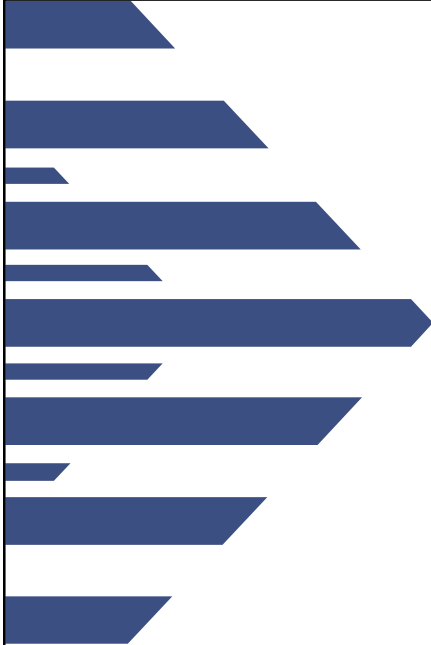




## A Product Line Architecture for Army Aviation Diagnostics and Maintenance: Views and Evolution

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May 2007

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### Advanced Multiplex Test System

#### Product Line Concepts

- Definition
- Application to AMTS

#### Architecture Views

- System Context
- Software

#### Evolution

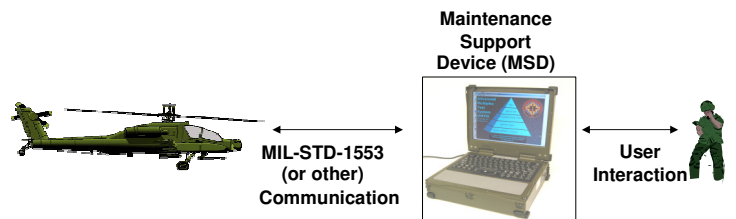
- Product line growth
- Tele-maintenance
- Condition-Based Maintenance

| Report Documentation Page                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                    |                                     |                                                           | Form Approved<br>OMB No. 0704-0188                  |                                 |
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## AMTS Product Description

A line of off-board (non-embedded) diagnostic products to:

- support Army and Joint Aviation weapon platform maintenance
- assist maintainers
- support all maintenance levels (flight-line, intermediate, and depot)
- diagnose and repair avionics data bus networks faults

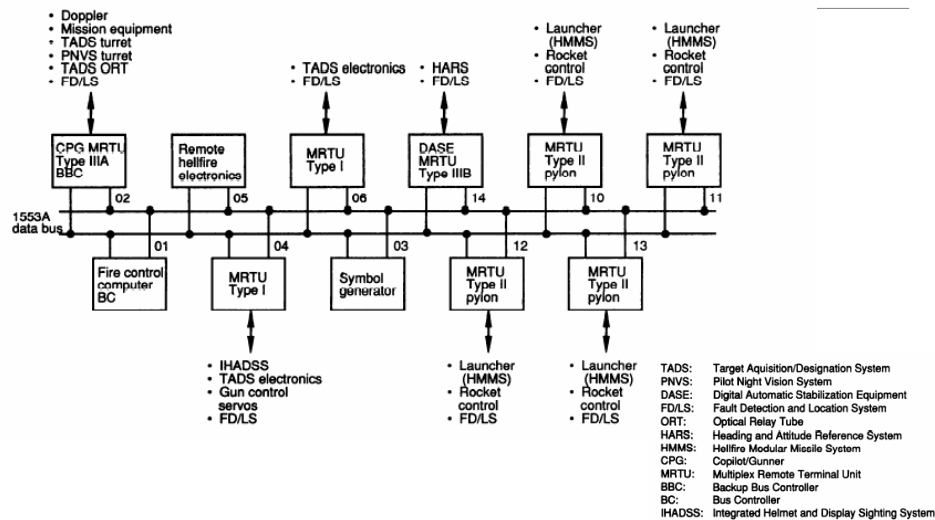


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## 1553B System for AH-64A



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## AMTS Business Goals

Improve productivity of maintenance activities and eliminate false diagnoses

- ✓ Increases aircraft readiness
- ✓ Reduces aircraft operation and sustainment (O&S) costs

Meet anticipated product demand with current resources

Reduce product development time and cost

Minimize customer's cost of entry

Provide products for various applications /maintenance levels

- Operational: Aviation or Vehicle Platforms
- Intermediate: Line Replaceable Unit (LRU)
- Depot: from LRU to card level

Support collaborative (i.e., tele-) maintenance



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## What's a Product Line?

