AIXM, WXXM, FIXM
the power of a unified approach

Ian Painter

ATM Lead

Snowflake Software

Conceptualizing the real world

class Flight Plan Conceptual Model

Flight

Route

FlightPlan
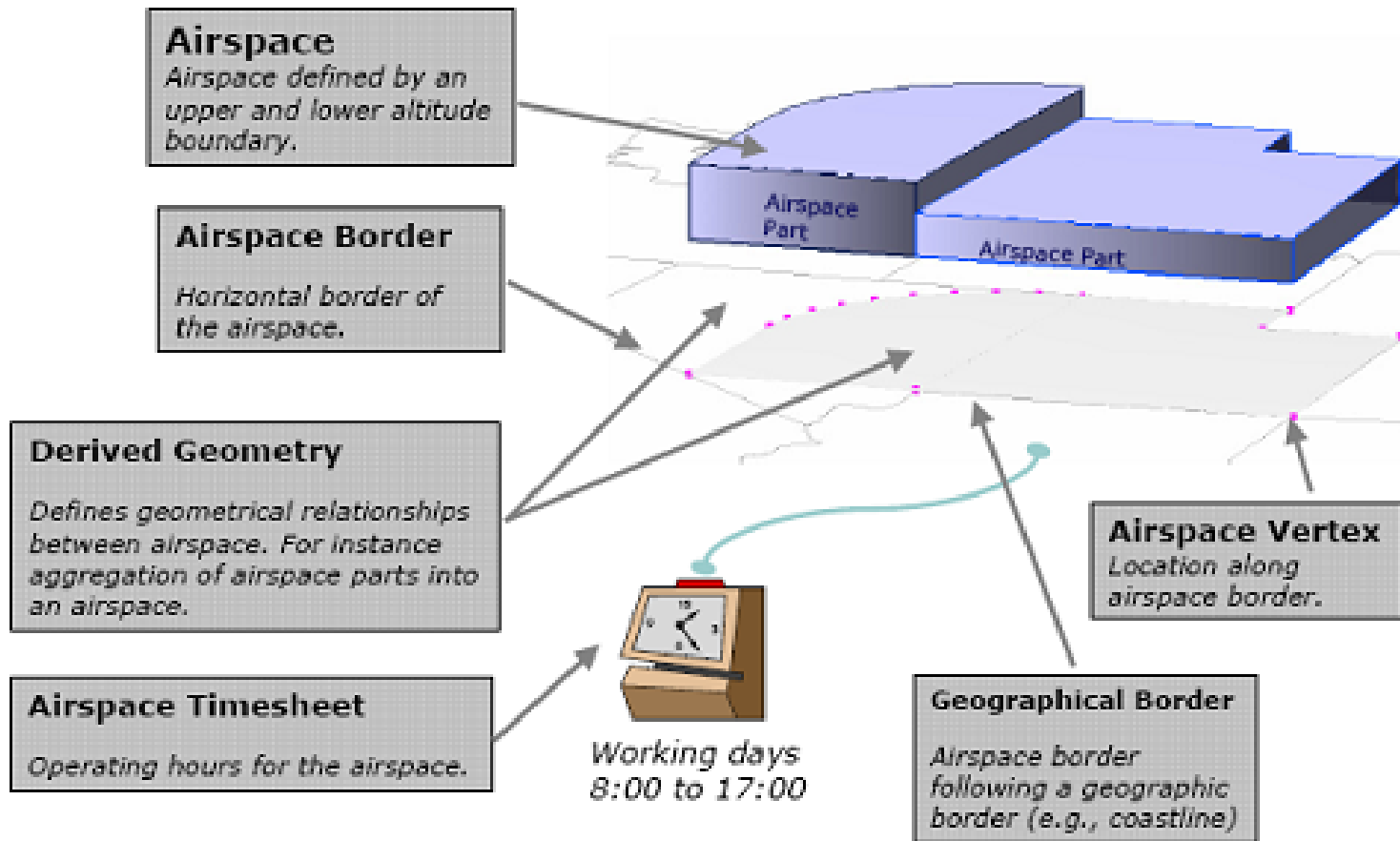
Aircraft

FIXM Flight Plan – Conceptual Model
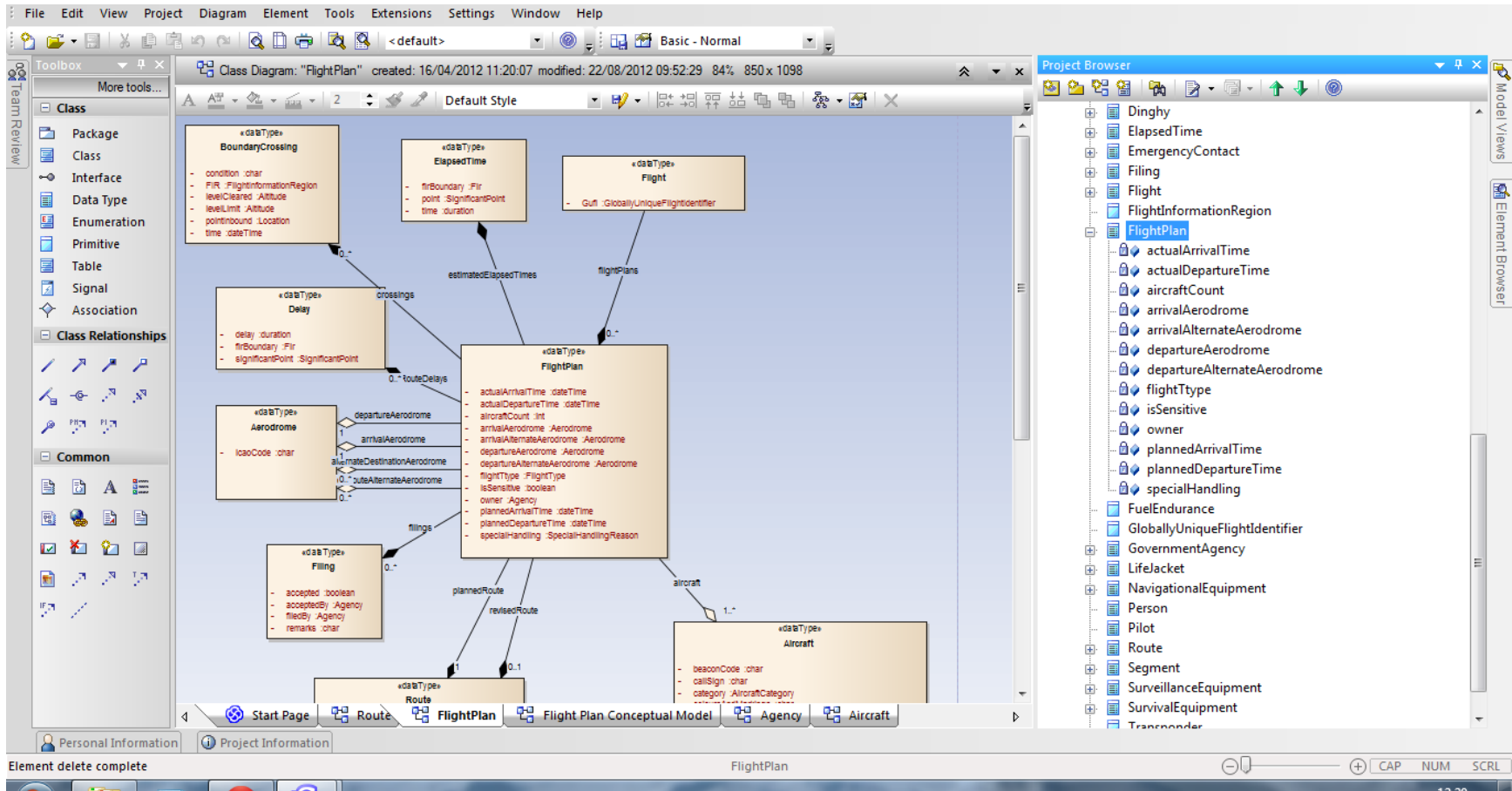
FIXM Flight Plan – Logical Model

