

HIGH INTEGRITY SYSTEMS AND SOFTWARE

Cross industry expertise in developing
systems that must never fail



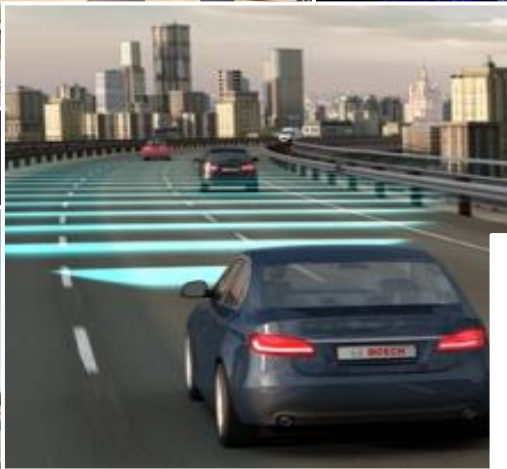
CAPGEMINI HIGH INTEGRITY SYSTEMS ARE ALL AROUND US ...



ADAS market is growing at 15% CAGR from \$30bn in 2021

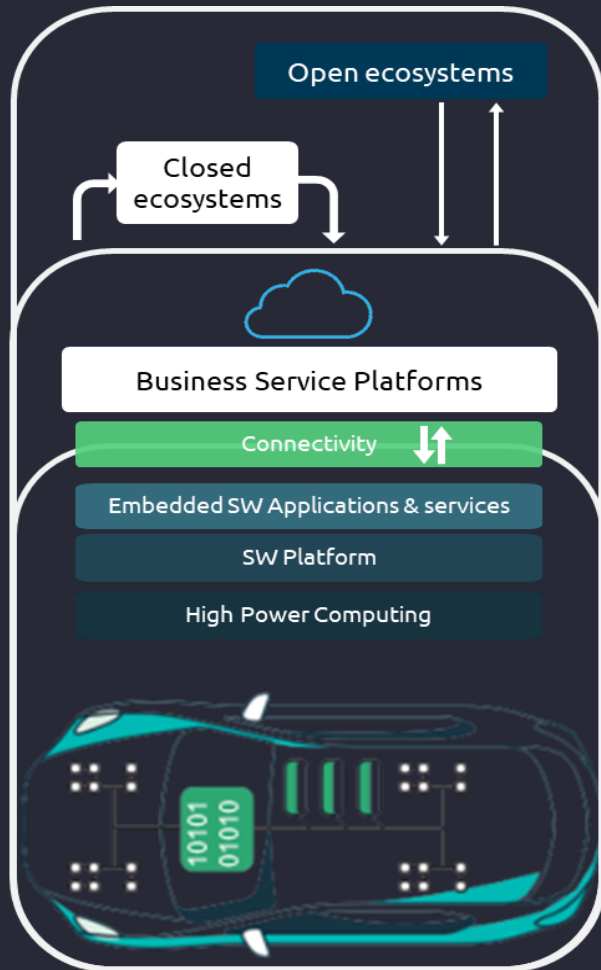
Safety technology market could grow to \$863bn by 2023*

Railway signalling systems market estimated to grow from \$10.6bn in 2020 to \$21bn in 2027^

