

Mobile Systems Verification

A million users in a box™

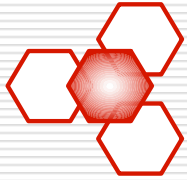
*Achieving Very High Reliability for
Ubiquitous Information Technology*

Robert V. Binder

Quality Week 2002

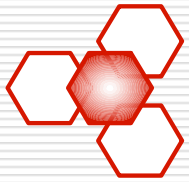
September 5, 2002

www.MobileSystemsVerification.com



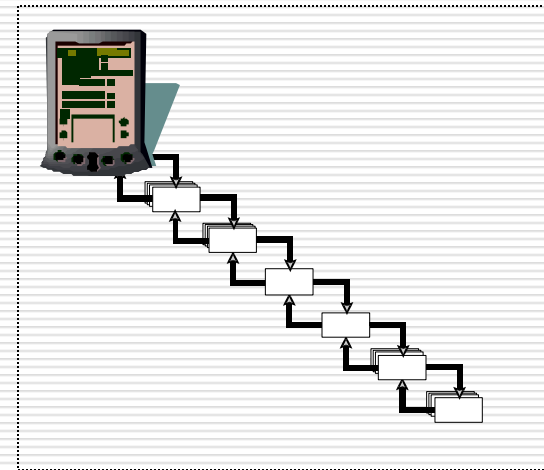
Overview

- The systems engineering challenge of a lifetime
 - Ubiquitous (mobile) IT – the next big thing
 - Very high reliability (five nines or better) necessary
 - Current practices/technology can't achieve very high reliability mobile apps
- Mobile Systems Verification approach
- But, first ...
 - Test automation cartoons
 - Full test automation case study