Flight Plan – Physical Model in XML

```xml
<xsd:include schemaLocation="fxAerodrome.xsd"/>

<xsd:complexType name="FlightPlanType">
    <xsd:annotation>
        <xsd:appinfo source="fx:implements">Aircraft Quantity</xsd:appinfo>
        <xsd:appinfo source="fx:implements">Flight Plan Remarks</xsd:appinfo>
        <xsd:appinfo source="fx:implements">Route</xsd:appinfo>
        <xsd:appinfo source="fx:implements">Route - Revised Destination</xsd:appinfo>
        <xsd:appinfo source="fx:implements">Center to Center External Remarks</xsd:appinfo>
        <xsd:appinfo source="fx:implements">Flight Plan Originator</xsd:appinfo>
        <xsd:appinfo source="fx:implements">Flight Type</xsd:appinfo>
        <xsd:appinfo source="fx:implements">Special Handling Reason</xsd:appinfo>
        <xsd:appinfo source="fx:implements">Estimated Elapsed Time</xsd:appinfo>
    </xsd:annotation>
    <xsd:complexContent>
        <xsd:extension base="base:AbstractFeatureType">
            <xsd:sequence>
                <xsd:element name="aircraftCount" type="base:CountType" minOccurs="1" maxOccurs="1"/>
