Gregor Hohpe | www.eaipatterns.com

Enterprise Integration Patterns

Topics for Today

1. Me
2. The Book
3. Enterprise Integration
4. Messaging
5. Messaging Patterns
6. Patterns and Pattern Languages Revisited
7. Messaging Patterns in Action
8. Conversations
9. Conversation Patterns
10. Conclusion

Me

Bounced around a lot

Diplom Computer Science

Masters Comp Science

Masters Engineering Management

Startup

Netpulse

Consulting

ams

Deloitte.

ThoughtWorks

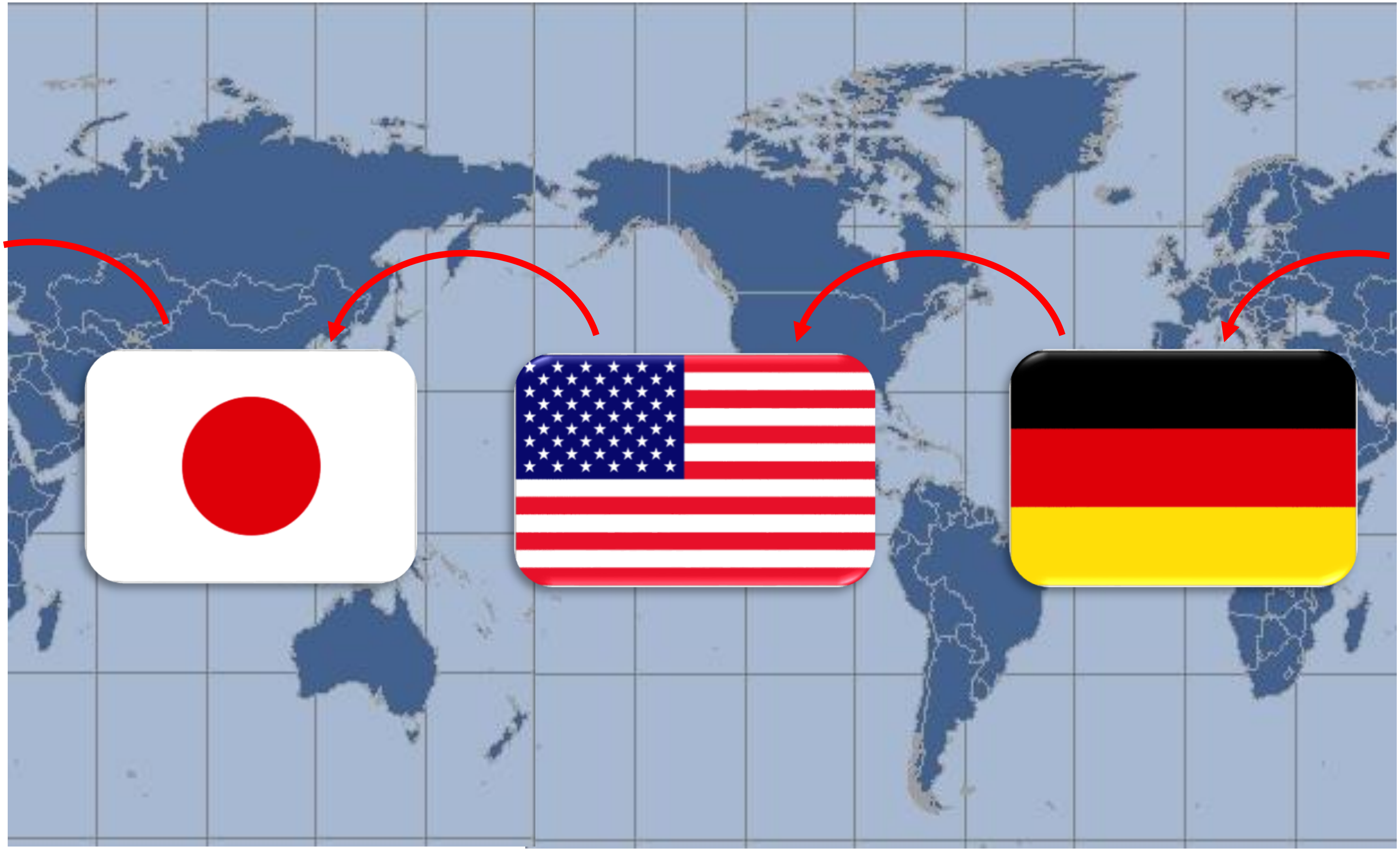
Software

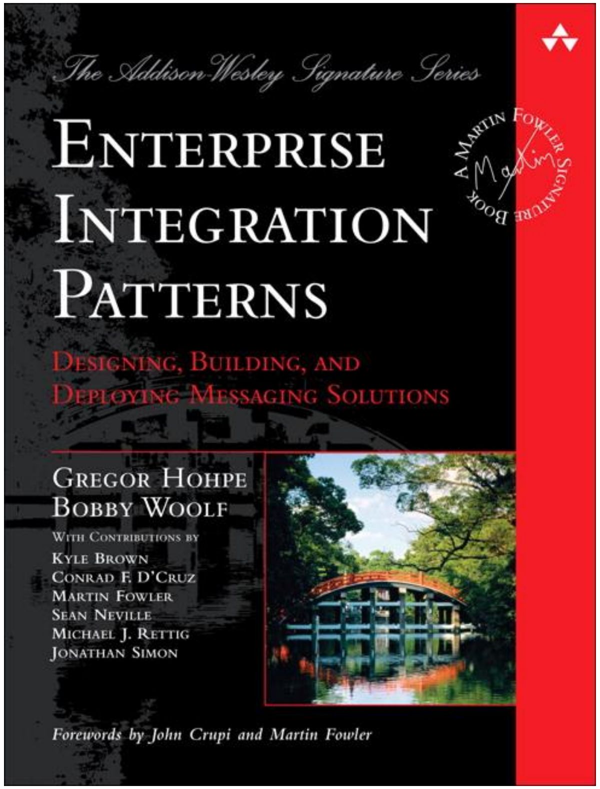
Google

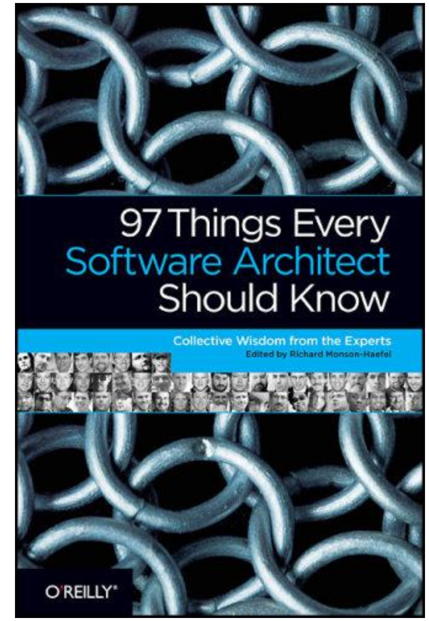
Corporate IT

Allianz

Around the world in 20 years







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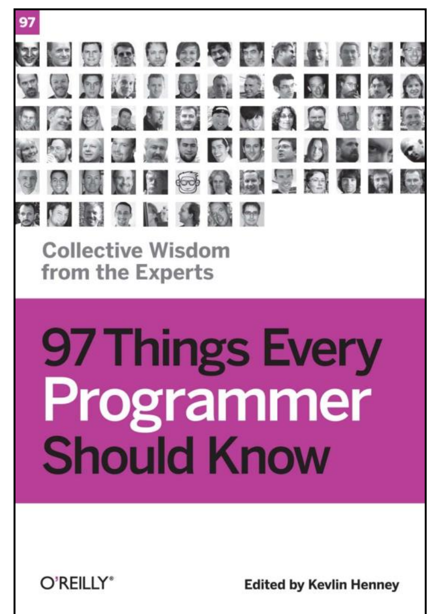
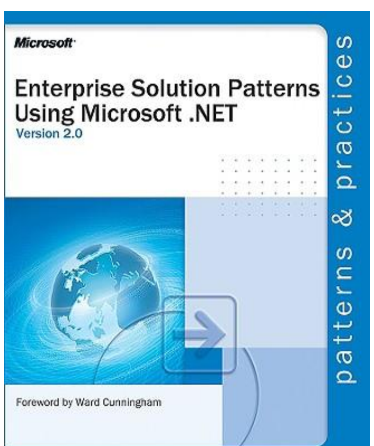
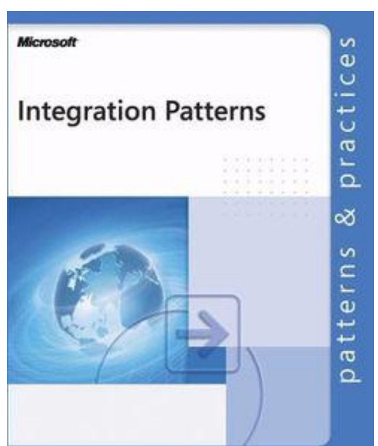
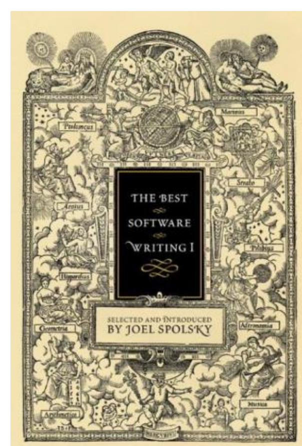
/ramblings









The Book

9th Conference on Pattern Language of Programs 2002

Monticello, Illinois

Welcome to PLoP 2002

PLoP 2002
Proceedings
Call for papers
Focus Topics
Paper Submissions
Schedule
Registration
Location
Call for Volunteers
All PLoPs

2 0 0 2

PLoP 2002 Proceedings (Draft)

Note to authors: Please check the link to the paper and make sure that it contains your final revision. Any corrections should be sent to Weerasak Witthawaskul at plop2002chair@yahoo.com.

Update: 9 Sep 2002 Mock Workshop Paper - Distributed Cache Pattern

Section 1 Accepted Papers

#	Authors	Title	Shepherd	Program Committee
	Plenary Session			
18	I. Araujo, M. Weiss	*Linking Patterns and Non-Functional Requirements (was 'Using the NFR Framework for Representing Patterns')*	Brian Marick	Eric Evans
	Group 2	**Leader: Martin Fowler and Ali Arsanjani**		
1	A. Arsanjani	*Patterns for Implementing Grammar-Oriented Object Design*	Masao Tomono	John Vlissides
3	A. Arsanjani	*Towards a Pattern Language for Web Services Architecture (was 'Patterns for Web Services Architectures')*	Gustavo Rossi	John Vlissides
14	G. Hohpe	*Enterprise Integration Patterns*	Philip Eskelin	John Vlissides
4	A. Corsaro, D. C. Schmidt, R. Klefstad, C. O'Ryan	*Virtual Component A Design Pattern for Memory-Constrained Embedded Applications*	Michael Kircher	Doug Schmidt

Section 2 Large Pattern Language Group Papers

Group	Pattern Language	Leaders
1	Patterns of System Integration with Enterprise Messaging	Bobby Woolf, Kyle Brown
2	Strategic Design (excerpt from Domain Driven Design) - Entire manuscript can be downloaded from here.	Eric Evans
3	Some Algorithm Structure and Support Patterns for Parallel Application Programs (abstract)	Berna Massingill, Timothy G. Mattson, Beverly A. Sanders

http://hillside.net/plop/plop2002/proceedings.html

“Enterprise Integration Patterns”
G. Hohpe

“Patterns of System Integration with Enterprise Messaging”
B. Woolf, K. Brown

Live from the Archives

Overview

Table of Contents

What are Enterprise Integration Patterns?

Very few business applications can live in isolation. More often than not, applications have to be integrated with other applications inside and outside the enterprise. This integration is usually achieved through the use of some form of "middleware". Middleware provides the "plumbing" such as data transport, data transformation, routing etc. Popular implementations of these concepts are found in EAI suites such as IBM MQ, TIBCO, SeeBeyond etc., as well as messaging specifications such as JMS or Web service standards like SOAP.

Architecting integration solutions is a complex task. There are many conflicting drivers and even more possible 'right' solutions. Whether the architecture was in fact a good choice usually is not known until many months or even years later, when inevitable changes and additions put the original architecture to test. There is no cookbook for enterprise integration solutions. Most integration vendors provide methodologies and best practices, but these instructions tend to be very much geared towards the vendor-provided tool set and often lack treatment of the bigger picture, including underlying guidelines and principles.

Therefore, we started to collect enterprise integration patterns, similar to the architecture and design patterns who have helped many application architects design robust applications over the past years. The patterns on this site have been harvested from multiple years of hands-on enterprise integration work with a variety of organizations. Still, the effort has just begun and is quite incomplete.

Who can use Enterprise Integration Patterns?

The patterns presented on this site help integration architects and developers design and implement integration solutions more rapidly and reliably. Most of the patterns assume a basic familiarity with publish-subscribe messaging architectures. However, the patterns are not tied to a specific implementation. Most patterns apply to EAI suites as well as Web Services or JMS-based applications. In some cases, a pattern may already be embedded in the middleware package. This is a sign that the vendor recognized the recurring problem and incorporated the solution into the package. We still present these patterns for two reasons. First, not all packages implement the same patterns, so a user workign with another package will still find the pattern useful. Second, despite the default implementation of the pattern in the middleware package, a description of the forces and alternatives is insightful for any architect or developer who is interested in EAI concepts beyond the specific package implementation.

The Patterns

Quick Reference

Message Channel
in progress...
Message
in progress...
Message Routing
Pipes and Filters
Content-Based Router
Sequencer
Aggregator
Distribution with Aggregate Response
Broadcast with Aggregate Response
Recipient List
Routing Table
Message Transformation
Data Enricher
Store in Library
Content Filter
Message Management
Control Bus
Message Header
Envelope Wrapper
Message History
Message Store
Test Message

OOPSLA 2003

- 185,000 Words
- 730 pages
- 65,000 copies sold

Languages

- English
- Russian
- Chinese Traditional
- Korean

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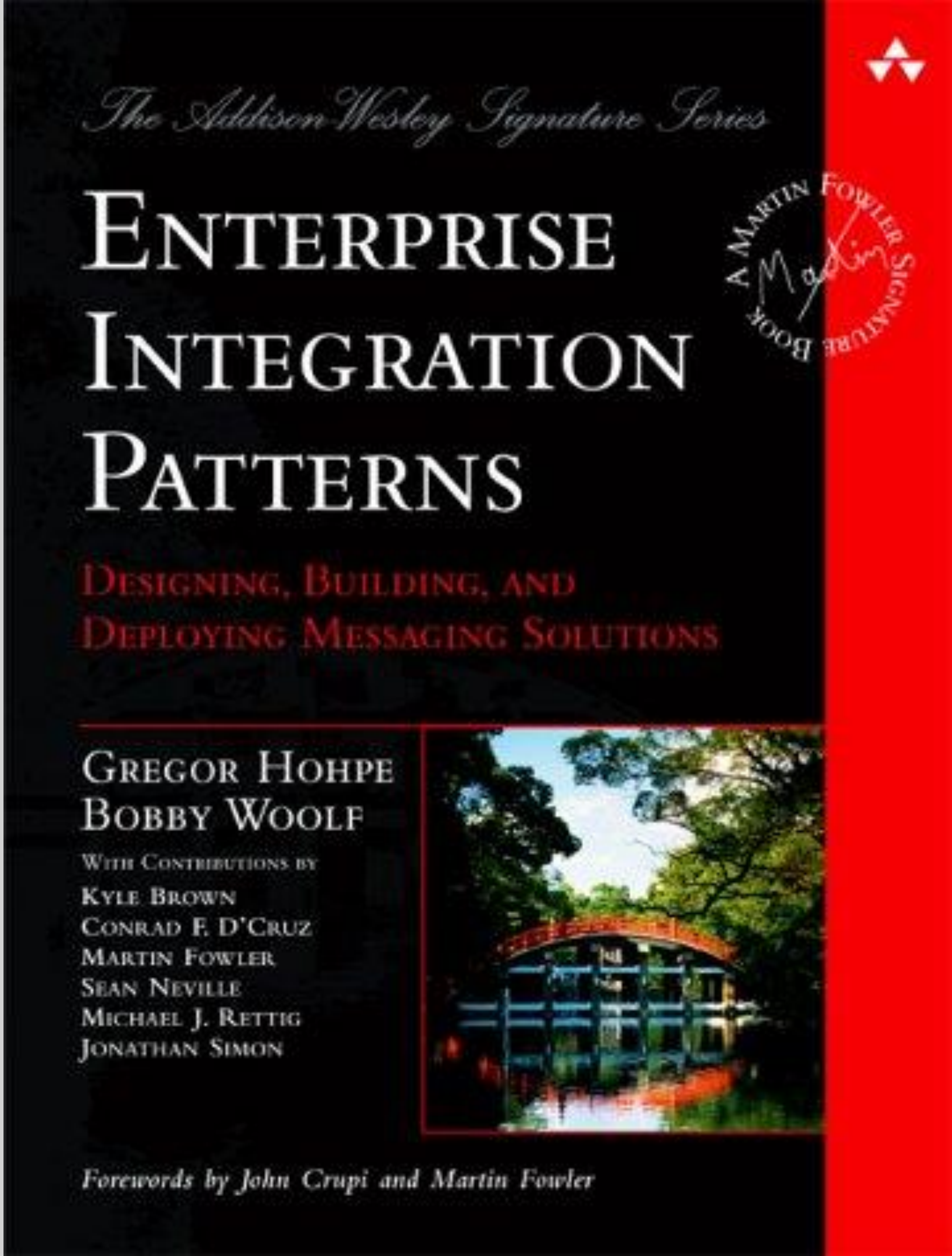
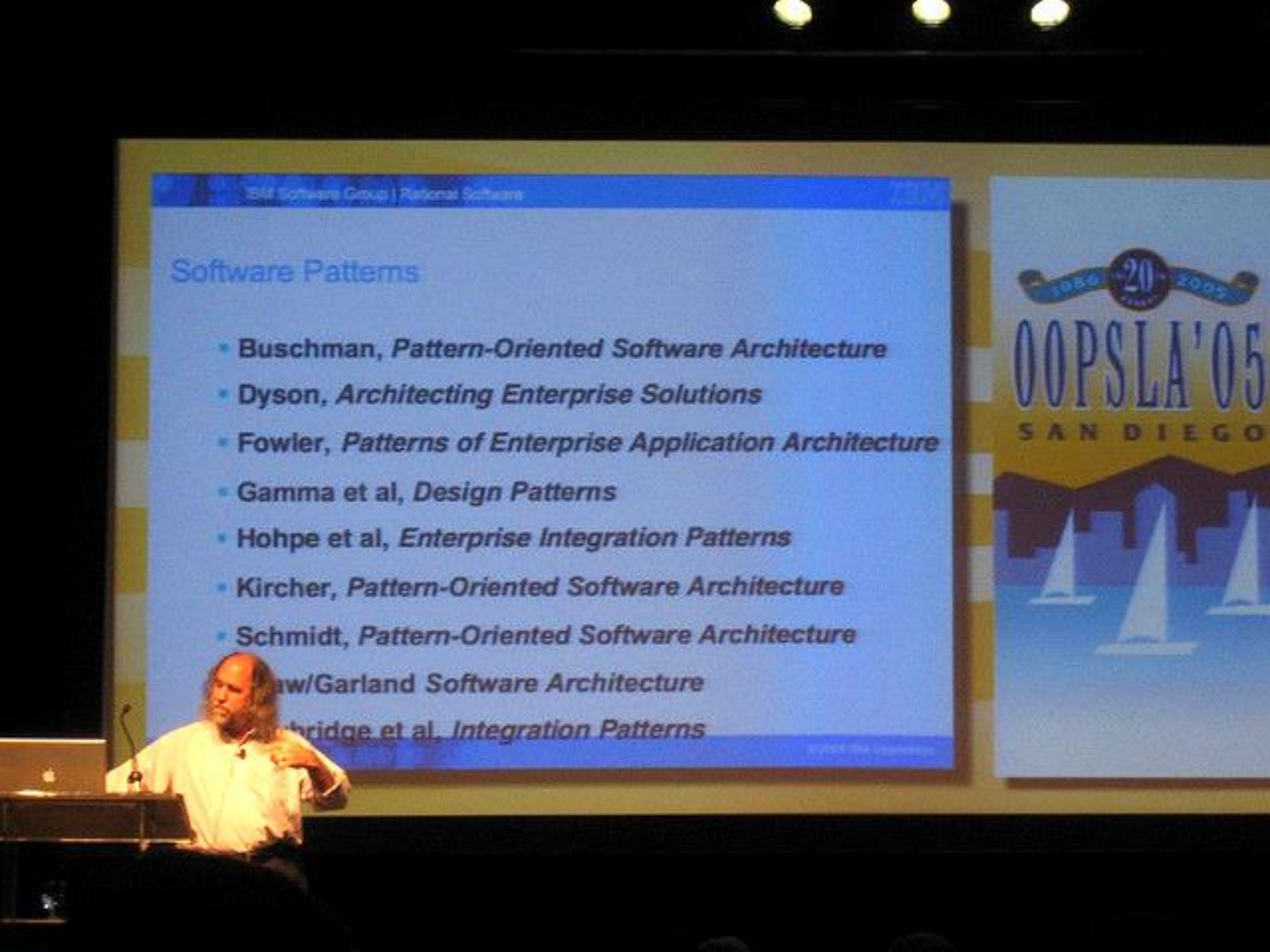
- Sketches, summaries under Creative Commons
- Visio, Omnigraffle stencils




IBM Software Group | Rational Software
Software Patterns
Buschman, Pattern-Oriented Software Architecture
Dyson, Architecting Enterprise Solutions
Fowler, Patterns of Enterprise Application Architecture
Gamma et al, Design Patterns
Hohpe et al, Enterprise Integration Patterns
Kircher, Pattern-Oriented Software Architecture
Schmidt, Pattern-Oriented Software Architecture
aw/Garland Software Architecture
bridge et al, Integration Patterns
OOPSLA'05
SAN DIEGO

James Strachan's Blog

Random ramblings on Open Source, integration and other malarkey

TUESDAY, 15 MAY 2007

Enterprise Integration Patterns in Java using a DSL via Apache Camel

For those of you who missed me rambling about this at JavaOne I thought I'd introduce Camel to you.

Apache Camel is a powerful rule based routing and mediation engine which provides a POJO based implementation of the Enterprise Integration Patterns using an extremely powerful fluent API (or declarative Java Domain Specific Language) to configure routing and mediation rules.

The Domain Specific Language means that Apache Camel can support type-safe smart completion of routing and mediation rules in your IDE using regular Java code without huge amounts of XML configuration files; though Xml Configuration inside of Spring 2 is also supported.

A good way to get started is to take a look at the Enterprise Integration Patterns catalog and see what the Java code of an example looks like. For example, try the message filter, content based router or splitter.

