# Chapter 10: Performance Patterns

# Patterns

- A pattern is a common solution to a problem that occurs in many different contexts
- Patterns capture expert knowledge about “best practices” in software design in a form
  - Allows knowledge to be reused
  - Applied in design of many different types of software
- Pattern address the problem of “reinventing the wheel”

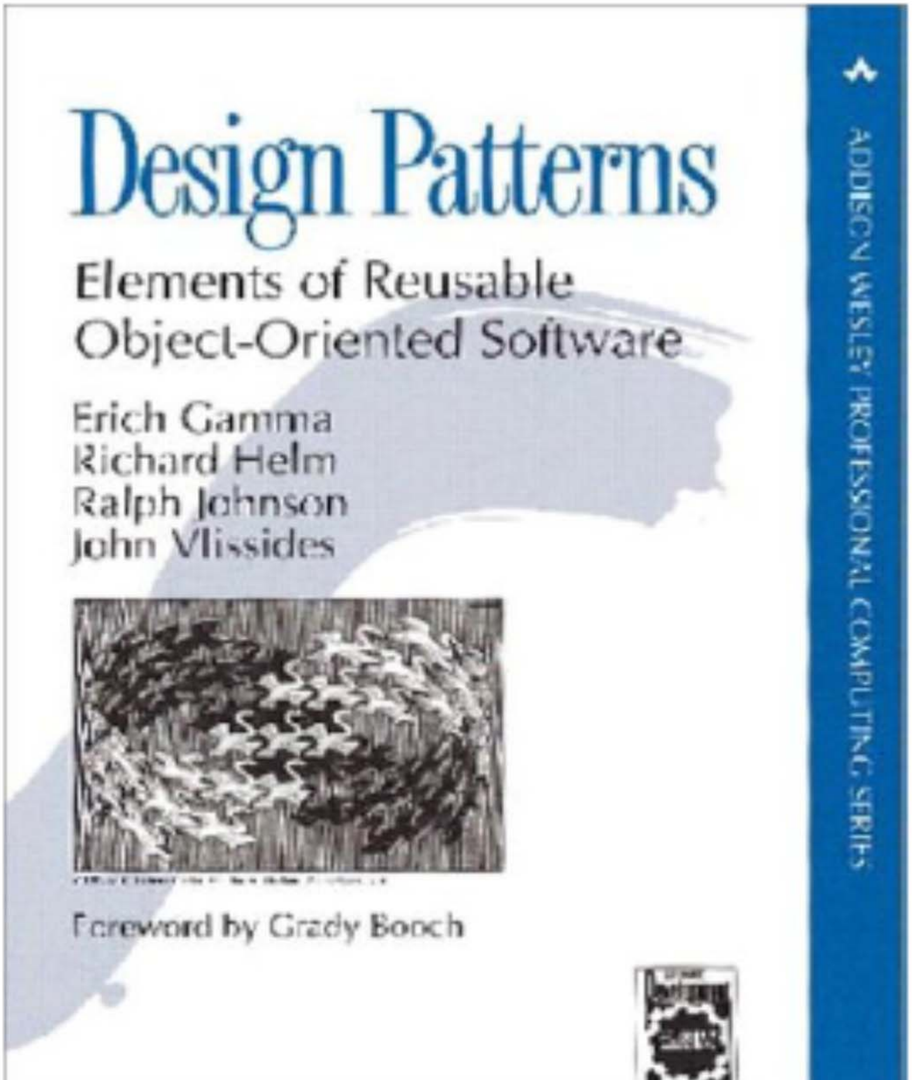
# History of Patterns

- The use of patterns in software development has its roots in the work of Christopher Alexander, an architect:

  *Each patterns describes a problem which* ***occurs over and over again*** *in our environments, and then describes* ***the core of the solution*** *to that problem, in such a way that you can* ***use*** *this solution in million times over,* ***without ever doing it the same way twice****.*

# Design Patterns

- In the late 1980s, several people in the software development community began to apply Alexander's ideas to software
  - *Design Patterns: Elements of Reusable Object-Oriented Software, by Erich Gamma, Richard helm, Ralph Johnson, and John Vlissides (the Gang of Four)*
- Design patterns identify abstractions that are at a higher level than individual classes and objects
  - Construct the software using patterns
    - Singleton Pattern, Proxy Pattern




Most popular book in Computer Science
Sold over one million copies in print

**Design Pattern Catalog.**

**Creational Patterns.**
Abstract Factory.
Builder.
Factory Method.
Prototype.
Singleton.
Discussion of Creational Patterns.