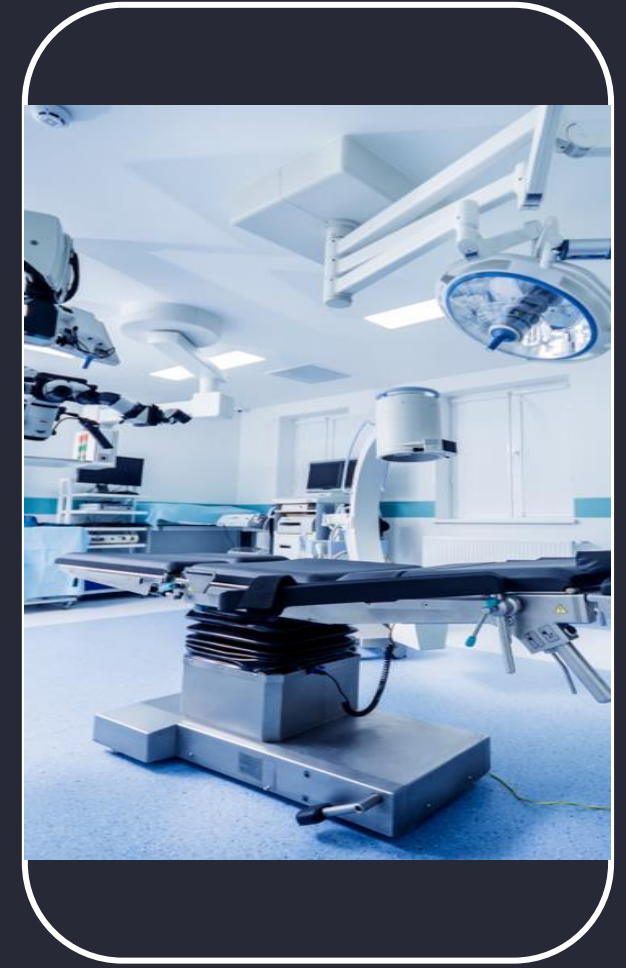
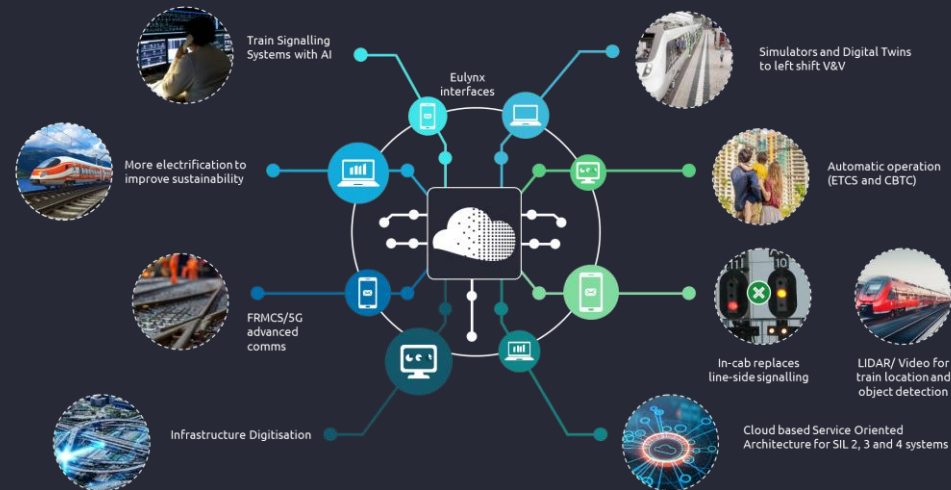




KEY TECHNOLOGIES ARE CONNECTING HI SYSTEMS AND MAKING THEM MORE INTELLIGENT



AI 5G Cloud



HIGH INTEGRITY AND INTELLIGENT INDUSTRY

Everything is becoming intelligent with software making more and more decisions

Where the products, operations and support services must always operate, 24/7, 365 without a single failure that could lead to significant loss (including injury/death, reputational damage, financial loss) even under the most extreme events, then those products, operations and support services are “High Integrity”.

