# Domain Specific Formal Languages

## – SOC and Service Orchestration –

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# Setting the scene

- This course part focusses on Service-Oriented Systems (SOSs)
- We will introduce the notion of:
  - Service-Oriented Computing as a paradigm for developing SOSs
  - Service as a basic block for building SOSs

# Setting the scene

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# Service-Oriented Computing (SOC)

- A compute paradigm for distributed and e-business computing
- Aims at enabling developers to build networks of integrated and collaborative applications, regardless of
  - the platform where the applications run (e.g., the operating system)
  - the programming language used to develop them

  through the use of *loosely coupled*, *platform-independent*, *reusable* components (called **services**)
- A modern attempt to cope with old problems related to information interchange, software integration, and B2B
  - Finds its origin in object-oriented and component-based software development
- **Service-Oriented Architecture** (SOA): an architectural style to realize SOC

# Web Services Composition

- XML-based technologies like WSDL, UDDI and SOAP
  - permit describing, locating and invoking web services
  - are usually sufficient for simple B2B application integration needs

- Creation of complex B2B applications and automated integration of business processes across enterprises require managing such features as
  - asynchronous interactions
  - concurrency
  - workflow coordination
  - business transaction activities and exceptions

  ...which the above mentioned standards do not deal with

- This raises the need for designing and employing

  Web Services composition languages

  an additional layer on top of the Web Services protocol stack

# Orchestration vs. Choreography

- Service composition permits building complex services out of simpler ones and is still an open challenge
- There are two main views of web services composition
  - Orchestration (= Executable Business Process)
    - Description of web services interactions, including the business logic and execution order of the interactions
    - Interactions may span applications and/or organizations, and result in a long-lived, transactional process
    - The process is always controlled from the perspective of *one* of the business parties
    - Main enabling technology: WS-BPEL (OASIS standard)
  - Choreography (= Multi-party Collaboration)
    - Description of the externally observable message exchanges among *multiple* web services
    - No party truly 'owns' the conversation
    - More collaborative in nature: each party involved in the process describes the role it plays in each interaction
    - Main enabling technology: WS-CDL (W3C Recommendation)

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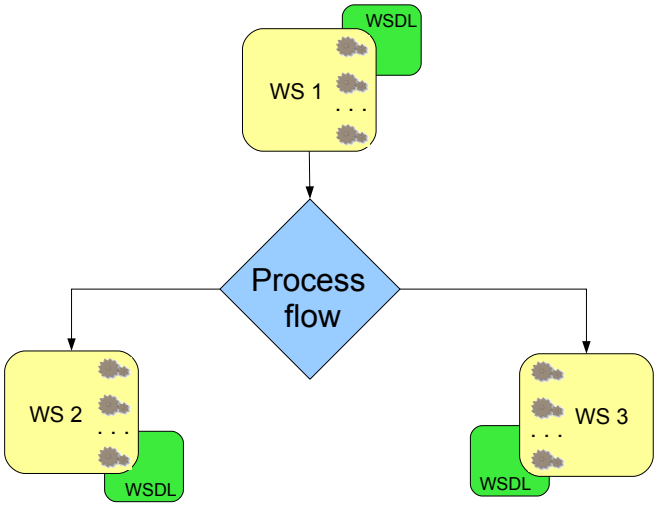
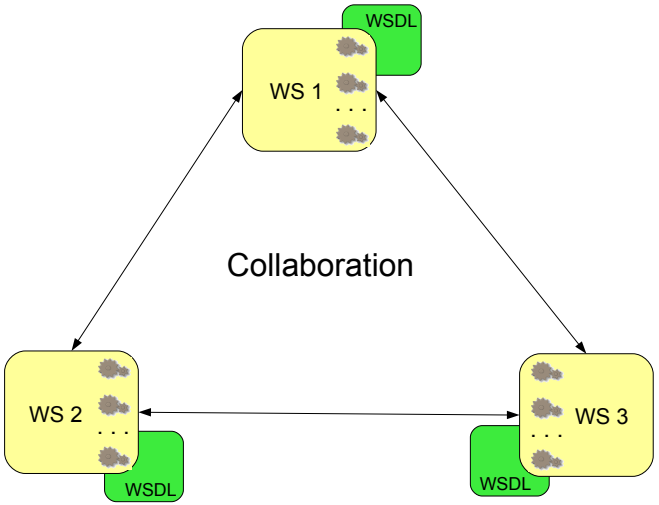



Orchestration




Choreography

We focus on web service orchestration

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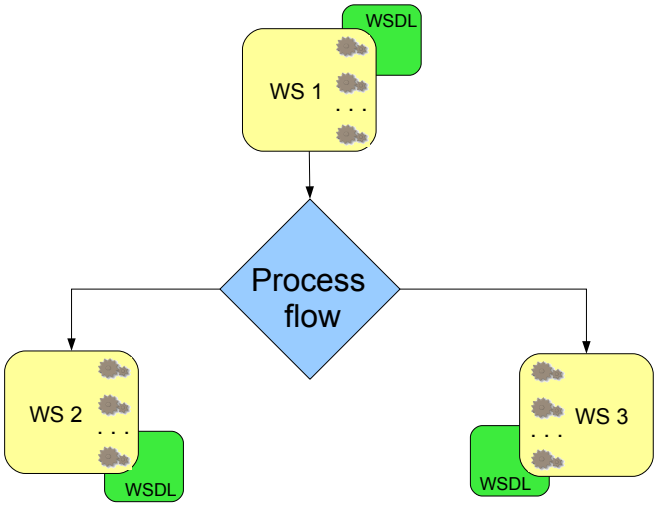


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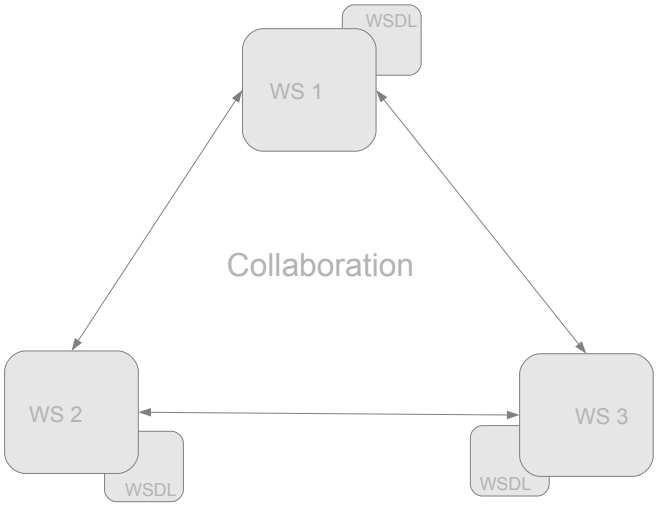


Choreography

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# Services & Business processes

- A process *orchestrating* web services is called business process i.e. an active entity that invokes available services according to a given set of rules to meet some business requirements

- A business process specifies
  - the potential execution order of operations originating from a collection of Web Services
  - the shared data passed between these services
  - the trading partners that are involved in the joint process
  - their roles with respect to the process
  - joint exception handling conditions for the collection of Web Services

  and other factors that may influence how Web Services or organizations participate in a process

- Web service orchestration thus permits to program complex inter-enterprise workflow tasks and business transactions

