System models

Behavioural models

- Behavioural models are used to describe the overall behaviour of a system.
- Two types of behavioural model are:
  - Data processing models that show how data is processed as it moves through the system
  - State machine models that show the systems response to events.
- These models show different perspectives so both of them are required to describe the system’s behaviour.

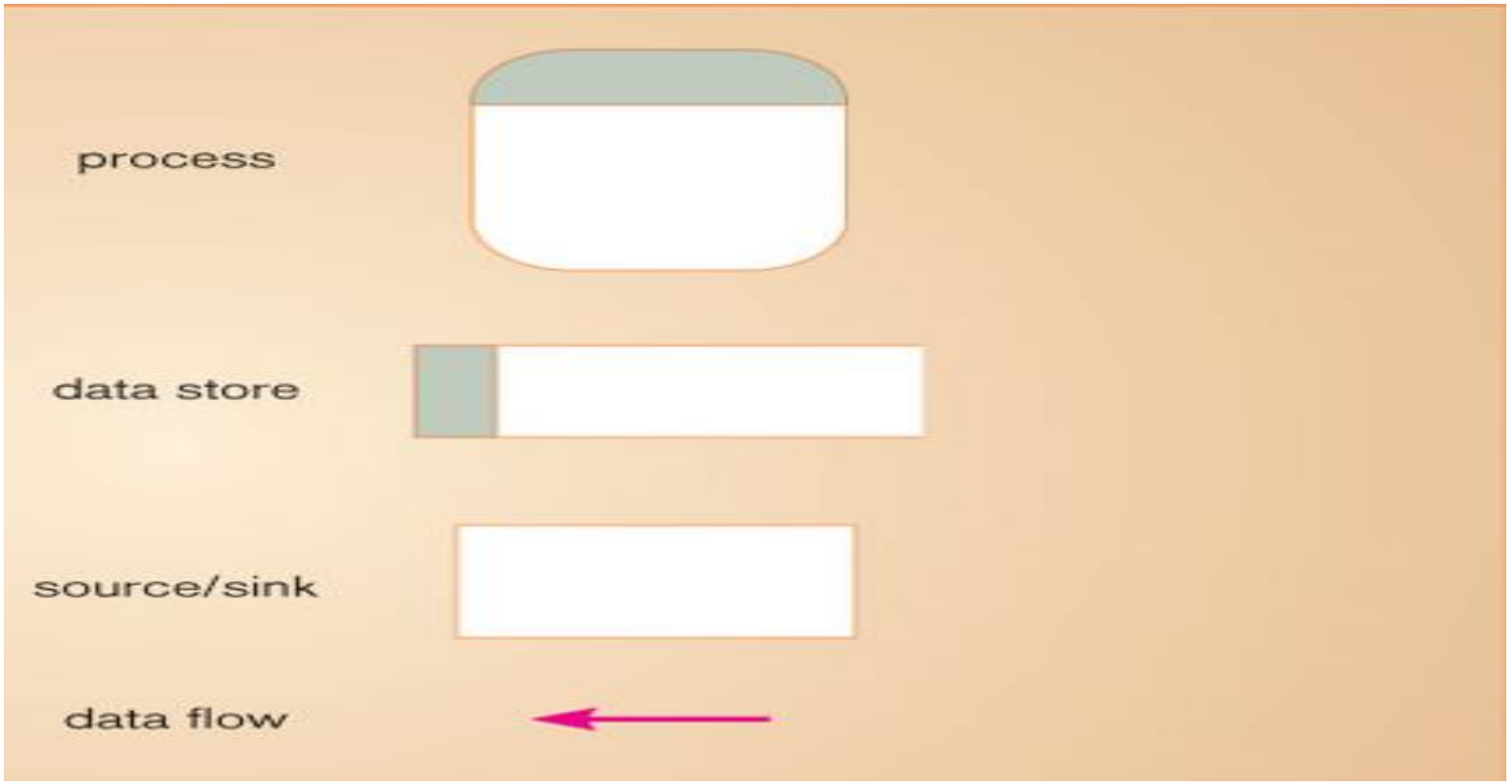
Data Flow Diagram (DFD)

The distinguishing features of DFDs are as follows:

1. Data flow diagrams capture the flow of data in a system.

2. It describes data origination, transformations and consumption in a system.

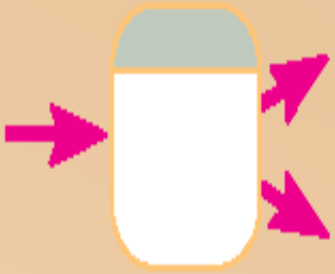
The DFD notation



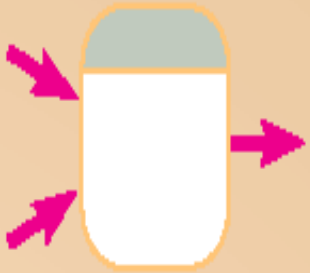
The DFD notation

- **Process:** work or actions performed on data (inside the system).
- **Data Store:** Data at rest (inside the system).
- **Source/ Sink:** External entity that is origin or destination of data (outside the system).
- **Data flow:** arrows depicting movement of data.

DFD Diagramming Rules
Process

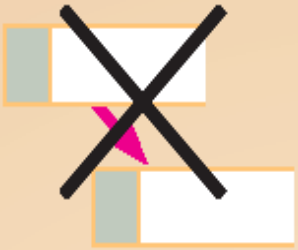


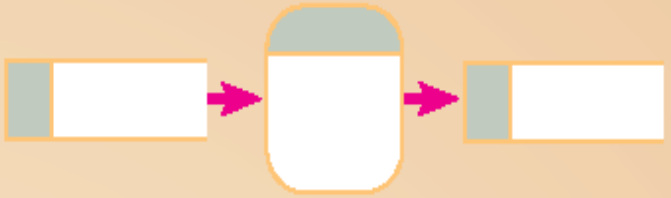
No process can have only outputs or only inputs. Processes must have both outputs and inputs.



