



arianeGROUP

ARIANE 6 FLIGHT SOFTWARE DESIGNED FOR A SIMPLER VALIDATION

Ada-Europe 2018
Lisbon, Portugal

Presented by Philippe Gast
20th June 2018

ARIANE GROUP

A world leader in access to space, serving institutional and commercial customers and supporting Europe's strategic independence

The flight software is developed by Ariane Group



A photograph of an Ariane 6 rocket on the launch pad at dusk. The rocket is the central focus, standing vertically on a mobile launcher platform. The launch pad is illuminated by several tall, lattice-structured service towers and a large floodlight on the right. The sky is a mix of orange and blue, indicating the time is either dawn or dusk. The text 'Ariane 6 maiden flight 2020' is overlaid in large, bold, red letters on the left side of the image.

Ariane 6 maiden flight 2020

THE SOFTWARE OF A LAUNCHER IS RESPONSIBLE FOR

Mission description

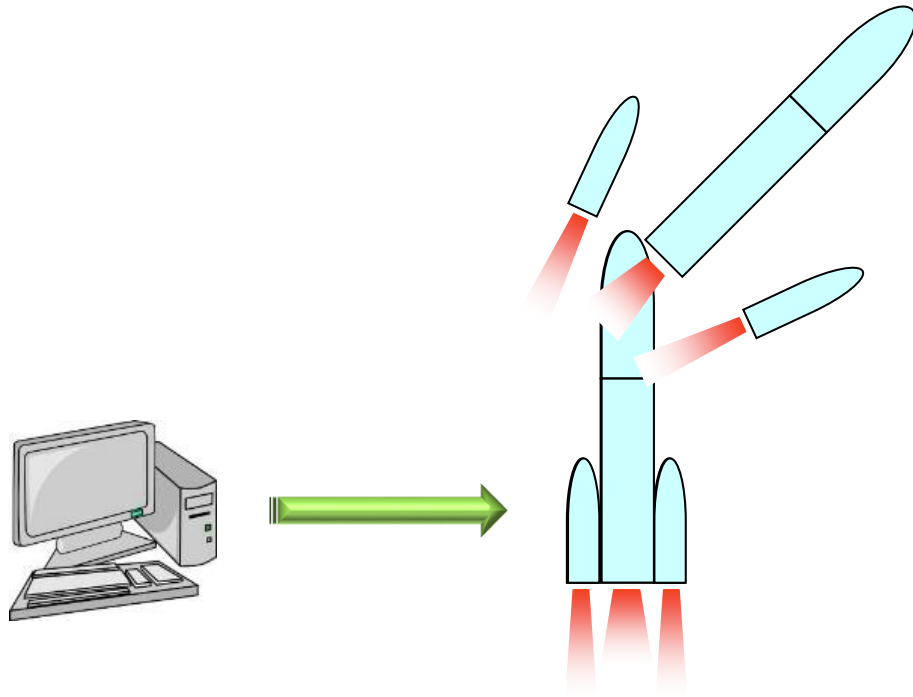
Engine ignition

Flight control

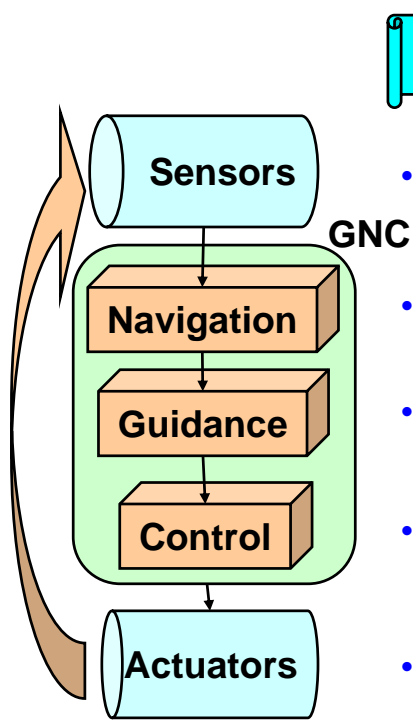
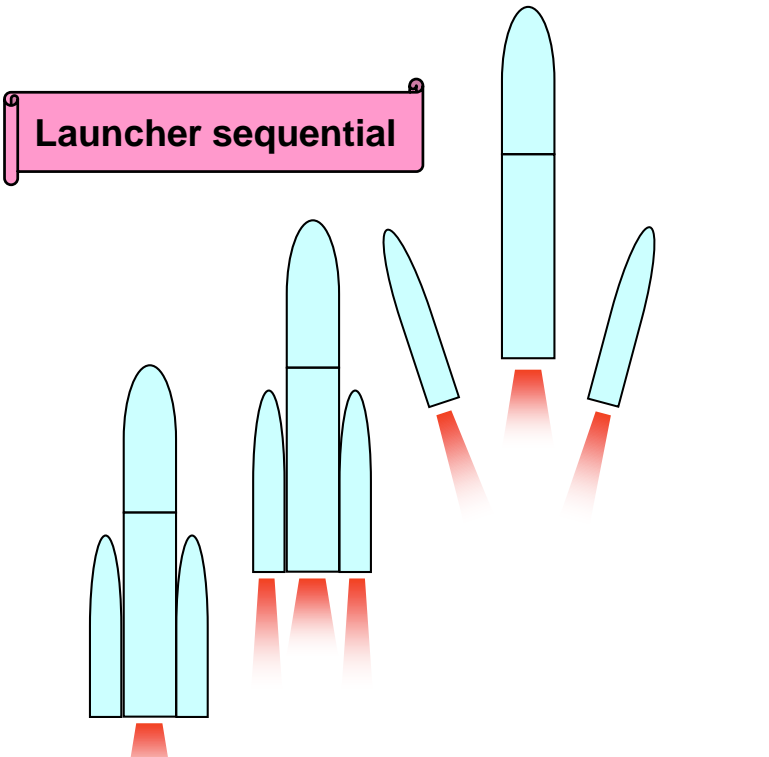
Stage release

Attitude control

...



