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Boeing Research & Technology

Research & Technology

Network Enabled Manufacturing (NEM) & Passive Wireless Technologies

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NEM Strategy

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Assembly & Integration – Mfg Domain

- Multi-disciplined technical skills development team
- Serve the customer needs in changing environment



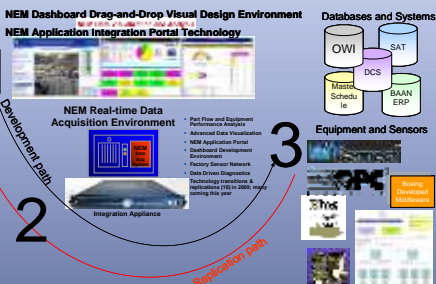
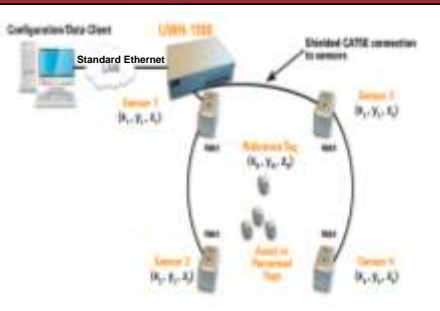
NEM Considerations

- Emphasis in Composites materials and processes
- In-house fabrication core competencies “Metallic and non-Metallic”
- Supplier management “Increases in the third party material suppliers”
- Wireless secured networks
- Multi-site manufacturing & replication opportunities
- Latest advancements in real time plug & play autonomous systems

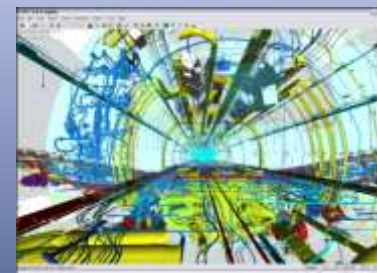
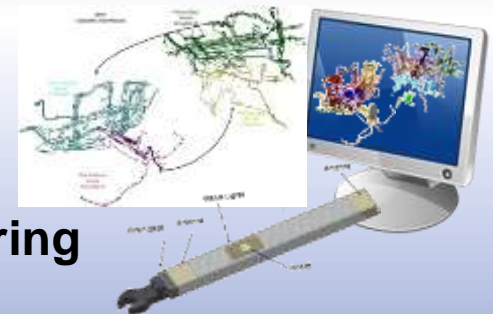
NEM Technologies

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Assembly & Integration – Mfg Domain



- **Sensors:**
 - Location, illumination, temperature, humidity, pressure, flow, vibration, proximity, etc.
- **Electronic Control Boards**
- **Portable Devices:** phones, tablets, etc.
- **Data Collection Systems**
- **Data Analysis Tools**
- **Communication Systems**
 - **Wired**
 - **Wireless**
 - **Modems and Routers**
- **Servers and CPU's**
- **Portal Technology**
- **Engineering technology in manufacturing**



Passive RFID

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pRFID (passive RFID); commonly used on high volume items

no power source

RF back-scatter

\$0.50 or less

EPCGlobal Standard Passive RFID Tag Inlay

**Gen 2 Class 1 – WMRM
(Write Many-Read Many)**



- RF backscatter activation (*No batteries*)
- Inexpensive
- Tag Inlay
 - RFID IC chip
 - RF antenna
- Minimal data storage



Due to some material types separation is required between the passive RFID tag and part.

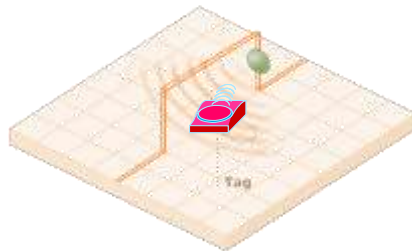


Real Time Location Services (RTLS) Scenarios

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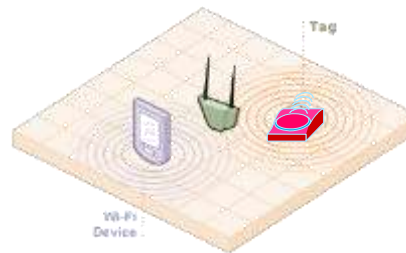
Assembly & Integration – Mfg Domain

