Strategy for the integration of the LMJ (Laser Megajoule) control system

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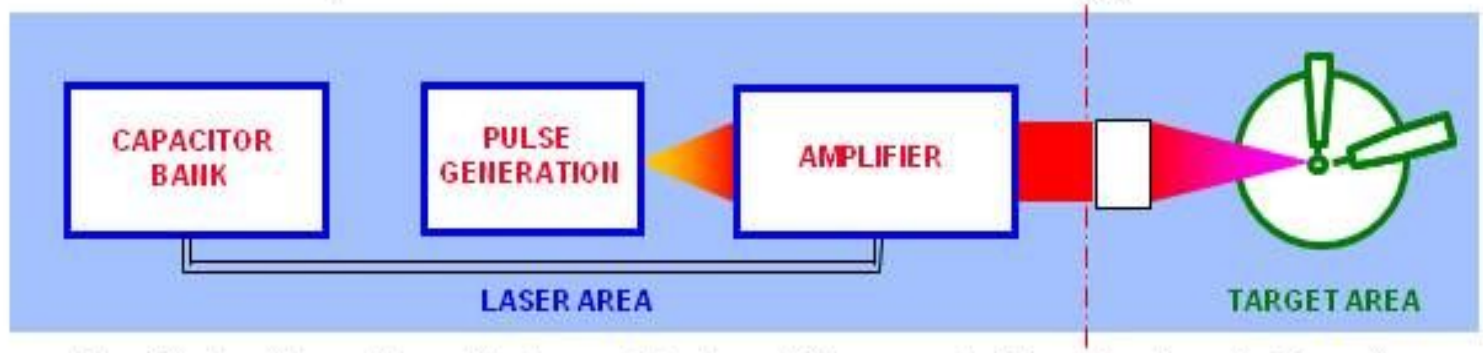
PRESENTATION OVERVIEW

1. Laser Megajoule (LMJ) Facility
2. LMJ Control System - Industrial Policy
3. Integration Strategy of the Control System
4. Strategy Steps
5. LMJ control system milestones

LMJ Facility