A FLIGHT SOFTWARE IS MAINLY COMPOSED OF



Control algorithms

- Acquisition of measurement
- Where am I ?
- Where shall I go ?
- Compute the commands
- Send commands to actuators

Middleware

THE ARIANE 6 FLIGHT SOFTWARE DESIGN DRIVERS

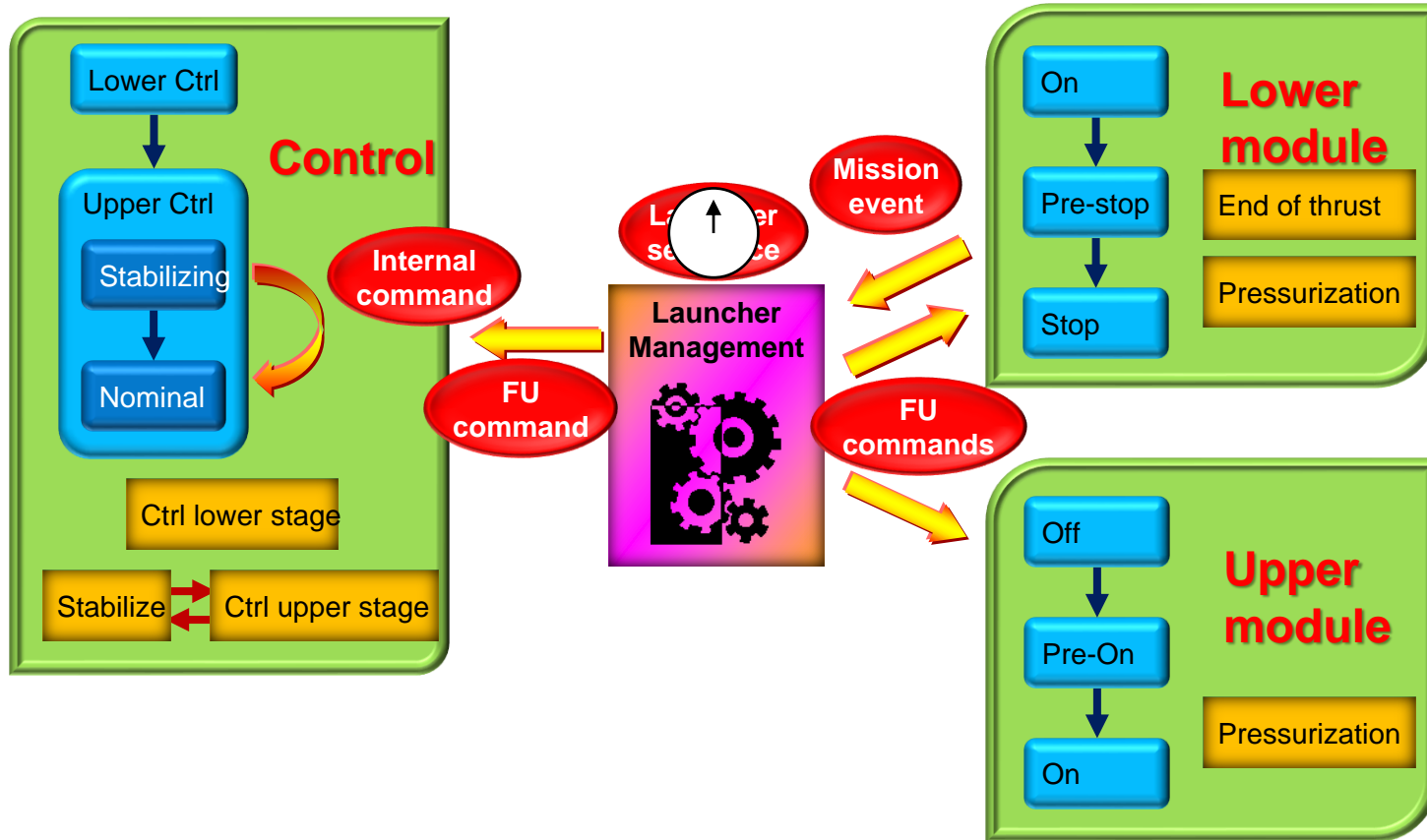
The objective is to define a software real time design which is correct by construction and fully deterministic

- **To reduce the tests combinatory,**
- **To be robust to system changes,**
- **To be consistent with incremental development approach,**
- **To permit software debug in non-real time environment**

The solution

- **A method to define the functional architecture of the system: the Functional Unit approach**
- **A synchronous design for the Flight Software synchronised with avionics,**
- **A dedicated light validation test facility to support debug**