Choke-point



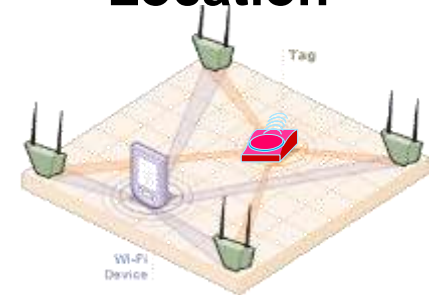
Aircraft is entering the building

Presence



Aircraft is in the building

Location



Aircraft is in the work zone

- **Used on higher valued items:**
 - battery powered
 - RF radio transmitter, \$40 or more per tag
- **Understanding How To Apply The Technology Is Key**

Typical Valuable Factory Assets for RFID Tracking

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Use Cases

- Location
- Status
- Inventory



Major Assembly and Aircraft Positions / Travel Work

Canopy / Windshield



Safety Equipment



Tool Boxes



Landing Gears/Dolly



Wing assembly



Installation Kit

Support Equipment



Test Cart



Hydraulic Cart



Electrical Kits

Material Management

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**Aircraft Parts Stored In-House
or at 3rd Party Supplier**



Kit Tray



Order Processing



**Packaging
& Shipping**

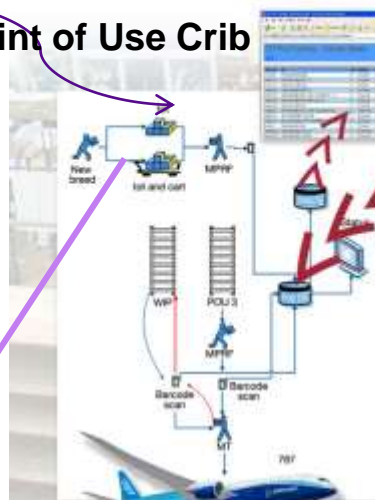


**“RFID Enabled”
Shipping Dock
Doors**



**Receiving Dock Door
“RFID Enabled”**

