

# MODEL EXCHANGE & VIRTUAL INTEGRATION WITH MATLAB/SIMULINK

MATLAB EXPO – MAY 2022

**Alessandro Mignogna**, Sr.PI MBD Methods & Tools - *Collins Advanced Technologies Center – Italy*  
**Giacomo Gentile**, DPLC Accelerator Leader - *Collins Advanced Technologies Center - Italy*



**Advanced Technologies Center – Italy**

G.Stazi, L.Lazzara, A. Ulisse, A.Mignogna, V.Di Valerio, S.Sinisi

# ABOUT COLLINS AEROSPACE

Collins Aerospace is a leader in technologically advanced, intelligent solutions that help redefine the aerospace and defense industry.

More than 78,000 people in more than 300 locations worldwide.

## AEROSTRUCTURES



## MECHANICAL SYSTEMS



## AVIONICS



## MISSION SYSTEMS



## INTERIORS



## POWER & CONTROLS



## Applied Research & Technology

Accelerating Transformative Technology for a safer, more connected and sustainable world

# THE PERSPECTIVE OF AEROSPACE INDUSTRY

“ONCE-IN-A-CENTURY” AIR-VEHICLES CONCEPTS SHAKE-UP ...



[1]



[2]



[3]

ELECTRIFICATION  
HYDROGEN  
AUTONOMOUS  
CONNECTED



[5]



[4]

Did malware cause the crash of Spanair Flight JK 5022?

[7]



Report: Pilots restarted software, causing fatal nosedive

Disparate pilots of an Ethiopian Airlines Boeing 737 Max reactivated the jet's flight control software that prevented automatic stalls when stallings did worked to avert their descent

By: DAVID ADENYI and TOM KERRISBERG, AP Business Writers  
March 2019, 4:00 PM - 10:00 AM



[6]

Airbus A400M plane crash linked to software fault

[8]



Hard Questions Raised When A Software 'Glitch' Takes Down An Airliner

[9]

Tajal Aramalingam, former Contributor @ Cybersecurity  
Lower software security and privacy

This article is more than 3 years old.



How the Boeing 737 Max Disaster Looks to a Software Developer

Design shortcuts meant to make a new plane seem like an old, familiar one are to blame

Gregory Swank  
The views expressed here are solely those of the author and do not represent positions of IEEE Spectrum or the IEEE.

Photo: James Cook/Reuters



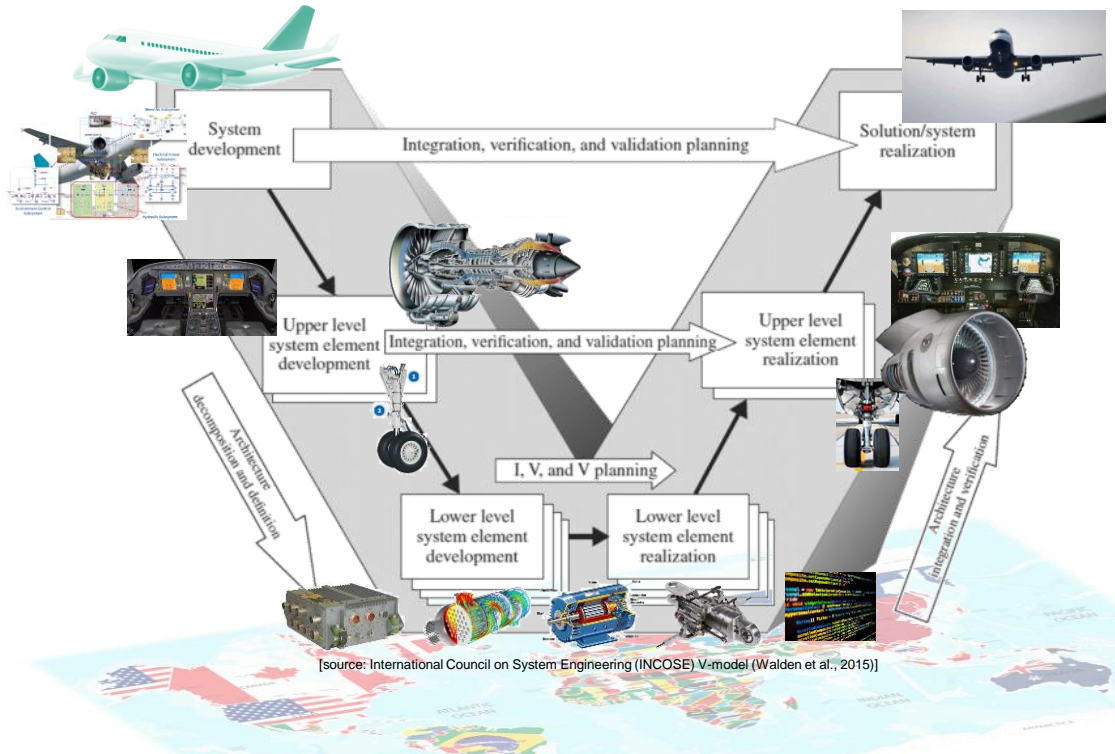
[10]