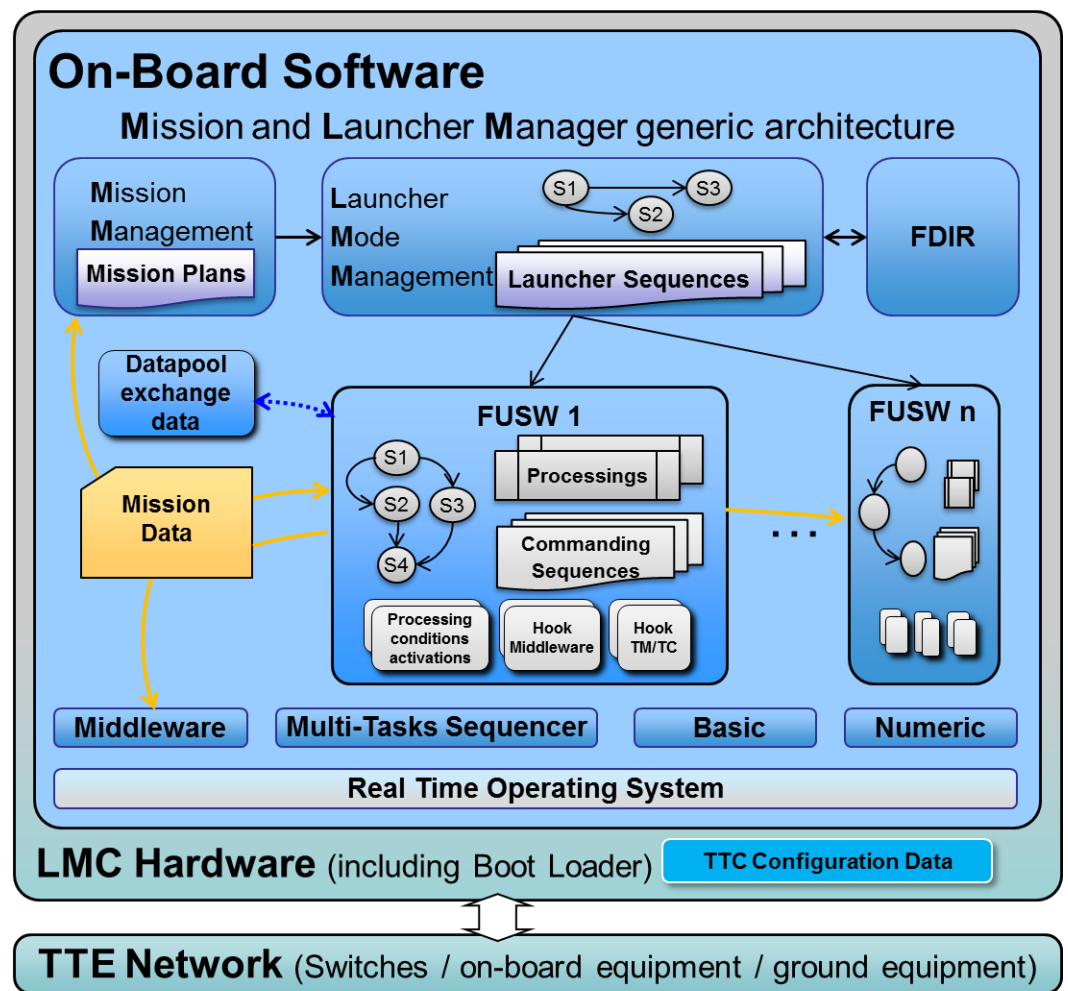
THE FUNCTIONAL UNIT APPROACH



FLIGHT SOFTWARE DESIGN OVERVIEW

Flight Software design rules

- Flight Software implementation strongly similar to system Functional Definition
- Functional software processing implemented in a limited number of cyclic tasks
- No acyclic tasks
- High consistency/low coupling limiting interface between Functional Unit

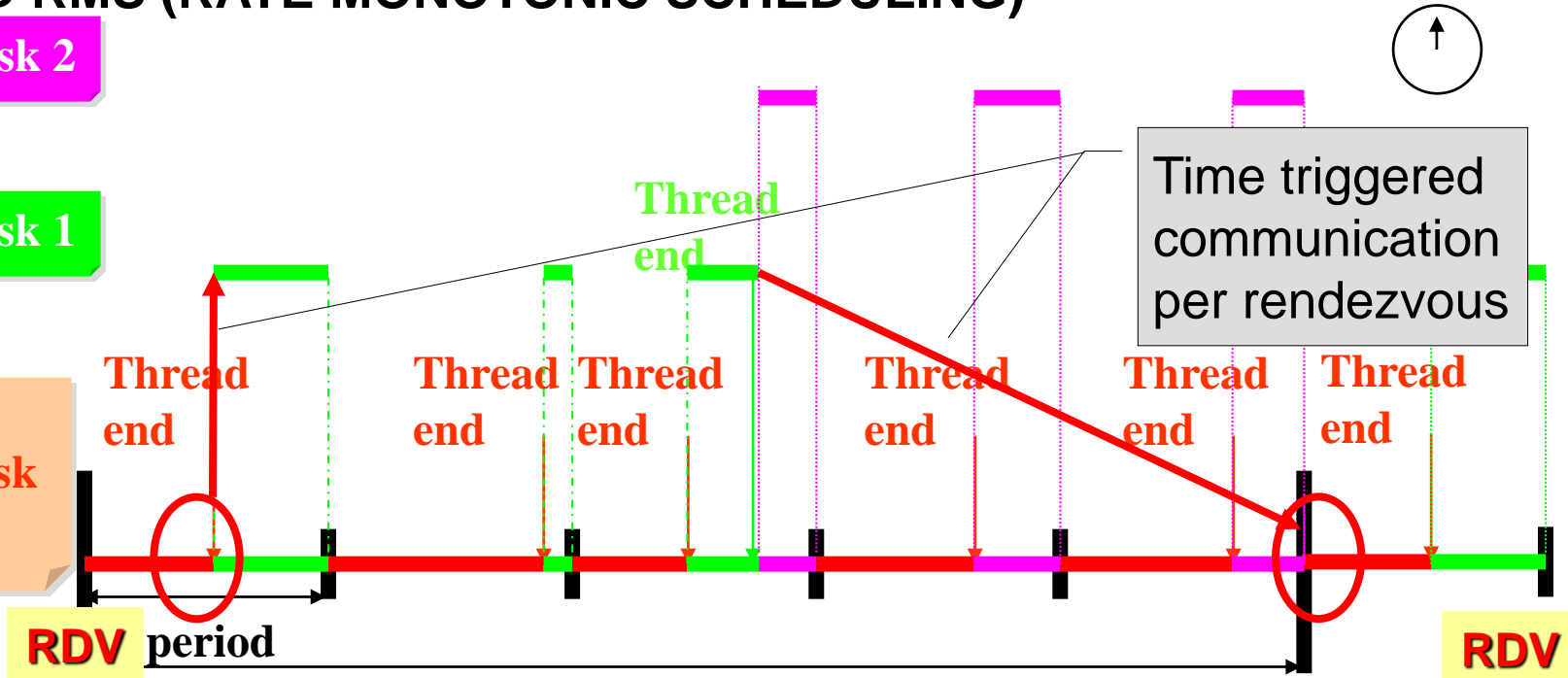


EXTENDED RMS (RATE MONOTONIC SCHEDULING)

