Systems Analysis and Design

Alan Dennis, Barbara Haley Wixom, and Roberta Roth
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Slides by Candace S. Garrod
Red Rocks Community College
Data Flow Diagrams

Chapter 5
Key Definitions

✓ **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 diagramming**
  - A common technique for creating process models
Key Definitions

- **Logical** process models describe processes without suggesting how they are conducted.

- **Physical** process models provide information that is needed to build the system.
DATA FLOW DIAGRAMS (DFD)
Reading a DFD

DFD for Appointment System:
- **Patient**
  - Get Patient Name and Address
  - Check Patient Status
  - Get Appointment Type
  - Schedule Appointment
- **D1 Patients**
- **D2 Appointments**
- **Process Steps**
  1.1 Get Patient Name and Address
  1.2 Check Patient Status
  1.3 Get Appointment Type
  1.4 Cancel Appointment
  1.5 Schedule Appointment
- **Data Flows**
  - Patient Info
  - Appointment Type
  - Desired Appointment Confirmation
  - Cancelation Confirmation
  - Appointment Selection
  - Potential Appointment
  - Patient Name Changing Appointment
Elements of a DFD

Process
- An activity or function performed for a specific business reason
- Manual or computerized

Data flow
- A single piece of data or a logical collection of data
- Always starts or ends at a process
DFD Elements

Data Store
- A collection of data that is stored in some way
- Data flowing out is retrieved from the data store
- Data flowing in updates or is added to the data store

External entity
- A person, organization, or system that is **external** to the system but interacts with it.
Naming and Drawing DFD Elements

<table>
<thead>
<tr>
<th>Data Flow Diagram Element</th>
<th>Typical Computer-Aided Software Engineering Fields</th>
<th>Gane and Sarson Symbol</th>
<th>DeMarco and Yourdan Symbol</th>
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</thead>
<tbody>
<tr>
<td><strong>Every process has</strong></td>
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<td><strong>Every external entity has</strong></td>
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Using a DFD to Define Business Processes

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 diagrams show a portion of the parent diagram in greater detail
Key Definition

Balancing involves insuring that information presented at one level of a DFD is accurately represented in the next level DFD.
Relationship among Levels of DFDs

Context diagram

Level 0 diagram

Level 1 diagram

Level 2 diagram
Context Diagram

- First DFD in every business process
- Shows the context into which the business process fits
- Shows the overall business process as just one process (process 0)
- Shows all the external entities that receive information from or contribute information to the system
Level 0 Diagram

☑ 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
☑ Adds data stores
Level 1 Diagrams

- 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, these three child processes wholly and completely make up the parent process.
Level 2 Diagrams

- 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
- Correctly numbering each process helps the user understand where the process fits into the overall system
Alternative Data Flows

- Where a process can produce different data flows given different conditions
- We show both data flows and use the process description to explain why they are alternatives
- Tip -- alternative data flows often accompany processes with IF statements
Your Turn

- At this point in the process it is easy to lose track of the “big picture”.
- Describe the difference between data flows, data stores, and processes.
- Describe in your own words the relationship between the DFD and the ultimate new application being developed.
Process Descriptions

- Text-based process descriptions provide more information about the process than the DFD alone.
- If the logic underlying the process is quite complex, more detail may be needed in the form of:
  - Structured English
  - Decision trees
  - Decision tables
CREATING DATA FLOW
DIAGRAMS
Integrating Scenario Descriptions

- DFDs start with the use cases and requirements definition
- Generally, the DFDs integrate the use cases
- Names of use cases become processes
- Inputs and outputs become data flows
- “Small” data inputs and outputs are combined into a single flow
Steps in Building DFDs

- Build the context diagram
- Create DFD fragments for each use case
- Organize DFD fragments into level 0 diagram
- Decompose level 0 processes into level 1 diagrams as needed; decompose level 1 processes into level 2 diagrams as needed; etc.
- Validate DFDs with user to ensure completeness and correctness
Creating the Context Diagram

- Draw one process representing the entire system (process 0)
- Find all inputs and outputs listed at the top of the use cases that come from or go to external entities; draw as data flows
- Draw in external entities as the source or destination of the data flows
A Context Diagram Example
Creating DFD Fragments

- Each use case is converted into one DFD fragment
- Number the process the same as the use case number
- Change process name into verb phrase
- Design the processes from the viewpoint of the organization running the system
Creating DFD Fragments

- Add data flows to show use of data stores as sources and destinations of data

- Layouts typically place
  - processes in the center
  - inputs from the left
  - outputs to the right
  - stores beneath the processes
A DFD Fragment Example
Creating the Level 0 Diagram

- Combine the set of DFD fragments into one diagram
- Generally move from top to bottom, left to right
- Minimize crossed lines
- Iterate as needed

**DFDs are often drawn many times before being finished, even with very experienced systems analysts**
A Level 0 DFD Example
Creating Level 1 Diagrams (and Below)

- Each use case is turned into its own DFD
- Take the steps listed on the use case and depict each as a process on the level 1 DFD
- Inputs and outputs listed on use case become data flows on DFD
- Include sources and destinations of data flows to processes and stores within the DFD
- May also include external entities for clarity
Creating Level 1 Diagrams (and Below)

When to stop decomposing DFDs?

Ideally, a DFD has at least three processes and no more than seven to nine.
Validating the DFD

Syntax errors – diagram follows the rules

Assure correct DFD structure

For each DFD:

Check each process for:

- A unique name: action verb phrase; number; description
- At least one input data flow
- At least one output data flow
- Output data flow names usually different than input data flow names
- Between 3 and 7 processes per DFD
Validating the DFD

For each DFD:

Check each **data flow** for:
- A unique name: noun; description
- Connects to at least one process
- Shown in only one direction (no two-headed arrows)
- A minimum number of crossed lines

Check each **data store** for:
- A unique name: noun; description
- At least one input data flow
- At least one output data flow

Check each **external entity** for:
- A unique name: noun; description
- At least one input or output data flow
Validating the DFD

Across DFDs:

**Context Diagram:**
Every set of DFDs must have one Context Diagram

**Viewpoint:**
There is a consistent viewpoint for the entire set of DFDs

**Decomposition:**
Every process is wholly and complete described by the processes on its children DFDs

**Balance:**
Every data flow, data store, and external entity on a higher level DFD is shown on the lower level DFD that decomposes it. No data stores or data flows appear on lower-level DFDs that do not appear on their parent DFD.
Validating the DFD

- Semantics errors – diagram conveys correct meaning
  - Assure accuracy of DFD relative to actual/desired business processes

- To verify correct representation, use
  - User walkthroughs
  - Role-play processes

- Examine lowest level DFDs to ensure consistent decomposition

- Examine names carefully to ensure consistent use of terms
A Quick Review of Decomposition for CD Selections
Context Diagram for CD Selections
Internet Sales System
Level 0 DFD for CD Selections Internet System
Level 1 DFD for CD Selections Process 1: Take Requests
Summary

☑ The Data Flow Diagram (DFD) is an essential tool for creating formal descriptions of business processes.

☑ Use cases record the input, transformation, and output of business processes and are the basis for process models.

☑ Eliciting use cases and modeling business processes are critically important skills for the systems analyst to master.