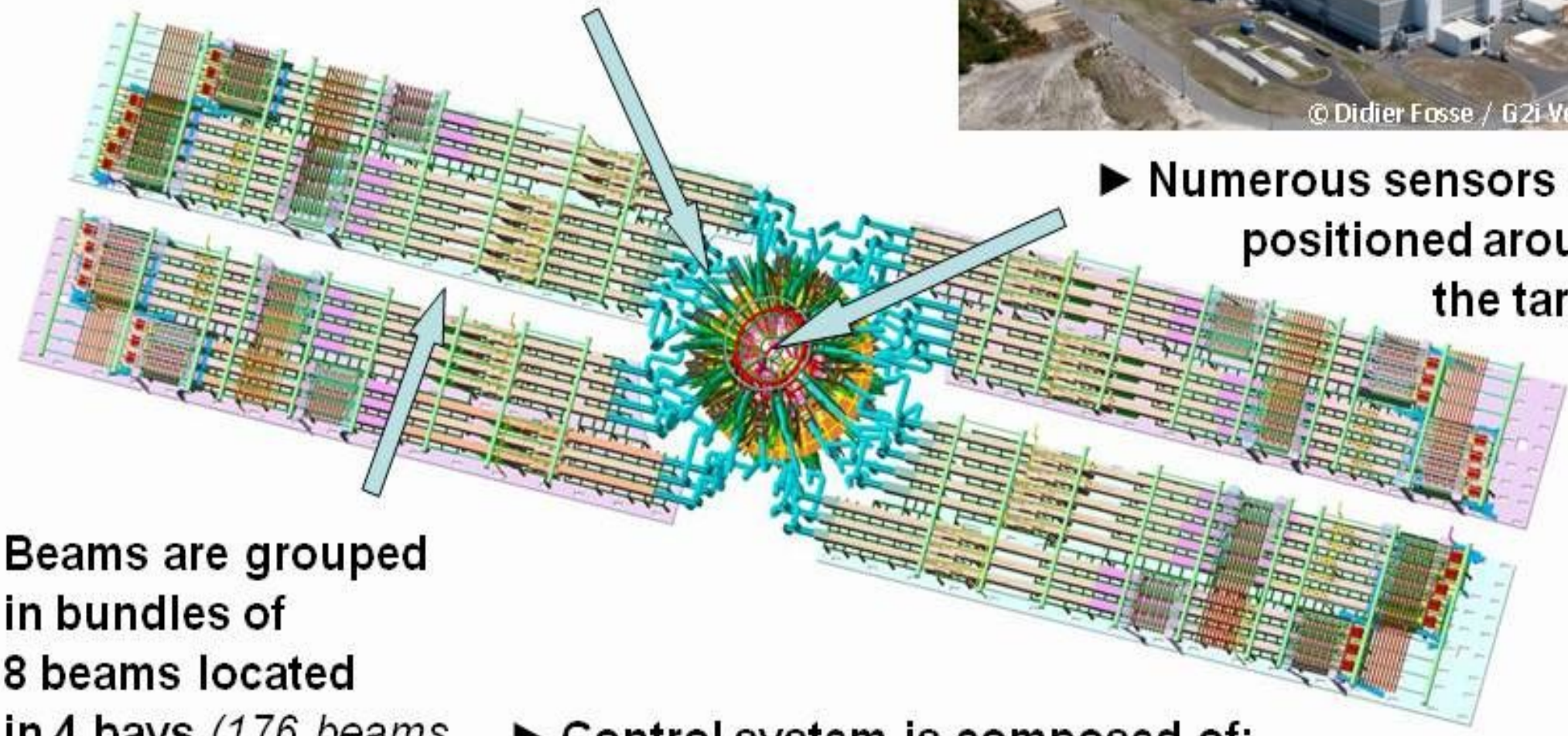
- The Simulation program forms the basis for the guarantee of the safety and reliability of French nuclear weapons without nuclear tests.
- LMJ, a cornerstone of this program, is dedicated to studying the physics of matter at high energy densities (plasmas, nuclear fusion, etc.).
- LMJ is a laser beam system which focuses an energy > 1 MJ on a tiny target.