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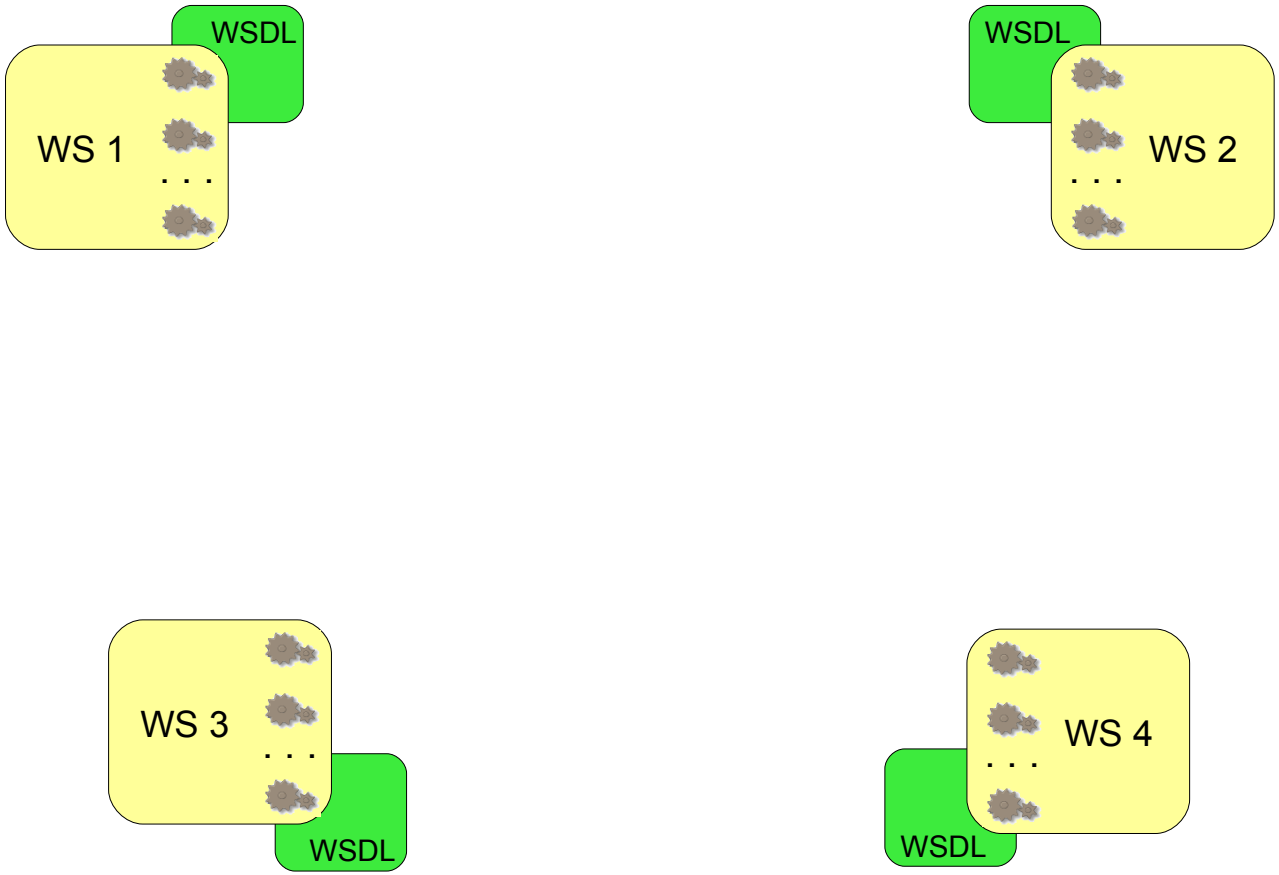

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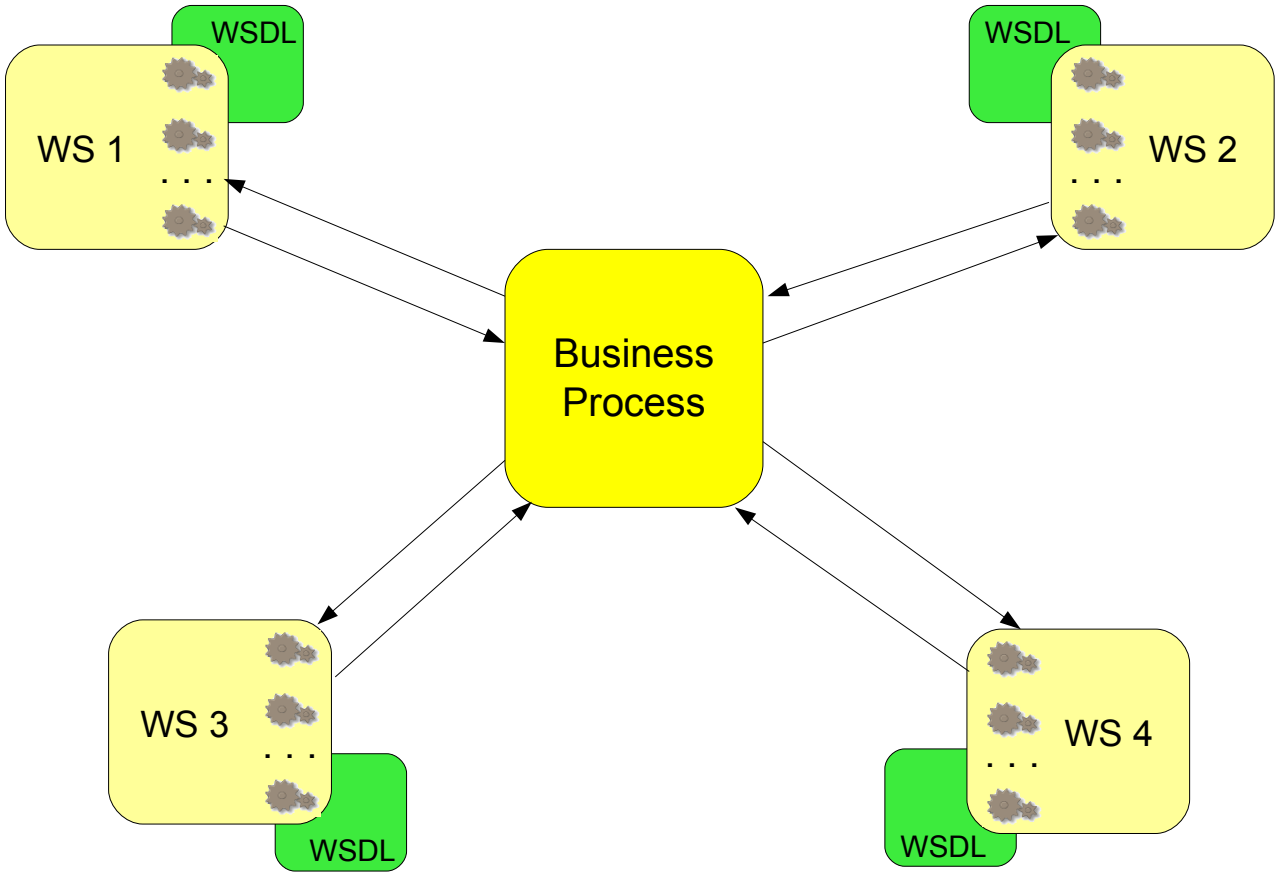