Examples



Intelligent Products

Automatic Train Protection

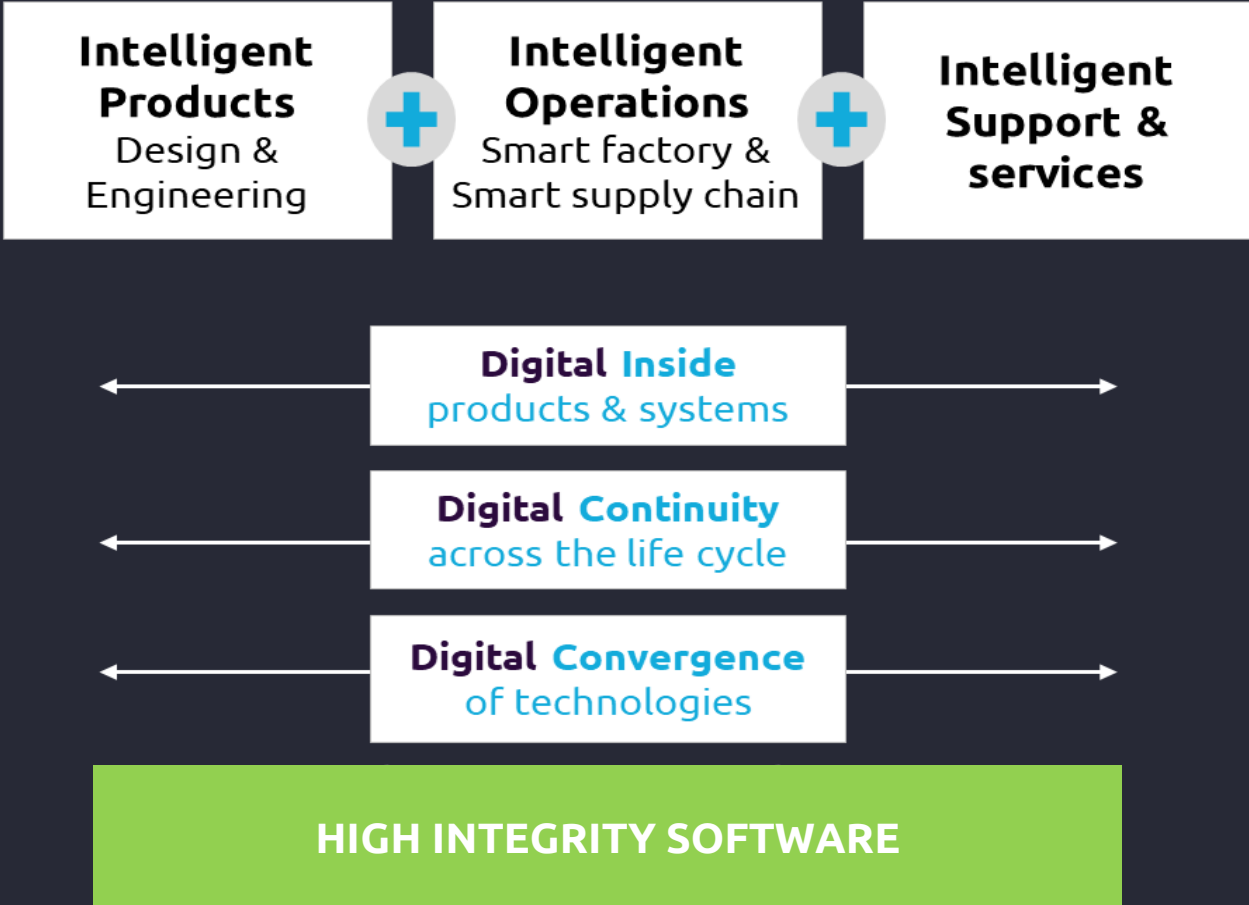


Intelligent Operations

Engine Health Monitoring



Everything becomes intelligent



CHARACTERISATION OF HIGH-INTEGRITY SYSTEMS



System Behaviour

- **always safe** (safety perspective)
(if system is safety related)
- **always secure** (security perspective)
- **always does the right thing** -
particularly under failure modes and
unexpected situations (systems
perspective)

“Always” requires:

- ultra-low defect software (software perspective),
- highly available and/or redundant hardware (RAM perspective) and
- well designed processes and tools that minimize human errors (human factors perspective).