- LMJ is been built in the Aquitaine Scientific and Technical Center (CESTA) of the CEA near Bordeaux

LMJ Facility Overview

- Beams are grouped in quads



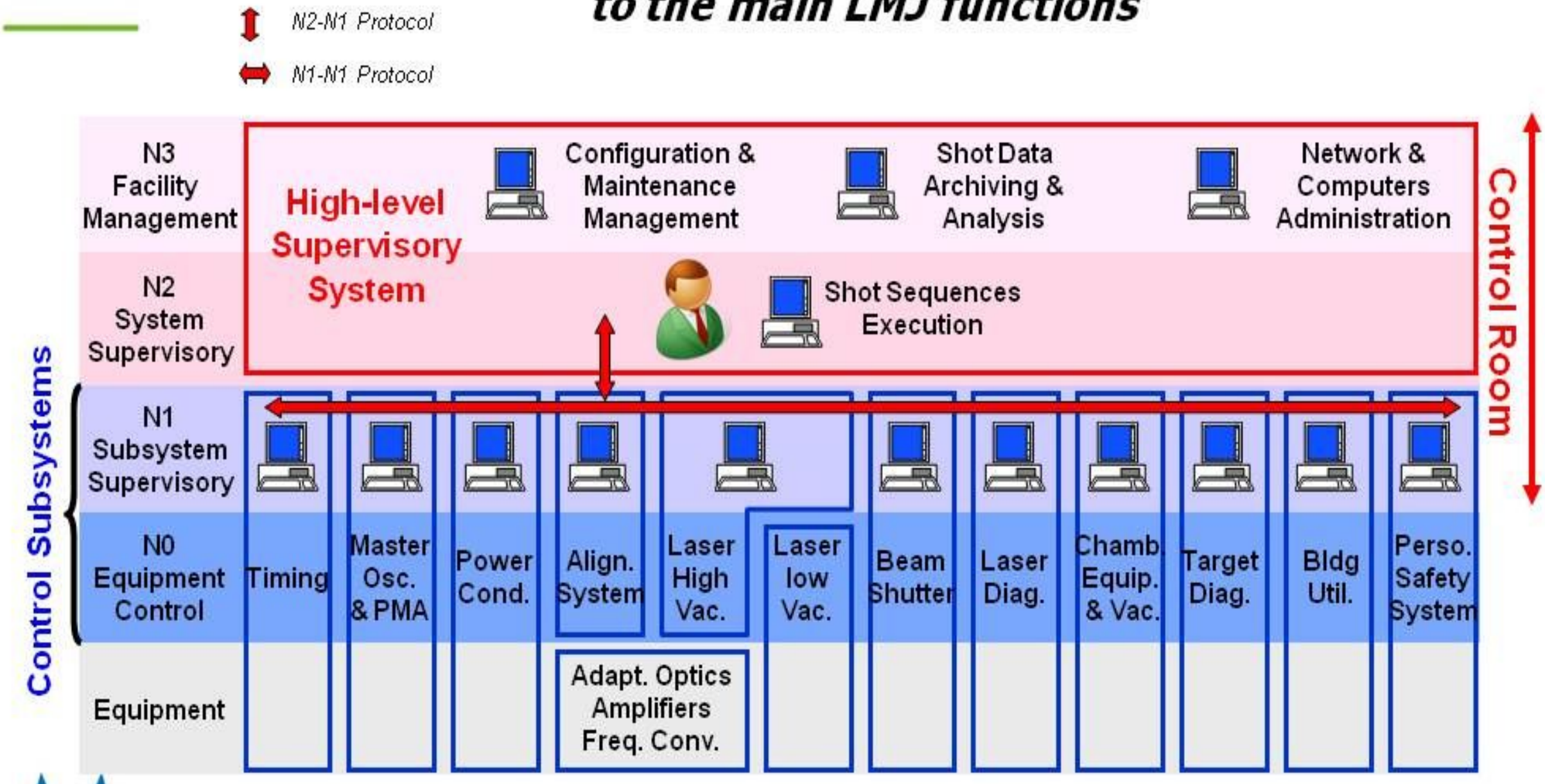
- Numerous sensors are positioned around the target

- Beams are grouped in bundles of 8 beams located in 4 bays *(176 beams upgradable to 240)*

- Control system is composed of:
  - ~ 150 servers in a computer room
  - ~ 450 PLC or rack-mounted PC next to equipment

LMJ Control System - Industrial Policy

A dozen major contracts correspond to the main LMJ functions



Integration Strategy of the Control System

The strategy derives from … constraints and solutions

- Give CEA the means to carry out numerous integrations.

  → ***"Integration" Contract***

- Qualify software outside the facility prior to their transfer to the LMJ:
  - Correct faults as soon as possible
  - Debug without damaging the system
  - Reduce as much as possible the LMJ activity

  → ***Integration Platform (PFI)***

- Promote the independence of the subcontractors

  → ***Simulators of External Interfaces (SITEX)***

- Integrate a new bundle in the LMJ building while using the commissioned ones

  → ***Network and control room dedicated to integration***

Integration Strategy of the Control System

The strategy is a 3-step process: ***Who ?*** ***Where ?***

- **STEP 1 : Factory acceptance tests**
  - Acceptance tests for equipment
  - Acceptance tests for control system

  .Contractors — **In Factory**

- **STEP 2 : Integration tests with equipment simulators**
  - Global tests for the supervisory system
  - Global tests for each control subsystems
  - Tests of the whole control system

  .CEA ***Subsystem By Subsystem*** — **On PFI**

- **STEP 3 : Functional integrations from an integration room with equipment**
  - Industrial tests for each subsystem
  - System tests of the whole process
  - Bundle delivery for validation from operations control room

