AARHUS
UNIVERSITY
DEPARTMENT OF ENGINEERING

Architecture & Design of Embedded Real-Time Systems (TI-AREM)

Design Pattern Introduction

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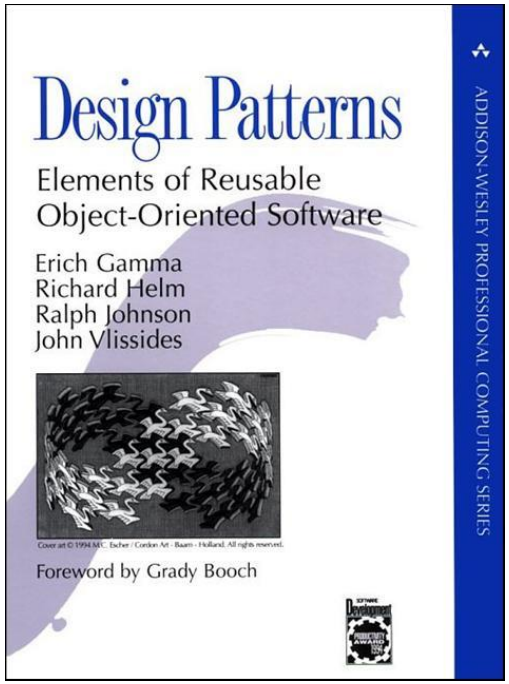
GoF Design Patterns

GoF (*Gang of four*) Design Pattern Book:
Design Patterns
Elements of Reusable Object Oriented Software,
By Erich Gamma, Richard Helm, Ralph Johnson and John Vlissides,
Addison-Wesley 1994, ISBN 0-201-63361-2



Three main parts:

1. Introduction
2. A Case study:
Designing a Document Editor
3. Design Pattern Catalog:
with 23 Design Patterns

Also available as
a CD-ROM version

What is a Design Pattern ?

A design pattern has four essential elements:

1. The **pattern name**
   - a design vocabulary
2. The **problem**
   - and its context i.e. when to apply the pattern
3. The **solution**
   - the design pattern elements (a solution template)
4. The **consequences**
   - the results and trade-offs (space and time trade-offs)

GoF – Design Pattern Template

- Pattern Name and Classification
- Intent
- Also Known As
- Motivation
- Applicability
- Structure (class diagram)
- Participants
- Collaborations (sequence diagram)
- Consequences (+/-)
- Implementation
- Sample Code (C++ code examples)
- Known Uses
- Related Patterns

GoF Design Pattern Categorization

- Creational Patterns (5 patterns)
  - abstracts the instantiation process
- Structural Patterns (7 patterns)
  - are concerned with how classes and objects are composed to form larger structures
- Behavioral Patterns (11 patterns)
  - are concerned with algorithms and the assignment of responsibilities between objects

GoF Design Pattern – Overview (1)

Creational Patterns:

- Abstract Factory
- Builder
- Factory Method
- Prototype
- Singleton

GoF Design Pattern – Overview (2)

