National Aeronautics and Space Administration
Glenn Research Center at Lewis Field

Millimeter Wave High-Speed Data Links: A Mobile Backhaul Perspective

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INTERNATIONAL SYMPOSIUM ON ADVANCED RADIO TECHNOLOGIES
CENTER FOR ADVANCED COMMUNICATIONS

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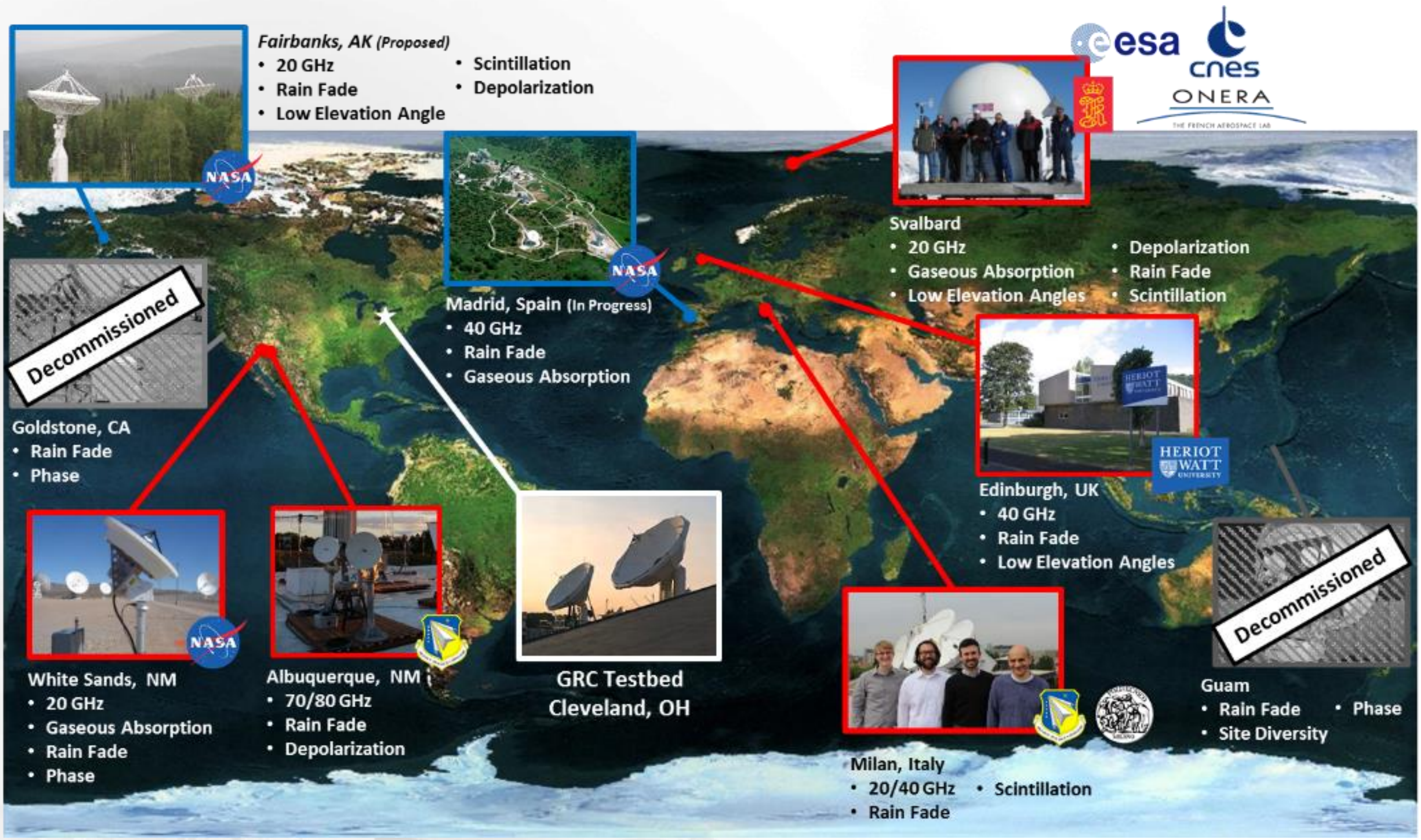
Overview of NASA Propagation Studies Efforts

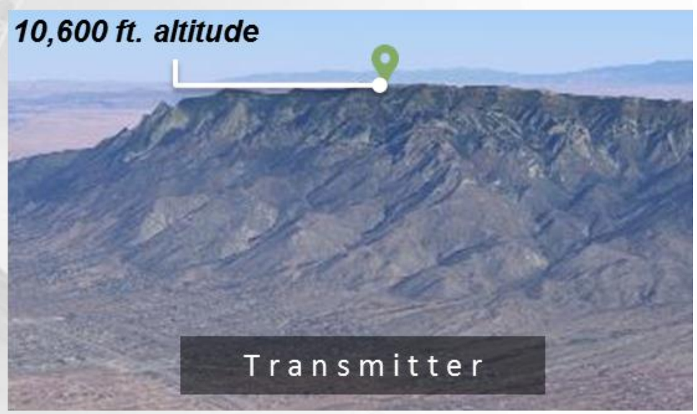


NASA Propagation Studies Efforts in the V/W-band

Measurement Capabilities

- 72/84 GHz CW beacon frequencies
- Co/Cross-Polarization Isolation
- Rain Attenuation
  (70 dB dynamic range)
- Scintillation
  (10 Hz sampling rate)
- Cloud Attenuation/Scintillation
- Optical Disdrometer
- Weather stations along path
- ABQ NEXRAD Radar

