Software Enabled Control: Background and Motivation

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CS and Controls

Enterprise

Internet

Computer Science

Desktop

Controls

Embedded

Real applications

Real applications
Challenges

Design control systems that
• are adaptable to new environments
• can be reconfigured easily for new missions and/or during run-time
• have plug-and-play extensibility
• work across various platforms and various languages
Enabling Technologies

• **Software Components**
  – Generic Patterns

• **Distributed Computing**
  – Networked Communication Methods
  – Middleware

• **Layered Architectures**
Software Components

First Application Domain

Second Application Domain

encapsulation: keep the interface to other components constant
Components of an Airplane

Identify generic patterns to build components for reusability
Enabling Technologies

• Software Components
  – Generic Patterns

• Distributed Computing
  – Networked Communication Methods
  – Middleware

• Layered Architectures
Organization of Computers

Centralized

Hierarchical

Decentralized

Distributed
Distributed Computing

Advantage: connecting heterogeneous components over a communication network

Key to success: remote procedure calls (remote method calls)
Communication Models

Client-Server

Communication Channel

Peer-to-Peer

Publish-Subscribe
Role of Middleware

For single processors or for distributed computing
Types of Middleware

• DCOM
  – works for interconnected Windows machines
  – not for real-time computation

• Java-based (Jini)
  – well-suited for Internet operations
  – has discovery service
  – not for real-time computation

• CORBA
  – well-established standard for enterprise applications
  – handles communication services
  – has real-time extensions
Flight Control Example

Guidance

Stabilizing Controller

Aileron

Elevator

Rudder

Sensor Readings

Desired Trajectory

Sensor Readings

Actuator Commands

Aileron Command

Elevator Command

Rudder Command

Publish-Subscribe Middleware

Altitude

Altitude, Location

Altitude

Altimeter

GPS

IMU
State of the Art

Computer Science
+ distributed computing (DCOM, CORBA, Java)
+ interoperability
+ reconfiguration
+ reusability
- real-time computation

Controls
+ distributed computing (CAN)
+ real-time computation
- interoperability
- reconfiguration
Future Considerations

Design for Multitasking

Analyze effects of QoS parameters on system stability and performance

Set guidelines for selection of QoS values