BPMN
(Business Process Model and Notation)

Shihong Huang

shihong@fau.edu
Florida Atlantic University

Based on BPMN Lecture by Dr. Arne-Jørgen Berre
SINTEF, Oslo Norway
arne.j.berre@sintef.no

The need of process modeling

- Process improvement is created with better understanding, communication, and organization
- Modeling is an important aspect of these
- Modeling translates verbal or tacit understanding into simple metaphors that assist these objectives
- A metaphor is a way of reducing the dimensions of the description of a process to a more understandable and visible basis
- Metaphors bridge complex concepts and build an understanding of the relationships between them

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Three manners of thinking - Process

- Can be defined as an organization of activities that happen in a series, relevant to a business' s goals and objectives
- At a fundamental level, a process diagram represents a single instance of a process
- For example, a purchase order process reflects an instance of a single purchase order, not an organization processing their work load of purchase orders

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Three manners of thinking - Event

- From another perspective, a process is actually a connected sequence of events that respond to states, causes, and conditions
- In an event-based view, the process is a linkage of the transitions from one processing state to another

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Three manners of thinking - Decision

- From yet another viewpoint, all activities and responses to events should be the result of a conscious decision by the organization.
- The decisions are an assemblage of business rules

- A process model is not merely a scenario;
- It is a scenario that exists within the context of the process, events, and decisions
- All these different perspectives are appropriately incorporated in a robust process model

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Business Process

- A business process is a sequence of activities that carry out a business goal
  - "A business process is an organized, coordinated flow of activities, conducted by participants, acting on and deciding with data, information, and knowledge, to achieve a business goal"

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Business rules

- A business rule is a mediator of information in computer systems for decision-making process participants, such as managers, employees, and salespeople
- More accurately, from the viewpoint of the business process:
  - "a business rule is an atomic logic step that uses data and knowledge to evaluate part of a proposition about a process decision"
- The business rule "meets" the process through the decision – when you change the business rule, you change decision outcome
- Think of a set of business rules as conditions that match data and create conclusions

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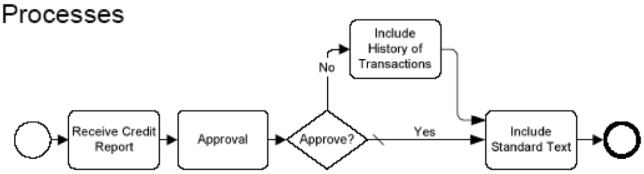
Business Event

- In a modern process modeling approach, opportunities, conditions, and factors that events must respond to are handled or managed with business events
  - "A business event is an event that is meaningful for conducting commercial, industrial, and governmental, or trade activities"
- In BPMN, we have start, intermediary, non-interrupting, and end events
- Correspond directly to a process instance

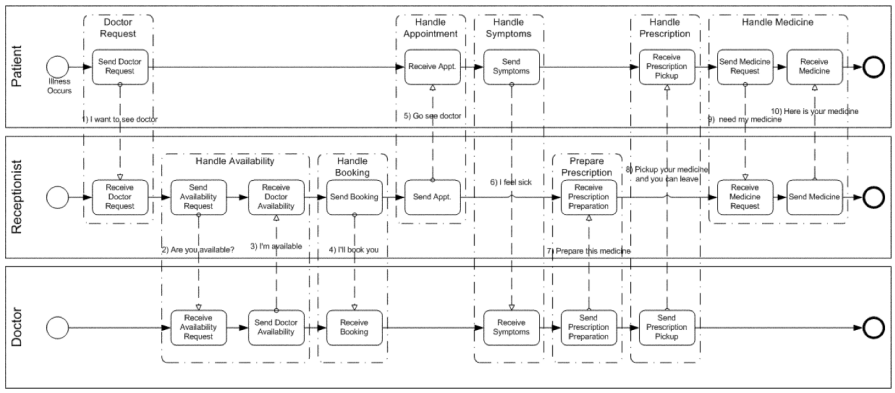
What is BPMN ?

- BPMN is flow-chart based notation for defining Business Processes



- BPMN is an agreement between multiple modeling tools vendors, who had their own notations, to use a single notation for the benefit of end-user understand and training
- BPMN provides a mechanism to generate an executable Business Process (BPEL) from the business level notation
  - A Business Process developed by a business analyst can be directly applied to a BPM engine instead of going through *human* interpretations and translations into other languages

BPMN example



BPMN 2.0 and SoaML tools today

- BPMN 2.0
  - Signavio Process editor has 2.0 Conversation and Choreography diagrams – a SaaS solution
  - Most BPMN 1.2 are doing stepwise migration, making existing parts 2.0 compliant
- SoaML (in most UML tools)
  - Magic Draw (Cameo), Enterprise Architect, IBM RSA/RSM, Modelio, …

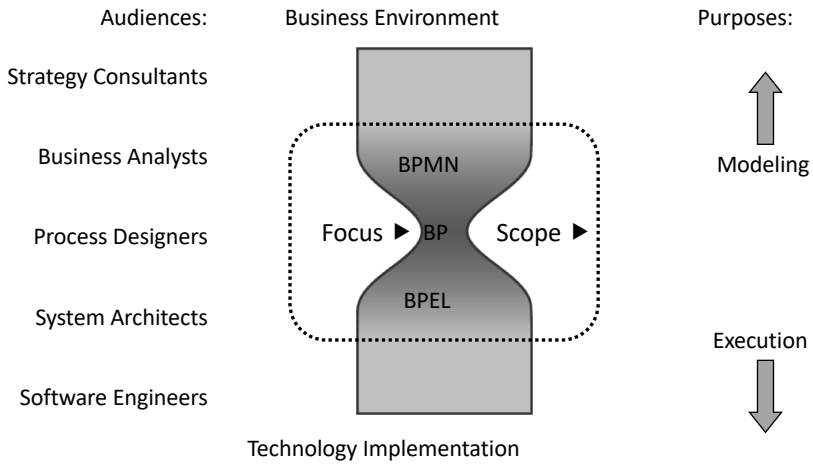
BPMN History

- BPMN 1.0 (BPMI) – May 2004
- BPMN1.x
  - BPMN 1.1 (OMG) – January 2008
  - BPMN 1.2 (OMG) – January 2009
- BPMN 2.0 final June 2010
- http://www.omg.org/spec/BPMN/2.0/

History for BPMN

- The Business Process Management Institute (BPMI—now a part of the OMG) develops BPML (an XML process execution language) and realizes need for a graphical representation
  - BPML was later replaced by BPEL as the target execution language
- August, 2001, the Notation Working Group is formed. The group was composed of 35 companies, organizations, or individuals.
- BPMN 1.0
  - May, 2004, the BPMN 1.0 specification was released to the public.
  - February, 2006, BPMN 1.0 was adopted as an OMG standard
  - Currently, there are 39 companies that have implementations of BPMN