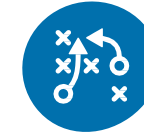
Context:

- typically regulated industry
- typically needs to integrate with or replace existing systems (ie brownfield)

Always Safe

Always Secure

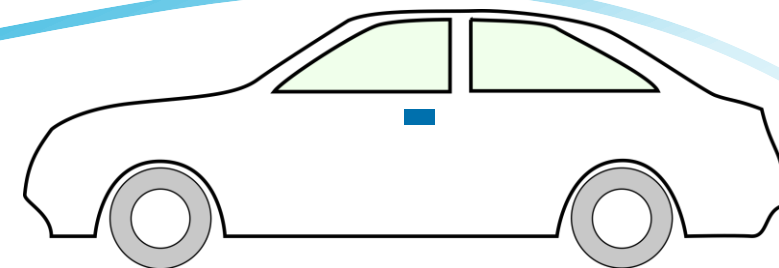
Always Does
the right thing



Building HI Systems is hard

Because of:

- The multiple perspectives that must be taken into account and reconciled
- The complexity of handling all possible failure modes
- The fact that HI systems almost always need to interact with or replace existing systems
- The primacy of safety and/or security above cost and schedule.





WHAT HIGH INTEGRITY SYSTEMS DO YOUR CLIENTS HAVE?



HOW ARE HIGH INTEGRITY SYSTEMS DEVELOPED DIFFERENTLY?



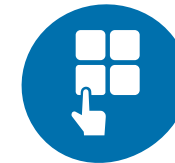
SYSTEMS LEVEL

- High-integrity systems demand a much more detailed analysis of the system context and use-cases including a thorough analysis of the failure scenarios, we therefore use Model-Based Systems Engineering
- Requirements for high-integrity systems need to be much more precise and completely unambiguous. For the highest integrity systems, specifications are written using formal methods.



CROSS LIFECYCLE

- Lifecycle models and tools all need to be tailored for High-Integrity development.
- Agile becomes High-Integrity Agile;
- CI/CD is about evidence generation as well as test execution
- Change and fault management tools need to collect extra evidence
- Software teams need to work closely with systems, safety, security, RAMs and Human Factors teams



SOFTWARE LEVEL

- Every aspect of software development from the processes, through the architecture, to the code and static analysis and verification need to be more precise.
- Automatic code and/or test generation is used to reduce defect injection
- Bug finding tools are not good enough for the highest levels of integrity, proof is the only way of guaranteeing no defects



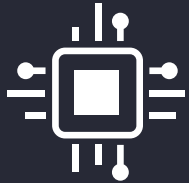
BUSINESS LEVEL

- Experience is key, project technical leaders need at least 10 years of high-integrity experience
- Strong governance is key to ensure a safety first attitude and to keep projects on track despite the additional burdens of high-integrity development

HIGH INTEGRITY SYSTEMS MUST BE DEVELOPED USING A RIGOROUS ENGINEERING PROCESS DESIGNED TO MINIMISE THE INTRODUCTION OF DEFECTS WHILST MAXIMIZING DEFECT REMOVAL AND GENERATING EVIDENCE ALONG THE WAY - WE CALL THIS **CORRECTNESS BY CONSTRUCTION**

Defects in high-integrity systems should be at least 10 times fewer than industry best practice

KEY CHALLENGES



The **rapidly increasing importance of software** is shifting the paradigm for many industries. This requires Organisations to transform the current way of doing business.

KEY CHALLENGES TO MAKE THE CHANGE

PRODUCT



HOW TO RAPIDLY DIGITIZE

Standardisation of interfaces, use of Service Oriented Architectures and Cloud...



IT/OT Flexibility

architect to cope with different lifecycles (Train/OT/IT) and enable interoperability between OEMs.



HOW TO IMPROVE GO TO MARKET ?

New way to monetise products, through X-as-a-service business models

ENGINEERING PROCESS



HOW TO MANAGE RESSOURCES SCARCITY ?

Retrain experienced people from other competencies/ industries, training academies



HOW TO ACCELERATE INNOVATION ?

