

Distributed State Machine

Configuration Management per Vehicle

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GLOBAL PRODUCT DATA INTEROPERABILITY SUMMIT 2023



Presenters Bio

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Digital Transformation
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Previous Experience

BCA, Senior Engineer, Propulsion PD

US Patent Agent

Dassault Systèmes, Architect

Situation

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1. **Technical Publishing Current State**
2. **Tech Pubs Multi-stage Engine**
3. **S1000D: Many Value Streams, One Configuration per Vehicle**
4. **Distributed State Machine (Configuration Management per Vehicle)**
5. **One INTEROPERABLE Layer, MANY PROPRIETARY VALUE STREAMS**
6. **Discussion, Next Steps and make it Super Simple**

Assumptions and Objectives

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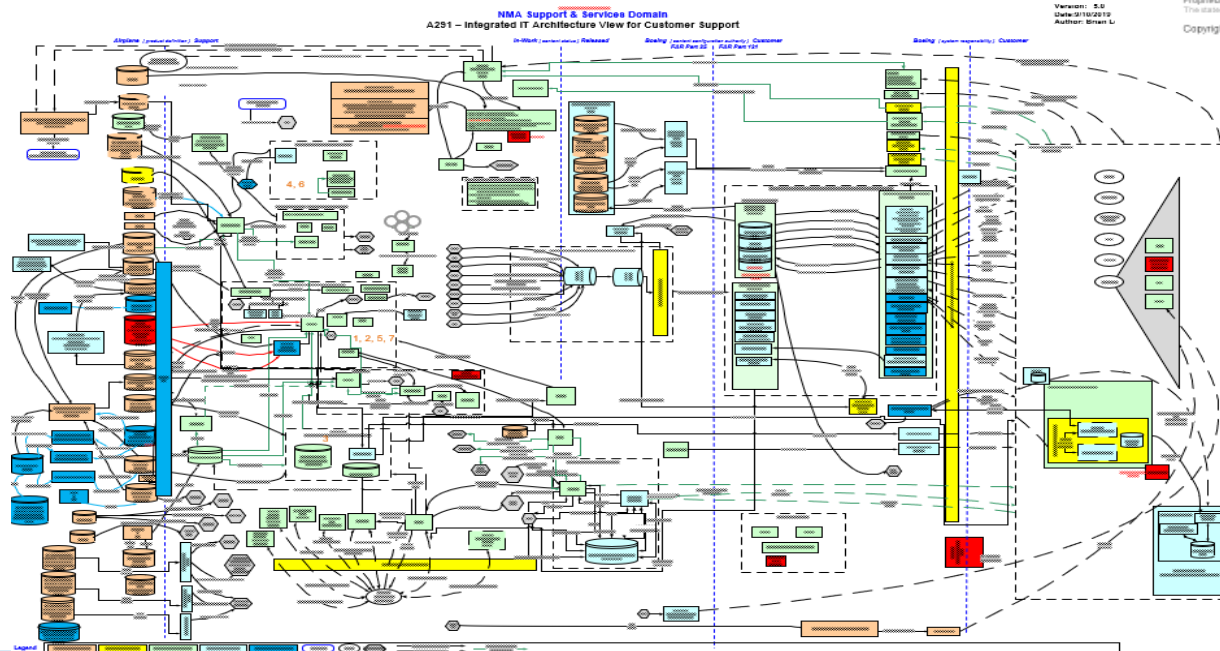
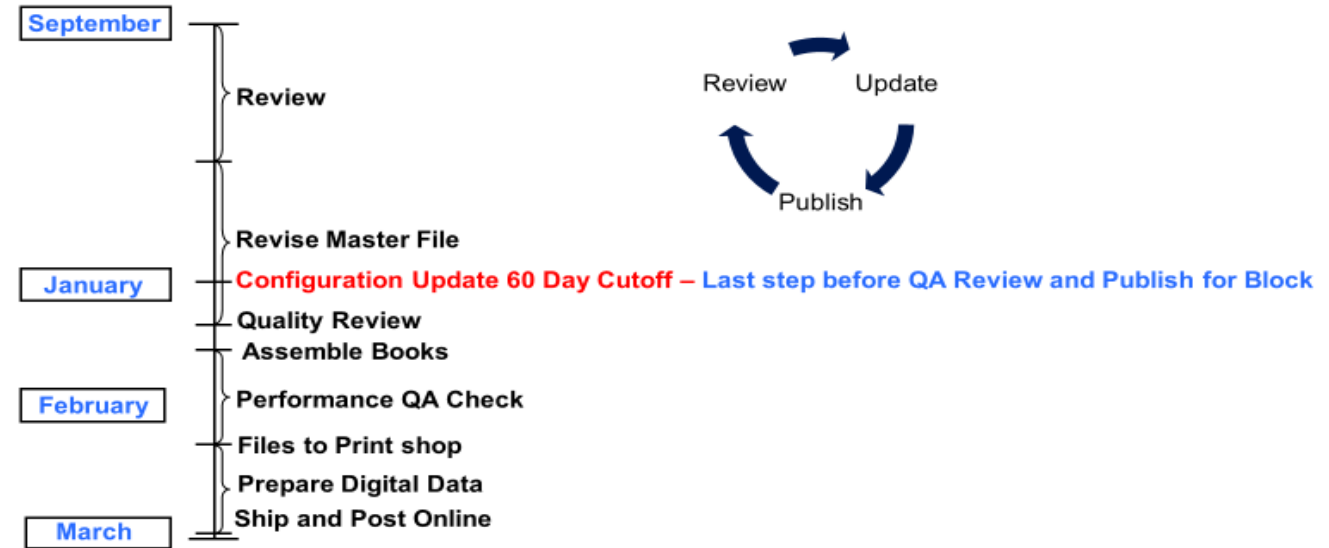
- Customer Support (CS) “Digital Thread” is Heterogeneous.
 - 3Dx will not provide a complete solution for CS Technical Products. Current capabilities, practices proven standards can be modernized to achieve digital thread.
 - CS Integrated Technology Roadmap envisions using 3D aligned, industry standards, for traceability, and change management.
 - To deliver an improved customer experience the “digital thread” must implement a full “end to end” data driven authoring, assembly and delivery experience.
- The “Digital Thread” for building Technical Products, multi-staged engine, includes.
 - **SNS** – Digital Artifact Index implemented at design engineering.
 - **STEP** – ISO 10303 industry data standard, most broadly acceptable 3D: **STEP AP242**.
 - Compliant with Long Term Archiving and Retrieving (LOTAR).
 - Customers prefer STEP over CATIA for data access.
 - **XML – Industry Publishing Standard**. S1000D and ATA Spec 2300 are “end to end” data centric XML publishing standards.

