Deployment

SWE 432, Fall 2019

Design and Implementation of Software for the Web

Today

- Midterm review
- Big picture: from ideas to great 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/

Midterm Review

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 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.

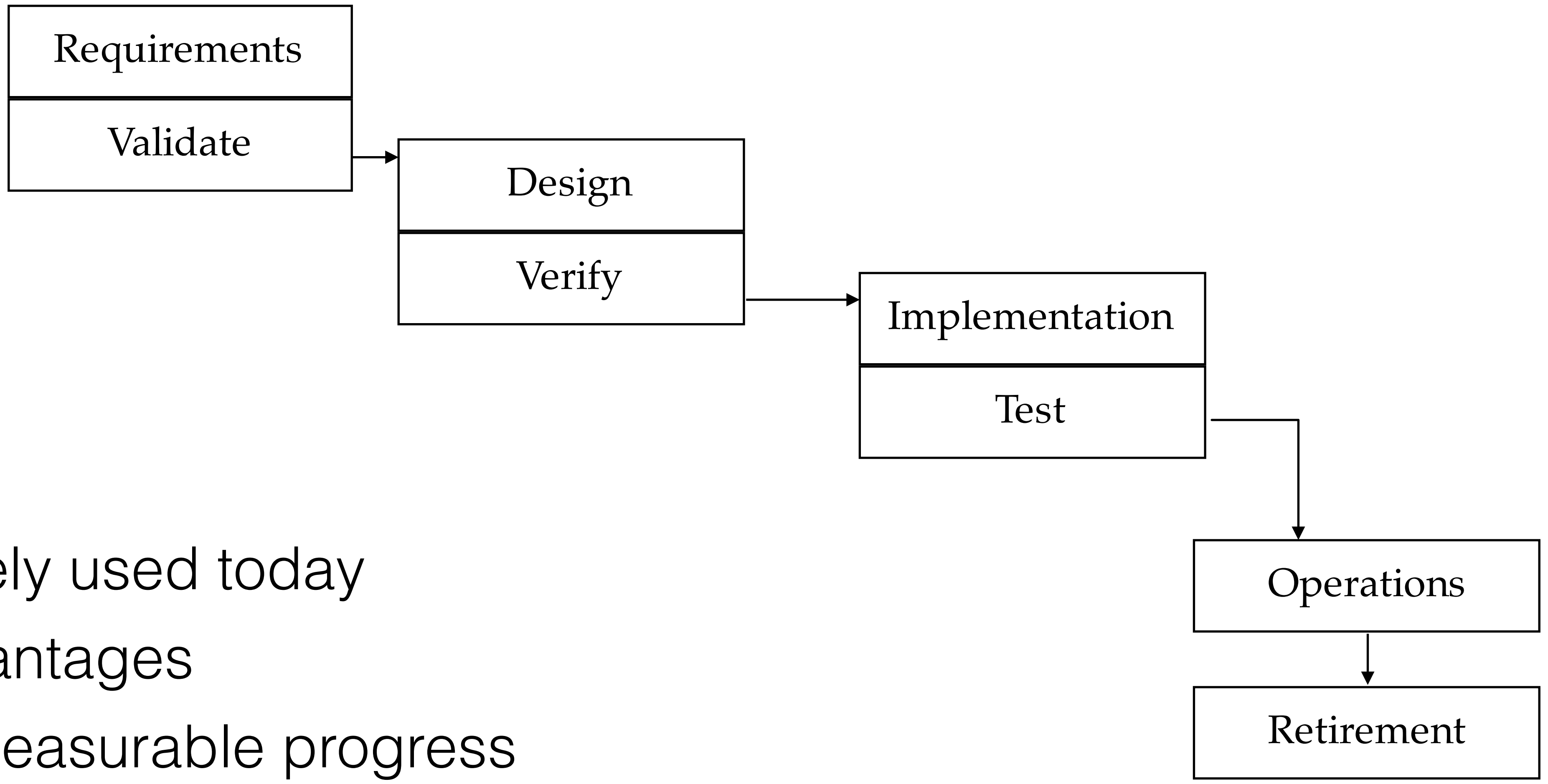
