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# Enterprise Service Bus Patterns

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## Agenda

- Why am I here to talk about the Enterprise Service Bus?
  - If we want to achieve business flexibility, intermediaries such as the ESB will be crucial components of a Service Oriented Architecture
  - If we ask what the “loose coupling” specified by Service Oriented Architecture really means, we drive infrastructure requirements.
  - If we want to implement SOA in a *manageable* way, we drive infrastructure requirements.

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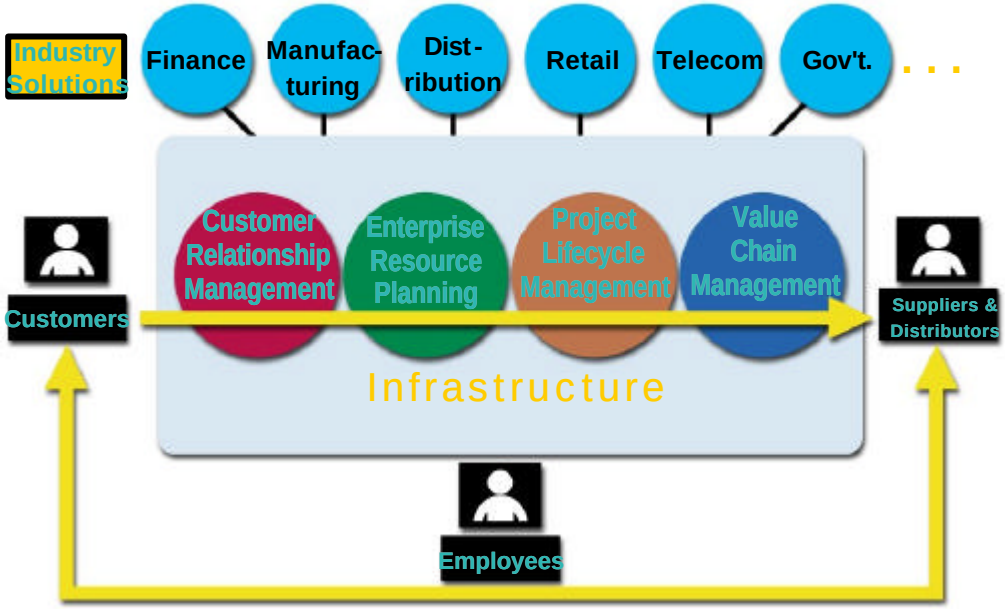
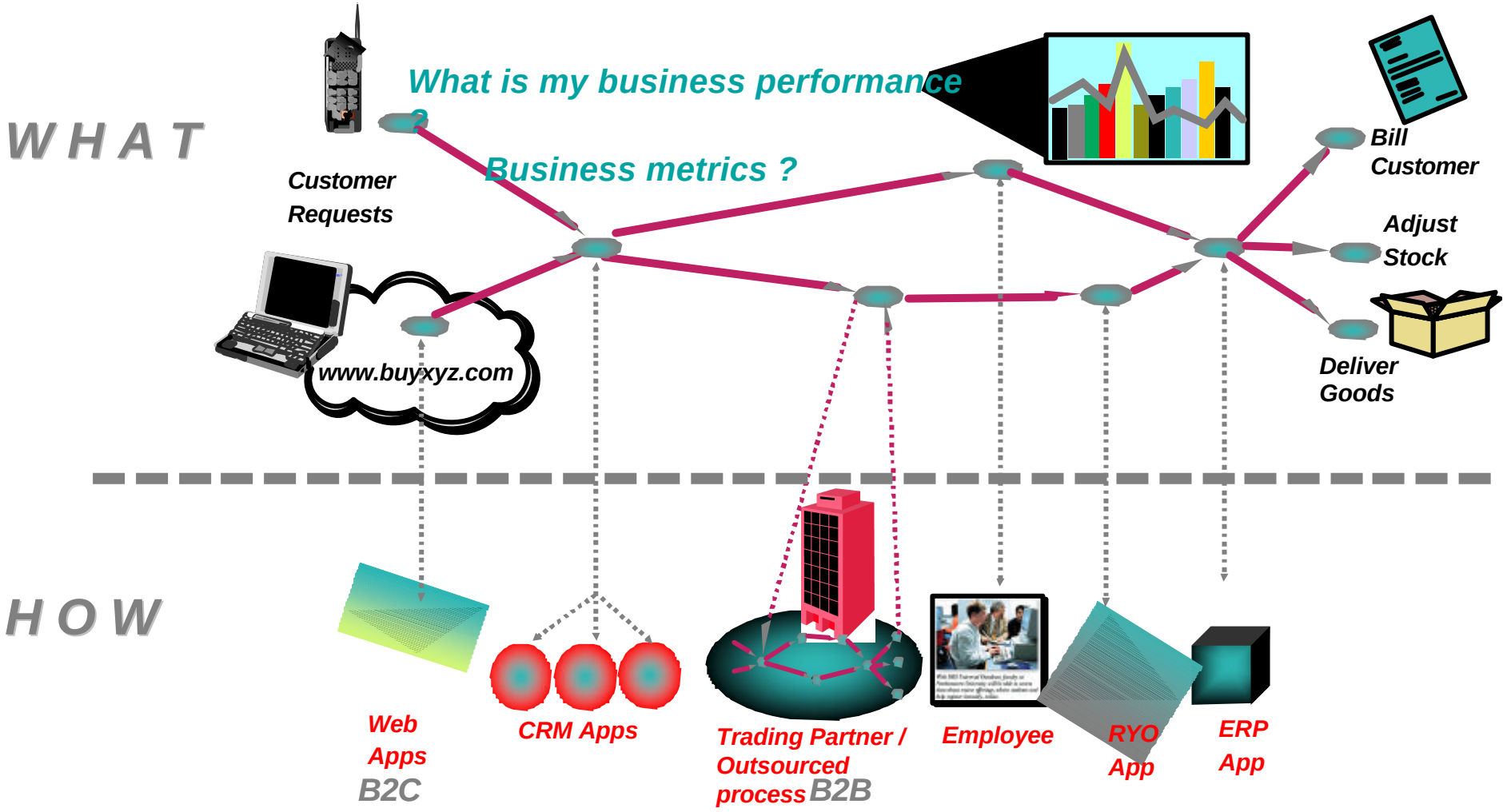
# What is Service Oriented Architecture and why do I care?

# Business are faced with some rather familiar problems ...




- Reduce cycle time and costs for external business processes
  - Move from manual transactions with suppliers towards automated transactions
  - Facilitate flexible dealings with partners with minimal process or IT impact
- Support an agile business model
  - The marketplace is changing - businesses need to change too
  - Many existing IT systems are inhibitors to change: complex and inflexible
  - Existing *integrations* can be inhibitors to change: multiple technologies, point-to-point integration, inflexible models
- Drive down cost
  - Eliminate duplicate systems
  - Re-use, don't re-build
  - Simplify skills base
- Integrate across the enterprise
  - Integrate historically separate systems
  - Completion of mergers and acquisitions
  - Across physical and technology barriers

... and solving them implies implementing flexible, automated business processes across the enterprise.



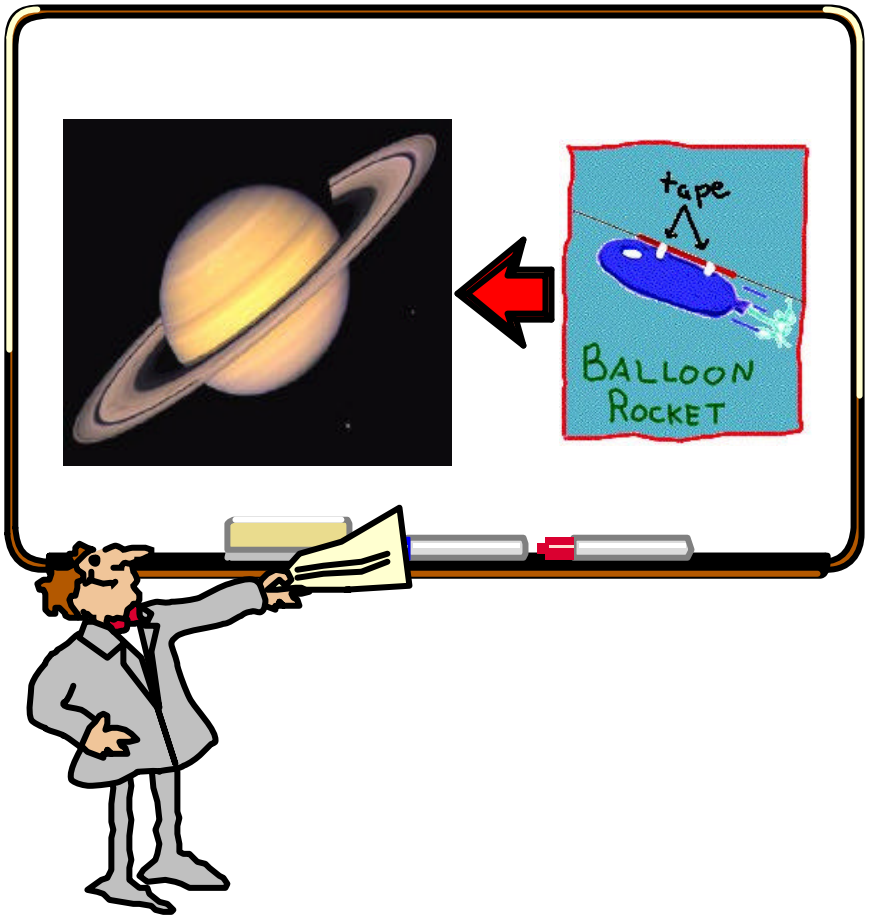
# There are many difficult problems in the way.

- **Technical Diversity**
  - A *multitude of technologies and platforms* support your business systems.
  - Processes may need to include the systems of *existing and future partners*, which are not only varied but beyond your control.
  - No single, fully functional integration solution will talk to them all.
- **Business Model Realisation**
  - Business process implementations are a combination of individual behaviour, business guidelines, application code and interactions between all of these.
  - It is *difficult to create and sustain* a consistent model of business data, function and processes across (or beyond) the enterprise.
  - Realising the business model in a flexible manner may involve refactoring the business, with all the attendant issues of transformation and change.
- **Undesirable Dependencies**
  - It is *difficult to isolate business behaviour* so that changing it to reflect business requirements tends to require changes to more than one system.
  - Traditional approaches to integration can suffer from the *same inflexibilities* as individual applications.