Point of Use Crib



**Chain of Custody
& Material
Tracking in
Factory and POU**



Top Shelf



Middle Shelf



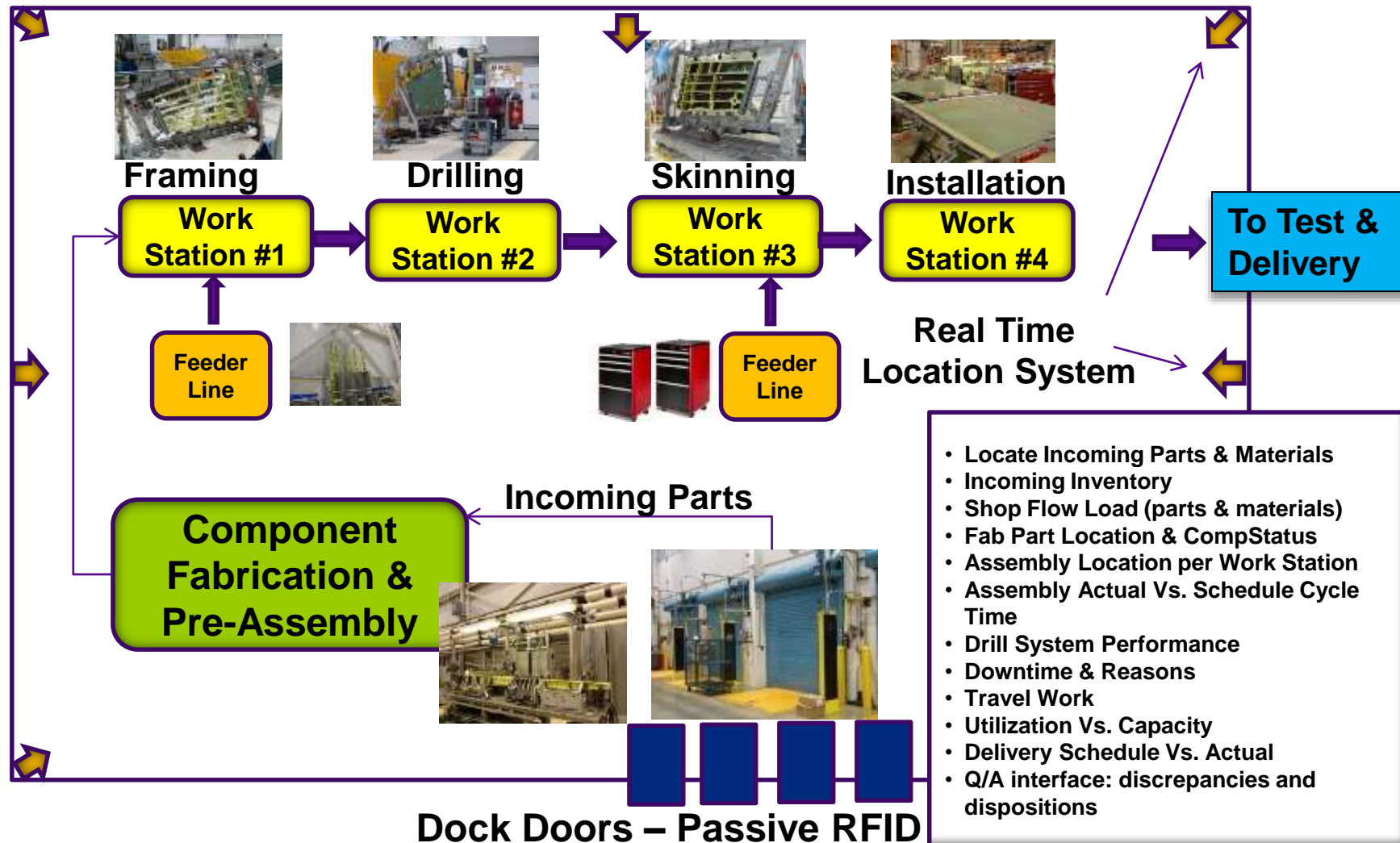
Network Enabled Manufacturing

Typical Integrated Control Process – Value Propositions

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Typical Fabrication & Assembly Line “Supplier or Depot Center”



Passive RFID Development

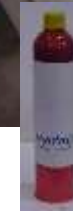
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- **Time & Temperature Sensitive Material**
 - Sealants inventory
 - Walk in freezer composite material out time / inventory
- **Paint**
 - Paint mix room
- **Receiving**
 - Incoming materials
- **Shipping**
 - UID Bar codes on selected shipments
- **Work in process – Tube shop**



Composite material



Gen 2 RFID Tag

Sealants Control



Tube Shop



Paint Shop



Receiving & Shipping



RFID Freezer Application Enhancements

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Assembly & Integration – Mfg Domain

