Boeing Technology
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2007 ICNS Conference

Air Traffic Software Factory

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Agenda

- **Problem Statement**
- **Approach**
- **ATM Software Factory**
- **ATM Data Language**
- **Summary**

Problem Statement

- **It is difficult for large organizations to upgrade or replace their legacy systems**
- **Impact on ATM**
  - **Opportunity Cost[1] – Current ATM system limits capacity**
- **Significant investment in COTS products**
  - **Much less emphasis on data and information layer**
- **Network Enabled Operations**
  - **Dramatically increased interoperability requirements**

1 (2002) The National Economic. Impact of Civil Aviation DRI-WEFA Inc. http://www.gama.aero/dloads/DRI-WEFA_EconomicImpactStudy.pdf

Network Enabled Operations: Data Everywhere

CAT33 binary position report:

```
ff ff 80 21 00 03 10 71 20 ba 00 aa aa aa 80 00
12 7c 00 7f 7e 39 a7 10 00 00 1f 20 01 68 02 f1
04 b0 0c 20 b1 00 00 00 0c 80 00
```

ASDI position reports:

```
E6E606215324KZMATZ USA1442/672 430 350 2051N/06809W
E6E706215324KZMATZ TAI583/987 429 310 2756N/08428W
```

TAAM .gfdr position report:

```
21,22:42:41     65      tvalt   NEE3762 SW4     4       1       EN_ROUTE        336     10430
21,22:42:41     65      tvtas   NEE3762 SW4     4       1       EN_ROUTE        336     156
21,22:42:41     65      tvias   NEE3762 SW4     4       1       EN_ROUTE        336     131
21,22:42:41     65      tvhdg   NEE3762 SW4     4       1       EN_ROUTE        336     39
21,22:42:41     65      tvgs    NEE3762 SW4     4       1       EN_ROUTE        336     156
21,22:42:41     65      tvroc   NEE3762 SW4     4       1       EN_ROUTE        336     1400
21,22:42:41     65      tvmach  NEE3762 SW4     4       1       EN_ROUTE        336     0.24
21,22:42:41     65      tvdist  NEE3762 SW4     4       1       EN_ROUTE        336     13
21,22:42:41     65      tvfuel  NEE3762 SW4     4       1       EN_ROUTE        336     83
21,22:42:41     65      latvlong        NEE3762 SW4     4       1       EN_ROUTE        282.855200      37.676934
```

FlightViz .csv position reports:

2.97,11:32:03,47.54026,-122.311113,25.634266,0.451512,-0.004494,143.215184,3.842 13,3.826944,92.201447,0,92.201447,0,down,down,down
3.96,11:32:04,47.540246,-122.311098,25.634947,0.466337,0.01047,143.20319,3.59155 6,3.57637,92.198884,0,92.198884,0,down,down,down

EDGE position import:

```
47.5400433333333 -122.31559833333 0 254306637
47.5400433333333 -122.3156 0 254306671
```

