LTAT.06.007 Distributed Systems
Practical Seminar 11

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Recap

• Quorum-Based Protocols
  ▪ Gifford's Scheme of Voting for supporting replicated writes
  ▪ Apply Gifford Quorum-Based protocol to a set of examples and look for Conflicts.
Agenda

• **Goal:** Fault Tolerance

• **Content:**
  - Get acquaintance with the concept of Fault Tolerance
  - Differences between a Fault, Error and a Failure
  - Implement the Program to show fault tolerance and failure.

- **Quiz**
Session Content

Description

• Get acquaintance with the concept of Fault Tolerance
• Differences between a Fault, Error and a Failure
• Implement the Program to show fault tolerance and failure - One of the methods introduces a fault that remains invisible (latent) to the main program.
• Fault in the second method shall manifest as an error, but will be detected by the main program and handled (tolerated) by method invocation.
• The third fault should be left unhandled by the main program and propagate as a failure to the user.

Observation

Instructions to complete this practical session can be found in the course website: https://https://courses.cs.ut.ee/2021/ds/spring/Main/Instructions6
BACKGROUND

Read the article Fault Tolerance by Design Diversity: Concepts and Experiments by Algirdas Avizienis and John P. J. Kelly
Fault Tolerance

- Fault tolerance is the survival attribute of computer architectures; when a system is able to recover automatically from fault-caused errors, and to eliminate faults without suffering an externally perceivable failure, the system is said to be fault tolerant.

- Being fault tolerant is strongly related to what are called Dependable systems.
Fault Tolerance – Dependable Systems

Dependability is a term that covers a number of useful requirements for distributed systems including the following:

**Availability** is defined as the property that a system is ready to be used immediately.

**Reliability** refers to the property that a system can run continuously without failure.

**Safety** refers to the situation that when a system temporarily fails to operate correctly, no catastrophic event happens.

**Maintainability** refers to how easily a failed system can be repaired.
Failure, Error and Fault

Failures: A failure occurs when the user perceives that the resource ceases to deliver the expected service. Examples of failures are:

- The CPU (u) perceives that the Memory (r) has delivered a Word (s) with the Wrong Parity,
- Transistor B (u) perceives that the output of transistor A (r) does not change (s) after a test input is applied to A by B.
Failure, Error and Fault

Errors: An error occurs when some part of the resource assumes an undesired state. Such a state is contrary to the specification of the resource or the expectation (requirement) of the user. Examples of errors are:

- **Parity error** - All words are stored in a memory with odd parity, but the "read" operation delivers a word that has even parity.
- **Comparison error** - Two identical adders receive the same operands and simultaneously deliver Sums to a comparator that are not identical in every bit position.
Failure, Error and Fault

Faults: A fault is detected when either a failure of the resource occurs, or an error is observed within the resource. The cause of the failure or error is said to be a fault. In most cases the fault can be identified; in some it remains a hypothesis that cannot be adequately verified. Examples of faults are:

- **A permanent physical fault** - The output of an AND gate is stuck on logic one.
- **A transient physical fault** - An alpha particle impact changes the state from one to zero in a dynamic MOSFET memory cell.
- **Latent Fault**: A fault is latent as long as it has not caused any errors, but exists in the resource as a potential cause.
Session Instructions at Course Page
Quiz

Content

• Lecture – **Fault Tolerance I**
• Two attempts
  ▪ One in Seminar Session
  ▪ Next available until Monday 23:59 (Deadline)
• Open Quiz in Moodle
• Total Quiz Points = 100

Observation

Quiz review is available after the quiz is closed
Questions?

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