



Rolls-Royce

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

Atomex 2011 Prague
26th of October

Jana Kubinova

© Rolls-Royce plc 2010

The information in this document is the property of Rolls-Royce Civil Nuclear SAS and may not be copied or communicated to a third party, or used for any purpose other than that for which it is supplied without the express written consent of Rolls-Royce Civil Nuclear SAS . This information is given in good faith based upon the latest information available to Rolls-Royce Civil Nuclear SAS , no warranty or representation is given concerning such information, which must not be taken as establishing any contractual or other commitment binding upon Rolls-Royce Civil Nuclear SAS or any of its subsidiary or associated companies.



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

£59.2bn

Underlying
Group revenue

£10.9bn

Underlying
profit

£955m

Original
equipment

49%

Services

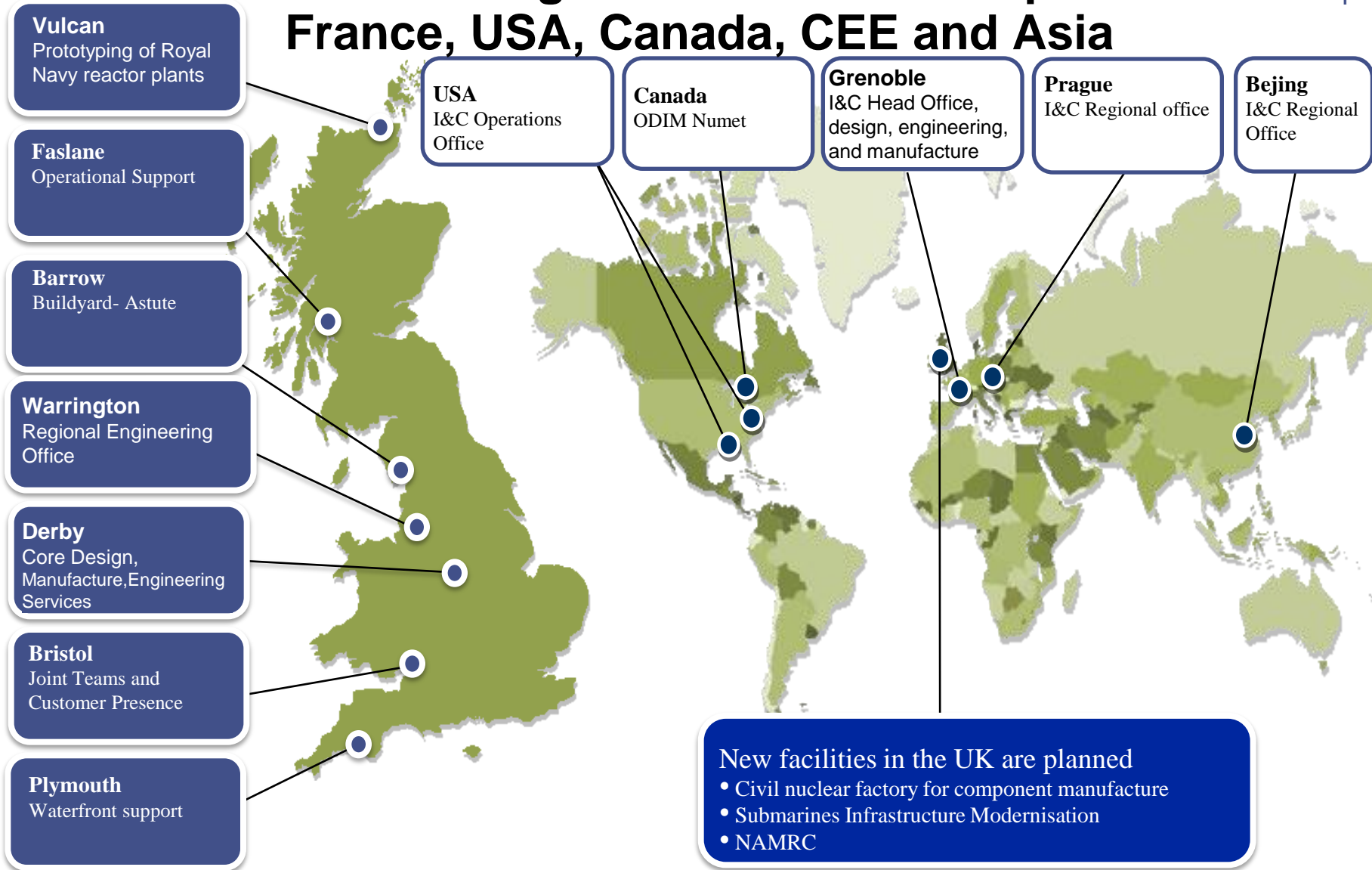
51%



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

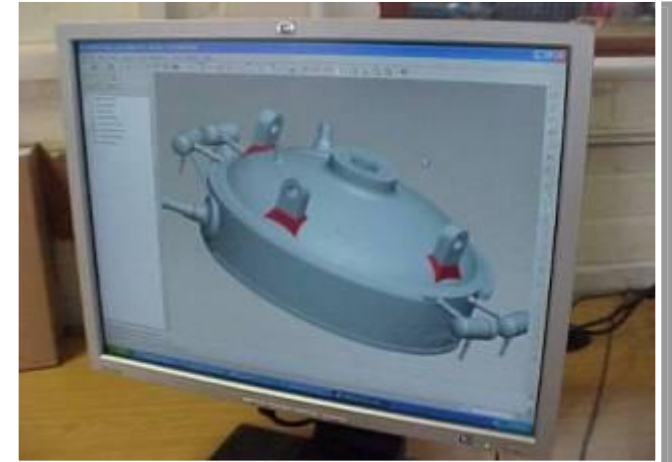
- Design and manufacture of bespoke process systems, components, remote handling tools and tele-robotic systems
- Majority of products and services for the CANDU reactor (in 2009 29 operational CANDU reactors in 7 countries)
- Holds ASME-N certification
- Capability to provide products and services at 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

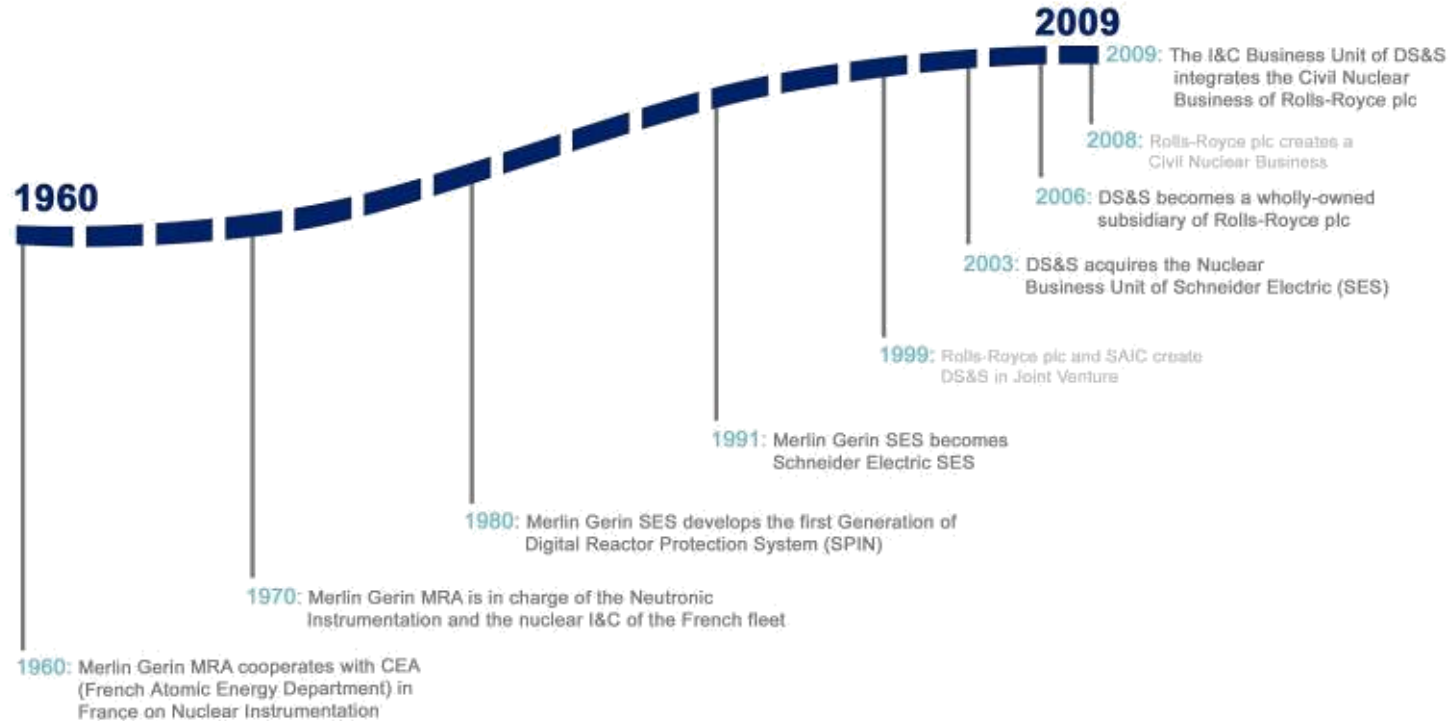


Rolls-Royce manufactured equipment and vessels including the pressuriser, conducted RPV inspection and performed technical design reviews for Sizewell B