Air Traffic Software Factory

N² Tower of Babel

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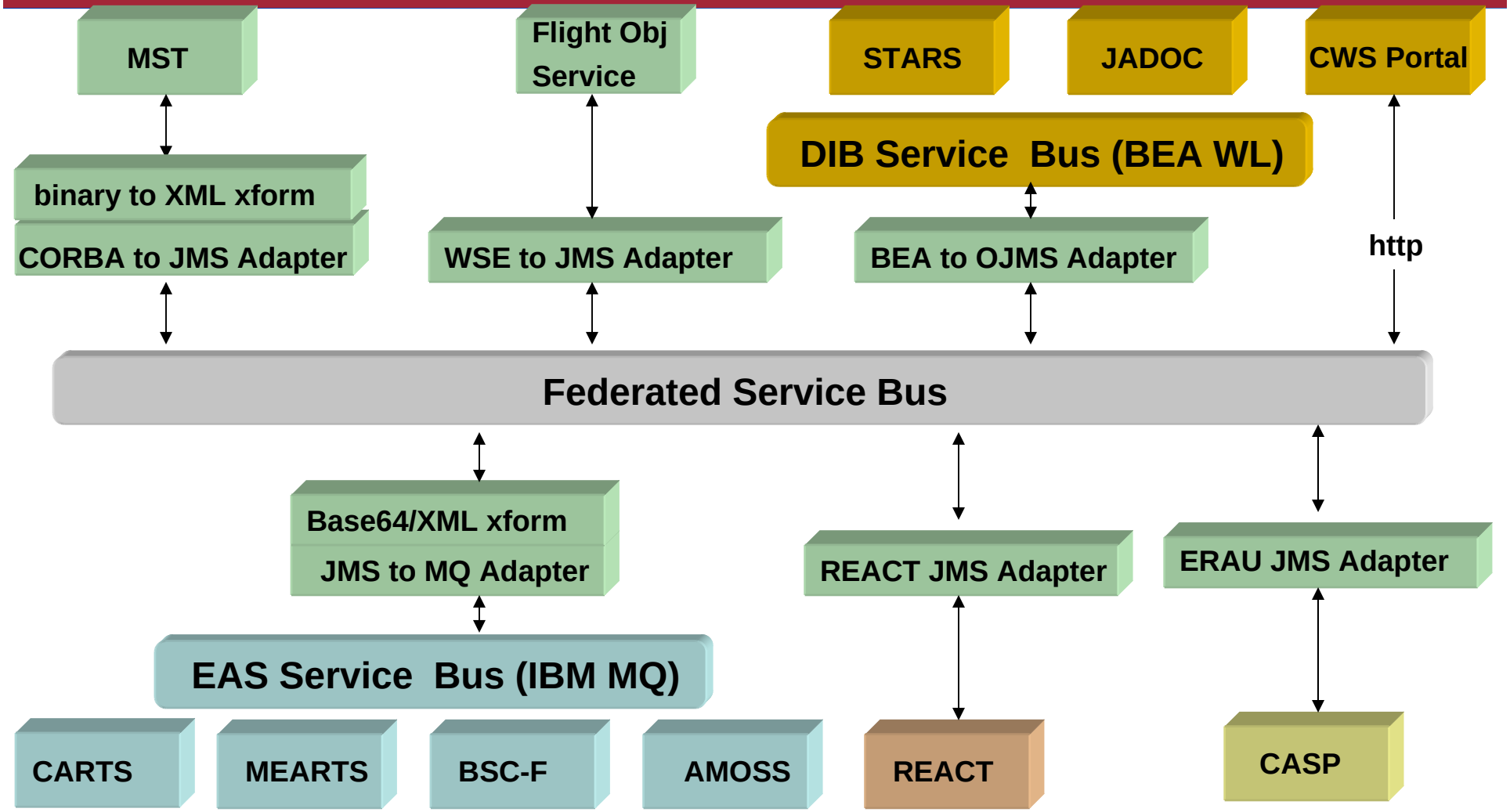
Advanced Air Traffic Management



Joint NEO Security Demo 2005/2007

Approach

- ***Research***
- Given: Aviation uses many unusual representations
  - **Create a limited software factory for use in the air traffic domain**
  - **Focus: Data Interoperability**
  - **Benefits:**
    - **Capture domain knowledge**
      - increase reuse, reduce errors
    - **More reliable systems**
    - **Shorter development time**
      - reduced cost
    - **Allow organizations to share information**
      - improved efficiency, cost, security

Air Traffic Software Factory

Data Interoperability Software Factory

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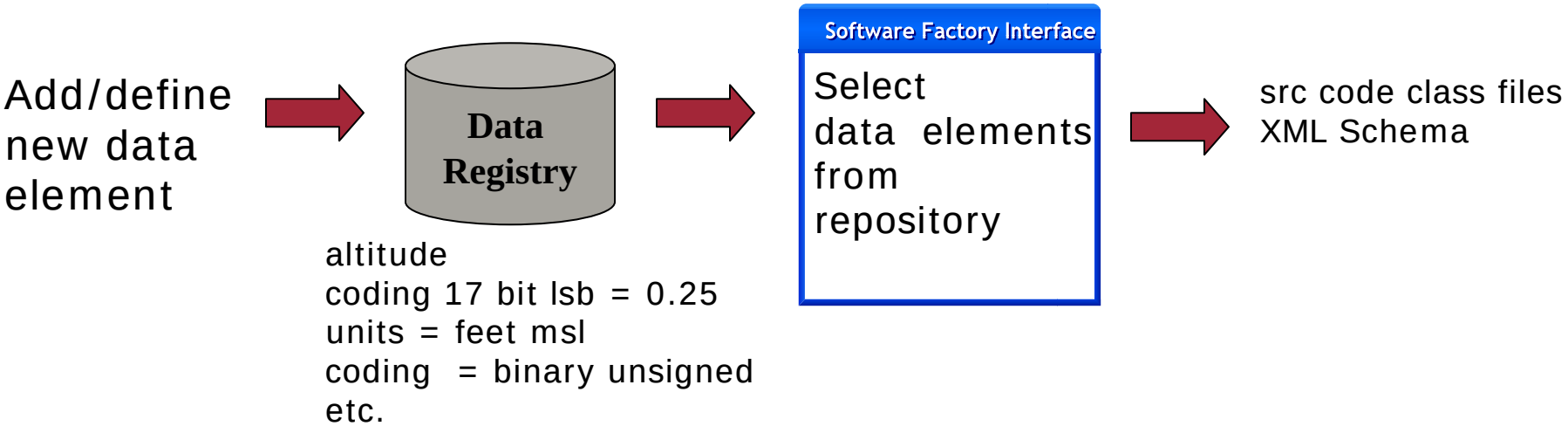
Advanced Air Traffic Management



Registry - The registry is a data catalog. Traditionally software interfaces and data structures are created by writing documents such as Interface Control Documents, Interface Design Specs, IRD, IDD etc. Use of the registry allows a designer to create the specification from a managed set of data items. The capability to add data through the use of limited domain specific data language is provided.