About Me

James Strachan
Mells, Frome, England, United Kingdom

Software Fellow at FuseSource

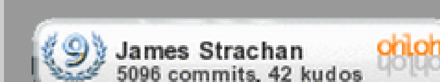
View my complete profile

Links

- FuseSource
- Delicious
- My old blog

Open Source Projects I work on

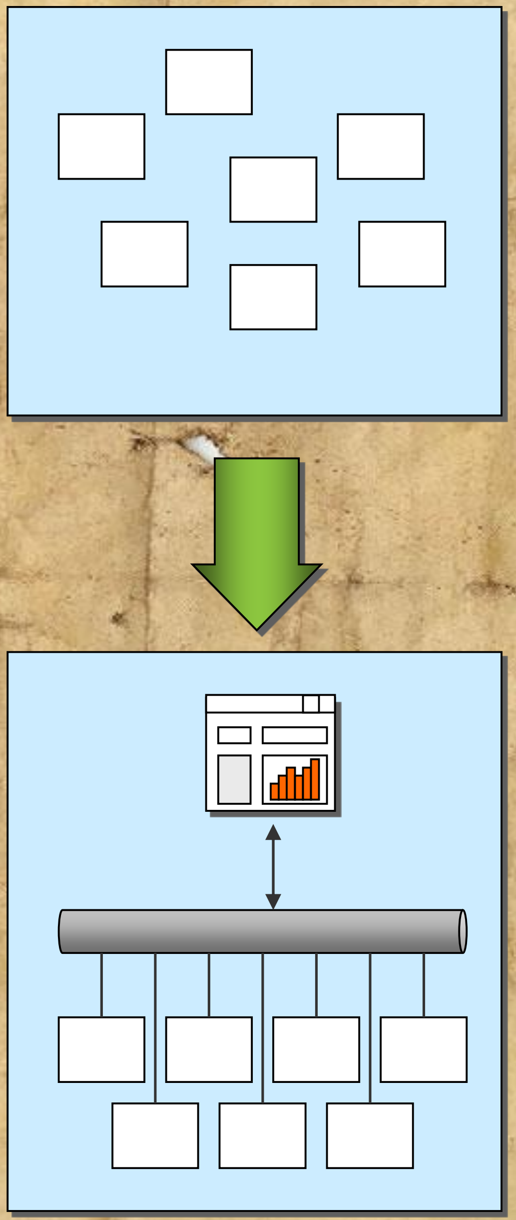
- Apache ActiveMQ
- Apache Camel
- Apache Karaf
- Apache ServiceMix
- Fuse Fabric
- Scalate



Enterprise Integration

Isolated Systems

Unified Access



Live from the Archives

Why This Is Still Interesting

- Large-scale and complex
- Far-reaching implications, business critical
- Distributed, heterogeneous environment
- Applications not designed to be connected
- Semantic Dissonance
- Not object-oriented
- Variety of skills and technologies
- Corporate politics

Plus

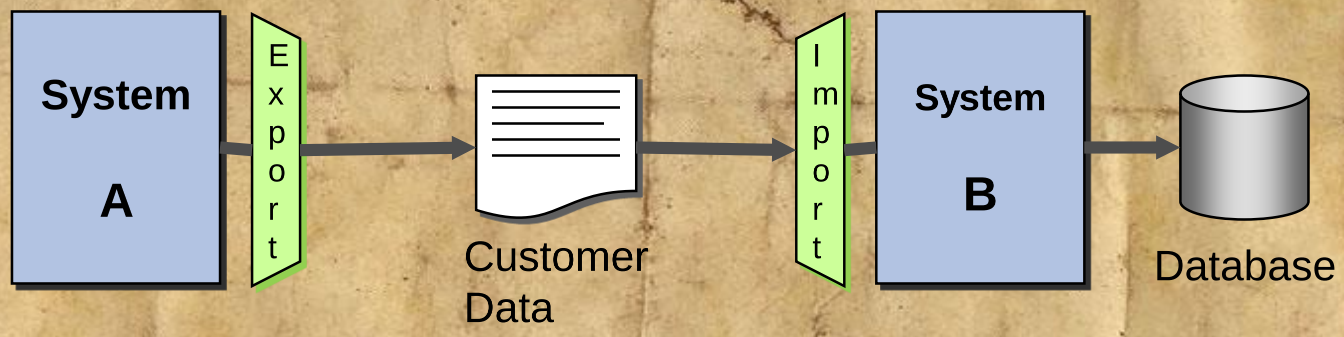
- Distributed applications are the norm
- Increased customer expectations
- REST services, simpler protocols

70s: Batch Data Exchange

Live from the Archives

Export information into a common file format, read into the target system

Example: COBOL Flat files



Pros:

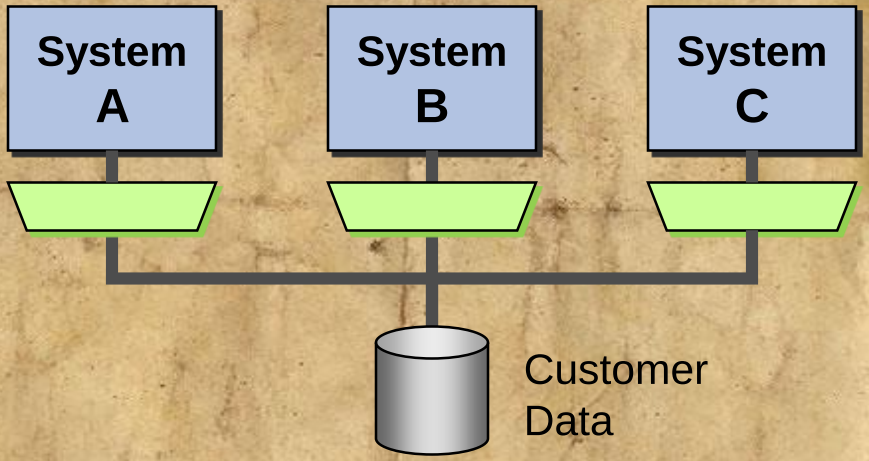
- Good physical decoupling
- Language and system independent

Cons:

- Data transfer not immediate
- Systems may be out of sync
- Large amounts of data

80s: Central Database

All applications access a common database



Pros:

- Consistent Data
- Reporting
- Transactional guarantees

Cons:

- Integration of data, not business functions
- Difficult to find common representation

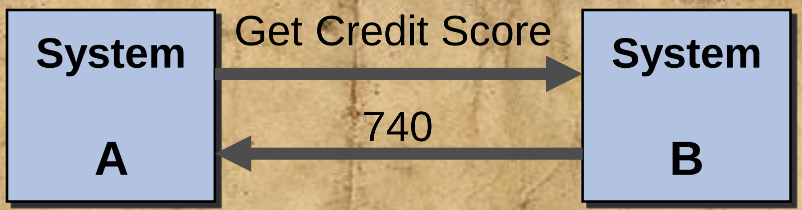
Live from the Archives

Live from the Archives

90s: Remote Procedure Calls

One application calls another directly to perform a function.

Data necessary for the call is passed along. Results are returned to calling application.



Pros:

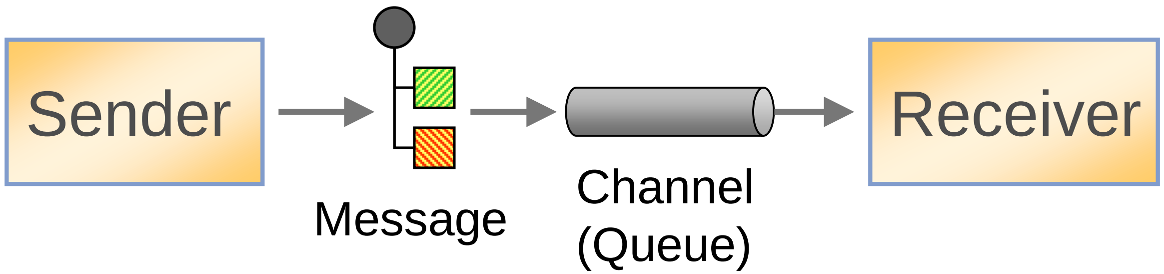
- Data exchanged only as needed
- Integration of business function, not just data

Cons:

- Works well only with small number of systems
- Fragile (tight coupling)
- Performance

Messaging

Asynchronous Messaging Style



- Systems send messages across Channels
- Channels have logical (location-indep.) addresses
- Placing a message into the Channel is quick ("fire-and-forget")
- The Channel queues messages until the receiving application is ready

Simplified Interaction

Location Decoupling

Temporal Decoupling

An "honest" architectural style that does not try to deny the limitations of the underlying medium.

Why Asynchronous Messaging?

Hidden in the Introduction

Asynchrony

- Sender does not have to wait for receiver to process message
- Temporal decoupling

Throttling

- Receiver can consume messages at its own pace
- Processing units can be tuned independently

Can be Reliable Over Unreliable Networks

- Messages can transparently be re-sent until delivered
- Think cell phones – intermittent and unreliable

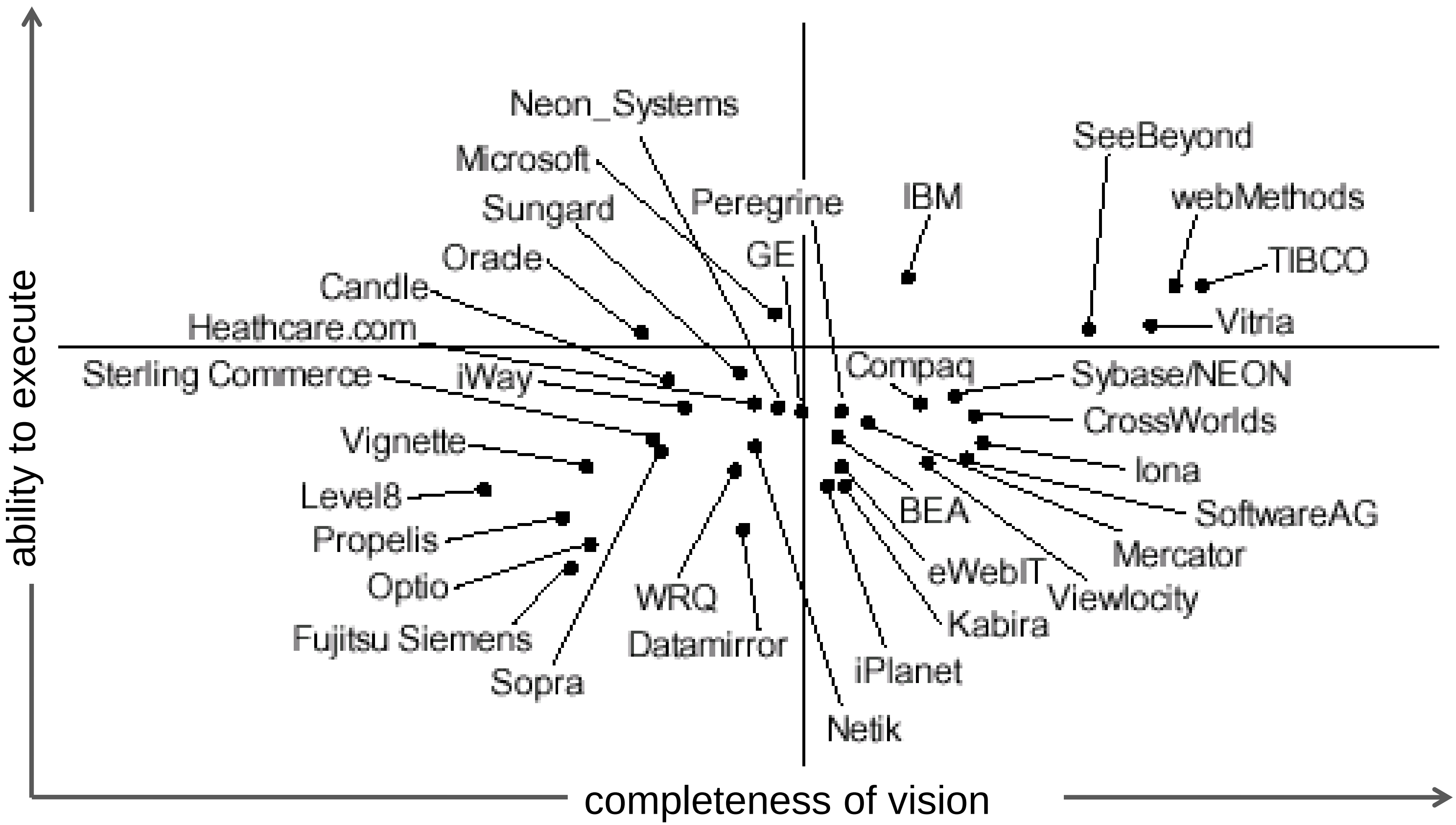
Insertion of intermediaries (Pipes-and-Filters)

- Composability
- Transformation, routing etc.

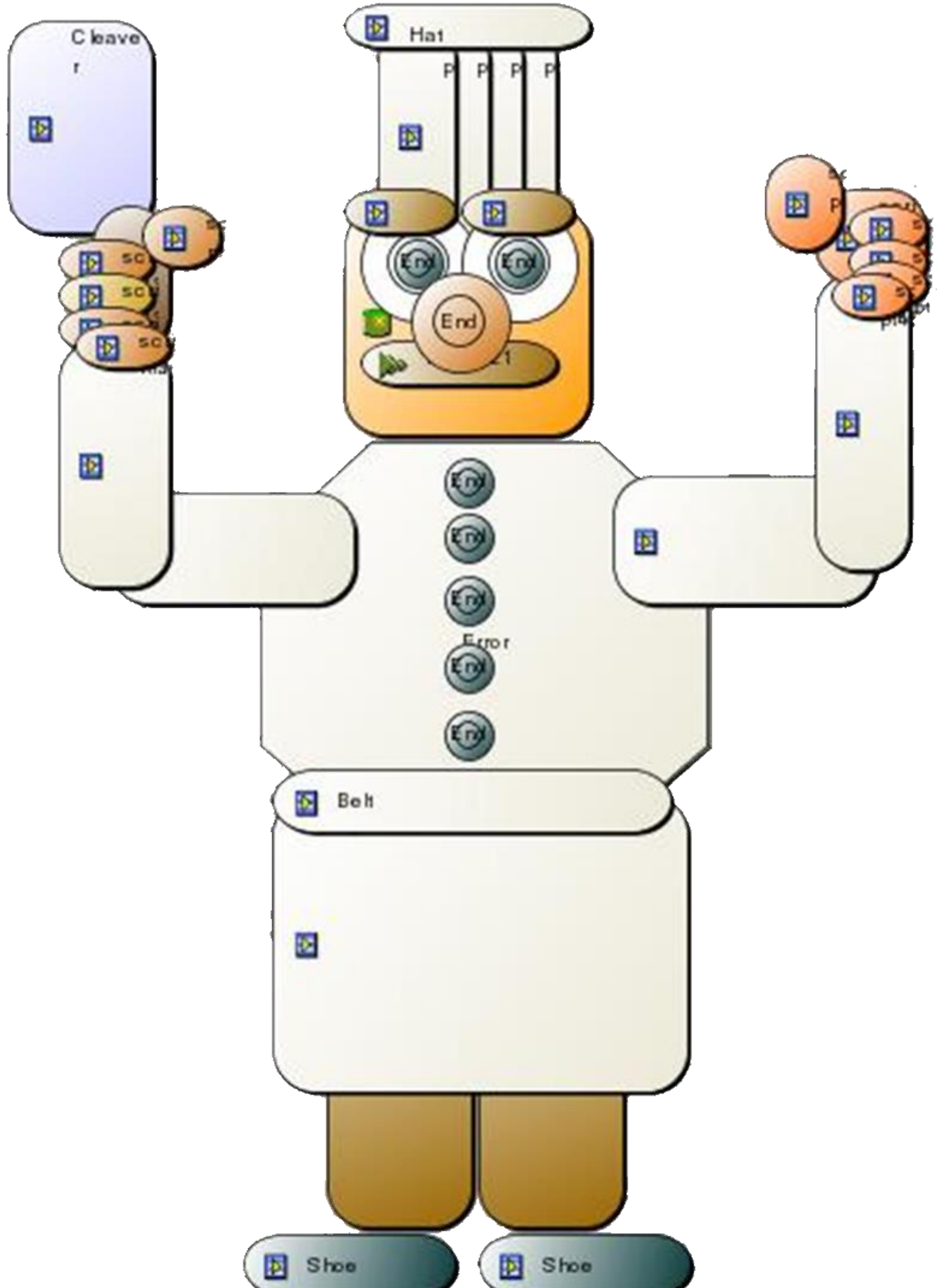
Throughput over latency

- “Wider bridges not faster cars”

A New “Tower of Babel”



Gartner “Magic Quadrant” for
Integration and Middleware 2001


Cleave
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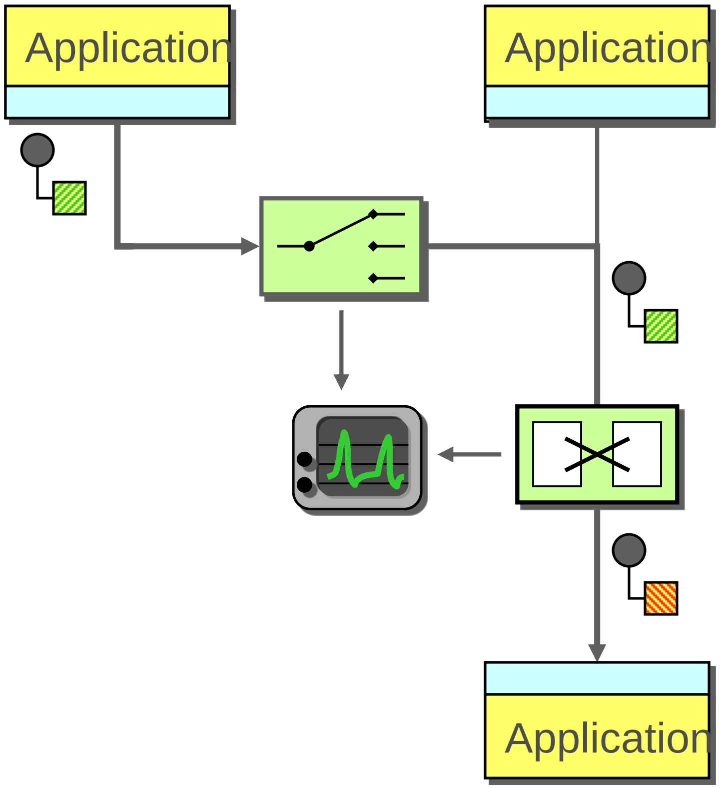
Hat
End
End
End
Error
Belt
Shoe
Shoe

Messaging Patterns

Messaging Pattern Language

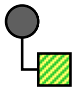
1. Transport messages
2. Design messages
3. Route the message to the proper destination
4. Transform the message to the required format
5. Produce and consume messages
6. Manage and Test the System



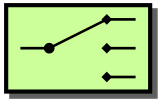
Messaging Pattern Language

1. Transport messages — *Channel Patterns*

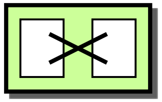
2. Design messages — *Message Patterns*



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

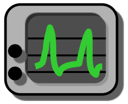


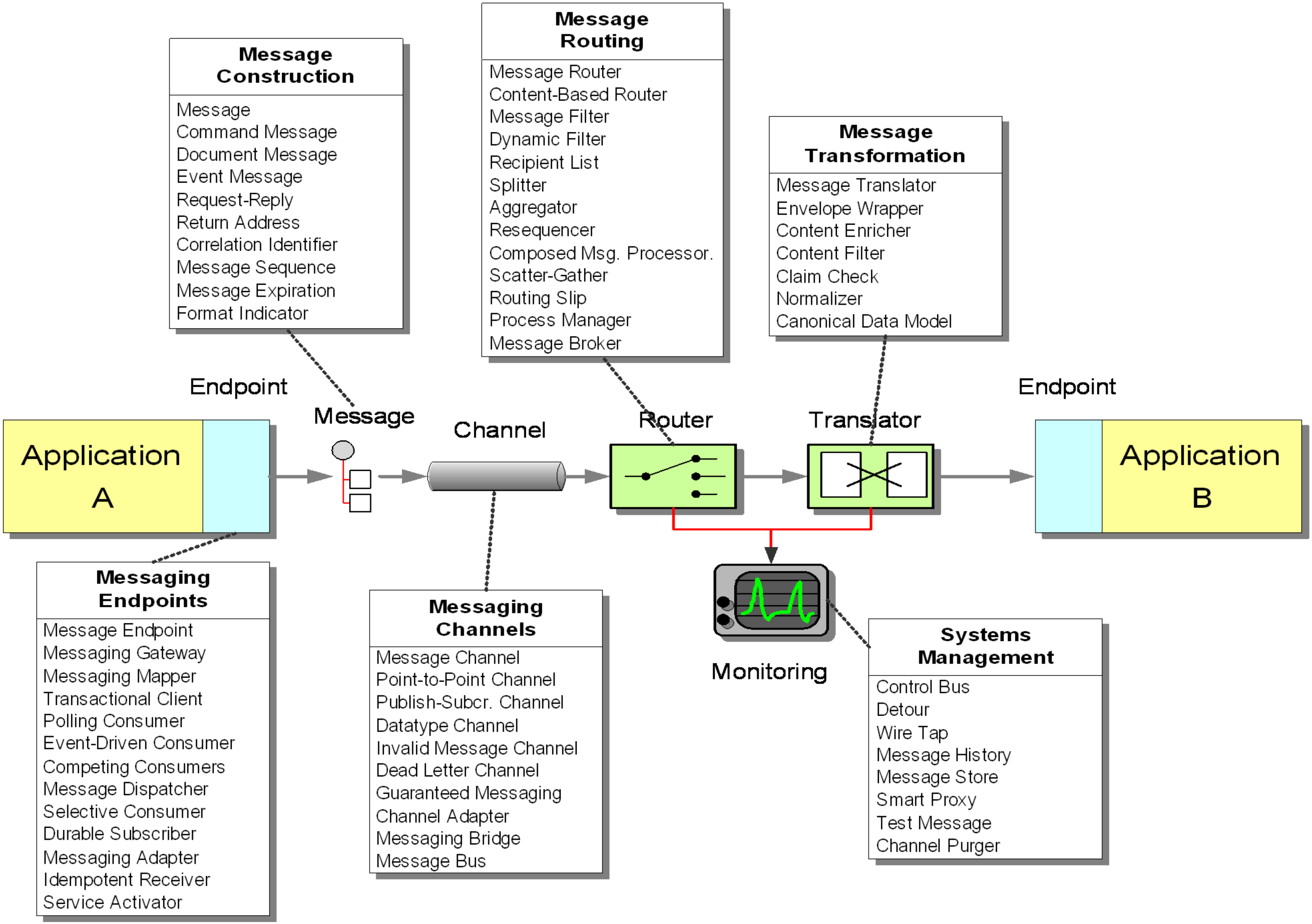
4. Transform the message to the required format — *Transformation Patterns*



5. Produce and consume messages — *Endpoint Patterns*

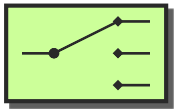
6. Manage and Test the System — *Management Patterns*



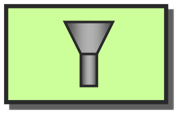


Message Construction
Message
Command Message
Document Message
Event Message
Request-Reply
Return Address
Correlation Identifier
Message Sequence
Message Expiration
Format Indicator
Message Routing
Message Router
Content-Based Router
Message Filter
Dynamic Filter
Recipient List
Splitter
Aggregator
Resequencer
Composed Msg. Processor.
Scatter-Gather
Routing Slip
Process Manager
Message Broker
Message Transformation
Message Translator
Envelope Wrapper
Content Enricher
Content Filter
Claim Check
Normalizer
Canonical Data Model
Endpoint
Message
Channel
Router
Translator
Endpoint
Application A
Application B
Monitoring
Messaging Endpoints
Message Endpoint
Messaging Gateway
Messaging Mapper
Transactional Client
Polling Consumer
Event-Driven Consumer
Competing Consumers
Message Dispatcher
Selective Consumer
Durable Subscriber
Messaging Adapter
Idempotent Receiver
Service Activator
Messaging Channels
Message Channel
Point-to-Point Channel
Publish-Subcr. Channel
Datatype Channel
Invalid Message Channel
Dead Letter Channel
Guaranteed Messaging
Channel Adapter
Messaging Bridge
Message Bus
Systems Management
Control Bus
Detour
Wire Tap
Message History
Message Store
Smart Proxy
Test Message
Channel Purger

