Designing for Change

Brittany Johnson
SWE 437

Adapted from slides by Paul Ammann & Jeff Offutt

Designing for maintainability

1. Integrating software components
2. Sharing data and message passing
3. Using design patterns to integrate

Designing for maintainability

1. **Integrating software components**
2. Sharing data and message passing
3. Using design patterns to integrate

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

Why integration is hard

Networks are **unreliable**

Networks are **slow**

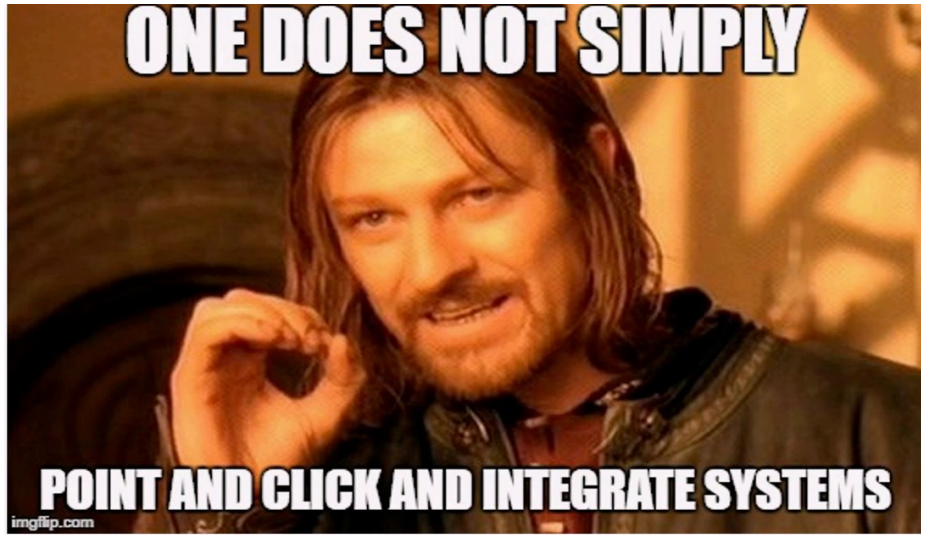
- multiple orders of magnitude slower than a function call

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

Extremely loose coupling

Tight coupling: dependencies encoded in logic

- changes in A may require changing 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 apps

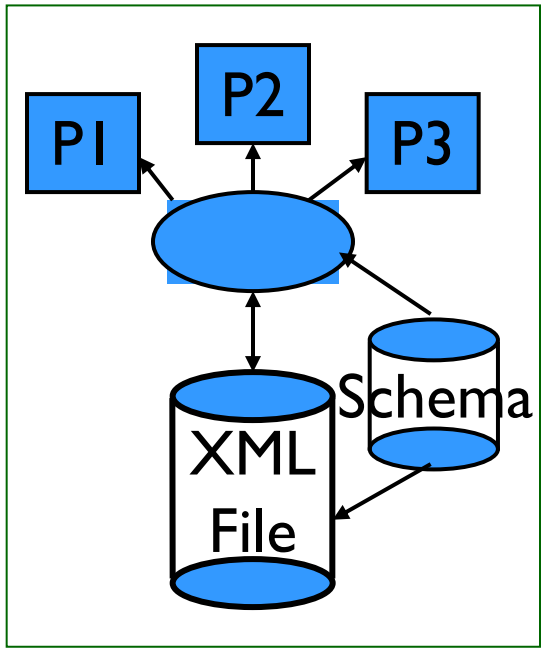
The issues are about how we share data…

XML supports extremely loose coupling

Data is **passed directly** between components

Components must agree on **format, types,** and **structure**

XML allows data to be **self-documenting**




```
<book>
  <author>Steve Krug</author>
  <title>Don't Make Me Think</title>
</book>
<book>
  <author>Don Norman</author>
  <title>Design of Every Day Things</title>
</book>
```

P1, P2, and P3 can see the **format**, **contents**, and **structure** of the data

