Model Driven Middleware

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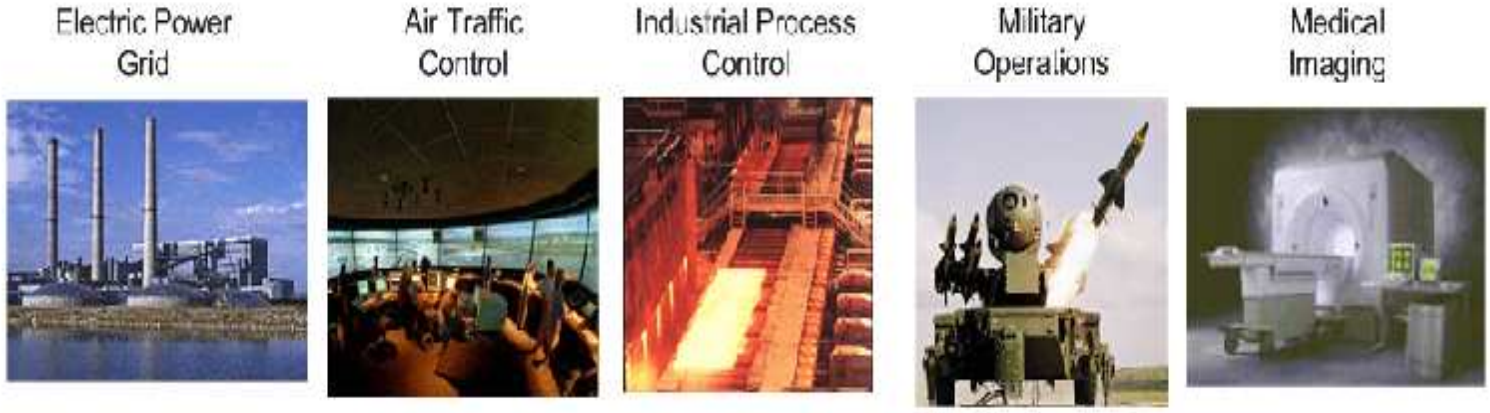
Overview

Applying Model Driven Architectures to Distributed Systems.

1. Distributed Real-Time Embedded Systems
2. Component Middleware
3. Model Driven Middleware
4. Existing Work on Real-Time MDM
5. Our Vision for Fault-Tolerant, Secure MDM