Tech Pub Current State

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- Legacy Print Document Based– 6 Month Revision Cycle
- Document centric publishing: Products are authored in Tool and Converted to XML at publication.

737NG Time to Block Revision - 6 Month Revision Cycle



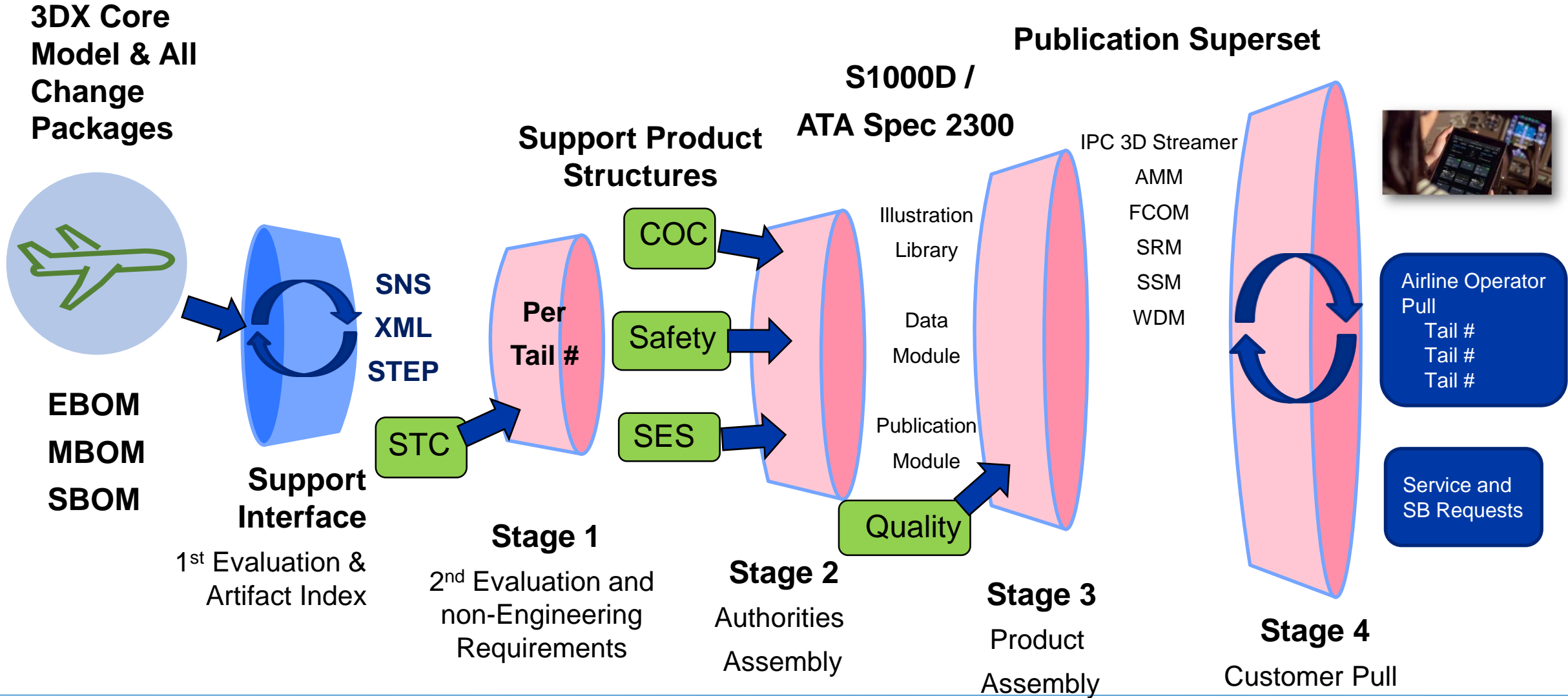
- Multiple Product Value Streams – Each team conducts it's own engineering research
- Multiple Product Specific Tools

