Environmental Monitoring of Shelf Life Material Using Automatic Identification Technology (AIT)

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Briefing Outline

• AIT Description
• DoD AIT Program Status
• What can AIT enable?
• What are the potential benefits?
• AIT for Shelf Life Management
• Advanced Technology Ordnance Surveillance (ATOS)
• Knowledge Management Recommendation
• Implications for DoD Shelf Life Management
AIT Definition

- AIT is not a system or a single product, but a family of commercial technologies that provide a spectrum of enabling capabilities for DoD to provide source data automation to information systems and transform supply chain management processes and other functional areas.

- AIT devices can automatically identify, locate/track, and monitor supplies and equipment.
“AIT is a suite of technologies that enable the automatic capture of source data, thereby enhancing the ability to identify, track, document and control deploying and redeploying forces, equipment, personnel and sustainment cargo.”

*Logistics AIT CONOPS – November 1997*

AIT devices can automatically identify, locate/track, and monitor supplies and equipment.
What Are The AIT Technologies?

- RFID
- MEMS
- GPS
- RFDC
- OCR & Machine Vision
- EDI
- STS
- Contact Memory
- OMC
- Card Tech.
- Biometrics
- Satellite Monitoring Communications
- Shelf Life
Identification Options for System-wide Visibility

Multi-level Identification

- Bar Code 2D Labels
- Optical Cards or Tags
- RFID Tags
- GPS Capability

Redundancy in Identifying Assets

Shelf Life
Characteristics of RFID

**Characteristics**

- A form of electronic labeling that can be updated (read/write)
- Can be interrogated at a distance and hands free in a fast and reliable manner- Permits “On-the-Fly” reads
- Depending on the frequency, does not require physical sight or contact between reader/scanner and the tagged item.
- Can contain large quantities of unique digital info
- Greater placement flexibility on or in an item
- Virtually low maintenance on the product
- Extremely low error rate
- Can be interfaced with micro sensors to collect previously non-existent environmental data
**AIT Objectives**

- Infuse AIT into the DoD Logistics AIT Business Processes
- Facilitate Source Data Collection
- Improve Data Accuracy
- Reduce Logistics Processing Times
- Enhance Asset Visibility
- Improve Support to the Warfighter
Players & Roles

**Principal**

- S
  - DUSD (L&MR)
  - JS-J4
  - Director, DLA
  - DCINC, TRANSCOM
  - Army
  - Navy
  - Air Force
  - Marines
  - DUSD (AS&C)
  - DISA
  - DARPA

**Players & Roles**

- Logistics IPT
- DoD Logistics AIT Standards Group
- CAC IPT
- AIT Framework Team

**Mission**

- DUSD(L&MR) & JS-J4 designated DLA as Executive Agent (EA) to:
  - Promote, manage, coordinate, and document the application of DoD and Joint Logistics AIT doctrine, technologies, and processes in support of the Warfighter

**Scope**

- Operate as a joint organization administratively supported by DUSD(L&MR) and DUSD (AS&C) and provided to EA by JS-J4 and AIT Principals

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GOAL IS TO IMPLEMENT AIT THROUGHOUT DoD

Institutionalize AIT in DoD Enterprise

- Implement Commercial Data Standards
- Log CAC Implementation: MAY 03
- Implement DoD AIT Policy
- OCT-NOV 01 Bright Star Exercise
- OCT 00 CAC Tasking
- JUN 98-FEB 99 EUCOM Operational Prototype
- SEP 97 DoD Log AIT Office

Future Logistics Enterprise

PLAN EXECUTION
65 ACTIONS
DoD AIT Office OPR - 10
DoD AIT Office OSR - 55
CENTCOM Operation Enduring Freedom

AIT Lessons Learned

• Institutionalize how we go to war
  - Train as we fight—smooth transition to war
  - Difficult to merge into coalition operations