Boeing



Freezer insert holds 4 antennas



Insert fits inside freezer invisible to employees



Reader installed under the freezer



Temp & Inventory Software

Supplier

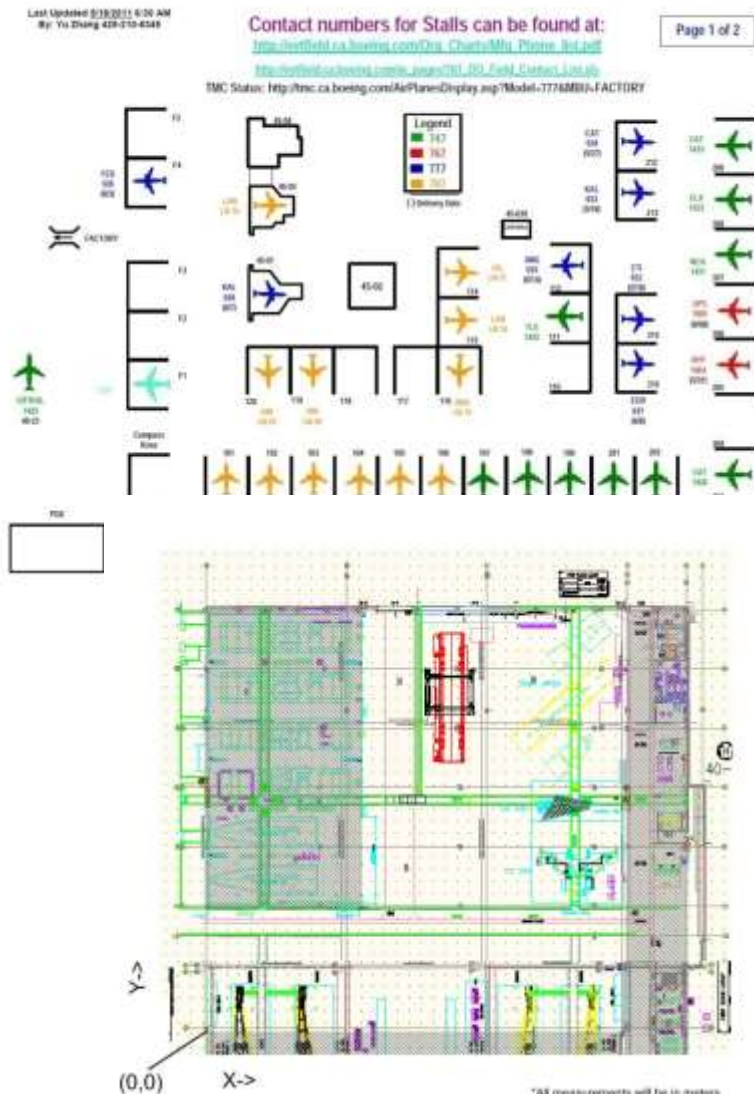


Commissioning cart holds antenna, reader, computer and tag printer.

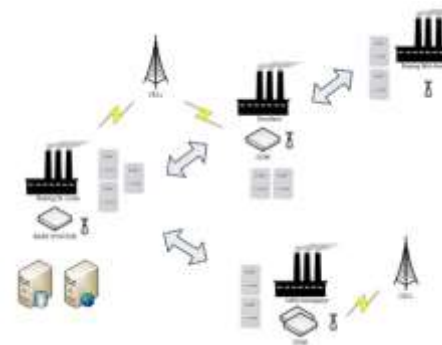
Advanced Mobile assets Tracking: Indoor & Outdoor

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Assembly & Integration – Mfg Domain



- Location system to enable high visibility asset management for multiple asset classes
- Focuses on multiple use cases
- Solutions
 - Fixed RTLS infrastructure
 - Fixed proximity readers
 - Mobile hand-held readers
 - Typically < 1.0m accuracy for indoor accuracy
- AIT Data Collection GSM Module prototype is being applied where Boeing network is not available



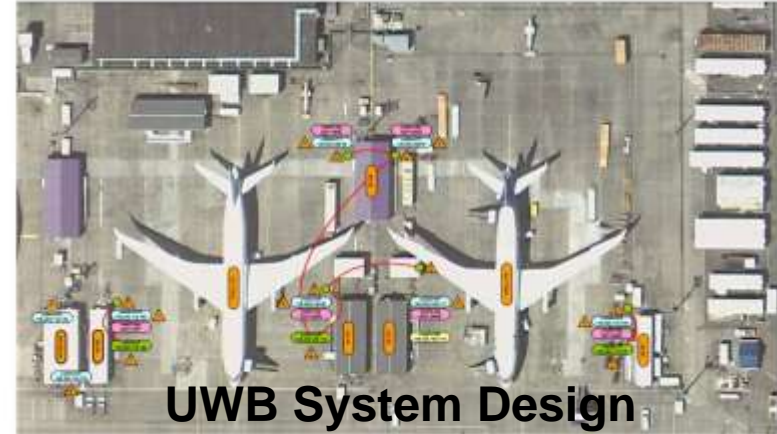
Contract Tools Monitoring – Indoor/Outdoor

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Assembly & Integration – Mfg Domain

Tool number, serial number, shelf location

- Passive RFID for tool level monitoring
- UWB indoor & outdoor system for Kits
- Deliverables include:
 - ➔ Barcode & passive RFID commissioning
 - ➔ Location detection by aircraft stall
 - ➔ integration & visibility suite
 - ➔ Alert notification
 - ➔ Use of hand-held location device



Large-scale Factory Data Integration

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Assembly & Integration – Mfg Domain



Backend
Enterprise
Systems

Visualization
Portal

Data Storage,
and Routing
Services

Analysis
Logic

Sensors and
Devices



- Connectivity Technology & Sensor Integration
- Data Acquisition & Data Integration
- Data Analysis and Application Integration
- Portal Technology

Gemcor Tool Tracking

Problem statement:

Tool life relies on visual inspection and the process is not accurate resulting in quality issues and material waste

Technology Approach:

- Biomark tags are embedded and tested for Gemcor cutters identification & tool life tracking
- Biomark tags operate at low frequency “134 kHz” and provide 100% unique identification.
- Tag available in very small sizes (4mm x 9mm)
- 6 prototype tools representing different configurations were precision drilled using EDM process
- Tags were then potted in tools and sent to the Gemcor machines for testing
- Preliminary tests show 100% read rate with hand held reader
- Business case considerations will determine the go/no-go decision. A successful case will offer RFID tags on all future Gemcor cutters to built by the tool maker.