Harmonic task 2

Harmonic task 1

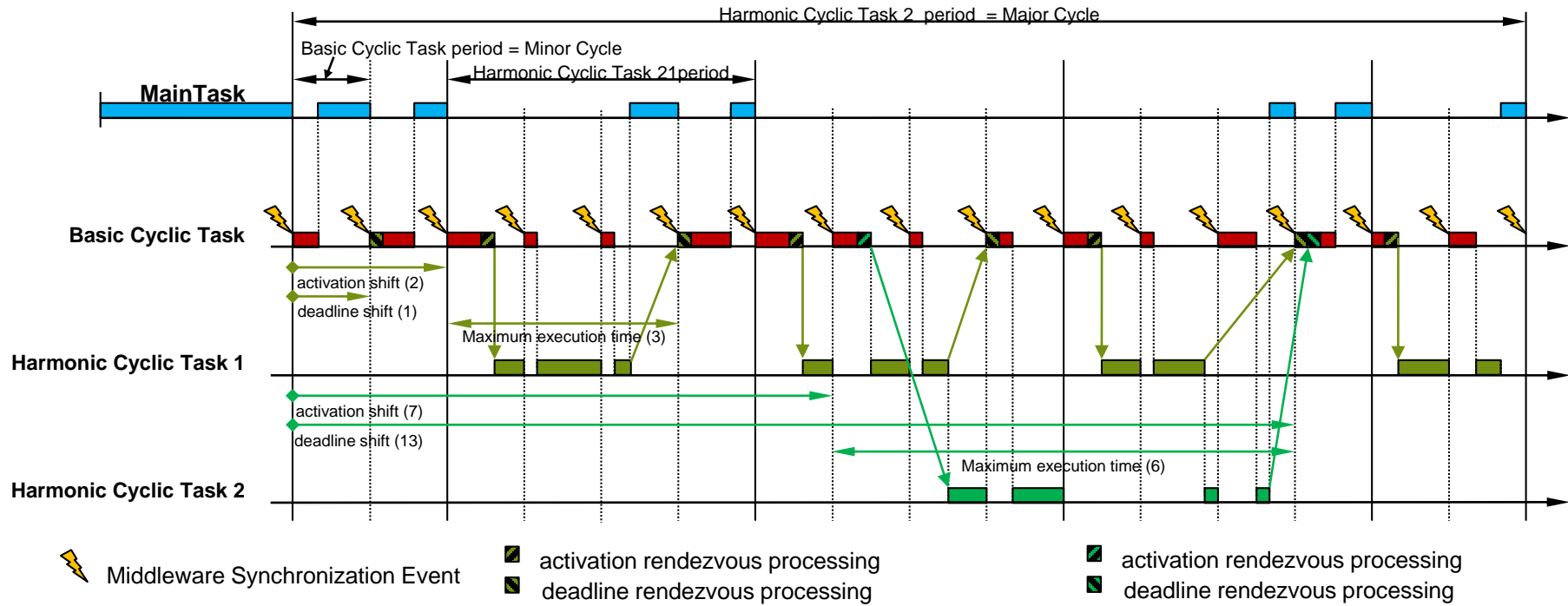
Highest frequency task



Real-time architecture manually designed

- ✓ List of threads, periods, deadlines, offsets
- ✓ Deployment of functional blocks on threads
- ✓ Mission Launcher Manager executed step by step at highest frequency

A DEDICATED REALTIME SEQUENCER



No shared data

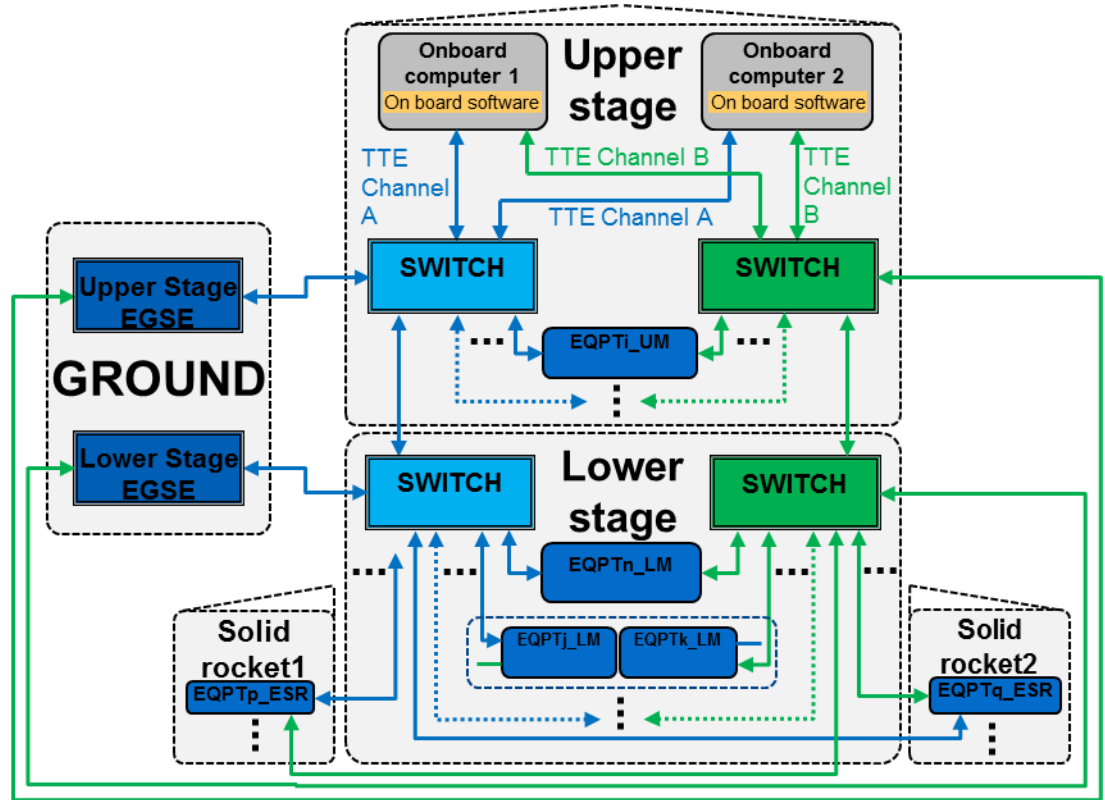
ON-BOARD SOFTWARE IN THE AVIONIC ARCHITECTURE

Processor's redundancy concept

- Same on-board software running in each processor in hot redundancy
- No data exchange between the two processors
- Each processors receives same data
- Processor fail silent

