

SAVI Approach to ECAD-MCAD Integration

Exploring Solutions to
the “Pin 1 Problem”

Greg Pollari, Rockwell Collins

GLOBAL PRODUCT DATA
INTEROPERABILITY
S U M M I T
2014



 **ELYSIUM**

 **Parker**

 **NORTHROP GRUMMAN**

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Gregory Pollari

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- **Education**

- BS Physics
- MS Electrical & Computer Engineering
- MBA

- **Motorola (1984 – 1986)**

- Cellular and Radio Products – ASIC and Electrical Engineer

- **Rockwell Collins (1986 – present)**

- ASIC, Power Supply, and Digital Electronics – Engineer
- Navigation and Vehicle Systems – Project Leader, Manager, Systems Engineer
- Advanced Manufacturing and Test – Systems Engineer

Introduction

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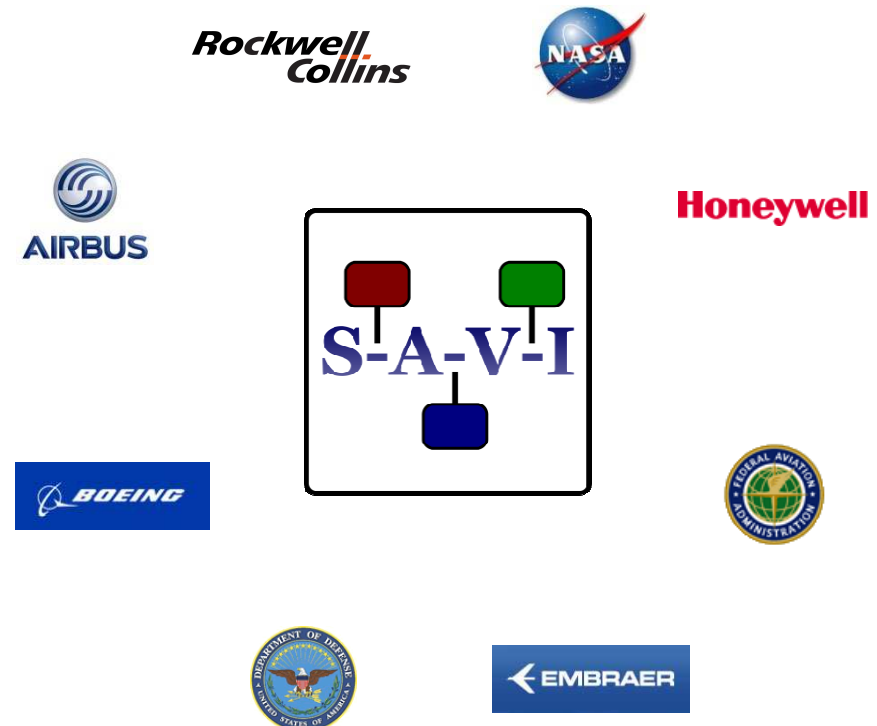
- **SAVI, Consistency Checking, and the Model Repository/Data Exchange Layer**
- **The “Pin 1 Problem” – A Failure to Interoperate**
- **Forming a Solution**
- **Next Steps**

SAVI, Consistency Checking, and the Model Repository/Data Exchange Layer

SAVI (Systems Architecture Virtual Integration)

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- SAVI is a project within AVSI (Aerospace Vehicle Systems Institute)
- VIP (Virtual Integration Process)
- Model consistency checking
- Find errors before build



The AVSI SAVI Project is a collaboration between aerospace system development stakeholders that aims to advance the state of the art of technologies that enable virtual integration of complex systems.

“Integrate, Analyze, then Build”

<http://savi.avsi.aero/>

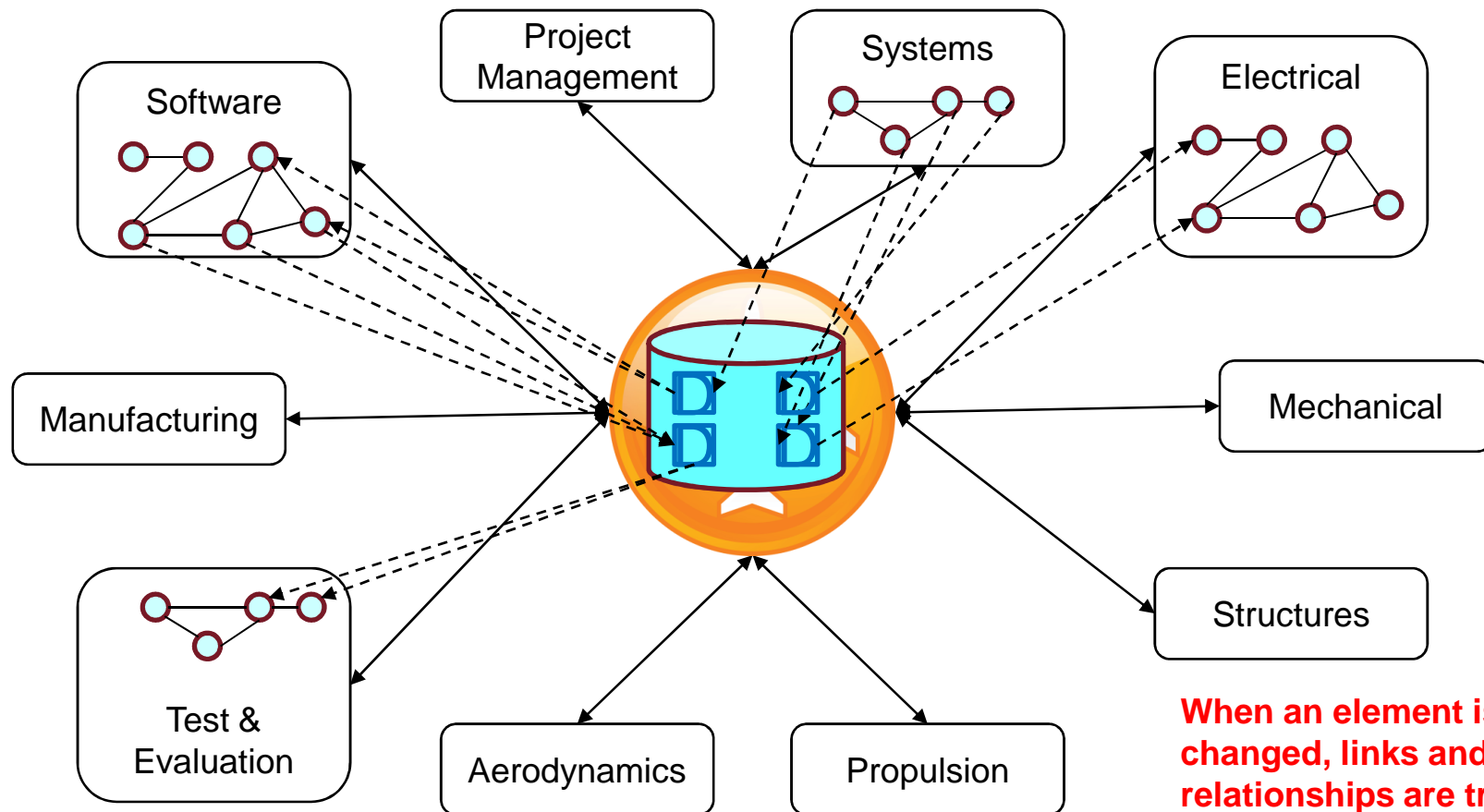
SAVI Interconnect Consistency Check Project Goals

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- **Explore how SAVI VIP (Virtual Integration Process) can address the electrical interconnect “Pin 1 Problem”**
 - **Prove physical matches the logical**
- **Develop a solution using commercially available tools**
 - **No duct tape and bailing wire solutions**
- **Minimize impact to existing design processes**
 - **Minimize business process risk**
- **Achieve TRL (Technical Readiness Level) 6 or above**
 - **Reliable and robust**