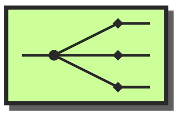
Visual Language



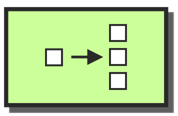
Content-Based Router



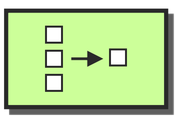
Message Filter



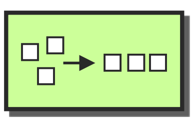
Recipient List



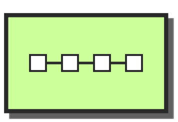
Splitter



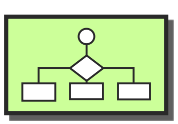
Aggregator



Resequencer



Routing Slip (Itinerary)



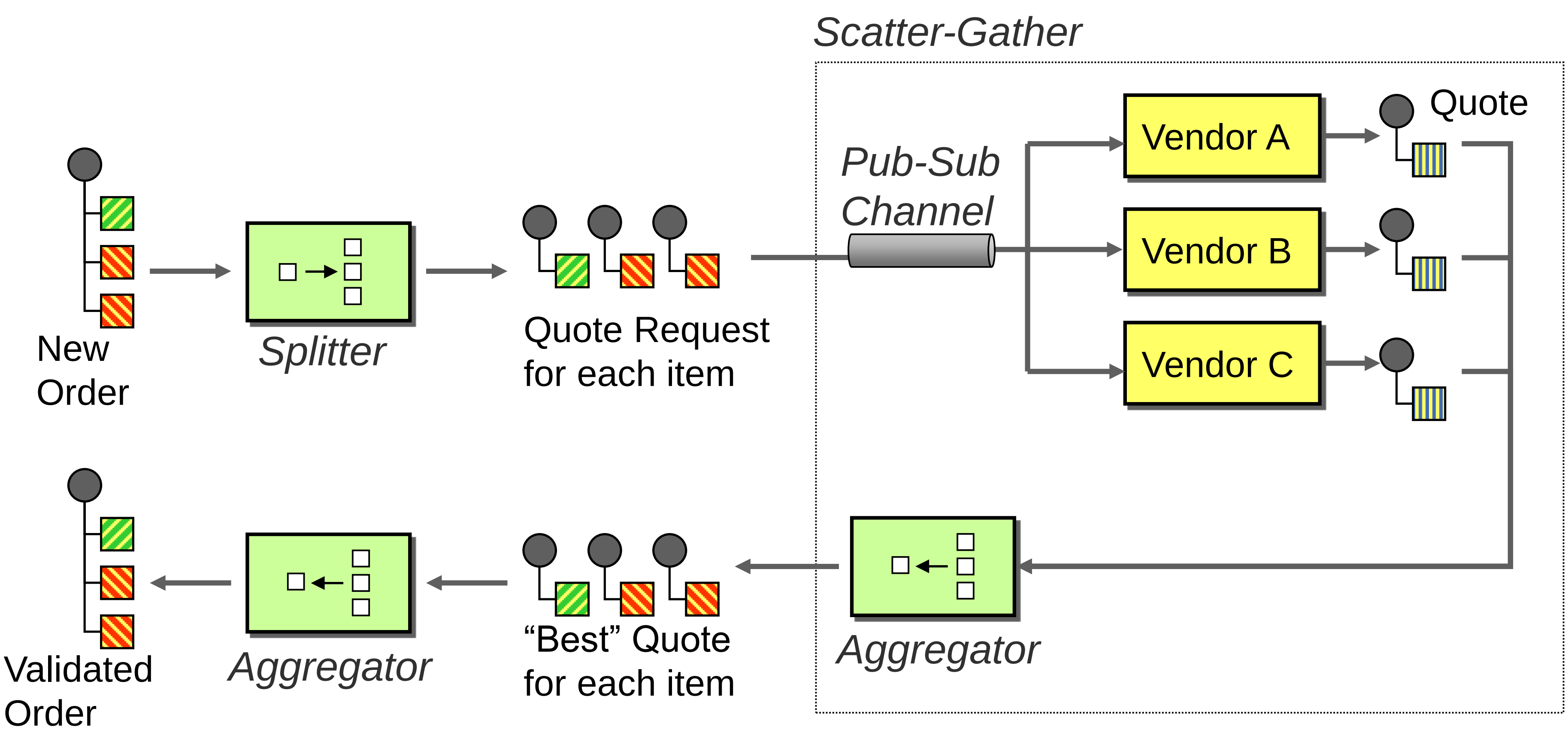
Process Manager

Composing Patterns

Receive an order

Get best offer for each item from vendors

Combine into validated order.



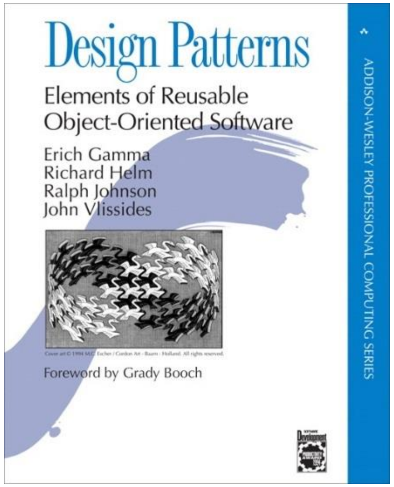
Patterns & Pattern Languages

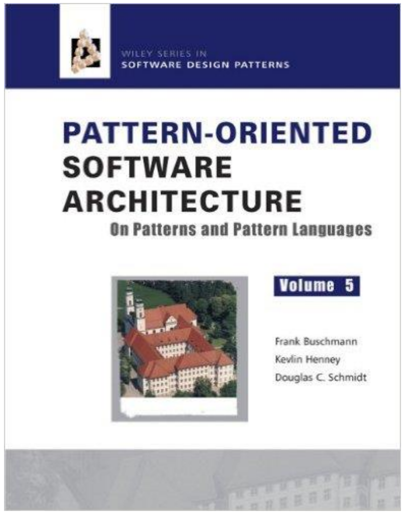
Patterns Revisited

- Shows a good solution to a common problem within a specific context
- “Mind sized” chunks of information (Ward Cunningham)
- Expresses intent (the “why” vs. the “how”)
- Observed from actual experience

NOT:

- A firm rule – always a time when not to use
- Copy-paste code snippet – just example
- Isolated – Part of a Pattern Language

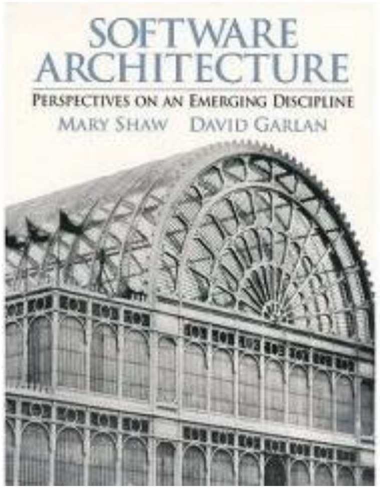




Patterns and Architecture Styles

Patterns exist at different levels

- Idioms (usually language specific)
- Design (usually system specific)
- Architecture



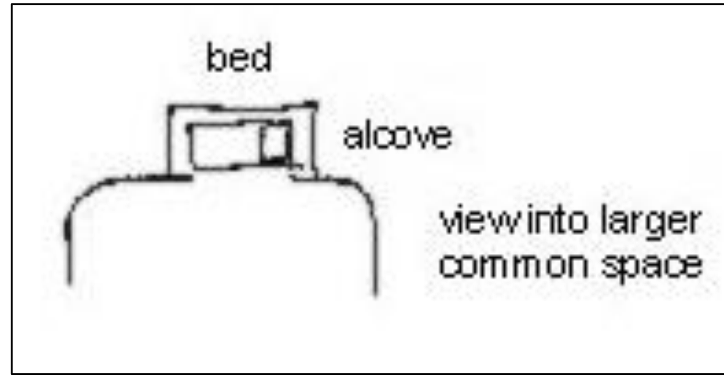
Patterns “belong” to an architectural style

- OO Patterns ≠ Messaging Patterns
- Architectural style provides vocabulary to express patterns
- Different vocabulary, composition rules, semantic interpretation

Integration uses a variety of architectural styles

- Messaging (pipes-and-filters), Data transformation (functional), endpoints (object-oriented), conversations (state machine)

Christopher Alexander's Patterns



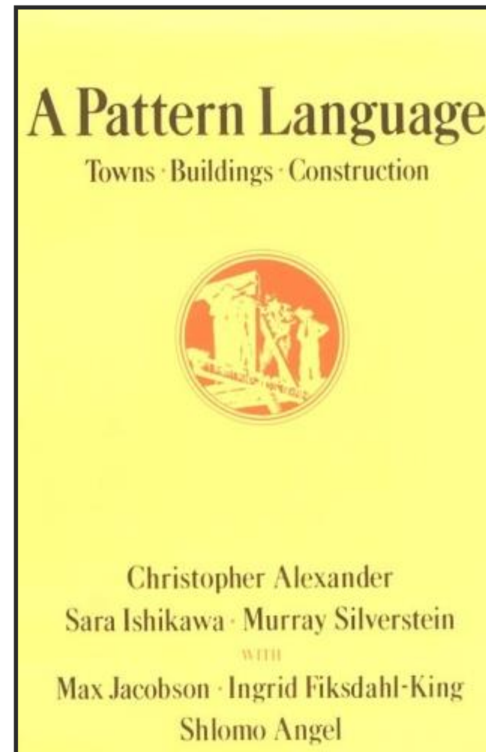
BED ALCOVE

Design problem
Bedrooms make no sense.

Forces
First, the bed in a bedroom creates awkward spaces around it: dressing, working, watching television, sitting, are all rather foreign to the side spaces left over around a bed. (...)
Second, the bed itself seems more comfortable in a space that is adjusted to it.

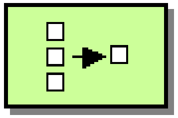
Solution
Don't put single beds in empty rooms called bedrooms, but instead put individual bed alcoves off rooms with other nonsleeping functions, so the bed itself becomes a tiny private haven.

Related Patterns
Communal Sleeping, Marriage Bed
Ceiling Height Variety, Half-open Room, Thick Walls



Pattern Structure

Name
Icon
Context
Problem
Forces
Sketch
Solution
Results
Next
Examples



Aggregator

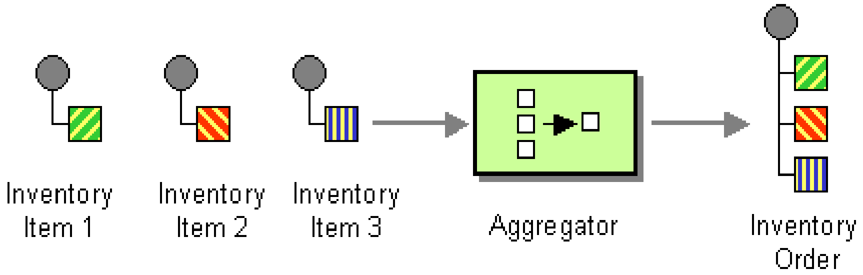
Messaging Patterns » Message Routing » Aggregator

Messaging Patterns

Previous Next

A *Splitter* is useful to break out a single message into a sequence of sub-messages that can be processed individually. Likewise, a *Recipient List* or a *Publish-Subscribe Channel* is useful to forward a request message to multiple recipients in parallel in order to get multiple responses to choose from. In most of these scenarios, the further processing depends on successful processing of the sub-messages. For example, we want to select the best bid from a number of vendor responses or we want to bill the client for an order after all items have been pulled from the warehouse.

How do we combine the results of individual, but related messages so that they can be processed as a whole?



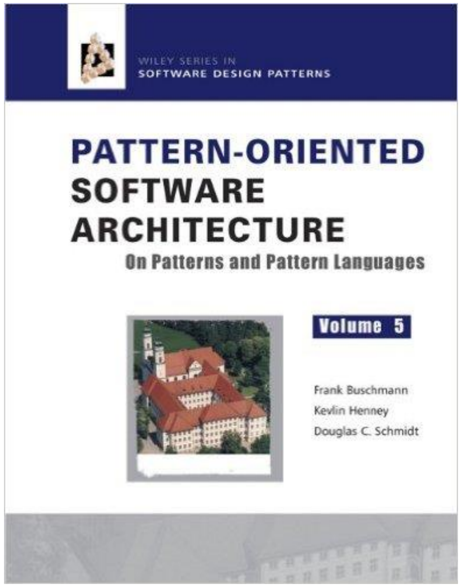
Use a stateful filter, an *Aggregator*, to collect and store individual messages until a complete set of related messages has been received. Then, the *Aggregator* publishes a single message distilled from the individual messages.

The *Aggregator* is a special *Filter* that receives a stream of messages and identifies messages that are correlated. Once a complete set of messages has been received (more on how to decide when a set is 'complete' below), the *Aggregator* collects information from each correlated message and publishes a single, aggregated message to the output channel for further processing.

Pattern Language

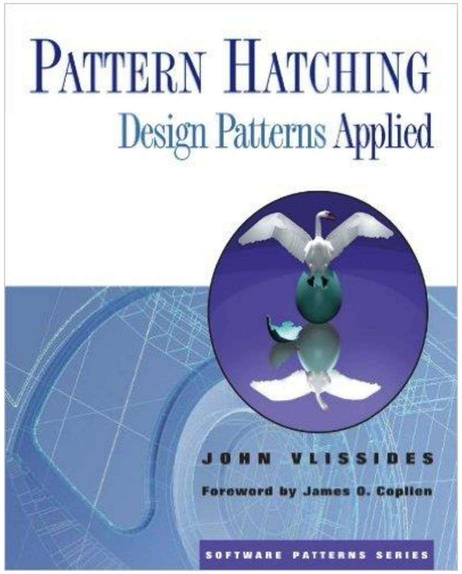
Patterns don't live in isolation

- Pattern Compounds
- Pattern Sequences
- Pattern Collections
- Pattern Languages

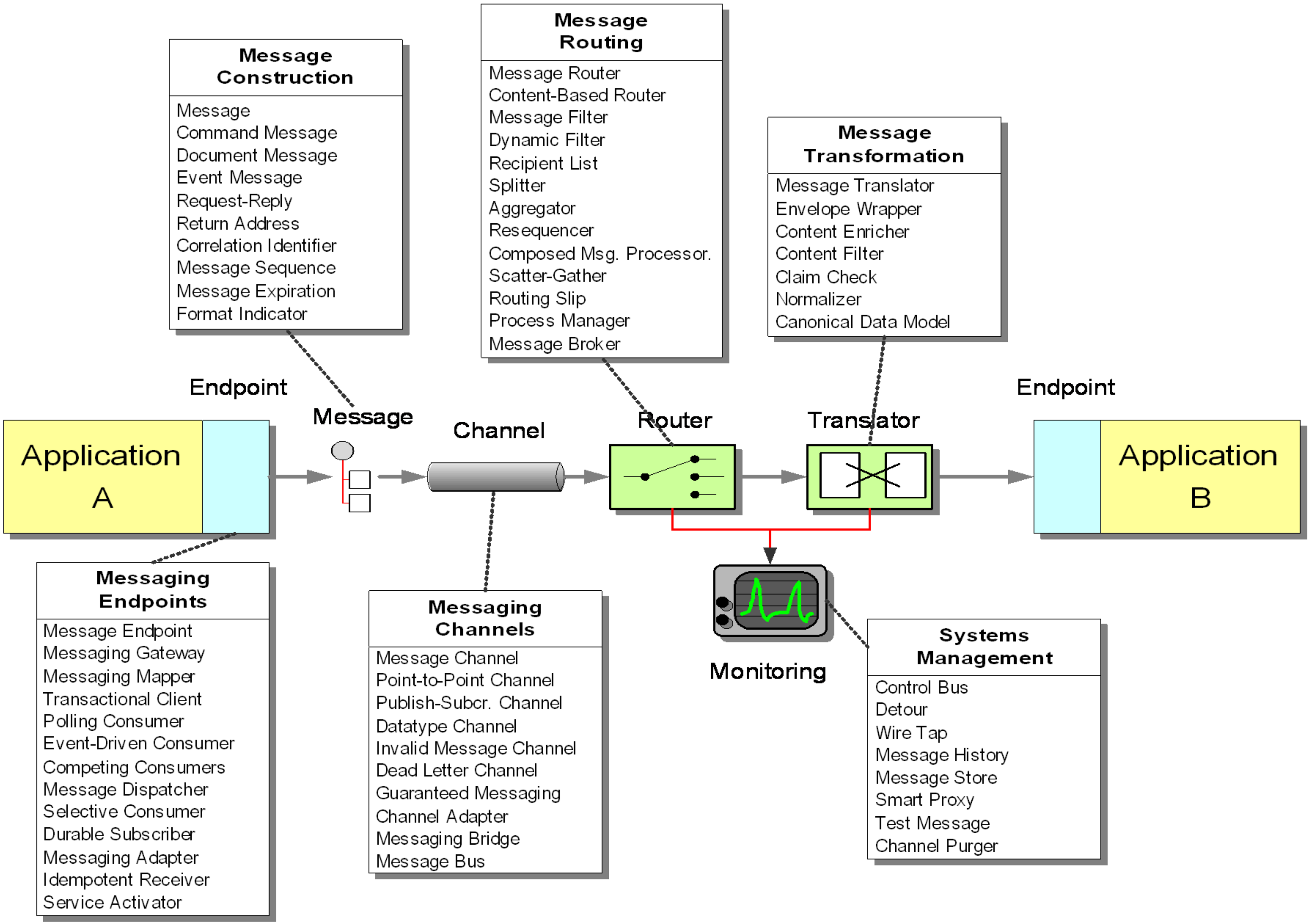


Patterns are "harvested"

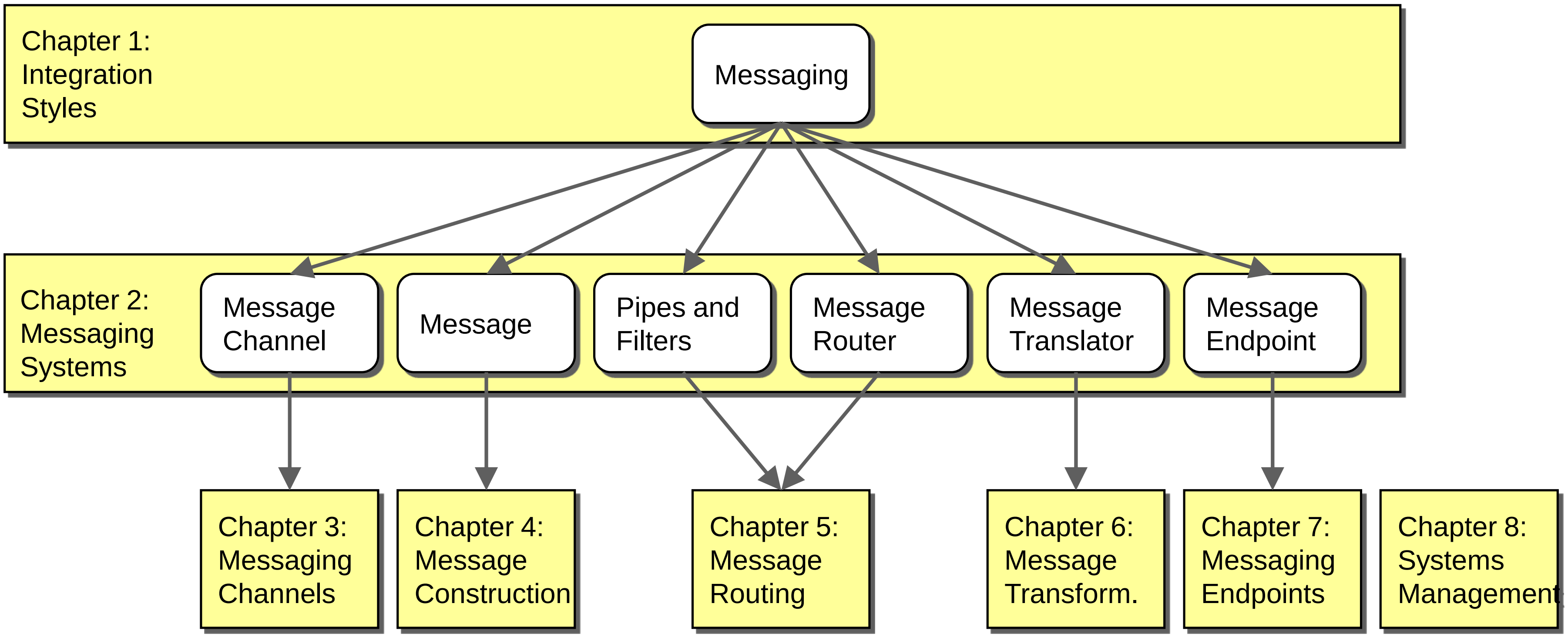
- Story behind the scenes for GoF
- How patterns are refined and applied



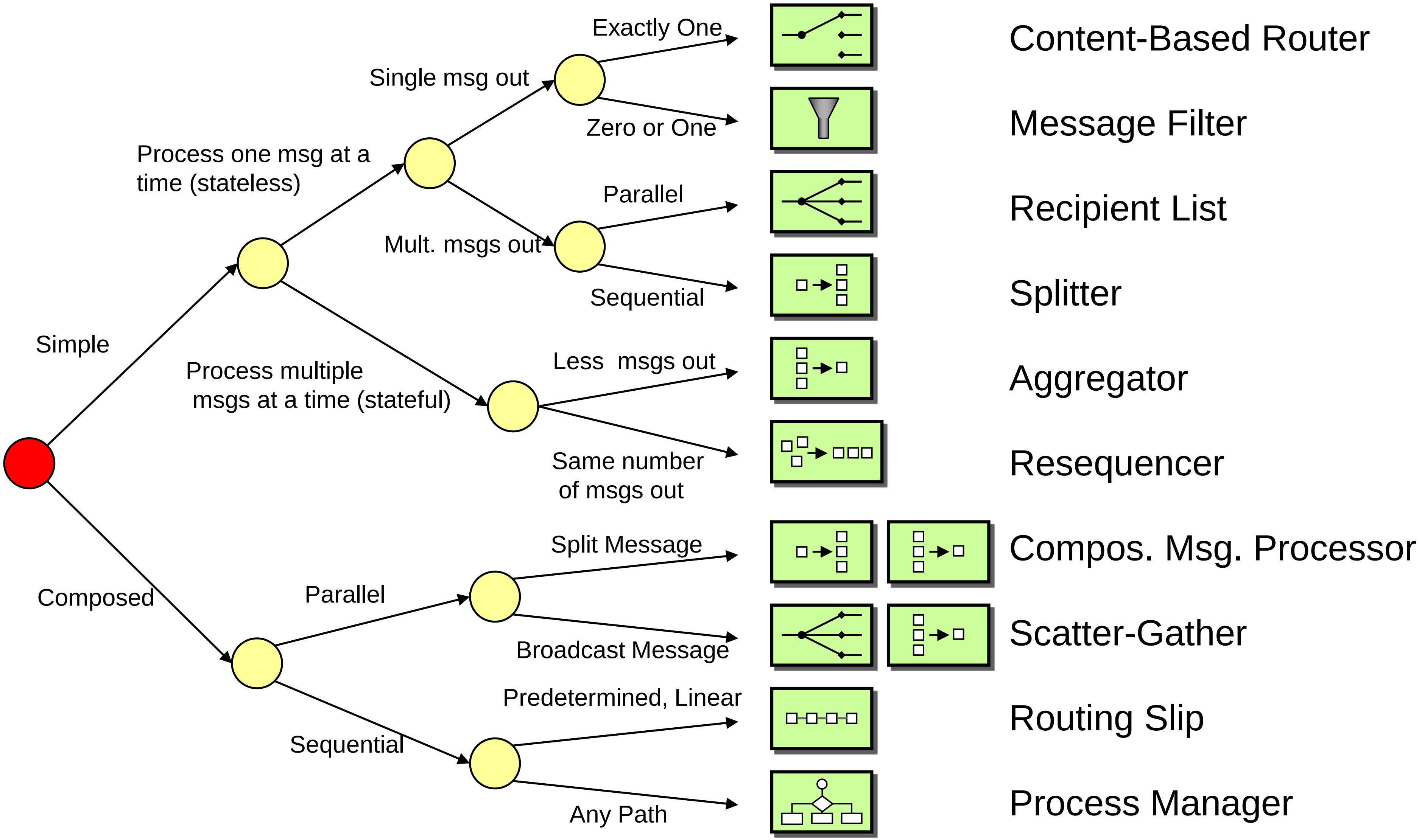
Pattern Language: Message Flow



Pattern Language: Root Patterns

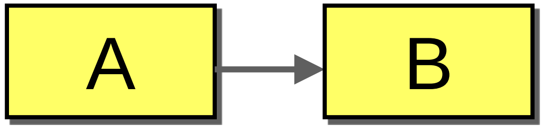


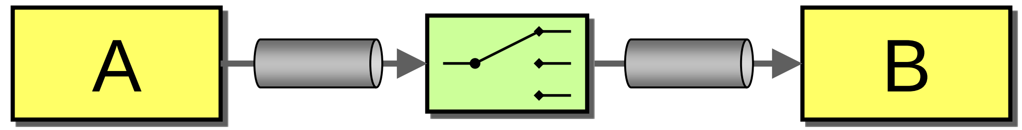
Pattern Language: Alternatives



Pattern “Sketches”: The Icons / Gregorgrams

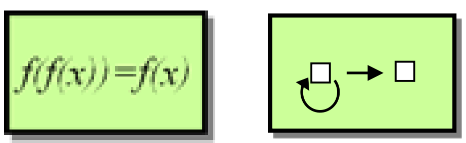
- Biggest step was having a “box in the middle”



