30th Annual INCOSE international symposium

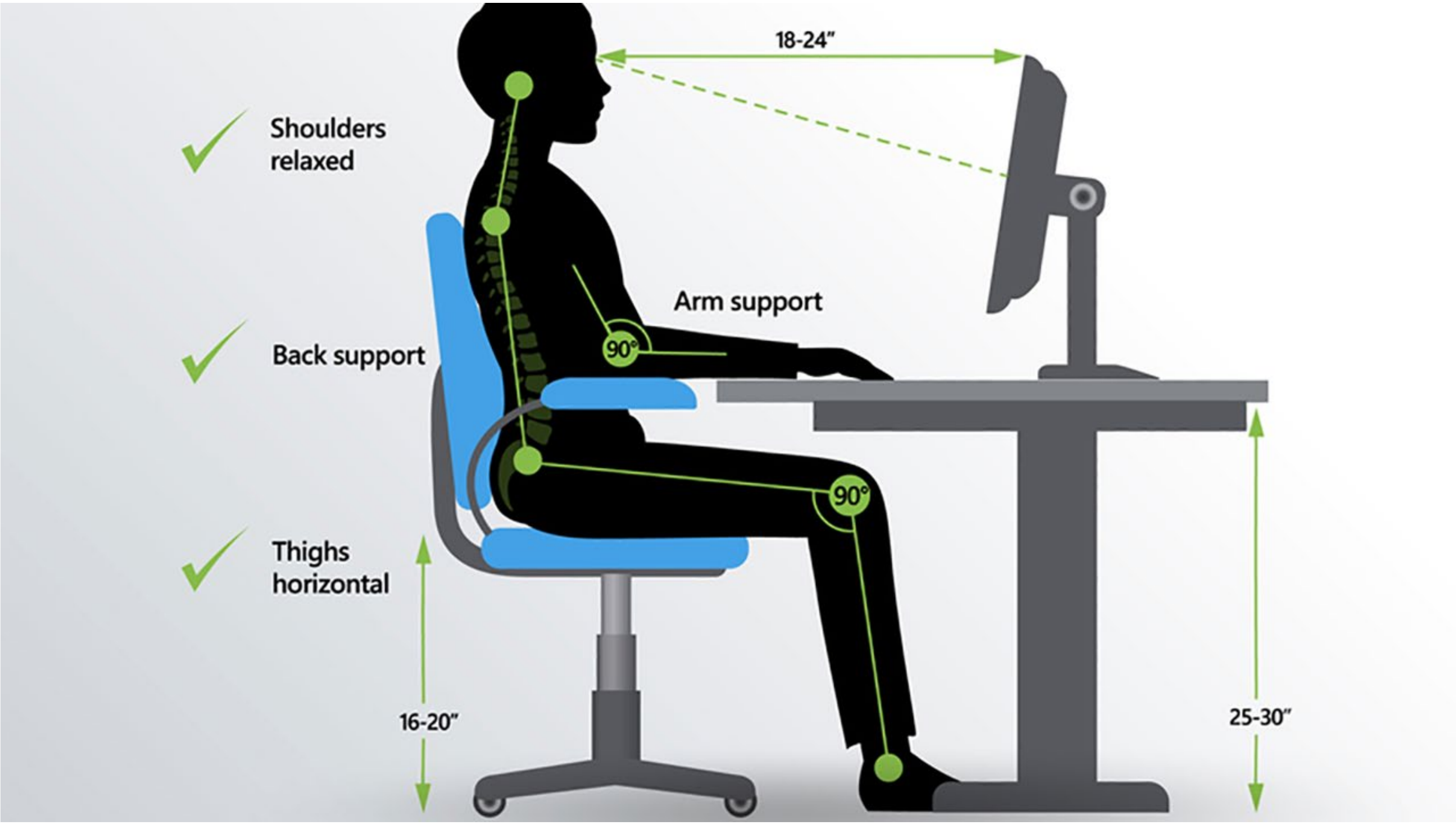
Virtual Event
July 20 - 22, 2020

Fabio G. da Silva

Distributed Architecture for Monitoring Urban Air Quality: A Systems Engineering Approach

