MBSE, IoT and PLM

MBSE and IoTization of PLM Systems for Validation, Testing and Support

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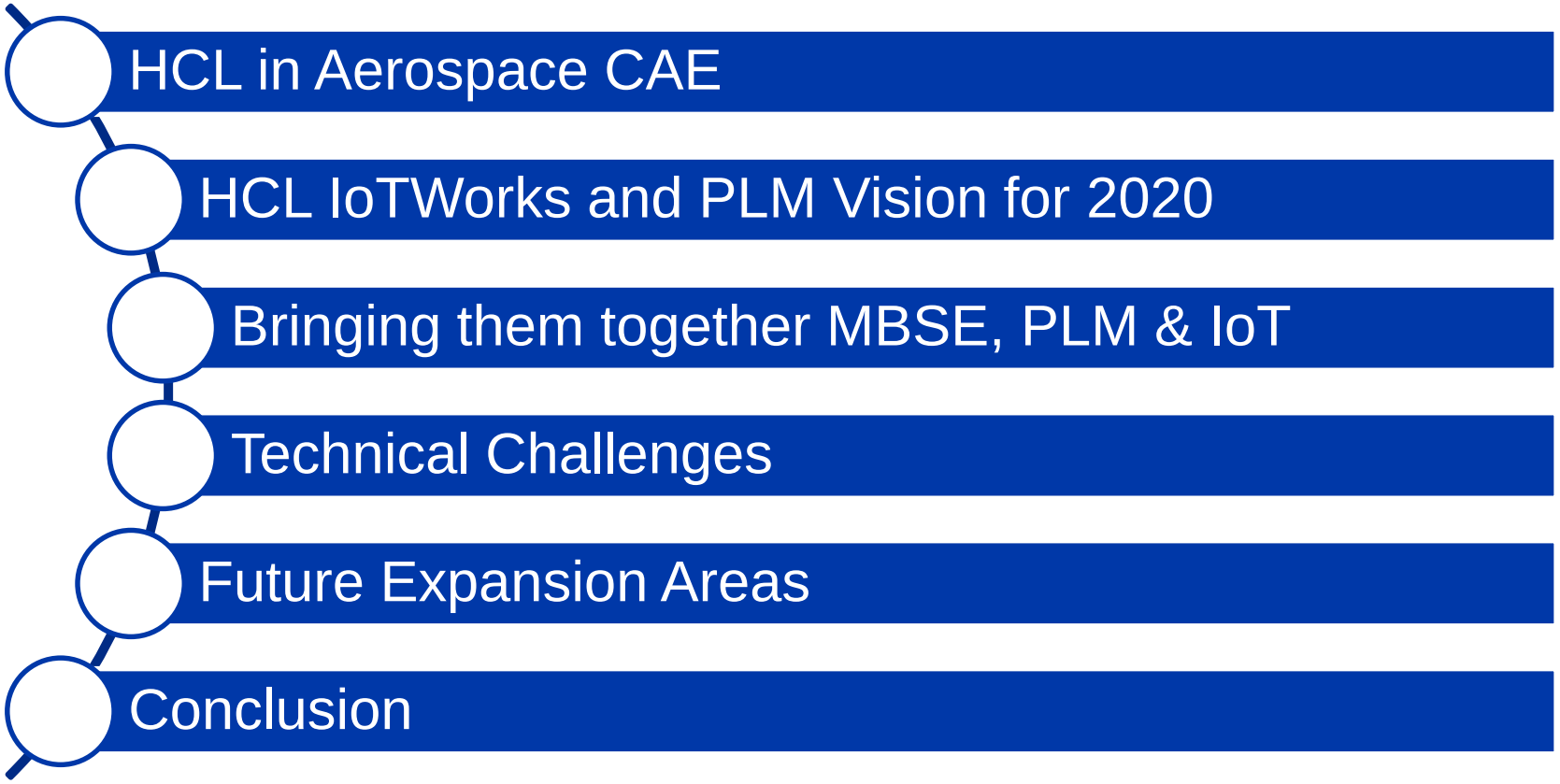
Structure