Free parsers are available

Discussion

Discuss in groups

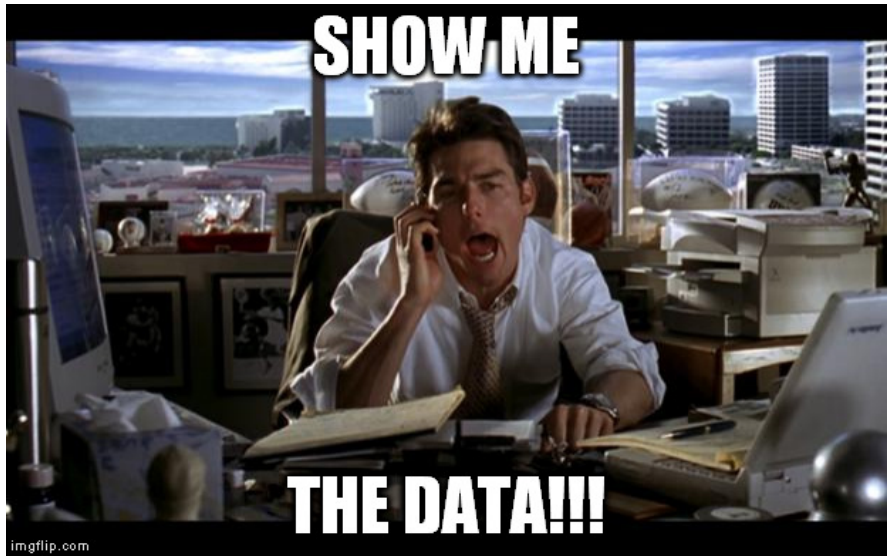
- Explain coupling to each other
- Have you used tight coupling?
- Have you used loose coupling?
- Have you used extremely loose coupling?

Designing for maintainability

1. Integrating software components
2. **Sharing data and message passing**
3. Using design patterns to integrate

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**
3. **Remote procedure invocation**
   - one program **calls a method** in another application
   - communication is **real-time** and **synchronous**
   - Data are passed as **parameters**
4. **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
   - communications is **asynchronous**
   - **XML** is often used to implement encoded messages



Message passing

Message passing is asynchronous and very loosely coupled

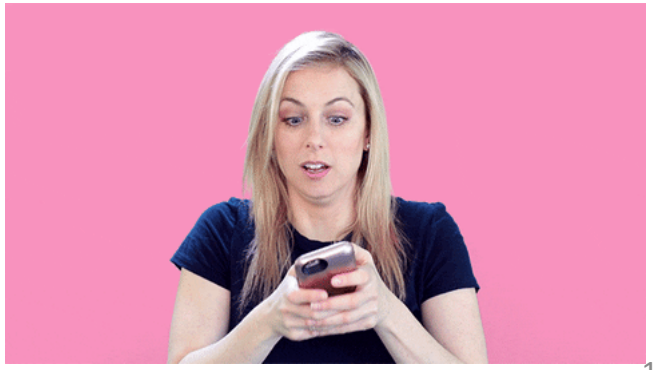
Telephone calls are **synchronous**

This introduces **restrictions**:

- other person must be there
- communication must be real time

Voicemail and texts are **asynchronous**

- messages left for **later retrieval**
- **real-time** aspects less important



Benefits of message passing

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

Message passing disadvantages

Programming model is different — and complex

- **universities** seldom teach event-driven software (SWE 432)
- **logic** is distributed across several software components
- **harder** to develop and debug

Sequencing is harder

- **no guarantees for when** messages will arrive
- messages 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 apps are synchronized

Ajax allows asynchronous communications

Message passing is **slower**, but good middleware helps

Discussion

Discuss in groups

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

Designing for maintainability

1. Integrating software components
2. Sharing data and message passing
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

- then **integrate** them!

Thus, integrating diverse programs into a coherent enterprise application will be a challenge for years to come

Information portals

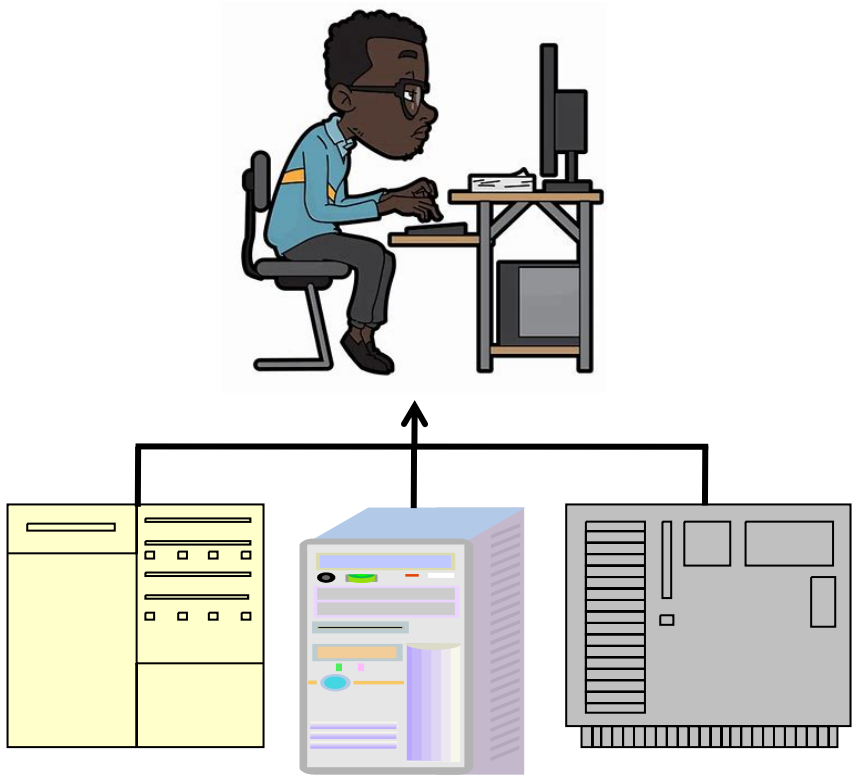
Information portals aggregate information from multiple sources into a single display to avoid making the user access multiple systems

