

COMP3027J

Software Architecture

Availability and its Tactics

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Faculty of Computer Science, BJUT

Data Mining & Security Lab (DMS Lab)



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Outline

1. The Meaning of Quality Attributes
2. Quality Attribute Scenario
3. The Meaning of Availability
4. Tactics to Improve Usability



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Quality Attributes (QA)

It is a non-functional requirement and is not determined by function.

- To implement functional features, each part (module) in the system must be given the correct responsibilities, the correct resources and the correct scheduling sequence.
- Implement functions first, then talk about quality attributes



Quality Attributes (QA)

Functional requirements
vs.
Non-functional requirements



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Quality Attributes (QA)

Different software projects focus on different quality attributes

- Influences the choice of architectural style

Quality attributes may inhibit each other

- Prioritize high-priority quality attributes



Quality Attributes (QA)

It must combine the three aspects of design, implementation and deployment to satisfy

- Indispensable
- At the architecture level, it is necessary to consider the implementation of quality attributes



Quality Attributes

Common Quality Attributes

- Availability.
- Modifiability.
- Performance.
- Security.
- Testability.
- Usability.

Outline

1. The Meaning of Quality Attributes
2. Quality Attribute Scenario
3. The Meaning of Availability
4. Strategies to Improve Usability



Quality Attribute Scenario

Just pointing out the name of a quality attribute is too vague

Customers want “systems to run fast”

- How fast is fast?
- Which services in the system should be prioritized to ensure speed?

Customers want “high system security”

- How safe is safe?
- What are the main threats?



Quality Attribute Scenario

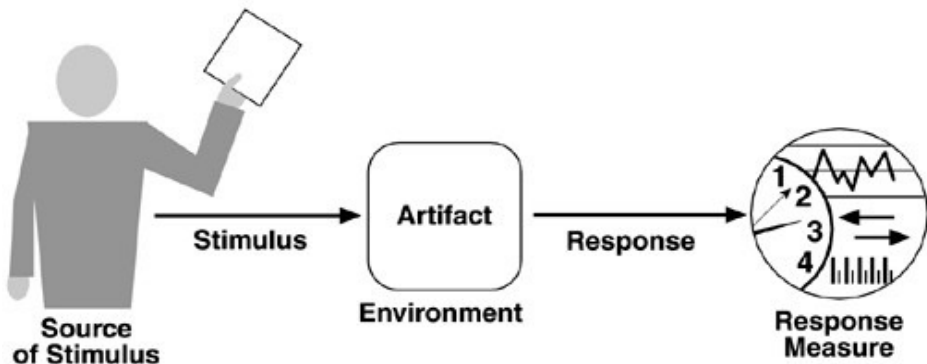
Describe how the system responds to stimuli

Six components of a quality attribute scenario

- 刺激源 (Source of Stimulus/Source) : Who caused the stimulus
- 刺激 (Stimulus) : A situation that affects a system
- 制品 (Artifact) : The part of the system that is affected
- 环境 (Environment) : The state of the system when stimulation occurs
- 响应 (Response) : The result of a stimulus
- 响应衡量指标 (Response Measure) : How to evaluate responses



Quality Attribute Scenario-Example



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The Meaning of Availability

Definition

- The probability that the system is available when a user uses 当用户使用系统时，系统可用的概率
- Maintenance shutdowns determined in advance are not included in the calculation 提前确定的停机维护不计入



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The Meaning of Availability

Concerns

- Whether a failure occurred (unable to provide normal services, discovered by the outside world) 是否发生了故障 (无法提供正常的服务, 被外界发现)
- Consequences of failure 故障的后果



The Meaning of Availability

From 99.9% available to 99.999% available, what does it mean?