A software product line is defined as

- "A set of software-intensive systems that share a common, managed set of features satisfying the specific needs of a particular market segment or mission and that are developed from a common set of core assets in a prescribed way."



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## Product Line Features and Variations

| Platforms supported                                       | Bus                                       | Message handling          |
|-----------------------------------------------------------|-------------------------------------------|---------------------------|
| Helo                                                      | Type                                      | Message analysis          |
| Apache A                                                  | 1553 (1553A, 1553B)                       | From text                 |
| Apache D                                                  | Ethernet                                  | From XML                  |
| UH-60                                                     | 1773                                      | Message DB                |
| Aircraft                                                  | ARINC (commercial aircraft)               | XML translator            |
| F-18                                                      | CAN? (automotive)                         | Read                      |
| C-17 (under discussion)                                   | Architecture                              | Write (for sim/stim tool) |
| Ground vehicles                                           | Single bus                                | Test level                |
| M1A1 Abrams                                               | Multiple bus                              | Operational               |
| Variations within each by tail # or other vehicle feature | Single type                               | Intermediate              |
|                                                           | Mixed type                                | Depot                     |
|                                                           | Nested (i.e., bus within bus; e.g., JTRS) | Development               |



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## Variation Example – Maintainer Interface

The screenshot shows the AMTS Maintainer Interface. On the left, there's a 'Bus Loadings' section with a table showing various bus loadings. The main area displays a fault detection screen for 'RHE' (RHE). A large red box at the top says 'RHE'. Below it, text indicates a detected problem: 'AMTS has detected a 1553 mux problem with the RHE or its associated DLTU and/or stub wiring. To further fault isolate, connect AMTS Bus Cable Adapter AAS328004 (RHE cable) between the RHE and the 1553 mux bus as follows:'. A numbered list follows: '1. Locate the RHE (Point B on picture)'. Below this, a 'REPLACE DASEC' dialog box is open, providing detailed instructions for replacing the DASEC, including steps like 'Do not shut down AMT1', 'Power down aircraft', and 'Refer to TM 1-1520-230-23-7-2, Section 11.018, for...'. The background shows a schematic diagram of the aircraft's wiring.



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## How AMTS Was Created

Leveraged years of experience supporting avionics maintenance and developing software/hardware tools

Exploited MIL-STD-1553 commonality

Established management support to develop prototype

Mined existing assets

Incorporated iterative/reactive Product Line engineering approach



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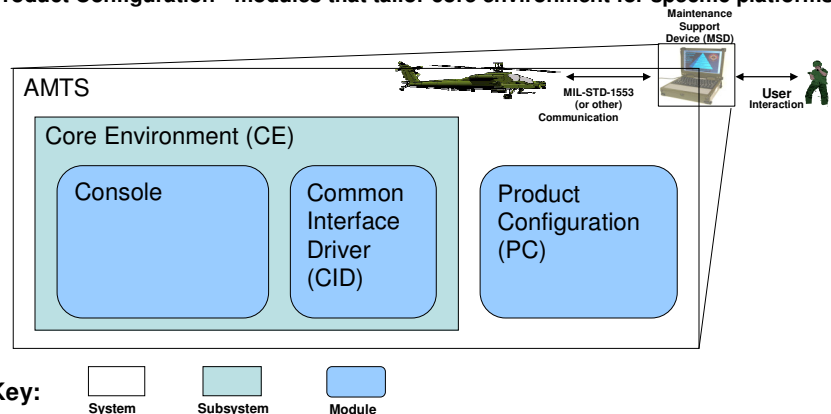
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## AMTS Decomposition View