                <xsd:element name="aircraft" type="fx:AircraftType" minOccurs="1" maxOccurs="1"/>
                <xsd:element name="formation" type="fx:AircraftType" minOccurs="0" maxOccurs="unbounded"/>
                <xsd:element name="originator" type="fx:OriginatorType" minOccurs="0" maxOccurs="1"/>
                <xsd:element name="remarks" type="base:FreeTextType" minOccurs="0" maxOccurs="1" nillable="true"/>
                <xsd:element name="filing" type="fx:FlightPlanFilingType" minOccurs="0" maxOccurs="1"/>
                <xsd:element name="sensitivity" type="fx:SensitiveFlightType" minOccurs="0" maxOccurs="1"/>
                <xsd:element name="specialHandling" type="fx:SpecialHandlingReasonType" minOccurs="0" maxOccurs="1"/>
                <xsd:element name="departure" type="fx:FlightPlanDepartureType" minOccurs="1" maxOccurs="1"/>
                <xsd:element name="arrival" type="fx:FlightPlanArrivalType" minOccurs="1" maxOccurs="1"/>
                <xsd:element name="enRoute" type="fx:FlightPlanEnRouteType" minOccurs="1" maxOccurs="1"/>
                <xsd:element name="requested" type="fx:FlightPlanRequestType" minOccurs="1" maxOccurs="1"/>
                <xsd:element name="assigned" type="fx:FlightPlanRequestType" minOccurs="0" maxOccurs="1"/>
                <xsd:element name="route" type="fx:RouteType" minOccurs="1" maxOccurs="1"/>
                <xsd:element name="revisedRoute" type="fx:RouteType" minOccurs="1" maxOccurs="1"/>
                <xsd:element name="boundaryCrossing" type="fx:BoundaryCrossingType" minOccurs="0" maxOccurs="unbounded"/>
                <xsd:element name="centerToCenterRemarks" type="base:FreeTextType" minOccurs="0" maxOccurs="1"/>
                <xsd:element name="type" type="fx:FlightTypeType" minOccurs="1" maxOccurs="1"/>
            </xsd:sequence>
            <xsd:attribute name="state" type="fx:FlightPlanStateType" use="required"/>
            <xsd:attribute name="identifier" type="fx:ComputerIdentificationType" use="required"/>
        </xsd:extension>
    </xsd:complexContent>
```
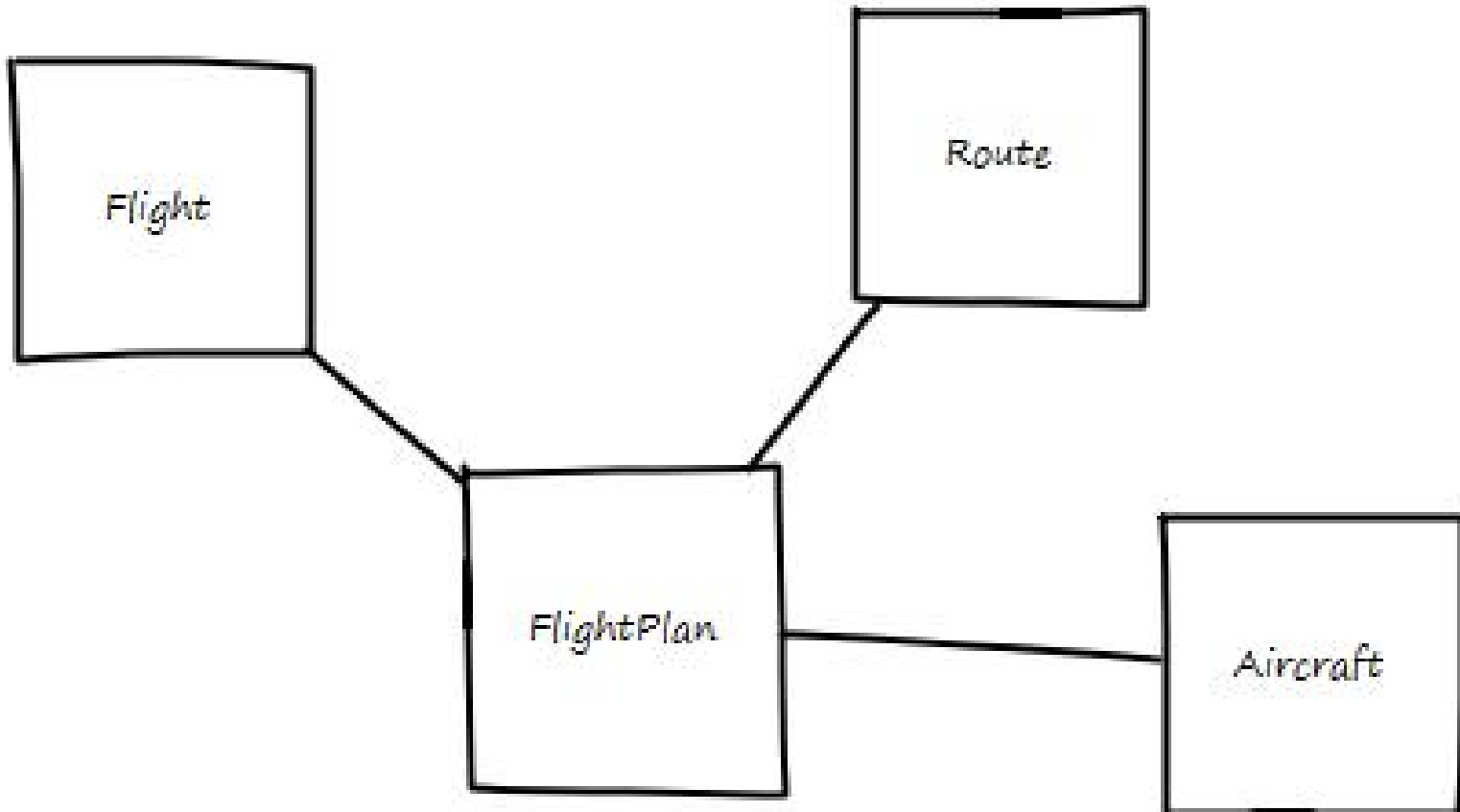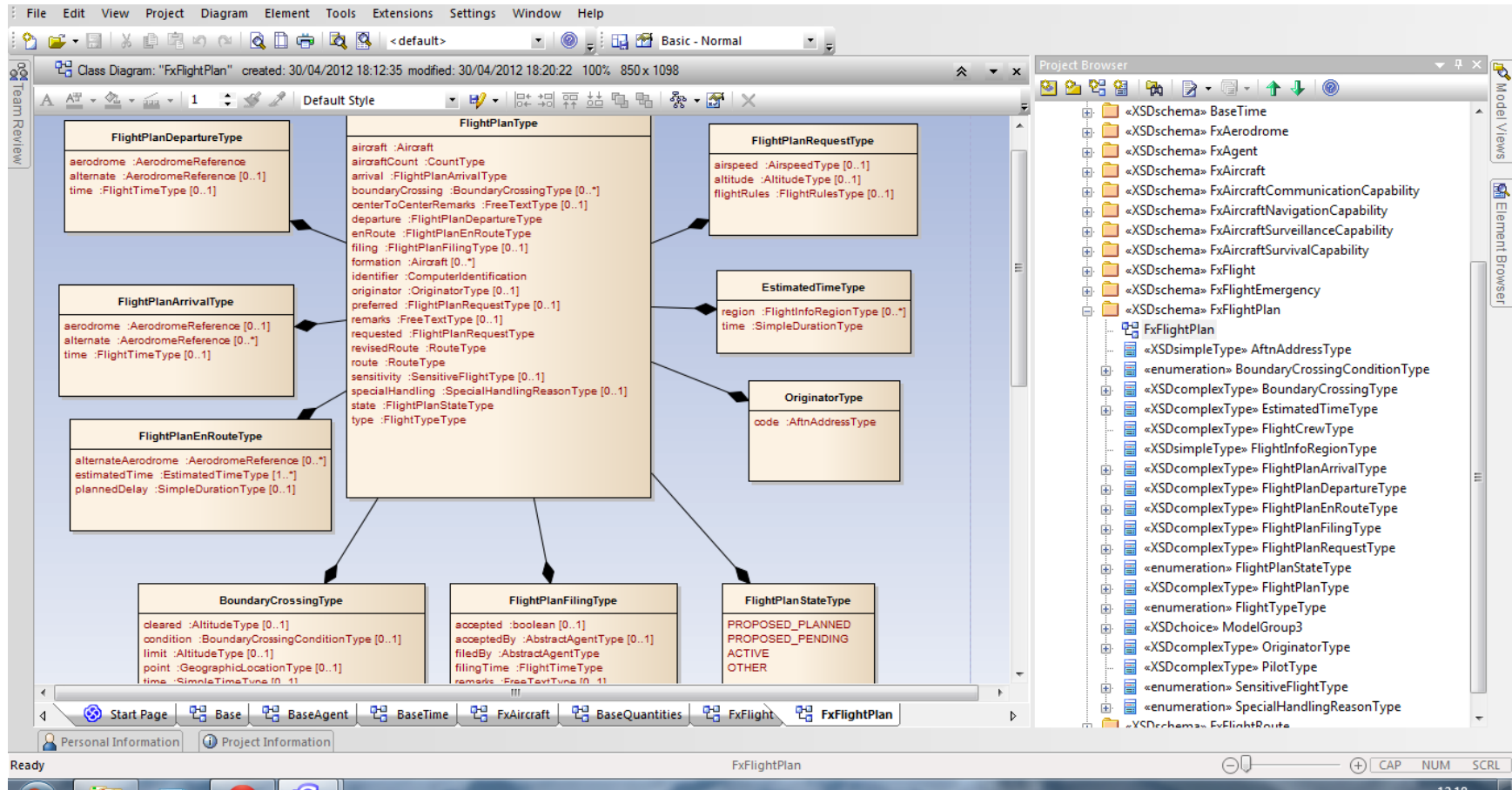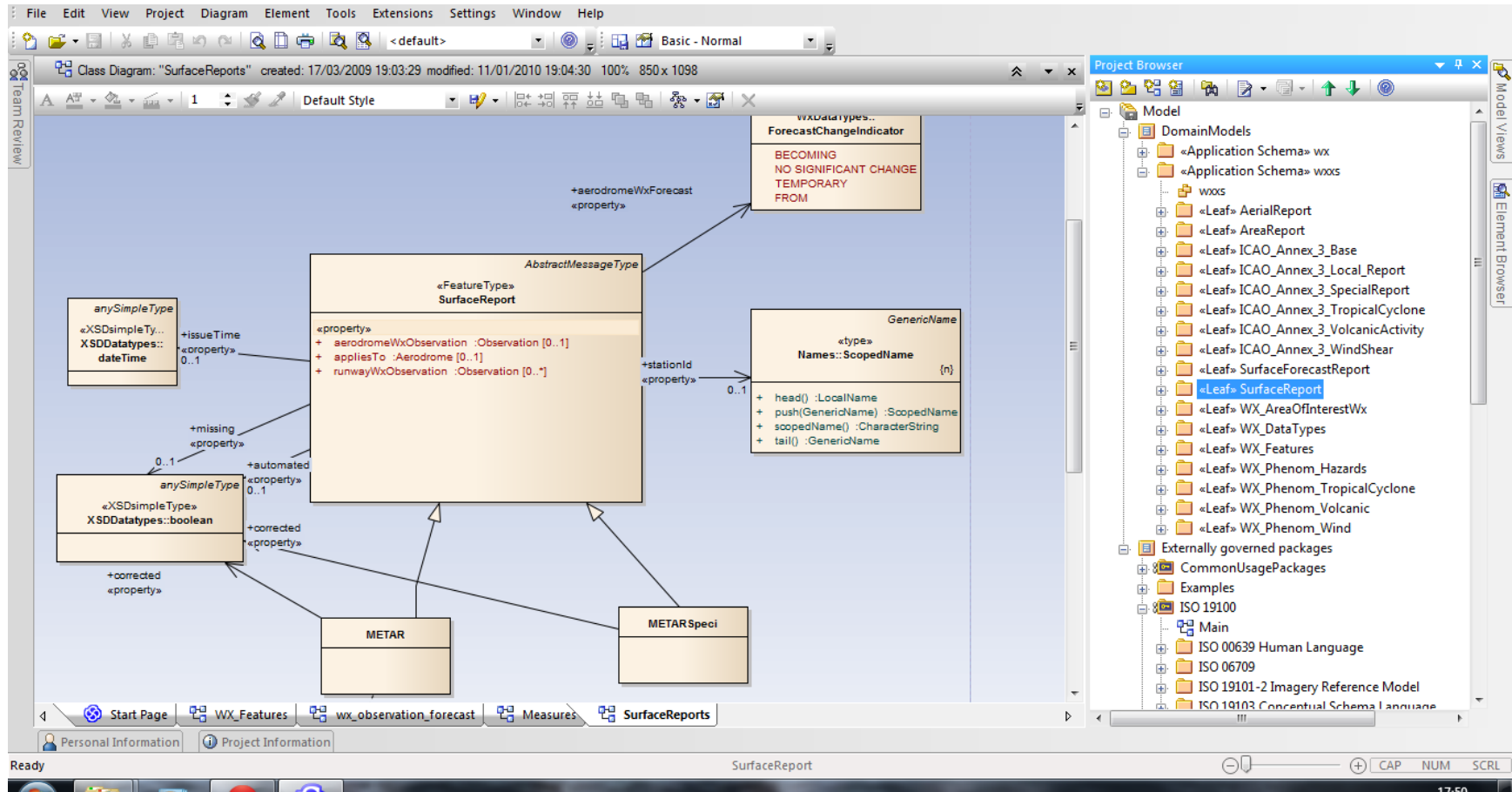
WXXM Logical Model