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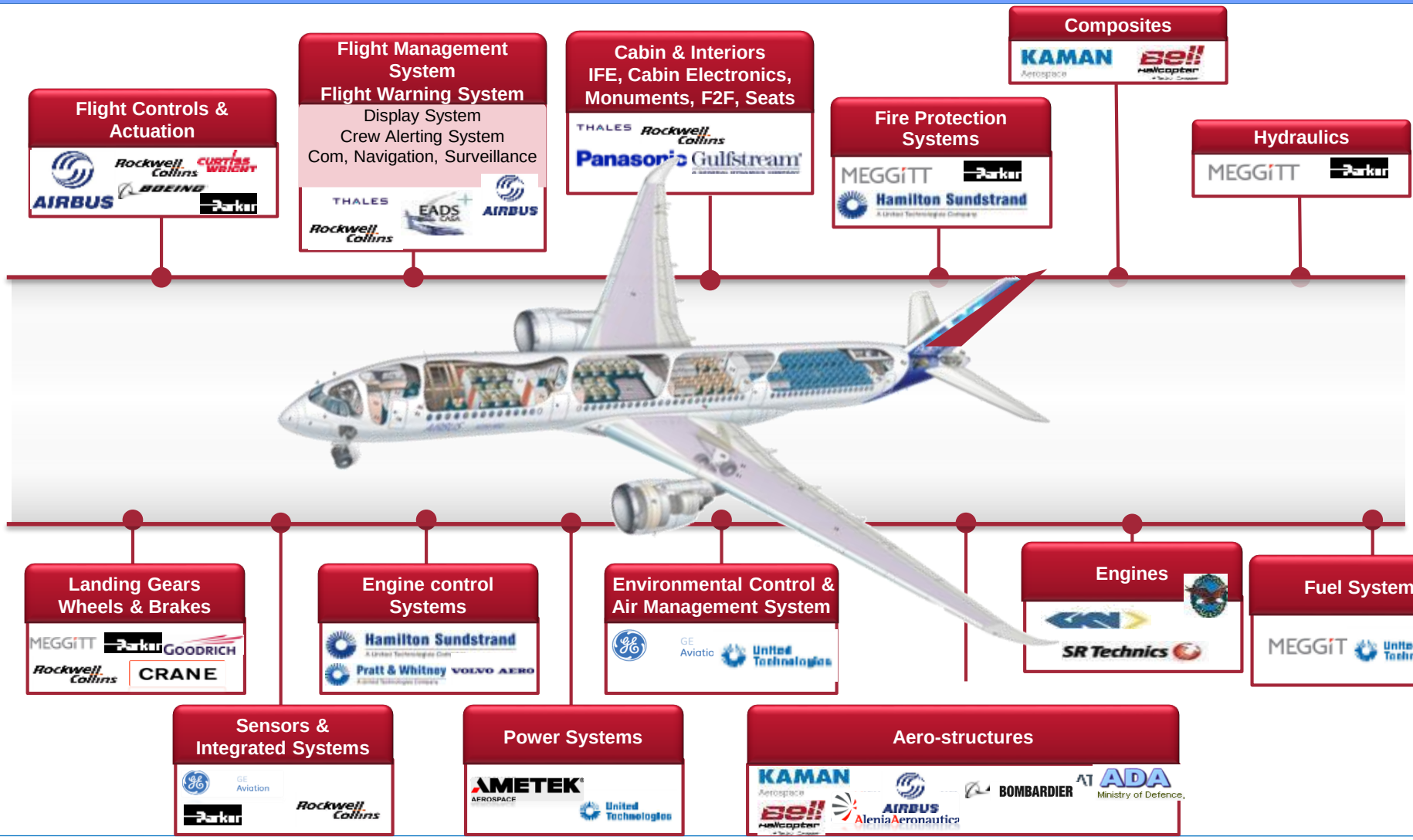
HCL Areas of Expertise in Aerospace Engineering

Global Product Data Interoperability Summit | **2016**



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Marquee Clients

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UNITED TECHNOLOGIES · GKN · SR Technics · PRATT & WHITNEY DEPENDABLE ENGINES · KAMAN AEROSTRUCTURES · Atos · ATKINS

MEGGiTT smart engineering for extreme environments · Parker · Rockwell Collins · THALES · AMETEK AEROSPACE · L3 communications · CRANE

ZODIAC AEROSPACE · COBHAM · ITT · Honeywell

Honeywell Technology Solutions Lab Pvt Ltd.

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PLM/IoT and Industry 4.0 in Industrial Software Space

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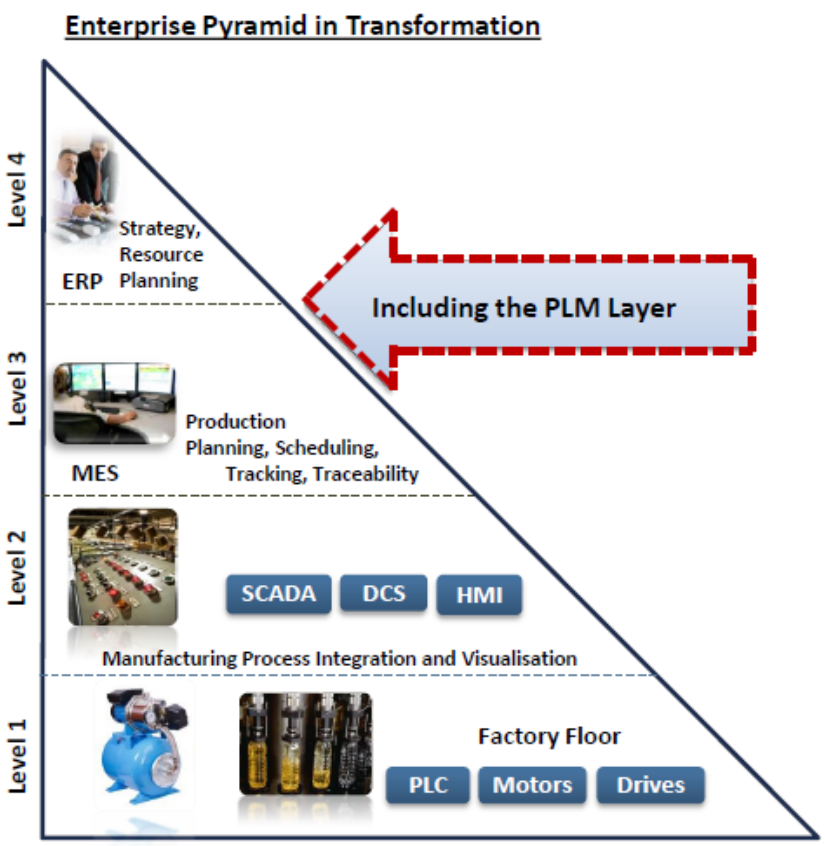

