Designing for Maintainability

Idaho State University | Computer Science

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Outcomes

At the end of Today's Lecture you will be able to:

- Describe key concepts for highly maintainable designs.
- Describe general methods to achieve these designs.
- Describe how these techniques play out in enterprise software systems.

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Inspiration

"When I'm working on a problem, I never think about beauty. I think only how to solve the problem. But when I have finished, if the solution is not beautiful, I know it is wrong." – Freeman Dyson

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Designing for Maintainability

1. **Integrating Software Components**
2. Sharing Data and Message Passing
3. Using Design Patterns to Integrate

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Modern Software is Connected

- Modern programs **rarely** live in isolation
  - They **interact** with **other programs** on the same computer
  - They use **shared library** modules
  - They **communicate** with programs on **different computers**
  - Data is **shared** among multiple **computing devices**
- **Web applications** communicate across a network
- **Mobile applications** live in a complex ecosystem
- **Web services** connect **dynamically** during execution
- **Distributed** computing is now common

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Why Integration is Hard

- Networks are **unreliable**
- Networks are **slow**
  - Multiple orders of magnitude slower than a function call
- **Programs** on different computers are **diverse**
  - Different languages, operating systems, data formats, …
  - Connected through diverse hardware and software applications
- Change is **inevitable** and **continuous**
  - Programs we connect with change
  - Host hardware and software changes

Distributed software must use extremely low coupling

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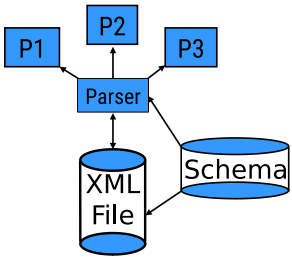
Extremely Loose Coupling

- **Tight Coupling**: Dependencies encoded in **logic**
  - Changes in **A** may require changing in logic in **B**
  - This used to be common
- **Loose Coupling**: Dependencies encoded in the **structure** and **data flows**
  - Changes in **A** may require changing data uses in **B**
  - Goal of data abstraction and object-oriented concepts
- **Extremely Loose Coupling (ELC)**: Dependencies encoded only in the data **contents**
  - Changes in **A** only affects the contents of **B**'s data
  - Motivating goal for distributed software and web applications

The issues are about how we share data...

XML for ELC

- Data is **passed directly** between components
- Components must agree on **format**, **types**, and **structure**
- XML allows data to be self-documenting

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  <title>Design of Every Day Things</title>
</book>
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- P1, P2 and P3 can see the **format**, **contents**, and **structure** of the data
- **Free parsers** are available

Discussion

Discuss in Groups

- Explain coupling to each other
- Have you used tight coupling?
- Have you used loose coupling?
- Have you used extremely loose coupling?

You must join a group … you may not discuss alone

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General Ways to Share Data

1. **Transferring files**
   - One program **writes** to a file that another later **reads**
   - Both programs need to **agree** on:
     - File name, location, and format
     - Timing for when to read and write it
2. **Sharing a Database**
   - Replace a file with a **database**
   - Most decisions are **encapsulated** in the **table design**

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General Ways to Share Data

❸ Remote Procedure Invocation

- One program **calls a method** in another application
- Communication is **real-time** and **synchronous**
- Data are passed as **parameters**

❹ Message Passing

- One program sends a message to a common **message channel**
- Other programs read the messages at a later time
- Programs must **agree** on the channel and message format
- Communication is **asynchronous**
- **XML** is often used to implement and encode messages

Message Passing

Message passing is asynchronous and very loosely coupled

Telephone calls are **synchronous**

- This introduces **restrictions**:
  - Other person must be available
  - Communication must be in real-time

- Voice mail and text messages are **asynchronous**
- Messages are left for **later retrieval**
- **Real-time** aspects are less important

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Benefits of Messaging

- Message-based software is **easier to change** and **reuse**
  - Better **encapsulated** than shared database
  - More **immediate** than file transfer
  - More **reliable** than remote procedure invocation
- Software components **depend less** on each other
- Several **engineering** advantages:
  - **Reliability**
  - **Maintainability** & Changeability
  - Security
  - Scalability

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Disadvantages of Messaging

- **Programming model** is different - and complex
  - **Universities** seldom teach event-driven software (including ISU)
  - **Logic** is distributed across several software components
  - **Harder** to develop and debug
- **Sequencing** is harder
  - **No guarantees for when** messages will arrive
  - Message sent in one sequence may arrive **out of sequence**
- Some programs require applications to be **synchronized**
  - Shopping requires users to **wait** for responses
  - Most web applications are synchronized
    - **Ajax** allows asynchronous communication
- Message passing is **slower**, but good middleware helps

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Discussion

Discuss in Groups

- Have you used message passing?
- Have you learned about message passing?
- If yes, describe to the other members of the group
- If not, do you understand message passing?

