Rolls-Royce capabilities to fit VVER in I&C area

Atomex 2011 Prague
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Agenda

- **Rolls-Royce and the Nuclear Sector at a glance**
- **Rolls-Royce Nuclear I&C Systems**
- **I&C Systems Engineering**
  - Safety-oriented Design
  - HW Qualification
  - Long Term Operations
- **Rolls-Royce I&C system integration**

2010 financial highlights

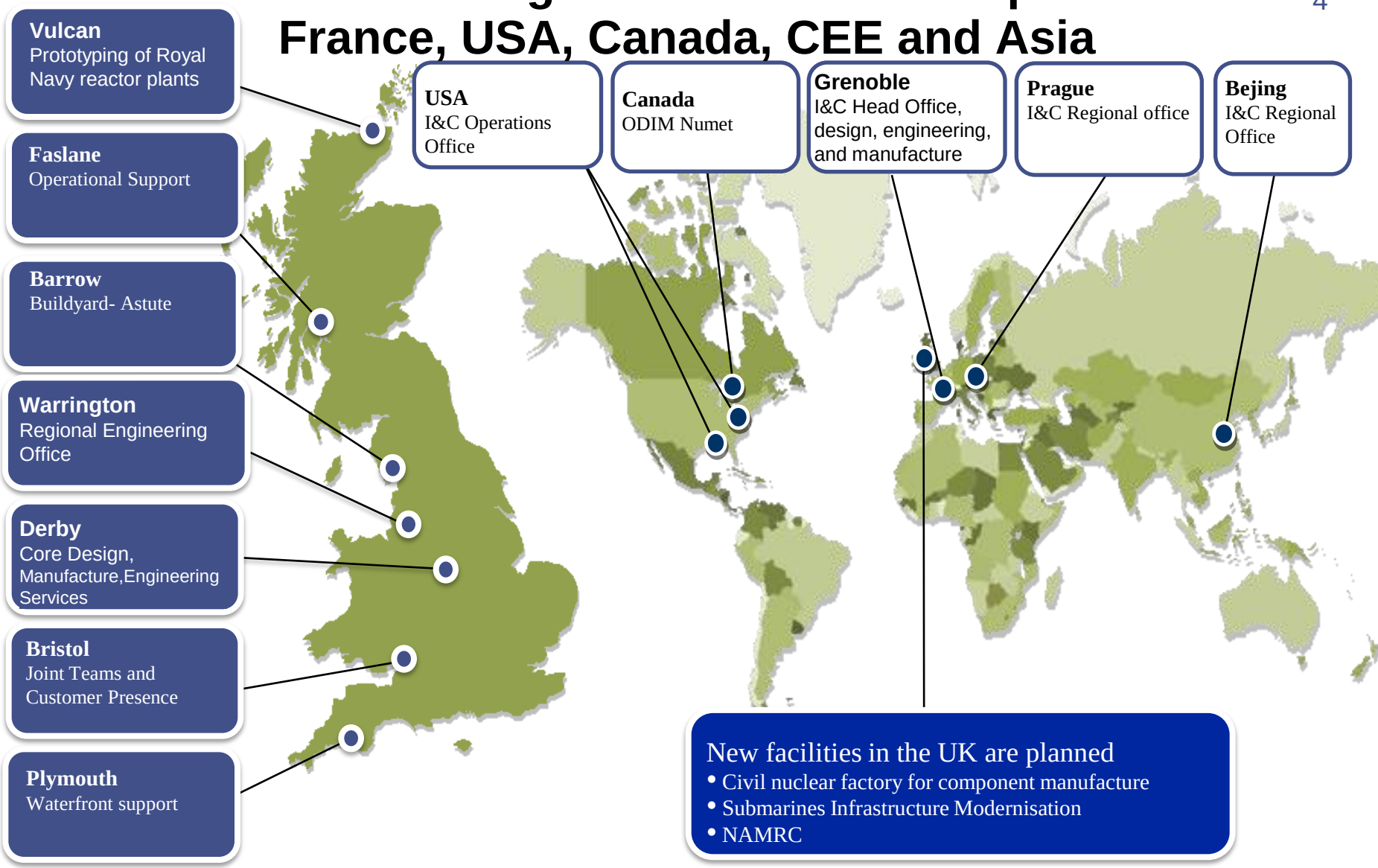
Order book	Underlying Group revenue	Underlying profit
£59.2bn	£10.9bn	£955m

Original equipment	Services
49%	51%

Underlying Group profit contribution 2010

Civil aerospace	37%
Defence aerospace	29%
Marine	31%
Energy	3%

...And is a global business with presence in France, USA, Canada, CEE and Asia



Rolls-Royce Nuclear sector covers both the defence and civil markets

Rolls-Royce Nuclear sector

Defence Nuclear

Submarines

- Design, manufacture & procurement of NSSS for all UK nuclear submarines
  - 50 years PWR experience
  - ~100 reactor cores delivered
  - 27 reactor plants delivered
  - 2 Nuclear licensed sites
  - 3 factories
  - Largest single UK employer of design /technical authority skills
- Deep safety case knowledge & UK regulator relationships
- Relationships with ~270 suppliers
- Full lifecycle NSSS capability
- 2000 people, 1000 engineers
- 1 Nuclear Reactor operation