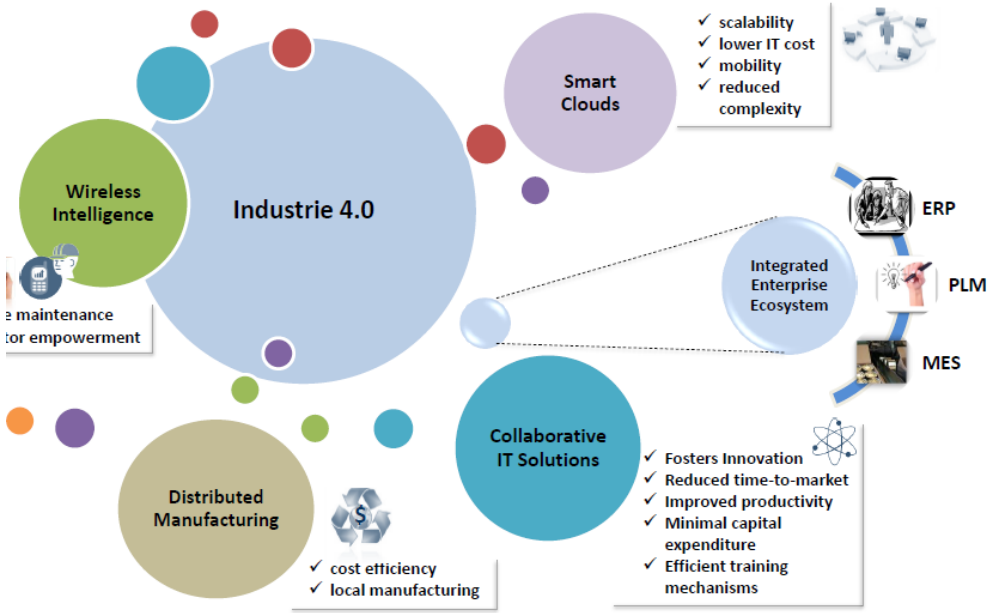

Industry 4.0 in Europe and Smart Manufacturing in US define the renaissance of Manufacturing in the western world.

IoT is the central gluing element in this approach and is the basis for more than a $1.0T opportunity in the next 10 years.

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IoT in the Product LifeCycle

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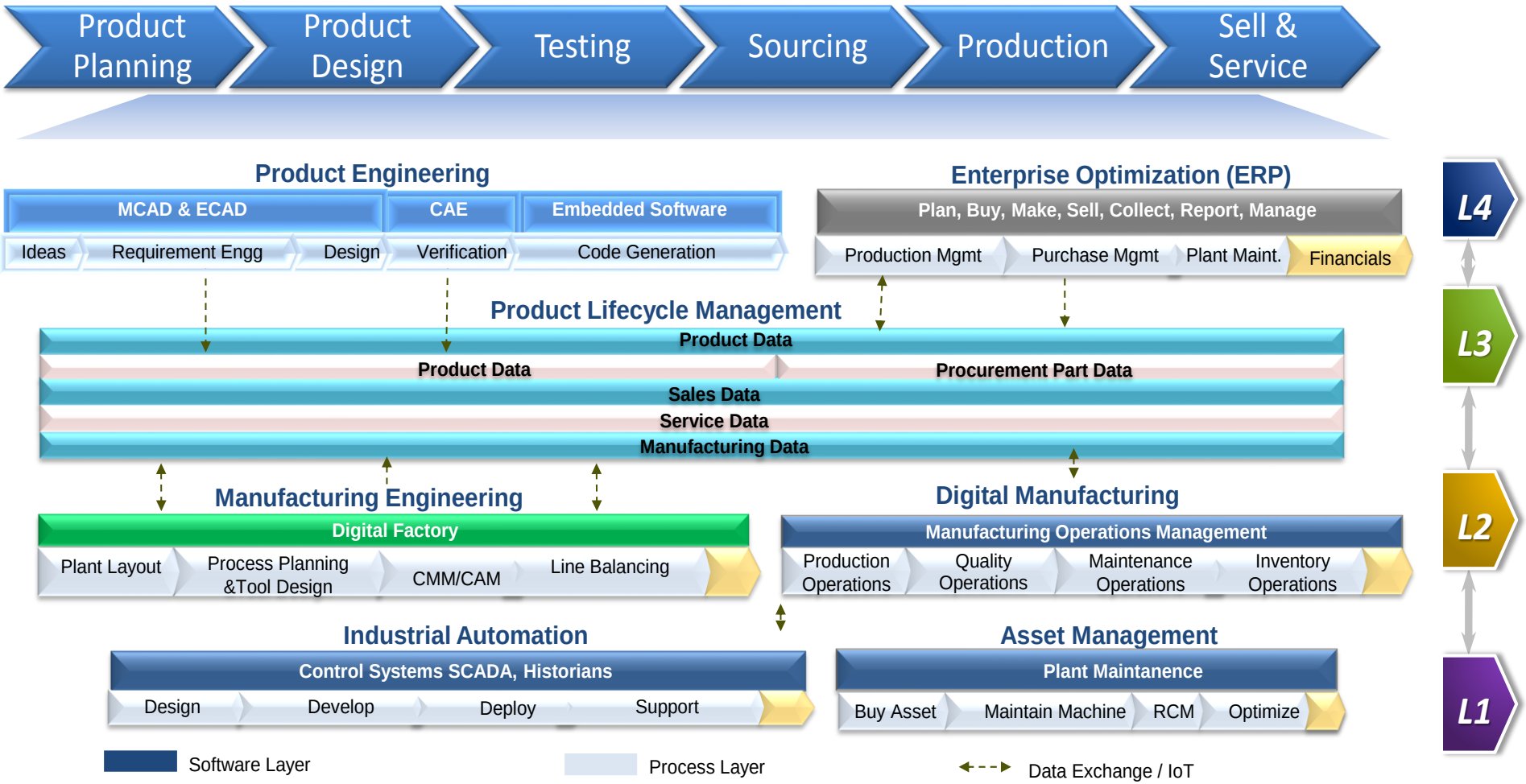

