Towards Interference-free Wireless Networks: the Role of FSO

Harsha Chenji

School of Electrical Engineering and Computer Science,
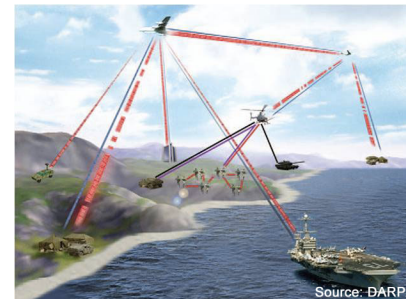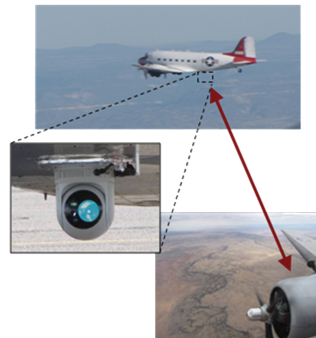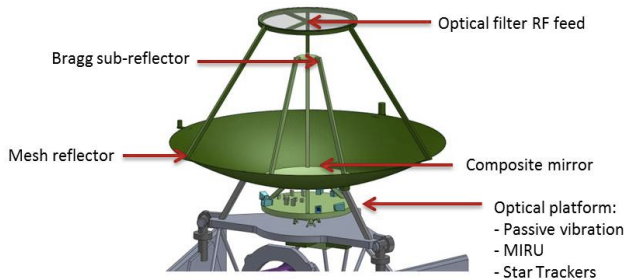
Ohio University, Athens, Ohio

chenji@ohio.edu

1. Assistant Professor since 2015
   ❑ Ph.D./M.S. work on RF Wireless Systems

2. June 2015: visit to NASA Glenn (Cleveland, Ohio)
   ❑ Tele-tenna (iROC), LLCD/LADEE (s FSO) *Connectivity*

Optical filter RF feed
Bragg sub-reflector
Mesh reflector
Composite mirror
Optical platform:
- Passive vibration
- MIRU
- Star Trackers

Source: "FALCON Fast, Far, and First", Wright-Patterson Air Force Base

Source: DARPA

3. That trip led me to

National Science Foundation (NSF) #1657279: "CRII: NeTS OP: A Software Defined Approach to Laser-based Free Space Optical Networks". $175K (2017-2019). Single PI.
REU Supplement: $16,000 (2017)

1. **<u>Highly directional networks</u>**: interference-free?
   - ❑ Gupta-Kumar limit for directional networks is inversely proportional to sqrt(beamwidth)
   - ❑ FSO networks with micro radian beamwidth are possible

2. Are M<u>A</u>C protocols a subset of P<u>A</u>T techniques?
   - ❑ Pointing, Acquisition and Tracking (PAT) is field proven
   - ❑ Omnidirectional antennas considered harmful?

3. Adaptive beam shaping in RF/mmWave/THz?
   - ❑ Beam splitting, expanding, shaping, steering
   - ❑ Lightweight diffractive optical elements?

1. Ultra-low latency networks: NSF Workshops' Report
   - ❑ MAC layer contributes 25ms
   - ❑ Eliminate MAC and instead, point once and track

2. Disaster response: high capacity back/front haul
   - ❑ Facebook's tether-tenna

3. Security – low probability of interception/detection
   - ❑ Get around obstacles with multi-hop!

4. FSO too can sense! LIDAR for localization?

5. Visible light comms: cheap phased arrays (cameras)

1. Micro/nano second PAT times with urad beamwidth
   - ❑ Orders of magnitude less than WiFi DIFS
   - ❑ Allows ultrafast realignment and tracking
   - ❑ May require non-mechanical steering mechanisms

2. Multi-receiver/multi-node PAT
   - ❑ Point a split beam at multiple <u>mobile</u> receivers

3. Software-defined optical radios/frontends
   - ❑ With coherent communication?
   - ❑ May not need high bandwidth at ultra high SNRs

4. Leverage quantum optics?

Immediate and Short-term Needs

1. Outreach and clearing misconceptions
   - ❑ FSO and RF/mmWave/THz are all neighbors on the spectrum
   - ❑ AIAA, SPIE, OSA, not just IEEE and ACM

2. Publication venues are needed!
   - ❑ Frequently mentioned at IWCMC 2017 WON symposium

3. Inexpensive experimentation platforms
   - ❑ Koruza: open source hw/sw
   - ❑ "deployable" form factors – ideal for SBIRs/STTRs

4. FSO testbeds with mobility
   - ❑ NASA SCaN testbed + optics?
   - ❑ AFRL/RI @ Rome: AOptix terminals, 20+ km link
   - ❑ NSF PAWR?