Model Based Enterprise

Managing a Complex World

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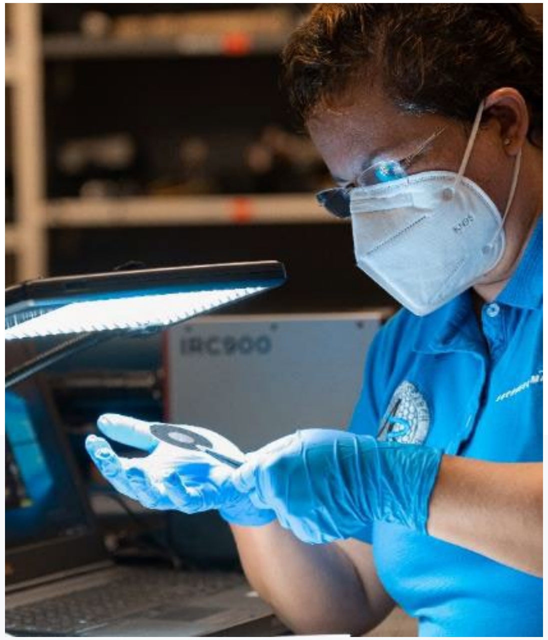
A Diverse Portfolio

By the Numbers

114,000
Employees



60,000
Engineers, Scientists and Technologists

345+
Facilities Worldwide

Operating in **78** Countries with **7,500** Employees

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Lockheed Martin Diverse Portfolio

Aeronautics

- Combat Air & ISR
- Air Mobility
- Sustainment
- Advanced Development

Missiles and Fire Control

- Air and Missile Defense
- Tactical Missiles
- Fire Control
- Combat Maneuver Systems
- Energy

Rotary and Mission Systems

- Cyber & Electromagnetic Warfare
- Radar & Surveillance Systems
- Rotorcraft & Aviation Systems
- Sustainment & Training
- Undersea & Surface Warfare

Space

- Surveillance and Navigation
- Global Communications
- Human and Deep Space Exploration
- Strategic and Defensive Systems

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Complexity of Customer Transformation

Transformation of new and legacy systems to enable joint decisions

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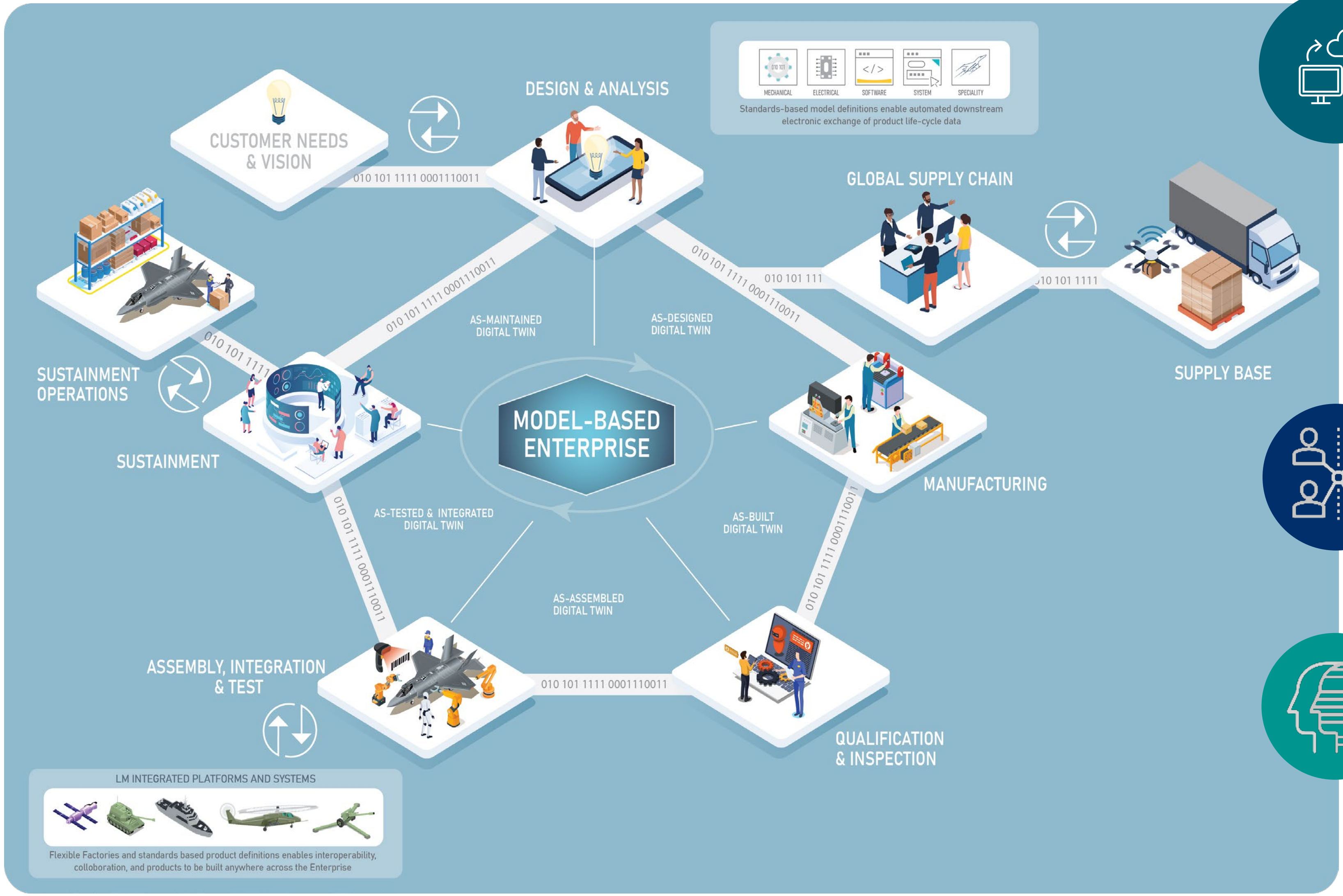
Model Based Enterprise