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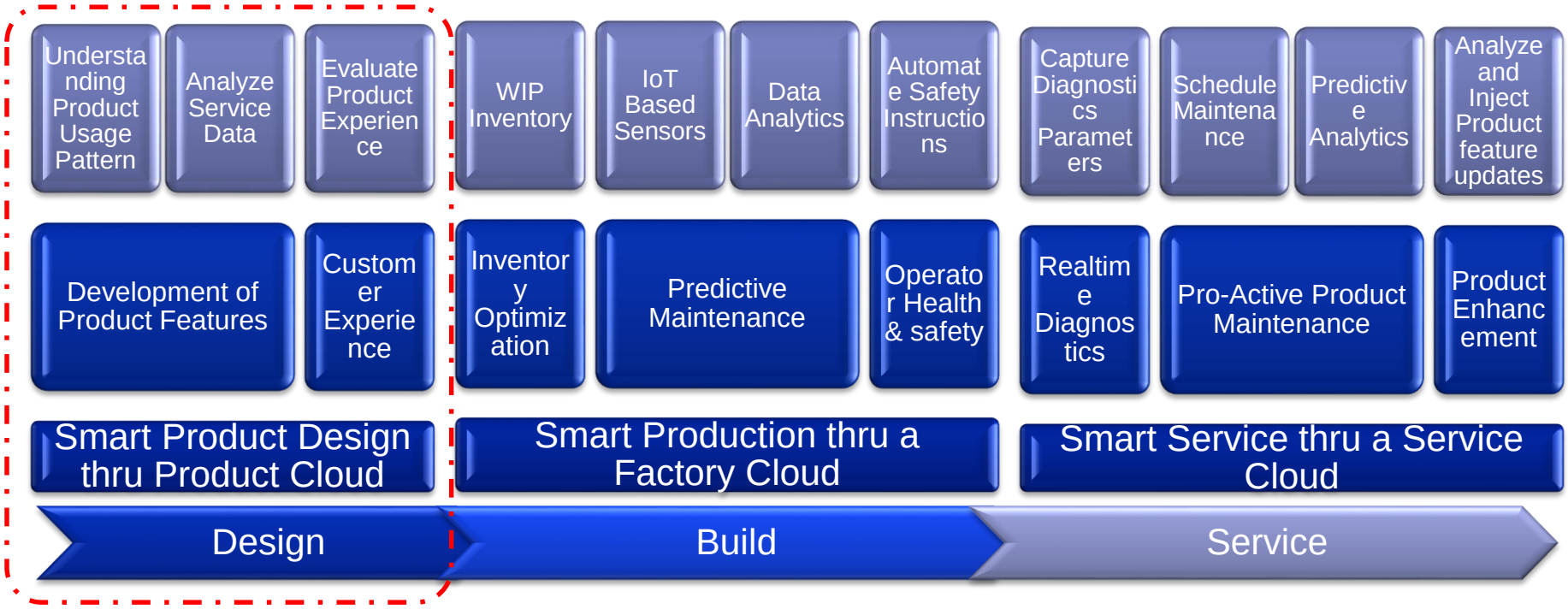
Role of IoT in the Product Life Cycle (Design – Build – Service)



IoT would be the bridge to connect the Physical Device or Machine with the 'Digital Twin' and then leveraging Analytics and the cloud multiple value added services can be created.

