Software Design and Architecture

Logical Models: Process Models
Data Flow Diagram

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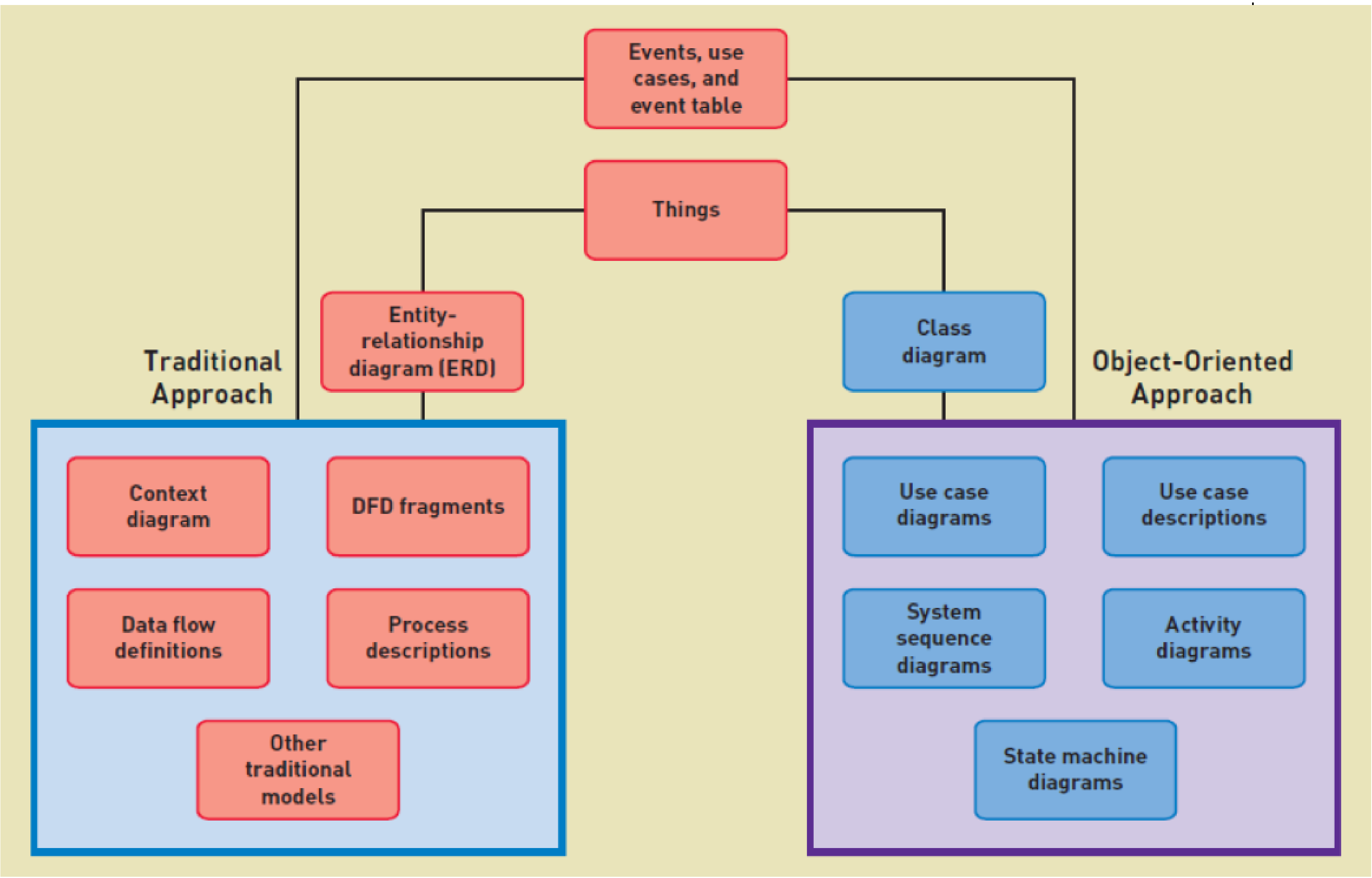
Lecture Material

- System Analysis and Design in a Changing World (Chapter 6 (Online Chapter B))
- System analysis and design by Alan Denis (Chapter 5)

Lecture Outline

- Traditional vs OO approach
- Data Flow Diagram (DFD) fundamentals
- DFD levels
- DFD Design Guidelines
- DFD Design Issues
- Example

