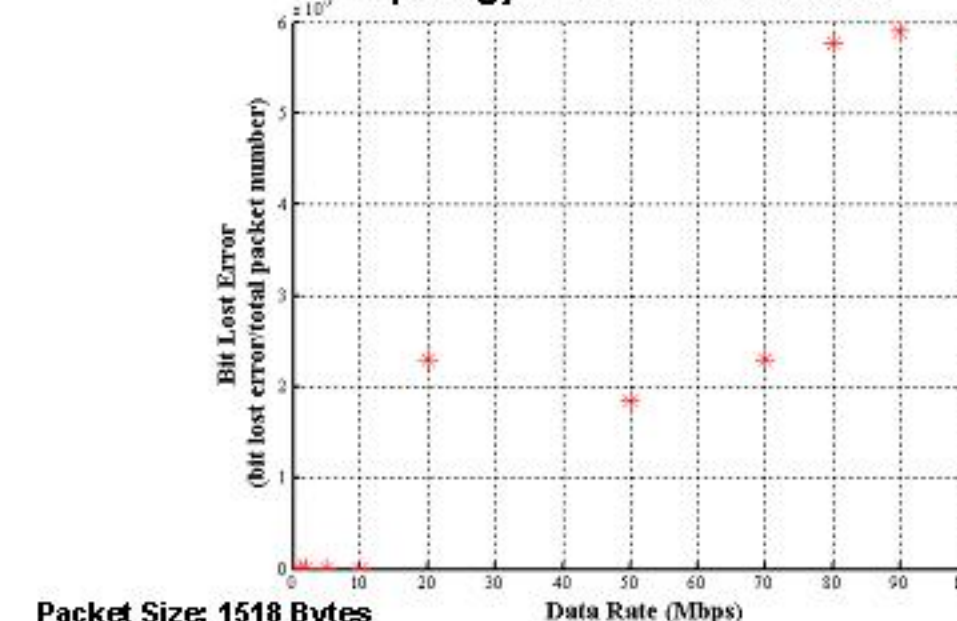
Topology Control for Optical Wireless Network



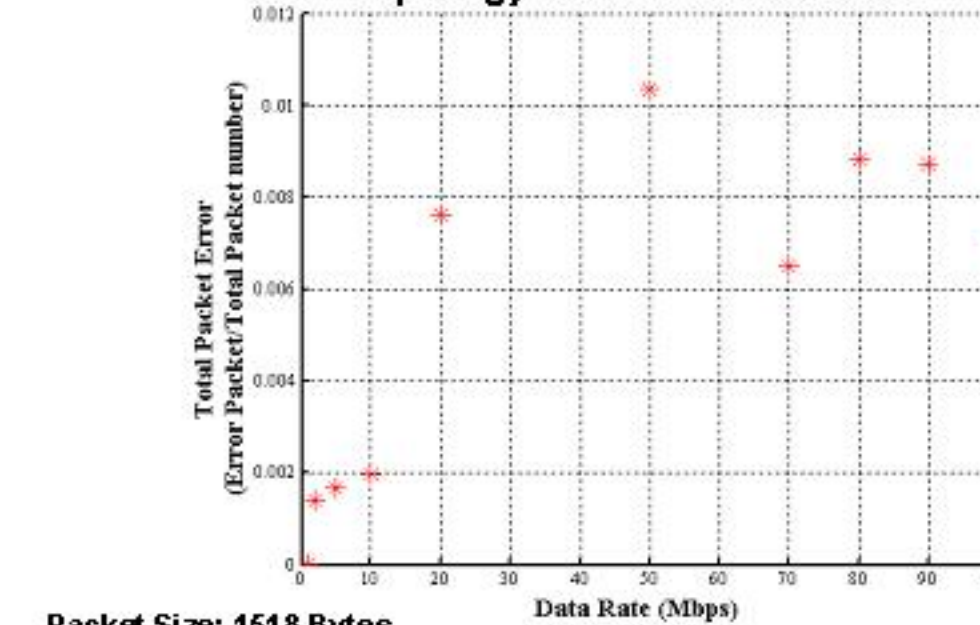
Total Error in Point-to-point Link



Bit Lost Error in Topology Controlled Network



Total Error in Topology Controlled Network



Topology Control Results

- Total latency for physically changing link = 1.636 ms (Mirror re-alignment time)
- Total latency for network recovery with topology control = 8.656 ms (Link re-establishment time)
- Average error percentage caused by changing 1 link = 0.039% (Total Errors/Number of link changes)
- Average link availability over more than 2500 link changes = 99.9947% (Packet Received - Packet Error)/(Packet Received)