SKA SYSTEM ENGINEERING NEEDS AN INDUSTRIAL VIEW

SKA-FRANCE Day 16/10/2017
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CIVIL Sector

- Development and production of space launchers Ariane 5 - Ariane 6
- Vega rocket engines
- R&D of future launchers

DEFENCE Sector

Prime contractor of deterrence systems

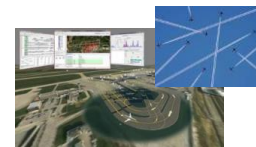## PRODUCTS, EQUIPEMENT & SERVICES

ArianeGroup offers services in both civilian and military domains

Ariane 5   Ariane 6

M51

Space Surveillance

Air Traffic Management
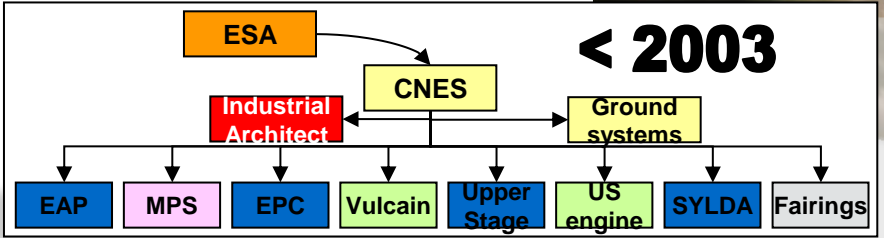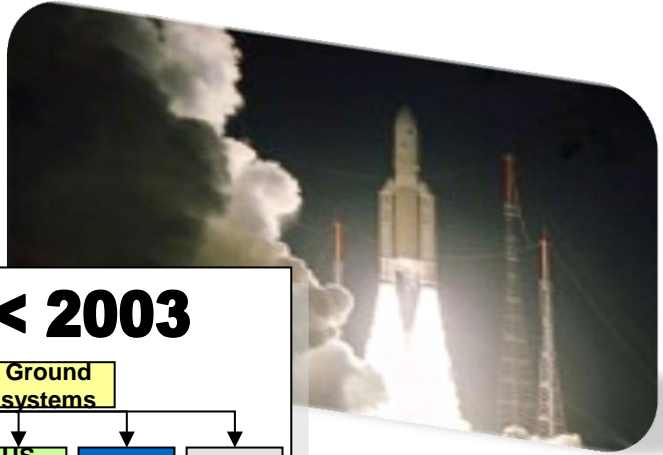
Infrastructures (nuclear, …)

FROM YESTERDAY TO NOW

System Engineering (SE) has been implemented since 1970s,

- ► **To meet performance and complexity challenges,**
- ► **To ensure success as soon as the first flight...**

From Europa to Ariane
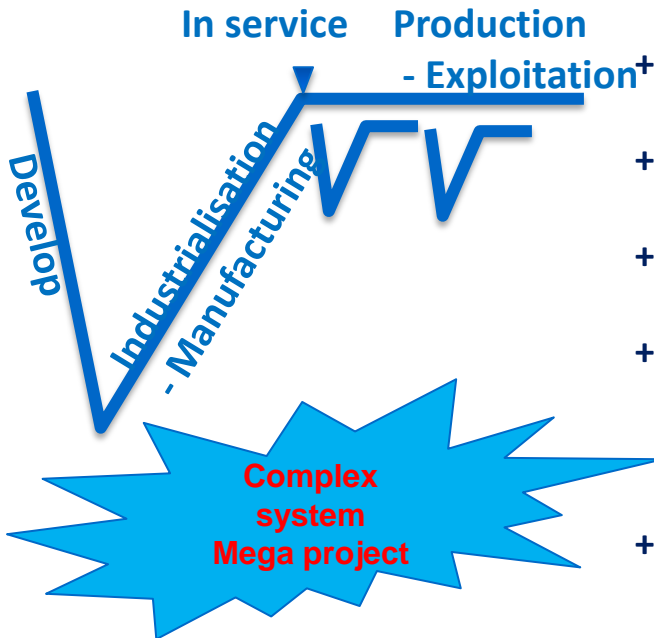
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ESA → CNES

Industrial Architect — CNES — Ground systems

| EAP | MPS | EPC | Vulcain | Upper Stage | US engine | SYLDA | Fairings |

System Engineering is now applied in all disciplines and in multi-disciplinary activities