Core Environment - common modules across the product line

Product Configuration - modules that tailor core environment for specific platforms



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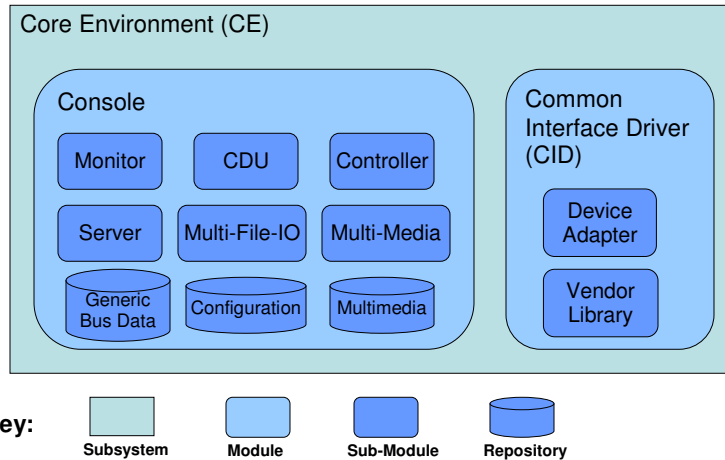
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## Core Environment Decomposition View

Common assets for building testing systems for specific aviation platforms, systems, and subsystems



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## Core Environment (CE)

Consists of Console and Common Interface Driver (CID) modules

- Console: data driven software utilizes
  - Non-specific data and graphics to provide a universal data bus analyzer
  - Specific data, graphics, and software modules to provide platform data bus specific diagnostics
- CID: software adaptor utilizes
  - Vendor libraries to provide device communication independent of manufacturer

Common assets include a 1553 data bus generic monitoring system without platform specific data (Bus Tester Tool Kit) .

- Every possible LRU on data bus, up to 32
- Specific LRU's unknown. Where located on bus unknown
- Configuration capability to be added in future with tools to build plug-ins



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## Product Configuration (PC)

### Product core assets and product specifics

- employ reverse engineering of platform system to understand behavior for data base system information and message repository
- Use Multiplex ICD to identify product-specific messages
- Use Bus controller SRS to understand behavior

### Product modules

- Core environment asset instances (console and CID)
- Product core (PCore) & PCore instances
- Product specifics (e.g., Read Codes for AH-64A)



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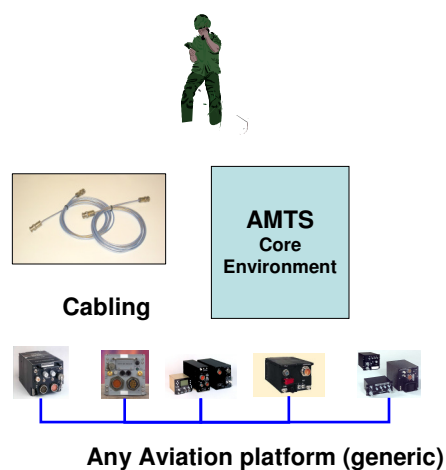
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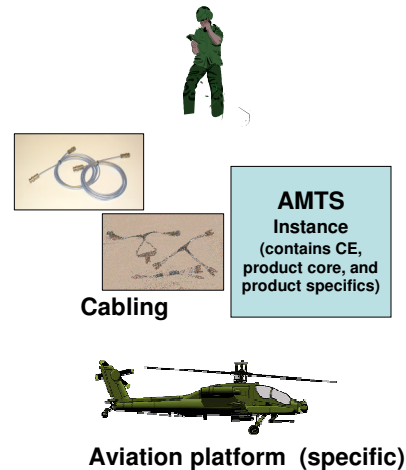
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## AMTS Layered Context

