SE3121021: Software Architecture

Course Review

turn off your phones and close your laptops

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课程主要内容

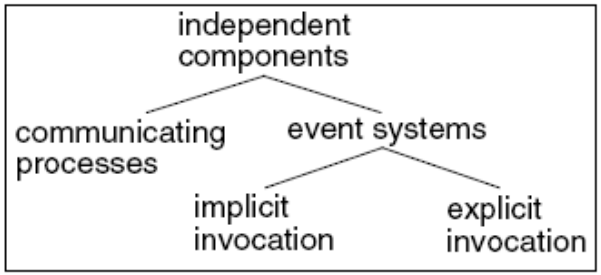
- 软件体系结构定义
- 软件体系结构风格
- 建模和文档化软件体系结构
- 理解质量属性
- 软件体系结构设计
- 软件体系结构评估

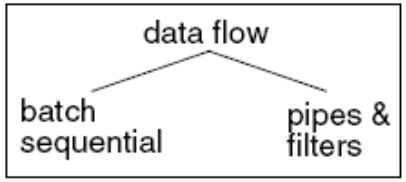
软件体系结构定义

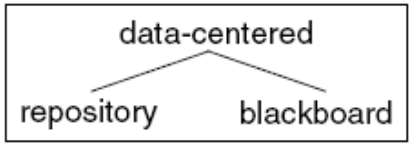
- 软件体系结构定义
  - 不存在一个统一的定义
  - 各个流派对软件体系结构的定义
  - 重点关注
    - **Garlan and Shaw的定义：**
      体系结构 = 组件 + 连接件 + 约束
      Software Architecture =
      Components + Connectors + Constrains

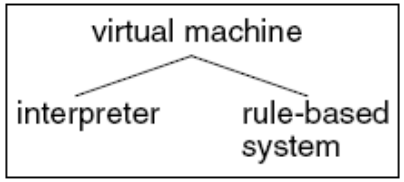
软件体系结构风格

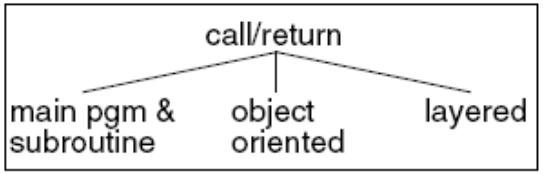
- 软件体系结构风格定义
- 软件体系结构风格的描述
- 常见的软件体系结构风格
  - 数据流
    - 顺序的批处理
    - 管道过滤器
    - 控制环路
  - 调用/返回
    - 主程序/子程序
    - 面向对象
    - 层次结构
    - 客户端/服务器









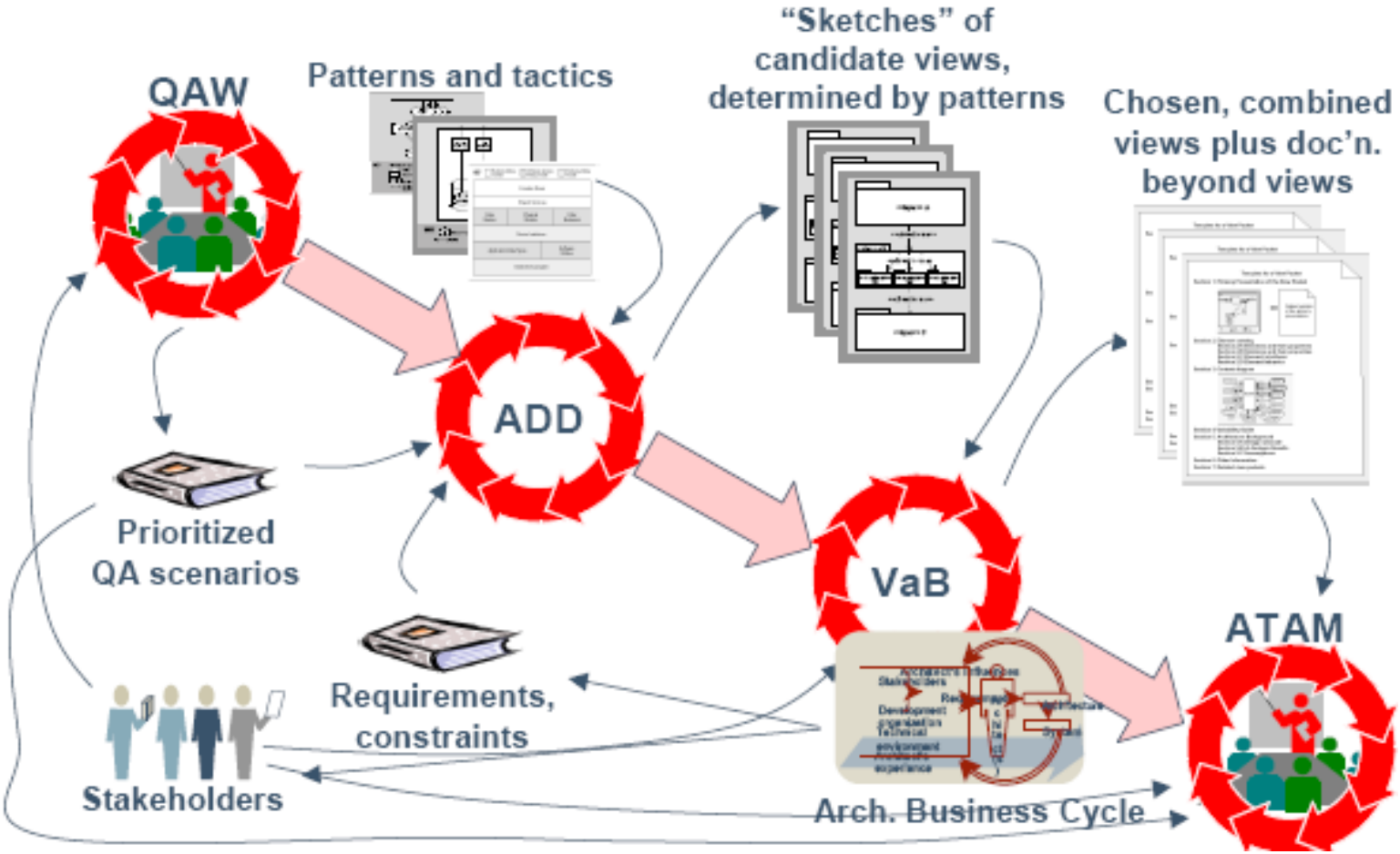


常见的软件体系结构风格（续）

- 以数据为中心（数据共享）
  - 数据存储（编译器的演化）
  - 黑板
- 虚拟机
  - 解释器
  - 基于规则的系统
  - 其它
- 独立组件
  - 通信进程
  - 事件（隐式调用）
  - 其它
- 其它风格
  - **C2**
  - **HMB**
  - **DSSA**