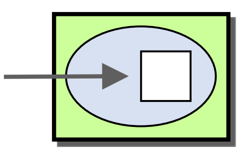


- Pipes-and-filters = Simplest form of Composability

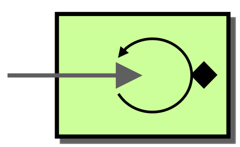
- Some icons missing



- Endpoint patterns compose differently

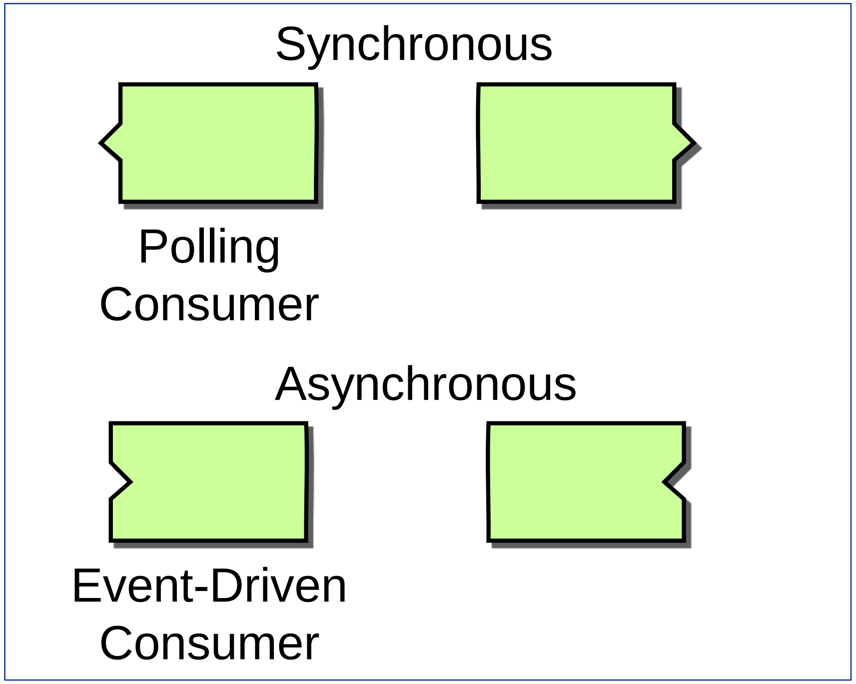


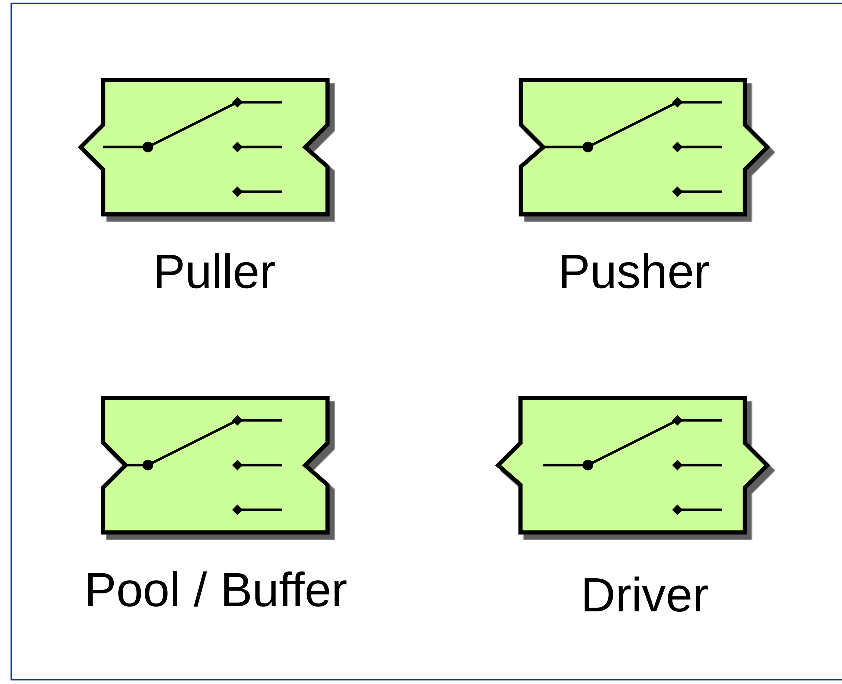
Transactional



Polling

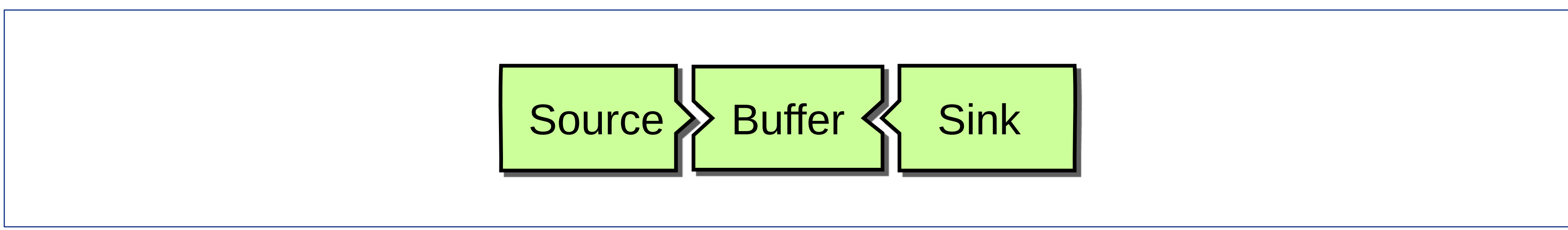
Pattern “Sketches”: Enriching the Vocabulary





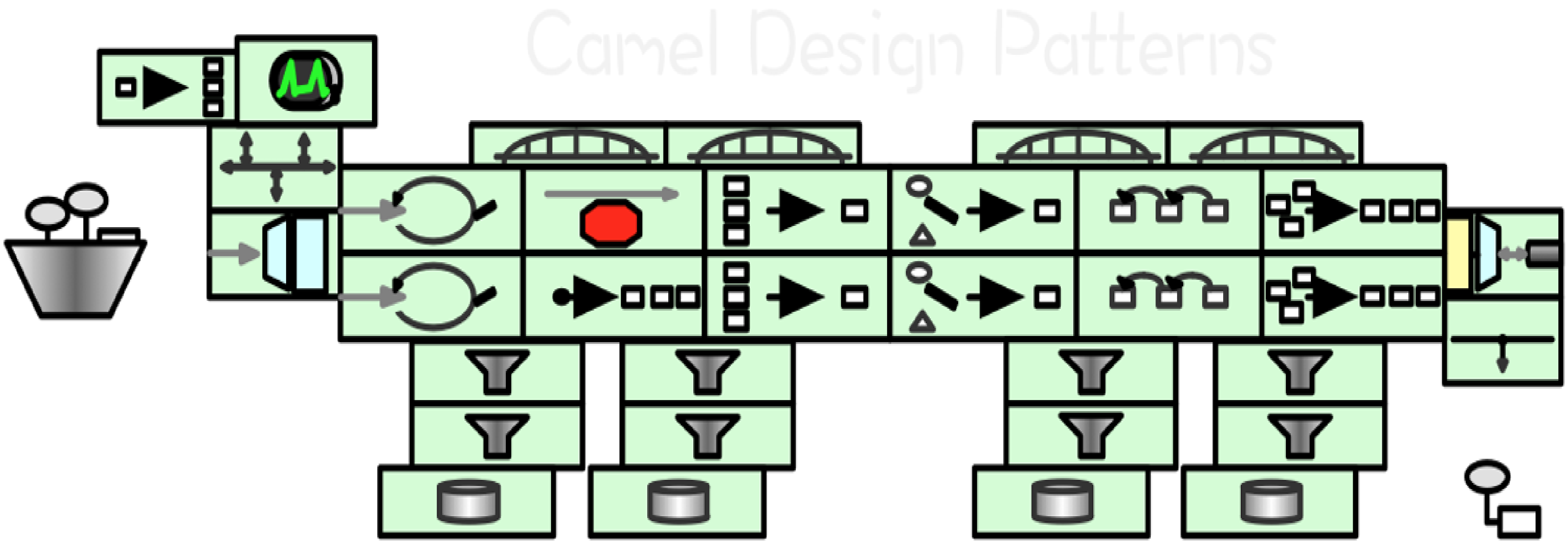
Endpoints

Connecting Elements



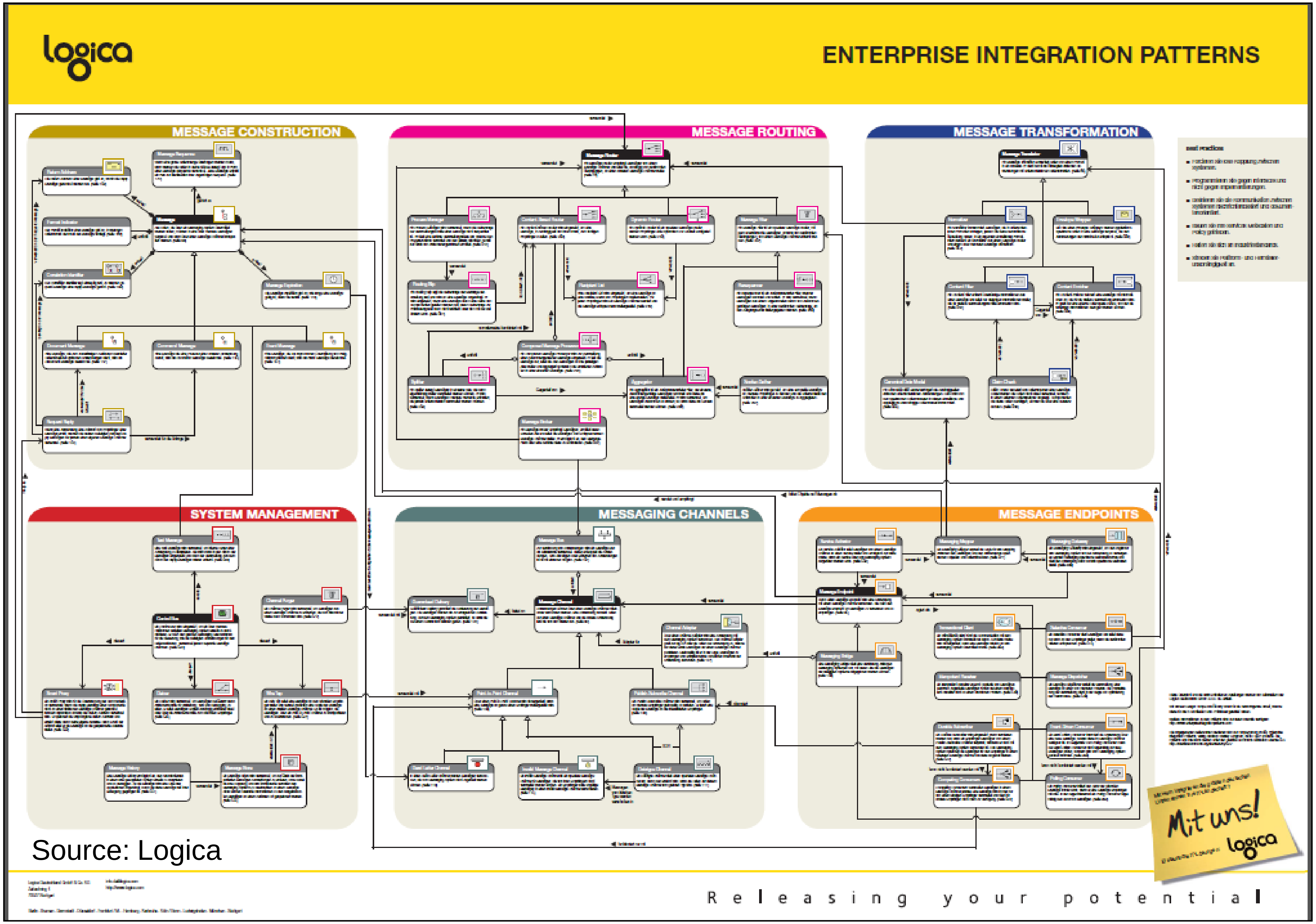
http://www.EnterpriseIntegrationPatterns/ramblings/80_syncorswim.html

Fun with Pattern Icons



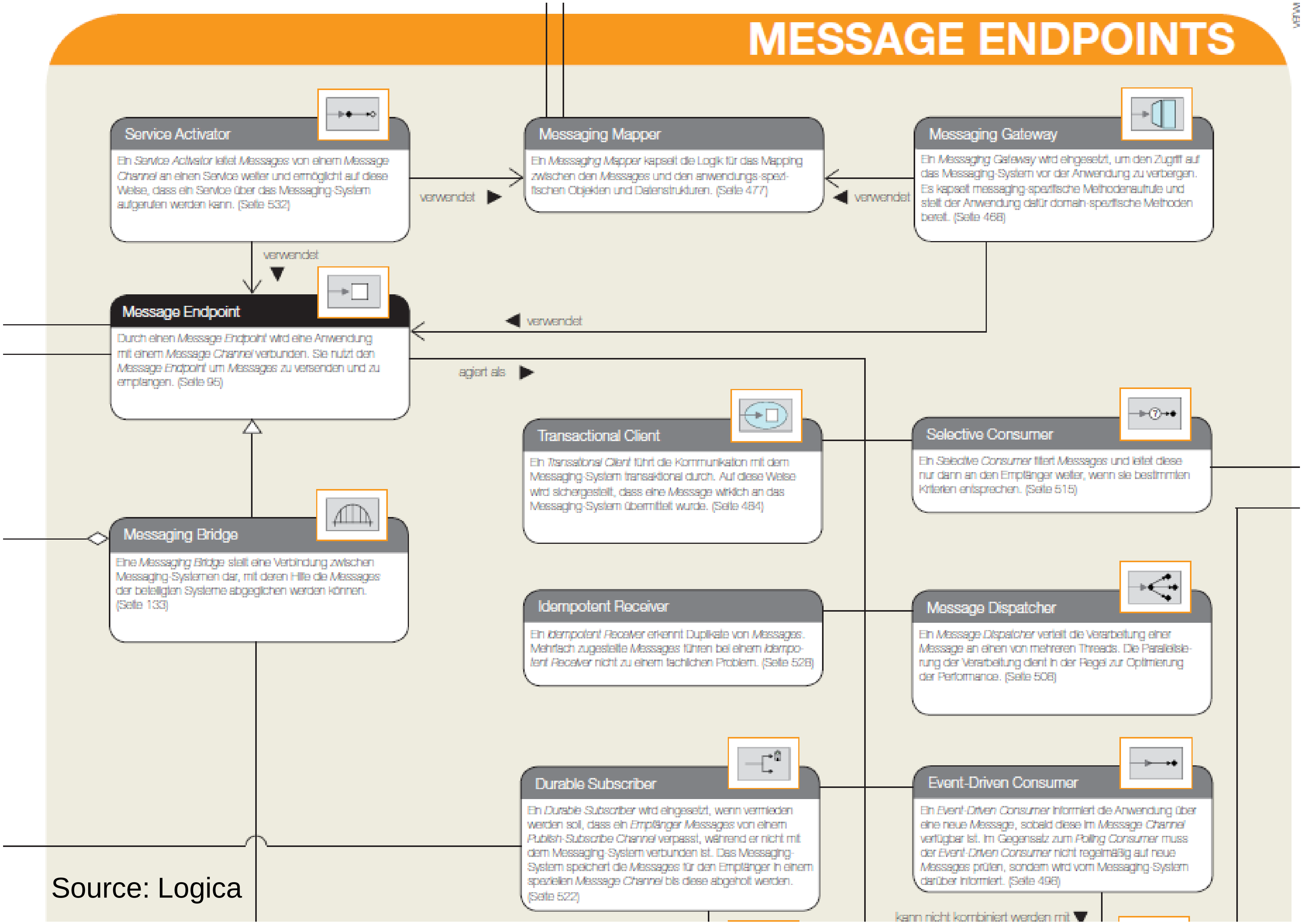
@bibryam

Richer Pattern Relationships



Source: Logica

Richer Pattern Relationships

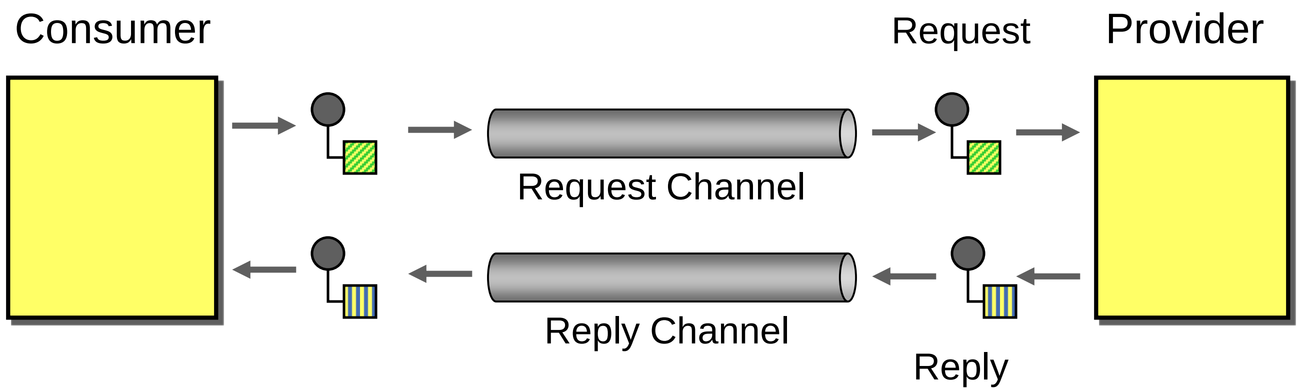


Source: Logica

Patterns Hands-on

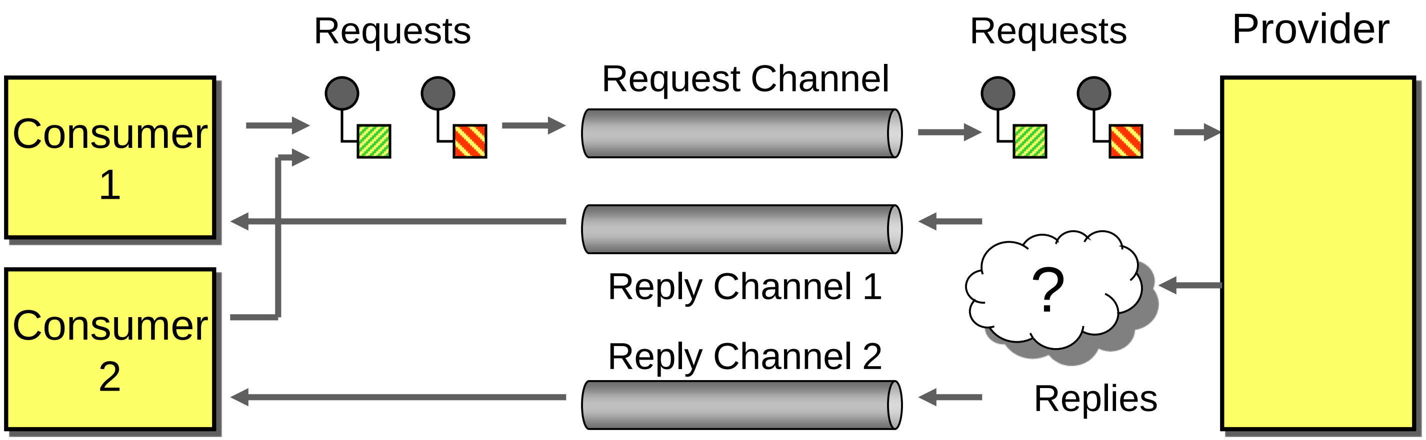
Messaging Patterns in Action

Pattern: *Request-Reply*



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

Multiple Consumers

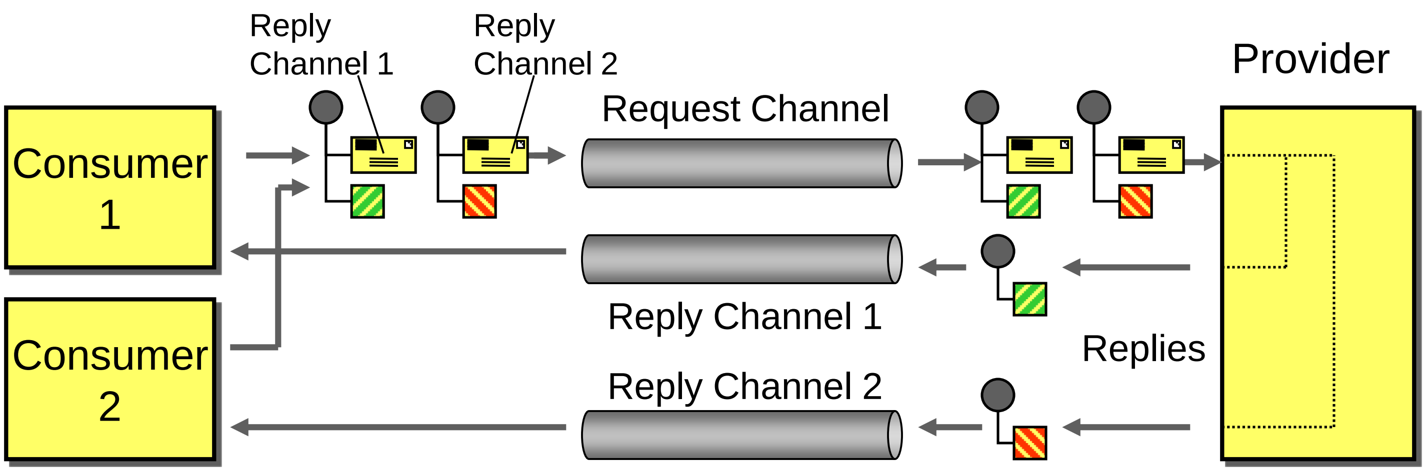


Each consumer has its own reply queue

How does the provider know where to send the reply?