Model Based Enterprise (MBE) Vision



A **model-based enterprise** realizes an **end to end digital vision**, building toward an integrated digital future where data is seamlessly connected across traditional functional silos and business areas to optimize the design, build, and sustain value chain

Transforming to a model-based enterprise requires **underlying data** to be **standardized and integrated**

The **digital thread** drives the end to end product lifecycle and includes all the process and system capabilities that **enable Digital Twins**

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Model Based Enterprise Bold Outcomes

Transformational Outcomes

Speed	Agility	Insights	Competitiveness
Concept to field faster than ever	*Responding to rapidly changing customer needs*	*Data as a strategic enterprise asset*	*Efficiency, value, solution innovation*

North Stars

- Operating Model
- Interoperability
- Commonality
- Data as a Strategic Asset
- Stakeholder Experience

1. All Digital Lifecycle Driven by Integrated Model based Data and Common Processes
   – All Digital Development Environment
2. Enable OneLM Factory To Seamlessly Share Work Across the Enterprise
3. High Velocity Supply Chain with Customer and Tiered Suppliers Integrated Into Ecosystem
4. Highly Integrated Tool Sets That Utilize Universal Standards and Interoperable Data Sets To Optimize Value Chain
5. Derive Artifacts On Demand (e.g. BOM) from the Digital Thread with Robust Change Management
6. Digital Thread Enables 21st Century Security Ops Analysis, Simulations, Sustainment and Logistics

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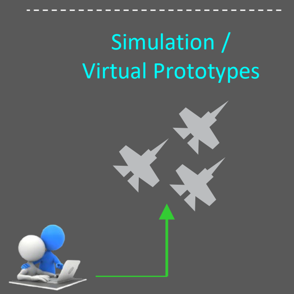
The Role of Digital Twins

LM Digital Twin Maturity Model



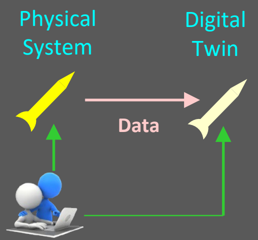
Level 1 – Virtual Digital Twins (DT)

Virtual Digital Twins – Prototype Modeling and Simulation

Do you have high fidelity or physics based digital twin models and simulations for :

- Configuration and Master Data
- Stealth
- Structural Performance
- MBSE Requirements and system interferences
- Vehicle Systems. Flt Controls, and SW
- Mission Systems and SW
- Operations Analysis
- Manufacturing/Production
- Supply Chain
- Sustainment
- Affordability/Cost/Capital Req.