Software Evolution

- 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

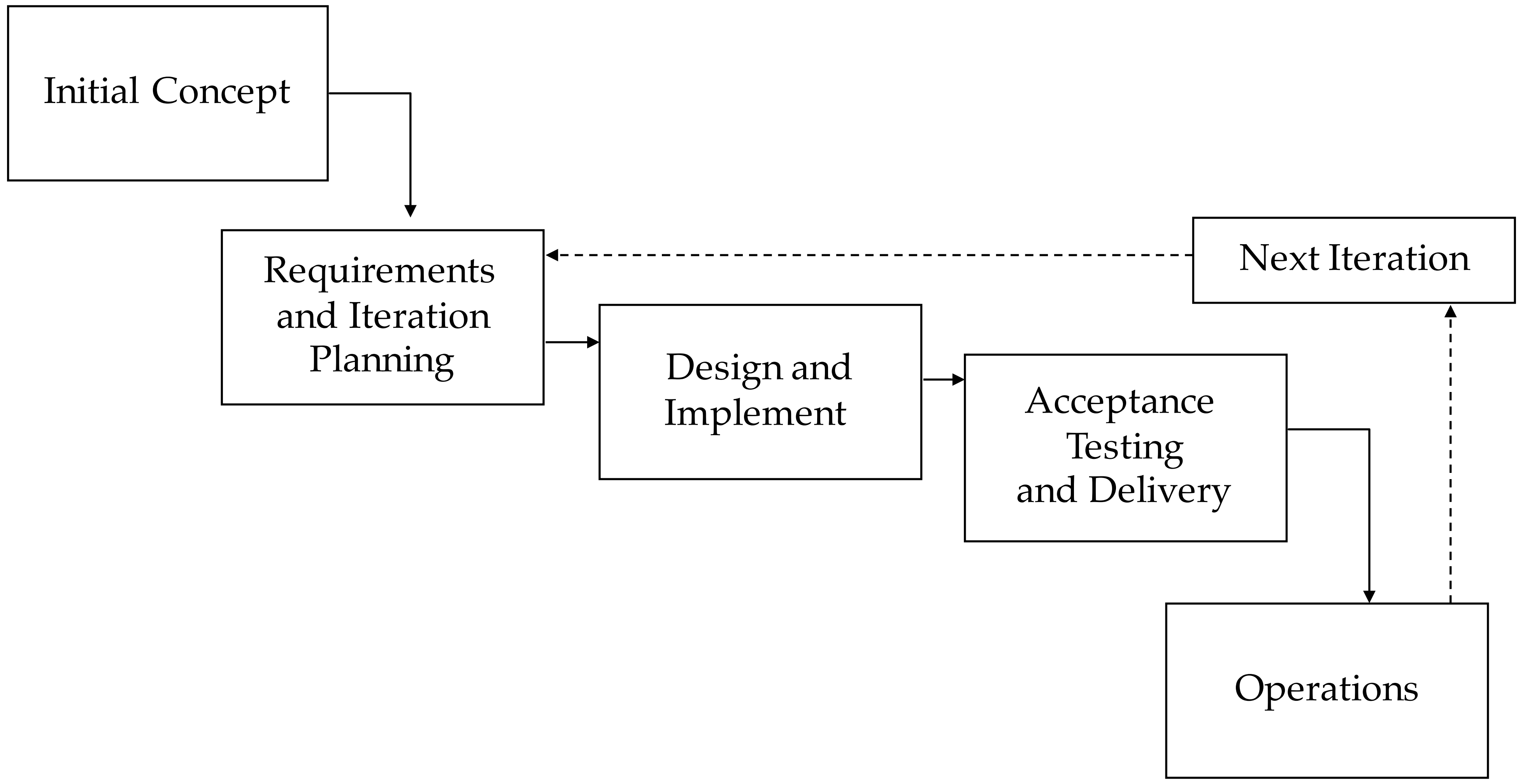
- If we say that building software requires:
  - Specification
  - Design/Implementation
  - Validation
  - Evolution
- How do we structure our organization/development teams/tasks to do this most efficiently?

