SFWR ENG 3A04: Software Design II

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Term 2

Acknowledgments: Material based on *Software Architecture Design* by Tao et al. (Chapter 12)

Outline of Part I

1. Client/Server
2. Multi-tier
3. Broker Architectural Style
4. Service-Oriented Architecture (SOA)

Outline of Part II

5. Overview
6. Methodology of Architecture Decision
7. System Quality Attributes
8. Selection of architecture styles
   - SAAM (Software Architecture Analysis Method)

Part I

Review of Previous Lecture

Part II

Today's Lecture

Heterogeneous Architecture Overview

- In practice, multiple architecture styles often need to be used in the same project
- For a large-scale software project, heterogeneous architecture styles are used
  - to combine benefits of multiple styles
  - to ensure quality and appropriateness
- We examine the analysis and design of a relatively large-scale project
- How do we choose the right architecture styles available that will achieve the project goals optimally?

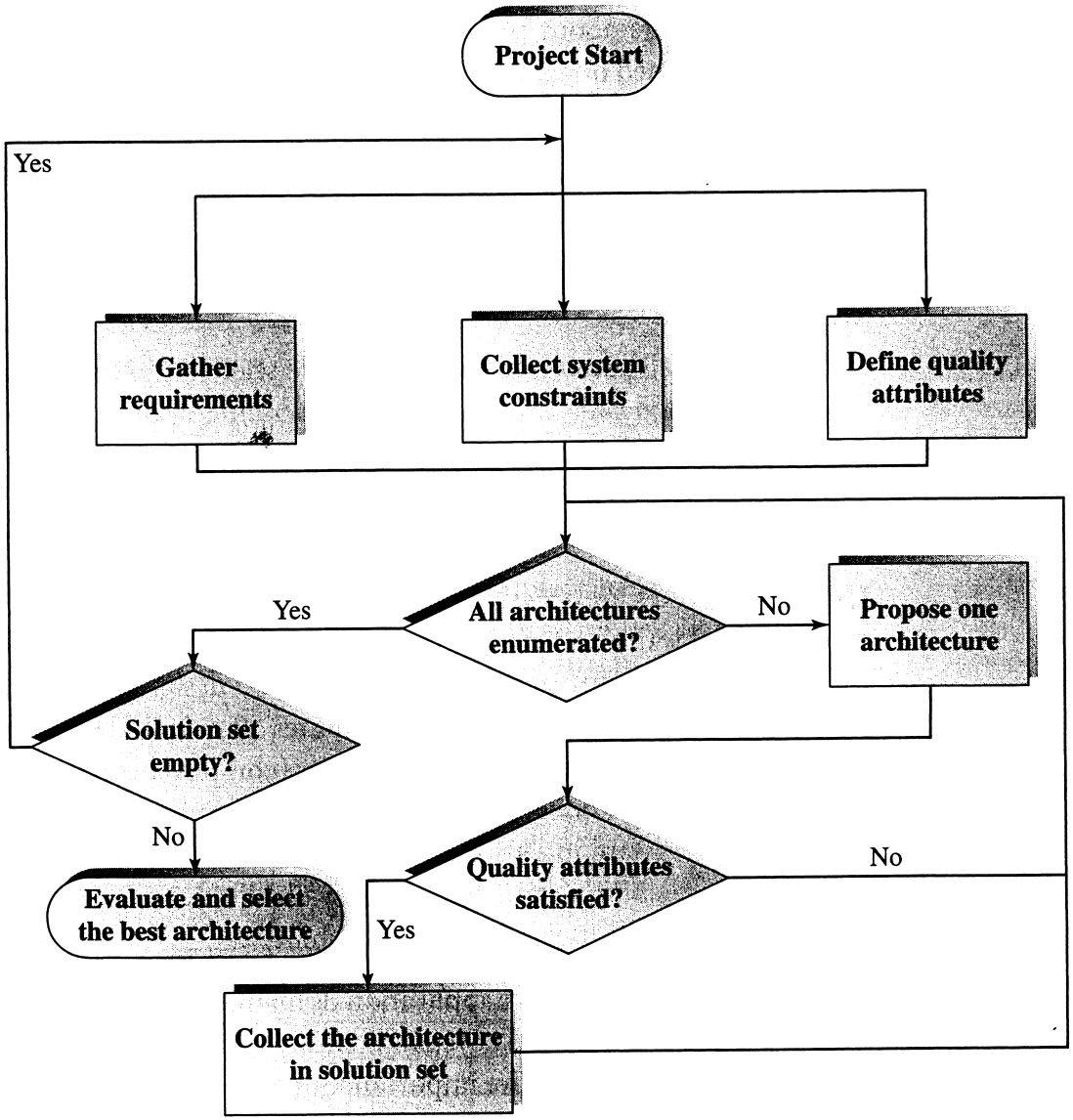
Heterogeneous Architecture

Overview

- The process of selecting the architecture of a software system is closely related to requirements analysis
  - the requirements of a system
  - the priority of each requirement
  - the system constraints (project budget, release date, etc.)
- The chosen architecture must be "optimal" and not necessarily focus on one particular aspect of the system constraints

Heterogeneous Architecture

Methodology of Architecture Decision



Heterogeneous Architecture

System Quality Attributes

	Performance (50%)	Reliability 10%)	Usability (10%)	Reusability (10%)	Cost-Effect. (20%)	**Sum**
Design 1	10	90	90	80	100	51
Design 2	80	80	20	90	70	73
Design 3	30	80	30	90	60	47
Design 4	20	20	20	20	100	36
Design 5	90	10	10	30	60	62

Figure: Sample quantitative evaluation of quality attributes

Score of Design 1 =

$$10 \times 50\% + 90 \times 10\% + 90 \times 10\% + 80 \times 10\% + 100 \times 20\% = 51$$

Heterogeneous Architecture Selection of architecture styles

- The selection of architecture styles usually depends on the expertise of software architects
- There are in the literature some helpful guidelines
- A general direction on how to select architecture style based on project requirements and constraints can be obtained from the requirements