THE CHALLENGES

In service   **Production**
- Exploitation

Develop

Industrialisation
- Manufacturing

Complex system Mega project

Space Launchers		**SKA**
+ Complex system	=	+ Complex system
+ Short development duration (time-to-market: 4 years)	=	+ Short development duration (5 years for SKA1)
+ Be competitive	=	+ Cost efficiency (constrained budget)
+ Stay reliable		+ High availability
+ Incremental development	=	+ Incremental integration
+ Complex organisation, multicultural, spread over Europe	~	+ Complex organisation, multicultural, spread over the world
+ Technologies at their limit	~	+ Some technologies (HPC) beyond current limits

Programmes driven by commitment to succeed

THE SYSTEMS TO BE DEVELOPED
= System of Interest + Enabling Systems

System of system to deliver LAUNCH SERVICE

System Of Interest : LAUNCHER SYSTEM

Enabling Systems

Development systems

Production Systems

Test Systems

System of Operation

Training Systems

Support Systems

Disposal Systems
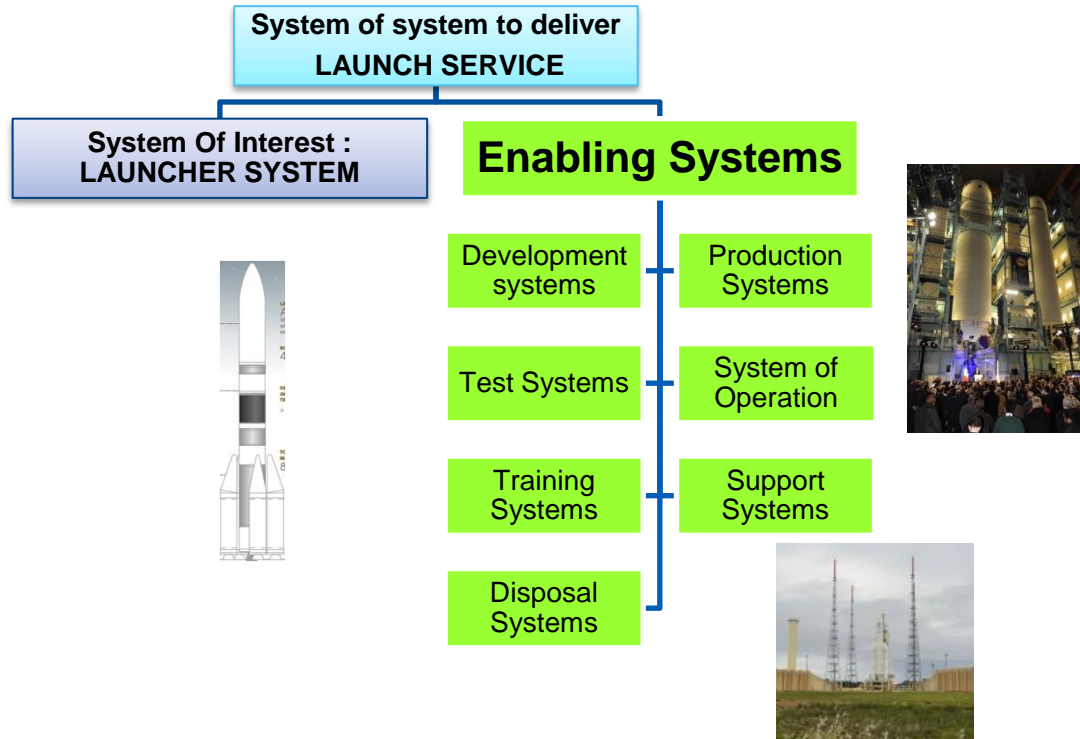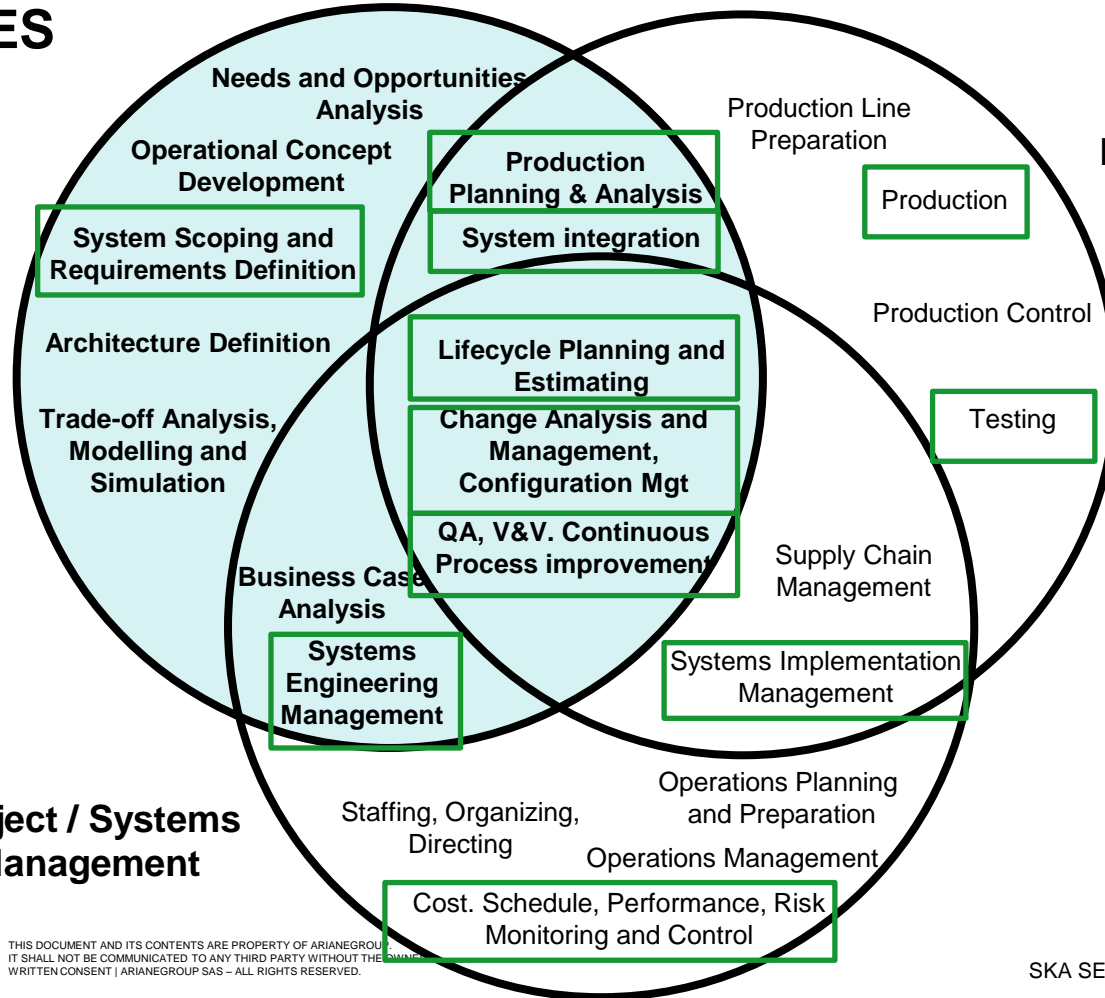
SKA

