Name: _____

Studentnr: _____

Exam Software Architecture

30 January 2017, 13:30 – 16:30

- This closed-book exam consists of 5 questions on 15 pages. Please check first whether you have properly obtained **all** pages.
- Enter the answers in the space allocated. In case you need more space, you can **use the back** of the pages. Make a proper reference to such an extra part on the back.
- When you have finished the exam, you should submit the complete package stapled in the correct order.
- Read carefully the question before you start answering!
- Reread your answers to check whether you really answered the question posed!
- Write clearly!

Question	Max. points	Awarded points
1	15	
2	20	
3	20	
4	10	
5	20	
6	15	
Total:	100	
Grade:	Total / 10	

Good luck with the exam!

1. Basic concepts (15p)

Software architecture is considered to be “the set of structures needed to reason about the system, which comprises software elements, relations among them, and properties of both”.

A. Software architecture entails more than just system design. Explain why. (3p)

When documenting an architecture, the architect uses views.

B. Explain what a view is. (2p)

C. Explain what a structure is. (2p)

D. Explain the relation between a view and a structure. (3p)

We distinguish two types of structures: static structures and dynamic structures.

E. Explain both (2p + 2p) and give an example for both structures. (1p)

Static structure

Explanation

Example

Dynamic structure

Explanation

Example

2. Software product lines (20pt)

A. Explain two different needs for variability in software product lines (4p)

A1:

A2:

A well-known variation mechanism in Data-Oriented Information Systems, such as ERP systems, is code generation.

B. Give an example of code generation in Data-Oriented Information Systems
Explain your example. (3p)

C. Explain the concept of variation mechanisms using the above example (5p).

D. Explain 2 additional variation mechanisms that can be used in product lines. (4p)

D1:

D2:

E. What are the two main criteria to decide which variation mechanism should be chosen in a software architecture? Explain your answer. (4p)

E1:

E2:

3. Modeling (20pt)

A model is an abstract representation of some system. Key in using models is that if property P holds on the model, then P should hold on system as well.

A. Explain what a false positive is (1p)

B. Explain what a false negative is (1p)

C. Explain why it is important to consider false positives and false negatives during architecture analysis. (3p)

Two important aspects of architecture evaluation are verification and validation.

D. Explain what verification is (1p)

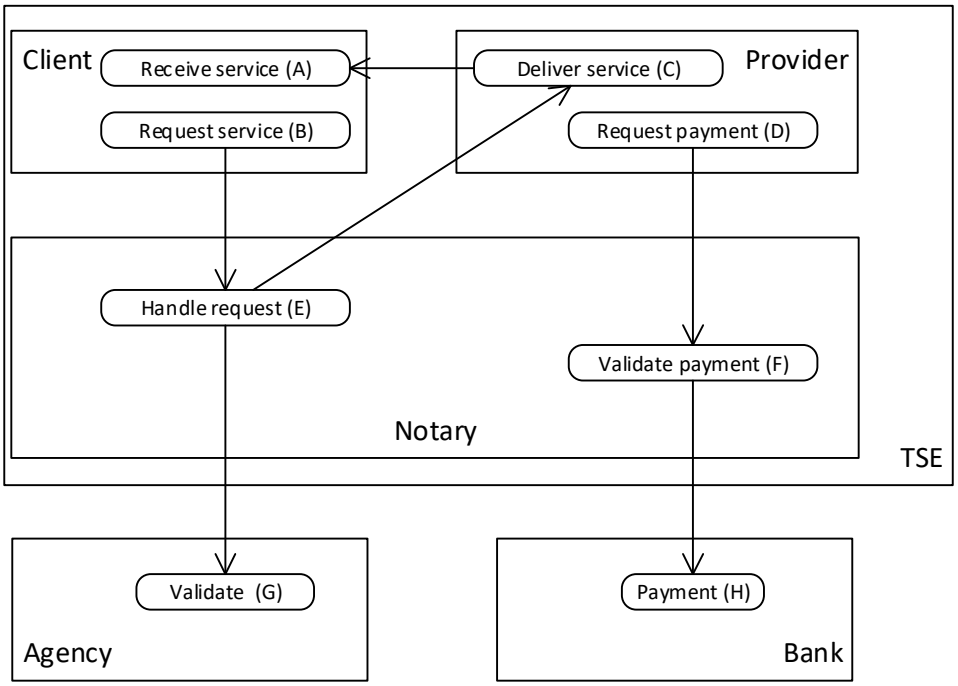
E. Explain what validation is (1p)

F. Explain their difference (3p)

Trusted Service Delivery (TSD)