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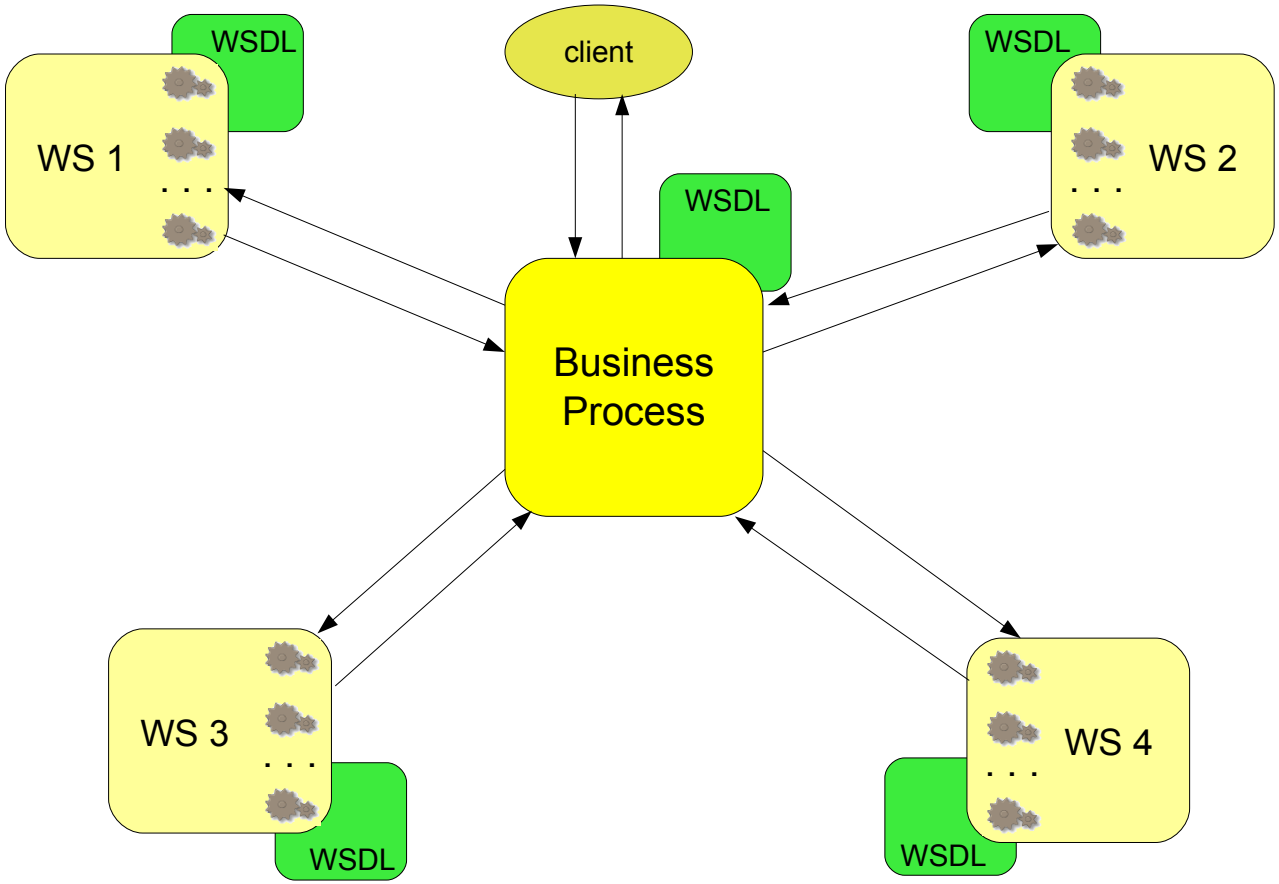

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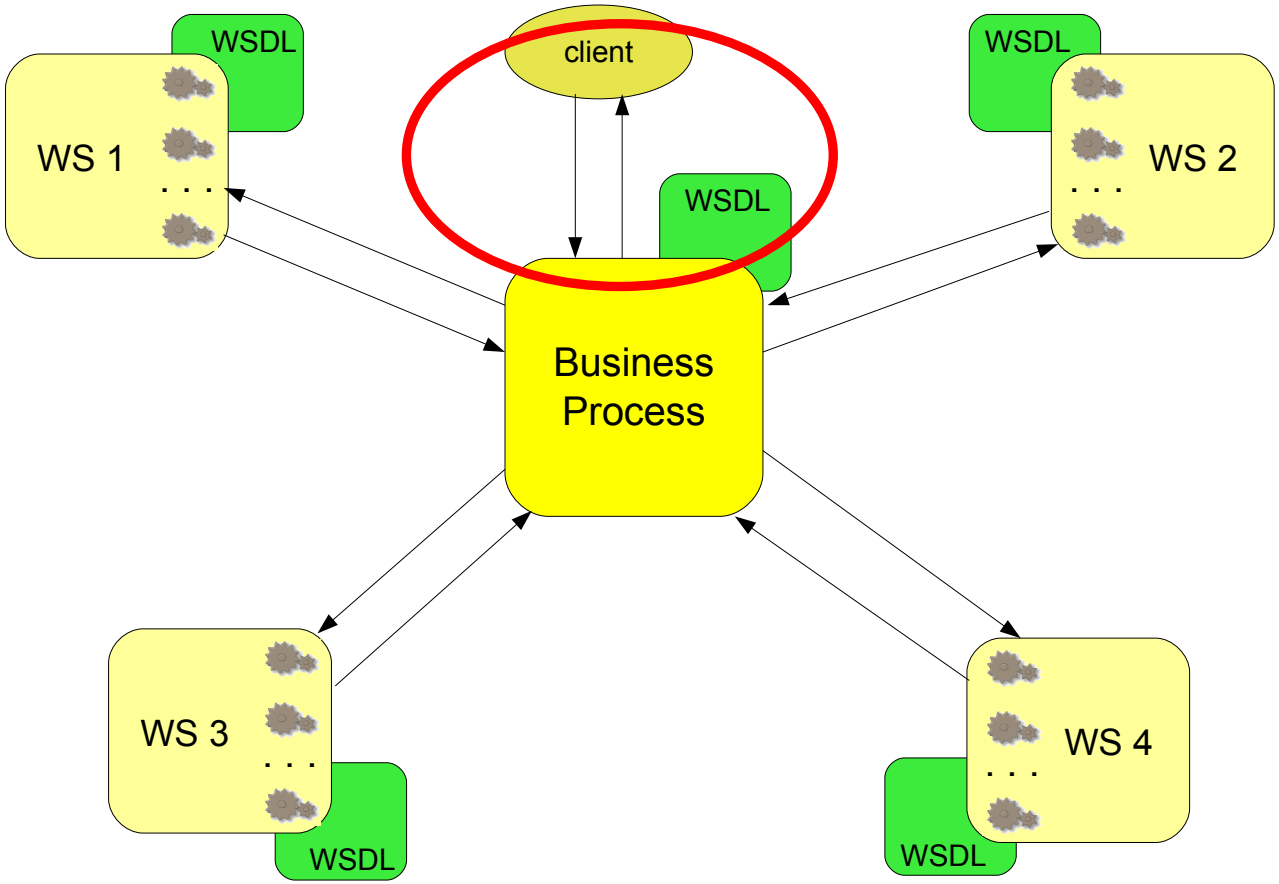

# Instantiation & Message Correlation

- To serve clients' requests service instances are created
- When a message arrives, it must be delivered:
  - either to a new instance (new conversation)
  - or to an existing instance (old conversation)
- Message correlation
- An message can be delivered only if its correlation set matches

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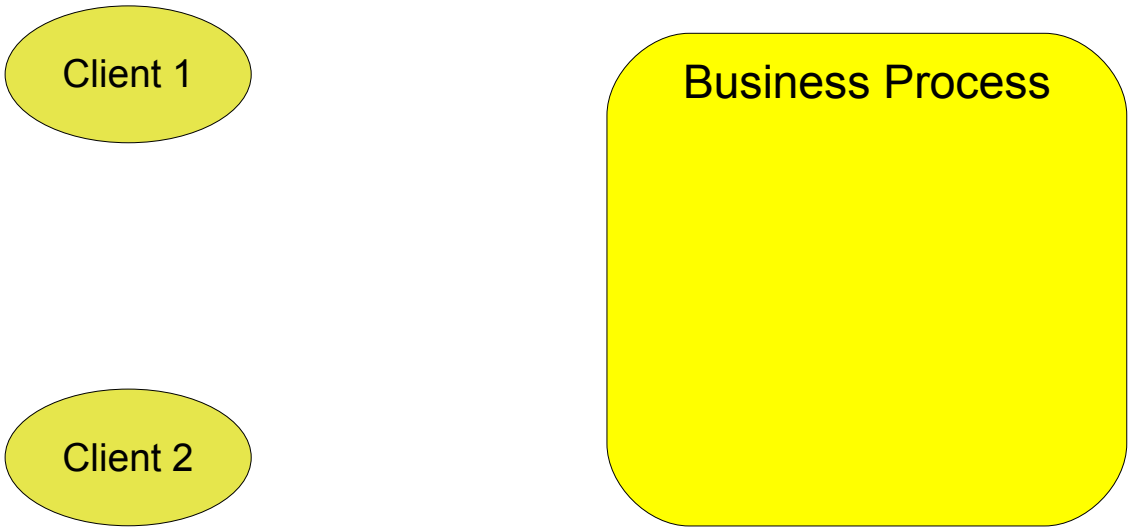