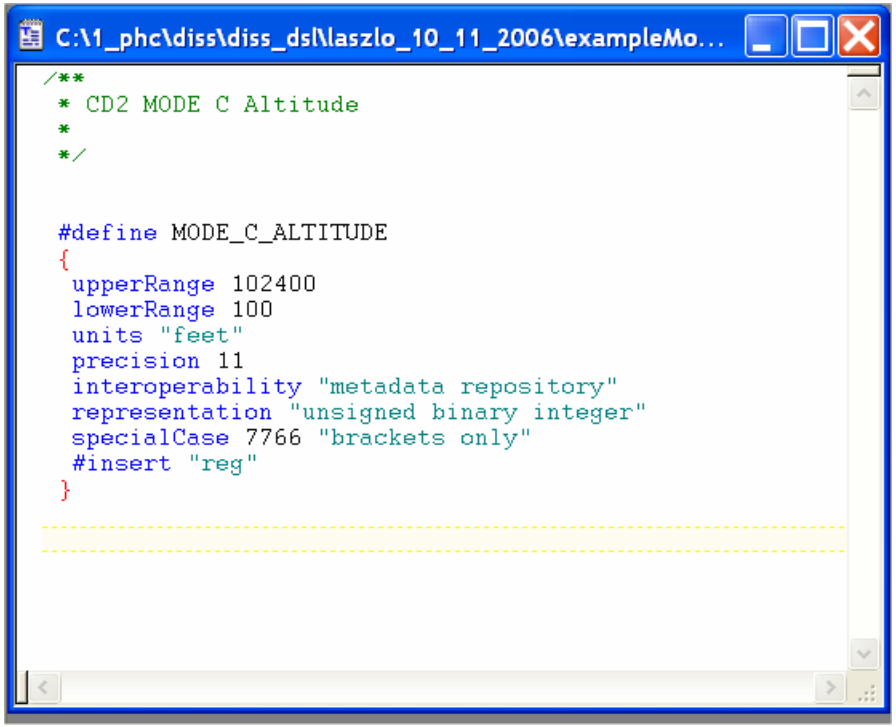
Factory – The designer creates data structures by specifying data elements from the registry. When creating messages the designer selects input format and desired output format.

Output – The output is an XML Schema or set of src files (classes)

ATM Data Language

- **A simple language for the specification of ATM data elements**
  - **Still an introductory prototype**

- Define element
  - #define MODE_C_ALTITUDE
- Identify characteristics
  - upperRange 102400
  - lowerRange 100
  - precision 11
- Apply to registry
  - #insert “reg”