Civil Nuclear

Components & Services

- Current contracts:-
  - Westinghouse design support
  - EdF Licensing support
  - British Energy fleet support
- Previous Sizewell B manufacturing and support
- Global corporate reputation for engineering excellence & advanced manufacturing
- Strong governmental relationships in key countries
- 120 people

Instrumentation& Controls

- Safety Instrumentation & Control (I&C) for civil nuclear plants
  - System in operations in >100 plants worldwide
  - 35 years experience in safety critical I&C
  - References in 15 countries in Europe, U.S. and Asia
  - Advanced ‘Spinline 3’ digital system
- 440 people, 220 engineers

Civil Nuclear Canada

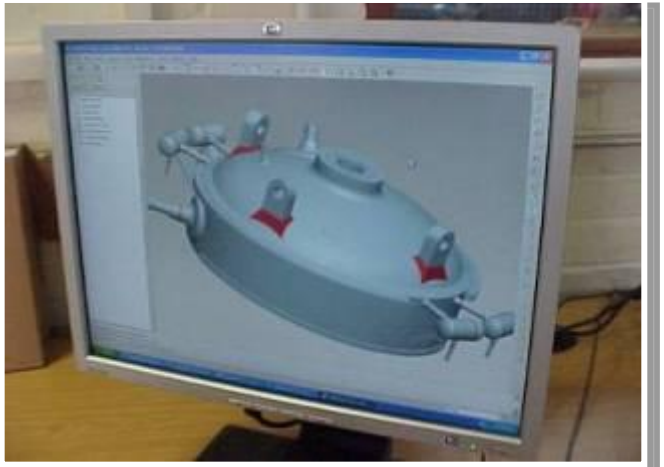
- Design and manufacture of bespoke process systems, components, remote handling tools and tele-robotic systems
- Majority of products and services for the CANDU reactor (in 2009 29 operational CANDU reactors in 7 countries)
- Holds ASME-N certification
- Capability to provide products and services at any stage in a civil nuclear reactor’s life cycle
- Over 100 highly skilled engineers, manufacturing professionals and support team members

Overall total > 2600 people

Our engineering capabilities have been developed from our PWR design and manufacturing experience

Specific skills:

- Reactor physics
- Reactor shielding
- Core mechanical design
- Stress analysis
- Core materials & metallurgy
- Reactor thermal design, analysis & experimental
- Reactor hydraulic design, analysis & experimental
- Core safety case
- Criticality analysis & design
- Operation of Neptune “zero energy” test reactor
- Operation of Radioactive Components Facility
- Design Justification
- Structural integrity assessment



