

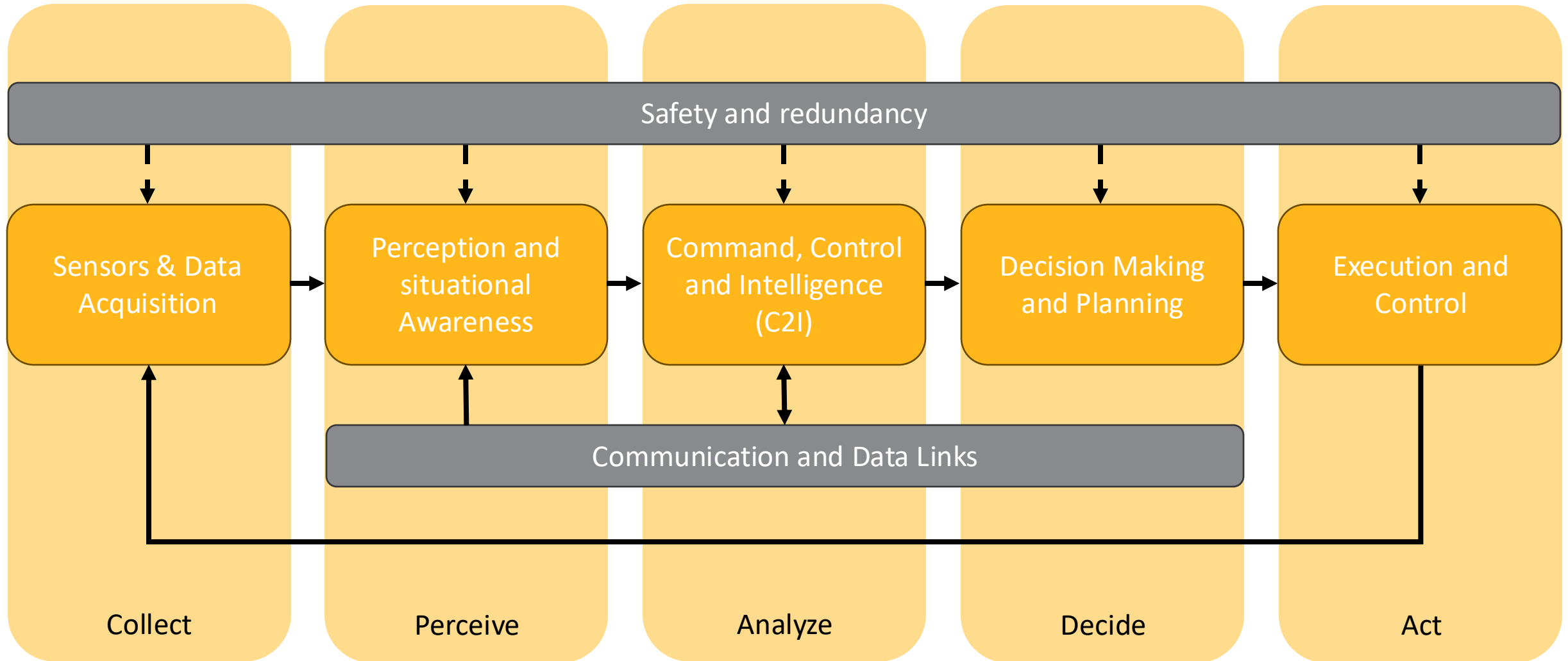


Powering Innovation That Drives Human Advancement

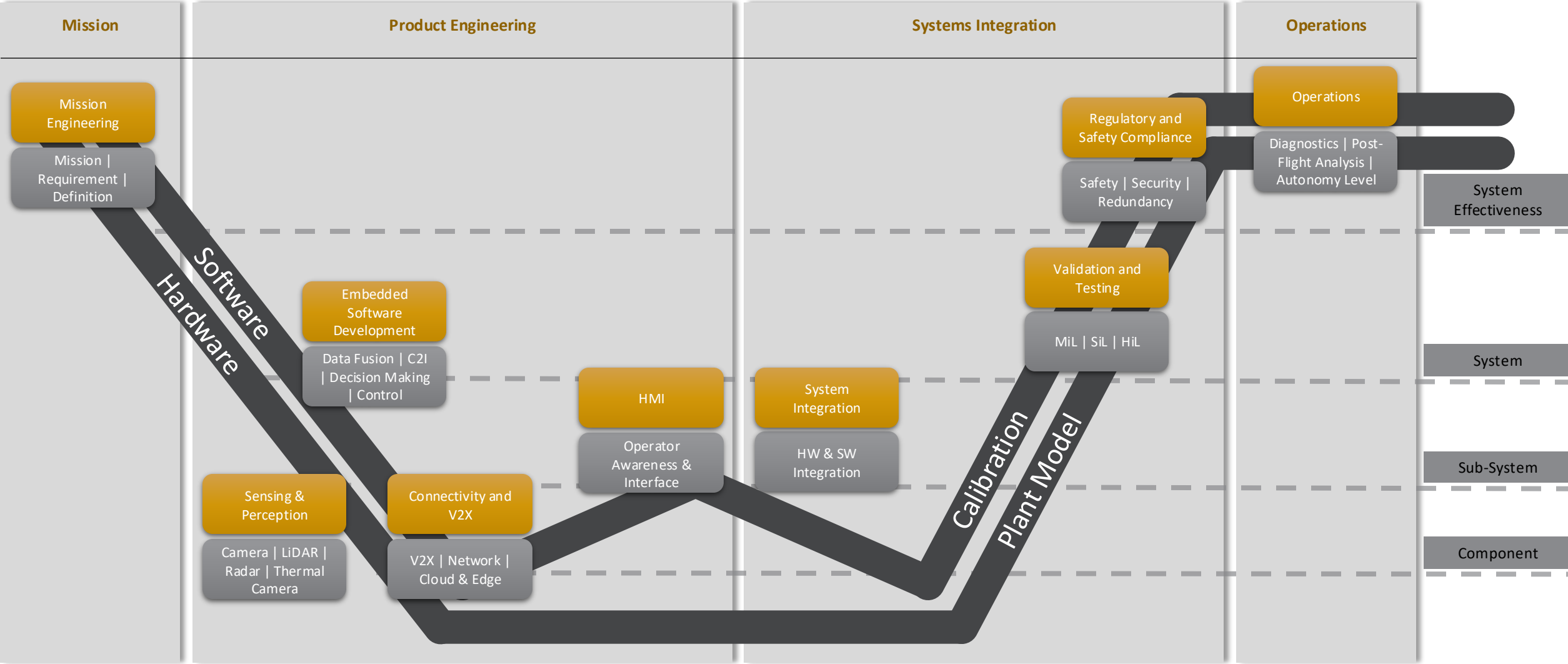
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# **Autonomous Solution – Embedded Software**

