

NTNU
Norwegian University of Science and
Technology

Faculty of Informatics, Mathematics and
Electronics

ENGLISH

Department of Computer and Information
Sciences



Examination results will be announced: 14. June

Exam in the subject
TDT4240 Software Architecture

Tuesday 24. May 2011
9:00 am – 1:00 pm

Aids code C:

Simple calculator allowed.

These specified printed documents are allowed:

- IEEE (2000), "IEEE Recommended Practice for Architectural Description of Software-Intensive Systems", Software Engineering Standards Committee of the IEEE Computer Society.
- Kruchten, P. (1995), "The 4+1 View Model of Architecture", IEEE Software, 12(6).
- English-Norwegian dictionary (or to your native language if your not Norwegian) and/or an English thesaurus (English-English).

Contact person during the exam:

Alf Inge Wang, phone 7359 4485, mobile phone: 9228 9577

The points show how much each problem is worth in this exam. For each problem, each question has the same weight unless otherwise stated. The exam has 5 problems giving a total of 70 points. The remaining 30 points are credits awarded from the software architecture project.

Good Luck!

Meng Zhu and Bian Wu

Controlled 13th of May 2011

Problem 1: Various questions (20 points)

Answer these questions shortly:

1.1	What is Bass, Clements and Kazman's definition of Software Architecture (the definition in the textbook)?
1.2	Write some key characteristics of agile software development.
1.3	What is domain-driven design?
1.4	What were the main findings in the paper "Agile Enterprise Software Development Using Domain-Driven Design and Test First"?
1.5	Describe two important differences between computing hardware architecture and software architecture described in Perry & Wolf.
1.6	Describe two similarities between building and software architecture.
1.7	Which three classes of architectural elements are described by Perry & Wolf?
1.8	Write five elements that a pattern description should contain in the format Alexandrian form (Coplien).
1.9	What is a pattern language according to Coplien?
1.10	Write the three main areas of tactics described in the textbook for achieving high availability.
1.11	What is the main advantage of using the Singleton design pattern in a software architecture?
1.12	Give examples of typical response measures for the quality attribute availability.
1.13	What is architectural erosion?
1.14	What are the main advantages of using ATAM in a development project?
1.15	What is a variation point in a software product line?
1.16	How are mediators used in development with Off-The-Shelves components?
1.17	What is an architectural driver (give examples)?
1.18	Describe how the quality attribute usability can be related to software architecture?
1.19	What is the relationship between a reference model and a reference architecture?
1.20	Describe shortly the four steps in the process of reconstructing a software architecture as described in the textbook.

References:

- Perry & Wolf: "Foundation for the Study of Software Architecture"
- Coplien: "Software Design Patterns: Common Questions and Answers"

Problem 2: Choose most appropriate architectural pattern (5 points)

Nominees:

- a) Model-view-controller
- b) Pipe-and-filter
- c) Layered
- d) Blackboard
- e) Hierarchical task tree
- f) Control Loop
- g) Peer-to-peer

Choose the *most appropriate architectural pattern* (one) for these 5 short descriptions of systems. Motivate for your choices:

1. Software for a system consisting of sensors for temperature, light, humidity and air pressure that will open or close windows in a building depending on the sensor readings.
2. Software for taking raw data from seismic samples and transforming the data through several stages until the data can be used for visualization.
3. Software for managing and representing the artificial intelligence (AI) of a strategy game where the strategy is represented in several levels of complexity from atomic actions up to strategic plans.
4. Software agent system where the software agents communicates through a repository by storing information objects, reading information objects, updating information objects and deleting information objects.
5. A system for managing air traffic that consist of an user interface that uses flight management and sector management that uses a set of classes providing general aeronautical services that uses general support mechanisms such as network, storage, resource management etc.

Problem 3: ATAM (5 points)

Do the step 6 (Analyze the architectural approaches) using the ATAM process based on the following information about an online-store for video games named Paystation network.

Utility tree:

- Security:
 - Scenario S1: It should be less than 1% chance to get unauthorized access to customer data. (L,M).
 - Scenario S2: 95% of unauthorized intruders should be identified (M,H).
- Availability:
 - Scenario A1. The system must be available 95% of the time (M,H).
- Usability:
 - Scenario U1: The user should be able to learn all Paystation network features within 10 minutes (M,H)

Identified architectural tactics:

- AT1: The server should have a hot-restart within 30 seconds if it fails.
- AT2: The server should have watchdog to check if the servers is running.
- AT3: Schedule time-critical components wisely.
- AT4: Structure the system to have semantic coherence.
- AT5: Use information hiding.

Problem 4: Creating a Game Architecture (10 points)

Use the first two steps (1. Find tokens, 2. Analyze interaction and events) in the method described in “Creating a Game Architecture” (Rollings & Morris) to analyze the architecture for the game described below.

Description of the game Space Invaders (see screenshot of the game below):

Space Invaders is a two-dimensional fixed shooter game in which the player controls a laser cannon by moving it horizontally across the bottom of the screen and firing at descending aliens. The aim is to defeat five rows of eleven aliens that move horizontally back and forth across the screen as they advance towards the bottom of the screen. The player defeats an alien, and earns points, by shooting it with the laser cannon. As more aliens are defeated, the aliens' movement and the game's music both speed up. Defeating the aliens brings another wave that is more difficult, a loop which can continue indefinitely. The aliens attempt to destroy the cannon by firing at it while they approach the bottom of the screen. If they reach the bottom, the alien invasion is successful and the game ends. A special "mystery ship" will occasionally move across the top of the screen and award bonus points if destroyed. The laser cannon is partially protected by several stationary defense bunkers—the number varies by version—that are gradually destroyed by projectiles from the aliens and player.



Problem 5 Design a software architecture (30 points)

Read the description of the SMP system below and do an architectural design. Your answer must include:

- Architectural drivers – 2 points
- Architectural tactics and patterns – 3 points
- Physical view (deployment view) – 5 points
- Logical view – 17 points
- Architectural rationale – 3 points

Motivate for your choices and state your assumptions.

Software for Surveillance and Monitoring of Patients (SMP)

The SMP hardware unit is used at hospitals to monitor the health of patients. The unit receives signals from various sensors e.g. pulse, temperature and blood pressure, which will be displayed on a LCD display, a screen or printed out on a on-device mini printer. The unit can be operated by buttons, a keyboard or a touch-based screen, depending on the version of the unit the customer buys. The operator can set values for when alarms should be fired off and enter data about the patient. The hardware unit will use sensors from various vendors. At given extreme values specified by the operator or by default values, the unit will initiate an alarm using text or symbols on the screen and high sound to warn that the patient is in a life-critical state and need immediate help. A more expensive version of the unit will also notify nurses or doctors by sending an SMS to registered cell phone numbers.

Here one example of how a SMP hardware unit can look like:

