Deployment

SWE 432, Fall 2016

Design and Implementation of Software for the Web

GEORGE MASON UNIVERSITY

Today

- Big picture: from ideas to awesome products
  - How do we structure the process that gets us those products?
- Buzzwords:
  - DevOps, Continuous Integration, Continuous Deployment, Continuous Delivery, and how we got there
- No specific technologies!

For further reading:

Chuck Rossi (Facebook) on Continuous Mobile Release

http://blog.christianposta.com/deploy/blue-green-deployments-a-b-testing-and-canary-releases/

What is a software process?

- A structured set of activities required to develop a software product
  - Specification
  - Design and implementation
  - Validation
  - Evolution (operation and maintenance)
- Goal: Minimize Risk
  - Falling behind schedule
  - Changes to requirements
  - Bugs/unintended effects of changes

Software Specification

- The process of establishing what features and services are required, as well as the constraints on the system's operation and development.
- Requirements engineering process
  - Feasibility study;
  - Requirements elicitation and analysis;
  - Requirements specification;
  - Requirements validation.

Software Design & Implementation

- The process of converting the system specification into an executable system.
- Software design
  - Design a software structure that realizes the specification;
  - Implementation
    - Translate this structure into an executable program;
    - The activities of design and implementation are closely related and may be inter-leaved.

Software Validation

- Verification and validation (V & V) is intended to show that a system conforms to its specification and meets the requirements of the customer(s).
- Involves checking and review processes, and acceptance or beta testing.
  - Custom software: Acceptance testing involves executing the system with test cases that are derived from the real data to be processed by the system in the customer's environment.
  - Generic software: Beta testing executes the system in many customers' environments under real use.

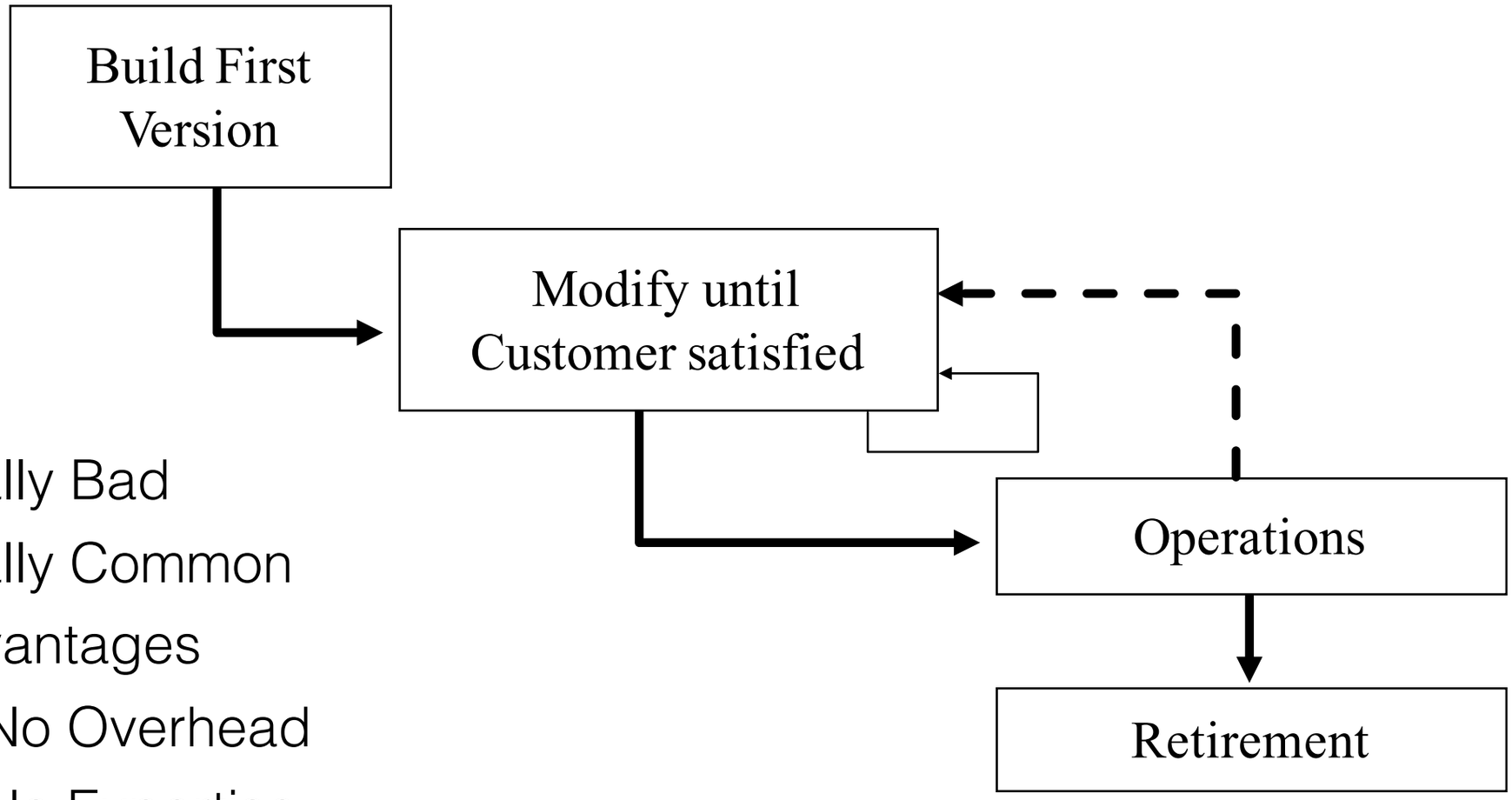
Software Evolution

- Software is inherently flexible and can change.
- As requirements change due to changing business circumstances, the software that supports the business must also evolve and change.
- Although there has historically been a demarcation between development and evolution, this is increasingly irrelevant as fewer and fewer systems are completely new.

Process Models

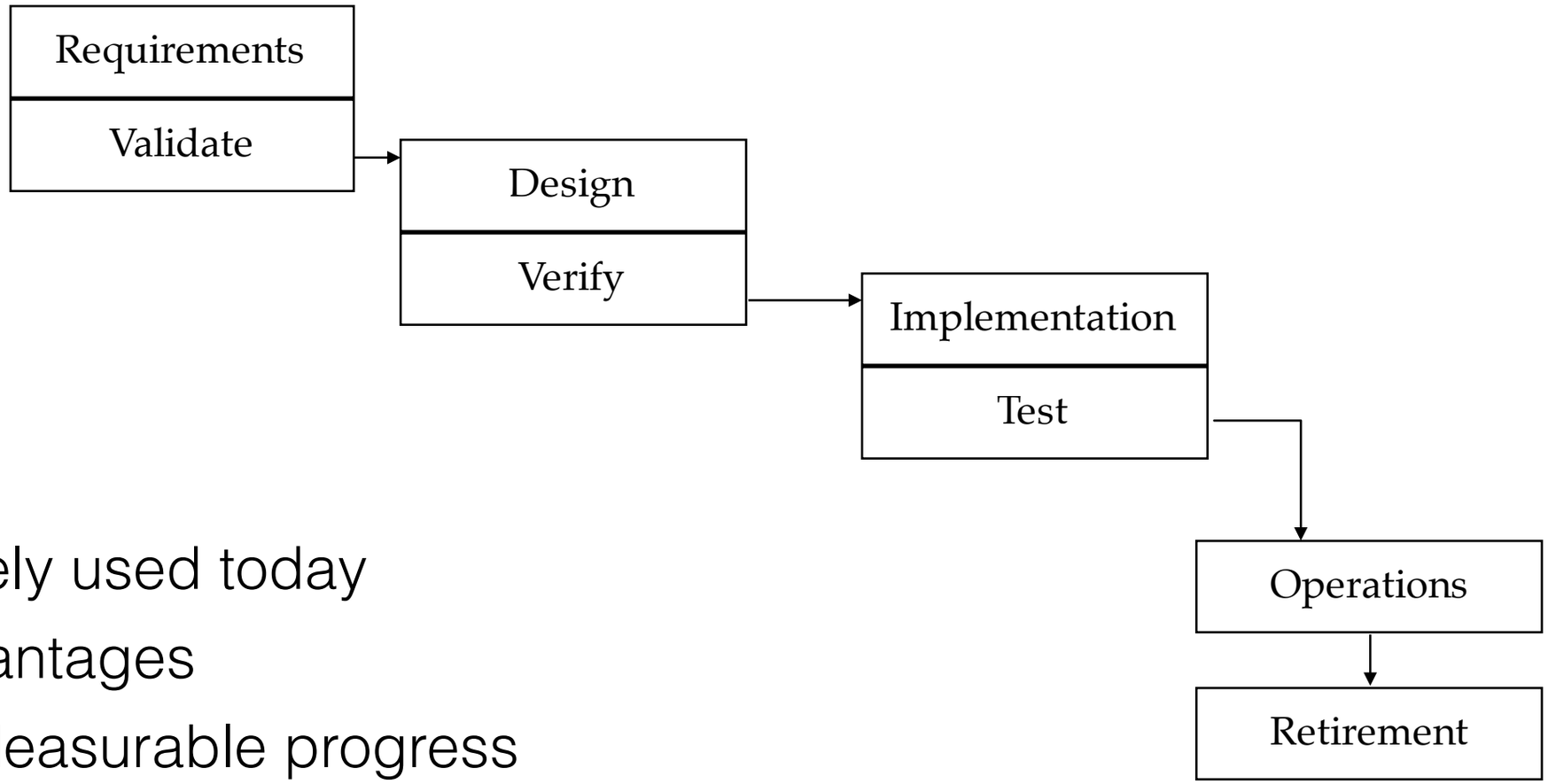
- If we say that building software requires:
  - Specification
  - Design/Implementation
  - Validation
  - Evolution
  - How do we structure our organization/development teams/tasks to do this most efficiently?

