SOFTWARE ENGINEERING

Week 11
Design Engineering - II

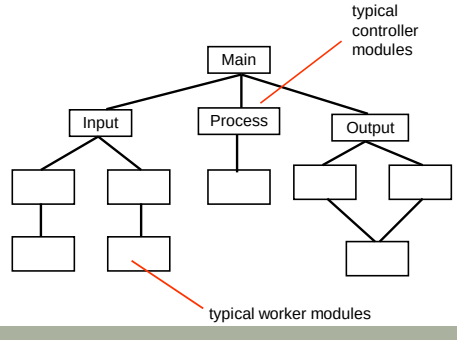
Agenda

1. Deriving Program Architecture
   1. Transform Mapping
   2. Transaction Mapping
2. Examle: SafeHome security system

Software Structure

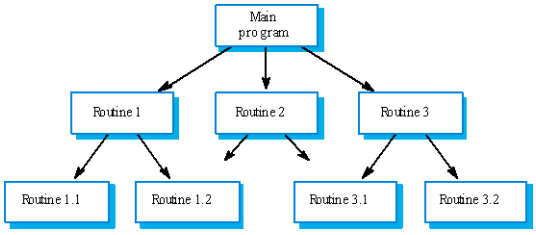
- Data Flow Diagrams provide the basis for software design.
- Data Flow Diagram will be mapped to build a hierarchical program structure chart.
- The structure chart is also called the software architecture.
- Structure chart representation defines the control hierarchy that connects modules in the system to one another.

General Program Structure Chart

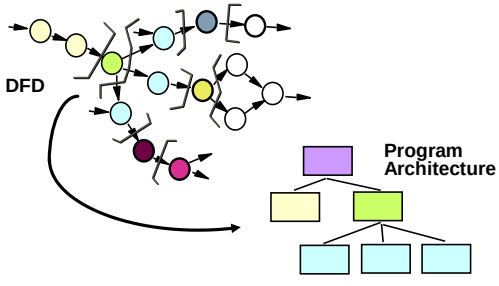


Call-return Model

- A control subroutine takes responsibility for managing the execution of other subroutines.
- Top-down model where control starts at the top of a hierarchy and moves downwards.

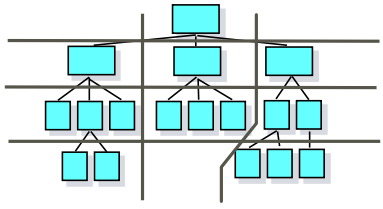


Deriving Program Architecture



Partitioning (factoring) the Architecture

- Horizontal and Vertical partitioning are required



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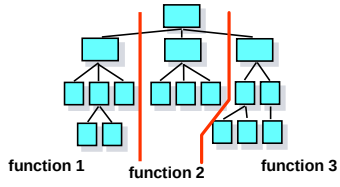
Vertical Partitioning

- define separate branches of the hierarchy for each major function group
- use control modules to coordinate communication between functions



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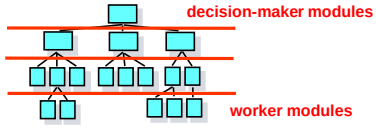
Horizontal Partitioning

- design so that modules are layered
- decision making modules should reside at the top of the architecture



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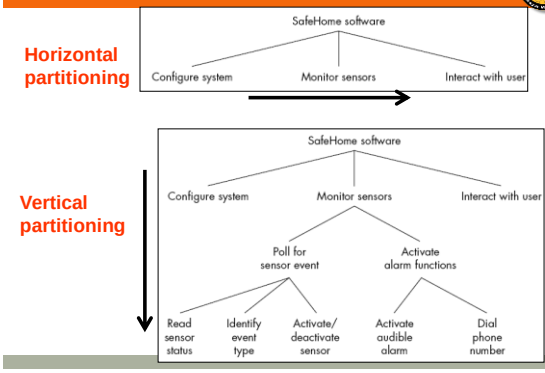
Example: SafeHome



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Why Partitioned Architecture?

- results in software that is easier to test
- leads to software that is easier to maintain
- results in propagation of fewer side effects
- results in software that is easier to extend

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Mapping from Data Flow Diagram to Structure Chart

- There are two types of data flows in DFD:
  - **Transform flow:** overall data flow is sequential and flows along a small number of straight line paths.
  - **Transaction flow:** a single data item triggers information flow along one of many paths.
- First step is to determine flow boundaries in DFD.
- Second step is to map the DFD into a program structure.