QUALITY  
SAFETY  
COST  
REGULATIONS  
TIME-TO-MARKET

... WHILE FACING ALL THE TRADITIONAL CHALLENGES!

DIGITAL ENGINEERING IS A MUST TO ENABLE DEVELOPMENT OF NEXT GENERATION AIRCRAFT SYSTEMS

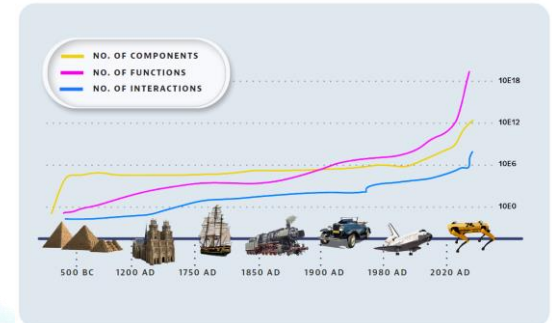
# COMPLEX SYSTEMS & COMPLEX INTEGRATION



[source: International Council on System Engineering (INCOSE) V-model (Walden et al., 2015)]

System complexity growing together with business organizations complexity

- Multi-fidelity
- Multi-domain
- Multi-criticality
- Multi-team / multi-companies
- Geographical Distribution



Derived from Systems Engineering Vision 2035 Copyright © 2021 by INCOSE  
<https://www.incose.org/about-systems-engineering/se-vision-2035>

**EARLY INTEGRATION** TO ENABLE SMOOTH EVOLUTION OF SYSTEM DEVELOPMENT

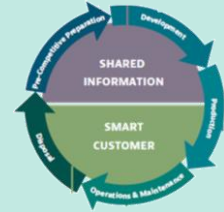
# DIGITAL ENGINEERING TO DEAL WITH INCREASING COMPLEXITY

## OEMS MBSE INITIATIVES

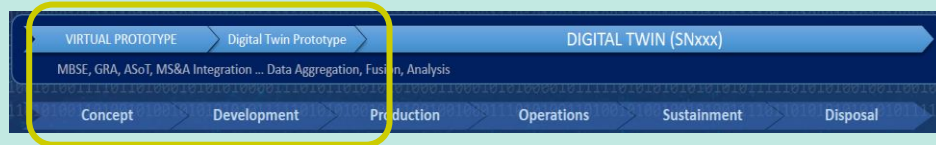


[source: AFNET Standard Days 6/10/2020 (pdf) + Boeing Mission Engineering, Digital Engineering, MBSE, and the Like: The One Underlying Essential Attribute]

## SHIFTS IN ACQUISITION TOWARDS COLLABORATIVE PROCESSES



## U.S. DEPARTMENT OF DEFENSE & AIR-FORCE DIGITAL CAMPAIGN



[source: AF Digital Campaign Virtual Industry Exchange Day]