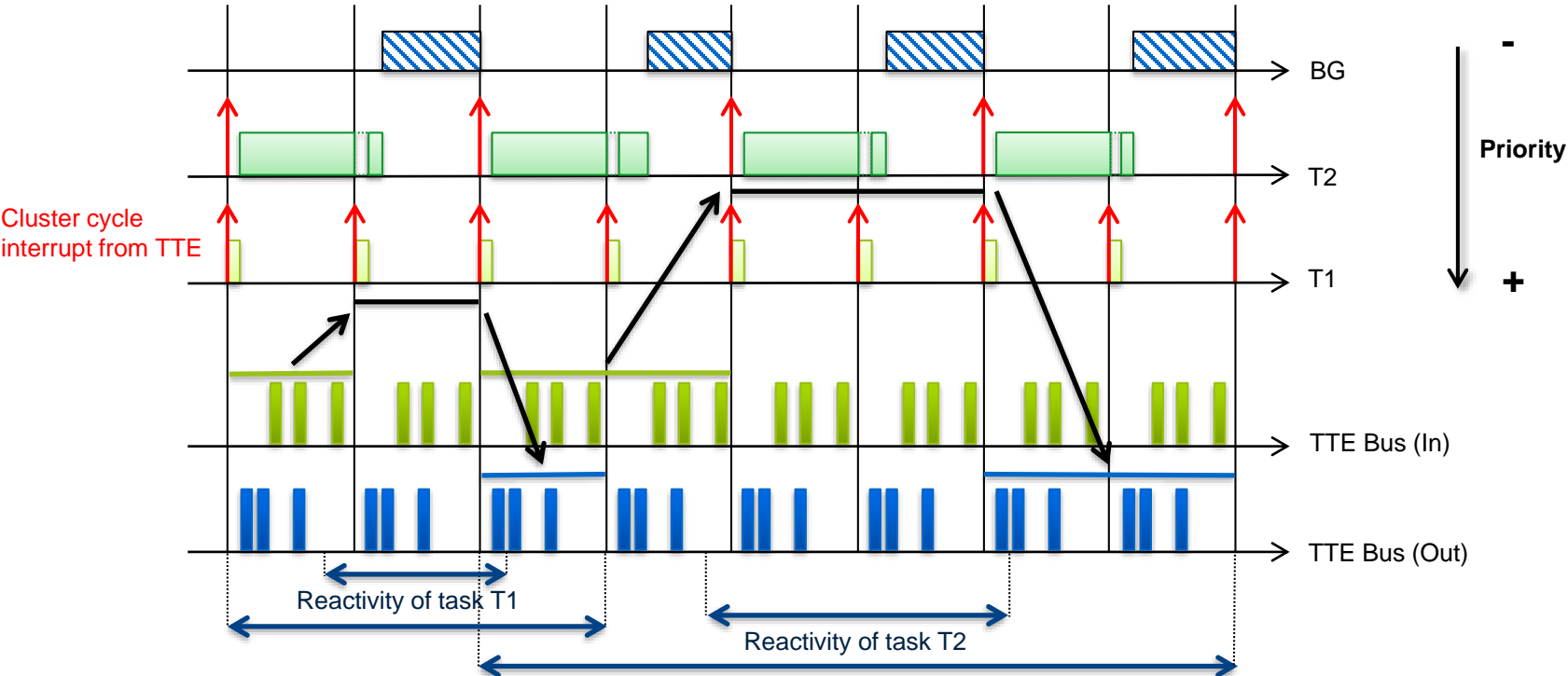
Avionics Communication Bus

- The Communication System is in charge of exchanging functional and telemetry data flows between avionic equipment of the launcher during both ground and flight phases. It is based on Time Triggered Ethernet (TT Ethernet).



I/O SYNCHRONISATION : LAST IN NEXT OUT

On target



FLIGHT SOFTWARE VALIDATION

2 types of Software Validation Facilities

Hardware Software Validation Facility (HSVF)

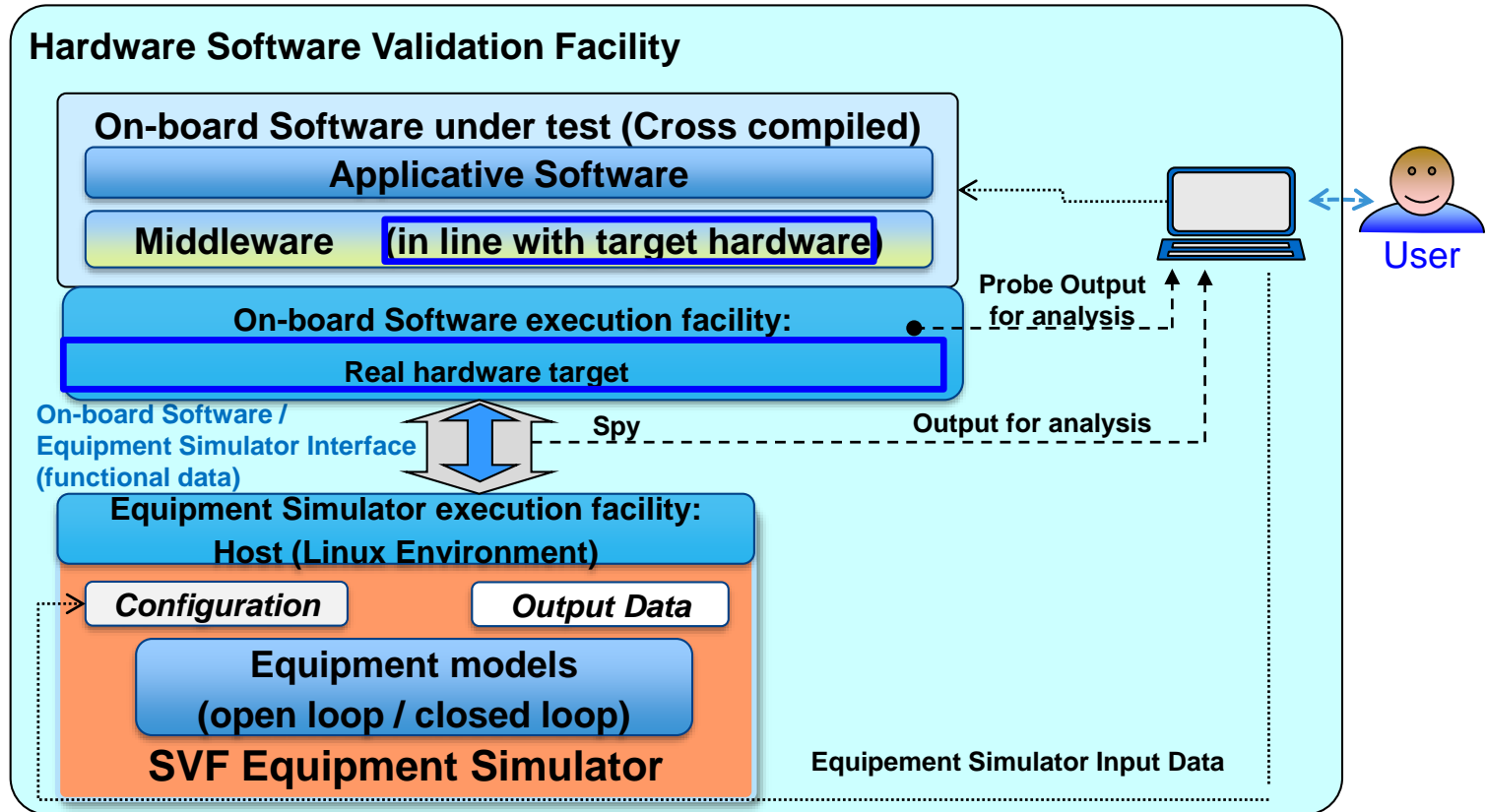
- With real on-board computer and avionics Interface (Time Trigger Ethernet)
- Real-time representativeness / full functional representativeness
- To be used for Ariane 6 flight software formal validation
- Expansive (only one item)