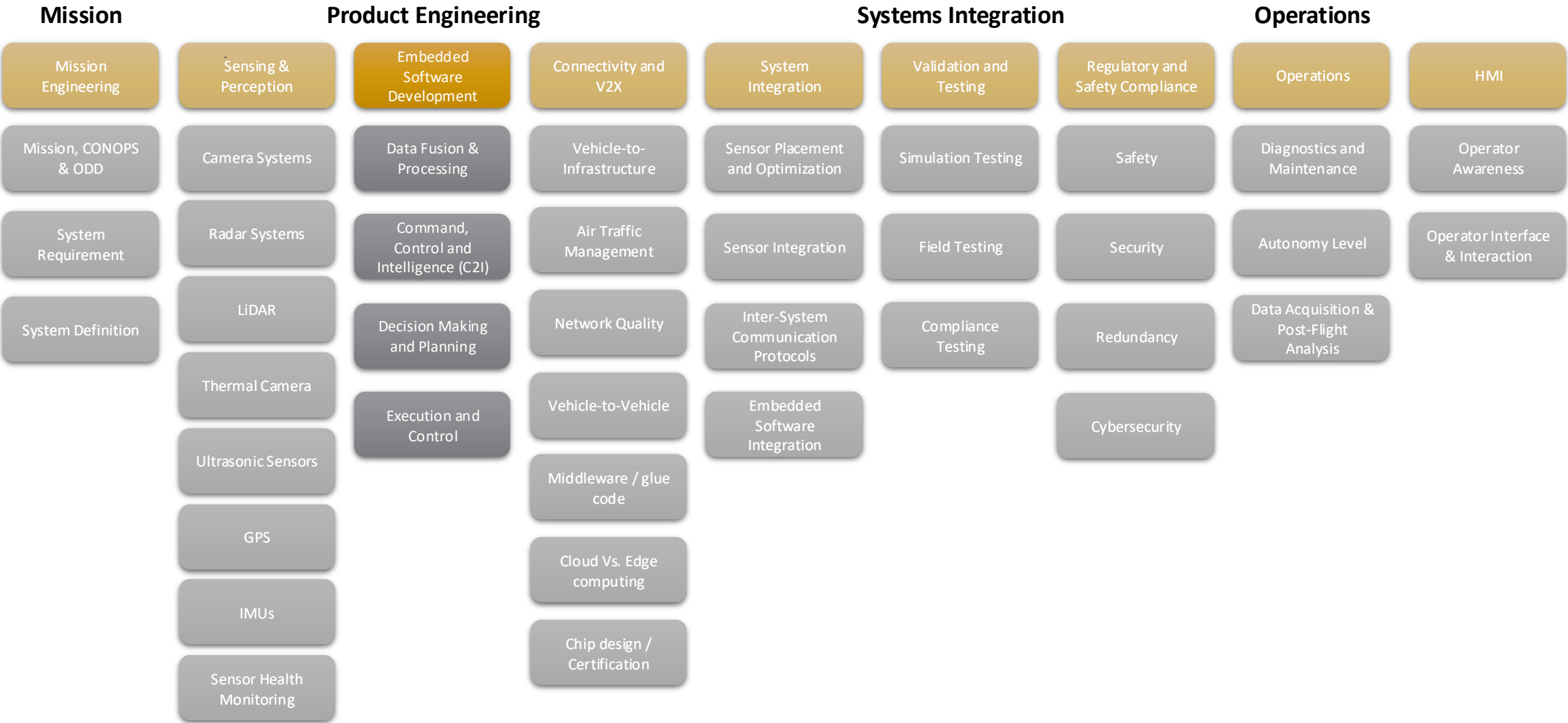
# Functional Architectural Viewpoint



# Product Development Process for Autonomous Systems



# Ansys Autonomous Solution – Overarching View

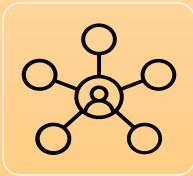


# Embedded Software Development: An Autonomy Key Components

## Introduction to Embedded Software Development

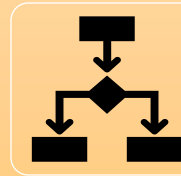
- **Purpose:** To develop reliable and efficient embedded systems that leverage AI for real-time data processing, adaptive decision-making, and intelligent control. These systems are designed to operate in dynamic environments, integrating AI to enhance performance, responsiveness, and autonomy.

### Data Fusion & Processing



- Integrate and process data from various sensors using AI algorithms to improve data quality and extract actionable insights. AI techniques enable predictive analytics and enhanced situational awareness in real-time.

### Decision Making & Planning



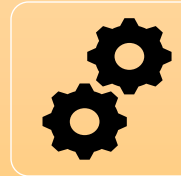
- Implement AI-driven command and control operations, enhancing the system's ability to analyze complex data and provide decision support. Real-time AI monitoring allows for dynamic adjustments to optimize performance.

### Command, Control and Intelligence (C2I)



- Develop AI-powered algorithms for real-time decision-making and planning. Machine learning models continuously refine decision-making processes, enabling the system to adapt to new data and changing conditions effectively.

### Execution and Control



- Develop robust control systems that utilize AI to learn from ongoing operations, adjusting execution strategies for optimal performance. This ensures seamless integration of all components and continuous improvement of system reliability.

