Dynamic Metadata Support in Air Traffic Environments

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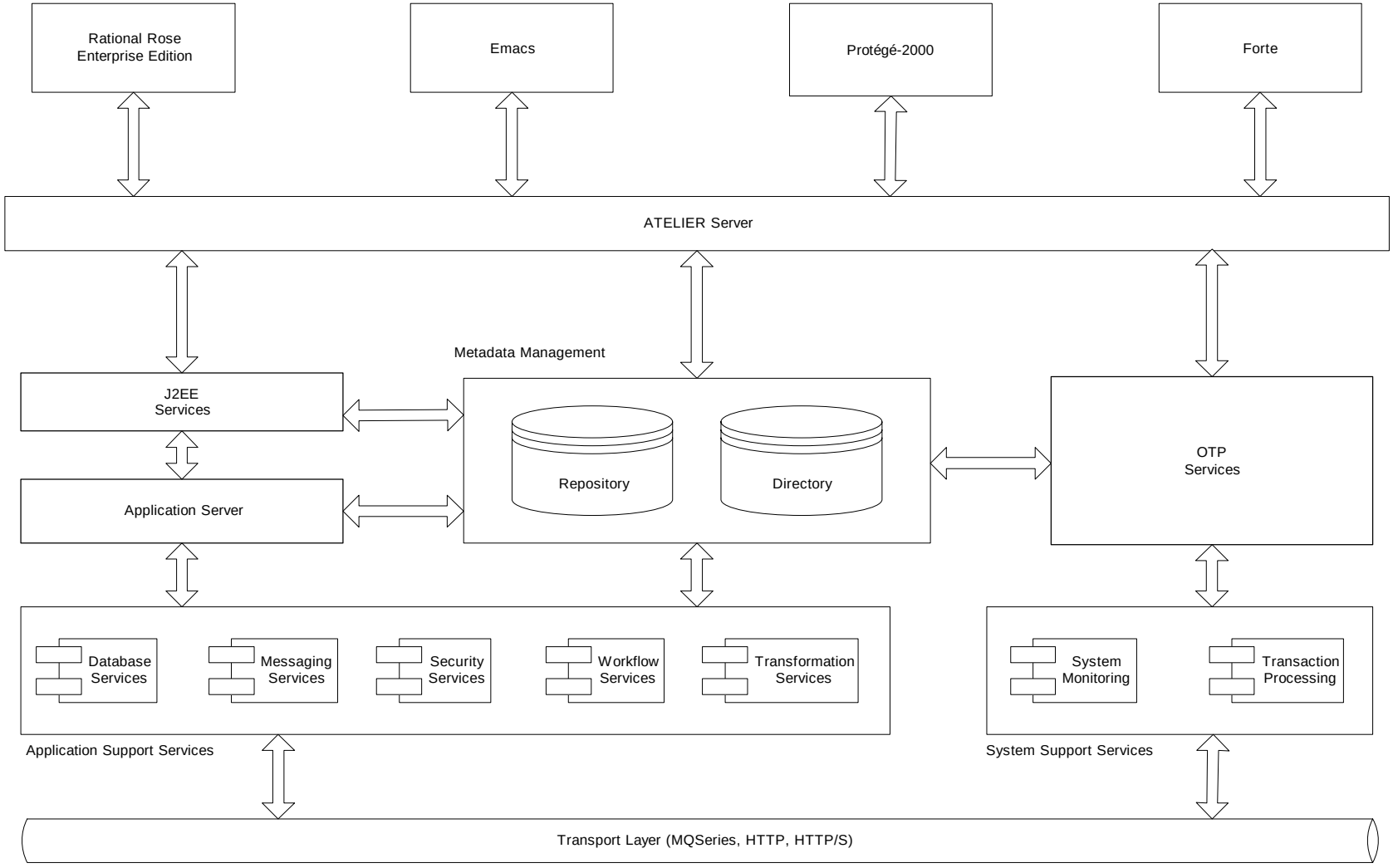
Agenda

- Introduction
- Background
- Enterprise View of Metadata for ATE
- Definition and Management Issues

Background (1)

