

AIAA DEIC

# DGE-02: Report on the Digital Twin Implementation Paper

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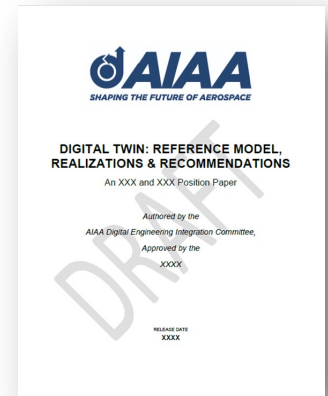
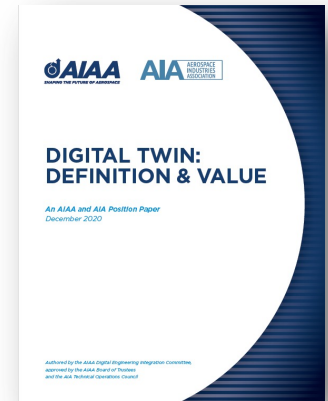
AIAA SCITECH 2022

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# Digital Twins – Definition, Value & Realization

- First AIAA/AIA endorsed Position Paper on Digital Twin Definition & Value
  - <https://www.aia-aerospace.org/report/digital-twin-paper/>
  - <https://www.aiaa.org/advocacy/Policy-Papers/Institute-Position-Papers>
  
- Digital Twin: Reference Model, Realizations & Recommendations Paper
  - Leverages Digital Twin position paper context and recommendations to promote implementation and use of digital twins for value realization across the Aerospace Industry
  - Release expected April 2022



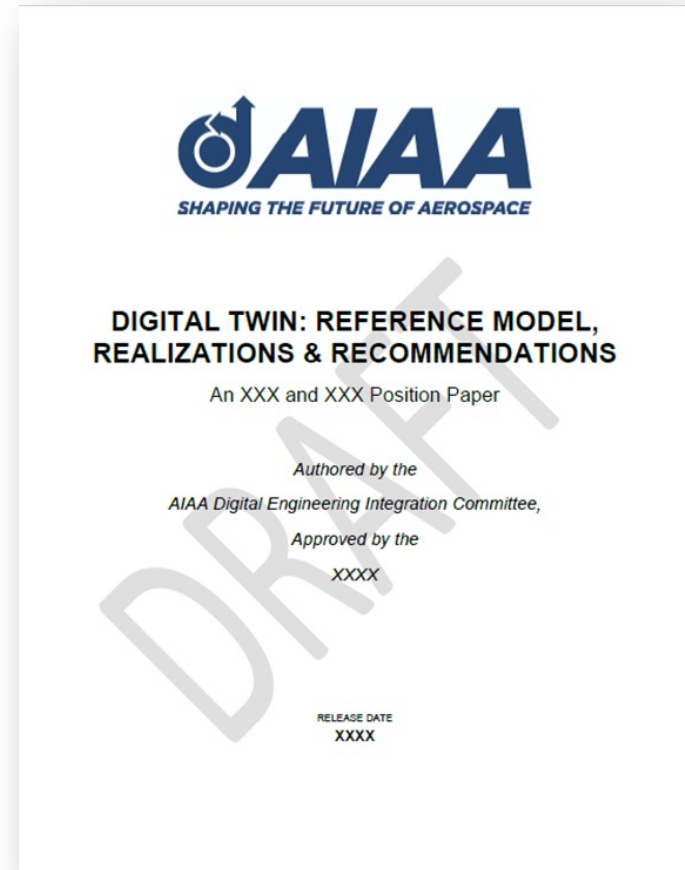
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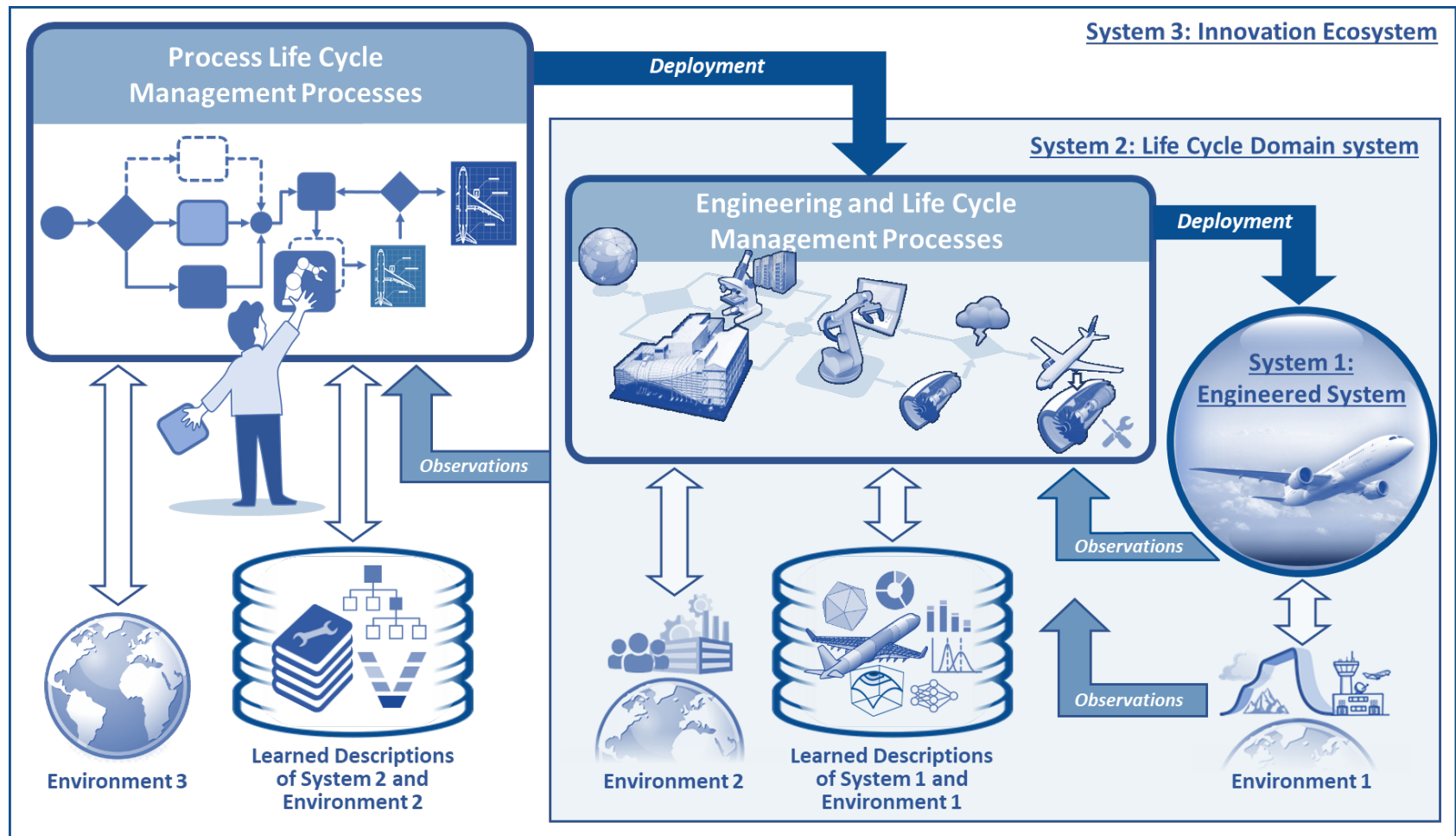
**Special Thanks to contributors from academia, industry and government who participated in our Pink Team Review**