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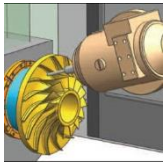
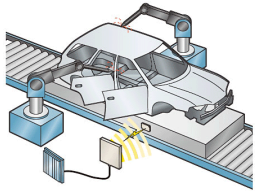
MBSE and the IoT Play

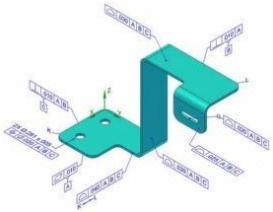
Product Planning → Product Design → Testing → Sourcing → Production → Sell & Service



Reuse 3D engineering data to generate manufacturing documents



3D CAD as the single source of 3D engineering data



Model Based Manufacturing (MBM)
{Process Definition}

Model Based Definition (MBD)
{Product Definition}

Model Based Operations (MBO)
{Tool & Process Definition}

Model Based Systems Engineering (MBSE)

IoT Data Acquisition and Analytics Layer

Engineering IT infrastructure

Siemens PLM Software NX · TEAMCENTER · SAP · CATIA · creo · Windchill

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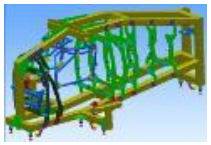
IoT Related Field Requiring a Cross Functional Approach

- Process Planning- Fabrication
- Process Planning- Assembly
- CNC Programming
- Jigs, Fixtures & Tooling



Manufacturing Engineering Services

- Iot Data will be leveraged across all these functions like Reliability, CAE and Value Engineering
- Linkage to CAE cloud for Loads and BCs

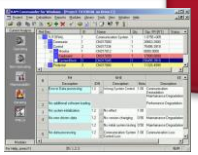
IoT Enablement

- Cost Modeling
- Value Analysis
- Tear down Analysis
- Benchmarking
- Sourcing Support

Value Engineering

Centers of Excellence

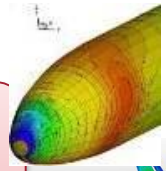
- Reliability prediction
- FMEA (Design, function, process)
- Life data analysis
- Warranty analysis

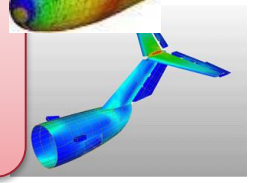


Reliability

CAE

- Structural analysis
- Thermal analysis
- Computational fluid dynamics
- Kinematic simulation
- Hand calculations
- F&DT





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IoT In ENGINEERING ANALYSIS : Loads and Boundary Conditions

Domains

Structural Analysis

- Static Stress Analysis
- Fatigue &Damage Tolerance (F&DT)
- Aero Elasticity
- Flight Load Computation
- Dynamic Analysis
  - Modal Analysis
  - Transient Analysis
  - Frequency response Analysis
  - Random response Analysis
  - Shock spectrum Analysis
- Impact Simulation – Bird Strike
- Drop Simulation
- Kinematics simulation

CFD Analysis

- Compressible and incompressible flow
- Steady and transient analysis
- Conjugate heat transfer analysis
- Fluid structure interaction
- Thermal Design and Analysis of Electronic systems

IoT Enablement

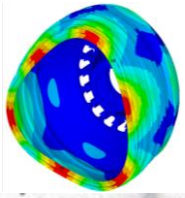
- IoT enabled product can be used to capture the static and dynamic loads
- **Validation of Results and Measurement of deflections in realtime.**

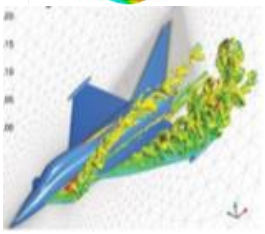
Tools and Servers

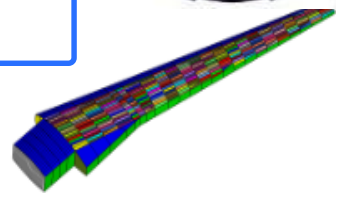
- ANSYS, MSC. Nastran, ABAQUS, LS-DYNA, IDEAS, Pro/MECHANICA, MSC. Adams, LMS Sysnoise, HyperMesh, FLUENT, CFX, ICEM-CFD, Icepak, Flotherm, CF-Design, Moldflow
- Server with 100 cores extendable up to 200 Cores for high end analysis

Productivity Tools

- Macros created for Post Processing . **~ 78%** time reduction
- Multiframe Restart Methodology
- Elastic-plastic curve generation automation for internal use
- Neuber correction Tool –Calculate Elasto-plastic behavior
- Macros- Fatigue Life calculator of moving parts







ELYSIUM Parker NORTHROP GRUMMAN BOEING GLOBAL PRODUCT DATA INTEROPERABILITY SUMMIT 2016

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IoT in AfterMarket Service : Predictive Maintenance

IOT Platform development for remote services and monitoring solution for a global industrial conglomerate covering **26 different business units, 1 Million + devices and 18,000 customers** of the customer spanning multiple geographies. Scope of the services cover develop, deploy and operate

Business Challenges

One seamless data acquisition and data management platform for all business units