- Auldenfire's Enterprise Systems Architecture Laboratory (ESAL) developed during 2001
- Developed for customers to experiment with application frameworks and configurations
- Provides all services required from technical views of "Enterprise Architecture"
- Based on distributed Repository between Auldenfire and customer sites
- Supports range of different enterprise informatics models: Web-centric, J2EE, J2ME, Workflow and Real-Time

Enterprise Systems Architecture Laboratory



Background (3)

- 4 main EA frameworks under development
  - Financial Messaging Services
  - Telecommunications
  - Data Warehousing
  - Air Traffic Management
- AT Management used as testbed for ESAL functionality in information management and security areas
- Future development for use in ATC simulation projects

Definitions of Metadata

- The classic definition: “Data about Data”
  - Conceptually restricted to entity-attribute modelling
  - Too narrow in scope
    - No notion of process or context
    - The OO and Business Process Reengineering paradigms have changed the outlook considerably

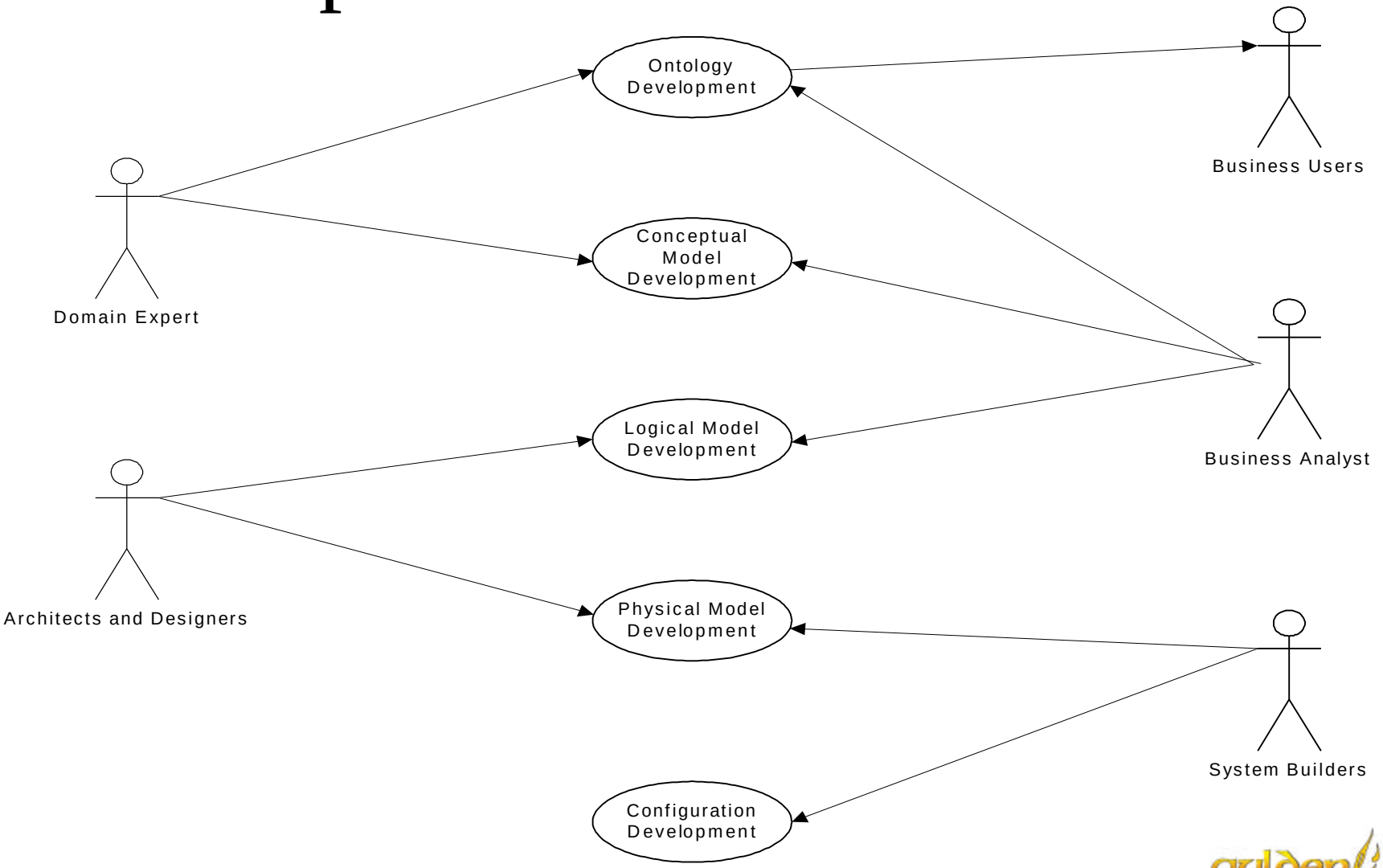
Different Audiences have different expectations

