Microservices architecture for CubeSat mission control systems

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ESTCube-2

Launch: 2019 Q1-Q2*
Mission Control System - Overall

Operator(s) → MCS → Ground Station → Ground Station → Ground Station

MCS (Mission Control System)
ESTCube-2 Team - Structure

SYS  AOCS  EPS

COM  OBCS  CAM

ST  STR  MCS*

MCS – Mission Control System
ESTCube-2 MCS - Role

• Extension of the ground station

• Track and maintain communication

• Control and exchange information
ESTCube-2 MCS - Team

• 10+ passionate students
• Following industry best practices
• Work-in-progress since 2016
Monoliths
**ESTCube-2 MCS - Vision**

- Fault-tolerant, Scalable and Secure
- Upgradable, Migration-friendly
- Easy for newcomers to adopt
ESTCube-2 MCS - Challenges

- Coordination
- Heterogenous
- Automation
- Deduplication
- Processing
ESTCube-2 MCS - Architecture

- Microservices architecture
- 50+ independent applications
- Powered by Docker
Containers

• Operating-system-level virtualization

• 1 container = 1 application

• 1 application does 1 job!
Containers versus Virtual Machines

![Diagram showing the comparison between Containers and Virtual Machines]

- **Containers** (Docker)
  - **App A**
  - **App B**
  - **App C**
  - **Bins/Libs**
  - **Host OS**
  - **Infrastructure**

- **Virtual Machines (VM)**
  - **App A**
  - **App B**
  - **App C**
  - **Bins/Libs**
  - **Guest OS**
  - **Hypervisor**
  - **Infrastructure**
Containers - Health
Containers - Scaling
Containers - Versioning

Version 1.0

Version 1.5
Containers - Scalability

- Scale horizontally across hosts
- Self-healing systems
- Powered by kubernetes
Containers – Pros and Cons

- Lightweight
- Resource Utilisation
- Build Once, Run Anywhere
- Security
- Complicated if not done properly
ESTCube-2 MCS – Hardware Test Platform

Operator(s) → MCS

TTCN-3 based HWT powered by Elvior

System under test → HWT – Hardware Test Platform

Spacecraft in orbit

31 May, 2017

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ESTCube-2 MCS – Model Based SE

- Predicting behaviour over time
- Models and simulation integration
- Dynamic nature of missions
ESTCube-2 MCS – Contact Terminal*

- Quicker than “clicking/tapping”
- Scripting capabilities
ESTCube-2 MCS – Contact Automation

- Make the operator’s life easier
- Auto re-scheduling of packets
- Dynamic queue assignment
ESTCube-2 MCS – Data Processing Platform

- Quick add/remove scientific libraries
- Better collaboration
- Highly scalable

DPP – Data Processing Platform
ESTCube-2 MCS – Adaptation
ESTCube-2 MCS – Offering

- MCS As A Service (MCSaaS)
- Partnerships (Operations and Resources)
Takeaway

• Make everything modular
• Think scalability
• Think interoperability
Ait äh!

(Thank you in Estonian)