BPMI.org Hourglass



BPMN requirements

- Must be acceptable and usable by the business community
- Must be able to generate executable processes (e.g., BPEL) through a BPMN Model (a combination of graphical elements and supporting information (attributes))
- Although executable processes triggered the development of BPMN, it was expected that BPMN would be used for more general business purposes
- BPM is intended to be Methodology Agnostic
  - Methodologies will give guidance as to the purpose and level of detail for modeling
  - BPMN is as complex as it needs to be. Just use what you need…

BPMN Building blocks

- Some of the concepts are part of the definitions of business process
  - "An event-activated flow of coordinated activities, conducted by participants, and acting on and deciding with data, information, and knowledge that achieve a goal"
- Participant, Activity, Flow, Process event, Data

Participant

- A participant is an actor or a person that interacts in a process
- The actor includes any human, digital, or virtual resource that involved in a business process
- Process can also be participants, sometime process interact with each other

Participant examples

"People" participants:

- Inventory receipt clerk inspecting the order
- Employee filling out a request
- Patient in hospital
- Manager approving a requisition
- Technician restoring a disk drive

"System" Participants:

- SAP, PeopleSoft
- DB server
- Rules engines
- A Web service
- A custom-build UI
- A telephony queuing switch

Activity

- An "activity" is work the participant performs with business process
- Is the basic units of process work, can be
  - Atomic (lowest level, indivisible unit of work)
  - Non-atomic (involving many steps)
- Process and subprocesses are compound activities
- In BPMN, the types of process activities include:
  - Tasks – is the atomic activity
  - Subprocesses – is compound activity, might contain other activities

Activity examples

- An activity can be manual, as a human participant completes the activity, or
- It might be automated by a system participant
- Examples:
  - Inspecting material delivery
  - Restoring a server
  - Completing contract requisition
  - Reviewing and approving a requisition
  - Reviewing loan application

Flow

- Is the order (and data) in which the activities or process steps are performed
- Multiple flows might occur within multiple participants roles
- Two types of flows in BPMN diagram
- Sequence – defines the order in which activities are performed for any given process participants
  - Sequence flow never occurs between participants
- Message – defines the flow of information and message between participants within a process
  - Message never occur within the same participant

Flow: transition

- Describes the hand-off between activities
- Transition means that one activity has stopped and another has started
- Transition never occurs between multiple participants
- e.g, a work area with people and workstations for each person's activities (tasks)
  - As each task is completed, the person transitions to the next task at another workstation
- Any communication is an interaction, not a transition

Flow: interaction

- Is the communication between participants
- Interactions occur between two or more participants in the form of message
- Interactions never occur from one participant back to itself
- Note: a flow from one participant back to itself is an activity transition, not an interaction

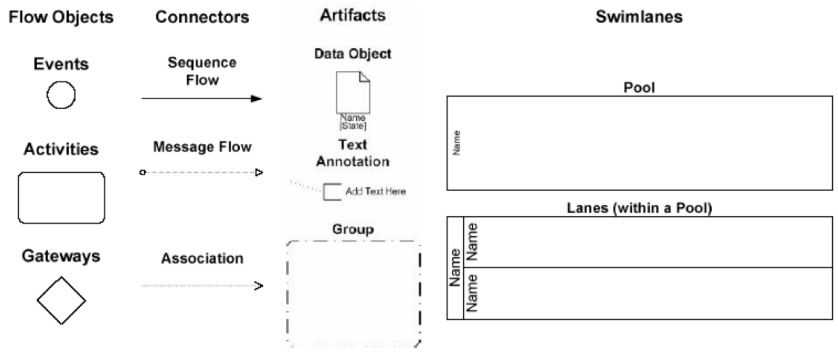
Process Event

- An even is something that happens
- A process event defines a point where the process is either started, stopped, halted, or continued
- Events define occurring activities "of interest"
- Participant actions, choices, or activities define or create events
- Examples:
  - Contract order submitted
  - DB unavailable
  - Requisition rejected

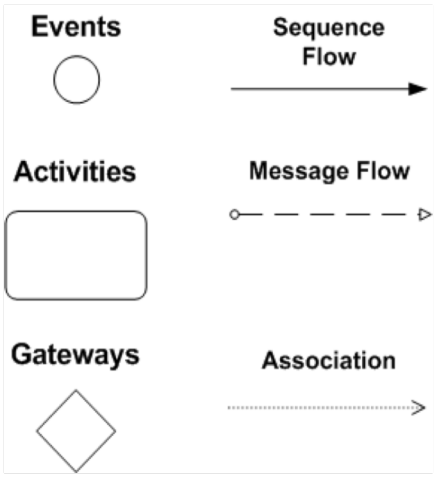
Data

- Data shapes in BPMN are artifacts, meaning, or an effect of process events occurring
- Data is never a cause of process activity occurring. Events trigger activity, resulting in data
- Data mostly originates from events, for example:
  - An airplane is cleared for a final approach. This event is added to the flight log (data)
  - The log data is a chorological series of event snapshots

Diagram elements

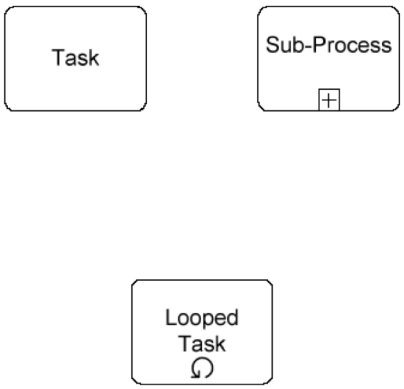


Core Set of Diagram Elements



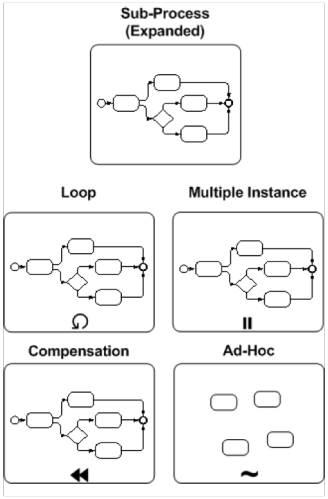
- The core set of modeling elements enable the easy development simple Business Process Diagrams that will look familiar to most Business Analysts (a flowchart diagram)

Activities - basics



- An activity is work that is performed within a business process. An activity can be atomic or non-atomic (compound). The types of activities that are a part of a Process Model are: **Sub-Process**, and **Task**
- Activities are rounded rectangles
- They can be performed once or can have internally defined loops

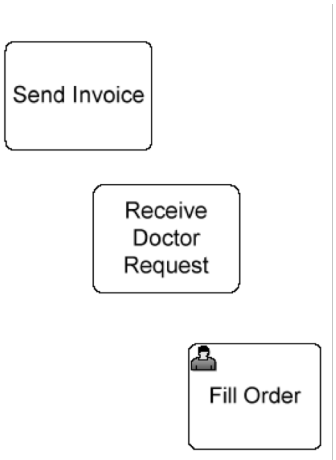
Complete Set of Diagram Elements: Activities



- A Sub-Process can be in an expanded form that shows the process details of the a lower-level set of activities.