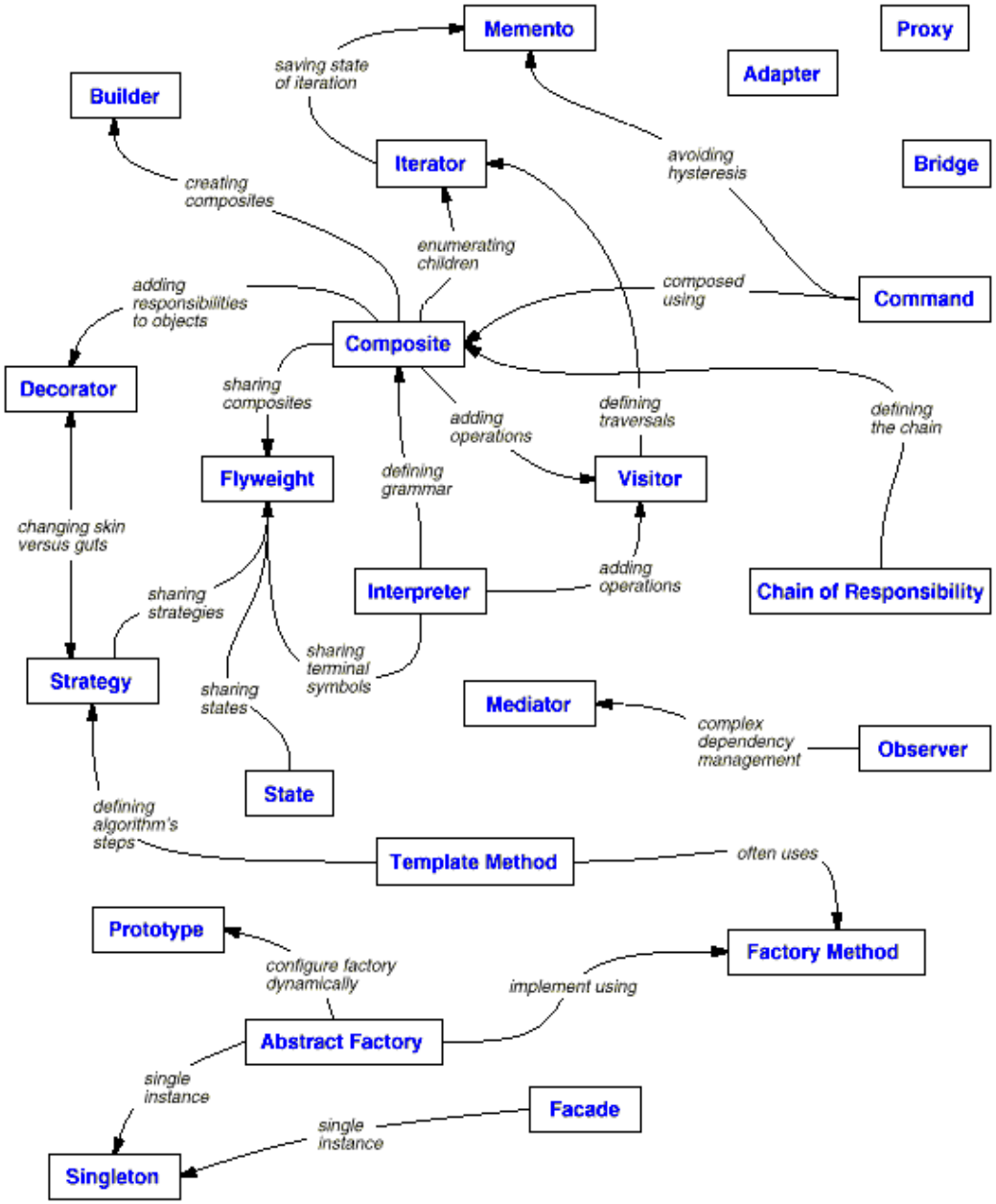
Structural Patterns:

- Adapter
- Bridge
- Composite
- Decorator
- Façade
- Flyweight
- Proxy

GoF Design Pattern – Overview (3)

Behavioral Patterns:

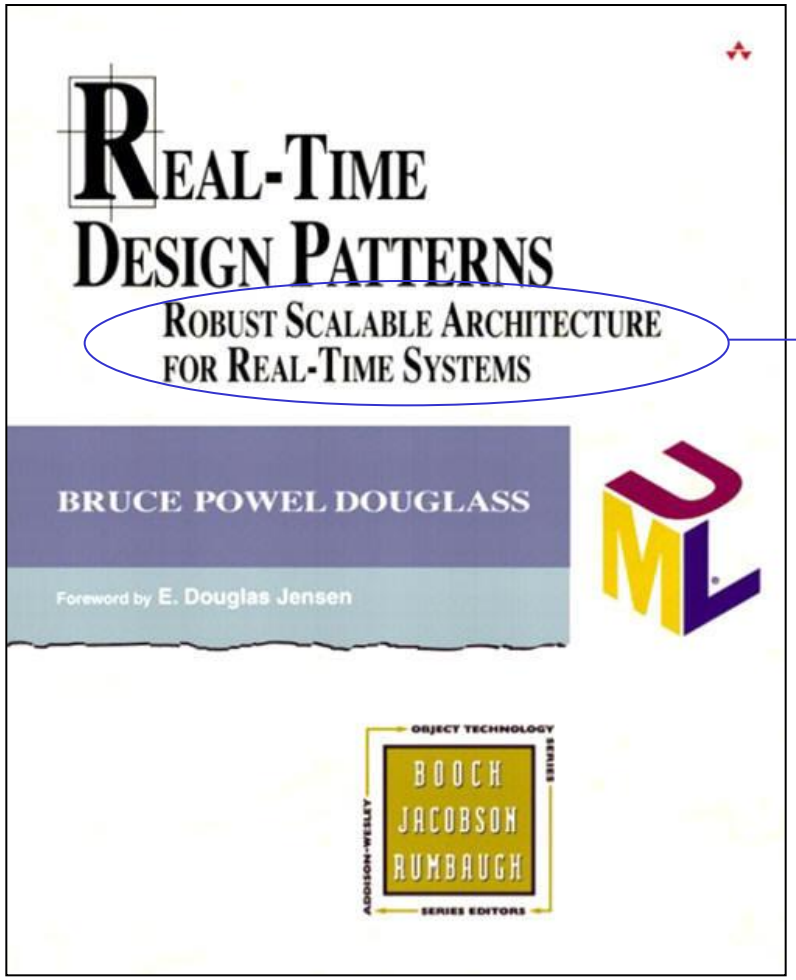
- Chain of Responsibility
- Command
- Interpreter
- Iterator
- Mediator
- Memento
- Observer
- State
- Strategy
- Template Method
- Visitor



GoF Design Pattern Relationships

Typical relationsships from the related patterns sections

Real-Time Design Patterns



Architecture for Real-Time Systems

BPD 1.6: What is a Design Pattern?

”A design pattern is a generalized solution to a commonly occurring problem”

- **Design is all about optimization**
- The hard part is that there are so many things to optimize and so little time

Design Optimization Criterions

- Performance (worst case, averarge case)
- Predictability
- Schedulability
- Minimize resource requirements (memory, heat, weight)
- Reusability
- Portability
- Maintainability
- Readability
- Development time / effort
- Safety
- Reliability
- Security

We must rank them in order of importance to the success of the project and the product

Another type of Pattern Categorization

- **Architectural patterns**
  - affect most or all of the system
  - are broadly and strategically applied to the system
  - covered by **BPDs "Real-time design patterns" book**
    - covers patterns particular relevant to real-time and embedded systems
- **Mechanistic design patterns**
  - GoF pattern with a more local scope
  - they define mechanisms for object collaborations
  - have a much more limited scope, but are general applicable
  - covered by **"Design Patterns" book, Gamma et. al. (GoF)**
    - covers patterns relevant to all kind of (OO) systems
- **Idioms**
  - language dependent design Patterns

