SFWR ENG 3A04: Software Design II

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Acknowledgments: Material based on *Software Architecture Design* by Tao et al. (Chapter 5)

Outline of Part I

1. Principle of Low Coupling and High Cohesion
2. Open-Closed Principle
3. Liskov substitution principle
4. Dependency Inversion Principle
5. Law of Demeter
6. Other Design Principles for Security
7. Questions???

Outline of Part II

Part I

Review of Previous Lecture

Part II

Today's Lecture

Data Flow Architecture Overview

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- The close loop process control is another typical data flow architecture style

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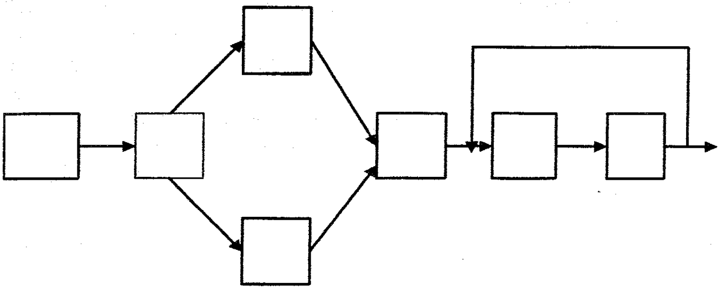

Figure: Block diagram of data flow architecture

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- RPG (Report Program Generator) and COBOL are two typical programming languages working on this model
- Each data transformation element cannot start its process until its previous element completes its computation
- Data flow carries a batch of data as a whole to move from one element to another

Data Flow Architecture Batch Sequential

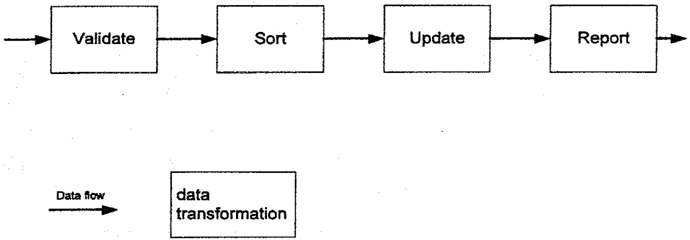

Figure: Batch sequential architecture

Data Flow Architecture Batch Sequential

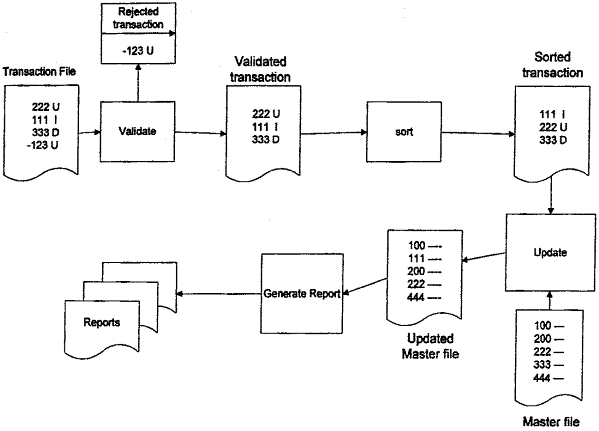

Figure: Batch sequential in business data processing

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scriptExample.sh

```
ls *.pdf > toto1
grep -ir ".pdf" toto1
 ls *.tex > toto2
cat toto1 toto2 > toto
mail john.do@mcmaster.ca < toto
```

mySHell.sh

```
(exec) searching kwd <inputFile> matchedFile
(exec) counting <matchedFile> countedFile
(exec) sorting <countedFile> myReportfile
```

- We can also implement the batch sequential software architecture at Programming language level

Data Flow Architecture Batch Sequential

```
public class batch_sequential
{
  . . .
  public static void main() {
      searching(kwd, inputFile, matchedFile);
      counting(matchedFile, countedFile);
      sorting (countedFile, reportFile);
  }

  public static void search(String kwd, String
      inFile, String outFile)
  { . . . }

  public static void counting(String inFile,
      String outFile)
  { . . . }

  public static void sorting(String inFile, String
      outFile)
  { . . . }
}
```

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- No interactive interface

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- A data stream is a first-in-first-out buffer type data structure
- Almost all operating system and programming languages provide data stream mechanism

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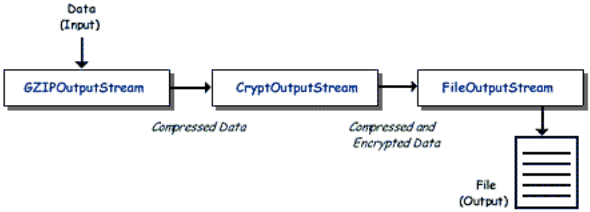
- A filter does not even know the identity of data upstream or data downstream
- A filter is just working in a local incremental mode

Example of Pipe and Filter Architecture



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- An object type data must be serialized to be able to go over a stream
- Serialization is the process of saving an object onto a storage medium or to transmit it across a network connection link in binary form

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- This process of serializing an object is also called deflating or marshalling an object
- The opposite operation, extracting a data structure from a series of bytes, is deserialization or unmarshalling

Serializing a structure (C language)

```
 #include "tpl.h"
struct ms_t {
    int i;
    char c[3];
    double f;
};
int main() {
    tpl_node *tn;
    struct ms_t ms = {1, {'a','b','c'}, 3.14};
    tn = tpl_map( "S(ic#f)", &ms, 3);
    tpl_pack( tn, 0 );
    tpl_dump( tn, TPL_FILE, "struct.tpl" );
    tpl_free( tn );
}
```

Deserializing a structure (C language)