Incremental Improvements made to a modular system is superior to building a complex system from scratch.

- **Multiple capability tools transition to a modular value stream with shared tool sets.**
- **Document centric system transitions to data-centric system.**
 - Data-centric systems share:
 1. Configuration,
 2. Illustrations, and
 3. Data modules.

CS Technical Publications – Multi-Stage Engine (Proposal)

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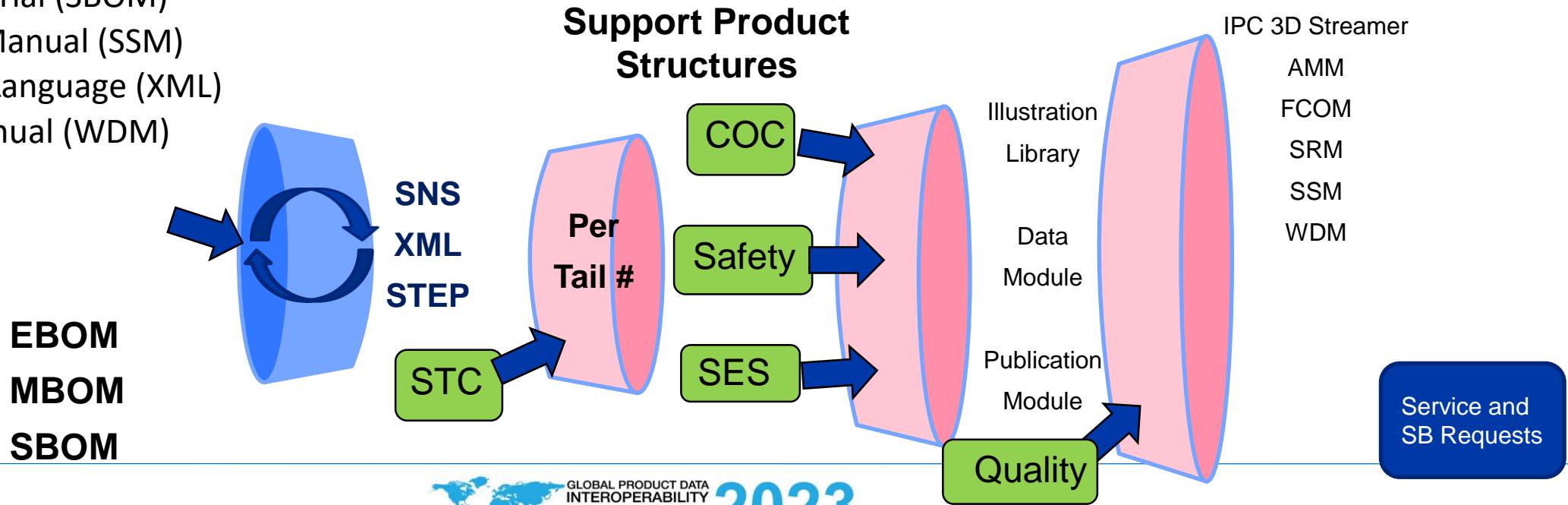