**Structural Pattern.**
Adapter.
Bridge.
Composite.
Decorator.
Facade.
Flyweight.
Proxy.
Discussion of Structural Patterns.

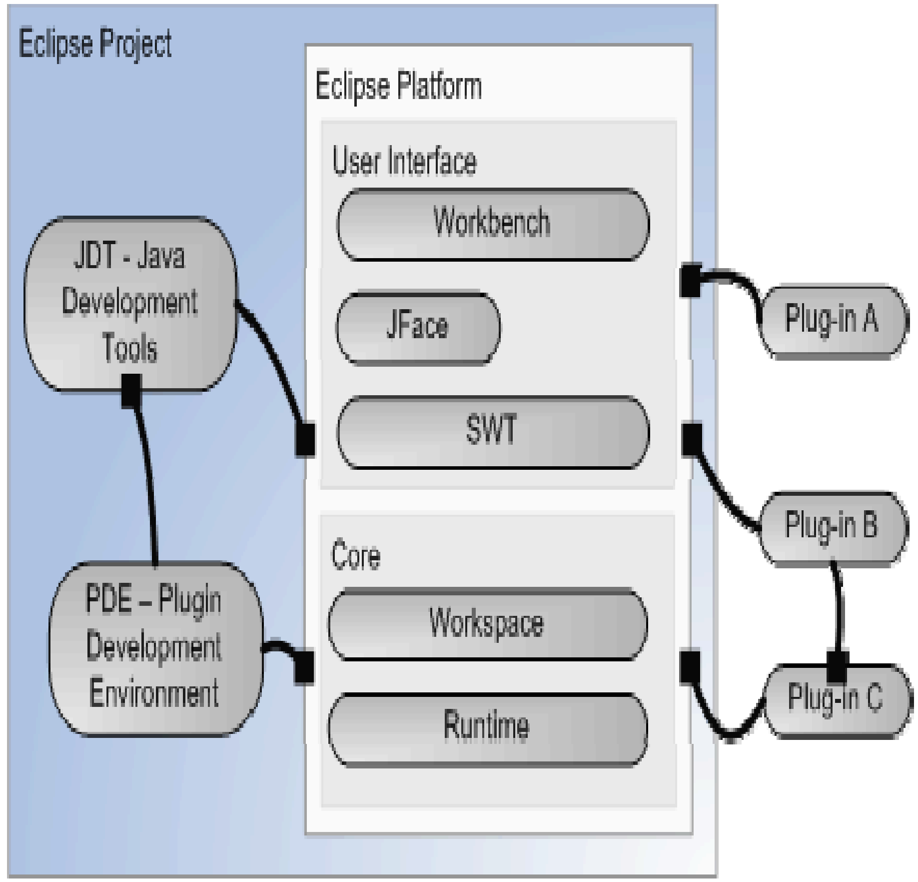
**Behavioral Patterns.**
Chain of Responsibility.
Command.
Interpreter.
Iterator.
Mediator.
Memento.
Observer.
State.
Strategy.
Template Method.
Visitor.