# Challenges & Opportunities in Validation and Testing

Challenges		Opportunities
<ul style="list-style-type: none"><li>Integrating data from diverse sensors and sources using AI algorithms.</li><li>Ensuring real-time processing accuracy in complex and dynamic environments.</li></ul>	<b>Data Fusion &amp; Processing</b>	<ul style="list-style-type: none"><li>Enhanced Situational Awareness: AI improves the quality and speed of data processing, leading to more accurate real-time insights.</li><li>Improved Decision-Making: Leveraging AI in data processing refines the accuracy of decisions, making them more actionable.</li></ul>
<ul style="list-style-type: none"><li>Coordinating command and control across multiple systems while integrating AI.</li><li>Maintaining responsiveness when incorporating intelligent analysis into control systems.</li></ul>	<b>Command, Control and Intelligence (C2I)</b>	<ul style="list-style-type: none"><li>Centralized Control: AI enables more efficient management of command and control across multiple systems.</li><li>Operational Intelligence: Enhanced by AI, operational decisions become more informed and responsive.</li></ul>
<ul style="list-style-type: none"><li>Developing reliable and accurate AI-powered decision-making algorithms.</li><li>Creating adaptable plans that respond to changing operational conditions.</li></ul>	<b>Decision Making &amp; Planning</b>	<ul style="list-style-type: none"><li>Automated Decision-Making: AI allows for quicker, more adaptive decision-making that enhances system responsiveness.</li><li>Planning Flexibility: AI-driven planning processes can dynamically adjust to new data and changing conditions.</li></ul>