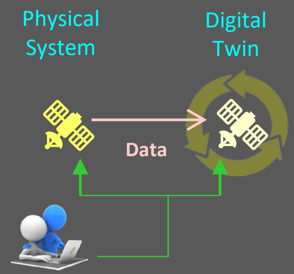
Does your Digital Twin predict mission success and compliance with customer requirements?



Level 2 – DT/PA Synchronization

Manual Virtual/Physical Synchronization of Digital Twins

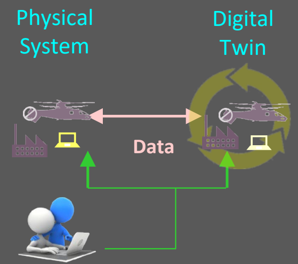
- Is your DT representative of the physical asset?
- Did your DT baseline facilitate design trades and configuration optimization?
- Are your DT models manually updated for design and requirement changes?
- Does your digital twin represent the physical asset performance and design?
- Are your DTs manually updated with the latest test data?
- How well did your level 1 DT support the physical asset performance and configuration baseline ?
- Were major changes required after design start to address performance or requirements issues unidentified by the DT?
- Are your DTs resident in an integrated design environment?



Level 3 – DT/PA Validation

Automated or Continuous Virtual/Physical Synchronization and Validation of Digital Twins with Physical Assets

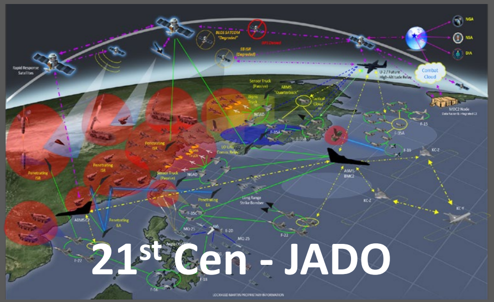
- Are your DT models routinely or automatedly synchronized to the latest configuration baseline?
- Do your DTs predict physical asset behavior?
- Are your DT models automatically updated to represent the latest test or analysis data?
- Have your DTs predicted problems with the physical asset performance, design, or requirements that require corrective action?
- Has validation or qualification of the physical asset identified unexpected problems?
- Do your DTs support visualization capabilities in the simulation environments?



Level 4 – DT/PA Integration

Enterprise Integrated Product Digital Twin

- Do your DT simulations drive your hardware in the loop?
- Does your DT enable parts monitoring, forecasting and predictions from operational data?
- Do you have mature integrated DT models to support Operations Analysis, spiral development, and sustainment?
- Are your physical asset validations used to improve your DT development tools in preparation for the next product development cycle?
- Does the DT accurately predict performance in the operational environment?
- Have your DTs eliminated some or most legacy physical testing and lab validation?
- Is the DT accepted as the Master Model of the Product that can be used for virtual customer validation of requirements?



Level 5 – DT Operational Ecosystem

Digital Twins Common Operational Simulation Eco-system

- Can your DT models be connected and integrated with other LM product DTs and with customer provided non LM assets in a common simulation environment?
- Do your DTs adequately predict actual performance in the JADO environment?
- Will customers use simulation based performance validation without requiring subsequent physical demonstrations?
- Is your DT development and testing used to upgrade your DT tools and processes?
- Do customers utilize integrated Digital twin effects as certification criteria?

DT/PA = Digital Twin/Physical Asset

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Individual Digital Twin Use Cases

- Design Validation
  - Product, Manufacturing, Test, Supply Chain, and Sustainment optimization
- Factory optimization & validation
- Operational Analysis
- Go Green – Facility Management
- Fleet maintenance planning and performance improvements
- Anomaly replay and resolution
- Flight software testing
- Requirements Verification
- Global logistics

Full Lifecycle Optimization

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Digital Twin Lessons Learned

- Operational, factory, product, and component digital twins used daily
    - Describe and predict performance of individual systems or components
    - Design, Manufacturing, Operations, and Supply Chain
- Digital Twins must be as interoperable as their physical twin
    - Framework of services vs monolith
- Joint All Domain Operations demand complex digital twin engines
    - 3D GeoTwin with high adjustable atmospherics and detailed terrain models
    - Visualization fed by multiple standard simulation/scenario engines and live data
    - Real-time analysis and interpretation overlays
    - Predict multi-platform mission performance within an adjustable scenario of choice
    - Exhaustively explore the current and future trade space

Interoperability Standards are Critically Needed

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