**Message correlation**

The message content permits identifying the proper target instance

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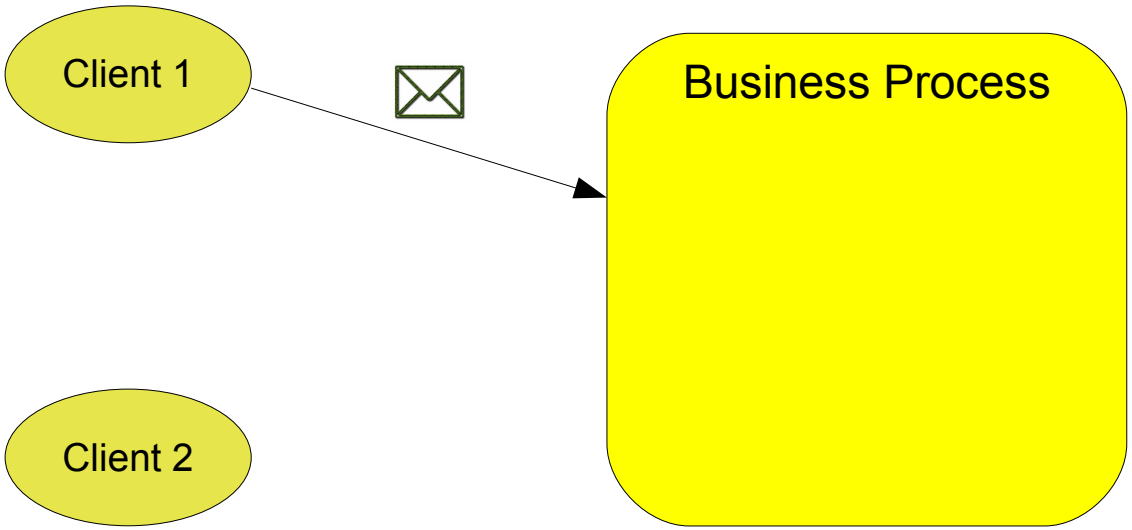


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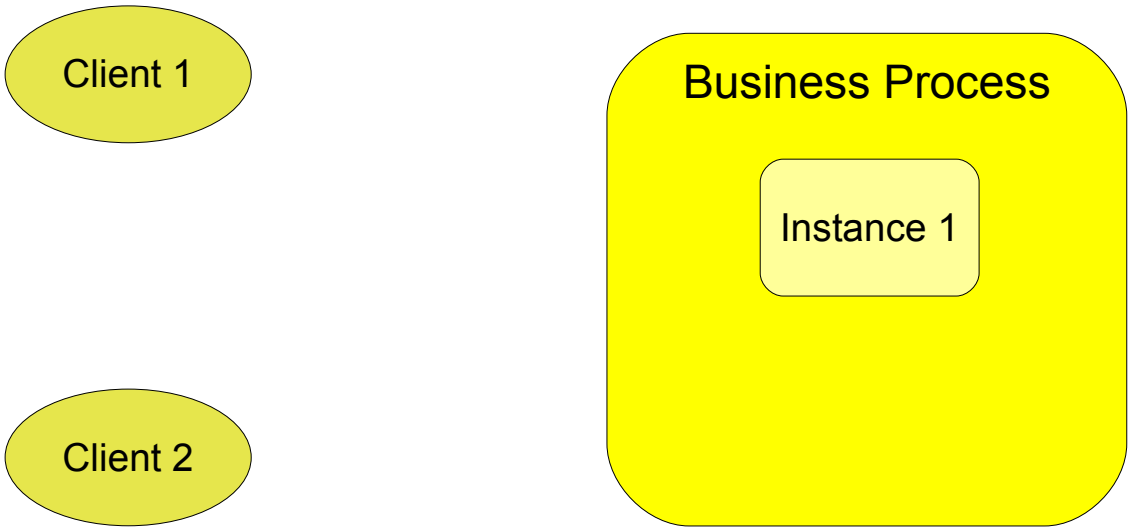


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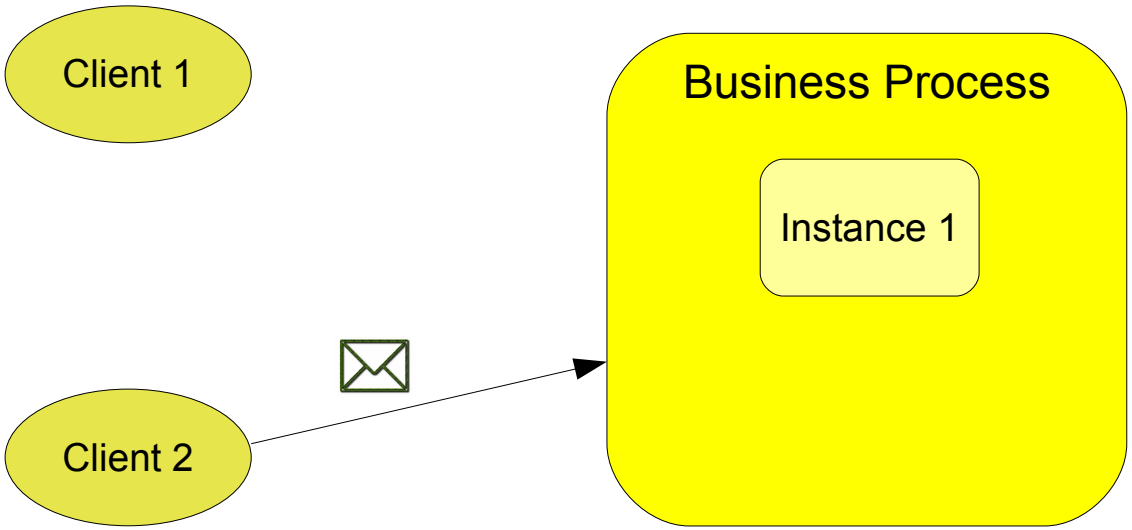


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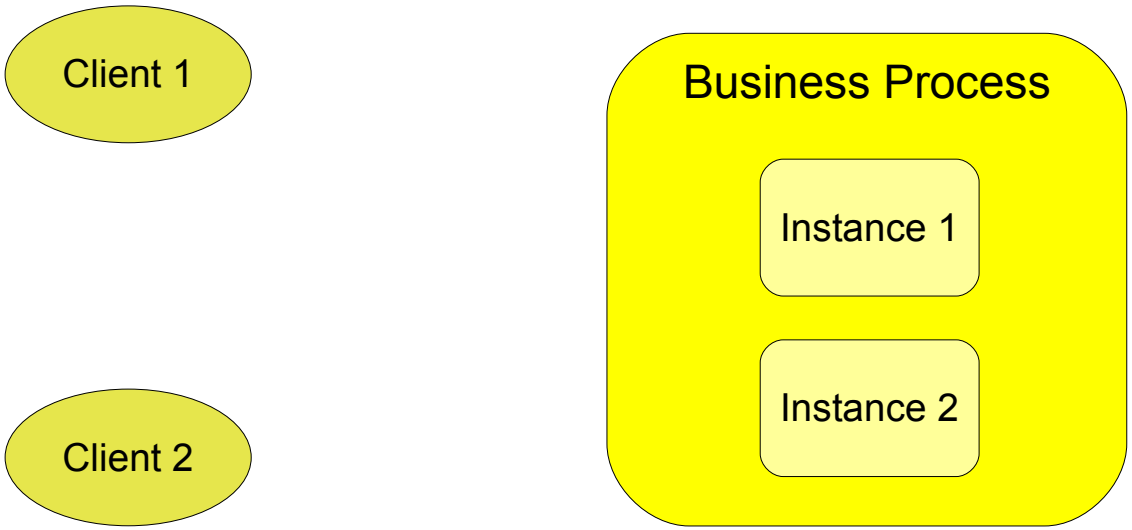