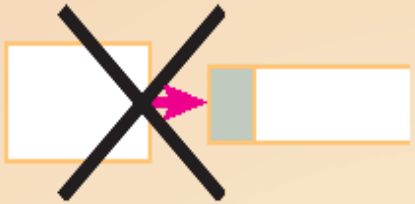
Process labels should be verb phrases.

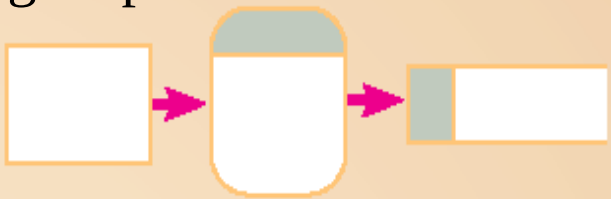
DFD Diagramming Rules
Data Store

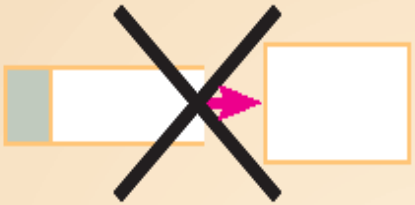


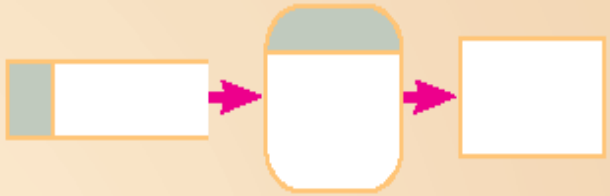


All flows to or from a data store must move through a process.









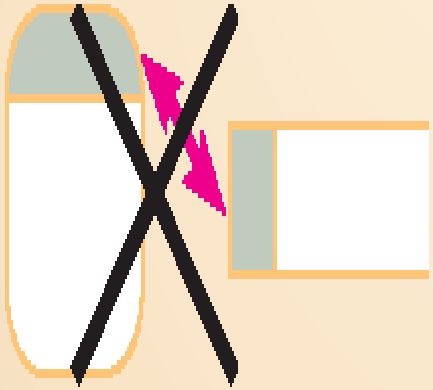
Data Store labels should be noun phrases.

DFD Diagramming Rules
Source/Sink

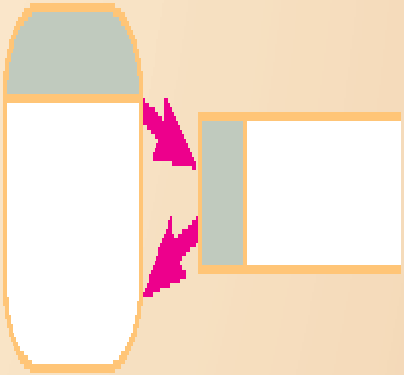
No data moves directly between external entities without going through a process.

Source and Sink labels should be noun phrases.

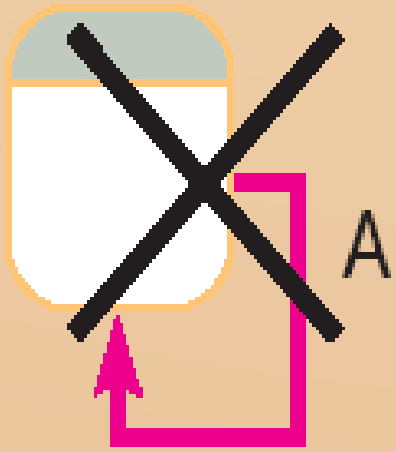
DFD Diagramming Rules
Data Flow



Bidirectional flow between process and data store is represented by two separate arrows.



DFD Diagramming Rules
Data Flow



Data flow cannot go directly from a process to itself, must go through intervening processes.