Rolls-Royce UK manufacturing capabilities

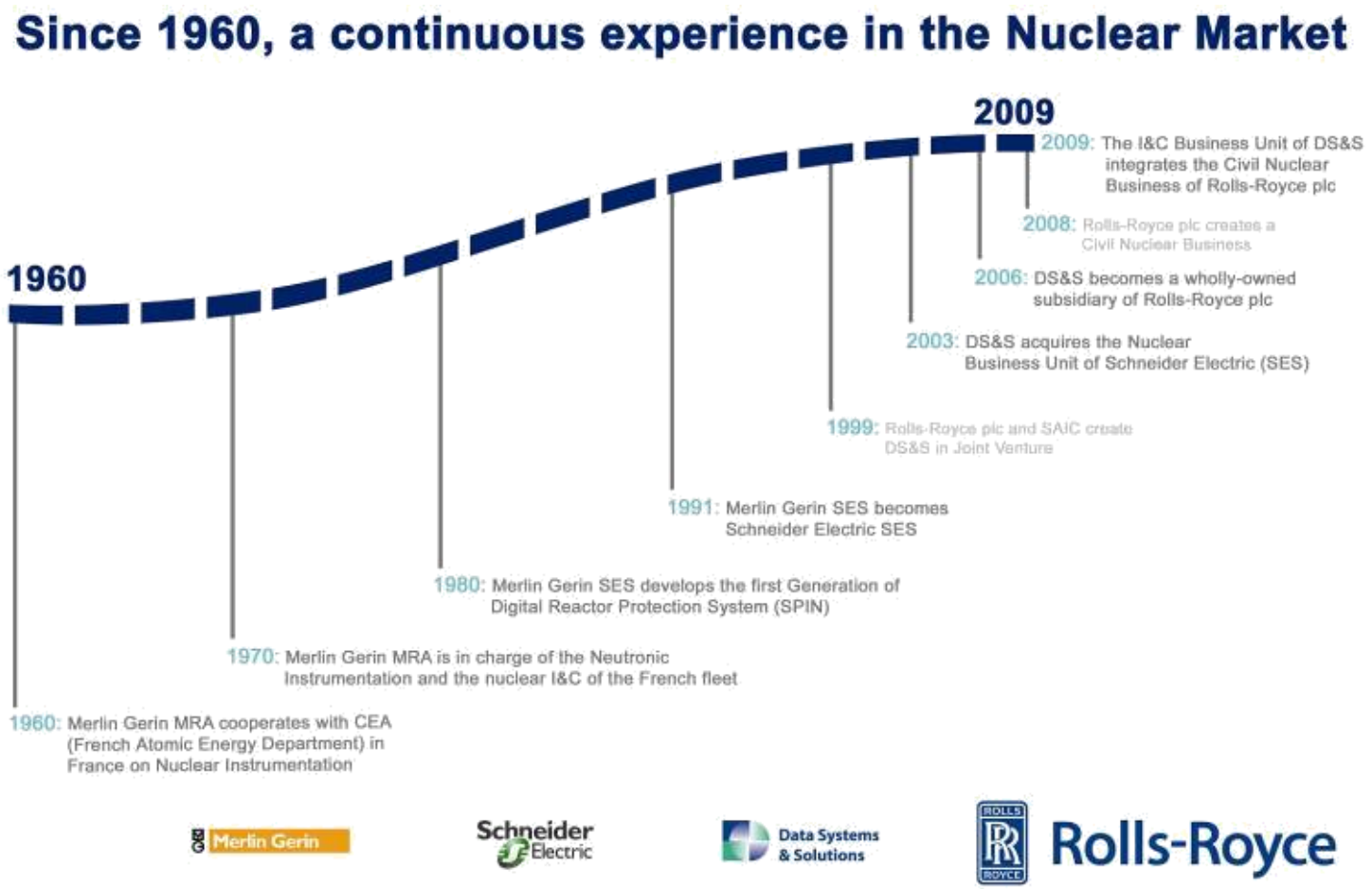
Design & Manufacturing capabilities

- Pressure Vessels
- RPV, Steam Generators, reactor cores (Submarines)
- RPV internals
- Heat Exchangers
- Valves
- Control Rod Drive Mechanisms
- Ion Exchange Columns
- Primary Circuit Filters
- Pumps
- Valve Operating Water Flasks
- Coolers & Minor Vessels
- Pipework
- Fuel Handling System
- Effluent Treatment System

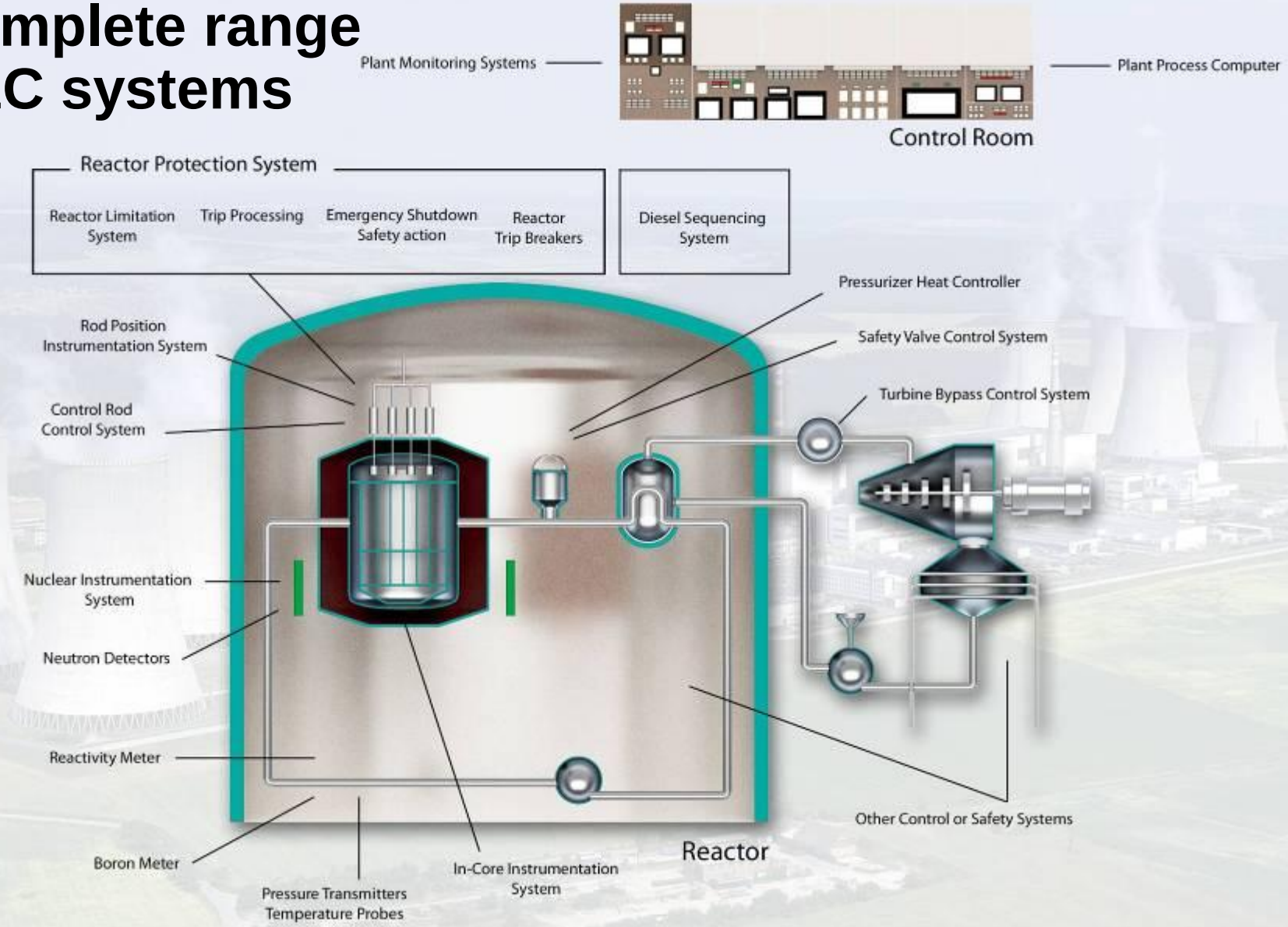
Rolls-Royce manufactured equipment and vessels including the pressuriser, conducted RPV inspection and performed technical design reviews for Sizewell B