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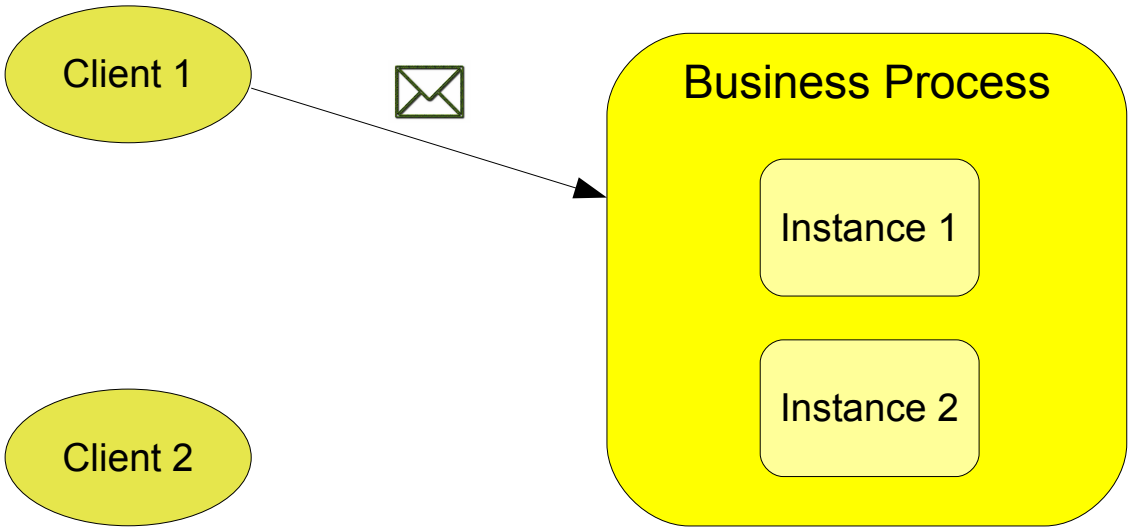


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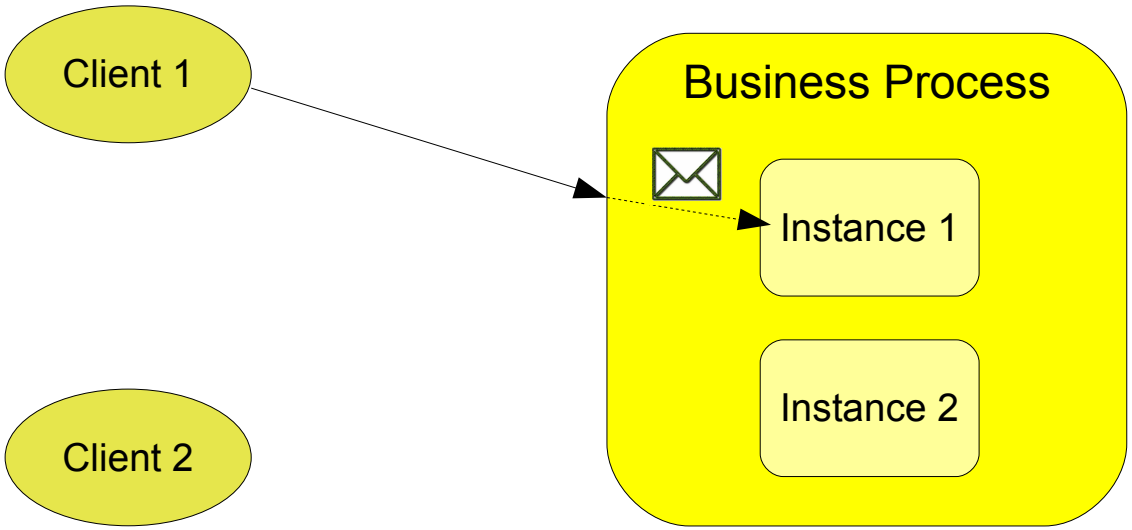


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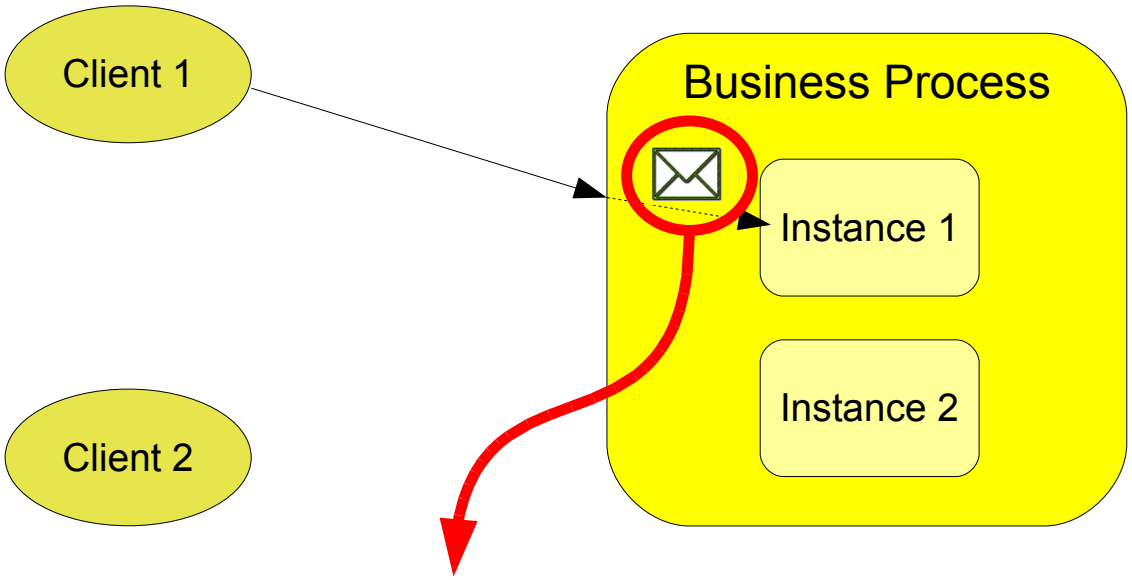


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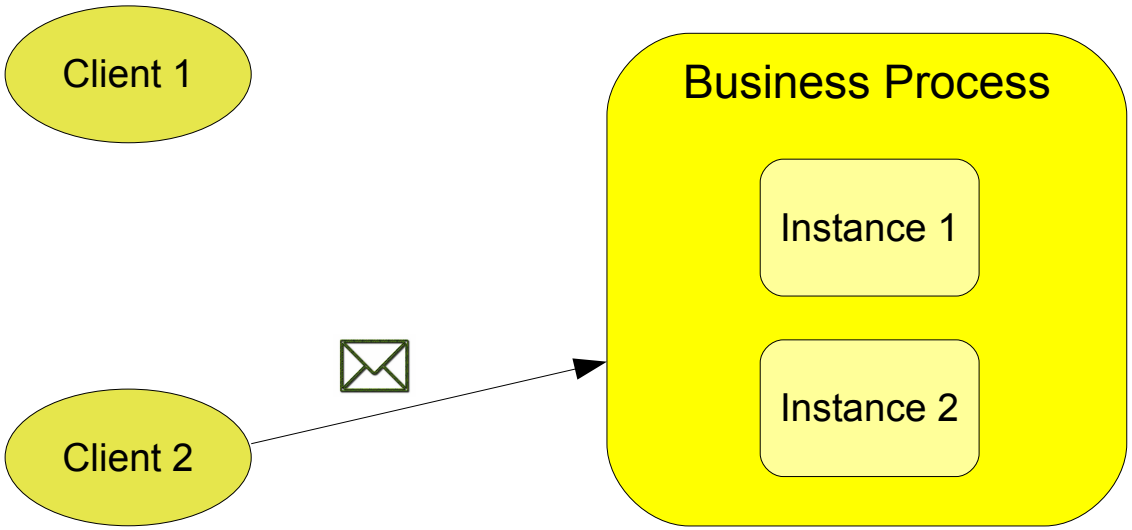