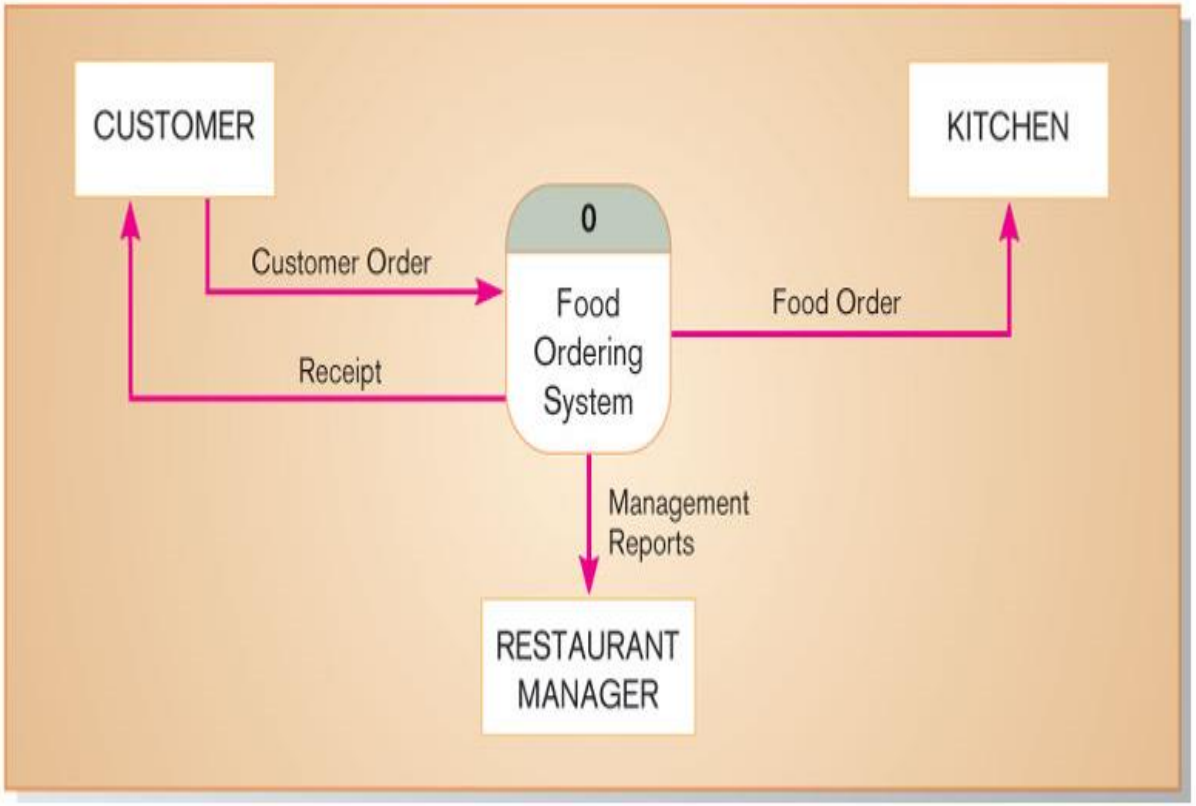
DFD Diagramming Rules
Data Flow

- Data flow from a process to a data store means update (insert, delete or change).
- Data flow from a data store to a process means retrieve or use.

DFD Levels

- Context DFD
- Level-0 DFD
- Level-1 DFD
- Level-n DFD

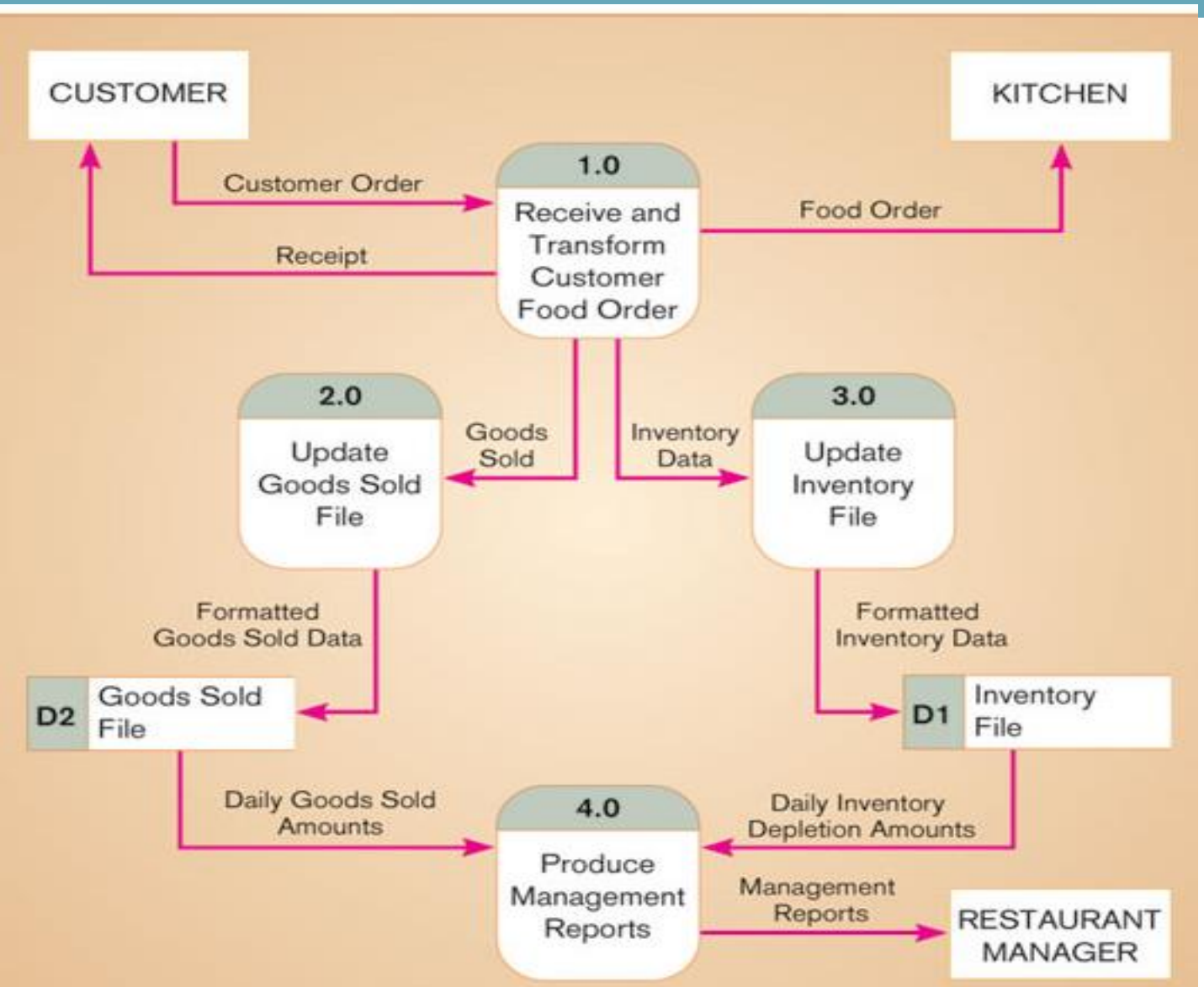
Context Diagram
of Burger's food ordering system



Context diagram shows the **system boundaries**, **external entities** that interact with the system, and **major information flows** between entities and the system.