Emulated Software Validation Facility (ESVF)

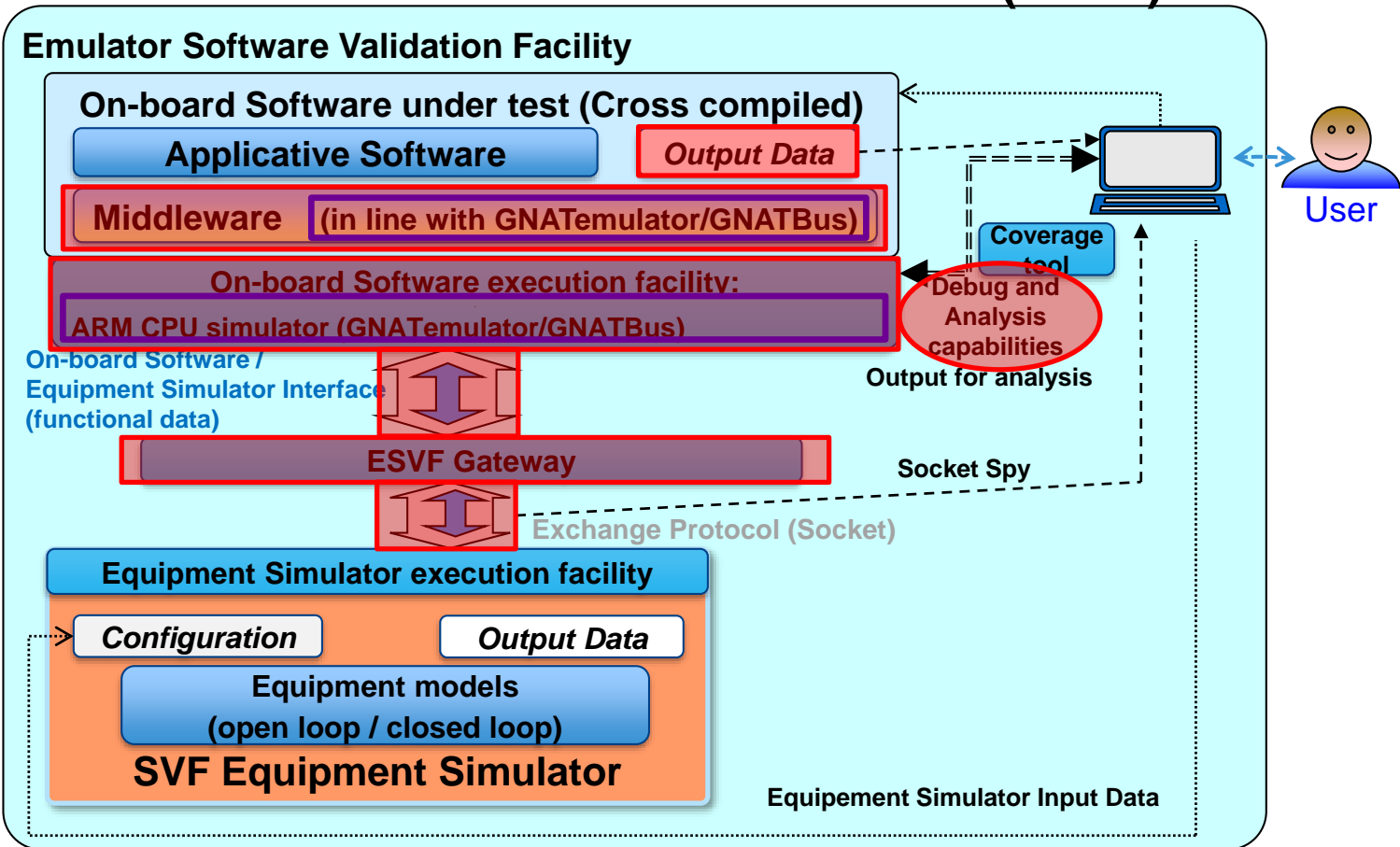
- With on-board processor emulator executed on host
- NOT real-time representativeness / full functional representativeness (**independently of real-time aspects**)
- Cheap (no dedicated Hardware)
- Used for flight software validation preparation/debug

Test preparation is similar between HSVF and ESVF; test execution is faster on ESVF (no real-time)