- Views and standards for metadata
  - Web discovery – HTML Meta tags
  - Information management – XML-Schema
  - Systems modelling and design – UML, SDL, ADL, XMI….
  - Data warehouse – CWMI
  - Social Sciences - Dublin Core
  - e-Business - UDDI, SOAP
  - Application Integrators - UML Profile for EAI
  - Financial Services - FIXML

Definitions of Metadata 2

- Pragmatic definition: Metadata describes the knowledge, structure, processes and organisation of information systems and their content
- Hierarchy of representation and organisation:
  - Ontology
  - Conceptual
  - Logical
  - Physical
  - Configuration
- Corresponds to Enterprise Architecture perspective

Enterprise Architecture View



Level 1: Ontology

- Thesaurus perspective of the metadata
- Establishes the working subject-matter vocabulary for all later developments
- Describes the concepts, definitions and relationships of the subject matter area
- Sources: Subject matter experts, standards, recognised reference materials…

Level 2: Conceptual

- Organisation/Enterprise perspective of the metadata
- Establishes the structure and content of metadata at the (business) operational level
- Describes the business objects, business processes, business environment, flows, models and infrastructure.
- Sources: Business leaders, analyses, BPR processes, operations manuals….

Level 3: Logical

- Implementation independent models of the information management assets
- Establishes the design, implementation or acquisition characteristics for the enterprise systems
- Describes the information system schemas, object library interfaces, functional specifications, component families and infrastructure requirements
- Sources: CASE tools, data dictionaries, business modelling tools

Level 4: Physical

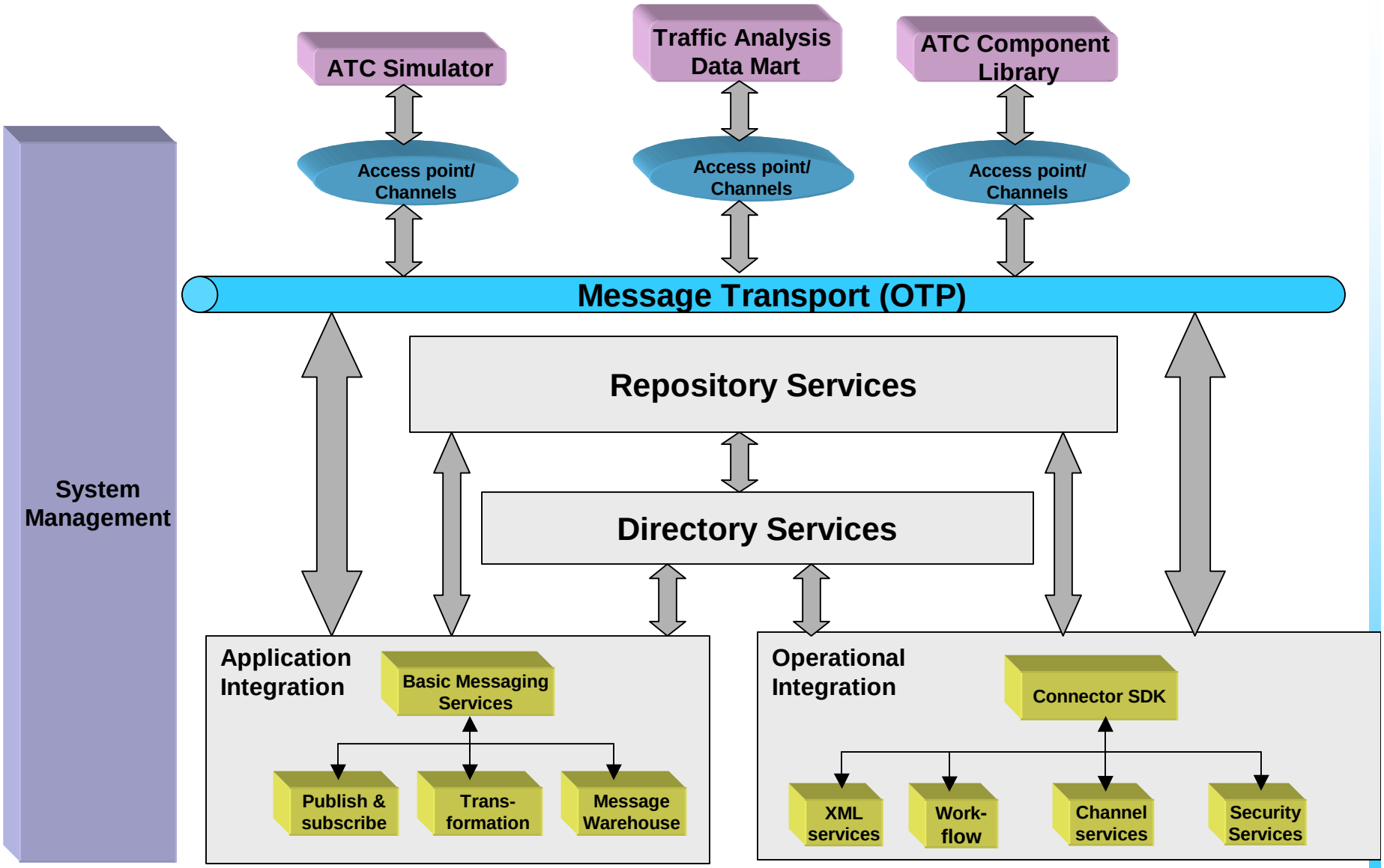
- Implementation specific models of information management assets
- Establishes the implementation characteristics information systems
- Describes the databases, components, applications, networks, directories…
- Sources: Implementation Tools