Instrumentation & Controls

Rolls-Royce Civil Nuclear SAS history



A complete range of I&C systems



Rolls-Royce Nuclear I&C

Full market coverage through complementary capabilities

Rolls-Royce Civil Nuclear France
Grenoble, France

Rolls-Royce Civil Nuclear UK
Warrington, UK

Rolls-Royce Civil Nuclear US
Huntsville, Alabama

Rolls-Royce Prague, CR

Rolls-Royce Submarines
Derby, UK

Supply

Independent Review

Civil
- Safety
- Non-Safety

Defence
- Design
- Supply
- Support

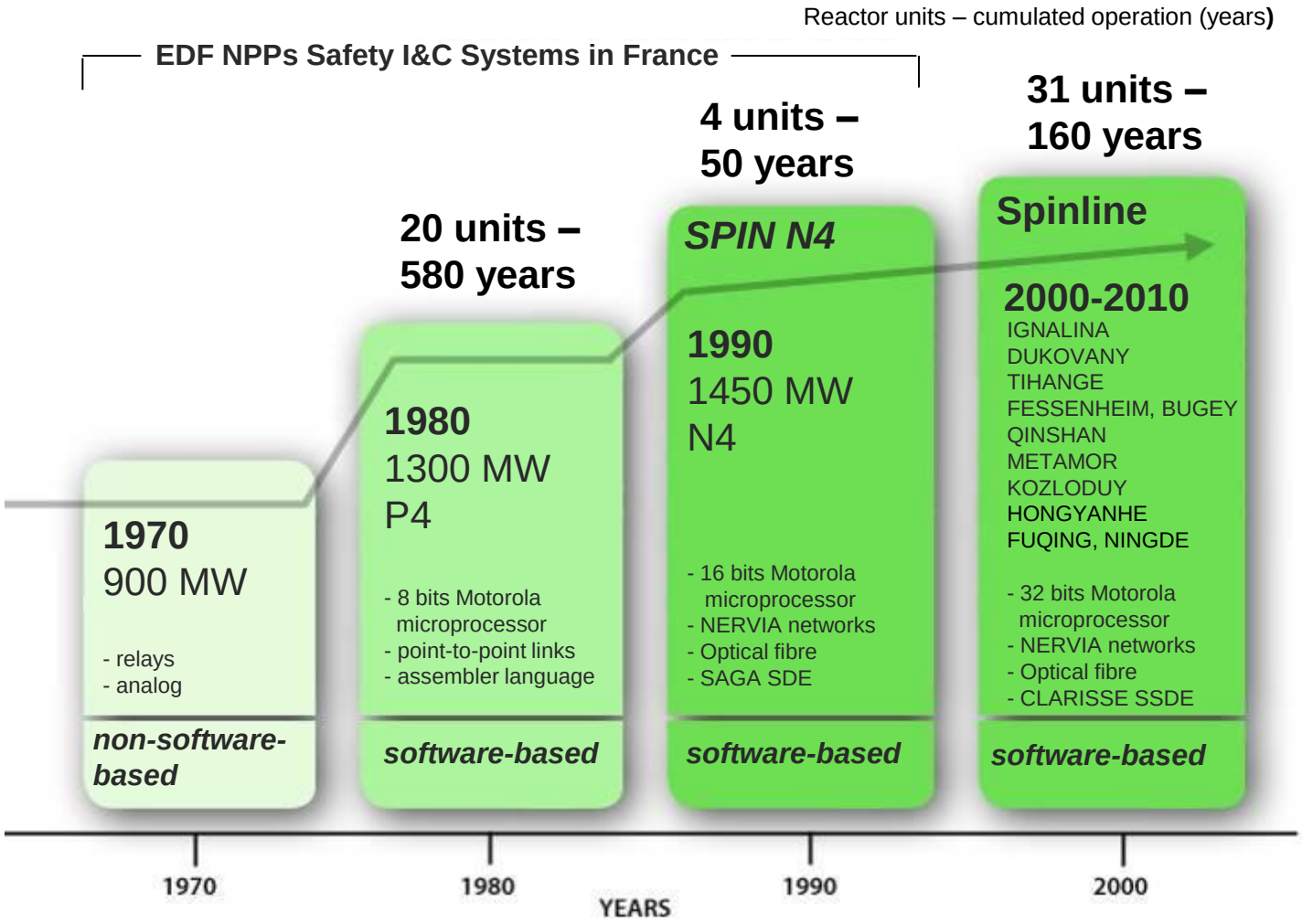
Civil
- New Build
- In Service Support
- Supply Chain Management

Civil
- System integration
- Project management
- Supply chain management

Civil
- Design studies
- R&D
- Peer review
- HW Qualification

Products / services

Evolution of Spinline technology – continuous innovation



Rolls-Royce: Building Safety with I&C systems

Proprietary Technology :
Spinline – Nervia

System Design:
Performance
Architecture

Safety Justification:
Standards
Licensing

Proprietary Technology – SPINLINE

- **Safety-oriented Design of components**
  - Characteristics (accuracy, response time)
  - Safety behavior :
    - Self monitoring signals
    - Test signals input
  - Reliability and safety performance calculation of each board
  - Qualification (according to nuclear standards) → tests
- **Communication – Nervia**
  - Safe transmission of data (100% safe)
  - Deterministic
  - Developed according to nuclear standards (IEC 60880)