Acronym Definitions

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- Airplane Maintenance Manual (AMM)
- Engineering Bill of Materials (EBOM)
- Flight Crew Operations Manual (FCOM)
- Manufacturing Bill of Materials (MBOM)
- Service Bulletin (SB)
- S1000D Standard Numbering System (SNS)
- Standard for the Exchange of Product model data" ISO 10303 (STEP AP242)
- Support Bill of Material (SBOM)
- System Schematic Manual (SSM)
- Extensible Markup Language (XML)
- Wiring Diagram Manual (WDM)

COC-Customer Originated Change
 STC-Supplemental Type Certificate
 SES-Spares Engineering System



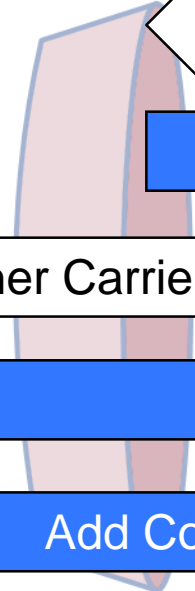
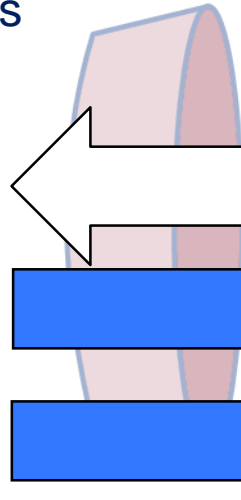
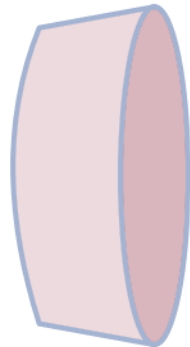
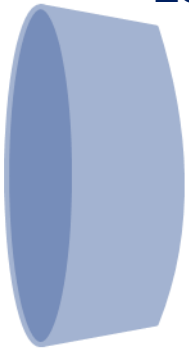
3D Philosophy: SNS is a **CONTEXTUAL** Part Instance, Part # is a Derivative, Illustration is a Derivative, DM XML is a Derivative.

SNS Part Instance

STEP AP242

Illustrations and XML

Left to right, no infinite loops



Work Instructions

Carrier SNS Query

Illustrated Parts Catalog (2D & 3D Part)

Other Carrier Contextual Branch Queries

3D Branch

Add Contextual Fastener Map

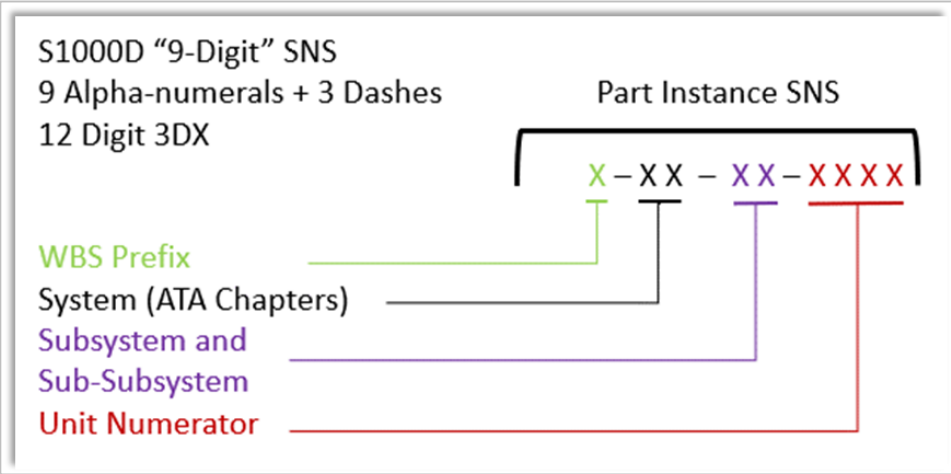
Add Contextual Airplane Outer Mold Line (OML)

STEP AP242 (i.e. "KUED" Bracket, Airplane OML for 4D Airport, SRM Maps)

Congruent Experience at that moment in time, for one vehicle, with all value streams.

S1000D: SNS, Data Modules, Publication Module and Publishing.