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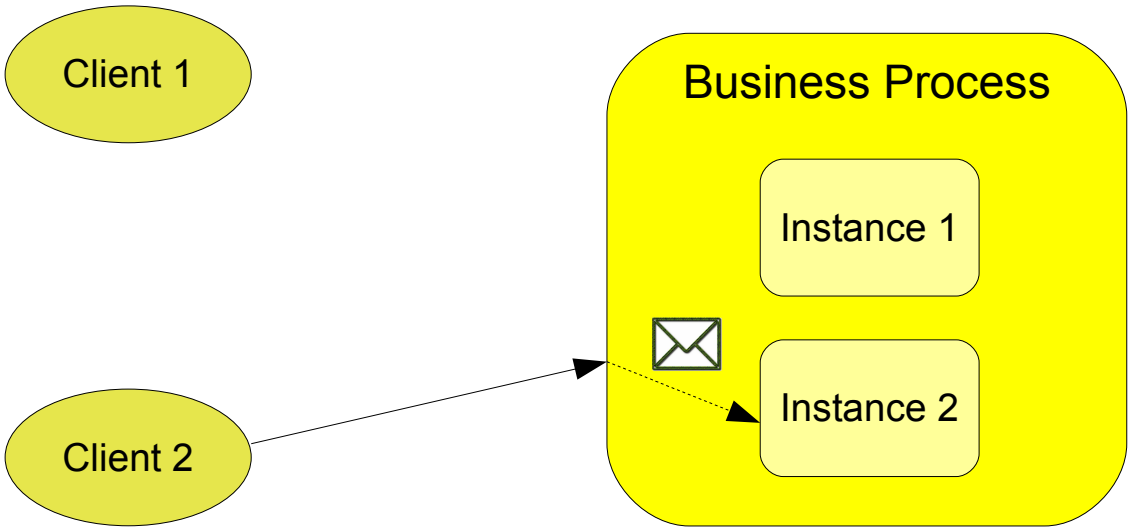


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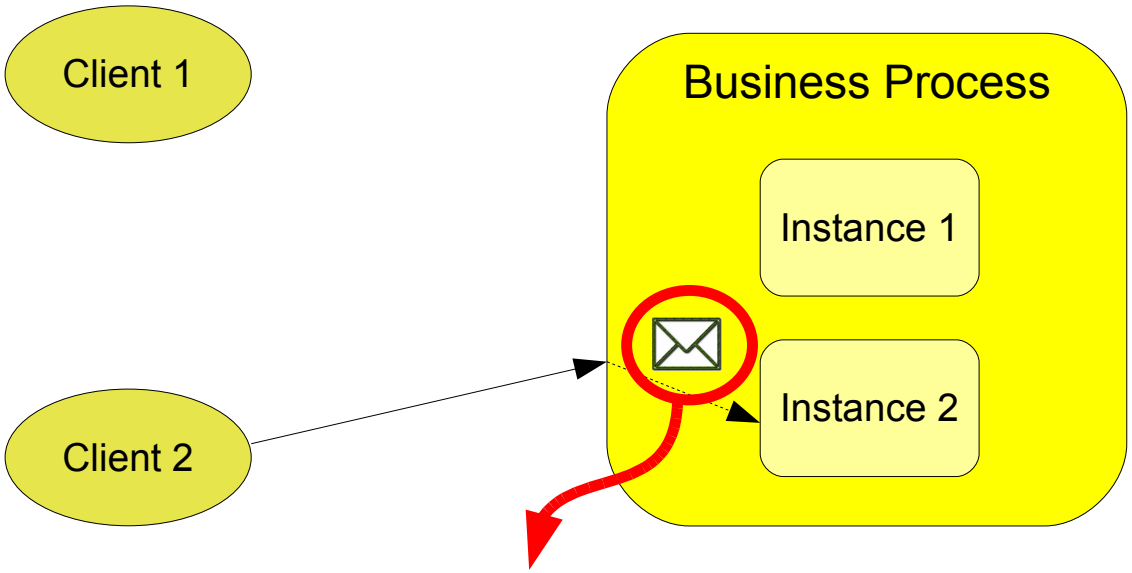


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  - tieing messages together in order to build long-lived interactions
  - implementing statefull *multiparty* conversations

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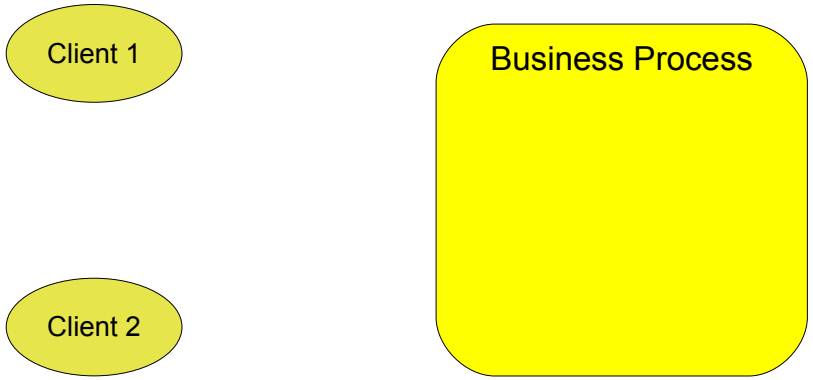

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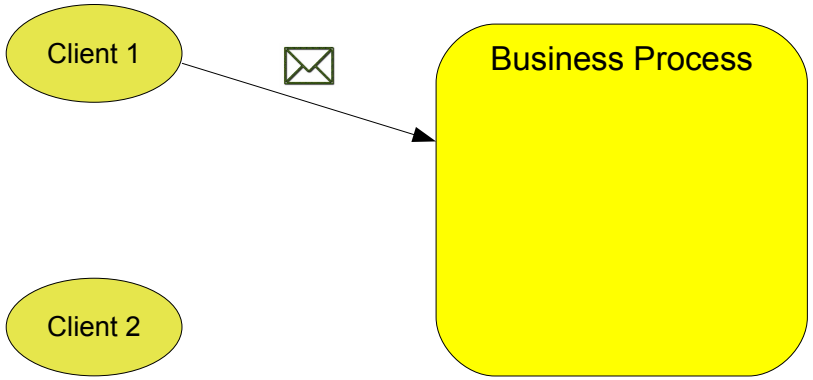

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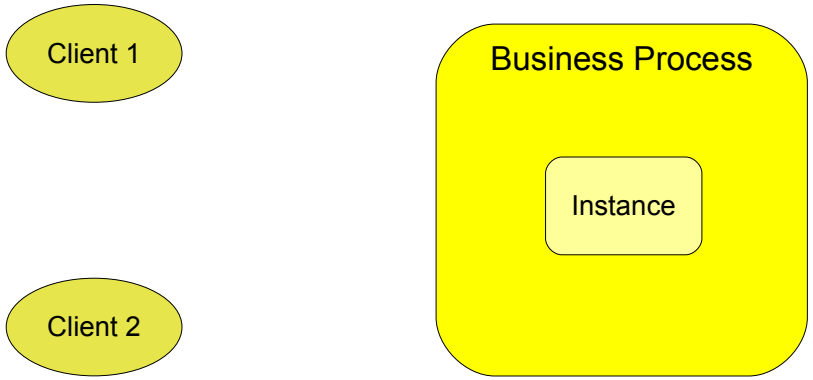

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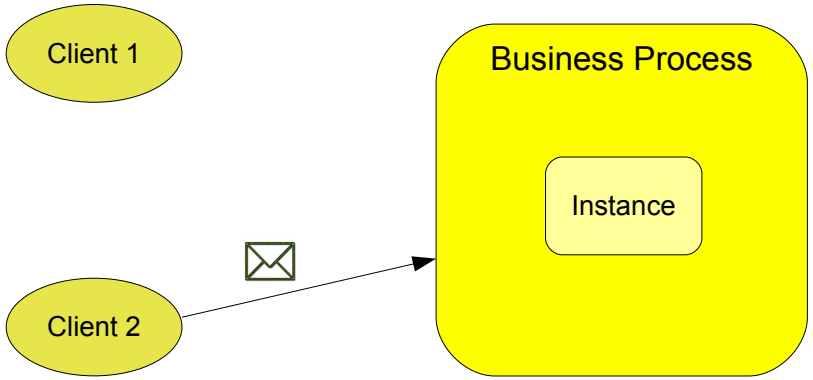