<ul style="list-style-type: none"><li>Ensuring seamless execution and control with AI-driven monitoring.</li><li>Adapting execution strategies in real-time to maintain optimal performance.</li></ul>	<b>Execution and Control</b>	<ul style="list-style-type: none"><li>Enhanced Control: AI improves the adaptability of control systems, making them more resilient to changes in real-time conditions.</li><li>Efficient Implementation: AI-driven execution strategies lead to more reliable and efficient plan implementation.</li></ul>



# Autonomous Solution – Embedded Software – Solution-Product Matrix

Learn more about Ansys products  
at: <https://www.ansys.com/products>

Applications					
	Ansys AVxcelerate Sensors™ Ansys Systems Tool Kit (STK®) Ansys optiSlang® Ansys SCADE Suite™ Ansys Twin Builder®				
Data Fusion and Processing	●	●	●		
Command, Control and Intelligence (C2I)		●		●	
Decision Making & Planning		●	●	●	
Execution and Control			●	●	●

/ Increased Collaboration; Faster Innovation; Customized Workflows; Optimization; Cloud & HPC

# Data Fusion and Processing

## Challenge

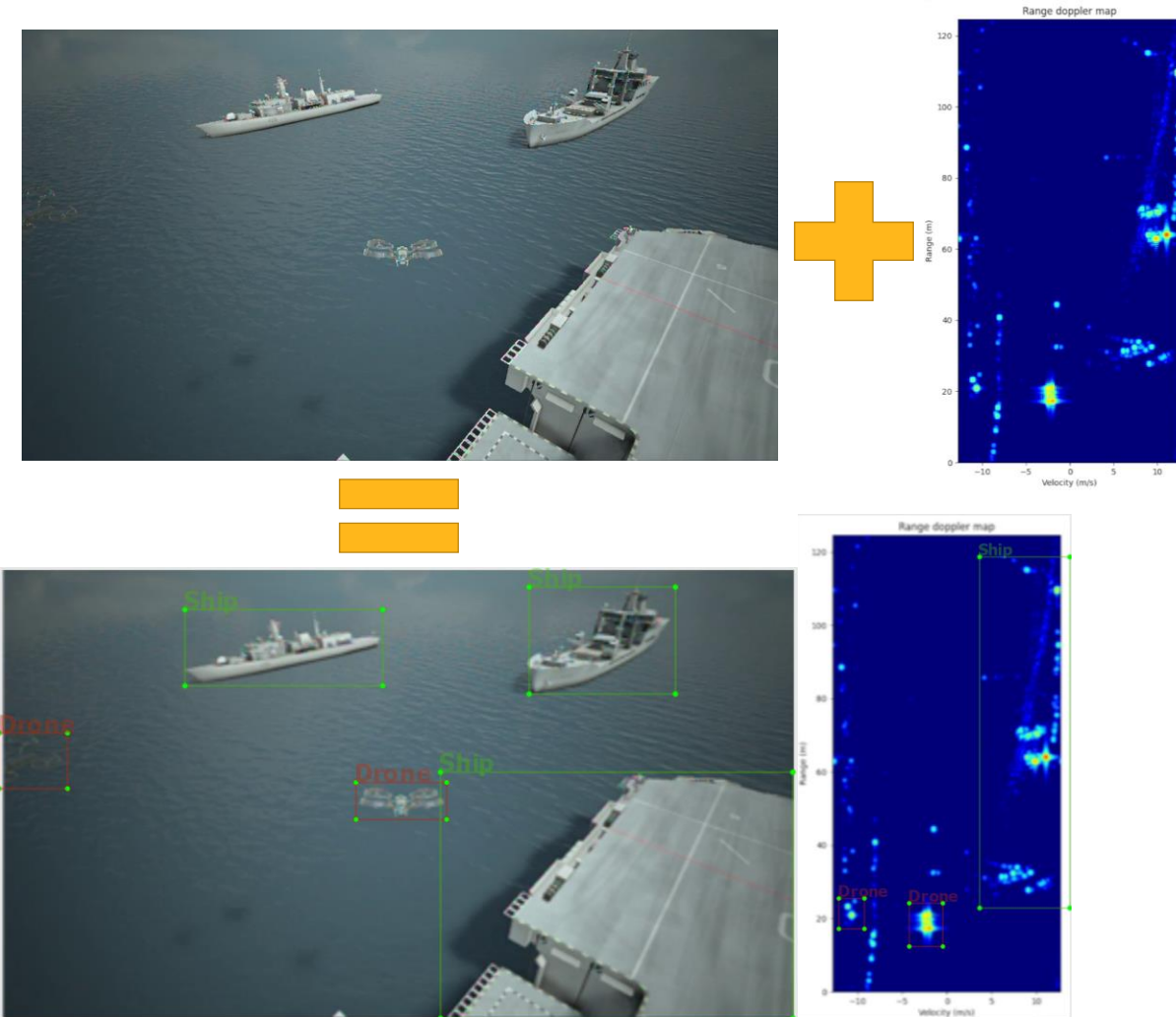
- **Accuracy and Reliability:** Ensuring the accuracy and reliability of fused data.
- **Complex Data Integration:** Integrating data from multiple sensors and sources.
- **Real-time Processing**
- **Scalability:** Managing increasing volumes of data while maintaining performance.
- **Corner Case Scenarios:** Identifying and simulating rare but critical scenarios.