- By examining the quality attributes (Non-functional requirements) and the application domain of each architecture style, a software architect can gain a rough idea of the applicability of an architecture style in a project

Heterogeneous Architecture

Selection of architecture styles

	Time Economy	Space Economy	Completeness	Security	Interoperability	Hardware Independence	Software Independence	Installability	Reusability	Error-Tolerance	Availability	Understandability	User Interface	Learnability
OO	+	+	+				+		+				+	-
Batch sequential					-				-					+
Pipe and Fitter		-			-				+					+
Process Control	+					+								-
Repository	+	+							+			-		-
Blackboard	-	+							+					-
Main/Subroutine	+	+		-	-				-			-		-
Master/Slaves	+								-					-
Layered	-			+		+			+	+	+	+		-
Virtual Machine	--	-		+		++	++	+	+	+	+			-
Event-Based (non-buffered)					+							+		+
MsgPassing (buffered)		-			+							+		+
MVC					+									+
PVC					+									+
Client-Server														+
Multi-tier	-	-		+	+									+
Broker	-													-
Service Ori, Arch. (SOA)	-	-			++	++	++	+	++		+	+	+	++
Component-Based					++		+		++		+			++

Figure: Comparison of the architecture styles

Heterogeneous Architecture

Selection of architecture styles –SAAM–

- The general idea of SAAM is to evaluate candidate architecture design using a collection of scenarios
- A design scenario represents an important usage of a system and reflects the viewpoints of stakeholders
- The SAAM analysis process generally consists of three stages:
  1. Define a collection of design scenarios that cover the functional and nonfunctional requirements
  2. Perform an evaluation on all candidate architecture designs, using the collection of scenarios.
  3. Perform an analysis on the interaction relationship among scenarios.

Selection of architecture styles –SAAM–

Example

- Case study is based on the taxpayer example
- The stakeholders are interested in the following quality attributes:
  - Expandability: Over time, more occupation types could be added to the system, such as AmericanFarmer, AmericanBusinessOwner, etc.
  - Performance: Since millions of cases could be processed each during peak times, time efficiency is very important.
  - Modifiability: The format of tax forms and the method of calculating tax rates change very often.