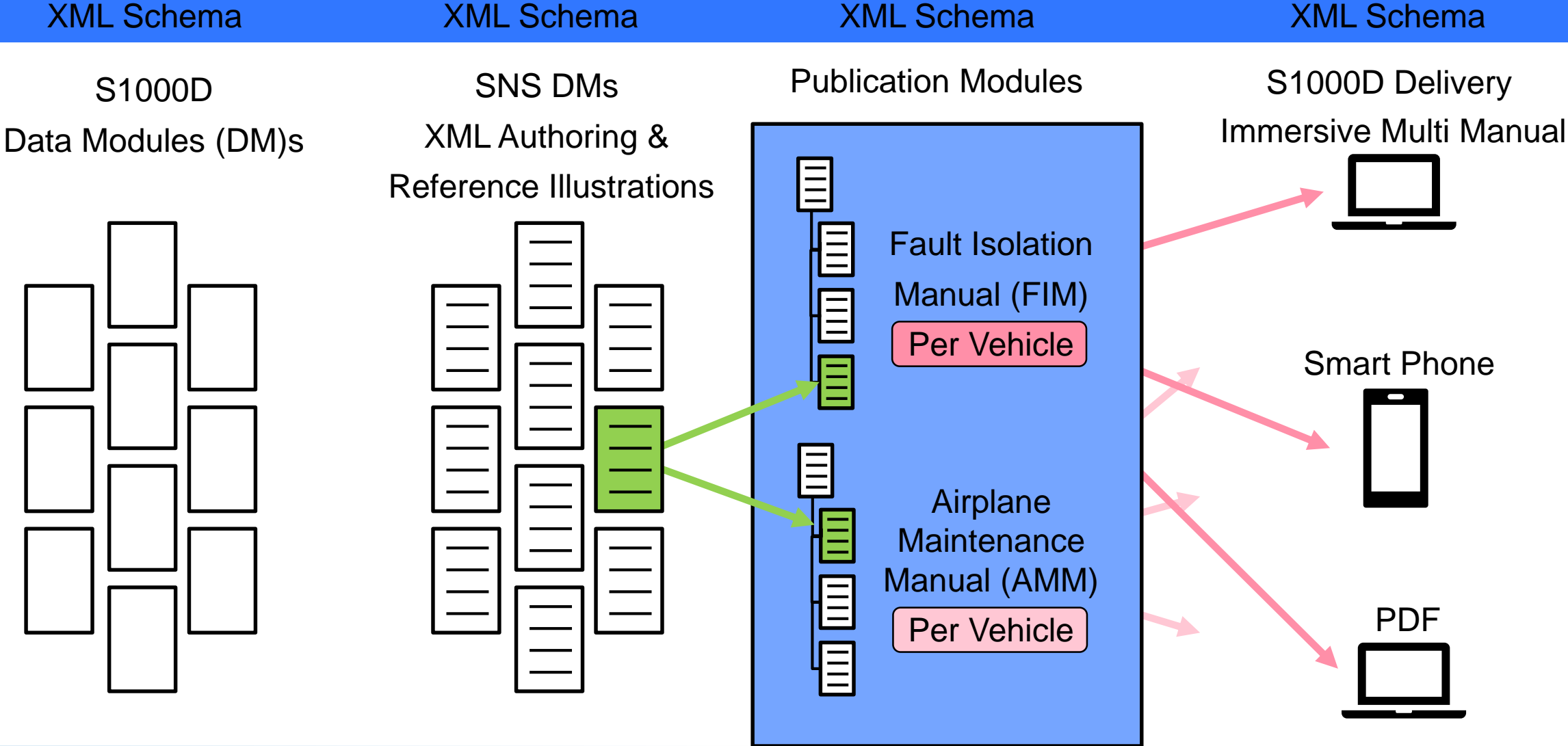
S1000D Standard Numbering System (SNS)



S1000D Data Modules are defined by SNS and XML Schemas

System	Subsystem	Title	Definition
21		Environmental control	Those units and components used for pressurizing, heating and treating the air within the pressure sensitive equipment cooling, turbine, valves, scoops such systems as cabin waveguide pressurization
	-00	General	
	-10	Compression	That portion of the system that provides compressed air. Includes indicating systems related to the cabin pressurization
	-20	Distribution	That portion of the system that provides compressed air to the cabin pressurization

S1000D: SNS, Data Modules, Publication Module and Publishing.

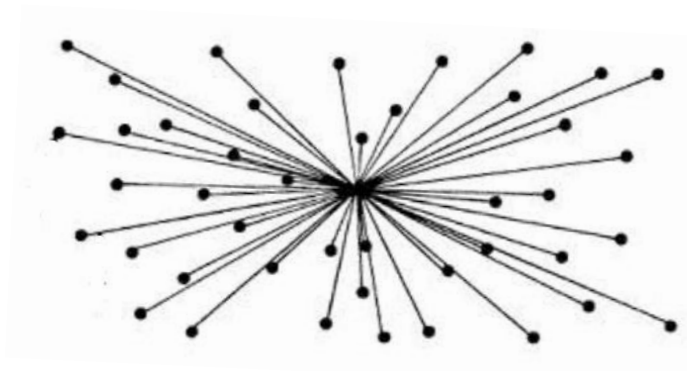


Distributed State Machine (Configuration Management per Vehicle)