## INDUSTRIAL STANDARDS FOR INTEROPERABILITY



ALIGNED WITH **OEMs, DOD & ENGINEERING COMMUNITY STRATEGY** & VISION

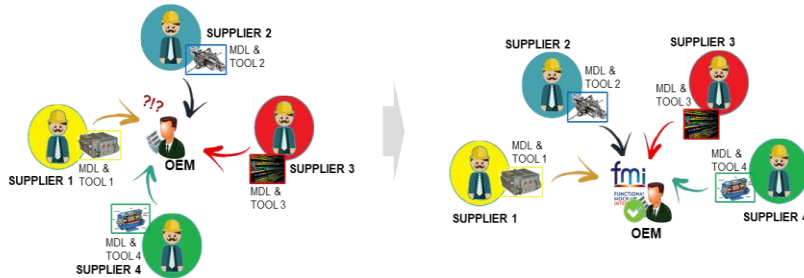
# FUNCTIONAL MOCK-UP INTERFACE STANDARD

**MODELISAR Standard** to exchange dynamic models and simulators (+10 years)



Defines an **open interface & a standard XML-based model descriptor** that models (FMU) shall comply with

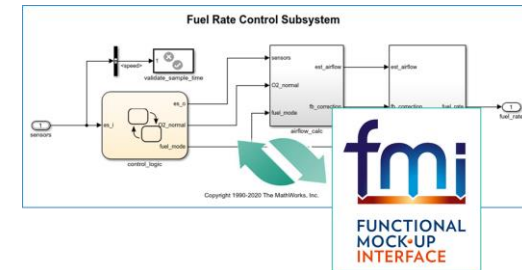
FMI is suitable for **continuous-time & discrete-time models** exchange and integration



Contribute to an **MBSE supply-chain** for an **agile and smooth integration** of heterogeneous models (inter & intra companies)

MathWorks provides full support for FMI standard:

- 1) **FMI Import** to integrate 3<sup>rd</sup> parties FMUs in MATLAB/Simulink
- 2) **FMI Export** to generate an FMU out of a MATLAB/Simulink model leveraging *Simulink Compiler*