## Solution

- Accurate sensor simulation capabilities for cameras, LiDAR, radar, and thermal sensors. It enables massive virtual data generation for algorithm training.
- A comprehensive environment for scenario simulation, corner cases and mission analysis.
- Automate and optimize scenario variation for dataset generation.

## Benefits

- **Enhanced Accuracy:** Physics-based simulations improve the accuracy of data fusion, reducing errors and enhancing decision-making.
- **Robust Algorithm Validation:** Generating synthetic sensor data and simulating corner cases ensure that fusion algorithms are robust and reliable across a wide range of scenarios.
- **Cost and Time Savings:** Virtual testing and simulation reduce the need for extensive physical testing, saving both time and costs in the development process.



*Object-Level Perception through Sensor Fusion: Initial raw camera and Doppler radar data merge to reveal a detailed, object-oriented view of the environment providing robust situational awareness.*

**Applicable Products:** Ansys AVxcelerate Sensors™, Ansys Systems Tool Kit (STK®), Ansys optiSLang®





# Decision Making & Planning

## Challenge

- **Complexity in Decision-Making:** Developing algorithms that can handle a vast array of inputs and variables to make accurate decisions in real-time.
- **Adaptability:** Ensuring that decision-making algorithms can adapt to changing environments and data inputs, maintaining accuracy and relevance.
- **Scalability:** Creating AI algorithms that can scale to handle increased data volume and complexity without performance degradation.

## Solution

- **Ansys STK (Systems Tool Kit):** Provides a comprehensive environment for scenario simulation, corner cases and mission analysis.
- **Ansys optiSLang:** Facilitates the optimization of AI algorithms by automating the design exploration process.
- **Ansys SCADE:** Provides a model-based development environment that supports the design, testing, and verification of AI-enabled decision algorithms.

## Benefits

- **Improved Accuracy:** Ansys tools enhance the precision of AI-driven decisions, leading to more reliable outcomes.
- **Faster Development:** Model-based approaches reduce development time, speeding up time-to-market.
- **Scalable Solutions:** Tools support scalable AI development, ensuring robust performance as system complexity grows.