Waterfall Model



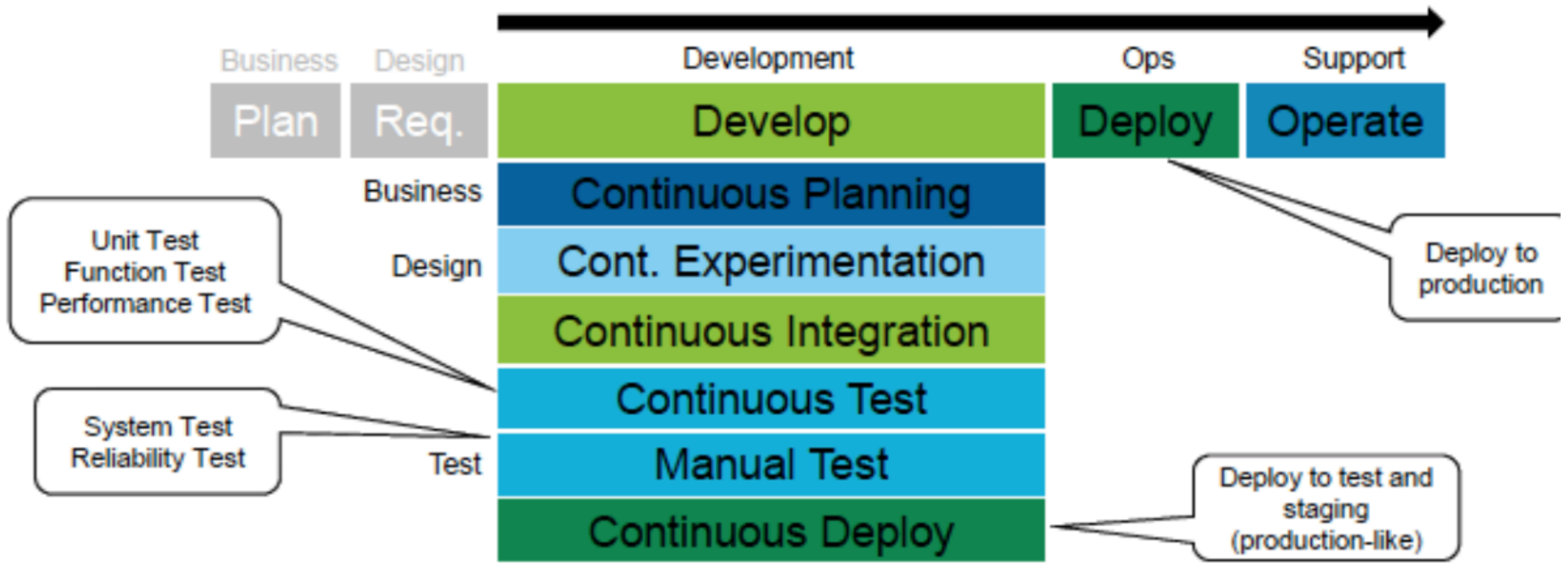
- Widely used today
- Advantages
    - Measurable progress
    - Experience applying steps in past projects can be used in estimating duration of “similar” steps in future projects
    - Produces software artifacts that can be re-used in other projects
- Disadvantages
    - Difficulty of accommodating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

Agile Model


Initial Concept
Requirements and Iteration Planning
Design and Implement
Acceptance Testing and Delivery
Operations
Next Iteration