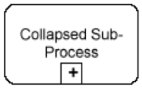
Task

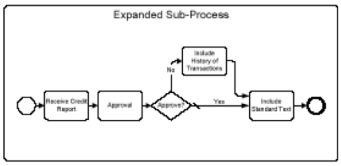
- A Task is an atomic activity that is included within a Process. A Task is used when the work in the Process is not broken down to a finer level of Process Model detail
- There are specialized types of Tasks for sending and receiving, or user-based Tasks, etc.
- Markers or icons can be added to Tasks to help identify the type of Task
  - Markers must not change the footprint of the Task or conflict with any other standard BPMN element



Sub-processes

- Sub-Processes enable hierarchical Process development
- A Sub-Process is a compound activity that is included within a Process. It is compound in that it can be broken down into a finer level of detail (a Process) through a set of sub-activities
- For a collapsed version of a Sub-Process, The details of the Sub-Process are not visible in the Diagram. A "plus" sign in the lower-center of the shape indicates that the activity is a Sub-Process and has a lower-level of detail.
- For an expanded version of a Sub-Process, the details (a Process) are visible within its boundary.
- There are two types of Sub-Processes: Embedded and Independent (Re-usable)

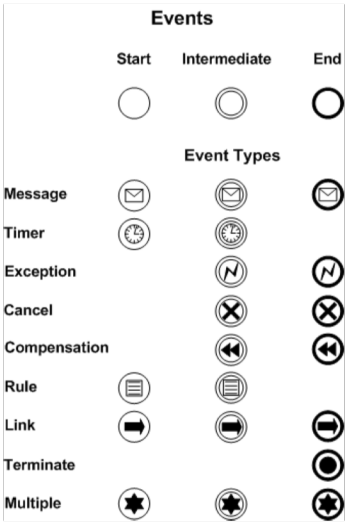




Events

- An **Event** is something that "happens" during the course of a business process. These Events affect the flow of the Process and usually have a trigger or a result. They can start, interrupt, or end the flow
- Events are circles
  - The type of boundary determines the type of Event

Complete Set of Diagram Elements: Events



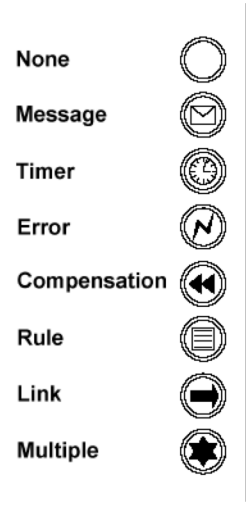
- An Event is something that "happens" during the course of a business process. These Events affect the flow of the Process and usually have a trigger or a result. They can start, interrupt, or end the flow.

Start Events

- Start Events indicate where a Process will begin
- There are different "Triggers" that indicate the specific circumstances that start the Process
  - None Start Events are used to mark the start of Sub-Processes or when the start is undefined
  - The Link Start Event will be removed in the next version of BPMN
  - Any one of the Triggers included in a Multiple Start Event will start the Process

Intermediate Events

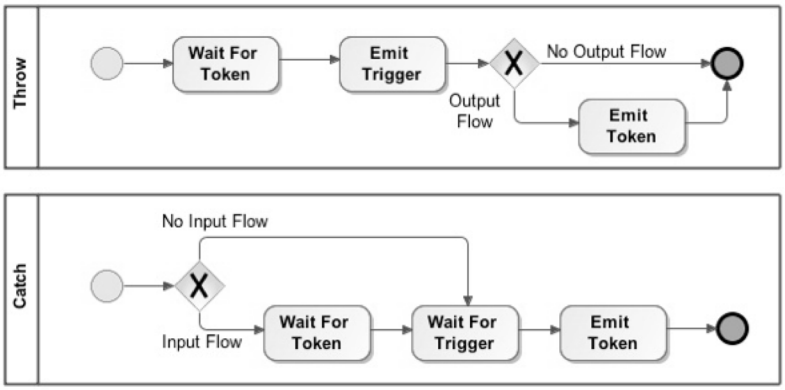
- Intermediate Events occur after a process has been started and before a process is ended
- There are different "Triggers" that indicate the specific circumstances of the Event
- They can be placed in the normal flow of the Process or attached to the boundary of an activity



Intermediate Events catch/throw

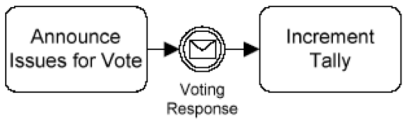
- They have a single (optional) input flow and a single output flow
- They may catch or throw:
- Catch - waits for the even trigger then emits a token
  - If there is an input flow – wait for a token
  - Wait for the event trigger
  - Emit a token on the single output flow
- Throw – throws the event trigger then emits a token
  - Wait for a token on the single input flow
  - Throw the event trigger
  - If there is an output flow: emit a token on the single output flow

Intermediate event behavior metamodel



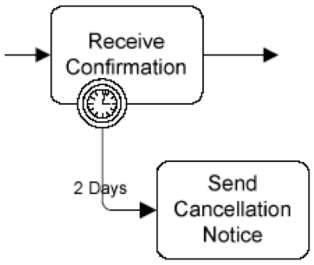
Intermediate events (normal flow)

- Events that are placed within the process flow represent things that happen during the normal operations of the process
- They can represent the response to the Event (i.e., the receipt of a message)
- They can represent the creation of the Event (i.e., the sending of a message)



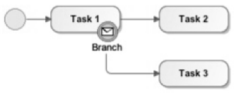
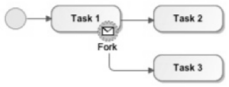
Intermediate events (linked to Boundary)

- Events that are attached to the boundary of an activity indicate that the activity should be interrupted when the Event is triggered
  - They can be attached to either Tasks or Sub-Processes
- They are used for error handling, exception handling, and compensation



