




**Presentation of doctoral research project:**

# 'Space systems for optical communications'

**Andrea Vettor**

# Outline

- Motivation
- Optical communication overview
- Research objectives
- Work organization

# Motivation

- **Recent trend**: integration of space technologies into private activities, such as: crop management, forest and biodiversity management, sea traffic management, internet applications, climate monitoring etc.
  **(New Space Economy)**

- Increase in requirements for telecommunication systems in terms of data rate, latency and reliability

- RF systems: performance ceiling ($R/P_{TX}$), spectrum saturation, security related problems

# Optical satellite communications

Optical wavelengths → Narrow beam → Higher antenna gain

Advantages:

- Higher $R/P_{TX}$
- No band regulation
- Data security
- Quantum applications

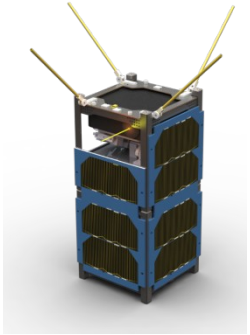
Challenges:

- Higher pointing requirements
- Cloud cover
- Components and systems TRL

Need for technology development for integration on small satellites

# Research project

- Apprenticeship contract at Stellar Project, spin-off of University of Padova
- Company background: LaserCube, a miniature optical communication terminal for nano and micro satellites, compliant to the CubeSat standard (2U)



Laser Cube

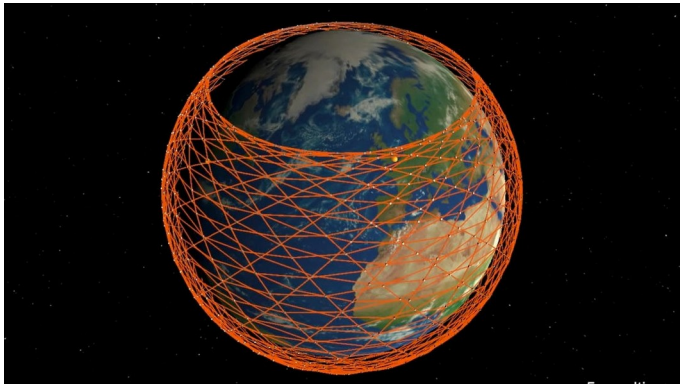
Doctoral research directions

- Network configurations
- Enabling technologies

## Networks

Emergence of commercial/scientific needs:

- Satellite generated data → DL
- Satellite generated data → ISL → DL
- Internet solutions (IoT, AIS, M2M etc.)
- Backhaul



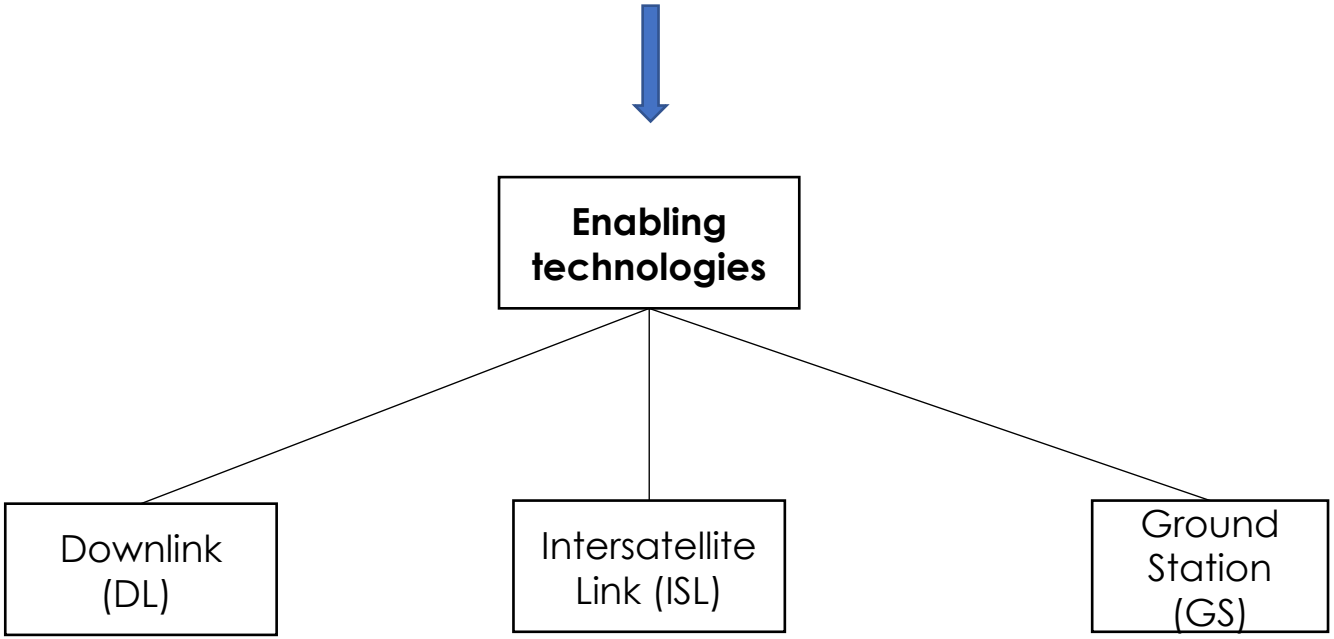
Starlink, a telecommunication satellite constellation proposed by SpaceX expected to employ optical communication.

→ Study of application specific satellite **network configurations**

# Research project

System requirements

- TX/RX signal path
- PAT (Pointing Acquisition and Tracking)
- Electronics
- Control
- …



## Enabling technologies: Downlink

- Payload optimization at system level
- Thermal/structural optimization
- PAT
- MAIT
- IOD operations and data analysis

## Enabling technologies: Intersatellite link

- Link budget definition
- Study of orbital/constellation parameters impact on system requirements
- PAT and Control optimization
- Satellite interface
- MAIT
- IOD operations and data analysis

## Enabling technologies: Ground Station

- System-level design of ground station for IOD support
- Requirements definition for GS design or third-party supplier
- ‘Progetti innovativi degli studenti’
  → PATHOS

# Work organization

| WBS NUMBER | TASK TITLE | FIRST YEAR (19/20) | | | | | | | | | | | | SECOND YEAR (20/21) | | | | | | | | | | | | THIRD YEAR (21/22) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | T1 | | | T2 | | | T3 | | | T4 | | | T1 | | | T2 | | | T3 | | | T4 | | | T1 | | | T2 | | | T3 | | | T4 | | |
| | | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S |
| **1** | **Enabling technologies** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.1 | DL terminal development/test/integration | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.2 | GS development (PATHOS) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.3 | ISL terminal development/test/integration | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.4 | IOD and data analysis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **2** | **Inter-satellite network configurations** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| … | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **3** | **Educational activities** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| … | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **4** | **Reporting, publications and thesis** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| … | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**Thanks for your attention**