Increase feature velocity to create Competitive differentiation

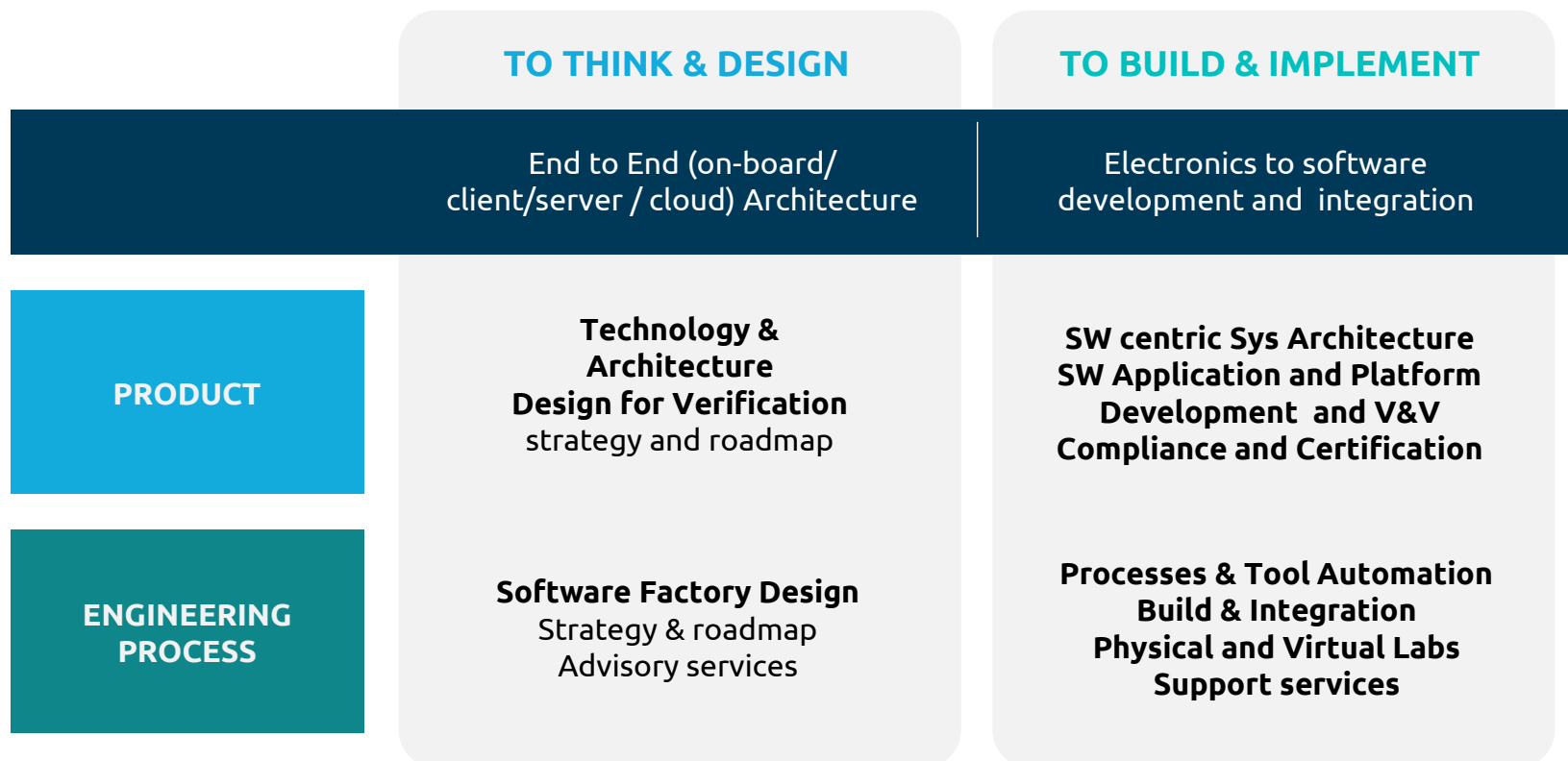


HOW TO CERTIFY RAPIDLY EVOLVING SYSTEMS

New approaches for analysis, incremental and modular cert ...

