Enterprise Integration Patterns

Asynchronous Messaging Architectures in Practice

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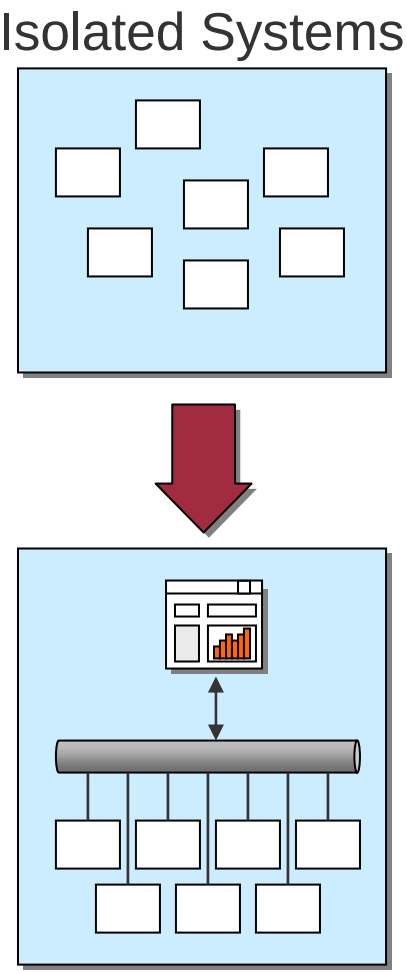
ThoughtWorks
The art of heavy lifting.

The Need for Enterprise Integration

- More than one application (often hundreds or thousands)
  - Single application too hard and inflexible
  - Vendor specialization
  - Corporate politics / organization
  - Historical reasons, e.g. mergers
- Customers see enterprise as a whole, want to execute business functions that span multiple applications

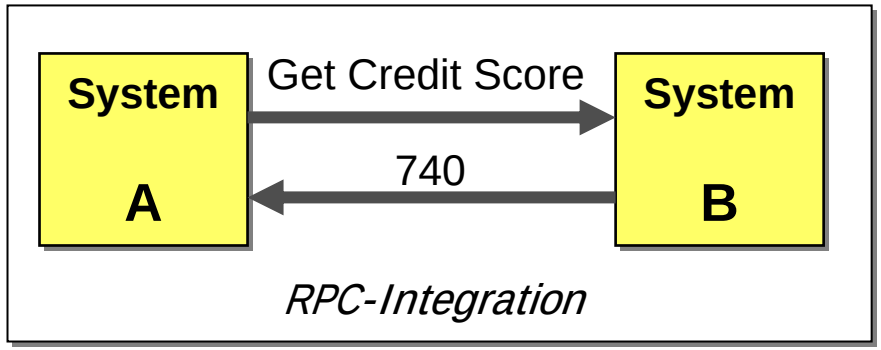


Integration Challenges

- Networks are slow
- Networks are unreliable
- No two applications are alike
- Change is Inevitable
- Plus…
  - Inherently large-scale and complex
  - Limited control over entities / applications
  - Far-reaching implications, business critical
  - Intertwined with corporate politics
  - Few standards exist, still evolving

Loose Coupling

- Coupling = Measure of dependencies between applications:
  - Technology Dependency
  - Location Dependency
  - Temporal Dependency
  - Data Format Dependency

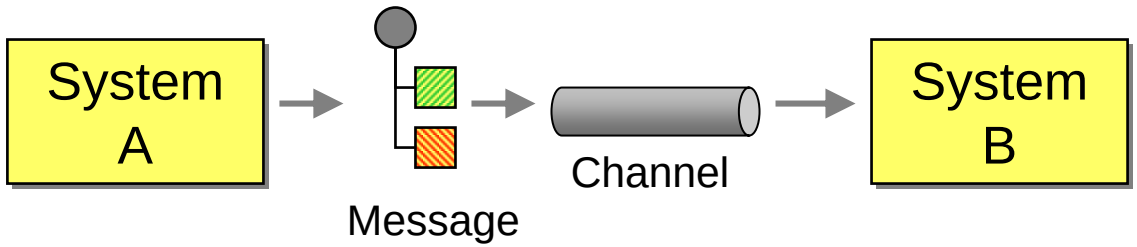


- Waldo et al, 1994:
  - *"Objects that interact in a distributed system need to be dealt with in ways that are intrinsically different from objects that interact in a single address space*

Message-Oriented Middleware

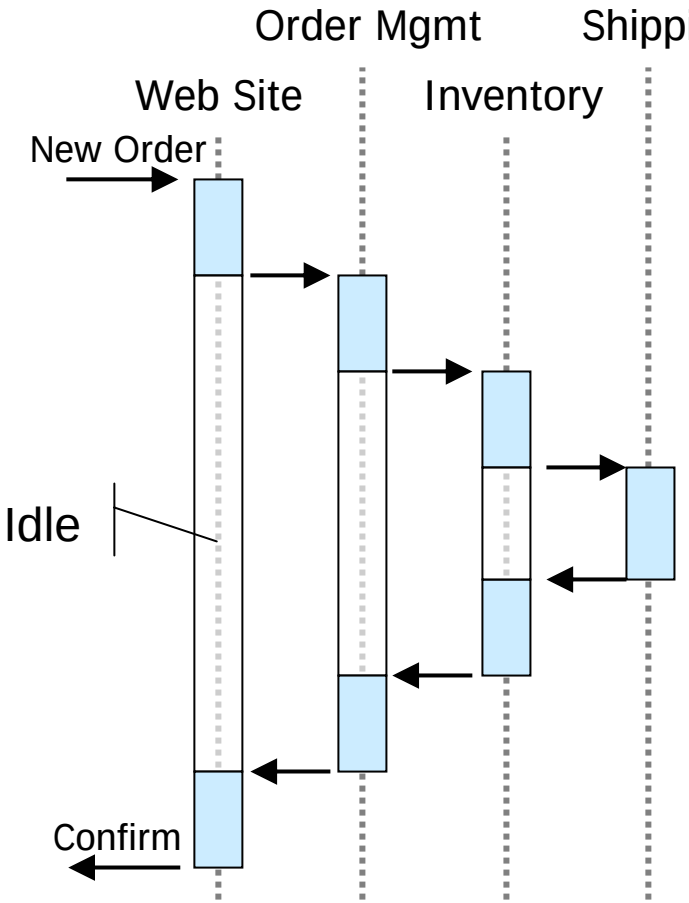
- Channels are separate from applications
- Channels are asynchronous & reliable
- Data is exchanged in self-contained messages

