Applying Adaptive RT Middleware to Grand Challenges of COTS-based RTMCS

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Introduction: the RTMCS Domain

- Diverse inputs
  - e.g., sensors, operator, C2

- Diverse outputs
  - e.g., actuation, displays

- Diverse resource management goals
  - e.g., timeliness, responsiveness, utilization
Grand Challenges for Real-Time COTS Middleware

- Determining *policies* to meet RTMC QoS requirements
- Determining *mechanisms* to enforce these policies
- Determining *patterns* for RTMC systems to balance diverse/competing QoS requirements
- Achieve systematic reuse using *adaptive* COTS middleware
Requirements for Lower-level Middleware

- Encapsulate details of low-level services
  - *e.g.*, communication, concurrency
- Provide flexible mechanisms for managing underlying resources
  - *e.g.*, CPU: dynamic dispatching queues, static dispatch priorities
  - *e.g.*, network: make resource reservations, monitor latency
- Provide low-level QoS management abstractions
Requirements for Higher-level Middleware

- Embed configurable policies - e.g., cancellation points along a time-critical path
- Flexibly specify QoS attributes - e.g., deadlines, periods, throughput reservations
- Encapsulate details of higher-level services - e.g., security, transactions, fault-tolerance, persistence
- Standardization is necessary to promote reuse - **caveat**: avoid excluding approaches crucial to key use-cases
• Desirable for many use-cases, but not feasible for all
  – Start with well-known policies: *e.g.*, RMS, EDF, MLF, MUF
  – Identified decision points along an end-to-end path
  – Notification of failure along an end-to-end path
Necessary Exclusions

- No restrictions on which QoS attributes are used
  - e.g., execution time, period, criticality

- No feature deprecation in COTS middleware standards
  - unless a fundamental contradiction arises

- No restrictions on non-real-time issues
  - e.g., fairness, throughput
"Path" is key for abstraction for end-to-end QoS activities, e.g., routes and virtual circuits.

- Network paths: e.g., Scout
- OS paths: e.g., REMOS
- Middleware paths: e.g., TAO, QuO, TMO, DARWIN

Then, can configure QoS paths in higher-level middleware: e.g., TAO, QuO, TMO, DARWIN

Need lower-level middleware components with well-defined QoS properties: e.g., ACE, REMOS
Unobtrusive monitoring must occur at all architectural levels: e.g., application, middleware, OS, network.

Adaptive reconfiguration necessary at all levels

- Higher levels suggest longer time scales

Visualization capabilities are needed for system design, validation, and maintenance.
Concluding Remarks

- Identifying the patterns, policies, and mechanisms for RTMC systems is crucial
  - Paths offer a fundamental abstraction for unifying QoS attributes end-to-end
  - Patterns for composition of components along a path segment are needed
- Applying adaptive real-time COTS middleware can simultaneously
  1. Meet the stringent and diverse QoS requirements of RTMC systems
  2. Offer improved software cost through reuse
For Further Information

- **TAO:**
  www.cs.wustl.edu/~schmidt/TAO.html

- **ADAPTIVE Communication Environment (ACE):**
  www.cs.wustl.edu/~schmidt/ACE.html

- **Quality Objects (QuO):**
  www.dist-systems.bbn.com/tech/QuO/

- **These slides:**
  www.cs.wustl.edu/~cdgill/grand_challenges.ps.gz