# SOA is the answer to everything!!!

Service Oriented Architecture describes:

- Viewing business as the delivery of services to consumers.
- Decoupling the packaging and delivery of those services from their implementation.
- Implementing those services as business processes that use a highly flexible combination of other business and technical services.
- Applying this view to the supporting IT systems:
  - by directly modelling and mapping services and processes to them.
  - by implementing interactions between systems as services.



# A more formal definition

(With thanks to Richard Whyte)

- A service-oriented architecture consists of an arbitrary number of services constructed to communicate through a consistent, integrated communication service.
- The communication service should insulate service interactions from the details of underlying communication protocols, and should support a variety of interaction types.
- A given SOA implementation may add but not remove constraints to the basic definition to facilitate additional benefit.
- Such an architecture specifies that all participating systems are fully encapsulated within properly formed services such that any exposed function forms part of a public interface described in a formal terminology.
- These services must support backward compatibility.

# An example service: roadside assistance

- Imagine the fictitious "Wildcat" luxury car manufacturer that offers a "roadside assistance" service to its customers.
- The package includes roadside and home assistance, vehicle recovery, the provision of replacement cars and covers the cost of temporary accommodation.
- However, Wildcat are not expert in any of these areas, and so they sub-contract delivery:
  - Roadside assistance - to a roadside assistance specialist
  - Vehicle recovery - to local garages with towing facilities
  - Replacement cars - to a car rental company
  - Temporary accommodation - to a motel chain.
- Wildcat therefore offer a comprehensive service to their customers without delivering any elements of that service themselves.
  - They can subcontract to the lowest cost or highest standard service provider in each area.
  - If a new provider becomes available offering lower cost or higher standards, Wildcat can switch to them.
  - If Wildcat need to offer a new package of slightly different services to some of their customers, it is easy for them to do so.

# Applying SOA to the roadside assistance service

- SOA Automates the provision of business services and the aggregation of service suppliers.
  - In the example, sourcing and aggregation of services could take place through face-to-face negotiation, telephone calls etc.
  - In SOA, services are increasingly located, selected and bound to through interactions between systems rather than people.
- SOA applies the same principles further down the technology stack to achieve flexibility in the way technology is applied to support the business.
  - The ability of a business to change is constrained by the agility of its IT systems
  - By treating IT capabilities as services and providing similar de-coupling and flexibility, SOA seeks to improve the overall agility of a business.
- SOA enables outsourcing or re-sourcing of business services at various levels of granularity.
  - In the example, relatively large-grained business services such as replacement cars are outsourced.
  - SOA enables more flexible outsourcing, such as:
    - Finer grained services, such as payments, credit checks etc.
    - More dynamic outsourcing large grained services, e.g. selecting between multiple hotel chains by geographical area or depending on current discount programmes etc.

# Implementing an SOA is a combination of many things

- The use of appropriate technologies to support process models, service interactions etc. with appropriate loose coupling.
  - XML, Web Services, EAI middleware etc.
- Modelling business to the level of detail required for automation.
  - Process Modelling, Component Business Modelling etc.
- Refactoring business capabilities and processes to achieve re-use and flexibility.
  - Business Process Reengineering, Business Transformation etc.
- Deploying a manageable supporting infrastructure.
  - Enterprise Service Bus, Service Management, Web Services etc.

# SOA is not ...

- EAI, OO, On-Demand or CBD
- Marketing rubbish
- Web services
- Dynamic discovery of services at runtime
- Particularly new
- Agreed by everyone
- ESB
- A product
- Composed of "AD services", "architecture services", "desktop support services"

# Reality Check – Some Service Oriented Architectures I Have Seen

- CORBA
  - ✓Custom common business object model
  - ✓Stateless business service model
  - ✓IDL or XML interface definitions supporting IIOP and HTTP communication protocols
- EAI
  - ✓XML interface definition language and data model.
  - ✓EAI routing and communications infrastructure, e.g. WebSphere MQ or WBI Message Broker
  - ✓Framework APIs (e.g. Java, C etc.) to discover, bind to and invoke services
- Web Services
  - ✓Sparkassen Informatik, Charles Schwab – Evolving EAI-based SOAs to Web Services

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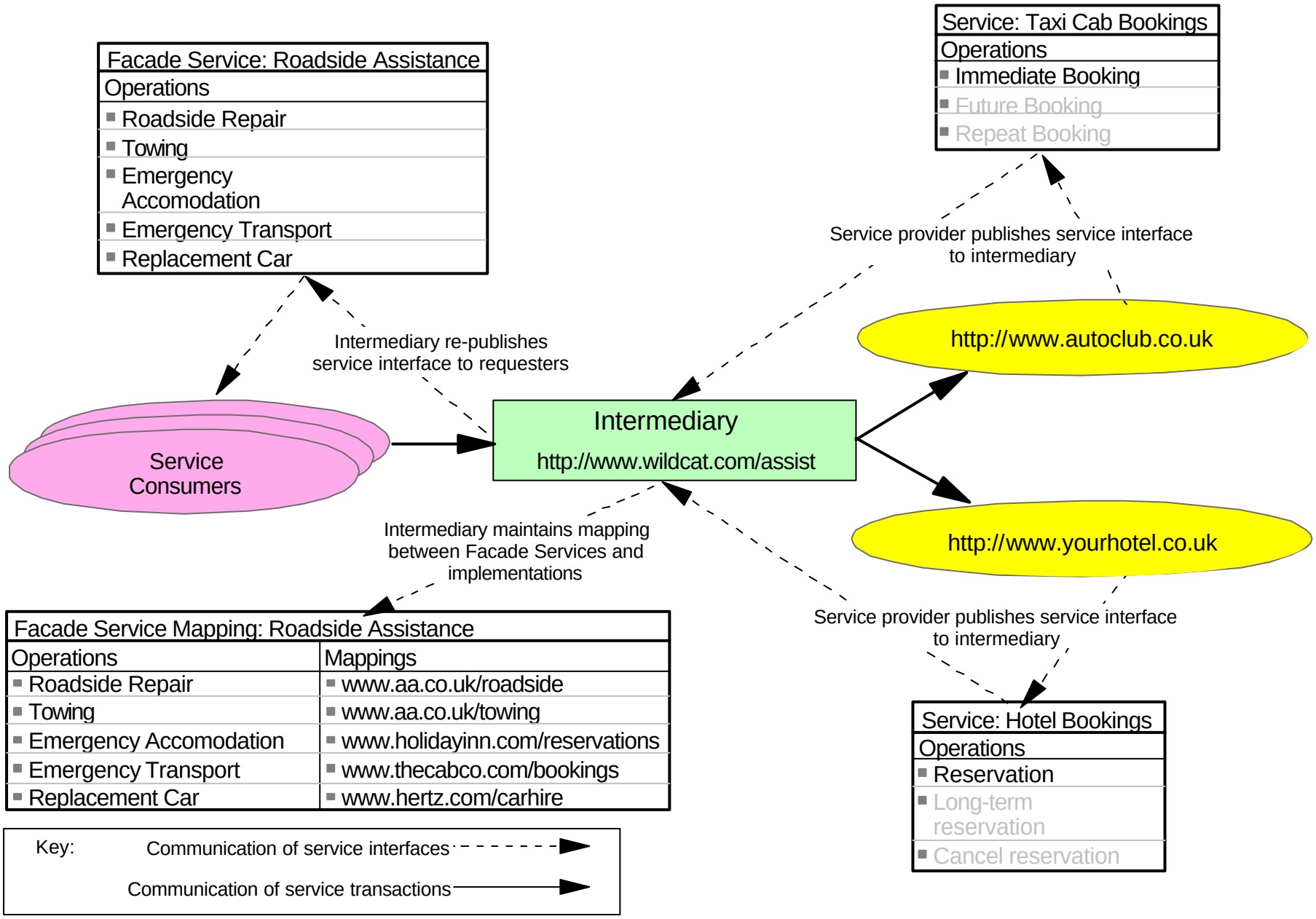
# Achieving Flexibility – Façade Services

# Intermediaries and Service Facades are vital to the way SOA promotes agility.

- SOA promotes business agility by decoupling the packaging and delivery of a service from its implementation.
- This implies that *more than one interface is involved in delivering each service:*
  - The service consumer binds to an interface published by a delivery channel.
  - The delivery channel binds to an interface published by the service provider.
- SOA therefore requires intermediaries to provide these "Facade Services":
  - Service Gateways
  - Enterprise Service Bus
  - Portals
  - etc.


Facade Service: Roadside Assistance
Operations
Roadside Repair
Towing
Emergency Accomodation
Emergency Transport
Replacement Car
Service: Taxi Cab Bookings
Operations
Immediate Booking
Future Booking
Repeat Booking
Service provider publishes service interface to intermediary
Intermediary re-publishes service interface to requesters
http://www.autoclub.co.uk
Service Consumers
Intermediary
http://www.wildcat.com/assist
http://www.yourhotel.co.uk
Intermediary maintains mapping between Facade Services and implementations
Service provider publishes service interface to intermediary
Facade Service Mapping: Roadside Assistance
Operations
Mappings
Roadside Repair
www.aa.co.uk/roadside
Towing
www.aa.co.uk/towing
Emergency Accomodation
www.holidayinn.com/reservations
Emergency Transport
www.thecabco.com/bookings
Replacement Car
www.hertz.com/carhire
Service: Hotel Bookings
Operations
Reservation
Long-term reservation
Cancel reservation
Key:
Communication of service interfaces
Communication of service transactions