NOTE: only one process symbol

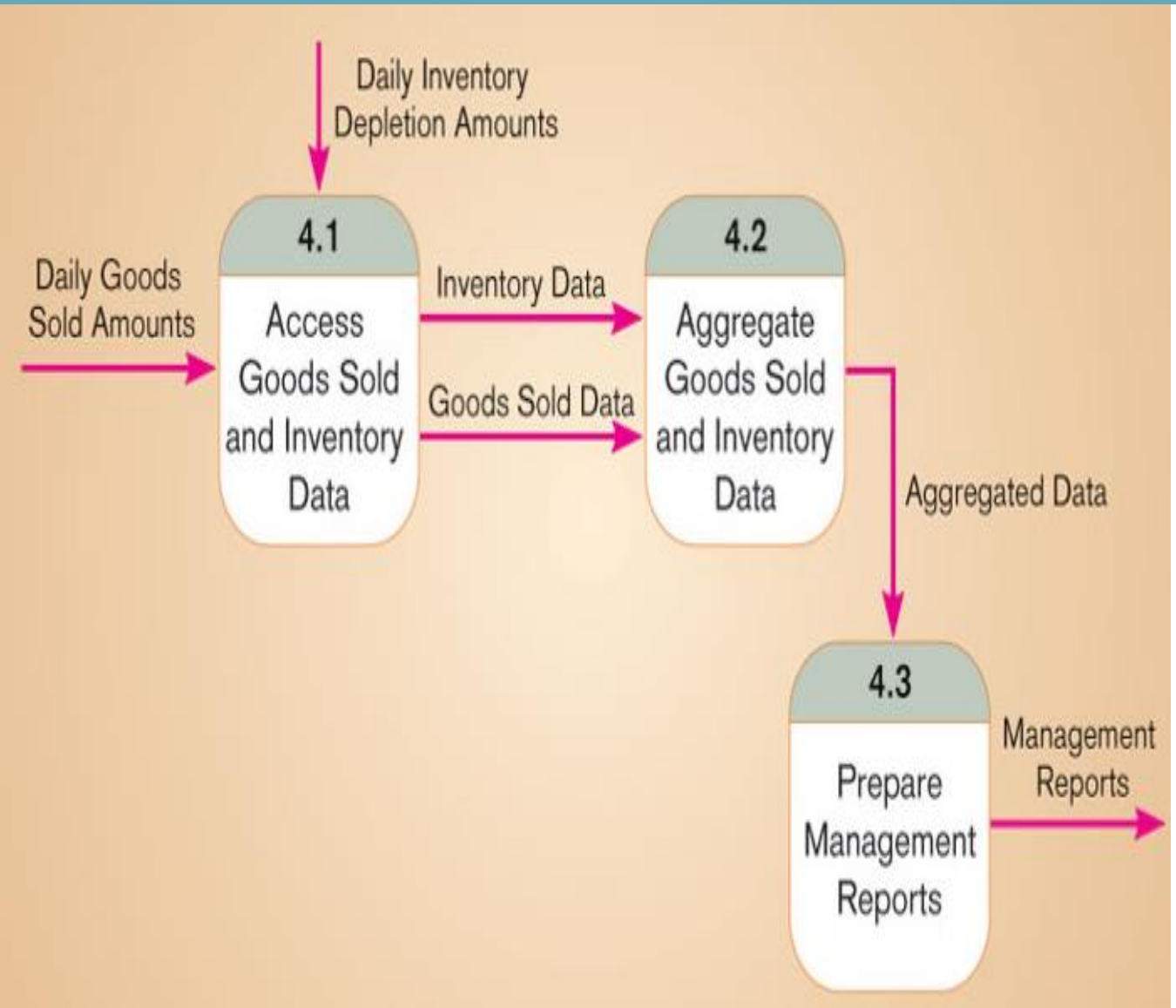
Level-0 DFD



Level-0 DFD shows the system's major processes, data flows, and data stores at a high level of abstraction.

Processes are labeled 1.0, 2.0, etc. These will be decomposed into more primitive (lower-level) DFDs.