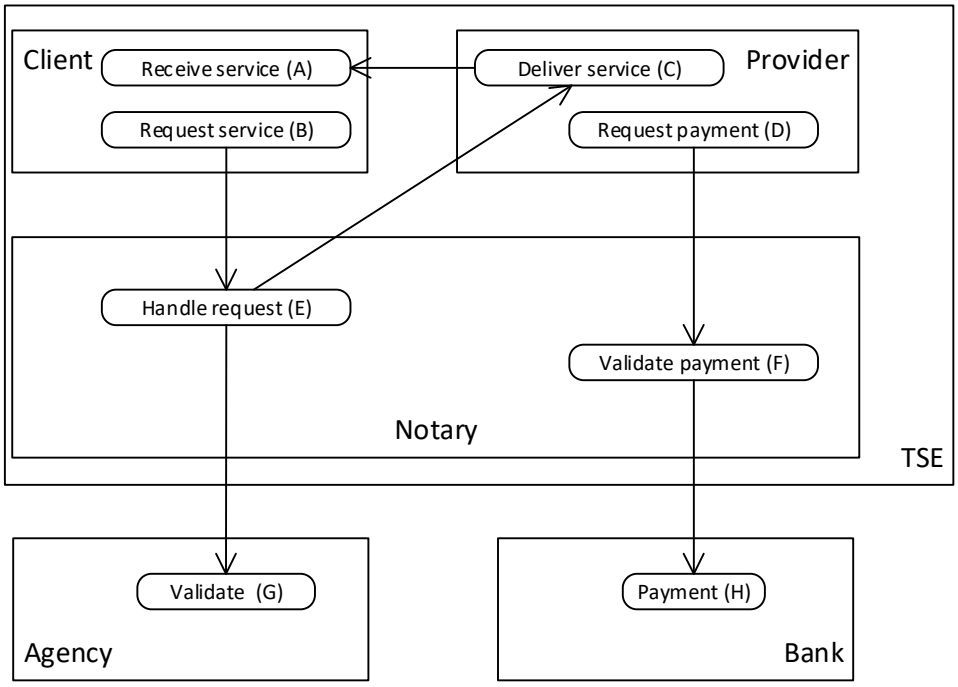
As an external architect, you have to create a system for a Trusted Service Delivery (TSD) between Clients and Providers. As trusted third party, TSD ensures the negotiation, contracts and service delivery between the different parties. Before a Client can ask for a Provider, the Client needs to get approval by TSD. In order to get this approval, TSD may ask the Client some additional information, and it needs to consult the Central Information Agency. Based on the outcome of the Agencies, TSD decides whether the Client may ask the Provider. Once TSD has approved the request of the Client, the Client will search a Provider. If a Provider comes to an agreement with the Client, the Provider will deliver its service. For this, the Provider will regularly send an approval form that the Client needs to sign. The Provider then sends this signed form to TSD to receive its payment.

Given is the functional architecture of TSD:



G. Explain the main elements of the functional architecture model based on the above model (5p)

H. Draw a scenario as overlay that describes the main flows of TSD, explain your scenario, and why this scenario is in your opinion the main flows (5p)



Explanation:

4. Patterns and rationale (10pt)

An architectural pattern

- Is a package of design decisions that is found repeatedly in practice;
- Has known properties that permit reuse; and
- Describes a class of architectures

An important aspect in software architecture are architecture candidates.

A. Explain how an architect uses patterns to come to an architecture candidate. (3p)

Given is the following definition of the Client-Server (CS) pattern:

Summary: The Client-Server pattern decouples functionality offering from the actual execution of functionality. It supports systems where many light-weight clients can use functionality that require heavy calculations

When to use it: Clients do not have the computational power to execute the required functionality, or when functionality is required by many different components in the system.

When to avoid it: Large data transfers are required to perform calculations, high availability of the functionality is required.

B. Explain by means of the CS pattern why an architectural pattern "Is a package of design decisions that is found repeatedly in practice" (2p)

An architectural pattern establishes a relation between a context, a problem and a solution.

C. Explain the CS pattern in terms of context, problem and solution. (3p)

Context:

Problem:

Solution

Another example of a pattern is the Service Oriented Architecture pattern:

Summary: Providers register their function to a Register. When a Client requires some functionality, the Register returns an appropriate Provider. The Client then contacts the Provider to handle its request.