- 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

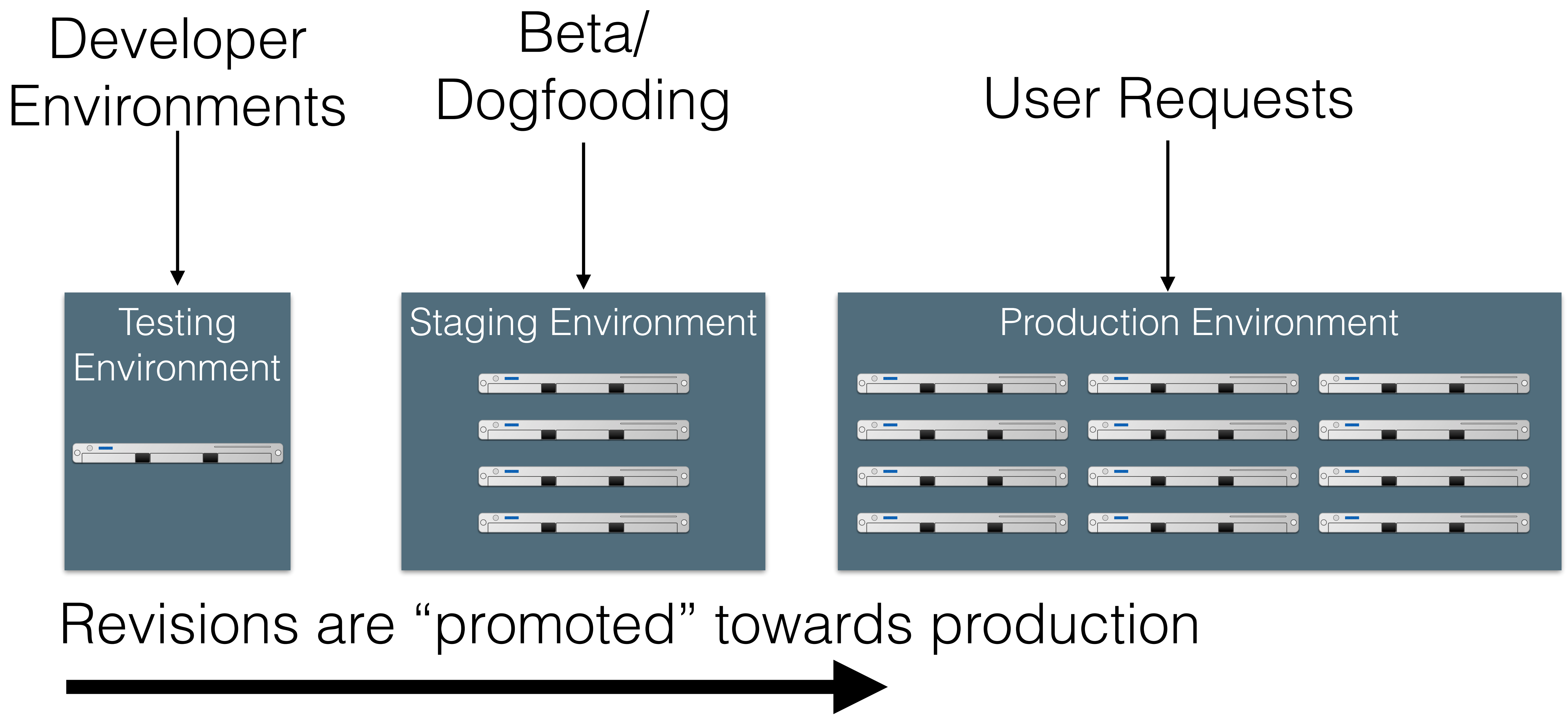


- Like agile, but…
  - We are always working on different features
  - We have a formal mechanism for deploying new versions of code and validating (test/staging/production)