- **MID and LOW Telescopes**
  - **Network of antennae**
  - **Communication system**
  - **Signal Processing**
  - **Data Handling**

- **System of Operation**

- **Production systems**

- **Test and integration systems**

- **Support System**

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SE PROCESSES

Systems Engineering

Systems Implementation

Project / Systems Management

Needs and Opportunities Analysis

Operational Concept Development

System Scoping and Requirements Definition

Architecture Definition

Trade-off Analysis, Modelling and Simulation

Production Planning & Analysis

System integration

Production Line Preparation

Production

Production Control

Lifecycle Planning and Estimating

Change Analysis and Management, Configuration Mgt

QA, V&V. Continuous Process improvement

Testing

Supply Chain Management

Business Case Analysis

Systems Engineering Management

Systems Implementation Management

Staffing, Organizing, Directing

Operations Planning and Preparation

Operations Management

Cost. Schedule, Performance, Risk Monitoring and Control

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MULTI DISCIPLINARY ENGINEERING

Launchers

- Propulsion
- Guidance, Navigation Communication
- Flight Software
- Operations
- Ground Software
- Mechanics
- Avionics
- Thermal
- Security
- Reliability, Availability, Maintainability, Safety

1. Concept of operations
2. Model Based SE
3. Co-engineering & simulation

SKA

- Electro-magnetics
- Fundamental physics
- Communications
- Signal processing
- Operations
- Data Handling
- Infra-structure Energy
- Command & Control
- Thermal
- Security
- Reliability, Availability, Maintainability, Safety
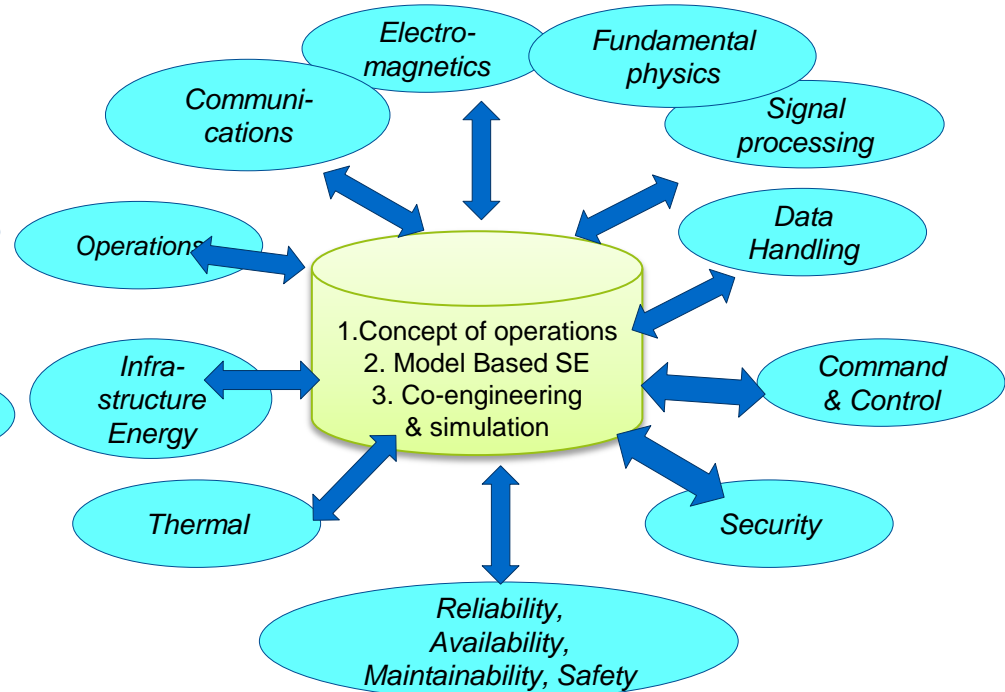
1. Concept of operations
2. Model Based SE
3. Co-engineering & simulation

INCREMENTAL PROCESS

The Development process is adapted to <u>incrementally</u> build the System in accordance with maturity and priority.
It results in a parallel multi-V cycles development logic

⇒ **To secure the Schedule, with early prototyping and Tests**

⇒ **To ensure early operations and reduce risks**

MG5　MG6　MG7　MG8　MG9　MG10

C1　　　C2　　　C3

QR

PDR

CDR

Shortened schedule for C1

PDR, CDR, QR
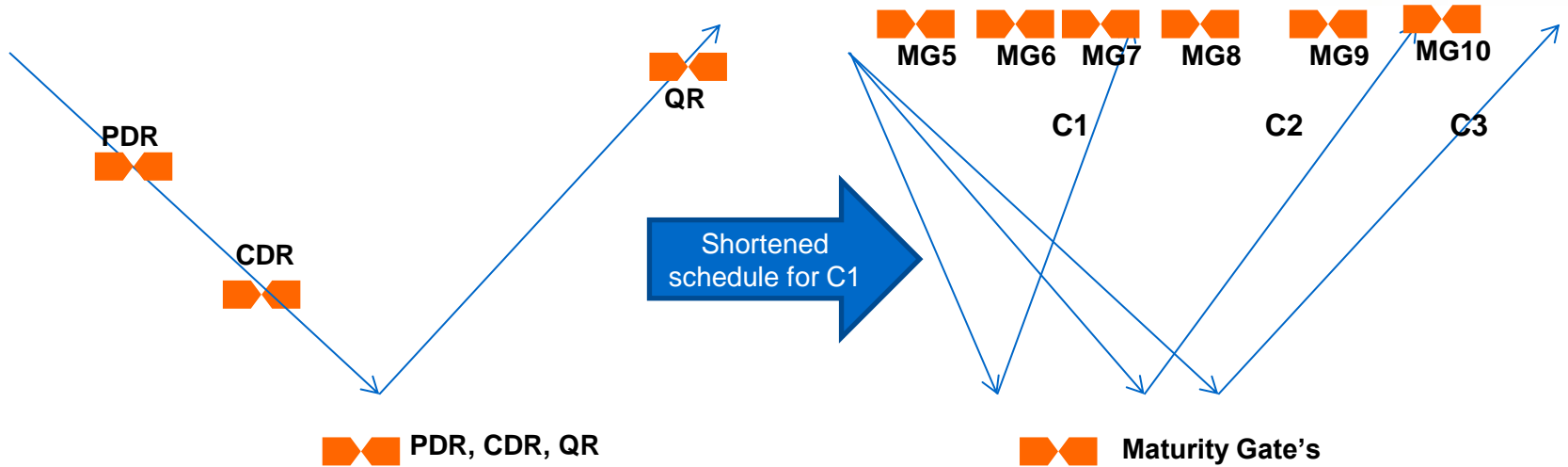
Maturity Gate's

System Engineering for overall coherency and efficiency

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THE CHALLENGE OF A TIGHT SCHEDULE