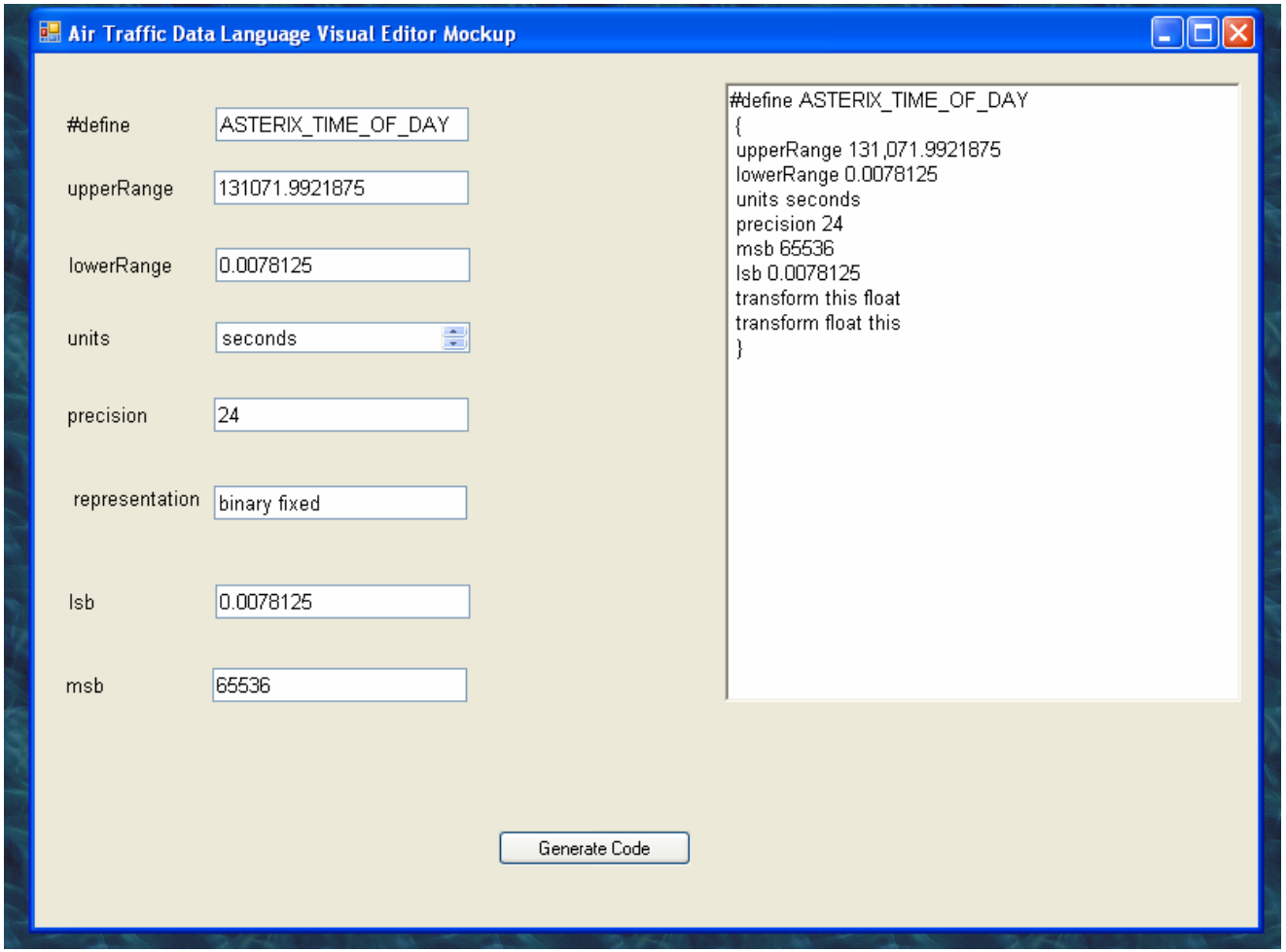
ATM Data Language - Messages

- **Provides the capability to assemble individual data elements**
- **Message or data structure**
- **#retrieve "repository" "element"**

C:\1_phc\diss\diss_dsl\laszlo_10_11_2006\exampleMessage...

```
#message ATM_MESSAGE
{
        /**
         * CD2 MODE C Altitude
         */
         #define MODE_C_ALTITUDE
         {
          upperRange 102400
          lowerRange 100
          units "feet"
          precision 11
          interoperability "metadata repository"
          representation "unsigned binary integer"
          specialCase 7766 "brackets only"
         }
         /* retreive an element from the repository */
         #define element
         {
          #retrieve  "repository" "element"
         }
         /**
          * 24 bit ASTERIX TIME of DAY in seconds
          */
          #define ASTERIX_TIME_OF_DAY
          {
          upperRange 131,071.9921875
          lowerRange 0.0078125
          units "seconds"
          precision 24
          msb 65536
          lsb 0.0078125
          transform "this" "float"
          transform "float" "this"
         }
}
```

- **Visual Template for specification of ATM data types and/or messages**



Source Code Generation


```
/**
 * This is an example of a hand written class for performing
 * data conversion. This class converts an IEEE 754 double
 * to a 24 bit lat/long as used by ADS.
 * The goal of the ATM data software factory
 * is to automatically generate code with this type
 *  functionality.
 *
 * Paul Comitz September 2006
 */
using System;
using System.Collections.Generic;
using System.Text;

namespace LatLong
{
    public class LatLong
    {
        private double position;
        private bool isLat;
        private byte[] cat33Position;

        public LatLong(double data, bool isLat)
        {
            this.position = data;
            this.isLat = isLat;
            cat33Position = new byte[3];
            for(int i =0; i < 3; i++)
                cat33Position[i] = 0;
            cat33Position = this.cat033LatLong(position, isLat);
        }
```

etc.

Vision

- **A software factory can provide a first class tool for creating messages. The elements used to compose message are defined in a metadata repository. Every system with access to the repository can read any message composed of elements from the repository. We publish and update repositories instead of ICDs.**

Summary/Planned Activities

- **Complete development of language specification**
- **Select metadata registry schema**
- **Continue building prototype**
  - **Emphasis on code generation**
    - **not currently implemented**
- **Questions**
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