Health & Safety Moment

chatelaine.com/home-decor/home-office-ergonomics-faq/



Home Office Ergonomics

Agenda

- Motivation
- Project goals
- Context
- Development process
- Conclusions
- Acknowledgements

Motivation

- Capstone Project
- Sponsor: Georgia Tech's PMASE program
- Co-sponsor: NASA's ESTO
- Support to New Observing Strategies (NOS) project

Project Goals

- Use of SE methods & tools
- Needs, use cases & high level requirements
- Distributed monitoring architecture
- Urban air quality domain

Why Urban Air Quality?

UN environment programme

Air pollution, which kills an estimated 7 million people every year, is the biggest environmental health risk of our time.

unenvironment.org/explore-topics/air/about-air

*The **short-lived climate pollutants** black carbon, methane, tropospheric ozone, and hydrofluorocarbons are the most important contributors to the man-made global greenhouse effect after carbon dioxide, **responsible for up to 45% of current global warming**.* (IGSD, 2013)

SUSTAINABLE DEVELOPMENT GOALS

3 GOOD HEALTH AND WELL-BEING

7 AFFORDABLE AND CLEAN ENERGY

11 SUSTAINABLE CITIES AND COMMUNITIES

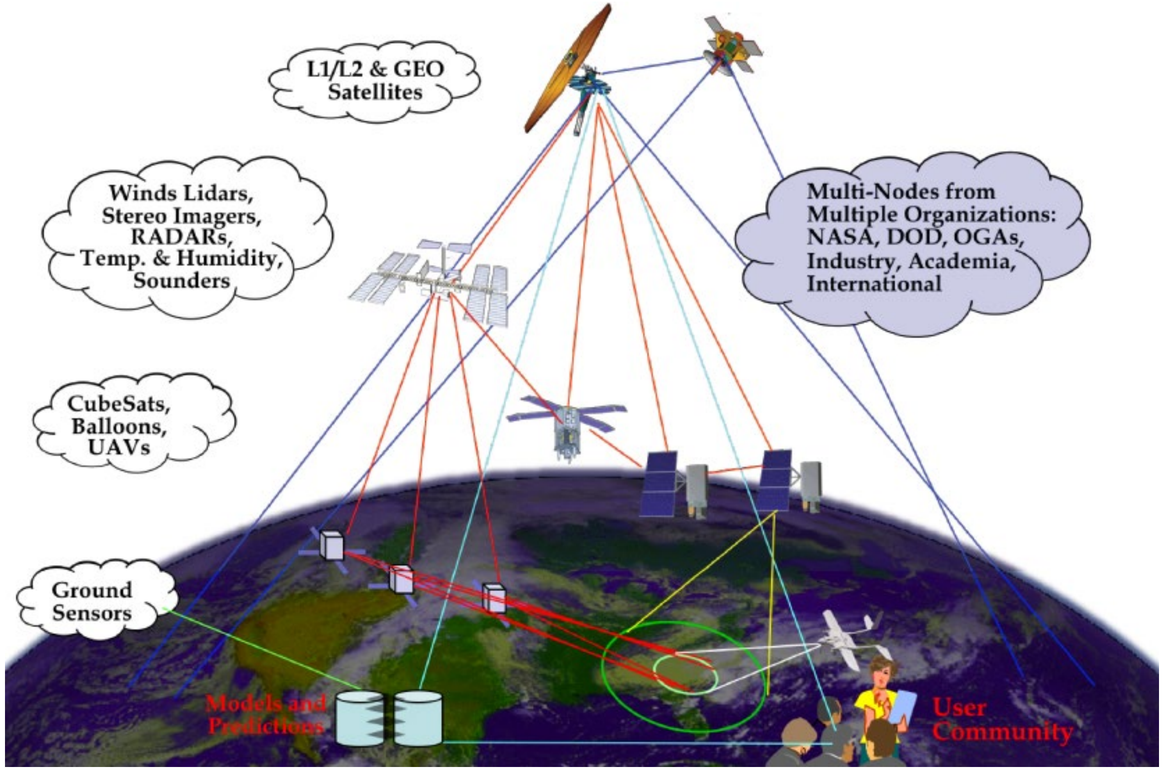
12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

17 PARTNERSHIPS FOR THE GOALS

Why a Distributed Monitoring System?