Level-1 DFD

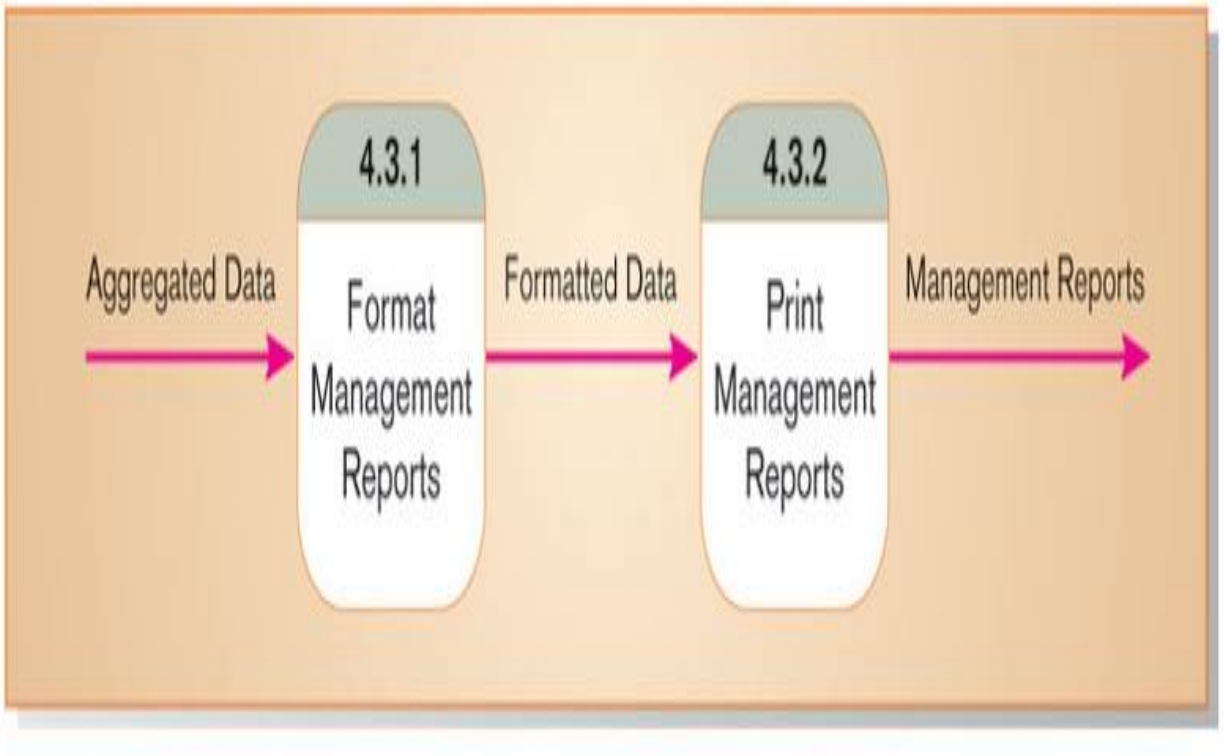


Level-1 DFD shows the sub-processes of one of the processes in the Level-0 DFD.

This is a Level-1 DFD for Process 4.0.

Processes are labeled 4.1, 4.2, etc. These can be further decomposed in more primitive (lower-level) DFDs if necessary.

Level-n DFD



Level-*n* DFD shows the sub-processes of one of the processes in the Level *n-1* DFD.

This is a Level-2 DFD for Process 4.3.

Processes are labeled 4.3.1, 4.3.2, etc. If this is the lowest level of the hierarchy, it is called a *primitive DFD*.

Draw a context level data flow diagram for a patient monitoring system.

Process of patient monitoring system:

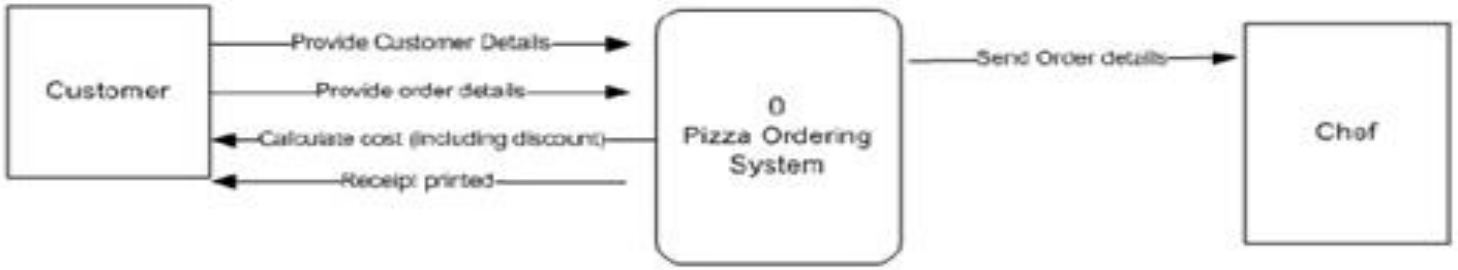
A patient's vital signs are transmitted to this system, which may invoke a warning message to the nurse if these signs fall into the critical range. Nurse may request for a report, which the patient monitoring system retrieves from the patient log, and returns it to the nurse again.

Consider the following case study and answer the questions written at the end of text.

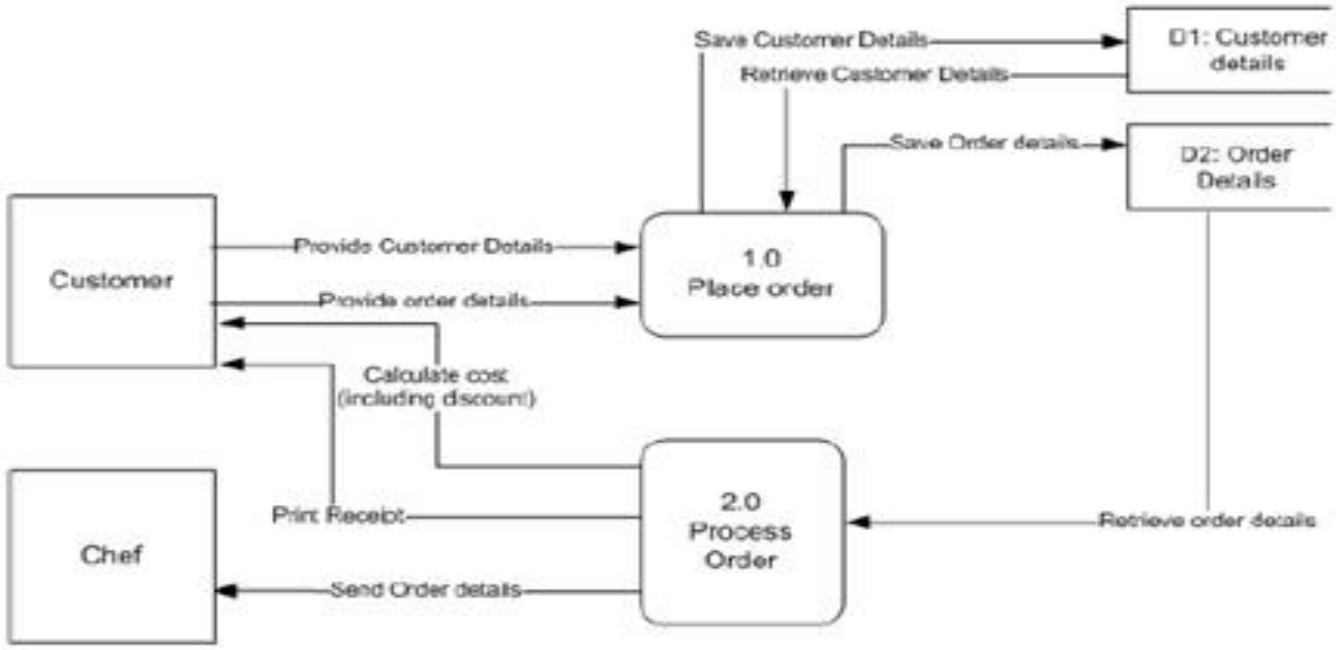
“ Pizza Express wants to install a new software system to record orders for take-away pizza. When regular customers call Pizza Express on the phone, they are asked their phone number. When the phone number is typed into the software system, the name, address, and last order date is automatically displayed on the screen. Once the order is taken the total cost (including delivery and any applicable discount) is calculated. A receipt is printed. The order is then given to the chef to make the pizza. Occasionally, special offers (coupons) are printed so that the customer can get a discount. Drivers who make deliveries of the pizza give customers a copy of the receipt and a coupon (if any). Weekly totals are kept for comparison with last year’s performance.”