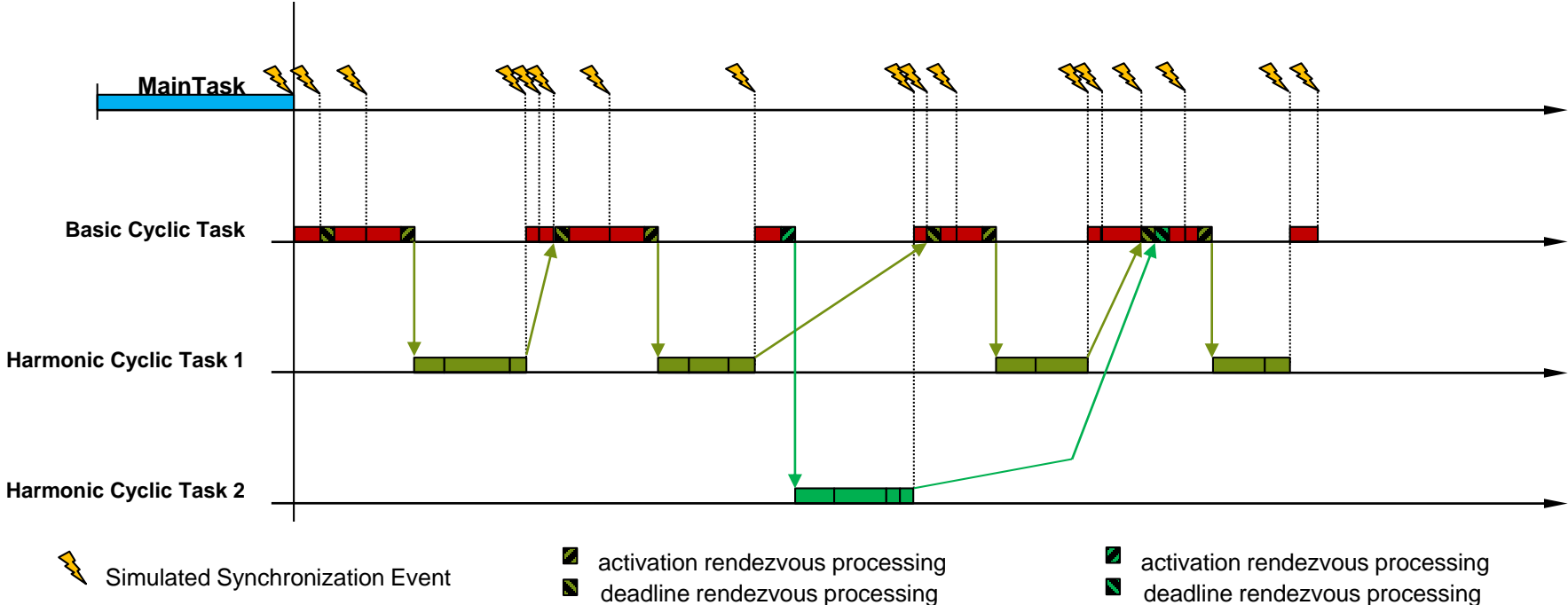
HARDWARE SOFTWARE VALIDATION FACILITY (HSVF)



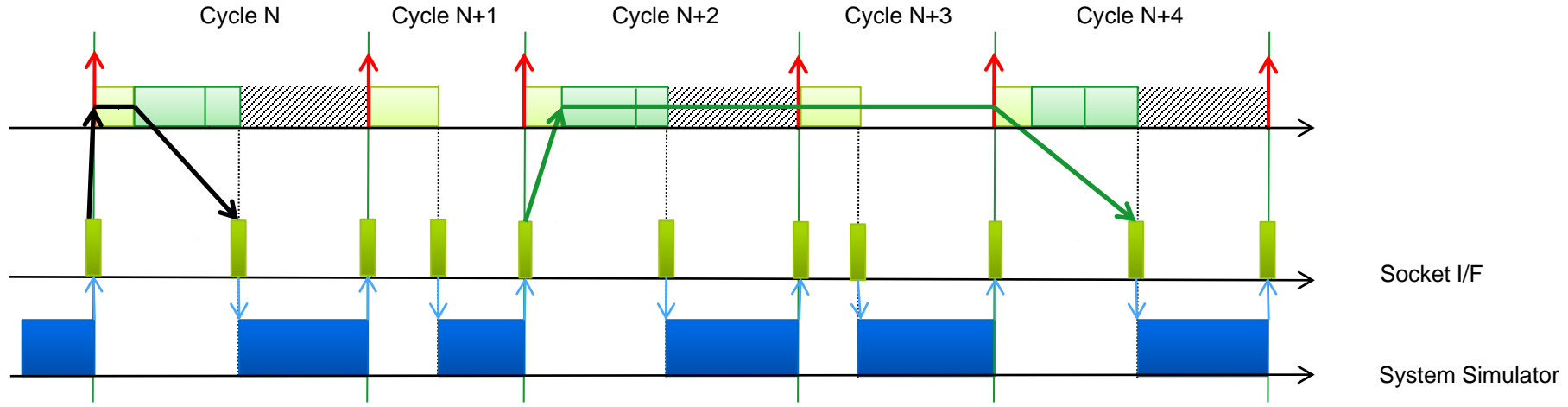
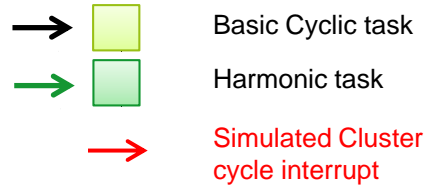
EMULATOR SOFTWARE VALIDATION FACILITY (ESVF)