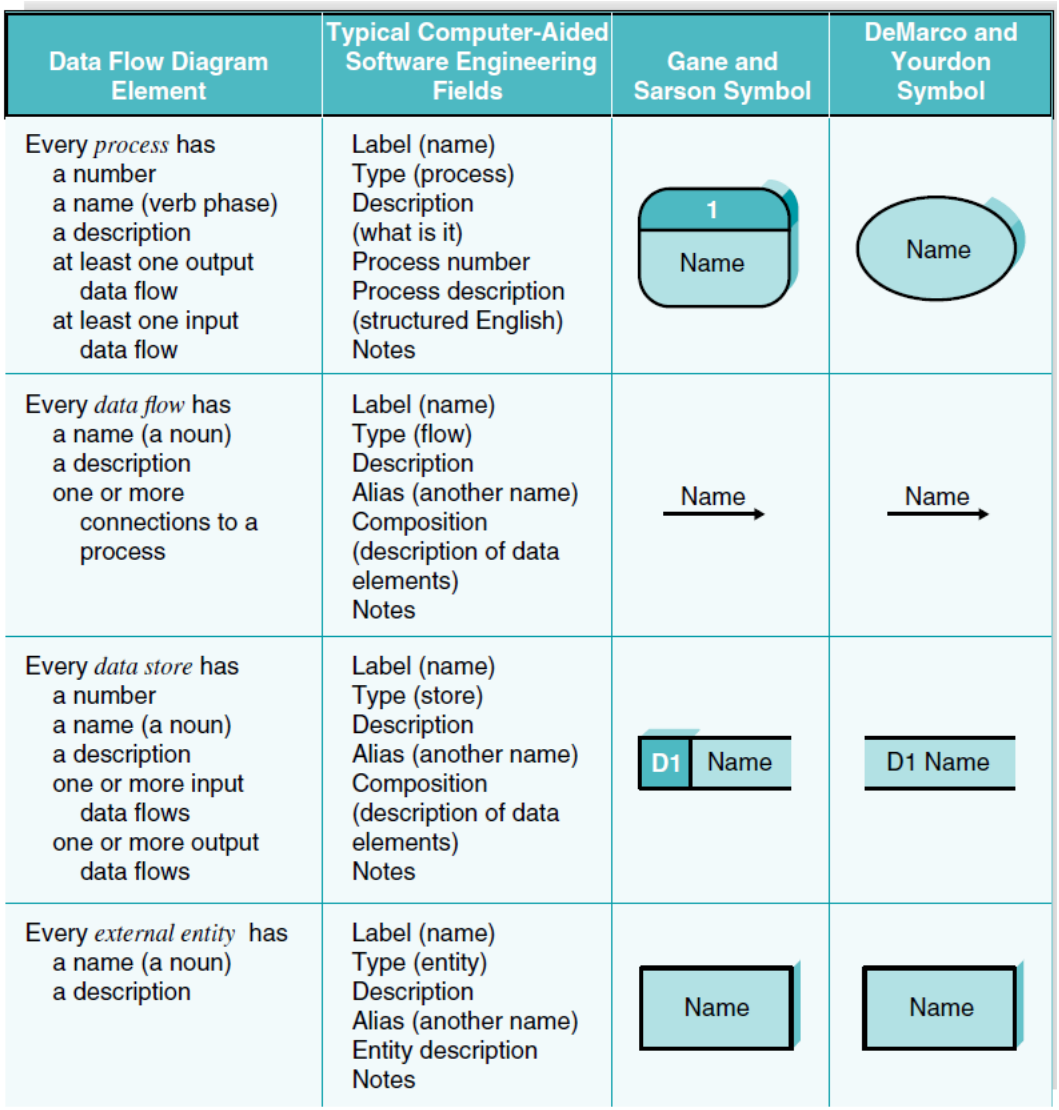
Traditional vs OO Approach



DFD Fundamentals

- Process model
  - » A formal way of representing how a *business system* operates illustrates the activities that are performed and how data moves among them
- Data flow diagrams
  - » A common technique for creating process models
- Sequence diagram along with class diagram serve this purpose in OOP.

DFD Fundamentals



Data Flow Diagram Element	Typical Computer-Aided Software Engineering Fields	Gane and Sarson Symbol	DeMarco and Yourdon Symbol
Every *process* has a number a name (verb phase) a description at least one output data flow at least one input data flow	Label (name) Type (process) Description (what is it) Process number Process description (structured English) Notes	1 Name	Name
Every *data flow* has a name (a noun) a description one or more connections to a process	Label (name) Type (flow) Description Alias (another name) Composition (description of data elements) Notes	Name →	Name →
Every *data store* has a number a name (a noun) a description one or more input data flows one or more output data flows	Label (name) Type (store) Description Alias (another name) Composition (description of data elements) Notes	D1 Name	D1 Name
Every *external entity* has a name (a noun) a description	Label (name) Type (entity) Description Alias (another name) Entity description Notes	Name	Name

DFD Fundamentals

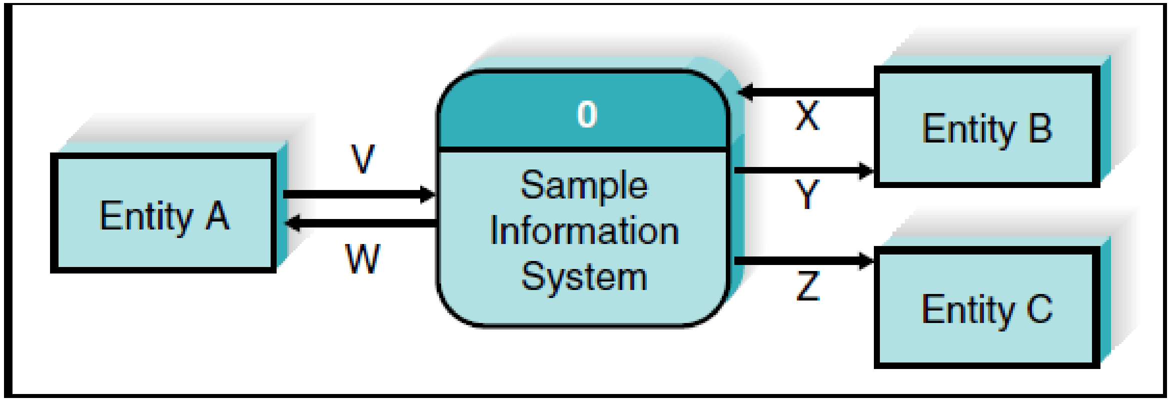
- Business processes are too complex to be shown on a single DFD

- *Decomposition* is the process of representing the system in a hierarchy of DFD diagrams
  - » Child diagram s show a portion of the parent diagram in greater detail

- *Balancing* involves ensuring that information presented at one level of a DFD is accurately represented in the next level DFD.

DFD Levels

- Context diagram
  - » First DFD in every business process, shows the *context* (environment) into which the business process fits
  - » Shows the overall business process as just *one process*
  - » Shows all the *external entities* that receive information from or contribute information to the system