  .Contractors ***.CEA*** ***Bundle By Bundle*** — **In LMJ**

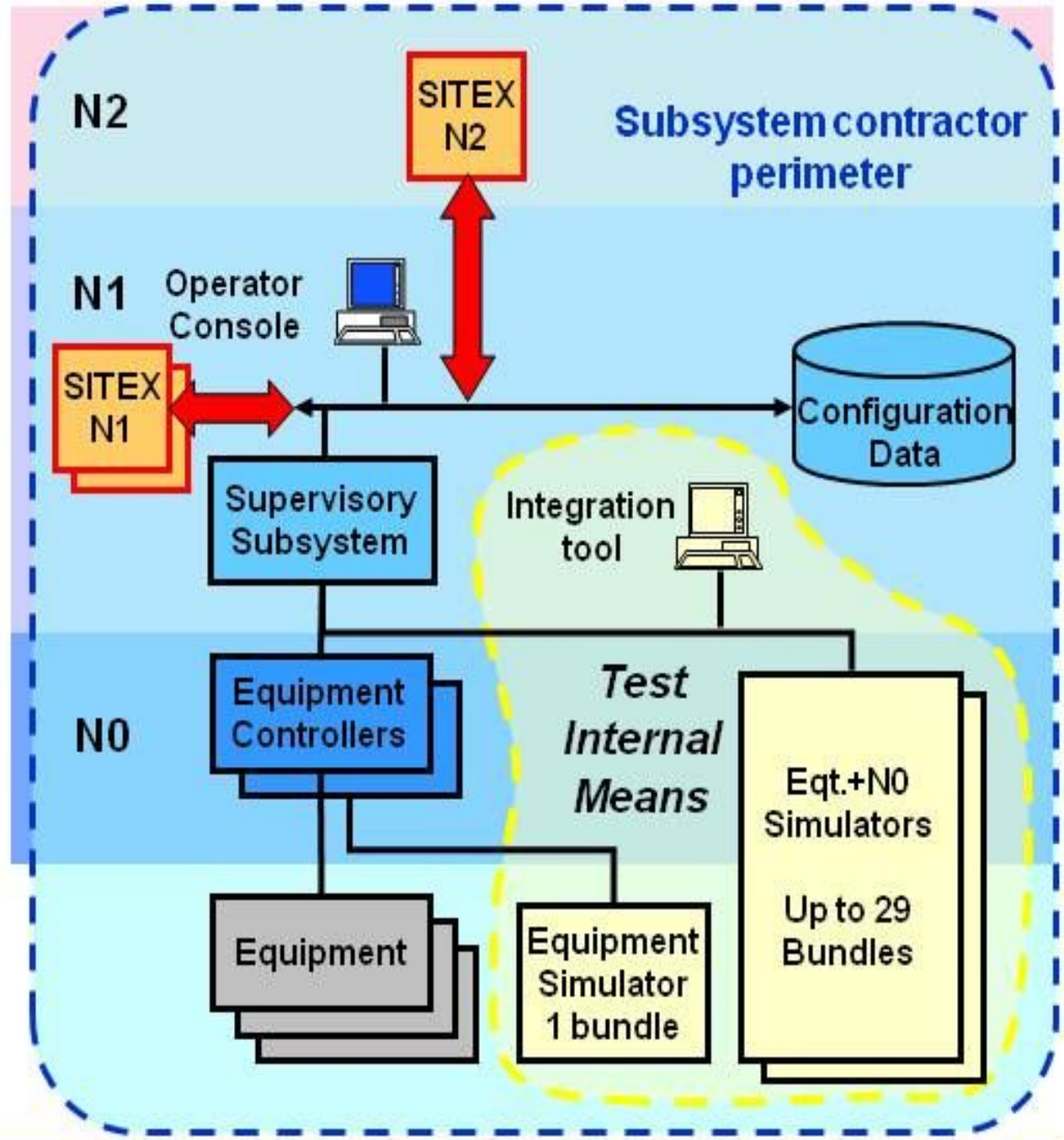
STEP 1 : Factory Acceptance Tests

Internal functional tests + protocols tests + reliability tests are required

- Subsystem Contractors in charge of all equipment and control subsystems
- Functional tests with the same LMJ configuration, despite missing equipment

  ⇒ The contractor must build and supply equipment simulators to replace missing equipment
- Protocols tests without any subsystem in interface