Embedded Tags



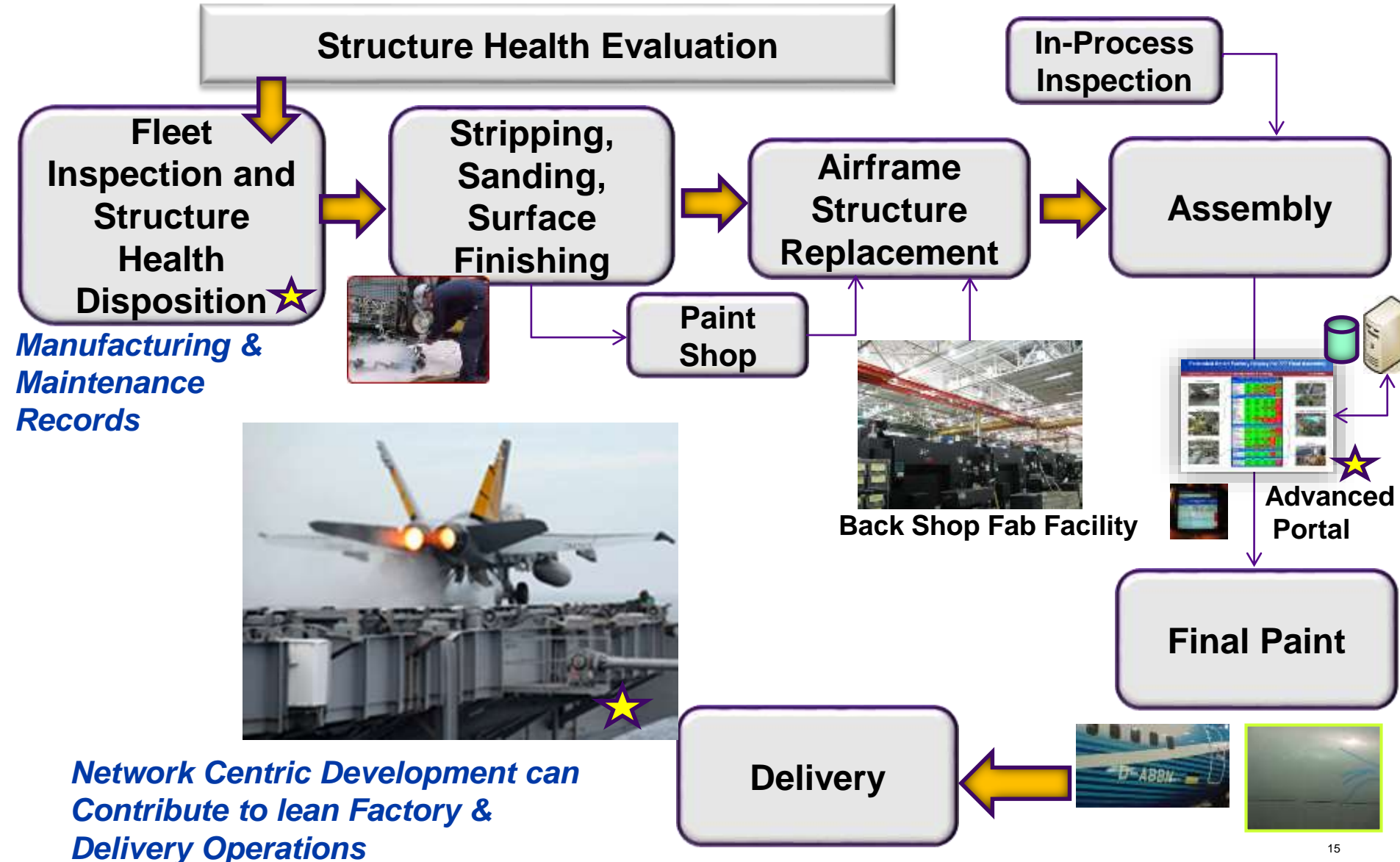
Hand Held Reader

Read Range 1 ½ ” to 2”