You must join a group … you may not discuss alone

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Designing for Maintainability

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3. **Using Design Patterns to Integrate**

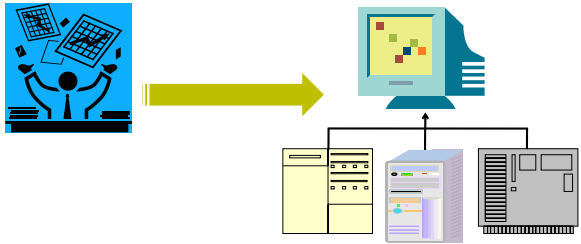
Enterprise Applications

- **Enterprise systems** contain hundreds or thousands of separate applications
  - Custom-built, third party vendors, legacy systems, …
  - Multiple tiers with different operating systems
- **Enterprise systems** often **grow** from disjoint pieces
  - Just like a town or **city** grows together and slowly integrates
- Companies want to buy the **best package** for each task

Thus – integrating diverse programs into a coherent enterprise application will be an exciting task for years to come

Information Portals

Information portals aggregate information from multiple sources into a single display to avoid making the user access multiple systems

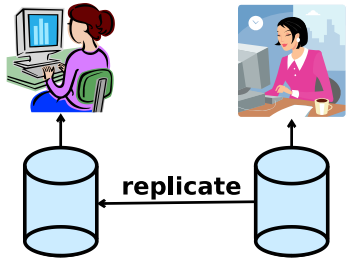


- **Answers** are accessed from more than one system
- Gradesheet, syllabus, transcript
- **Information portals** divide the screen into different zones
- They should **ease moving data** from one zone to another.

Data Replication

Making data that is needed by multiple applications available to all hardware platforms

- Multiple business systems often need the **same data**
- Student **email address** is needed by professors, registrar, department, IT, …
- When email is **changed** in one place, all copies must change

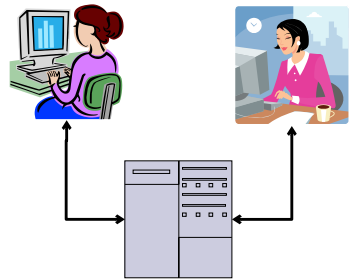


- **Data replication** can be implemented in many ways
  - Built into the **database**
  - **Export** data to files, re-import them to other systems
  - Use **message-oriented** middleware

Shared Business Functions

Same function used by several applications

- Multiple users need the same **function**
- Whether a **particular course** is taught this semester
  - Student, instructor, admins
- Each function should only be **implemented once**

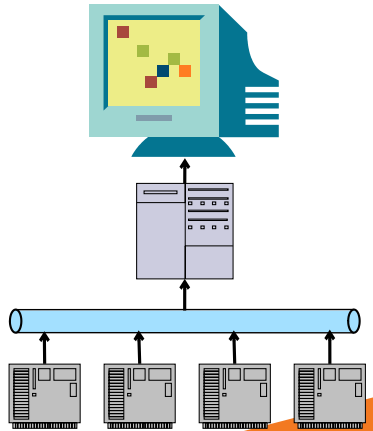


- If the function only **accesses data** to return result, duplication is simple
- If the function **modifies data**, race conditions can occur

Service-Oriented Architectures (SOA)

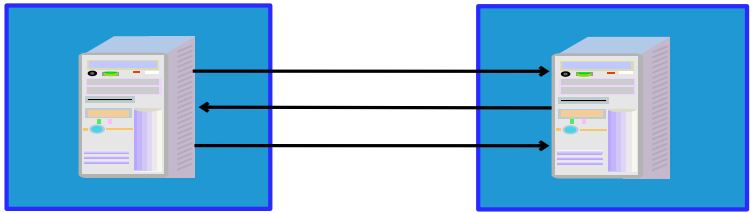
A service is a well-defined function that is universally available and responds to requests from "service consumers"

- Managing a collection of useful services is a **critical function**
  - A service **directory**
  - Each service needs to describe its **interface** in a generic way
- A mixture of **integration** and **distributed** application



Business-to-Business Integration

Integration between two separate businesses



- **Business functions** may be available from outside suppliers or business partners
- Online travel agent may use a **credit card** service
- Integration may occur **"on-the-fly"**
  - A customer may seek the **cheapest price** on a given day
- **Standardized** data formats are critical

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Coupling, Coupling, Coupling

- We have always known coupling is important
- **Goal** is to **reduce the assumptions** about exchanging data
  - Loose coupling means **fewer assumptions**
- A local **method call** is very **tight** coupling
  - **Same** language, same process, typed parameters, return value
- **Remote procedure call** has **tight** coupling, but with the complexity of distributed processing
  - The **worst of both** worlds
  - Results in systems that are **hard to maintain**
- **Message passing** has extremely loose coupling

Message passing systems are easy to maintain

Are there any questions?