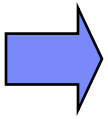
The ESB Architectural Pattern

Topics



- Introduce the concepts of a Service Oriented Architecture (SOA)
- Introduce the Enterprise Service Bus architectural pattern
- Evaluate the appropriate application of several ESB implementations
- Review a methodology for designing an SOA using an ESB
- Introduce the concepts of SOA governance and the role of a service registry and repository

Topic Agenda

- **What is an Enterprise Service Bus?**
- **The Enterprise Service Bus Pattern**
- **Service Virtualization**
- **What's inside an Enterprise Service Bus?**

What is an Enterprise Service Bus (ESB)

ESB is an “Architectural Pattern”

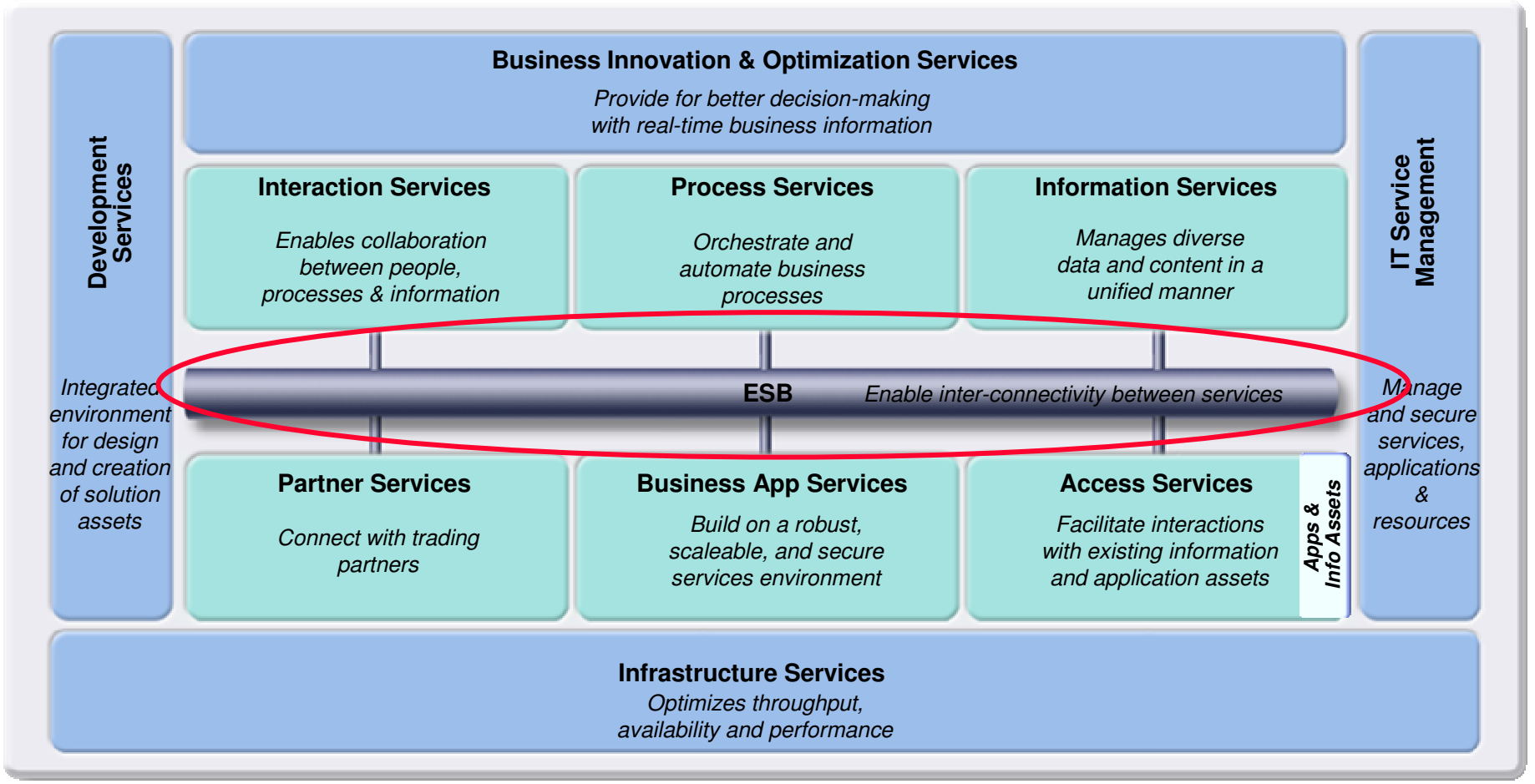
*“ We describe the enterprise service bus first and foremost as **an architectural pattern**. In fact, it is possible to construct service buses from a variety of different underlying integration technologies.*

***The architecture pattern** remains valid and is a guiding principle to enable the integration and federation of multiple service bus instantiations.”*

– Rob High, SOA Foundation Chief Architect in the SOA Foundation Architecture Whitepaper

SOA Reference Architecture

Model of the Logical Architecture



What is an Enterprise Service Bus?

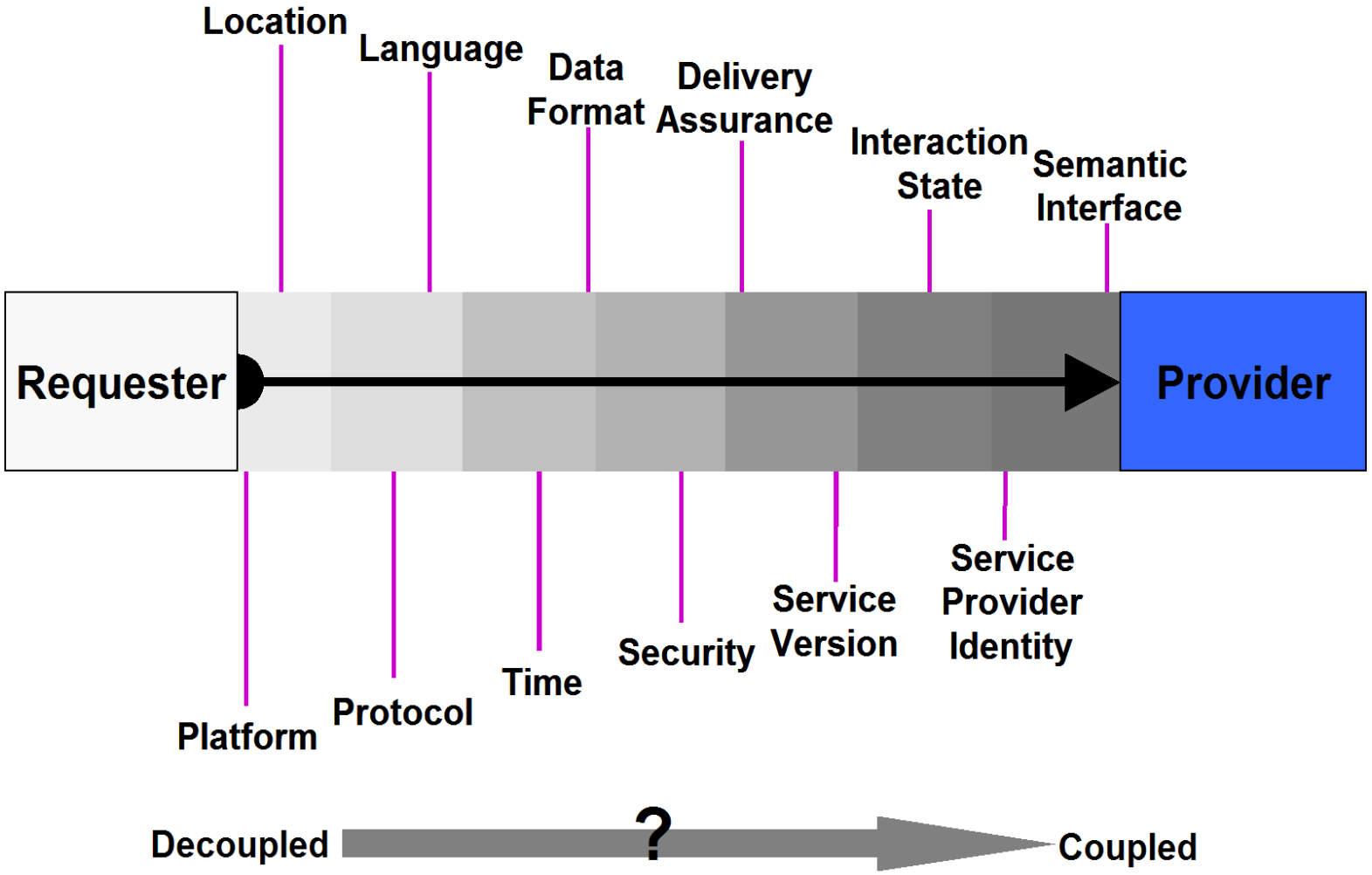
- An ESB enables standards-based integration between loosely-coupled applications and services within and across…
  - ***Services oriented architectures*** – distributed applications are composed of granular re-usable services with well-defined, published and standards-compliant interfaces
  - ***Message driven architectures*** - applications send messages through the ESB to apps
  - ***Event driven architectures*** - applications generate and consume messages anonymously

- An ESB enables **application integration** across different platforms, programming models & messaging standards
  - Underpinning Business Process and managed Business Partner integration

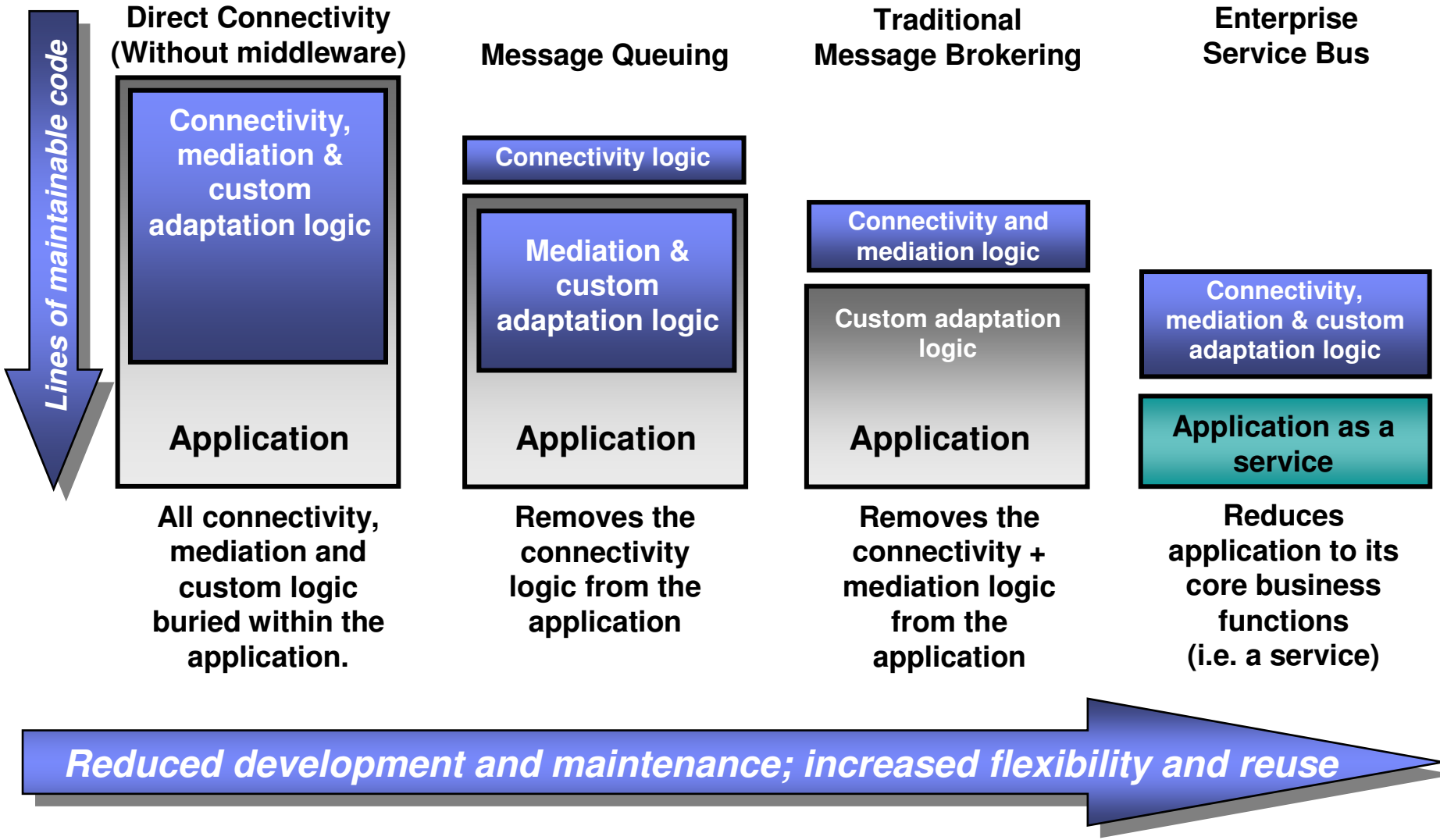
What is loose coupling?