The IV&V activities shall be carefully planned and monitored

⇒ **A top-down master plan is set with Maturity Gates (Master plan Milestones)**

⇒ **The Integration, Verification and Validation Plan shall meet the Master Plan milestones**

Maturity increase = Risk Reduction = increase the Confidence that Requirements will be met
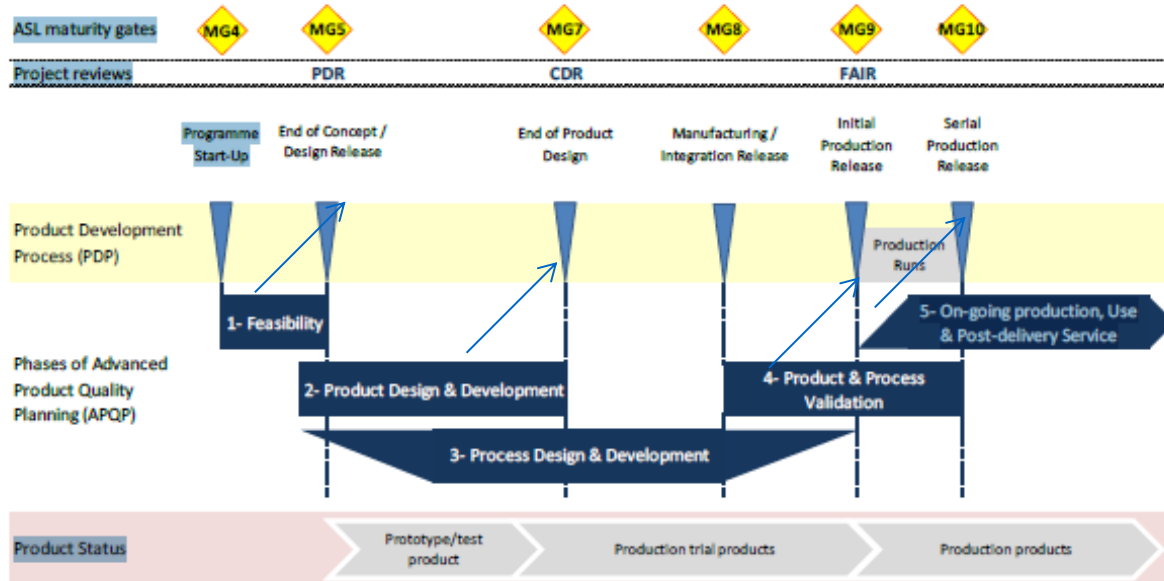
SYSTEM ENGINEERING

A common reference for all actors, working in <u>collaboration</u>:

- **Requirements,**
- **Architecture,**
- **Models,**
- **Multi-physical simulation**
- **Design, including interfaces,**
- **Verification and Validation (V&V),**
- **Performance**

➔ **To ensure OTOCOQ (On Time, On Cost, On Quality)**

➔ **To secure Stakeholders' investments**

With a team to support:

- *Technical coherence assurance*
- *SE data (Requirements, V&V) configuration management*
- *Maturity assessment and monitoring*

With
Processes, Methods & Tools

CONCLUSION

SYSTEM ENGINEERING IS KEY TO ENSURE <u>TECHNOLOGIES</u> ARE MATURE AND COHERENTLY IMPLEMENTED TO REACH THE <u>OVERALL PERFORMANCE</u>

SYSTEM ENGINEERING IS KEY TO SECURE <u>SCHEDULE, COST</u> AND <u>QUALITY</u>

⇒ **Applies to <u>all phases</u> of the System Life Cycle**

⇒ **Relies on good collaboration with <u>Programme Management</u>**

⇒ **Structures <u>collaborative</u> working**

French Industry have proven expertise in System Engineering that can be applied for SKA

⇒ **ArianeGroup could provide System Engineering support as well as the engineering of the SKA System of Operations and System of Support**

> **French participation will benefit to SKA, via its scientific and industrial involvement notably in System Engineering**

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THANK YOU
ANY QUESTIONS ?

SKA SE NEEDS -