WXXM Physical Model

```xml
<schema xmlns="http://www.w3.org/2001/XMLSchema"
        xmlns:gml="http://www.opengis.net/gml/3.2"
        xmlns:wx="http://www.eurocontrol.int/wx/1.1"
        targetNamespace="http://www.eurocontrol.int/wx/1.1"
        elementFormDefault="qualified"
        attributeFormDefault="unqualified">

<!-- Schema auto-generated by FullMoon, applying rule suite xmi11ea -->

    <annotation>
        <documentation>
            [WARN-A001] - No package description in UML model
        </documentation>
    </annotation>
    <import namespace="http://www.opengis.net/gml/3.2"
            schemaLocation="http://schemas.opengis.net/gml/3.2.1/gml.xsd"/>
    <simpleType name="UomDistanceType">
        <restriction base="string">
            <enumeration value="SM"/>
            <enumeration value="NM"/>
            <enumeration value="mm"/>
            <enumeration value="m"/>
            <enumeration value="km"/>
            <enumeration value="ft"/>
            <enumeration value="cm"/>
            <enumeration value="FL"/>
        </restriction>
    </simpleType>
    <simpleType name="UomAngleType">
        <restriction base="string">
            <enumeration value="rad">
                <annotation>
                    <documentation>Radian.</documentation>
                </annotation>
            </enumeration>
            <enumeration value="deg">
                <annotation>
                    <documentation>Degree.</documentation>
                </annotation>
```

