Mitigating Performance Risk

Four Steps to Releasing with Confidence

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Introduction

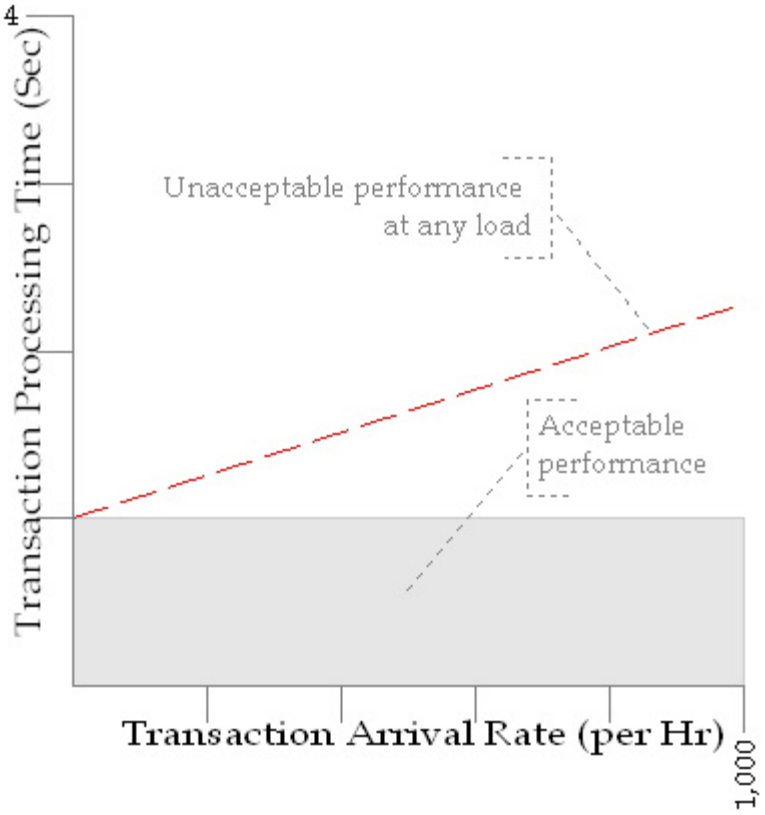
- Have you worked on a project where performance was the last item on the agenda, and it blew up in everyone's face?
- Ever seen projects cancelled due to performance problems?
- Nasty end-of-project performance surprises are avoidable
- It's not complicated, but it is hard work
- Let's review some typical performance problems, then a four step process you can use to avoid performance disasters

Typical Performance Problems

- Often, one or more of the following performance problems are observed during performance testing
  - Slow response under all load levels
  - Slow response under moderate-to-heavy (but supposedly allowed) load levels
  - Degraded response over time
  - Inadequate or graceless error handling under heavy or over-limit load
- Let's take a look…

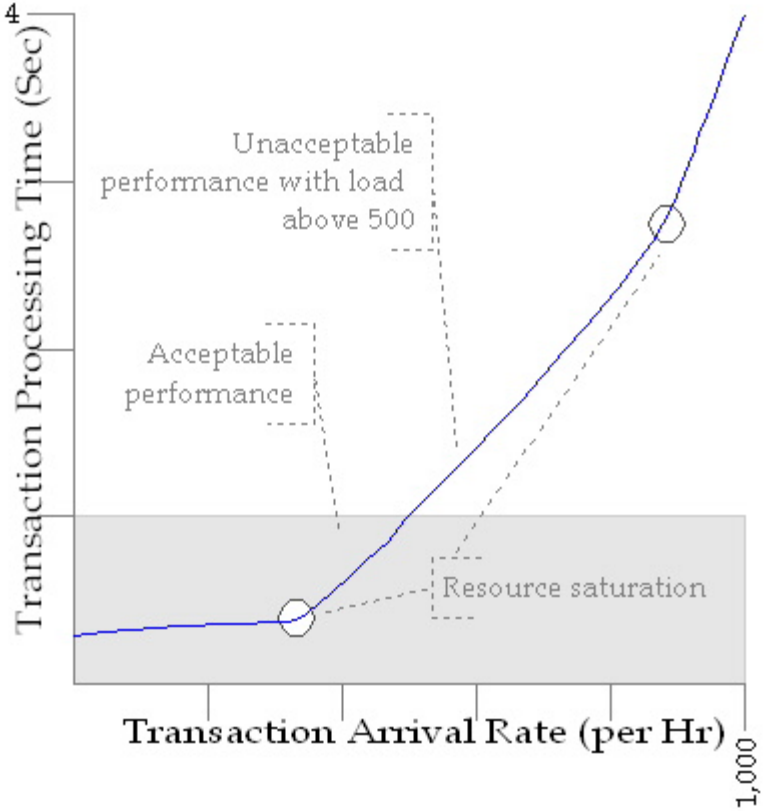
Slow Response Under All Load Levels

- In some cases, response is unacceptable regardless of load
- Underlying bugs include:
  - Bad database design or implementation
  - Network latency
  - Other background loads
- These problems can be detected under regular functional testing, not just performance testing



