Beyond Optical Ground Terminals – How to Ensure High Quality of Service

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User Workshop on Data Formats for Optical LEO Downlinks
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Outline

• Quality of Service – Lessons Learned from
  – 50 Years of Ground Operations at the Station Complex Weilheim
  – Operations of the Interconnection Ground Sub Network (IGS)

• Description of the Problem and Parameter Space

• Potential Attempt at a Solution

• Out of Band Forward Tasking

• Implications on Ground Operations
50 Years Station Complex Weilheim
Ground Station Subsystems
The M&C Subsystem WARP10
Communications Infrastructure

<table>
<thead>
<tr>
<th>Data Link GSOC-OP / Weilheim</th>
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<tbody>
<tr>
<td>Main</td>
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<tr>
<td>Backup</td>
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<tr>
<td>Data Transmission Protocol</td>
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\(^{(1)}\) can be upgraded to 100 Mbit/s without hardware exchange
Columbus Network

- Main relays (MCC-H, MCC-M, HOSC and ATV-CC) are nearly 100% redundant.
- Col-CC has full node redundancy.
- Bandwidth: varies from 10 Mbit/s to 100 Mbit/s; Col-CC has 1 Gbit/s
Demanding Quality of Service in TM/TC Business

- High Link Availability
- Fast Response to Contingencies
- Redundancy of Essential Infrastructure Elements
- High Order of Automation
How Does This Relate to OLEODLs?
How Does This Relate to OLEODLs?

- Large data volumes
- Unreliable connection
- Corrupt transmission
- High BERs
- Distributed downlink

**OGS Network** required to overcome limited availability due to clouds
- High degree of complexity
- Highly dynamic
- Project specific topologies to be taken into account
Parameter Space (Suggestion)
How to Solve This?

The right **strategies** are essential!

- Data Dump
- Data Storage
- Data Re-Assembly
- Error Correction of Fragmented Data
- Collection of Site-Specific Weather Data
- Analysis of Station Uptime
  - Timing is a main concern
  - Complexity scales with number of stations involved
Out of Band Signaling

From Ground

- Decentralized weather analysis in \textit{regional processing units}
- \textbf{S-Band} forward tasking

From Space

- Centralized weather analysis in \textbf{MOC}
- Forward tasking via \textit{relay satellite} (RF-Band ISL)
Impacts on Ground Operations

Focus on the development and optimization of:

• Automated Systems
• Strategies
• Monitoring (24/7)
• Maintenance
• Obsolescence
Thank you for your Attention!