建模和文档化软件体系结构

- 基于软件体系结构的开发（**ABD**）



软件架构文档化

- 如何文档化软件架构
- 好文档的评价准则
- 采用视图描述软件架构
  - IEEE 1471
  - “4+1”视图
- 体系结构语言ADL
- UML
  - 熟练掌握并理解所有UML的图和适用场合

软件质量属性

- 软件质量属性定义
- 软件质量属性与功能、非功能性需求的关系
- 软件质量属性情景
  - 定义
  - 如何描述
- 常见的质量属性
  - 可用性（**Availability**）
  - 可修改性（**Modifiability**）
  - 性能（**Performance**）
  - 安全性（**Security**）
  - 可测试性（**Testability**）
  - 易用性（**Usability**）
- 其它质量属性

软件体系结构设计

- 架构模式的应用
- 常见质量属性的设计
  - 可用性（**Availability**）
  - 可修改性（**Modifiability**）
  - 性能（**Performance**）
  - 安全性（**Security**）
  - 可测试性（**Testability**）
  - 易用性（**Usability**）

软件体系结构评估

- 常见的体系结构评估方法
  - 重点掌握ATAM
  - ATAM的过程
- 质量属性评估效用树（Utility Tree）
- 风险/非风险、敏感点和权衡点的理解与应用

考试题型

- 第一题：基本概念题
  - 问答形式
- 第二题：选择题
  - 软件体系结构定义
  - 软件体系结构风格
  - 软件文档、建模等
  - 软件质量属性及实现方法
  - 软件评估
- 第三题：综合题
  - 质量属性/场景、设计策略、软件体系结构风格
  - 软件体系结构设计
  - 软件质量评估：效用树、风险点、敏感点

架构设计-例题讲解

例题讲解-1

- **A company wants to develop a software system used in its intranet（局域网）. The function of this systems is same as Weibo and Twitter. Each department（部门） can publish information about the department using this system, and Employees in the company can follow（关注） one or more departments to receive information published by these departments. When one department publishes a piece of new information, the system will send the information to all the followers（关注者） of this department. After one employee unfollows one department, he/she will not receive information published by this department in future**
- **Following are some detailed requirements of this system.**

例题讲解-1

- **One employee can follow one or more departments, and can unfollow one department at any time.**
- **The total unavailable time of the systems should be less than 10 hours in a year. The average recovery time of each system fault should be less than one hour.**
- **The system copies the interface（界面） of Weibo, so it's easy to use.**
- **Every minor update of this system should be accomplished by 2 developer within 1 days.**
- **A hardware firewall is used to separate the system from the Internet.**
- **One employee can send private messages to another employee using this system.**
- **The loading time from an employee's login to displaying his/her homepage should be less than 0.1s.**
- **The system provides special interfaces to do automated（自动的） testing.**

例题讲解-1

- **Please analyze the requirements and complete following 4 questions:**
  a) Identify and name the related quality attributes according to the requirements.
  b) For each quality attribute, give the corresponding quality attribute scenario.
  c) For each quality attribute, list at least 2 solutions for archiving the corresponding quality attribute.
  d) According to the requirements, which software architecture style is better for this system? Describe the reason and list the advantages and disadvantages of architecture style you choose for the system.

第一步-去伪存真

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第二步-归类

- **The total unavailable time of the systems should be less than 10 hours in a year. The average recovery time of each system fault should be less than one hour.（可用性）**
- **The system copies the interface（界面） of Weibo, so it's easy to use.（易用性）**
- **Every minor update of this system should be accomplished by 2 developer within 1 days.（可修改性）**
- **A hardware firewall is used to separate the system from the Internet.（安全性）**
- **The loading time from an employee's login to displaying his/her homepage should be less than 0.1s.（性能）**
- **The system provides special interfaces to do automated（自动的） testing.（可测试性）**

第三步-六要素法描述质量属性场景

- **The total unavailable time of the systems should be less than 10 hours in a year. The average recovery time of each system fault should be less than one hour.（可用性）**
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第四步-针对质量属性要求给出设计策略