Distributed Real-Time Embedded (DRE) Systems



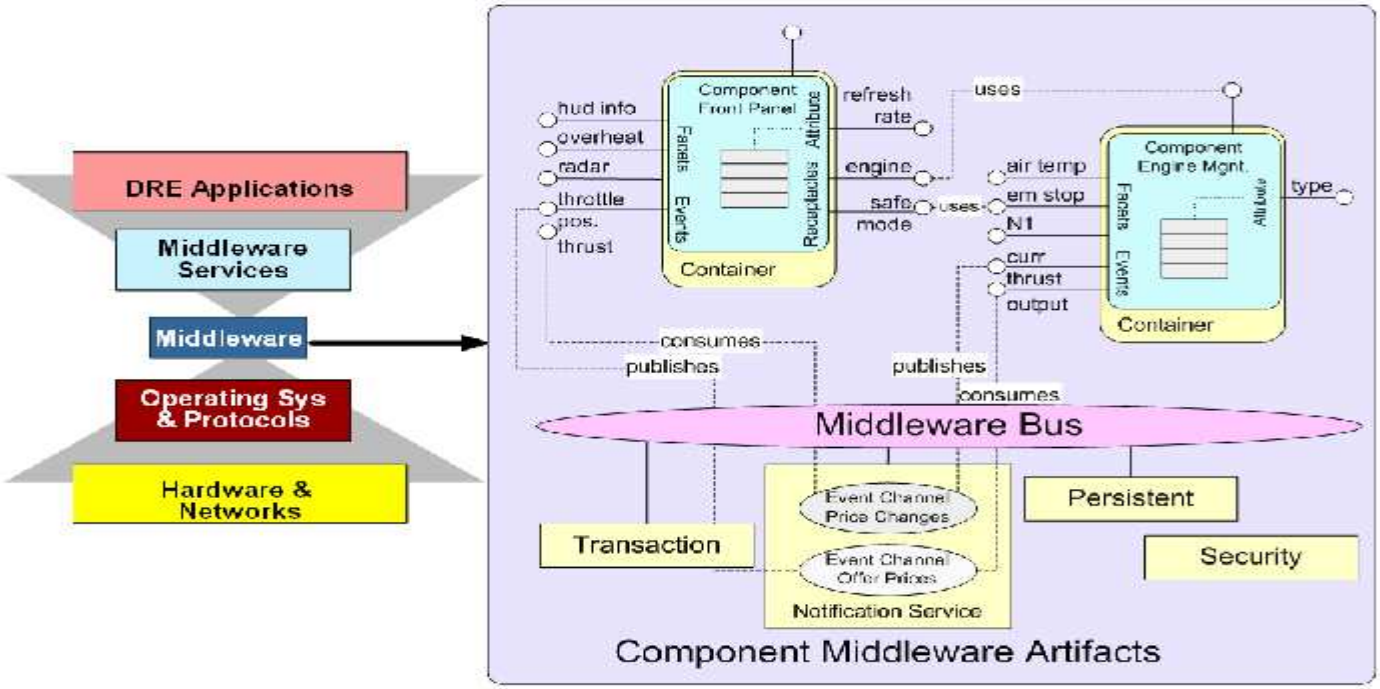
Networks:

- Large-scale
- Heterogeneous
- Dynamic

DRE Requirements

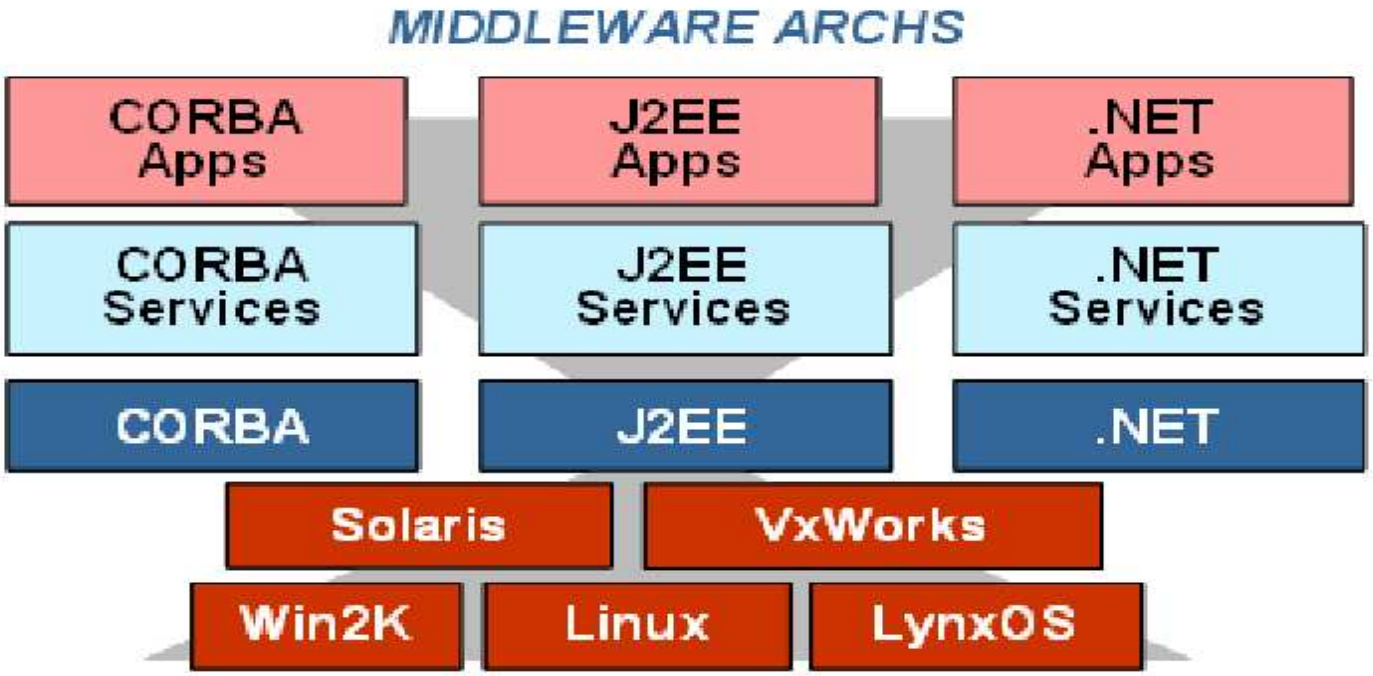
- **Real-time**:
  - low latency, bounded jitter
- **Availability**:
  - bounded fault propagation/recovery
- **Security**:
  - authentication, authorization
- **Physical Requirements**:
  - weight, power consumption, memory footprint

