

## CS514: Intermediate Course in Operating Systems

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## Systems of Systems

- Last week we looked briefly at issues that arise in systems of systems
- We focused on real-time because we've been on that theme for a few lectures
- But building these sorts of complex, interconnected systems raise other kinds of very serious issues

## Scale of GTE's (Verizon's) IT Environment

- ◆ \$1.2 billion/yea IT expense
- ◆ > 5000 ISs
- ◆ > 1.5 petabytes operationa data



## Magic bullets

- A very common pattern in computing, especially in the business world
  - You are spending a fortune on something
  - Technology is the problem
    - Most of that money is spent because a technology is somehow inadequate
  - Then along comes a (snake oil) salesman with "a radical advance"
    - And you leap because the consequence of being left behind is too horrible to contemplate

## Magic bullets

- When a vampire is stalking the castle, loading your gun with magic silver bullets can have irresistible appeal
- (especially to management!)



## What's the threat?

- Enormous complexity of modern distributed computing systems is overwhelming organizational resources
- People needed to
  - Install/configure software, hardware
  - Diagnose problems
  - Repair things that aren't working right

## Real world "issue?"

- System administration can be overwhelmingly hard
- Talk by Michael Brodie focuses on this...

<http://www.cs.cornell.edu/Courses/cs514/2007sp/brodie.pdf>  
(visit Brodie materials here!)

## Why IBM created Autonomic Computing Initiative



- Autonomic Computing represents an exciting [new research direction in computing](#).
- IBM believes that the spiraling cost of managing the increasing complexity of computing systems is one of the biggest single issues threatening to undermine the future growth and societal benefits of information technology, and proposes a solution inspired by the human body: *autonomic computing*.
- The goal is to create computing networks and systems that -- like the biological analog -- hide complexity from the user and deliver much greater value than today's systems can.
- These new systems need to be self-managing, self-configuring, self-healing, self-protecting, and continuously self-optimizing.

## Technical and Social Issues

- Represent nominal system
- Capture current state
- Diagnose problems
- Plan response
- Carry out repair strategy
- Evaluate outcome...
- Does anyone have any idea what the system looks like?
- Are the components "instrumentable"?
- Faults cascade: How can we construct fault-trees?
- How long will it take for the repair to occur?

## Is Autonomic Computing Hopeless?

- Strictly speaking: yes. The problem can't be solved
- But we can certainly improve systems
  - Need new services to capture state
  - Routine attention to robustness
  - Avoid tighter-than-needed coupling of components

## Lesson from Y2K?

- People reasoned that
  - Systems are complex and interdependent
  - If many fail at same time, results will cascade worldwide
  - And society as we know it will end!
- But Y2K came "not with a bang, but a whimper"
  - Indian outsourcing companies claim responsibility but some people doubt this explanation!

## Strange robustness

- Social engineering forces heavily used systems to become robust
- People tend to focus on and improve components that often cause disruptive failures
- Causes systems to be much more robustness than we can explain



## From Shakespeare in Love.



- *Lambert holding Henslowe's feet to the fire*
- HENSLOWE Mr. Fennyman , let me explain about the theatre business. (they stop). The natural condition is one of insurmountable obstacles on the road to imminent disaster. Believe me, to be closed by the plague is a bagatelle in the ups and downs of owning a theatre.
- FENNYMAN So what do we do?
- HENSLOWE Nothing. Strangely enough, it all turns out well.
- FENNYMAN How?
- HENSLOWE I don't know. It's a mystery.
- LAMBERT (dumbly) Should I kill him, Mr. Fennyman ?
- *A din is heard in the background. A messenger, ringing a bell, is running through the street.*
- MESSENGER The theatres are reopened. By order of the Master of the Revels, the theatres are reopened