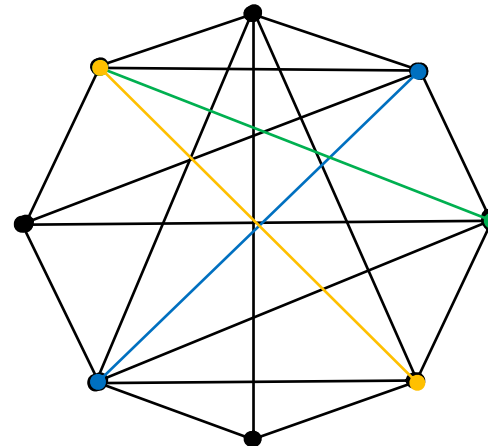
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- More Resilient.
- Synchronization maintains backups.
- Digital Signatures blur the line between a person, organizations and machines.
- Not Blockchain. Vehicle Nodes are self aware, not fleet aware.
- Synchronize Boeing Centralized Nodes and Distributed Vehicle Nodes
 - Synchronize: MRO Signature, Carrier Signature, Mechanic Signature, Pilot Signature.

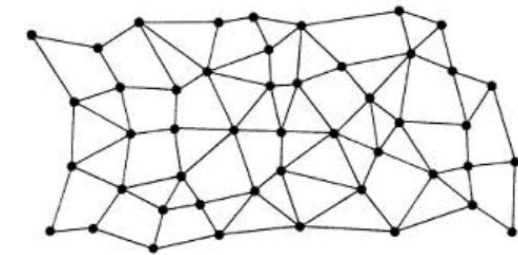
Boeing Centralized Nodes



Decentralized

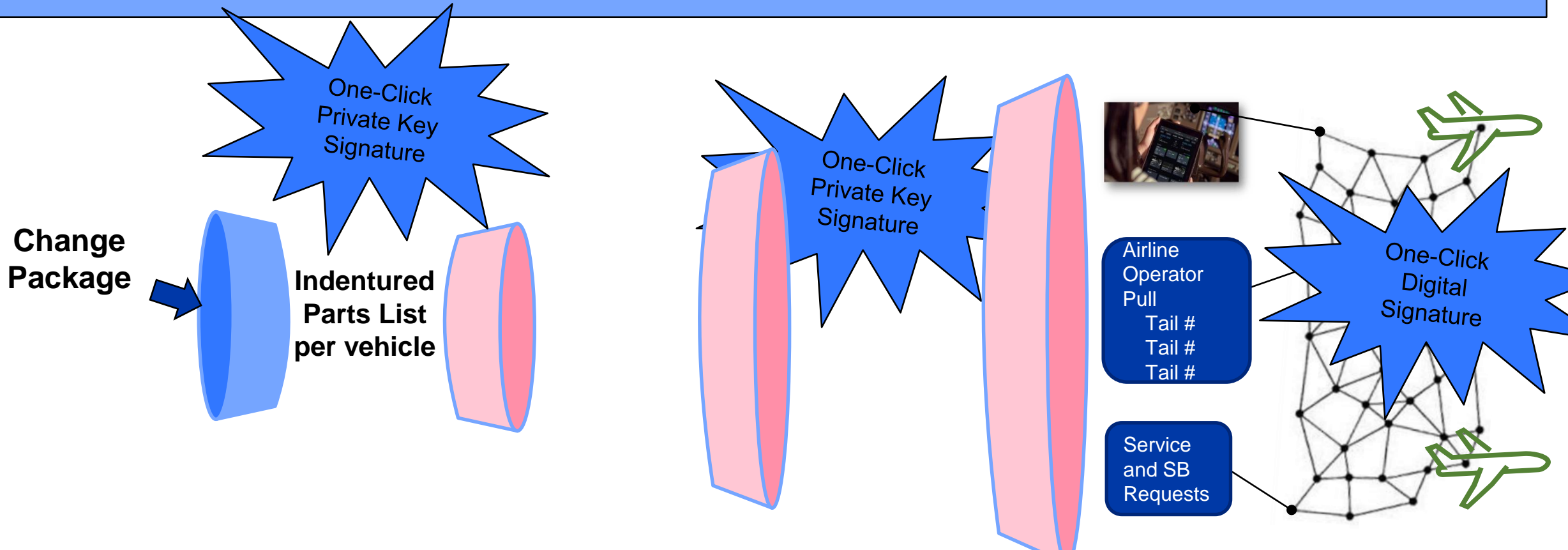
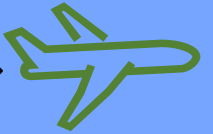


Distributed Vehicle Nodes



Distributed State Machine: Synchronizes Inservice Configuration

Digital Signatures Mature indentured-parts-list (change package) to inservice vehicle



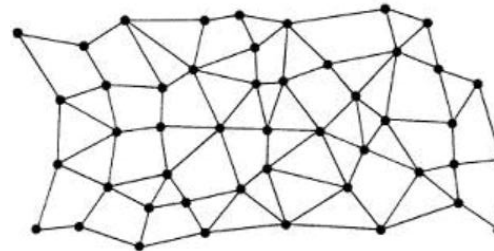
Distributed State Machine **SYNCHRONIZES** Configuration across Boeing, Vehicle Nodes and Partner Nodes.