Proprietary Technology – SPINLINE

- **Software development**
  - According to Nuclear Standards
  - Restriction rules for programming – simplicity
  - Software development tools (Clarisse – Scade)
  - Methods and procedures – QA
  - Documentation

- **Design for Long term operation**
  - Components are selected with long term supply guarantee
  - Obsolescence management strategy
  - Organization : skills / tools / documentation : the design of all components is internally managed

Rolls-Royce Long Term Support Solution

Organization & Process

Obolescence management
Lifecycle management

Skills and tools availibility
to manufacture, modify, repair, test components and systems

Maintenance
Technical assistance
Expertise
On-site maintenance
Spare parts supply
Customer Training

Limited Modification
Refurbishment & Repairs
Maintenance
Technical assistance
Expertise
On-site maintenance
Spare parts supply
Customer Training

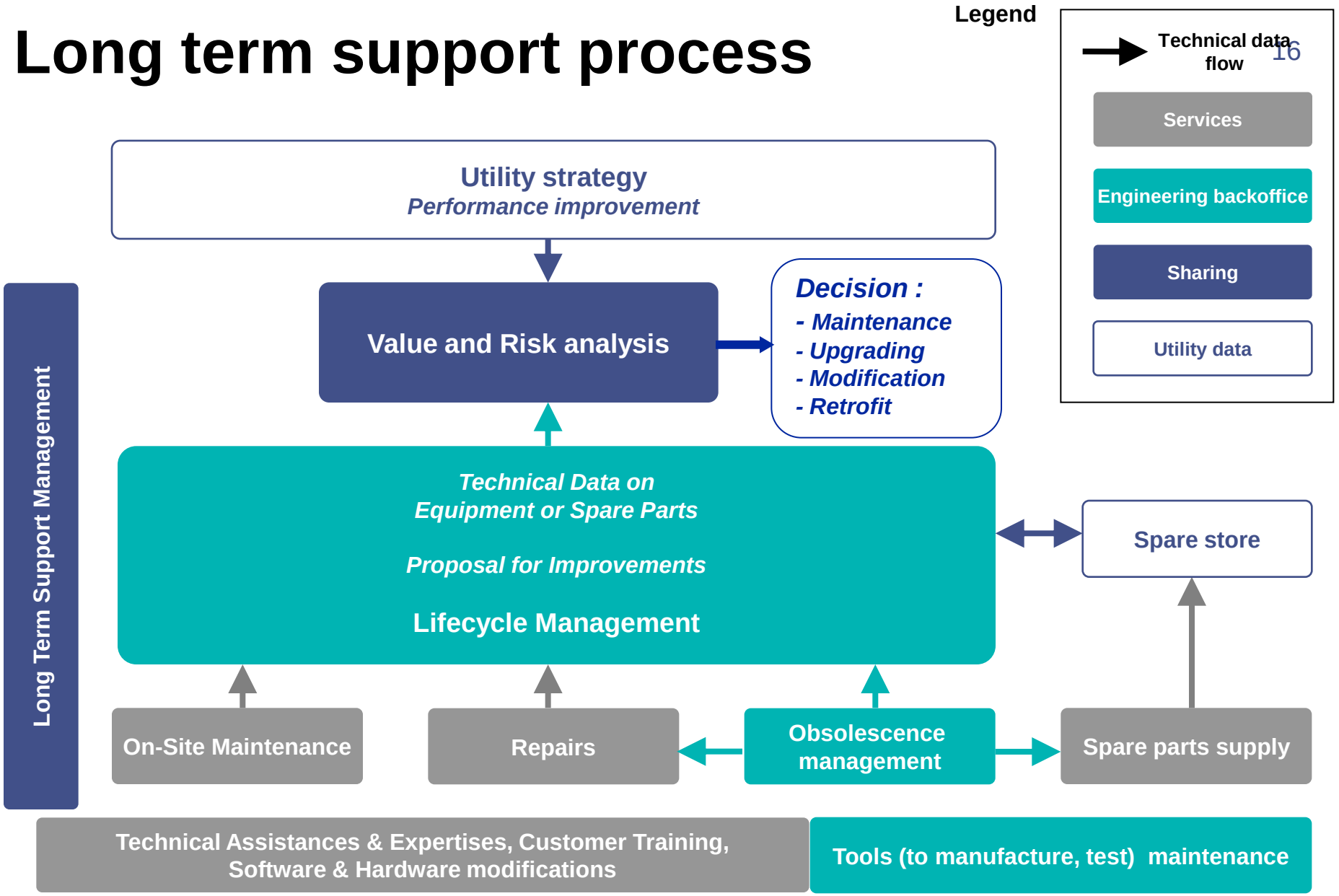
Retrofit
Evolutionary modification
Upgrading
Limited Modification
Refurbishment & Repairs
Maintenance
Technical assistance
Expertise
On-site maintenance
Spare parts supply
Customer Training