# History of Eclipse

- 1997 – VisualAge for Java ( implemented in small talk)
- 1999 -- VisualAge for Java Micro- Edition (code based from here)
- 2001 – Eclipse (change name for marketing issue)
- 2003 — Eclipse.org
- 2005- Eclipse V3.1
- 2006- Eclipse V3.2

# Architecture of Eclipse

- The eclipse plug-in architecture – increase modularity
- Everything is a plug-in
- Extension points
  - its component configuration points



# Performance Patterns

- The performance patterns describe best practices for producing responsive, scalable software
- Performance patterns complement and extend the performance principles
- Seven performance patterns address ***performance*** and ***scalability***
  - Fast Path
  - First Things First
  - Coupling
  - Batching
  - Alternate Routes
  - Flex time
  - Slender Cyclic Functions

# Performance Patterns vs. Design Patterns

- Each performance pattern is a realization of one or more of the performance principles
- The performance patterns are at a higher level of abstraction than design patterns
  - A design pattern may provide an implementation of a performance pattern

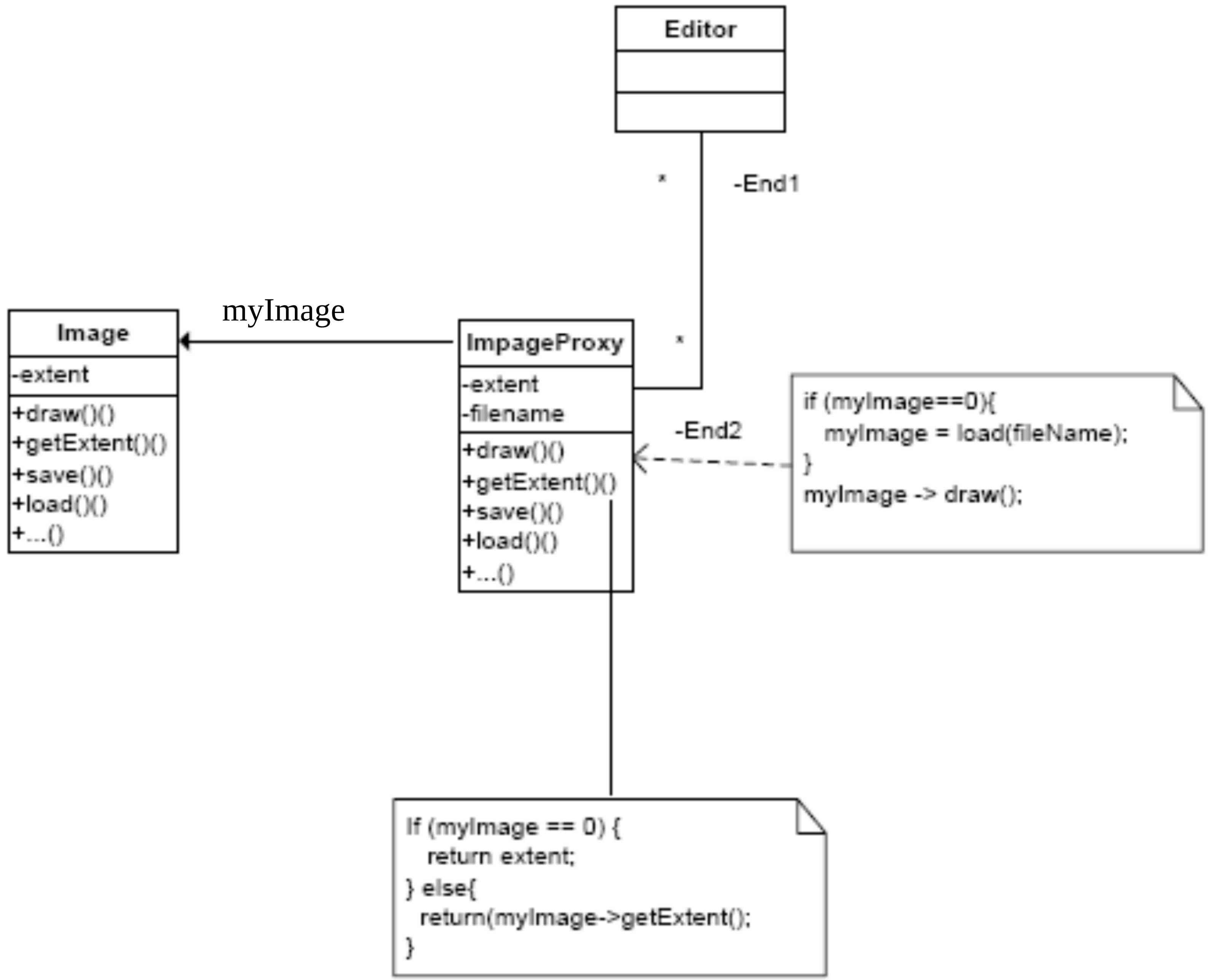
| level of abstraction (↓) | | Example |
|---|---|---|
| | Performance Principles | Centering Principles |
| | Performance Patterns | ⇒ Fast Path |
| | Design Patterns | Proxy |

