Real-Time CORBA Experiences in an Avionics Domain

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OMG Real-Time Embedded and Distributed Object Computing Workshop

June 7, 2001
**Bold Stroke Architecture**

- **Hierarchical Component Based Architecture**
  - Real-Time CORBA (TAO)
- **Enhanced Platform Support**
  - Added support for X86 boards
- **Real-time Operating Systems**
  - Redhat Linux
  - Linux RT (soon)
  - SunOS
  - VxWorks (Tornado native)
  - Windows 2000
- **Transitioned to FA-18, F-15, T-45, AV-8B, UCAV Programs**
- **Scheduling Framework**
  - Dynamic Strategies
  - Hybrid (RMS/Dynamic)
- **Resource Management**
  - Rate adaptation
- **Reconfiguration Support**
  - Transition Support
- **Framework for Application Development**
- **Tool Integration**
  - MATLAB Integration
  - Integration with other tool suites
Lessons Learned from Bold Stroke

Application First Architecture Process

1. Develop Architecture Forces
   Use Forces to Drive Architecture Development Decisions

2. Develop and Document Application Architecture
   Use Architecture To Develop System

3a. Develop Application Components
3b. Select Domain Independent Middleware
3c. Develop Architecture Specific Middleware Services

Use Concrete Development to Identify Architectural Issues and Refine Architecture
Research Programs Built on Bold Stroke

Bold Stroke

- SEC
- OSAT-I
- OSAT-II
- HC SEC
- ASFD
- RTJES
- NEST
- ASTD
- WSOA
- PCES

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### Run-Time Platform Programs

#### Open Systems Avionics Technology 1 & 2

**AV-8B**

- First flightworthy application of RT CORBA and Ada95
- Static Scheduling

#### Adaptive Software Demonstrations

- Dynamic Scheduling
- Performance feedback and adaptive resource mgt

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**Legacy OFP**

- **Legacy Wrapper**
- **OSAT I Software**
- **OSAT II Software**

**Mission Computer**

- **AV-8B OFP (C)**
- **Wrapper (C++)**
- **Common OFP**
  - Ballistics (Ada95)
  - NAV (C++)
  - Radio (C++)
  - ORB (IDL)

**PowerPC Processor**

**POSIX Application Program Interface**

**POSIX**

**Second OFP**

- **Ballistics (Ada95)**
- **NAV (C++)**
- **ORB (IDL)**

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**Ada JPI, AFRL, OS-JTF Program**

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**AFRL Program**

**Real-Time CORBA component**
Weapons System Open Architecture

- ORB Interoperability (ORBexpress and TAO)
- Legacy System Interoperability
- Transition of Quality of Service Management Technology
- Adaptive scheduling and resource management
- Pluggable protocols over tactical data network

AFRL IFTA, DARPA ITO, OS-JTF Program
Software Enabled Control

Open Control Platform

- Adds support for dynamic system reconfiguration

High Confidence Open Control Platform

- Time/Space Partitioning
- On-line System Verification

High Criticality Architecture

- High Criticality (HCr) Applications (e.g. flight controls)
- HCr Application Services
- ACE Subset or Equivalent

Lower Criticality Architecture

- Lower Criticality (LCr) Applications (e.g. mission processing)
- LCr Application Services
- TAO
- ACE

Partitioning Layer (ARINC 653 or equivalent)
- Operating System
- Core System Services

Configurator
Application
Infrastructure Services
Existing SEC OCP
Time / Space Partitioning Middleware

COORDINATED OPERATION OF HIGHLY AUTONOMOUS UAVS

C = \frac{1}{2} \rho V^2 S L

\frac{m}{V} = \frac{1}{T-D-W} \sin \alpha

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DARPA ITO Programs
Future Programs

Program Composition of Embedded Systems
Advancing Aspect Oriented Programming Research for Embedded Systems
- Develop tool for building single component from aspects
- Develop multi-component analysis tool
- Extend framework with real-time database from University of Virginia
- Leverage run-time platform for testing and integration

DARPA ITO Program

Real-Time Java for Embedded Systems
Investigating RT Java for avionics applications
- Selected Module(s) (Java)
- Java Class Libraries
- RT Java Virtual Machine(s)
- Operating System
- Board Support Package
- Hardware (CPU, Memory, I/O)
- Infrastructure Services (Bold Stroke)
- Software Layer Legend
- Define Requirements
- Implement Tests
- Perform Experiments & Demonstrations
- Investigate Critical Real-Time Concerns
- Collect Metrics
- Feed Comparison Data back to Industry Groups

AFRL Program

Networked Embedded Software Technology
Very large number of small processing nodes (>100,000)

Traditional Approach
Sensor Node
- Data acquisition and raw signal processing only in sensor node

NEST Approach
Nodelet
- Addition of middleware capabilities and coordination services

Computing Node
- Node
- Application
- Architecture Specific Services
- Distribution
- Portability
- RTOS
- BSP

Software Layer Legend
Appl
- Fusion
- Signal Processing
- Data Acq

Appl Services
- Quality Objects
- RTARM

TAO
- ACE
- Operating System
- Core System Services

DARPA ITO Program

Extending Real-Time Middleware Platforms

DARPA ITO Program
Lessons Learned from Research Programs

- Middleware for non-computer scientists is evolving to shrink wrap capabilities

- Existing avionics applications are not fully utilizing all the latest middleware capabilities

- ORB interoperability exceeded expectations

- Test community verification processes need to be refined to deal with dynamic middleware

- Pluggable protocols is an enabler of new system capabilities in a tactical environment