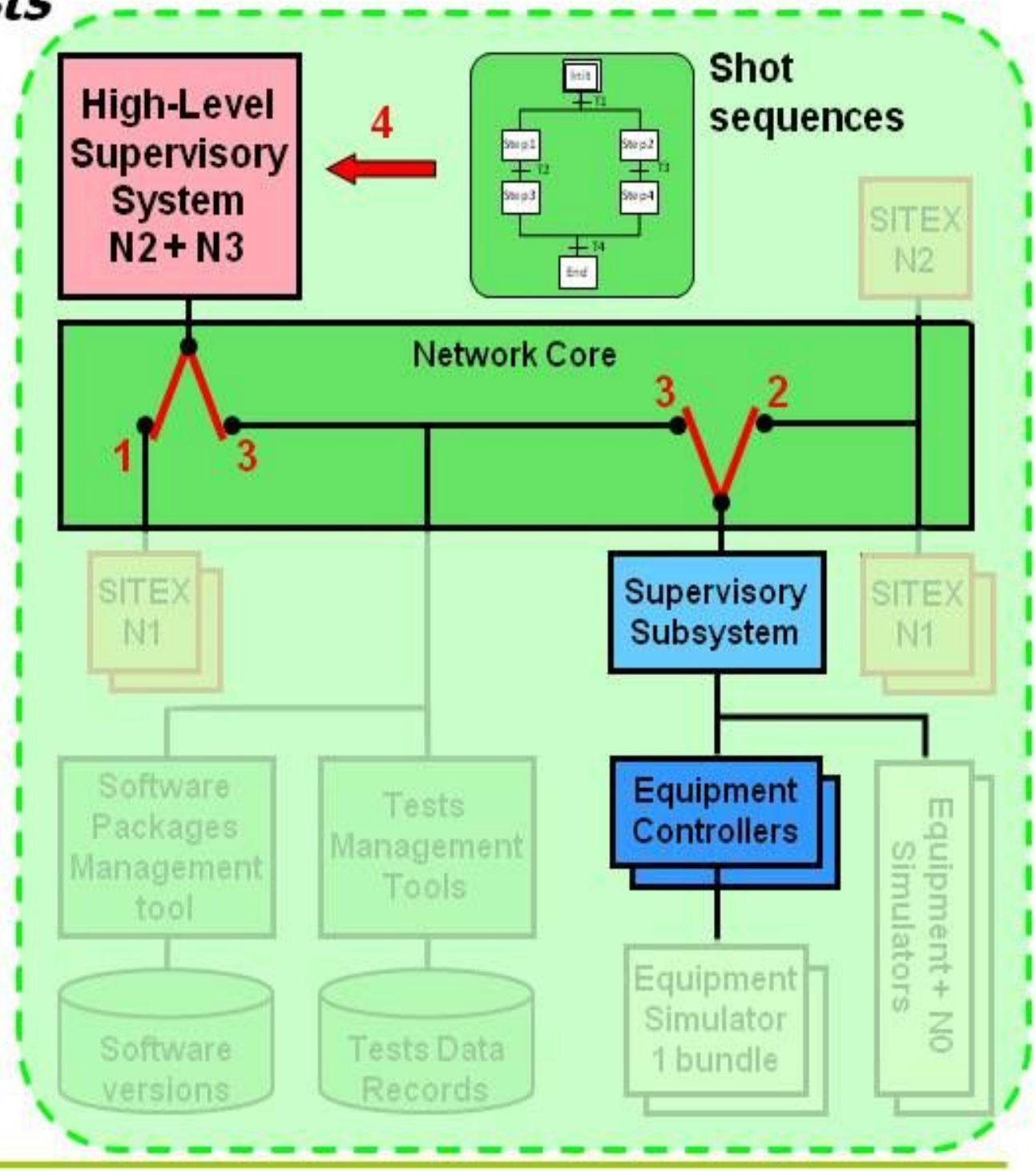
  ⇒ The interface simulators supplied by CEA implement standardized protocols and allow testing.
- Reliability tests and their automation require the two types of simulator