Youth

Maturity

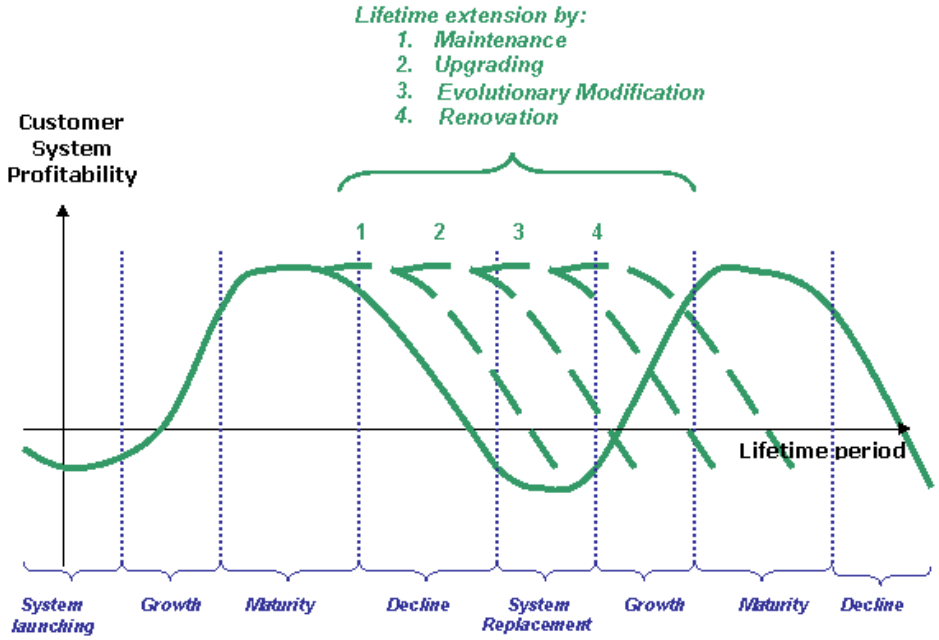
Lifetime extension

Long term support process



Long Term Support

- **Rolls-Royce Long Term Support solution contributes to System life extension**
  - **Limiting major retrofits**
  - **Reducing cost**
  - **Risk limitation**