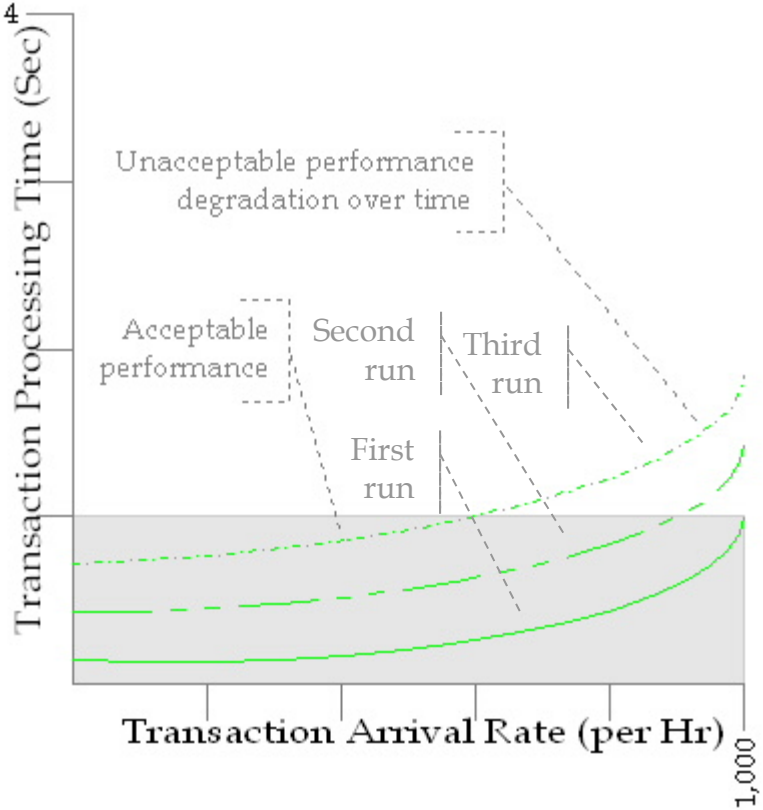
Slow Response At Moderate-to-Heavy Load

- In some cases, response degrades unacceptably with moderate-to-heavy load
- Underlying bugs include:
  - Saturation of one or more resources
  - Varying background loads