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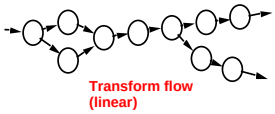
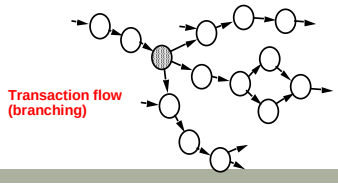
Flow Characteristics



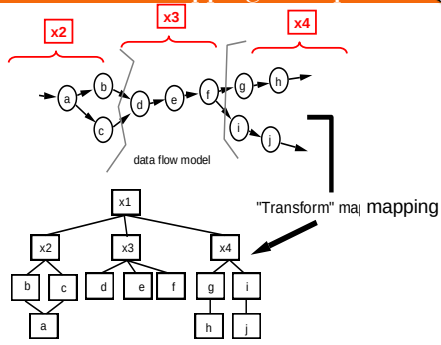


Transform Mapping

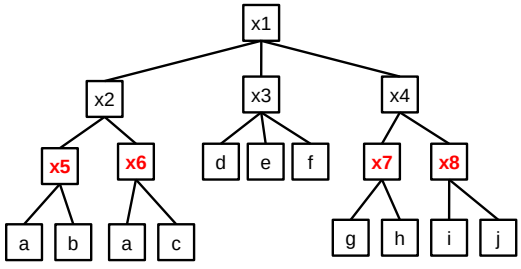
Transform Mapping

- Determine that the DFD has transform characteristics
- Isolate the transform center by specifying incoming and outgoing flow boundaries
- Add control modules as required (control hierarchy)
  - Perform levels of structuring

Transform Mapping Example

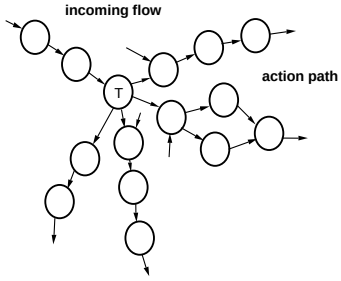


Example : Alternative mapping



Transaction Mapping

Transaction Flow



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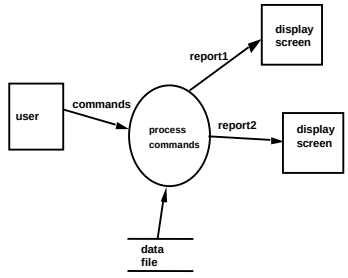
Transaction Example



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Transaction Mapping

- Determine that the DFD has transaction characteristics
- Identify the transaction center and flow characteristics along each action path
- Map the DFD to a program structure consistent with transaction processing
- Refine the transaction structure and the structure of each action path

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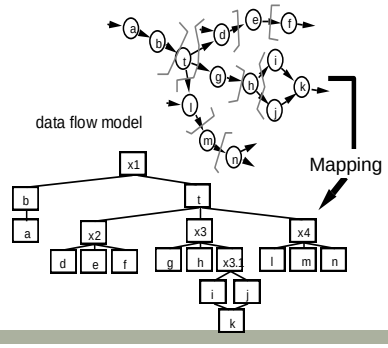
Transaction Mapping Example (1)



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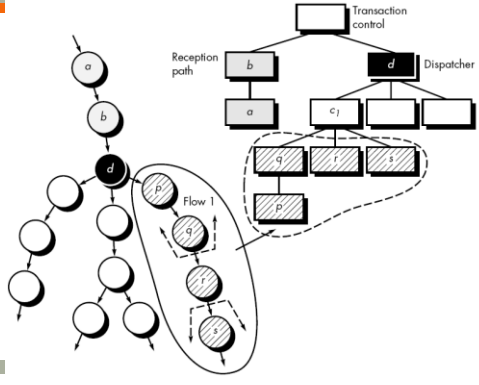
Transaction Mapping Example (2)



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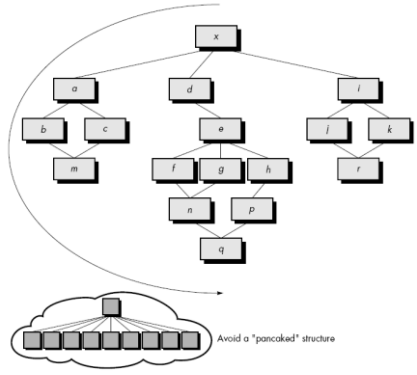
Avoid Flat Structure



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Example:

SafeHome security system

SafeHome Product Definition

The product, called SafeHome, is a microprocessor based home security system (**embedded**) that would protect against burglary, fire, flooding and others.

