西 安 电 子 科 技 大 学

考试时间 120 分钟

试 题

一、什么是软件体系架构？（软件体系结构的定义）

基于 1993 年 D Garlan,Mshaw 的软件体系结构定义，可以认为软件体系结构由三大要素组成，分别为：组件，连接件，约束。其作用如下：

- 组件：具有某种功能的可重用的**软件模块单元**，表示了系统中主要的**计算单元**和**数据存储**。
- 连接件：表示了**组件之间的交互**。简单的连接件有：管道、过程调用、事件广播等。复杂的连接件有：客户－服务器通信协议，数据库和应用之间 SQL 连接等。
- 约束：表示了组件和连接件的拓扑逻辑和约束。

Note: Write all answers on the answer sheet(请将答案写在答题纸上).

Question 1: Explanations (10 points)

1) **According to your understanding, please describe what software architecture is.**
2) **Please describe the "virtual machine" architecture style, and give one typical application scenario.**

Question 2: Multiple Choice（单项选择）(20 points)

1. Which of the following tactic cannot be used to achieve the *Availability*?

A) Heartbeat **B) Semantic coherence**

C) Passive redundancy **D) Active redundancy**

2. Which of the following tactic can be used to achieve the *Modifiability*?

A) Process monitor **B) Authenticate users**

C) Semantic coherence **D) Built-in monitors**

3. Which of the following tactic can be used to achieve the *Performance*?

A) Ping/echo **B) Limit access**

C) Use an intermediary **D) Fixed-priority scheduling**

4. Which of the following tactic can be used to achieve the *Security*?

A) Ping/echo **B) Authenticate users**

C) Use an intermediary **D) Removal from service**

5. Which of the following tactic can be used to achieve the *Testability*?

A) Maintain data confidentiality **B) Record/playback**

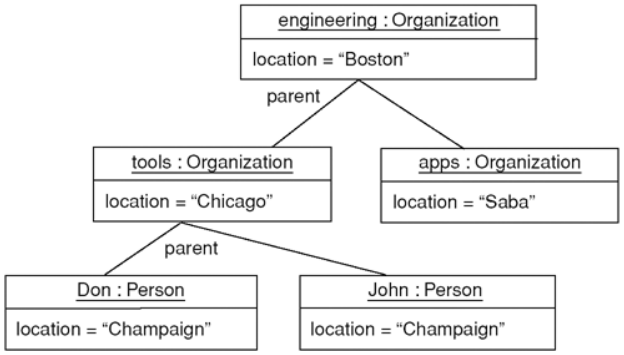
C) Heartbeat **D) Rollback**

6. Which diagram is suitable to represent an external view of a system?

A) Use case diagram **B) Deployment diagram**

C) Activity diagram **D) Interaction overview diagram**

7. Which kind of diagram is the following diagram?



C.

A) Class diagram **B) Component diagram**

C) Object diagram **D) Sequence diagram**

8. Which diagram is suitable to show the interactions between objects?

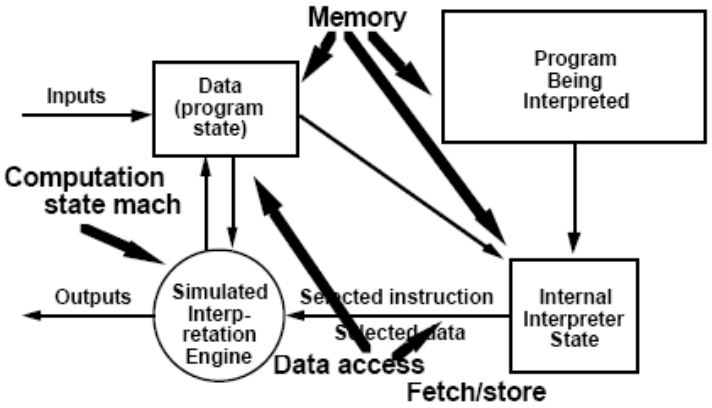
A

A) Sequence diagram **B) Use case diagram** X

C) Activity diagram **D) State diagram** X

9. Which architecture style does the following diagram describe?

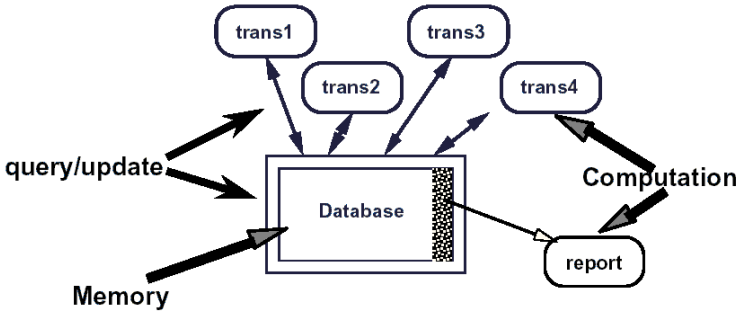
B.