- Could send to all consumers → very inefficient
- Hard code → violates principle of context-free service

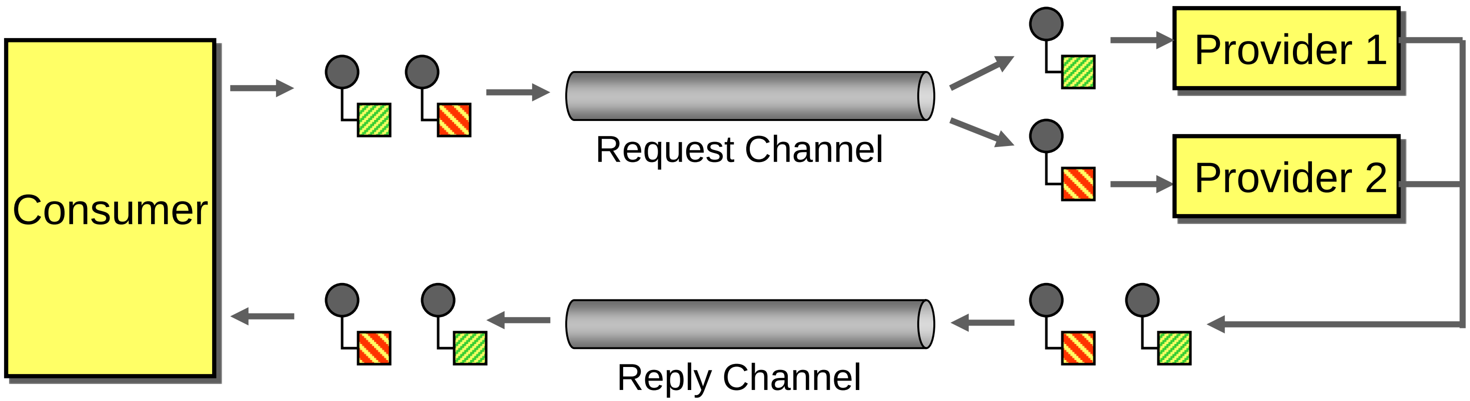
Pattern: *Return Address*



Consumer specifies *Return Address* (reply channel) in the request message

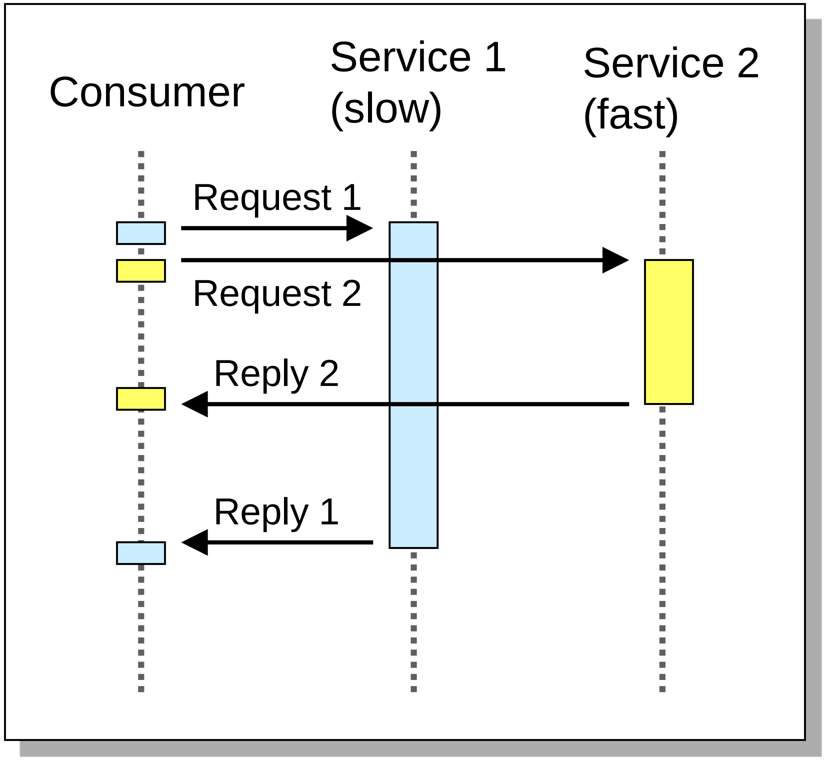
Service provider sends reply message to specified channel

Multiple Service Providers



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

Multiple Service Providers

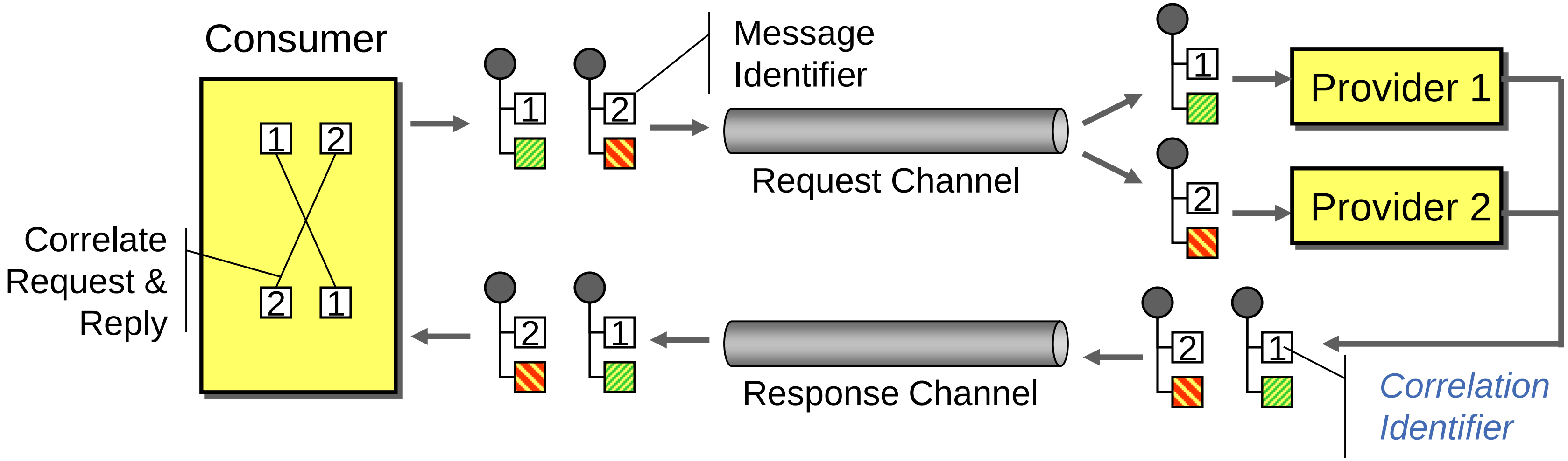


Reply messages get out of sequence

How to match request and reply messages?

- Only send one request at a time
  → very inefficient
- Rely on natural order
  → bad assumption

Pattern: *Correlation Identifier*



Equip each message with a unique *Correlation Identifier*

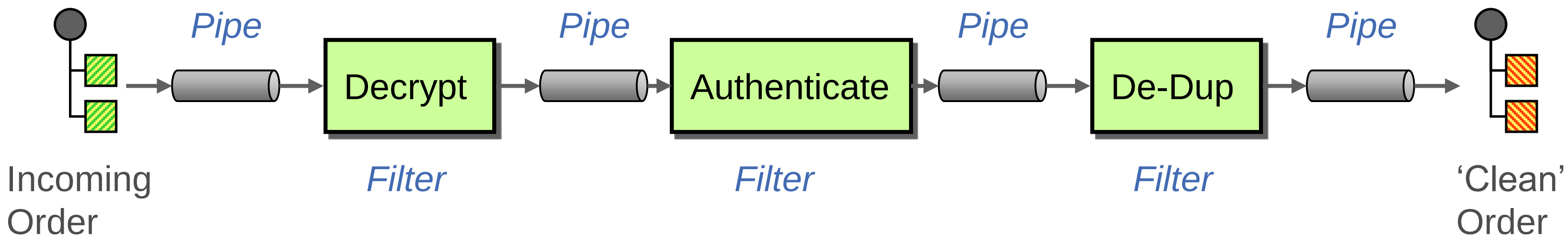
- Message ID (simple, but has limitations)
- GUID (Globally Unique ID)
- Business key (e.g. Order ID)

Provider copies the ID to the reply message

Consumer can match request and response

Insert a *SmartProxy* if provider does not support this

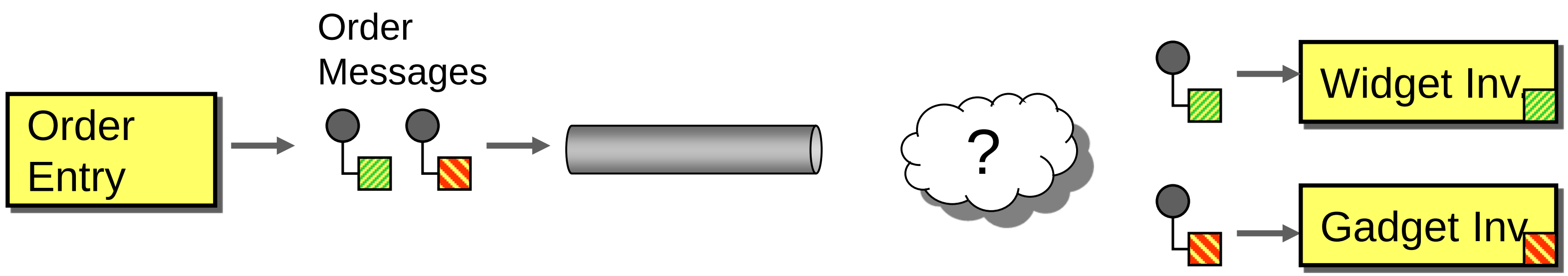
Pattern: *Pipes-And-Filters*



Connect individual processing steps (filters) with message channels (pipes)

- Pipes decouple sender and receiver
- Participants are unaware of intermediaries
- Compose patterns into larger solutions

Multiple Specialized Providers

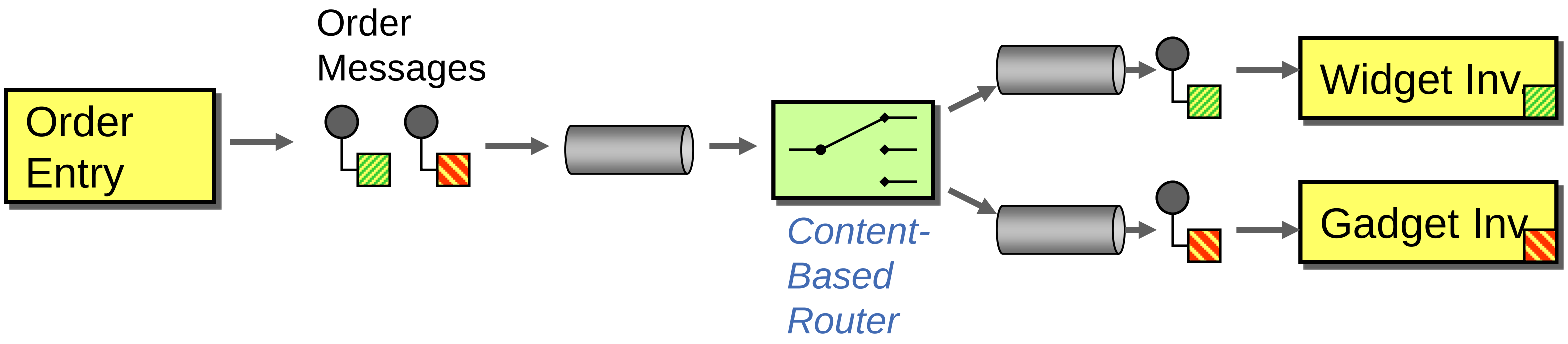


Each provider can only handle specific type of message

Route request to the "appropriate" provider based on the content of the request message

- Do not want to burden sender with decision (decoupling)
- Letting each consumer "pick out" desired messages requires distributed coordination

Pattern: *Content-Based Router*

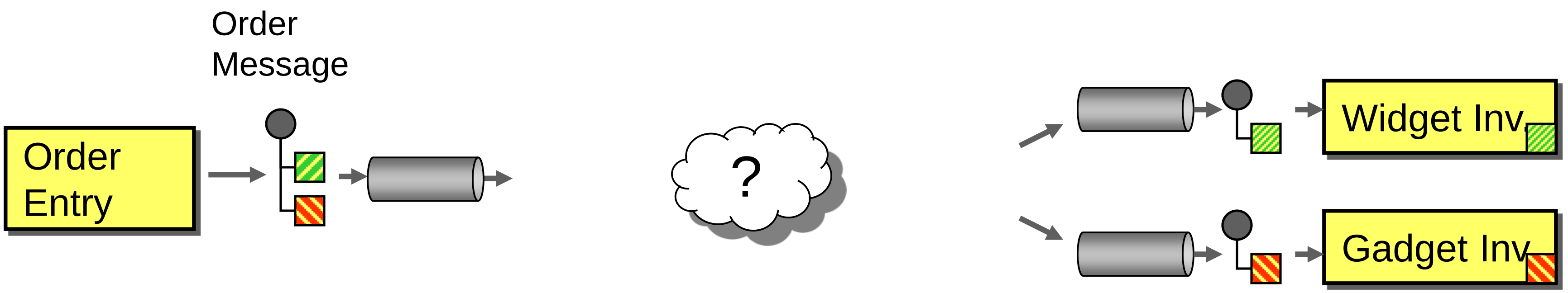


Insert a *Content-Based Router*

Message routers forward incoming messages to different output channels without changing message content.

Mostly stateless, but can be stateful (e.g. de-duper)

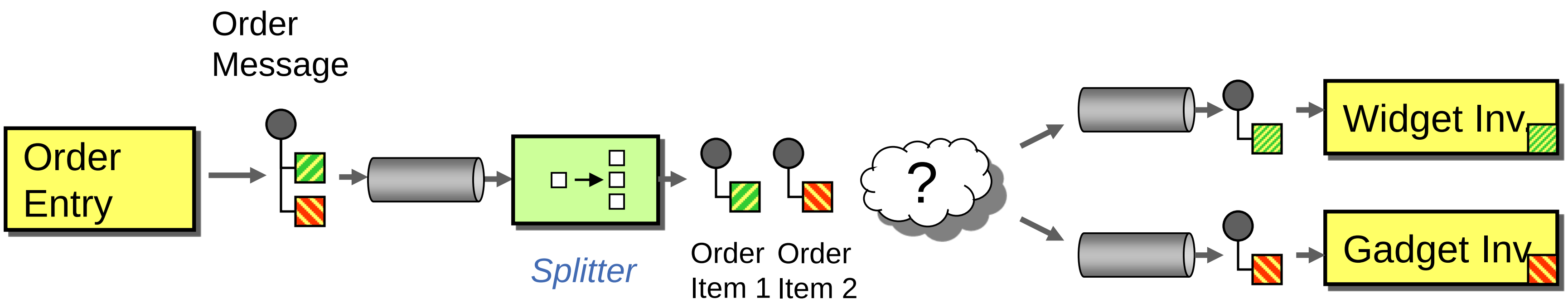
Composite Message



How can we process a message if it contains multiple elements, each of which may have to be processed in a different way?

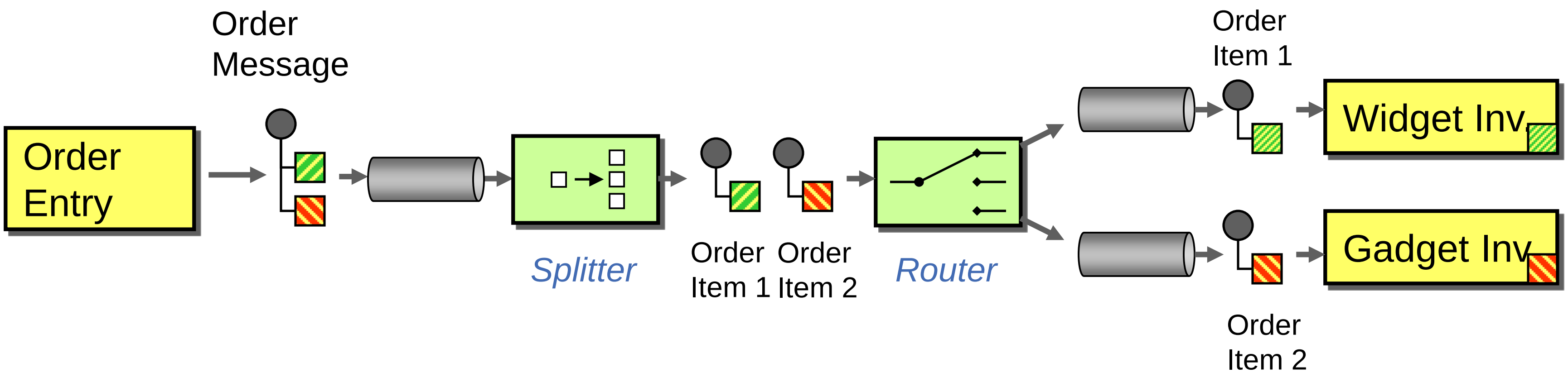
- Treat each element independently
- Need to avoid missing or duplicate elements
- Make efficient use of network resources

Pattern: *Splitter*



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

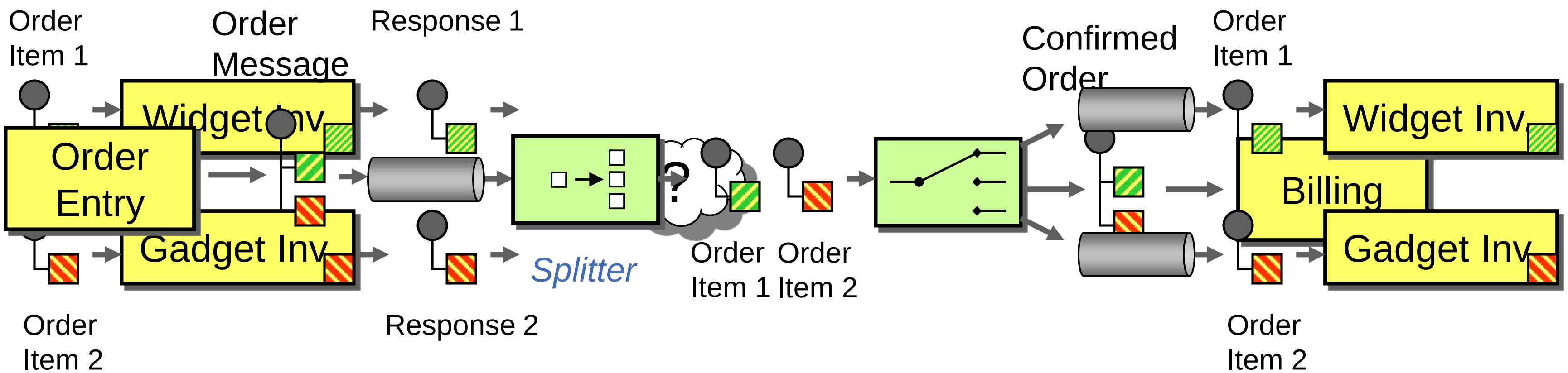
Composite: *Splitter & Router*



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

Then use a *Content-Based Router* to route the individual messages to the proper destination

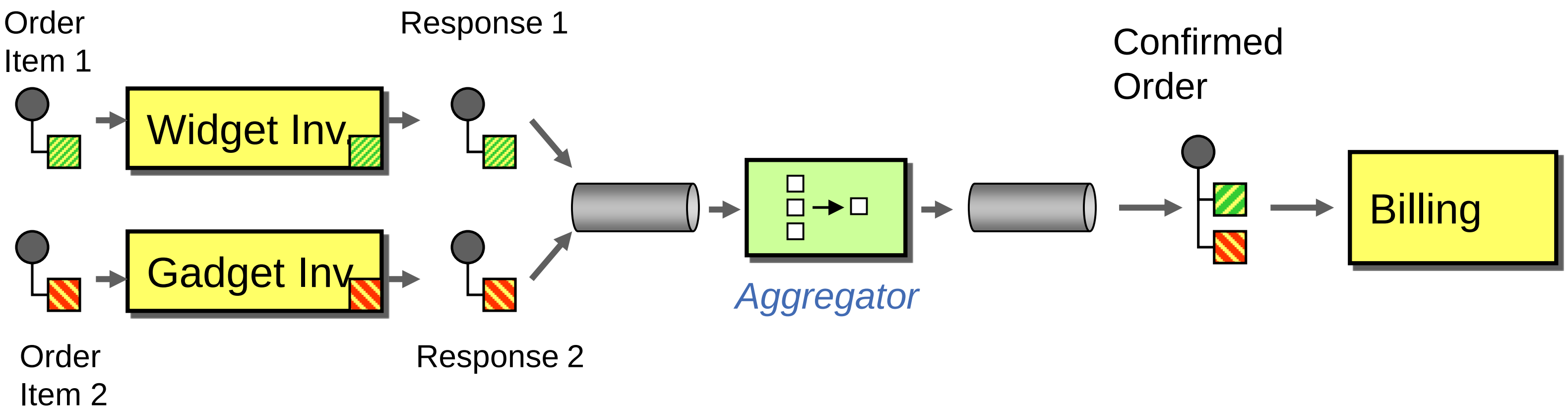
Producing a Single Response



How to combine the results of individual, but related messages so that they can be processed as a whole?

- Messages out of order
- Message delayed
- Which messages are related?
- Avoid separate channel for each system

Pattern: *Aggregator*



Use a stateful filter, an *Aggregator*, to collect and store individual messages until a complete set of related messages has been received.

- Aggregator publishes a single message distilled from the individual messages.

Aggregator Design Decisions

Correlation: Which incoming messages belong together?

Completeness Condition: When to publish the result message?

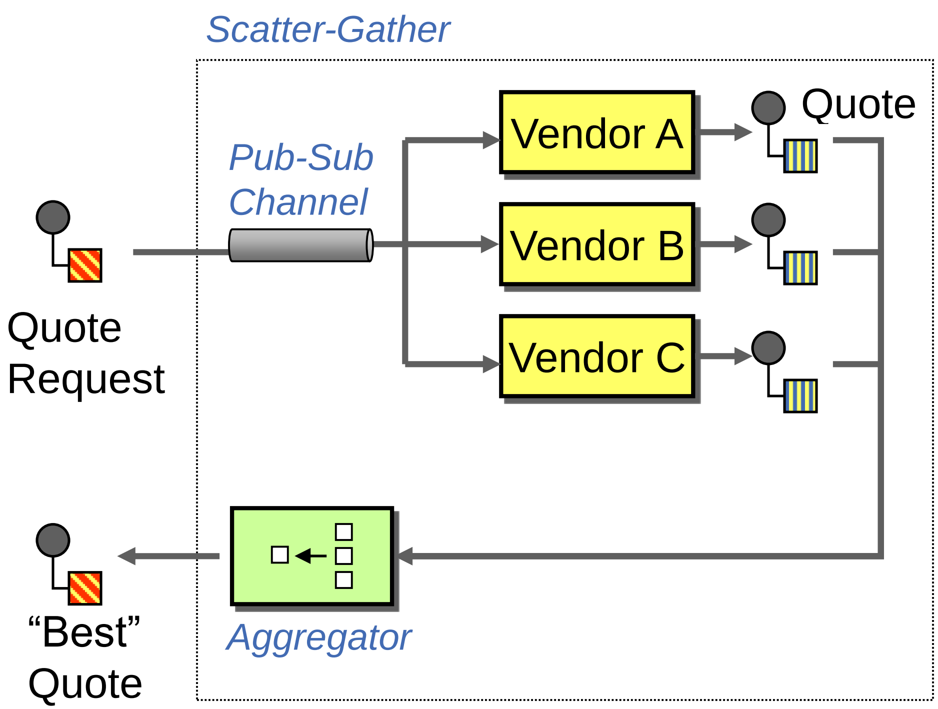
- Wait for all
- Time out (absolute, incremental)
- First best
- Time box with override
- External event

Aggregation Algorithm: How to combine the received messages?