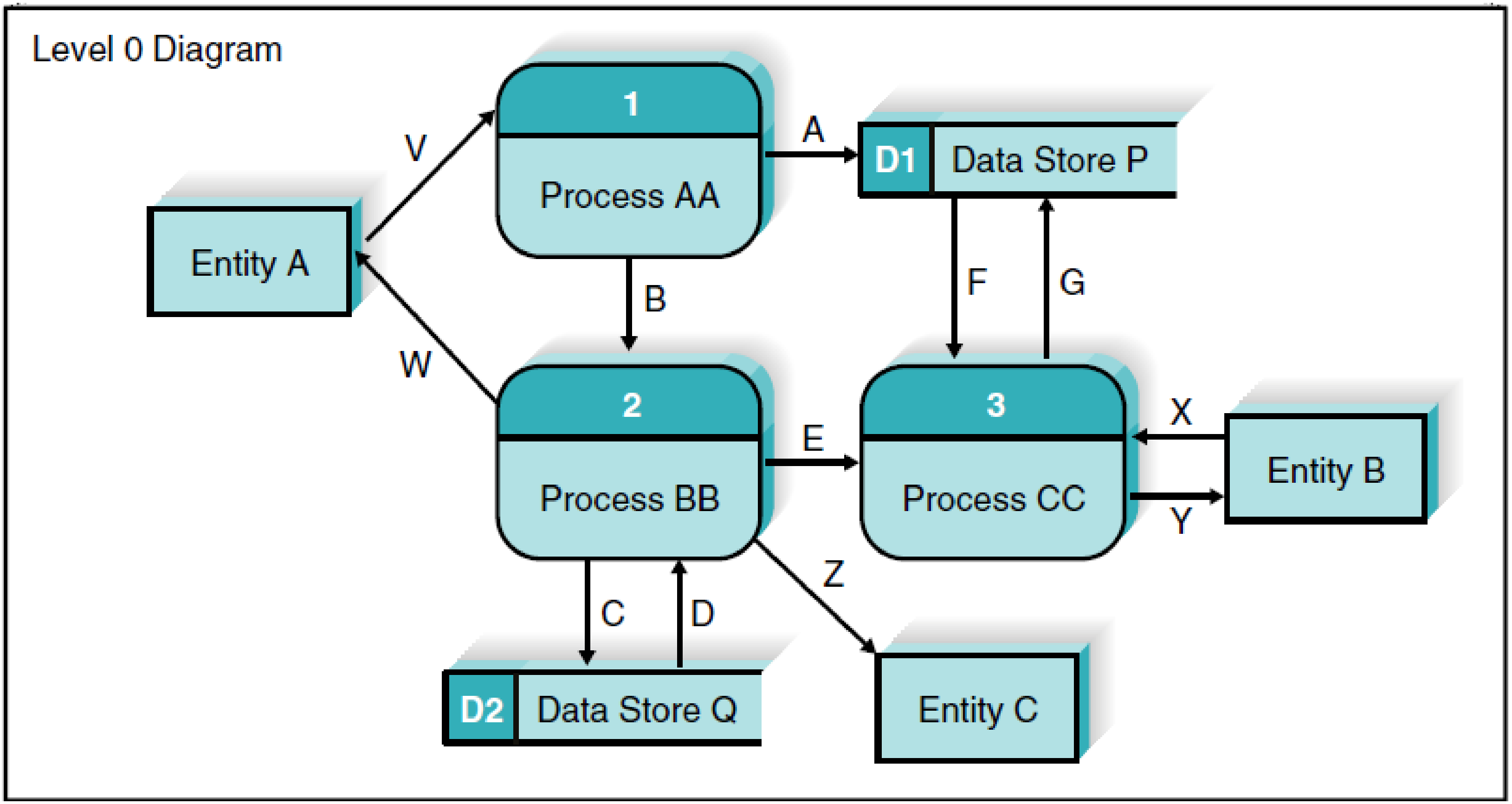


DFD Levels

- Level 0 DFD
  - » Shows all the *major processes* that comprise the overall system - the internal components of process 0
  - » Shows how the major processes are interrelated by *data flows*
  - » Shows external entities and the major processes with which they interact
  - » Add data stores

DFD Levels

- Level 0 DFD

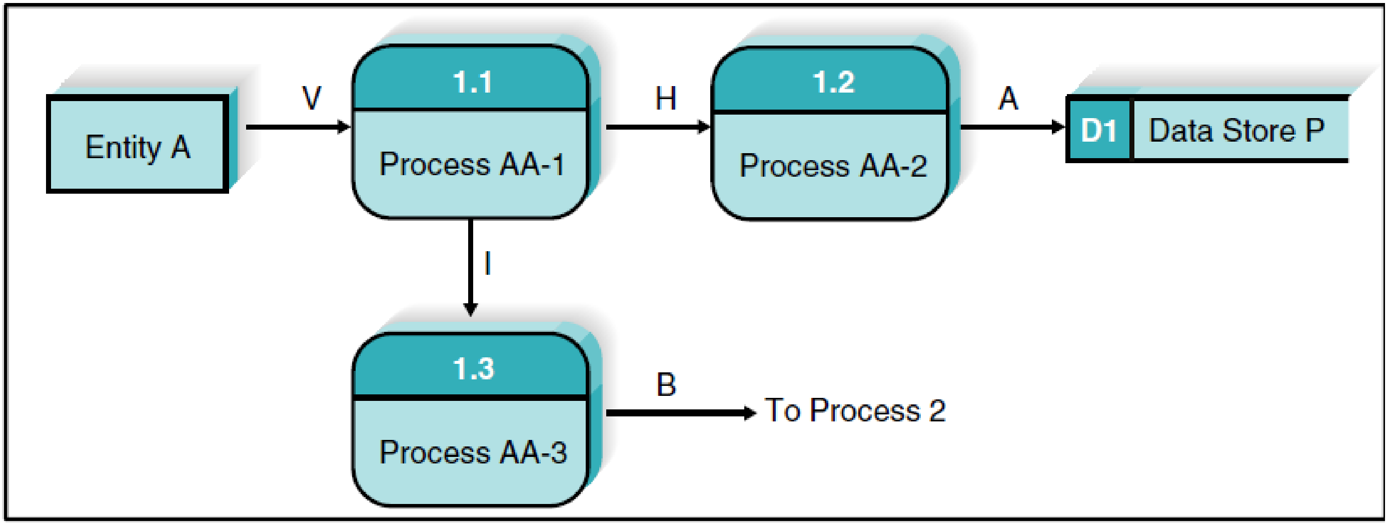


DFD Levels

- Level 1 DFD
  - Generally, one level 1 diagram is created *for every major* process on the level 0 diagram
  - Shows all the internal processes that comprise a single process on the level 0 diagram
  - Shows how information moves from and to each of these processes
  - If a parent process is decomposed into, for example, *three* child processes, (Miller’s Law)