# OUTLINE & CONTENT

1. Purpose
  - Articulate the need for such paper
2. Descriptive Reference Model for Digital Twins
  - Provide a generic reference model and framework (INCOSE's Agile Systems Engineering Life Cycle Management (ASELCM) Pattern) for describing how Digital Twins integrate with the broader digital enterprise
3. Summary of Realization Case Studies
  - Provides context for demonstrating specific instance of the reference model
  - Industry prioritized case studies for Space, Air & Ground
4. Summary of ASELCM Applications
  - Synthesize how the generic reference model supports the various use case applications
5. Recommendations & Next Steps
  - Stay consistent with & integrate "recommendations/next steps" agreed as part of the AIA/AIAA Digital Twin Position Paper
6. Appendices
  - Full descriptions of the 7 use cases



# GENERIC REFERENCE MODEL / PATTERN OVERVIEW



Agile Systems Engineering Life Cycle Management (ASELCM) Logical Architecture – Level 0

# SELECTED DIGITAL TWIN CASE STUDIES

## Realization Case Studies

1. Cygnus Orbital Ferry Vehicle (Northrop Grumman)
2. Aerospace ICME (NASA)
3. Rotorcraft Component (Vanderbilt University)
4. Manufacturing Twin Family (Raytheon Technologies / STEP Tools, Inc)
5. Airplane Seat Certification Twin (The Boeing Company)
6. Building Twin (Georgia Tech)
7. Digital Ghost – Cybersecurity for critical assets leveraging Digital Twins (GE Research)

## Recap of Case Study / Use Case attributes & intent:

- Open & Non-proprietary
- Stay aligned to Position Paper
- Pervasively relevant & prioritized by multiple Orgs to get “Aerospace Voice”
- Demonstrate vertical alignment (cross supply chain/system) & horizontal alignment (across life cycle)
- Case Studies/Use Cases will be a select subset configured from the much larger Digital Twin reference/pattern model

Paper anchored in actual realizations

# RECOMMENDATIONS - METHODOLOGY

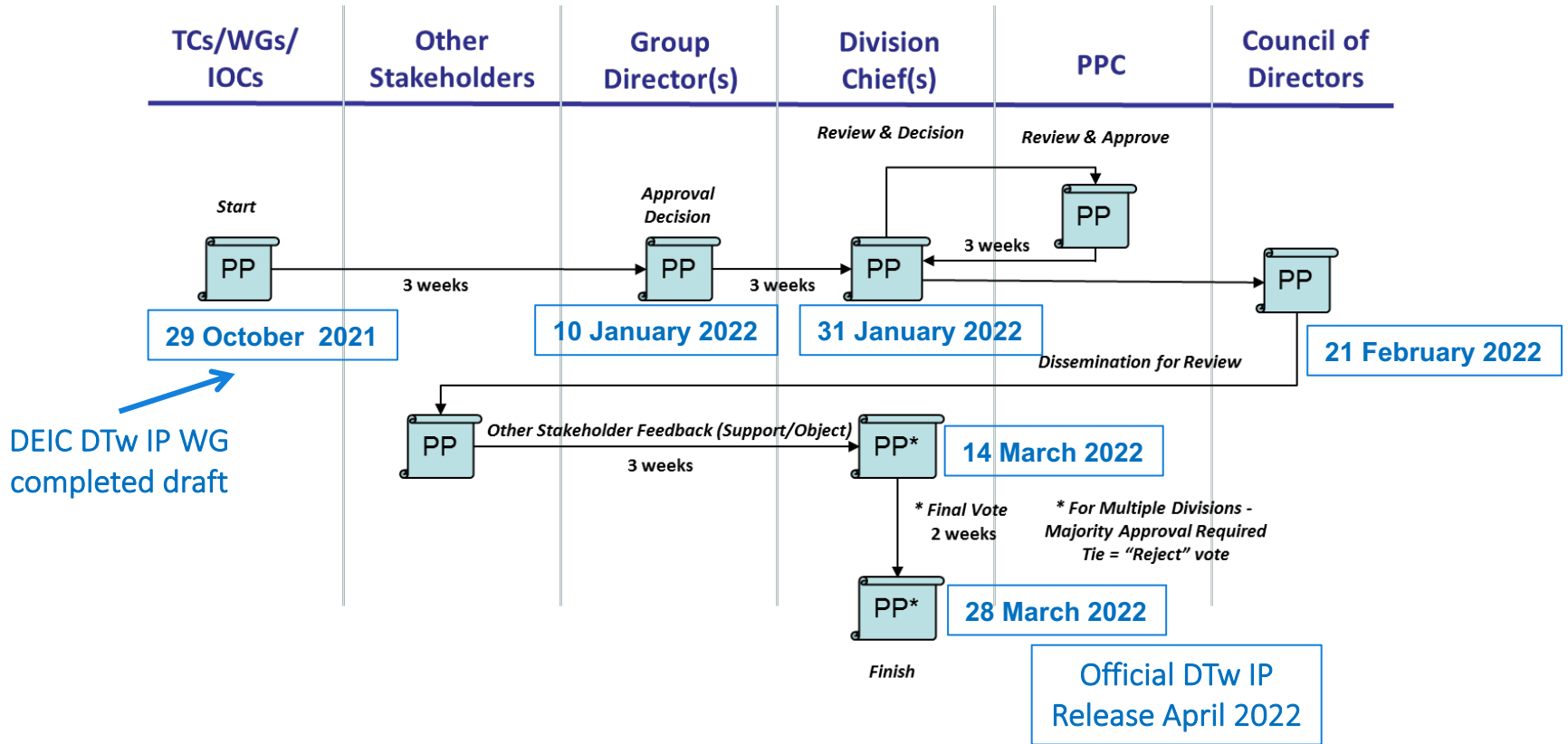
- Adopt a **methodology** that ...
  1. Requires enterprise level **systems engineering**
    - **Managing change** across enterprise functional silos and life cycle stages
    - **Representing the enterprise system** in an integrated way
  2. Aligns with **related enterprise efforts**
    - **Leverage many programs of change** across Aerospace Industry
    - **Promote complement, not compete** where possible
  3. Manages **'trust' over time**
    - **Understand level of model trust** for the decision being informed
    - **Conscious management of Digital Twin credibility** as model of a real system
  4. Pursues on-going **multi-level group learning**
    - **Leverage Digital Twins as "learning"** of the real-world systems they describe
    - **Realize learning occurs at all levels** of a system of systems