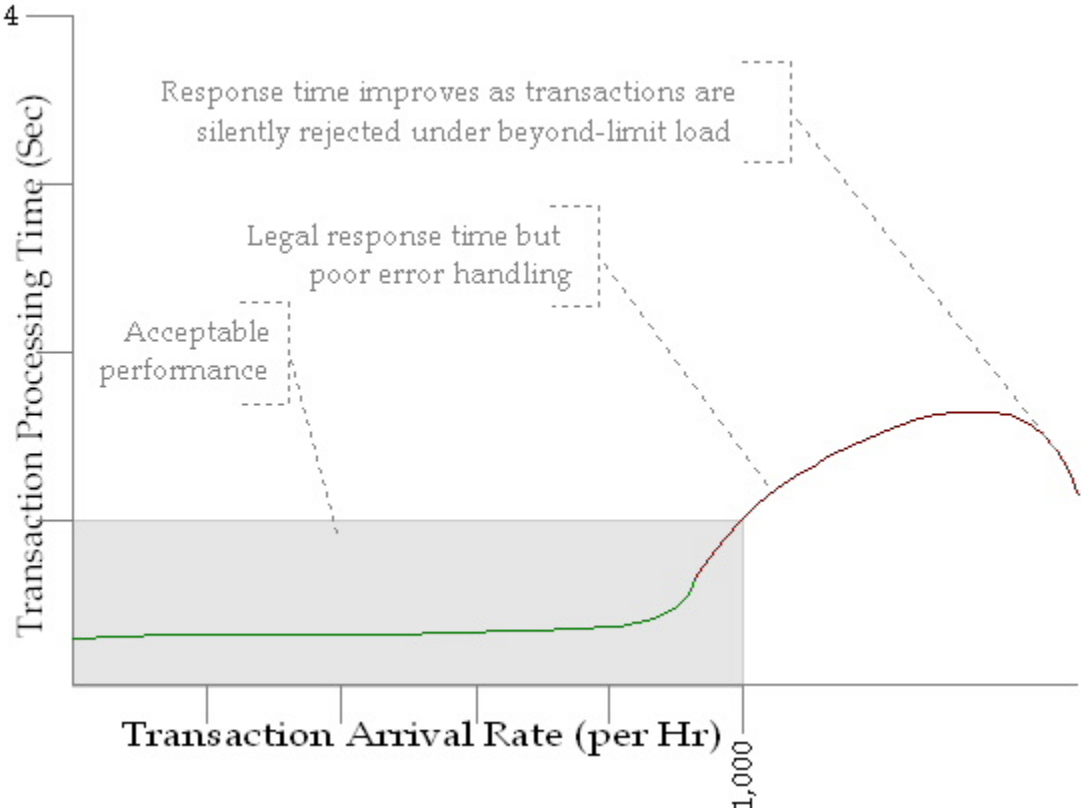
Degraded Response Over Time

- In some cases, response degrades over time
- Underlying bugs include:
  - Memory leaks
  - Disk fragmentation
  - Increasing network load over time
  - Database growth



Graceless Error Handling Under Load

- In some cases, response time is acceptable, but error handling degrades at high and beyond-limit load
- Underlying bugs include:
  - Insufficient resource pools
  - Undersized queues and stacks
  - Too-rapid time-out settings



The Case Study

- This case study involves testing a set of cloud servers supporting Internet appliances
- A key quality risk was that these servers might not handle anticipated loads
- The project was planned to last about six months
- The four steps to manage performance risk:
  1. Static performance tests of server designs
  2. Performance simulation of server designs
  3. Unit performance tests during implementation
  4. System performance tests of the implemented system
- Most organizations skip steps 1-3 and begin step 4 just before installation

Static Performance Testing

- At the start, the server system architects built a model of system behavior
- Model built in a spreadsheet
  - Estimated resource utilization levels based on number of deployed Internet appliances
  - Estimated resource utilization included CPU, memory, network bandwidth, etc.
- Model was peer reviewed by testers, developers, and managers
- The model was adjusted until we were confident in the initial design

Performance Simulation

- Next, the server system architects created a dynamic simulation
- This required diverse skills in network and internetwork architecture, programming, system administration, and the use of the simulation tool
- The simulation was fine-tuned iteratively until the architects had confidence in its predictions
- Purchasing hardware and configuring the servers also were iterative
- Once confident in the model's prediction of the need for a certain element, we would purchase it

Unit Performance Testing

- The system consisted of ten servers providing five key capabilities:
  - E-commerce hosting
  - E-mail repository
  - IMAP mail
  - Various user-related databases
  - Software and operating system updates.
- Load balancing split each key capability's work across two servers
- Each of these five capabilities underwent unit testing, with a unit defined as a distinct service provided as part of the capability
- Developers used some internally developed tools to which we added some enhancements

System Performance Testing

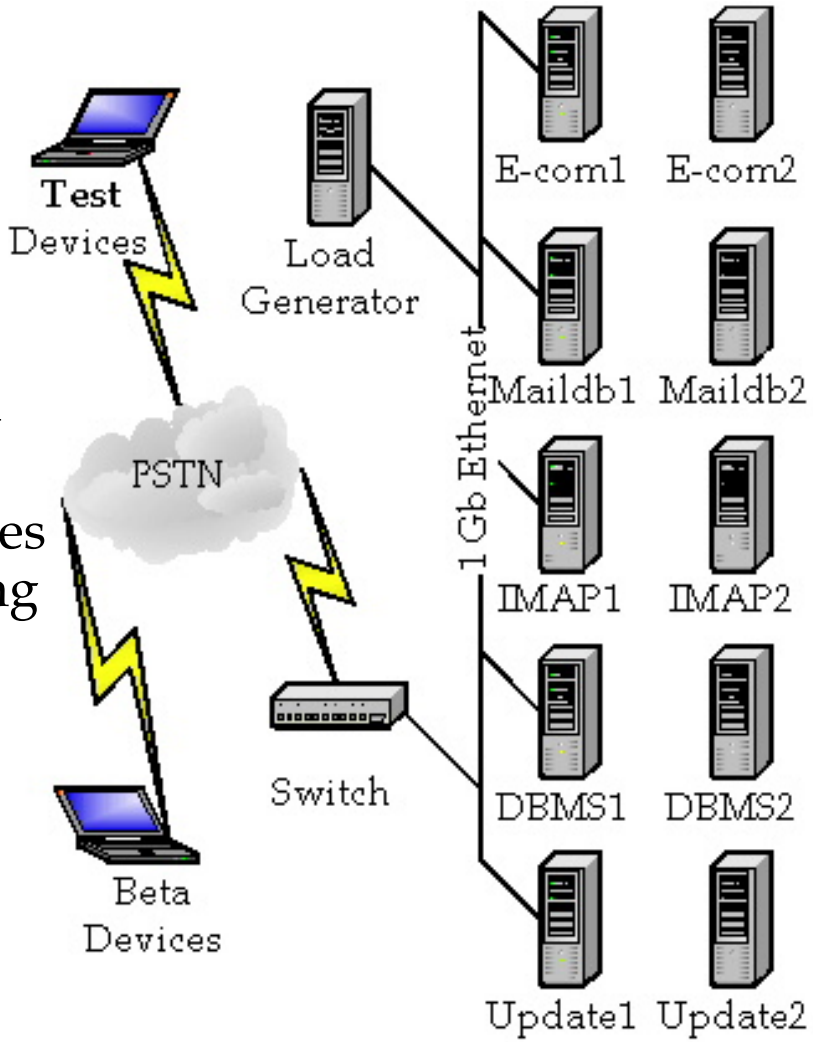
- During development and unit performance testing, we planned and prepared for system testing, including performance testing
- Performance testing had its own test plan, with the following main objectives:
  - To meet and exceed real-world, realistic loads
  - To test our load test tools
  - To provide early, quick feedback about performance bugs
  - To validate the performance simulation
  - To test robustness and recovery by forcing system and component failures
- We also planned to iterate tests expeditiously and efficiently as bugs were found and fixed