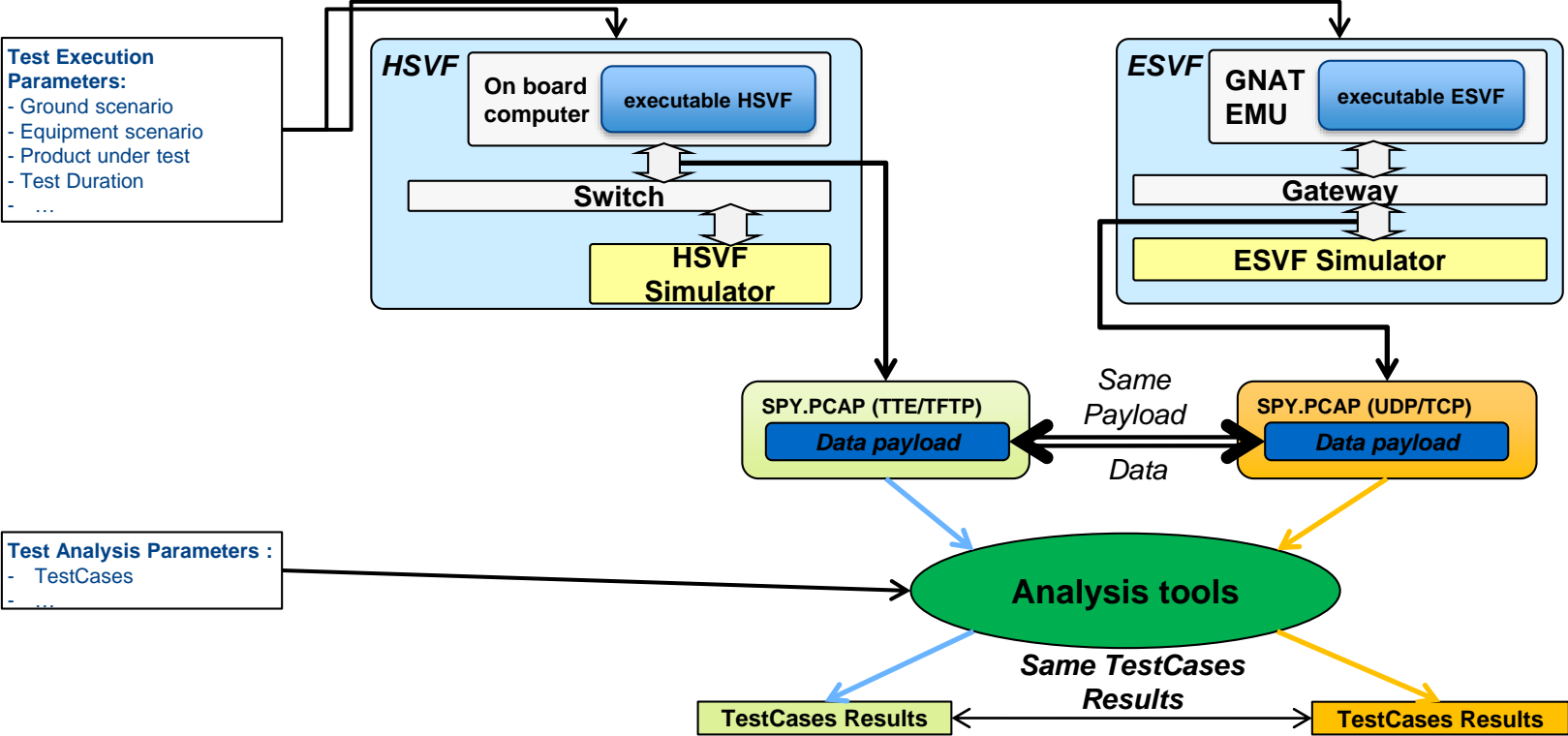
REAL-TIME SEQUENCER ON ESVF



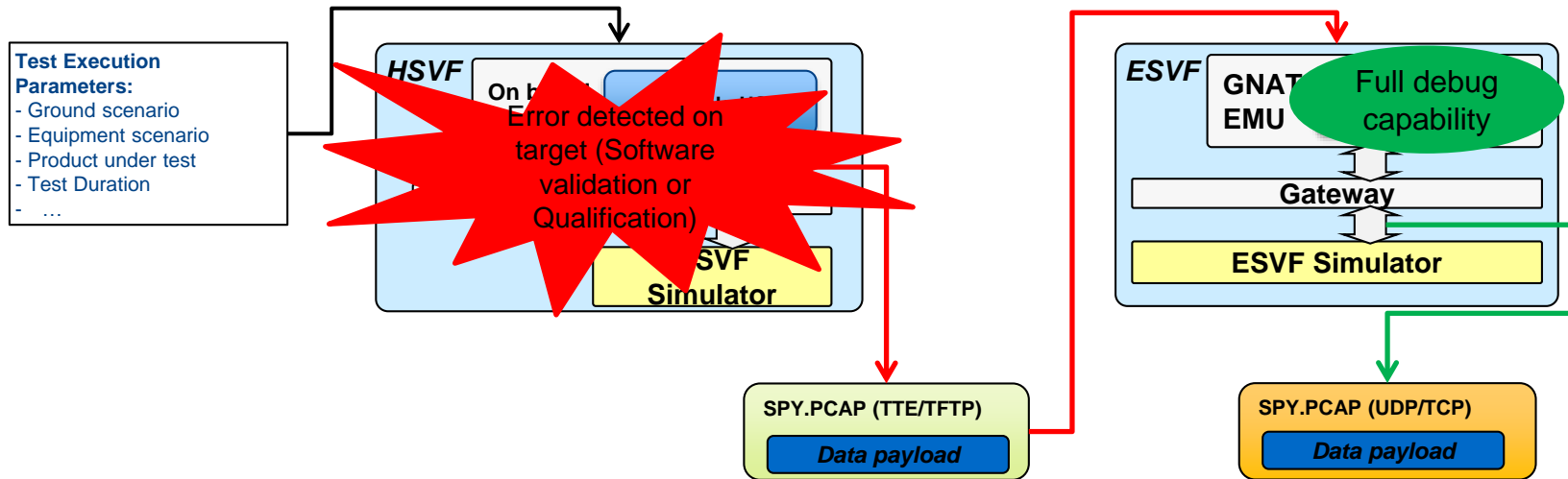
INPUT/OUTPUT SYNCHRONISATION ON ESVF



USAGE HSVF / ESVF: PREPARE TEST PROCEDURE ON ESVF BEFORE EXECUTION ON HSVF



USAGE HSVF / ESVF: REPLAY FUNCTIONALITY → DEBUG REAL RUN ON ESVF



CONCLUSION

Flight software fully synchronous design consistent with System Functionnal breakdown method (Functional Units approach)

- **Lean transition from System to Software**
- **Easier to debug flight software or test: Emulator Software Validation Facility provides full debug capability with behavioural flight representativeness**
- **Emulator Software Validation Facility is available on software development platform**

Such approach for launcher is an adapted reuse from orbital vehicle (Automated Transfer Vehicle). It can then be applied to various types of Software Intensive Systems.

Any questions ?

philippe.gast@ariane.group



arianeGROUP