A) Process control **B) Interpreter** **C) Blackboard** **D) batch sequential**

10. Which architecture style does the following diagram describe?

B



A) Blackboard **B) Repository**

C) Implicit invocation **D) Layered**

Question 3: Architecture Analysis and Design (70 points)

1. Quality Attribute and Architecture Style (34 points)

A software company plans to develop a Supermarket Member Management System (short for SMMS) for a membership-based (会员制) supermarket. The membership-based supermarket means that only members can consume in this supermarket. One of the most important functionality of SMMS is to calculate the discount for each product according to a member level and records of her/his consumption(消费). There are three different member levels in the supermarket, as silver, gold and platinum. Meanwhile, the member level will be extended in the future. Besides, the way to calculate discount may change from time to time.

Followings are some detailed requirements for SMMS system.

a) The SMMS should not be accessible remotely to updating without internal protocols.

b) The code coverage of SMMS should be bigger than 70%.

c) If a develop wishes to change the UI at development time, the change must be made with no effects in 2 days.

d) When an unanticipated message from external arrives in SMMS under normal operations of the system, the operator(操作人员) must be informed and she/he can continue to operate without downtime.

e) When a member initiates（发起）a "purchase order" transaction under normal operations of SMMS, the transaction must be processed with average latency of one second.

f) The SMMS should have a friendly look-and-feel（外观）, so it is easy for members to accomplish a desired task in PC, Mobile Phone and Tablet.

g) When an authorized member tries to modify her profile under normal operations of SMMS, the system should maintain an audit trail and the modified data is restored.

Please analyze the requirements and complete following 4 questions:

1) Identify and name the related quality attributes according to the requirements.

2) For each quality attribute, give the corresponding quality attribute scenario.

3) For each quality attribute, list at least 2 solutions for archiving the corresponding quality attribute.

4) According to the requirements, which software architecture style is better for the SMMS? Describe the reason and list the advantages and disadvantages of architecture style you choose for the SMMS.

日期: /

(7) 安全性均等.

刺激源	一个合法用户
刺激	修改个人资料操作.
制品	系统中用户的个人资料数据
环境	SaaS正常运行.
响应.	系统保持常规服务.
响应统计指标.	修改后的数据被恢复.

局用性 均等.

刺激源	用户
刺激	完成一个任务
制品	PC, 手机或平板系统
环境	系统正常运行.
响应.	系统在良好界面下实现用户要求
响应统计指标	用户软件实现所需功能

性能

刺激源	用户
刺激	“访问”事务
制品	系统
环境	SaaS 正常样式工作.
响应.	事务被执行.
响应统计指标	平均处理为1s

日期: /

	可用性.
刺激源.	外部意外消息.
刺激	消息到达 SMS
制品	系统.
环境	系统正常运行
响应.	通知操作人员可以继续操作.
响应衡量指标	不停工

	可修改性
刺激源.	系统开发人员
刺激	修改UI
制品	系统UI组件
环境	在系统开发过程中
响应.	系统UI界面被修改.
响应衡量指标	修改在2天之内完成.

日期: /

3. 可用性:
- 故障检测
  - ping/echo
  - heartbeat.
  - exception.
- 故障恢复
  - 投票
  - 主动冗余
  - 被动冗余
  - spare: 备用
  - 影子接引
  - 检查点/回滚.
- 故障避免
  - 服务下线
  - 手动
  - 进程监控

可修改性.
- 局部化修改.
  - 语义一致性
  - 通用化接口.
  - 考虑可能发生变化
  - 限制可能选项
- 避免连锁反应
  - 隐藏信息
  - 维持接口不变.
  - 限制通信路径
  - 使用中介
- 延迟绑定时间
  - 运行时流程.
  - 配置文件
  - 多态.