Metrics

- Available (or down) time percentage
- Time required to repair failure
- mean time between failures
-



The Meaning of Availability-Scenario

Source of Stimulus

- Signs of failure (from internal or external sources)

Stimulus

- System faults
- System crash (repeated faults)
- Results are not given on time (early or late)
- Return wrong results



The Meaning of Availability-Scenario

Artifact

- Compute or storage or network transmission

Environment

- Normal state or "sub-healthy" state



The Meaning of Availability-Scenario

Response

- Record logs (fault reports) and send them back to the manufacturer
- Notify administrator or other system
- Shut down the system; the system is unavailable during maintenance

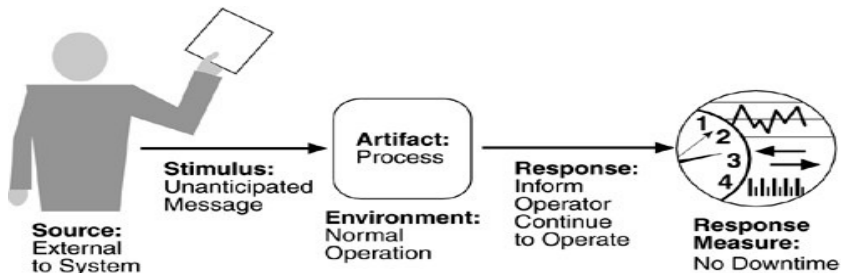
Response Measure

- Percentage of time to failure, time to repair failure
-



The Meaning of Availability

-Example of Scenario



Outline

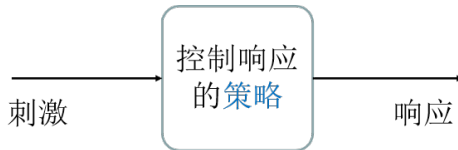
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Tactics to Improve Availability-Definition

Tactics

- Specific design means to meet specific quality attributes
- Is the basic unit of architectural style



Tactics to Improve Availability-Definition

Target

- Reduce the impact of faults

1. Fault Detection

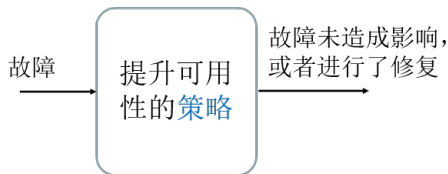
- How to detect faults as soon as possible

2. Fault Recovery

- How to restore correct results

3. Fault Avoidance

- How to proactively reduce the occurrence of faults



Tactics to Improve Availability

-Fault Detection

Ping/echo

- The monitoring component sends ping messages to the monitored component from time to time, and responds based on the received echo message (whether received, delay)

```
U:\>ping www.baidu.com -t

Pinging www.a.shifen.com [115.239.210.26] with 32 bytes of data:

Reply from 115.239.210.26: bytes=32 time=32ms TTL=53
Reply from 115.239.210.26: bytes=32 time=35ms TTL=53
Reply from 115.239.210.26: bytes=32 time=29ms TTL=53
Reply from 115.239.210.26: bytes=32 time=31ms TTL=53
Request timed out.
Request timed out.
Reply from 115.239.210.26: bytes=32 time=26ms TTL=53
```



Tactics to Improve Availability

-fault Detection

Heartbeat (心跳)

- The monitored component periodically sends heartbeat messages to the monitoring component
- Periodic heartbeat signals are maintained between nodes to detect the status of each node. If the number of heartbeat signals that are not received continuously reaches a certain number, it is considered that the corresponding system has failed.



Tactics to Improve Availability

- Fault Detection

Exceptions（异常）

- Throw + catch + handle
- Requires programming language support

```
log4j:WARN No appenders could be found for logger (org.hibernate.cfg.Environment),
log4j:WARN Please initialize the log4j system properly.
Exception in thread "main" org.hibernate.HibernateException: /hibernate.cfg.xml not found
    at org.hibernate.util.ConfigHelper.getResourceAsStream(ConfigHelper.java:170)
    at org.hibernate.cfg.Configuration.getConfigurationInputStream(Configuration.java:1453)
    at org.hibernate.cfg.Configuration.configure(Configuration.java:1475)
    at org.hibernate.cfg.Configuration.configure(Configuration.java:1462)
    at org.test.HibernateTest.getCurrentSession(HibernateTest.java:31)
    at org.test.HibernateTest.main(HibernateTest.java:17)
```



Tactics to Improve Availability

- Fault Recovery

Vote (投票)

- Multiple redundant components, using unified or different algorithms to complete the same task. If the calculation results are different, the minority obeys the majority



Tactics to Improve Availability

- Fault Recovery

Vote (投票)

- To reduce the probability of simultaneous faults, multiple components can be developed by different development teams on different software and hardware platforms.