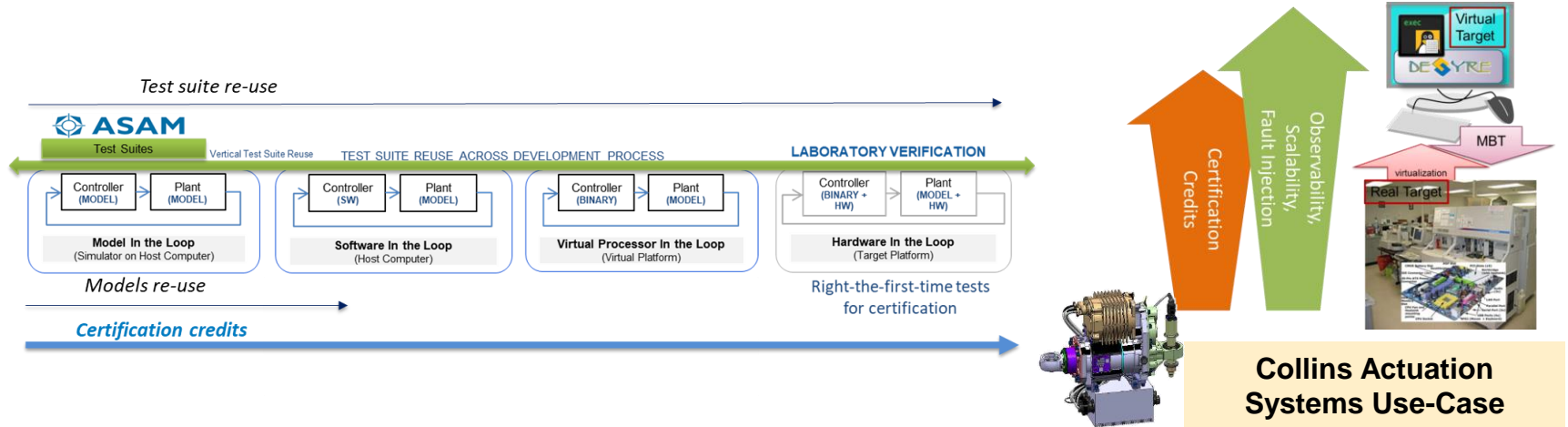
# CLEAN-SKY2 EUROPEAN USE-CASES

SIMULINK FMI IMPORT/EXPORT TO SUPPORT SYSTEM VALIDATION & VERIFICATION



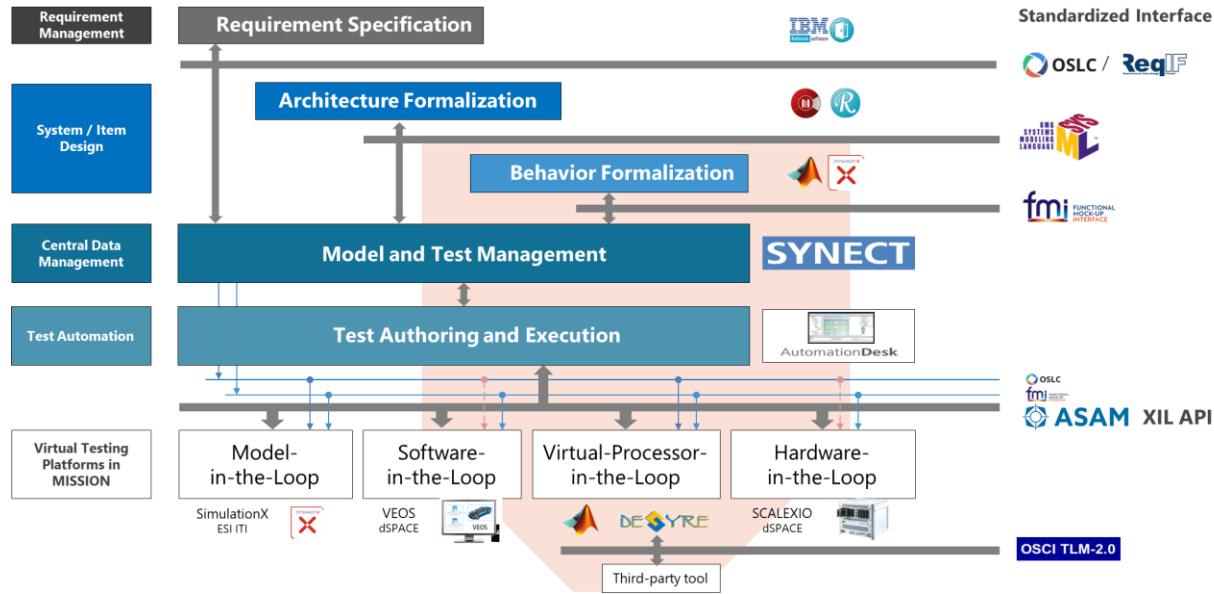
## Modelling and Simulation Tools for Systems Integration on Aircraft

Methods & Tools to enhance Aerospace system development and integration reducing testing costs and paving the road to certification by simulation



# CLEAN-SKY EUROPEAN USE-CASES

## SIMULINK FMI IMPORT/EXPORT TO SUPPORT SYSTEM VALIDATION & VERIFICATION



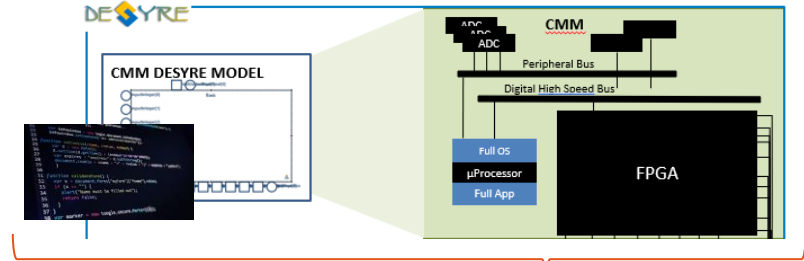
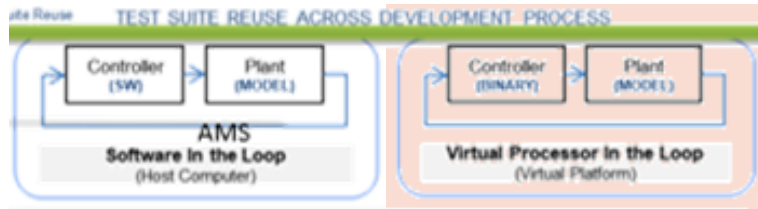
- First-time-right tests for certification
- Eligibility of virtual tests for certification credits
- Dependability and quality assurance