Answers are pulled from different places

- e.g., grade sheets, syllabus, transcript…

Information portals divide the screen into different zones

They should make it easy to **move data** between zones



Data replication

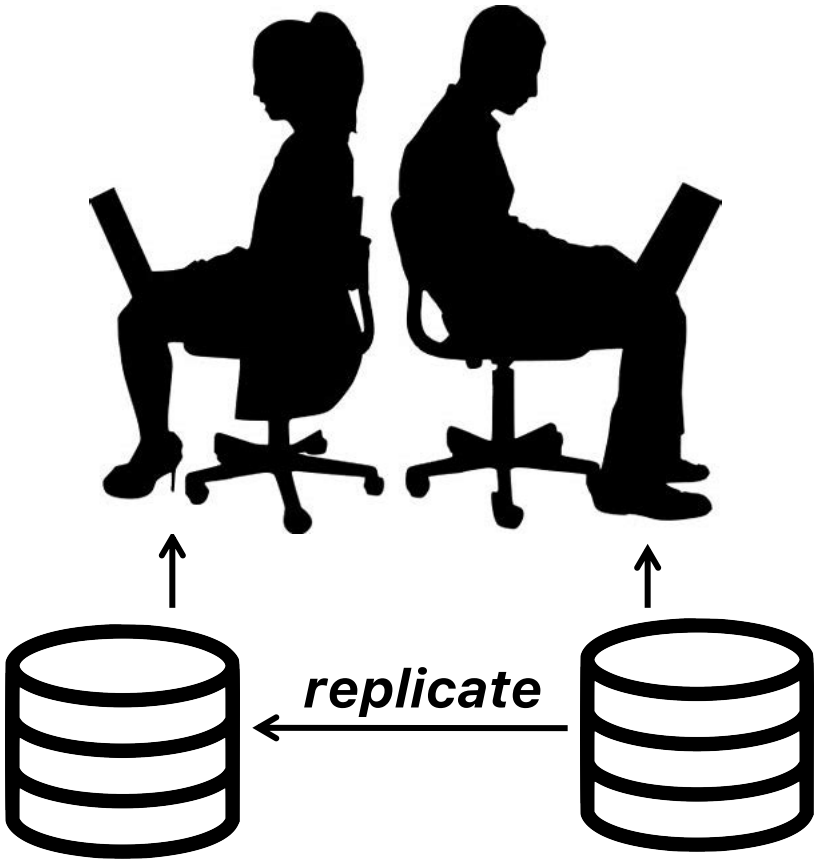
Making data needed by multiple applications available where it's needed

Multiple business systems often need the **same data**

- e.g., 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 functions used by several applications