Distributed State Machine (Configuration Management per Vehicle)

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- Secure network NOT required with asynchronous cryptography (private key and public key pair).
- Public Key is similar to a username.
- Anybody can encrypt a message with your Public Key (User Name).
- Only your Private Key can open the message.
(Passwords can be reset. Private Keys Cannot Be Reset)
- Private Key software and Private Key hardware are becoming ubiquitous.
- How do we know there are no backdoors? Open Source.

2008 Bitcoin is a Distributed State Machine

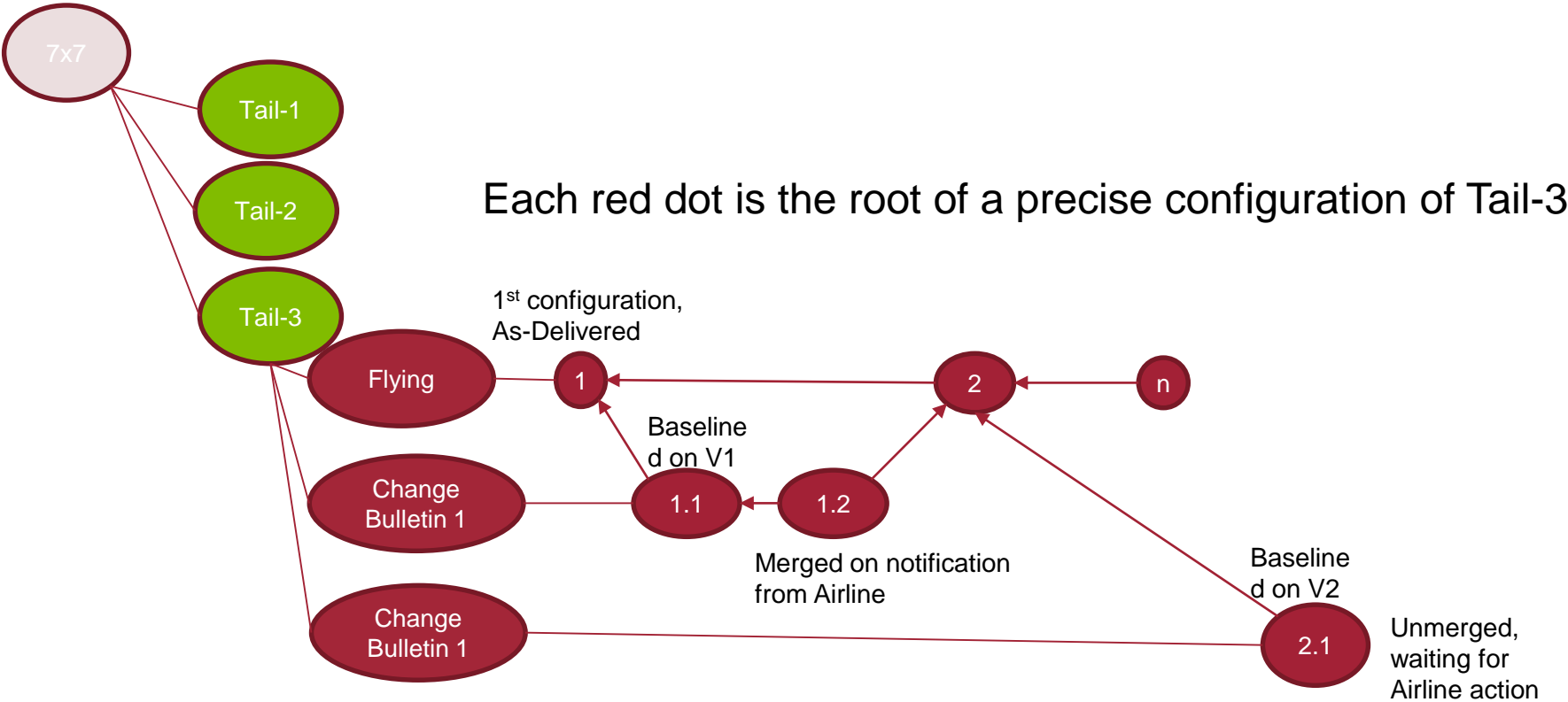


Configuration Management for 1) Boeing, 2) Machines (Airplane), and 3) Partners.