Code-and-Fix



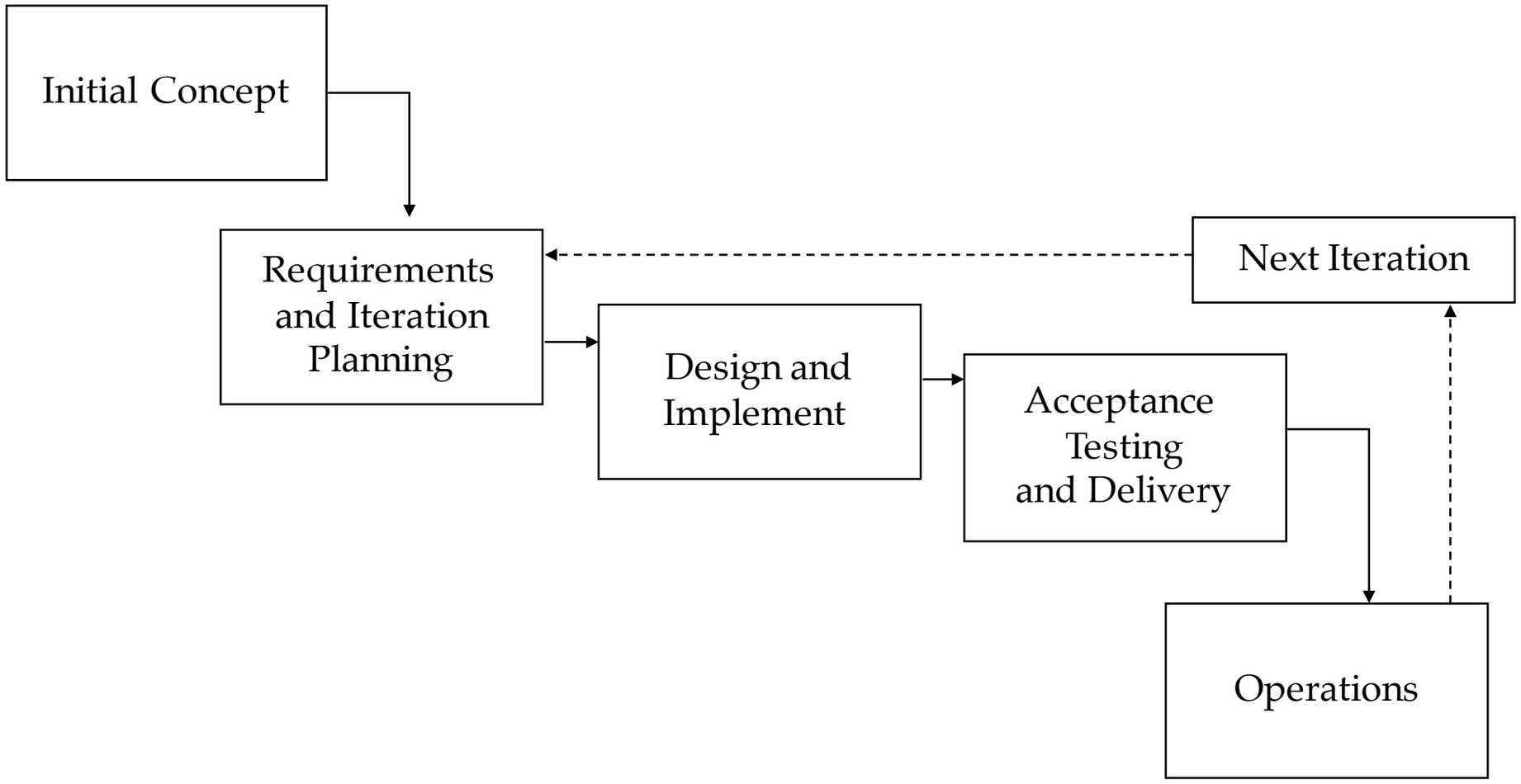
- Really Bad
- Really Common
- Advantages
  - No Overhead
  - No Expertise
- Disadvantages
  - No means of assessing progress
  - Difficult to coordinate multiple programmers
- Useful for “hacking” single-use/personal-use programs: start with empty program and debug until it works

Waterfall Model



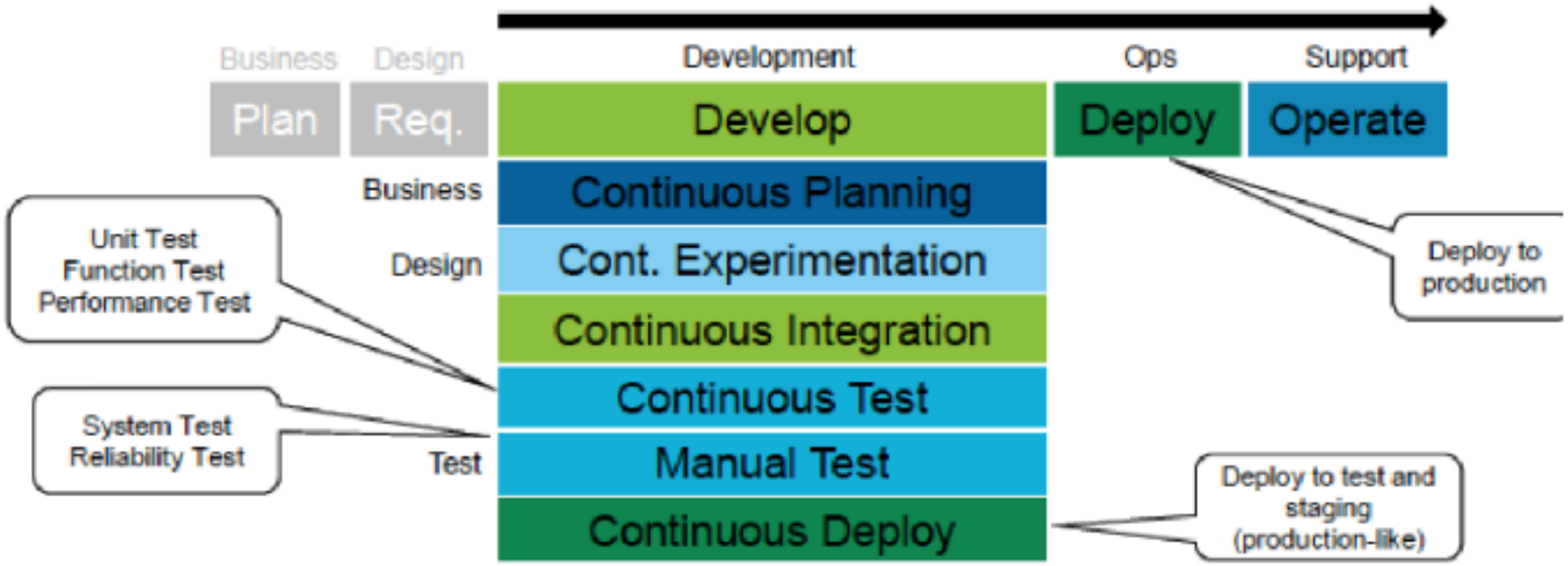
- Widely used today
- Advantages
  - Measurable progress
  - Experience applying steps in past projects can be used in estimating duration of “similar” steps in future projects
  - Produces software artifacts that can be re-used in other projects
- Disadvantages
  - Difficulty of accommodating change after the process is underway: One phase has to be complete before moving onto the next phase.