Instrumentation & Controls

Rolls-Royce Civil Nuclear SAS history

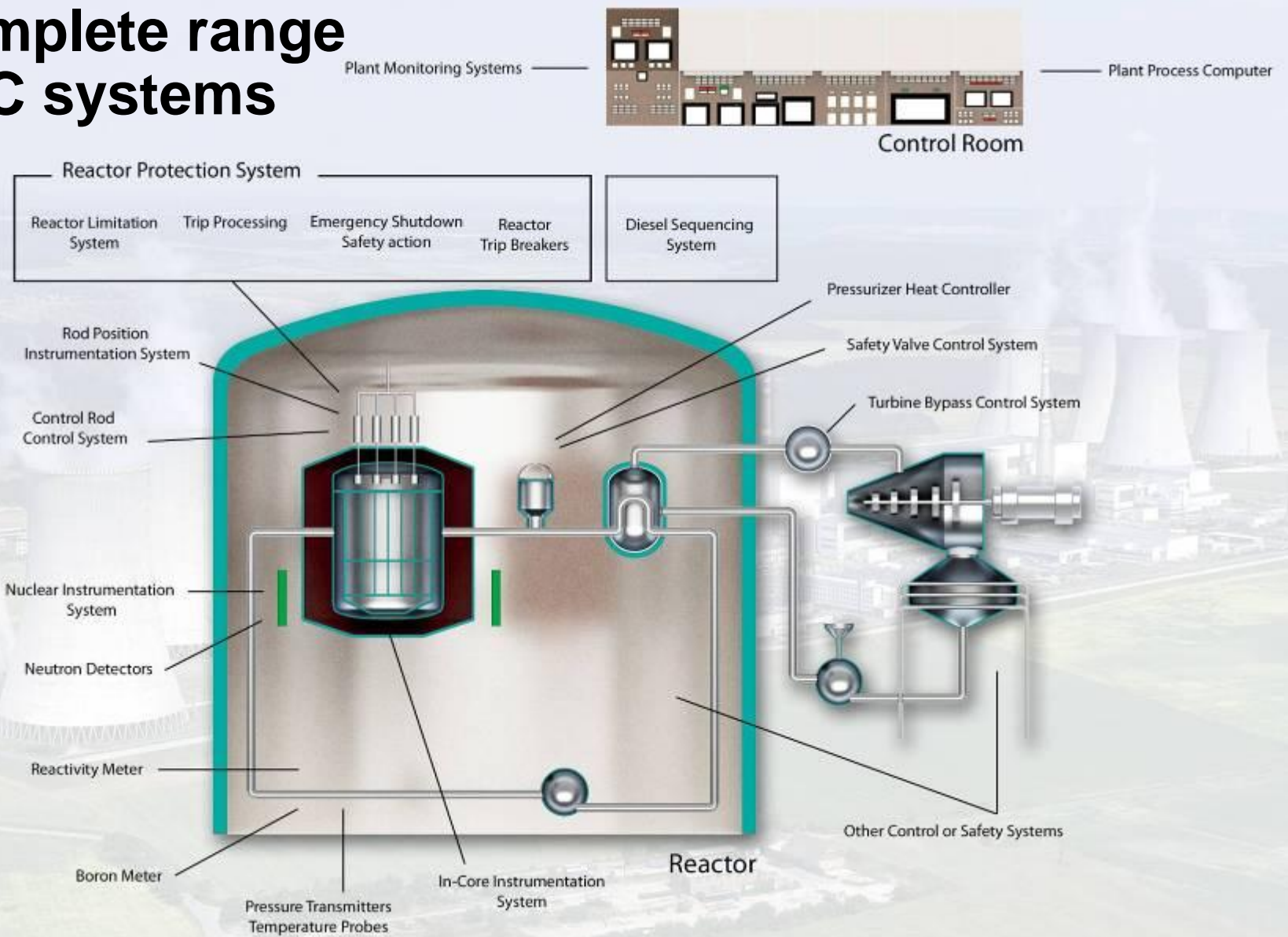
Since 1960, a continuous experience in the Nuclear Market