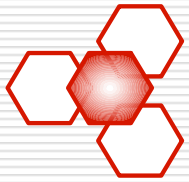


Testing by Poking Around

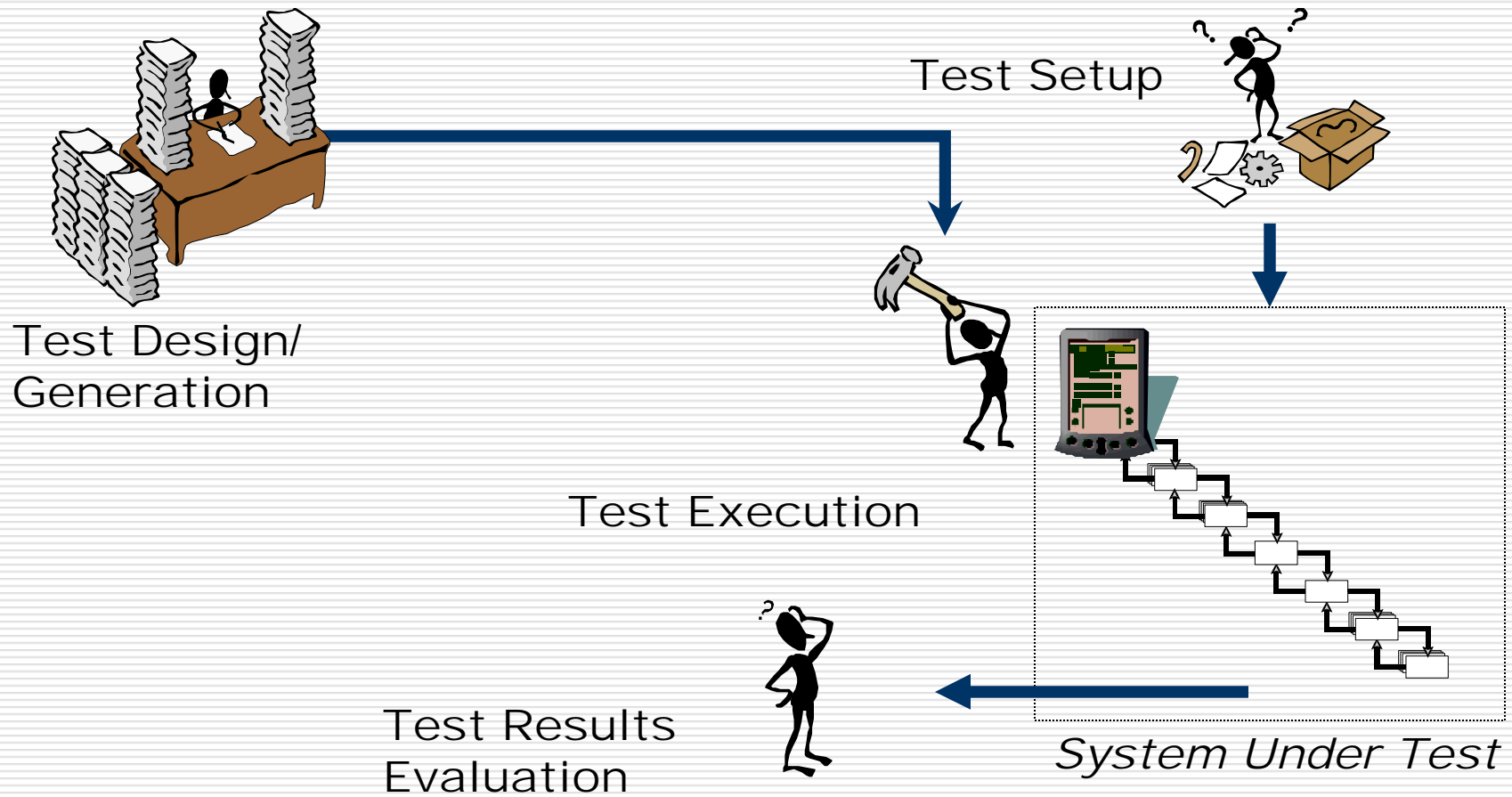
Test Execution

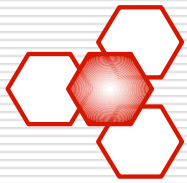


System Under Test

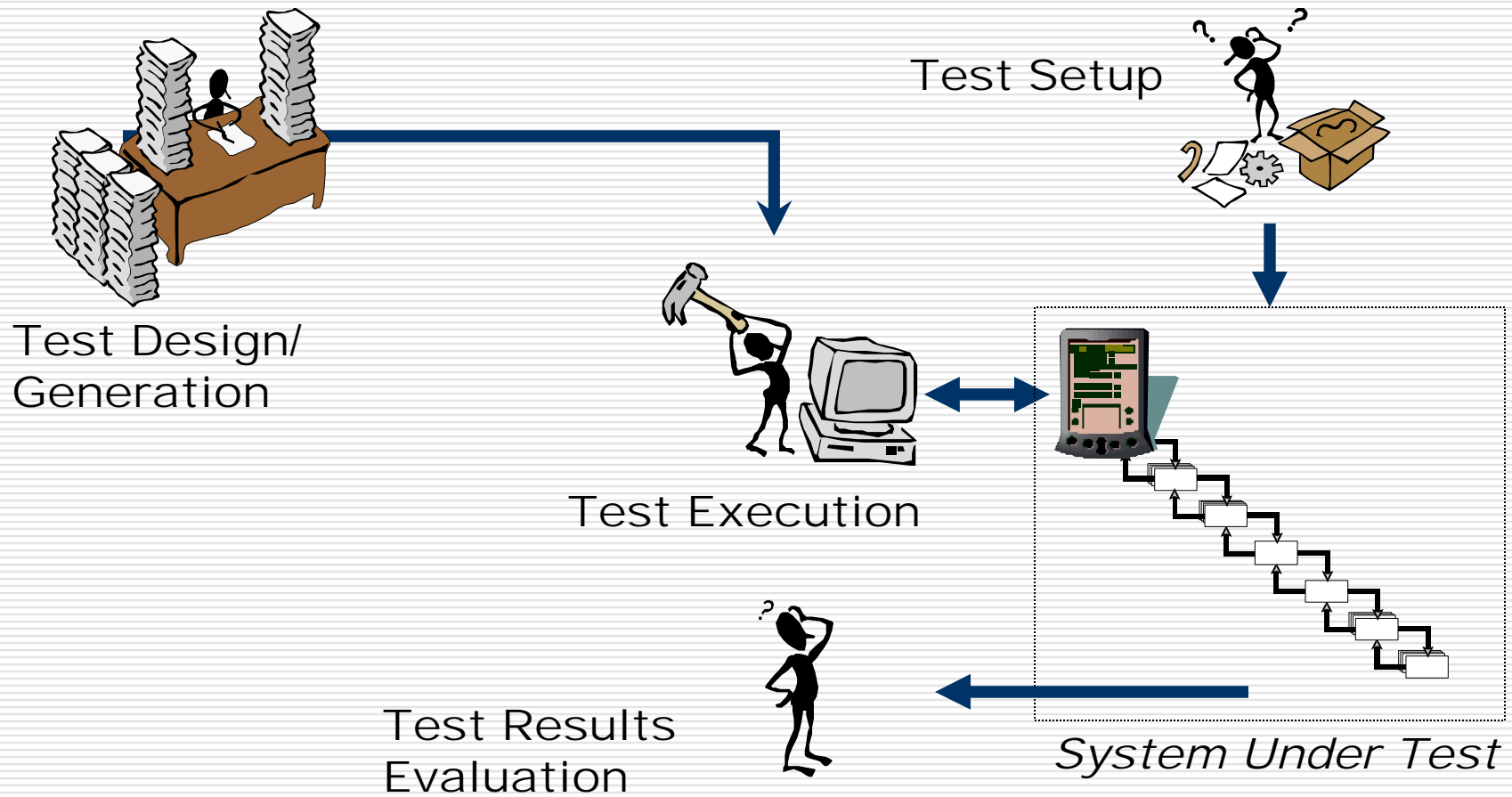


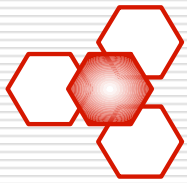
Manual Testing



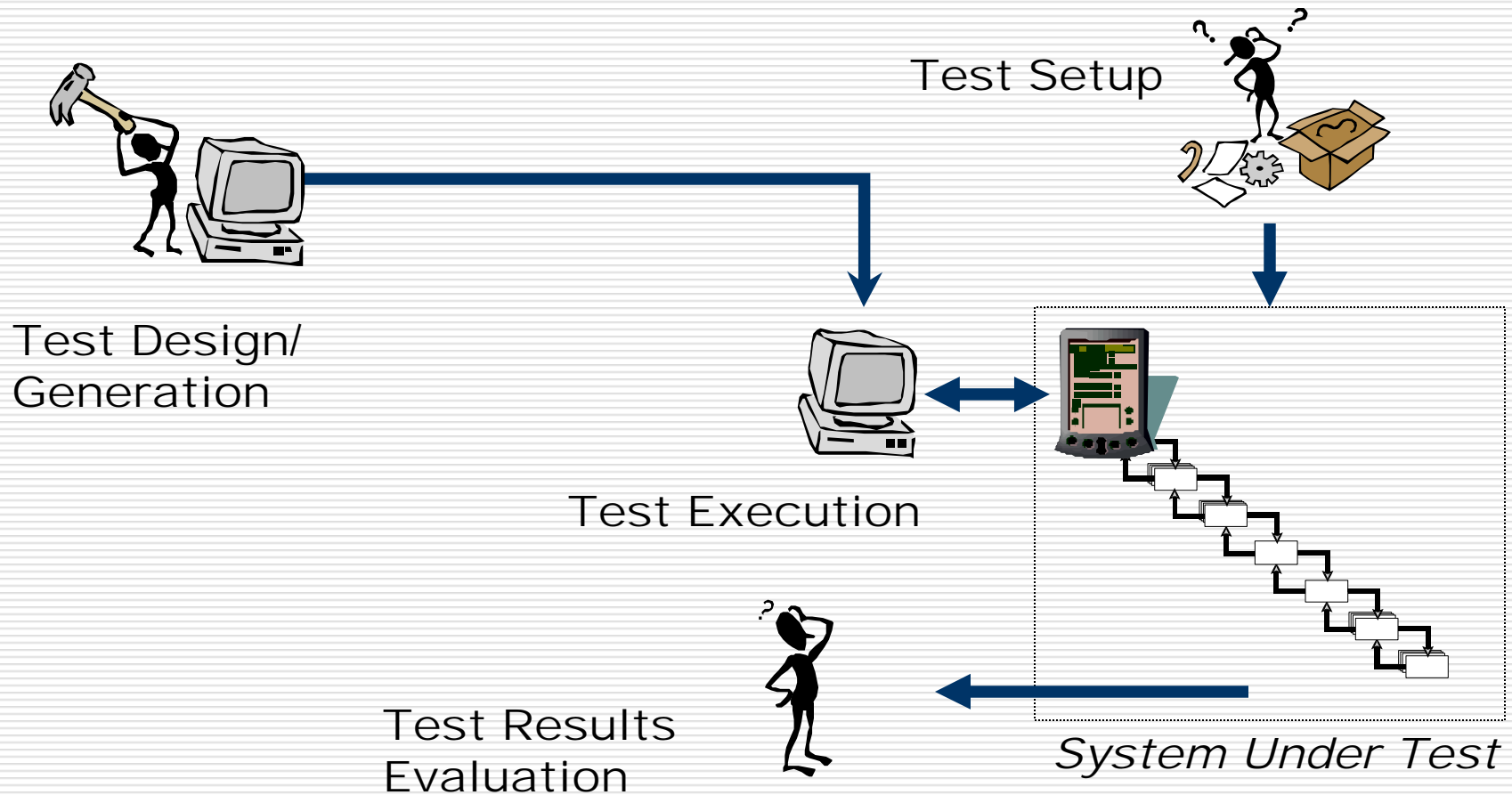


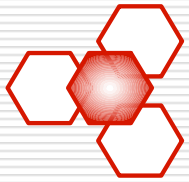
Automated Test Script



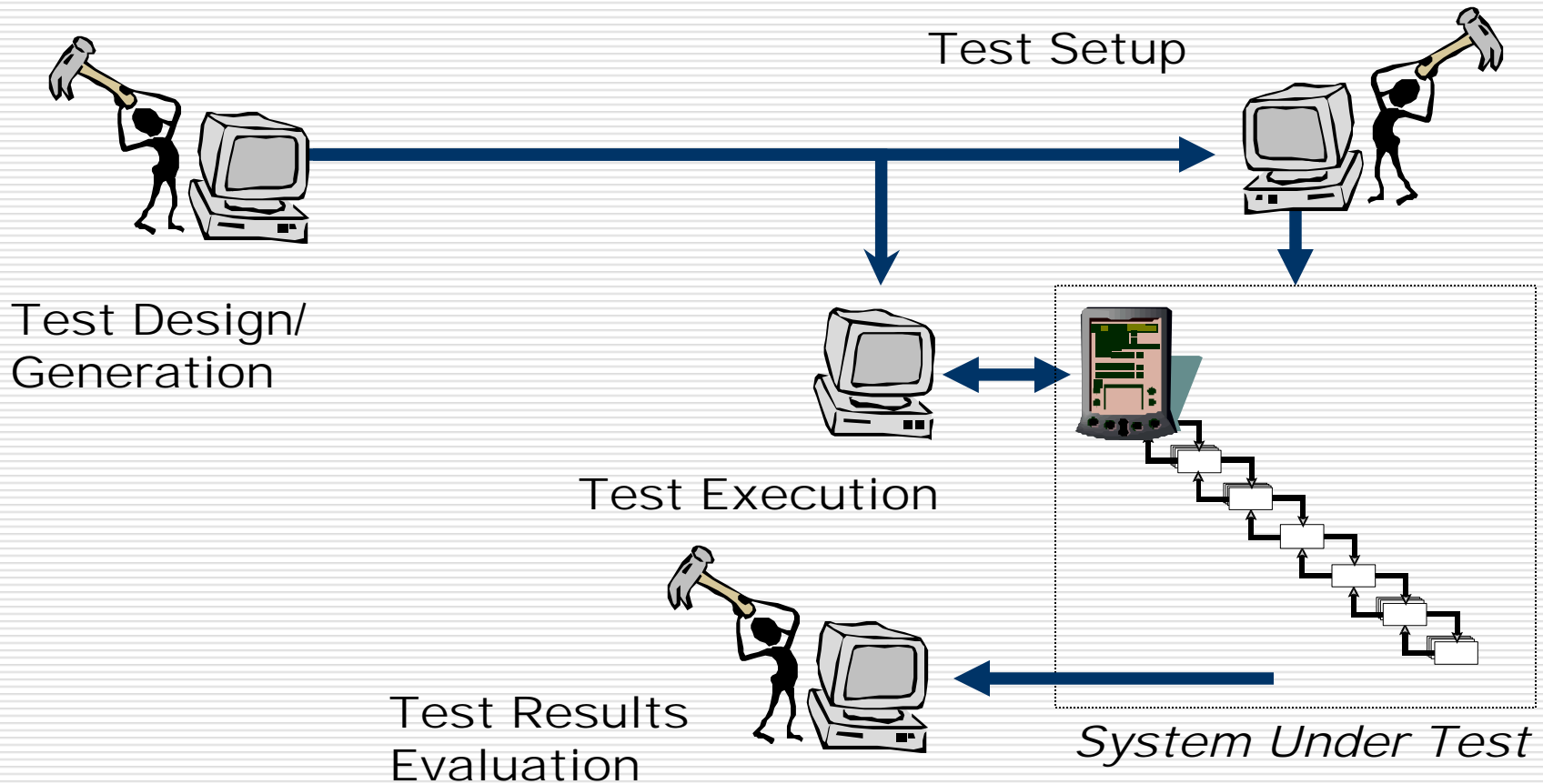


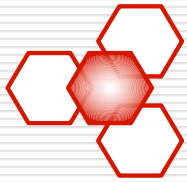
Automated Generation/Agent





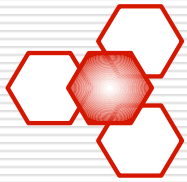
Full Test Automation





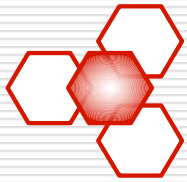