SAVI Model Repository/Data Exchange Layer

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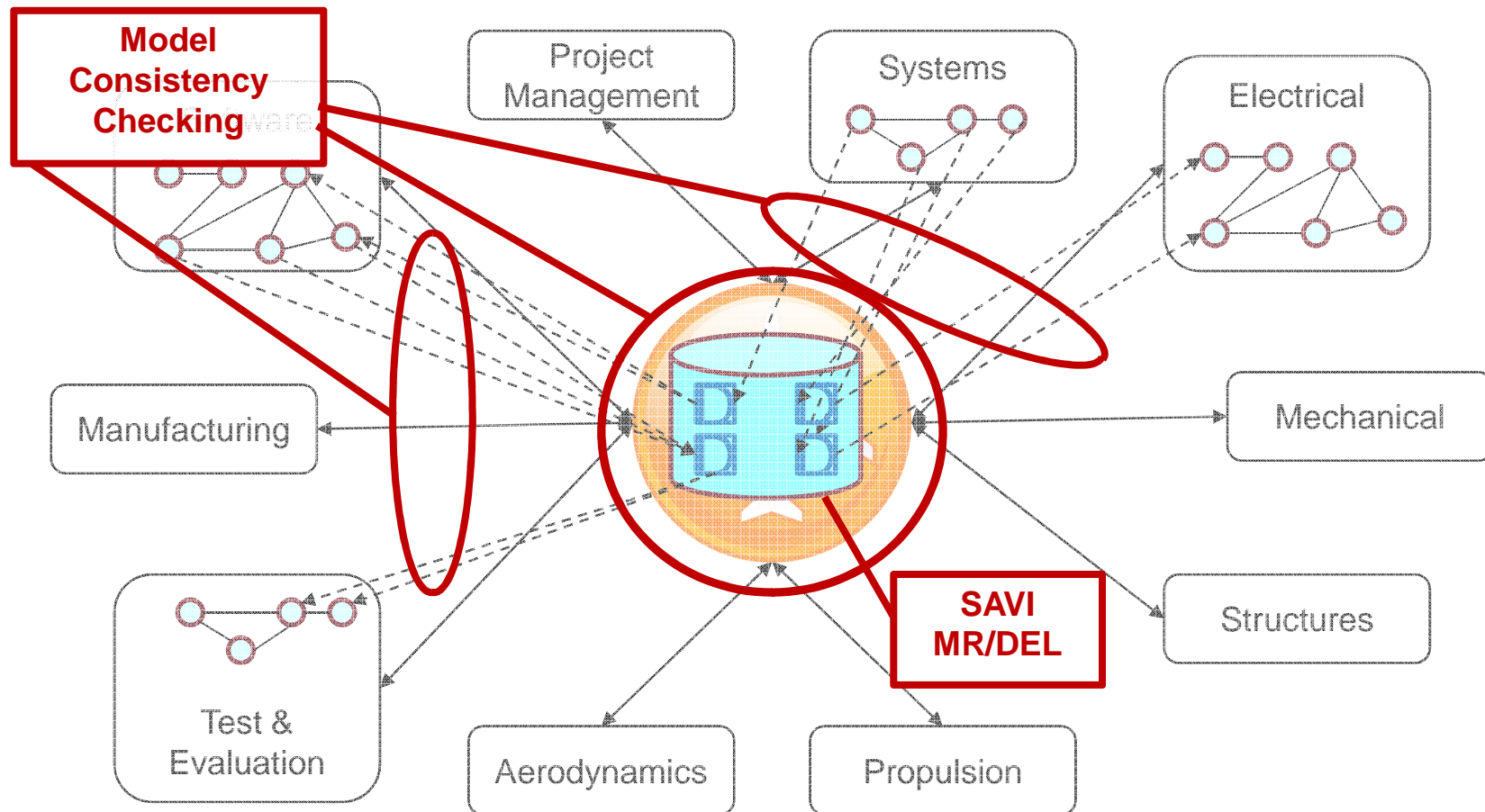


When an element is changed, links and relationships are traced to find affected elements

The SAVI Model Repository is for links, not entire models

SAVI Model Consistency Checking

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Focus on subset of models' properties

The “Pin 1 Problem” – A Failure to Interoperate

Terms & Definitions

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- **PWB = Printed Wiring Board**
- **PCB = Printed Circuit Board**
- **CCA = Circuit Card Assembly**
- **MCAD = Mechanical Computer Aided Design**
- **ECAD = Electrical Computer Aided Design**
- **SAVI = Systems Architecture Virtual Integration**
- **VIP = Virtual Integration Process**
- **MR/DEL = Model Repository/Data Exchange Layer**
- **IDF = Intermediate Data Format**
- **3D = Three Dimensional**
- **DEX = Data Exchange Specification**
- **MoSSEC = Modelling and Simulation in a collaborative Systems Engineering Context**

The “Pin 1 Problem”

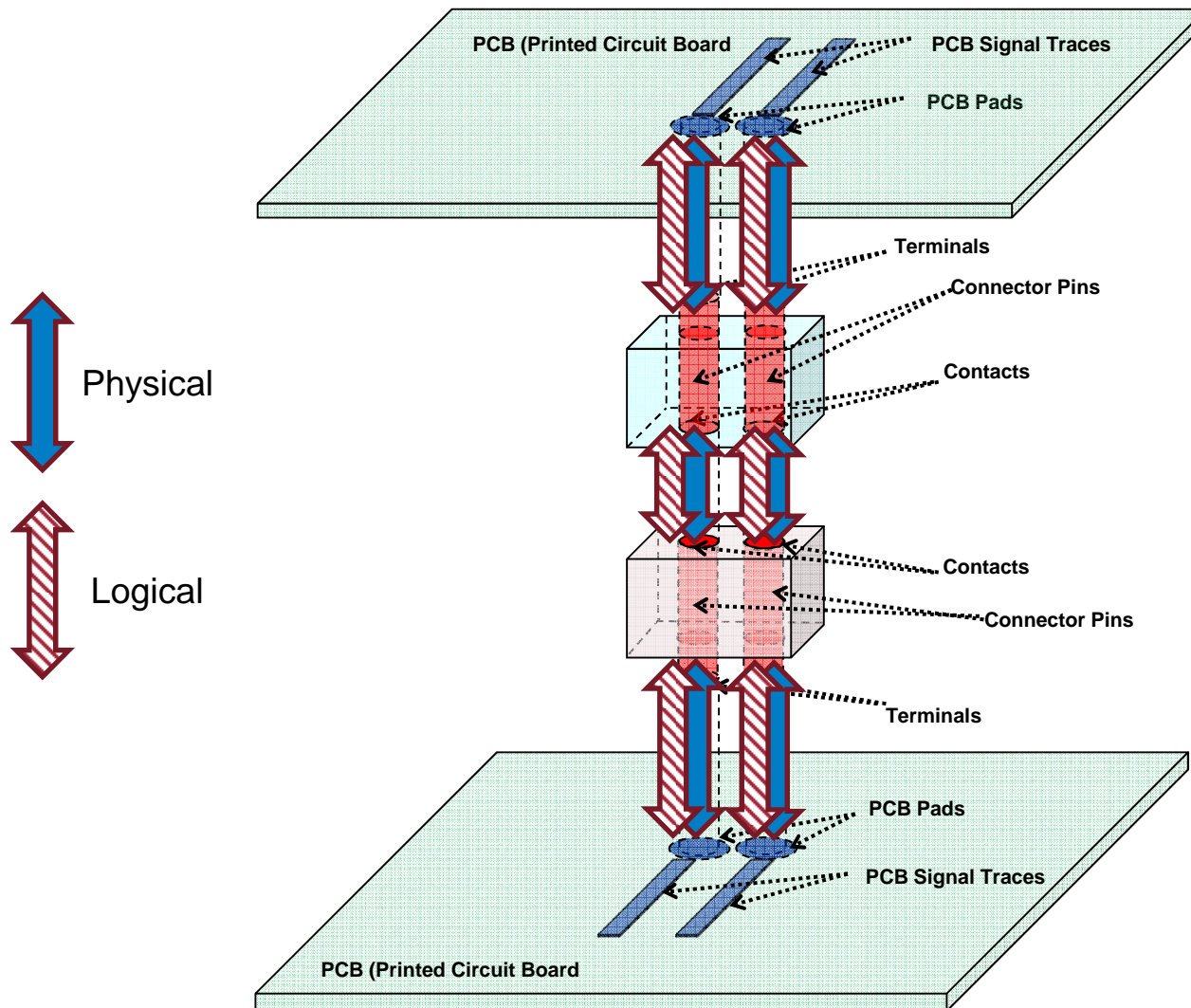
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- **Connector pin physical locations across interfaces are not consistent with logical design (pin mismatch, swapped signals)**
 - **Connector PWB footprint pad locations do not match connector pin locations**
 - **Mating connector pin number mismatch**
 - **Logical (schematic) signals are connected to the wrong pin**