Agile Model



- Agile results in an *iterative* model, where each iteration is several weeks long and results in several features being built
- Recognize that requirements ALWAYS evolve as you are trying to build something
- Plus, maybe you can get useful feedback by delivering a partial app early

Continuous Development

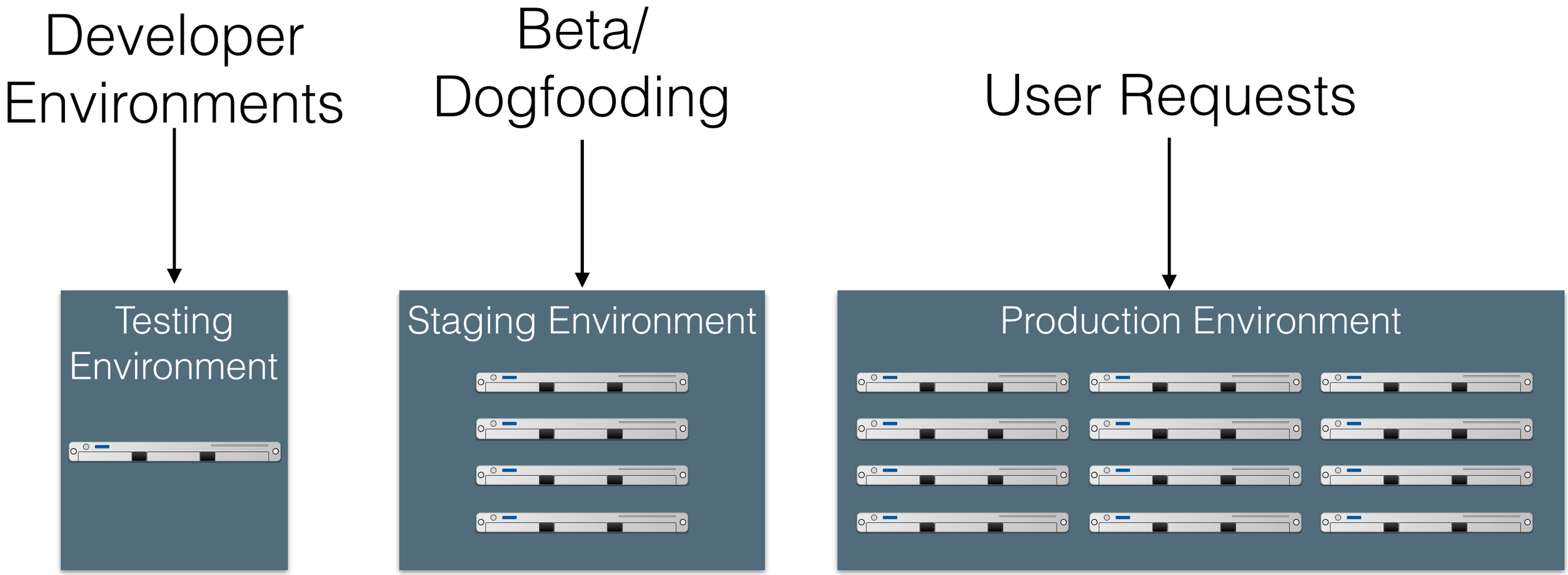


- Like agile, but…
  - We are always working on different features
  - We have a formal mechanism for deploying new versions of code and validating (test/staging/ production)

The value of the Staging Environment

- As software gets more complex with more dependencies, it's impossible to simulate the whole thing when testing
- Idea: Deploy to a complete production-like environment, but don't have everyone use it
  - Examples:
    - “Eat your own dogfood”
    - Beta/Alpha testers
- Lower risk if a problem occurs in staging than in production

Test-Stage-Production



Revisions are “promoted” towards production

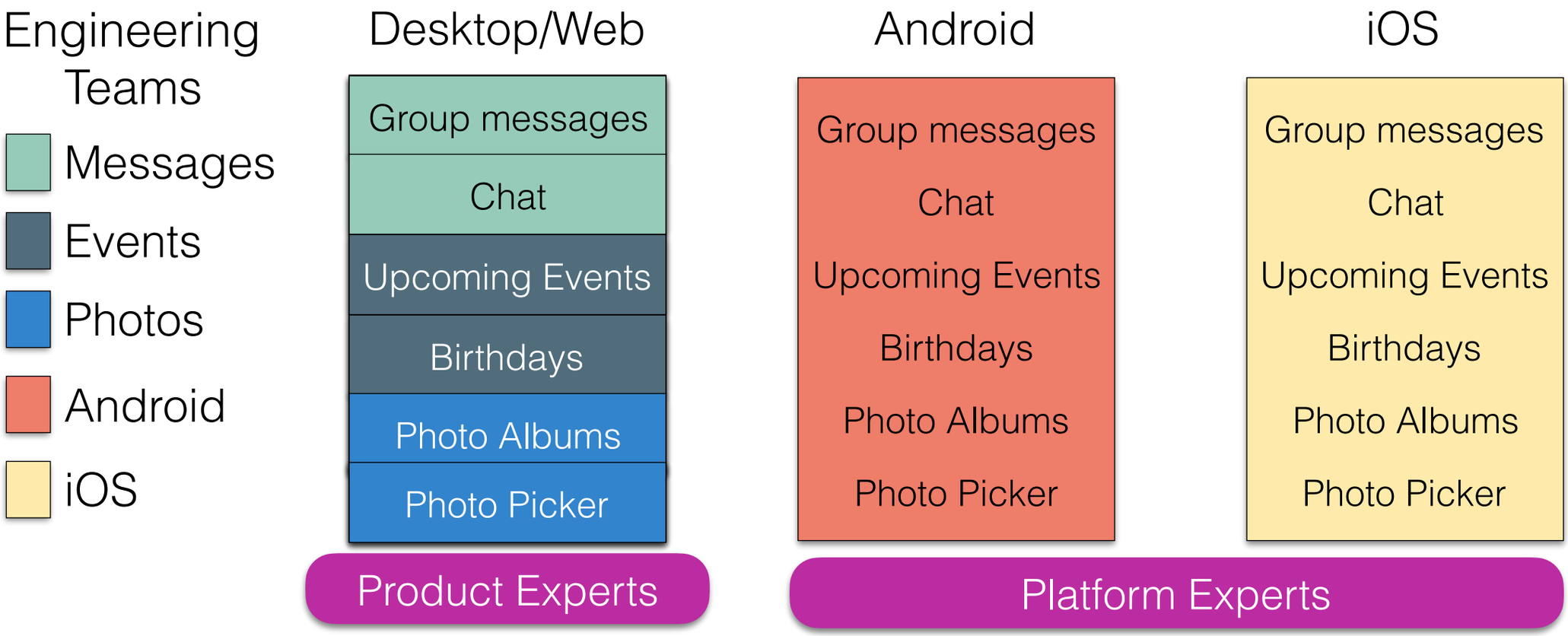
Operations Responsibility

- Once we **deploy**, someone has to monitor software, make sure it's running OK, no bugs, etc
- Assume 3 environments:
  - Test, Staging, Production
- Whose job is it?

	Developers			Operators		
Waterfall				Test	Staging	Production
Agile	Test				Staging	Production
DevOps	Test	Staging	Production			Production

DevOps Values

- No silos, no walls, no responsibility "pipelines"
- One team owns changes "from cradle to grave"
- *You* are the support person for your changes, regardless of platform
- Example: Facebook mobile teams