Heterogeneous Architecture
Selection of architecture styles –SAAM–

Example –Continued–

- Scenario 1: Add one more occupation, called AmericanFarmer, into the system (Tests the expandability)
- Scenario 2: Perform a virtual exhaustive testing on the system (Tests the performance)
- Scenario 3: Alter the tax rate calculation algorithm in ReportTax(), for example, to change the rules of itemized deduction (Tests the modifiability)

Heterogeneous Architecture

Selection of architecture styles –SAAM–

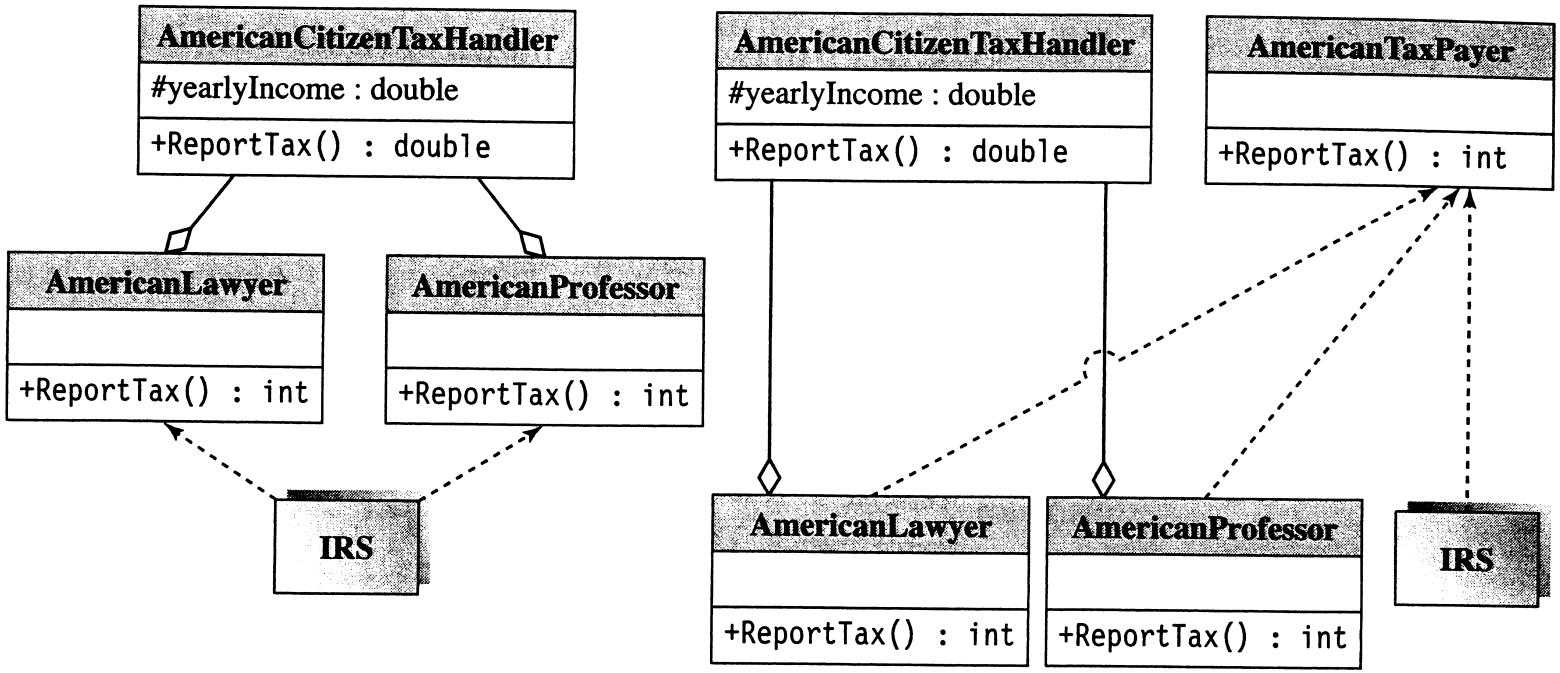


Figure: Two candidate architecture designs (both of OO style)