### Core Environment



### Product



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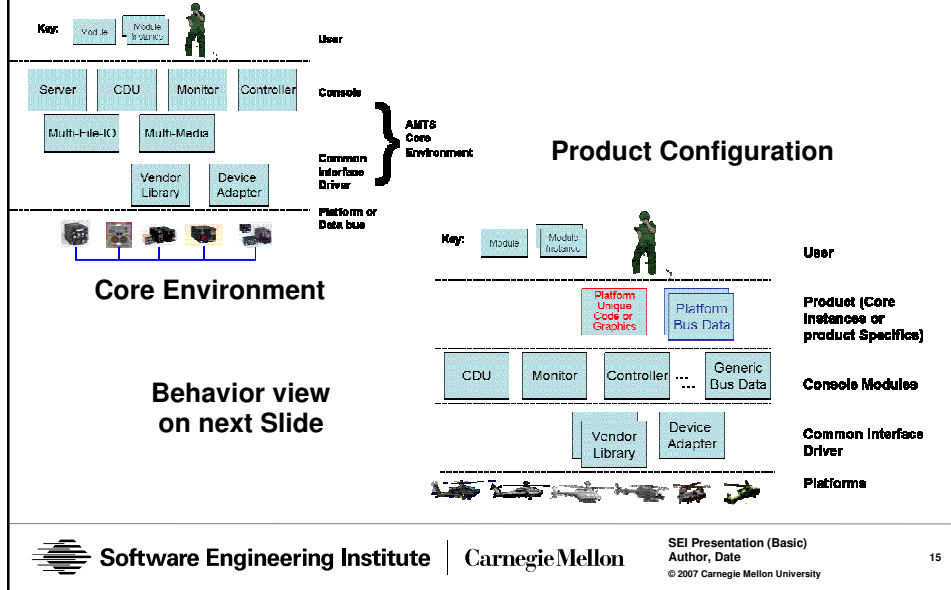
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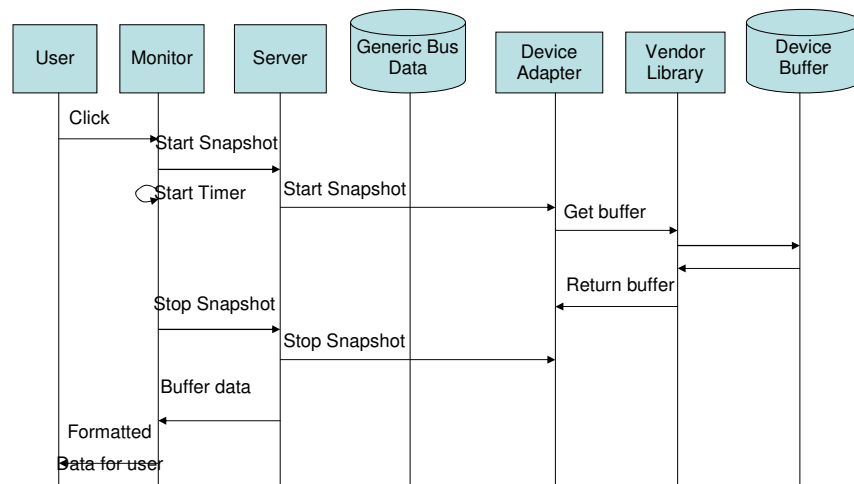
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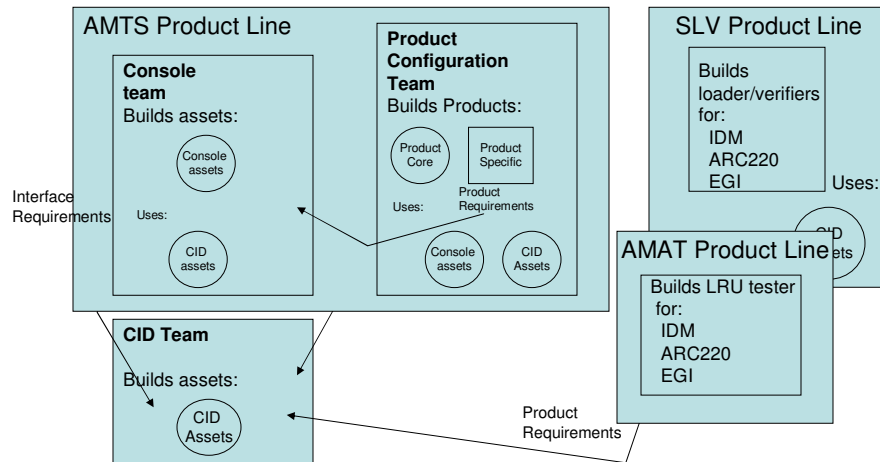
## Layer View – Core and Product Configuration