DFD Levels

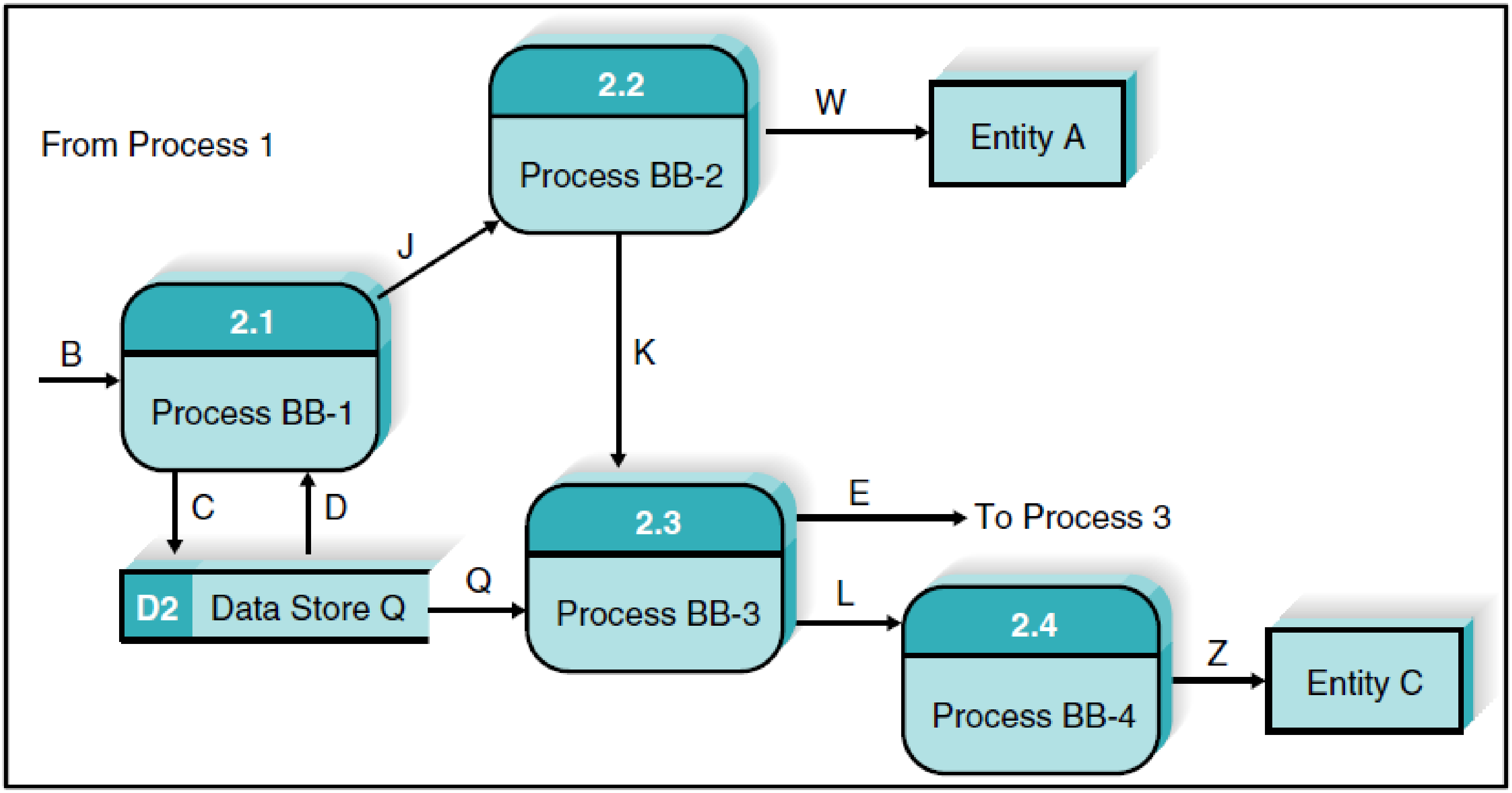
- Level 1 DFD



Process 1 Level 1 Diagram

DFD Levels

- Level 1 DFD



Process 2 Level 1 Diagram

DFD Levels

- Level 2 DFD
  - » Shows all processes that comprise a single process on the level 1 diagram
  - » Shows how information moves from and to each of these processes
  - » Level 2 diagrams may not be needed for all level 1 processes

DFD – Design Guidelines

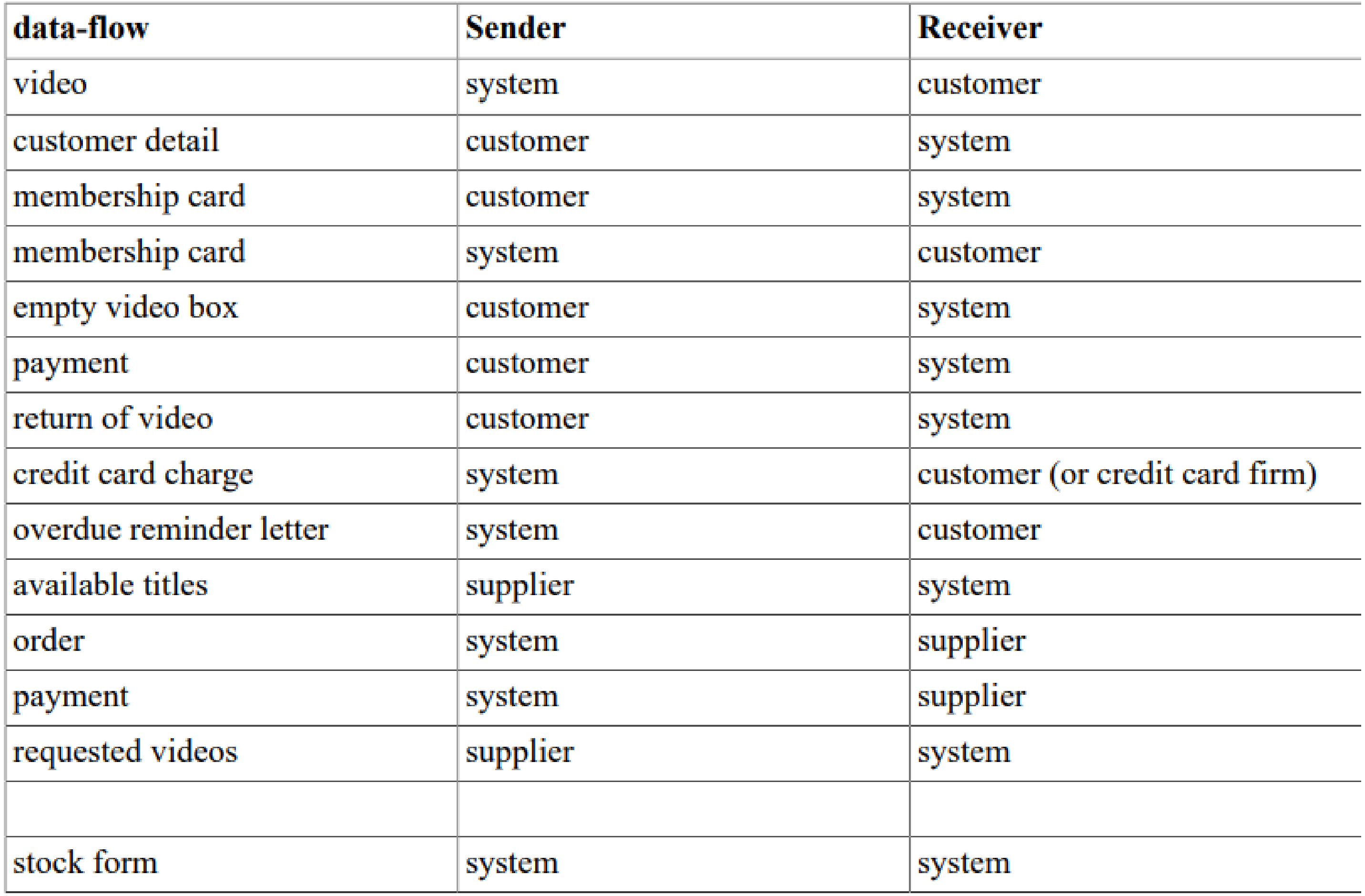
- Context Diagram
  - » Draw one process and connects all the entities either based on use case diagram or ERD