- ➢ Remove location dependencies
- ➢ Remove temporal dependencies
- ➢ Remove data format dependencies

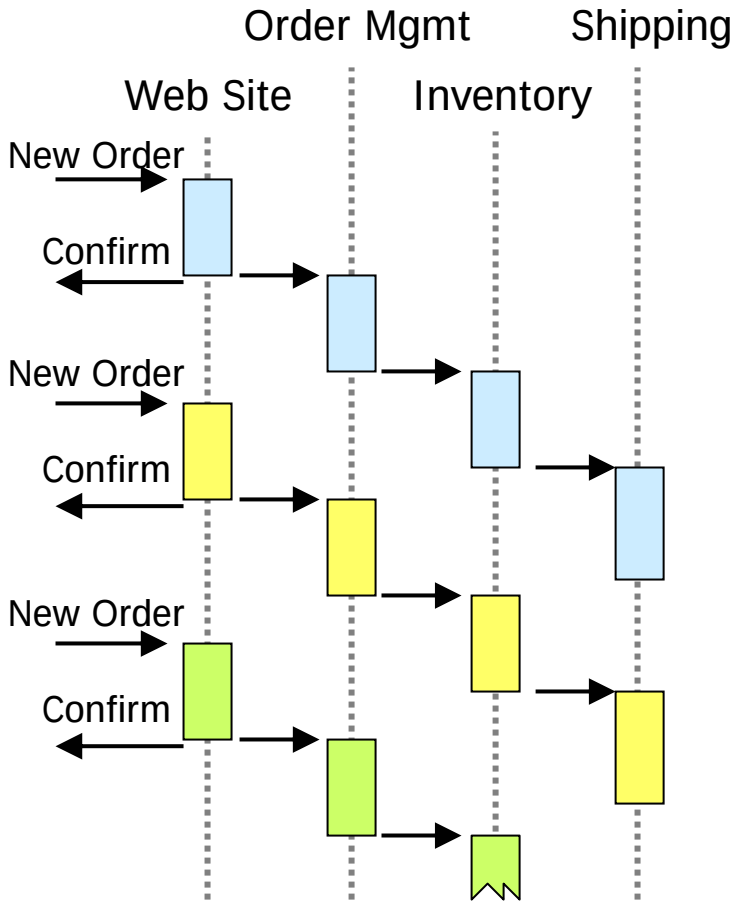


➡ Loosely coupled integration enables independent variation

Thinking Asynchronously



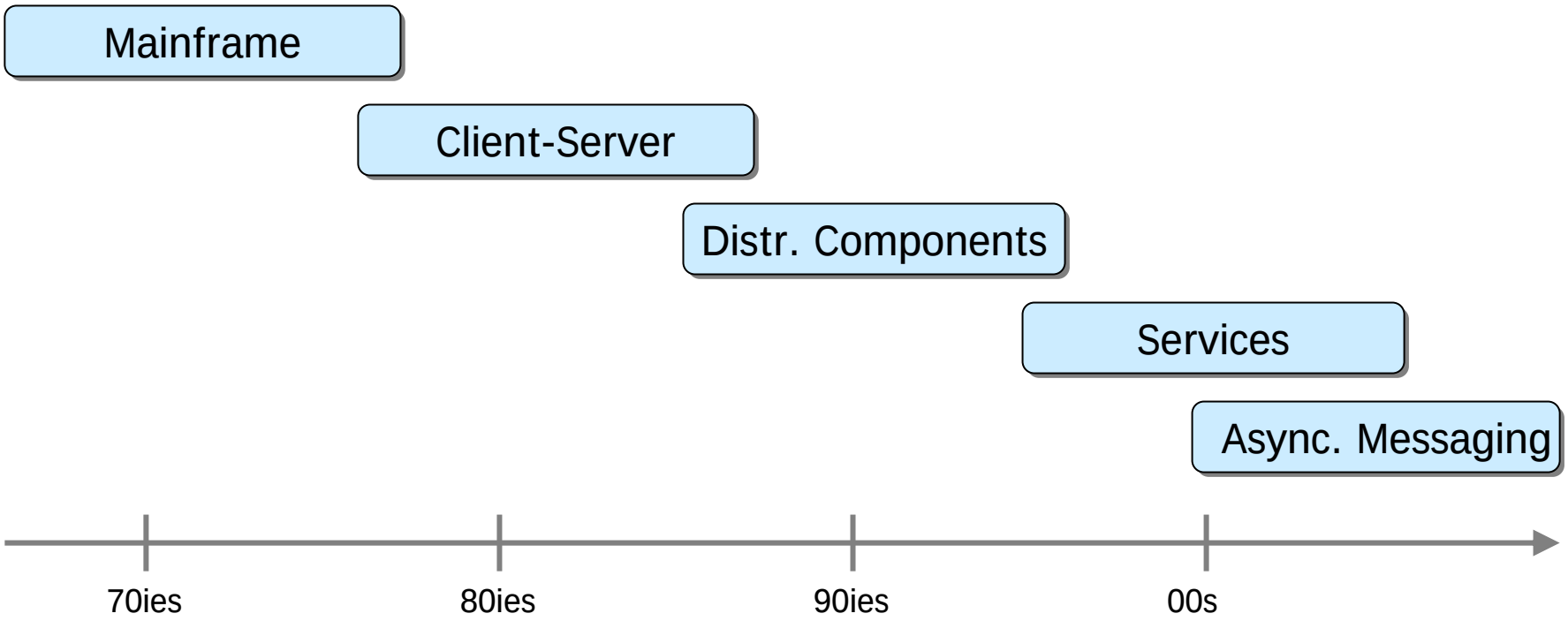
Synchronous



Asynchronous

Asynchronous Messaging Architectures

- The emerging architectural style of the new millennium



Many Products & Implementations

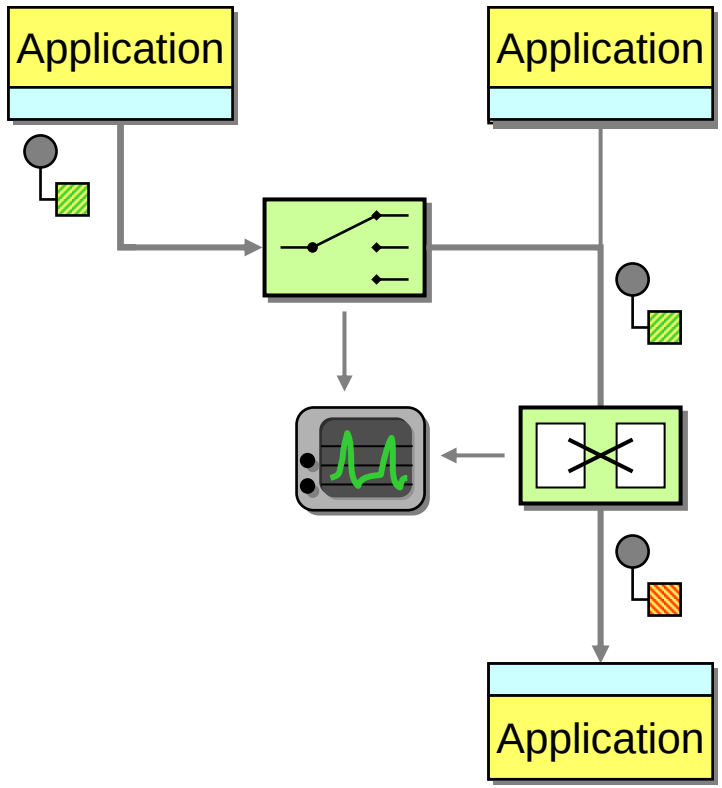
- Message-oriented middleware (MOM)
  - IBM WebSphere MQ
  - Microsoft MSMQ
  - Java Message Service (JMS) Implementations
- EAI Suites
  - TIBCO, WebMethods, SeeBeyond, Vitria, ...

- Asynchronous Web services
  - WS-ReliableMessaging, ebMS
  - Sun's Java API for XML Messaging (JAXM)
  - Microsoft's Web Services Extensions (WSE)

The Underlying Design Principles Are the Same!

Message-Oriented Integration

1. Transport messages
2. Design messages
3. Route the message to the proper destination
4. Transform the message to the required format
5. Produce and consume messages
6. Manage and Test the System

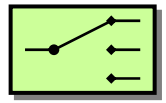


Integration Patterns

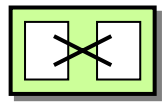
1. Transport messages → *Channel Patterns*

2. Design messages → *Message Patterns*

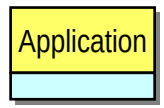
3. Route the message to the proper destination → *Routing Patterns*