Level 5: Configuration

- Describes the configuration metadata used in the runtime environment
- Documents application interfaces, message structures, queues, workflows, load-balancing configurations, exception management channels, object broker configurations…

Dynamic Metadata

- Metadata artifacts that are used as:
  - Models for systems development
  - Inputs to code or database generators
  - Control information for systems configurations
  - Runtime support artefacts in developed systems
  - Configuration views of information or application systems (i.e. Enterprise Portals



ESAL Air Traffic Management Framework

Enterprise View of Metadata for ATE

- Ontological
  - ATC Thesaurus and glossary of terms (dbms, XML RDF)
- Conceptual
  - ATC Metadata Model (Business objects and processes) in XML RDF
- Logical
  - ATC Model in UML,
  - ATC Component Model in ADL
- Physical
  - Functional interface in IDL, Java Class Library, Oracle RDMS Schema
- Configuration
  - OTP Configuration, Message Structures, Workflows

Ontological – Example

- **AIRCRAFT**
- A device designed to be capable of atmospheric flight.
- **AIRCRAFT-MODEL**
- Make and model information for a vehicle capable of atmospheric flight.
- **AIRCRAFT-MOVEMENT-SURFACE**
- A surface for the movement, including take off and landing, of aircraft on a land airport.
- **AIRCRAFT-MOVEMENT-SURFACE-ASSOCIATION**
- A associative entity depicting the relationship among AIRCRAFT-MOVEMENT-SURFACES.
- **AIRCRAFT-MOVEMENT-SURFACE-LIGHTING**
- A lighting system for an AIRCRAFT-MOVMENT-SURFACE

