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DEFINING THE FUTURE

SERVICE-ORIENTED ARCHITECTURE ISSUES AND SOLUTIONS FOR MISSION CRITICAL APPLICATIONS

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SOA Challenges for Mission Critical Applications

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- Performance with respect to real-time and data-intensive systems
  - Transport, Data Representation
- Coupling of service providers and requestors
  - Variations in degree of coupling
- Quality of service (QoS) considerations
  - Latency, loss, jitter, fault recovery
- Support for publish/subscribe models of component interaction
  - Beyond request-response message patterns
- Levels of interoperability
  - Technical, semantic, and business process interoperability

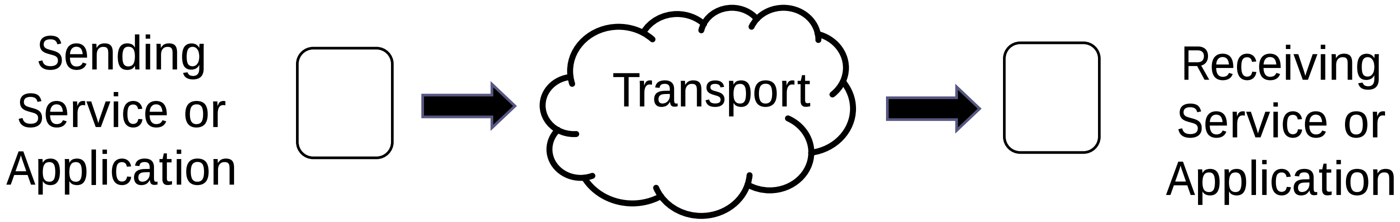
Performance – Message Transfer Latency

- In a ground system, information is often exchanged between components (e.g., services, applications) in the form of messages
- Latency of message transfer is often a derived ground system requirement
- Message transport mechanism and data representation are two architectural aspects that affect latency
- Message length is an important consideration in selection of transport mechanism and data representation

Transport Mechanism Dominates → Data Representation Dominates

Shorter Message Length → Longer Message Length

Performance Considerations - Transport



Common Transport Options *	Latency (rough relative order of magnitude) for very short (i.e., ping) messages
Web services (HTTP/SOAP)	50x
Session EJB	8x
Messaging middleware	5x (guaranteed message delivery using persistent queues can increase latency ~50%)
REST	4x
Data Distribution Service (DDS)	1x

* Note: Northrop Grumman is developing other transport mechanisms more optimized for the challenging performance and interoperability needs of ground systems

Latency is an important consideration when selecting a transport mechanism but is not the only consideration

Performance Considerations – Data Representation/Conversion

Conversion performed during serialization/deserialization	Serialization time for large messages (rough relative order of magnitude)
Java → Serialized Object	1x
Java → XML (SAX)	3x
SDO → Serialized Object	4x
SDO → XML	8x
Java → JSON	17x
Java → XML (DOM)	41x

Large message conversion can introduce large latencies. XML provides good interoperability but there are alternatives to pure XML that provide lower latency

Alternatives to XML

- Compressed XML
  - Use a lossless compression algorithm (e.g., gzip, bzip2) to compress XML messages prior to transport and decompress them when they are received
  - Smaller binary messages consume less network resources
  - Extra processing is needed for compression/decompression at the end points
- Pass a reference to data in a shared data store
  - How to maintain integrity between reference and data when data is modified or deleted?
  - Lifetime of shared data
- Native object formats
  - Need to consider platform/language differences between end points
  - OMG Data Distribution Service (DDS) is an open standard

SOAs can use data representations other than XML (sometimes they need to for performance reasons)

Quality of Service (QoS) Considerations

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We consider QoS to include

- Latency
  - Commanding, telemetry, mission data processing & distribution, reports/notifications
- Data Loss
  - Dropped packets, best effort delivery
- Jitter
  - Important for certain types of streaming data like voice and video

QoS is important because

- The network is not always reliable
- Network bandwidth is not unlimited
- Processing resources are not unlimited
- Different applications require different levels of QoS

How to manage network resources to deliver the desired QoS?