Verify physical implementation matches logical design

“Pin 1” Problem: Does Physical = Logical?

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The “Pin 1 Problem” Sources of Error

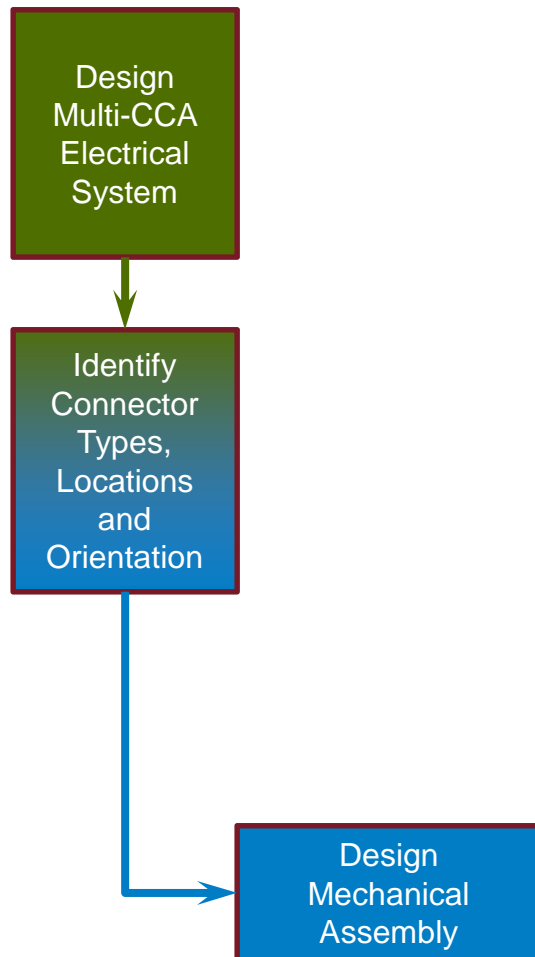
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- **Examples of error sources**
 - **Modeler uses connector pin layout bottom versus top view**
 - **Designer rotates a connector 180 degrees**
 - **Design Engineer assigns signals to wrong schematic pins**