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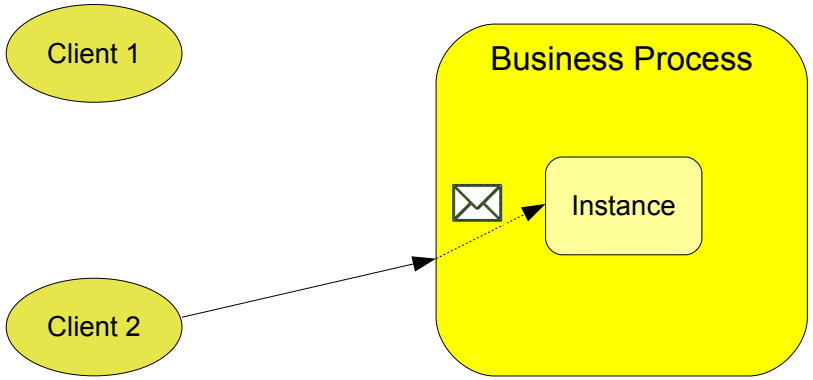


# WS-BPEL

# Web Services Composition Languages

- Different organizations have been involved and are presently working on the design of languages for specifying business processes

- Two WS-BPEL's forerunners are
  - Microsoft's XLANG
    a block-structured language with basic control flow structures
    - e.g. sequence, switch (conditional), while (looping), all (parallel) and pick (choice based on timing or external events)
  - IBM's WSFL (Web Services Flow Language)
    a language for specifying arbitrary directed acyclic graphs

- Afterwards, the two proposals have been combined into a new language, WS-BPEL, that has been submitted to OASIS for standardization also by BEA systems, SAP and Siebel Systems

# WS-BPEL

- Web Services Business Process Execution Language Version 2.0
- Is an OASIS standard (11 April 2007)
- Is the most widespread language for orchestration of Web Services
- Has an XML-based syntax and relies on the following XML-based specifications
  - WSDL for interfaces
  - XML Schema for types
  - XPath for expressions

# WS-BPEL: engines

- Three of the most known freely available WS-BPEL engines

Oracle BPEL Process Manager

`http://www.oracle.com/technology/bpel`

ActiveBPEL

`http://www.activevos.com`

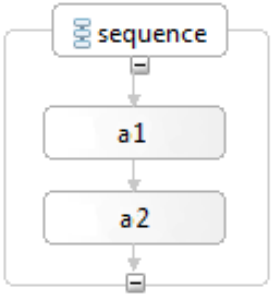
Apache ODE

`http://ode.apache.org`

# WS-BPEL: basic activities

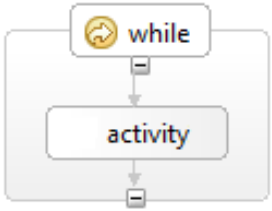
- empty to do nothing
- invoke to invoke an operation offered by a (partner) service
  - partner services are identified by *partner links* defining the shape of peer-to-peer conversational relationships
- receive to wait for a request to arrive
- reply to send a message in reply to a received request
- assign to update the values of variables with new data
- wait to wait for a given time period or until a certain point in time has been reached

# WS-BPEL: control flow activities




to perform a collection of activities in sequential order

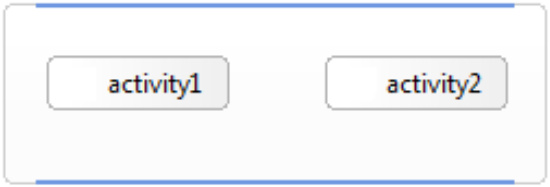

to select exactly one activity for execution from two alternatives




to repeat an activity as long as a given condition is true

# WS-BPEL: control flow activities


to wait for one of several possible requests to arrive
or for a time-out to occur




to concurrently perform a set of activities (flow activity)

# WS-BPEL: fault and compensation

- *Fault handling*: similar to exception handling of ‘classic’ programming languages
- *Compensation*: execution of specific activities (attempting) to reverse the effects of previously executed activities

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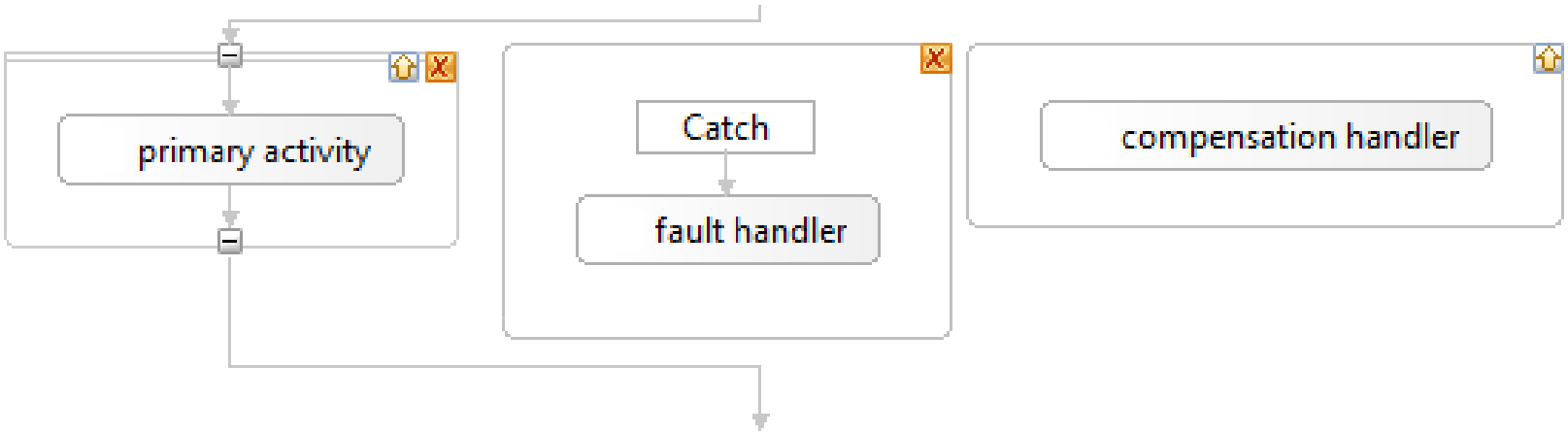
- *Fault handling*: similar to exception handling of ‘classic’ programming languages
- *Compensation*: execution of specific activities (attempting) to reverse the effects of previously executed activities
- *Scope activity*: groups a primary activity together with fault handling activities and a compensation handling activity



# WS-BPEL: fault and compensation

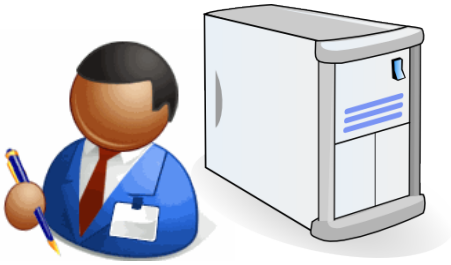
- exit to immediately terminate an instance
- throw to generate a fault from inside an instance
- rethrow to rethrow the fault that was originally caught by the immediately enclosing fault handler
- compensate to start compensation on all inner scopes that have already completed successfully, in the *reverse order* of completion
- compensateScope to start compensation of a specified inner scope that has already completed successfully

# WS-BPEL: other aspects

- Termination and event handlers within scope activities
- Synchronization dependencies within flow activities
- repeatUntil and forEach activities

# WS-BPEL at work

# A shipping scenario

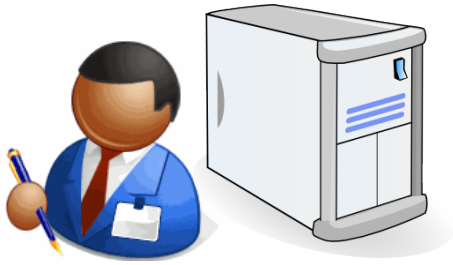


Back-end service

Client service

Shipping service

# A shipping scenario



Back-end service

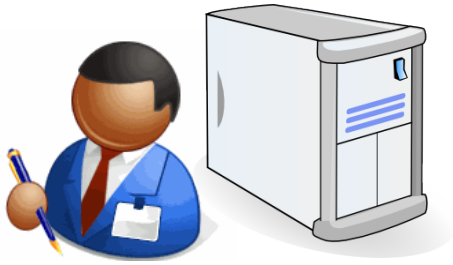

Client service

Shipping service

# A shipping scenario

- An order is composed of a number of items (e.g. 7)