- Single best answer
- Condense data (e.g., average)
- Concatenate data for later analysis

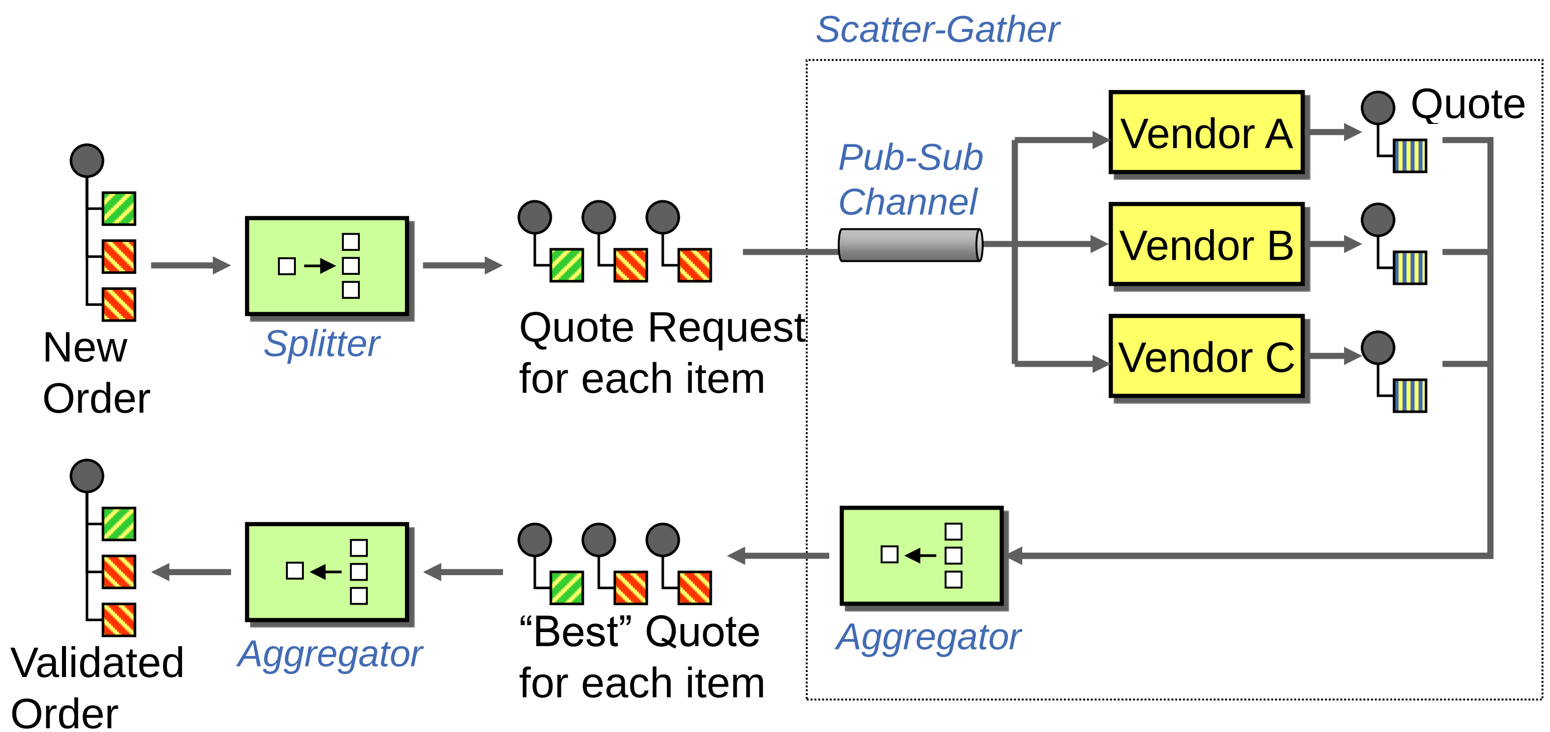
Pattern: *Scatter-Gather*

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

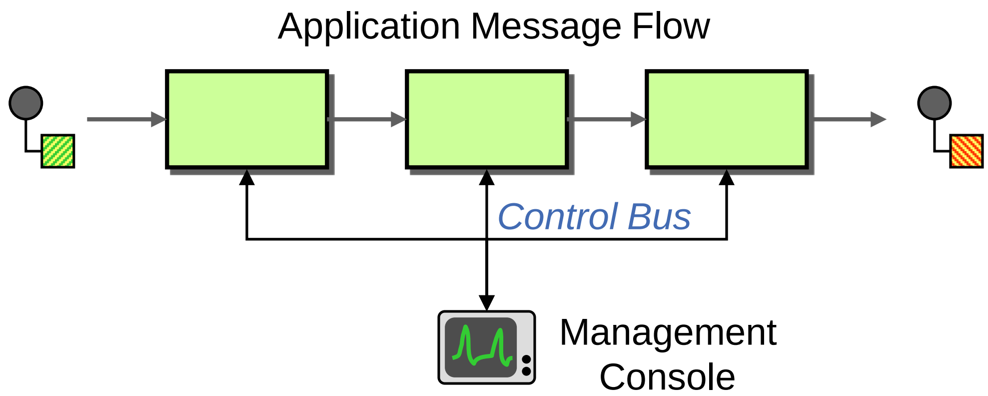


Composing Patterns

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

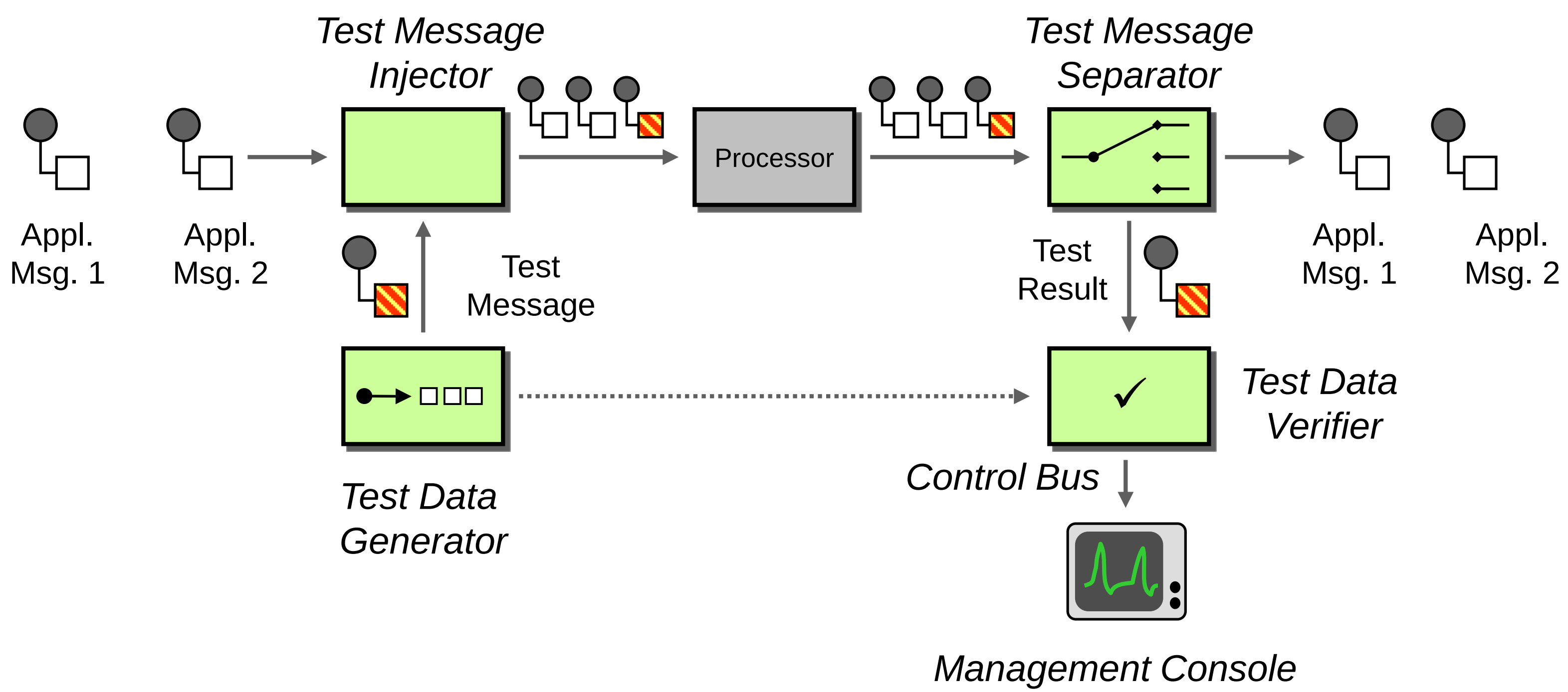


Pattern: Control Bus



- Configuration
- Heartbeat
- Test messages
- Exceptions / logging
- Statistics / Quality-of-Service (QoS)
- Live console

Pattern: Test Message



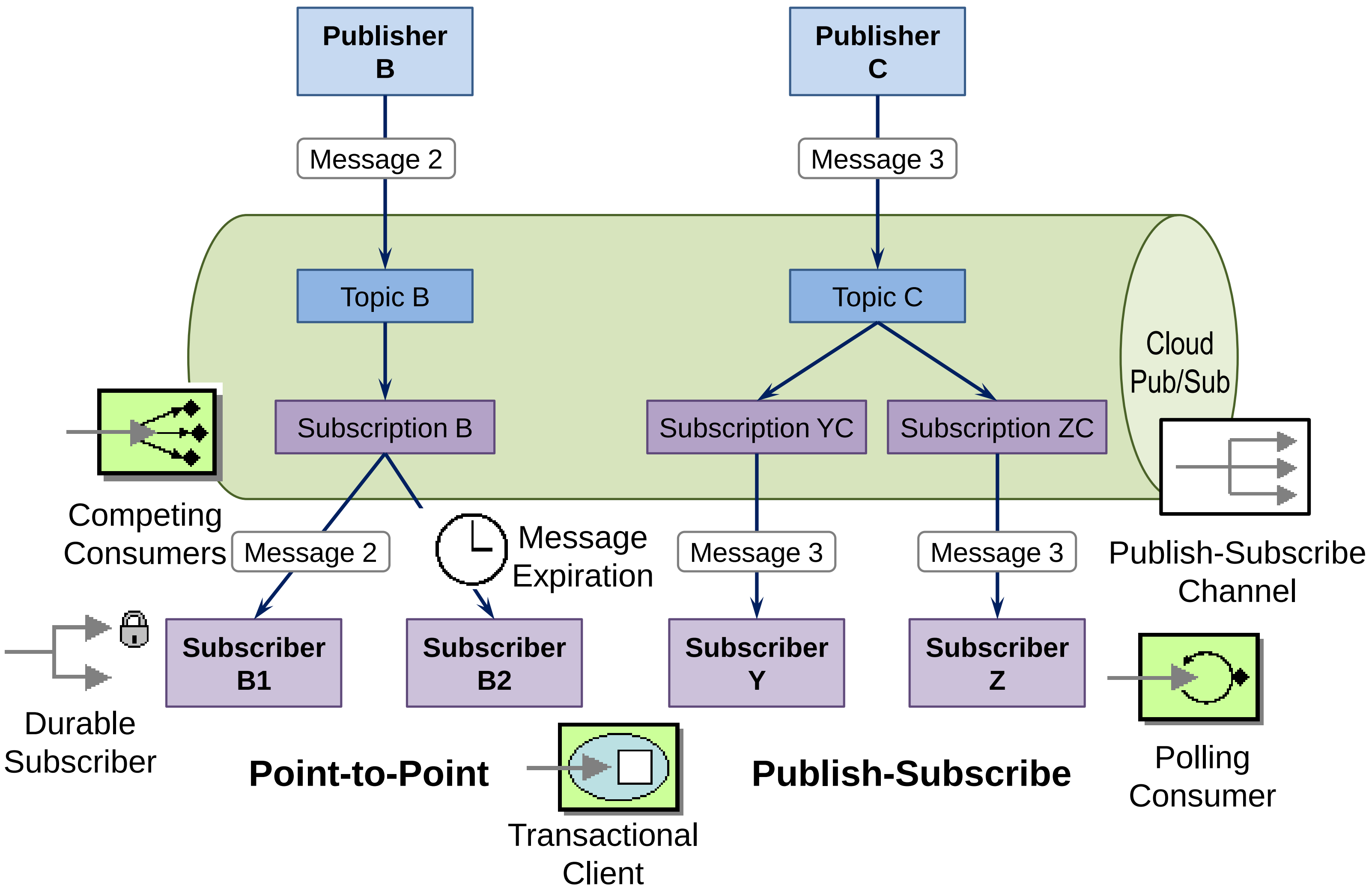
Inject application specific test messages

Extract result from regular message flow

Compare result against predefine (computed) result

Messaging Patterns Today

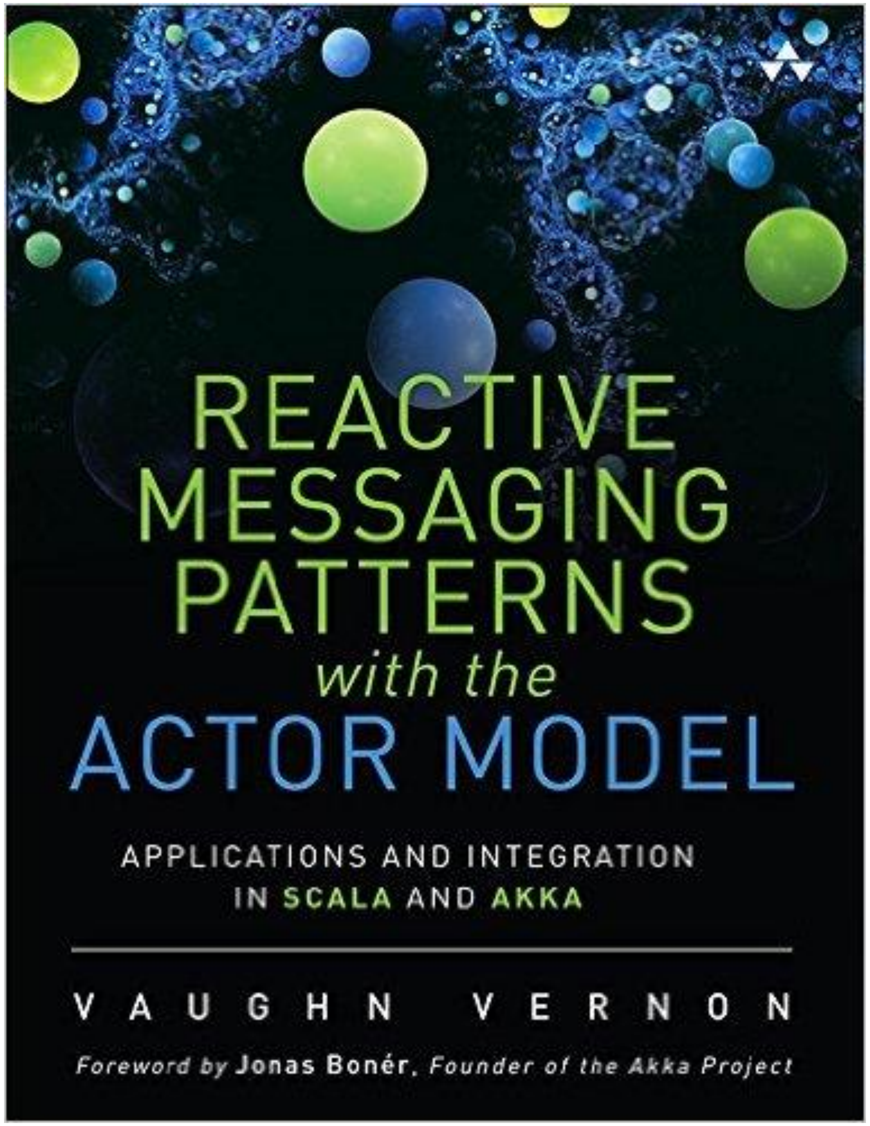
Google Cloud Pub-Sub



Serverless

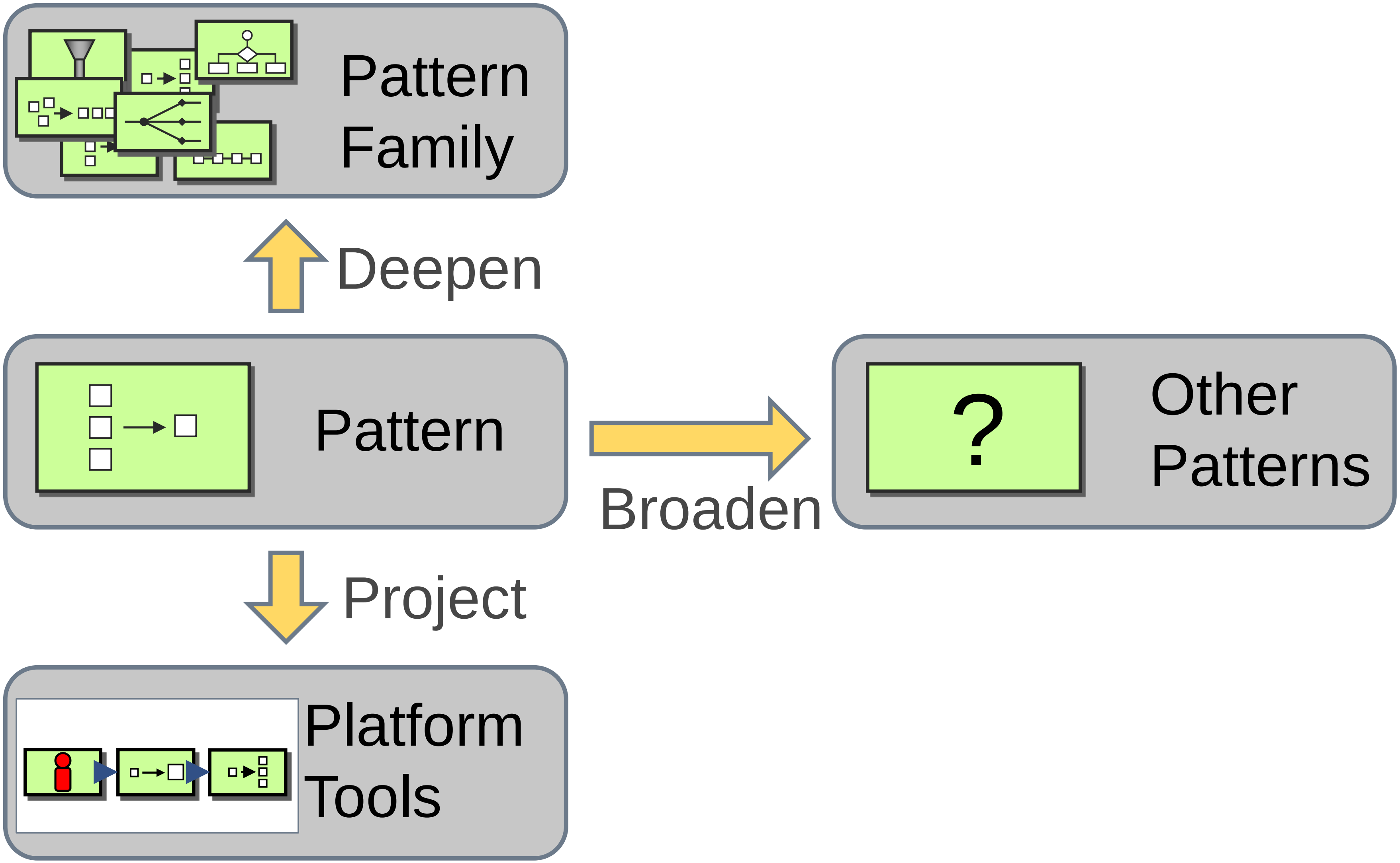
13. Architectural Patterns
13.1 Asynchronous Messaging
13.2 Big Ball of Mud
13.3 Command and Query Responsibility Segregation (CQRS)
13.4 Event-Driven Architecture
13.5 Orchestrated Workflow
13.6 Pipes and Filters
14. Microservice Roles
14.1 Message Originator
14.2 Content Enricher
14.3 Event Mediator
14.4 Event Processor
14.5 Coexistant Versions
14.6 Fanout
14.7 Async Waterfall (with optional Fanout)
14.8 Need Solution
14.9 Transformer
14.10 Worker
15. Integration Styles
15.1 File Transfer
15.2 Shared Database
15.3 Remote Procedure Invocation
15.4 Messaging
16. Messaging Systems
16.1 Message Channel
16.2 Message
16.3 Message Router
16.4 Message Translator
16.5 Message Endpoint

Reactive


REACTIVE
MESSAGING
PATTERNS
with the
ACTOR MODEL
APPLICATIONS AND INTEGRATION
IN SCALA AND AKKA
V A U G H N V E R N O N
Foreword by Jonas Bonér, Founder of the Akka Project

Extending Messaging Patterns

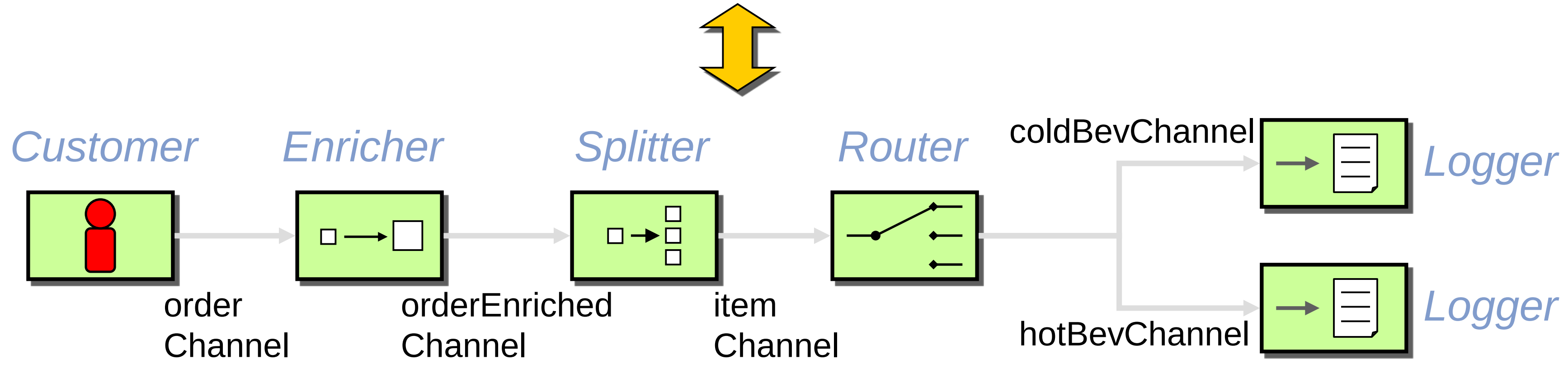
Expanding the Integration Patterns



Patterns as Domain Language

- Messaging toolkit
- Compose solutions from the command line
- Raised level of abstraction

```
call Customer orderChannel
call Enricher orderChannel orderEnrichedChannel
call Splitter orderEnrichedChannel itemChannel "/Order/Item"
call Router itemChannel coldBevChannel "Item = 'FRAPPUCINO'" hotBevChannel
call Logger coldBevChannel
call Logger hotBevChannel
```