Three Modeling Perspectives

- **Conceptual Model**
  - Platform independent

- **Logical Model**
  - Platform specific

- **Physical Model**
  - Implementation specific

ISO Conceptual Schema Modeling Facility (CSMF)

The CSMF allows distinction between the concept and the representation of the concept

- Developed by Object Modeling Group (OMG)

- ISO Blueprint for modeling

- Used extensively by TC211

  - ISO 19103:2005 'Conceptual schema language'

  - ISO 19109:2005 'Rules for application schema',

  - ISO 19107 'Spatial Schema'

  - ISO 19118:2005 'Geographic Information - Encoding',

  - ISO 19136 'Geographic information – GML

ISO Conceptual Schema Modeling Facilities (CSMF)

Platform Independent UML Model (PIM) — **Platform Specific UML Model (PSM)** — **Physical Implementation Model generated from PSM**
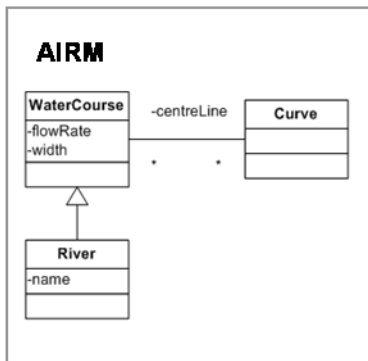
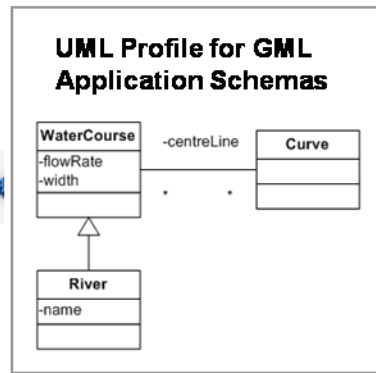AIRM → MDA Transform → UML Profile for GML Application Schemas → ShapeChange → GML Application Schema / JSON
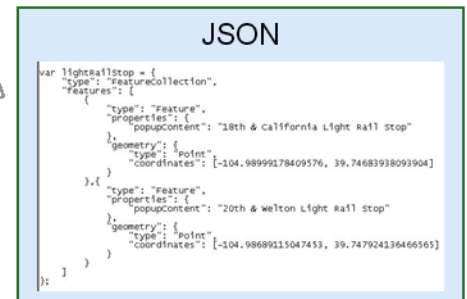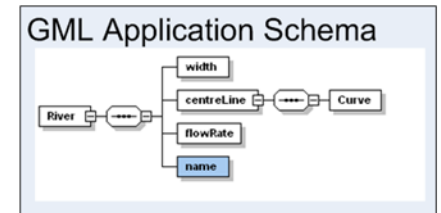
Adds platform specific stereotypes, tagged values etc. necessary for generating physical implementation model

MDA transform adding stereotypes
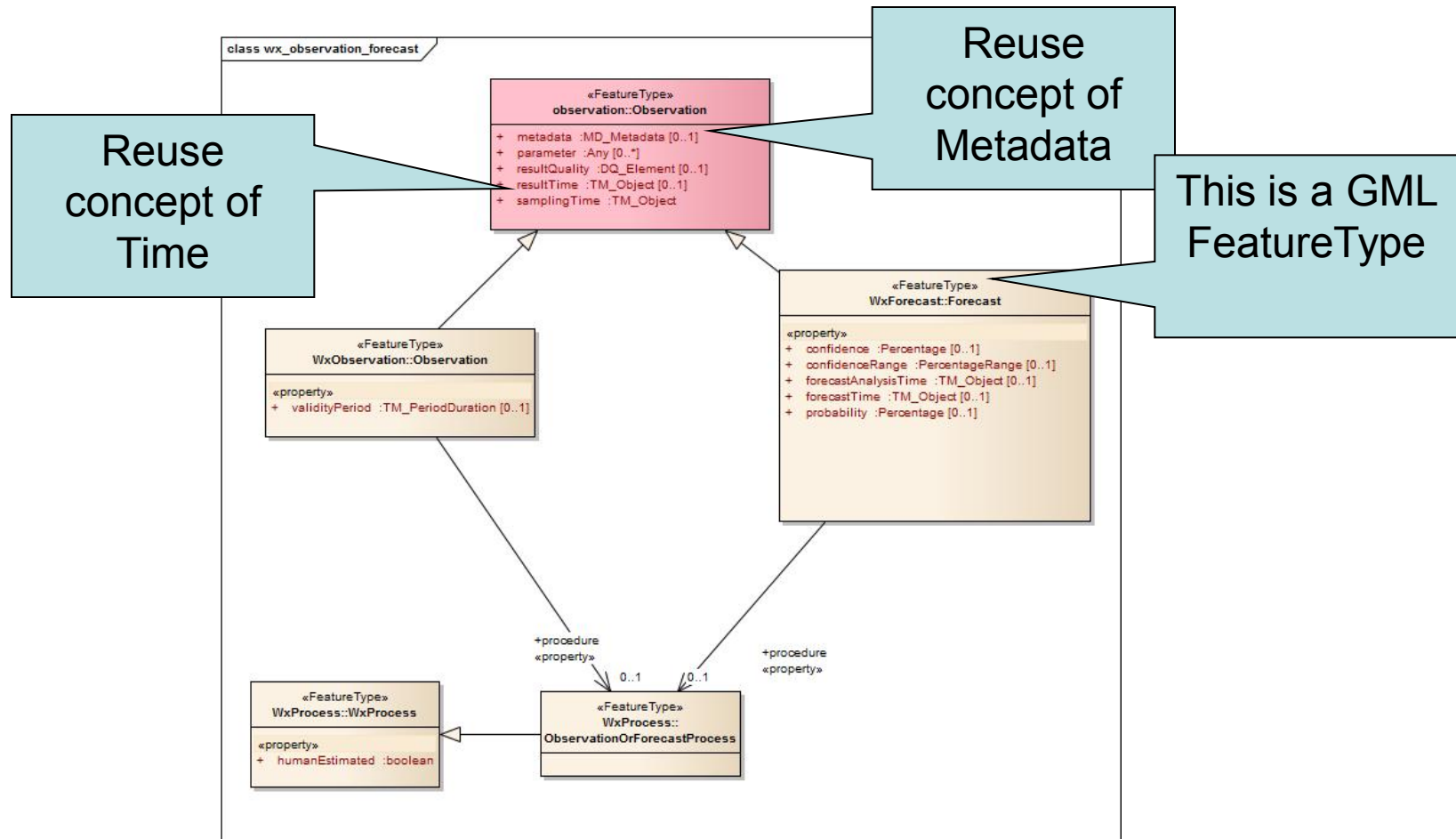
ShapeChange