## Sequence Diagram for Get Message Stack



## Evolution – Product Line Growth

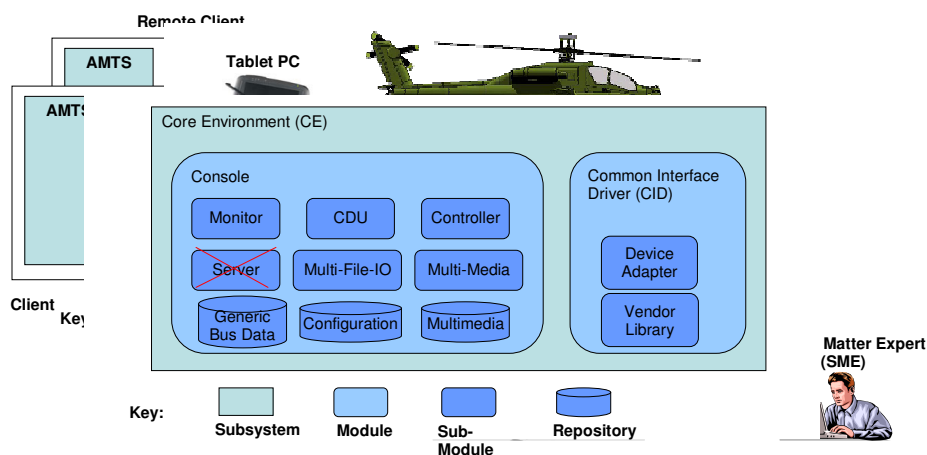


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## Evolution – Tele-maintenance