- Level 0 DFD
  - » Draw *one process* for *each use case* and connect entities and data sources based on use case diagram and ERD. It is also called DFD fragments.

- Level 1 DFD
  - » Draw *one sub-process* for *every use case normal flow event*.

DFD – Design Guidelines

Add Process name here

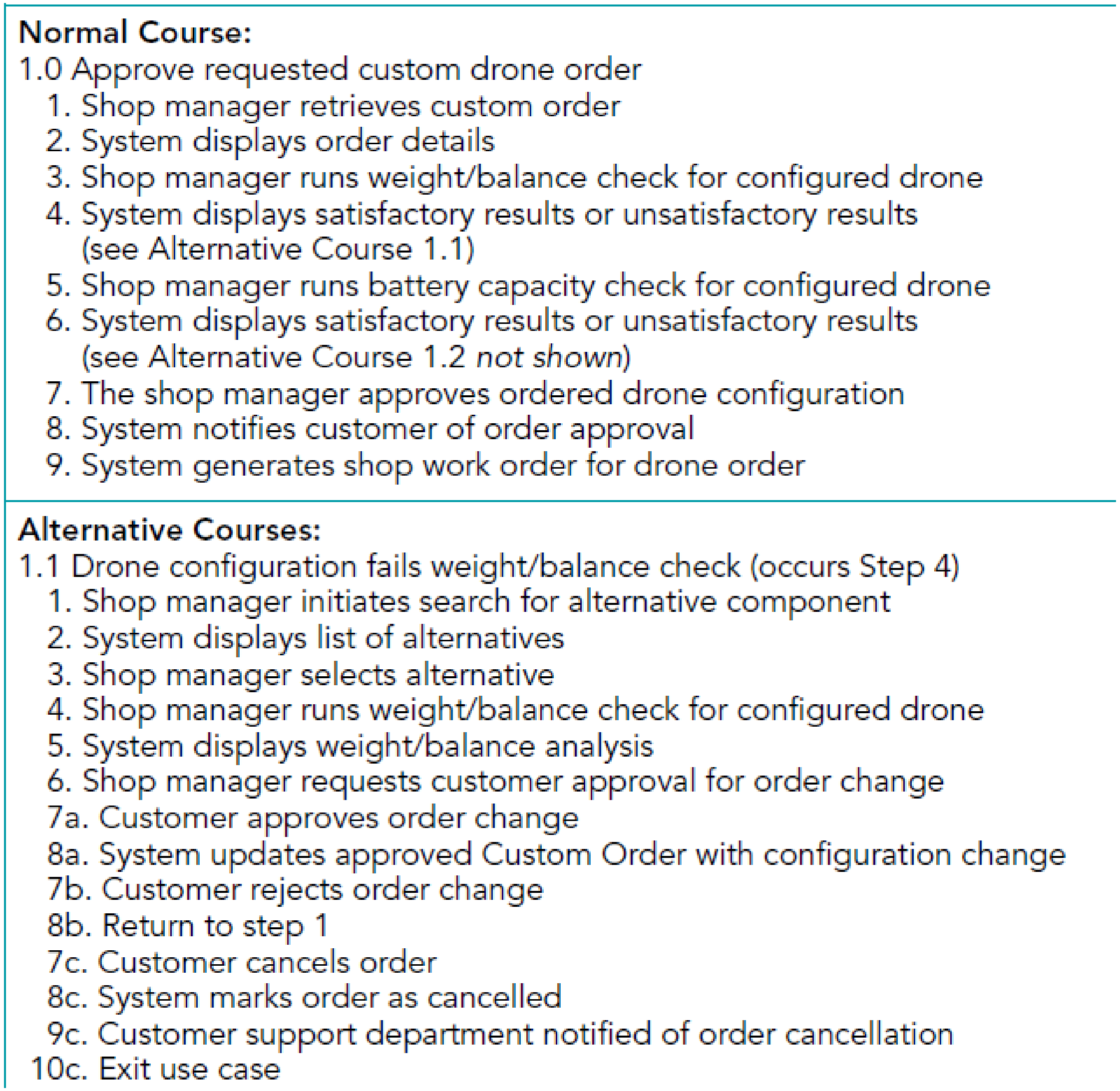


data-flow	Sender	Receiver
video	system	customer
customer detail	customer	system
membership card	customer	system
membership card	system	customer
empty video box	customer	system
payment	customer	system
return of video	customer	system
credit card charge	system	customer (or credit card firm)
overdue reminder letter	system	customer
available titles	supplier	system
order	system	supplier
payment	system	supplier
requested videos	supplier	system
stock form	system	system

DFD – Design Issues

- Is every data-flow attached to a process at either the beginning or the end of the arrow?
- Is every data-flow labelled with a sensible *noun?*
- Does every process have *at least one input and at least one output*?
- Is every process named sensibly (no uses of words such as “process” or “handle”) with an action and what is acted upon? (The template is “Do something to something”)
- Is every data store named with the type of thing it stores in the plural?
- Do all diagrams *balance*? That is, where a diagram expands a process in a higher level, are the inputs and outputs to the process identical to the inputs and outputs on the expanded, lower level diagram?
- Are all external entities shown on both the context diagram and level one diagram?