- Variety of systems available
  - Satellites to indoor monitoring
- Why not an interconnected platform?
- Allow data sharing and processing
- Better decision-making
- More research data



ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20190028350.pdf

Development Process

- Mission Analysis
- Use Case Analysis
- Sociotechnical Analysis
- Requirements Analysis
- System Architecture

Development Process

- **Mission Analysis**
- **Use Case Analysis**
- **Sociotechnical Analysis**
- **Requirements Analysis**
- **System Architecture**

Mission Analysis

Monitoring

- Access by nodes
- Raw & processed data
- Data validation (reliability)

Action

- Action from nodes
- Current situation triggers
- Enhanced monitoring or mitigation

Predictive

- Action from nodes
- Predictive model triggers
- Avoid or reduce consequences

Mission Analysis

Use Case Analysis

Sociotechnical Analysis

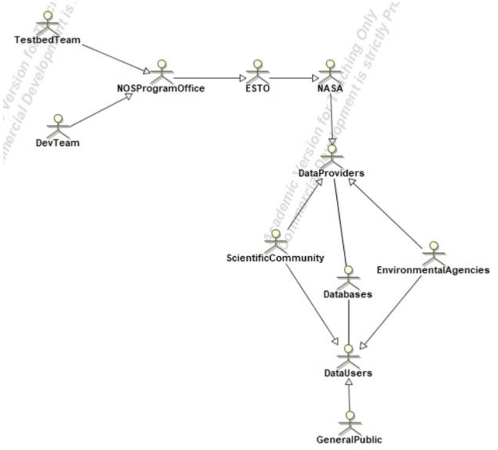
Requirements Analysis

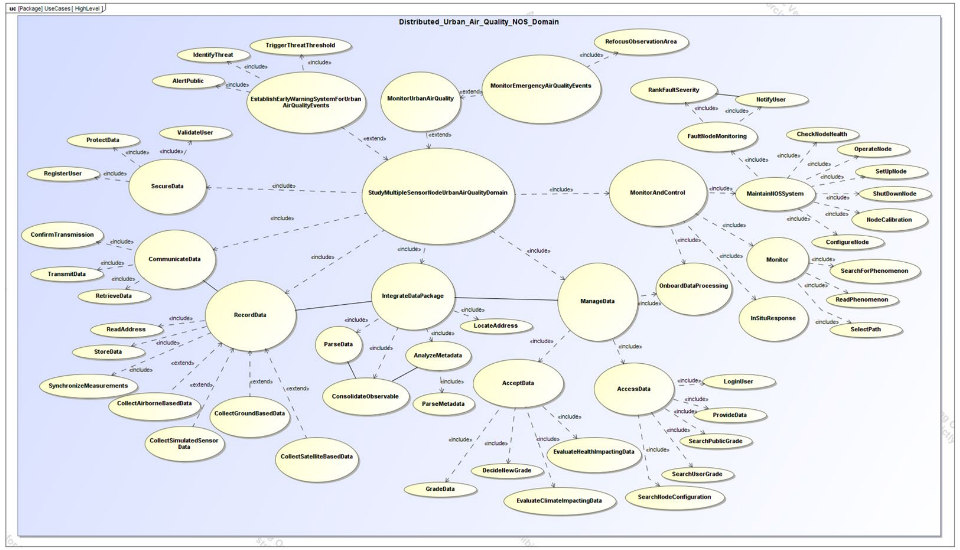
System Architecture

Use Case Analysis

- Actors identification

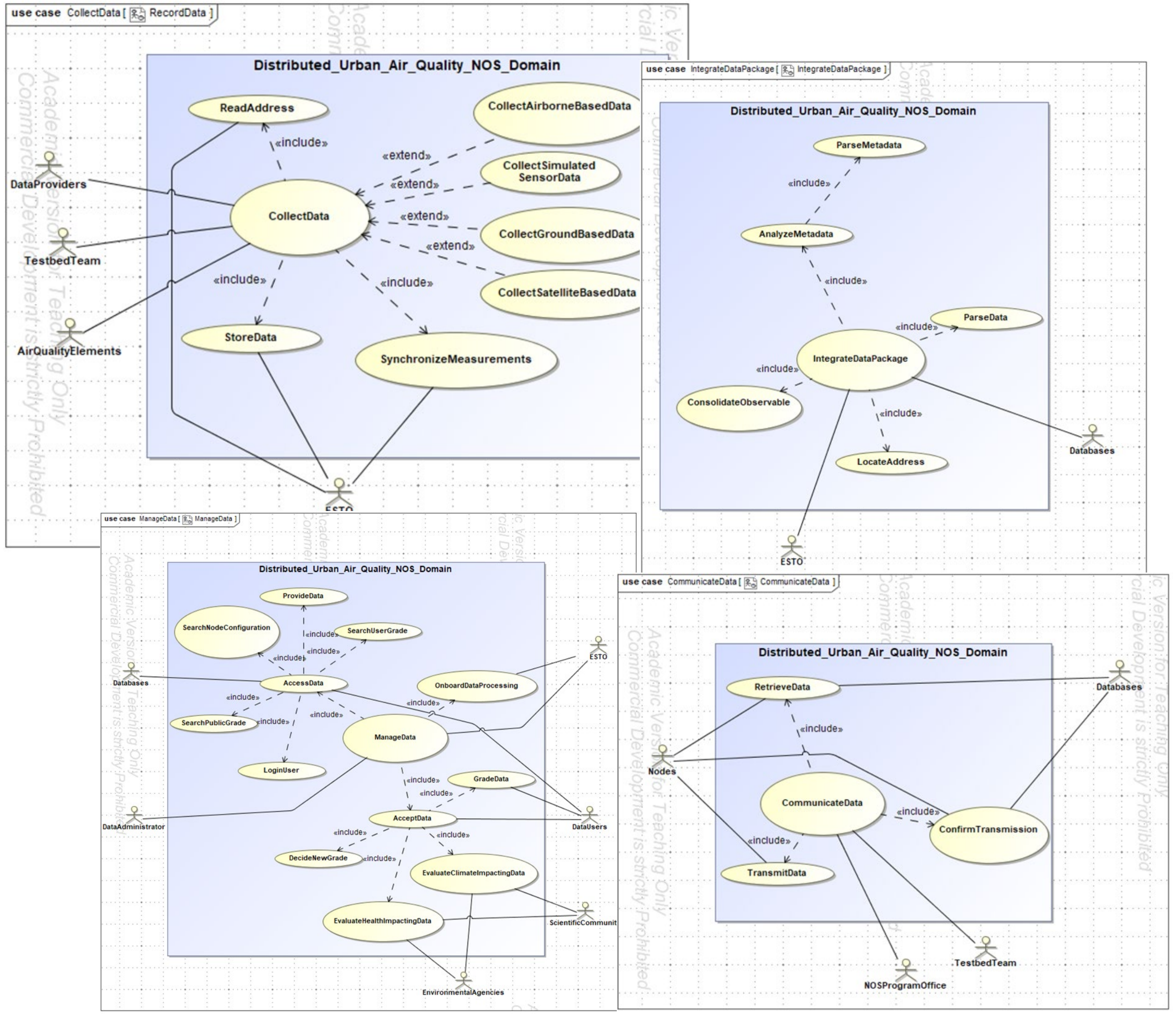
- Multi-level use cases





Use Cases

- Collect Data
- Integrate Data
- Manage Data
- Communicate Data
- Secure Data
- Monitor & Control