Open new avenues by exploiting the potential of value-added-services;

Assist in New Product Development using big data techniques

contracts/integrated solutions to end customers - cross-sell and up-sell business BU services to across different customer segment

HCL Solution

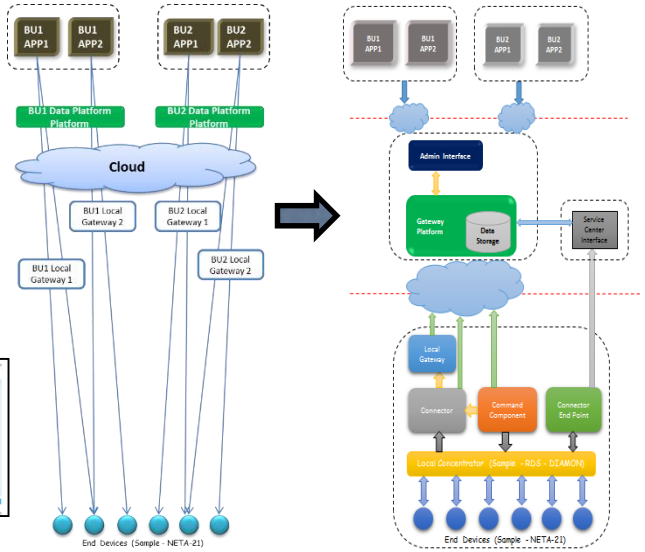
The Scope of the services covers 'Develop' , 'Deploy' and 'Operate' of an IOT based data platform

Operational Efficiency of 20% achieved through implementation of Remote Services (Predictive Maintenance, Asset Management etc.)

Remote Services for Predictive Maintenance

AS IS State
Different BUs using different apps and different means to collect and store data from the devices

Target State
A common platform that standardizes the communication to the devices and way data is collected and stored



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IoT in Reliability, Maintainability and Safety (RM&S)

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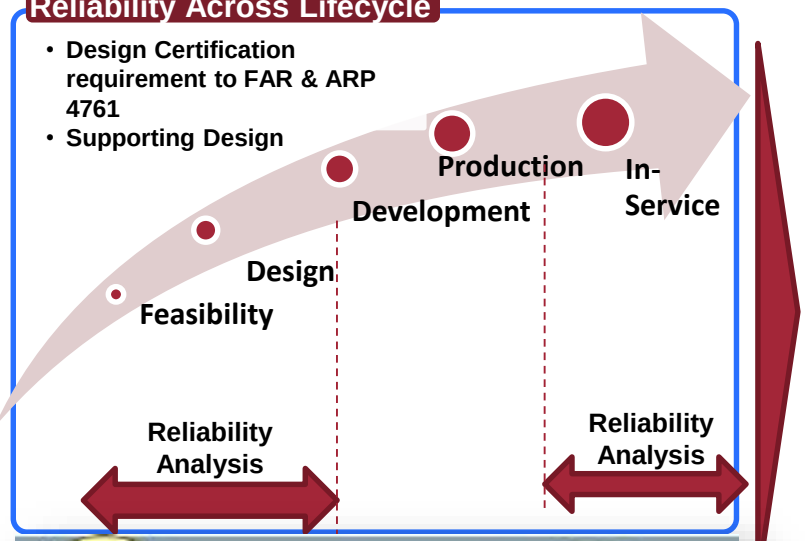
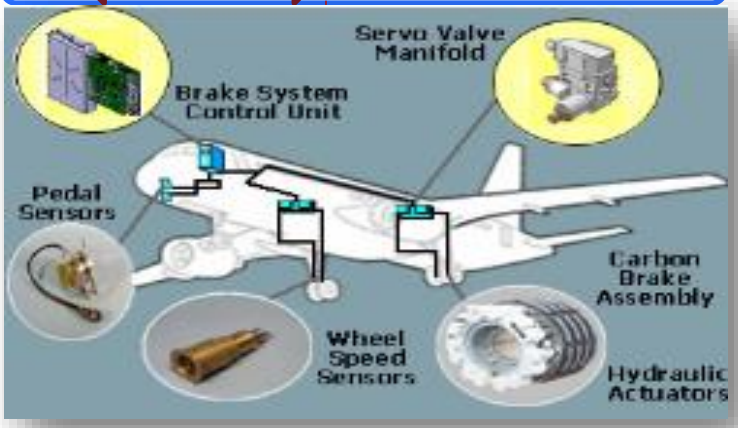
Reliability Across Lifecycle

- **Design Certification requirement to FAR & ARP 4761**
- **Supporting Design**





Team consists of Reliability Engineers from Mechanical and Electronics engineering background

Services

- Reliability Plan & Approach
- PSSA & SSA reports
- Reliability Prediction (Parts count /Parts Stress)
- Functional Hazard Analysis (FHA)
- Fault Tree Analysis (FTA)
- FMEA / FMECA (LRU & System level)
- Common Mode Analysis
- Intrinsic & Environmental Condition Hazard Analysis
- BIT / testability Analysis
- Logistic Support Analysis (LSA)
- Warranty & Reliability Analysis with Failure Data
- MMEL Analysis
- Maintainability & MSG3 Analysis
- Reliability Test Plan (HALT/RGT/ALT)