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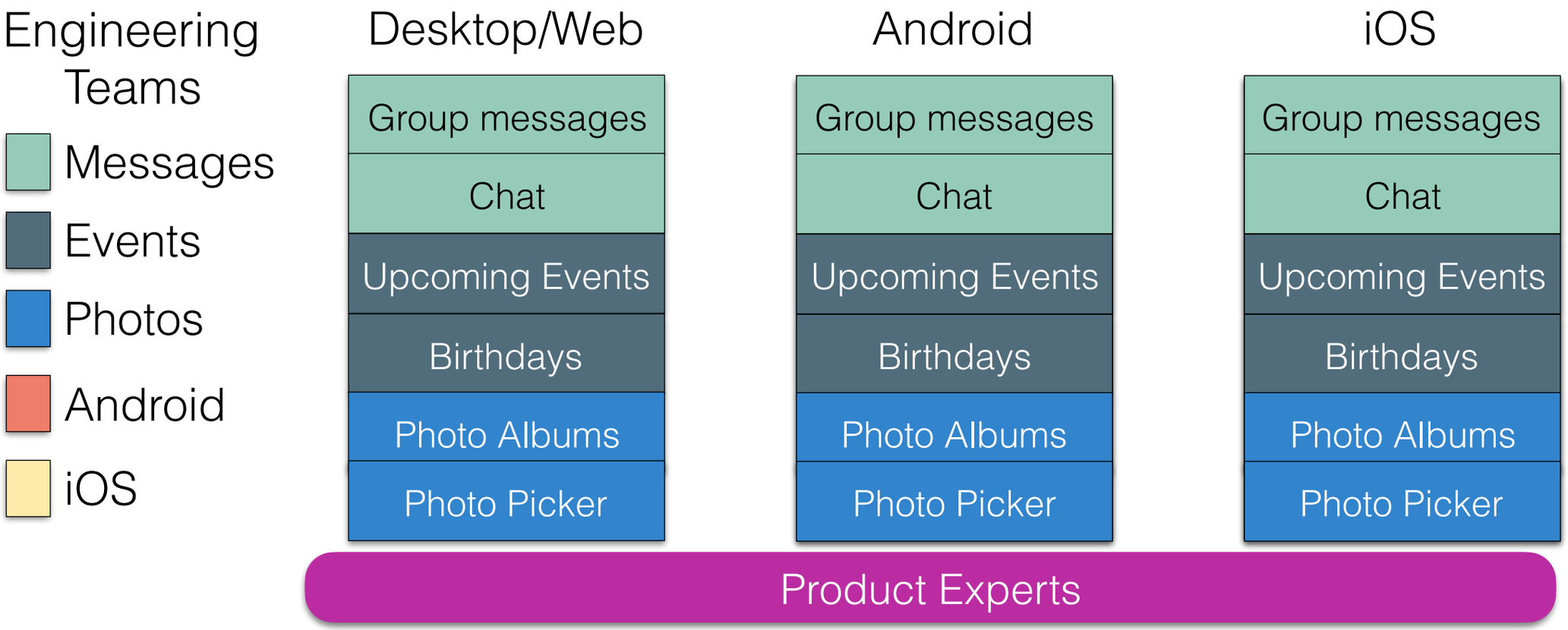
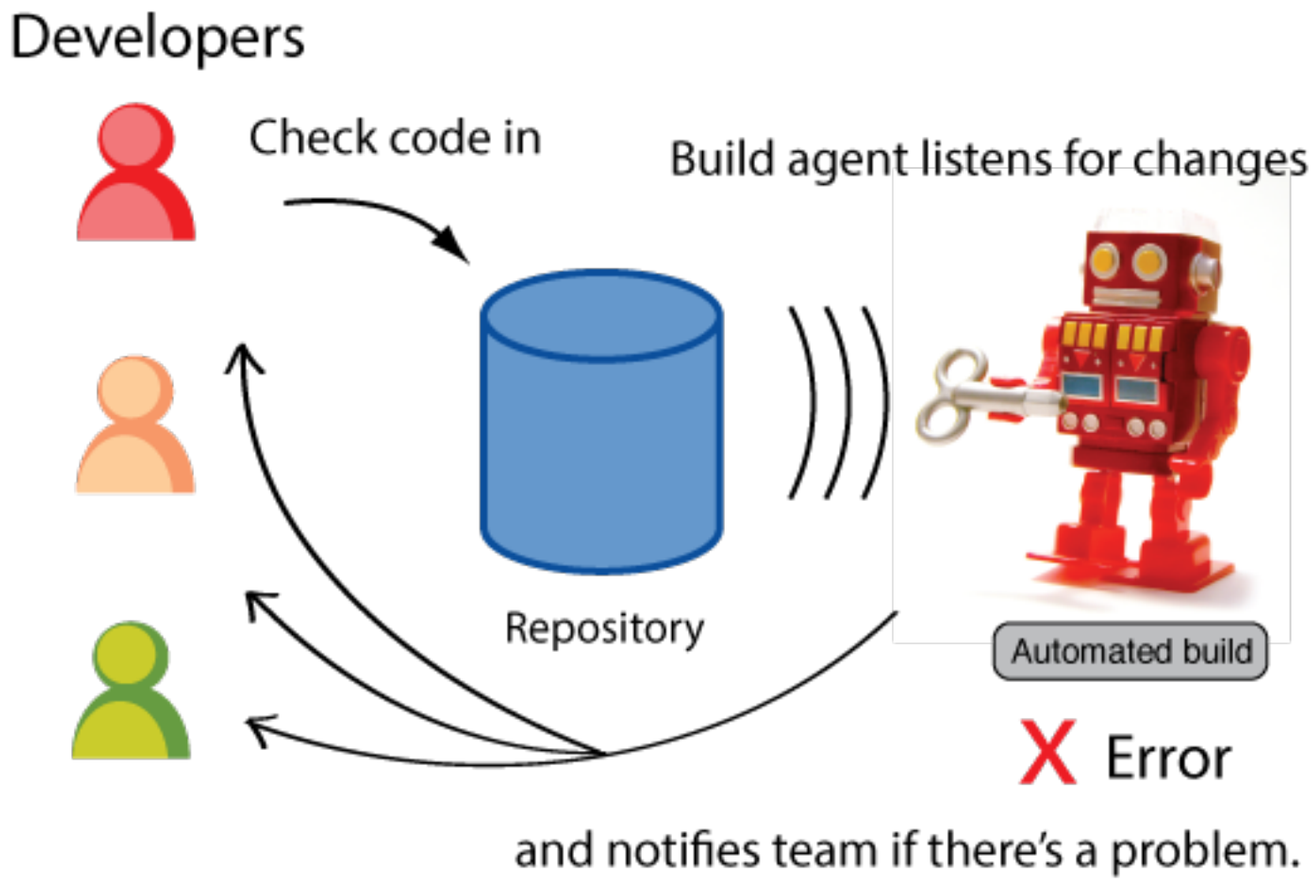


Continuous X

- Continuous Integration:
  - A practice where developers automatically build, test, and analyze a software change in response to every software change committed to the source repository.
- Continuous Delivery:
  - A practice that ensures that a software change can be delivered and ready for use by a customer by testing in production-like environments.
- Continuous Deployment:
  - A practice where incremental software changes are automatically tested, vetted, and deployed to production environments.