STEP 2 : Integration Tests on the Integration Platform

Global tests + system tests are required

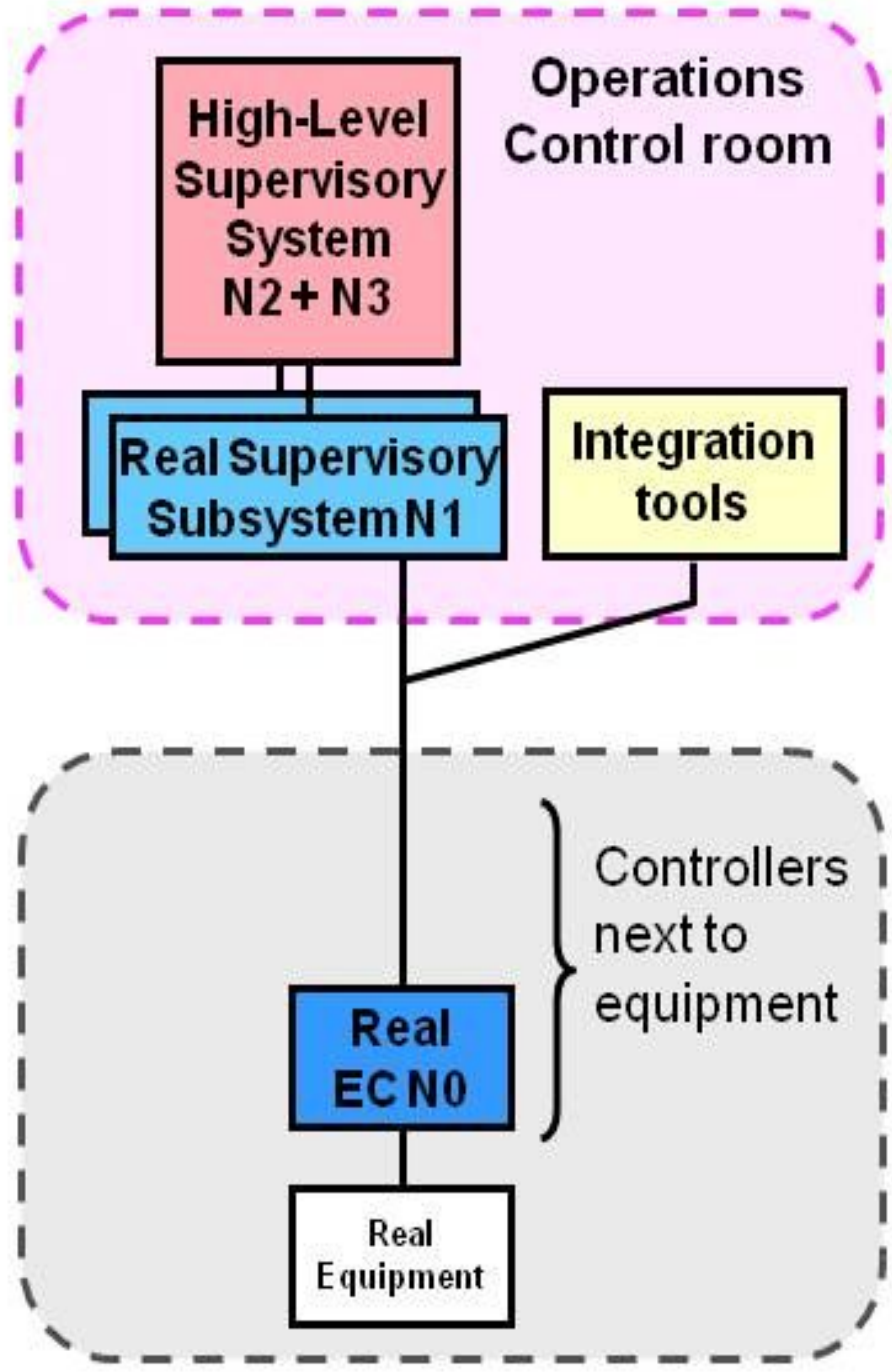
- Integration contractor supplies and installs the PFI heart:
  - Network core
  - Management tools
  - Interface and equipment simulators
- High-level supervisory system is installed to perform global tests **(1)**
- Each control system is added and:
  - his good installation is verified **(2)**
  - It is integrated to the high-level supervisory system to finish the global tests **(3)**
- Integration contractor tests the whole control system with : **(4)**
  - Sequences that he has developed
  - Settings automatic computations