Boundary Event

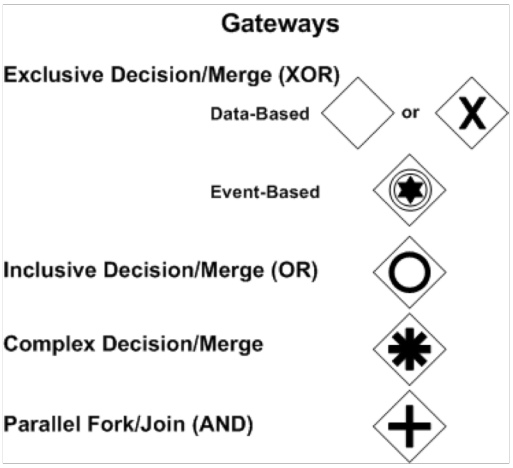
- Boundary events are catching intermediate evens placed on activity boundaries
  - Interrupting – branch the process flow
  - Non-interrupting – fork the process flow

Boundary event semantics		
Syntax	Behaviour	Semantics
	Interrupting	If Branch triggered before Task 1 finishes terminate Task 1 execute Task 3 Else execute Task 2
	Non-interrupting	If Fork triggered before Task 1 finishes continue executing Task 1 AND fork to execute Task 3 concurrently Else execute Task 2

End events

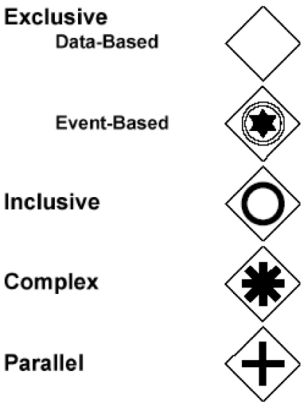
- End Events indicates where a process will end
- There are different "Results" that indicate the specific circumstances that end the Process
  - None Start Events are used to mark the start of Sub-Processes or when the start is undefined
  - The Link End Event will be replaced in the next version of BPMN (probably with a Signal)

Complete Set of Diagram Elements: Gateways



■Gateways are modeling elements that are used to control how Sequence Flows interact as they converge and diverge within a Process. If the flow does not need to be controlled, then a Gateway is not needed.

Gateways



- **Gateways** are modeling elements that are used to control how Sequence Flows interact as they converge and diverge within a Process
- All types of Gateways are diamonds
  - Different internal markers indicate different types of behavior
  - All Gateways both split and merge the flow
- *If the flow does not need to be controlled*, then a Gateway is not needed. Thus, a diamond represents a place where control is needed

Exclusive Gateways

- Exclusive Gateways (Decisions) are locations within a business process where the Sequence Flow can take two or more alternative paths. This is basically the "fork in the road" for a process.
- Only one of the possible outgoing paths can be taken when the Process is performed
- There are two types decision mechanism:
  - Data (e.g., condition expressions)
  - Events (e.g., the receipt of alternative messages)
- They are also used to merge Sequence Flow
  - The merging behavior may change in the next version of BPMN

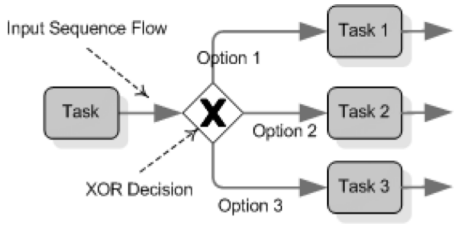
Data-based vs. event-based gateway

- Data-based gateway means that it evaluates a data condition, which then leads to a specific sequence flow path.
  - For example, "hire the candidate?" could have answers such as "yes", "no", "maybe"
- Event-based gateway, the decision is not related to data, but rather, to an event
  - For example, "offer letter response received", the path could be:
    - Acceptance Message
    - Rejection Message
    - Negotiation Message
    - No response after 5 days

Data-based XOR Gateway (or Decision)

- A data-based XOR Gateway (or Decision) relies on the arrival of a data token that has traversed the Process Flow. The path (or 'gate') that it flows out on is chosen based on the condition expressions for each gate of the gateway.
- For example, the Task on the left may have interrogated someone's bank account and the resulting data token may be holding the account 'balance' and the 'date of last transaction'. Based on these values, one of the 'gates' (which may be labeled: 'Active', 'Overdrawn', or 'Dormant') would be followed, traversing the data token to the appropriate Task (such as 'Close dormant account').

Data-based XOR Gateway (or Decision)



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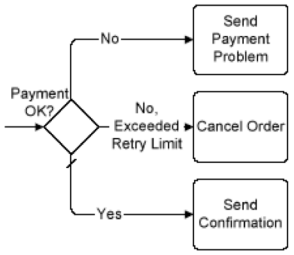
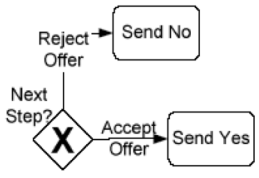
Exclusive Gateways, based on data

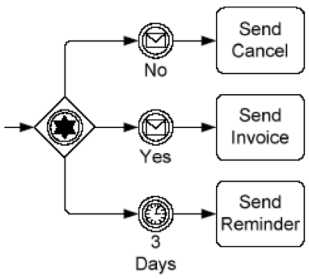
- These are the most commonly used type of Gateways.
  - They can be shown with or without an internal "X" marker. Without is the most common use.
- The Gateway (Decision) creates alternative paths based on defined conditions



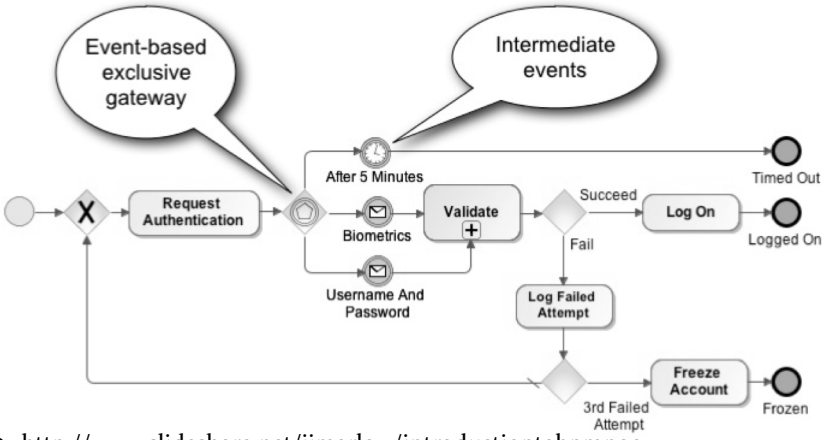


Exclusive Gateways, based on events

- This type of Decision represents a branching point in the process where the alternatives are based on events that occurs at that point in the Process, rather than conditions
- The Multiple Intermediate Event is used to identify this Gateway
- The Event that follow the Gateway Diamond determine the chosen path
  - The first Event triggered wins