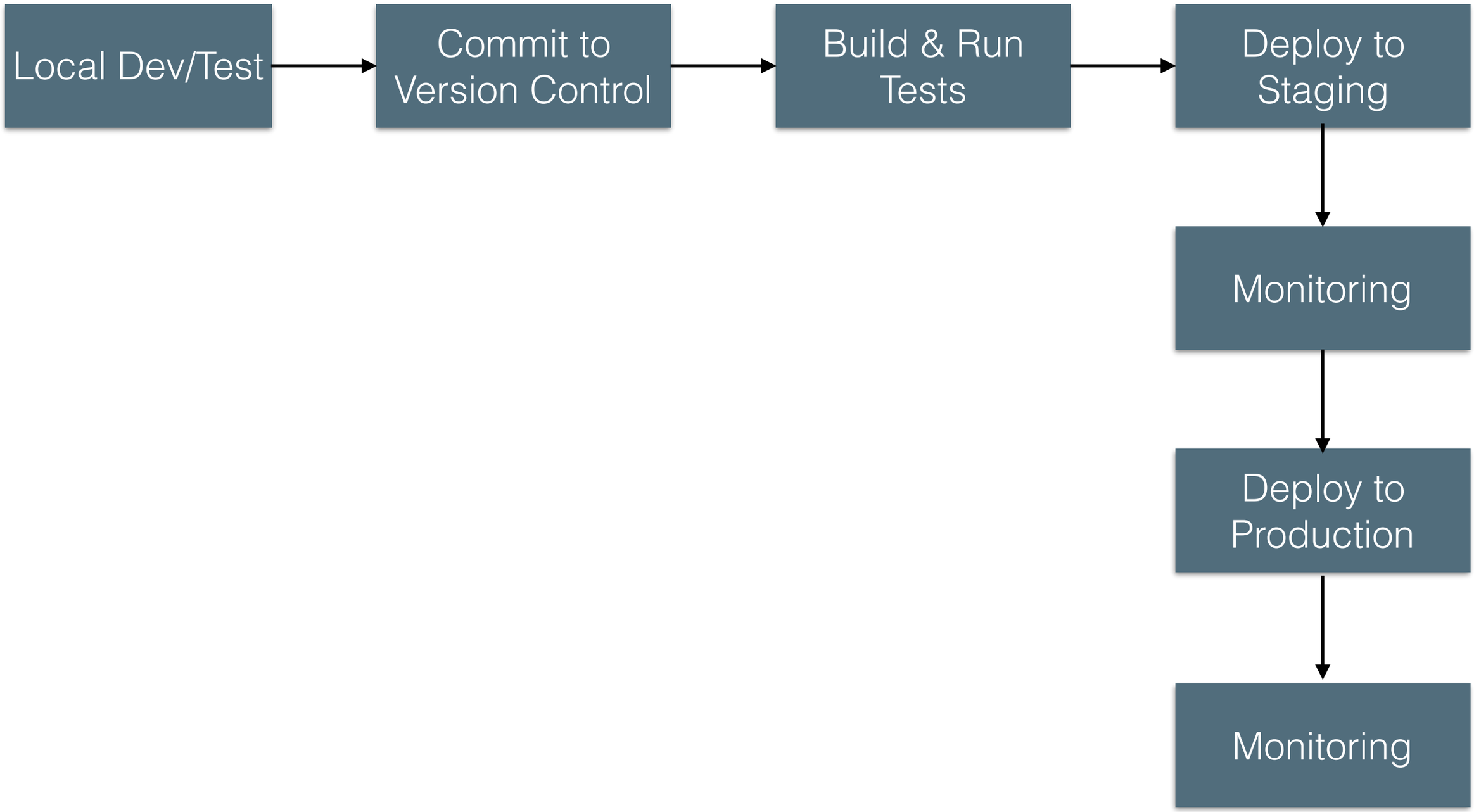
Continuous Integration



Continuous Integration

- Commit Code Frequently
- Don’t commit broken code
- Fix broken builds immediately
- Write automated developer tools
- All tests and inspections must pass
- Run private builds
- Avoid getting broken code

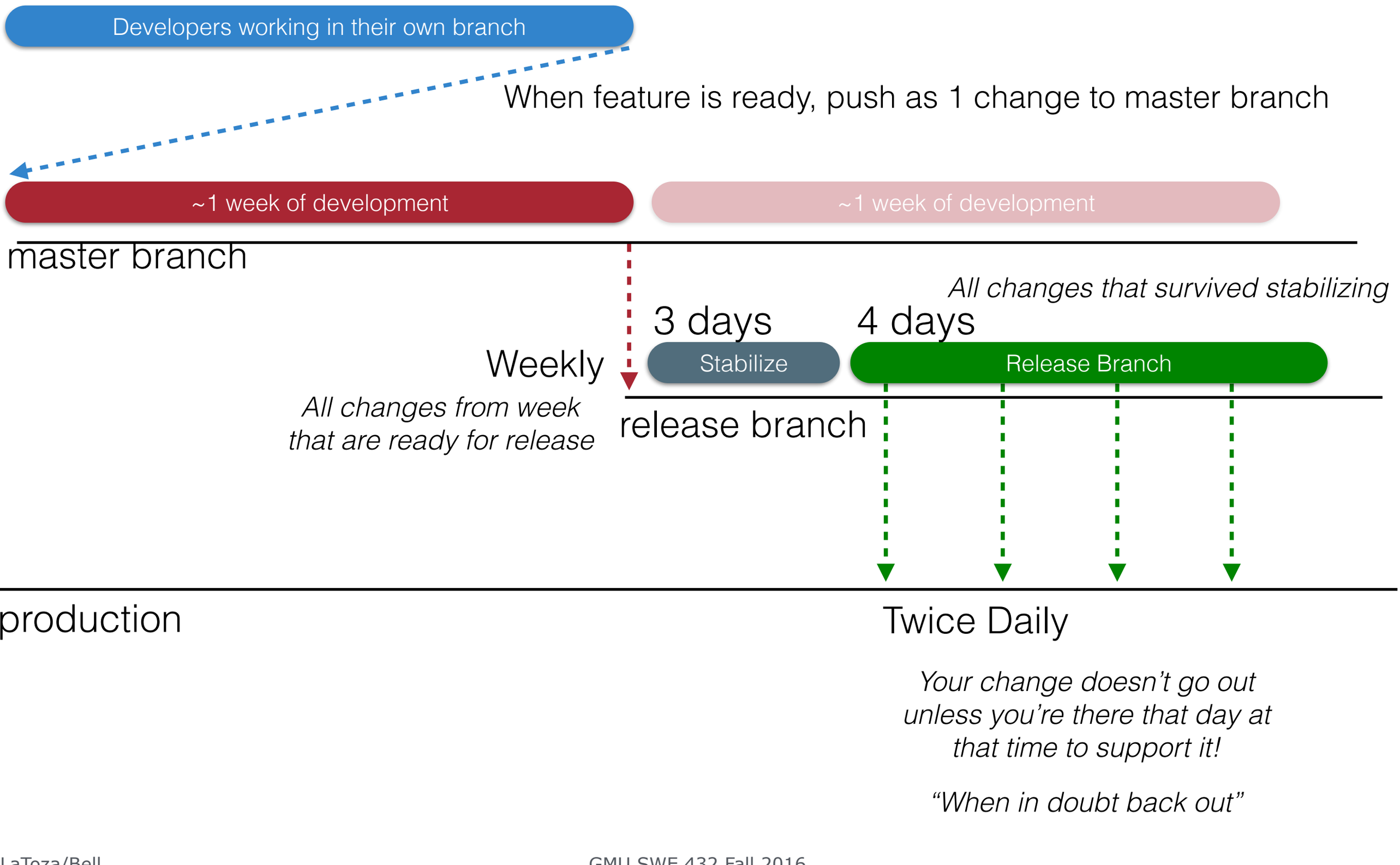
Deployment Pipeline



Deployment Pipeline

- Even if you are deploying every day, you still have some latency
- A new feature I develop today won't be released today
- But, a new feature I develop today can begin the **release pipeline** today (minimizes risk)
- **Release Engineer**: gatekeeper who decides when something is ready to go out, oversees the actual deployment process