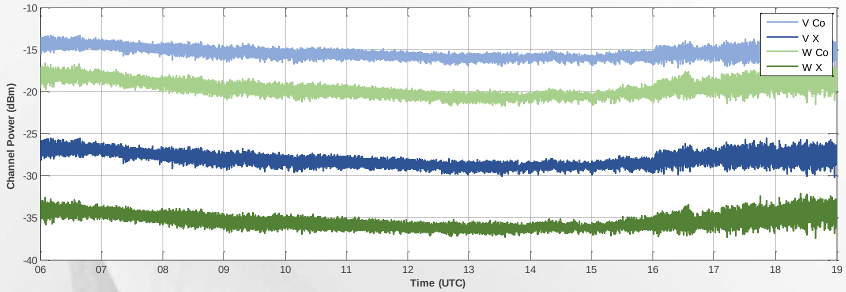
COSMIAC (University of New Mexico)
(Photo: Google Earth)

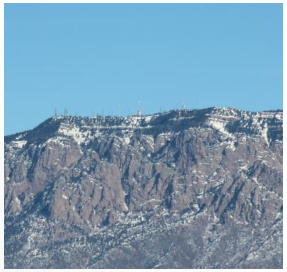


Sandia Crest
(Photo: Google Earth)

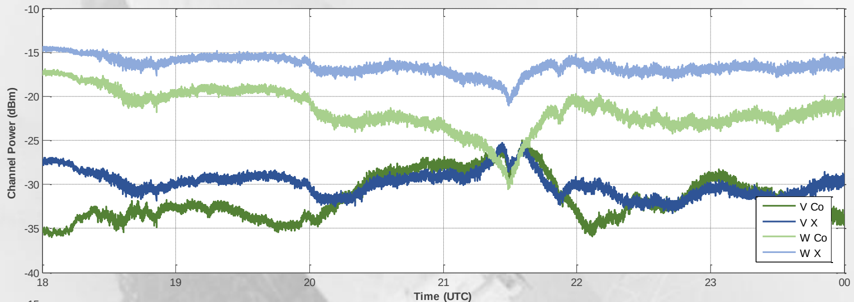
V/W-band Receiver at COSMIAC building

Observations of Millimeter Wave Propagation Effects

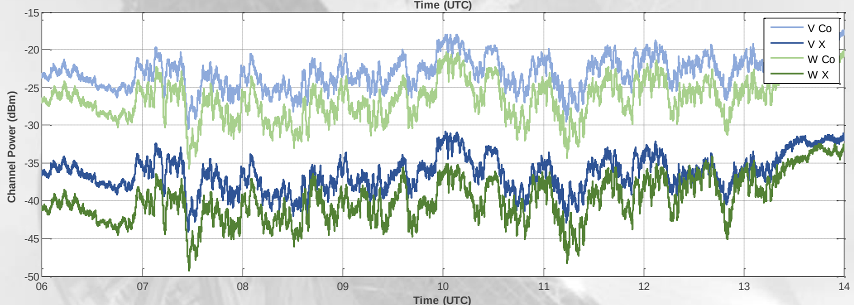


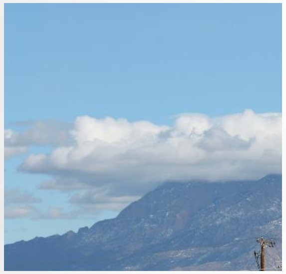


Clear Sky Conditions:
- Diurnal variations up to 3 dB due to gaseous absorption along path
- Turbulence-induced scintillations along path can cause high scintillation noise

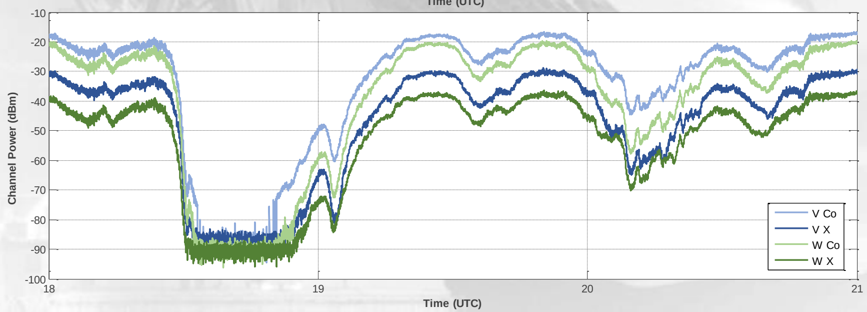


Snow Conditions:
- Depolarization through snow indicates potential for strong ISI for dual-pol systems





Cloud Conditions:
- Have observed >10 dB attenuation through clouds
- Have observed strong cloud scintillation effects (>5 dB peak-to-peak variations)



Rain Conditions:
- Rain attenuation easily causes loss of link
- Antenna wetting has been identified as a contributor to rain loss

Millimeter Wave System Design

Propagation Considerations

- Millimeter wave systems offer the opportunity to exploit very wide bandwidths and provide tens of Gbps data services, but atmospheric channel can be a limiting factor.
- Measurement observations to date indicate:
  - Current models for millimeter wave (>50 GHz) are inconsistent in estimation of total path attenuation (specifically in the presence of clouds+rain).
    - **Impact on air-to-ground/space-to-ground link design (e.g., power requirements, diversity requirements)**
  - High scintillation effects due to high humidity/high turbulence (along ground level) or cloud conditions (air-to-ground links) could pose significant issues.
    - **Impact on maximum terrestrial distance links, data buffering requirements, diversity requirements**