OUR VALUE PROPOSAL : *INDUSTRIALISED HIGH INTEGRITY SOFTWARE DEVELOPMENT*

To help our clients realise the digital transformation, we have industrialised software development. We can standardise the processes, procedures and tools of software development ensuring adherence to norms and standards for certification, supporting the rapid mobilisation of teams and increased efficiency.



PRODUCT – THINK & DESIGN

We help our clients to define and develop systems and software architectures that build upon technology developments from across a broad range of sectors to create robust and future proof products that are safe and secure.



High Level Advisory

We perform audits

- Process
- Organization
- Architecture
- Tools
- Methods
- Safety

We advise and intervene on projects with our experts in various domains

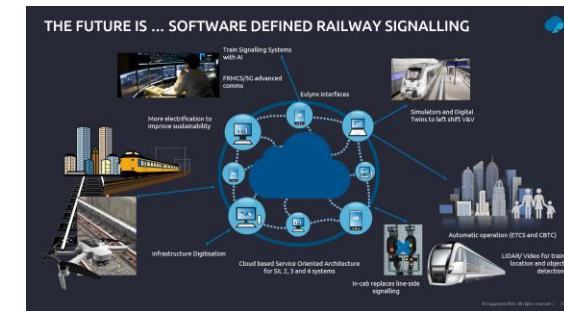


MBD System integrator Fast Prototyping

As integrator we connect system, software and hardware using model base approach and assets associated

In many industries systems will move away **from independently operating embedded systems** that respond to mechanical changes **to highly interconnected digital systems** that utilize high-bandwidth comms, Service Oriented Architectures and Safety Critical Cloud infrastructure to reduce physical infrastructure and enable manufacturers to deliver services rather than products.

We enable our clients to develop future proof product architectures and take account of likely future changes to their industry by providing technology & architecture, strategy and roadmap and advisory services.



Options analysis

- Identify a diverse range of options, from many different industries
- Systematically assess the options based on a range of factors including time-to-market, cost, safety, security etc.
- Down select to 2-3 to take to the next stage



Systems analysis of software architectures

- Capture high-level use-cases to be supported
- Analyze architectural options
- Specify subsystems
- Carry out pre-liminary Safety and Security analyses



Prototyping and demonstration

- Rapidly develop prototypes to support detailed analysis and demonstration
- Build prototypes based on existing code bases/ technologies that Capgemini have

SERVICES

PRODUCT – BUILD

Critical software development is difficult. Industry software development standards (EN 50128, DO-178C, ISO 26262 etc.) are very rigorous and demonstrating the highest level of integrity is much more involved than developing software in non-regulated industries.

Outsourcing this most important and costly software needs to be done carefully and only to businesses with significant experience.

Capgemini's High-Integrity Agile approach combines waterfall and Agile to create a process that is perfect for critical systems software development. Combining this with **automatic test generation, simulators, virtualization and advanced tooling** reduces cost and time-to-market whilst maintaining quality

We enable our clients to get surety of delivery by agreeing to fixed price, and fixed schedule projects.

Providing:

- Design, build and test services with a warranty
- Support to certification including Safety, Security and Human Factors Engineering
- Monitor and maintain software systems once they are operational



HIGH-INTENSITY AGILE SOFTWARE DEVELOPMENT

Delivers critical systems with assurance and flexibility while maintaining schedule and cost



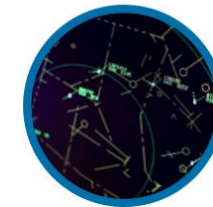
REVEAL

A disciplined approach to requirements engineering for high-integrity software



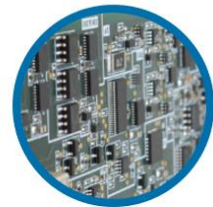
CONTESTOR - CONTRACT-BASED INTELLIGENT SOFTWARE

Automatic constraint-driven test data generation and execution for high-integrity systems



SPARK

Contract-based programming language and static verification tools for high-integrity systems



FULL-LIFECYCLE ENGINEERING

High-integrity software, hardware, warranty and regulatory approval in a single engagement

PROCESS – THINK & DESIGN, BUILD AND OPERATE

Software development costs are taking an increasing percentage of the total R&D development costs for systems across all industries.