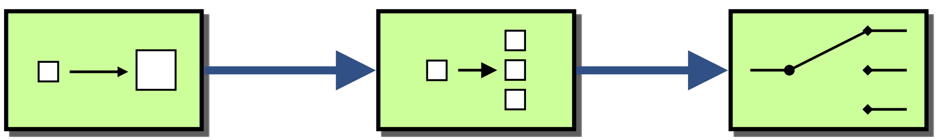
Patterns

- Human communication
- Fuzzy
- Design tool
- Platform independent

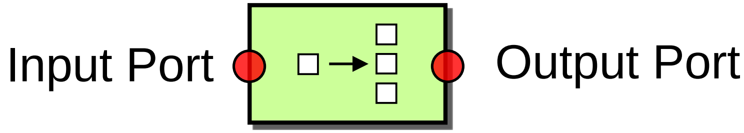
Components

- System Communication
- Precise
- Executable
- Platform dependent

- Simple composability: Pipes and Filters

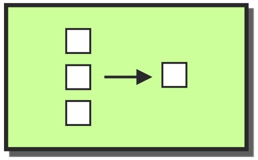


- Easy formalization: Input ports, Output ports



- Other domain languages: XSLT, XPath

Improving Projection – Variability Points

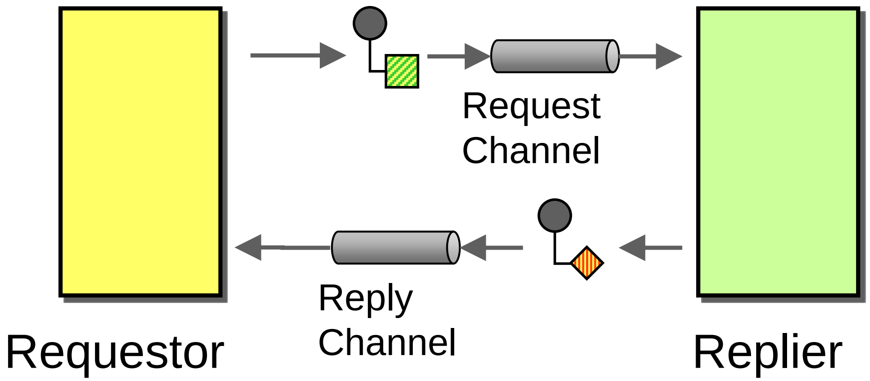


Aggregator

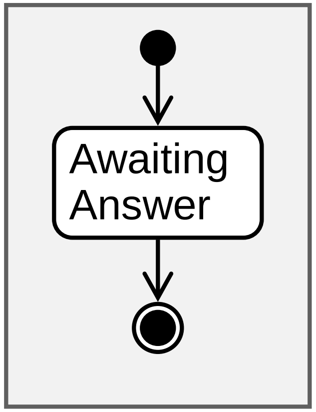
Element ID	
Input Channel	
Output Channel	
Correlation Function	
Completeness Condition	
Aggregation Algorithm	

Conversations

Request-Reply



Conversation
State Chart

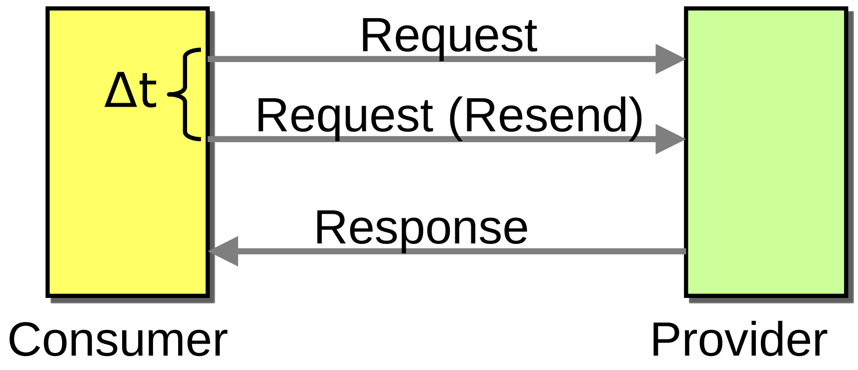


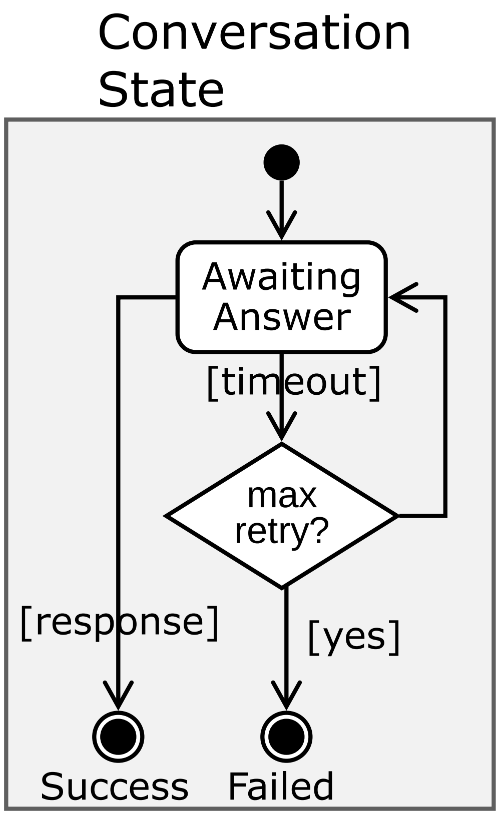
Simplest conversation

Single Conversation state: waiting for reply, complete

Gets more complicated once error conditions considered

Request-Reply with Retry





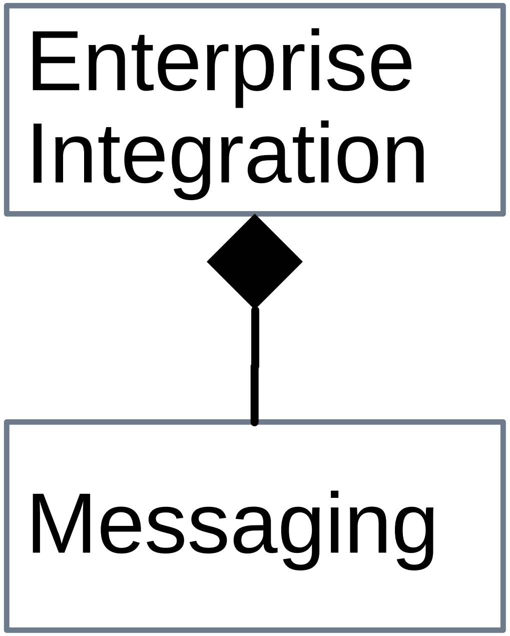
Sender can repeat request *n* times

Provider has to be idempotent

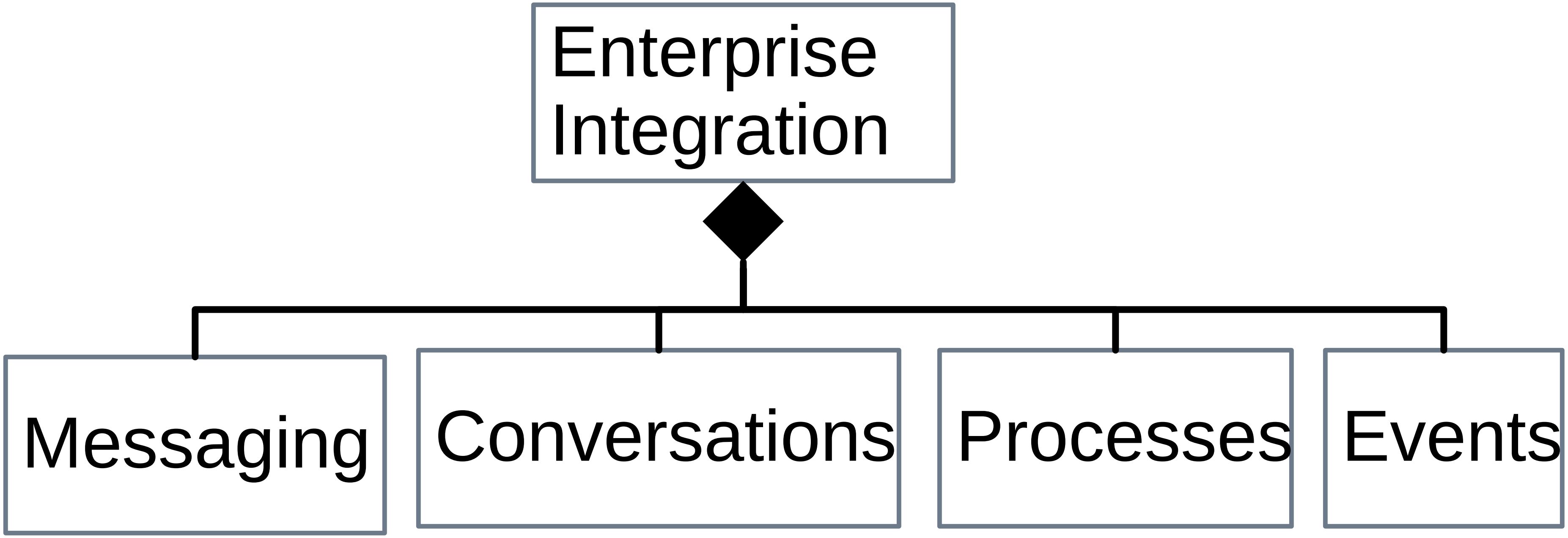
Receiver also has to be idempotent

Example: RosettaNet Implementation Framework (RNIF)

Enterprise Integration or Messaging Patterns?

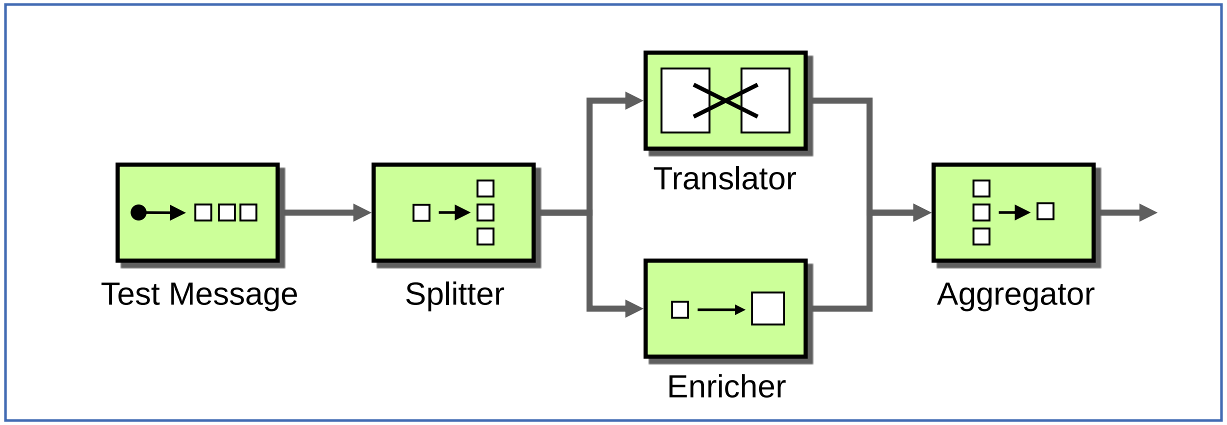


Enterprise Integration or Messaging Patterns?



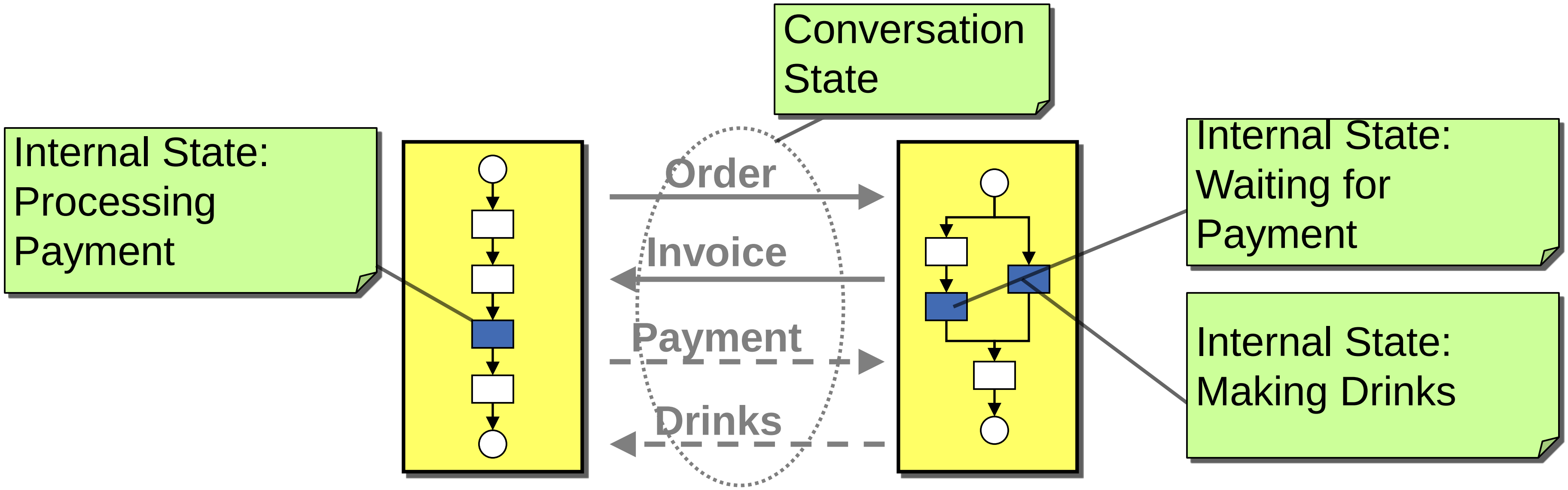
Messaging

Flow of messages through processing nodes



- Stateless -> scaleable, decoupled
- Error handling?
- Complex interactions (no guarantees)

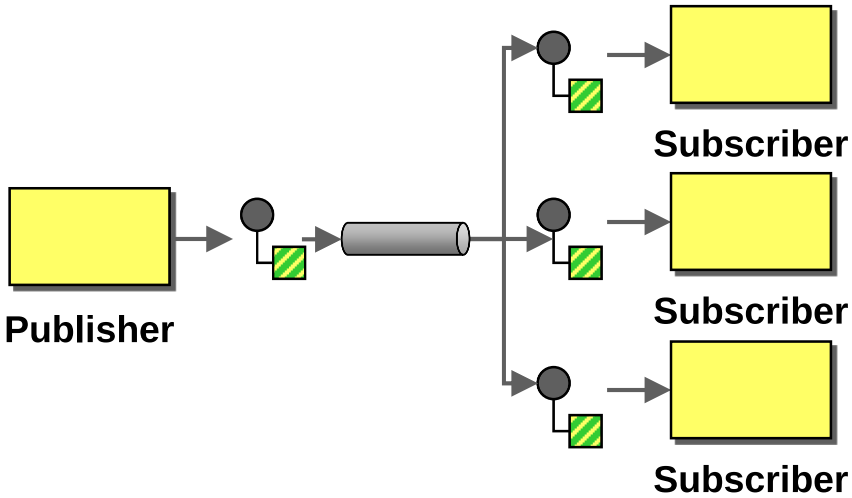
Conversations



- Each conversation corresponds to one process instance
- Each participant has a (potentially different) process definition

Example: Subscriptions

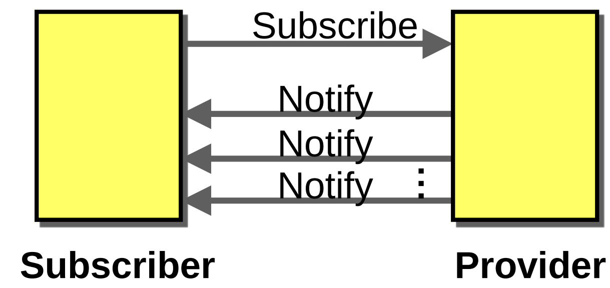
Publish-Subscribe Channel



How can the sender broadcast an event to all interested receivers?

- Follows the message
- Multiple receivers
- One-way
- Deals with transport issues

Subscribe-Notify



How can one participant receive information from another participant if that information cannot easily be packaged into a single message?

- Follows time
- Single receiver
- Two-way
- Deals with state / resources

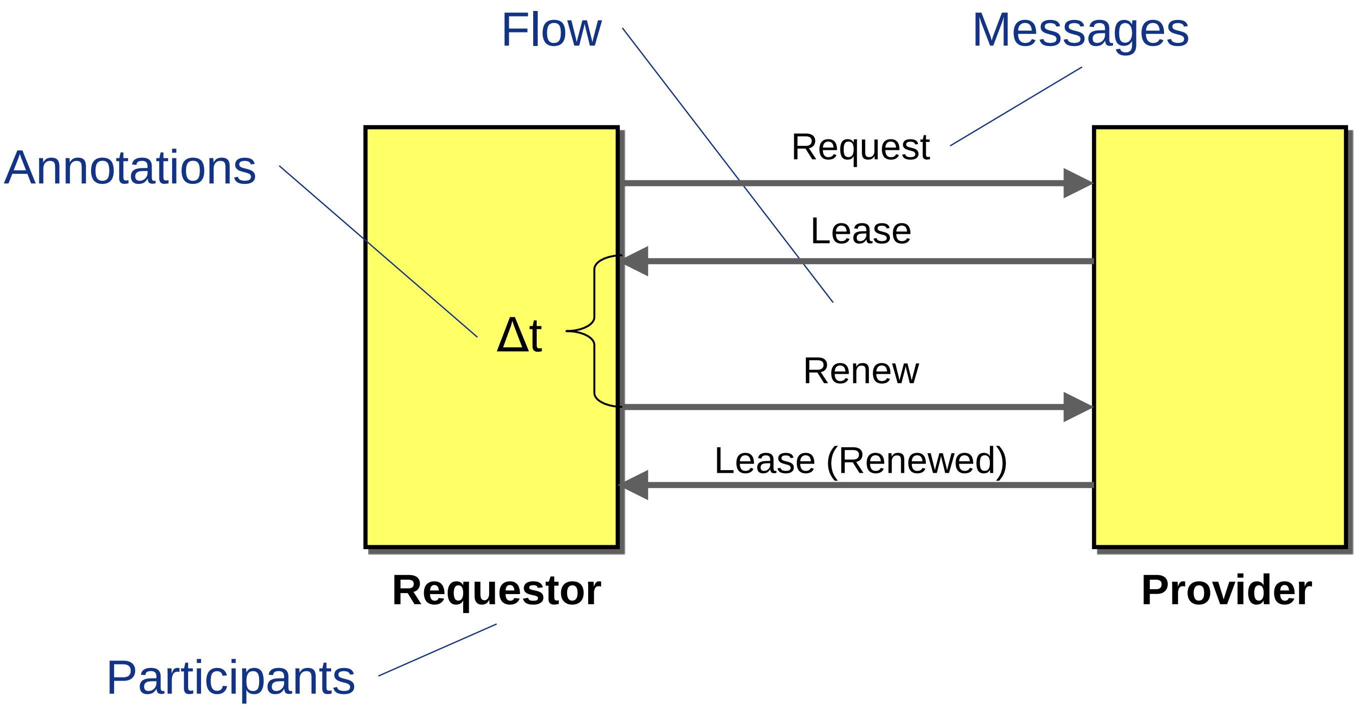
Conversation Patterns

Challenges: Describing Conversations

- Sequence Diagrams (UML 1.x) only show one instance, not the rules of interaction
- Sequence Diagrams (UML 2.0) more powerful, but non-intuitive notation
- WS-CDL pretty much died.
- WS-BPEL too verbose and technical, looking from participant perspective
- Temporal Logic expressive, but not good for sketch
- BPMN probably best choice, but tough to see the essence.

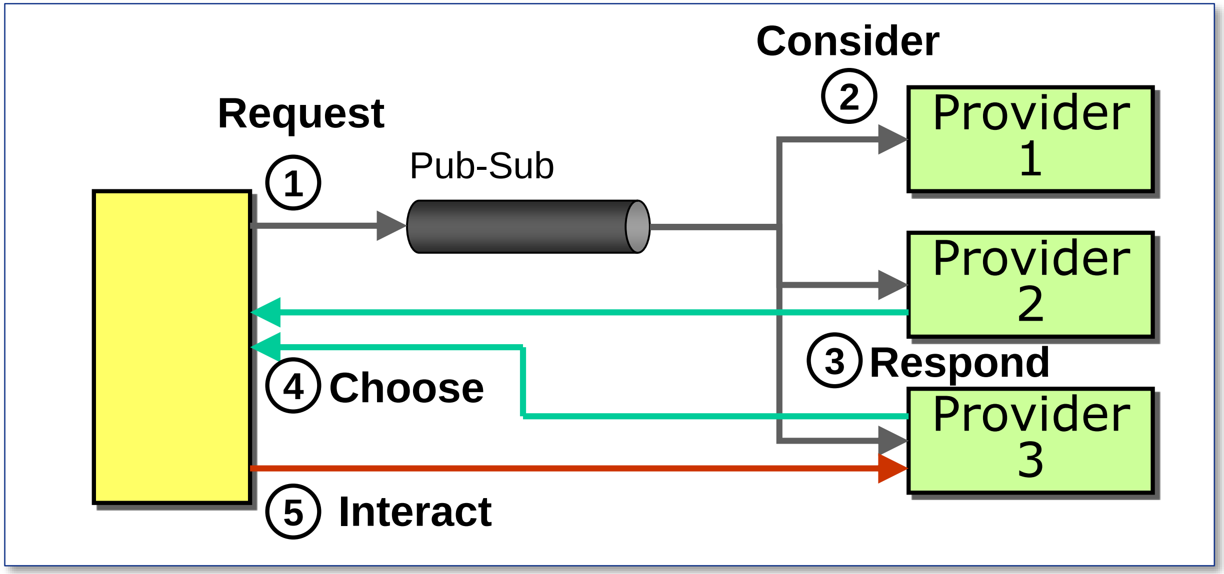
> Dynamic views are much tougher for the brain to process as it requires a translation from a static image to a dynamic process.