Rolls-Royce



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



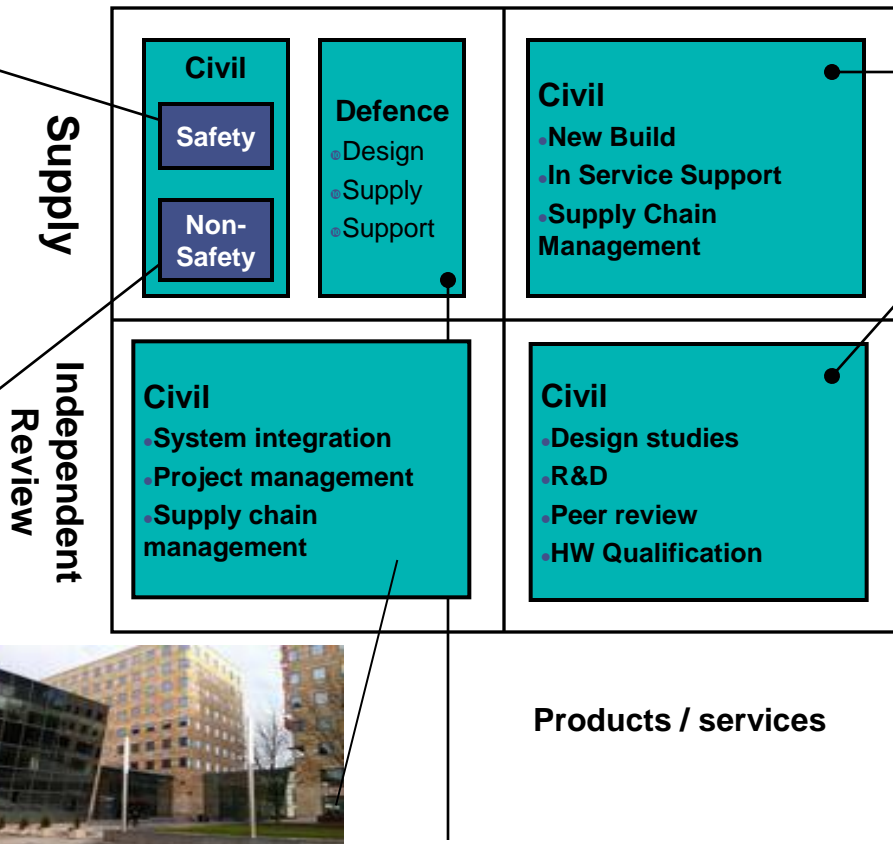
Rolls-Royce Civil Nuclear US
Huntsville, Alabama



Rolls-Royce Prague, CR



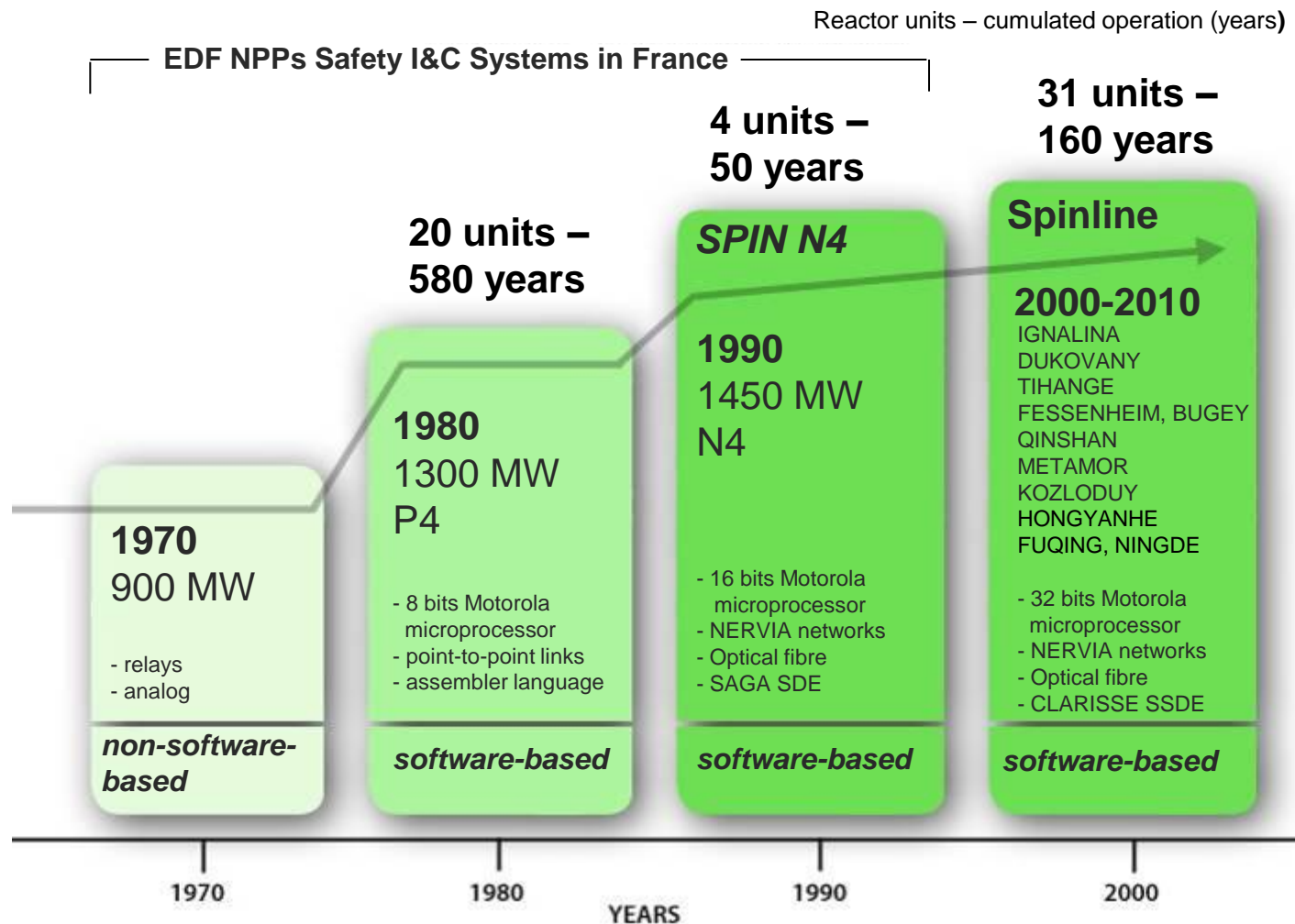
Rolls-Royce Submarines
Derby, UK



Products / services



Evolution of Spinline technology – continuous innovation



Rolls-Royce: Building Safety with I&C systems