Mission Analysis

Use Case Analysis

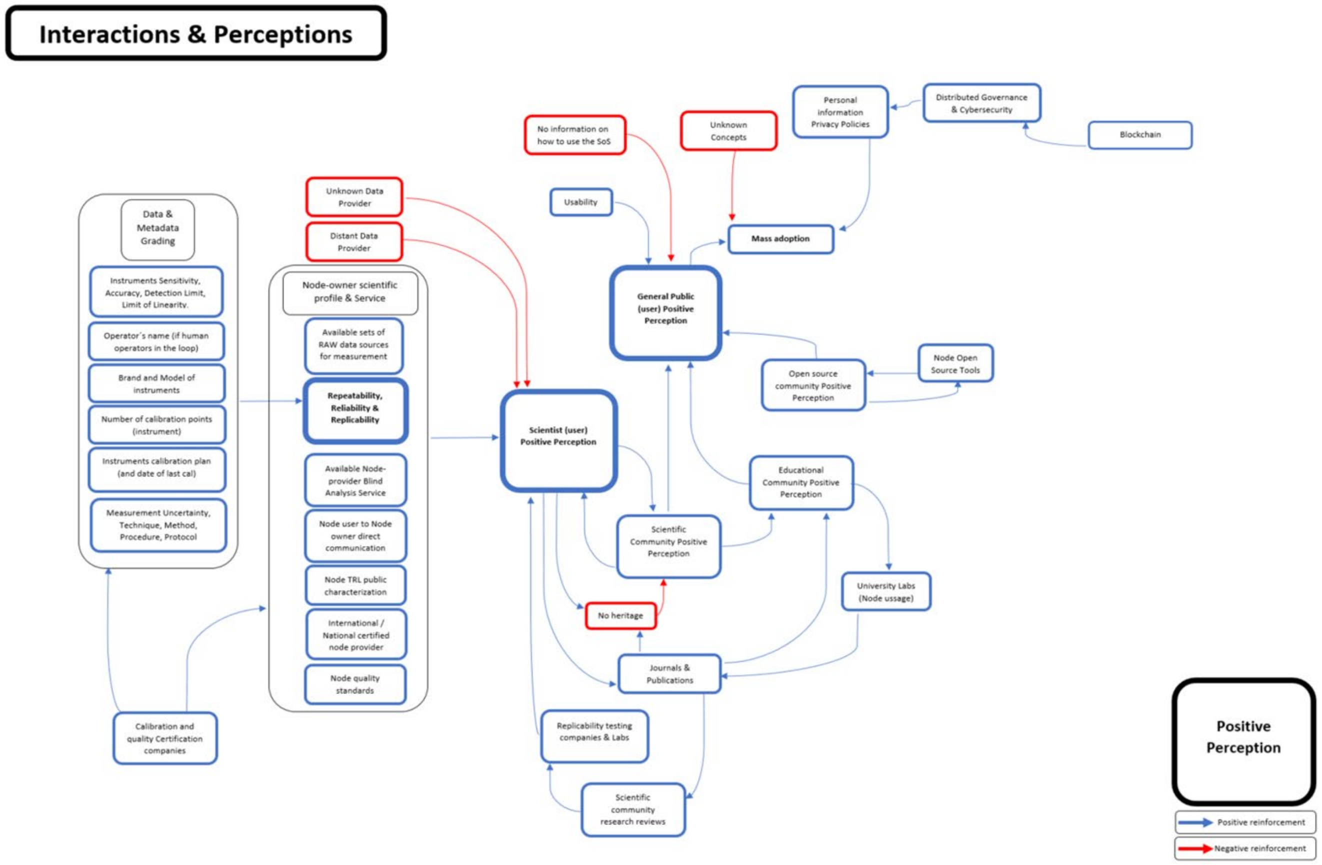
Sociotechnical Analysis

Requirements Analysis

System Architecture

Sociotechnical Analysis

- High-level mapping
- Support to requirement analysis
- Perception & confidence
- Required & desired
- Key aspects of influence