Conversation Sketches



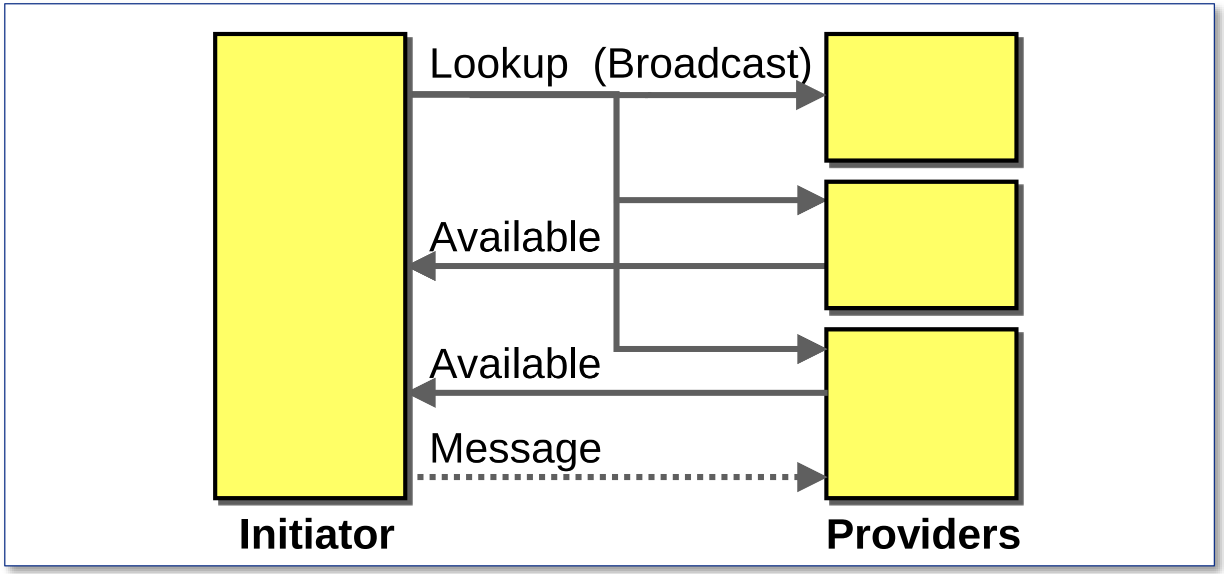
- Prefer a sketch with loose semantics that highlights the essence
- Use BPMN as implementation example

De-Junking the Notation



Focus on Actions

Sequence Numbers



Focus on messages

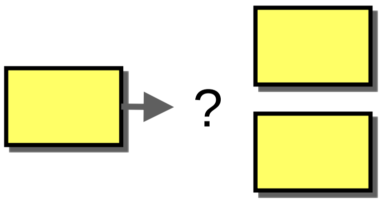
Named participants

Top-down timeline

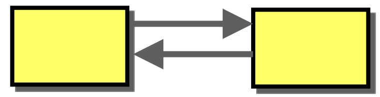
Simpler graphics

Conversation Pattern Language

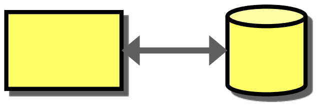
Setting Up | **Participants** | **Application-level**



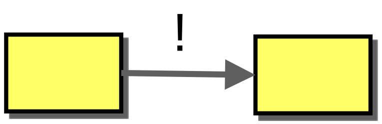
Discovery



Basic Conversations

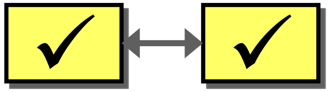


Resource Management



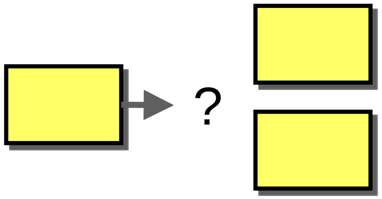
Initiation

Intermediaries



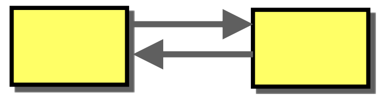
Ensuring Consistency

Conversation Pattern Language



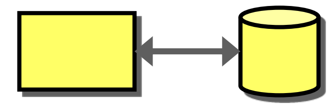
Discovery

- Dynamic Discovery
- Advertise Availability
- Consult Directory
- Referral
- Leader Election



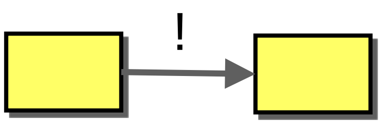
Basic Conversations

- Fire-and-Forget
- Asynchronous Req-Resp
- Req-Resp with Retry
- Polling
- Subscribe-Notify
- Quick Acknowledgment



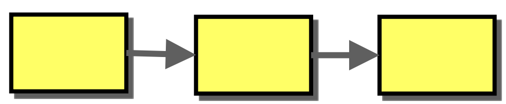
Resource Management

- Incremental State
- Lease
- Renewal reminder



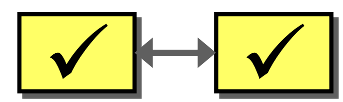
Initiation

- Three-way Handshake
- Acquire Token First
- Rotate Tokens
- Verify Identity
- User Grants Access



Intermediaries

- Proxy
- Relay
- Load Balancer
- Scatter Gather



Ensuring Consistency

- Ignore Error
- Compensating Action
- Tentative Operation
- Coordinated Agreement

How can a conversation initiator find a partner when it has no knowledge whatsoever about available partners?

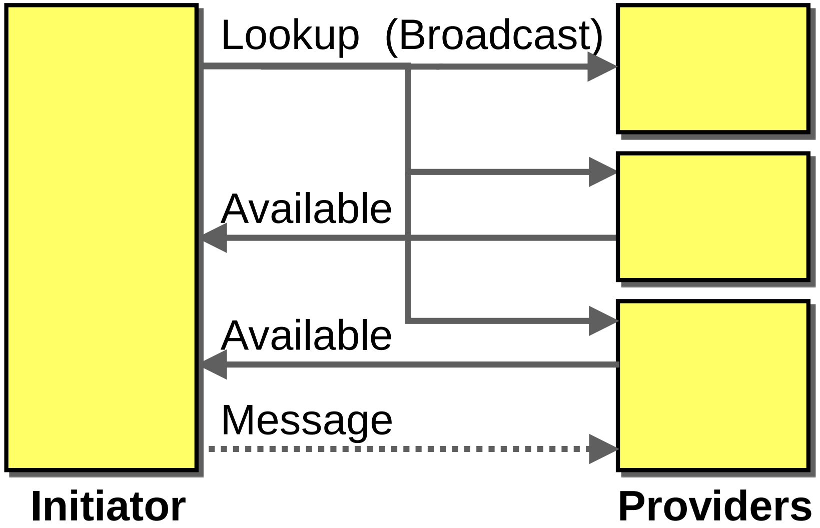
Point-to-point communication requires knowledge of the conversation partner (or channel).

Late binding between a participants lowers the location coupling.

Discovery may be on the critical path to establishing a conversation.

Even in the presence of a central lookup service, a new participant has to first establish a connection to the lookup service.

Dynamic Discovery



1. Broadcast *Lookup* request
2. Interested providers send *Available* responses
3. Requestor initiates interaction with chosen provider

Examples: DHCP, TIBCO Repository discovery

How can a participant let others know that it is available?

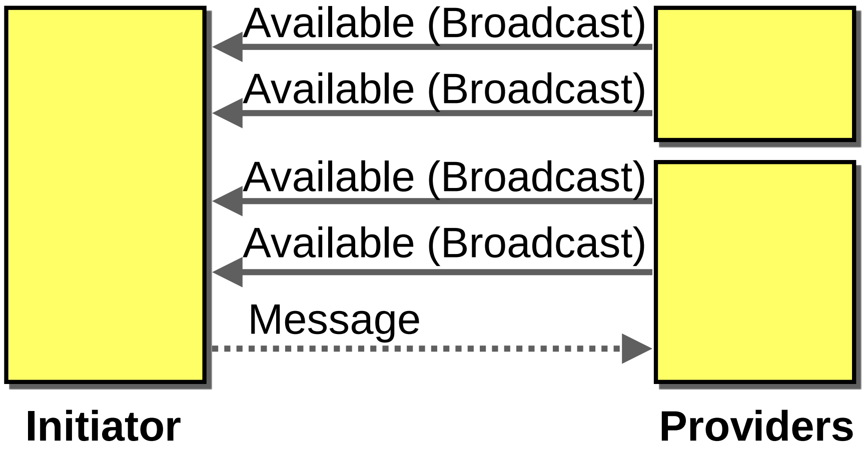
Central services for discovery are bound to get out of sync with reality.

Centralized administration may result in a single point of failure.

Dynamic Discovery can flood the network with requests.

The number of available providers is often small compared to the number of initiated conversations.

Advertise Availability



Directory may store additional metadata about the service

"Match making based on"

Unique Identifiers

Interface Definition / Type

Attributes

Keyword match

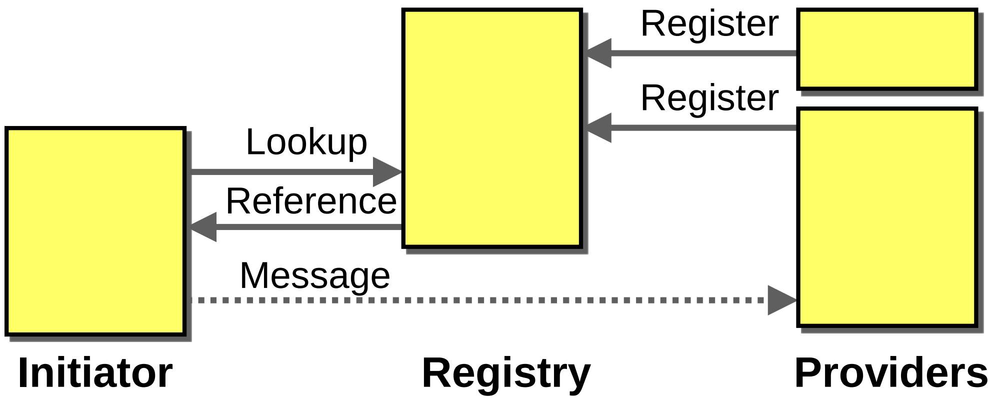
How can a conversation initiator find a partner across a large network without flooding the network with requests?

Late binding between participants lowers the location coupling.

Many networks do not route broadcast packets beyond the local network.

Often centralized administration is involved in setting up a new service.

Consult Directory



Directory may store additional metadata about the service

"Match making based on"

Unique Identifiers, *Interface Definition* / Type, *Attributes*

Example: UDDI Directory, DNS

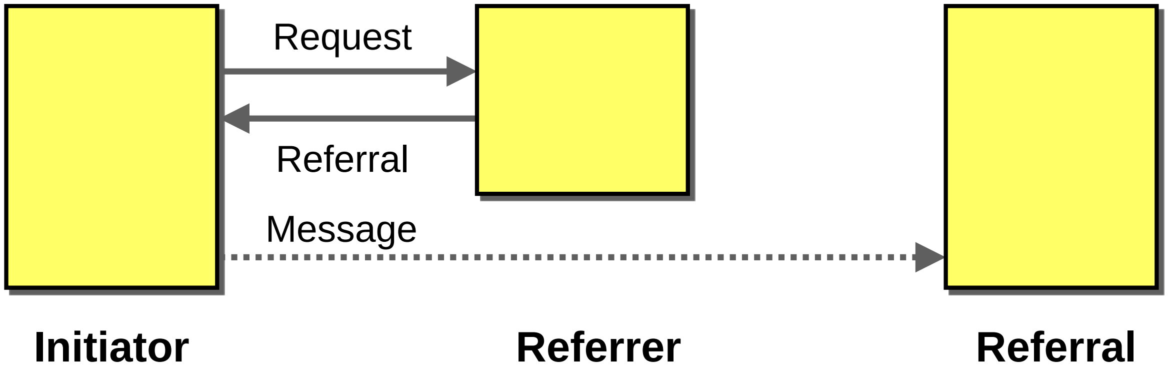
The choice of conversation partner may depend on the context of a conversation or may change over time.
How can an initiator discover the right conversation partner?

A participant may be required to interact with the same partner that another participant is already interacting with.

Directories are generally context free, i.e. they do not keep track of existing conversations and when assigning an initiator to a partner.

Some participants may not want to be "discovered". However, "friends of friends" are allowed to interact with them.

Referral

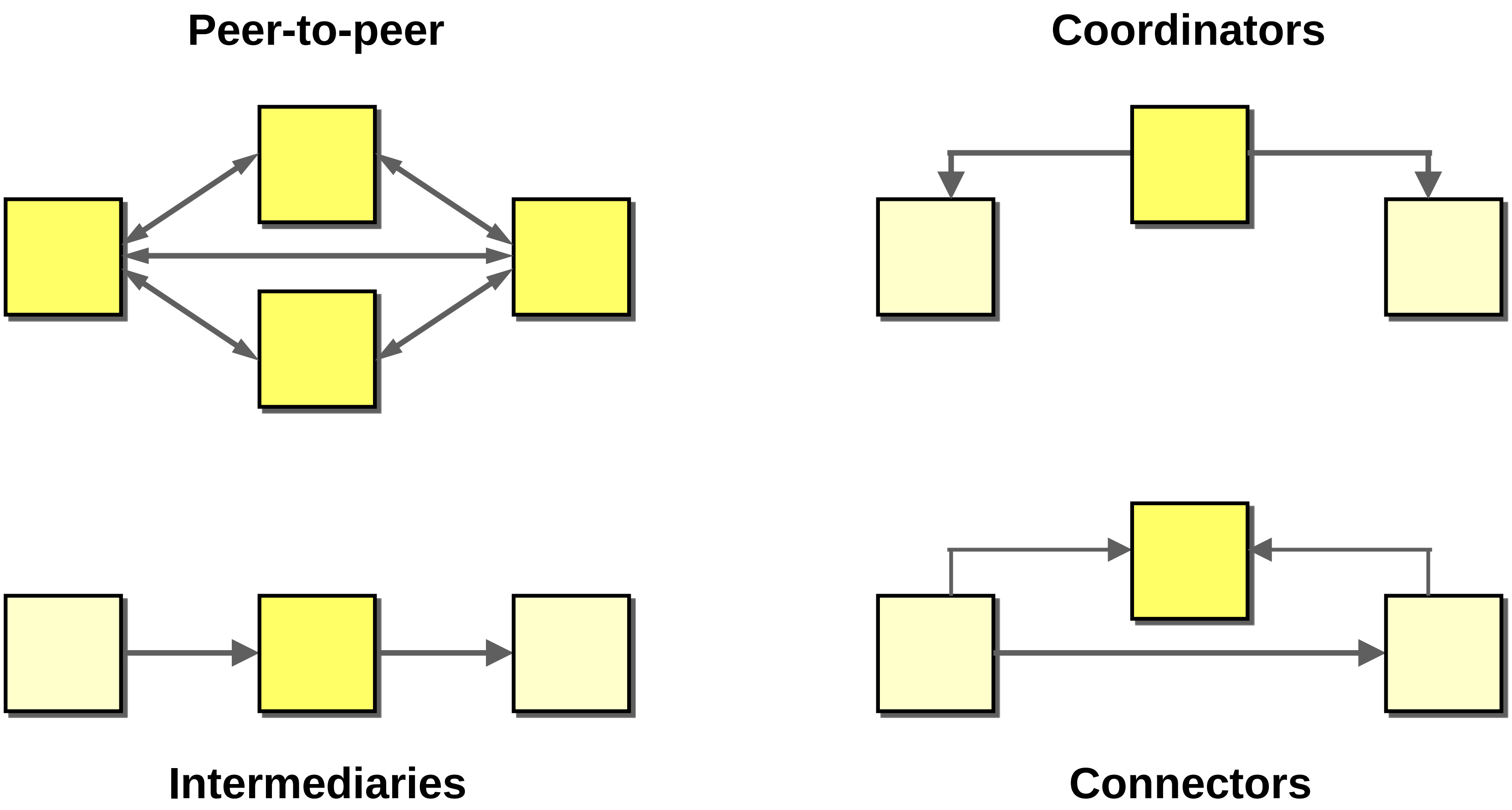


Consult Directory is a specialized case of Referral

Requires *addressability*, i.e. to embed addresses in messages

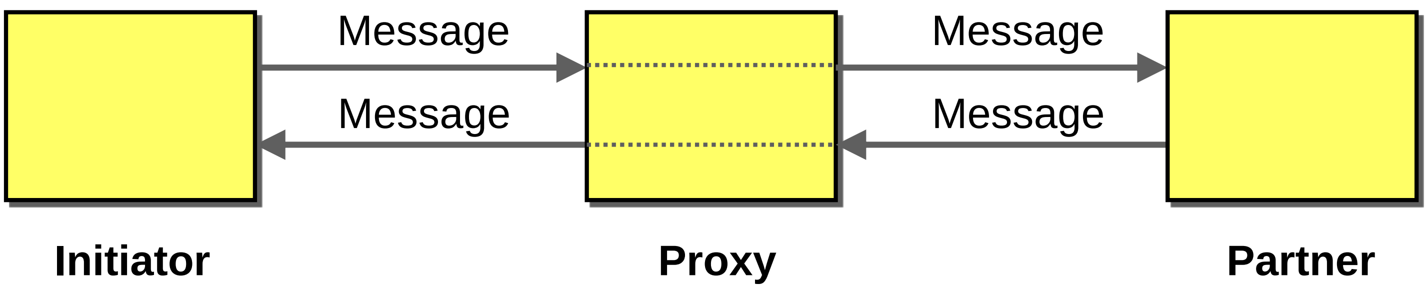
Example: HTTP 302

Multi-Party Conversations: Intermediaries



Proxy

How can a participant communicate with a partner that is not visible or not reachable?



Initiator can hide identity using a *Proxy*

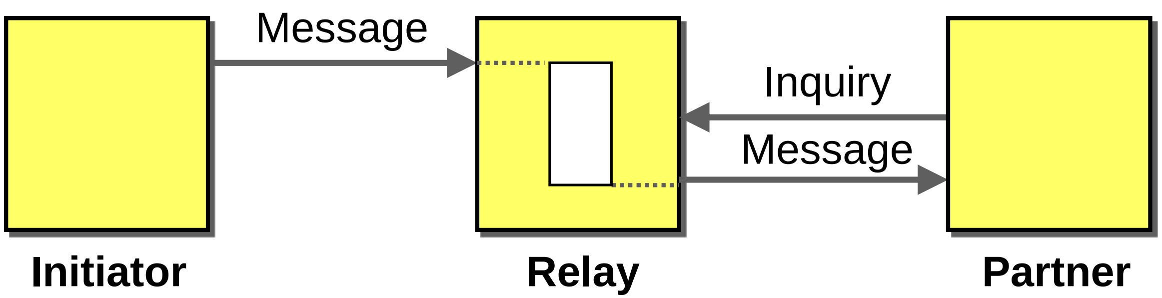
Proxy can monitor conversations

Proxy may need to be stateful for two-way conversations

Proxy can become a bottleneck

Relay

How can participants engage in a two-way communication when each participant is limited to outbound requests?



High overhead when using *Polling*

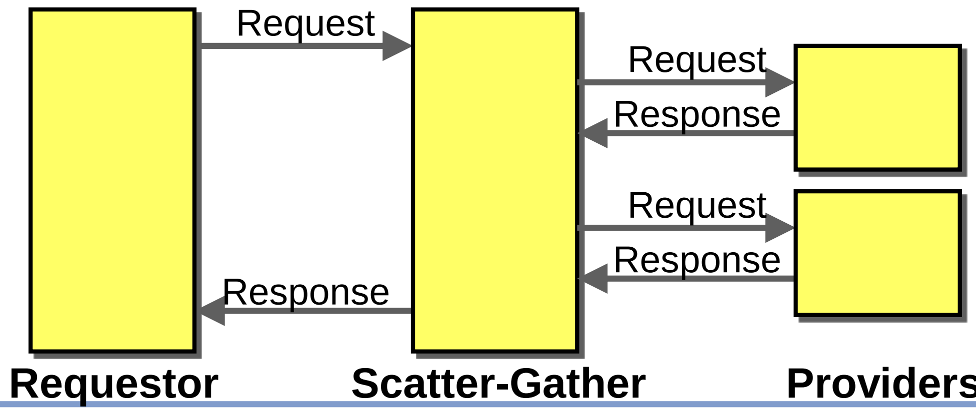
All other conversations can be layer on top of *Relay*

Needs to be stateful

Example: Amazon SQS

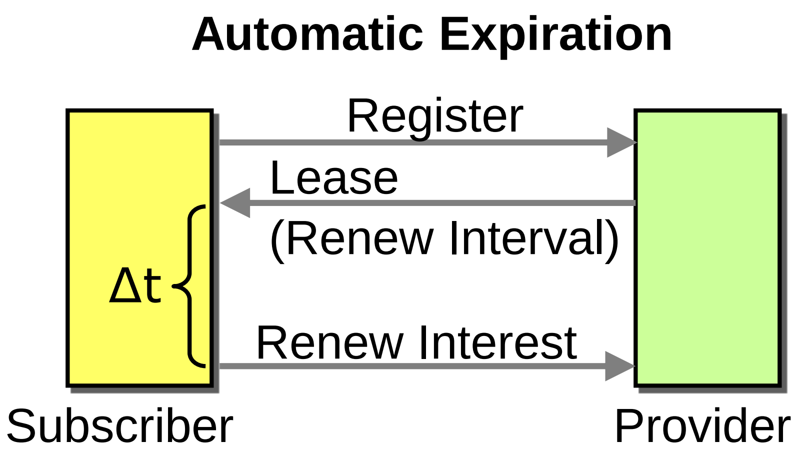
Scatter-Gather (Aggregator)

How can a participant solicit responses from a number of participants without connecting to all of them



Widespread business model, e.g. “Aggregators”

Resource Management

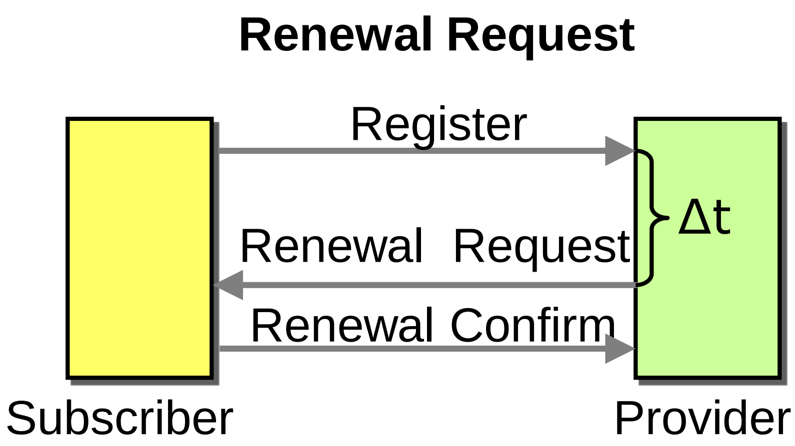


"Lease" model

Heartbeat / keep-alive

Subscriber has to renew actively

Example: Jini



"Magazine Model"

Subscriber can be simple

Provider has to manage state for each subscriber

REST Conversations

- Simpler transport protocols are more likely to hold conversations
- Loose coupling generates conversations: discovery, negotiation
- HTTP has built-in conversation patterns, e.g. 302

```
201 Created
Location: http://starbucks.example.org/order/1234
Content-Type: application/xml

<order xmlns="http://starbucks.example.org">
 <drink>latte</drink>
 <cost>3.0</cost>
 <next xmlns=http://example.org/state-machine
       rel="http://starbucks.example.org/payment"
       uri=" http://starbucks.example.org/payment/order/1234“
       type="application/xml"/>
</order>
```

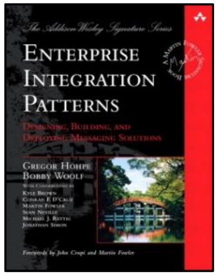
Pautasso et al:
Modeling RESTful Conversations with Extended BPMN Choreography Diagrams

Conclusion

Conclusions

- Enterprise Integrations is more than messaging
- Enterprise Integration needs multiple pattern languages
- Good patterns languages are timeless, but difficult to make
- A good notation is a critical element of a pattern language
- Follow evolution of conversation patterns

@ghohpe, #eaipatterns



eaipatterns.com
eaipatterns.com/patterns/conversation