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 availability
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

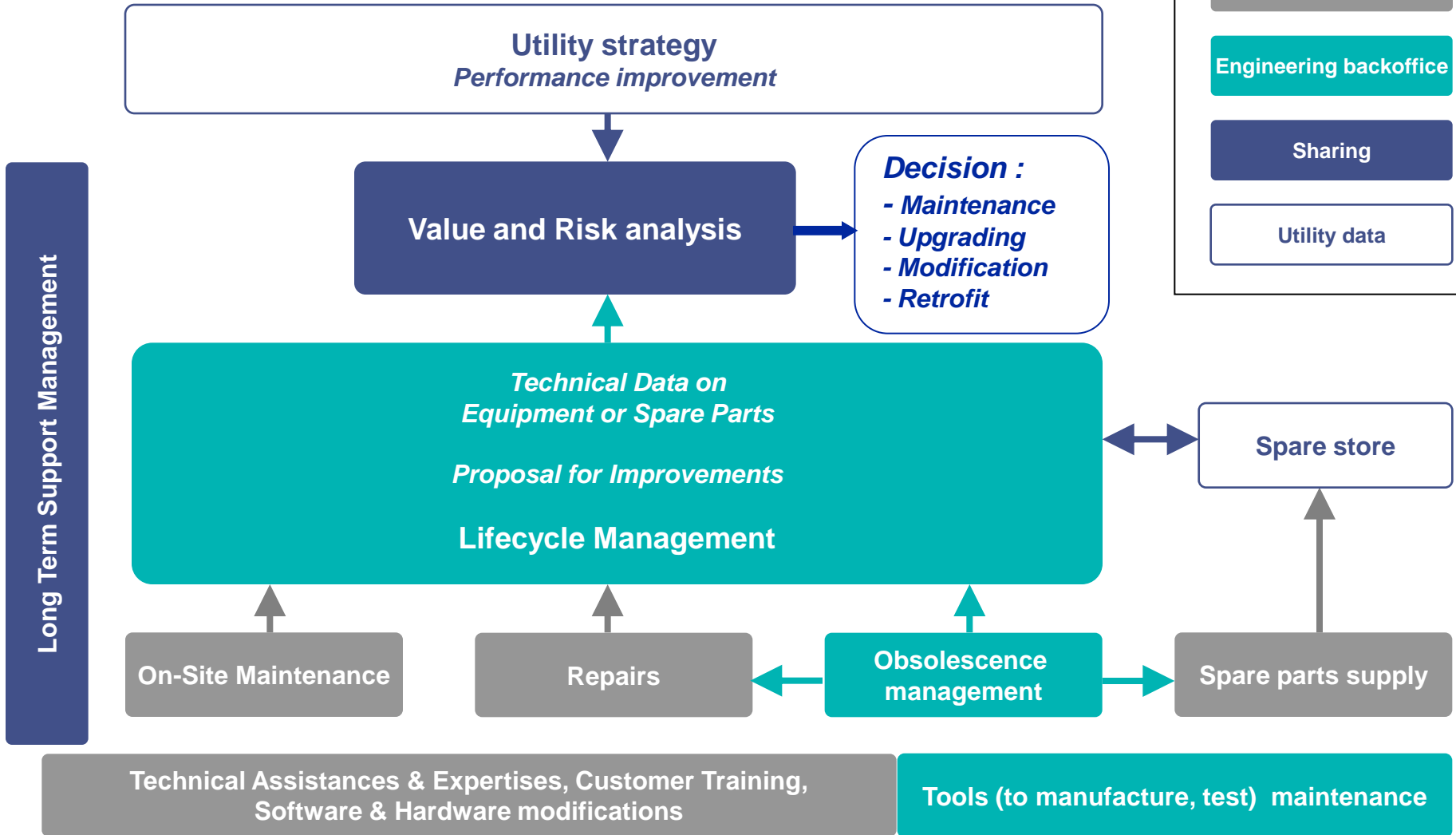
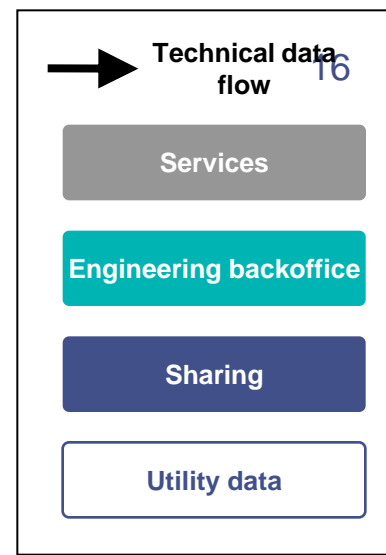
Youth