ShapeChange converts ISO 19109 application schemas in UML to GML application schemas and other targets
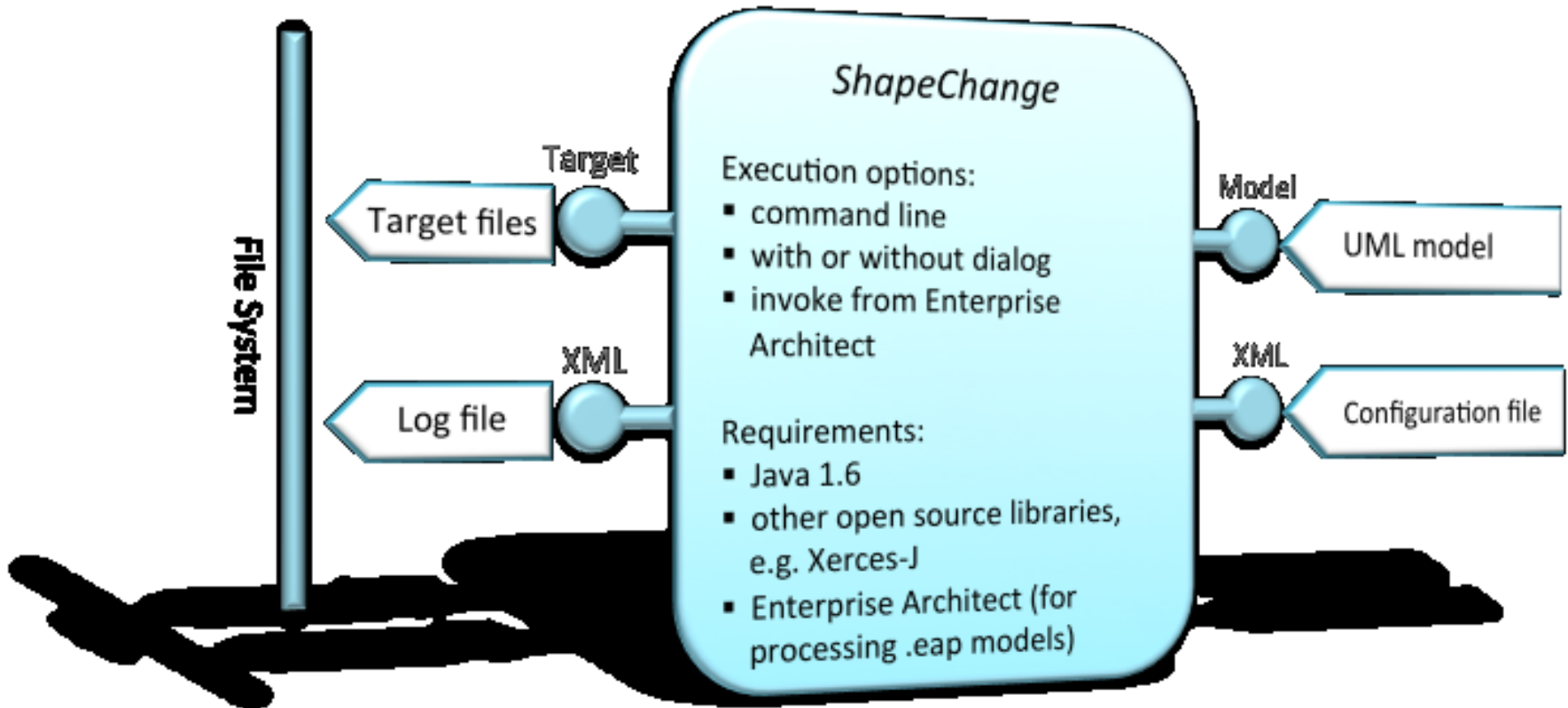
ShapeChange overview

Input options:

- Enterprise Architect via the EA Java API
- Rational Rose, ArgoUML, etc via XMI 1.0 / UML 1.3 files
- GSIP-compatible model stored in a MDB

Output options (selection):

- XML Schema
  - GML & ISO 19139 encoding rules plus extensions
  - Supports GML 2.1/3.1/3.2/3.3
- Feature catalogues
  - XML and HTML
- GML dictionaries for code lists and enumerations
- RDF/OWL/SKOS representations
- *JSON Schema (will be added in OWS-9)*

Putting it all into practice …

OWS-9 Kickoff – Aviation thread
AIRM to WXXM Derivation

"Lean and Mean WXXM"

Debbie Wilson and Clemens Portele
Snowflake Software & Interactive Instruments
May 14-16, 2012

© 2012 Open Geospatial Consortium, Inc.

Introducing the ATM Information Reference Model (AIRM)

The ATM Information Reference Model (AIRM) is used as a common reference for the different models that will be developed as part of SESAR. The AIRM represent civil, military and civil-military information constructs relevant to ATM

- AIRM provides the conceptual application schema defined as UML from which different physical models (XML, JSON) can be derived
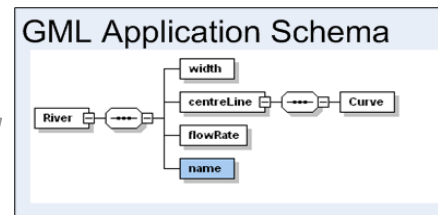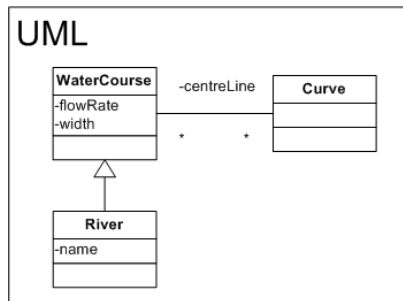
OWS 9 - AIRM to WXXM Objectives