Pattern Hatching - Locating the Right Patterns

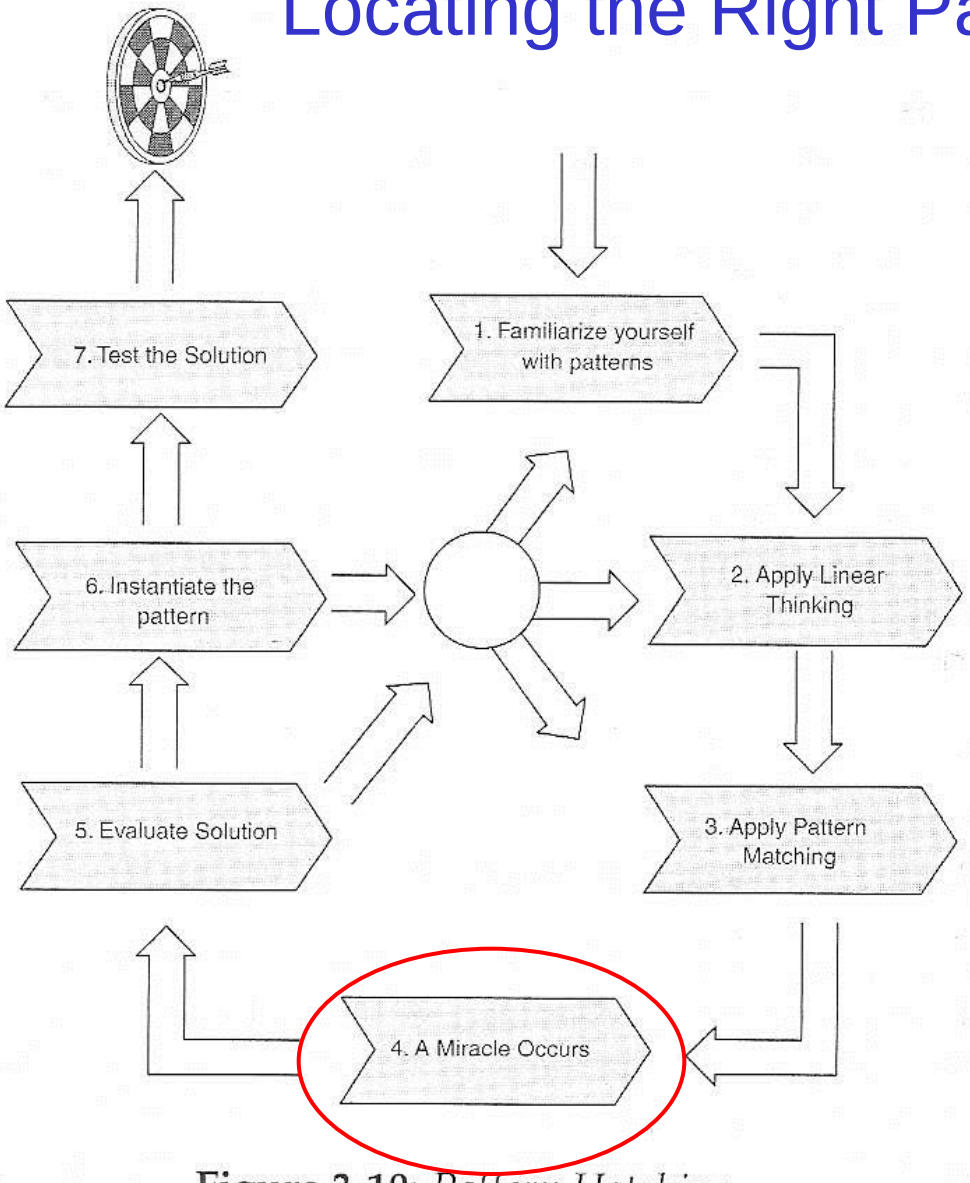


Figure 3-10: *Pattern Hatching*

Pattern Mining – Rolling Your Own Patterns