Deployment Example: Facebook.com

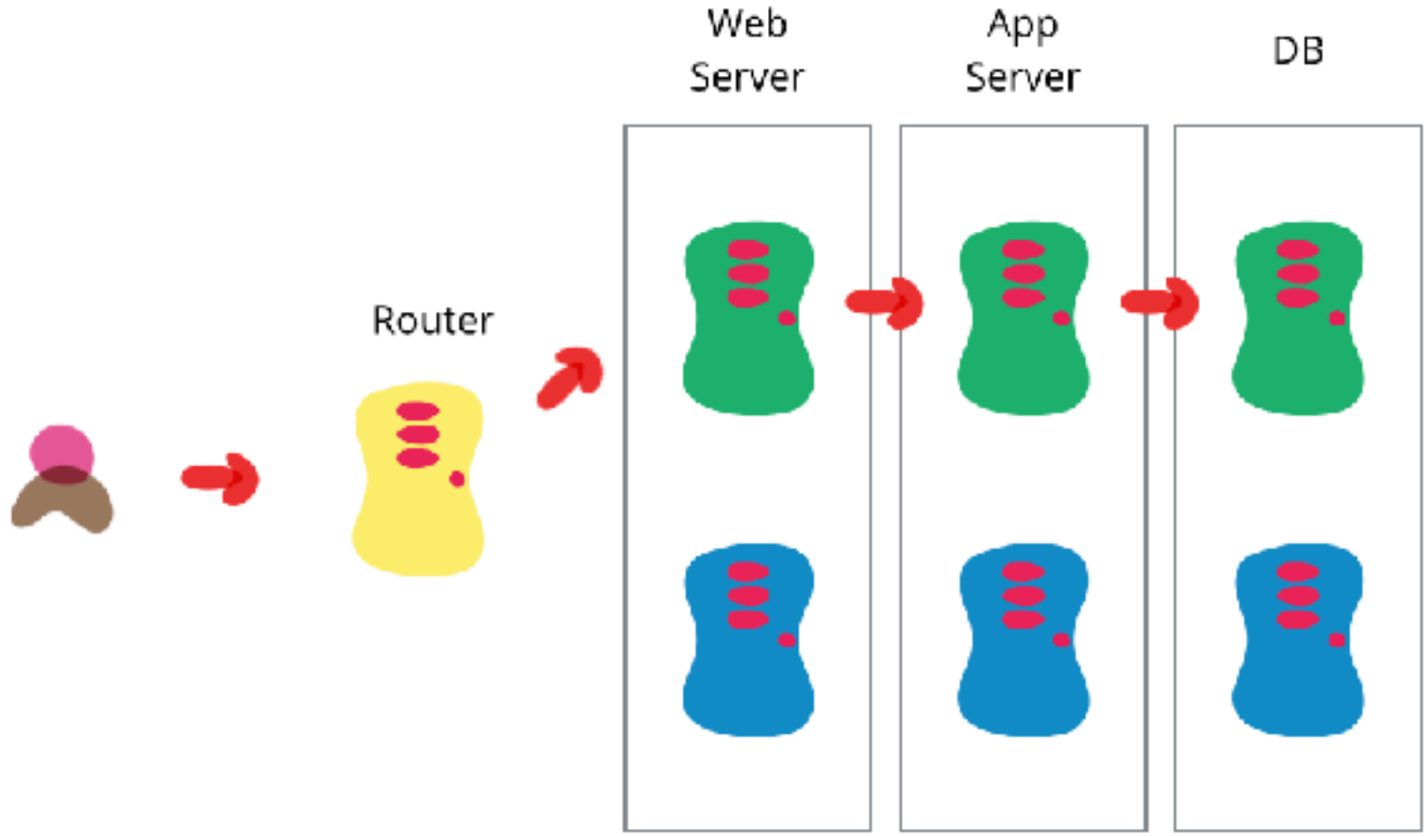


Continuous Integration & Continuous Deployment

- Thousands of changes coming together at once
- To isolate problems:
  - Every time that every change is potentially going to be introduced, the entire system is integrated and tested
  - Facebook does 20,000-30,000 complete integrations PER DAY for mobile alone
- General rule:
  - Cost of compute time to run tests more often is way less than the cost of a failure

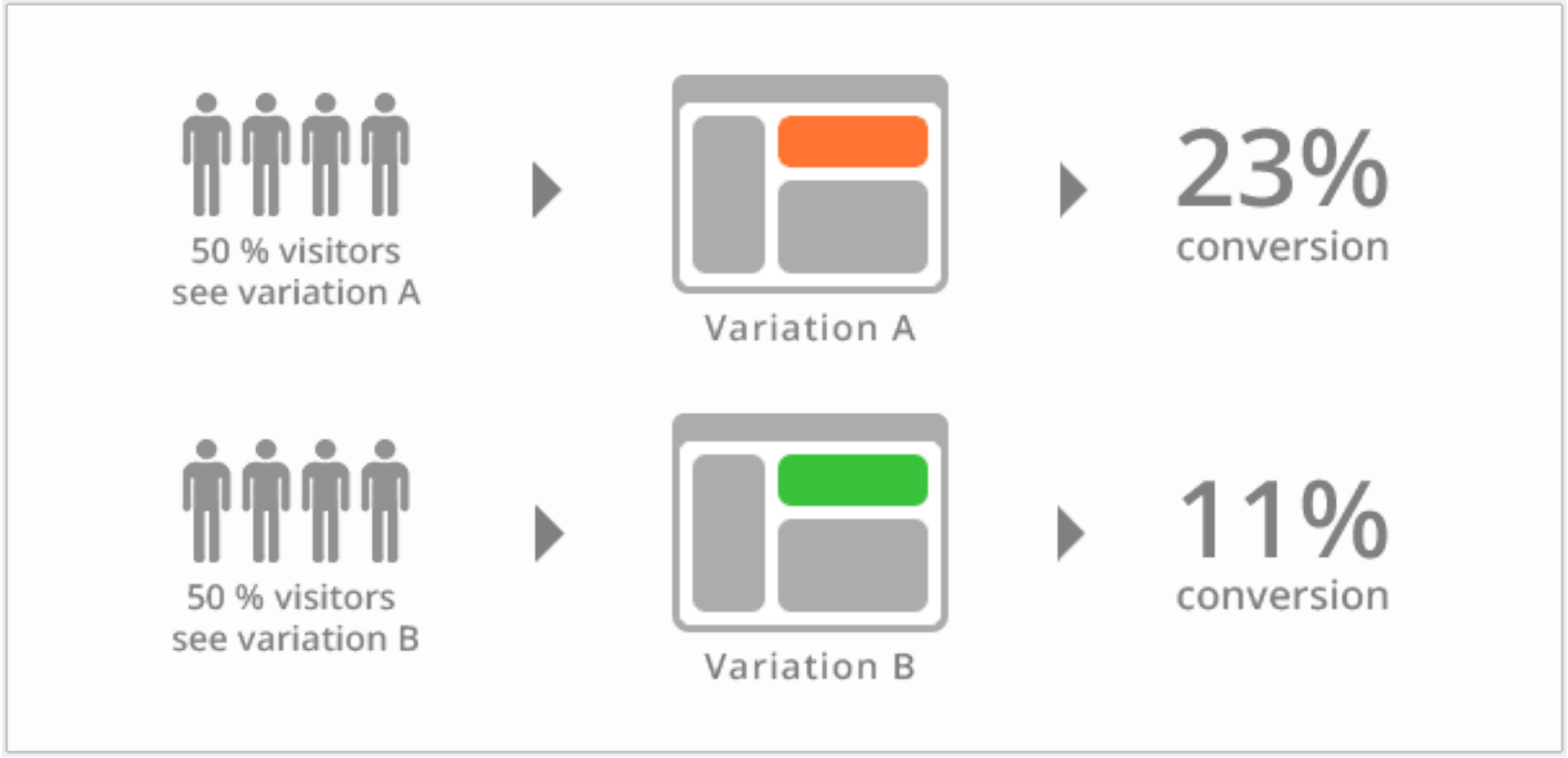
Blue-Green Deployment

- Always have 2 complete environments ready:
  - One that you're using now
  - One that you're just about ready to use
- Easily switch which is handling requests



A/B Testing

- Ways to test new features for usability, popularity, performance
- Show 50% of your site visitors version A, 50% version B, collect metrics on each, decide which is better