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



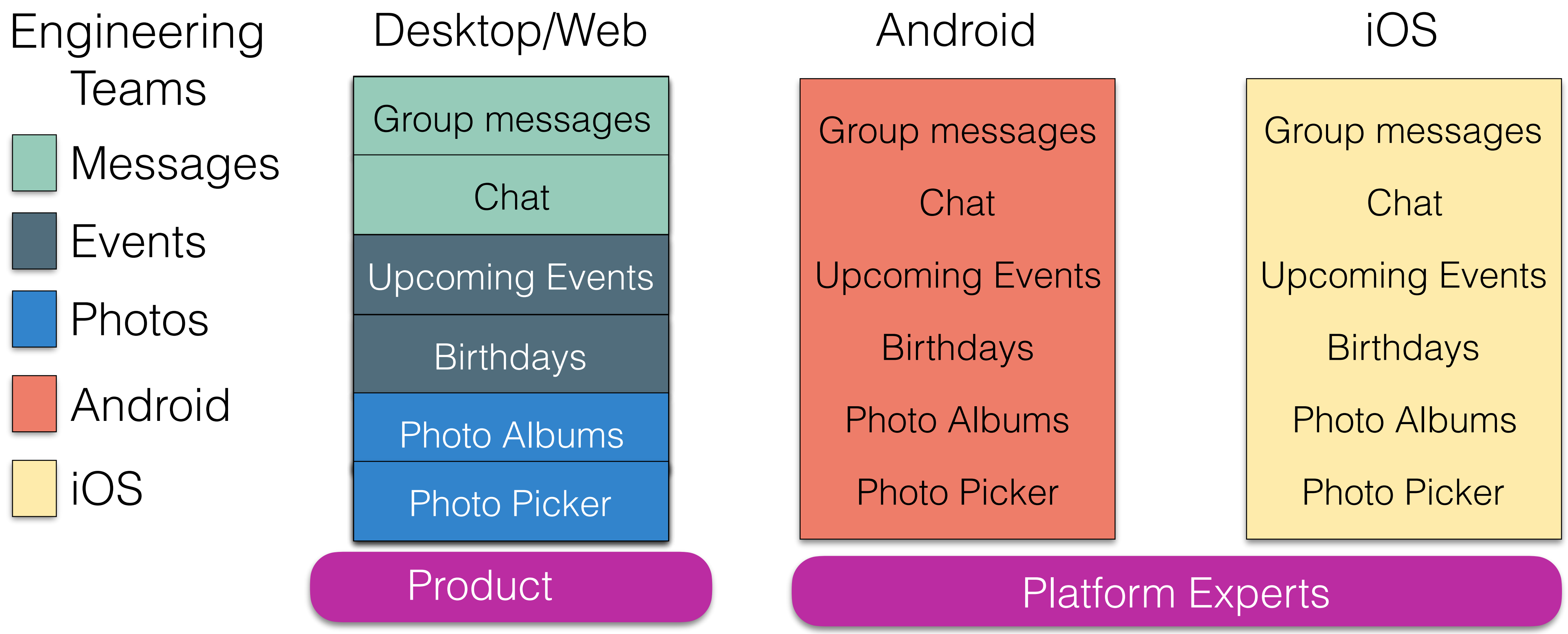
Operations Responsibility

- 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