Mission Analysis

Use Case Analysis

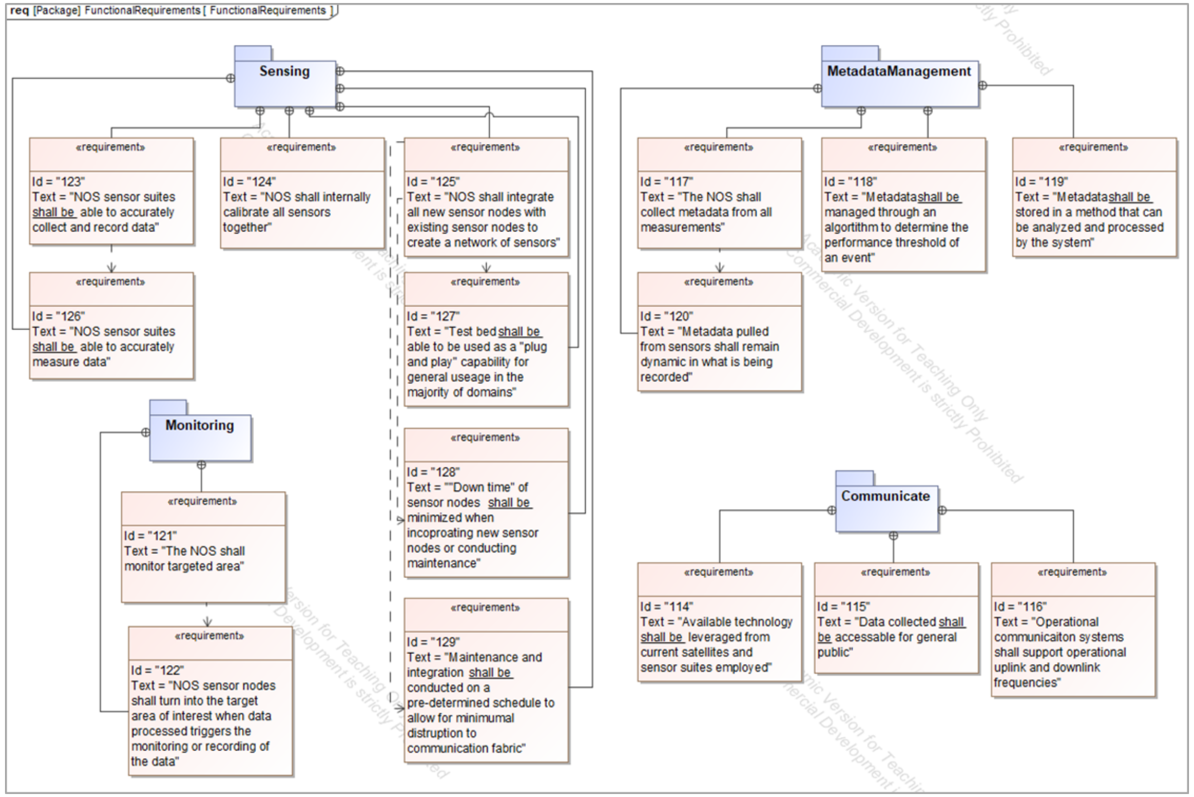
Sociotechnical Analysis

Requirements Analysis

System Architecture

Requirements Analysis

- Functional
- Data architecture
- Hardware architecture
- Sociotechnical
- Project management
- Air quality
- Human systems integration