- It will be configured by the homeowner.
- It will use appropriate sensors to detect each emergency situation.
- It will automatically make a telephone call to a monitoring agency (police, fire brigade) when a situation is detected.

Statement of Software Scope (1)

SafeHome software ***enables*** the homeowner to ***configure*** the security system when ***installed***, ***monitors*** all sensors ***connected*** to the security system, and ***interacts*** with the homeowner through a keypad and function keys ***contained*** in the SafeHome control panel.

During installation, the SafeHome control panel is ***used to "program" and configure*** the system. Each sensor is ***assigned*** a number and type, a master password for ***arming*** and ***disarming*** the system, and telephone numbers are ***input for dialing*** when a sensor event occurs.

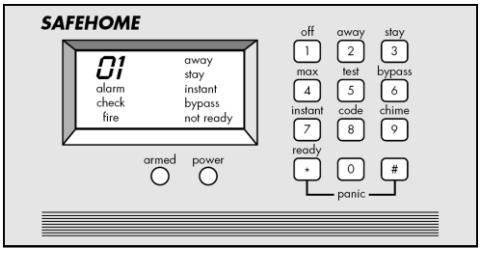
- Data objects: Underlined nouns
- *Processes: Italic verbs*

Statement of Software Scope (2)

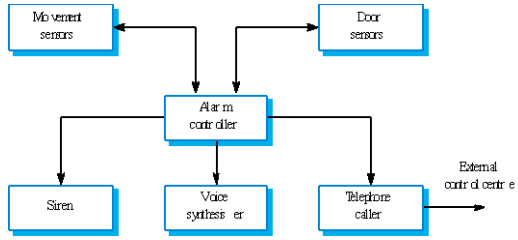
When a sensor event is ***recognized***, the software ***invokes*** an audible alarm attached to the system. After a delay time, that is ***specified*** by the homeowner during the system configuration activities, the software dials a telephone number of a monitoring service agency, ***provides*** information about the location, ***reporting*** the nature of the event that has been detected. The telephone number will be ***redialed*** every 20 seconds until telephone connection is ***obtained***.

All interaction with SafeHome is ***managed*** by a user-interaction subsystem that ***reads*** input provided through the keypad and function keys, ***displays*** prompting messages and system status on the LCD display. Keyboard interactions takes the following form: (continues...)

SafeHome Control Panel



SafeHome "Alarm sub-system"



Alarm sub-system descriptions

Sub-system	Description
Movement sensors	Detects movement in the rooms monitored by the system
Door sensors	Detects door opening in the external doors of the building
Alarm controller	Controls the operation of the system
Siren	Emits an audible warning when an intruder is suspected
Voice synthesizer	Synthesizes a voice message giving the location of the suspected intruder
Telephone caller	Makes external calls to notify security, the police, etc.

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Customer Requirements

Objects:
- Smoke detectors
- Door and window sensors
- Motion detectors
- An audio-alarm
- A control panel with a display screen
- Telephone numbers to call

Services:
- Setting the alarm
- Monitoring the sensors
- Dialing the phone
- Programming the control panel
- Reading the display

Performance Criterias:
- A sensor event should be recognized within one second
- An event priority scheme should be implemeted

Constraints:
- Must be user friendly
- Must interface directly to a standard phone line

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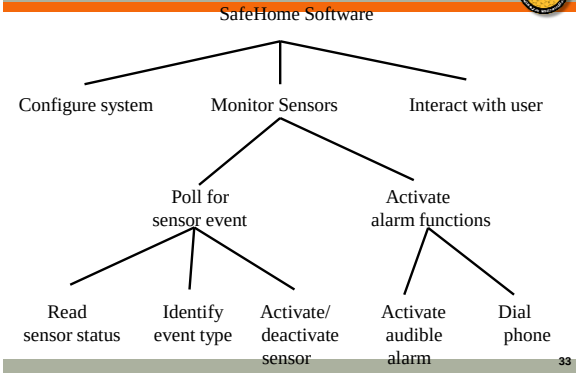
SafeHome Functions