- **Tighter coupling tends to cost more over time**
  - Synchronizing multiple organizations on change
  - Hard to move, hard to scale, hard to distribute, hard to replace
  - Making changes is hard and expensive, or impossible:
    - Knowledge is distributed throughout the code
    - Same people are solving business and infrastructure problems
  - Different parts of the solution are difficult to manage separately
  - Adapting, redeploying updated components without affecting others
- **Looser coupling requires greater investment up front**
  - More design work
  - More implementation work

Loose coupling: aspects of service interaction

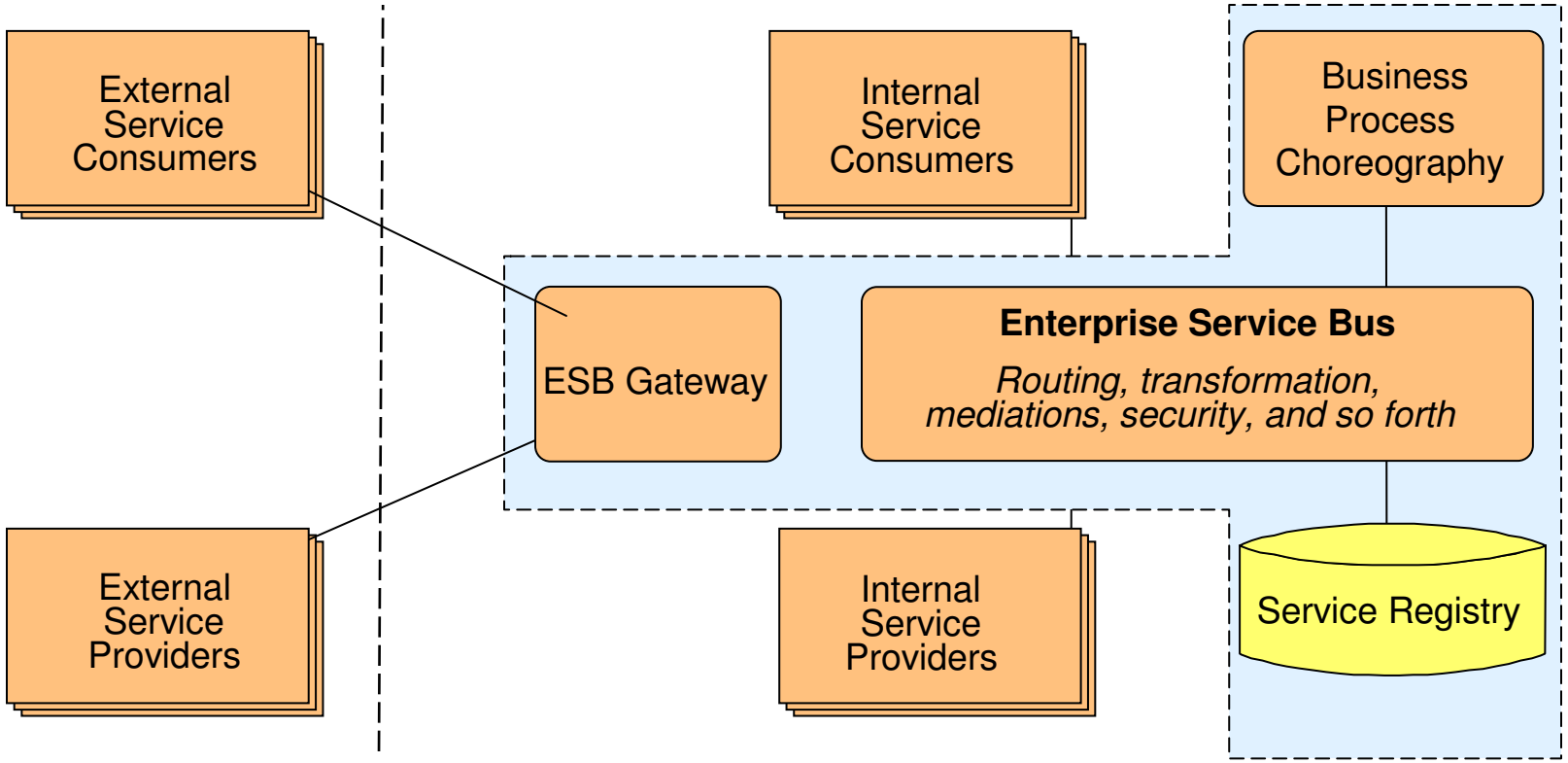


ESB – an evolution of existing technology



The Enterprise Service Bus (ESB) Pattern

The SOA Runtime Pattern Family



Infrastructure components for service-oriented architecture

Enterprise Service Bus Pattern

ESB's need to provide support for…

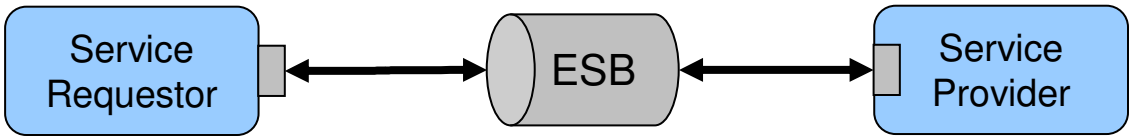
- Large numbers of service interactions in a manageable way
- Web Services and traditional EAI communication standards and technologies
- A variety of interaction styles such as synchronous request/response, messaging, publish/subscribe, and events
- Advanced service interaction capability, for example, transactions, store and forward, infrastructure services, security, and quality of service
- Service routing and substitution, protocol transformations, and other message processing

Implementations

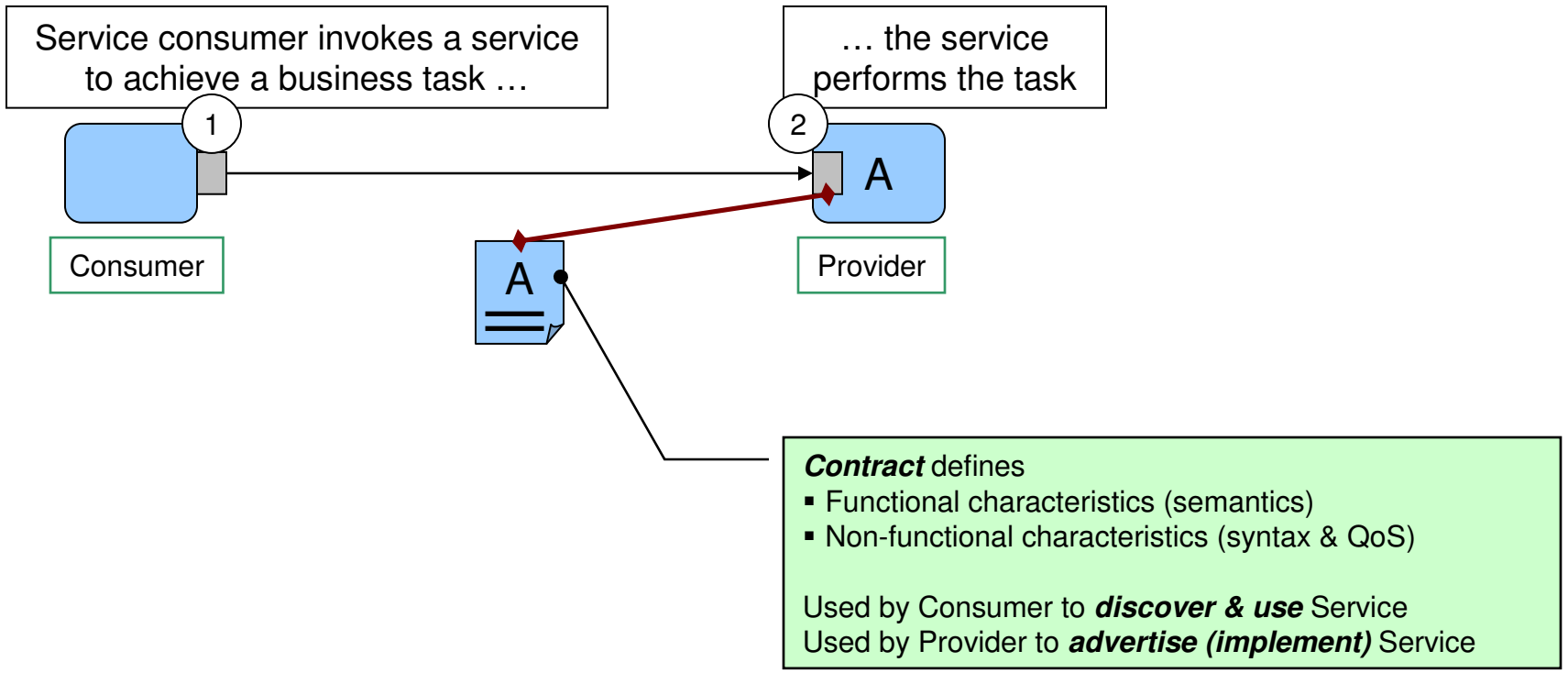
- EAI and messaging technologies
- "Gateway" technologies
- ESB products

Core ESB Principal – Virtual Service Provider Pattern

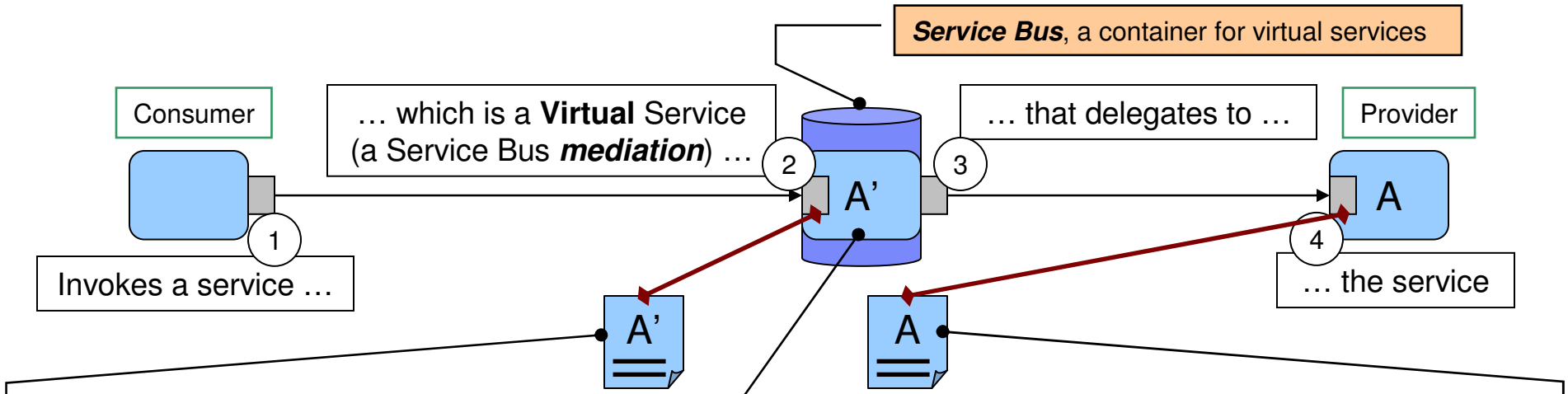
- **ESB inter-connects requestor and provider**
  - Interactions are *decoupled*
  - Supports key SOA principle – *separation of concerns*
- **ESB provides *Service virtualization* of**
  - Location and identity
  - Interaction pattern and protocol
  - Interface
- **ESB also enables Aspect-oriented connectivity or mediation**
  - Security
  - Management
  - …



