



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

J.-C. Picon, P. Bétrémieux, J.-J. Dupas, J. Nicoloso, F. Signol
CEA/DAM
France

Presented by
Jean-Claude PICON



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

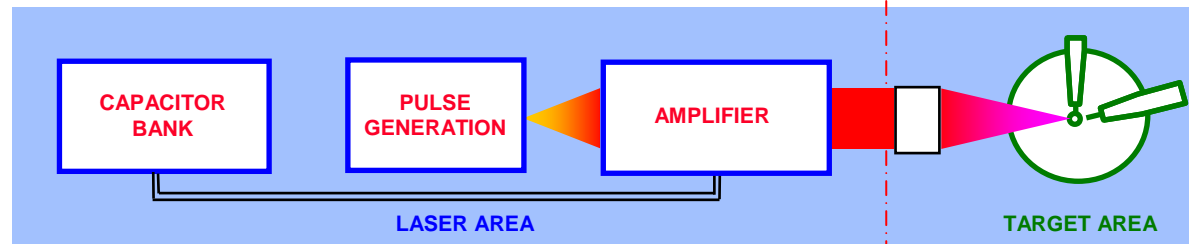


© Didier Fosse / G2i Vertigo



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.



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



LMJ Facility Overview



© Didier Fosse / G2i Vertigo

- ▶ 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



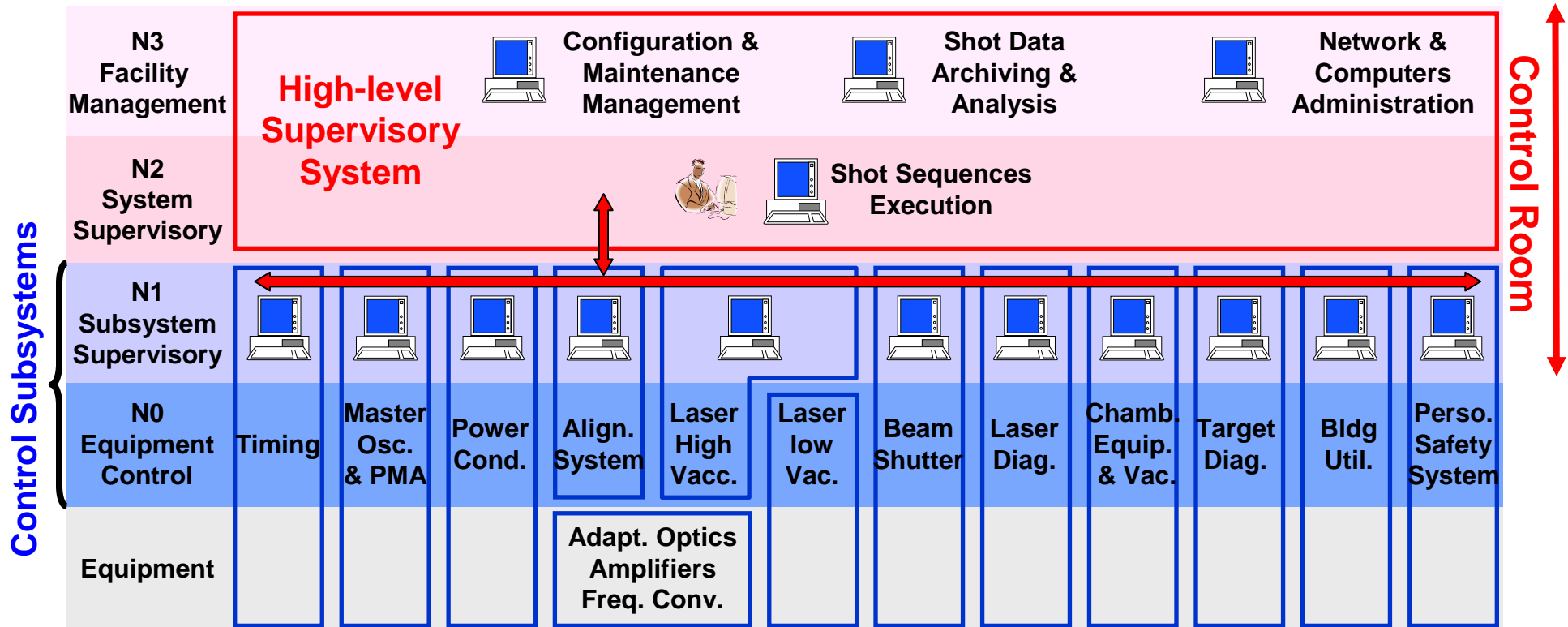
LMJ Control System - Industrial Policy



A dozen major contracts corresponds to the main LMJ functions

↕ N2-N1 Protocol

↔ N1-N1 Protocol

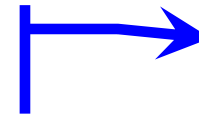


Integration Strategy of the Control System



The strategy derives from constraints and solutions

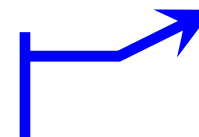
- Give CEA the means to carry out numerous integrations.
- Qualify software outside the facility prior to their transfer to the LMJ:
 - Correct faults as soon as possible
 - Debug without damaging the system
 - Reduce as much as possible the LMJ activity
- Promote the independence of the subcontractors
- Integrate a new bundle in the LMJ building while using the commissioned ones



