Multi-Aspect Adaptive Middleware for Distributed & Embedded Real-time Mission-Critical Systems

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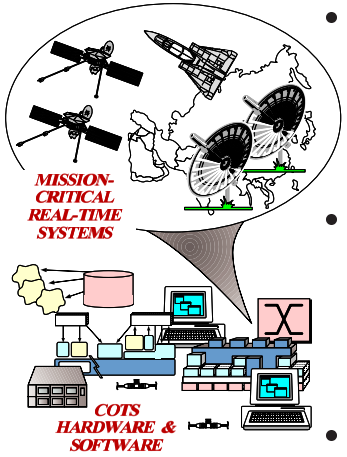
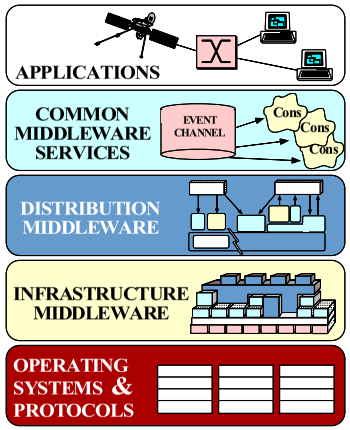
DARPA Program Synopsis

Motivation: the COTS Hardware & Software Crisis



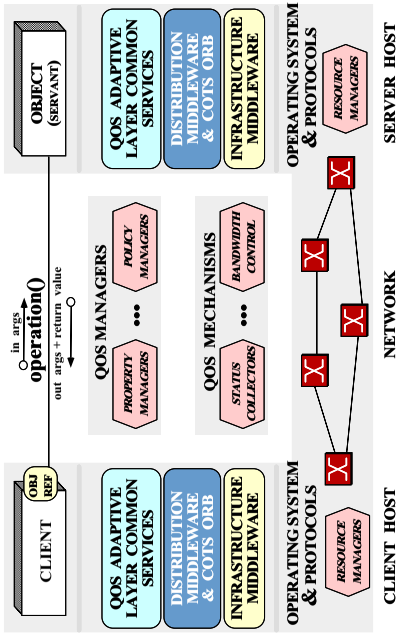
- **Context**
  - Mission-critical systems increasingly use COTS hardware & ***middleware***
  - Middleware alleviates many ***inherent*** and ***accidental*** software complexities
- **Problems**
  - Achieving multiple QoS aspects ***simultaneously*** is hard
    - *e.g.*, efficiency, scalability, predictability, dependability, security, evolvability, ***and*** flexibility
- **Proposed Solution**
  - ***Multi-Aspect Adaptive Middleware***

Problem: Lack of QoS Support in COTS Middleware



- Most mission-critical systems require QoS guarantees
- Building these systems manually is inefficient, *e.g.*:
  - Hard to ride COTS technology curve
  - Hard to evolve to new environments/requirments
- Conventional COTS middleware does not support QoS effectively
  - Lack of QoS specification & enforcement
  - Lack of real-time features and optimizations
  - Lack of layered resource management

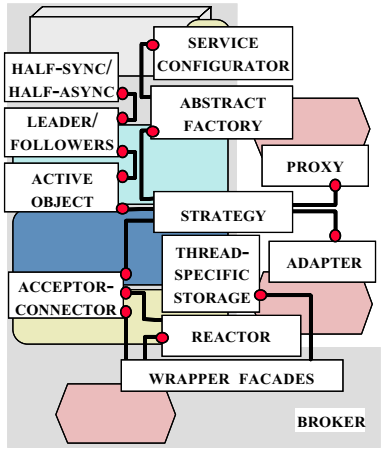
Proposed Solution Approach → Adaptive Middleware



Hard Problems

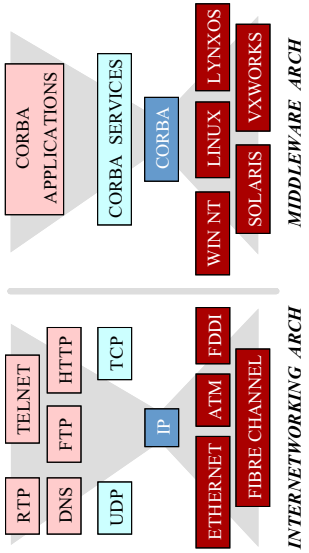
- Decoupling *functional* path from *QoS* path and applying QoS meta-data
- Achieving *horizontal* & *vertical* QoS integration
- Leveraging and customizing COTS components
- Developing & integrating cross-cutting QoS aspects

Promising Technical Approaches



- Documenting and applying **patterns** and **architectures** that enable multi-aspect **components** and **frameworks**
- Leveraging **open-source** R&D processes
- Focusing formal verification and advanced validation techniques on reusable & well-specified components and frameworks
- Multi-layer, multi-aspect adaptive feedback loops within development processes and middleware run-time systems

Program Impact



- Pioneer new strategies and tactics for multi-aspect adaptive middleware
  - *e.g.*, real-time component, integrate high-level real-time modeling & low-level middleware techniques
- Greatly reduce effort & cycle-time and improve key aspects of DoD mission-critical systems and product lines
  - *e.g.*, dependability, performance, and evolvability
- Create self-sustaining COTS market for DoD software
- Establish vibrant middleware research community

Concluding Remarks

- R&D on distributed & embedded real-time mission-critical applications must address many similar challenges
  - *e.g.*, service initialization and distribution, error handling, flow control, scheduling, end-to-end timeliness, event demultiplexing, concurrency control, persistence, fault tolerance
- Successful R&D efforts must apply *components*, *frameworks*, *patterns*, and *architectures* to resolve these challenges and create adaptive middleware that integrates multiple QoS aspects
- Many research challenges must be addressed to ensure that middleware for next-generation mission-critical DoD systems and product lines will simultaneously satisfy multiple cross-cutting QoS aspects
  - *e.g.*, efficiency, predictability, scalability, dependablity, security, evolvability, *and* flexiblity