性能.
- 资源需求
  - 增高计算处理
  - 减少计算开销.
  - 增加采样速率
  - 并发机制
- 资源管理
  - 增加可用资源
  - 维护数据和计算资源副本.
  - 管理并行副本速率
- 资源仲裁. 资源调度策略

日期: /

安全性.

抵抗攻击
- 对用户身份进行验证.
- 用户授权
- 数据完整性
- 数据保密性
- 试为采购
- 限制访问

检测攻击 — 入侵检测系统

从攻击中恢复
- 正在恢复状态：维护系统管理正本副本.
- 攻有有识别. 跟踪审计、记录事

可测试性

管理输入输出.
- 记录/回放.
- 将接口与实现分离.
- 提供专用测试路径.

内部监控 — 内置监视器

易用性
- 运行时等次
  - 用户 model
  - 系统 model
  - 任务 model
- 设计时策略. 用户界面与应用程序分离.

2. Utility Tree (16 points)

A software company plans to develop a data processing system. The development team analyzed the Quality Attributes, designed architecture and wanted to use Utility Tree to evaluate the architecture, followings are the scenarios.

a) ***There are two roles in the system: administrator and user. An administrator can create one or more users, and grant them the permissions accordingly.***

b) ***Users are identified by their mobile phone numbers, and they can set a nickname having least 5 characters starting with letters.***

c) ***The cost for adding a new data processing algorithm to the system by a developer is less than 10-person days.***

d) ***The processing latency on main database need to be reduced to 100ms.***

e) ***Change Web user interface in <3-person weeks.***

f) ***The application can display the processing results for an authentication user, and the authentication works 99.99% of the time.***

g) ***When power outrage happens at site 1, it takes at most 3s to redirect all traffic from site 1 to site 3.***

h) ***If a user forgets his password, he can reset his password by receiving a message from the system.***

i) ***The latency for processing a 1GB video data (1080p) must be less than 10s.***

j) ***The network failure can be detected automatically and recovered in < 2.5 min.***

k) ***The system must have a user authorization database to record the user permissions, and the authorization works 99.99% of the time.***

According the scenarios, please construct a Utility Tree.

3. Architecture Evaluation (20 points)

Identifying and recording risks and non-risks, sensitivity points and tradeoffs are important tasks in architecture evaluation. Please describe the definitions of risk, non-risk, sensitivity point and tradeoffs and then read the following descriptions and point out each description is a risk, non-risk, sensitivity point or tradeoff.

a) ***The number of concurrent requests will affect the number of transactions a database can process per second.***

b) ***Changing the level of authentication could have a significant impact on both security and performance.***

c) ***Some business processing component is provided by a third-party company, there is no way of detecting the failure of them directly.*** risk.

d) ***Assuming the request arrival rate is twice per second, and the average processing time is less than 80ms; a 1 second response time seems reasonable for our system.*** non-risk

e) ***Some of the legacy data processing components are implemented by the C++ programming language, which should be encapsulated (封装) first and are hard for a Java program to maintain and modify them.*** risk

f) ***The selection of the encryption algorithm might be closely related to the number of bits of encryption.*** sensitivity

2. 效用树 (重要性, 实现难度)

效用树
- 性能
  - 数据延迟
  - 交易吞吐量
  - (M, L) 加载主数据库延迟小于100ms
  - (H, M) 处理10Gbp的1GB视频数据高于10s
- 可修改性
  - 产品改动
  - 新系统同步
  - 以小于10人天的工作量给系统增加算法 (M, M)
  - 以小于3人月的工作量修改web接口 (M, L)
- 可用性
  - 硬件故障
  - 软件故障
  - 在1分钟内检测并恢复网络故障 (H, M)
  - 若结点断电, 则在3s内将其重定向到新结点 (L, M)
- 安全
  - 数据机密性
  - 数据完整性
  - 客户数据库认证在99.99%时间内正常工作. (L, H)
  - 应用显示认证用户处理结果, 认证成功率99.99% (L, H).

3. 风险点：可能引起风险的因素，行为风险点：
通过不断分析风险，架构师可以解决架构缺陷，，采取纠正措施来降低风险。

非风险点：不会引起风险的因素

敏感点：是一个或多个构件的特性，研究敏感点可使设计人员或分析员明确在搞清楚如何实现质量目标时应注意什么

权衡点：影响为个质量属性的特性，是多个质量属性的敏感点