- **The total unavailable time of the systems should be less than 10 hours in a year. The average recovery time of each system fault should be less than one hour.（可用性）**
- **The system copies the interface（界面） of Weibo, so it's easy to use.（易用性）**
- **Every minor update of this system should be accomplished by 2 developer within 1 days.（可修改性）**
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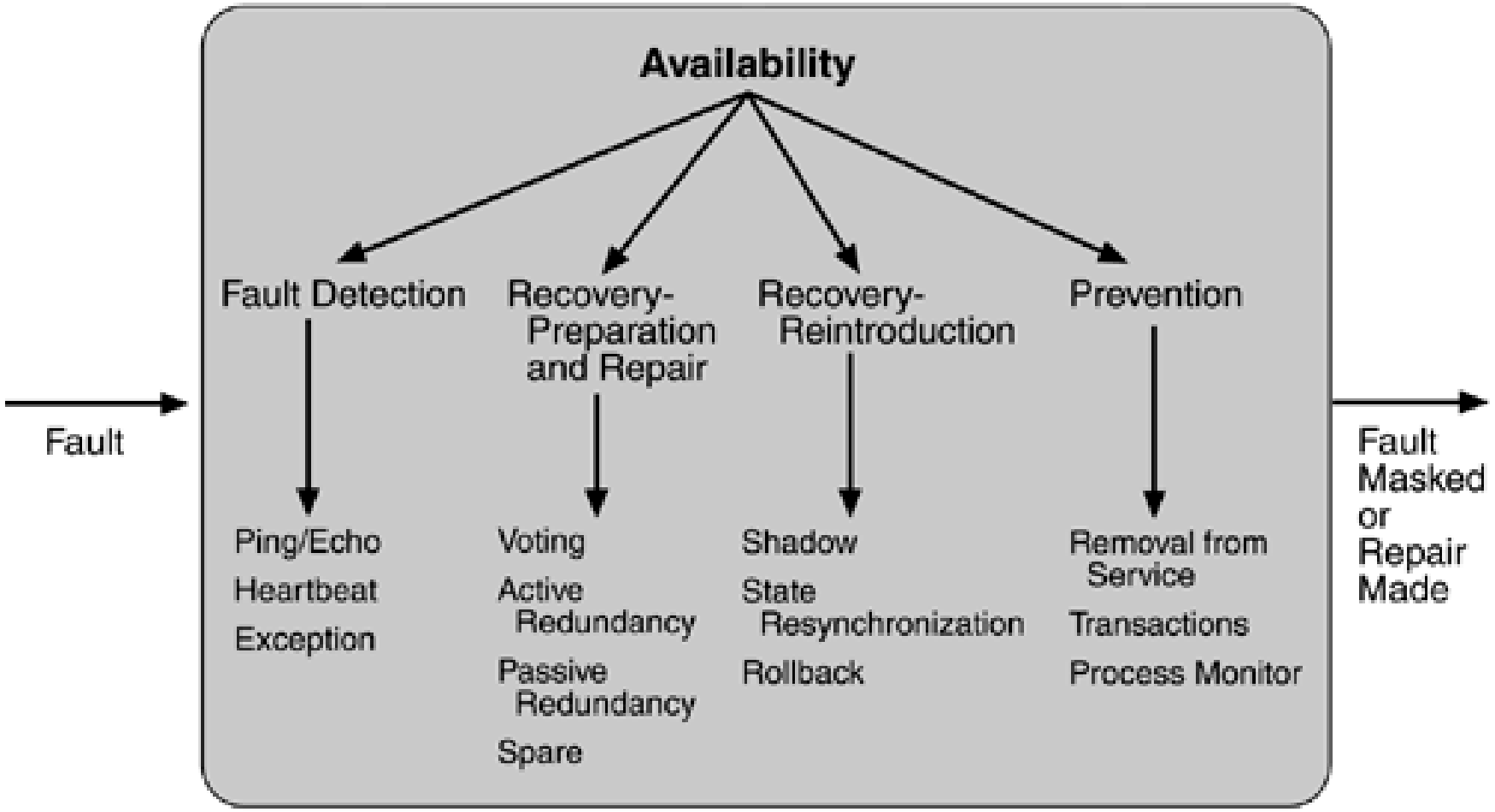
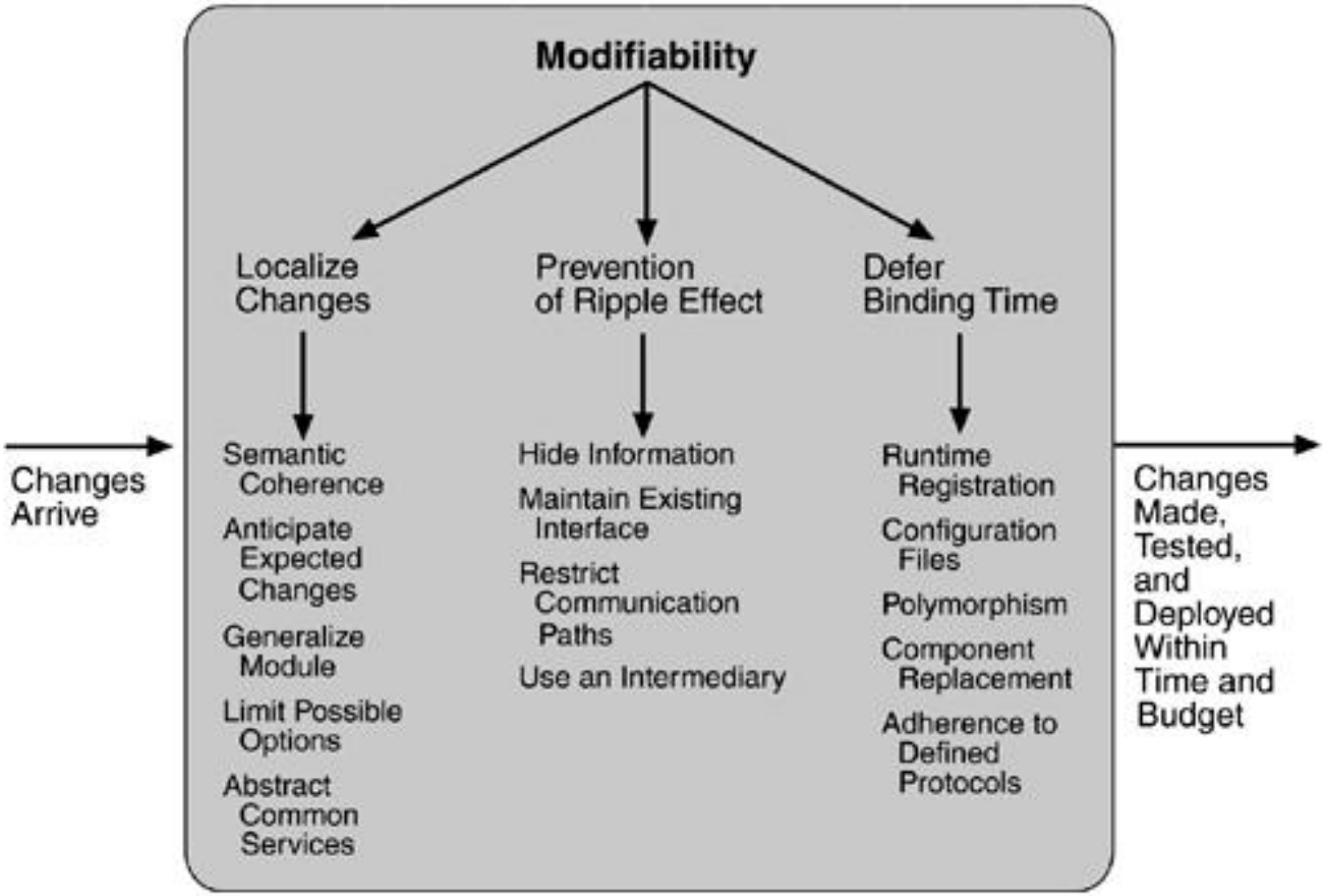
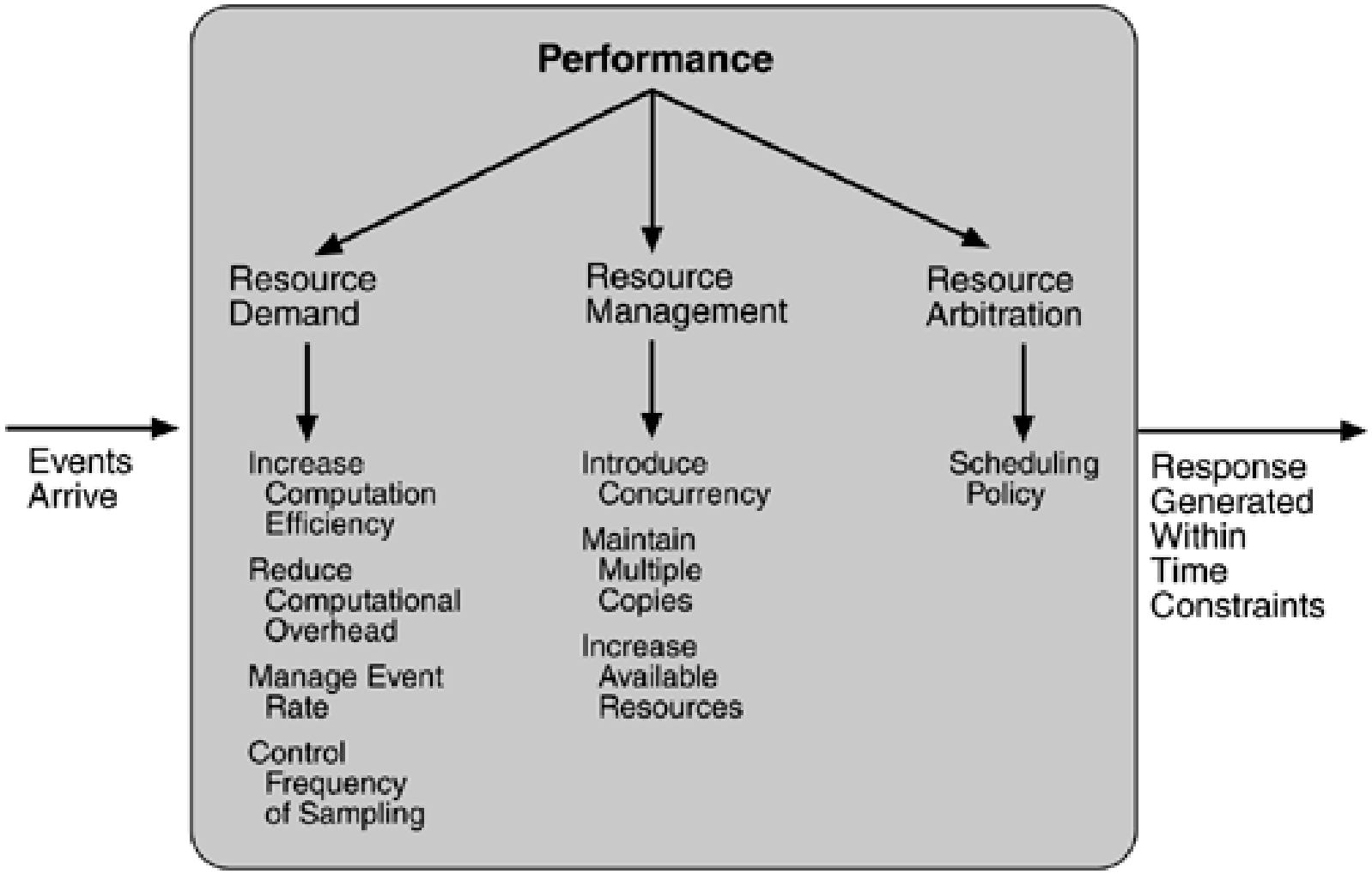
Summary of availability tactics