# Service Facades give us a new way of considering cohesion and encapsulation

- In existing techniques (e.g. OO and CBD) that use interfaces, the cohesion between operations in the interface is driven by ***implementation*** concerns.
  - Component and Object interfaces are composed of behaviours that it makes sense to implement in one place.
- For facade services, the cohesion between operations in the interface is driven by ***consumption*** concerns.
  - Facade services interfaces are composed of behaviours that it makes sense to access in one place.
- Examples:
  - In the "roadside assistance service" example, the services available were those that made sense to someone with a broken-down car. They do not necessarily make no sense implement together, which is why the car manufacturer has to source them from elsewhere.
  - In the world of banking, many supermarkets now sell financial services - insurance, current accounts, mortgages etc. Each supermarket could source these services from a variety of financial providers. Again, it makes more sense to *offer* these services together than to *implement* them together.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Achieving Loose Coupling
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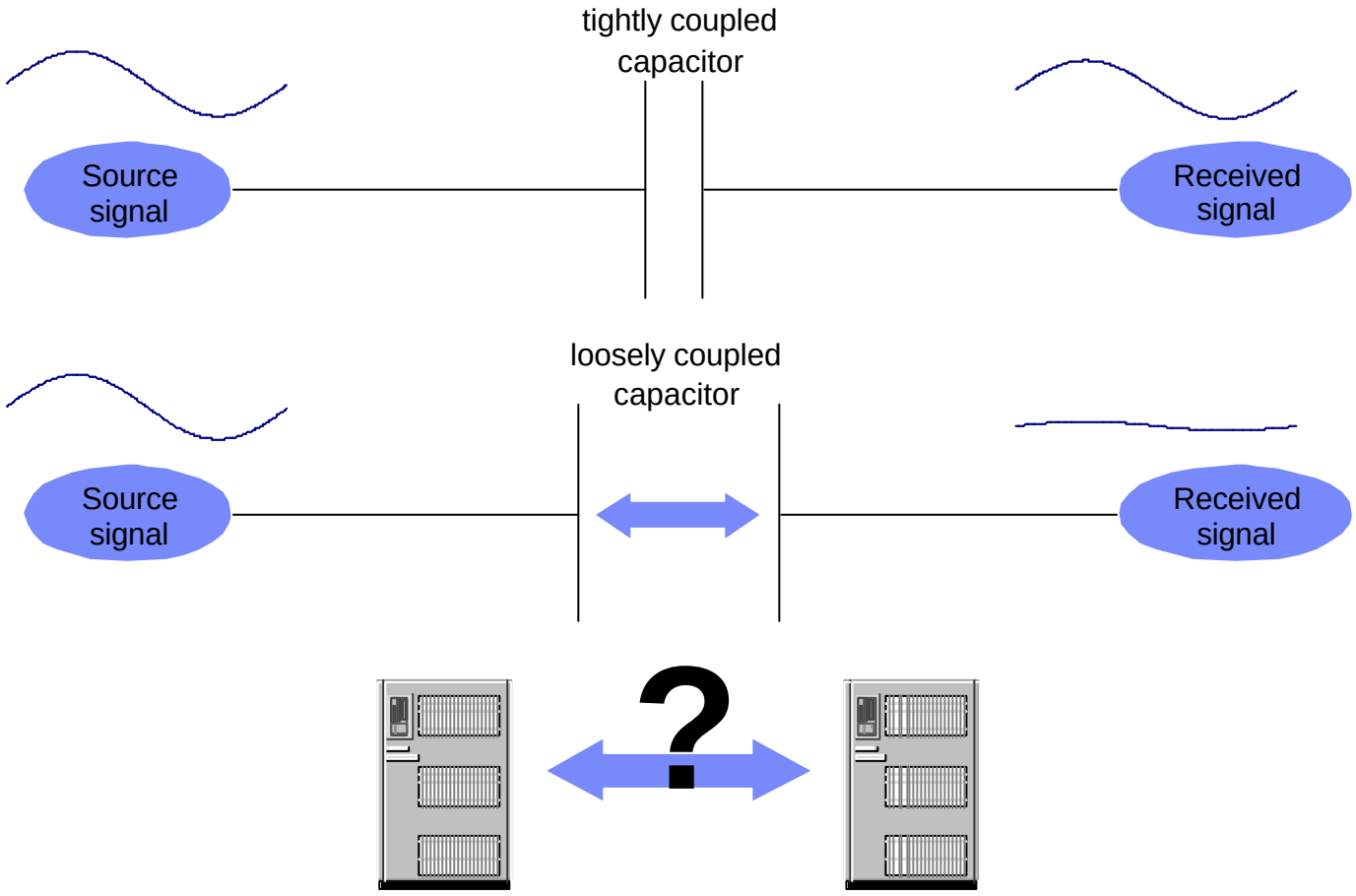
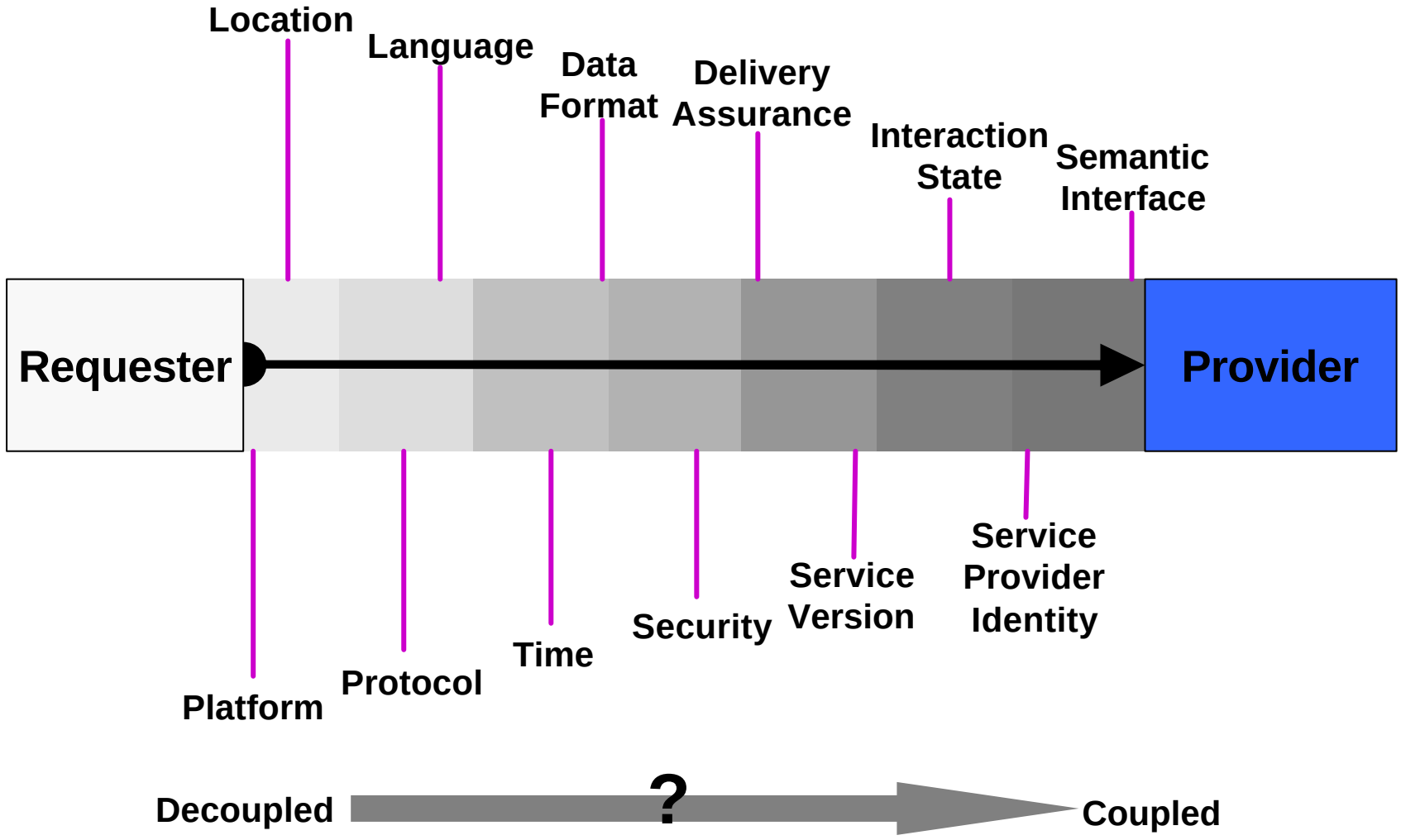
# The “loose coupling” required by Service Oriented Architecture is not something I know how to implement for IT systems …

- *“Services are loosely coupled and invoked through communication protocols that stress location transparency and interoperability.”*



## … but I can consider whether I would like to couple various *aspects* of service interactions …



## … and I can use more sophisticated *coupling styles* than "coupled" or "decoupled".

- **Coupled**
  - Directly manipulated by service requester and provider application code.
  - e.g. business data model

- **Declared**
  - Clients and providers declare matching behaviour in interfaces.
  - e.g. WS-Security
  - **Transformed**
    - Specified in the service interface, but not manipulated by application code. Services declare different characteristics but the service infrastructure can mediate between requester and provider.
    - e.g. data format
  - **Negotiated**
  - Requester and provider interfaces declare a spectrum of behaviours, infrastructure negotiates an agreed behaviour for each interaction.
  - e.g. proposed WS-Policy, service provider identified dynamically through UDDI

- **Decoupled**
  - Entirely independent between client, provider and infrastructure.
  - e.g. platform independence through use of XML and HTTP

# Applying coupling styles to aspects of service interactions implies infrastructure capabilities as well as standards and protocols.

| Aspect | Coupling Style | Techniques |
|---|---|---|
| **Semantic Interface** | Coupled | WSDL, Application code, common objects, data dictionary |
| **Language** | Decoupled | Open standards, Web Services, J2EE, HTTP, XML |
| **Platform** | Decoupled | As above |
| **Data Format** | Declared or Transformed | WSDL, XML, adaptors, stylesheets, AD tools, middleware |
| **Protocol** | Declared or Transformed | HTTP, SOAP, Middleware, adaptors |
| **Location** | Decoupled | Communication protocols, HTTP, SOAP, middleware |
| **Service provider identity or implementation** | Declared, transformed or negotiated | Service routing, middleware, "broker"s, UDDI etc. |
| **etc. ...**<br>Time, Delivery Assurance, Error Handling, Security, Service Version, Interaction State | etc ... | etc ... |