IoT Enablement

- IoT Enablement for System Uptime, MTBF and Safety.
- Analytics of IoT Data to work with Predictive algorithms

Software

Relex SW – Prediction: MIL-HDBK-217, MIL 217Plus, Telcordia, FTA, FMEA

Reliasoft – Blocksim, Weibull++, Alta Pro, MPC3

Cafta – FTA

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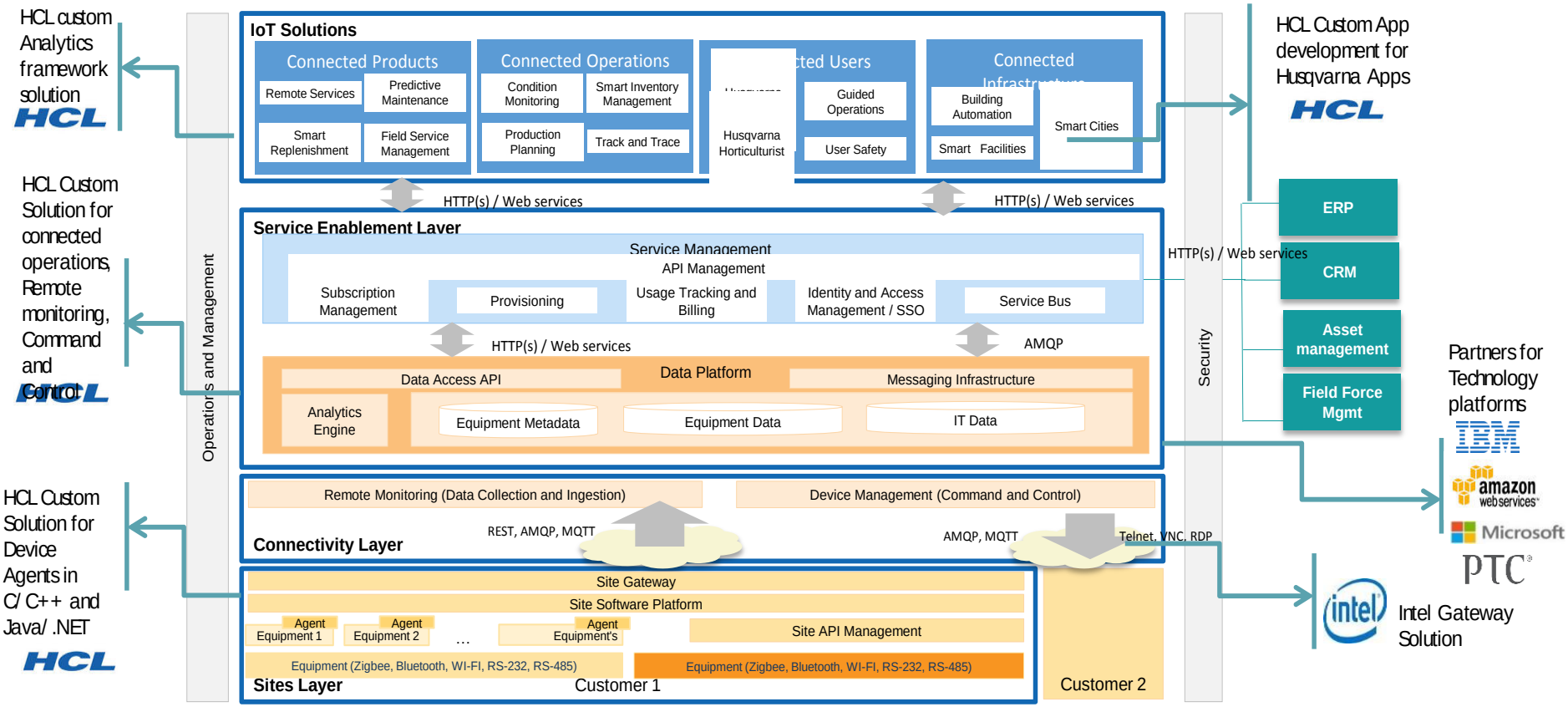
HCL IoT PLATFORM REFERENCE ARCHITECTURE

IoT WoRKS

The HCL IoT platform will enable a standardized layer for the onboarding of Husqvarna connectivity hubs



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Getting Started with IoT with PLM and MBSE