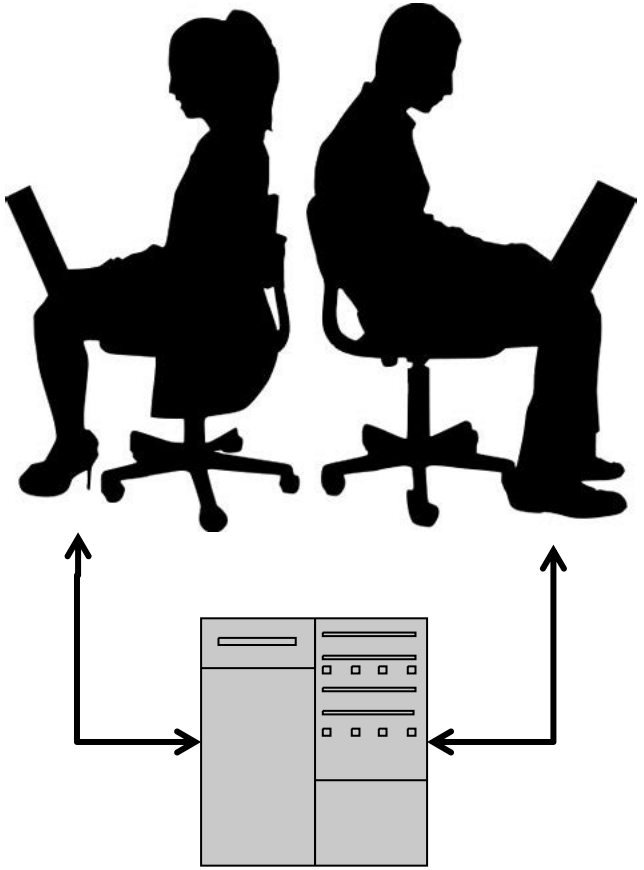
Multiple users need the same **function**

- e.g., 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 function **modifies data**, race conditions can occur



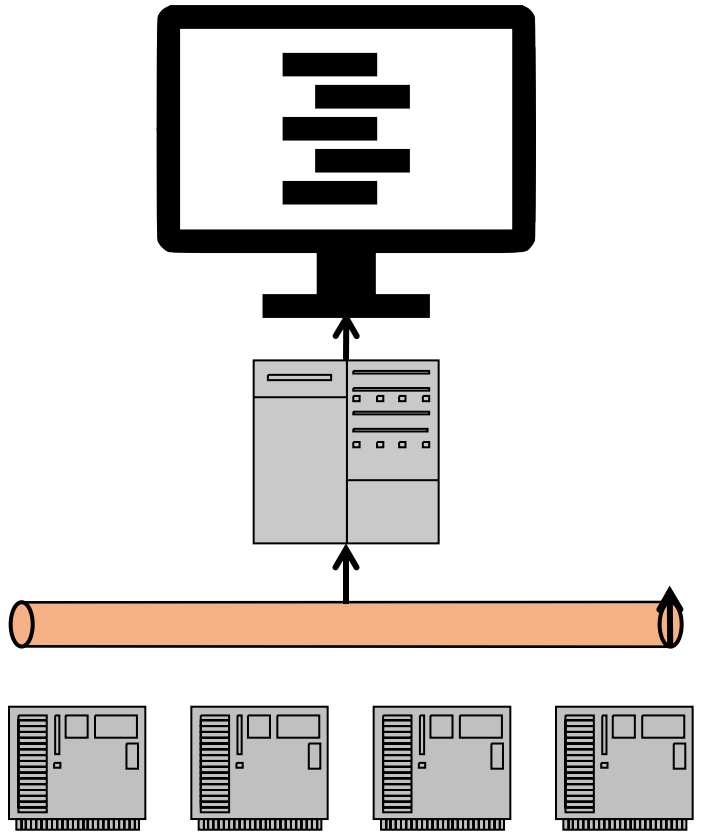
Service-oriented architectures (SOA)

A service is a well-defined function that is available from anywhere

Managing a collection of useful services is a **critical function**

- service **directory**
- each service needs to describe its **interface** in a generic way

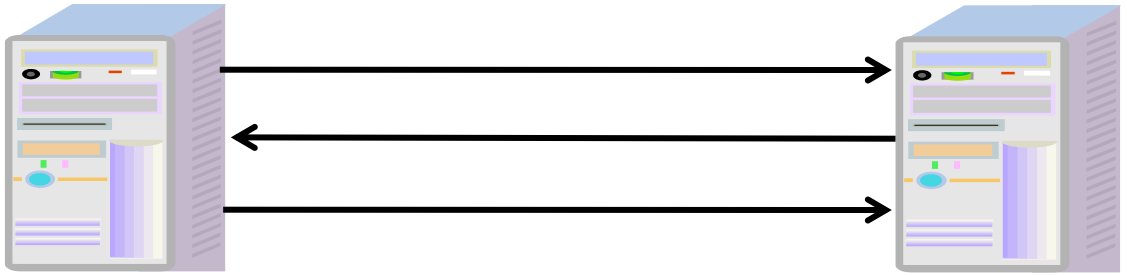
A mixture of **integration** and **distributed** application



Patriot web
A Self Service Web Site for Students, Faculty, and Staff

Business-to-business integration

Integration between two separate businesses



Business functions are available from outside suppliers or business partners

- e.g., online travel agents use **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

Summary: 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 params, 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