Integration – the application of Systems Engineering

Customer requirements

Plant design basis

Integrated overall I&C system

Rolls-Royce Nuclear I&C Integration Process

Individual I&C system requirements specifications

Individual I&C system V-cycles

RPS

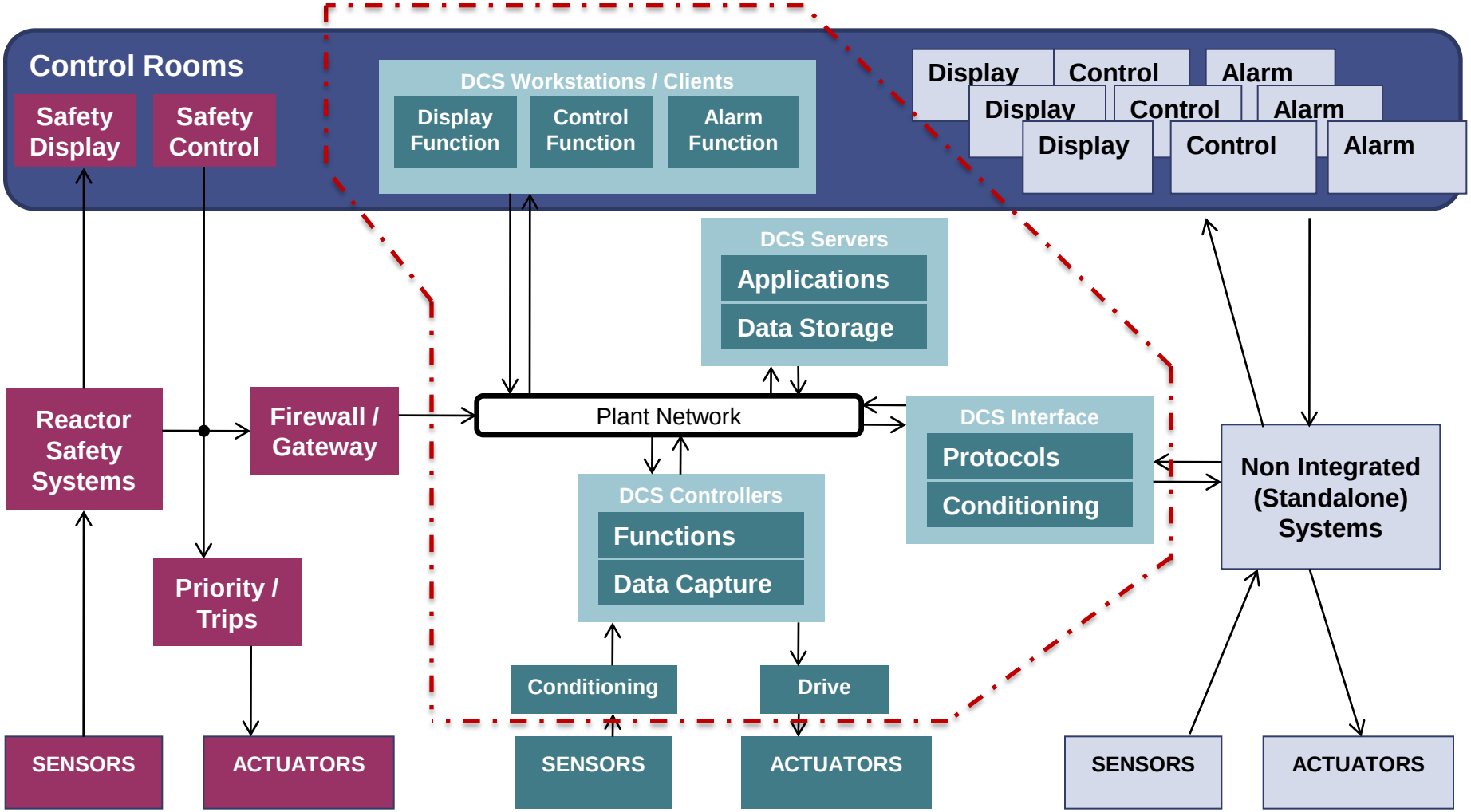
DCS

Control room

Etc.….

Multiple individual I&C system suppliers

Integrated I&C Systems



Integration process

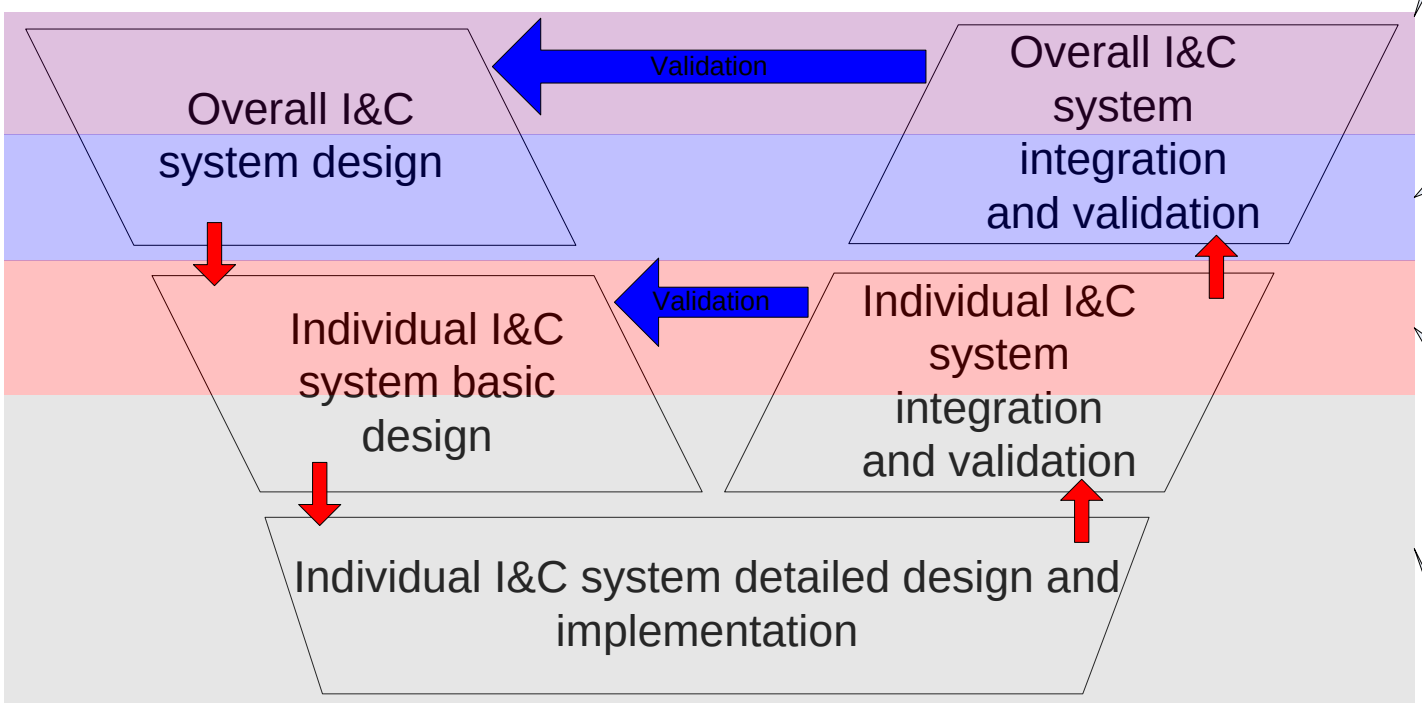
Objectives

- Provide a single solution for the full I&C scope
- Integrate proven Rolls-Royce safety technolgy with locally supplied non-safety technology

Advantages

- Enhances the export prospects of the VVER through brand and localisation
- Offers a single customer I&C interface, in all export markets

Integration Process roles



Customer

Overall I&C system definition and proving

Rolls-Royce

(Prague)

Individual I&C system acquisition

Rolls-Royce

(Prague)

Individual I&C system supply

Safety – R-R (Grenoble)

Rolls-Royce

Non-safety – Local suppliers

Astute class Submarine I&C

Customer: United Kingdom Ministry of Defence

Scope

HMS Astute is powered by the Rolls-Royce PWR2 reactor. Rolls-Royce Submarines provided the complete nuclear steam raising plant including the instrumentation and control.

- Complete integration of reactor into submarine
- Reactor protection and rod control system
- Sensors and cabling
- Interface to the platform management system
- I&C elements of the human machine interface
- Safety case
- Through life management plans

Delivery scheme

For the I&C element Rolls-Royce worked with a four large UK based suppliers to deliver the complete plant scope.