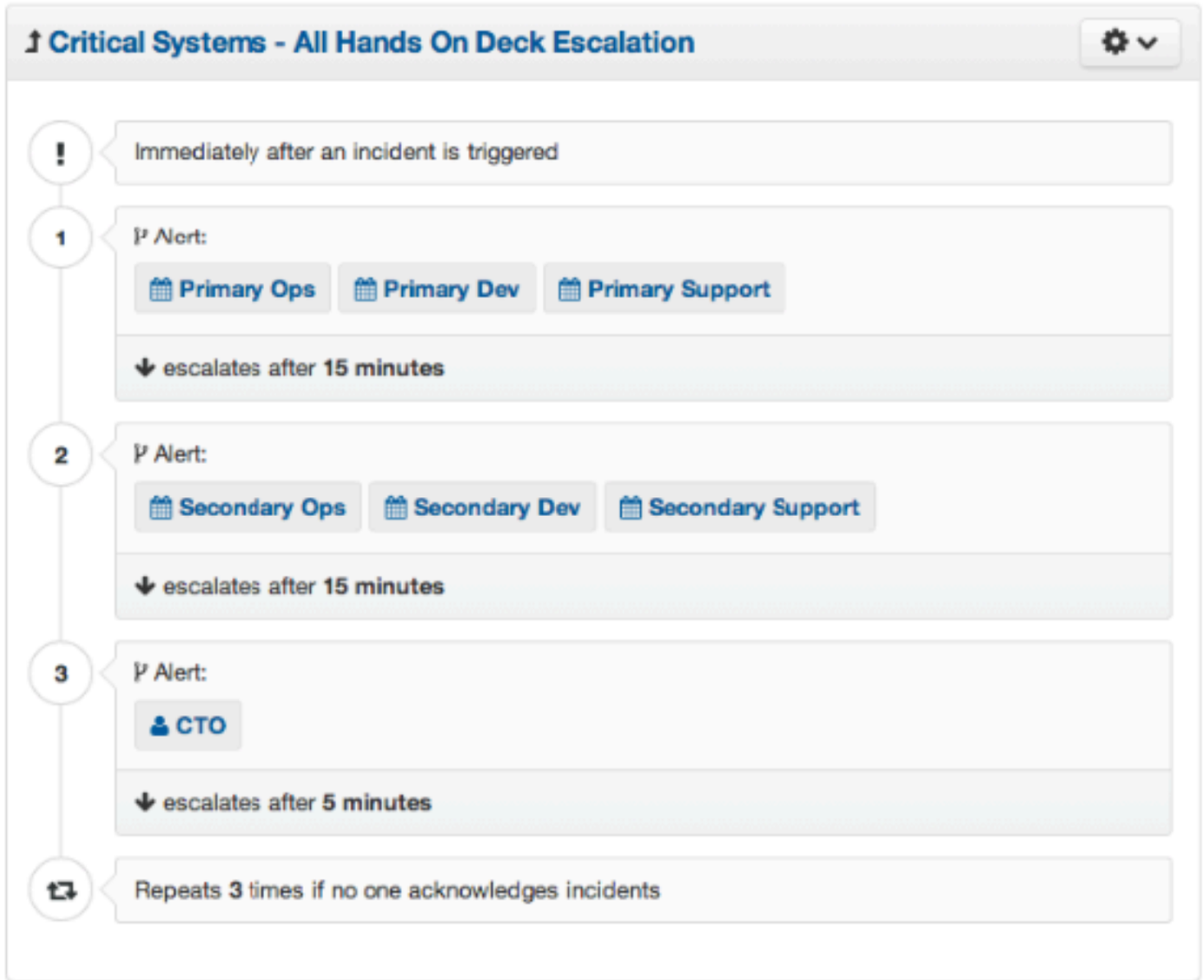


Monitoring

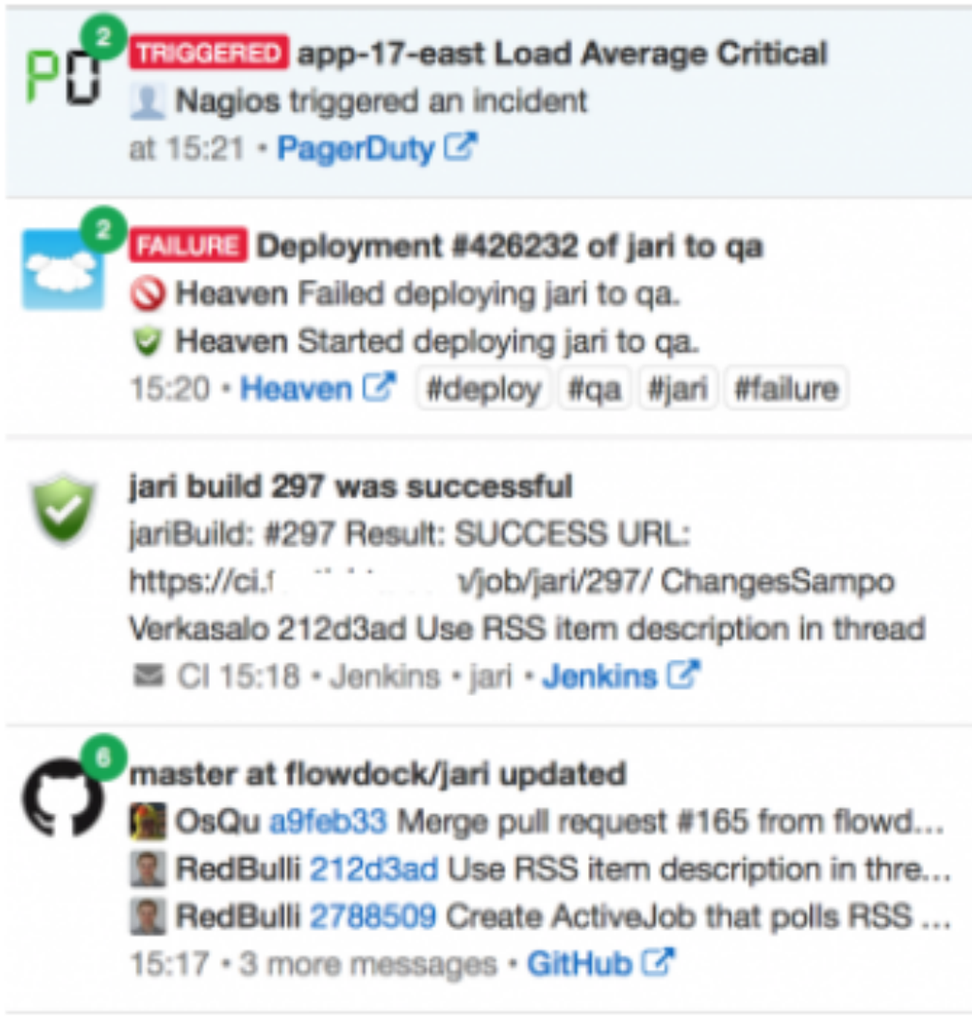
- Hardware
  - Voltages, temperatures, fan speeds, component health
- OS
  - Memory usage, swap usage, disk space, CPU load
- Middleware
  - Memory, thread/db connection pools, connections, response time
- Applications
  - Business transactions, conversion rate, status of 3rd party components

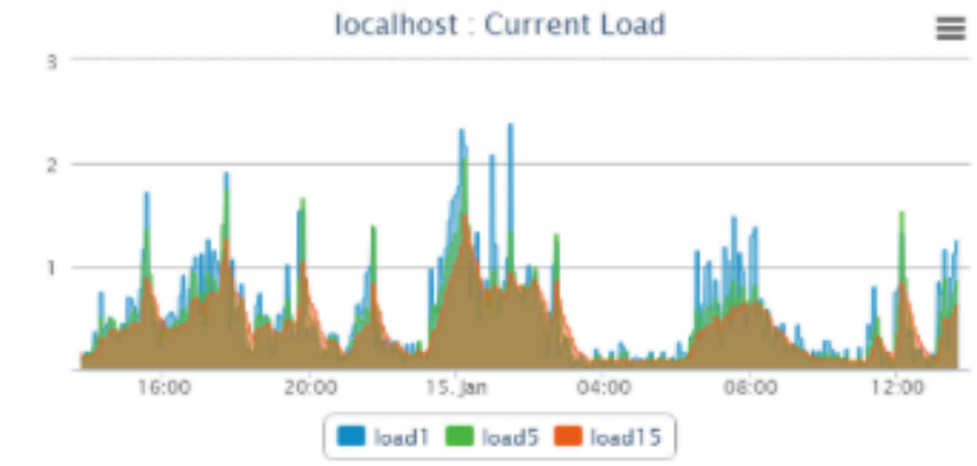
When stuff goes wrong

- Automated monitoring systems can notify “on-call” staff of a problem
- Triage & escalation



Monitoring Dashboards





Host Status Summary

Up	Down	Unreachable	Pending
33	4	0	0
Unhandled	**Problems**		**All**
4	4		37

Last Updated: 2014-01-15 13:45:04

Service Status Summary

Ok	Warning	Unknown	Critical	Pending
279	5	1	47	1
Unhandled		**Problems**		**All**
51		53		333

Last Updated: 2014-01-15 13:45:04

Disk Usage

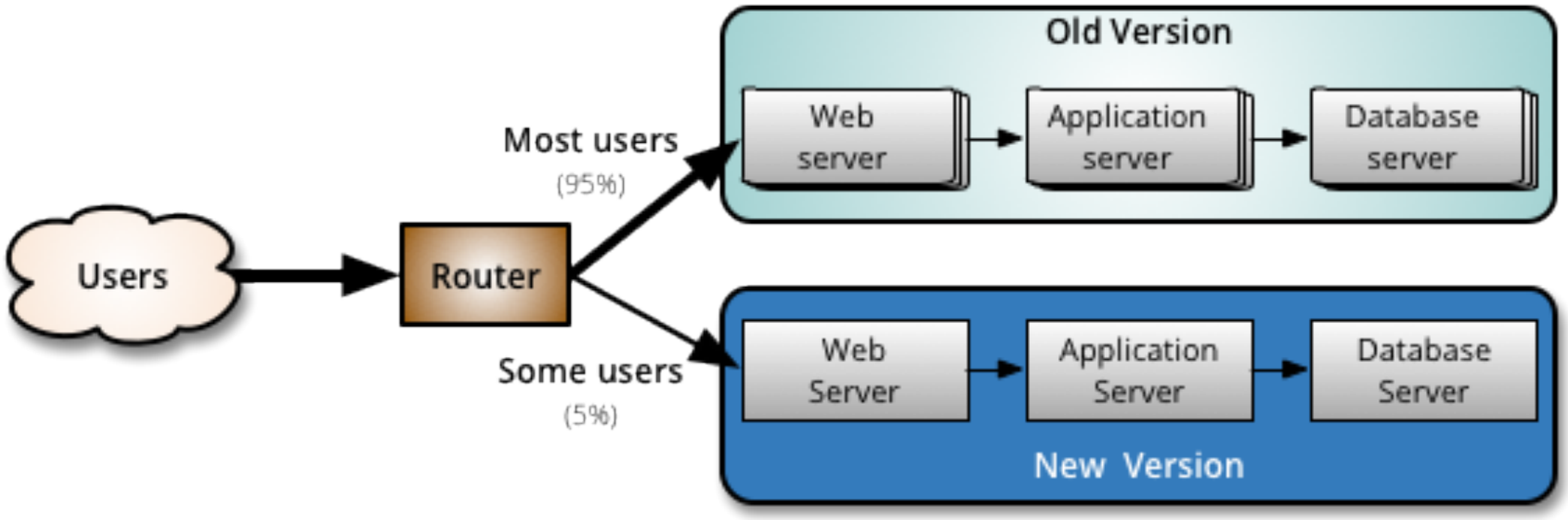
Host	Service	% Utilization	Details
localhost	Root Partition	75.0%	DISK OK - free space: / 1516 MB (21% inode=83%):
ScottsServer	Drive D: Disk Usage	69.4%	D:\ - total: 232.88 Gb - used: 161.71 Gb (69%) - free 71.17 Gb (31%)
ScottsServer	Drive C: Disk Usage	29.1%	C:\ - total: 452.96 Gb - used: 131.70 Gb (29%) - free 321.26 Gb (71%)
vs1.nagios.com	/ Disk Usage	27.0%	DISK OK - free space: / 56392 MB (71% inode=97%):
exchange.nagios.org	/ Disk Usage	6.6%	DISK OK - free space: / 73482 MB (93% inode=98%):

