



LTAT.06.007 Distributed Systems

Practical Seminar 11

Farooq Ayoub

TEACHING ASSISTANT

Tartu, Estonia 28/04/2021

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://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?

E-mail: farooq.ayoub.dar@ut.ee