# Pattern Template

- Each pattern is defined in a standard template:
  - **Name**: The title of the subsection
  - **Problem**: What is motivating us to apply this pattern?
  - **Solution**: How do we solve the problem?
  - **Benefits**: What are the potential positive outcomes of applying this pattern?
  - **Consequences**: What are the potential shortcomings and consequences of applying this patterns?

# Fast Path

- Concerned with improving response time by reducing the amount of processing required for dominant workloads
  - Example: menus in automated telephone system
- Problem: ***dominant workload***
- Solution:
  - Create an express “train” that stops only at the most important stations along the route
  - Identify the data most frequently used together
  - Implemented by Proxy patterns
  - Based mainly on the ***centering principle***



Editor
*
-End1
myImage
Image
-extent
+draw()()
+getExtent()()
+save()()
+load()()
+...()
ImpageProxy
*
-extent
-filename
+draw()()
+getExtent()()
+save()()
+load()()
+...()
-End2
if (myImage==0){
myImage = load(fileName);
}
myImage -> draw();
If (myImage == 0) {
return extent;
} else{
return(myImage->getExtent();
}

# Fast Path (Con't)

- Benefits:
  - Reduces the response time for dominant workload functions by reducing the amount of processing required for the most frequent uses of the software
  - Reduces the overall load on the system by avoiding some resource consumption
- Consequences:
  - It is not enough to recognize the need for the Fast Path you must also ensure that it is likely to be used
  - Usage patterns change over time
  - Use the instrumenting principle to monitor usage patterns, and adapt your system to changing patterns

# First Things First

- Focus on the important processing tasks to ensure that, if everything cannot be completed within the time available, then the least important tasks will be the ones omitted
- Problem:
  - Temporary overload may cause input data to be lost or response times to be unacceptably slow
  - Example: online-trading
- Solution:
  - Assign priorities to tasks and execute them so that the most important activities receive preference
  - Example: transaction of billions of dollars
  - Use the ***Centering Principle*** to focus attention on the most important work