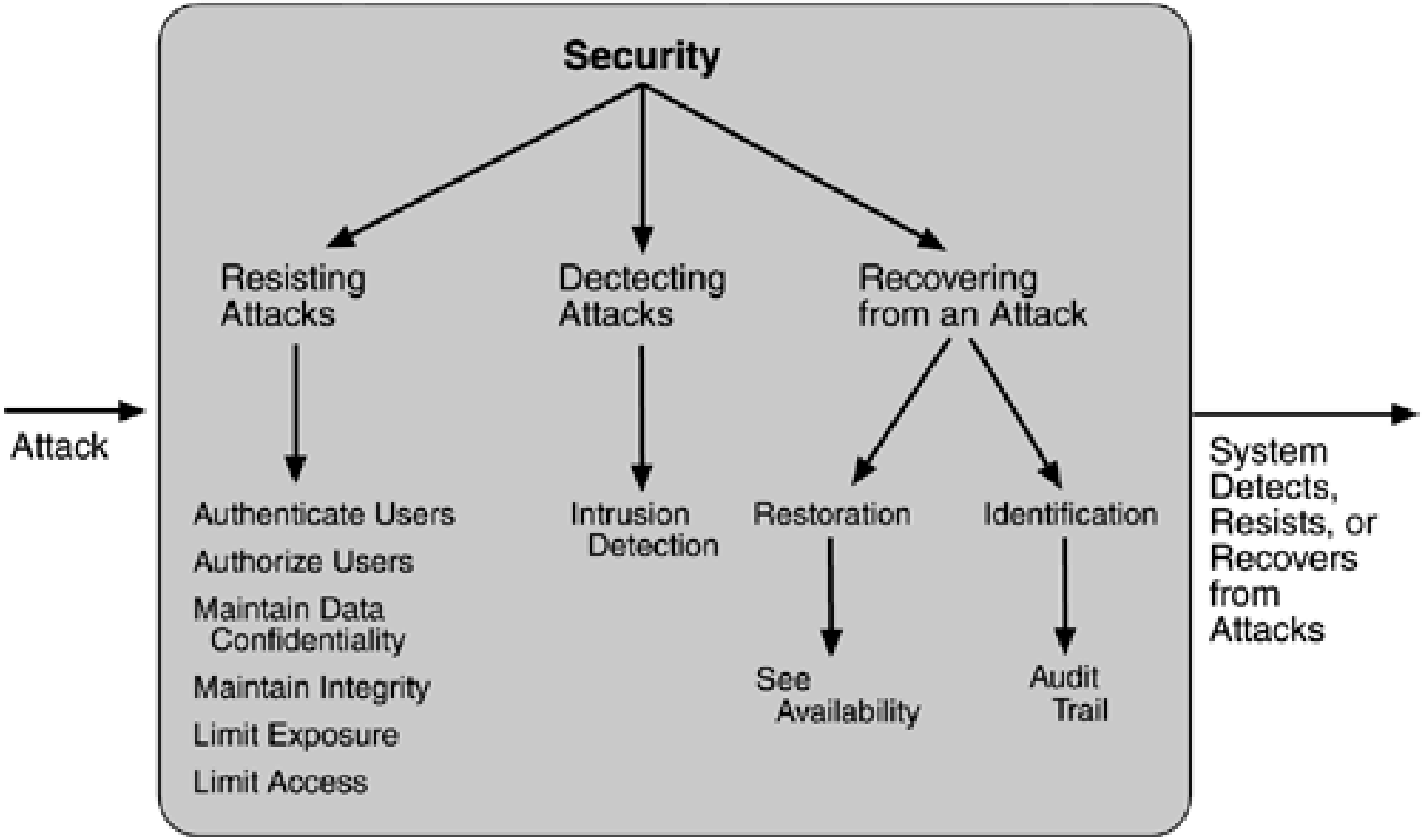
Summary of modifiability tactics



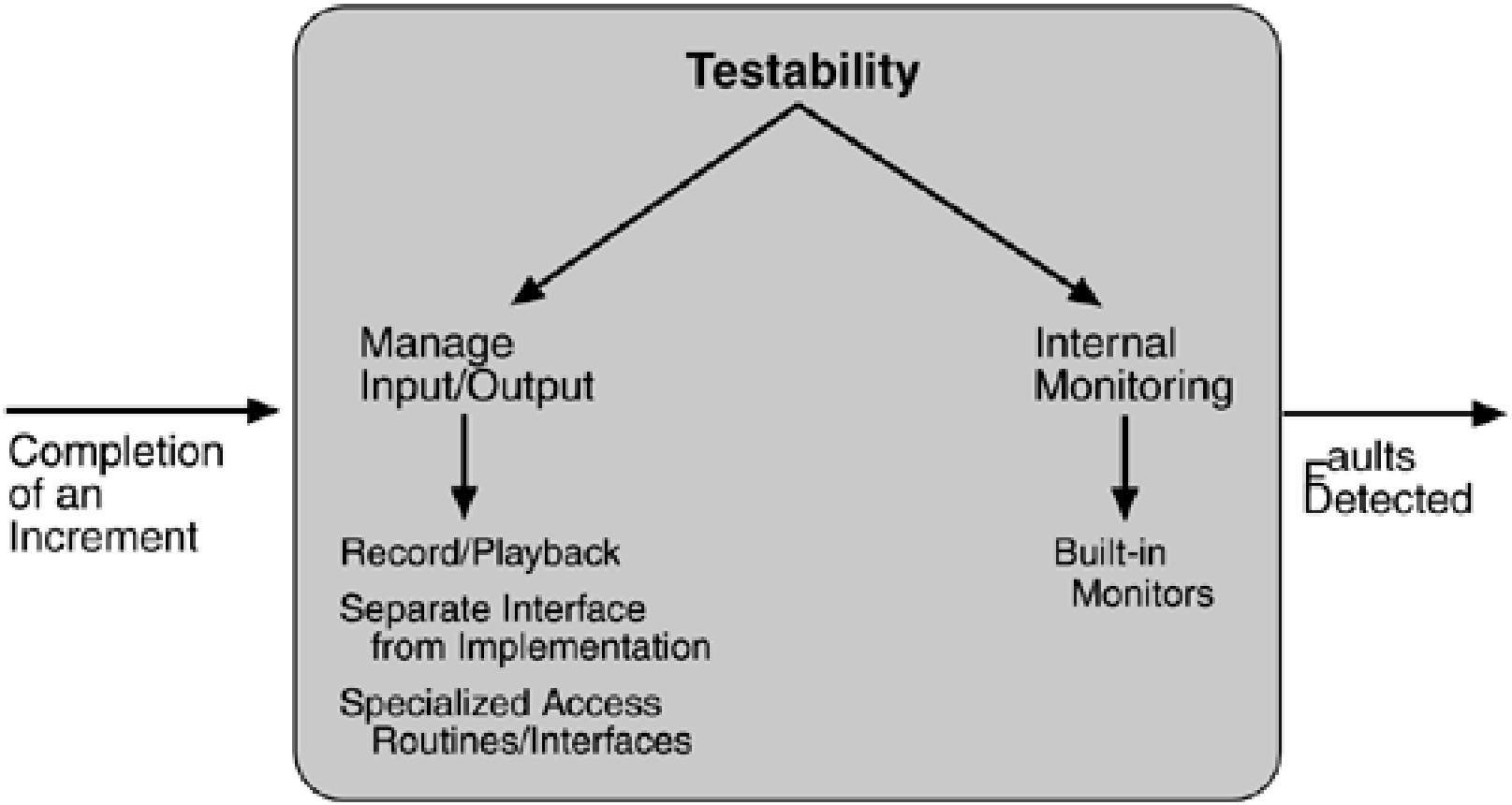
Summary of performance tactics



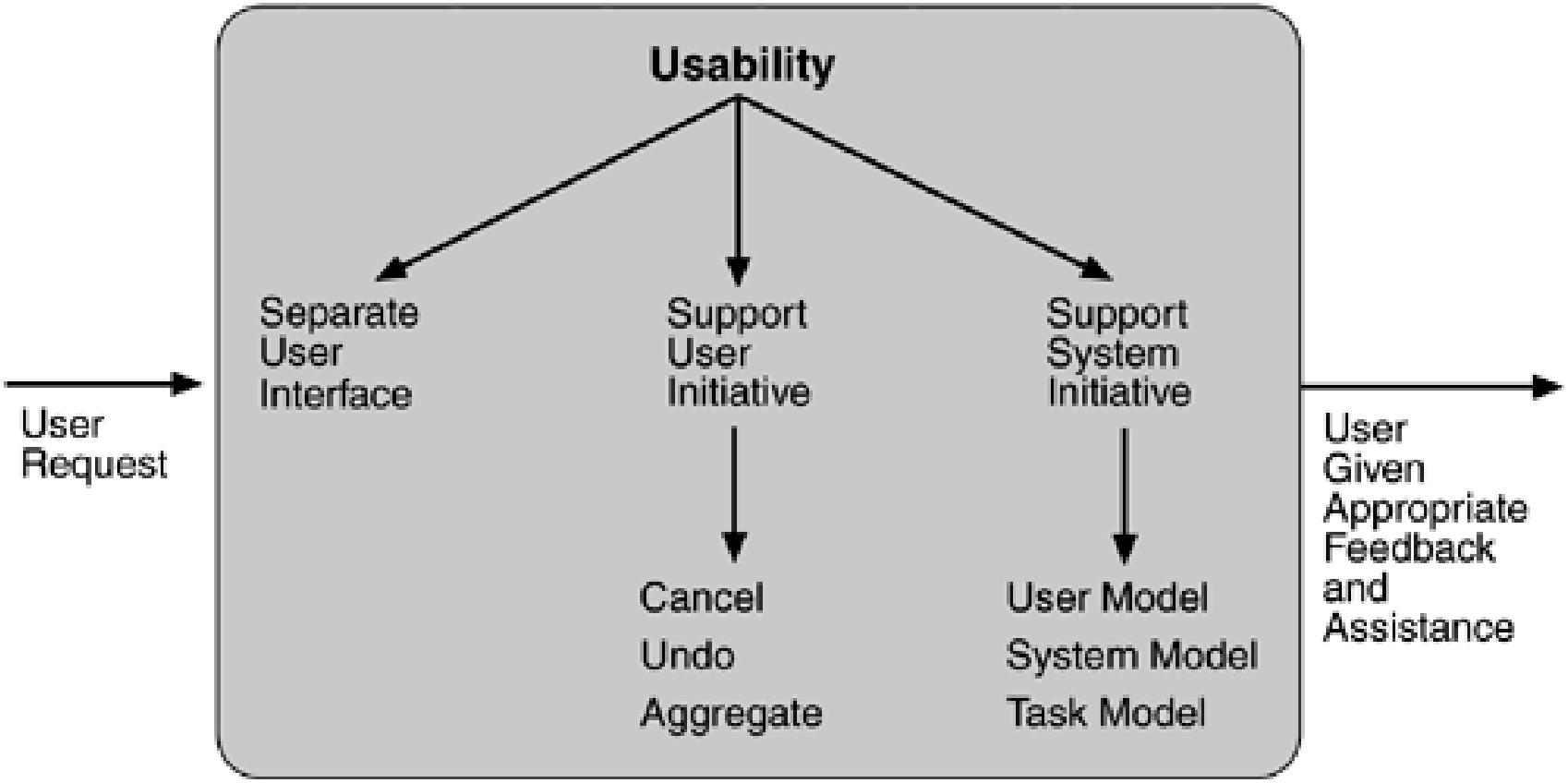
Summary of Tactics for Security



Summary of Testability Tactics



Summary of Runtime Usability Tactics



第五步-抓住主要矛盾，给出架构风格

- **A company wants to develop a software system used in its intranet（局域网）. The function of this systems is same as Weibo and Twitter. Each department（部门） can publish information about the department using this system, and Employees in the company can follow（关注） one or more departments to receive information published by these departments. When one department publishes a piece of new information, the system will send the information to all the followers（关注者） of this department. After one employee unfollows one department, he/she will not receive information published by this department in future**

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- **Implicit Invocation！**
- **Why？**

例题讲解-2

- **A software company plans to develop a Member Service Management system (short for MSM) for a golf club. One of the most important functionality of MSM system is to calculate the discount for each club member according to her level, history activities and records of consumption(消费). The club now has silver, gold and platinum three different member levels, and the member level will be extended in the future. Besides, the way to calculate discount may change from time to time.**
- **Following are some detailed requirements for MSM system.**

例题讲解-2

- **Each Member owns her personalized UI interface.**
- **The MSM system should be accessible remotely for testing and debugging using some internal protocols.**
- **To become a qualified member, a person must older than 18 years and have a >$50000 annual income.**
- **If a develop wishes to change the UI at design time, the change must be made with no effects in 3 hours.**
- **When an unanticipated message from external to MSM system arrives under normal operations of MSM system, the operator(操作人员) must be informed and she can continue to operate without downtime.**
- **When a member initiates a "purchase order" transaction under normal operations of MSM system, the transaction must be processed with average latency of two seconds.**
- **The MSM should have a Windows look-and-feel（外观）, so it is easy for members to accomplish a desired task.**
- **When a correctly identified member tries to modify her profile under normal operations of MSM system, the MSM system should maintain an audit trail and the modified data is restored within 10 minutes.**

