CS 548 Fall 2022

Enterprise Software Architecture and Design

Instructor

Dominic Duggan
Email: Canvas Email.
Class Schedule: Tuesday 6:30-8:00pm (Pierce 120 and Zoom).
Instructor Office Hours: Tuesday 5-6pm (Zoom)
Course Assistants: Shraddha Kumbhar (skumbha6@stevens.edu), TBD

Course Objectives

This course covers the issues in designing and engineering large enterprise software systems. Technologies such as Web Services and cloud computing provide platforms for building such systems, and architectures such as service-oriented architecture (SOA), event-driven architecture (EDA) and representational state transfer (REST) are idioms for structuring such systems. This course will focus on analysis and design of enterprise software systems, with particular emphasis on the architectures recommended for such systems. The emphasis of the course is on "design patterns" that the working software engineer for enterprise systems can use to develop DDD, SOA, REST and EDA for enterprise computing, and CQRS for "cloud native" applications. The course also considers data modeling, including JSON Schemas, semantic data modeling (RDF and OWL), object-relational modeling (ORM) and NoSQL data modeling, as well as business process modeling from the viewpoint of high-level workflow models such as Business Process Modeling Notation (BPMN). Assignments include hands-on experience with tools such as Eclipse, Jakarta EE, Docker, Kubernetes and Amazon EC2, including building a simple enterprise application exemplifying the principles of the course.

Two useful companion courses are:

- **CS526 Enterprise and Cloud Computing:** This course considers cloud computing from the perspective of Web applications and Web services, using the Microsoft Azure platform, including ASP.NET MVC and Web API. It also goes into depth on virtualization as part of the infrastructure for the cloud.
- **CS549 Distributed Systems and Cloud Computing:** This course considers cloud computing from the perspective of advanced Java frameworks such as Jersey, and advanced NoSQL stores such as Dynamo. It also goes into depth on high availability (e.g. the Paxos algorithm and the CAP theorem) as part of the infrastructure for the cloud.

Course Outcomes

1. **[Architectures]** Explain the use of architectural styles such as domain-driven, resource-oriented, microservice, serverless and event-driven software architectures, and the principles and best practices underlying those architectures.
2. **[Data Modeling]** Perform data modeling using modeling languages such as JSON Schemas, object-relational mapping (ORM), semantic data modeling using RDFS and OWL, and NoSQL data models such as DocumentDB and Cassandra.
3. **[Middleware]** Use middleware to develop and deploy enterprise applications, including the use of containers and dependency injection.
4. **[Processes]** Specify workflows for enterprise applications using approaches such as BPMN and Petri net-based workflow languages.

Texts

1. **[D] Recommended:** *Enterprise Software Architecture and Design: Entities, Services and Resources* by Dominic Duggan. Wiley, 2012.
2. Supplementary material made available as PDF or Web links.

Grading

- Assignments: 50%
- Mini-Exams: 40%
- Participation: 10%

Late Policy

Assignments may be submitted after the due date, but up until the first cutoff date (usually a week after the original due date), with a penalty of -5%. Assignments may be submitted up until the second cutoff date (usually two weeks after the original due date), with an additional penalty of -20%. Assignments may be submitted up until the third cutoff date (usually three weeks after the original due date), with an **additional** penalty of -25%. There will be no extensions past the third cutoff date. If the cutoff date is the same as the due date, no late extensions are allowed. Please note that an assignment with a penalty of -25% or -50% still carries a much higher grade than no assignment at all. *Please also note that resubmission of assignments is not allowed. We do not have the resources to regrade assignments, so please be sure to submit the final version when it is ready.*

All exam and quizzes must be submitted by the time and date posted. There will be no extensions and no late submissions allowed. However, assuming that N quizzes are administered during the semester, your quiz grade will be based on the best N-1 of your quiz scores. Therefore you maximize your possible grade by taking all quizzes, but you do not suffer any penalty if you miss a single quiz. It is your responsibility not to miss more than one quiz.

Course Schedule

Week	Date	Topics Covered	Read	Assignment
1	9/6	**Introduction.** Enterprise software architecture. Middleware, microservices and cloud computing.	D 2.1-2, 2.4-7	
2	9/13	**Data Modeling.** E-R models. JSON Schema. JSON Binding.	D 3	Cloud
3	9/20	**Domain-Driven Architecture.** Domain-driven design (DDD). Object-relational mapping (ORM).	D 5.1-6	JSON
4	9/27	**Service-Oriented Architecture (SOA).** Service abstraction. Contexts and dependency injection.	D 6.1-11	ORM
5	10/4	**Resource-Oriented Architecture (ROA).** REST. JAX-RS. Hypermedia networks.	D 7.1-6	DDD
	10/11	**MONDAY SCHEDULE**		SOA
6	10/18	**Message-Oriented Middleware (MOM).** Asynchronous enterprise integration patterns.		REST
7	10/25	**Microservices.** Orchestration frameworks: Kubernetes. Cloud native. Serverless. Micro Profile		MOM
8	11/1	**Event-Driven Architecture.** Complex event processing (CEP). CQRS. Cloud eventing: Kafka.		Kubernetes
9	11/8	**NoSQL Data Stores.** Relational vs co-relational data models. SimpleDB.		CQRS
10	11/15	**Enterprise Blockchain.** Hyperledger Fabric.		NoSQL
11	11/22	**Smart Contracts**. Hyperledger codechains.		Blockchain
		THANKSGIVING BREAK		
12	11/29	**NoSQL.** Columnar data models and CQL **Workflow and Business Process Management.** State machines and Petri Nets..		Smart Contracts
13	12/6	**Business Process Modeling Notation BPMN.** Descriptive and analytic BPMN.		NoSQL
14	12/13	**Semantic Data Modeling.** RDFS and OWL		BPMN
	12/20			OWL