***"Integration"
Contract***



***Integration Platform
(PFI)***



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



***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**

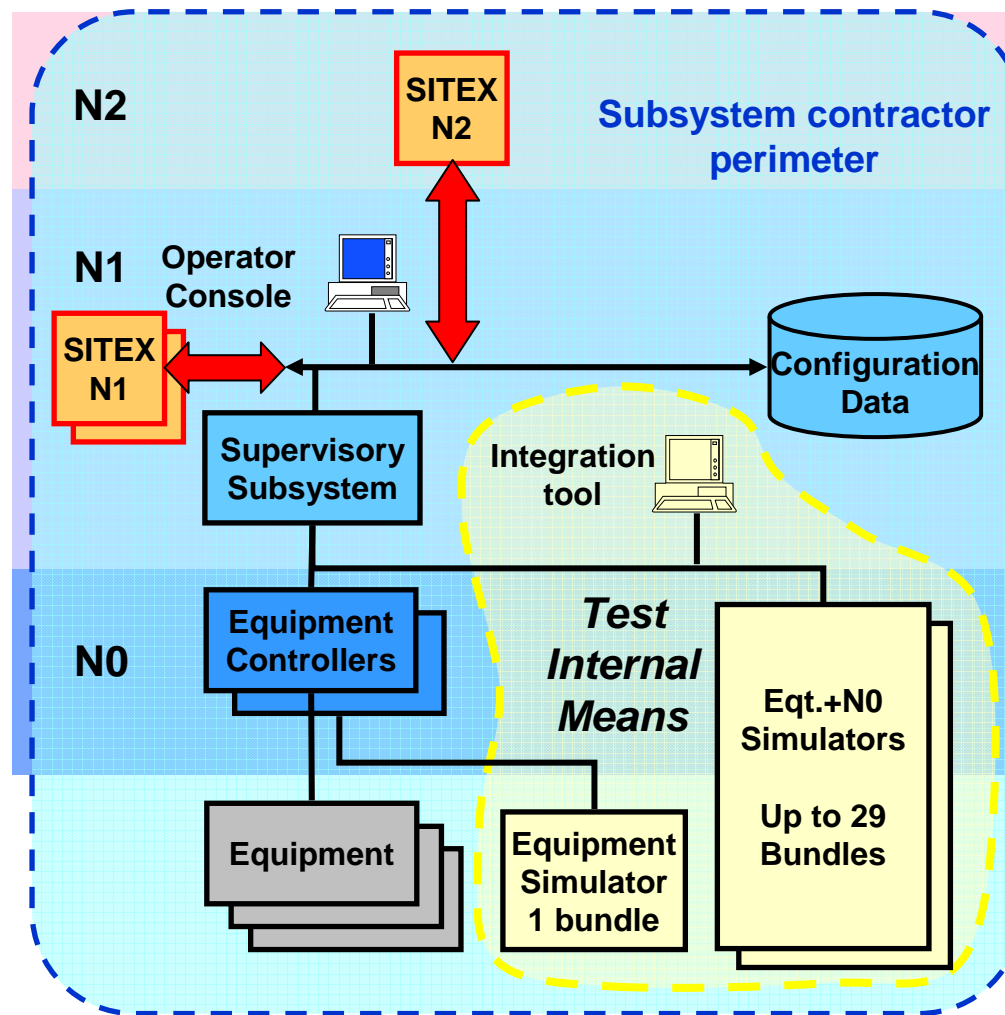


STEP 1 : Factory Acceptance Tests



Internal functional tests + protocols tests + reliability tests are required

- Subsystems 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

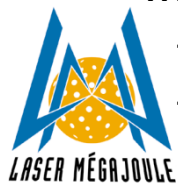
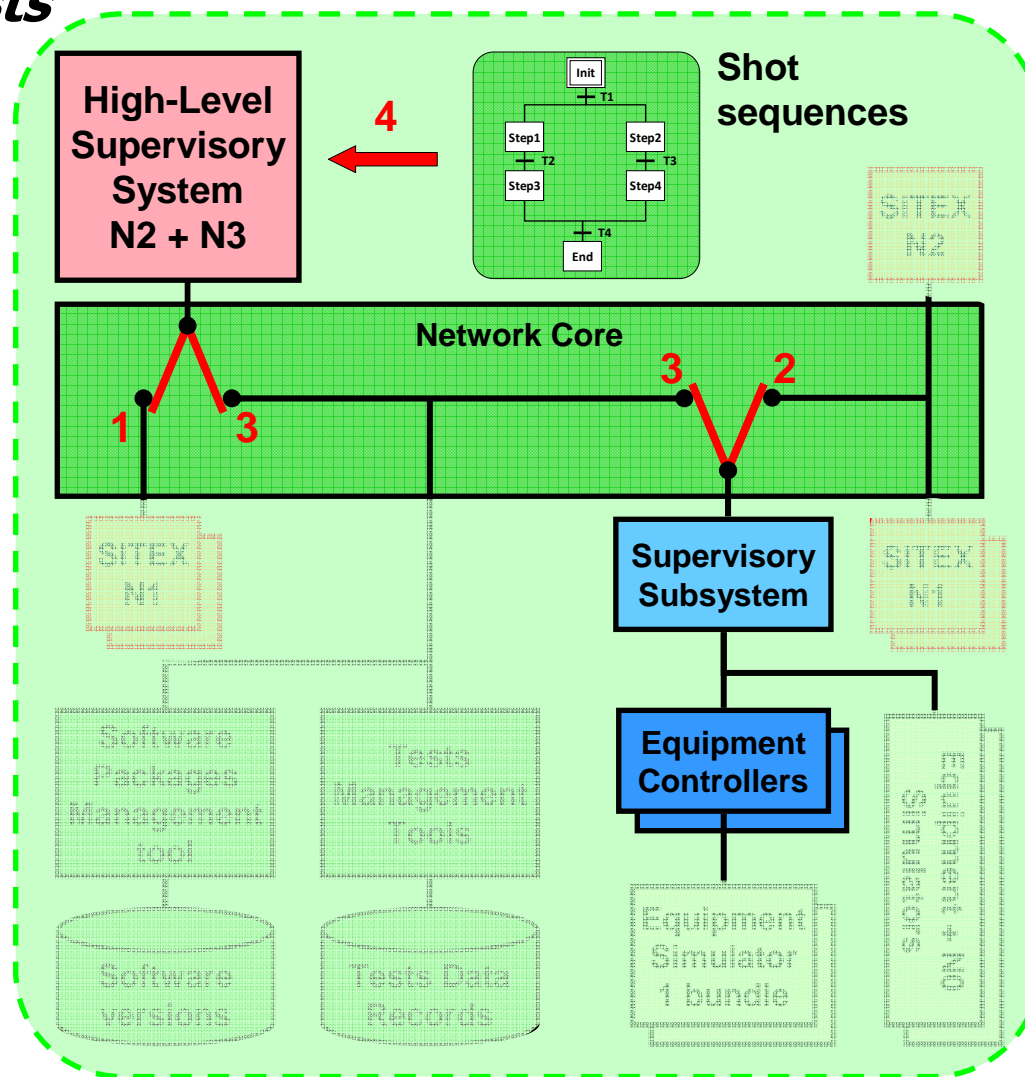