- Two types of shipments:
  - items are held and shipped together
  - items are shipped piecemeal until the order is fulfilled



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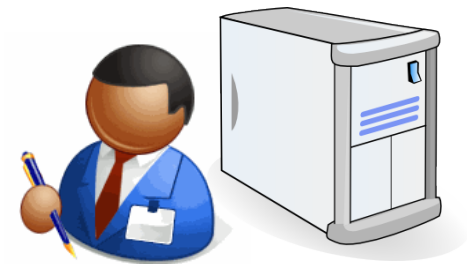
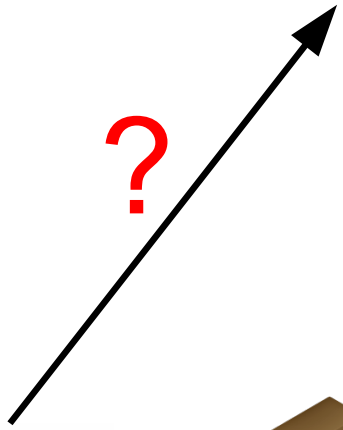


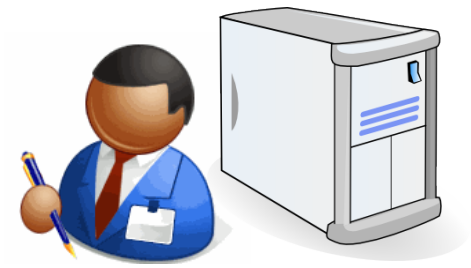
Back-end service




Client service

Shipping service

# A shipping scenario



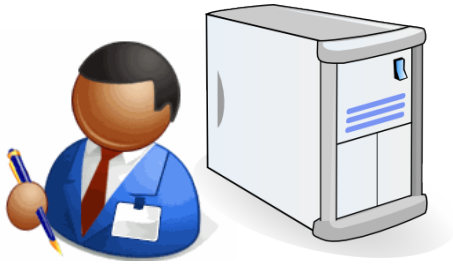
Back-end service

3

Client service

Shipping service

# A shipping scenario

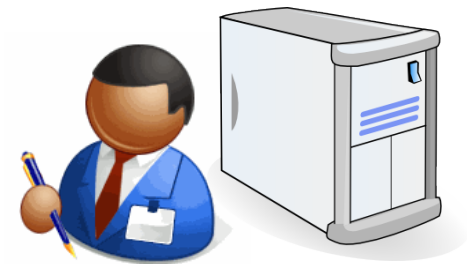


Back-end service

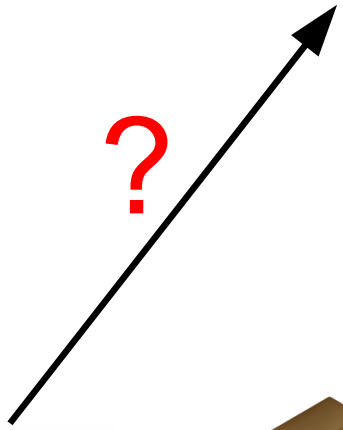
Client service


Shipping service

# A shipping scenario



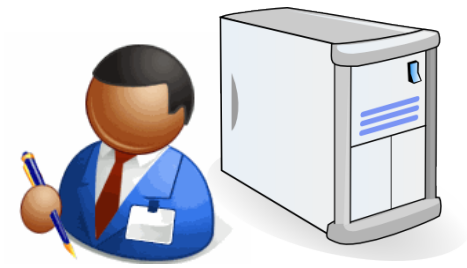
Back-end service




Client service

Shipping service

# A shipping scenario



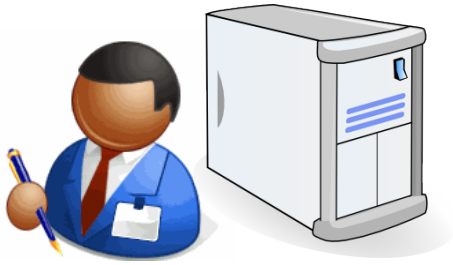
Back-end service

4

Client service

Shipping service

# A shipping scenario

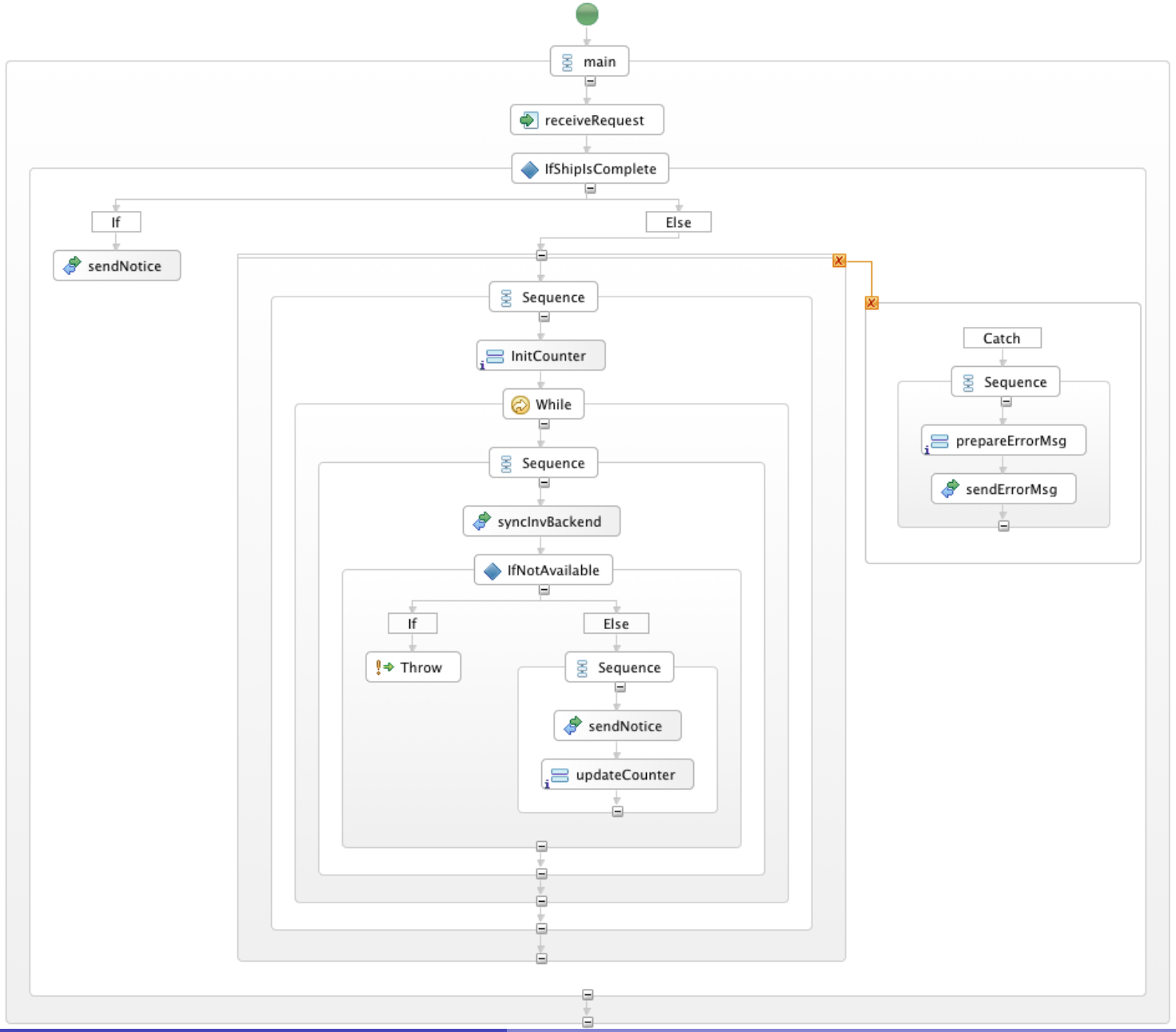


Back-end service

Client service


Shipping service

# A shipping scenario in BPEL



# References

# Some references

- http://docs.oasis-open.org/wsbpel/2.0/wsbpel-v2.0.pdf
- ...