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    int i;
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int main() {
    tpl_node *tn;
    struct ms_t ms;

    tn = tpl_map( "S(*)", &ms);
    tpl_load( tn, TPL_FILE, "struct.tpl" );
    tpl_unpack( tn, 0 );
    tpl_free( tn );
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  - It works with active pipes that pull data out from a filter and push data into next filter

Data Flow Architecture Pipe and Filter Architecture

solid lines indicate the class connections; dash lines indicate an alternative configuration for pipes

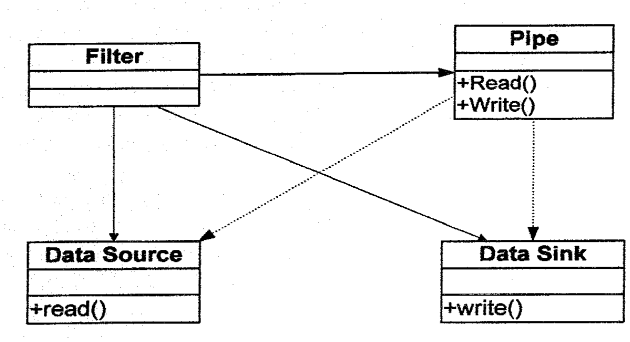

Figure: Pipe and active filter class diagram

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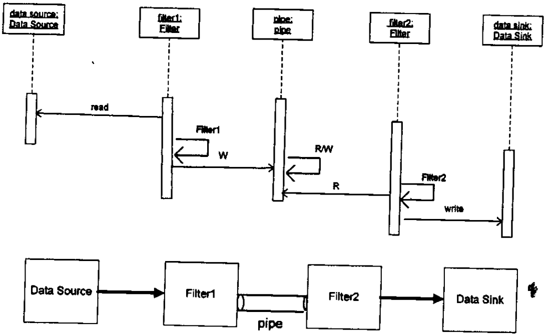

Figure: Pipe and filter block diagram and sequence diagram

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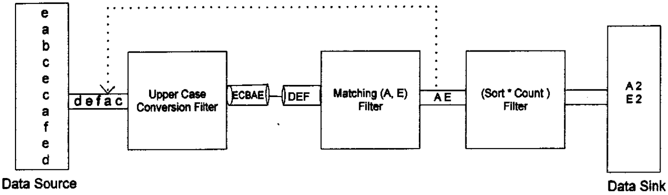

Figure: Pipelined pipe and filter

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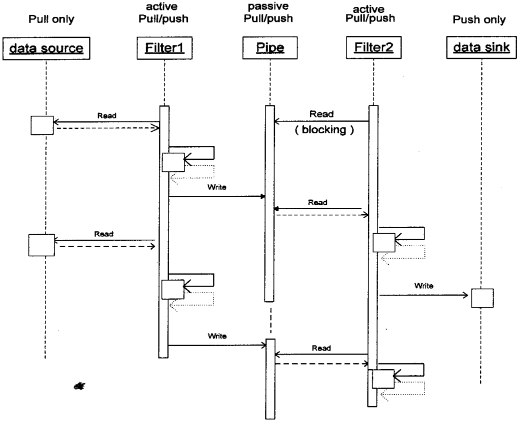

Figure: Pipe and filter sequence diagram

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  - Flexibility: It supports sequential + parallel execution

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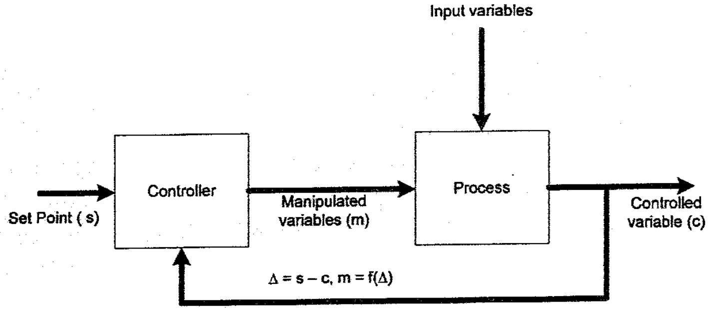

Figure: Data flow in the process control architecture

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Process-Control Architecture is subject of SFWR ENG 3DX3 Dynamic models and control of physical systems

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  - Example: speed in a cruise control system
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Process-Control Architecture is subject of SFWR ENG 3DX3 Dynamic models and control of physical systems

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- Manipulated variable: can be adjusted by the controller

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Data Flow Architecture Process-Control Architecture

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  - The software can be completely embedded in the devices
- Limitations: Can be unstable and requires a thorough mathematical analysis

Data Flow Architecture

What class model would be appropriate to implement a given data flow?

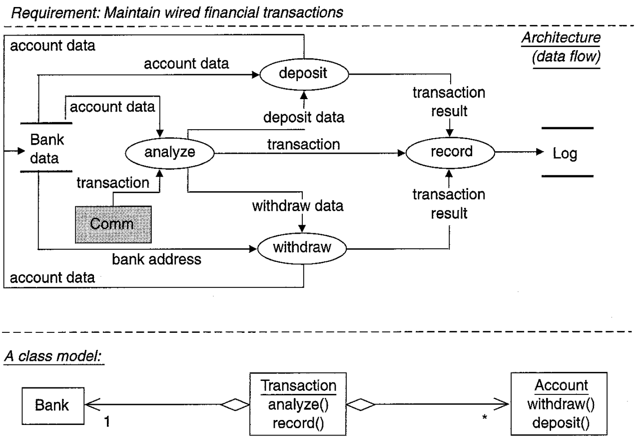

Figure: Example of Data Flow Architecture and Corresponding Class Model