QoS Examples and Architecture Patterns

Application	QoS Parameters	Architecture Patterns
Telemetry updates sent to HMI operator station	Loss Latency	1. Best effort delivery 2. Discard aged data
Streaming data distribution to users (voice, video)	Loss Latency Jitter	1. Jitter buffer 2. Per-stream QoS control
External tasking requests sent to ground system	Loss Latency	1. Gateway for throttling, message screening 2. Perimeter guard

Coupling of Service Requesters and Providers

More Tightly Coupled	Less Tightly Coupled
Synchronous interaction (coupled in time)	Asynchronous interaction (decoupled in time)
RPC-style parameters bound to operation signature of service provider (procedure centric)	Messaging without programming language constructs (data centric)
Service requester has knowledge of service provider	Service requester and provider have **no** knowledge of each other
Request/Response interaction pattern	Publish/Subscribe interaction pattern

The degree of coupling in a SOA can vary widely depending on the design decisions made by the architect

Publish/Subscribe Pattern is a Good Match for Event Driven Service Interactions

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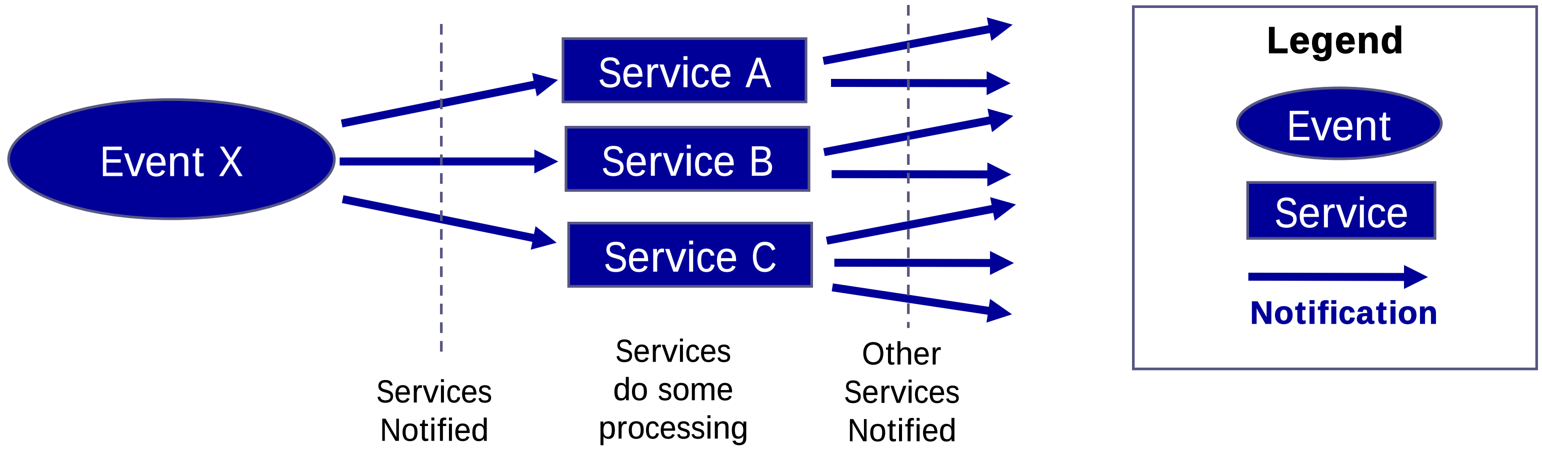

- Events can be externally triggered (e.g., task request received, sensor event) or generated by an internal service (e.g., out-of-bounds state condition, anomaly detection)
- Request-reply pattern is very different from publish-subscribe pattern
  - Publish-subscribe is a good match for event-driven and data-centric models
  - Web services are based on the request-reply pattern

When architecting the infrastructure of mission critical applications, it is important to consider the messaging patterns that must be supported

Levels of Interoperability

- Technical (Protocol, Syntactic) Interoperability
  - The ability of two or more systems to exchange data and use information
  - Usually concerns protocols and infrastructure needed for protocols to operate as well as data formats, syntax, and encoding
- Semantic (Contextual) Interoperability
  - The ability of two or more systems to exchange information and have the meaning of that information automatically interpreted by the receiving system accurately enough to produce useful results, as defined by the end users of both systems
- Business Process Interoperability
  - The ability of services to be assembled into a workflow to deliver a business function

SOA interoperability considerations should extend past technical interoperability to include semantic and business process interoperability

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