4. Transform the message to the required format → *Transformation Patterns*

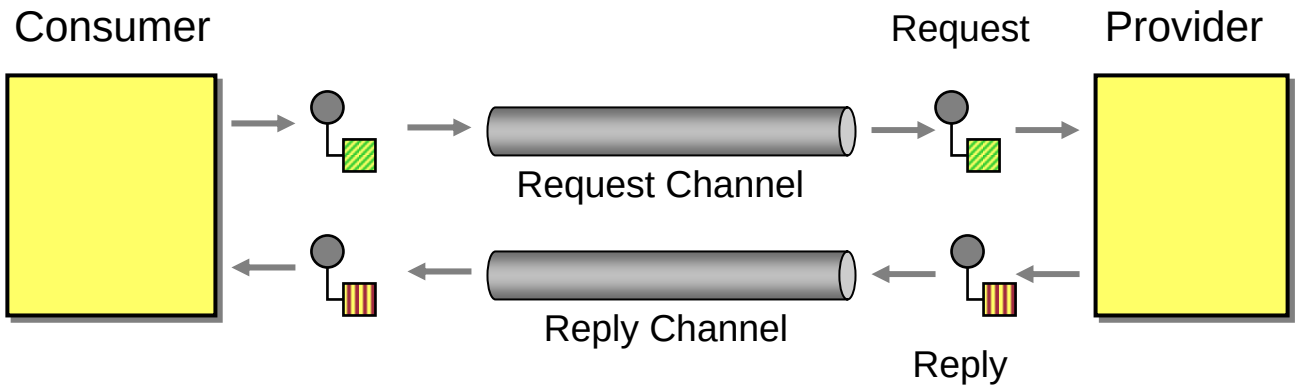


5. Produce and consume messages → *Endpoint Patterns*



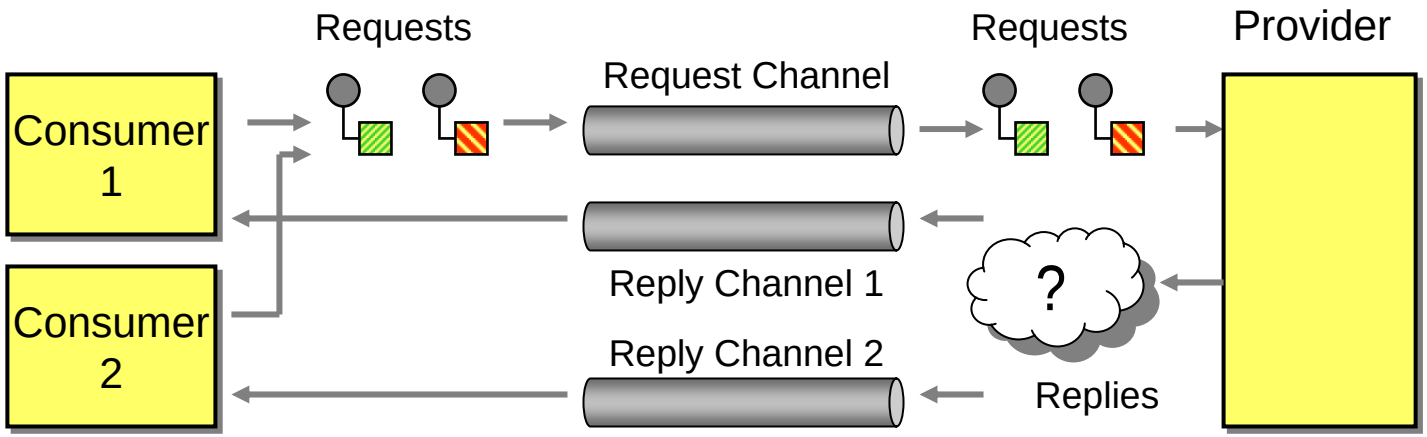
6. Manage and Test the System → *Management Patterns*

“Hello, Asynchronous World”



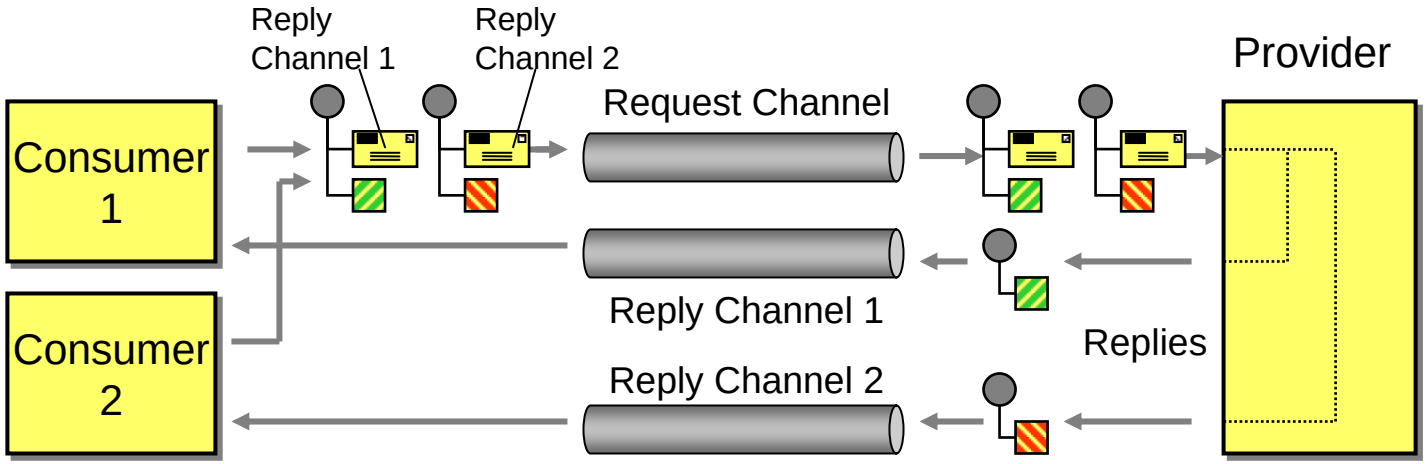
- Service Provider and Consumer
- *Request-Reply* (similar to RPC)
- Two asynchronous *Point-To-Point Channels*
- Channels are unidirectional
- Separate request and response messages

Multiple Consumers



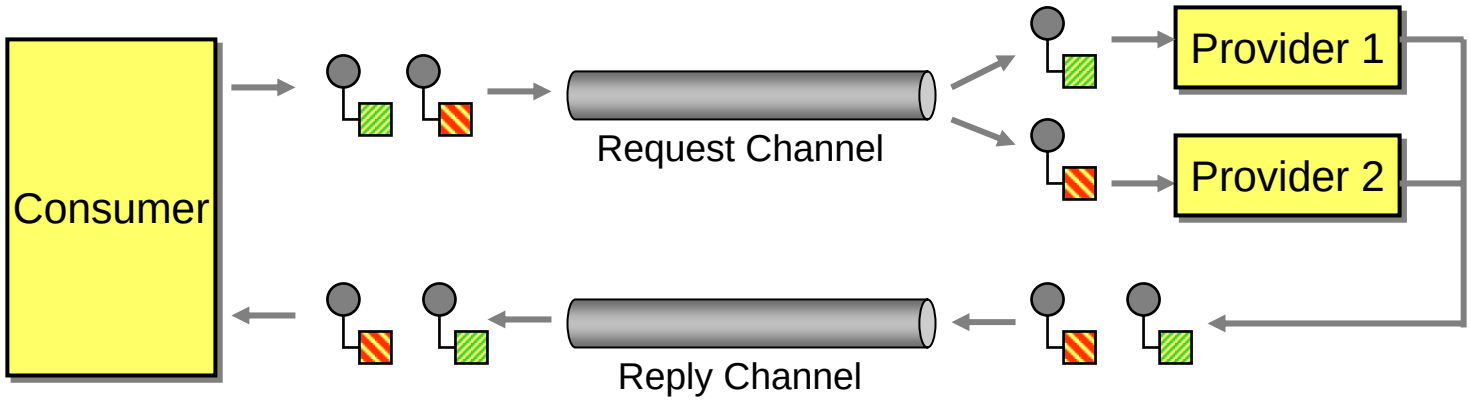
- Each consumer has its own reply queue
- How does the provider know where to send the reply?
  - Could send to all consumers → very inefficient
  - Hard code → violates principle of service

