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# Cpre 545: Fault Tolerant Systems

## What is Fault Tolerance all about

*Arun K. Somani*

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### Course Information:

- ◆ Web:
  - Ecpe web page, follow students information, course web pages, cpre 545
- ◆ Notes and other reference books and journals on Web
- ◆ Grade: 25% 7 HWs, 25% Project, 20% Test, 30% Final
- ◆ Project:
  - Study/Implementation/Design
  - Written report of about 25 pages
  - Need creative component
- ◆ No cheating allowed. Collaboration preferred.
- ◆ Feel free to send your feed back to improve the quality
- ◆ Tolerate failures

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### Motivation

- ◆ Systems are implemented using COTS parts
- ◆ Components may fail due to various reasons
  - Hostile Environment
  - Operating conditions out of specification range
  - Aging
  - Poor design
- ◆ Being able to tolerate an individual failure may save the day

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## Why Fault Tolerance?

- ◆ 10,000 units of a component are used in a system
- ◆ Failure rate of components: 0.5%/1000 hours
- ◆ Total Failure rate:  $(0.5 \times 10000) / (100 \times 1000) = 0.05/\text{hour}$
- ◆ Approximate Unreliability =  $\lambda t$
- ◆ Desired reliability = 0.99
- ◆ Time duration,  $t = (1 - 0.99) / \lambda = 0.01 / 0.05 = 1/5$  hours
- ◆ System goes below desired level after 12 minutes

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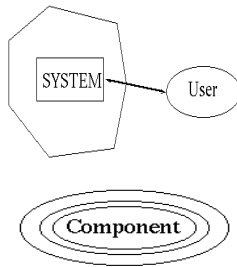
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## System and Fault Tolerance

- ◆ Function: What the system in intended for
- ◆ Behavior: what it does
- ◆ Structure: What makes it do what it does
- ◆ System may be layered
- ◆ In layered system, each layer behaves as a component at the next layer
- ◆ Function and service may be plural



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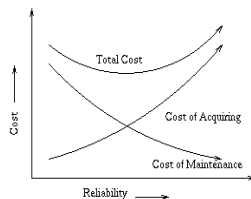
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## Ownership Cost and Fault Tolerance

- ◆ Two Systems
- ◆ System A
  - Acquiring: \$2000
  - Maintenance: @250/year
  - Total cost: \$3000
- ◆ System B
  - Acquiring: \$1000
  - Maintenance: @500/year
  - Total cost: \$3000
- ◆ But down time frustration can be avoided



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## Some Definitions

- ◆ Fault: Physical Change => Physical World
- ◆ Error: Result of a Fault => Information World
- ◆ Failure: Deviation from intended function => External Effect
- ◆ Three World Model



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## Why Fault Tolerance is More Important?

- ◆ System speed is higher => More reason for Timing Faults
- ◆ Harsher environments => Systems are employed in all kind of applications
- ◆ Higher cost for repair => manpower and down times are expensive
- ◆ Larger systems => Use more components, more chances of failure

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## Issues

- ◆ At what level to introduce redundancy?
- ◆ Duplicate or triplicate?
- ◆ How to manage redundancy?
- ◆ Automatic or user assisted fault tolerance?
- ◆ Fault tolerance or reliability and relationship?
- ◆ Information redundancy?
- ◆ How to evaluate?

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