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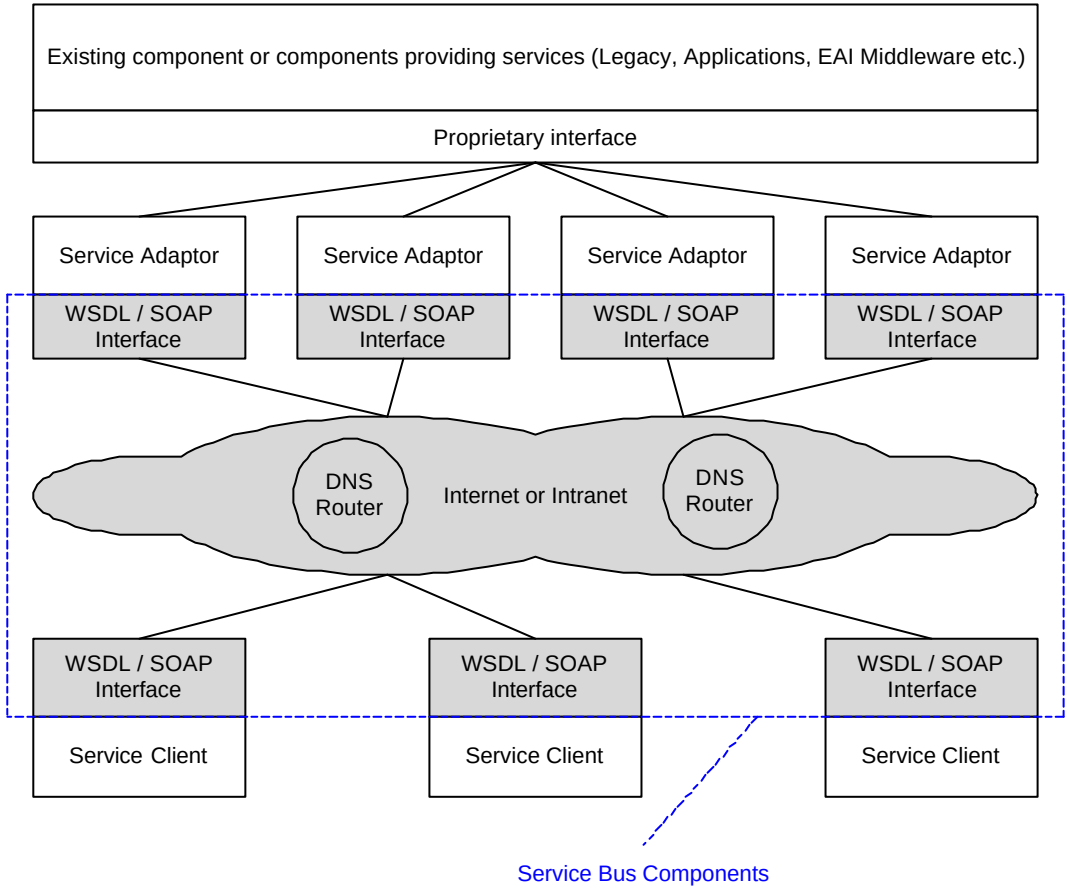
# A manageable infrastructure for SOA

# Infrastructure capabilities are also required to implement a manageable SOA in the enterprise.

**As a counter-example, consider the use of simple SOAP/HTTP wrappers**

- SOAP/HTTP and WSDL leverage URL addressing and the existing HTTP and DNS infrastructure for Service Oriented Architecture.
- But they do not address enterprise requirements for SOA:
  - Multiple qualities of service
  - Widespread integration and interoperability
  - Transformations and mediations
  - Substitution of service implementations

Critically, management of an SOA “infrastructure” provided in this way is distributed between service endpoints and the existing infrastructure.

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Enterprise Service Bus
Patterns and Implementations
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# The marketplace uses the term “Enterprise Service Bus” to describe infrastructure technology providing these capabilities.

- Analysts describe a middleware capability …
  - “…a new architecture that exploits Web Services, messaging middleware, intelligent routing and transformation…” Roy Schulte, Gartner, Predicts 2003: Enterprise Service Buses Emerge
- … but some are more sceptical
  - ""ESBs have no defining advantage over products such as WebSphere MQ, and they lack its credentials.“ … Andrew Binstock (Integration Watch), December 2003 http://sdtimes.com/cols/integrationwatch.htm
- You have built your own … often using XML with EAI technology (e.g. message brokers or adaptors) or HTTP.
- A unifying view:
  - ESB is a logical infrastructure component that can be described by patterns
  - The ESB is defined by capabilities required to support SOA in the Enterprise in combination with other integration styles (messages and events)
  - The ESB provides a means to concentrate control and distribute topology

# ESB capabilities can be categorised and summarised based on the drivers described previously … but not all capabilities are required in all scenarios.

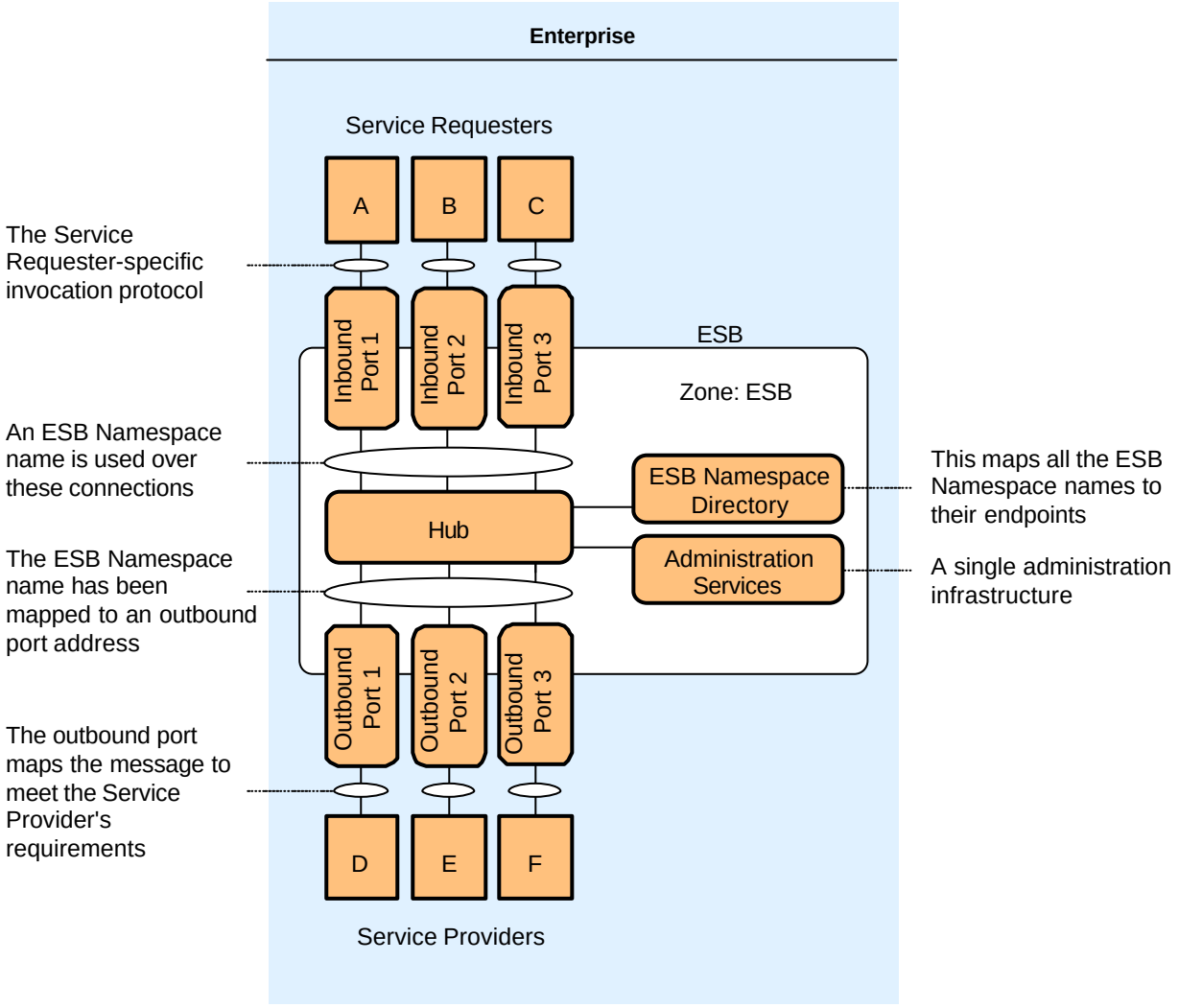
| | |
|---|---|
| **Communications, e.g.**<br>▪ Routing, addressing, protocols, pub/sub, async. | **Service Interaction, e.g.**<br>▪ Interface definition, service substitution, messaging model, SOAP, WSDL, directories |
| **Integration, e.g.**<br>▪ Database, legacy, middleware connectivity, service aggregation, app server connectivity, protocol transformation. | **Quality of Service, e.g.**<br>▪ Transactions, delivery assurance |
| **Security, e.g.**<br>▪ Authentication, authorisation, non-repudiation, confidentiality, standards support (WS-Security, Kerberos etc.) | **Service Level, e.g.**<br>▪ Performance, throughput, availability, scalability. |
| **Message Processing, e.g.**<br>▪ Encoded logic, content-based logic, message and data transformations, intermediaries etc.. | **Management and Autonomic, e.g.**<br>▪ Service provisioning and registration, logging, metering, monitoring, systems management etc.. |
| **Modelling, e.g.**<br>▪ Object modelling, common formats and libraries, public vs. private etc.. | **Infrastructure Intelligence, e.g.**<br>▪ Business rules, policy driven behaviour, pattern recognition, etc.. |

## *Minimum* ESB capabilities can be defined from the requirement to support SOA in the enterprise, and define which technologies are consistent with the ESB.

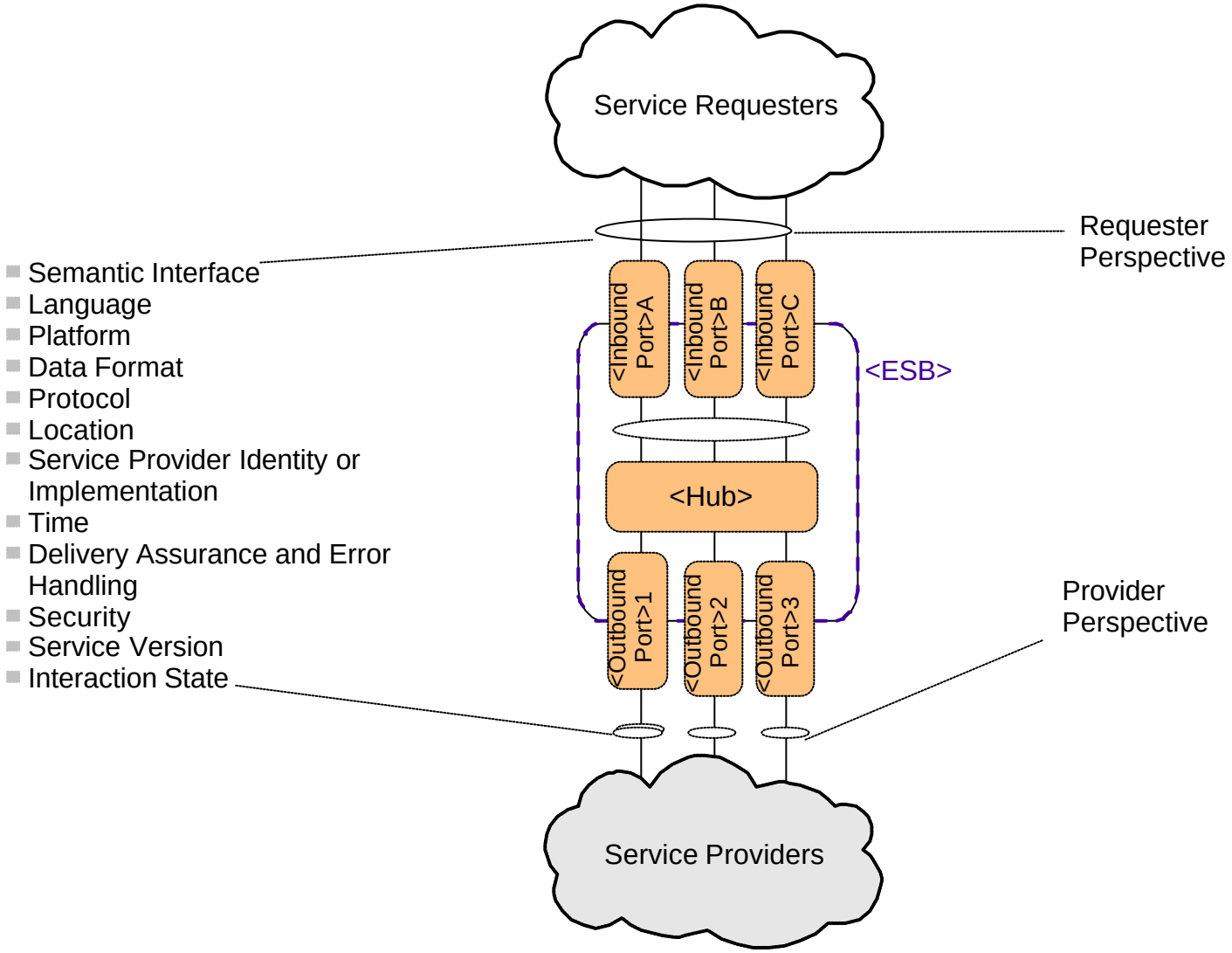
- If we require ESB to support our definition of SOA and add :
  - *The ESB provides the means to manage the service infrastructure and the capability to operate in today's distributed, heterogeneous environment.*
- We can define a minimum capability ESB implementation:

| Communication | Integration |
|---|---|
| ▪Routing and addressing services providing location transparency.<br>▪An administration capability<br>▪At least one messaging paradigm (e.g. request / response, pub/sub, etc.).·<br>▪At least one transport protocol that is or can be made widely available. | ▪Support for multiple means of integration, e.g. Java 2 Connectors, Web Services, etc. |
| **Service Interaction** | |
| ▪Service messaging and interfacing model. | |

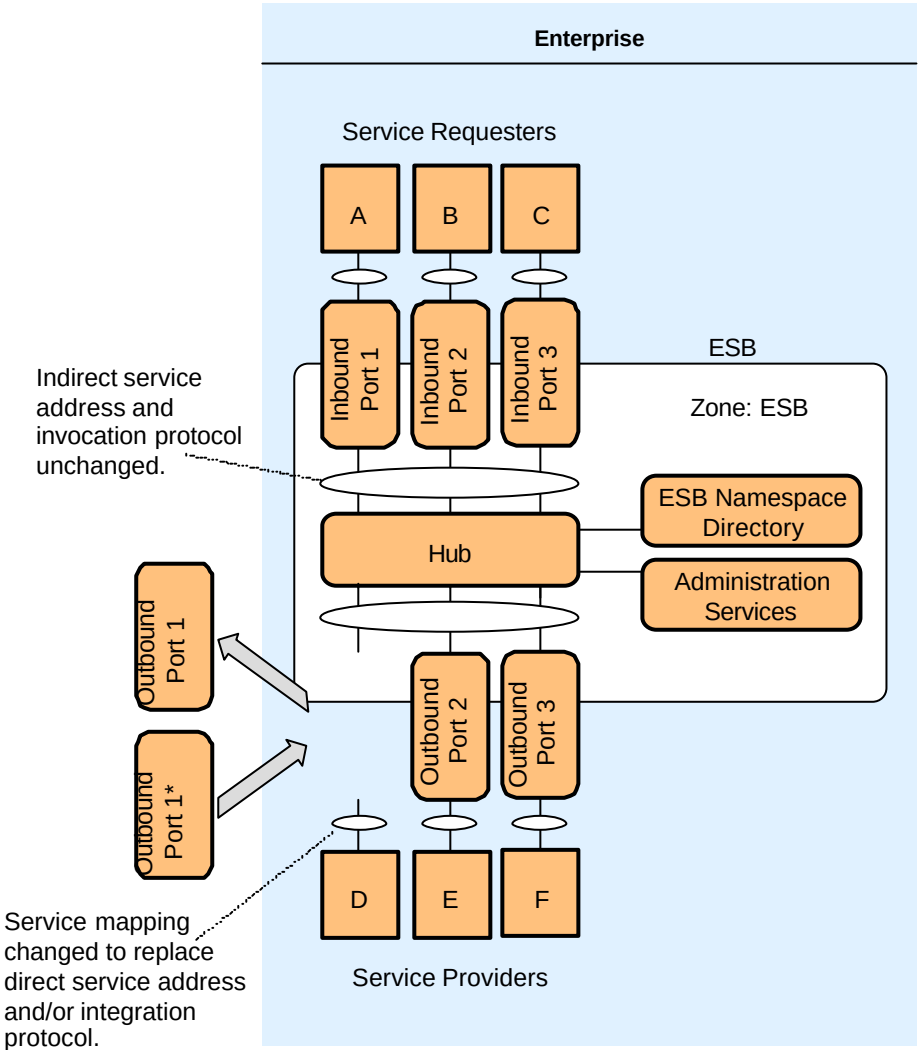
# In the IBM Patterns for e-business we model the ESB as a “Zone” supported by several “hubs”