As systems get more complex and take on ever increasing responsibility the costs associated with certifying them increases exponentially. Advanced development techniques that use model based, lean approaches and automation are required to control cost increases.

Capgemini have been at the vanguard of **software development techniques** and approaches for many decades and is able to share its return of experience through a **four-step process**:

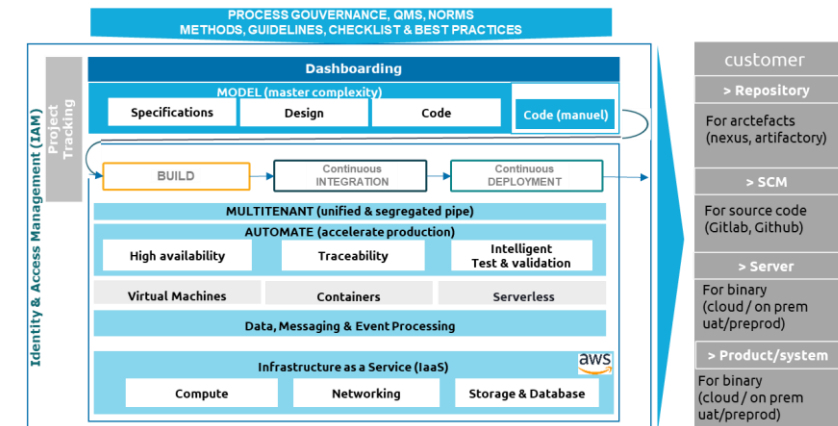
1. Operational strategy: Assess as-is situation / Develop roadmap for improvement
2. Design and Engineer new methods and tools built on Capgemini's own methods and tools
3. Operate the tools providing 1st, 2nd and 3rd line support
4. Accelerate delivery – apply DevOps techniques to rapidly accelerate the development and deployment process

We enable our clients to:

- modernize its software development approach
- take advantage of technologies used in other industries
- take advantage of the latest developments from academia, industry
- take advantage of tools and techniques applied across a range of industries