STEP 2 : Integration Tests on the Integration Platform



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 well 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

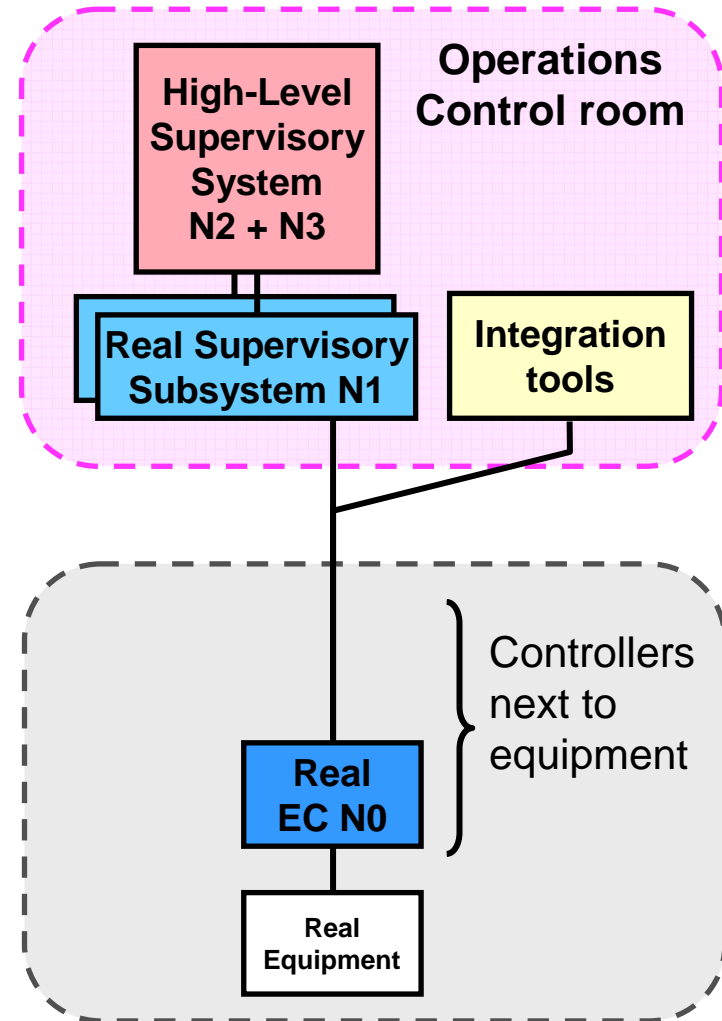


STEP 3 : Functional Integrations in the LMJ building

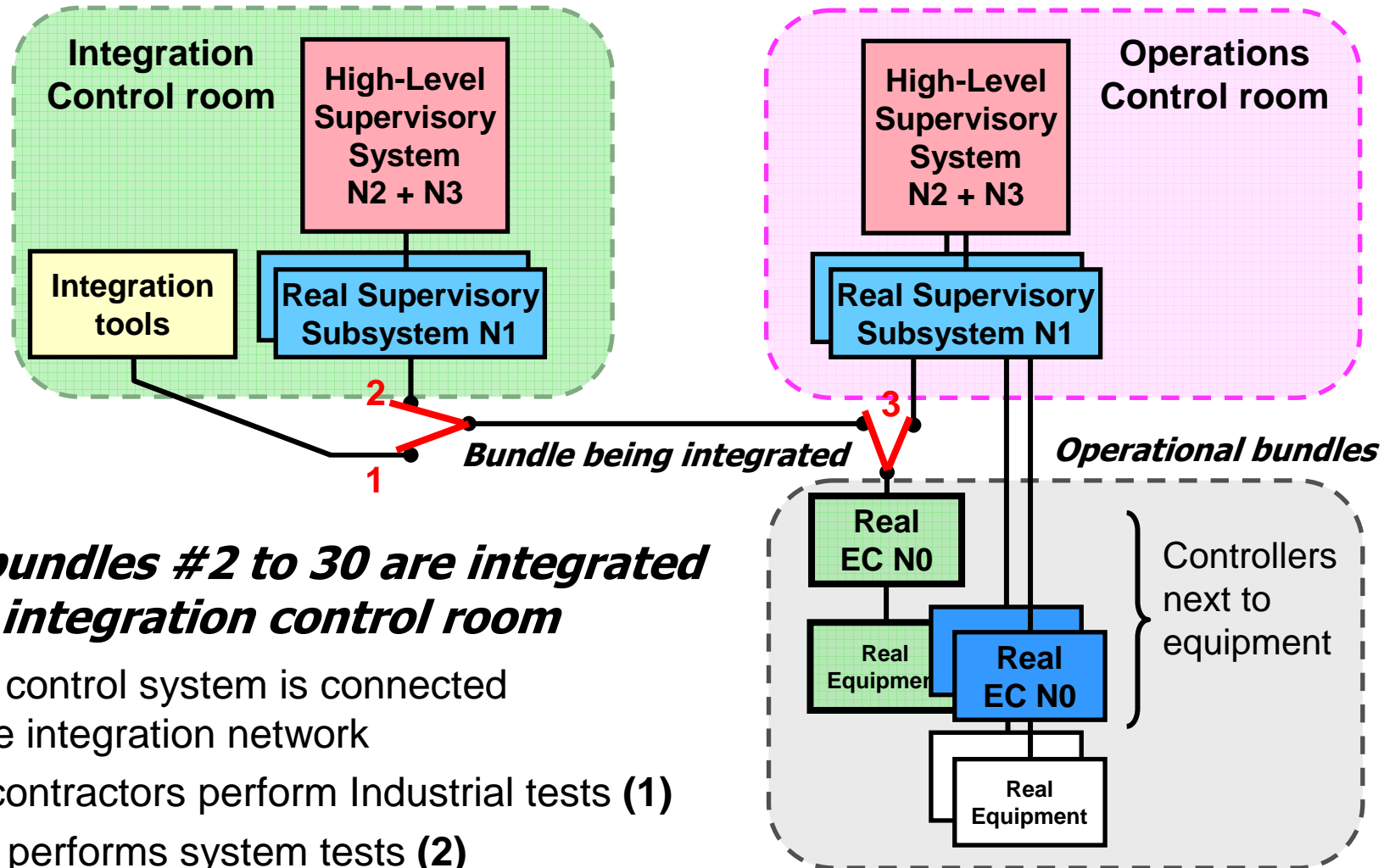


The first bundle is integrated from the operations control room:

- **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



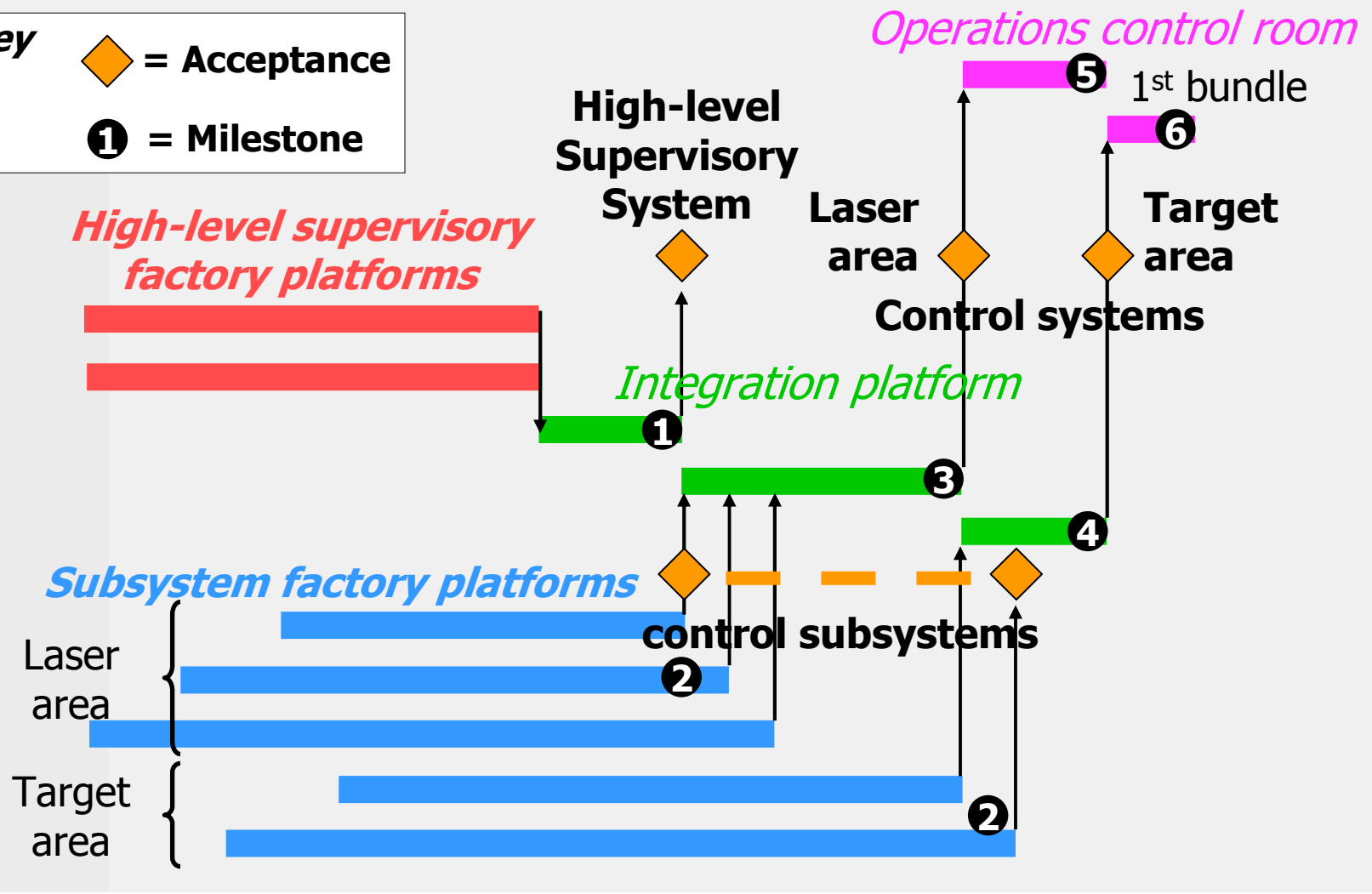
The bundles #2 to 30 are integrated from integration control room

- 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 ?