Last Updated: 2014-01-15 13:44:06

Status Grid

Hosts	Services
192.168.5.200	
192.168.5.33	
192.168.5.41	
abc.com	
APC-UPS-27	
arcade.nagios.local	
Business Process	
conference.nagios.lo	
exchange.nagios.org	
firewall	
gateway.nagios.local	
google.com	

Canaries



Monitor both:
But minimize impact of problems in new version

Making it happen

- Build Tools
- Test Automation
- Build Servers
- Deployment Tools

Build Tools

- Need to be able to automate construction of our executable software… Example:
  - "Install d3 with bower with grunt with npm with brew." *phew*
- We talked about it getting a little better with npm (which installs modules), but need something more general to handle build tasks:
  - Minify my code
  - Run my tests
  - Generate some documentation
  - Deploy to staging
- Ensure that builds are repeatable, reproducible and standard

Build tools example: Push to gh-pages

```
grunt.initConfig({
  'gh-pages': {
    options: {
      base: 'dist'
    },
    src: ['**']
  }
});
```

Build Servers

- Once we have a standard mechanism for describing how to build our code, no reason to only build it on our own machine
- Continuous Integration servers run these builds in the cloud
  - Bamboo, Hudson/Jenkins, TravisCI
  - Easy to use - typically monitors your source repository for changes, then runs a build
  - Really helps with organizing tests and results
  - Can scale the build server independently of the rest of your processes

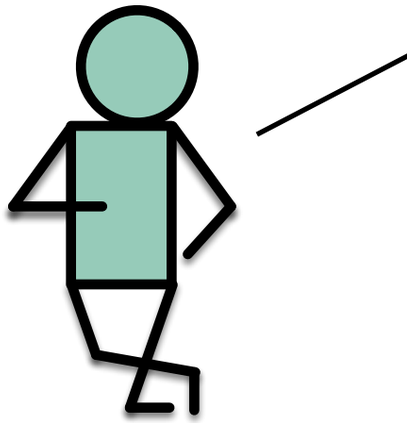
TravisCI

GitHub

Commits code to

Checks for updates

Developer



TravisCI

Runs build for each commit

TravisCI

- Can see history and status of each branch

Travis CI Blog Status Help Jonathan Bell

Search all repositories

My Repositories +

✓ Programming-Systems-Lab/pho #175
Duration: 41 min 31 sec
Finished: 10 days ago

✓ Programming-Systems-Lab/vmv #14
Duration: 1 min 29 sec
Finished: 12 months ago

Programming-Systems-Lab / phosphor build passing

Current Branches Build History Pull Requests More options

Default Branch

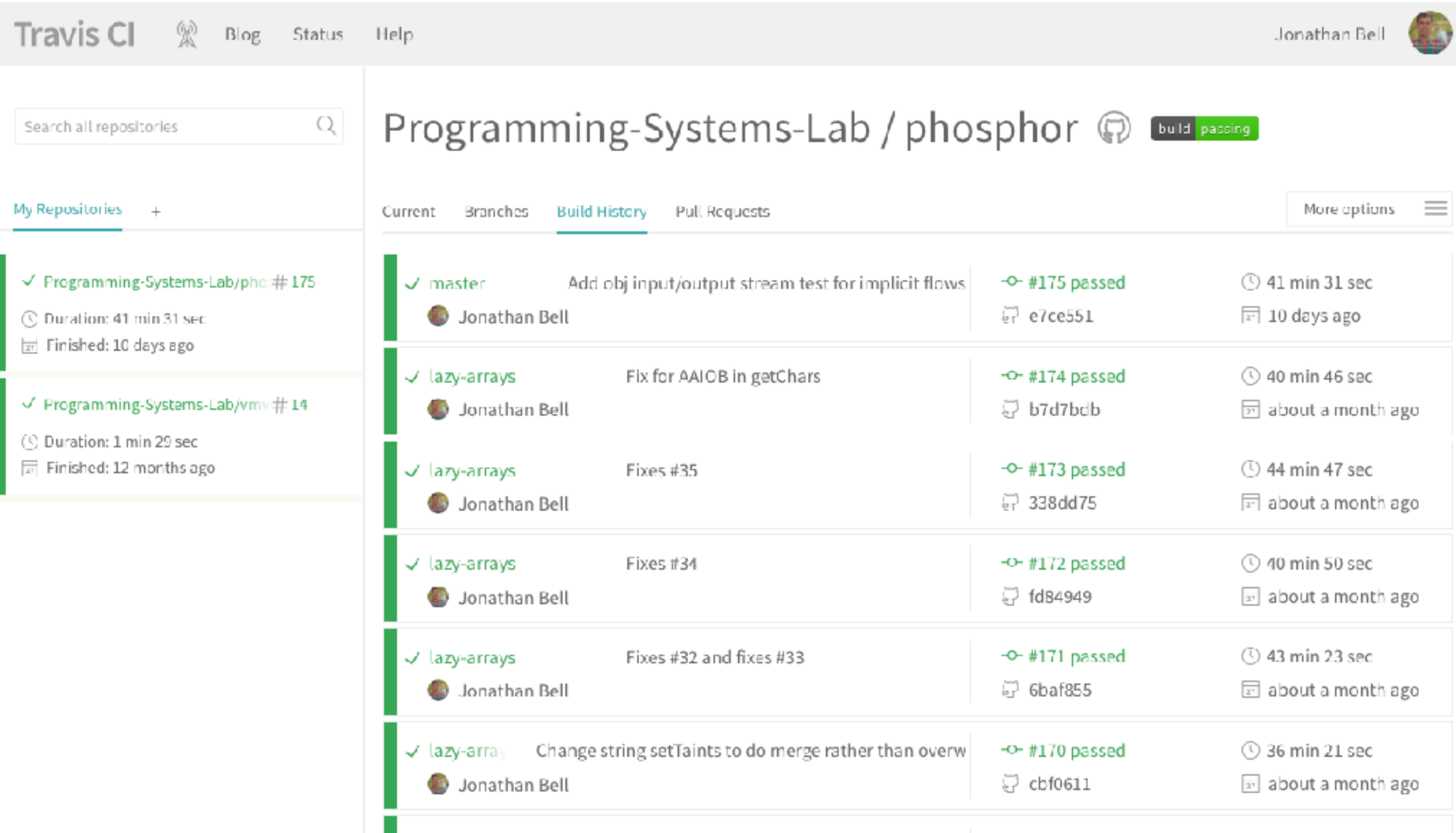
✓ master	#175 passed	e7ce551	✓ ✓ ✓ ✗ ✗
60 builds	10 days ago	Jonathan Bell	

Active Branches

✓ lazy-arrays	#174 passed	b7d7bdb	✓ ✓ ✓ ✓ ✓
14 builds	about a month ago	Jonathan Bell	
✗ dev	#140 failed	0aac6ca	✗ ! ! ! !
23 builds	5 months ago	Jonathan Bell	
✗ lazy-prealloc	#138 failed	eecb2b4	✗
1 builds	5 months ago	Jonathan Bell	

TravisCI

- Can also see status per-commit



Summary

- DevOps: Developers as Operators
- Continuous Integration & Deployment: Techniques for reducing time to get features out the door
- Staging environments reduce risk
- Build Systems and Services help automate CI