Direct Service Connectivity in SOA



Mediated Service Connectivity in SOA



Consumer Contract defines
- Functional characteristics
- Non-functional characteristics

Used by Consumer to ***discover & use*** "Service"
Used by Domain Owner to ***advertise*** "Service"
Used by Bus Owner to ***implement*** Virtual Service

Service Contract (may be informal) defines, for Provider
- Functional characteristics
- Non-functional characteristics

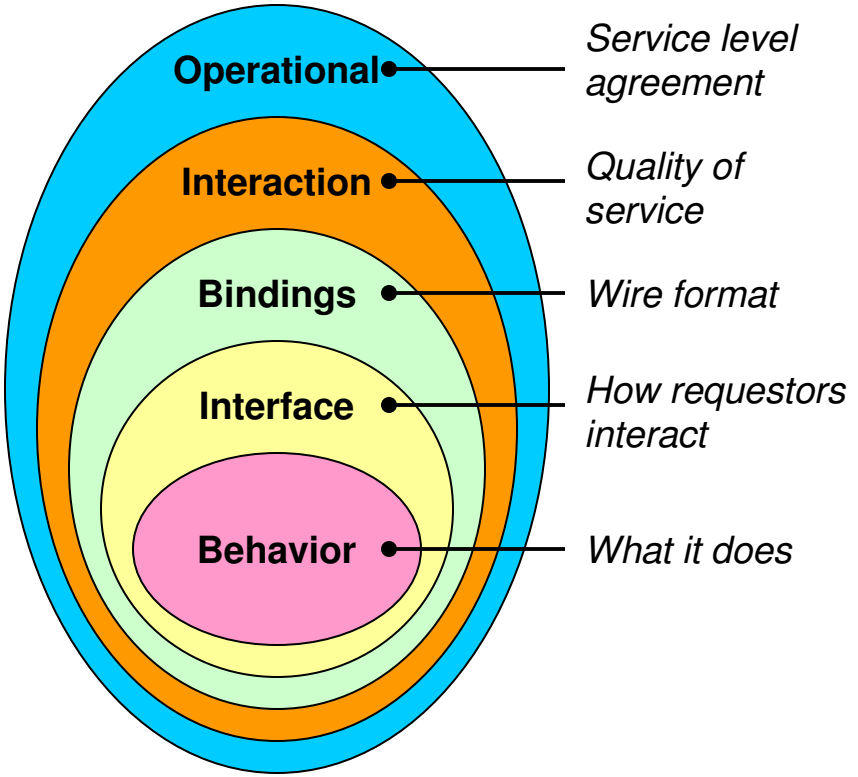
Used by Provider to ***advertise (& implement)*** Service
Used by Bus Owner to ***implement*** Virtual Service

Virtual Service/Mediation
- Enforces "policy" regarding interaction
  - Management, security, log, …
- Is in effect a governance control point for service access
- ***Is*** the service from a Consumer (business) perspective

Service Virtualization

Service Contract

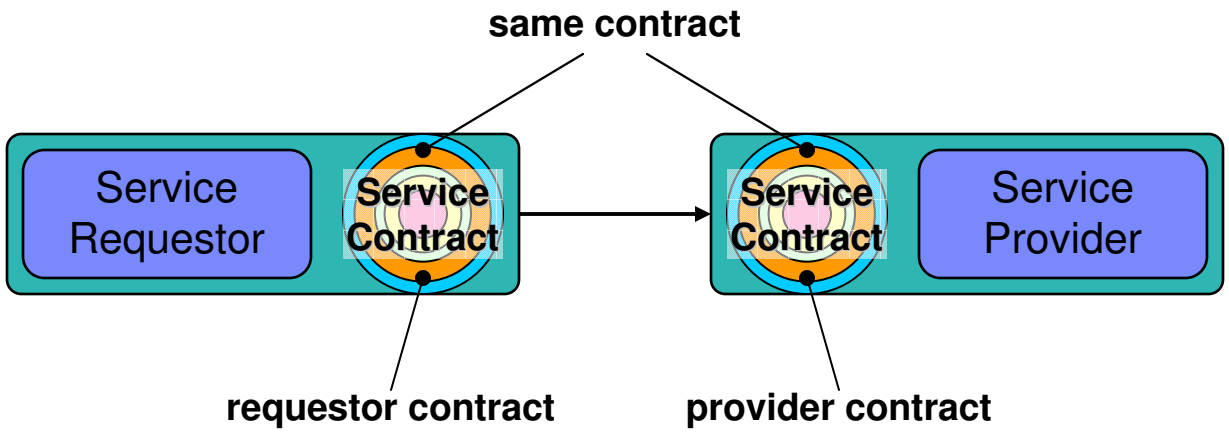
- Documents everything requestors and providers must agree upon
  - Behavior
    - What it does
  - Interface
    - How requestors interact
  - Bindings
    - Wire format
  - Interaction
    - Quality of service (QoS)
  - Operational
    - Service level agreement (SLA)
- All externally visible characteristics of a service



Service Contract

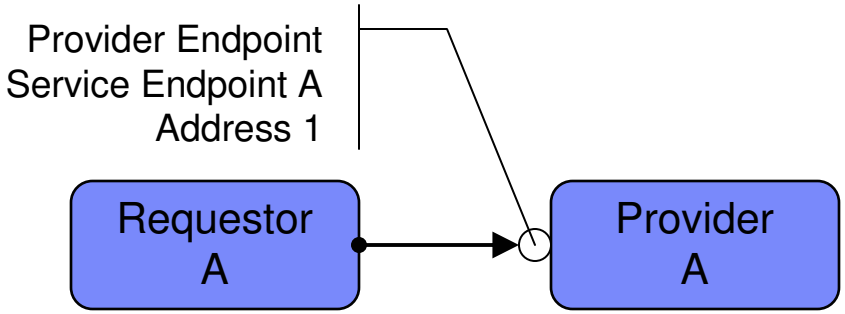
Service Connectivity

- Connects requestors and providers
  - Enables requestors to invoke providers
- Must agree on service contract
  - Requestor contract - the one the requestor delegates to
  - Provider contract – the one the provider implements
- Integration of contracts which don't match requires mediation



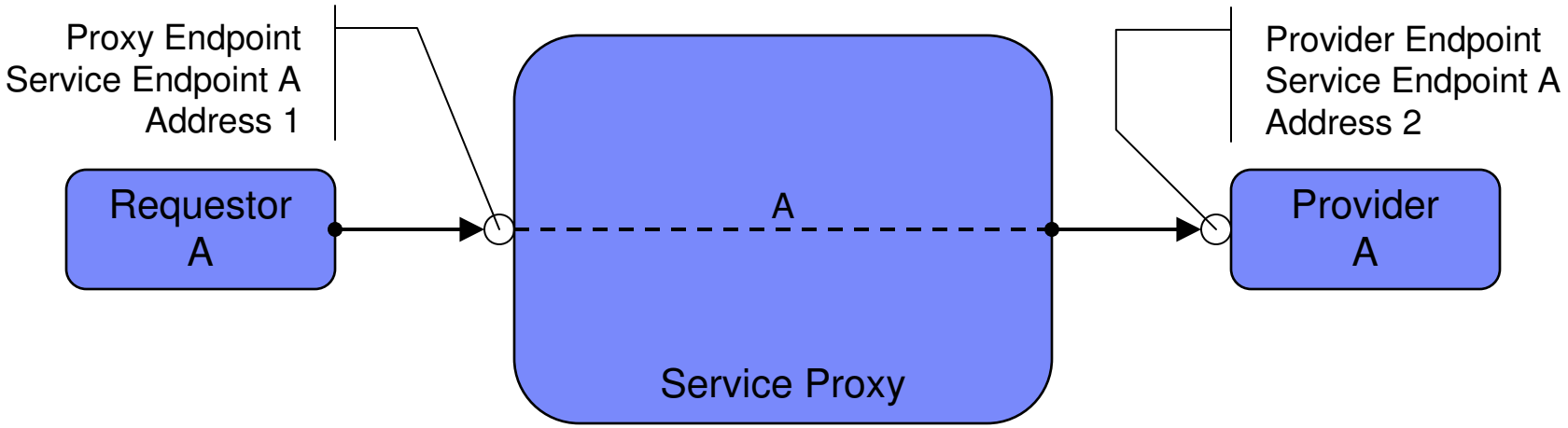
Direct Service Connectivity

- Requestor gets/knows endpoint address of the provider
  - Uses that to invoke the provider
  - Standard Web services UDDI approach
- Consequences of this design
  - Requestor can only use a single provider
  - Requestor contract and provider contracts must match
  - Unreliable: busy provider, flakey network
  - Tighter coupling: Changes in provider affect requestor



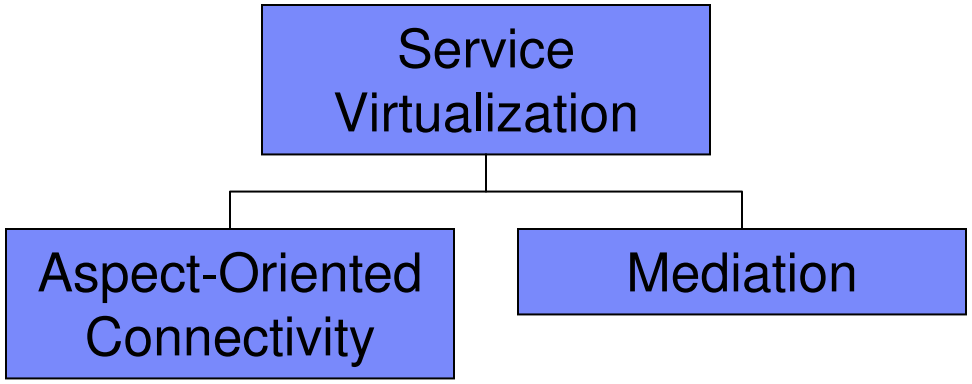
Indirect Service Connectivity

- Service proxy (i.e. Proxy pattern) between requestor and provider
  - Service virtualization – separate proxy and provider endpoints
- Consequences of this design
  - Requestor can use multiple providers
  - Requestor and provider contracts do not have to match
  - Increases reliability of invocations
  - Looser coupling: Changes in provider affect proxy, not requestor



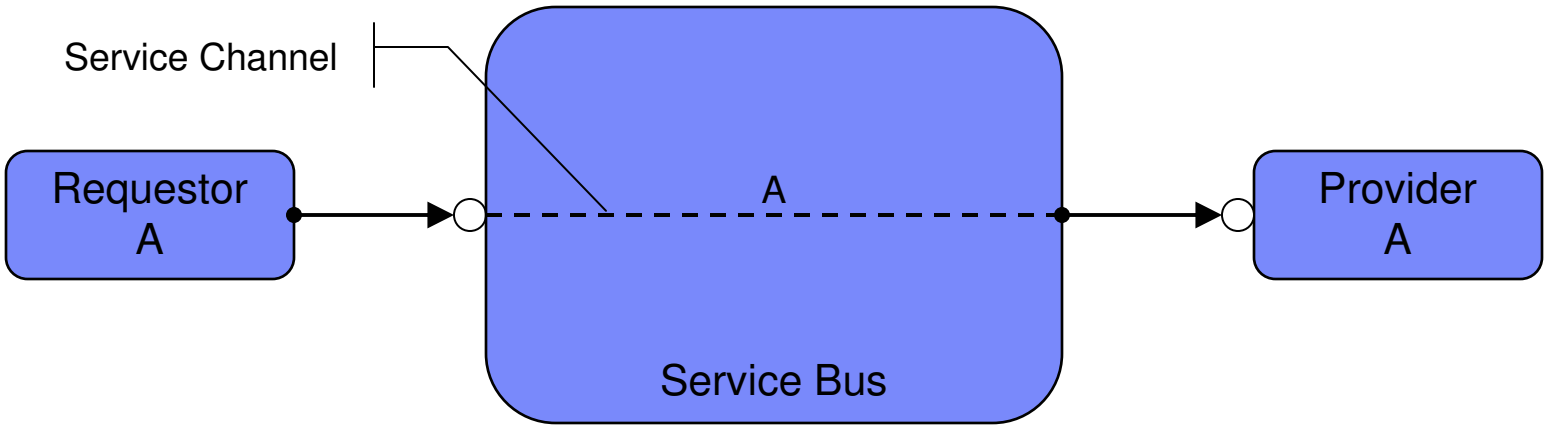
Service Virtualization

- By-product of indirect service connectivity
  - Provided by the service proxy
  - Result of the proxy's endpoint being different from provider's endpoint
- Provides opportunity for aspect-oriented connectivity and/or mediation
  - Aspect-oriented connectivity to improve the quality of the connectivity
  - Mediation to bridge the differences between service contracts