Logical – Example

Physical – DB Schema Example

```
CREATE TABLE T_Airspace_Ground_Resource(
    Capacity VARCHAR(),
    Configuration VARCHAR(),
    Demand VARCHAR(),
    Load VARCHAR(),
    Location VARCHAR(),
    Name VARCHAR(),
    SaturationThreshhold VARCHAR(),
    SeperationMinima VARCHAR(),
    UsageRestrictions VARCHAR(),
    Airspace_Ground_ResourceId NUMBER(5),
    PRIMARY KEY(Airspace_Ground_ResourceId))

CREATE TABLE T_Traffic_Manager(
    Airport_Radar_Services_AreaId NUMBER(5) REFERENCES T_Airport_Radar_Services_Area(Airport_Radar_Services_AreaId),
    Airport_Traffic_AreaId NUMBER(5) REFERENCES T_Airport_Traffic_Area(Airport_Traffic_AreaId),
)

CREATE TABLE T_Air_Traffic_Manager(
    Airport_Radar_Services_AreaId NUMBER(5) REFERENCES T_Airport_Radar_Services_Area(Airport_Radar_Services_AreaId),
    Airport_Traffic_AreaId NUMBER(5) REFERENCES T_Airport_Traffic_Area(Airport_Traffic_AreaId),
)

CREATE TABLE T_Flight_Manager(
    Airport_Radar_Services_AreaId NUMBER(5) REFERENCES T_Airport_Radar_Services_Area(Airport_Radar_Services_AreaId),
    Airport_Traffic_AreaId NUMBER(5) REFERENCES T_Airport_Traffic_Area(Airport_Traffic_AreaId),
)
```

Physical – IDL Script Example

```
//## Module: Pilot
// ======================================================================
//## Pilot Documentation:
//      An aircraft operator or an on-board automation
//      system with decision-making authority who interacts
//      with ATC.
interface Pilot {
  //##begin Pilot.initialDeclarations preserve=yes
  //##end Pilot.initialDeclarations
  // Attributes
// Relationships
  // Associations
  attribute Aircraft the_Aircraft;
  // Operations
  void executeFlight();
  void executeMovement();
  void manageEquipment();
  void planFlight();
  void reportAircraftAltitude();
  void reportAircraftPosition();
  void reportAircraftIdentification();
  void requestMovement();
```

Physical – Java Stubs Example

```
/**
   Devices that are used or intended to be used for flight in the air.
 */
public class Aircraft {
    private String aircraftId;
    private Position Location;
    public ACF_Airspace m_ACF_Airspace[];
    public Airport_Radar_Services_Area m_Airport_Radar_Services_Area[];
    public Airport_Traffic_Area m_Airport_Traffic_Area[];
    public Pilot m_Pilot[];
    public Vehicle_Navigation_System m_Vehicle_Navigation_System[];
    public Vehicle_Communication_System m_Vehicle_Communication_System[];
    public Vehicle_Surveillence_System m_Vehicle_Surveillence_System[];

    Aircraft() {
    }
    /**
      @roseuid 3C4FEF4A0181
     */
    public Enum { Airborne, OnGround } Airborne_Status() {
    }
}
```

Metadata Definition and Management Issues (1)

- Collecting Metadata
  - Sources:
    - OO Analysis of Air Traffic (MITRE/CAASD)
    - National Imaging and Mapping Agency Conceptual Data Model for Geographic Features
  - Analysed and modelled using UML
  - Stored in ESAL Repository
- Managing Metadata
  - Core Representation in XML (Schema, RDF and XMI)
  - All entities under CM with full version control enabled
- Securing Metadata

Metadata Definition and Management Issues (2)

- Security
  - Often overlooked as a priority in metadata management
  - Too central to risk appropriation or total access by all comers – 70% of information on an e-Business platform is metadata!
  - Needs to be centrally controlled – policy is definitely required!

Uses of Metadata

- Describing the AT environment
- Systems Modelling and Development
- Communication Management

Describing the AT environment

- Developing detailed information model of the generic AT environment
- Providing views to create instances of metadata objects reflecting the real world ATE
- Exporting the instances to other tools for further processing (I.e. use in ATC simulation tools)

Systems Modelling and Development

- Development of platform independent models of systems (PIMs) based on components and their connections
- Development mappings from the PIM(s) to platform-specific models (PSM's)
- Generate code and other artefacts by applying the mappings
- This is basis of OMG's Model-Driven Architecture (MDA) Approach

Communication Management

- Message library in XML based on ATC Business Objects
- Configuration of OTP platform for “soft” real-time secure data communications
- VPN model under development for trials between Sweden and New Zealand
- Aim is to link ATC simulation environments

Conclusions

- ATC is the most challenging of the ESAL frameworks – mix of complexity, security and performance needs make for interesting requirements
- Initial stage of ATC framework to be completed by end of March
- Future activities based on collaborations & work of the OMG Transport Committee

Contact Information

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