RBSC Full Automation

- ❑ E-commerce/securities market, screen-based trading over private network
- ❑ 3 million transactions per hour
- ❑ 15 billion dollars per day
- ❑ 3 years, version 1.0 live Q4 2001



RBSC Full Automation

- Rational Unified process
- About 90 use-cases, 600 KLOC Java
- Java (services and GUI), some XML
- Oracle DBMS
- Many legacy interfaces
- CORBA/IDL distributed object model
- HA Sun server farm
- Dedicated test environment



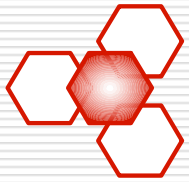
RBSC Full Automation

Approach

- *Extended Use-case, Mode Machine, Invariant Boundaries*
- AI-based user simulation generates test suites
 - Every test run unique and realistic (about 200)
 - Evaluate functionality and load response
- Test agents (COTS + custom)
- Automate pass/no pass evaluation

Estimated reliability at five nines

- All inputs generated under operational profile
- 1,000,000 transactions in four hours
- No critical or major failures



The New IT Reality

Hardware

- Moore's law, watts/MIPS ...

Storage and Bandwidth

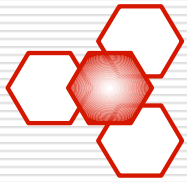
- VLDB, broadband to the hand ...

Mobility

- location-based, peer-to-peer ...

Wearable

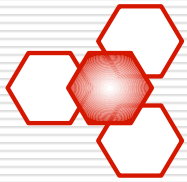
- Pocket router, new human interfaces ...