Typically human error at manual steps

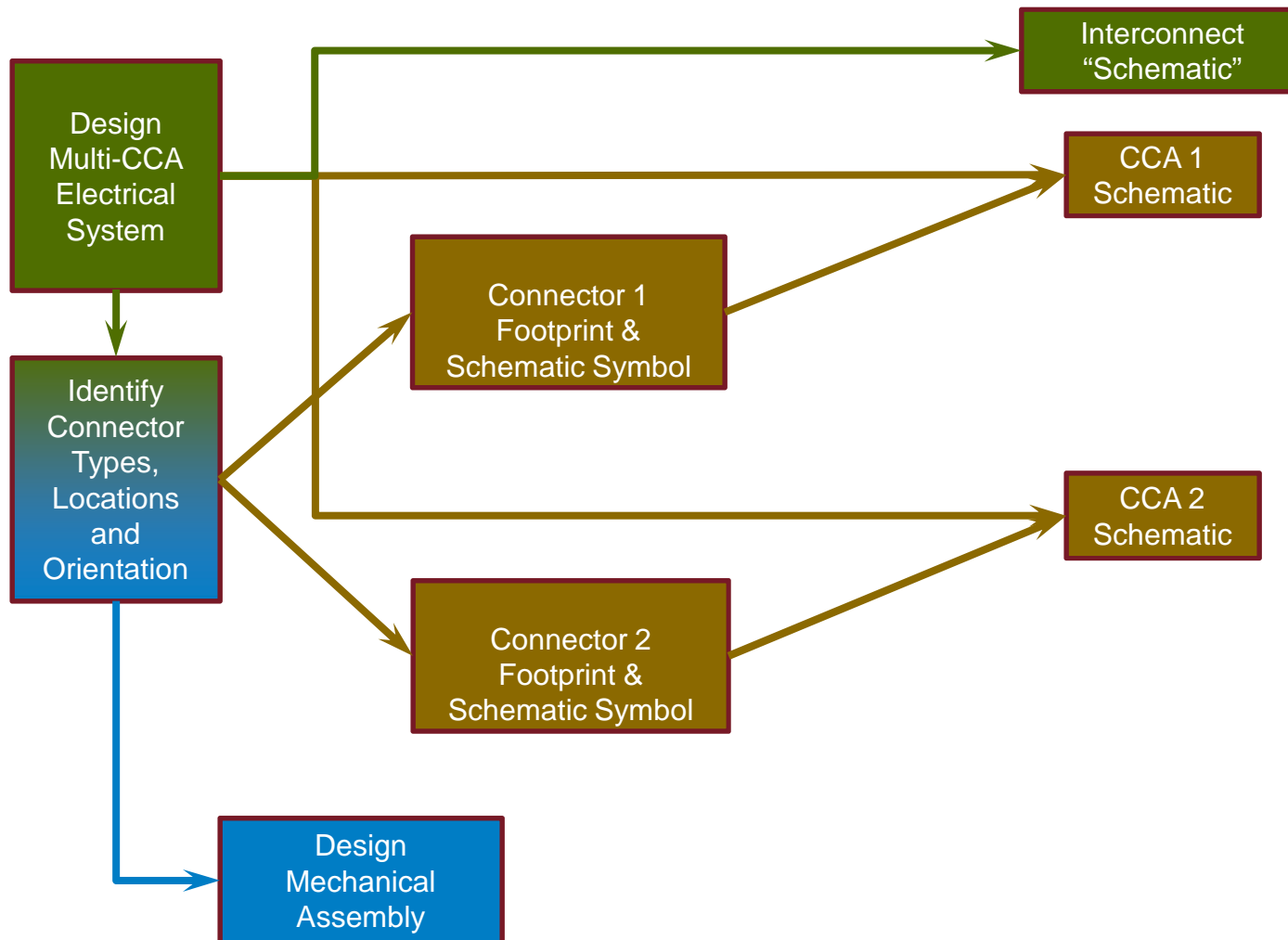
Design Electrical-Mechanical System

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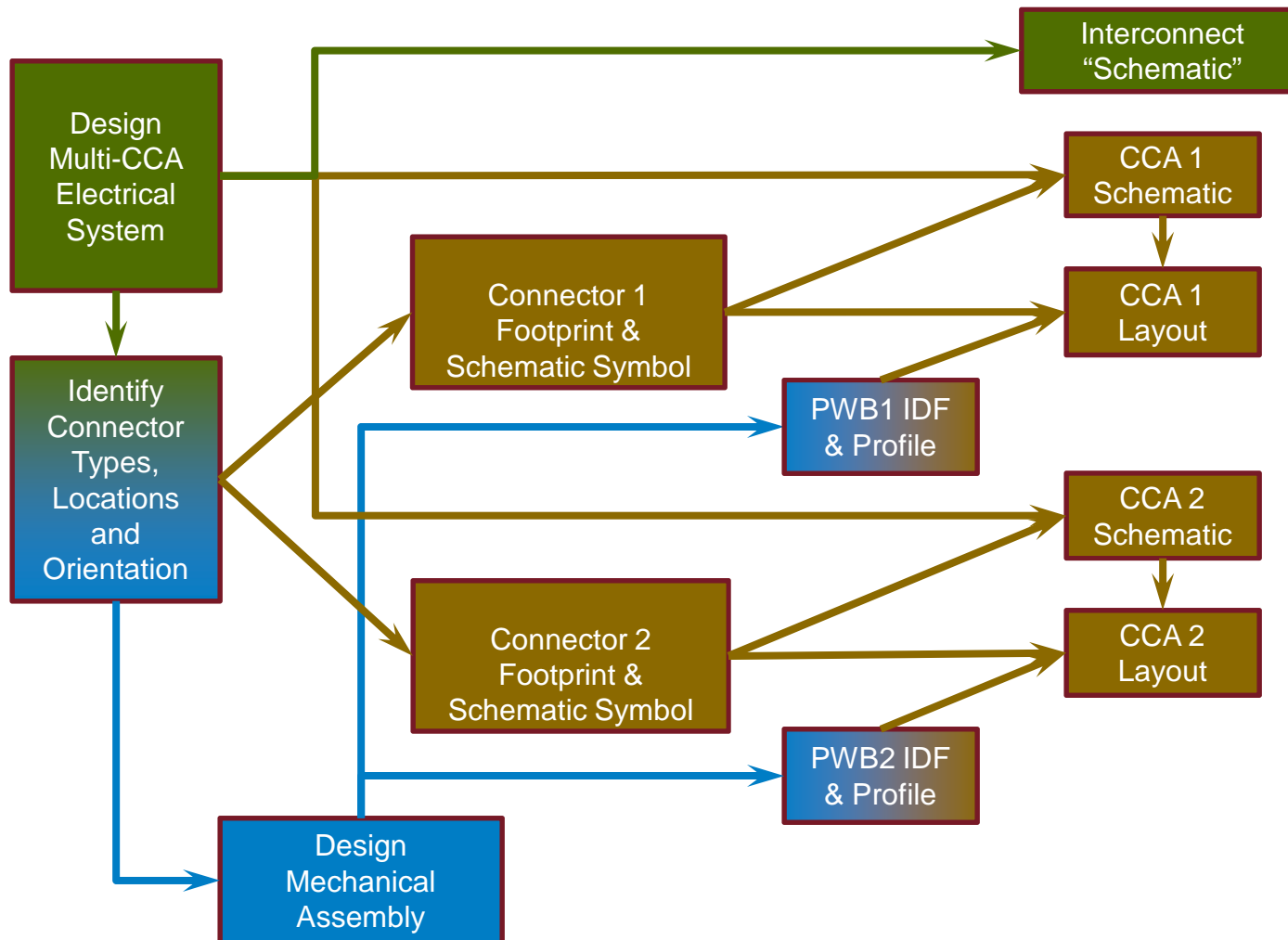
Create Schematics (Logical Models)

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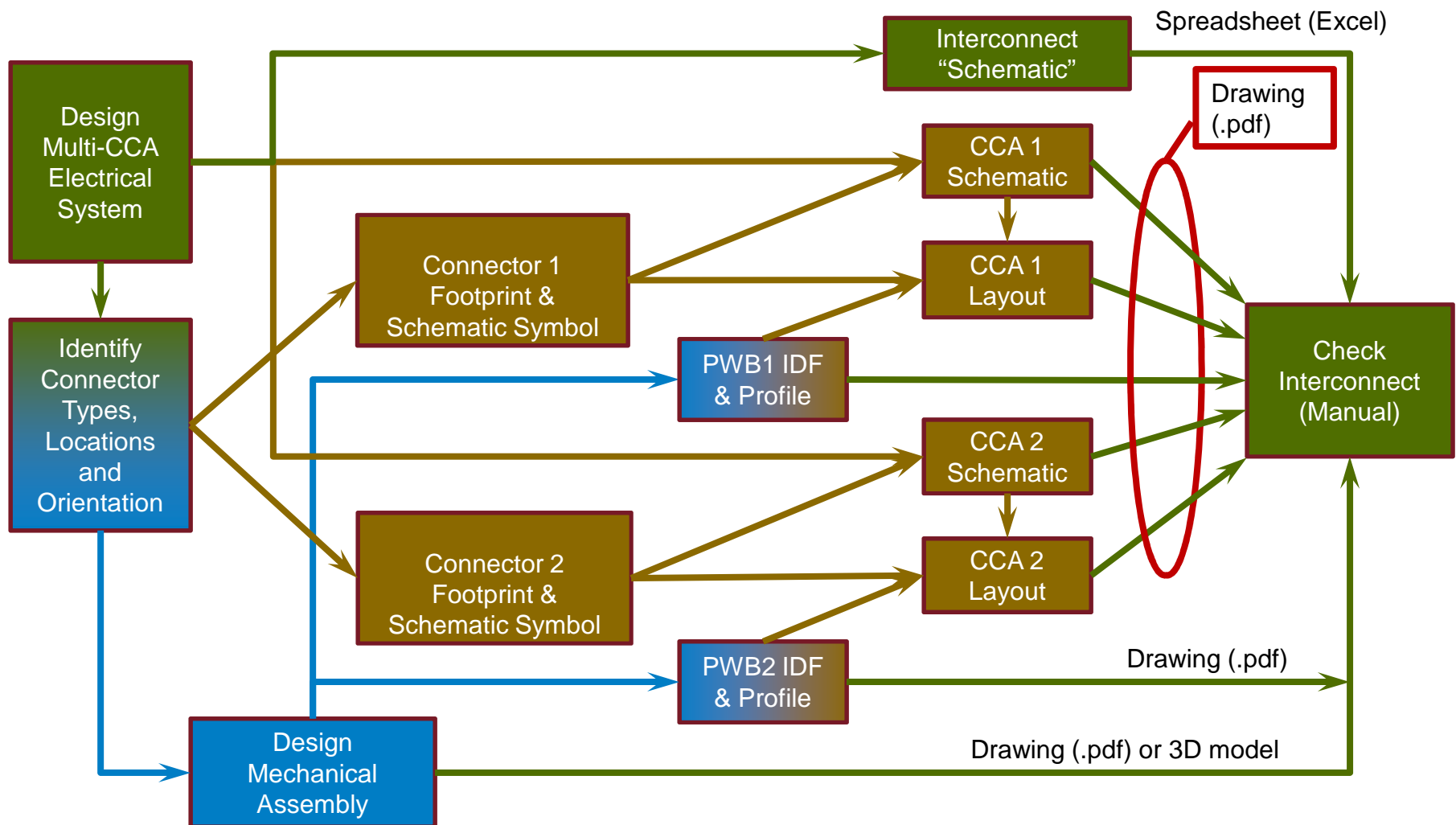
Create Electrical and Mechanical Physical Models