## Simulated Mission Examples



Air taxi flying through city with vectors displaying important directions and distances



Air taxi flying through city with airspaces for vertical takeoff and landing

**Applicable Products:** Ansys optiSLang®, Ansys SCADE Suite™  
Ansys Systems Tool Kit® (STK®)

# Execution and Control

## Challenge

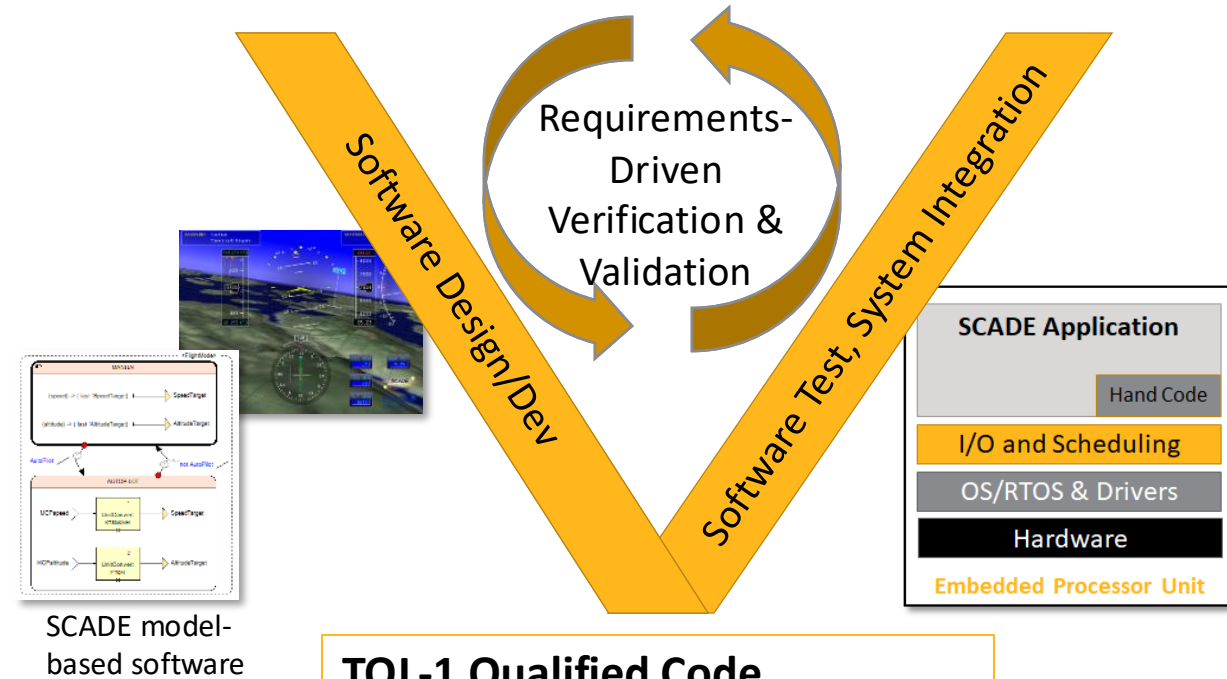
- **Real-Time Execution:** Ensuring precise, real-time control with minimal latency.
- **Safety Compliance:** Meeting stringent safety standards (e.g., ISO 26262, DO-178C) for mission-critical systems.
- **System Integration:** Integrating control algorithms while maintaining safety and performance.
- **Robustness:** Ensuring control systems are resilient and safe under various conditions.

## Solution

- **Ansys SCADE:** Supports the design and certification of safety-critical control systems, ensuring compliance with key industry standards.
- **Ansys Twin Builder:** Enables thorough testing and validation of control strategies via digital twins, ensuring safe, reliable performance before deployment.
- **Ansys optiSLang:** Optimizes control algorithms, ensuring they are efficient, robust, and compliant with safety requirements.

## Benefits

- **Safety Compliance:** Ensures control systems meet critical safety standards.
- **Real-Time Performance:** Optimizes control systems for reliable, real-time operation.
- **Robust Systems:** Improves system resilience and safety under varying conditions.
- **Reduced Certification Risk:** Early detection of safety issues reduces certification risks and costs.



# Embedded Software Development with Ansys



## Enhanced Accuracy and Decision-Making

- Precision in AI-Driven Systems



## Optimized Performance and Efficiency

- Efficiency in Execution



## Safety Compliance and Robustness

- Meeting Safety Standards / Resilience Under Varying Conditions



## Reduced Development Time and Risk

- Streamlined Development and Certification / Scalability and Flexibility

The Ansys logo, featuring a stylized orange and black 'A' followed by the word 'nsys' in black.