The New IT Reality

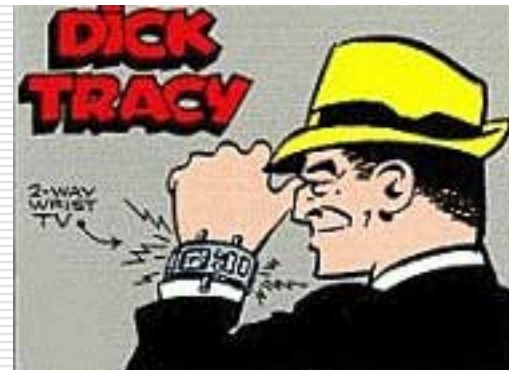
A few data points ...

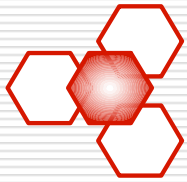
- 188 million km fiber laid in last 3 years
- Location Based Services (GPS, AOA, TDOA) on 1 cm chip
- Texas Instruments OMAP – System on a chip DSP+ARM+ ...
- 2.5G cellular data service (1XRTT)
- 2003: 600 million people Internet access
- 2004: U.S. 100 million cable modems, 43 million DSL lines
- 2004: 1.2 billion worldwide *wireless* users (2x)
- 2004: 33.7 million PDAs by 2004
- WiFi: 5x to 54 Mbps (now), multi-media QoS, roaming, security (2004)



The New IT Reality

- Everything, anytime, anywhere
- Persistent partial attention
- Embedded wireless agents
- Human interfaces, eventually

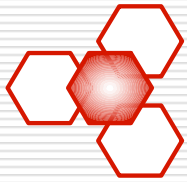




The Old IT Reality: Software

Still no silver bullet

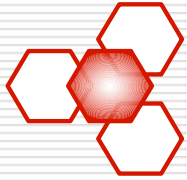
- Bug barrier \cong 5 per KLOC (pre-test) any language, any process
- Subtractive component reliability
- Design limited to human bandwidth
- Low-fidelity test suites aren't effective
- Hand crafted test suites can't scale



Unique Wireless Test Problems

- Users move through physical space
 - Bandwidth varies wrt user location and speed
 - User behavior varies by location and time
 - Location-specific inputs/requirements
- Load changes system dynamics
 - 3G breathing, MUD power consumption
- Very mixed bag of airlink equipment
- *PLUS* basic functionality/performance/integration

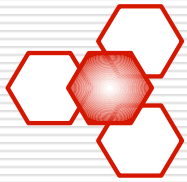
Mobility adds several degrees of freedom to testing combinatorics