DFD – Example



Normal Course:

1.0 Approve requested custom drone order

1. Shop manager retrieves custom order
2. System displays order details
3. Shop manager runs weight/balance check for configured drone
4. System displays satisfactory results or unsatisfactory results (see Alternative Course 1.1)
5. Shop manager runs battery capacity check for configured drone
6. System displays satisfactory results or unsatisfactory results (see Alternative Course 1.2 *not shown*)
7. The shop manager approves ordered drone configuration
8. System notifies customer of order approval
9. System generates shop work order for drone order

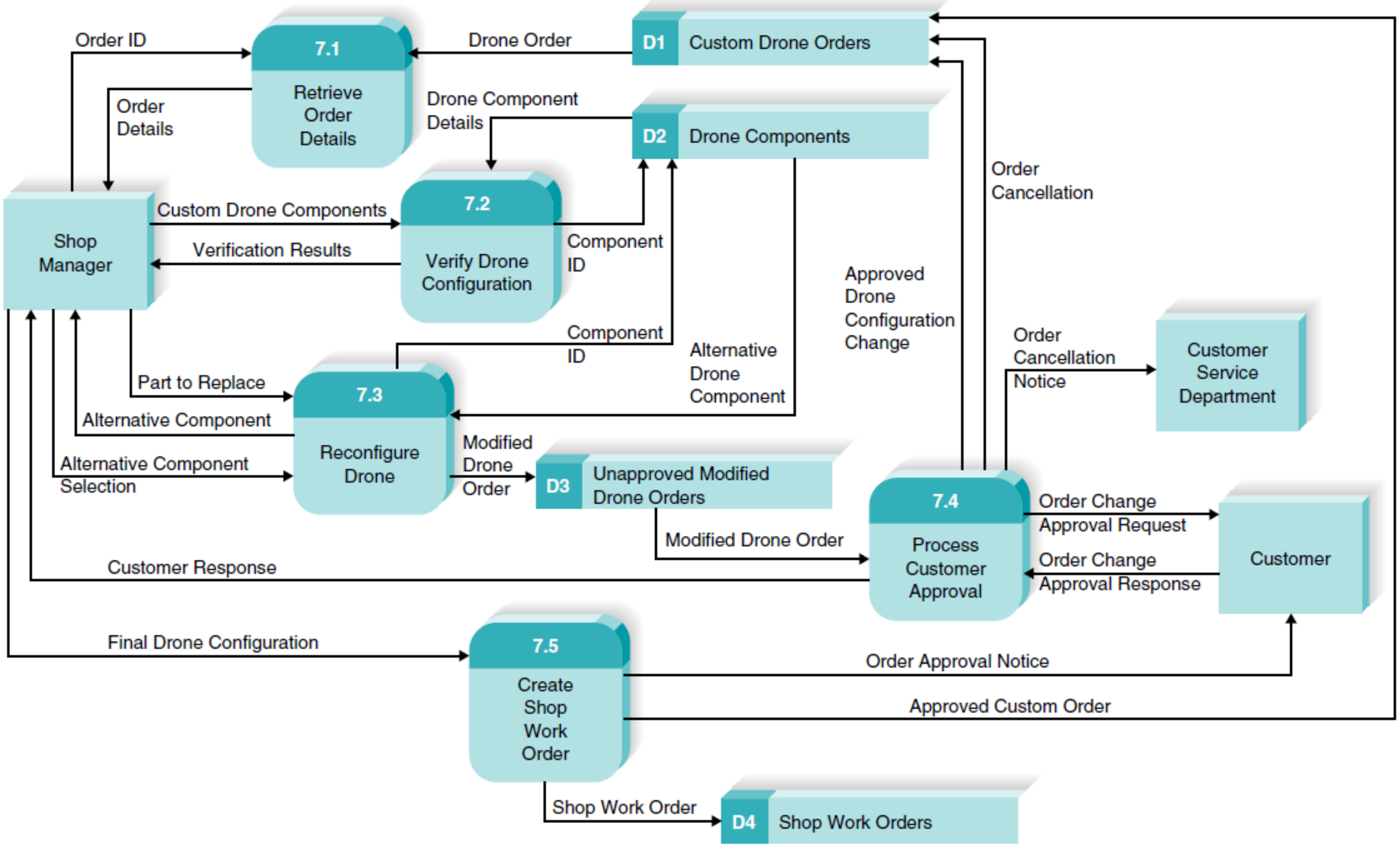
Alternative Courses:

1.1 Drone configuration fails weight/balance check (occurs Step 4)

1. Shop manager initiates search for alternative component
2. System displays list of alternatives
3. Shop manager selects alternative
4. Shop manager runs weight/balance check for configured drone
5. System displays weight/balance analysis
6. Shop manager requests customer approval for order change

7a. Customer approves order change
8a. System updates approved Custom Order with configuration change
7b. Customer rejects order change
8b. Return to step 1
7c. Customer cancels order
8c. System marks order as cancelled
9c. Customer support department notified of order cancellation
10c. Exit use case

DFD – Example


Order ID
7.1
Retrieve Order Details
Drone Order
D1
Custom Drone Orders
Order Details
Drone Component Details
D2
Drone Components
Shop Manager
Custom Drone Components
Verification Results
7.2
Verify Drone Configuration
Component ID
Component ID
Order Cancellation
Approved Drone Configuration Change
Alternative Drone Component
Part to Replace
7.3
Reconfigure Drone
Alternative Component
Alternative Component Selection
Modified Drone Order
D3
Unapproved Modified Drone Orders
Order Cancellation Notice
Customer Service Department
Modified Drone Order
7.4
Process Customer Approval
Order Change Approval Request
Order Change Approval Response
Customer
Customer Response
Final Drone Configuration
7.5
Create Shop Work Order
Order Approval Notice
Approved Custom Order
Shop Work Order
D4
Shop Work Orders

