Communication Systems-West

FSO Network Challenges

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Requirements for an FSO transit network

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- Provide backbone class IP transit networks
  - Provide end to end network connectivity of XX% or greater
  - Data rate range of 1-100 Gbps
  - IPv4/IPv6
  - Protocol compliance with edge networks
  - QoS and Latency Guarantees
  - MANET for mobile deployments including self forming and self healing
  - Secure management and data transfer
- Fixed and mobile infrastructure
- Airborne, ground, and space applicability
- Multiple SWAP and environmental conditions

Diverse application of FSO transit networks presents challenges to hardware, software, and mechanical aspects of FSO network nodes

Challenges

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	Ground	Air	Space
Ground	Fog, Scintillation	Fog/Clouds, Scintillation, Mobility, Acq/Track, Platform Obscuration	SWAP, Weather, Reliability, Latency
Air	Clouds, Scintillation, Platform Obscuration, Acquisition	Scintillation, Mobility, Acq/Track, Platform Obscuration	SWAP, Reliability, Mobility, Latency, Weather
Space	SWAP, Weather, Latency	SWAP, Mobility, Weather, Latency	SWAP, Reliability, Latency, Weather

Building systems for addressing these challenges requires coordinating link and network level mitigation techniques

DARPA ORCA/FOENEX – Meeting the challenges - 1

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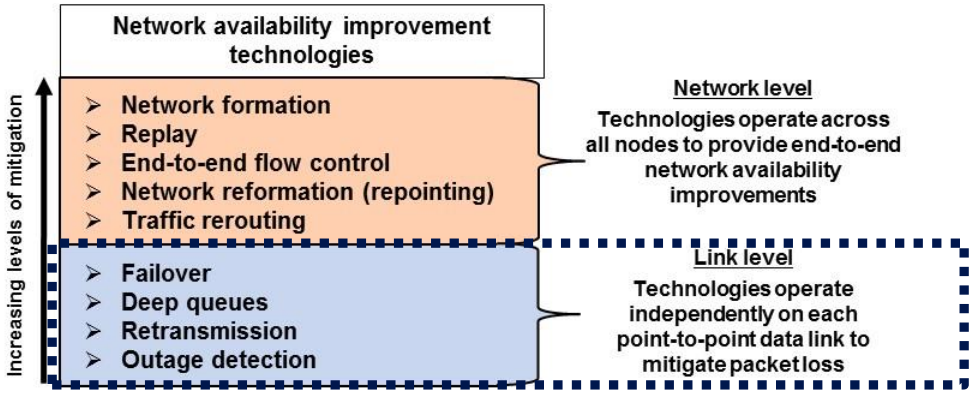
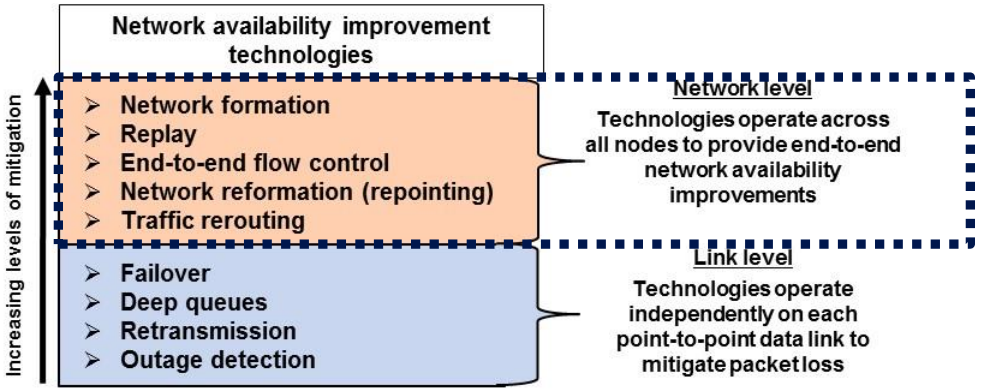
- Link diversity (system complexity impacts)
  - multiple FSO links, hybrid FSO/RF links
- Link outage detection (overhead, latency impacts)
  - Utilizes Link State Rolling Average (LSRA) samples, zero detection indicato to determine outage type
- Layer 2 retransmission (ReTx) (latency, overhead impacts)
  - Outage type - link disruption events < 100ms (e.g. scintillation)
- Deep queues (latency, complexity impacts)
  - Outage type - Clouds (2-3s)
- Backpressure and Failover (latency, complexity)
  - Remapping of priority queues from one physical layer to the other after triggering backpressure



DARPA ORCA/FOENEX - Meeting the challenges - 2

- Data path switching (complexity impacts)
  - Virtual interface switch to dampen effects of mobility on standard protocols
- Link outage prediction (processing impacts)
  - Utilization of flight profiles, antenna patterns, link budgets
- Topology Management (complexity, overhead, processing)
  - Topology adjustments considering link and overall network health
- Integrated Diffserv QoS, traffic management and flow control
- Replay of delay tolerant data (overhead, complexity, processing)
  - Outage type - platform/terrain/weather blockages (>100ms<5 sec)
  - Replay of delay tolerant traffic from ingress node



Impacts to overhead, latency, PER, QoS, and implementation constraints must be balanced using multiple techniques to meet requirements

Future Focus Areas

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- Link quality or outage prediction techniques
- Reduction of specialized technology
  - Investigation of emerging technologies and their applicability to decreasing complexity and cost of FSO network nodes
    - Hardware : Processors (CPUs, GPUs), memory, interconnect, FGPAs
    - Software: Software defined networking techniques (e.g. applicability of things like OpenFlow)
    - Emerging IETF standards including MANET and link exchange protocols
- Application of distributed topology algorithms

Opportunities exist for further improvements to the construction of high availability FSO transit network nodes