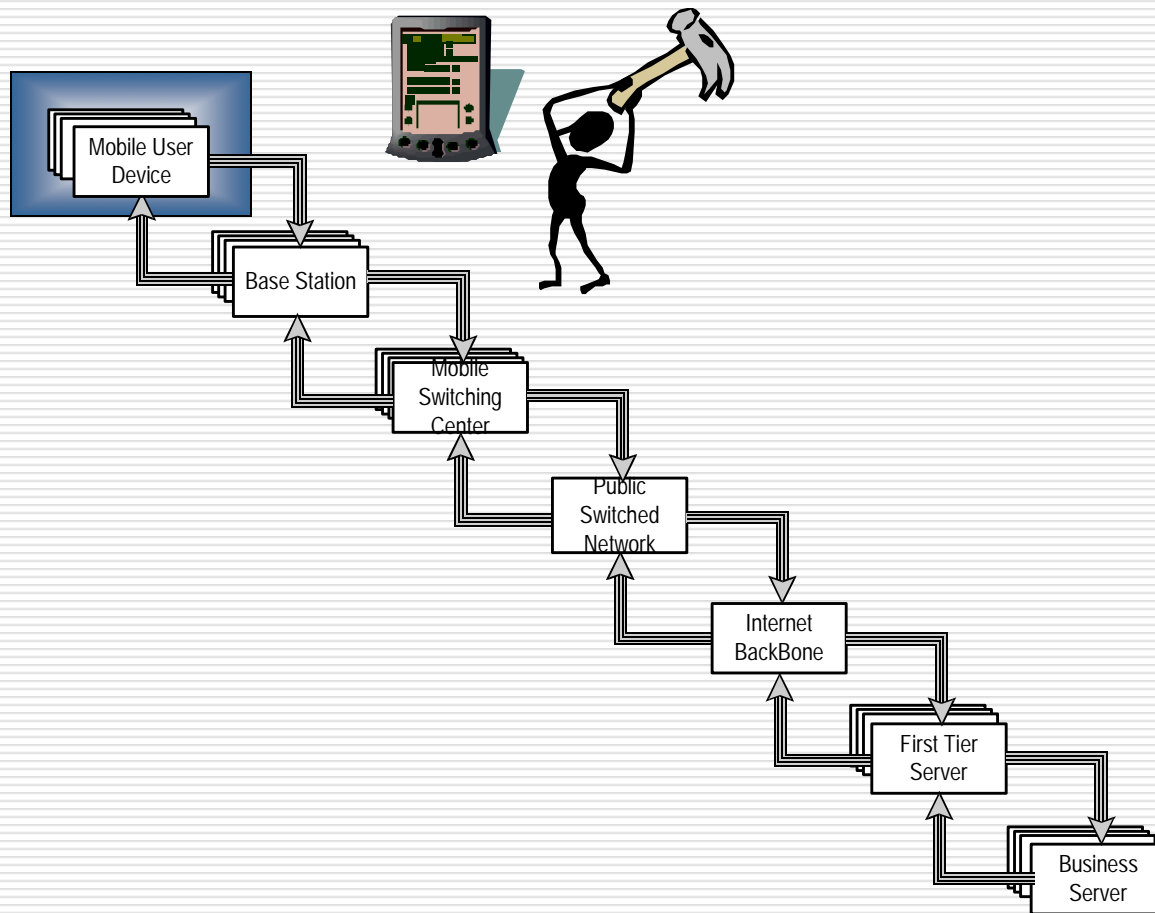
Mobile App Fault Model

- ❑ MUD Application Client
 - Functionality
 - Response Time
 - MUD Resource Utilization
 - Airlink Variation
 - ❑ QOS Edge Combinations
 - ❑ In-cluster Hand Offs
 - ❑ Multiple Base St Protocol
 - ❑ Roaming
 - Location Services
 - Server Interaction
 - Server Exception
 - Configuration
- ❑ Base Station
 - Op/Admin/Maintenance
 - Background load ("breathing")
 - Packet Load
 - Weather, solar, etc.
- ❑ Application Server
 - Functionality
 - Response Time
 - Server Resource Utilization
 - Billing/Provisioning/Security
 - Background contention
 - Dispatch/Allocation
 - Background IP Load
 - Client transaction saturation
- ❑ End-to-End
 - Response time
 - Capacity
 - Reliability
 - Availability
 - Geographic coverage

What minimum scope of testing is needed to reveal mobile app bugs?



Effectiveness: MUD Scope



MUD Application Client

- Functionality
- Response Time
- MUD Resource Utilization

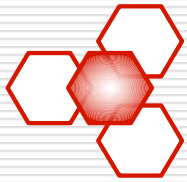
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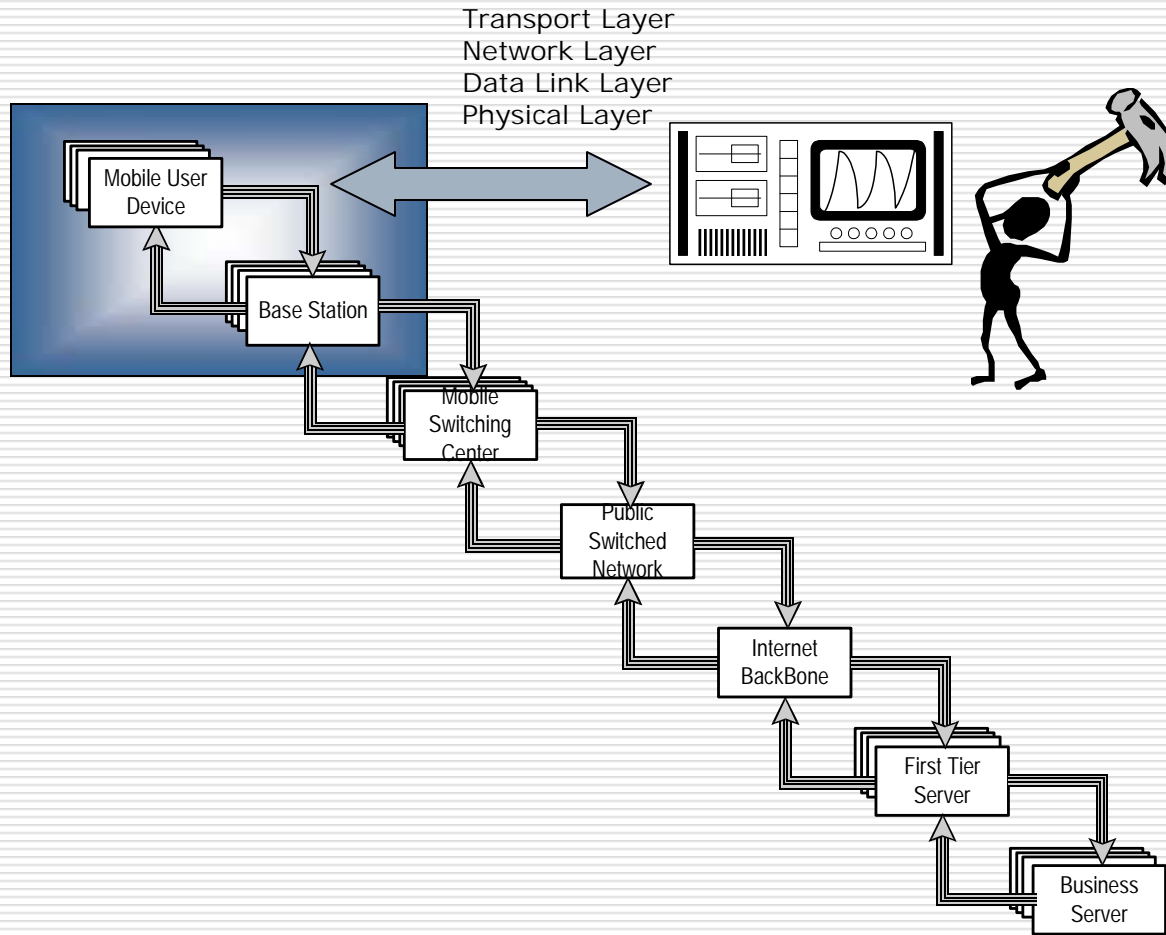
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Effectiveness: MUD + Base



