Re-Use of Integrated Dictionary Components for C4ISR Architectures

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C4ISR Architecture Framework (CAF) Products Version 2.0

CAF Version 2.0 provides architecture specifications.

Objectives of CAF are to provide,
- Rules, guidance and product description for developing architectures.
- Common unifying approach for different agencies for architecture development.
CAF describes a set of products to represent three views of architecture:
- Operational Architecture View
- System Architecture View
- Technical Architecture View

However, no well defined or widely accepted approach to produce these products is provided.
Approaches for Developing CAF Products

- **Structured Analysis (SA) Products**: Focused on Functions & Data
- **Object Oriented (OO) Products**: Focused on entities and their Interactions

CAF Products
Problem Illustration

Existing C4ISR Products (SA approach)  Not difficult

Existing C4ISR Products (OO approach)  Not difficult

Non-Trivial

New Products (SA approach)

New Products (OO approach)
Research Objective

Find out Possibility of Re-Using the definitions

Integrated Dictionary (AV-2) Containing definitions for C4ISR Products developed using SA approach

Integrated Dictionary (AV-2) Containing definitions for C4ISR Products developed using OO approach
Methodology Adopted for Research

- C4ISR Products
  - SA approach
  - OO approach

Operational Concept

Compare Dictionary Components

Integrated Dictionary AV-2
Mapping Between CAF/SA/OO Products

Operational Concept Diagram (OV-1)

SA
Derived from OV-1 & Functional decomposition

Node Connectivity Description

Command Relationship Chart

Derived from the UML Class diagram

Derived from Class/Object diagram

Derived from Domain Knowledge
Mapping Between CAF/SA/OO Products (Contd..)

- **Activity Model**
  - SA
  - OO
  - IDEF0

- **State Transition Diagram**
  - OV-6b
  - SA
  - OO

- **State Transition Diagram for each object**
  - SA
  - OO

- **Derived directly from Data Model**
  - SA

- **Logical Data Model**
  - OV-7
  - SA
  - OO

- **Operational Event/Trace Description OV-6C**
  - SA
  - To be consistent
  - OV-2 and OV-5

- **UML Sequence diagram**
  - Can be used directly
  - SA
  - OO

- **May be derived from Class diagram**
  - SA
  - OO
Mapping Between CAF/SA/OO Products (Contd..)

- **System Interface diagram (SV-1)**
  - SA: System nodes and links
    - Derived from operational concept
  - OO: Derivable from the System class diagram

- **System communication Diagram (SV-2)**
  - SA: Derived from Operational concept
  - OO: Logically similar to SV-1

- **System Functionality Description (SV-4)**
  - SA: Graphically can be represented as activity Model as DFD
  - OO: UML activity diagram for System classes can be used directly
FastPass System Operational Concept (OV-1)

- Driver enters bay
- Drive Activates FastPass with device
- After Permission, driver selects grade of gas and fuels car
- Driver leaves

Turn on FastPass Light to show process is working
Issue Permission to fuel
Print Receipt
Turn off FastPass Light

Gas Pump
FastPass light
LAN
WAN

Gas Station Office
OilCo Central Data Base

Retrieve Driver Information

Check credit information
Authorize credit purchase
Update credit information

Financial Institution
Comparison of Data Dictionaries

Components

Many definitions for two set of products match with each other. For example,

- Operational Nodes/Classes
- Information Exchange
- Organizational Units
- Operational Activities
- Object State
- ICOM/Message Flow

Reason being, products for both sets were produced using same operational concept.
Mapping between Operational Concept, Operational Node Connectivity Description and UML Class Diagram
Mapping Between Activity Model, Operational Node Connectivity and UML Activity Diagram

OV-5, Child Diagram

- FP_ID
- Show FP_ID
- Ass Class
- Op Activity
- Ass Class
- Ass Class
- Op Activity

OV-2, Operational Node Connectivity Description

- Driver
- Op Node
- Ass Class
- Operational Activities
- Ass Class
- Ass Class
- Ass Class

OV-1, Child Diagram

- Driver
- Class 2
- Ass Class
- Ass Class
- Ass Class
- Ass Class

UML Class Diagram

- Driver
- Ass Class
- Show FP_ID
- Ass Class

- Class 2
- Ass Class
- Pump Gas
- Ass Class

- Class 3
- Ass Class
- Take Receipt
- Ass Class
Comparison of Data Dictionaries (Contd..)

However, certain definitions did not match.

<table>
<thead>
<tr>
<th>Definitions in SA dictionary</th>
<th>Definitions in OO dictionary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Op activities for $A_0$, $A_1$, $A_2$, and $A_3$</td>
<td>None</td>
</tr>
<tr>
<td>None</td>
<td>ICOM/Message Flow at Decision point in UML Activity diagram</td>
</tr>
<tr>
<td>Relationships between entities in the Logical data model</td>
<td>None</td>
</tr>
</tbody>
</table>
Comparison of Data Dictionaries
Components (Contd..)

For System Architecture view products many definitions match with each other. For example,
- System Nodes
- System Data Exchange
- System Elements
- Communication Nodes
- System Functions/Operations of the classes
- Data Stores/Aggregate Classes
Mapping Between UML Activity Diagram and the Data Flow Diagram
Comparison of Data Dictionaries Components (Contd..)

However, no definitions of systems functions for external entities in DFD diagram, like,

- Functions for Driver
- Functions for Financial Institution

In SA approach Information provided by “Data stores” in DFD match with information contained by the aggregate classes in OO approach.
Summary & Conclusion

- Re-Use of definitions contained by Integrated dictionary was discussed.
- CAF products were developed using SA and OO approach.
- Components of the two dictionaries were compared.
- Results showed that most of the terms were identical and can be reused.
- Certain differences in definitions were due to the difference of product development techniques.
- Hence, use experience and domain knowledge to “fill in the blanks” for reusing definitions from one architecture into another.
Questions