Component Middleware



- Control of QoS properties
- Platform independence
- Cost reduction

Middleware Architectures



- Real-time CORBA
- Fault-tolerant CORBA

Unresolved Challenges

- Isolation of applications from middleware platforms
- Composing applications from components
- Configuring component middleware
- Automated deployment
- Satisfying multiple QoS properties simultaneously

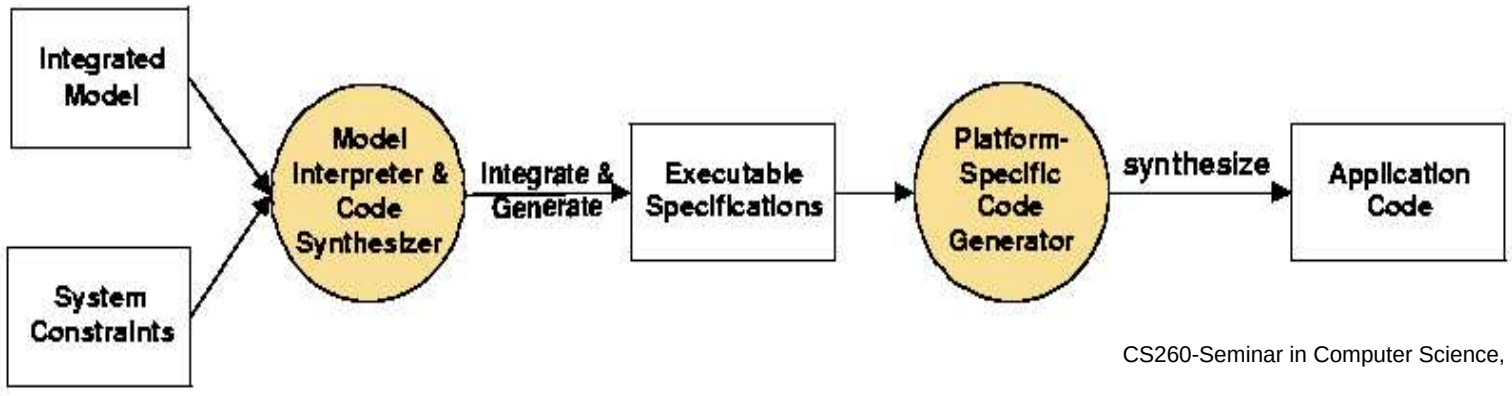
Ad hoc (manual) techniques:

- Do not scale well
- Are tedious
- Are error-prone
- Lack verification and validation mechanisms

MDA to the rescue...