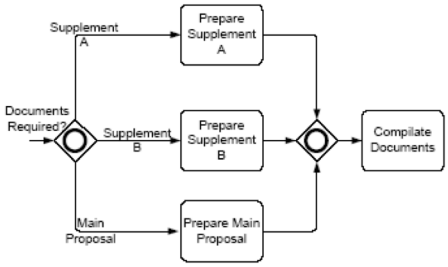
Event-based exclusive gateway example



- http://www.slideshare.net/jimarlow/introductiontobpmn005

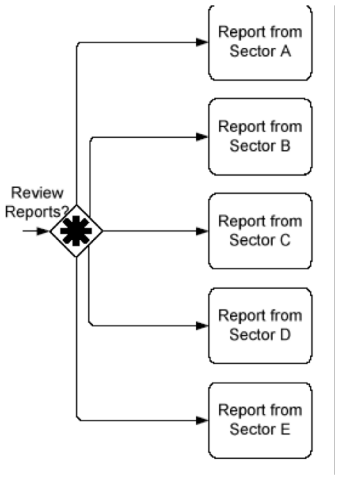
Inclusive Gateways

- Inclusive Gateways are Decisions where there is more than one possible outcome
- The "O" marker is used to identify this Gateway
- They are usually followed by a corresponding merging Inclusive Gateway



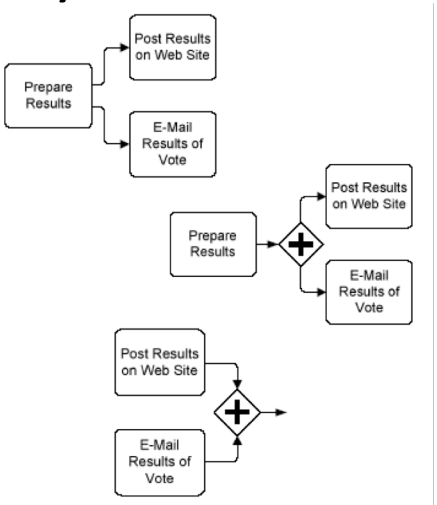
Complex Gateways

- Complex Gateways are Decisions where there is more advanced definitions of behavior can be defined
- The asterisk marker is used to identify this Gateway
- Complex behavior can be defined for both the merging and splitting behavior



Parallell Gateways

- Parallel Gateways are places in the Process where multiple parallel paths are defined
  - They are not required for forking in most situations.
  - They can be used for methodological purposes
- The "+" marker is used to identify this Gateway
- The Gateway is also used to synchronize (wait for) parallel paths



Connectors

Sequence Flow

Message Flow

Association

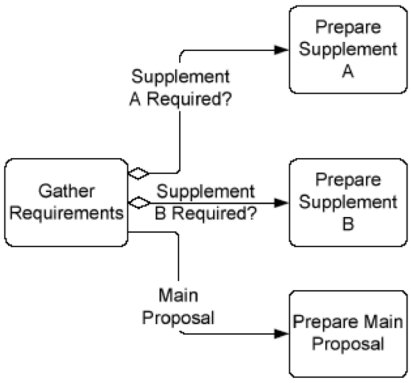
- A **Sequence Flow** is used to show the order that activities will be performed in a Process
- A **Message Flow** is used to show the flow of messages between two entities that are prepared to send and receive them
- An **Association** is used to associate data, information and artifacts with flow objects

Sequence flow

- A Sequence Flow is used to show the order that activities will be performed in a Process
- The source and target must be one of the following objects: Events, Activities, and Gateways
- A Sequence Flow cannot cross a Sub-Process boundary or a Pool boundary

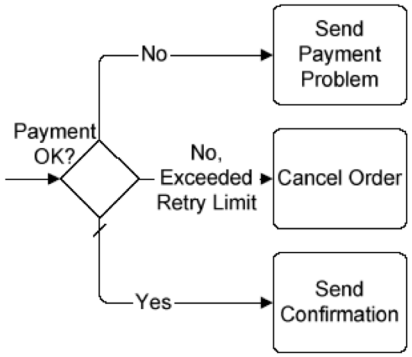
Conditions in sequence flow

- A Sequence Flow MAY have a defined condition if it exits an activity
  - Such an activity must have at least two Sequence Flows
- The condition has to be True to allow the flow to continue down the Sequence Flow
  - A mini-diamond shows that the Sequence Flow has a condition
- At least one of the outgoing Sequence Flow must be chosen during Process performance



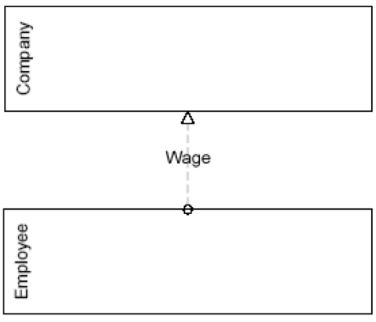
Default sequence flow

- A Sequence Flow that exits an Exclusive or Inclusive Gateway may be defined as being the default path
  - A hatch mark at the line beginning shows the default Sequence Flow
- The default path is chosen only if all the other conditions of the Gateway are False



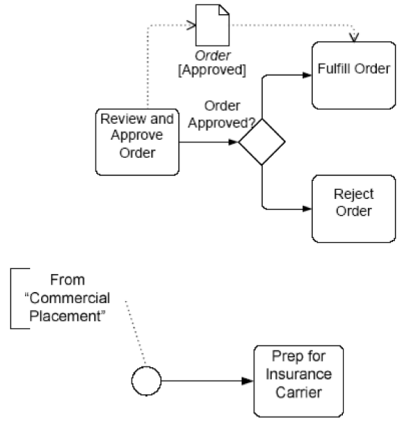
Message flow

- A Message Flow is used to show the flow of messages between two Participants of Process
  - In BPMN, separate Pools are used to represent the Participants
- A Message Flow can connect to the boundary of the Pool or to an object within the Pool
- Message Flow are not allowed between objects within a single Pool



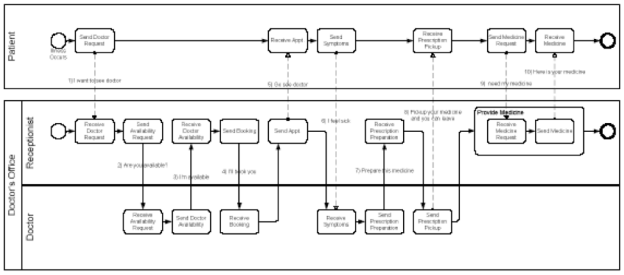
Associations

- An Association is used to associate objects to one another (such as Artifacts and Activities)
- Associations are used to show how data is input to and output from Activities
- Text Annotations can be Associated with objects