MUD Application Client

Functionality
Response Time
MUD Resource Utilization

Airlink Variation

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Location Services

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Base Station

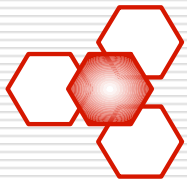
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Application Server

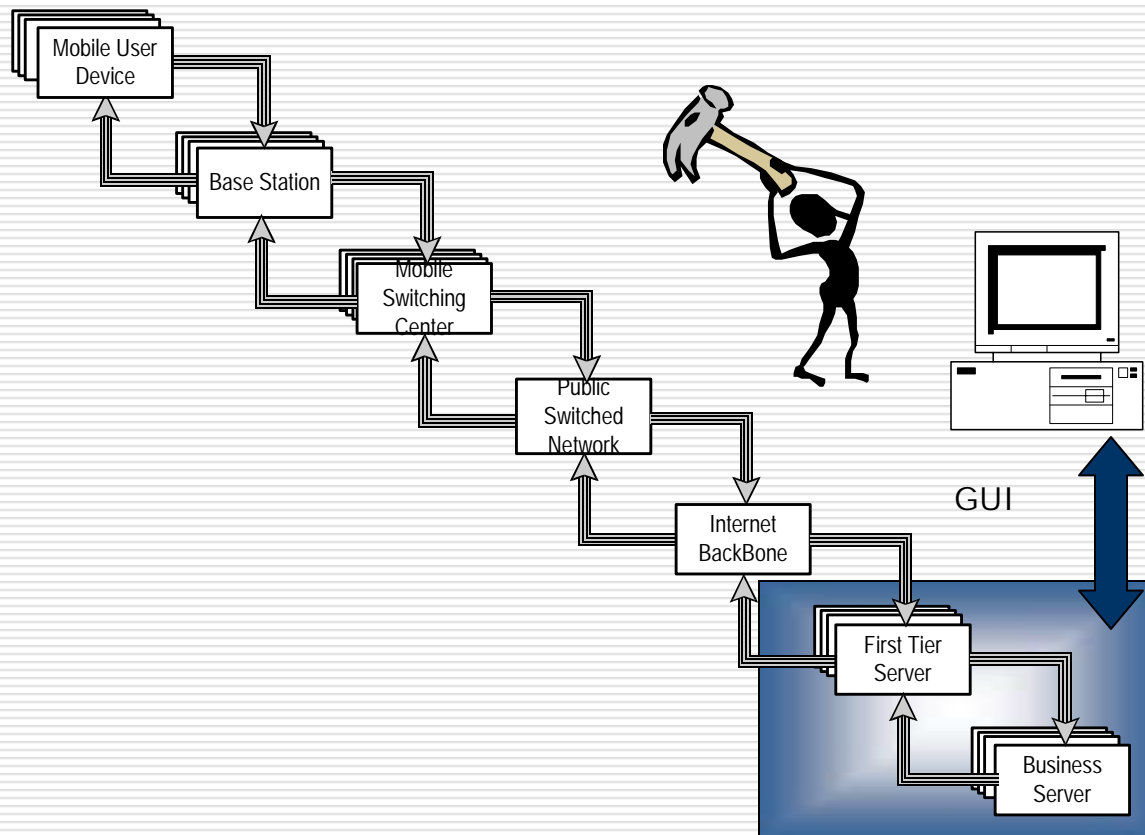
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End-to-End

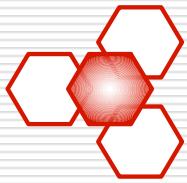
Response time
Capacity
Reliability
Availability
Geographic Coverage