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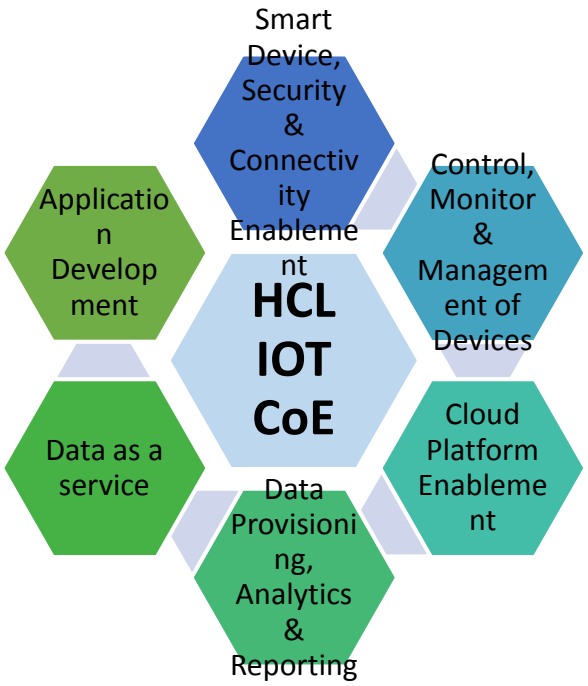
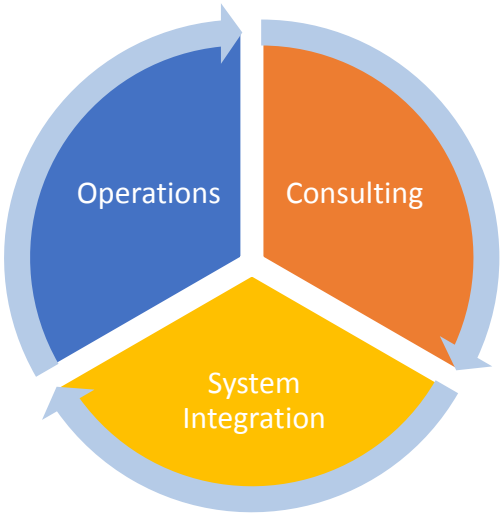


IoT Solution Components

- Device & Equipment Connectivity
- Central Compute & Data Store Platform
- Big Data Platform
- Analytics
- Business Applications



HCL Services

- Technical Consulting
- Platform design
- Platform development & deployment
- Operate
- Support

Increased Revenue from Services & decreased Cost of services

Flexible and Modular solutions

Evermore Cost effective plants with Advanced controls

Better AMC management – spare parts, engineer planning etc.,

Comprehensive Services

- Smart Energy Management
- Remote Monitoring and Diagnostics
- Asset Tracking
- Preventive Maintenance
- Fleet Management
- Reduction in unplanned outages and equipment downtime
- Spare part management
- XaaS based service

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HCL

Relationship™

BEYOND THE CONTRACT

$6.4 BILLION | **95,000** EMPLOYEES | **31** COUNTRIES

Engineering Analysis Overview

Services

Structural Analysis

- Static Stress Analysis
- Fatigue &Damage Tolerance (F&DT)
- Aero Elasticity
- Flight Load Computation
- Dynamic Analysis (Modal, Transient, Frequency /random response , Shock spectrum)
- Impact Simulation – Bird Strike
- Drop Simulation
- Kinematics simulation

CFD Analysis

- Compressible and incompressible flow
- Steady and transient analysis
- Conjugate heat transfer analysis
- Fluid structure interaction
- Thermal Design and Analysis of Electronic systems

Expertise

- More than **1 Mn man hours** in aerospace simulation
- Average Experience: Manager **15+ years**; Team lead **8+ years**; and Team members with **5+ years**

Tools and Servers

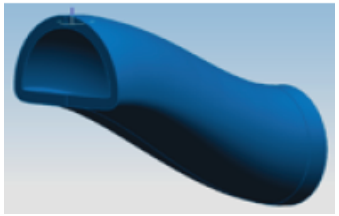
- ANSYS, MSC. Nastran, ABAQUS, LS-DYNA, IDEAS, Pro/MECHANICA, MSC. Adams, LMS Sysnoise, HyperMesh, FLUENT, CFX, ICEM-CFD, Icepak, Flotherm, CF-Design, Moldflow
- Server with 100 cores extendable up to 200 Cores for high end analysis
- 64 High performing computing licenses (flow regimes)
- Handled 48 million cell count grid for external aerodynamic problem

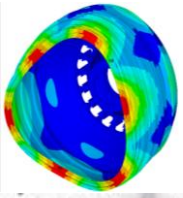
Productivity Tools

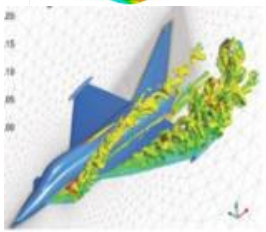
- Macros created for Post Processing . **~ 78%** time reduction
- Multi Frame Restart Methodology
- Elastic-plastic curve generation automation for internal use
- Neuber correction Tool –Calculate Elasto-plastic behavior
- Macros- Fatigue Life calculator of moving parts

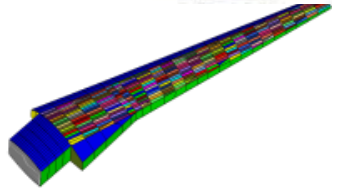
Advanced Simulation / Analysis Services

- ✓ **High-end structural analysis**
  - ✓ Aero Elasticity
  - ✓ Flight Load Computations
  - ✓ F & DT
- ✓ **Fatigue &Damage Tolerance**
- ✓ **External Aerodynamics**
- ✓ **High-end Computational Fluid Dynamics**









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