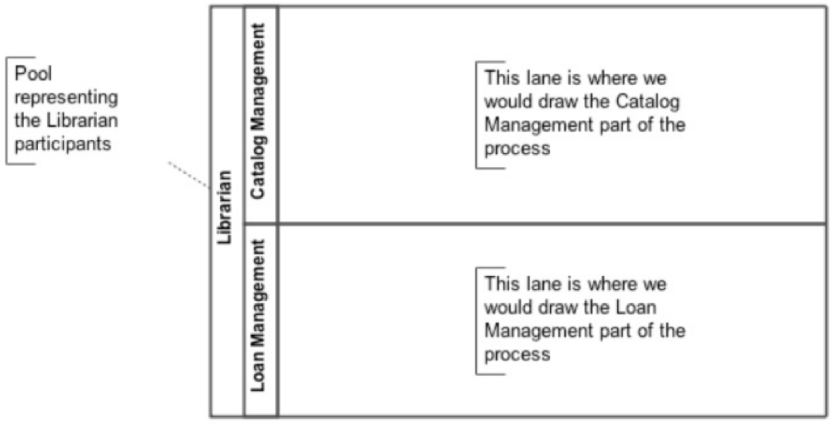


Swim lanes

- BPMN uses the concept known as "swimlanes" to help partition and/organize activities
- There are two main types of swimlanes: Pool and Lane
  - Pools represent Participants in an interactive (B2B) Business Process Diagram
  - Lanes represent sub-partitions for the objects within a Pool

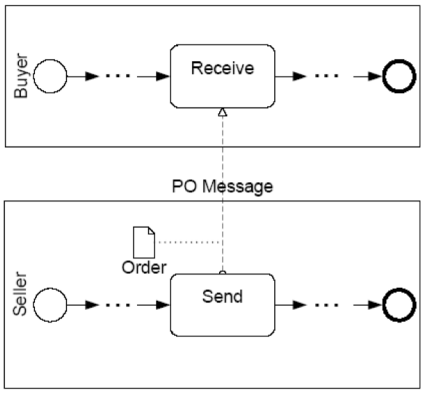


Collaboration diagram



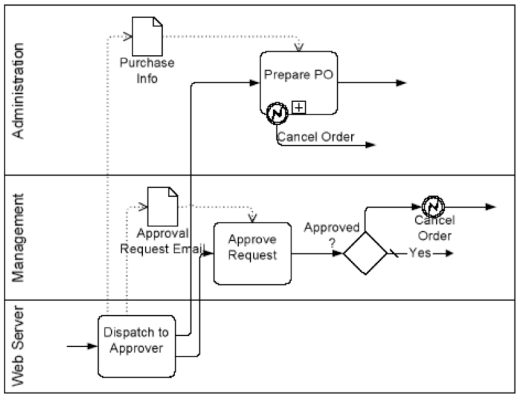
Pool

- Pools represent Participants in an interactive (B2B) Business Process Diagram
  - A Participant may be a business role (e.g., "buyer" or "seller") or may a business entity (e.g., "IBM" or "OMG")
- A Pool may be a "black box" or may contain a Process
- Interaction between Pools is handled through Message Flow
- Sequence Flow cannot cross the boundary of a Pool (i.e., a Process is fully contained within a Pool)



Lanes

- Lanes represent sub-partitions for the objects within a Pool
- They often represent organization roles (e.g., Manager, Associate), but can represent any desired Process characteristic
- Sequence Flow can cross Lane boundaries

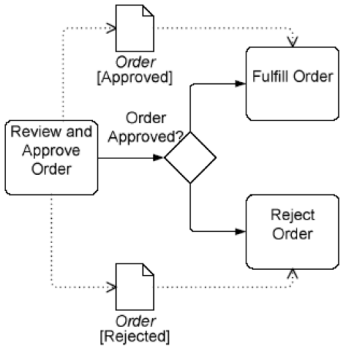


Artifacts

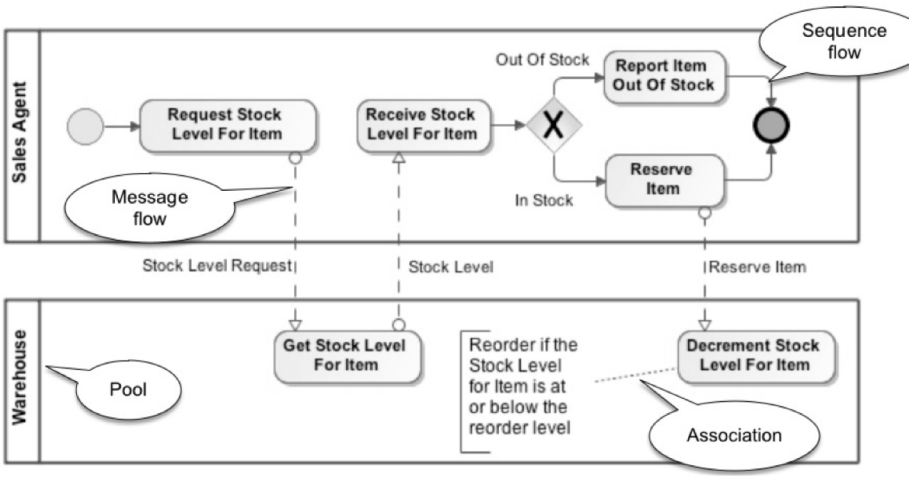
- Artifacts provide the capability to show information beyond the basic flow-chart structure of the Process
- There are currently three standard Artifacts in BPMN: Data Objects, Groups, and Annotations
  - Additional Artifacts may be standardized in later version
  - Sets of vertical market Artifacts may also be developed
- A modeler or tool can extend BPMN by defining new Artifacts

Data objects

- Data Objects are Artifacts that are used to show how data and documents are used within a Process
- Data Objects can be used to define inputs and outputs of activities
- Data Objects can be given a "state" that shows how a document may be changed or updated within the Process

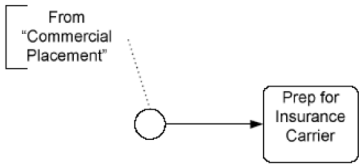


Connecting objects



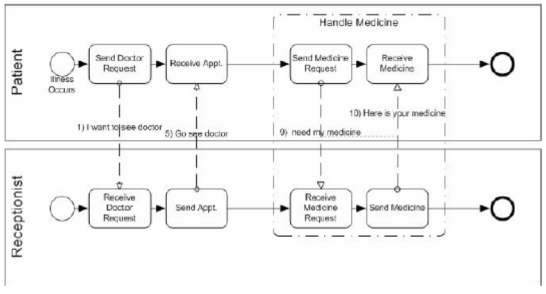
Text annotations

- Text Annotations are a mechanism for a modeler to provide additional information about a Process
- Text Annotations can be connected to a specific object on the Diagram with an Association