Software

All assignments will be done in the Java programming language, using the Eclipse IDE. Assignments will involve the use of tools such as:

- Docker, Kubernetes and Kafka (free to download)
- Payara server and Payara micro (free to download).
- Hyperledger Fabric (free to download)
- Datastax (free to download)

Class Format

1. **Classroom lectures:** You are expected to attend lectures each week, where class material and assignments will be discussed. Class will be both on-campus and online. It will largely consist of review (of quizzes and assignments), and lectures introducing new material. Your participation grade is based on recording, in Canvas, the most important thing that you did in class. You will have ten minutes at the end of class to record this, so you must be able to access Canvas if you are in the physical classroom (e.g., using your phone).
2. **Lecture slides and videos:** I will be making slides and supplementary lecture videos available each week, via Canvas. It is your responsibility to review these materials and take the exams (see below). It is important that you keep up with this material.
3. **Reading:** There will sometimes be reading associated with each topic. It is highly recommended that you do the reading. You should view the lectures as intended to draw out what is important in the reading and explain the key points of understanding. By doing the reading, you will get much better depth of understanding in the material than can be made available in the slides alone. Readings will be from the texts and from other on-line materials as the term progresses.
4. **Assignments:** There will be approximately weekly programming assignments. I will provide "starter" projects that you complete. They will be due at midnight on Sunday at the end of the week in which their due date falls, via Canvas. There will be a Slack workspace where people can discuss the assignments.
5. **Exams:** There will be weekly "mini-exams" (more extensive than a quiz, but shorter than a full exam). They will be due on Monday the week after the material is covered in on-line lectures.
6. **Virtual Office Hours** are a weekly synchronous session (through Zoom) to give you the opportunity to ask questions related to course material and/or assignments.
7. I will be available via **Canvas email** and will respond as soon as I am available (generally within 24-48) hours. For the Slack discussions, I will check in at least 3 times per week. Often I will not need to respond to questions, as students often can answer each others' questions before I have a chance to respond. For urgent matters, feel free to email me; Canvas email is much preferred as the Canvas mailbox is not as cluttered as regular email (and gets forwarded to my regular email anyway).

Ethical Conduct

Undergraduate Honor System

Enrollment into the undergraduate class of Stevens Institute of Technology signifies a student's commitment to the Honor System. Accordingly, the provisions of the Stevens Honor System apply to

all undergraduate students in coursework and Honor Board proceedings. It is the responsibility of each student to become acquainted with and to uphold the ideals set forth in the Honor System Constitution. More information about the Honor System including the constitution, bylaws, investigative procedures, and the penalty matrix can be found online at http://web.stevens.edu/honor.

The following pledge shall be written in full and signed by every student on all submitted work (including, but not limited to, homework, projects, lab reports, code, quizzes and exams) that is assigned by the course instructor. No work shall be graded unless the pledge is written in full and signed.

"I pledge my honor that I have abided by the Stevens Honor System."

Reporting Honor System Violations

Students who believe a violation of the Honor System has been committed should report it within ten business days of the suspected violation. Students have the option to remain anonymous and can report violations online at www.stevens.edu/honor.

Graduate Student Code of Academic Integrity

All Stevens graduate students promise to be fully truthful and avoid dishonesty, fraud, misrepresentation, and deceit of any type in relation to their academic work. A student's submission of work for academic credit indicates that the work is the student's own. All outside assistance must be acknowledged. Any student who violates this code or who knowingly assists another student in violating this code shall be subject to discipline.

All graduate students are bound to the Graduate Student Code of Academic Integrity by enrollment in graduate coursework at Stevens. It is the responsibility of each graduate student to understand and adhere to the Graduate Student Code of Academic Integrity. More information including types of violations, the process for handling perceived violations, and types of sanctions can be found at www.stevens.edu/provost/graduate-academics.

Special Provisions for Undergraduate Students in 500-level Courses

The general provisions of the Stevens Honor System do not apply fully to graduate courses, 500 level or otherwise. Any student who wishes to report an undergraduate for a violation in a 500-level course shall submit the report to the Honor Board following the protocol for undergraduate courses, and an investigation will be conducted following the same process for an appeal on false accusation described in Section 8.04 of the Bylaws of the Honor System. Any student who wishes to report a graduate student may submit the report to the Dean of Graduate Academics or to the Honor Board, who will refer the report to the Dean. The Honor Board Chairman will give the Dean of Graduate Academics weekly updates on the progress of any casework relating to 500-level courses. For more information about the scope, penalties, and procedures pertaining to undergraduate students in 500-level courses, see Section 9 of the Bylaws of the Honor System document, located on the Honor Board website.