# RECOMMENDATIONS – FUTURE STEPS

- Create/leverage **Aerospace Digital Transformation Consortia**
  1. **Tactical:** Provide focus
    - Define & launch appropriately **scoped pathfinders** (e.g. JADC2, CBM+, LCAAT)
    - Accelerate adoption of **digital inspection** across supply chain & life cycle
  2. **Strategic:** Ensure scalability
    - Realize **consistency management** for digital engineering
    - Establish **trust** in models and use of models
    - Promote digital **standardization**
  3. **Marketing:** Promote awareness
    - Facilitate cross consortium **collaboration**
    - Benchmark and publicize **benefits**
  4. **Political:** influence policy & regulation
    - Inform creation of smart **policy & regulation**
    - Facilitate realization of **digital airworthiness certification**
  5. **Education:** Inform workforce development
    - Focus **tools and methods** development
    - Establish digital **maturity model and assessments**
    - Leverage **competitions & grand challenges**



# PAPER REVIEW PROCESS TIMELINE



# NEXT STEPS

- Industry wide release “Red Team” review ~early December
- Collate Industry feedback across Professional Societies
  - AIAA, AIA, INCOSE, NAFEMS, OMG Digital Twin Consortium, Team Defence Information Group (UK)
  - We welcome YOUR feedback! (*email: John Matlik and Olivia Pinon Fischer*)
- Adjudicate feedback / update paper for ~ Feb 2022 publication
  
- **Path Forward:**
  - Position Papers > Implementation Papers > Technical Papers > Book
  - Solicit series of technical papers to support the development of a book
  - Proposed Digital Twin Subcommittee focus for SciTech 2023:
    - Promote & solicit Digital Twin technical paper sessions (targeting content and authors)
    - Organize open & invited sessions
    - Other?
  - Support Aerospace Digital Transformation Consortia being formed to address gaps
  - Leverage JADC2 as initial pathfinder focus area to use in initial ADTC effort

# OTHER DEIC EVENTS AT SCITECH 2022

## ➤ Digital Engineering Integration Committee Technical Panels & Paper Sessions

| Abbrv  | Title  | Duration | Date        | Start Time  | Room           |
|--------|--|----------|-------------|-------------|----------------|
| DGE-01 | Digital Engineering for Product Qualification and Certification            | 75       | Mon, 03-Jan | 11:30:00 AM | Virtual (Zoom) |
| DGE-02 | Report on the Digital Twin Implementation Paper                            | 60       | Mon, 03-Jan | 2:00:00 PM  | Marina Room    |
| DGE-09 | Model-Based Engineering – Product and Environment Digital Twin Simulations | 75       | Mon, 03-Jan | 4:00:00 PM  | Virtual (Zoom) |
| DGE-03 | Report on the Digital Thread Position Paper                                | 60       | Tue, 04-Jan | 11:30:00 AM | Marina Room    |
| DGE-04 | Digital Engineering – Aerospace Perspectives                               | 60       | Tue, 04-Jan | 2:00:00 PM  | Marina Room    |
| DGE-05 | AI/ML to support Digital Twin Capabilities                                 | 40       | Wed, 05-Jan | 09:30:00 AM | Marina Room    |
| DGE-06 | Model-Based Engineering & Digital Twins                                    | 40       | Wed, 05-Jan | 10:30:00 AM | Marina Room    |

# UPDATE ON OTHER DEIC DIGITAL TWIN 2021 ACTIVITIES

## ➤ AIAA AVIATION 2021

- [Plenary: “Digital is the New Battlefield” – Dr. Will Roper](#)
- [Forum 360: “Modern Development in a Digital Environment”](#)
- [Forum 360: “Advantages of Digital Thread for the Entire Product Lifecycle”](#)

## ➤ AA&S 2021

- [NAC Keystone Panel: “Digital Transformation”](#) (US Gov’t Panel)
- [Keynote Panel: “Digital Airworthiness Certification”](#) (Industry Panel)
- Expert Designed Sessions:
  - [“The U.S. Air Force Digital Airworthiness Team”](#) – Turek (USAF SAF/AQR)
  - “The AIAA Digital Engineering Integration Committee” – Fischer (Georgia Tech)
  - [“Thoughts on Model Based Verification for Airworthiness & Certification”](#) – Gregg (Boeing)
  - [“MBSE Support for Digital Airworthiness”](#) – Siders (AFLCMC/EZ)

## ➤ Digital Ecosystem Alignment & Collaborations

- [AIA Business Technology & Interoperability Committee](#) & [Digital Transformation Council](#)
- MOU for AIAA & [Digital Twin Consortium](#) Collaboration
- USAF/Ohio “Digital Twin Center of Excellence” TIM planning
- USAF/Indiana “Aerospace & Defense Supply Chain Ecosystem” TIM
- USAF/Ohio “Regional Fabrication & Certification Training Lab”
- EU/UK engagement: [Team Defence Information](#) (Digital Twin) & [ASD](#) (Standards)