Heterogeneous Architecture

Selection of architecture styles –SAAM–

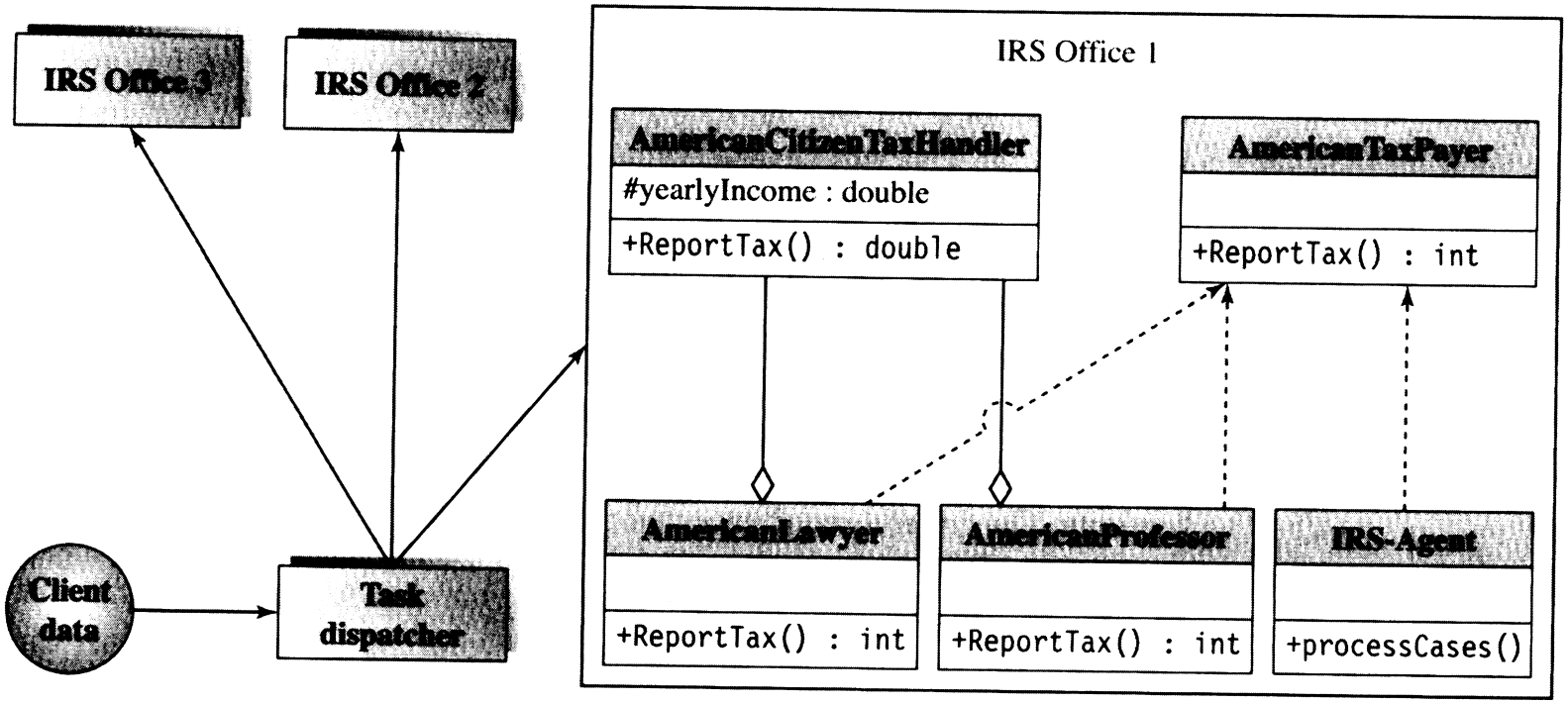


Figure: Service working model

Heterogeneous Architecture

Selection of architecture styles –SAAM–

	Scenario 1 (Expandability)	Scenario 2 (Time Efficiency)	Scenario 3 (Modifiability
Design 1	–	–	+
Design 2	+	–	+
Design 3	+	+	+

Figure: Task dispatcher for parallelism