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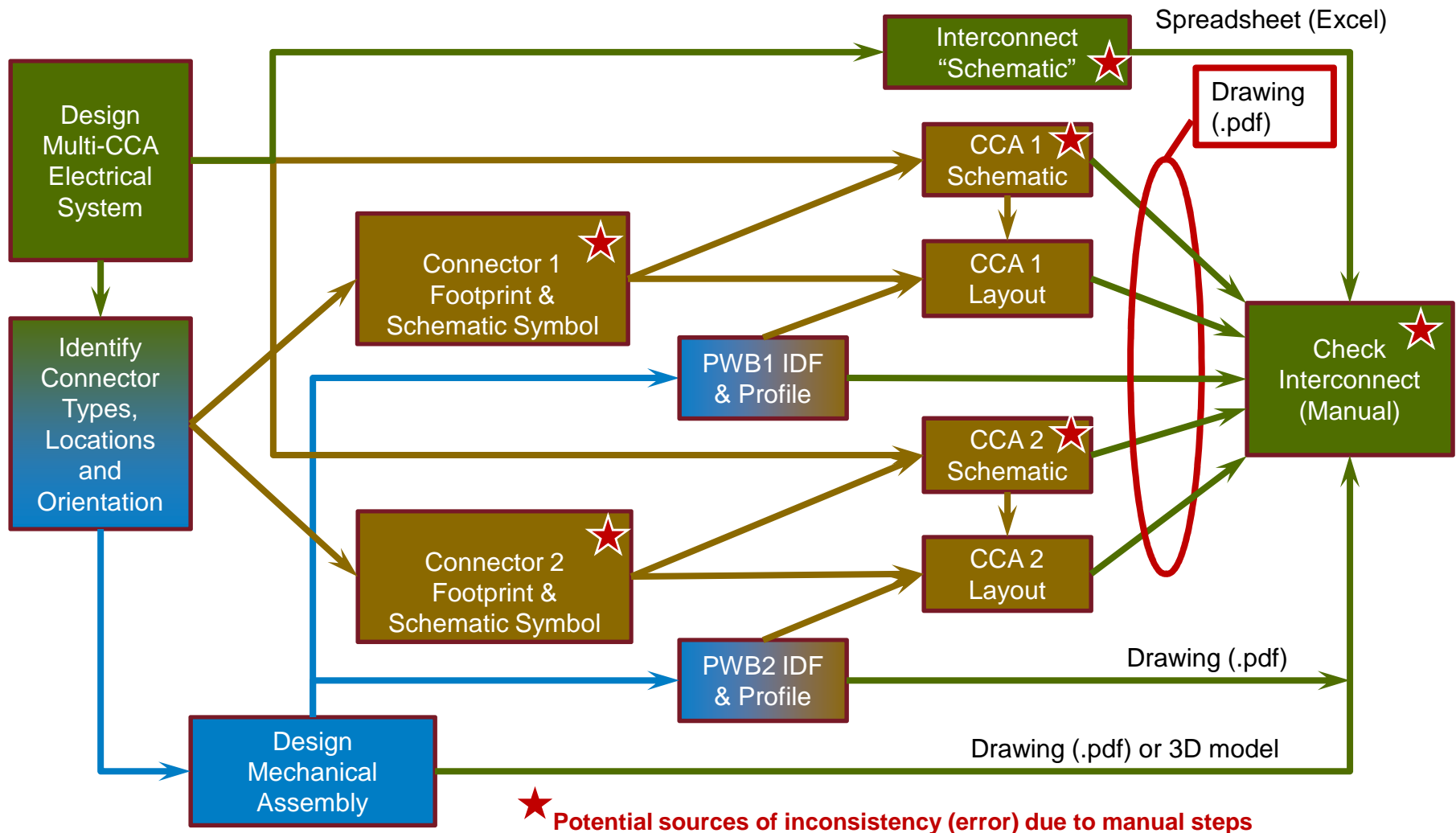
Conduct Manual/Visual Check

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Sources of Error – Candidates for Automation

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Model Set

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- **(1) System interconnect model (Spreadsheet)**
- **(1) Assembly model (MCAD)**
- **(2) PWB/CCA profiles (MCAD)**
- **(2) PWB/CCA models (ECAD)**
- **(2) Connector models (MCAD)**
- **(2) Connector models (ECAD)**
 - Logical and physical

10 models with different, but (hopefully) consistent views

Nature of the Problem

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- ECAD and MCAD have evolved in different silos
- ECAD and MCAD aren't good at sharing data
- MCAD has no “electrical awareness”
- ECAD is “2 ½-D” whereas MCAD is 3D
- Connector models are not “electrically aware”

If this was easy, it would have been fixed already

Assumptions

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- **Sufficient information exists in all the models to analytically verify that the physical matches the logical**
 - **System interconnect model (Excel)**
 - **MCAD models (native → STEP AP-203)**
 - **ECAD models (native → STEP AP-210)**
- **Need “intelligent” connector model**
 - **Geometry model + electrical properties**

If relevant properties are extracted, can problem be solved?

Root Cause Analysis

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- **Boils down to data interoperability problem**
 - **Tools don't communicate**
 - **Data in different, incompatible forms**

Candidate for data exchange standards-based solution

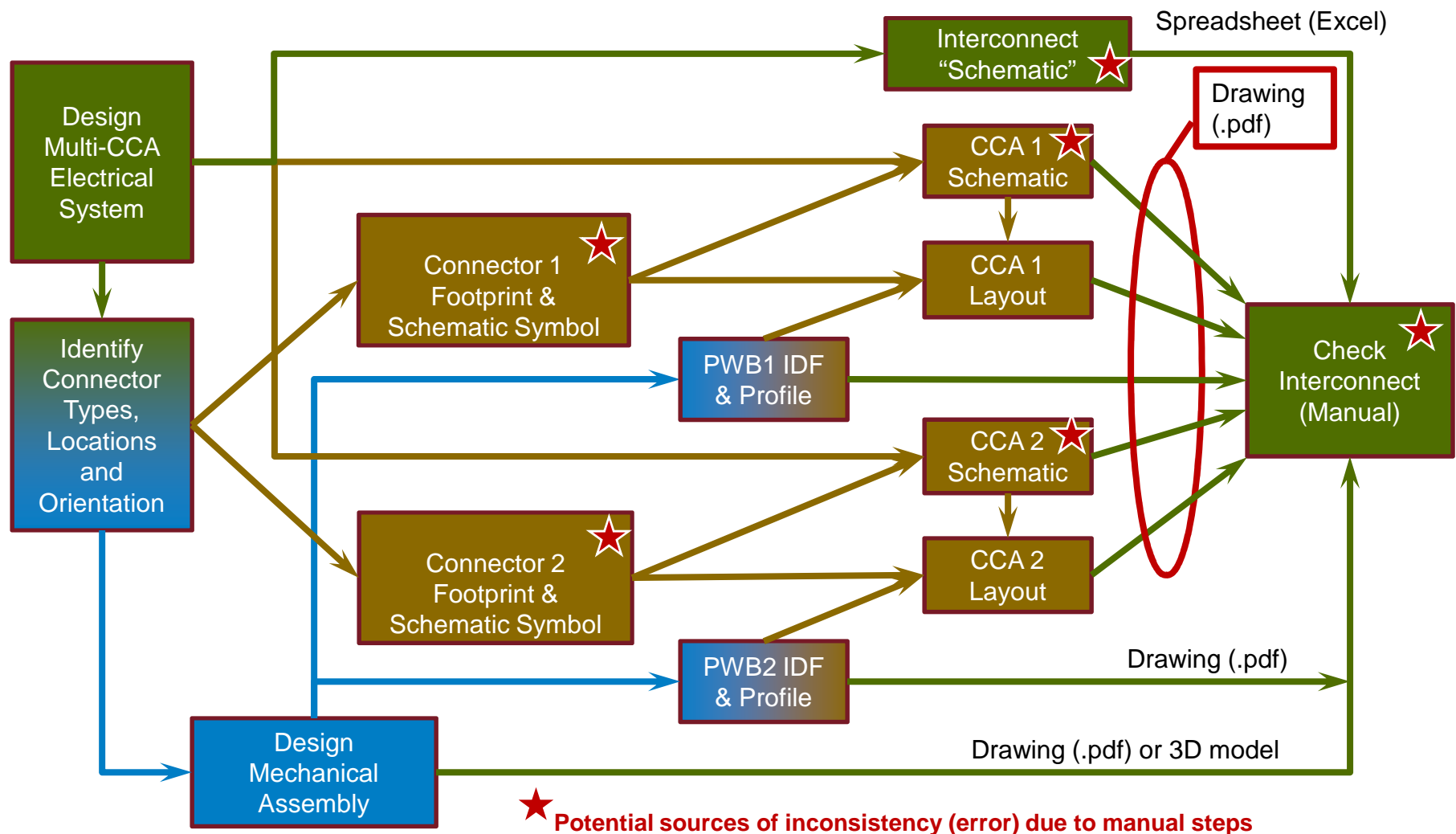
Approach

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- **Extract relevant properties from models (ECAD, MCAD, Excel)**
- **Convert to common representation (STEP AP-239)**
- **Perform SAVI VIP consistency check in common environment**