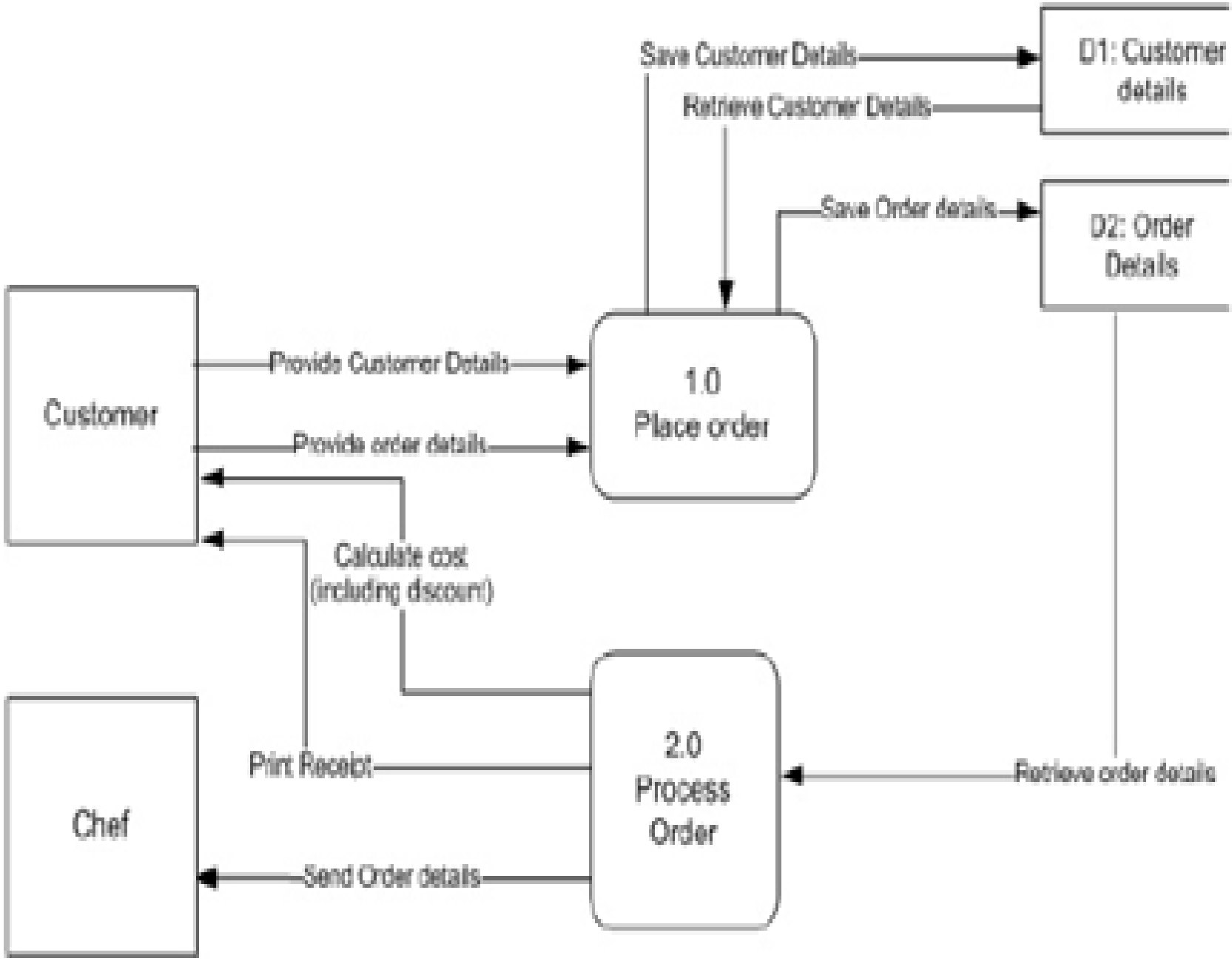
- Develop the Context Level DFD and DFD Level 0 Diagram for the above scenario.