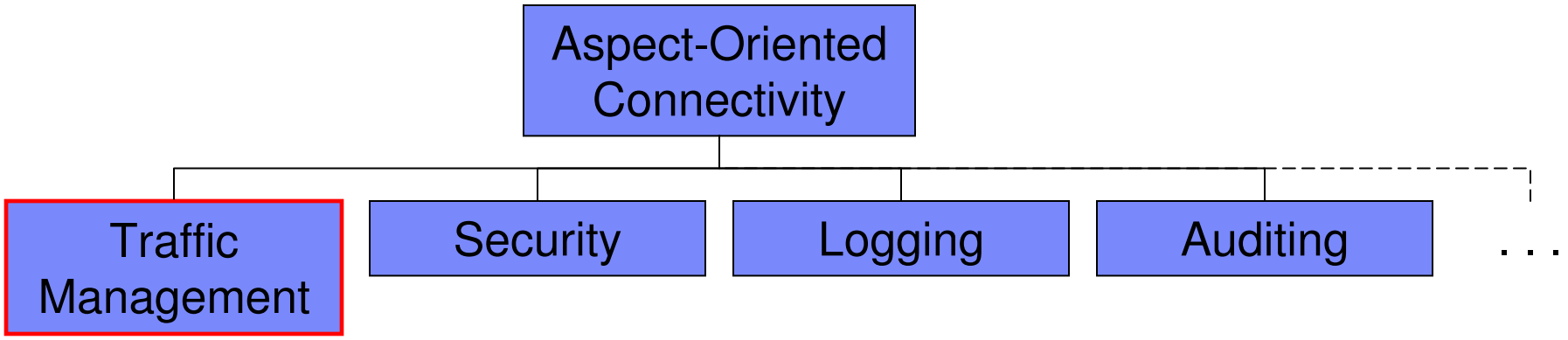
Service Channel

- Implements a service endpoint within a service proxy
  - Connects all requestors of a service to all providers of that service
- Requestor invokes proxy's endpoint; proxy invokes provider's endpoint
  - Structure within the proxy that manages the invocations
- Opportunity to increase the quality of the connection
  - Aspect-oriented connectivity



Aspect-Oriented Connectivity

- Cross-cutting aspects of connectivity
- Can be added or removed without affecting requestors and providers
- Applied per service channel
  - Zero or more aspects can be combined
- Various kinds of aspect-oriented connectivity
  - Traffic management, security, logging, auditing, etc.

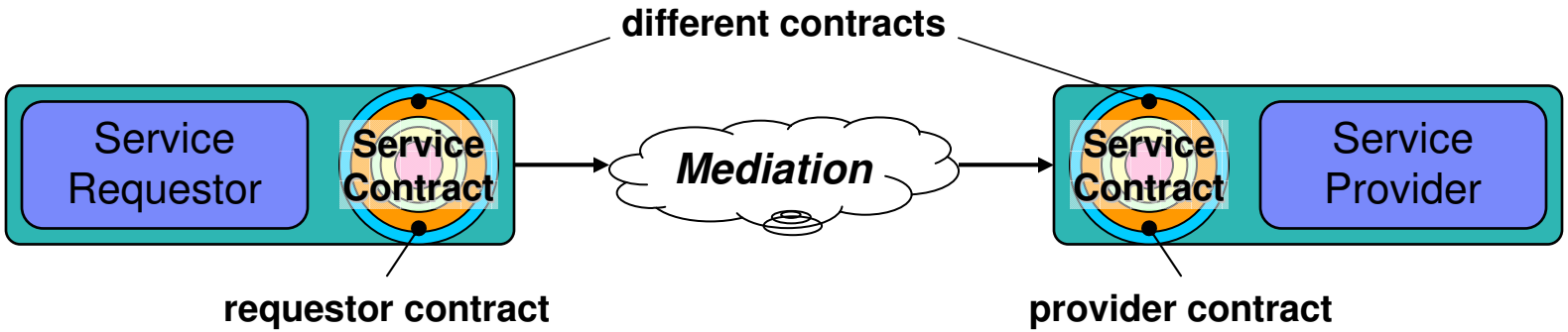


Traffic Management Patterns

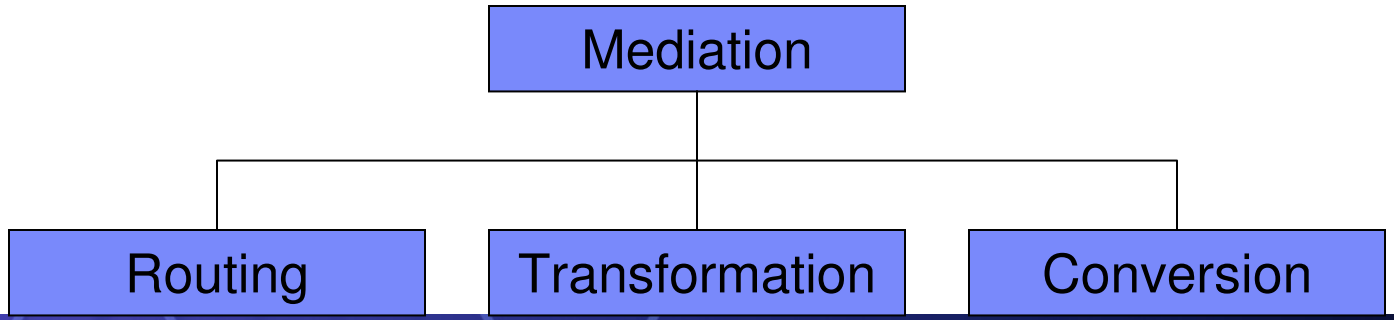
- Queuing
  - Stores invocation messages until they can be transmitted
  - Enables asynchronous invocation
- Prioritization
  - Process more important invocations before lesser ones
- Load distribution
  - Spread invocations across equivalent target endpoints
- Service invocation throttling
  - Rejects invocations past a specified frequency threshold
- Provider invocation retry
  - Reattempt a failed invocation until it succeeds

Mediation

- Mediation
  - Used when requestor contract and provider contract do not match

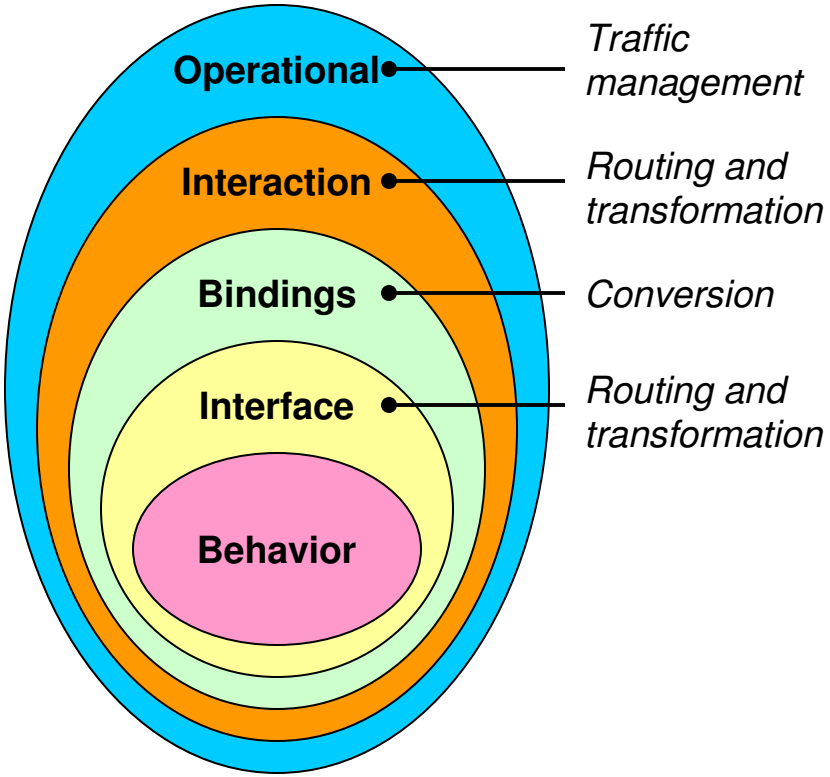


- Three kinds of mediation
  - Routing, transformation, and conversion



Service Contracts and Mediation

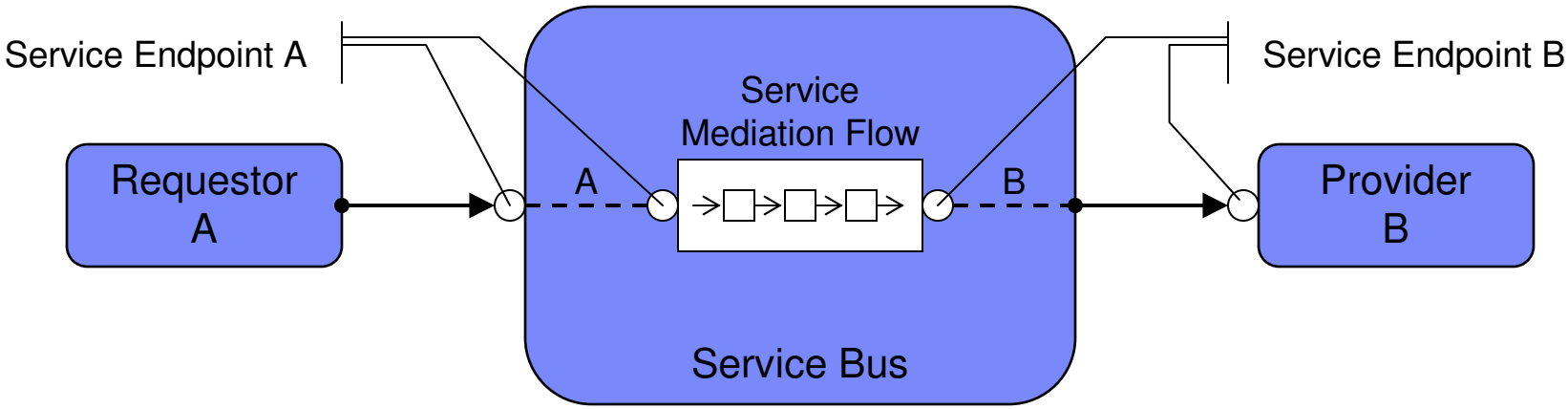
- Service connectivity connects service contracts
  - Differences between contracts bridged by mediation
- Different parts of contract bridged by different kinds of mediation
  - Behavior must be equivalent
  - Interface – Routing and transformation
  - Bindings – Conversion
  - Interaction – Routing and transformation
  - Operational – Traffic Management