DFD – Example

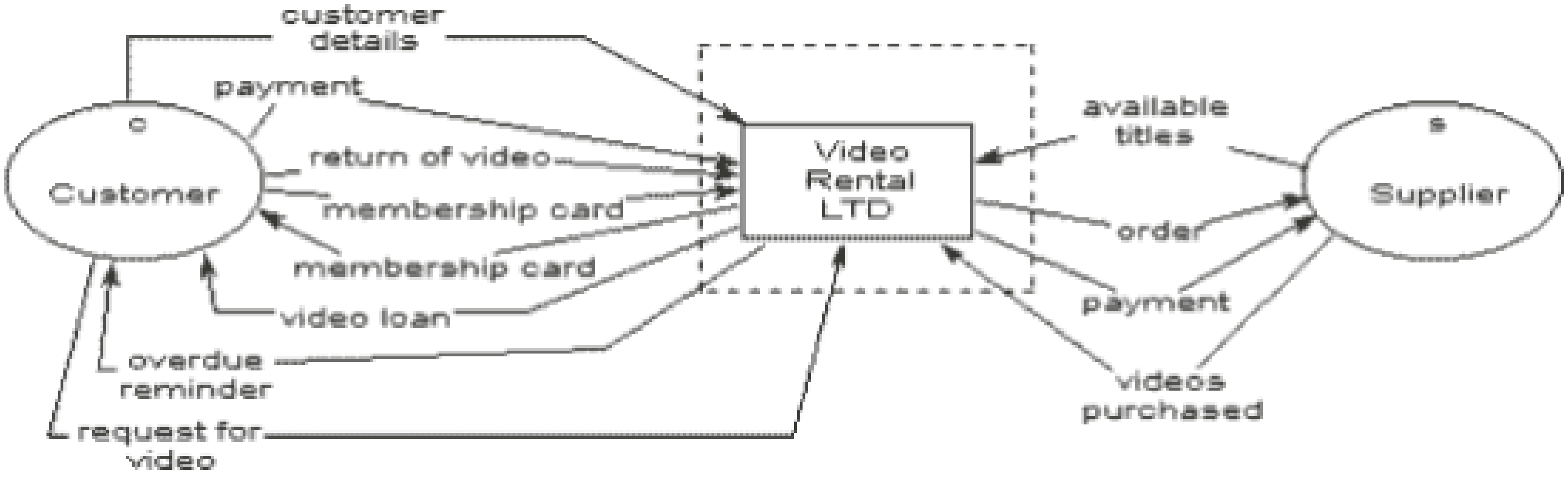
- Video-Rental LTD is a small video rental store. The store lends videos to customers for a fee and purchases its videos from a local supplier.

- A customer wishing to borrow a video provides the empty box of the video they desire, their membership card, and payment – payment is always with the credit card used to open the customer account.

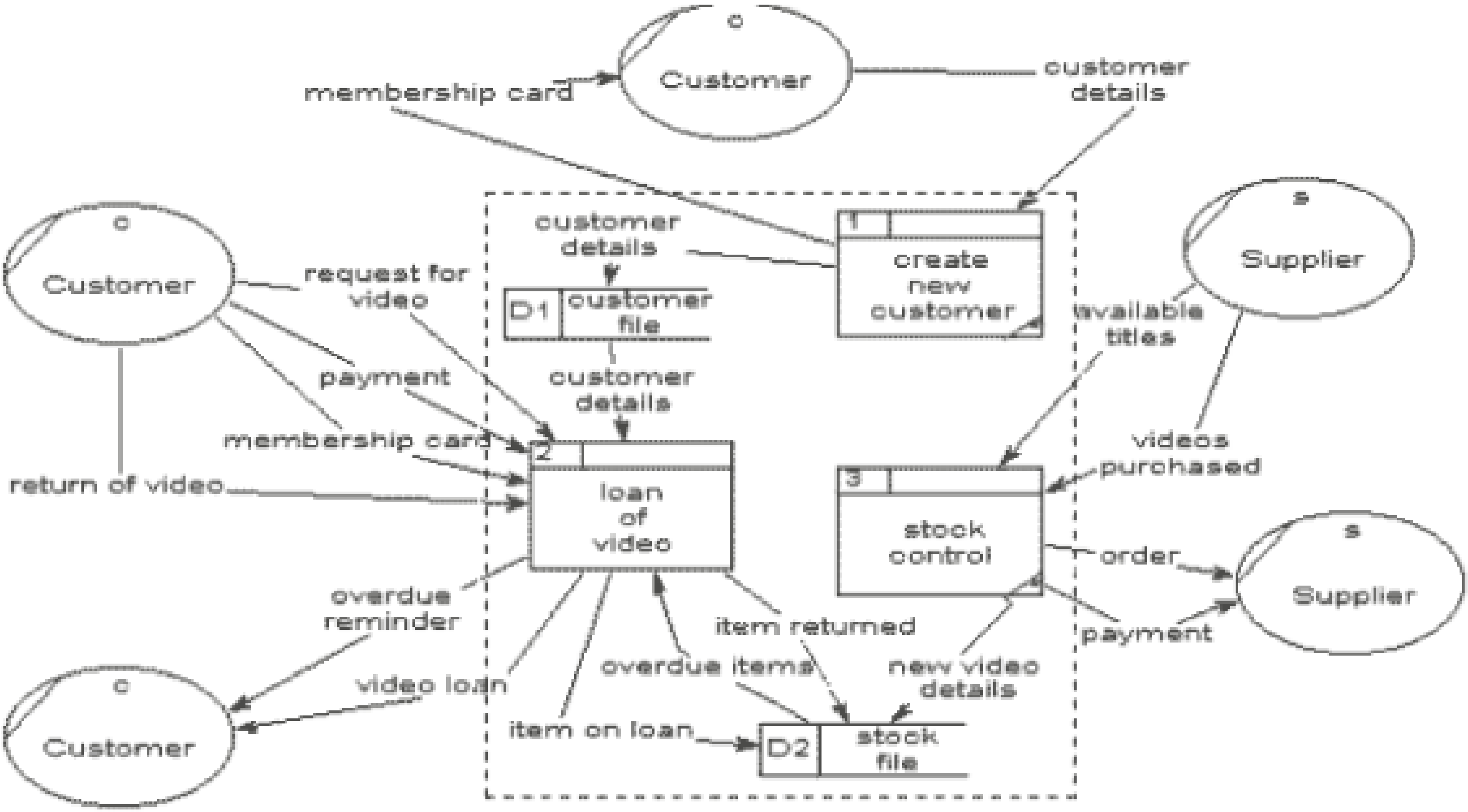
- The customer then returns the video to the store after watching it. If a loaned video is overdue by a day the customer's credit card is charged, and a reminder letter is sent to them. Each day after that a further card is made, and each week a reminder letter is sent. This continues until either the customer returns the video, or the charges are equal to the cost of replacing the video.

- New customers fill out a form with their personal details and credit card details, and the counter staff give the new customer a membership card. Each new customer's form is added to the customer file. The local video supplier sends a list of available titles to Video-Rental LTD, who decide whether to send them an order and payment. If an order is sent then the supplier sends the requested videos to the store. For each new video a new stock form is completed and placed in the stock file.