WORKFLOW FOR SEAMLESS AND STANDARD BASED TOOLS INTEGRATION

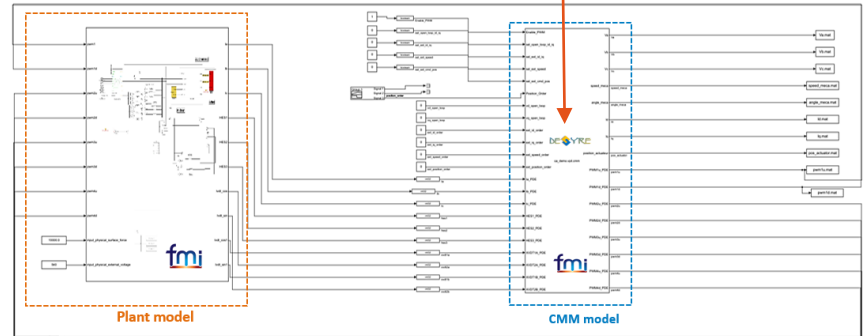


# CLEAN-SKY EUROPEAN USE-CASES

SIMULINK FMI IMPORT/EXPORT TO SUPPORT SYSTEM CLOSED-LOOP V&V



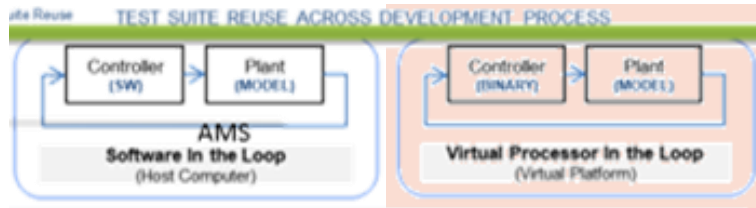
	INTEGRATION & Tests	CMM-SW	CMM-HW	PEB	MOTOR & EMA
SiL	ControlDesk + Automation Desk	Host object code	N/A		Simulink model
VPiL	Simulink	Target Object code	DESYRE model		Simulink model (refined w.r.t. SiL)
HiL	ControlDesk + Automation Desk	Target Object code	Physical part		dSPACE model & Simulink model