MDA can express application functionality and QoS requirements at higher levels of abstraction than by using 3GLs:

- Model properties
- Analyze requirements
- Synthesize code
- Provision deployment

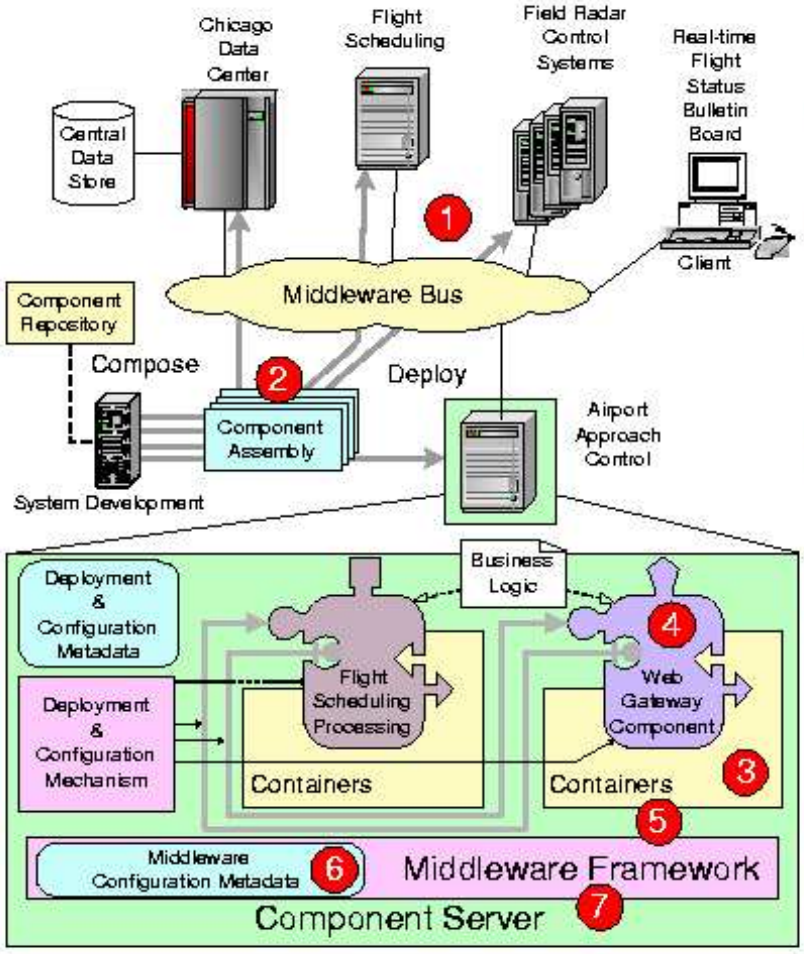


Model Driven Middleware

Bridge the gap between specification and implementation:

- Compose applications from reusable components.
- Synthesize new extended components.
- Automate the configuration of QoS aspects.
- Model the interfaces of components in a standard way.
- Easily handle changes in components.