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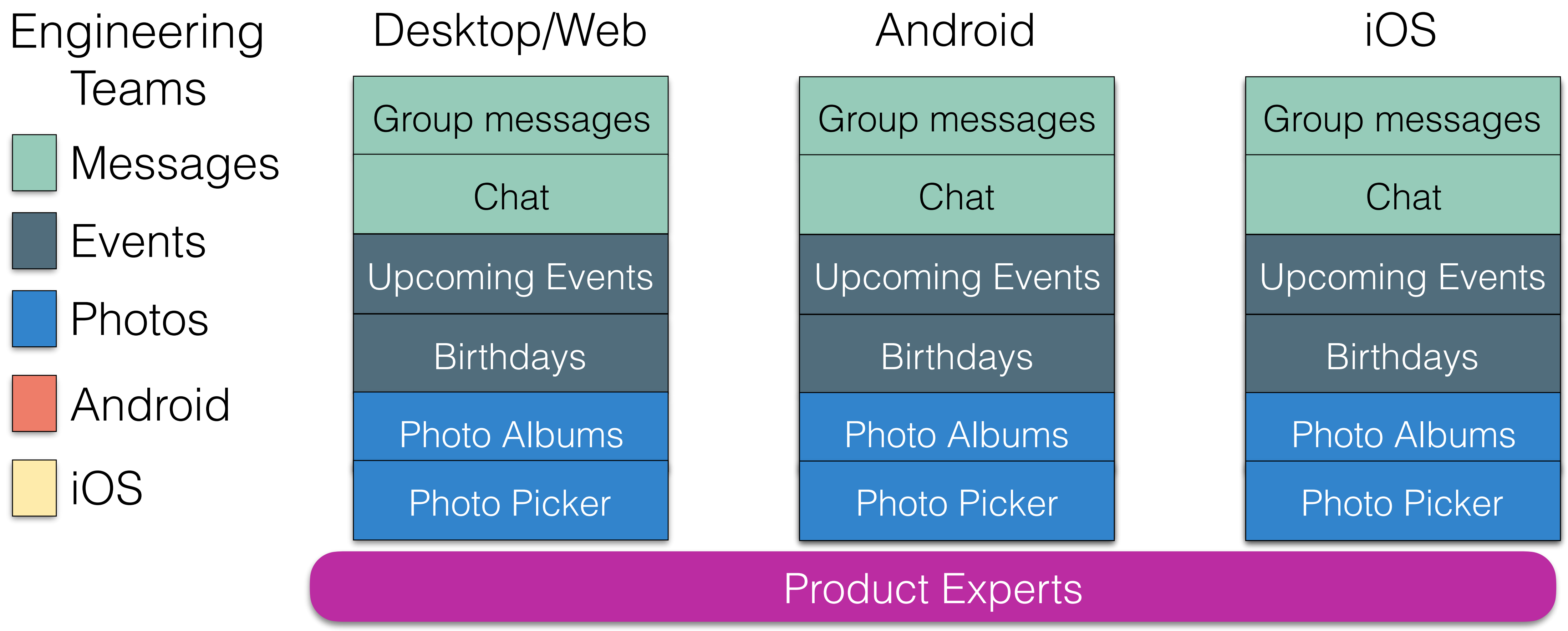
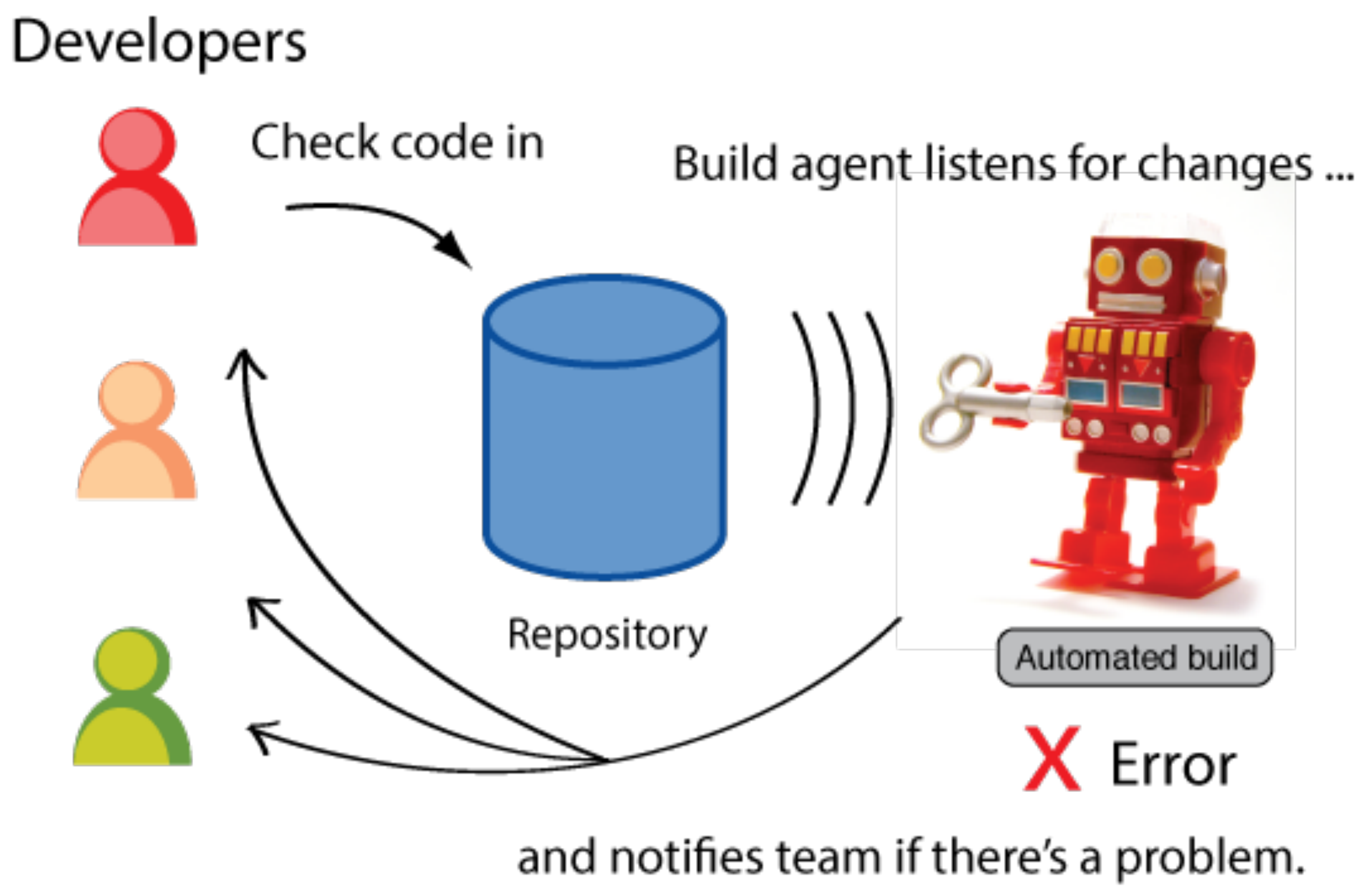


Continuous X

- 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.