例题讲解-2

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- **To become a qualified member, a person must older than 18 years and have a >$50000 annual income.**
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- **When a correctly identified member tries to modify her profile under normal operations of MSM system, the MSM system should maintain an audit trail and the modified data is restored within 10 minutes.（安全性）**

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- **Rule-based System**
- **Why?**

例题讲解-3

- **A Computer Aided Software Engineering （ CASE） tool company wants to development an integrated development environment（IDE，集成开发环境） for a new programming language named ‘GO’, which is invented by Google.**
- **This IDE must support programming, compiling（编译）, linking and execution for GO programs. Besides, it also needs to support interactive（交互式） and incremental（增量式） code-editing and covers the full life cycle of software development written by GO language, including software documentation, configuration and deployment.**
- **Following are some detailed requirements of this IDE**

例题讲解-3

- **The compiling and linking time of a 1000-line GO program must be less than 0.01s**
- **The IDE should be accessible remotely for diagnosis (诊断) and debugging using some diagnosis and debugging protocols.**
- **The IDE should support automatically spell-checking（拼写检查） when the developer editing a GO program.**
- **The IDE should have a Windows look-and-feel（外观）, so it is easy for the developer to accomplish a desired task.**
- **The IDE should be modified and re-deployed in another operating system**
  by 3 developers within 2 months.

例题讲解-3

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- **Repository**
- **Why?**

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- **Repository**
- **Why?**

效用树-例题讲解

例题讲解-1

- **There was a system concerned about Performance, Modifiability, Availability and Security. A development team analyzed the Quality attributes, designed architecture and wanted to use Utility Tree to evaluate the architecture, the following are the scenarios.**
  - **The Power off (电力中断) at Web site 1 requires traffic redirected to Web site 2 in < 3 seconds**
  - **Credit card transactions are secure 99.999% of the time**
  - **Deliver video in real time**
  - **Change Web user interface in < 4 person-weeks**
  - **Network failure detected and recovered in < 1.5 minutes**
  - **Reduce storage latency on customer DB to < 200ms**
  - **Add CORBA middleware in < 20 person-month**
  - **The system is able to be accessed from the intranet(局域网) to support remote invocation and debugging**
  - **The user password must have least 16 characters mixed with numbers**

第一步：去伪存真

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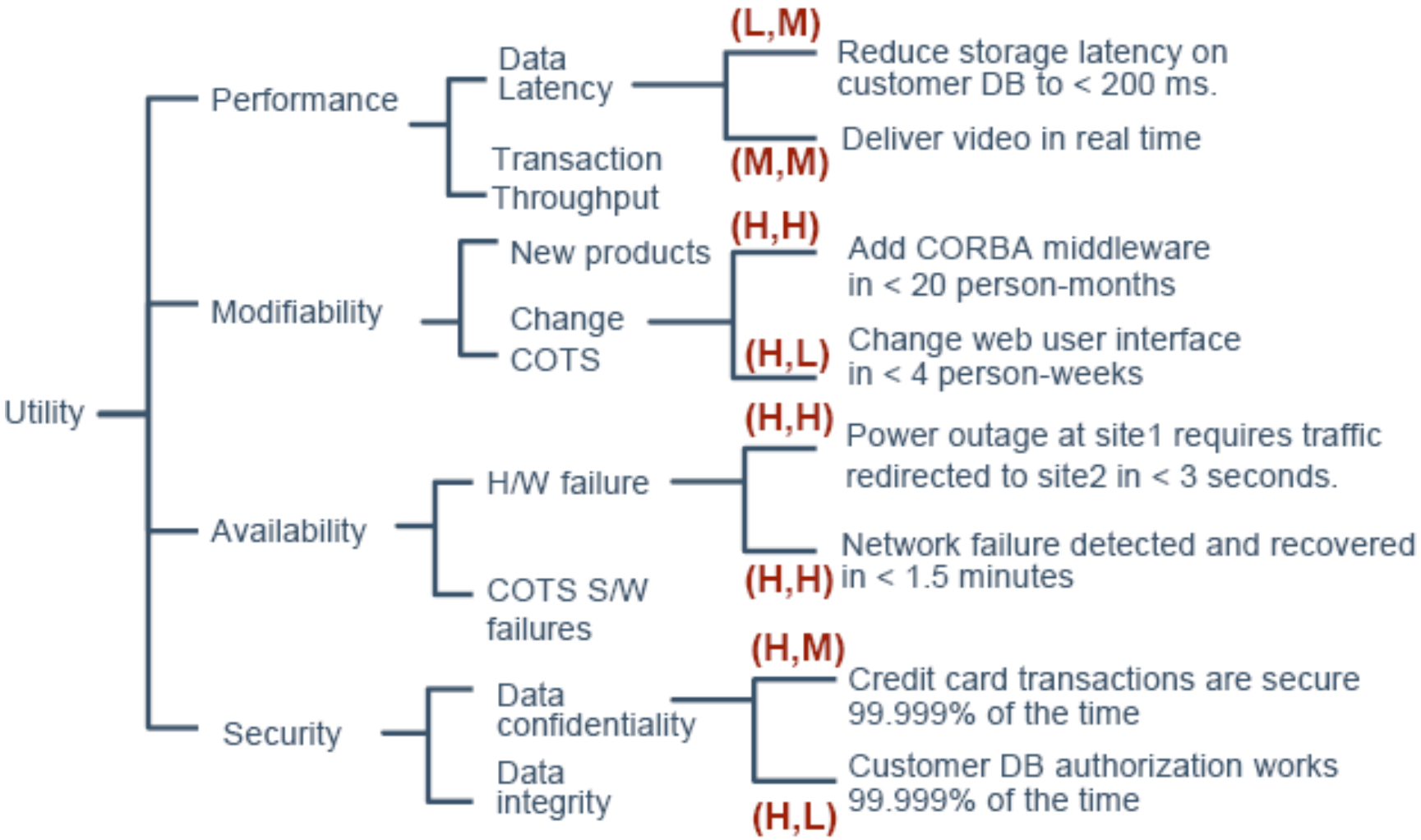
  - **The user ~~password~~ name must have least 16 characters mixed with numbers**