**SIMULINK AS THE SYSTEM INTEGRATION ENVIRONMENT**  
**(CONTROLLER IMPORTED IN SIMULINK AS AN FMU)**

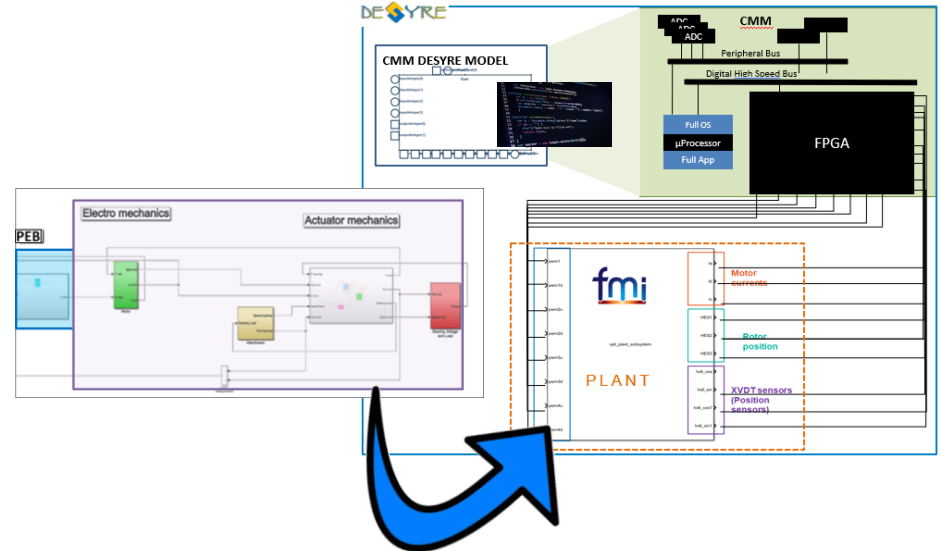
# CLEAN-SKY EUROPEAN USE-CASES

SIMULINK FMI IMPORT/EXPORT TO SUPPORT SYSTEM CLOSED-LOOP V&V



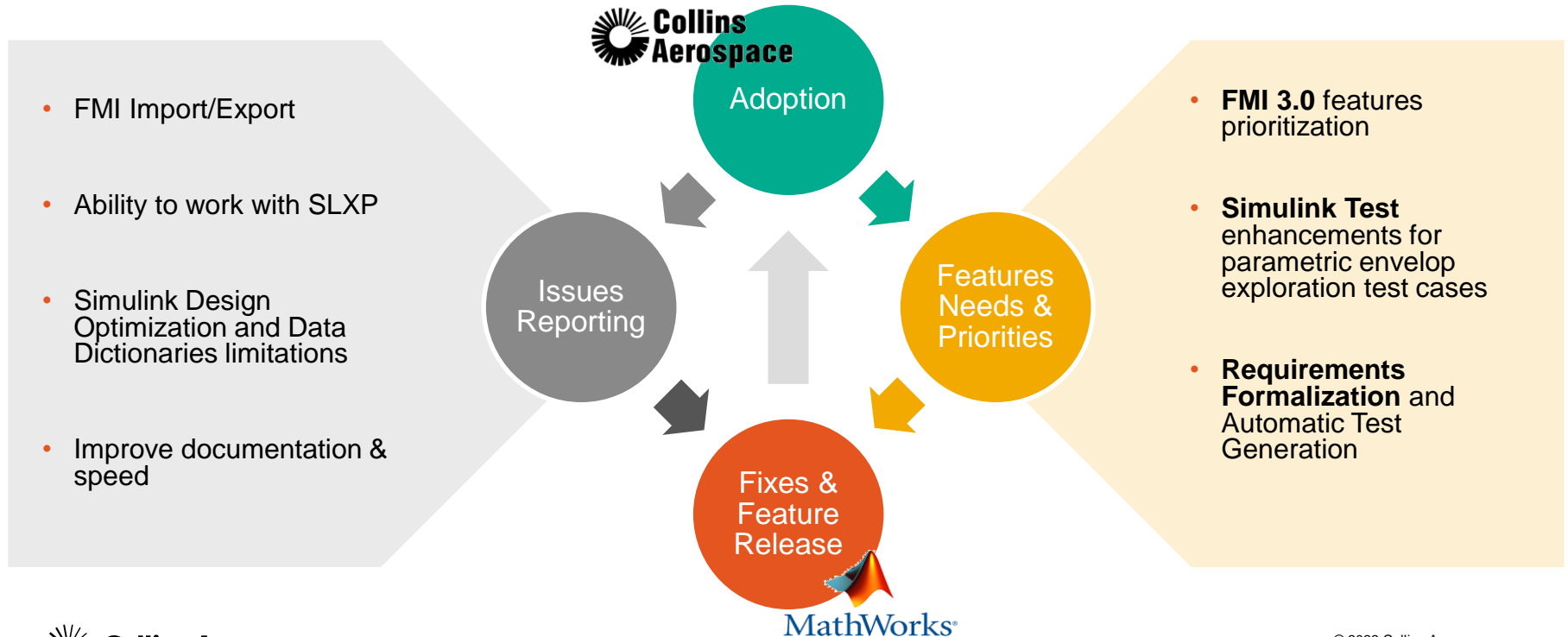
COLLINS SIMULATOR AS AN INTEGRATION ENVIRONMENT (SIMULINK PLANT EXPORTED AS FMU)

	INTEGRATION & Tests	CMM-SW	CMM-HW	PEB	MOTOR & EMA
<b>SiL</b>	ControlDesk + Automation Desk	Host object code	N/A		Simulink model
<b>VPiL</b>	Desyre + Automation Desk (via ASAM-XiL)	Target Object code	DESYRE model		FMU from Simulink model (refined w.r.t. SiL)
<b>HiL</b>	ControlDesk + Automation Desk	Target Object code	Physical part		dSPACE model & Simulink model



# FINDINGS & FORWARD LOOKING

## CONTINUOUS ENGAGEMENT WITH MATHWORKS TEAM



# CONCLUSIONS

- Digital Engineering and standard-based Virtual Integration solutions is the answer that the aerospace community is pushing to cope with the increasing complexity of next generation aerospace systems
- Collins Aerospace industrial use-cases have been presented to demonstrate how the support for interoperability standards in MATLAB/Simulink (e.g. FMI import/export) permits to realize efficient virtual integration workflow
- The strong interaction with MathWorks teams permitted to efficiently report and fix issues, and discuss and introduce new capabilities in MATLAB/Simulink to best serve the industry needs

THANK YOU