# We can model the role played by the ESB in mediating coupling in service interactions.

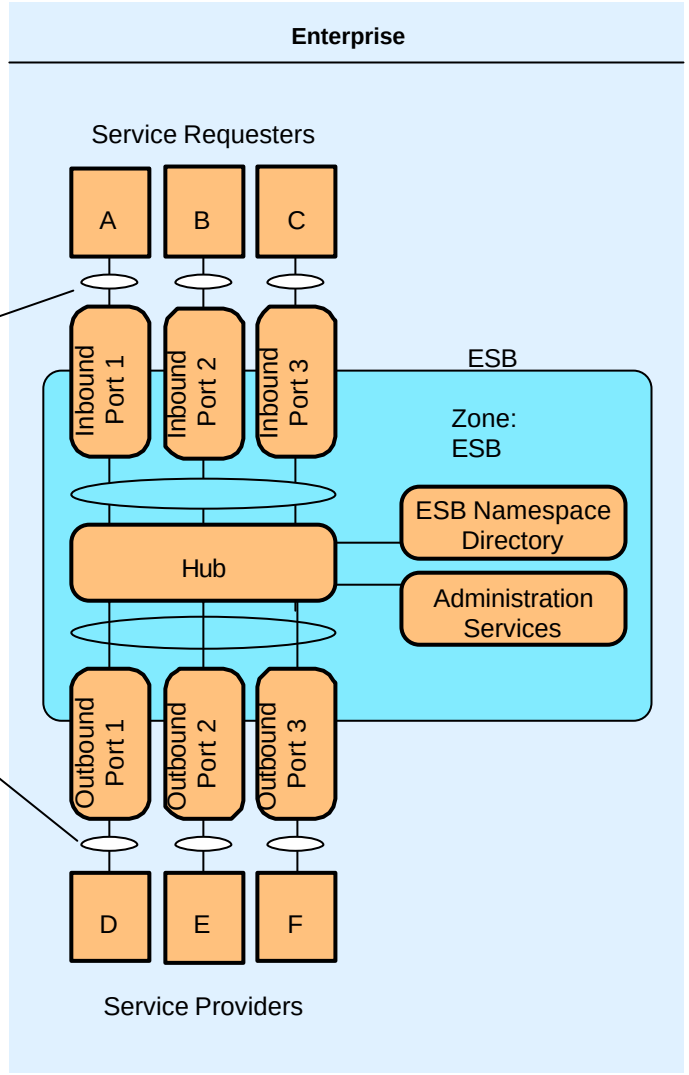


# The ESB supports substitution of service implementation

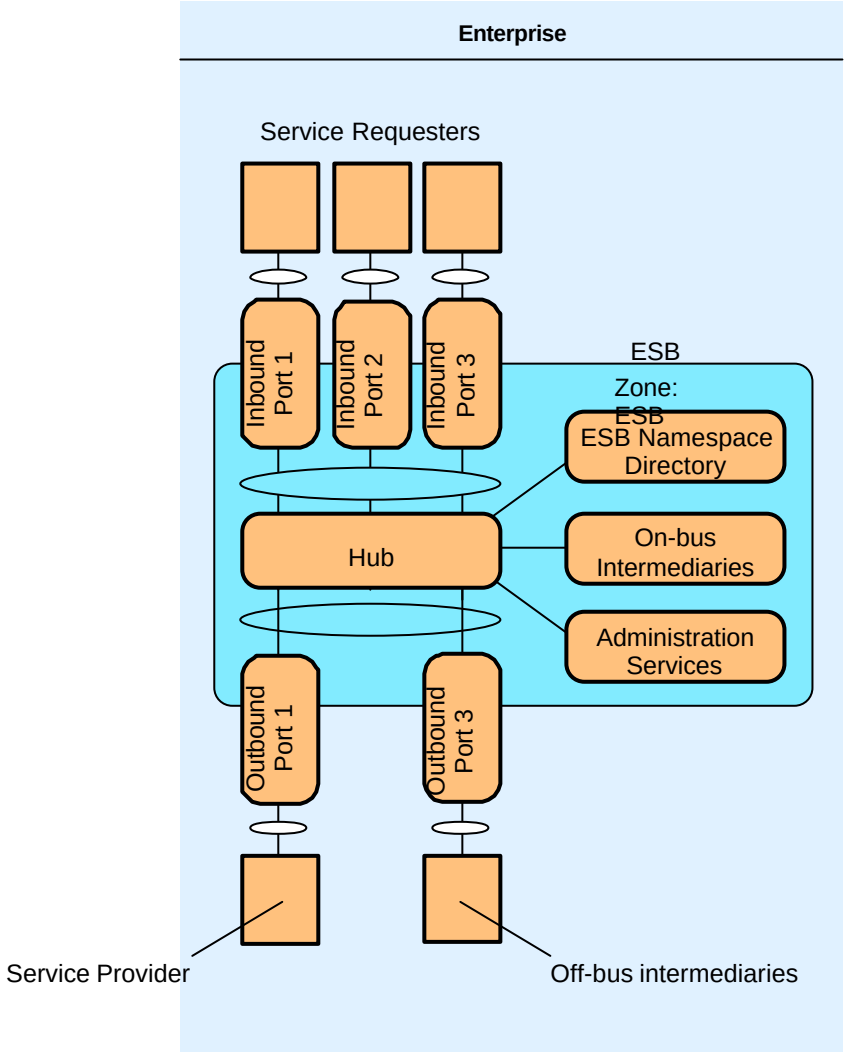


# The ESB supports a variety of connection styles

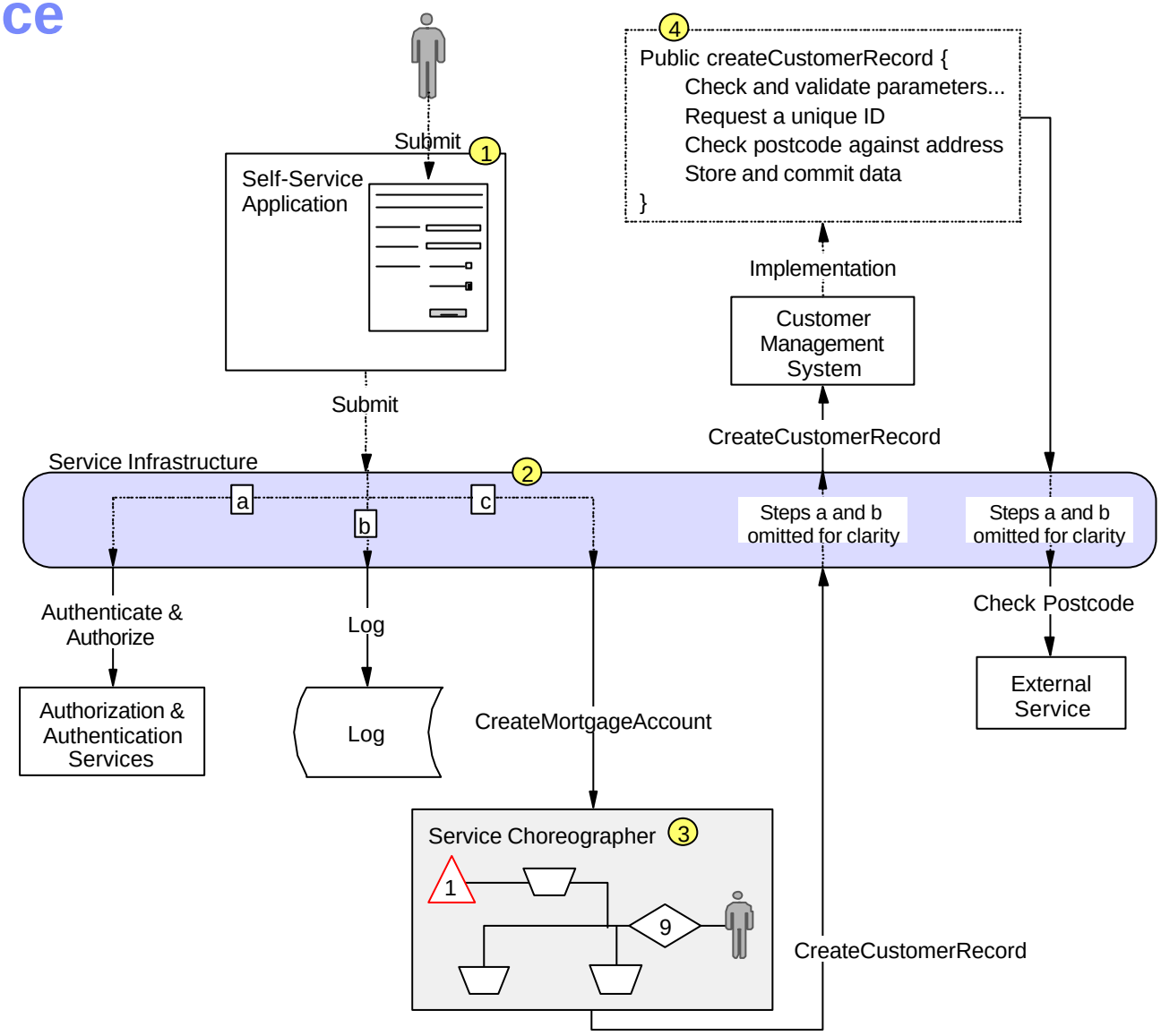
- API
- Protocol
- Adaptor



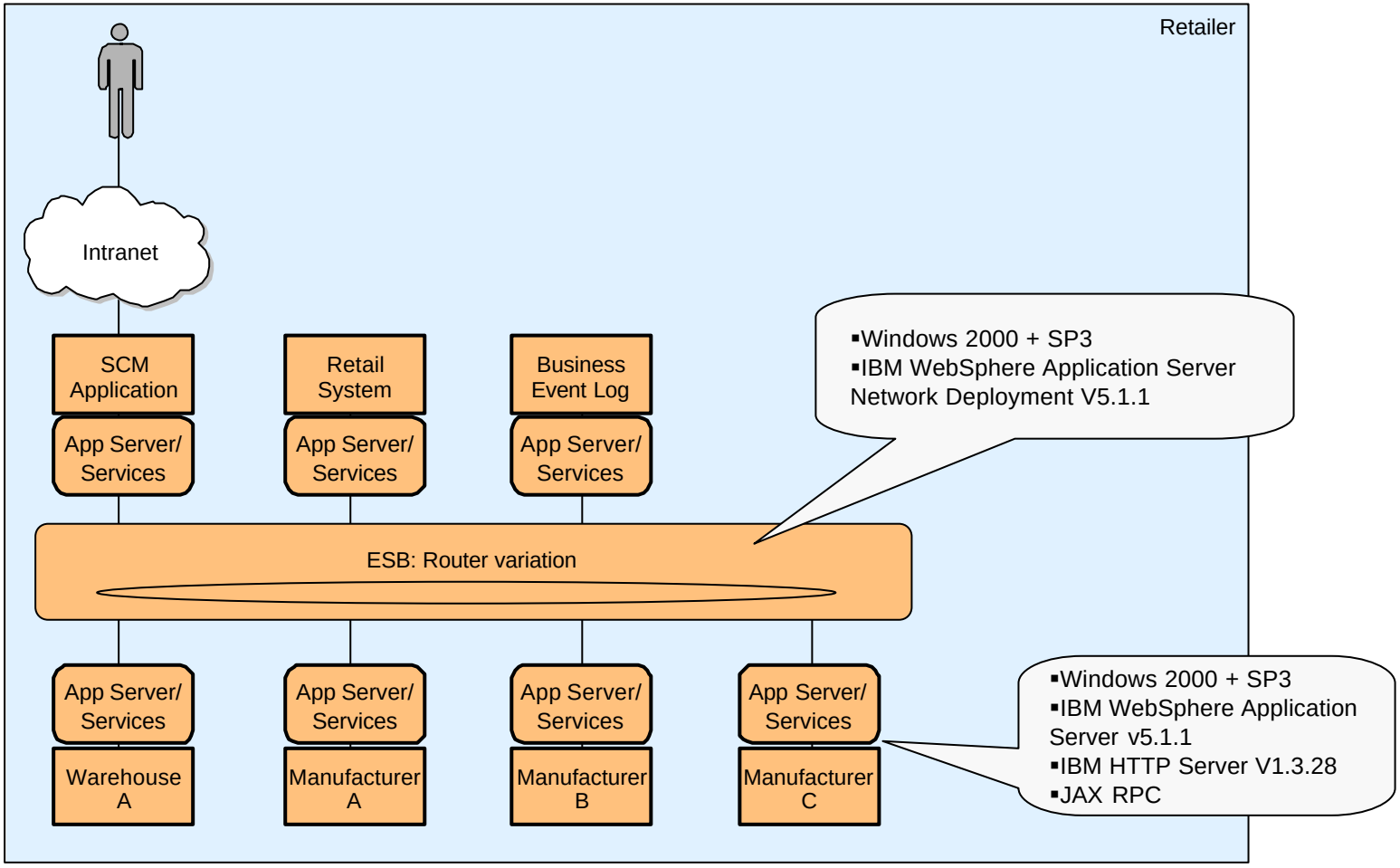
# The ESB allows on- and off-bus intermediaries to be sequenced around service invocations