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Tactics to Improve Availability

- Fault Recovery

Active redundancy

- Servers A and B complete the same calculation (the statuses of A and B remain consistent at all times), and usually only take the result calculated by A.
- When A fails, the system can switch to B extremely quickly

Passive redundancy

- After server A completes the operation, it notifies B of its own status within a certain period of time, and B then updates its own status to A's status.
- When A fails, you need to confirm that B's status is up to date firstly.

Before going online again, you need to **resynchronize the status.**



Tactics to Improve Availability

- Fault Recovery

Internal testing (Alpha version)

- Developers fix bugs and test them internally, and then release patches after confirming that they are correct.

Checkpoint/rollback

- Save regularly for easy recovery



自定义文档保存方式。

保存演示文稿

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☒ 如果我没保存就关闭, 请保留上次自动恢复的版本(U)

自动恢复文件位置(R): C:\Users\huawei\AppData\Roaming\Microsoft\PowerPoint\



Tactics to Improve Availability

- Fault Avoidance

Service offline

- If you know for sure that you are about to be attacked by a devastating attack, it is better to offline the service proactively.

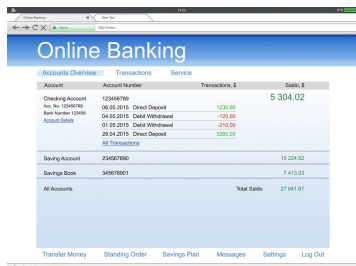


Tactics to Improve Availability

- Fault Avoidance

Transaction (事务)

- Multiple operations must be completed
- Case: A's transfer to B includes 2 operations (decreasing A's account balance and increasing B's account balance). If any one operation fails, the other one must also be cancelled.



The screenshot shows a web browser window with the title 'Online Banking'. The page has a blue header with the text 'Online Banking'. Below the header, there are tabs for 'Accounts Overview', 'Transactions', and 'Service'. The 'Transactions' tab is selected. The main content area displays a table of transactions for a 'Checking Account' (Account Number: 123456789, Balance: 5,304.02). The table lists several transactions with their dates, descriptions, and amounts. Below the table, there are links for 'All Transactions', 'Transfer Money', 'Standing Order', 'Savings Plan', 'Messages', 'Settings', and 'Log Out'.

Account	Account Number	Service	Transactions, \$	Saldo, \$
Checking Account	123456789			5,304.02
Asst. No. 123456789				
Bank Number 123456				
Account Details				
	06.05.2015	Direct Deposit	1230.00	
	04.05.2015	Debit Withdrawal	-120.00	
	01.05.2015	Debit Withdrawal	-210.00	
	28.04.2015	Direct Deposit	3200.00	
		All Transactions		
Saving Account	234567890		15,224.02	
Savings Book	345678901		7,413.03	
All Accounts		Total Saldo	27,941.07	

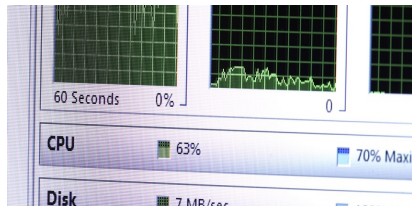


Tactics to Improve Availability

- Fault Avoidance

Process monitoring

- E.g., Windows Task Manager



QA Availability - Summary

Concerns of the Availability

- Faults

Tactics to Improve Availability

- Fault Detection
- Fault Recovery
- Fault Avoidance



Thank you!



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