When to use it: Many different providers deliver the same service, functionality is offered cross-organizational

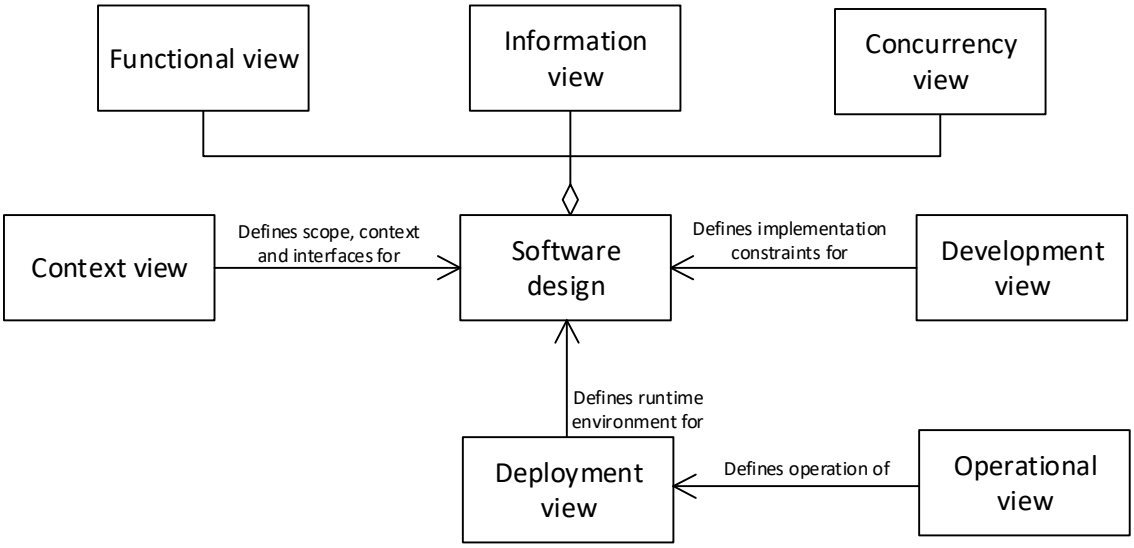
When to avoid it: Large data transfers are required to perform services, performance and availability are essential for the software system.

Consider again the example of TSD.

D. Explain, using the above two patterns, how different patterns can be integrated and used within the same architecture. (2p)

5. Viewpoints and perspectives (20pt)

To document an architecture, we use the concept of viewpoints. An aid to address quality attributes is using perspectives. During the course, we used the viewpoint catalog, containing seven viewpoints:



A. Explain the relation between views and viewpoints (2p)

B. Explain how viewpoints support architecture documentation (3p)

C. Explain the difference between viewpoints and perspectives (2p)

D. Explain how a perspective helps in addressing quality attributes using the above catalog (5p).

An important task of the architect is to ensure consistency within the architecture.

E. Explain why consistency is a vital characteristic of architectural documentation (3p)

F. Explain using the above viewpoint catalog how an architect can address consistency (5p)

6. Analyzing Perspectives (15pt)

Consider again TSD. An important perspective is scalability. The Central Information Agency expects that multiple organizations like TSD will use the same feature. Internally, the agency has divided the work over three departments: File, Stamp and Champion. The first department, File, stores the request, and decides whether it is a complicated case, or a simple case. On average, about 20% of the cases are complicated. For the simple cases, the Stamp department will do an easy validation and send their approval. The complicated cases are handled by the Champions.

As the agency expects more customers similar to TSD, they want to analyze the performance of their current system, which is one to one mapped to the organizational structure.

As architect, you decide to model the system as a queueing network with M/M/1 nodes.

A. Although modeling the performance of a system using a queueing network with M/M/1 queues has many advantages, one has to be careful about the assumptions. What are the main assumptions the architects have to validate before they can safely decide to use this analysis technique? (3p)

B. After some validation, it turns out that TSD generates 40 requests per day, and that all other organisations that use their service will generate an additional 60 request per day. At the agency, all departments manage to work around the clock (i.e., 24/7) as they work in shifts. The Files department is able to handle 5 claims per hour, the Stamp manages to handle 4 per hour, whereas the Champions manage to handle 1 claim per hour.

C. Draw the queueing network of the agency (5p).

D. Calculate the average time a request from any organization, including TSD, needs to wait in the system of the agency. Explain your answer and calculations! (7p).

M/M/1 formulae

- Utilisation: $\frac{\lambda}{\mu}$
- Expected number of elements in a node: $\frac{\rho}{1-\rho}$
- Expected number of elements in the queue: $\frac{\rho^2}{1-\rho}$
- Expected waiting time: $\frac{\rho}{\mu-\lambda}$
- Expected sojourn time: $\frac{1}{\mu-\lambda}$

End of the exam