# The ESB acts as a bridge between different types of service

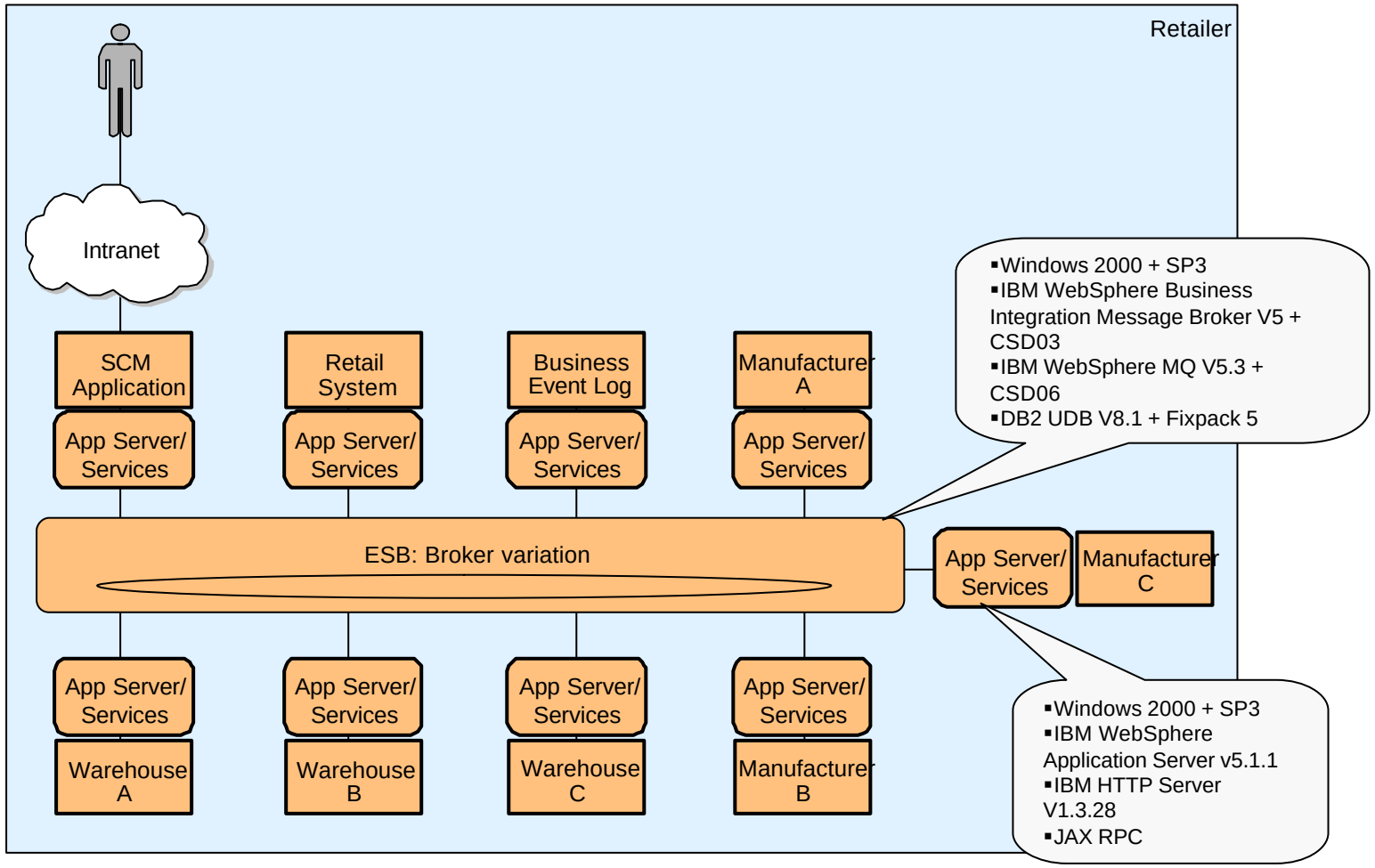


# ESB Today: a simple implementation with Web Services Gateway



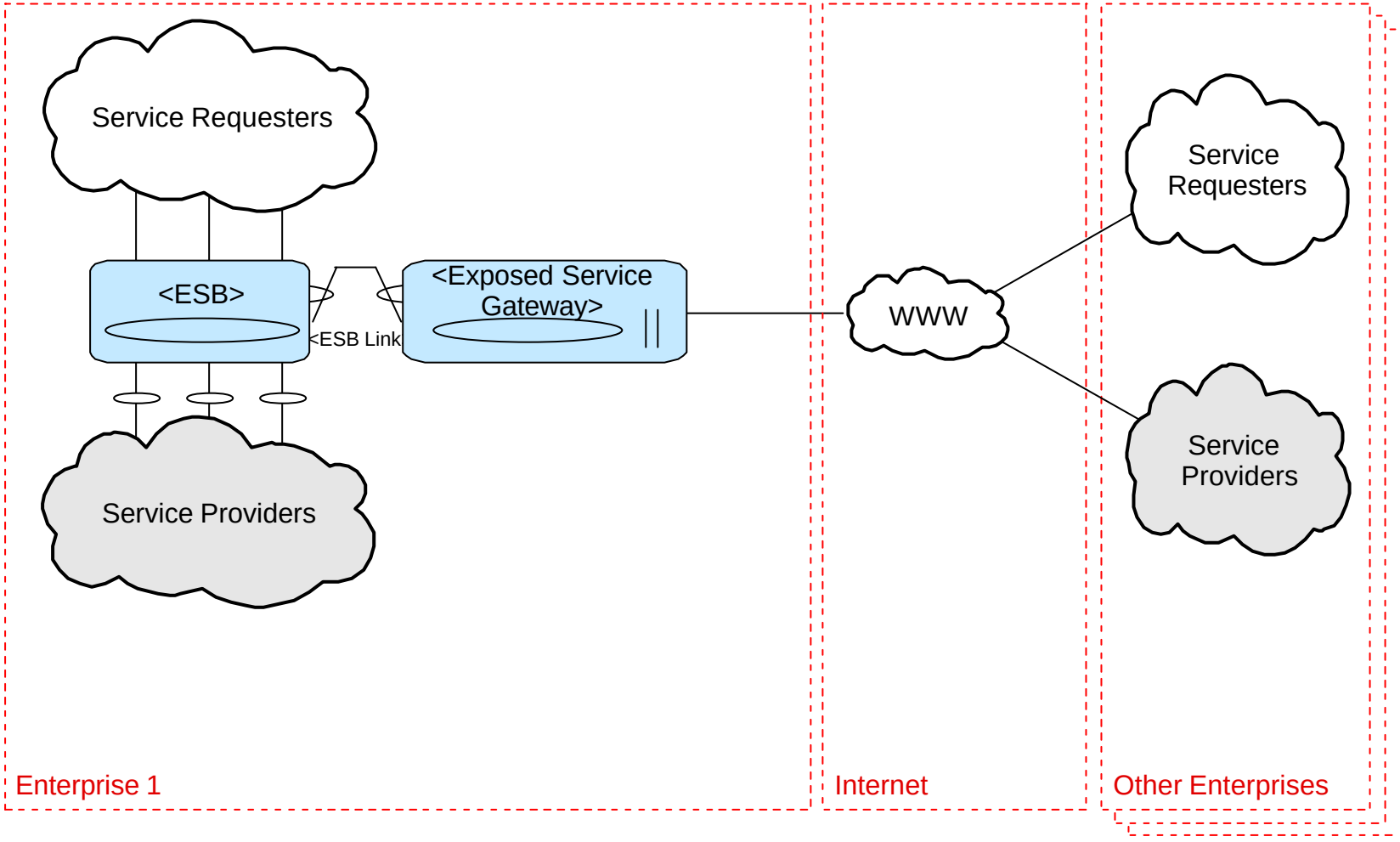

See redbook - Patterns: Implementing an SOA using an Enterprise Service Bus, SG24-6346

# ESB Today: a more sophisticated implementation with WBI Message Broker

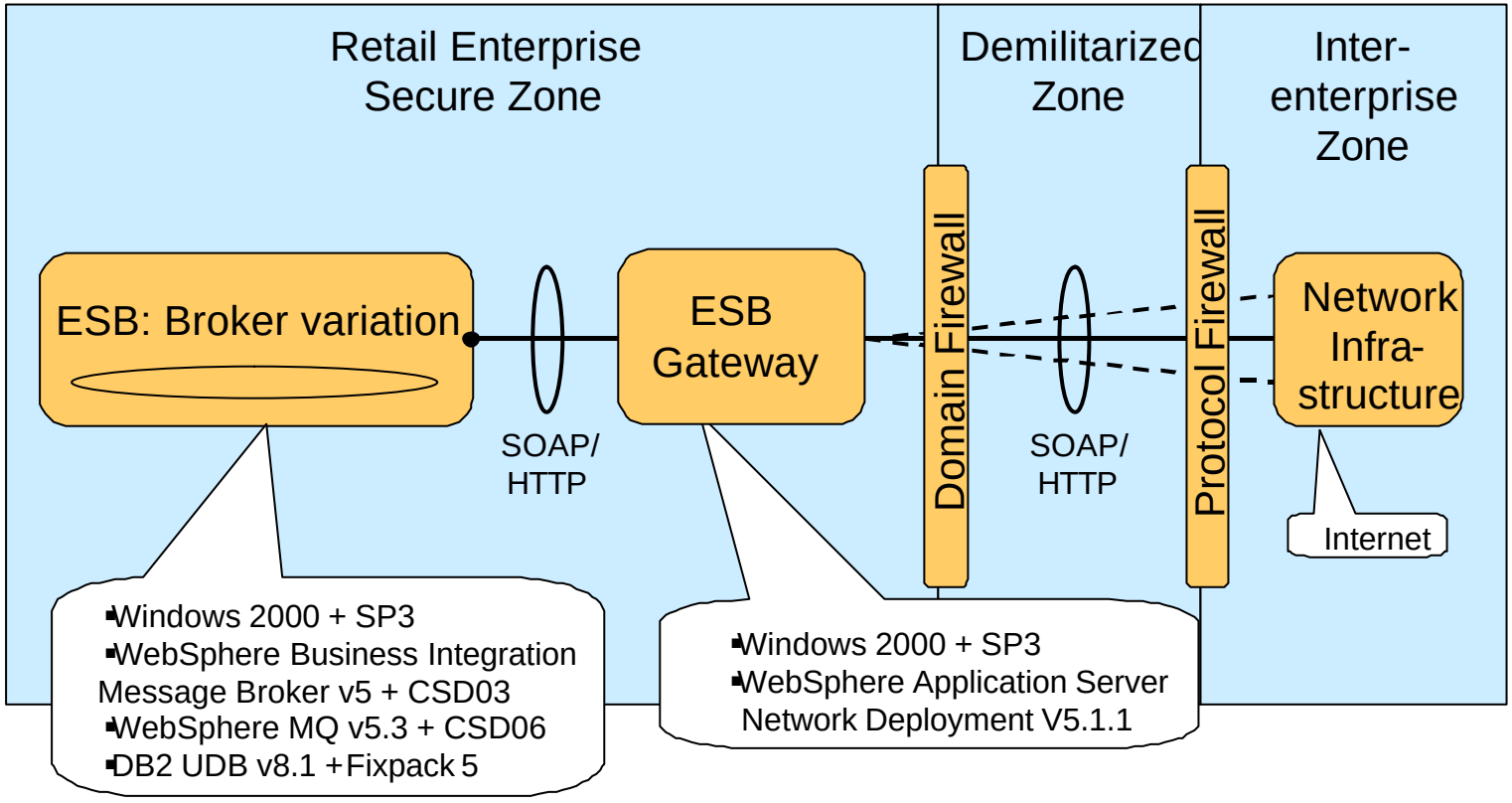



See redbook - Patterns: Implementing an SOA using an Enterprise Service Bus, SG24-6346

## Some scenarios will require more than one ESB pattern. Linking patterns in this way identifies requirements to match service interaction characteristics between infrastructure components.