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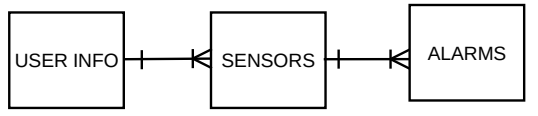
SafeHome Entity Relationship Diagram



- address
- password

- sensor ID
- sensor name
- sensor type (smoke, thief, etc)
- sensor location

- sensor ID
- alarm type
- time-out duration
- phone number
- agency name
- message (sound or text)

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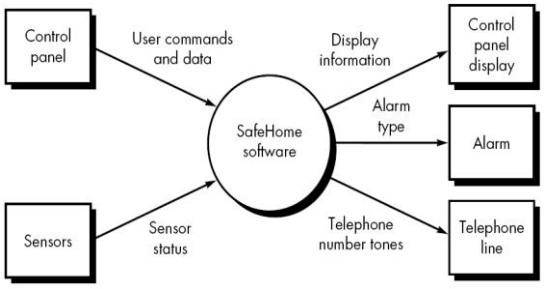
Level-0 DFD



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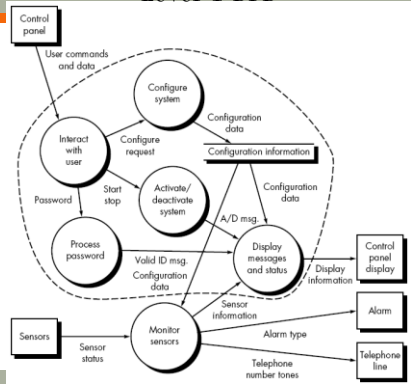
Level-1 DFD



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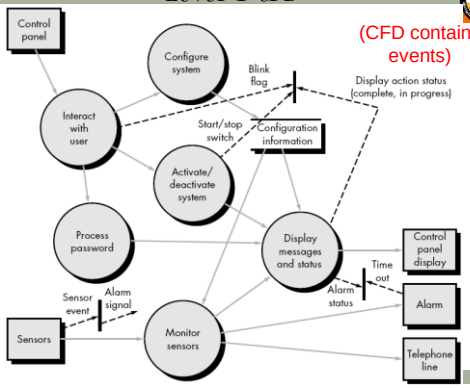
Level-1 CFD



(CFD contains events)

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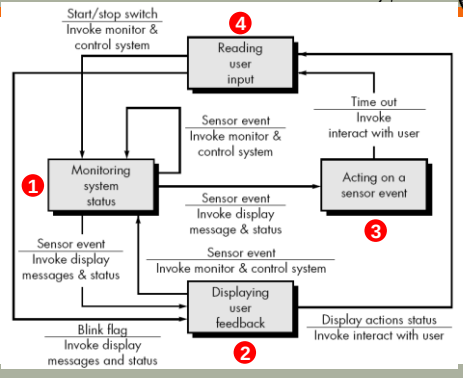
SafeHome State Transition Diagram



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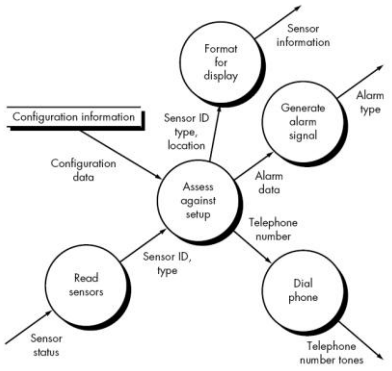
Level-2 DFD ("Monitor sensors")



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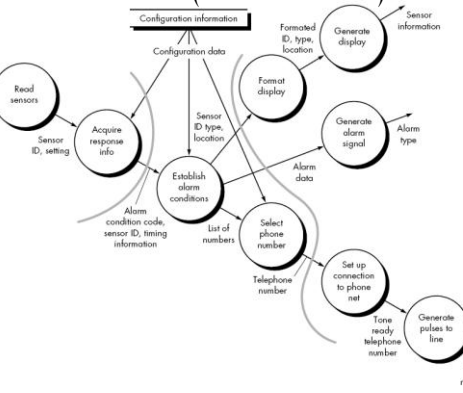
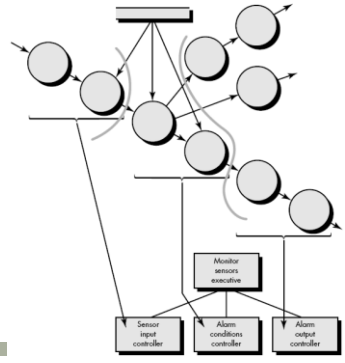
Level-3 DFD ("Monitor sensors")



Program Structure: First factoring ("Monitor sensors")



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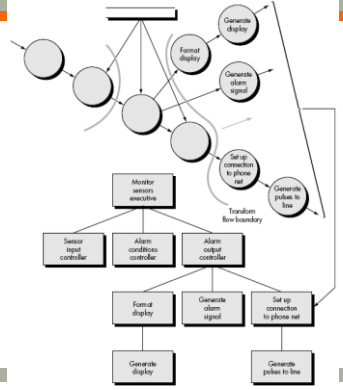
Program Structure: Second factoring



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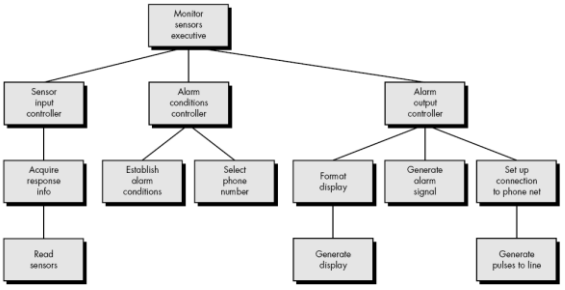
Program Structure: ("Monitor sensors")



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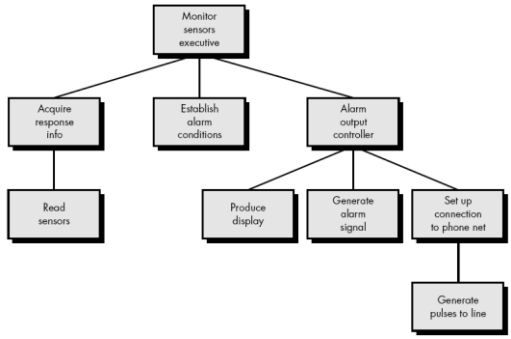
Refined Program Structure: ("Monitor sensors")



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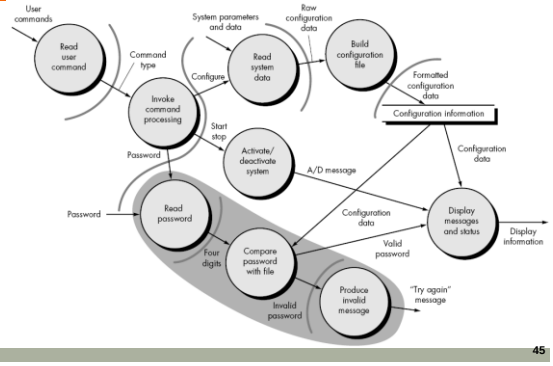
Level-2 DFD (user interaction subsystem)



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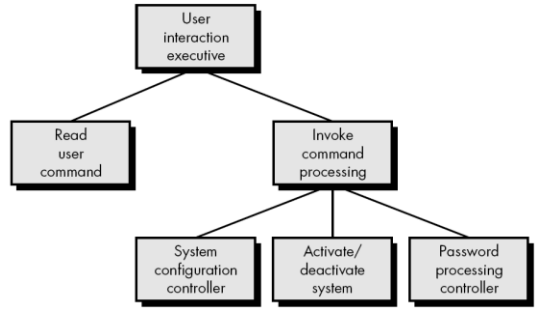
Program Structure: First factoring (user interaction subsystem)



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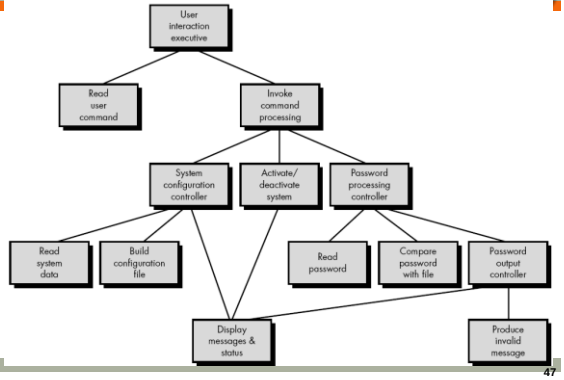
Program Structure:(user interaction subsystem)



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