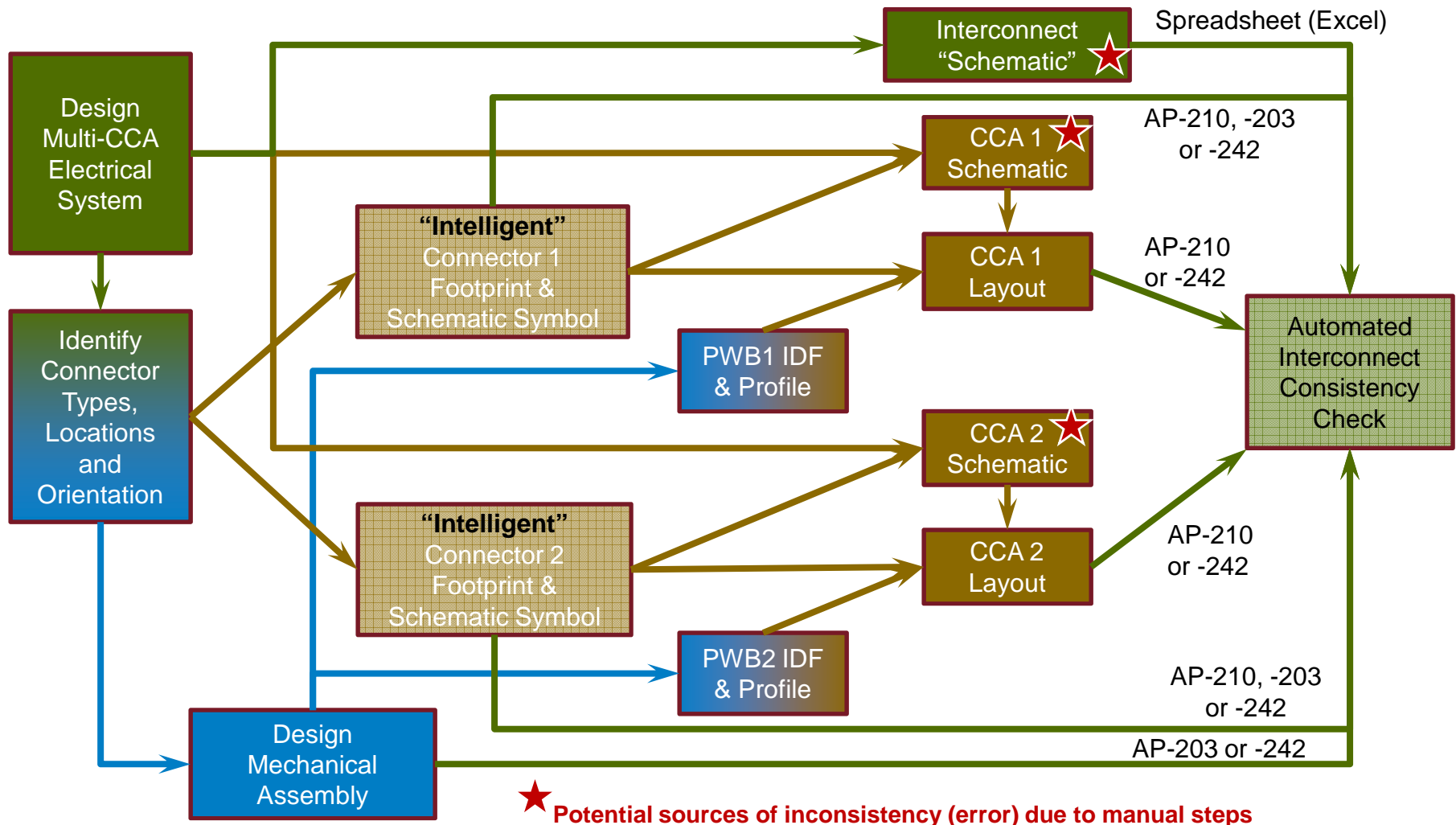
Tedious Manual and Visual Design Verification

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SAVI VIP Consistency Check

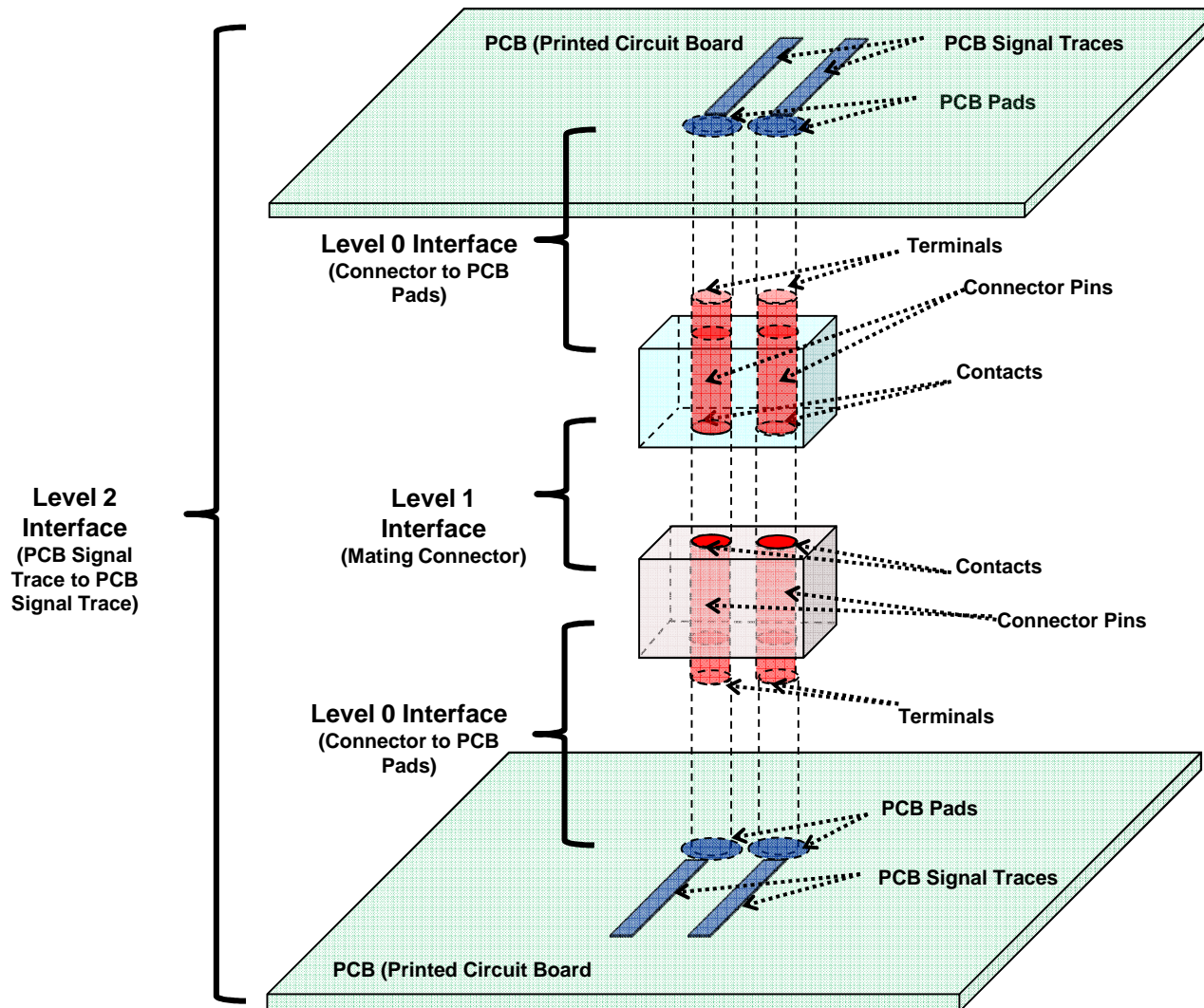
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Forming a Solution