构建效用树


Utility
Performance
Modifiability
Availability
Security
Data Latency
Transaction Throughput
New products
Change COTS
H/W failure
COTS S/W failures
Data confidentiality
Data integrity
(L,M)
Reduce storage latency on customer DB to < 200 ms.
(M,M)
Deliver video in real time
(H,H)
Add CORBA middleware in < 20 person-months
(H,L)
Change web user interface in < 4 person-weeks
(H,H)
Power outage at site1 requires traffic redirected to site2 in < 3 seconds.
(H,H)
Network failure detected and recovered in < 1.5 minutes
(H,M)
Credit card transactions are secure 99.999% of the time
(H,L)
Customer DB authorization works 99.999% of the time

例题-2

- **A software company plans to develop a video sharing Web site. The development team analyzed the Quality Attributes, designed architecture and wanted to use Utility Tree to evaluate the architecture, followings are the scenarios.**
  - **The crash of Web server #1 requires traffic redirected to Web server #2 in < 5 seconds**
  - **Credit card transactions are secure 99.999% of the time**
  - **Deliver video in real time**
  - **Change Web user interface in < 4 person-weeks**
  - **Any network failures should be detected and recovered in < 10 minutes**
  - **User password must have least 16 characters mixed with numbers**
  - **Reduce storage latency on customer DB to < 200ms**
  - **Add message queue(消息队列) middleware in < 20 person-month**
  - **The system is able to be accessed from the intranet(局域网) to support remote invocation and debugging**
  - **User Database accessing is secure 99.99% of the time**

例题-2

- **A software company plans to develop a video sharing Web site. The development team analyzed the Quality Attributes, designed architecture and wanted to use Utility Tree to evaluate the architecture, followings are the scenarios.**
  - **The crash of Web server #1 requires traffic redirected to Web server #2 in < 5 seconds（可用性）**
  - **Credit card transactions are secure 99.999% of the time（安全性）**
  - **Deliver video in real time（性能）**
  - **Change Web user interface in < 4 person-weeks（可修改性）**
  - **Any network failures should be detected and recovered in < 10 minutes（可用性）**
  - **User password must have least 16 characters mixed with numbers**
  - **Reduce storage latency on customer DB to < 200ms（性能）**
  - **Add message queue(消息队列) middleware in < 20 person-month（可修改性）**
  - **The system is able to be accessed from the intranet(局域网) to support remote invocation and debugging**
  - **User Database accessing is secure 99.99% of the time（安全性）**

例题-3

- **A software company plans to develop a purchase2pay system. The development team analyzed the Quality Attributes, designed architecture and wanted to use Utility Tree to evaluate the architecture, followings are the scenarios.**
  - **Minimize storage latency on customer DB to 200ms**
  - **Deliver video in real time**
  - **Maximize average throughput to authentication server**
  - **Add new product categories**
  - **User name must have least 5 characters started with letters**
  - **Change web user interface in <4 person weeks**
  - **Power outage at site 1 requires traffic redirect to site 3 < 3s**
  - **Network failure is detected and recovered in < 1.5min**
  - **Customer database authorization works 99.99% of the time**

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架构权衡-例题讲解

Risks, Tradeoffs, Sensitivities, and Non-Risks

- **A *risk* *is a potentially problematic architectural decision.***
- ***Non-risks* *are good architectural decisions that are* frequently implicit in the architecture.**
- **A *sensitivity point* *is a property of one or more components* (and/or component relationships) that is critical for achieving a particular quality attribute response.**
- **A *tradeoff point* *is a property that affects more than one* attribute and is a sensitivity point for more than one attribute.**

例题1

- **Identify and record risks and non-risks, sensitivity points and tradeoffs is an important task 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 risks, non-risks, sensitivity points or tradeoffs.**
  - ***a) "Changing the way of login could have a significant impact on both security and performance.***
  - **b)** ***"Rules for 'deposit money' business process are not clearly articulated. This could result in replication of functionality thereby compromising modifiability of the third tier."***
  - ***c) "The average number of person-days of effort it takes to maintain a system might be sensitive to the degree of encapsulation of its communication protocols and file formats.***
  - ***d) "Assuming message arrival rates of once per second, a processing time of less than 30ms, and the existence of one higher priority process, a 1 second soft deadline seems reasonable."***

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例题2

- **Descriptions of architecture evaluation**
  a) "although the underlying(底层) framework of this system is good and stable, rules for writing business logic tier of your 3-tier style are not clearly articulated（说明）. This could result in replication of functionality thereby compromising modifiability of the third tier."
  b) "Changing the timing scheme from a harmonic（谐波） framework to a non-harmonic framework would be easy, but due to implied timing dependencies, there would impact far reaching impacts（极大地影响） to other modules."
  c) "In order to achieve the required level of performance in the discrete event generation component, assembly language had to be used thereby（因此） reducing the portability of this component."
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例题3

- **Descriptions of architecture evaluation**

  a) There is no way of detecting the "live" failure of a critical component.
  b) The number of simultaneous database clients will affect the number of transaction a database can process per second.
  c) Changing the level of encryption could have a significant impact on both security and performance.
  d) "Assuming message arrival rates of once per second, a processing time of less than 30ms, and the existence of one higher priority process, a 1 second soft deadline seems reasonable."
  e) "Rules for 'calculate tax rate' business process are not clearly articulated. This could result in replication of functionality thereby compromising (损害) modifiability of the third tier."
  f) "The level of confidentiality in a virtual private network might be sensitive to the number of bits of encryption."

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Thank You for Your Time