Features Tested

- Update: The appliances were updated by update servers
  - We built a load generator from unit test tools to simulate thousands of appliances
  - The simulated appliances requested updates, loading update servers
- Mail: The clients sent and received e-mail via IMAP e-mail servers
  - We simulated client e-mail traffic, including attachments
  - Emails varied in size
- Web: When an appliance was sent to a customer, the servers would set up and support its features via web services, so we simulated realistic loads of activity
- Database: Information about each appliance was stored in database servers, so we simulated various database activities, often using SQL scripts
- Our usage scenarios, assumptions, and plan were reviewed with developers throughout the test preparation process

Performance Test Environment

- We built and validated the test environment during preparation
- Load balancing devices are not shown but are part of the configuration
- We were able to use the production servers as the test environment
- We had both client testing appliances and beta testing appliances accessing the servers
- Sometimes, we ran other functional and non-functional tests during performance testing to get a subjective impression of the users' experience



So, What Did We Find?

- Once system testing started, we ran tight cycles of performance testing, getting fixes regularly
- We found some interesting server performance bugs:
  - Sending corrupted update files hung the update process
  - Large log files caused performance problems
  - Network management agents failed silently when server crashes were simulated
  - Memory leaks degraded performance
  - The database was configured improperly
  - Hardware was not hot-swappable
  - Throughput was too low on critical processes
  - Load balancing did not work properly
  - Proxy and filtering bugs caused slow Internet access
- Most of these bugs couldn't have been found in steps 1-3
- All were manageable code problems, not fundamental design issues
- Let's look examples of some e-mail bugs we found…

At First Glance…

- Simulation results for the IMAP e-mail servers
  - 45% server utilization at 25,000 users
  - 75% server utilization (saturation) at 40,000 users
- Worst-case snapshots (25,000 users)

Server	CPU Idle
MTA1	68%
MTA2	79%
Maildb1	67%
Maildb2	89%
IMAP1	59%
IMAP2	55%

∴ Test results appear to support simulation results at 25,000 users, but…

…But Actually…

We did a detailed analysis of performance, too

Transaction	Server	Frequency	Simulation Time (ms)	Observed Time (ms)
Connect	IMAP	1 per connect	0.74	0.77
Banner	IMAP	1 per connect	2.57	13.19
Authorize	IMAP	1 per connect	19.68	19.08
Select	IMAP	1 per connect	139.87	163.91
Fetch	IMAP	1 per connect	125.44	5,885.04

To do this, you must design your tests and models so that you can compare the results

Conclusions

- Emergent system behaviors like performance can blow up your project at the very end…if you let them
- However, hard, upfront work on these four basic steps can reduce the risk to a manageable level
- Resource analysis, simulation, unit testing, and system testing each filter defects, including performance defects
- Don't gamble with your project's future by waiting until the end to address performance

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Address:	RBCS, Inc. 31520 Beck Road Bulverde, TX 78163-3911 USA
Phone:	+1 (830) 438-4830
E-mail:	info@rbcs-us.com
Web:	www.rbcs-us.com
Twitter:	@RBCS, @LaikaTestDog
Facebook:	RBCS, Inc.