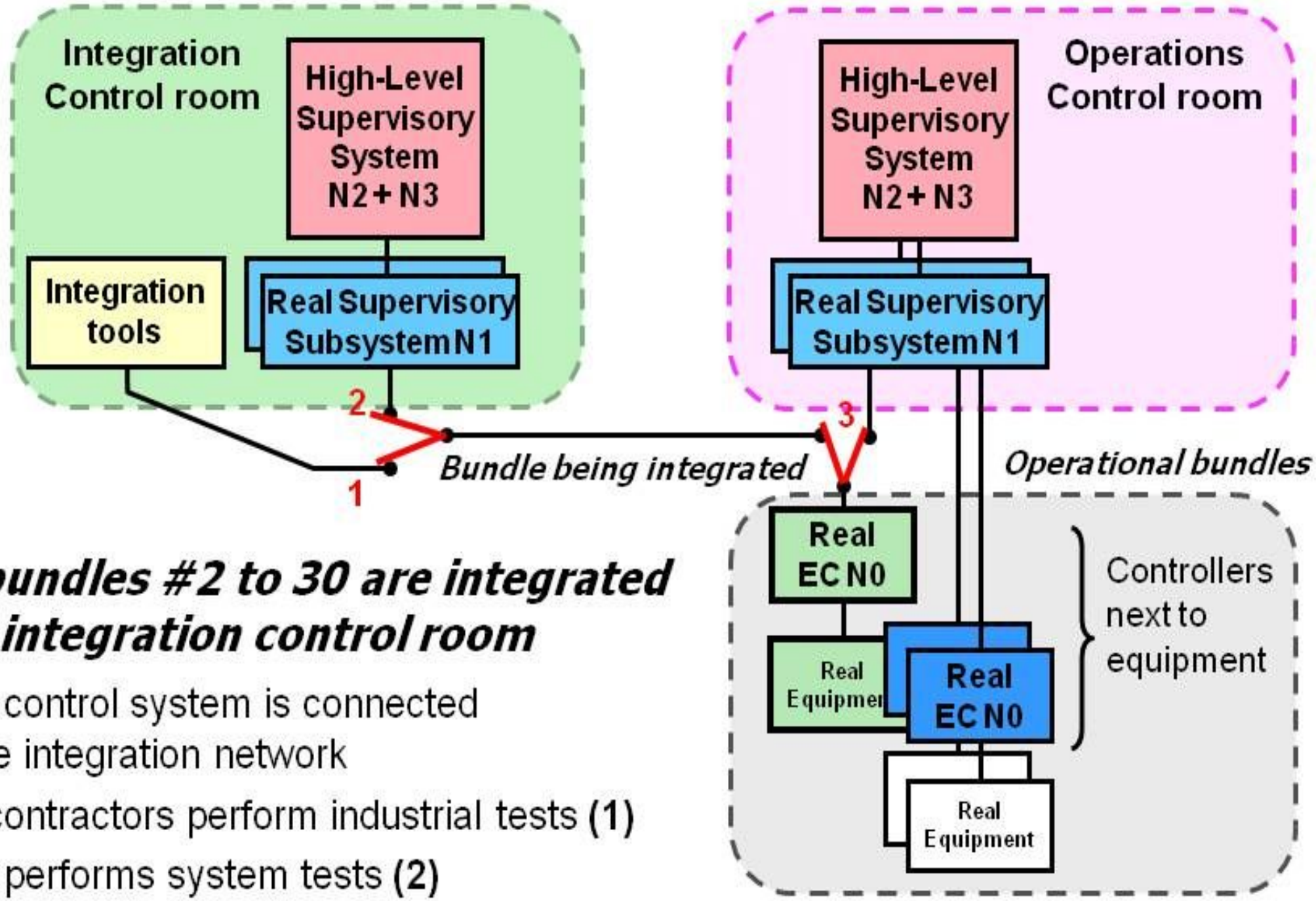
STEP 3 : Functional Integrations in the LMJ building

The first bundle is integrated from the operations control room:

- **Industrial tests** are performed by the contractors to check the behaviour of equipment and the wiring
- Servers are installed in a computer room and connected to the operation network
- **System tests** are then performed by CEA to make sure that all subsystems work well together



