TRUE OPERATIONS AUTOMATION: FROM A GEO FLEET TO A SINGLE LEO SATELLITE

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**CHALLENGE**

- Satellite operations are simple and can be largely anticipated
- Humans needed (even if subsystems automated)
- Large fleet, large team
- Tedious tasks
VISION

- End-to-end unattended automation
- Subsystems orchestrated

- One (1) supervisor
- Keep the manual mode!
SOLUTION

GSAW 2016 - True Operations Automation: from a GEO Fleet to a Single LEO Satellite
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The subsystems kernels shall
- Be automatable
- Expose an automation API

The automation components shall
- Exploit the kernel automation API
- Be controllable
- Expose a control API to be used by the orchestrator
PROCEDURES

- Assisted mode
  - Rewrite or convert manufacturer FOPs to express them in the subsystem automation language

- Unattended mode
  - Remove user interaction
  - Pre- and post-checks
  - Support the switch from unattended to assisted mode
  - Provide feedback upon non-nominal paths being taken
  - Handle inputs/outputs via central data repository

Updates required!
The orchestrator may take a long-term plan from a MPS and allows short-term plan approval.

API for external systems to add unplanned activities (such as payload reconfiguration).

Activities are shown in a Gantt display.

Resource conflicts are detected and reported.

Orchestration includes:
- Chain of activities for different subsystems
- Dependencies and data exchange
- Scripted activities for dynamic planning
**ORCHESTRATOR: DYNAMIC PLANNING**

**Planning**
- East/west manoeuvre 2-4 days after south one
- South manoeuvre planning activity: internal flyplan activity that calls FDS for the computation of the manoeuvre details...

**Execution**
1. **T1**
   - Ranging campaign before south manoeuvre
   - The ranging campaign gets executed

2. **T2**
   - South manoeuvre every 14 days
   - East/west manoeuvre 2-4 days after south one

...and schedules the manoeuvre execution at the precise time and for the precise duration...
GLOBAL AWARENESS

- Master Fleet Terminal (MFT)

  Operations orchestrator (**flyplan**)

  Infrastructure monitoring (**NMS**)

- Centralized logging (**centralLog**)

- Alarms (**fleet dashboard**)

- Monitoring of plan execution
- Notify non-nominal situations
  - Drill-down to offending issue
  - Interact with the plan (stop/resume, shift...)
  - MCS workstations ready for intervention (assisted mode)
GLOBAL AWARENESS: INFRASTRUCTURE MONITORING

- NMS
  - Independent hardware and software monitoring
  - Alarm routing to the centralized logging module (next slide)
  - Multiple views (tactical, network, processes...)
GLOBAL AWARENESS: CENTRALIZED LOGGING

- *centralLog*
  - Selected messages from all subsystems
  - Only application with audible feedback
  - Error and warning messages acknowledge
  - Live and retrieval modes
GLOBAL AWARENESS: ALARMS (OUT OF LIMITS)

- fleet dashboard
  - Current list of satellite alarms (out of limits, status of TM link)
  - No sound
  - No acknowledge
  - Live mode only

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APPLICATION CASES

- Trade-offs performed by our customers have concluded that they will apply fully-automated operations

- GMV’s full automation solution has been adopted in two scenarios:
  - (GEO) Fleets
  - Low cost mission: CHEOPS CHaracterising ExOPlanet Satellite
    - The CHEOPS mission is a partnership between Switzerland and ESA's Science Programme (first S-class mission from ESA)
    - Participation from a number of European countries Austria, Belgium, France, Germany, Hungary, Italy, Portugal, Spain, Sweden, and the United Kingdom
    - http://sci.esa.int/cheops/
    - http://cheops.unibe.ch/
TELECOM FLEET OPERATIONS

- 2-30 Geostationary satellites.
- +1 spacecraft every 1-4 years.
- Few routine operations per week.
- Operations involve FDS (comput.), M&C (ground) and MCS (sat).
- Spacecraft is always visible → MCS in the operations loop
- Controllers team cannot grow linearly → Need to automate
LOW COST MISSION OPERATIONS

- Relatively simple routine activities.
- Limited number of interfaces within ground systems and well defined and fixed processes (in routine)
- Operations involve FDS, G/S and MCS
- Unmanned downlink passes
- Manned uplink passes for monitoring the automation system
- Heavy budget constraints → need to automate operations + need of simple/reused systems
GEO FLEET CASE

- MFT: Four wall-mounted 55” displays plus two monitors
- flyplan, new fleet sequences
- Thales’ SMAC, flyplan interface
- GMV’s hifly and autofocus
- Airbus’ PIL procedures → SPELL with SES’ PIL2SPELL translator
- Unattended mode: a few services added to hifly & SPELL
- GMV’s focusgeo and autofocus
- New SOL procedures
LOW-COST MISSION

- **flyplan**, new sequences
- MCS based on ESA’s SCOS-2000
- MCS Automation: thin layer based on simple python scripts (basic requirements, no assisted mode)
- Relatively simple operations: - pass-independent, and - pre, during, post-pass activities
- GMV’s **focusgeo** and **autofocus**
- New SOL procedures
LESSONS LEARNT

- Manual → assisted automation is tough, → unattended tougher
- End user involvement is always important, here critical
- Unattended operations
  - No human will check your thruster firings: extensive data validation and integrity
  - When something goes wrong, tools and information shall be available
  - Put practices in place for keeping the operational knowledge
- Technical corner:

“A robot may not harm humanity, or, by inaction, allow humanity to come to harm.”
— The Zeroth Law, Isaac Asimov
Thank you

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