Mission Analysis

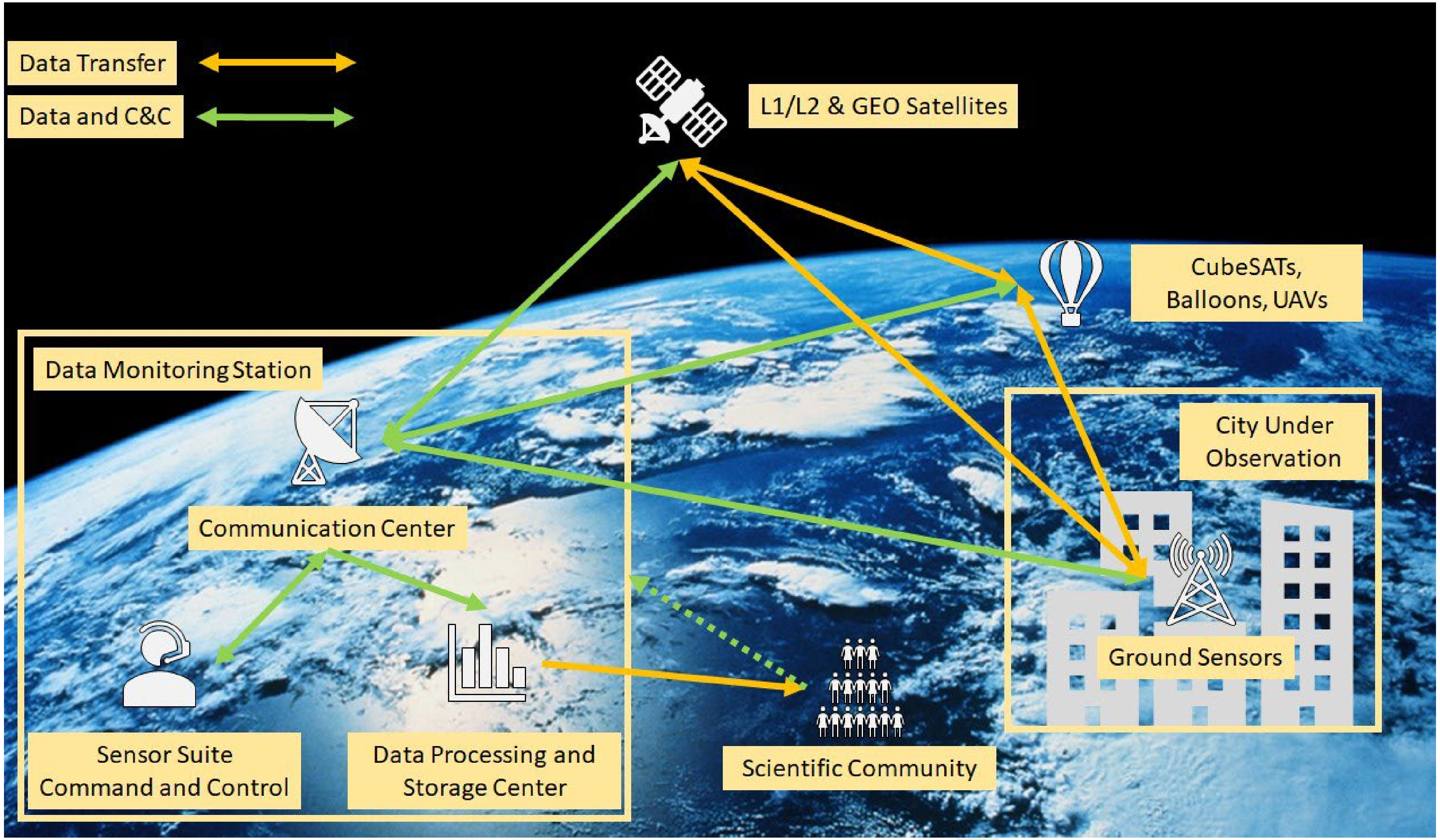
Use Case Analysis

Sociotechnical Analysis

Requirements Analysis

System Architecture

System Architecture



System Architecture

NOS System

Data System	Information System	Support System	User System

Conclusions

- Flexible network node interface increase acceptance
- User perception and confidence is important
- 3 “Rs”: Repeatability, Reliability & Reproducibility
- Data validation and security as building blocks
- Commercial partners would enhance capabilities
- International standards may speed up definitions
- This is a starting point. Much further work still required.

ccacoalition.org/en/news/ccac-scientists-put-out-call-comments-climate-and-clean-air-responses-covid-19

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