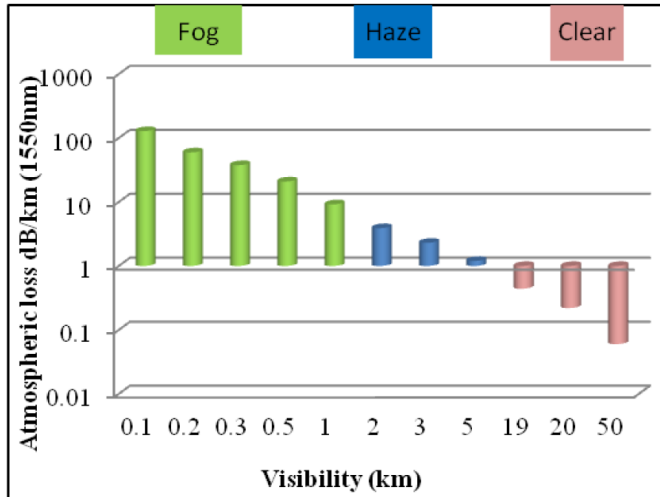# *Designing Reliable FSO Networks*

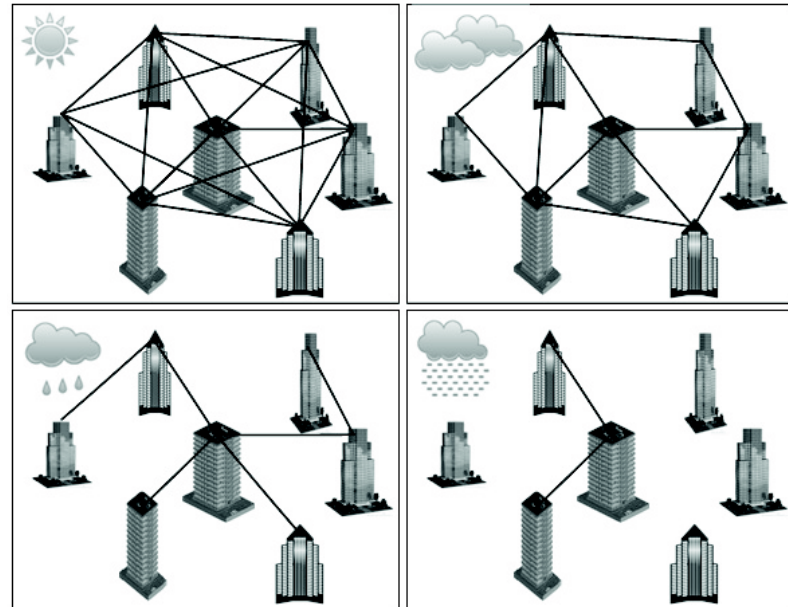*Suresh Subramaniam*
George Washington University
suresh@gwu.edu

7/13/17

Impact of weather on FSO

Courtesy: FSO vs. RF,
R. Alsemmeari et al.,
IJITCS, Sep. 2016

# *Dynamic FSO topology reconfiguration*

- In clear weather, link ranges are large
  - many "potential" FSO topologies
- FSO range quickly decreases in foggy weather
  - Only a few short links are possible
- Local weather in near future (a few minutes to hours) can be predicted well
- Use it to reconfigure FSO transceivers to form "best" topology
- Questions
  - How many FSO transceivers and where to place them?
  - How to reconfigure transceivers and reroute traffic flows?

- Design problem also comes up in other situations, e.g., disaster recovery

Hybrid RF/FSO Networks

- ## FSO has abundant capacity, but is unreliable
  - 1-10 10Gbps
  - Atmospheric turbulence, building movements

- ## RF is capacity-limited but generally reliable
  - 10-100 Mbps
  - Fog doesn't affect RF as much as FSO

- ## Hybrid RF/FSO networks
  - Combine the best of both worlds
  - Use RF for connectivity/reliability
  and FSO for capacity
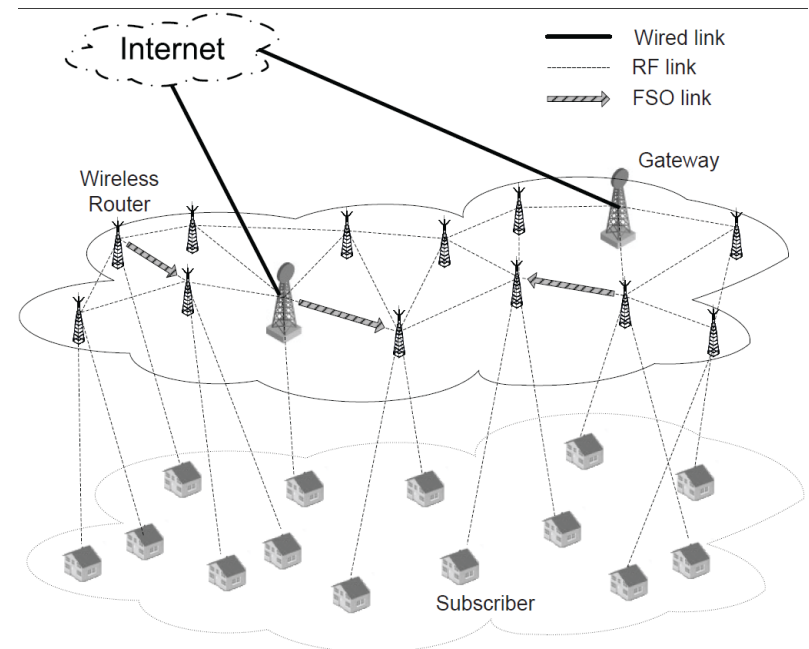
F. Ahdi and S. Subramaniam, "Capacity enhancement of RF wireless mesh networks through FSO links," JOCN, July 2016.

Improving reliability in hybrid FSO/RF networks

- Questions
  - How to design the RF and FSO networks together so that the RF network "backs" up the FSO network?
  - How should traffic be split between the RF and FSO network?
  - How to schedule traffic among the interfering RF links?

Backhauling via high-altitude balloons

- Inexpensive solution (rural and remote areas)

- High bandwidth wireless
  - Free space optics (FSO)
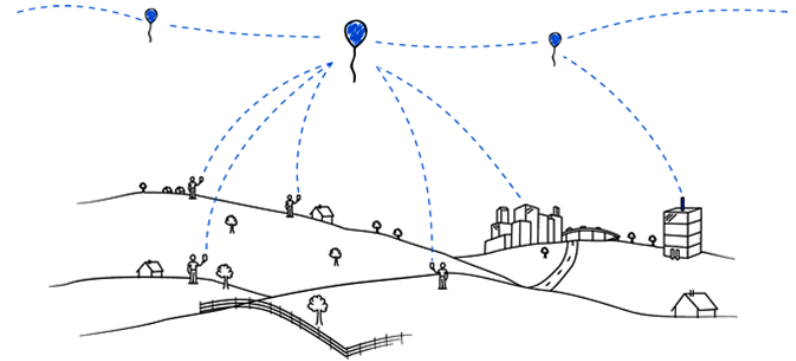
Positioned in the stratosphere
  - Above civil air routes, jet-streams, and clouds (17 to 22 km)
  - No signal blockage (common reasons fog, cloud, and rain)
  - Minimal scintillation (weak air turbulence in less dense and clear air medium)

- The balloons can be auto-controlled or remotely operated through satellites and Global Positioning System (GPS)

- The balloons' trajectories are governed by speeds and directions of stratospheric winds

- Challenge: Design of the balloon FSO network