Service Contract and Mediation

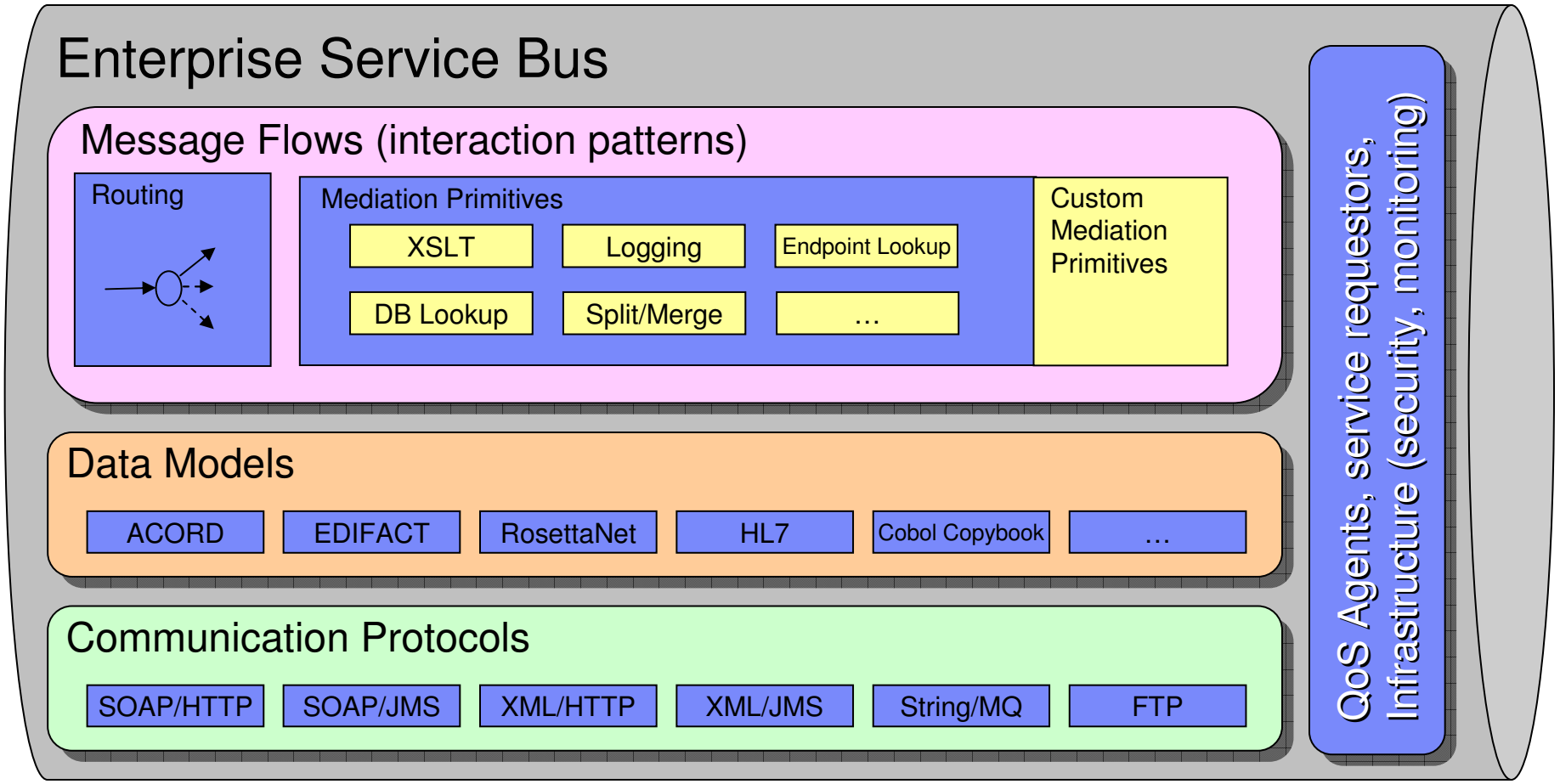
Mediation vs. Traffic Management

- Change the invocation during transmission
  - Proxy endpoint and provider endpoint have different contracts
  - Requestor contract and provider contract differ
  - Mediation bridges the differences
- Traffic management changes the handling of the invocation
  - Mediation changes the content and destination of the invocation



What is inside an Enterprise Service Bus?

Enterprise Service Bus Reference Architecture



ESB Request Flow Decomposition

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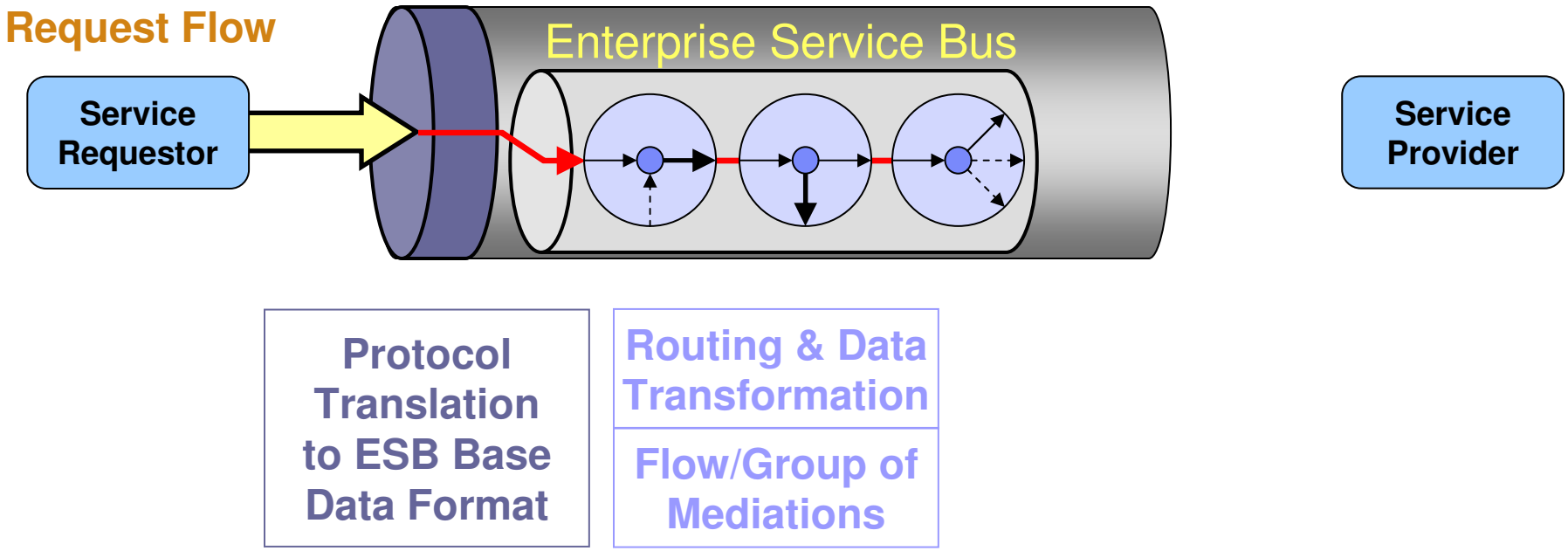
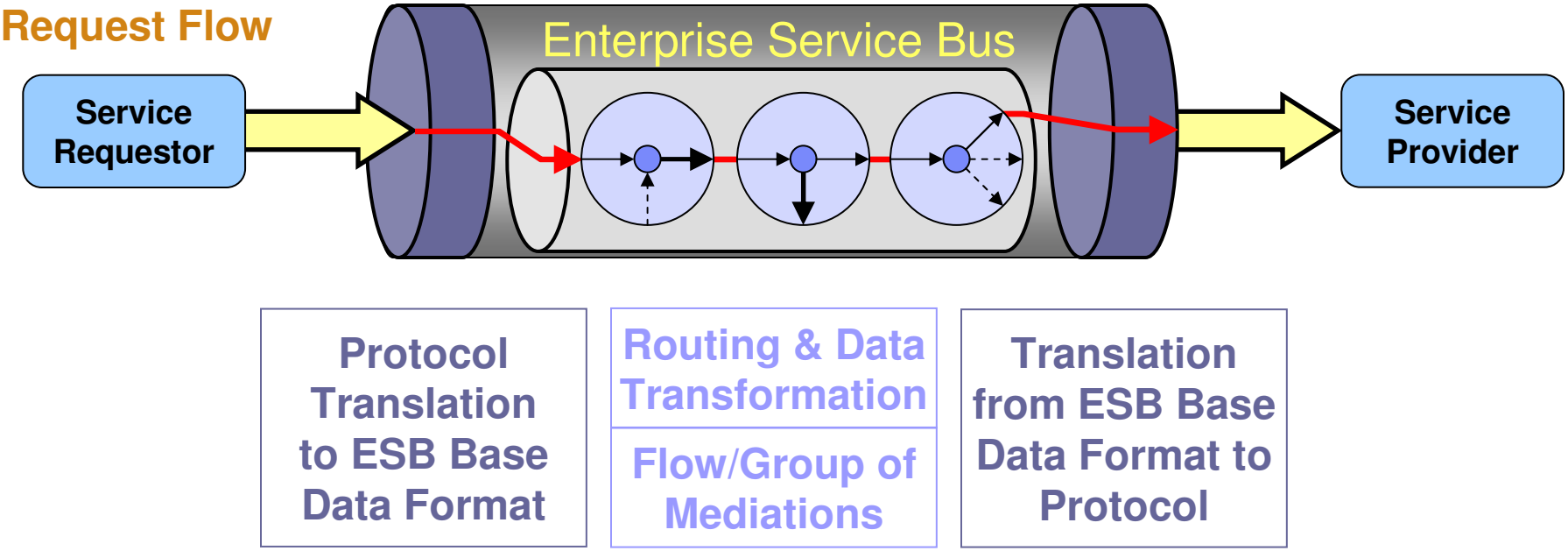
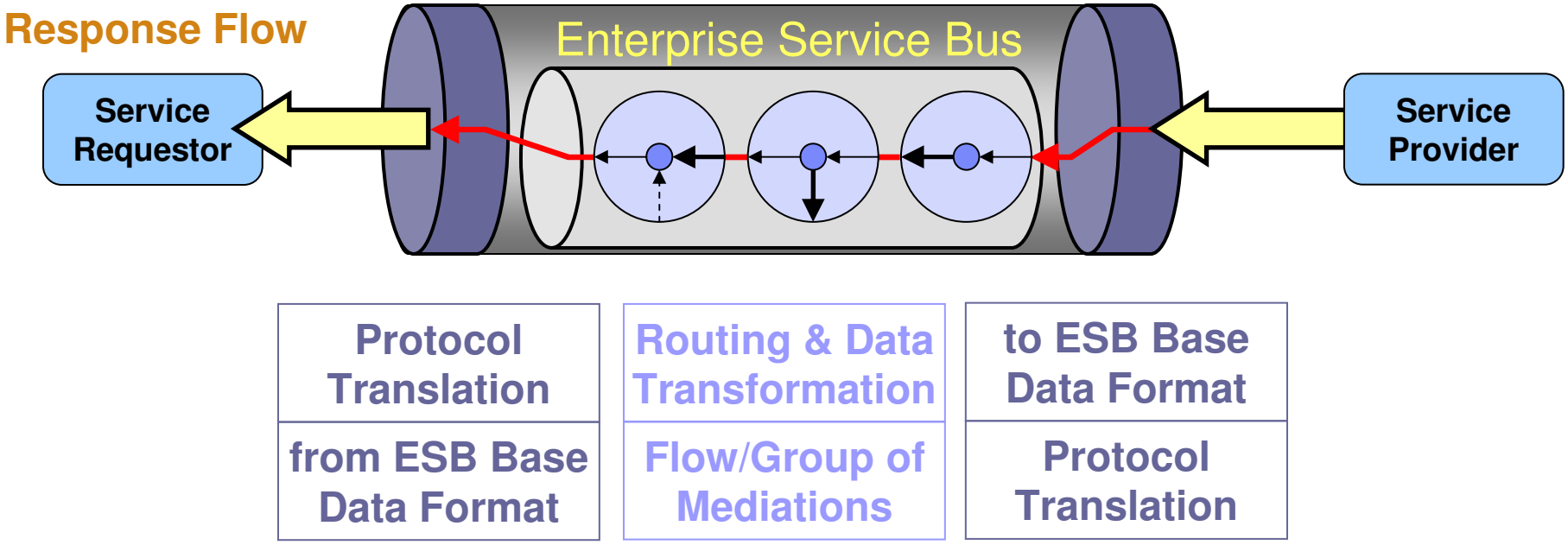