STEP 3 : Functional Integrations in the LMJ building

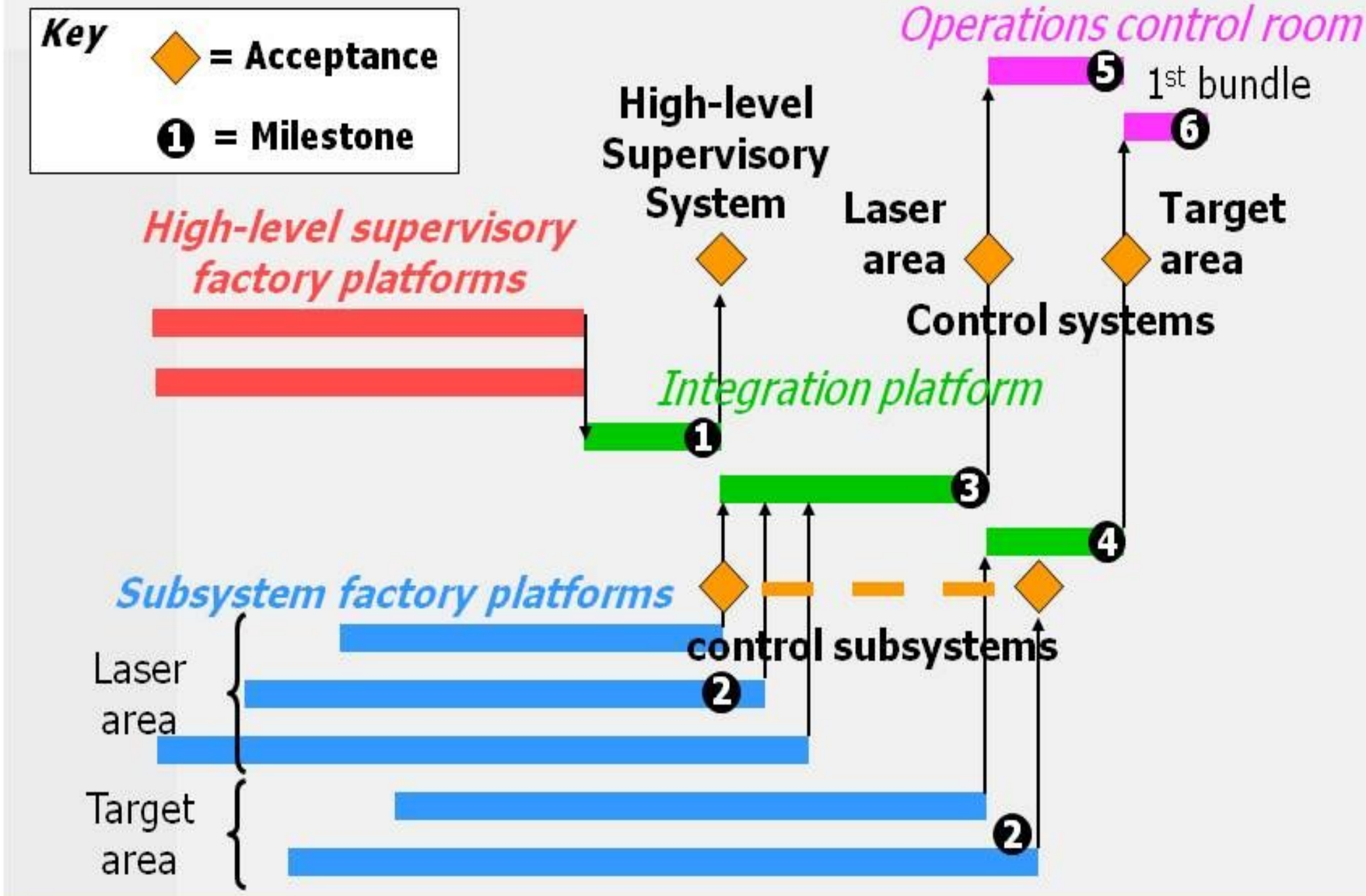


The bundles #2 to 30 are integrated from integration control room

- New control system is connected to the integration network
- Subcontractors perform industrial tests **(1)**
- CEA performs system tests **(2)**
- And commissions from operations control room **(3)**

LMJ Control System Milestones

The challenge is to coordinate the dozen of contractors



Are there any questions ?