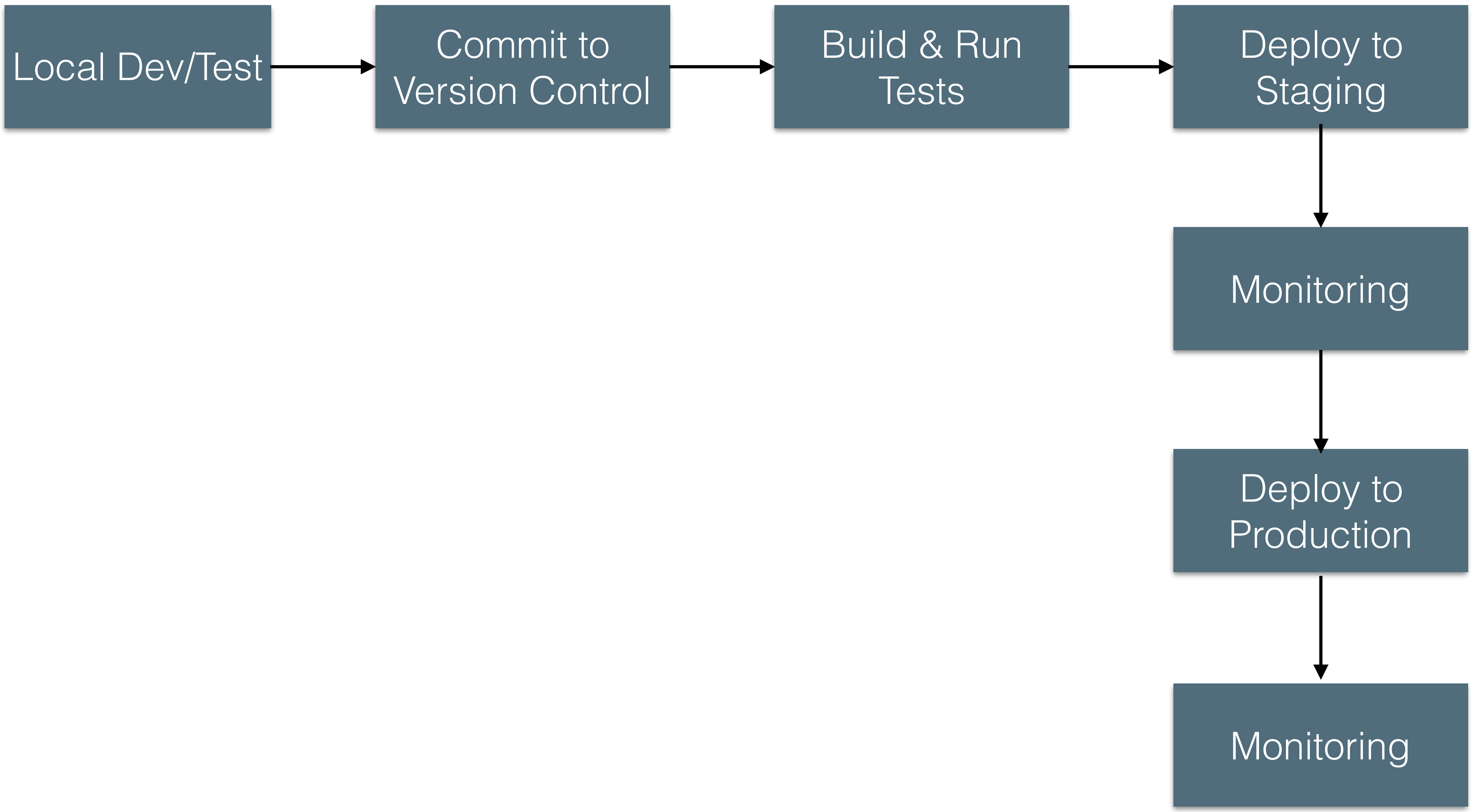
Continuous Integration


Developers
Check code in
Build agent listens for changes ...
Repository
Automated build
X Error
and notifies team if there's a problem.