Timeline

Ordered in 1997 and laid down in 2001, HMS Astute is the first of a new class of hunter-killer nuclear Submarines for the Royal Navy. The vessel was built by BAE Systems in Barrow-in-Furness and launched on 8th June 2007.

Control and Protection System for IGNALINA modernisation

Project ID: IGN_DSS

- **Customer:** EU Funders for **Ignalina NPP – 2 units**

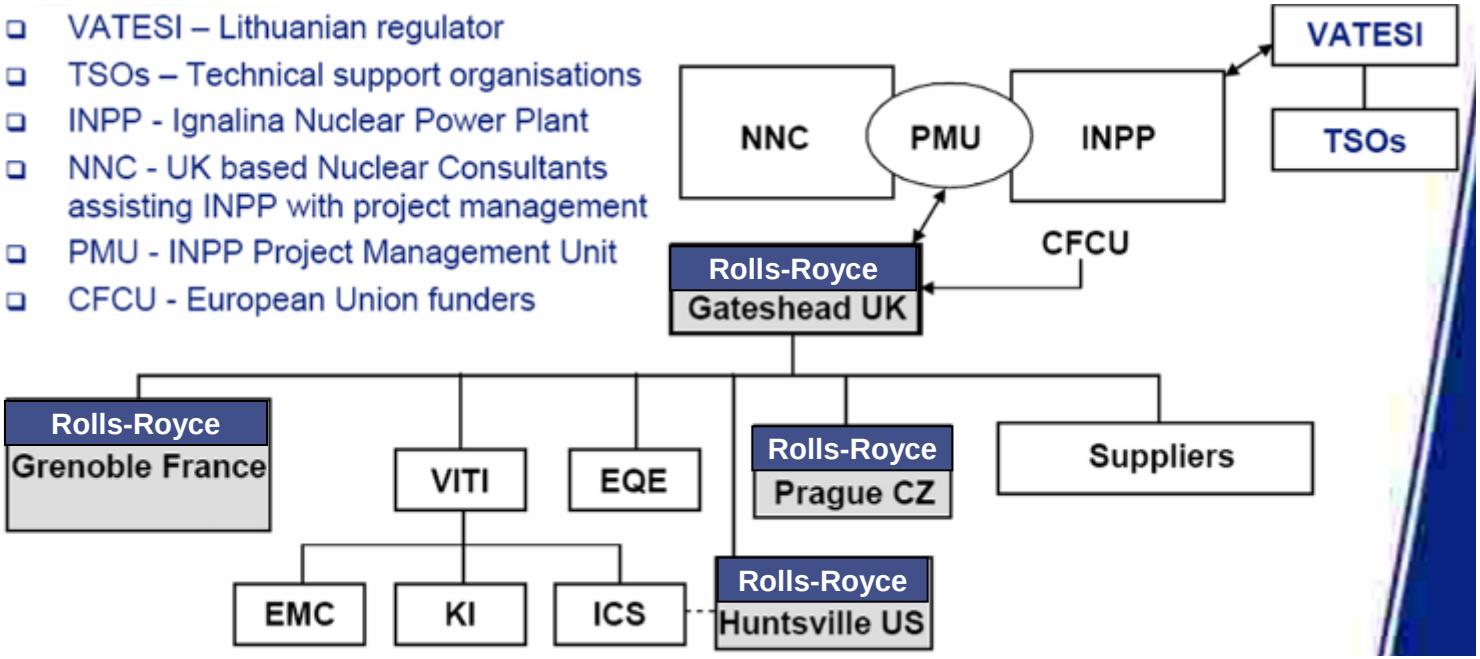
Scope:

- Extensive studies concluded to enhancement of Plant.
- Safety through priority 1: **implementation of a second independent Shutdown System**
  - Diverse Protection System, **including sensors (ex-core and in-core), digital protection system, output relay devices**
  - **Manual trip, key interlock, power distribution, cabling and conduit**
  - Modification of existing Control and protection System
  - Interfaces between new equipment and existing **(e.g Control room PICS)**
- Plant Process Computer replacement (TITAN)
- Safety Parameters Display System

ID	Task Name	2002	2003	2004
1	Contract Start	◆		
2	Preliminary Design Report	◆		
3	Final Design Report		◆	
4	Factory Acceptance Tests		▬	
5	On-site Trial Run			▬
6	Outage			▬
7	Completion			◆

Control and Protection System for IGNALINA

- VATESI – Lithuanian regulator
- TSOs – Technical support organisations
- INPP - Ignalina Nuclear Power Plant
- NNC - UK based Nuclear Consultants assisting INPP with project management
- PMU - INPP Project Management Unit
- CFCU - European Union funders



- RR Grenoble Major subsystem supplier of reactor protection equipment
- VITI - Lithuanian State Institute – detailed plant design and safety analyses
- EMC - Lithuanian company – performing modifications to existing CPS
- ICS - Lithuanians modifying NPP Information Computer System supported by Rolls-Royce US
- KI - Kurchatov Institute – Russian company performing accident analysis
- EQE - Equipment qualification company from UK
- Rolls-Royce CZ Probabilistic fault tree analyses

Rolls-Royce

Trusted to deliver excellence

Thanks for your attention