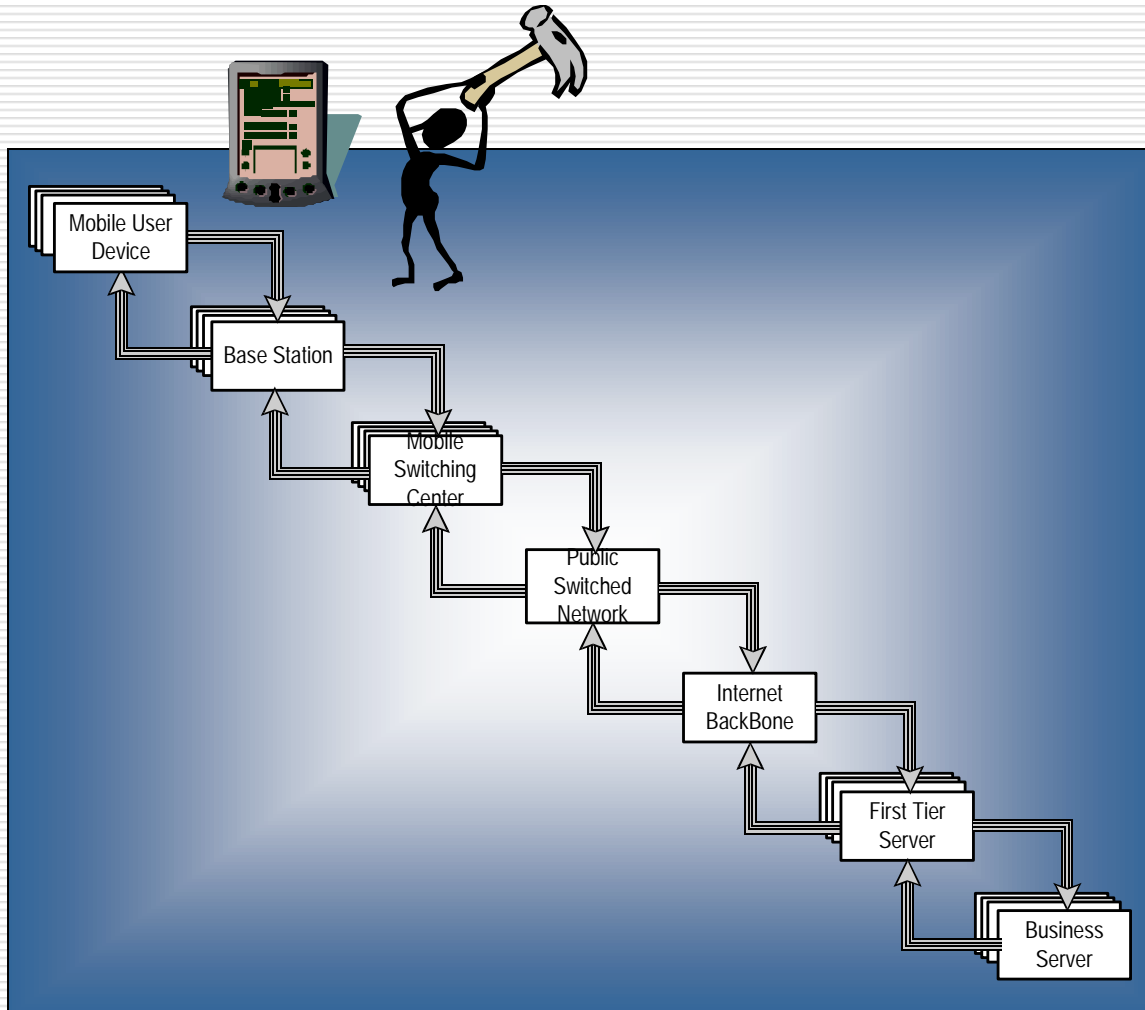
Effectiveness: App Server Scope



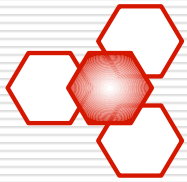
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Effectiveness: End-to-end Scope



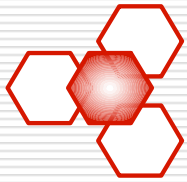
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Challenge of Ubiquitous IT

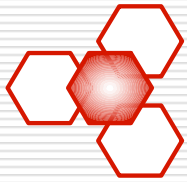
- Component scope testing necessary, but hardly sufficient
- Typical user population much larger, behavior more complex
- *Realistic, end-to-end testing sufficient to achieve high reliability*

How to achieve realistic testing with combinatorics increased by several degrees of freedom and scale of use up by 100x?



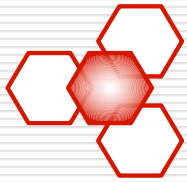
Key Capabilities

- Scalable, end-to-end
- Realistic and automated interleaving ...
 - Variation of mobility-related system dynamics
 - Variation of app functionality
 - Variation of aggregate load
- Test design patterns/model-based testing
- Sampling under operational profile
- Lightweight mobile test agents
- ...



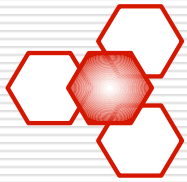
Wireless Testing System

- Application environment simulator
 - Extended use-cases
 - AI-based domain sampling
 - Mobility
 - User itinerary, signal contour map
 - Load profiles
 - Several time-domain load functions
- "A million users in a box"TM



Wireless Testing System

- Mobile User Device Test Agents
 - Lightweight agent applies generated tests in real time
 - Open source scripting – [incr Tcl]
 - Windows CE (15 PDAs) (Q4 2002)
- Airlink automatically controlled
- Server side application-specific frameworks
 - Comparator and oracle
 - Server-side event probe
 - Logical state invariant functions (LSIF)



The Vision

- Very high reliability mobile application systems through fully automated, mobile-aware, high-fidelity testing
- Very high reliability no longer exotic luxury
- Testers get respect: test engineering = system engineering