# First Things First (Con’t)

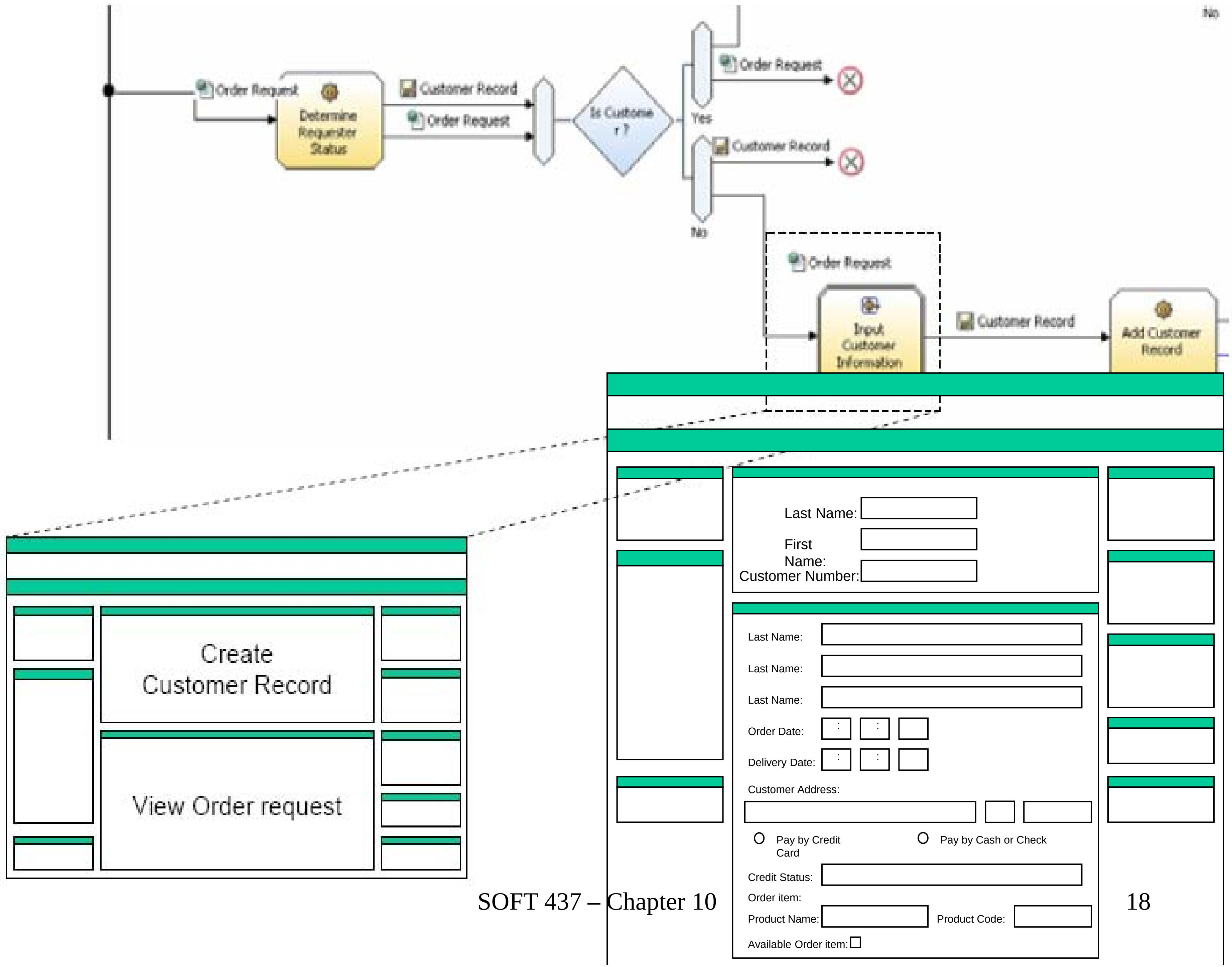
- Benefits
  - Focuses on the most important tasks and ensures that they complete
  - Maximizes the quality of service of the system and improves scalability
- Consequences
  - Only appropriate if the overload is temporary
  - If the overload is not temporary, reduce the amount of processing required by other means or upgrade the processing environment

# Coupling

- Match the interface of an object with its most frequent uses
- Problem: Applications use fine-grained objects to request remote information
  - The number of interactions is large
  - Cost of remote calls is high in distributed systems
  - Responsiveness is poor in multi-tier Web applications
  - Using a class structure identical to the physical database schema can lead to performance problems

# Coupling (Con't)

- Solution:
  - Use more ***coarse-grained*** objects to eliminate frequent requests for small amount of information
  - The best way of constructing the aggregation will depend on the access patterns for the data
  - Data that is frequently accessed at the same time should be grouped into an aggregation
  - Use the ***Centering Principle*** to identify interfaces
  - Use the ***Locality Principle*** to combine information
  - Use the ***Processing vs. Frequency Principle*** to minimize the total processing required for the interface


Order Request
Determine Requester Status
Customer Record
Order Request
Is Customer ?
Yes
No
Order Request
Customer Record
No
Order Request
Input Customer Information
Customer Record
Add Customer Record
Create Customer Record
View Order request
Last Name:
First Name:
Customer Number:
Last Name:
Last Name:
Last Name:
Order Date:
Delivery Date:
Customer Address:
Pay by Credit Card
Pay by Cash or Check
Credit Status:
Order item:
Product Name:
Product Code:
Available Order item:

# Coupling (Con't)

- Benefits:
  - Match the business tasks to the processing required to accomplish them
  - Reduce the total resource requirements of the system
- Consequences:
  - Start by identifying information that is stable, and use those objects to reduce the amount of communication overhead required to obtain data