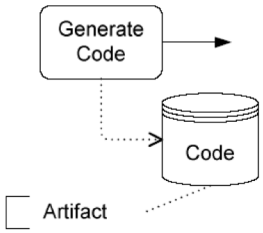
Groups

- Groups are Artifacts that are used to highlight certain sections of a Diagram without adding additional constraints for performance – as a Sub-Process would
  - Groups can be used to categorize elements for reporting purposes
- Groups are not constrained by restrictions of Pools and Lanes



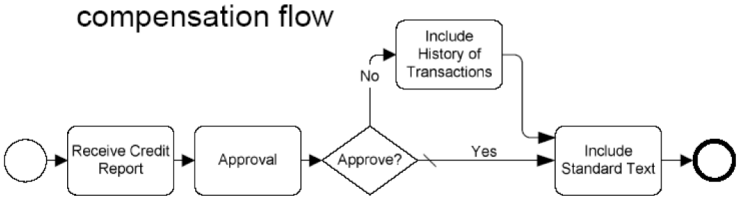
Extended artifacts

- Modelers and Modeling Tools can add new Artifacts to a diagram
  - Specific industries or markets may have their own set of Artifacts
- Their shapes must not conflict with existing shapes
- They are not part of normal flow, but can be associated with other elements



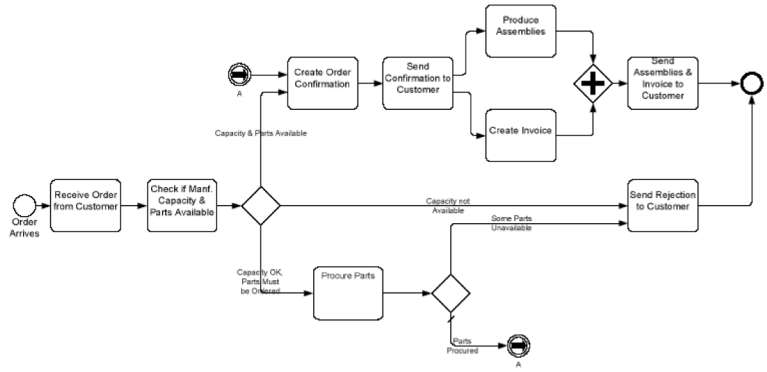
Normal flow

- Normal Sequence Flow refers to the flow that originates from a Start Event and continues through activities via alternative and parallel paths until it ends at an End Event
  - Normal Flow does not include exception flow or compensation flow



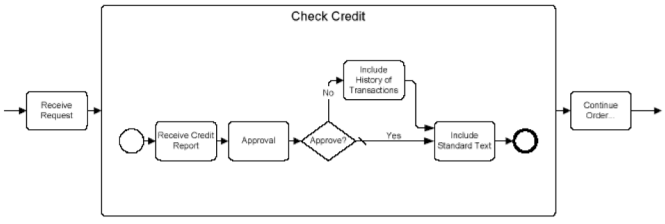
Link events

- Link Events can be used for Off-Page connectors
- Link Events can be used as "Go-To" objects

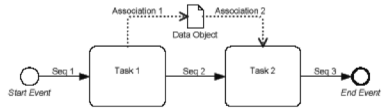


Process levels

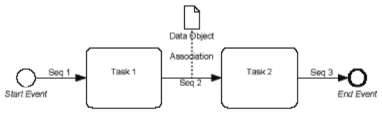
- Processes can be developed hierarchically, with multiple levels through Sub-Processes
- Sequence Flow cannot cross a Sub-Process boundary
  - Message Flow and Associations can cross Sub-Process boundaries



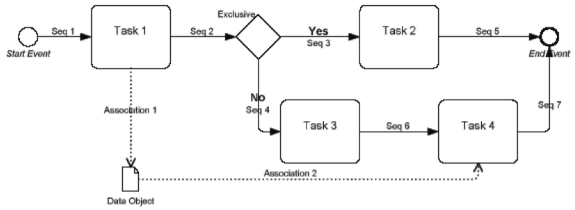
Data flow



Sequence Flow and Data Flow are decoupled

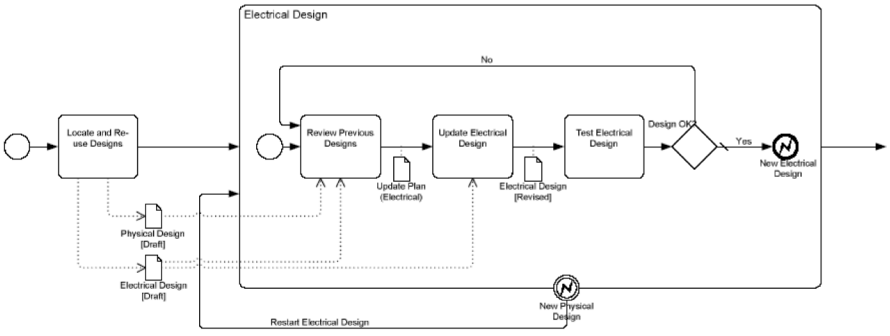


They can be bound together



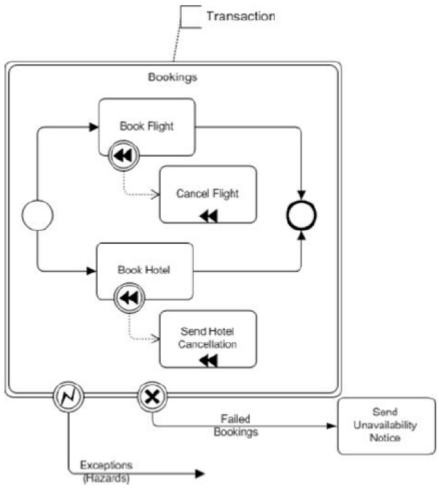
Use case for decoupling

Exceptions



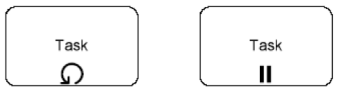
Intermediate Events attached to the boundary of an activity represent triggers that can interrupt the activity. All work within the activity will be stopped and flow will proceed from the Event. Timer, Errors, Messages, etc. can be Triggers.

Compensations and transacations

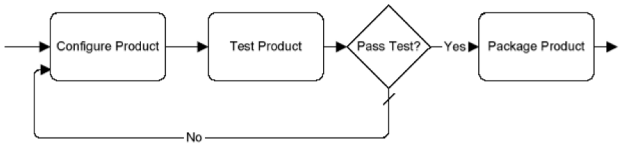


- A Transaction is an activity that has a double border. Transactions are supported by a transaction protocol (e.g., WS-Transaction)
- Normal Outgoing Sequence Flow represents the path to follow a successful completion
- A Cancel Intermediate Event represents the path to follow a cancelled completion
- An Exception Intermediate Event represents the path to follow a transaction hazard (but no compensation is performed)
- Activities used for compensate (with marker) are outside normal flow and are Associated normal activities. Compensation flows "backwards."