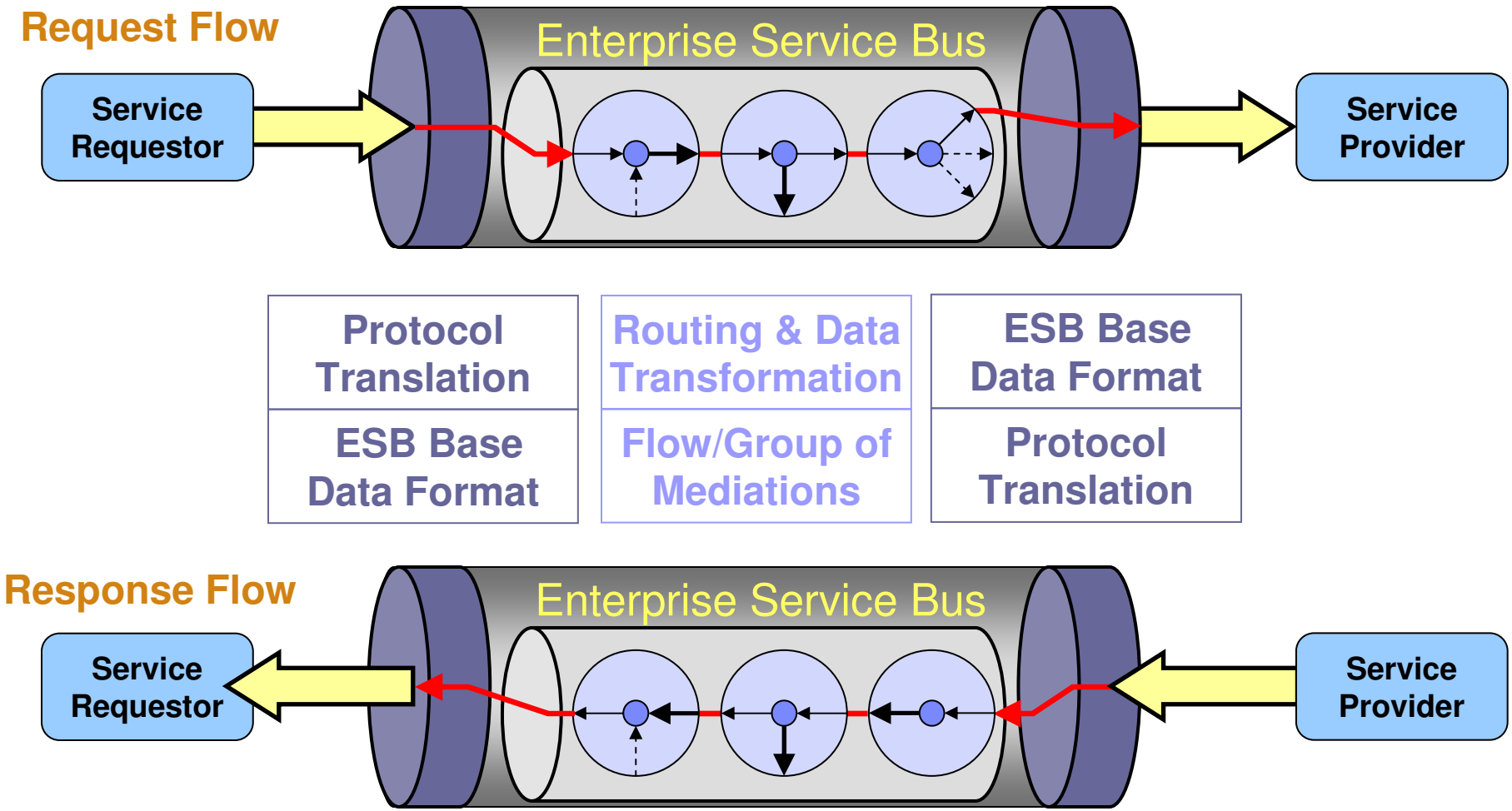
ESB Request Flow Decomposition



ESB Response Flow Decomposition



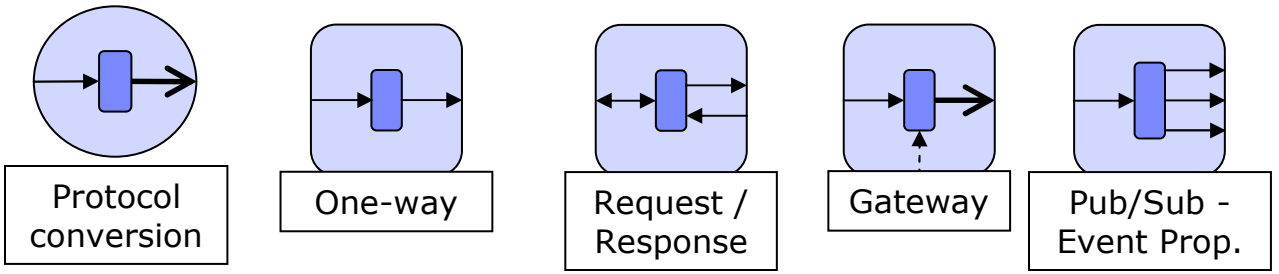
ESB Request-Response Flow Review



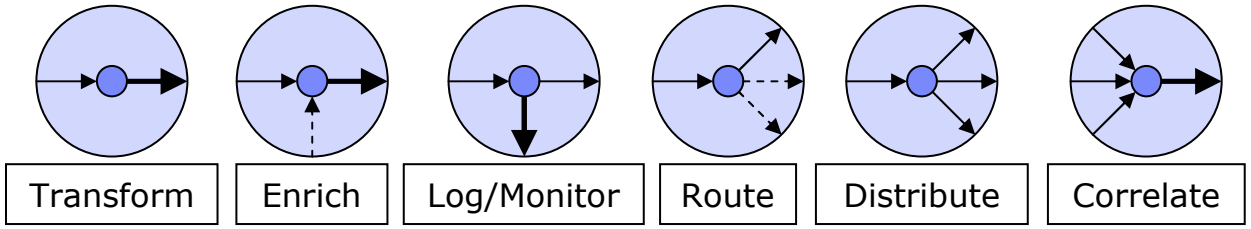
Typical Enterprise Service Bus Patterns?

Mediation Patterns - Examples

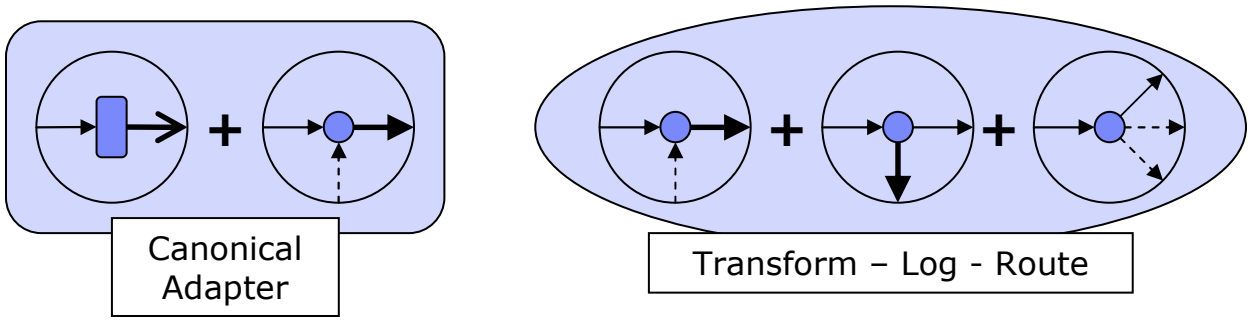
Conversion & Interaction Patterns



Transformation & Routing Patterns



Composite Patterns Examples



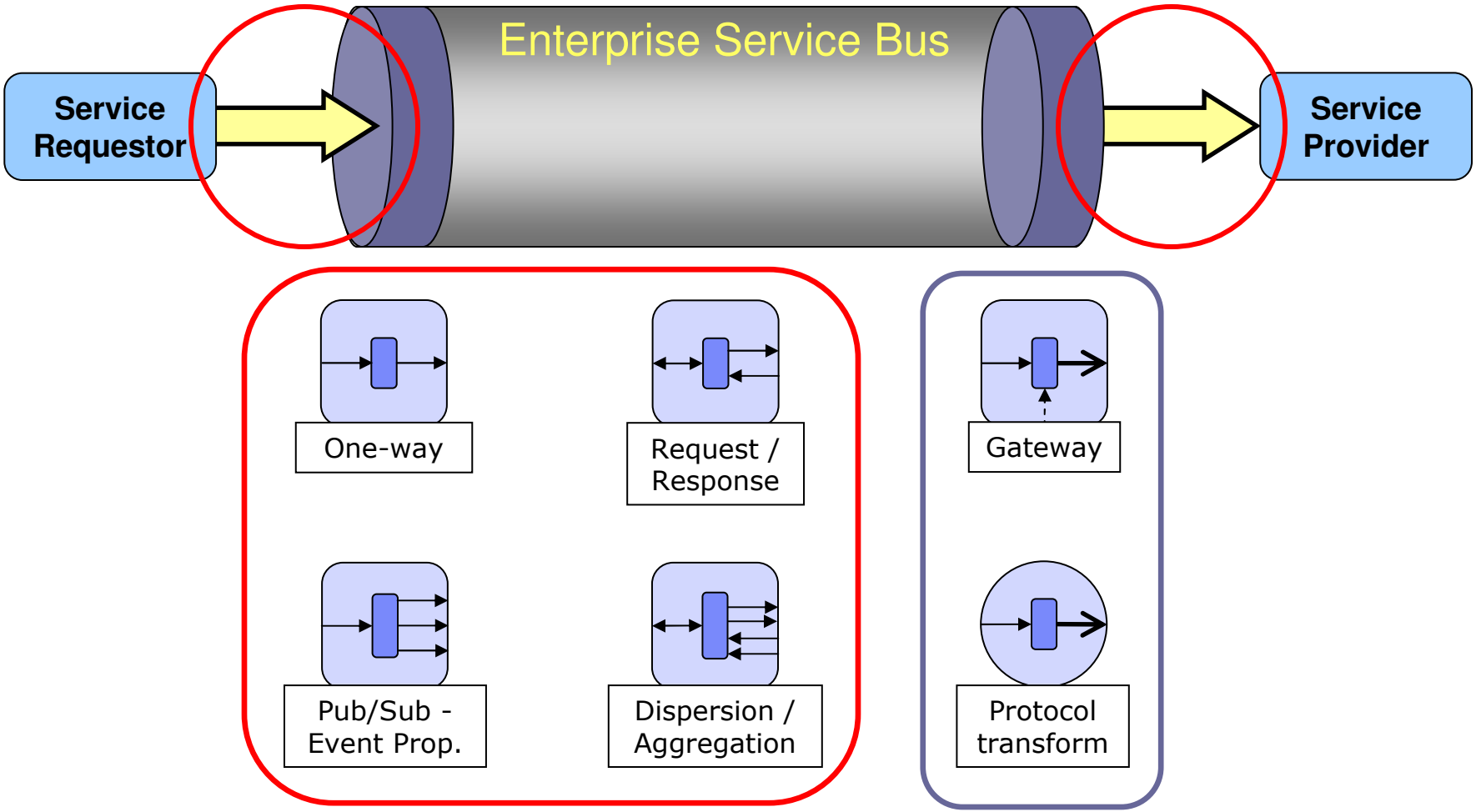
ESB Transport Protocols and Conversion

- Basic connectivity supported via one or more transport protocols
  - Dependent on underlying communication fabric(s)
- Conversion inherent with support for more than one transport protocol
- Enables
  - Virtualization of *interaction protocol*
  - Aspects of QoS (e.g., reliable delivery, transactions)
- Typical requirements
  - HTTP (SOAP/HTTP, XML/HTTP)
  - MQ (SOAP/JMS/MQ, XML/MQ, text/MQ, …)
  - Adapters (legacy, EIS)