# Batching

- Combines frequent requests for services to save the overhead of initialization, transmission, and termination processing for the request
- Problem:
  - Requested tasks require considerable overhead processing for initialization, termination, and in distributed systems, for transmitting data and requests
  - For very frequent tasks, the amount of time spent in overhead processing may exceed the amount of real processing on the system
  - Example
    - Insert new rows
    - Send secured messages

# Batching (Con't)

- Solution:
  - Combine the requests into batches so the overhead processing is executed once for the entire batch instead of for each individual item
    - Sender-side batching (e.g., insert new rows)
    - Receiver-side batching (e.g., transfer secured messages over links)
  - Using the ***Processing vs. Frequency Principle*** to minimize the product of the processing times the frequency of requests

# Batching (Con't)

- Benefits:
  - Reduce the total amount of processing required for all tasks
  - Improve responsiveness by reducing the contention delay
  - Improve scalability by freeing up resources
- Consequences:
  - Batching is appropriate for frequent tasks that require a large amount of overhead processing
  - Batching is most effective when the amount of overhead and the frequency of requests are both high

# Alternate Routes

- Spread the demand for high-usage objects spatially to different objects or locations
- Reduce contention delays for the objects
- Problems:
  - Occurs frequently in database systems when many processes need exclusive access to the same physical location, usually to execute an update
  - Happens when several processes must coordinate with a single concurrent process
  - When a single dispatching process receives inbound requests and determines which subsequent process is to handle the request

# Alternate Routes (Con't)

- Solution:
  - Find an alternate route for the processing
    - In database access situation, find a way for the access to go to different physical locations
    - For the process coordination problems, find a way to route requests to different processes
    - For the one-inbound dispatcher problem, use multiple instances of the dsipatcher
  - Use the Spread-the-Load Principle

# Alternate Routes (Con't)

- Benefits:
  - Reduces delays due to serialization
  - Improves responsiveness and scalability
  - Reduces the variability in performance
- Consequences:
  - Make sure that your alternate route effectively spreads the load spatially

# Flex Time

- Spread the demand for high-usage objects temporally to a different period of time
- Reduce contention delays for the objects
- Problems:
  - Processing is required at a particular frequency, or at a particular time of day
  - Users are allowed to select the time of day when they want the reports, but are all given the same choices for time of day

# Flex Time (Con't)

- Solution:
  - Identify the functions that execute repeatedly at regular, specific time intervals, and modify the time of their processing
  - Solution to the time-of-day problem is to move the processing to a different time of day
  - Solution to the processing-time-choice problem is to generate a random number for the selection choices
  - Solution to the periodic processing problem is to do less work more often
  - Apply the Spread-the-Load Principles

# Flex Time (con't)

- Benefits:
  - Spread the load temporally to reduce the congestion
  - Reduces the amount of time that processes are blocked and cannot proceed
  - Reduces the resource demand so that concurrent process encounter fewer queueing delays for computer resources
- Consequences:
  - Some of the Flex Time solutions require more processing
  - The net effect is to reduce the time that processes wait in queues
  - The Flex Time has the same potential problem as Alternate Routes
    - if everyone chooses the same alternate time, you have a new bottleneck

# Slender Cyclic Functions

- Concerned with processing that must execute at regular intervals
- Problem:
  - A cyclic or periodic function is characterized by its:
    - Period: the amount of time between successive executions
    - Execution time: the amount of time required for the function to execute
    - Slack time: the amount of time between the completion of execution and the end of the period

# Slender Cyclic Functions (Con't)

- Solution:
  - Identify the functions that execute repeatedly at regular, specific time intervals, and minimize their processing requirements
  - Use both the Centering Principle and the Shared Resources Principles
- Benefits:
  - Reduce the processing requirements so that we have more resources available to share and thus reduce queueing delays

# Slender Cyclic Functions (Con't)

- Consequences:
  - Operating conditions may change over time
  - The cycle frequency may need to change, or the amount of processing per cycle may change
  - Instrument systems and monitor their performance over time for early warning of potential problems