Maturity

Lifetime extension

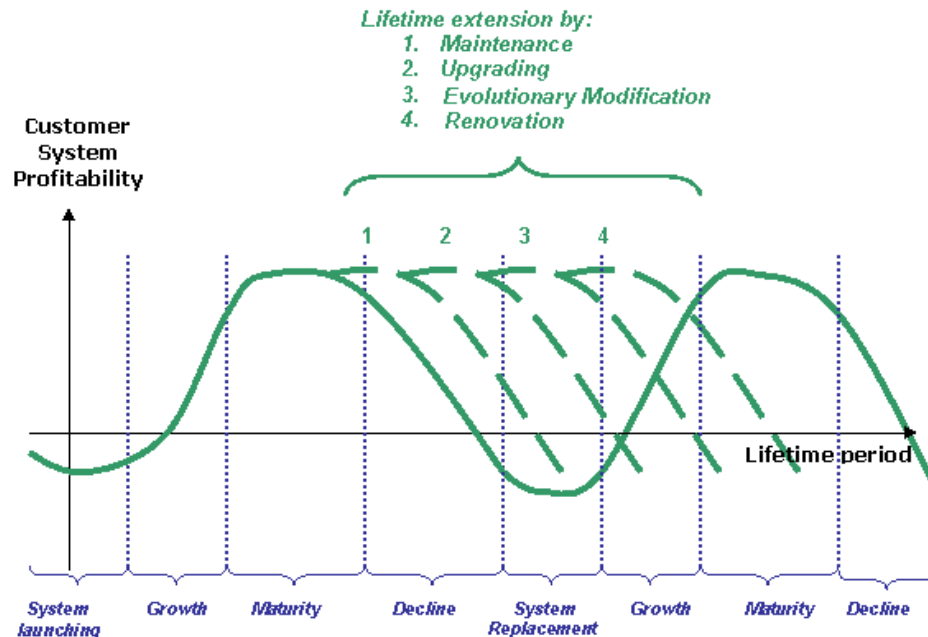
Long term support process

Legend



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

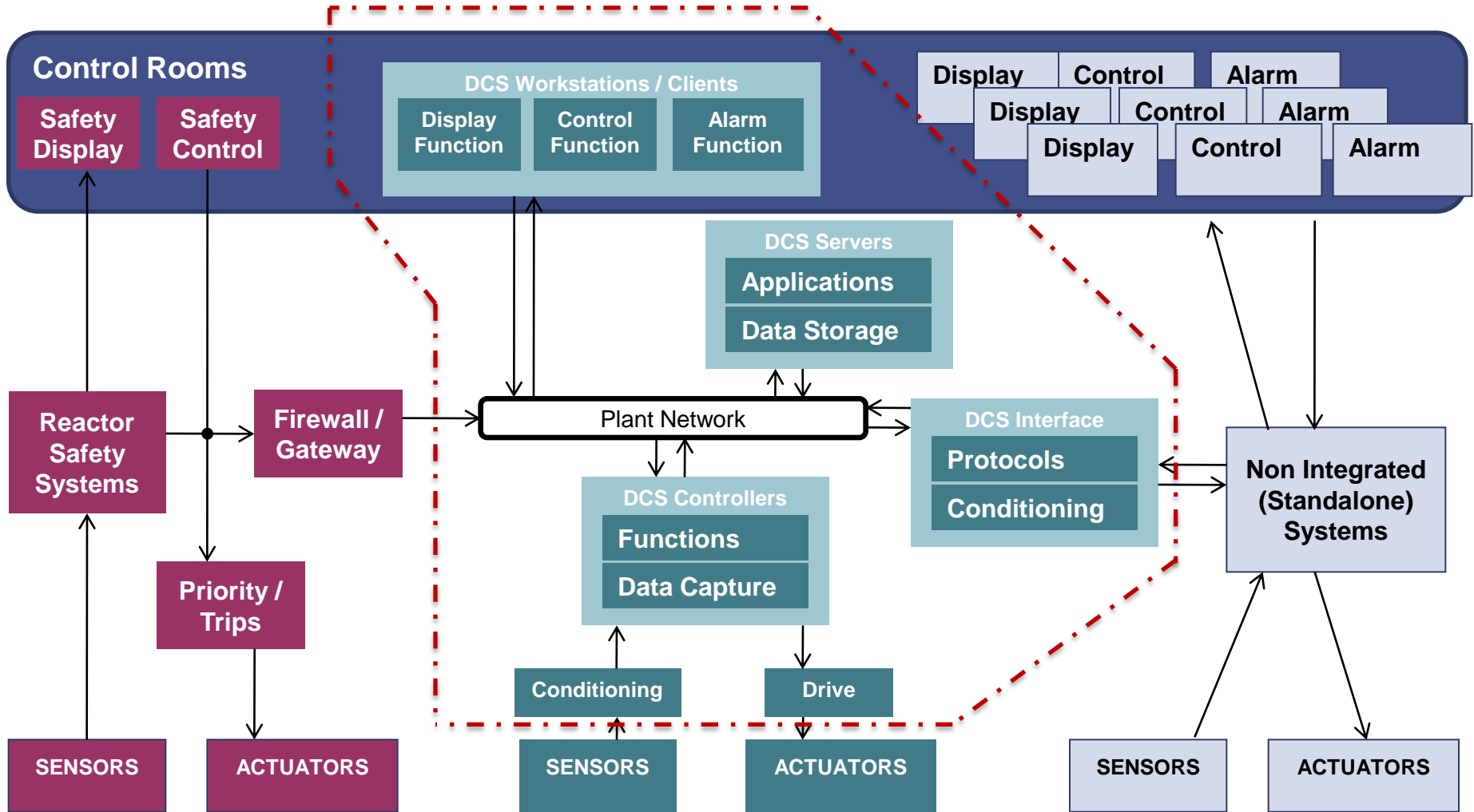
RPS

DCS

Control room
Etc.....