Repair & Overhaul Shop

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Life-Cycle Manufacturing & Repair Data Storage / Retrieval

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Everett, Wash. factory building

Container
Tracking
Commercial
Device



High Volume Low Cost
Tracking: Location & duration



Data
Back-up

Usable Data Storage

High Value Assets:

- Location,
- In Transit: Temp, Humidity, Vibration, Gyro
- Mfg records



Data Log

OEM
Shipments

Life Cycle Data Management

Fabrication & Assembly

Records
from
Factory
Operations



Flight & Maintenance Records



Field Operation

Data
Back-up



Repair &
Overhaul

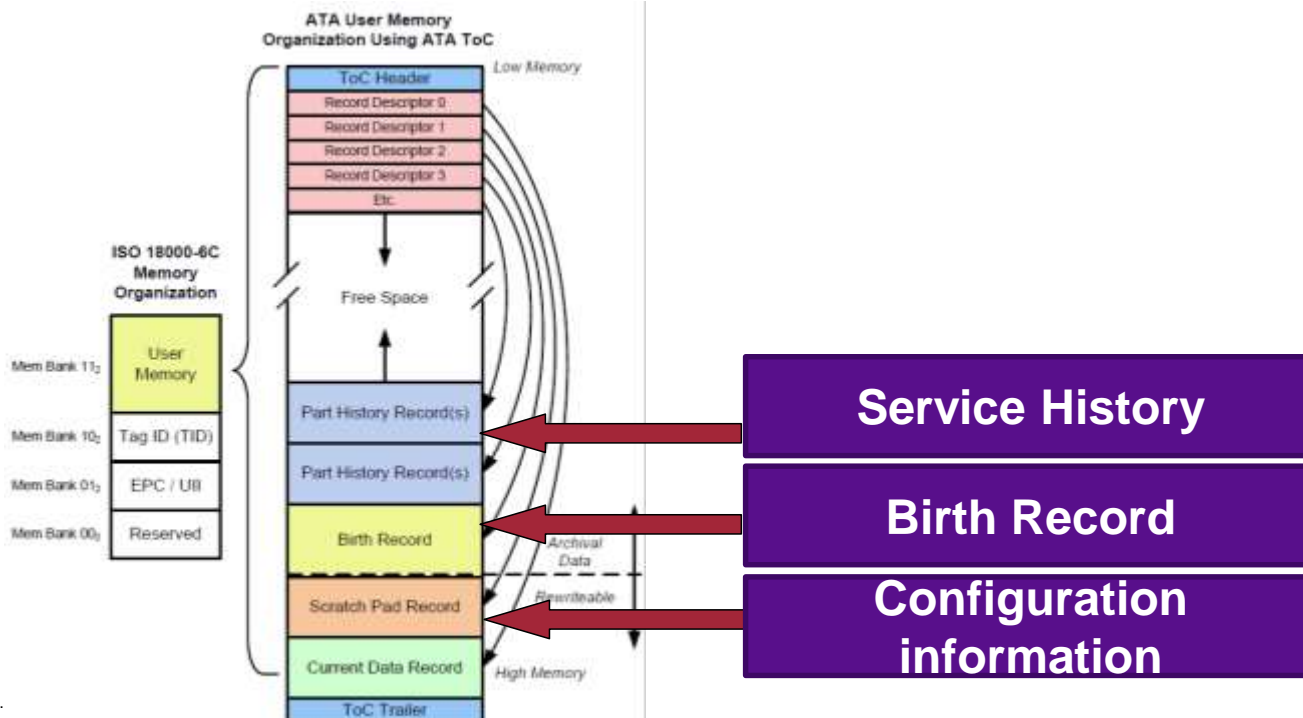


Data Retrieval:
Field Update +
Repair Procedure



Use of High Memory Passive RFID Tags

- **Maintenance, Repair and Overhaul (MRO) organizations need to record origination information for parts as well as maintenance history information, and storing this information directly on the parts instead of in a difficult to access database has many advantages. The aviation industry has taken a leadership position in this area and with the publication of Spec 2000 the Air Transport Authority has created a database structure suitable for use on passive RFID high-memory tags.**
- **Spec 2000 Chapter 9.5, RFID on a series of records. Parts, includes a memory structure that includes a Table of Contents and maintenance data.**



Manufacturing & Flight Data Collection/Analysis

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