Context Diagram for Pizza Express



Level-1 Diagram for Pizza Express




Save Customer Details
D1: Customer details
Retrieve Customer Details
Save Order details
D2: Order Details
Customer
Provide Customer Details
1.0 Place order
Provide order details
Calculate cost (including discount)
Chef
Print Receipt
2.0 Process Order
Retrieve order details
Send Order details

Exercise1:Draw Context and Level 0 DFD

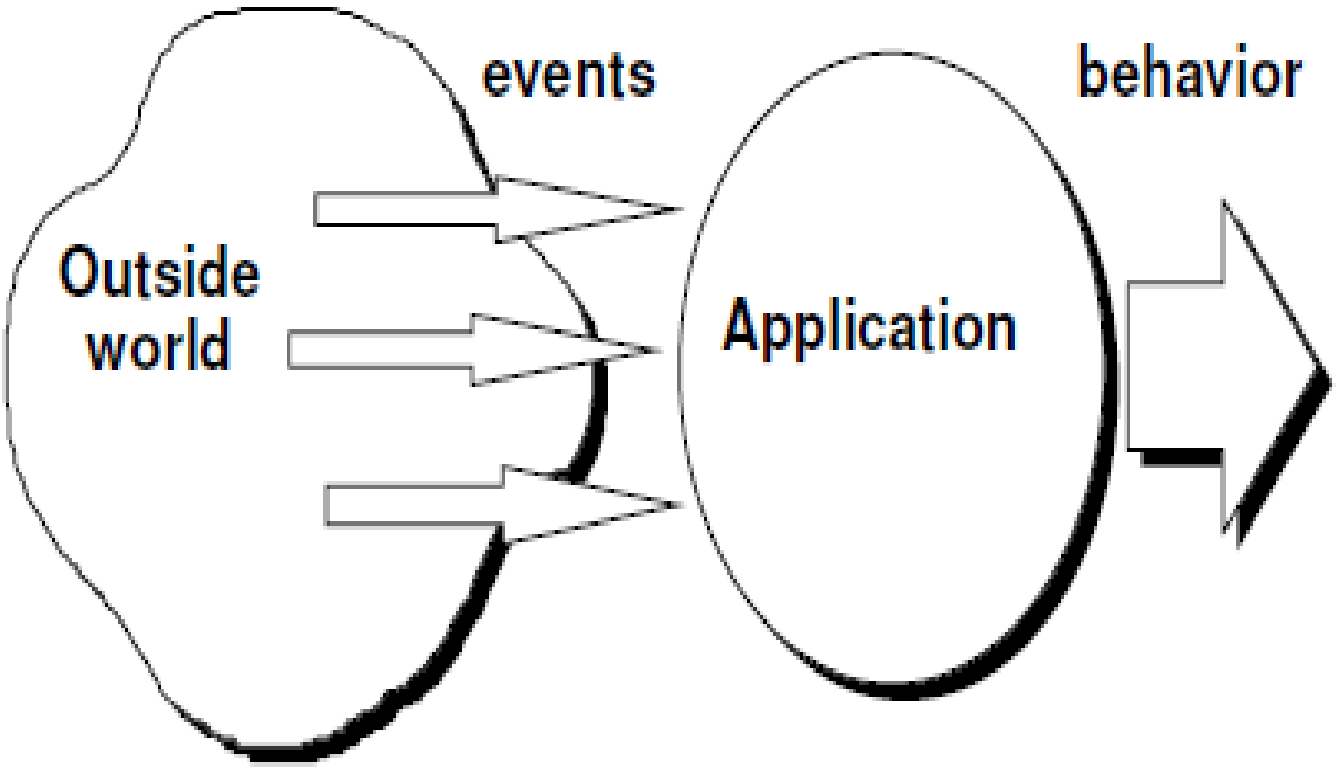
A fifth-grade class uses a simple word processing program to create the class newspaper. Every month the teacher makes a list of different topics. Each student writes an article on one of the topics and stores it on his or her own floppy disk. Students read and edit one another's article files. A final version of each of the articles is then created. These individual master copies are cut and pasted by the newspaper editor to produce the paper. Copies are then made and distributed to the entire school.

Exercise2:Draw Context and Level 0 DFD

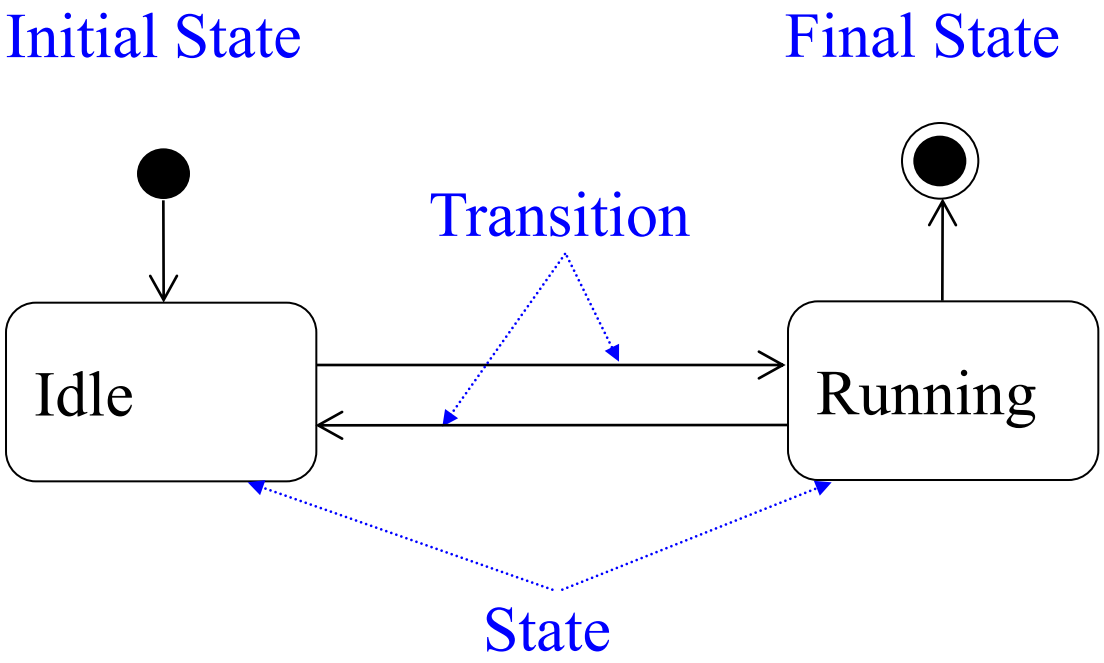
Grocery store checkers at Big Bob's Supermarket use a scanner that reads universal product bar codes (UPC). The bar code for each purchase is translated by the special-purpose computer (the cash register), accessing a product file. This translation triggers a voice output of the price. The product type and the price of each purchase are stored in a file to be used in printing the receipt. After all purchases have been scanned, a receipt is produced and given to the customer.

