

Design of Software Architectures

(211133)

Examination, 30 October 2007, 9:00:12:30

This is an open book exam. Good luck!

QUESTION 1 – OVERALL THEORY (24 POINTS)

- a) Explain two differences between a use-case driven architecture design approach and a domain-driven architecture design approach.
- b) A critique to domain-driven approaches might be that it is too heavyweight and as such less practical. Explain two reasons for this possible critique. Provide counter arguments for the two reasons.
- c) Agile-driven software development usually does not explicitly model the architecture but utilizes very often the concept of *metaphor*. Consider the following statement in the domain of agile-driven software development:

"The system metaphor is a story that everyone—customers, programmers, and managers—can tell about how the system works A metaphor is meant to be agreed upon by all members of a project as a means of simply explaining the purpose of the project and thus guide the structure of the architecture, thus it is very important for communication, both among the team and with the client."

Explain three problems of using a metaphor instead of explicitly modeling software architecture from the perspective of support for:

- 1. communication
 - 2. development
 - 3. evaluation
- d) Scenario-based evaluation is usually considered as an easy and effective way to analyze the architecture before the architecture is implemented. Provide two limitations of these approaches. Explain what you would recommend to complement these limitations.

Example Case: Temperature Control System

Consider a company which produces temperature control systems for a large category of applications, from home temperature control systems to sophisticated green houses. Traditionally, software has been developed specifically for each application and platform. However, this has proved to be not very economical since software had to be redesigned from scratch each time a different application and/or platform was required. Therefore, the company has decided to design and implement reusable software architecture.

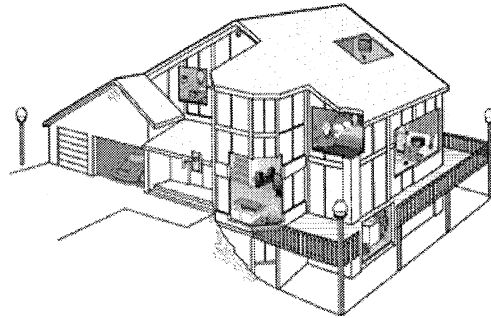
In the company product development is divided among various project groups.

The project group BHCC (Basic home climate control) has adopted a system which is equipped with a processor, program and data memory, a simple display and various peripheral devices such as sensors (temperature, humidity, pressure, wind, etc.) and actuators (heating, cooling). A home climate control system has to be developed providing the following measurements:

- Outside and inside temperature
- Barometric pressure;
- Humidity.
- Wind speed and direction;

The system must also provide the following derived measurements:

- Wind chill (what is the temperature sensed considering the effect of wind);
- Temperature trend;
- Barometric pressure trend.



The system must provide a means of determining the current time and date, so that it can report the highest and lowest values of any of the four primary measurements during the previous 24 hour period.

QUESTION 2 - PROBLEM ANALYSIS & DOMAIN ANALYSIS (16 POINTS)

- Identify the most relevant 10 technical problems and motivate (using a sentence per motivation).
- Identify six possible solution domains, and motivate why you need these.

QUESTION 3 – MODELING ARCHITECTURE (25 POINTS)

- a) Define a module view (using UML) of the architecture (hint adopt a feedback control architecture). Consider each measured entity as a separate concern and model accordingly.
- b) Define the operation of the UML classes and show the interaction diagram (collaboration diagram) of the architecture. Explain how your architecture can support (implement) the requirements.
- c) Define a deployment view of the architecture in which you show the allocation of modules to hardware nodes. Explain your architectural decisions.

QUESTION 4 – EXTENDING THE ARCHITECTURE (15 POINTS)

The project group GHPC (Green House Process Control) has been established to design architecture for controlling the process in green houses. Green house process control has to provide the following additional features:

- Climate control from the perspective of the plants;
 - Different plants may have different ideal temperature. Therefore different plant models must be adopted;
 - The controller must also regulate light, nutrition (food), water (humidity);
- a) Discuss the following approaches from the perspective of cost-effectiveness (advantage-disadvantage with respect to cost)
 1. A common architecture is defined and home control system and green house control system is derived from the basic system;
 2. The green house control system is derived from the home system;
 3. The house control system is derived from the green house system;
 4. These systems are designed from scratch separately;
 - b) Define the module view of the second case. Explain how your architecture can support (implement) the additional features. Explain how the architecture is extended (reused).

QUESTION 5 – CONFLICTING REQUIREMENTS AND CHANGE SCENARIOS (20 POINTS)

The stakeholders for the case are defined at the business level (Marketing Analyst, Business Manager, and Sales Manager) and at the technical level (Project Manager, Architect, and Programmers). Furthermore, a person is assigned responsibility for the reusability and evolvability of the architecture (Reuse Manager).

a) Provide an example of conflicting requirements for the following pair of stakeholders:

- Business Manager vs. Architect
- Project Manager vs. Architect
- Business Manager vs. Reuse Manager

b) Assume that the stakeholder Marketing Manager claims that there may a market for the following extensions:

- Turn on the home climate control system remotely by the help of Internet access;
- Support of home gardening system (spraying water in case of dry and hot weather, etc.);
- Controlling different types of plants by the help of climate zones and different sensors and actuators;
- Delaying and speeding up the plant growth based on the market demands.

What would be the effect of these scenarios to architecture? Explain each scenario listed above separately.

Kenmerk : TW2007/DWMP/54/ha

Vak : **Calculus II voor INF/TEL**

Vakcode : 152102

Datum : 31 oktober 2007

Tijdstip : 13.30-16.30 uur

Alle antwoorden dienen gemotiveerd te worden.

Gebruik van een rekenmachine is toegestaan (ter controle), maar de gevraagde berekeningen dienen exact te worden uitgevoerd, tenzij expliciet om een (decimale) benadering wordt gevraagd.

Bij dit tentamen is een formuleblad gevoegd.

1. (a) [2 pt] Toon aan dat $\sum_{n=0}^{\infty} \frac{(-1)^n}{3^{2n+1}} = \frac{3}{10}$.
Hint: herschrijf tot een meetkundige reeks (*geometric series*).
- (b) [2 pt] Onderzoek of de reeks $\sum_{n=1}^{\infty} \frac{1}{n + \sqrt{n}}$ convergent of divergent is.
- (c) [3 pt] Onderzoek m.b.v. de integraaltest of de reeks $\sum_{n=2}^{\infty} \frac{1}{n \ln^2 n}$ convergent of divergent is.
- (d) [2 pt] Onderzoek of de reeks $\sum_{n=2}^{\infty} \frac{\sin n}{n^2 - n}$ absoluut convergent, voorwaardelijk convergent of divergent is.
2. (a) [2 pt] Bepaal de convergentiestraal van de machtreeks $\sum_{n=1}^{\infty} \frac{3^n (x+1)^n}{(-2)^n}$.
- (b1) [2 pt] Bepaal een machtreeksrepresentatie van $f(x) = \frac{x}{1+x^3}$.
- (b2) [1 pt] Gebruik (b1) om een machtreeksrepresentatie te bepalen van $\int \frac{x}{1+x^3} dx$.
- (b3) [1 pt] Gebruik (b2) om de integraal $\int_0^{\frac{1}{2}} \frac{x}{1+x^3} dx$ te benaderen met een fout kleiner dan 10^{-4} .

Z.O.Z