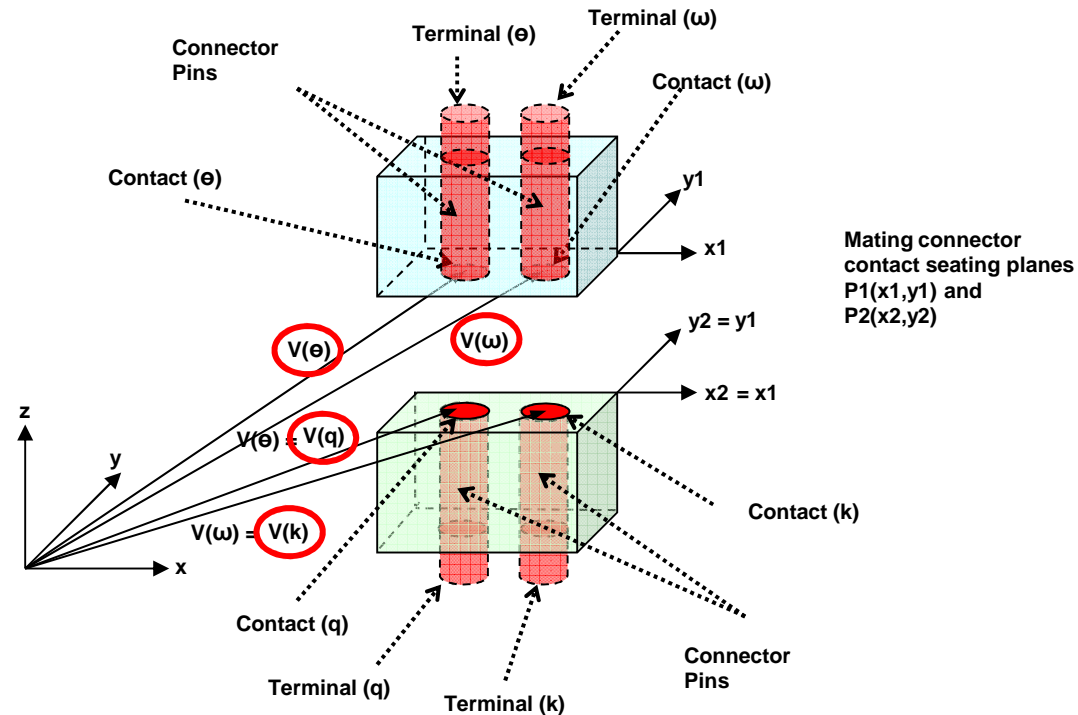
Problem Decomposition – Interfaces

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Interconnect Alignment Conditions

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Connection/alignment is made when... vectors $V(\theta) = V(q)$... and vectors $V(\omega) = V(k)$

(+/- Tolerance)

3D Geometric Inter-Model Consistency

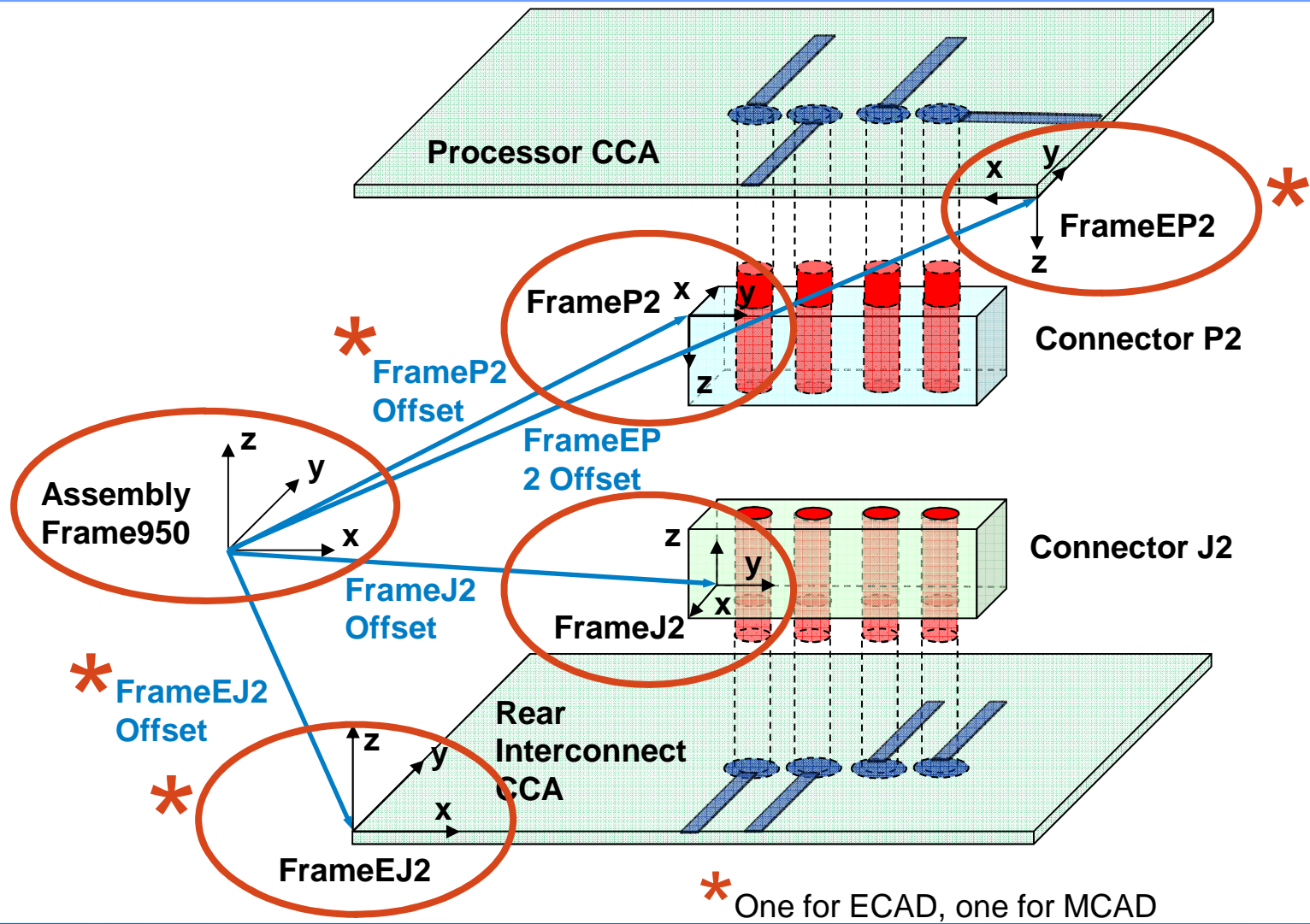
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- **Geometric properties must be in a common form**
 - Units of measure
 - Coordinate frame of reference
- **Seven different coordinate frames, 6 frame offsets**
 - Relationships are known
- **STEP provides a well-defined, consistent frame representation and method for coordinate system transformation**

Frame rotation/offset transforms must be done right

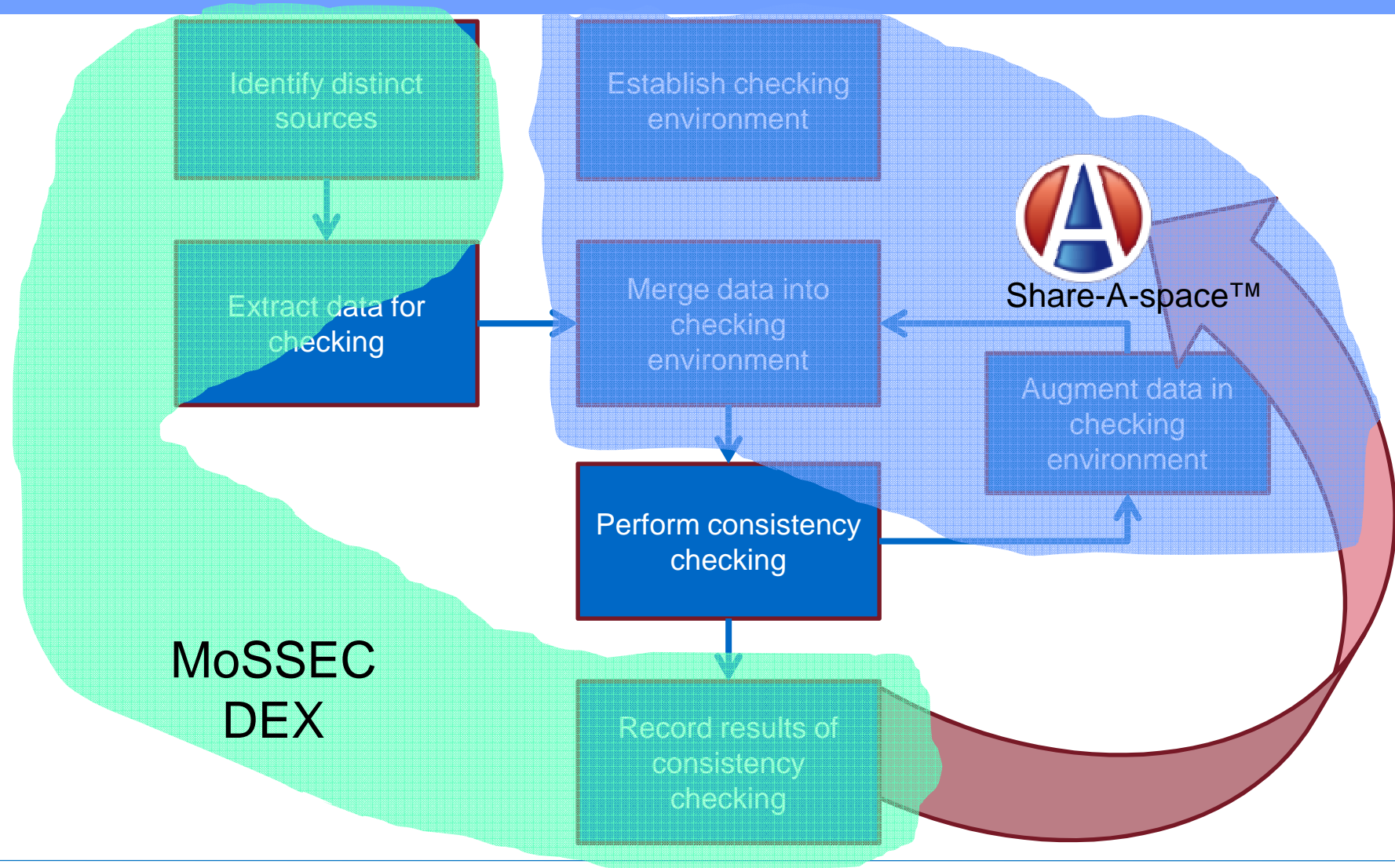
Coordinate Systems: 7 Frames and 6 Offsets

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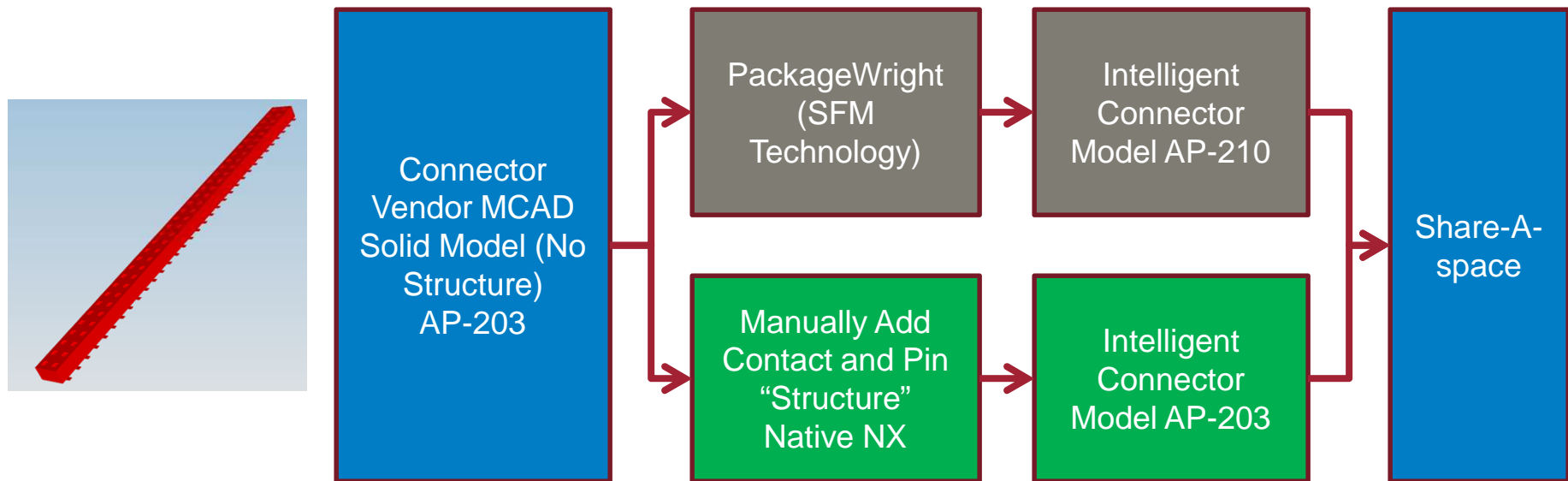
Leverage Existing Tools and Standards

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“Intelligent” Connector Model

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Use one or the other in production
SAVI exploring both approaches to learn the pros and cons

SAVI Solution Set: Tools

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- **MR/DEL: Share-A-space™, translators (Eurostep)**
- **“Intelligent” Connector: PackageWright (SFM Technology)**
- **Tool interface: web services (Share-A-space™ and client)**
- **DEX: MoSSEC plus extensions**

Use commercial tools, drive to TRL 6 and beyond

Next Steps

Summary

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- The “Pin 1 Problem” is plagued by lack of data interoperability between Systems, ECAD, and MCAD
- SAVI VIP uses a standards based data exchange approach
- Project driving toward commercially available tools

Future

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- **Demonstrate SAVI VIP consistency checking solution by December 2014**
- **Seek additional SAVI Tool Vendor Partners to develop commercial solutions**
- **Expand use cases to include wiring harnesses**

Questions?

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Contact

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