• Detailed ITV picture
  - Takes multiple systems to obtain complete ITV picture
  - Queries are difficult to build for complete ITV picture
  - Understanding of ITV is inconsistent throughout DoD

• Fund AIT technology
  - Accelerate AIT/AIS fielding
  - Provide AIT/AIS contingency funding
AIT Program: Next Steps

• Revise DoD Logistics Implementation Plan for AIT to encompass entire supply chain

• Achieve Supply Chain interoperability by engaging International/American standards groups

• Proliferate AIT requirements in DoD policy

• Implement DoD AIT policy...Enforce the policy

• Continue to work special AIT actions
DoD Logistics AIT Implementation Plan Revision

DoD Concentration to Date

- Manufacture/ Acquisition
- Inbound Transportation
- Supply
- Outbound Transportation
- Maintenance
- Disposition

Maintenance activities represent 50% of DoD Log costs and 68% of Log workforce.

AIT supports end-to-end distribution
## Supply Chain Interoperability

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### International

| I | ISO 15416 - Print Quality and Conformance |
| II | ISO 15418 - Data Application Identifier Standard |
| III | ISO 15434 - Syntax for High Capacity Media |
| IV | ISO 15394 - Packing: Bar Code and 2D Symbols for Transport Shipping & Receiving Labels |
| V | ISO 15420 - Bar Code Symbology Specification - EAN/UPC |

### ANSI

| A | EIA 706: Electronics Industries Association Component Marking Standard |

### ANSI (cont’d)

| B | MH10.8.1M |
| C | EIA 624: Electronics Industries Association Product Package Bar Code Label Standard |
| D | UCC1: General Specification |
| E | UCC6: Application Standard for Shipping Container Codes |
| F | EIA 556-B |

### Industry

| * | EIA 802: Electronic Industry Alliance Product Marking Std |
| # | AIAG B4: Parts Identification and Tracking |
Implement DoD AIT Policy

• Reengineer logistics business processes for current AIS in order to fully integrate AIT

• Fully integrate AIT into new logistics AIS

• Emphasize AIT tactics, techniques, procedures in schoolhouses

Requires AIS owners’ attention
Maintenance Data Element Standardization

- Aviation maintenance/configuration management standard data elements
- Ammunition marking with 2D (item, pallet, container)
- Future standard data element focus
  - Watercraft (Navy & Army)
  - Tank Automotive
  - Other commodities

Supports condition based maintenance and total lifecycle management
MIT Auto ID Center

ELECTRONIC PRODUCT CODE

- EPC code can be used from food to drugs to assemblies and components.
- Naming scheme also accommodates depth throughout the Supply Chain, including vehicles, pallets, containers, packages and items.

Electronic Product Code

01.0000A89.00016F.000169

DC0

Header 0-7 bits
EPC Manager 8-35 bits
256M manufacturers
Object Class 36-59 bits
SKU or NSN
Serial Number 60-95 bits
Unique Object ID number

Shelf Life
What can AIT enable?

- How much time and effort is expended in:
  - Manually entering data into computerized or manual information systems, and other record keeping?
  - Counting material that you have?
  - Looking for material that is not where it should be?
  - Reconciling inventory records with inventory counts?
  - Inspecting and testing material to be sure of its condition?
  - Checking and rechecking documents, forms, labels, and equipment nameplates to ensure receipts and issues are correct?
  - Requisitioning and handling unnecessary material (Needed material that was on site but not recorded, or on its way in the pipeline but not visible)?
  - Demilitarization and Disposal

- AIT can radically reduce the requisite time and effort to accomplish these tasks and more
AIT Potential Self Life

Benefits

• Support Material Management requirements for shelf-life and equipment prognostics/diagnostics through automated, remote monitoring
• Create a safer and more secure environment
• Save considerable work and costs by:
  - Streamlining
  - Consolidating and
  - Eliminating non-value-added processes
• Has applications beyond supply chain functions:
  - Access control, security monitoring, foreign substance detection, substance deteriorization deteriorate
Current DoD Shelf Life Program

