TECHNISCHE UNIVERSITEIT EINDHOVEN
Faculteit Wiskunde en Informatica

Examination Architecture of Distributed Systems (2XI45)
on Wednesday November 9, 2011, 14.00h-15.30h

Work clearly. Read the entire exam before you start. Motivate each answer concisely and to-the-point. Maximal grades are given between parentheses. The total score sums up to 20 points.

1. Give the following two definitions.
   a. (1) Define and explain the term 'Architectural View'.
      A collection of models that address one or more concerns of a stakeholder; the view conforms to a viewpoint.
   b. (2) Describe and explain briefly two views proposed by Kruchten.
      – *Logical view*: externally visible structure, typically modeled as an object diagram
      – key stakeholder: user; concerns: using the system, associated qualities

      – *Development view:*decomposition into subsystems, organization into files and modules
      – key stakeholder: programmer; concerns: implementing and modifying the system

      – *Process view:* units of deployment ('programs', 'components') and concurrency ('threads','processes')
      – key stakeholder: system integrators; concerns: performance aspects

      – *Physical (deployment) view: computers, networks, infrastructure, distribution, mapping of software to hardware*
      – key stakeholder: System Engineer; concerns: putting systems together

      – (+1) Scenario's (structured use cases) - sets of interactions with the system integrating the (models in the) views and providing behavioral models inside the views
      – all stakeholders

2. (2) Describe immediate service discovery and its pros and cons (at least three in total).
   a. see ADS.06.Naming.pdf: slide 9
3. A server for a web site must be setup to deal with an increasing number of users. The server consists of a single machine for hosting the site, but in order to deal with more users it has been made possible to add machines to form a cluster and to adapt the access procedure in order to dispatch requests.
   a. (1) Describe the architecture scalability concern that is playing here, formally.
      i. usage parameter: # clients
      ii. architecture parameter: # servers
      iii. metric (to remain constant): query response time
          The architecture scalability concern is how the architecture can accommodate an increase in the number of clients by increasing servers and adjusting the access procedure in order to maintain response time constant.
   b. (1) Describe (potential) limitations to the scalability.

        i.   consequences of the physical organization: the amount of data that can enter and leave the entire system, or a single server.

        ii.   consequences of logical organization: a single gateway for all servers.

    c.   (1) Describe at least two methods to improve scalability of the access procedure to the server cluster.

        i.   See ADS.06.Naming.pdf: slide 8.

4. (2) Describe the publish & subscribe architectural style using the proper vocabulary, name the concepts involved, give a motivation for its usage and mention its typical operation.

    a.   ADS.03.ArchitectureStyles.pdf: slide 17

5. (2) Describe the difference between broadcast, multicast and anycast and give an application of all three.

    a.   broadcast: message without destination reaching all reachable neighbors. Example: DHCP, other service discovery

    b.   multicast: message sent to a given set of destinations. Example: IP multicast, e.g. in UPnP.

    c.   anycast: message delivered to one destination out of a set of possible ones. Example: DNS requests to root servers.

6. In the *Open Service Architecture for Sensors* a technique called *content-based addressing* is used.

    a.   (1) Explain what this means.

        i.   the destination of a message is defined by a predicate on the message content and the state of a node.

    b.   (1) Explain the benefit of this technique in the distribution of virtual machine code.

        i.   The machine code is distributed as a single sequence with content-based addresses indicating which nodes needs to install it. This allows to send just a single sequence into the network rather than specialized codes, per node.

7. (2) Confirm or deny the following statements, with one line of motivation.

    a.   Each DNS resolve request is sent to a root server.

        i.   no; caching is used.

    b.   There are only 13 DNS root servers.

        i.   no; these are replicated and accessed using anycast.

    c.   Each DNS server will resolve recursive queries.

        i.   no; root servers will typically not.

    d.   A Distributed Hash Table supports efficient flat name resolution.

        i.   yes, by replacing linear search by binary search.

8. (2) Explain the concepts of coupling and cohesion. Give an example of bad cohesion.

    a.   ADS.07.QA.pdf: slide 41, 43 (using 42)

9. Interactions and interaction styles have certain qualities (for example, whether a pending interaction is persistent).

    a.   (1) discuss and explain at least 4 different quality aspects (quality categories) of interactions;

Memory/storage

        i.   *transient*: interaction requires sender and receiver to 'execute' at same time

        ii.   *persistent*: interaction remains while sender and receiver disappear

Synchronization

        iii.   *asynchronous*: sender/caller does not wait or block;

        iv.   *synchronous*: caller blocks till request acceptance

           1.   several different synchronization points, see next slide
      v. *buffered*: limited difference between #calls and #responses

Units of information:
     vi. *discrete*: structured unit, independent and complete
    vii. *continuous (streaming)*: basic units without message structure

Connection
   viii. Connection oriented
     ix. Connection-less

Reliability

Time dependence
      x. temporal relationships typically with streaming
     xi. *synchronous*: bounded delay
    xii. *isochronous*: bound minimum and maximum delay (i.e., jitter)

b. (1) what are qualities of a *remote procedure call system* for the quality aspects you discussed in 9a?
transient, synchronous, discrete, reliable, connectionless, no temporal relationships