Pattern: *Return Address*



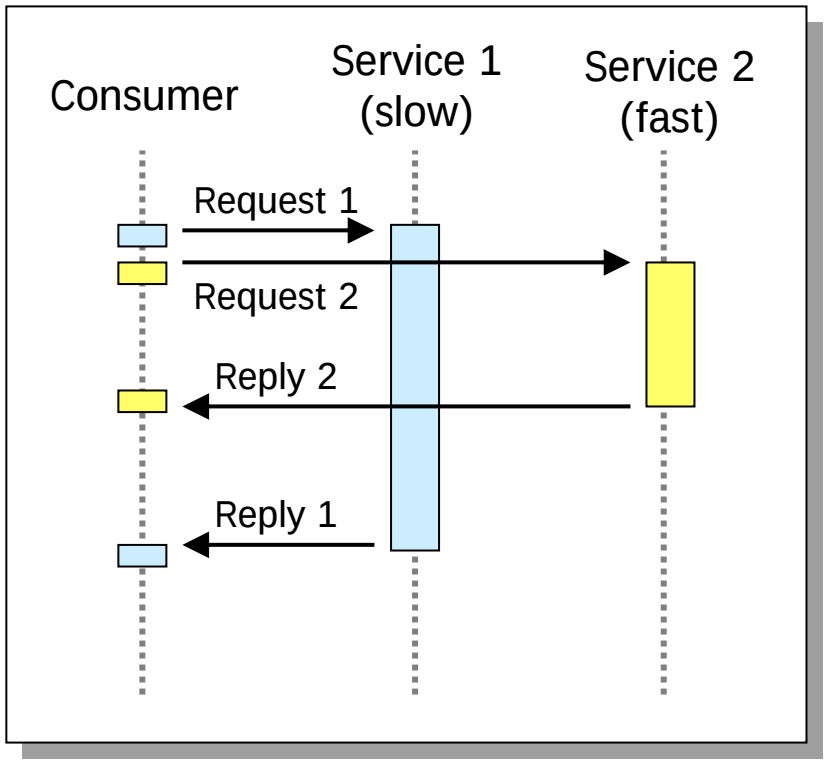
- Consumer specifies *Return Address*
- Service provider sends reply message to specified channel
- *Return Address* can point to a component different from the consumer → chaining

Multiple Service Providers



- Request message can be consumed by more than one service provider
- *Point-to-Point Channel* supports *Competing Consumers*, only one service receives each request message
- Channel queues up pending requests

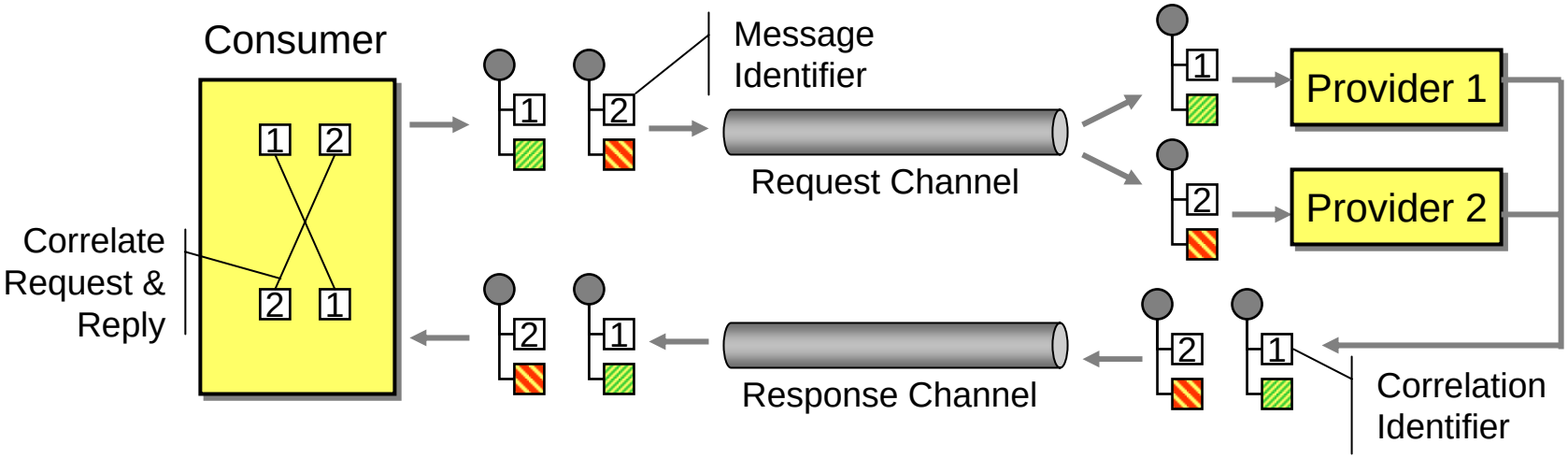
Multiple Service Providers



- Messages can be processed by different consumers
  - Competing Consumers (load balancing)
  - Content-Based Router
- This causes messages to get out of sequence