State machine models

- A state machine model describes how a system responds to internal or external events.
- It shows a system states and events that cause transitions from one state to another
- It does not show the flow of data within system.
- This type of model is often used for modelling real-time systems.
- Model uses a notation called state charts


events
behavior
Outside world
Application

Elements of State chart

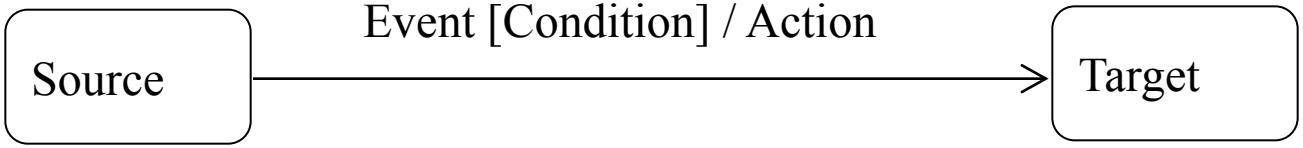


State

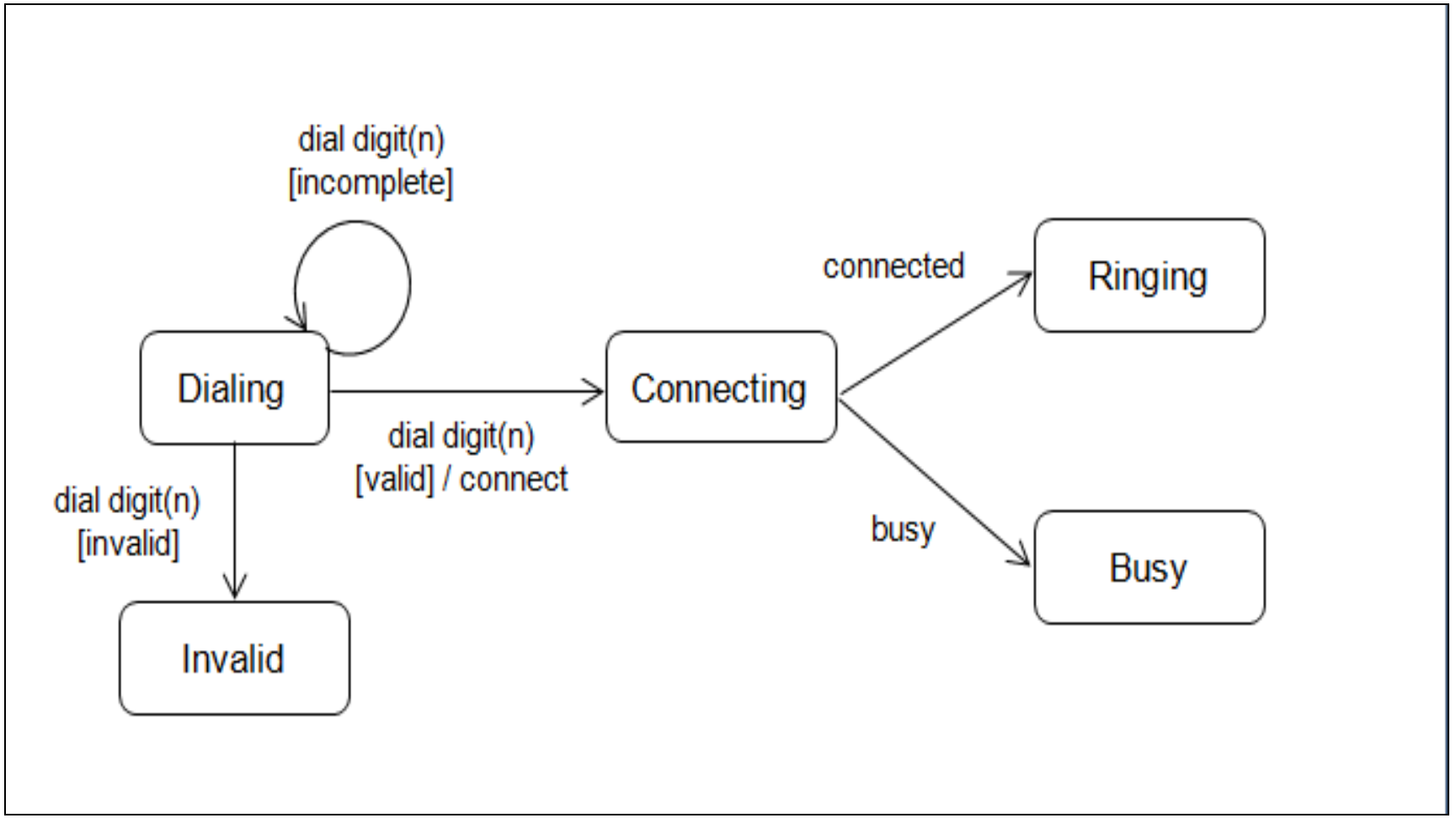
- Condition or situation in the life of a system (or object) during which it:
  - Satisfies some condition
  - Performs some activity
  - Waits for some events

Transition

- Relationship between two states indicating that a system (or object) in the first state will:
  - Perform certain actions
  - Enter the second state when specified event occurs and specified condition is satisfied.
- Consists of:
  - Source and target states
  - *event ,action*



Example


dial digit(n)
[incomplete]
Dialing
dial digit(n)
[valid] / connect
Connecting
connected
Ringing
busy
Busy
dial digit(n)
[invalid]
Invalid