• Inventory approximately $3.1 B
• Includes approx 60,000 chemical protective clothing and equipment, food, packaged POL, batteries, tires, paints, hoses, o-rings, sealants, adhesives, pharmaceuticals
• Type I and II Categories IAW DoD

Since other supply classes have shelf life issues, how can we maximize knowledge sharing?
Implementation Challenges

- How long and how much effort does it really take now? (Cost Metrics?)
- Standards: Pick anyone you wish
- Technology: “Let’s wait for the next big thing”
- Functional Roles: How do you “save” a half of a work year, or half of a sailor?
- Functional Relationships: Don’t need as many support people, if you have less people and equipment to support
- Organizational Friction: Creating consensus
- Divergence vs. Convergence in IT Systems
ATOS ACTD Overview

• An ACTD takes mature technology and puts it in the hands of the warfighter to assess Military Utility

Technical Manager
Transition Manager
USAREUR
USAFE
CINCUSNAVEUR

Operational Manager
Demonstration Manager
Independent Demonstration Site

ATOS Demonstrations for Military Utility Assessment to be conducted at Crane Army Ammunition Center, Miseau Army Depot, and on two CINCLANTFLT Ships, June-August 2003

Shelf Life
Field a system and develop associated standards to...

“Give ordnance managers the ability to accurately locate and continuously determine the status of individual munitions on a near real-time basis while simultaneously updating predictions of their future condition and performance with a high level of confidence.”

Shelf Life
Safety & Reliability

Background

• **Limitations in Ordnance Surveillance**

  - Sampling based on age, vice age & weapon life-cycle environmental exposure

  - Requires destructive testing

  - 9 F to 120 F

  - 20 F to 130 F

  - 60 F to <180 F

Magazine Storage  Transportation  Field Storage

Shelf Life
Manual Data Entry
Humans in the Loop

Average 1 error in approximately **80-100** key strokes

- **70%** of data hand keyed into computers came from another computer

| 123F4FS4D4F44G4SD4SDFG4S4DG4G4GG77G44G774 |
| 65DD4DHJ5D5S5E5THG1H4G56R6D2DFG4G5G5F6D6 |
| 5G5G5G5T8T8YY5F5FFF21FFFF5F52225555G22G5G5F4F |
| G2G55FF2R2R5F85FF22F5G5T5TTTT52T3467589545134 |
| 5545354562452458456845145D5G5JH5J5DFGDFG5DFGS |
| 52456555245526623823848235262225456824852/2456522 |
| 5634546345645344413425616134526437838RTYTERTYY |
| FYYYY3567LDFDF4467456735923-02L23452342345332 |

Shelf Life
✓ **Radio Frequency Identification (RFID)**
  - Low Power, Active ASIC Radio Transmitter ( <40 μW)
  - Range (~ 300 ft.)
  - Low Cost
  - High Detection (> 99%)
  - High Battery Life (> 5 years)
  - Non-Volatile Read/Write Memory

✓ **Sensors**
  - Temperature, Humidity, Shock,
  - Vibration, Acoustic, Chemical
  - Sensor array tailored for each weapon system if required
ATOS Concept

Near Real-time surveillance and Inventory Updates Through the Long-range Comm Link

Additional RF Extenders

Ammunition Containers

Reader Control Unit with Integrated RF Extender (Fixed Configuration)

Reader Control Unit with Integrated RF Extender (Portable Configuration)

Tag

Pre-process

Service’s Munitions AIS

Environmental Data Base

Ammunition Magazine

Handheld Reader Allows for Mobile Reads

Additional RF Extenders

Handheld Reader

Shelf Life
Tag Data Elements

Tag Data
• Tag Serial No.
• Battery Mfg. Date
• Package ID

Sensor Data
• Temperature Historical Data
• Humidity Historical Data

Threshold Flags
• Temperature Min. and Max. Flags
• Humidity Min. and Max Flags
• G-Level Shock Flag