Baseline is an Indentured Parts List (IPL).

EGPS (Extended Generic Product Structure) organize IPL into “**Branches**”

Kevin Puterbaugh.



Cord Sheet Evolution (Signature Evolution)

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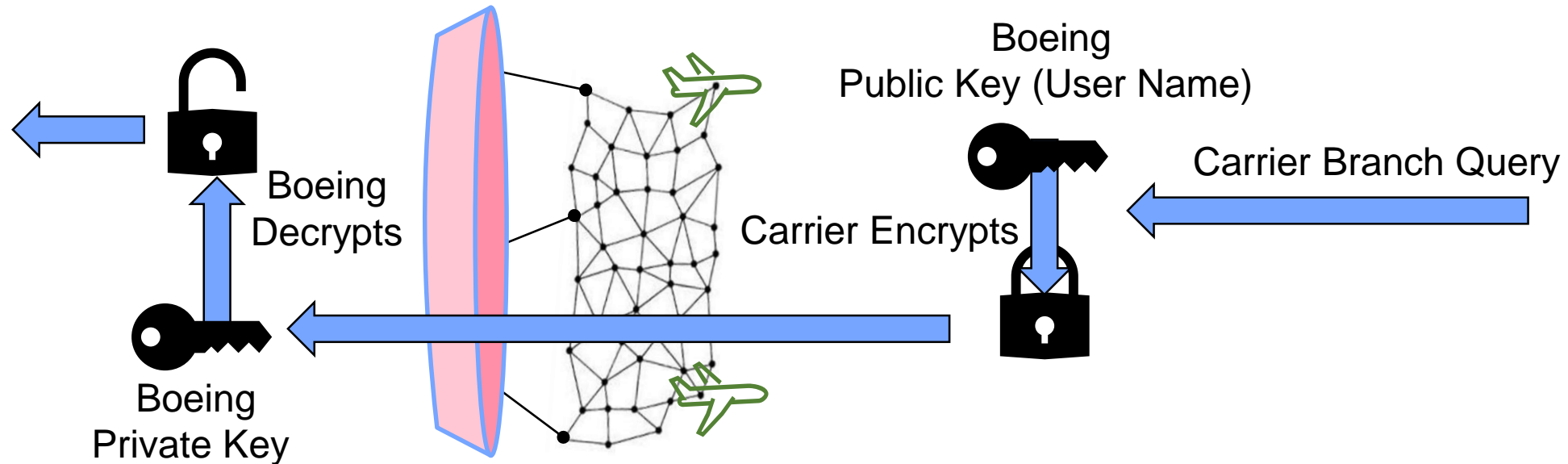
Paper: Teams on both sides on an interface sign the cord sheet with pen.

Digital Cord Sheet: Teams on both sides on an interface **sequentially** sign with a software application to a centralized database. **Requires secure network.**

Digital Cord Sheet: Teams on both sides on an interface **sequentially** sign. **Requires secure network.**

Mature Change Package, or Query, over a Distributed (Unsecure) Network. ↔

SIMPLIFIED Private Key – Public Key PAIR method:



Distributed State Machine will provide a scalable, immersive network.

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Completed elements of the Distributed State machine

- Verifiable Digital Signature for Boeing, Boeing Partners and Machines (Same Private Key Method).
- Accurate configuration per vehicle.
- Accurate “Branches” of indentured parts list PER VEHICLE.

Contextual Menus can now send secure queries (Layer of Cooperation):

1. **Boeing** IMMERSIVE Support and Services
2. To **Partner** networks
3. AOG Use-Case: leverage Large Language Models based on accurate configuration branches
4. Working together, Distributed State Machine will provide an emergent, scalable, and immersive network.

One INTEROPERABLE Layer, MANY PROPRIETARY VALUE STREAMS
(Boeing, Partners and Machines)

Distributed State Machine will provide a scalable, immersive network.

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One INTEROPERABLE Layer, MANY PROPRIETARY VALUE STREAMS
(Boeing, Partners and Machines)

Open Source Methods 1- 4

1. **Public-Private Keys**
2. **Indentured Parts List**
3. **Branches**
4. S1000D Data Module (DM) and ATA 2300 Data Module (DM for Flight Ops)
5. Proprietary Value Streams

← Congruent Experience at that moment in time, for one vehicle, with all value streams.

Discussion and Next Steps

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- Feedback/Initial Thoughts
- Which partners will lead digital signature for people, organizations and machines?
- How do we make Distributed State Machine super simple?