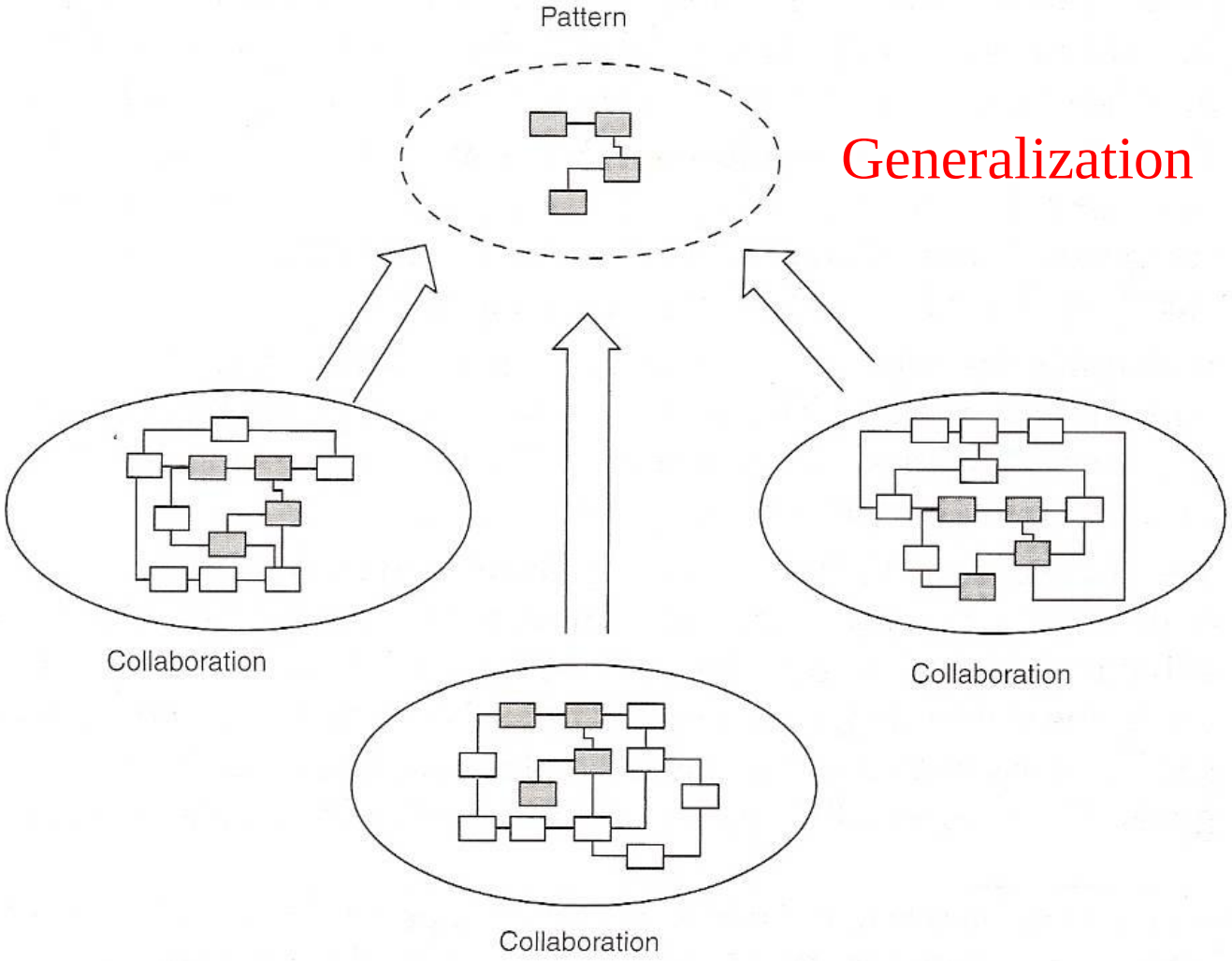


Figure 3-11: *Pattern Mining*

Pattern Instantiation – Applying Patterns in Your Design

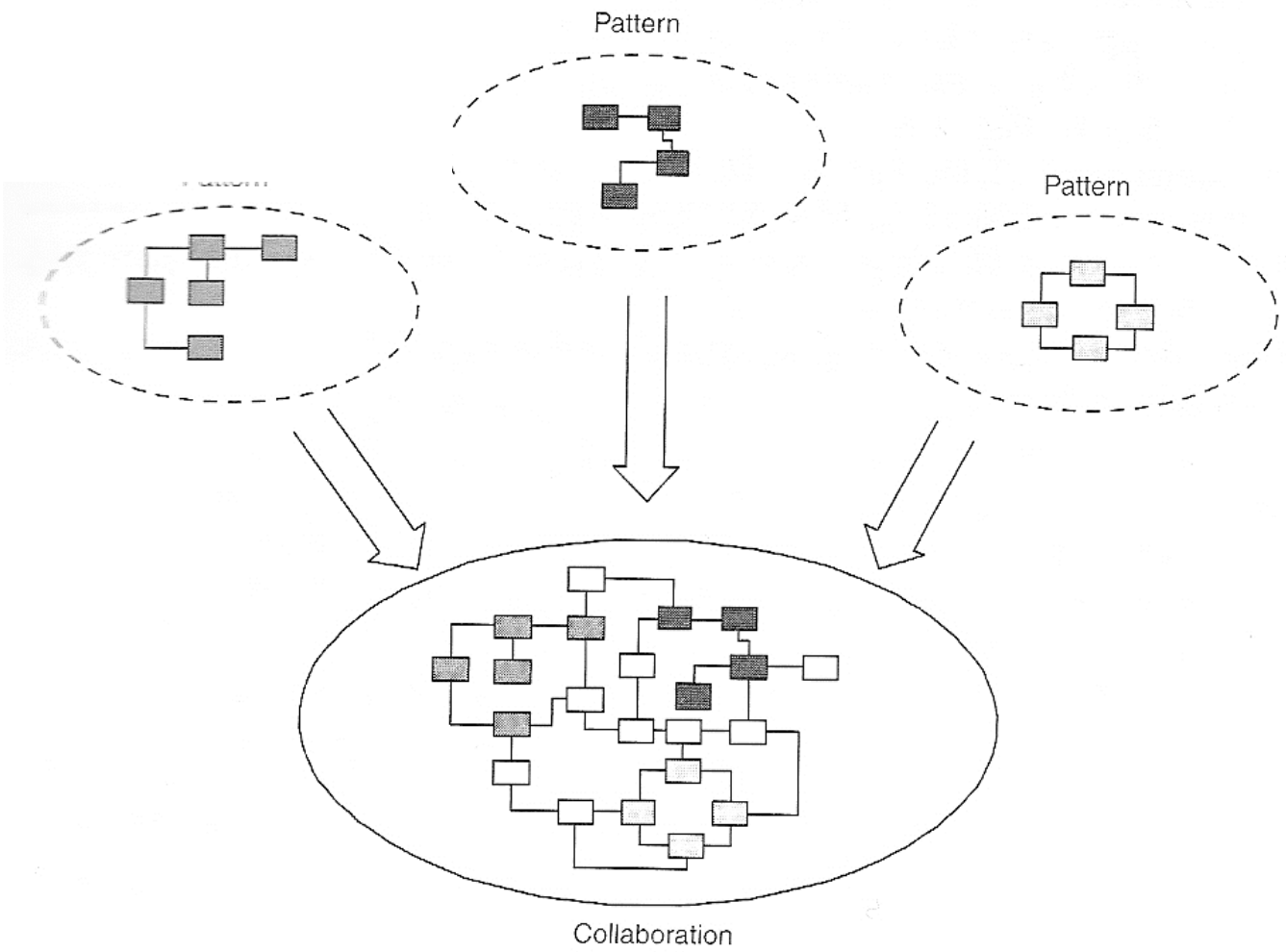
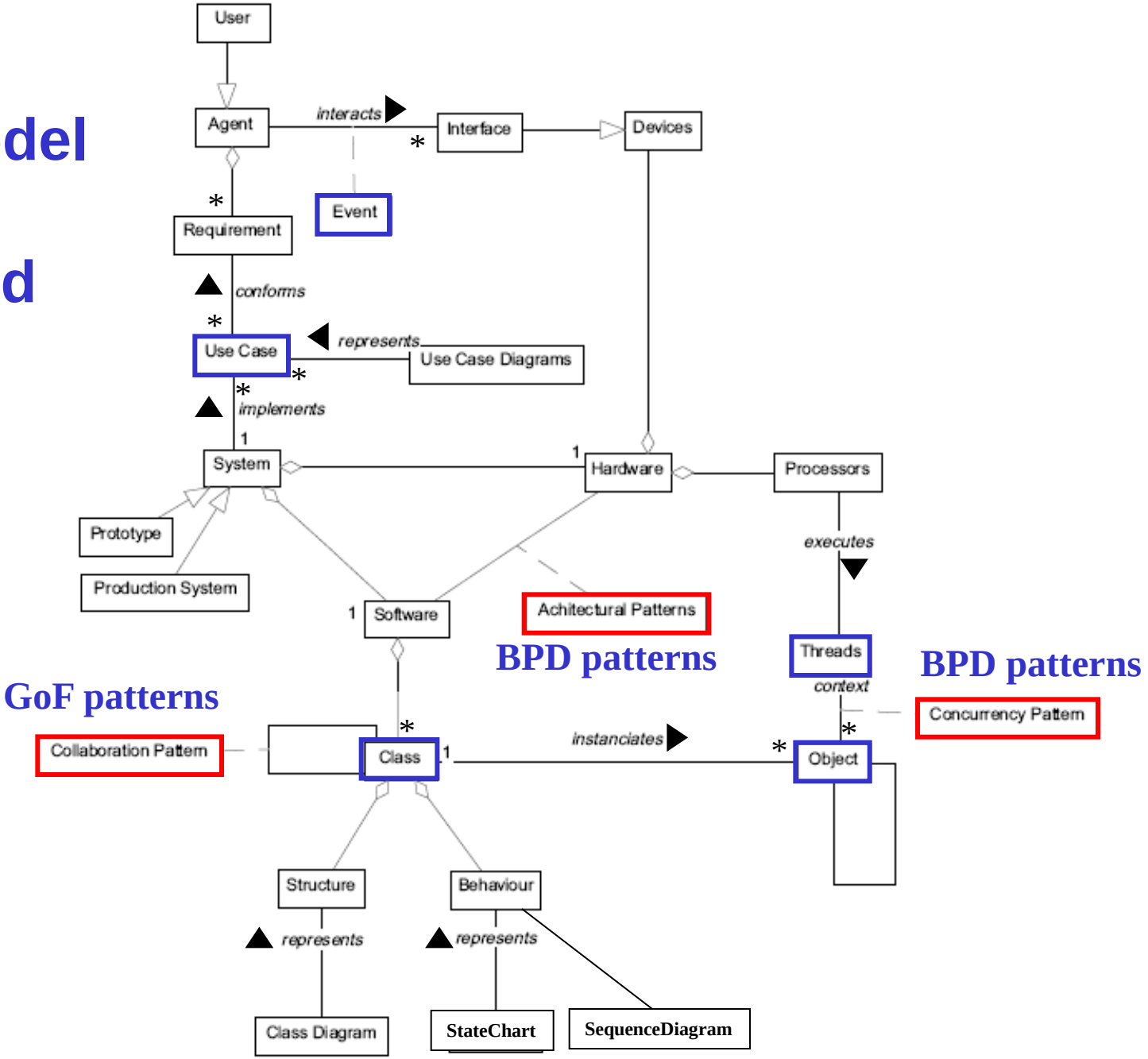


Figure 3-12: *Pattern Instantiation*

Domain Model for an Embedded System



Summary

- Different types of pattern categorization
- Architectural patterns
  - e.g. Real-Time Design Patterns
- Mechanistic Design Patterns
  - e.g. GoF Patterns with categorization
    - Creational
    - Structural
    - Behavioral
- Idioms (code dependent patterns)