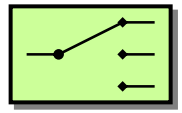
- How to match request and reply messages?
  - Only send one request at a time → very inefficient
  - Rely on natural order → bad assumption

Pattern: *Correlation*

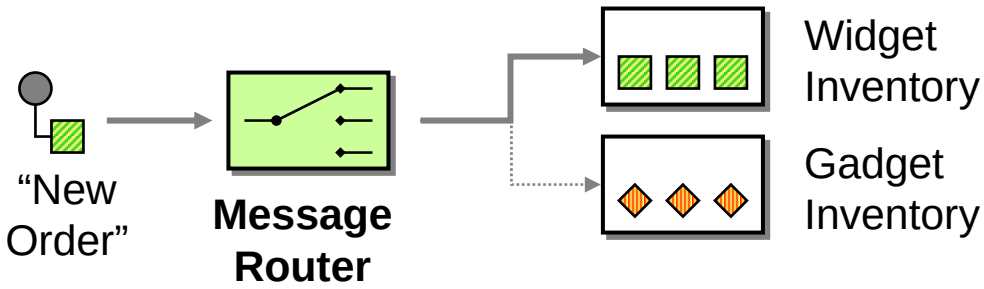


- Equip each message with a unique identifier
  - Message ID (simple, but has limitations)
  - GUID (Globally Unique ID)
  - Business key (e.g. Order ID)
- Provider copies the ID to the reply message
- Sender can match request and response

Routing Pattern: *Message Router*

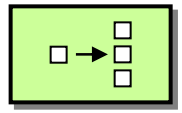


- How can we decouple individual processing steps so that messages can be passed to different components depending on some conditions?
  - Different channels depending on message content, run-time environment (e.g. test vs. production), …
  - Do not want to burden sender with decision (decoupling)

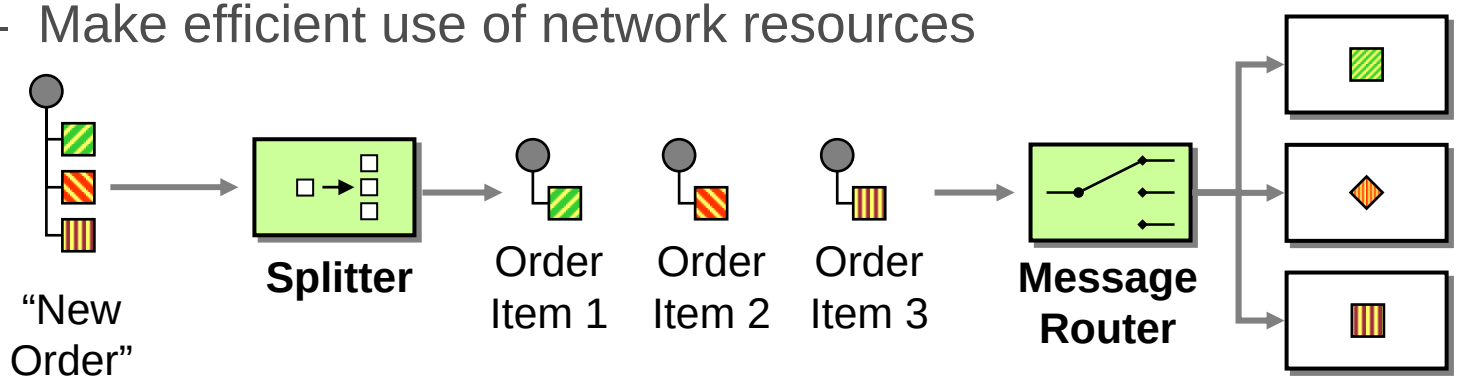


- Use a special component, a *Message Router*, to route messages from one channel to a different channel.

Routing Pattern: *Splitter*

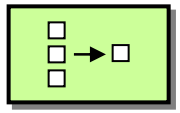


- How can we process a message if it contains multiple elements, each of which may have to be processed in a different way?
  - Treat each element independently
  - Need to avoid missing or duplicate elements
  - Make efficient use of network resources

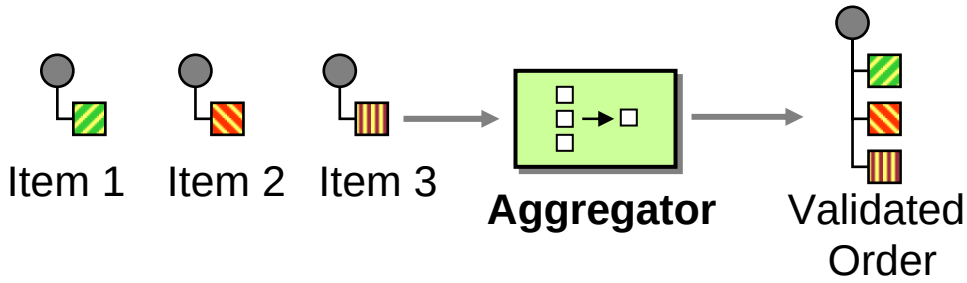


- Use a *Splitter* to break out the composite message into a series of individual messages, each containing data related to one item.