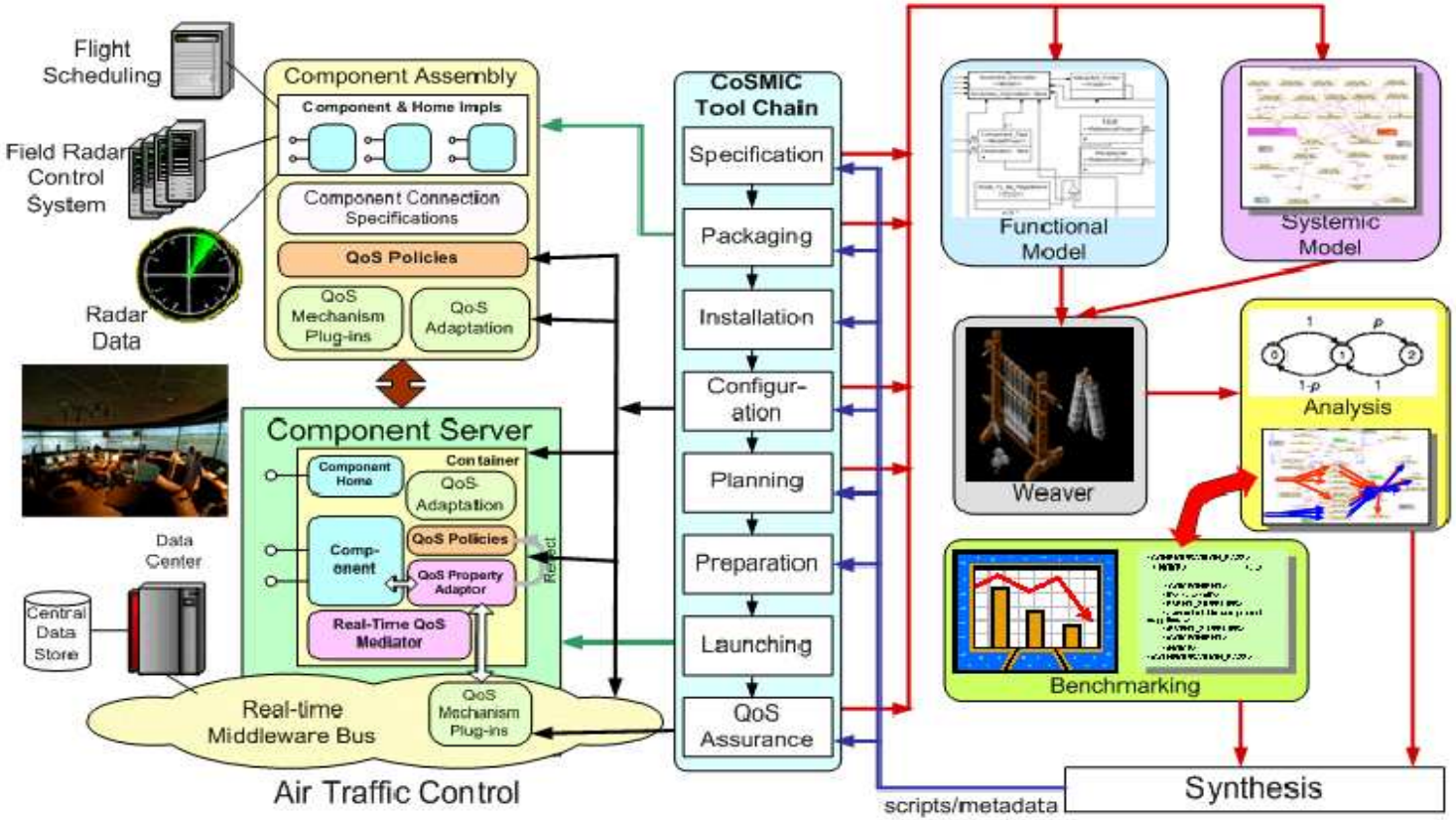
MDM Example



1. Configuring and deploying an application services end-to-end
2. Composing components into application server components
3. Configuring application component containers
4. Synthesizing application component implementations
5. Synthesizing dynamic QoS provisioning and adaptation logic
6. Synthesizing middleware-specific configurations
7. Synthesizing middleware implementations