- Develop tools for generating physical ATM Exchange Models (**XM) from AIRM
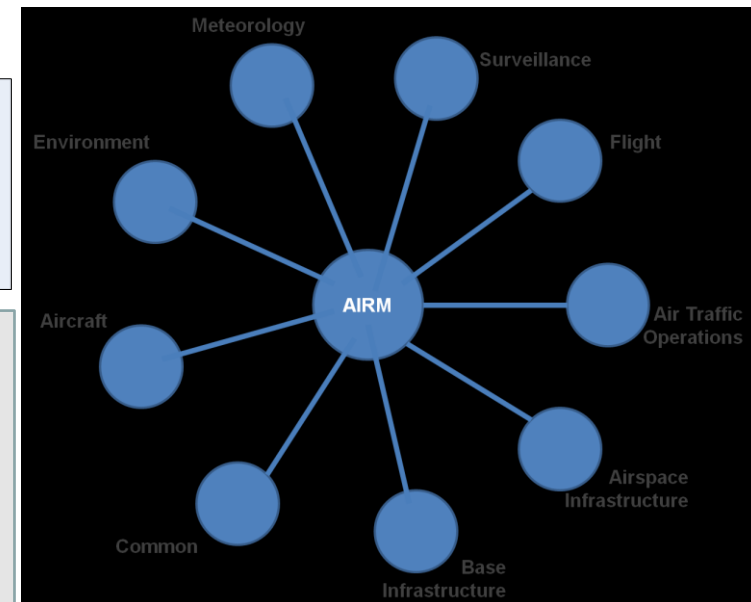
- Develop and document AIRM to ISO 19109 UML Application Schema mapping rules

- Define any additional mapping rules needed for programmatic derivation of AIRM

- Demonstrate transforming AIRM Meteorology package into two physical models:
  - XML based on GML 3.2.1
  - JSON

AIRM to ISO 19109 UML Application Schema

1. Identify and document rules for converting AIRM to ISO 19109 Application Schema

2. Identify requirements for using ISO 19136 UML Profile or optionally develop an AIRM UML profile

3. Update AIRM Meteorology package to implement ISO 19109 Application Schema and UML Profile

Programmatic derivation of WXXM

- Programmatic derivation of the two WXXM physical models: GML 3.2.1 and JSON

- Any additional programmatic rules needed to derive WXXM GML 3.2.1

- UML to JSON encoding rules shall be developed
  - Assumption: Output schema will be expressed in JSON Schema
  - Two options for geometries: GeoServices JSON or GeoJSON

Deliverables

1. Rules for converting AIRM into UML ISO 19109 Application Schemas

2. WXXM to GML 3.2.1 / JSON derivation rules and user instructions

3. WXXM GML 3.2.1 application schema and example data

4. WXXM JSON schema and example data

The Benefits of Model Driven CSMF Approach

- Separates implementation from domain understanding
- Encourages consistent and repeatable approach
- Encourages reuse
- Enforces normative documentation
- No bespoke development or hand editing
- One model, many implementations:
  - XML, JSON, GML, Oracle, SQL Server, Java, C++ …
- Far more than a paper document
 - All implementation starts from the model

In Conclusion

- Irrelevant of implementation it's important to
  - Standardise on one approach
  - Provide a common understanding

- Reuse across ATM models is key
  - Modeling decisions can have huge cost implications down the line
  - Reinventing the wheel on a per model basis:
    - Increases implementation costs
    - Increases implementation complexity

- CSMF paired with ISO 19*** provides proven best practice for modeling and is the ideal candidate for ATM modeling

In Summary

One Ring to rule them all,
One Ring to find them,
One Ring to bring them all,
and in the darkness bind them.

J.R.R Tolkien,
The Fellowship of the Ring
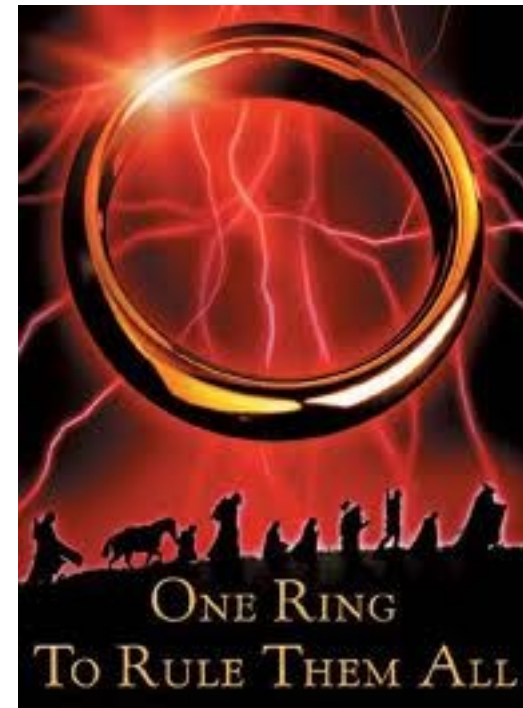
In Summary

One Approach to capture them all,
One Approach to model them,
One Approach to implement them all,
and in the NAS exchange them.

Ian Painter
Snowflake Software
ian.painter@snowflakesoftware.com
http://www.snowflakesoftware.com
@iapainter