Routing Pattern: *Aggregator*

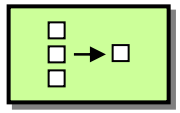


- How do we combine the results of individual, but related messages back into a single message?
  - Responses may be out of sequence
  - Responses may be delayed



- An *Aggregator* manages the reconciliation of multiple, related messages into a single message
  - Stateful component

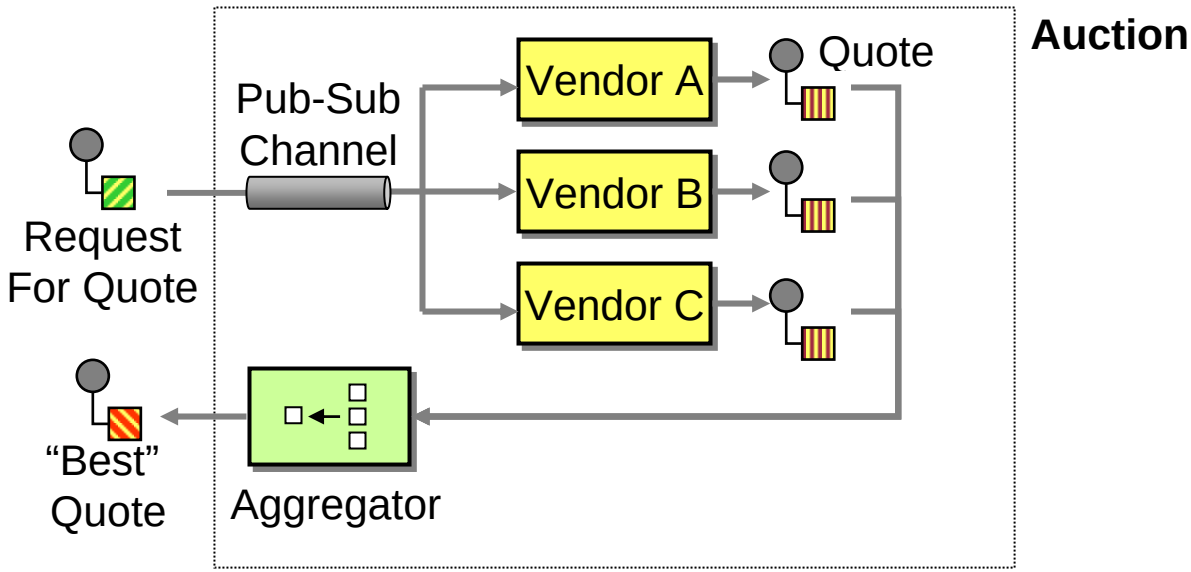
Routing Pattern: *Aggregator*



- Correlation
  - Which incoming messages belong together?
- Completeness Condition
  - When are we ready to publish the result message?
    - Wait for all
    - Time out (absolute, incremental)
    - First best
    - Time box with override
    - External event
- Aggregation Algorithm
  - How do we combine the received messages into a single result message?
    - Single best answer
    - Condense data (e.g., average)
    - Concatenate data for later analysis

