Robust System Design for Cellular Networks

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Personal Communication Systems
The Dreaded D-Word

- Downtime. In today’s 24-7-365 world, an hour costs $6M
- Three leading causes
  - Software
  - Operator
  - Malicious attacks
- Need an end-to-end solution with failure tolerance at each level of the architecture

Failure Tolerant Architecture

- Applications
  - Checkpointing and rollback, application replication, software, voting (fault masking), recovery blocks, N-version programming,
- SIFT Middleware
- Reliable communications
  - CRC on messages, acknowledgment, watchdogs, heartbeats, consistency protocols
- Operating system
  - Memory management, detection of process failures, hooks to support software fault tolerance for application
- Hardware
  - System network, Processing element, Memory, Storage system
  - Error correcting codes, N_of_M and standby redundancy, voting, watchdog timers, reliable storage (RAID, mirrored disks)
### Phases of Failure Tolerance Process

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<th>How?</th>
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### Evaluation:
- Analytical
- Simulation
- Prototyping

### Domain Specific Challenges
1. Low Power
2. Disconnected operation
3. Uncertain environment

### Research Directions in Dependable Computing Systems Lab

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1) Self-checking software
2) Isolation of intrusions

1) Signatures prior to state change
2) Enforcing containment boundary around affected components through limiting interactions

1) Embedded software with source code
2) Interacting services
Control Flow Signatures

**Correct execution**
- Assertion block (AB)
- Branch Free Interval (BFI)
- Control Flow Instruction (CFI)

**Incorrect execution without preemptive checking**
- Error-free execution path
- Not taken (but valid) execution path

**Incorrect execution with preemptive checking**
- Preemptive check detects erroneous control flow
- Computation stops

- Error-free execution path
- Arbitrary Block

Evaluation

- What are the evaluation criteria? Examples include
  - Latency of detection
  - Prevention of propagation of failures
- How good are the following metrics for the systems
  - Reliability
  - Availability
  - Survivability
- Evaluated through
  - Theoretical analysis: Probabilistic models
  - Simulation: Discrete event simulation, Markov simulation
  - Prototyping: Systems are built and stressed with faults and intrusions
## Info

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