Loops



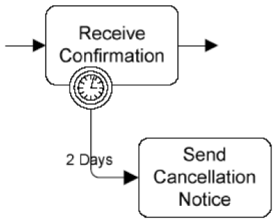
Activity Looping: Do-While; While-Do; Multiple Instance



Sequence Flow Looping

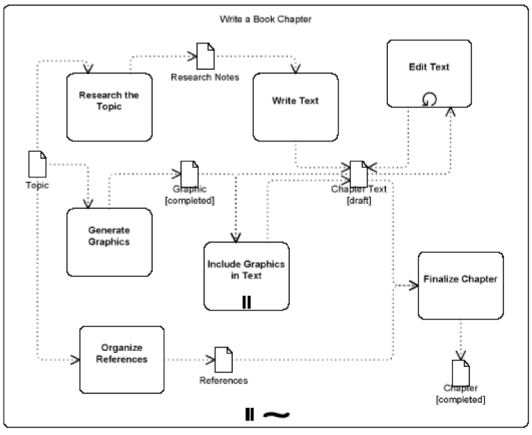
Timers

Timers to add delays in the Process



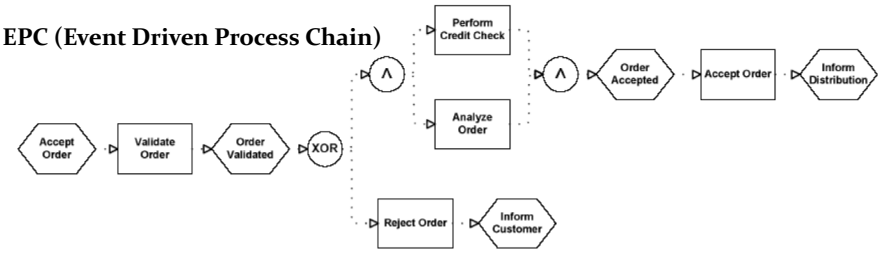
Timeouts for exception handling

Ad hoc processes

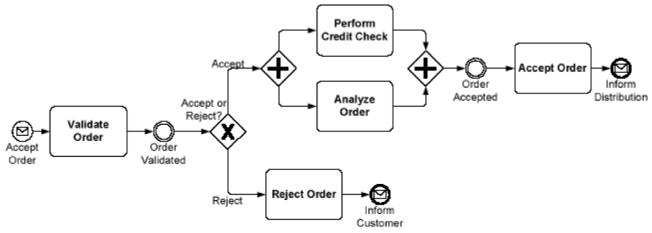


There is no pre-defined Sequence Flow

EPC (Event Driven Process Chain)



BPMN

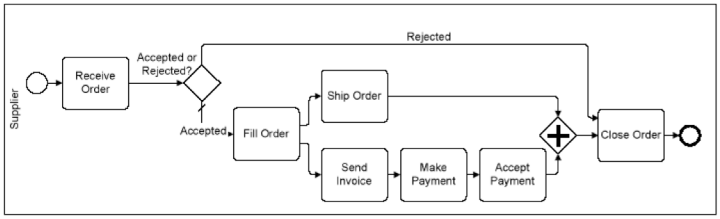


Orchestration versus Choreography

- Orchestration: Workflow, internal processes, private processes
  - Contained within one Pool
- Choreography: Collaboration, global processes, B2B processes
  - Defined by the interaction between Pools

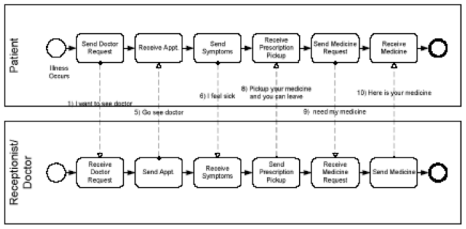
Orchestration

- Orchestration defines processes that are internal to a specific organization
  - Thus, they are contained within a single Pool



Choreography

- A Choreography process depicts the interactions between two or more business entities (as modeled with Pools)
  - Shown by the Message Flow between the Pools
- Or a sequence of interaction (global) types of activities
- BPMN V2.0 will likely update how Choreographies are modeled



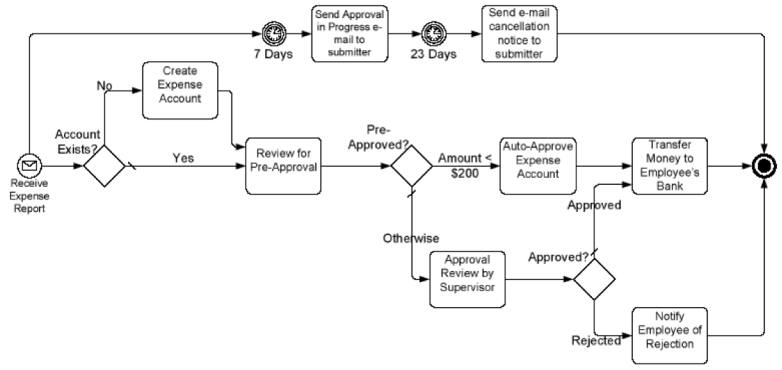
Example

- In this exercise you will read a text descriptive information about a process and will map the process on paper
- The process is a sample expense reimbursement process:
  - This process provides for reimbursement of expenses incurred by employees for the company. For example buying a technical book, office supplies or software. In a normal day there are several hundreds of instances of this process created.
- Concentrate on the basic flow of the Process…

Process information

- After the Expense Report is received, a new account must be created if the employee does not already have one
- The report is then reviewed for automatic approval
  - Amounts under $200 are automatically approved
  - Amounts equal to or over $200 require approval of the supervisor
    - In case of rejection, the employee must receive a rejection notice by email
- The reimbursement goes to the employee's direct deposit bank account
- If no action has happened in 7 days, then the employee must receive an approval in progress email
- If the request is not finished within 30 days, then the process is stopped and the employee receives an email cancellation notice and must re-submit the expense report

Proposal


7 Days
Send Approval in Progress e-mail to submitter
23 Days
Send e-mail cancellation notice to submitter
No
Create Expense Account
Account Exists?
Yes
Review for Pre-Approval
Pre-Approved?
Amount < $200
Auto-Approve Expense Account
Transfer Money to Employee's Bank
Receive Expense Report
Approved
Otherwise
Approval Review by Supervisor
Approved?
Rejected
Notify Employee of Rejection