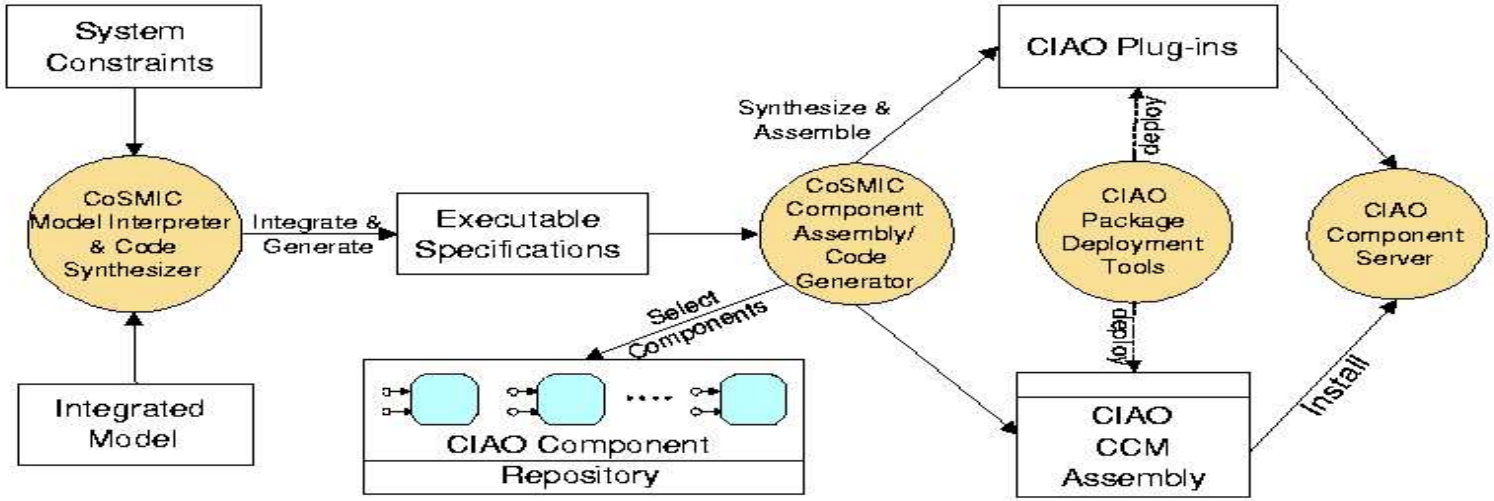
Existing Work on Real-Time MDM

Component Synthesis using Model Integrated Computing (CoSMIC - Douglas Schmidt - Vanderbilt University)



CoSMIC

- Each CoSMIC tool synthesizes metadata in XML for use in the underlying middleware.
- CoSMIC uses a Platform Specific Model to integrate the modeling technology with the CIAO QoS-enabled component middleware.



CoSMIC Details

CoSMIC Modeling Paradigms:

- OCML (Options Configuration Modeling Language) to model configuration parameters and constraints and synthesize the middleware configuration metadata.
- CADML (Component Assembly and Deployment Modeling Language) to model component assembly and deployment.

Our Vision for Fault-Tolerant, Secure MDM

Systems able to continue normal operation despite the presence of hardware or software faults:

- Communication network failures
- Node failures
- Object failures

Different security levels and domains:

- Authentication
- Authorization

Goals

Fault-tolerance:

- Automatic creation and allocation of replicas
- Automatic maintenance of replica consistency
- Automatic fault detection and recovery

Security:

- Automatic admission control
- Automatic conformance to specific security levels

System Architecture

- Replication Manager
- Fault Detector
- Admission Manager

System Parameters:

- Probability of failure for each component
- Replication degree of each component
- Security level satisfied by each component
- Access privileges of each component

A Model-Driven Approach

- Modeling of components
- Configuration of parameters
- Deployment
- Fault-tolerance and security assurance

Conclusions

- Distributed Real-Time Embedded Systems are increasingly being developed using component middleware.
- Unresolved challenges include isolation of applications from the middleware platform, automatic application composition, and automatic middleware configuration.
- Model Driven Architectures can provide a scalable and verifiable solution to the above.
- Model Driven Middleware can automate the creation, configuration, and deployment of Real-Time, Fault-Tolerant, Secure distributed applications.

References

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2. Aniruddha Gokhale et al., “ Model Driven Middleware: A New Paradigm for Deploying and Provisioning Distributed Real-time and Embedded Applications”, Elsevier Journal of Science of Computer Programming: Special Issue on Model Driven Architecture, 2004.
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5. The OMG Fault Tolerant CORBA Specifi cation v1.0, 2000.
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Thank you!

Questions/Comments?