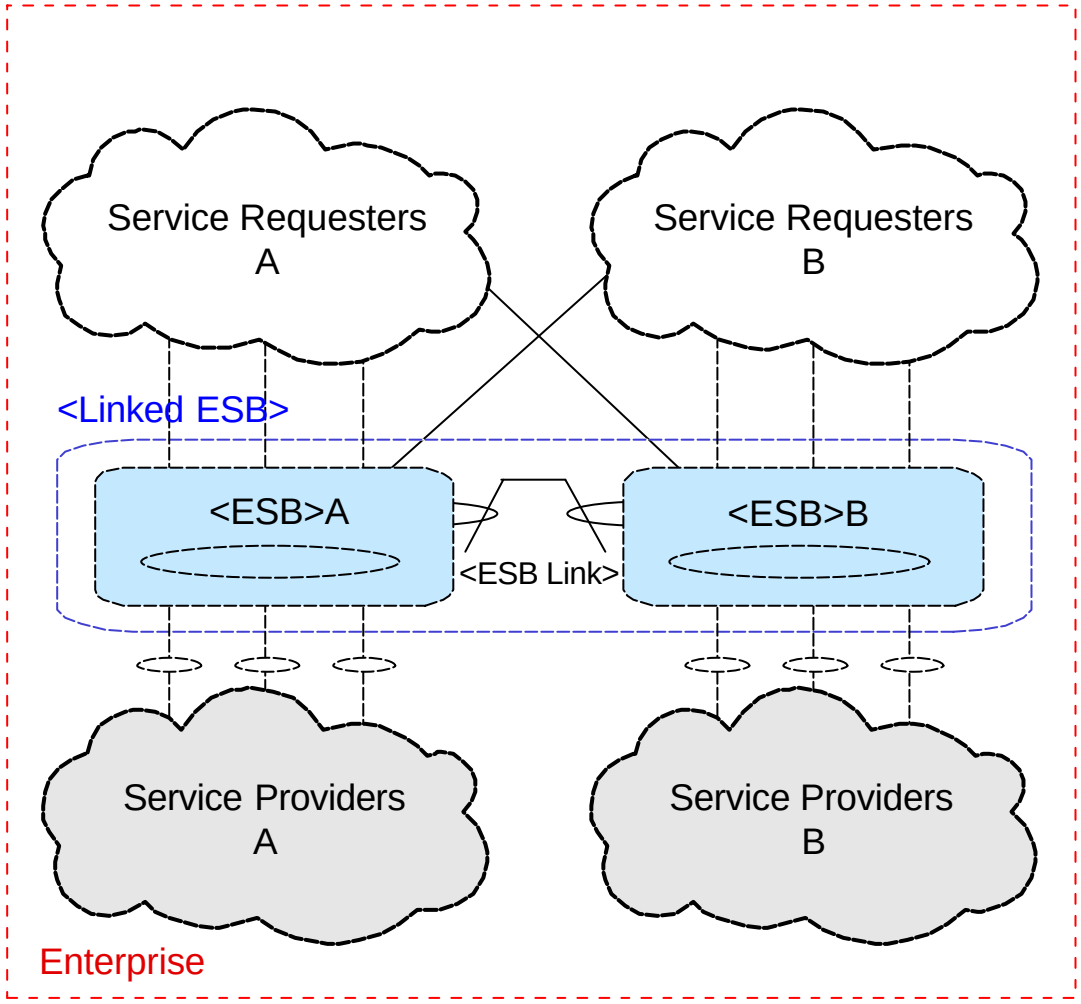


# Implementing an ESB and a Gateway with WBI Message Broker and Web Services Gateway




See redbook - Patterns: Implementing an SOA using an Enterprise Service Bus, SG24-6346

# In more complex situations ESBs will need to be linked



# Summary and Resources

# SOA and ESB are still evolving

- SOA is an architectural style that promotes architectural and business flexibility. Organisations have derived real business value from its principles.
- It is an evolution that takes succesful, proven techniques from previous architectural styles (OO, CBD) and technologies (CORBA, EAI etc.).
- SOA is not Web Services, but Web Services will become an increasingly important technology.
- The Enterprise Service Bus is an evolving conceptual architecture to support the loose coupling, business flexibility and manageability required by SOA in the Enterprise.
- ESBs can be constructed using current technology, but patterns and products will evolve to implement more sophisticated ESB capability in future.

# Plugs

- **Redbook: Patterns: SOA and Web Services, SG246303** http://publib-b.boulder.ibm.com/Redbooks.nsf/RedbookAbstracts/sg246303.html?Open
  - Mark Endrei, Jenny Ang, Ali Arsanjani, Sook Chua, Philippe Comte, Pål Krogdahl, Dr Min Luo, Tony Newling.
  - Introducing SOA concepts, standards and technologies
- **Redbook: Patterns: Implementing a Service Oriented Architecture using Enterprise Service Bus patterns, SG246346**
  http://publib-b.boulder.ibm.com/Redbooks.nsf/RedbookAbstracts/sg246346.html?Open
  - Martin Keen, Amit Acharya, Susan Bishop, Alan Hopkins, Sven Milinski, Chris Nott, Rick Robinson.
  - Further SOA concepts and implementation patterns for the Enterprise Service Bus
- **Enterprise Service Bus whitepapers**
  http://www-106.ibm.com/developerworks/webservices/library/ws-esbscen/

  http://www-106.ibm.com/developerworks/webservices/library/ws-esbscen2.html
  - http://www-106.ibm.com/developerworks/webservices/library/ws-esbscen3/
- **Perspectives on Web Services**
  http://publib-b.boulder.ibm.com/Redbooks.nsf/RedbookAbstracts/sg246346.html?Open
  - Olaf Zimmermann, Mark Tomlinson, Stefan Peuser
  - Architectural and development guidance on implementing SOA using Web Services and IBM software

# Resources

- IBM Web Services hompage
  - http://www-3.ibm.com/software/solutions/webservices/
- Web Services Interoperability organisation
  - http://www.ws-i.org/
- OASIS open standards organisation (ebXML etc.)
  - http://www.oasis-open.org/
- Specifications:
  - Business Process http://www-106.ibm.com/developerworks/library/ws-bpel/
  - Transactions http://www-106.ibm.com/developerworks/library/ws-transpec/
  - Security http://www-106.ibm.com/developerworks/webservices/library/ws-secmap/
  - SOAP http://www.w3.org/TR/SOAP/
  - WSDL http://www.w3.org/TR/wsdl
  - UDDI http://www.uddi.org/specification.html (public directory at https://uddi.ibm.com/ubr/registry.html)
  - WS-ReliableMessaging at http://www-106.ibm.com/developerworks/library/ws-rm/
- Tutorials, articles, technologies
  - http://www.ibm.com/webservices/
  - http://msdn.microsoft.com/webservices/
- Detailed presentations and LOTS more links
  - http://www.ibm.com/developerworks/speakers/colan
- Preview Technology
  - http://www.alphaworks.ibm.com/webservices
- Case Studies
  - http://www.ibm.com/software/ebusiness/jstart/casestudies/webservices.html

# Resources continued ...

- "Web Service Oriented Architecture - The Best Solution to Business Integration", Annrai O'Toole, Cape Clear Software CEO at
  - http://www.capeclear.com/clear_thinking1.shtml
- "SOA - Save Our Assets", Lawrence Wilkes, CBDI Forum (subscription required) at
  - http://www.cbdiforum.com/report_summary.php3?topic_id=2&report=623&start_rec=0
- The IBM series of articles "Migrating to a Service Oriented Architecture" by Kishore Channabasavaiah, Kerrie Holley and Edward M. Tuggle Jr. at
  - http://www-106.ibm.com/developerworks/library/ws-migratesoa/
  - http://www-106.ibm.com/developerworks/webservices/library/ws-migratesoa2/
- LooselyCoupled.com has a list of Enterprise Service Bus links at
  - http://www.looselycoupled.com/blog/2003_07_13_lc.htm - 105836683995371084
- The original Gartner article defining the Enterprise Service Bus requires a subscription, but can be found by searching their site http://www.gartner.com , and is entitled "Predicts 2003: Enterprise Service Buses Emerge", published 9th December 2002 by Roy W. Schulte.
- IBM Patterns for e-Business website at
  - http://www.ibm.com/developerworks/patterns/
- "The On Demand Operating Environment" at
  - http://www-3.ibm.com/e-business/doc/content/evolvetech/operating_environment.html
- "Using Web Services for Business Integration", Geert Van de Putte et al, IBM Redbook SG246583 at
  - http://publib-b.boulder.ibm.com/Redbooks.nsf/RedpieceAbstracts/sg246583.html?Open
- "WebSphere Version 5.1 Application Developer 5.1.1 Web Services Handbook", Ueli Wahli et al, IBM Redbook SG246891-01 at
  - http://publib-b.boulder.ibm.com/Redbooks.nsf/9445fa5b416f6e32852569ae006bb65f/d336dbf7a0ae01c385256d5000578477?OpenDocument
- "Coarse-Grained Interfaces Enable Service Composition in SOA", Jeff Hanson, Builder.com at
  - http://builder.com/5100-6386-5064520.html