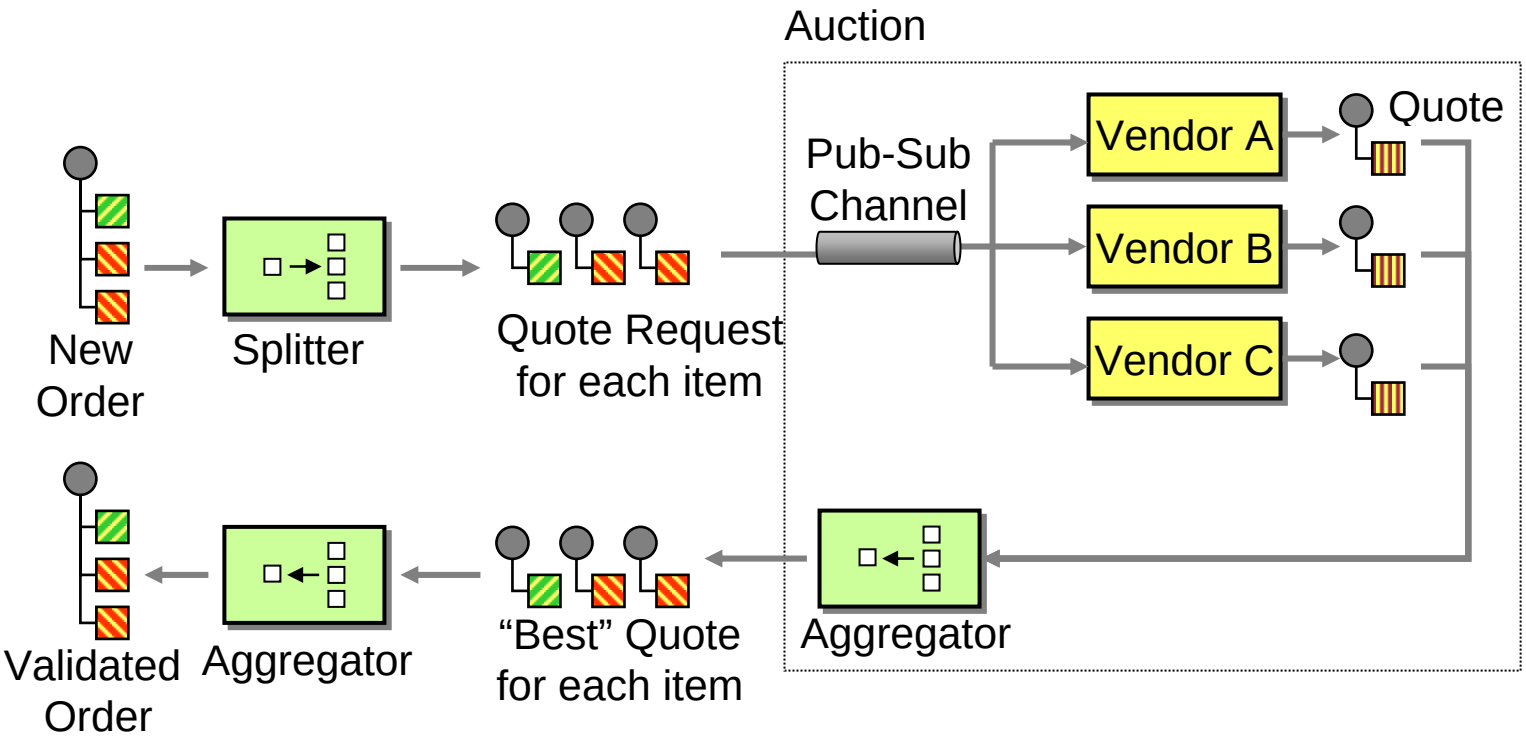
Composed Pattern: *Auction*

- Send a message to a dynamic set of recipients, and return a single message that incorporates the responses.



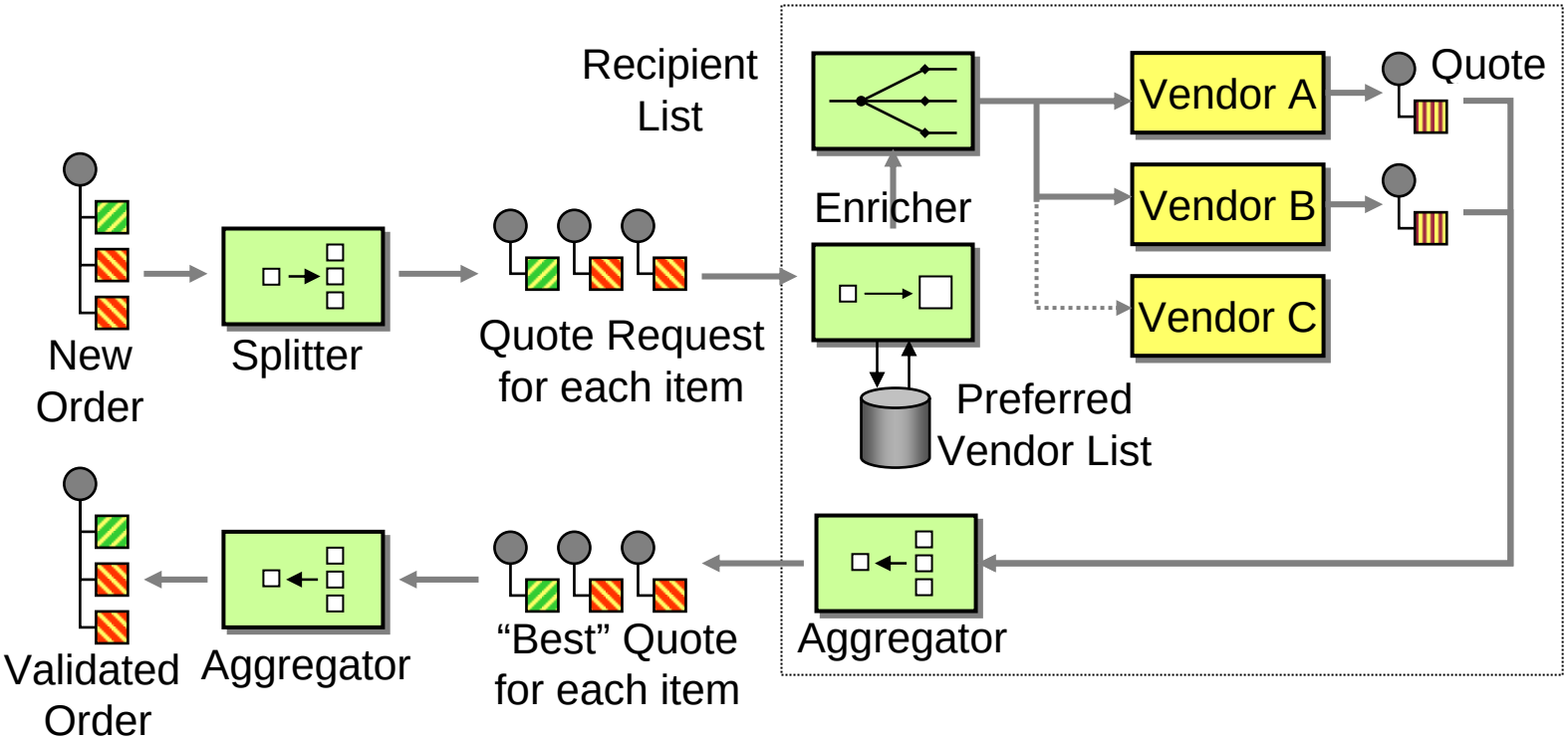
Example: Combining Routing Patterns

- Receive an order, get best offer for each item from vendors, combine into validated order.



Example Continued…

- Only vendors on the preferred vendor list get to bid on an item.



In Summary…

- Visual and verbal language to describe integration solutions
- Combine patterns to describe larger solutions
- No fancy tools – whiteboard or PowerPoint
- No vendor jargon
- Not a precise specification language
  - (e.g., see OMG UML Profile for EAI)
- Not a new “methodology”
- Each pattern describes trade-offs and considerations not included in this overview

Resources

- Book (late October):
  - Enterprise Integration Patterns
  - Addison-Wesley, 0-321-20068-3
- Contact
  - Gregor Hohpe
  - ghohpe@thoughtworks.com
- Web Site
  - http://www.eaipatterns.com
  - Pattern catalog
  - Bibliography, related papers
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