We provide

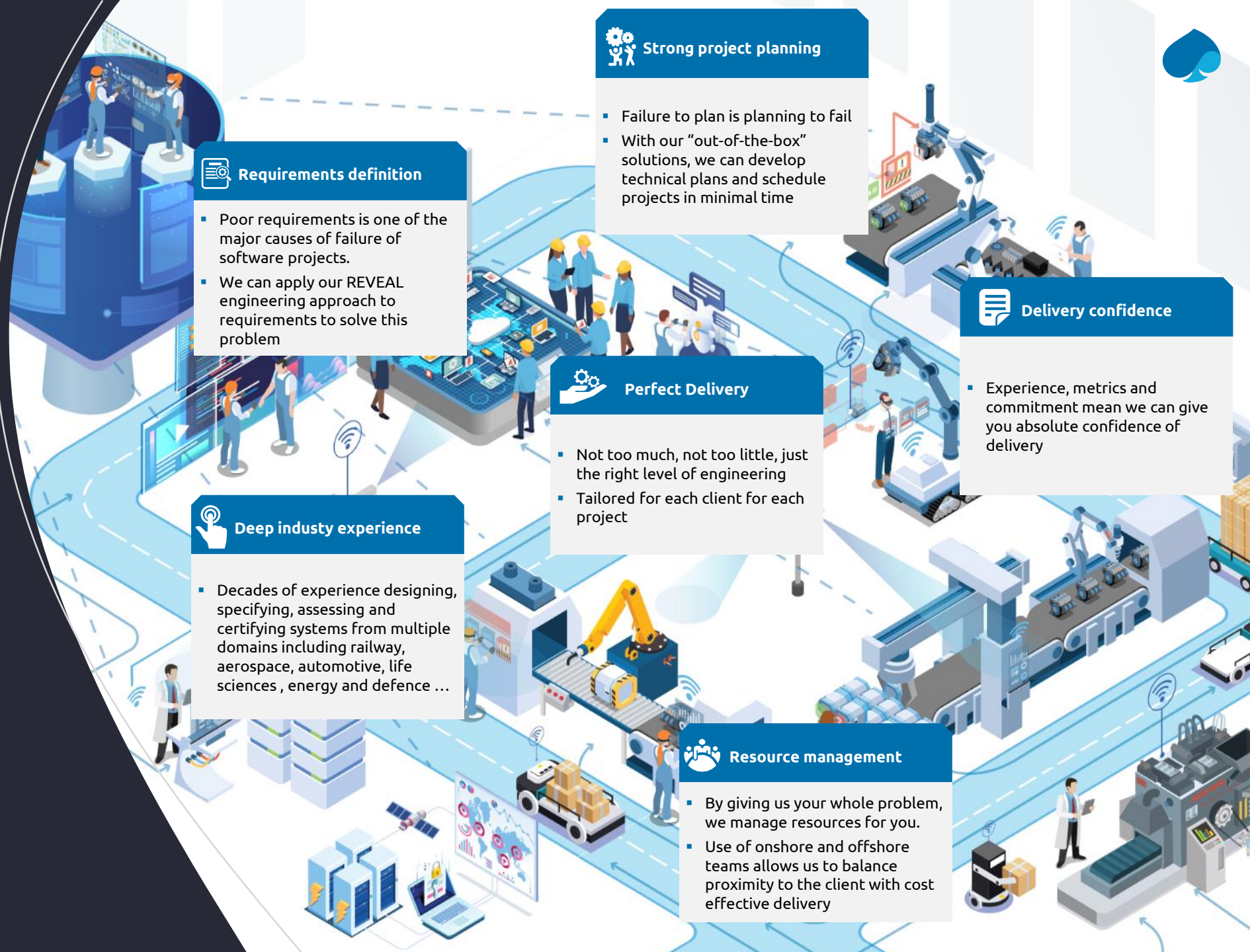
- Software development process and tooling enhancement services including analysis of inefficiencies in existing processes, identification of new techniques and tools to increase efficiency, road mapping to enable you to incrementally develop your approach and roll-out
- DevOps services including building, operating and enhancing DevOps pipelines for high-integrity software



WHERE WE BRING VALUE

Traditional development approaches, particularly for high-integrity systems, are slow, costly and difficult to scale.

Our clients need to get products to market more quickly to beat their competitors and realize the value of their investments as early as possible



CONTACTS

For more information please contact



Andrew Hawthorn

High Integrity
Solution Architect



Stephane Ramilhon

Solution Manager
and Pre-Sales



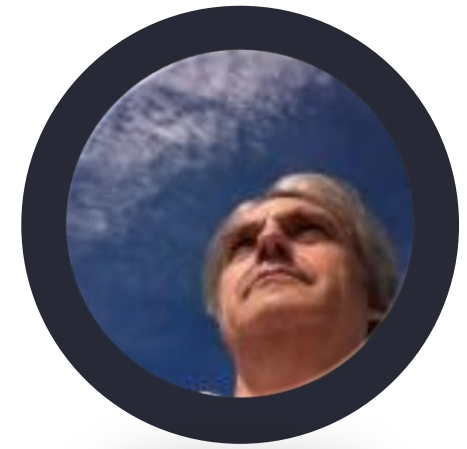
Suresh Sarojani

CTO Medtech



Mauro DiCesare

Head of Safety Critical SW
Capgemini Engineering, Italy



Mark Hersey

Technical Director



Jorge Lopes

Head of Software
Industrialisation



Alexandre Esper

Capgemini Engineering
Safety Manager