Asset Data Elements

DOD Identification Code (DODIC)
• National Stock Number (NSN)
• Quantity per Tag
• Item Serial Number(s)
• Lot Number(s)
• Condition Code (CC)
• DOD Activity Address Code (DODAAC)
• Unit Identification Code (UIC)
• Storage Routing Identifier Code (RIC)
• Document Number
• Consignee & Consignor
• Ownership Code
• Purpose Code / Activity Class Code
• Storage Point Code
• Cognizance Code
• Account Code
• Acceptance Code
• Date of Last Test (DOLT)
• Maintenance Due Date (MDD)
• Type Next/Last Inspection & Due Date
• Defect Code
• Restriction Code
• Free Text Fields A, B, C, & D
• Location (Bldg. & Grid)
• High & Low Temperature Limit
• High & Low Humidity Limit
• Temperature Min. and Max. Flags
• Humidity Min. and Max Flags
• G-Level Shock Flag
Surveillance Data
(Multiple Lots)

Lot to Lot Variability

Less Scatter within families with similar environmental histories... More precise and accurate predictions.
Operational Environment

Temperature Profile (-20 F to 155 F)
Over 1500 years of data (1 hr sampling rate)
180 bytes Memory Required (60 - 3°F Bins)

Temperature Bin
3 bytes Memory per Bin
Size optimized for sensor accuracy
Recommended Size = 3 °F

Number of Data Points within Bin
Starts at 0, increments by 1 per exposure
16,777,216 maximum counts per bin

Operational Environment
ATOS Products/Deliverables

• Fully tested, MEMS-capable RFID system with temperature and humidity sensing
  - Explosives Safety and Security policy compliant
  - Adapted to authorized international frequencies
  - Installed & fully operational on two ships and in two land-based magazines

• Generated data that uses emerging DoD standard data identifiers

• Software interfaces
  - Compatible with Service Automated Information Systems (AIS) and Quality Evaluation/ Assurance (QE/QA) databases
ATOS Benefits

• Fully automated item MILSTRAP (receipt/issue/transfer) transactions
• Standard MILSTRIP & MILSTRAP transaction feeds for any DoD inventory AIS
• Periodic and on-demand inventory status (by location and condition)
• Serialization of pallets/containers
• Life-cycle environmental history at the pallet/container level
ATOS Benefits

• Provide source data for existing Predictive and Statistical Models (ie. Cumulative Damage Model)

• Allow for “Smarter” Surveillance, by identifying test samples Based on exposure to adverse conditions and/or Known Aging Trends

• “Flag” the Occurrence of Environmental conditions or events, like over-temps and drops, that may result in damage or failure

• Reduce the overall time and costs associated with Engineering Investigations, by providing insight into the mode and mechanism of the failure.

• Provide insight as to whether the problem is an isolated occurrence or applicable to the entire population.
ATOS Summary

• ATOS provides both improved asset visibility and improved stockpile safety, security and reliability

• ATOS automates the receipt and inventory process

• The ROI calculated for the Navy shows:
  • Saves 373 Sailor work-years annually
  • Cost savings/avoidance of $41.4M annually

• ATOS is easily modifiable for other commodities

• Successful transition requires all services to participate in planning and budgeting

• More can be achieved by collaborating on improving sensors, developing algorithms and models

• Goal is to continue to improve system and
Implications for Shelf Life Management

• Environmental experience is a more important factor for determining material shelf life than age alone.
• AIT is evolving rapidly and new devices have demonstrated the capability to reliably and cost effectively monitor key environmental factors with a high level of precision.
• Now never-before-available data can be generated and then correlated with stock surveillance test results, which can then be used to greatly improved aging models and subsequently enable more precise shelf life predictions.
http://www.ih.navy.mil/atos

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