ESB Interaction Patterns and Enhanced Routing

- Fundamental interaction patterns based on underlying communications fabric(s)
  - Point-to-point
    - Request/reply (synchronous and asynchronous)
    - One way
  - Pub/Sub
- Enhanced (dynamic) routing of messages
  - Via mediation patterns
- Enables
  - Virtualization of *location* and *identity*
  - Aspects of QoS (e.g., SLA, failover)
- Typical routing requirements
  - Round robin
  - Content based
  - Service registry driven

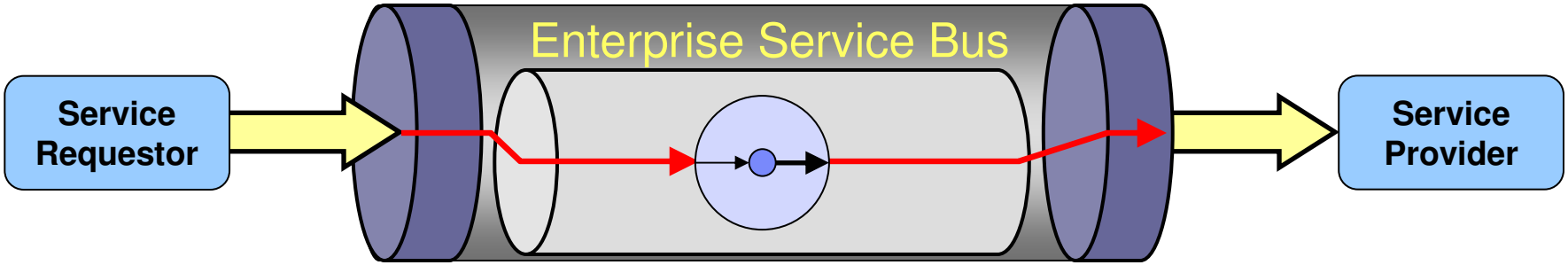
Mediation Patterns – Interaction Patterns



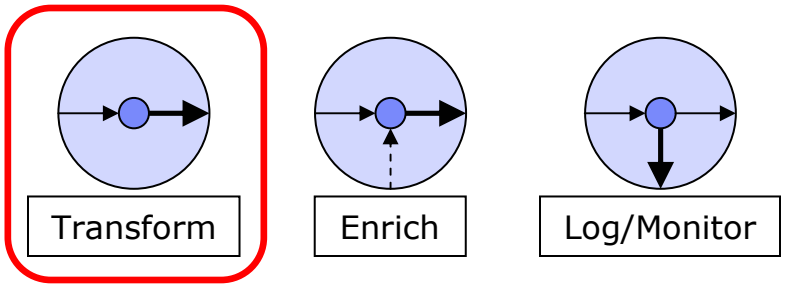
ESB Mediation Patterns and Message Processing

- Allow manipulation of messages during a message flow
  - Provided by a mediation framework enabling pattern construction
- Enhance the basic interaction patterns, e.g.,
  - Message enrichment
  - Monitoring and logging
  - Registry, security and management
  - Distribution/aggregation
- Enables
  - Aspects of QoS (security and management)
- Typical requirements beyond routing and transformation
  - Retry
  - Recipient list
  - Custom

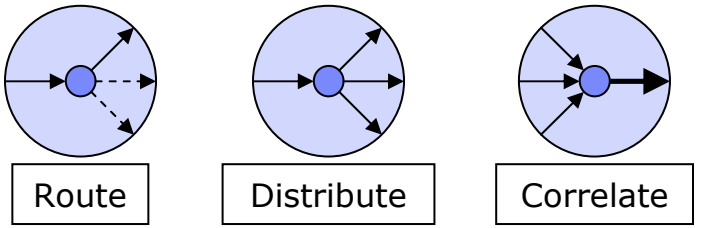
Transformation Pattern - Transform



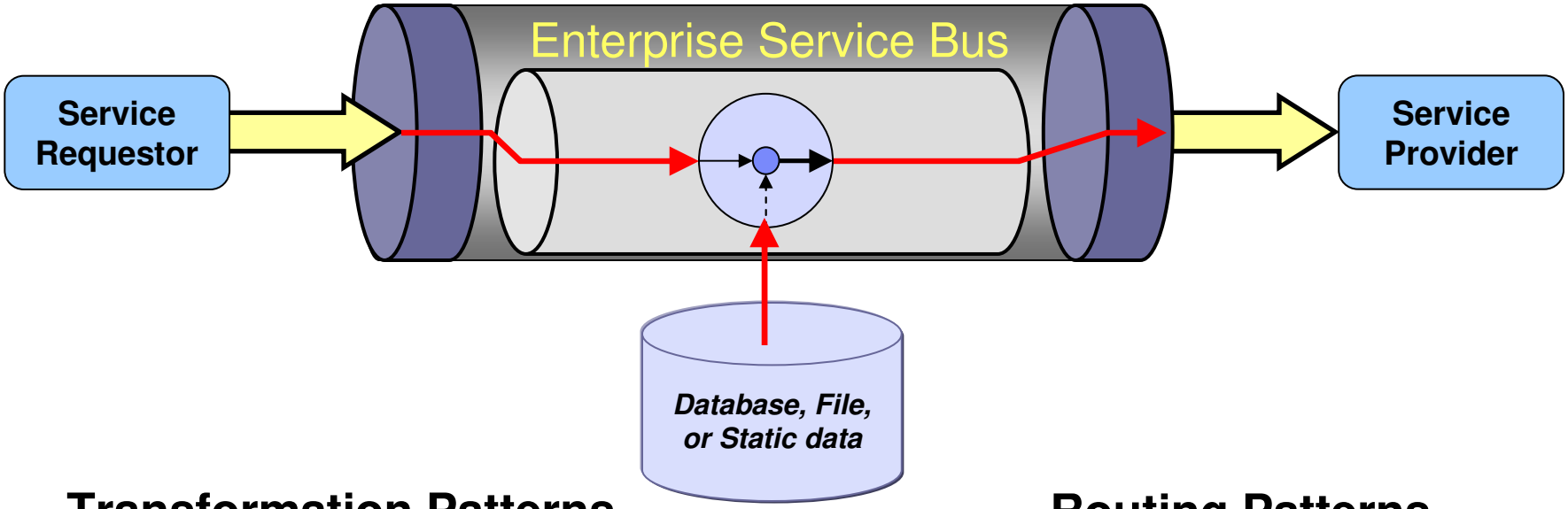
Transformation Patterns



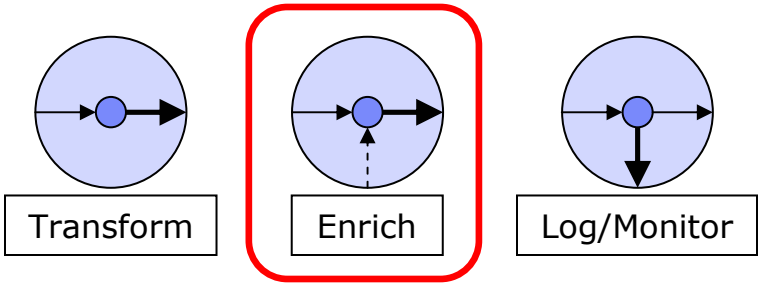
Routing Patterns



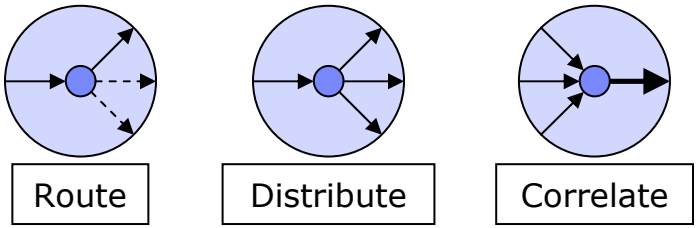
Transformation Pattern - Enrich or Augment