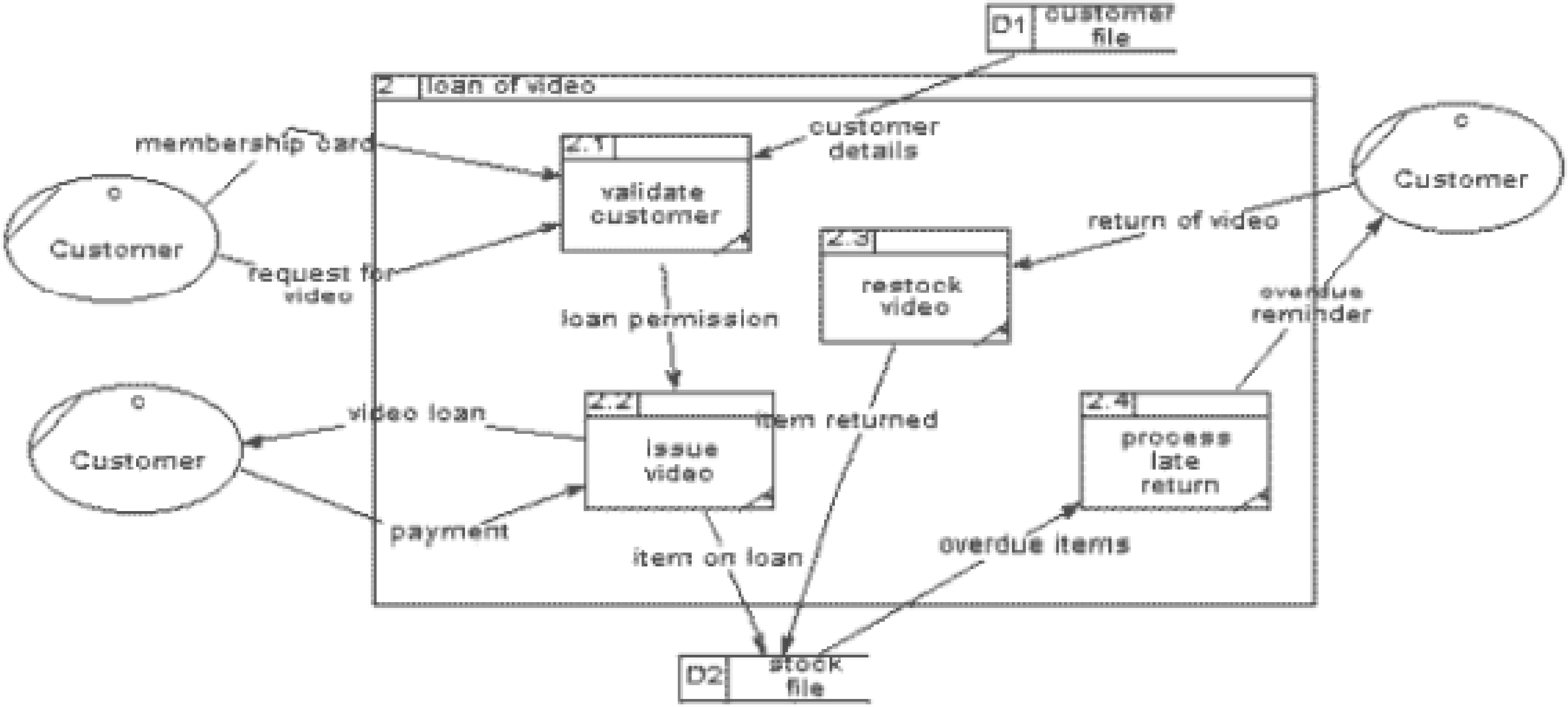
DFD – Example


customer details
payment
c
Customer
return of video
membership card
membership card
video loan
overdue reminder
request for video
Video Rental LTD
available titles
order
payment
videos purchased
s
Supplier

DFD – Example


c
Customer
membership card
customer details
c
Customer
request for video
payment
membership card
return of video
customer details
D1 customer file
customer details
1
create new customer
s
Supplier
available titles
videos purchased
2
loan of video
3
stock control
order
s
Supplier
payment
overdue reminder
video loan
c
Customer
item on loan
overdue items
item returned
new video details
D2 stock file

DFD – Example


D1 customer file
2 loan of video
membership card
customer details
C
Customer
2.1
validate customer
return of video
request for video
2.3
restock video
overdue reminder
loan permission
C
Customer
video loan
2.2
issue video
item returned
2.4
process late return
payment
item on loan
overdue items
D2 stock file

DFD – Example (Home Task)

1. Place Requests for CDs
   1. Customers will access the Internet system to look for CDs of interest. Some customers will search for special CDs or CDs by specific artists, while other customers want to browse for interesting CDs in certain categories (e.g. rock, jazz, classical).
   2. When the customer has found a CD he or she wants, the customer will check to see which store(s) have the CD in stock. They will use zip code to find stores close to their location.
   3. Customers can immediately place a hold on any CD in stock at any of the stores and then come into the store and pick it up (see requirement 3 below).
   4. If the CD is not available in the customer's preferred store, the customer can request that the CD be special ordered to that store for later pickup. The customer will be notified by e-mail when the requested CD arrives at requested store; the CD will be placed on hold (which will expire after 7 days). This process will work similarly to the current special order system.

DFD – Example (Home Task)

1. CD Marketing
   1. The Internet system provides an additional opportunity to market CDs to current and new customers. The system will provide a database of marketing materials about selected CDs that will help Web users learn more about them (e.g., music reviews, links to Web sites, artist information, and sample sound clips). When information about a CD that has additional marketing information is displayed, a link will be provided to the additional information.
   2. Marketing materials will be supplied primarily by vendors and record labels so that we can better promote their CDs. The Marketing Department will determine what marketing materials will be placed in the system and will be responsible for adding, changing and deleting the materials.

▪

1. Process In-store Holds
   1. When a CD is available in a store, the system will send a hold request to the in- store system at the selected store.
   2. The in-store system will alter the store staff (through an audible alarm and a pop- up message).
   3. Staff will print a label for the requested CD(s), pull them from the shelves, attach the label, and place them on the special order shelf. Just like the special orders, the hold items will be held for 7 days.
   4. Once the hold has been placed on the shelf, the staff will enter a hold confirmation, and the system will do an inventory adjustment to the main inventory database so that no other holds are accepted for the item.