Multiple individual I&C system suppliers

Integrated I&C Systems



Integration process

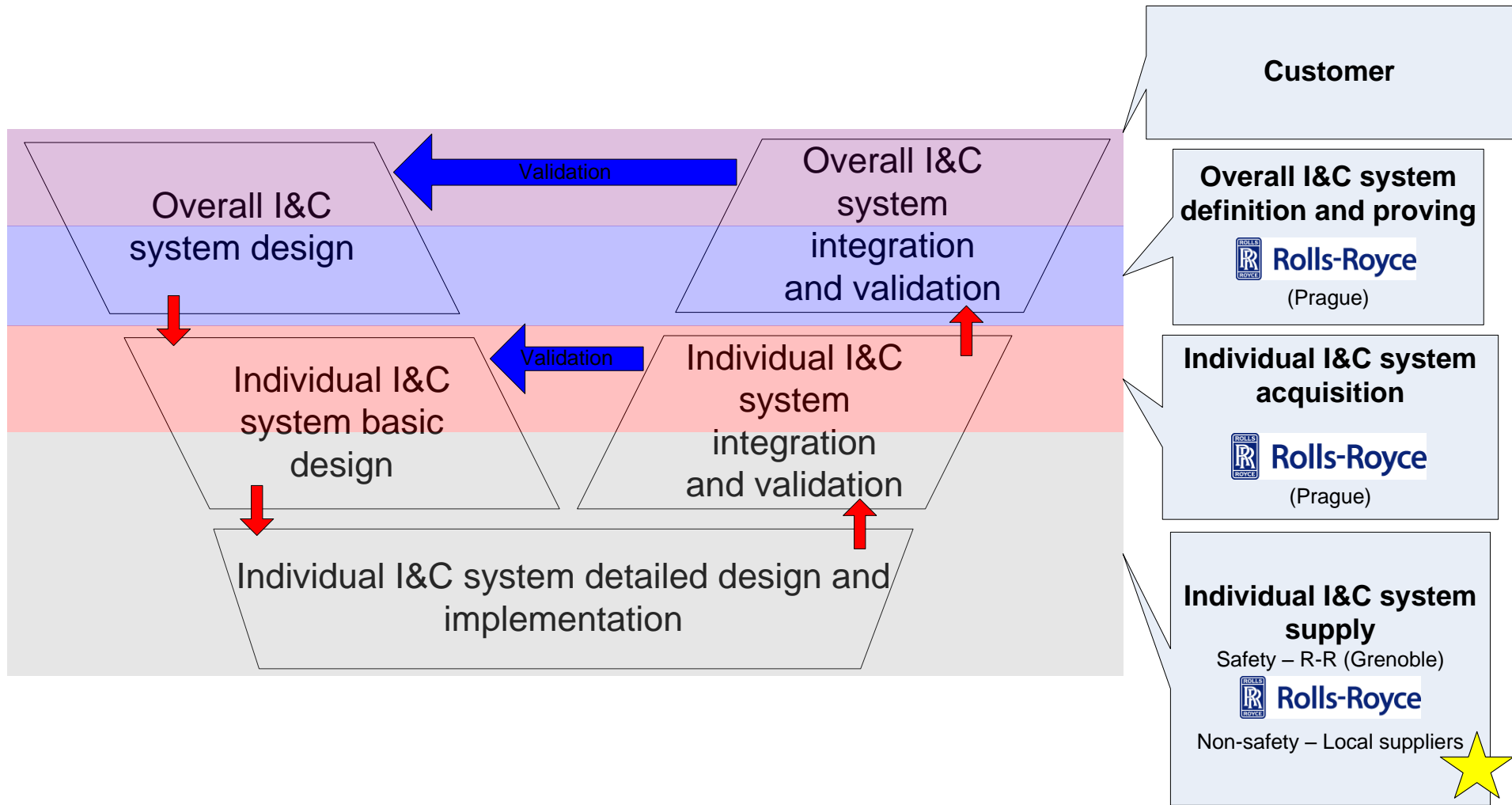
Objectives

- Provide a single solution for the full I&C scope
- Integrate proven Rolls-Royce safety technology 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



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:

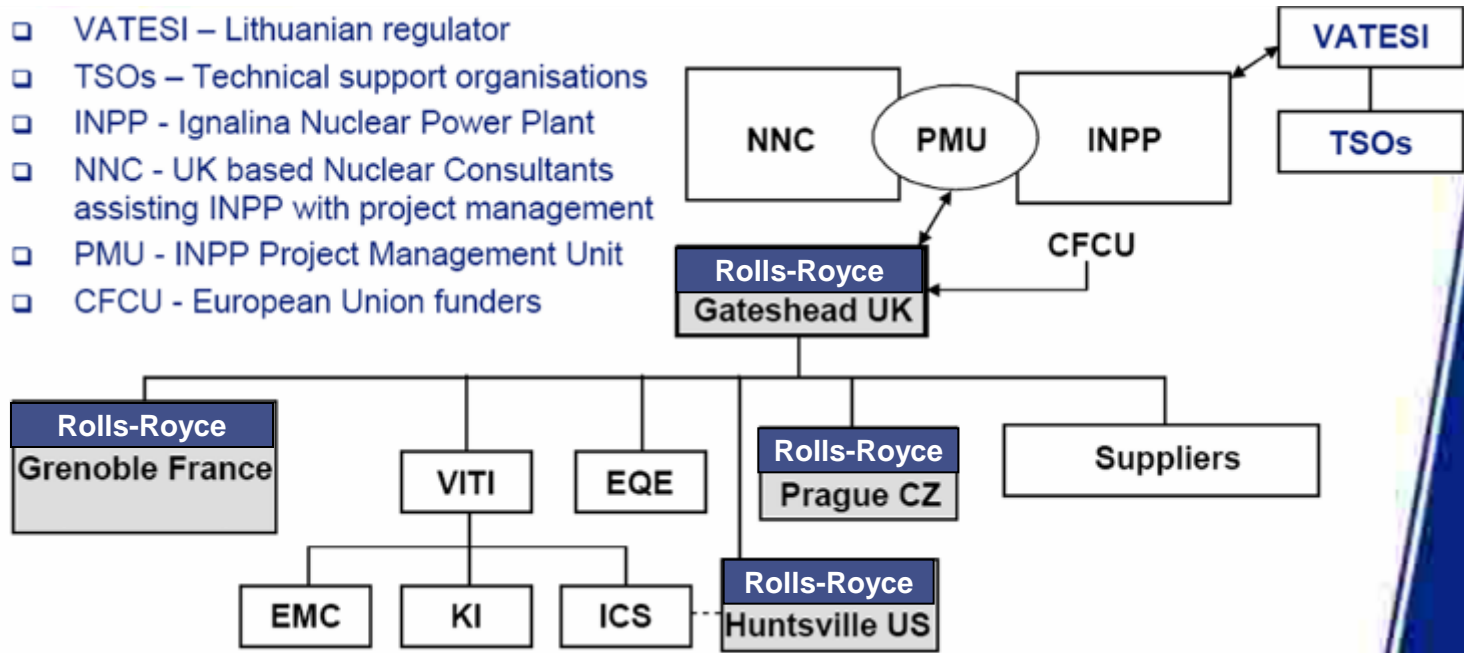
- Extensive studies concluded to enhancement of Plant.
- Safety through priority 1: **implementation of a second independent Shutdown System**
 - Diverse Protection System, **including sensors (ex-core and in-core), digital protection system, output relay devices**
 - **Manual trip, key interlock, power 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**
- ❑ **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



Rolls-Royce