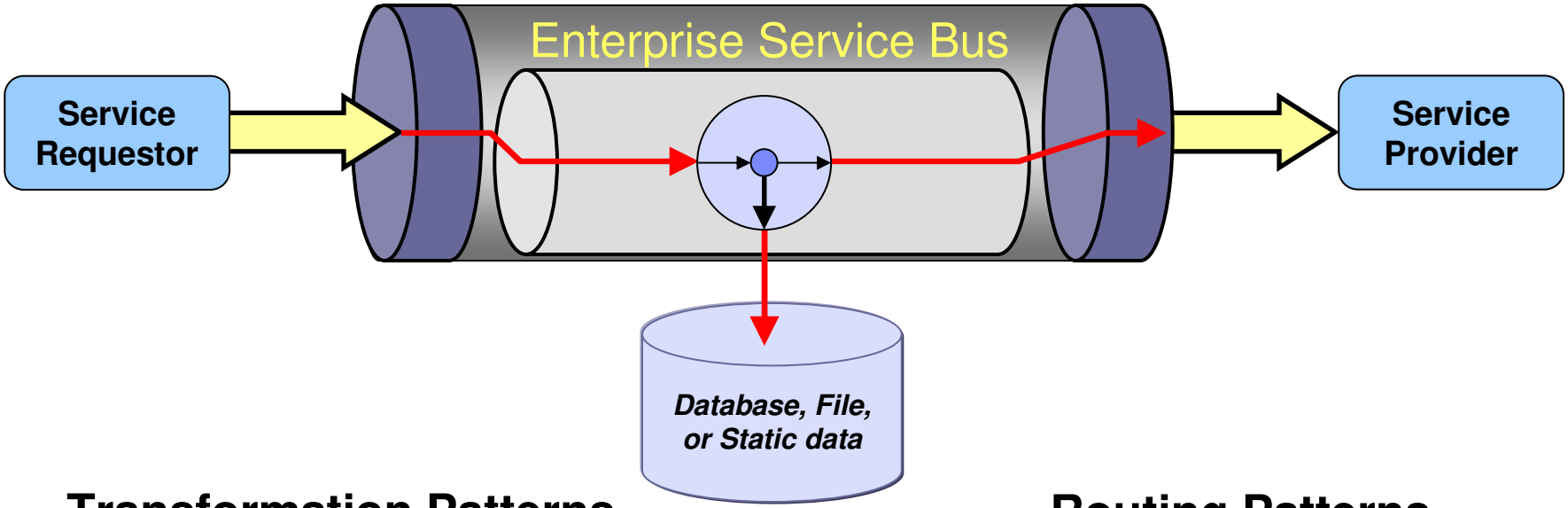
Transformation Patterns



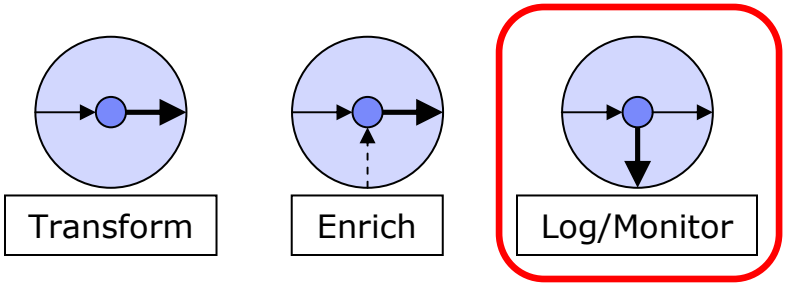
Routing Patterns



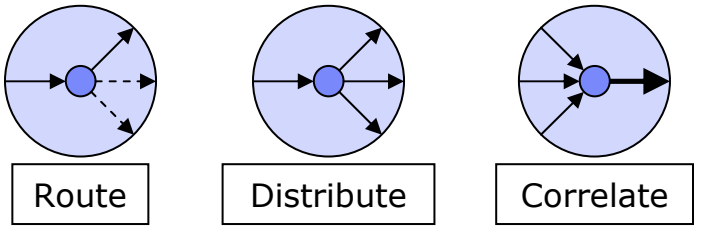
Transformation Pattern – Log or Monitor



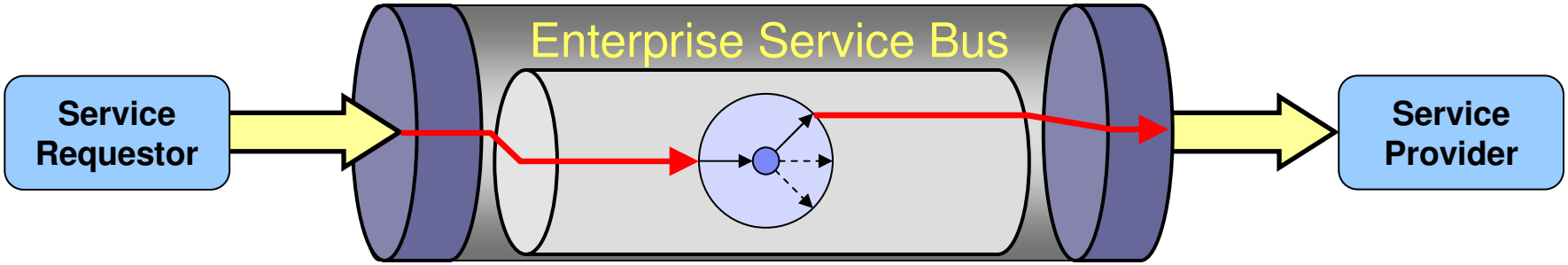
Transformation Patterns



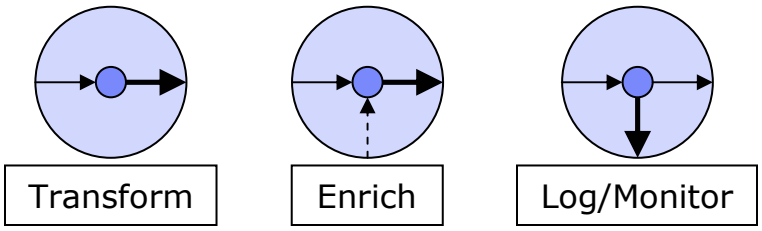
Routing Patterns



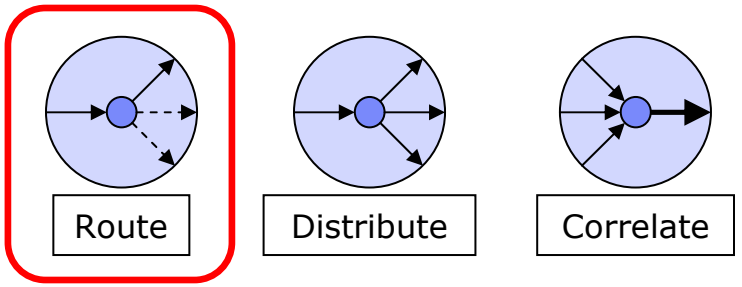
Routing Pattern - Route



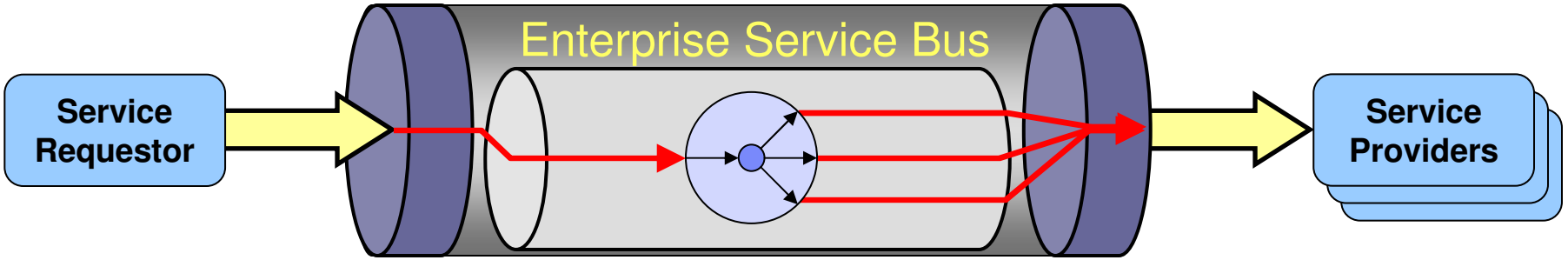
Transformation Patterns



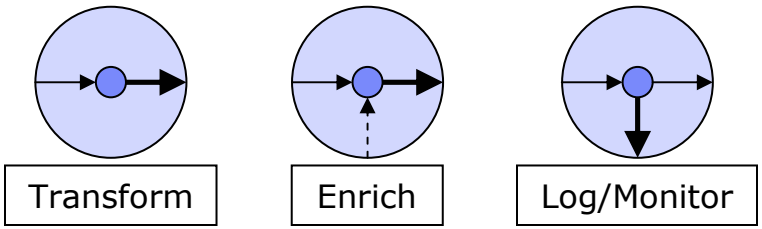
Routing Patterns



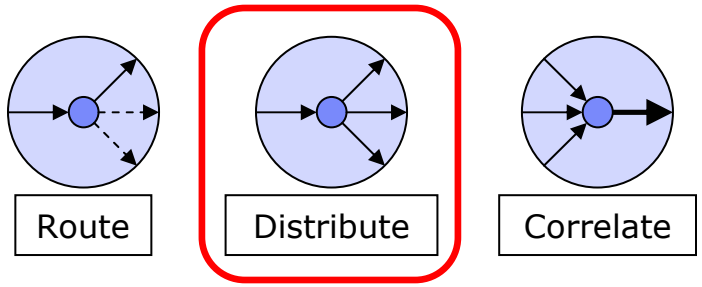
Routing Pattern - Distribute



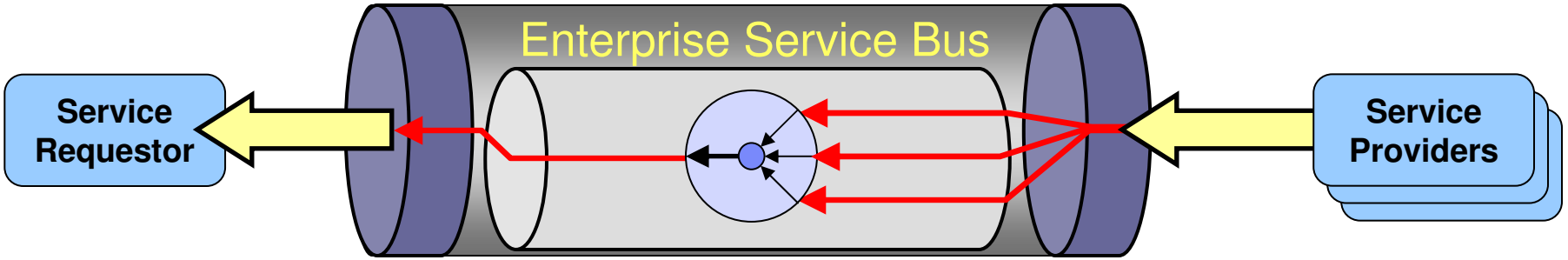
Transformation Patterns



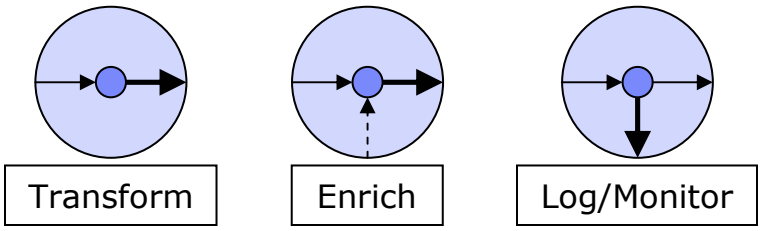
Routing Patterns



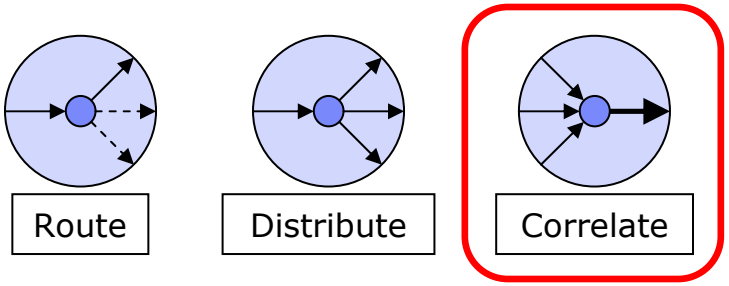
Routing Pattern - Correlate



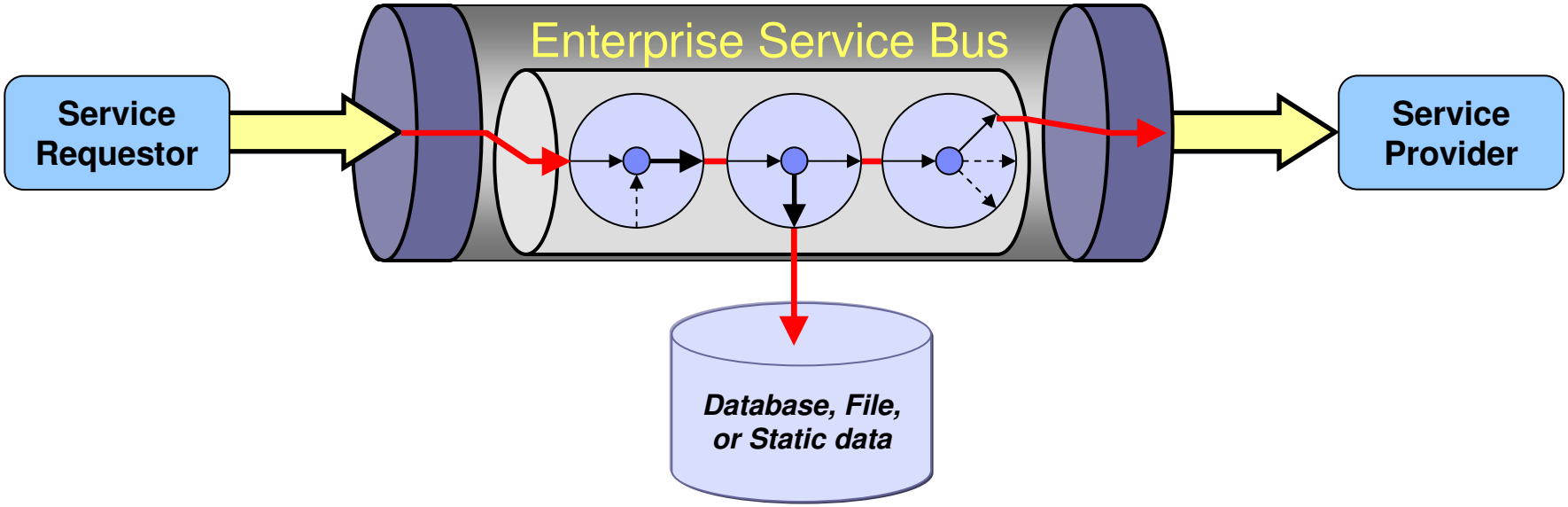
Transformation Patterns

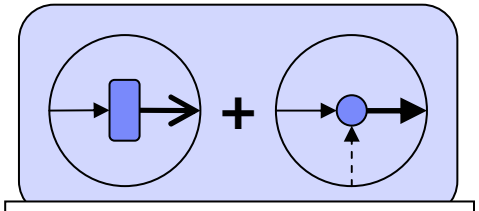


Routing Patterns

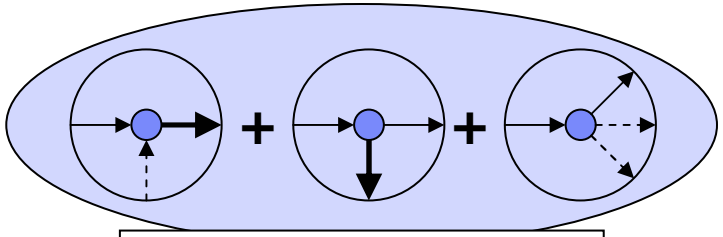


Mediation Patterns – Common Composite Pattern Example





Canonical Adapter
Protocol+Data Transform



Transform – Log - Route

Review

- ✓ **What is an Enterprise Service Bus?**
- ✓ **The Enterprise Service Bus Pattern**
- ✓ **Service Virtualization**
- ✓ **What's inside an Enterprise Service Bus?**