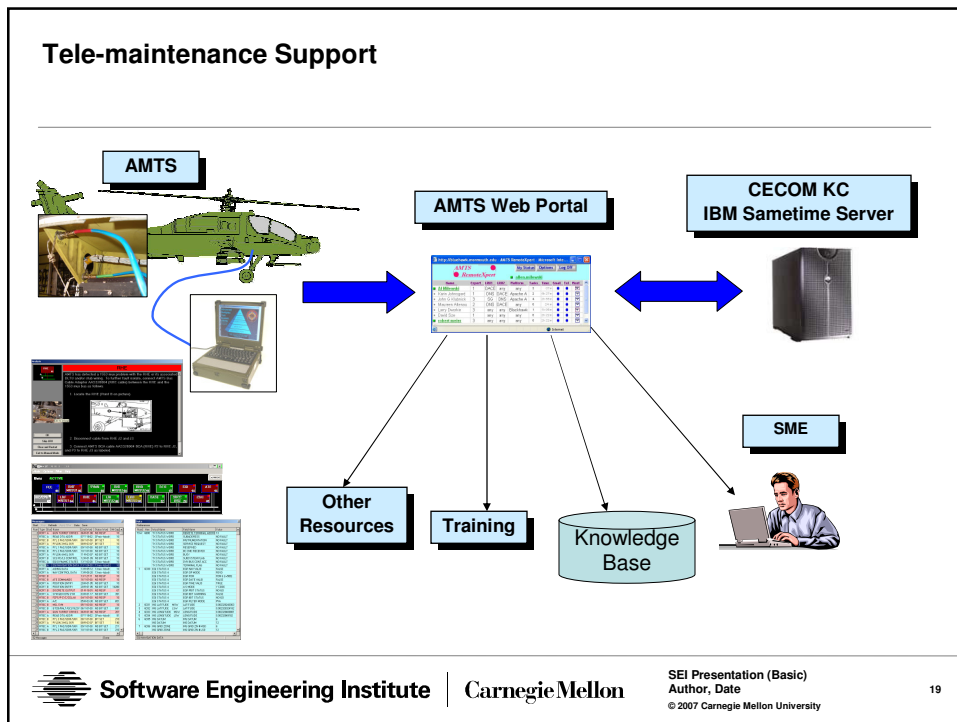


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## Evolution – Condition Based Maintenance

Need expressed by maintainers in field

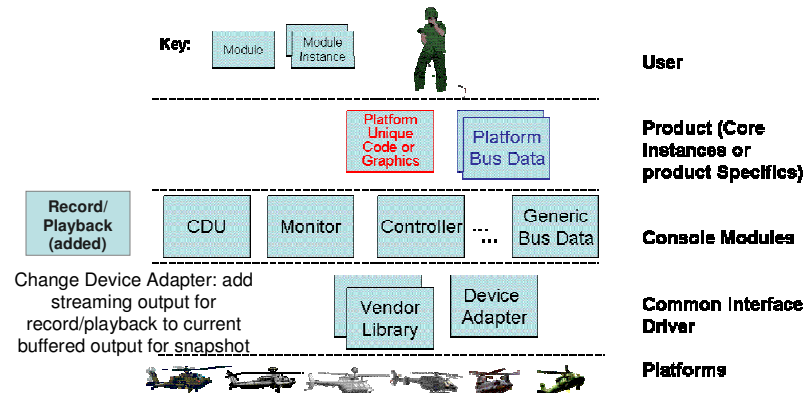
Aviation Responsive Maintenance System (ARMS) to consolidate and provide situational awareness picture

- of aircraft readiness for use in CBM
- of current data state across the fleet
- for playback on AMTS (collect data (one-hour's worth) and the SME who is providing assistance has it for analysis.

Use existing built-in analysis capabilities as model to determine how to retrofit this in off-board for all aircraft

Product line approach is an enabler

## Evolution for CBM



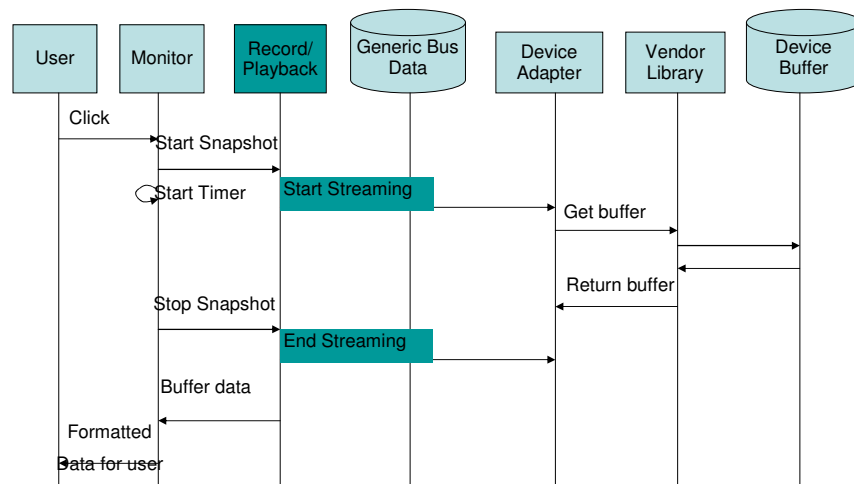
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## Evolution – Changes to Behavior for CBM



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## Summary

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AMTS architecture supports multiple and growing list of diagnostic/maintenance products

Changes managed through architecture evolution

- Identification of new goals (e.g., adding CBM capability)
- Technology changes (e.g., secure collaboration support)

Variation mechanisms not covered in this presentation – possible topic for working group discussions



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