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

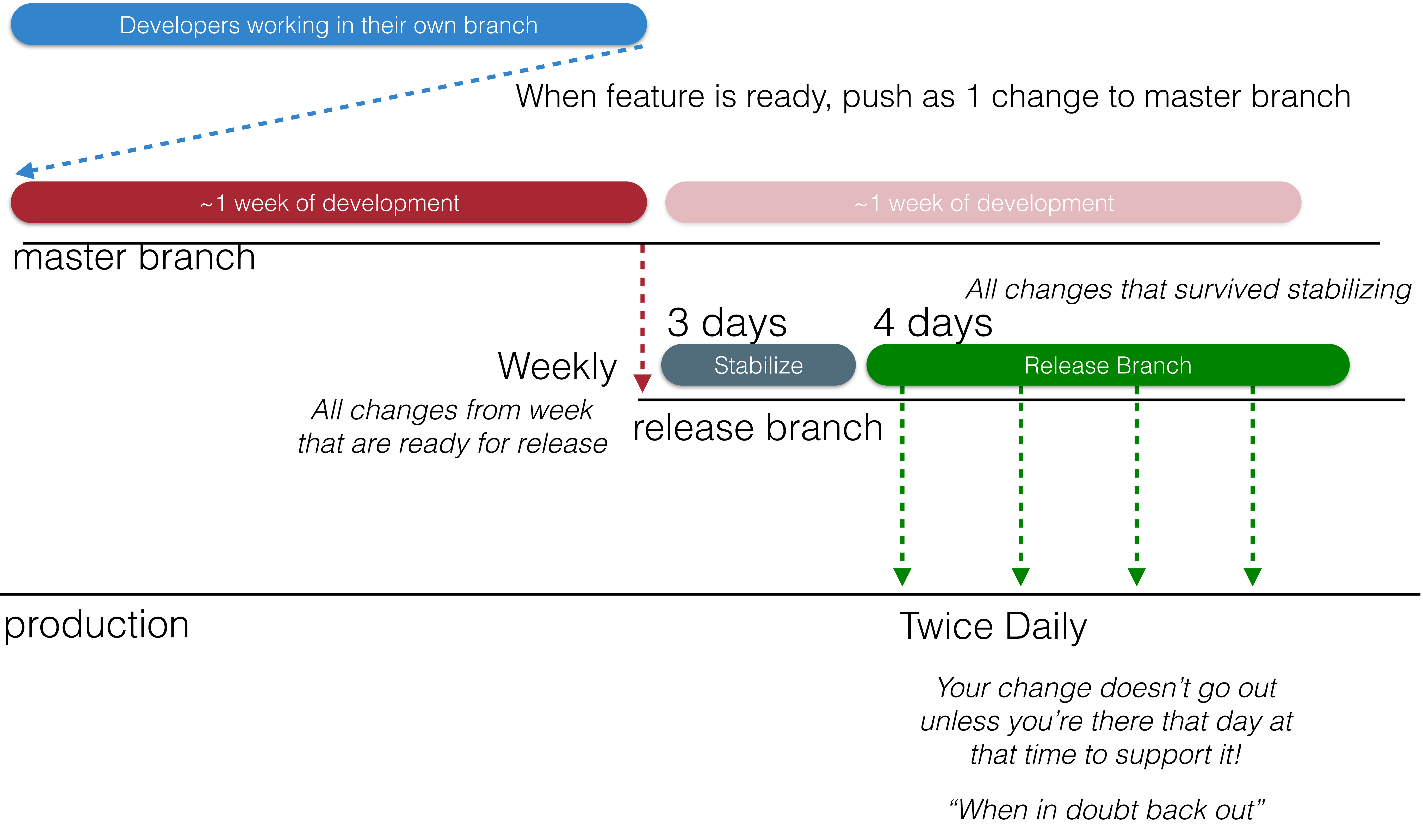
Deployment Pipeline



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



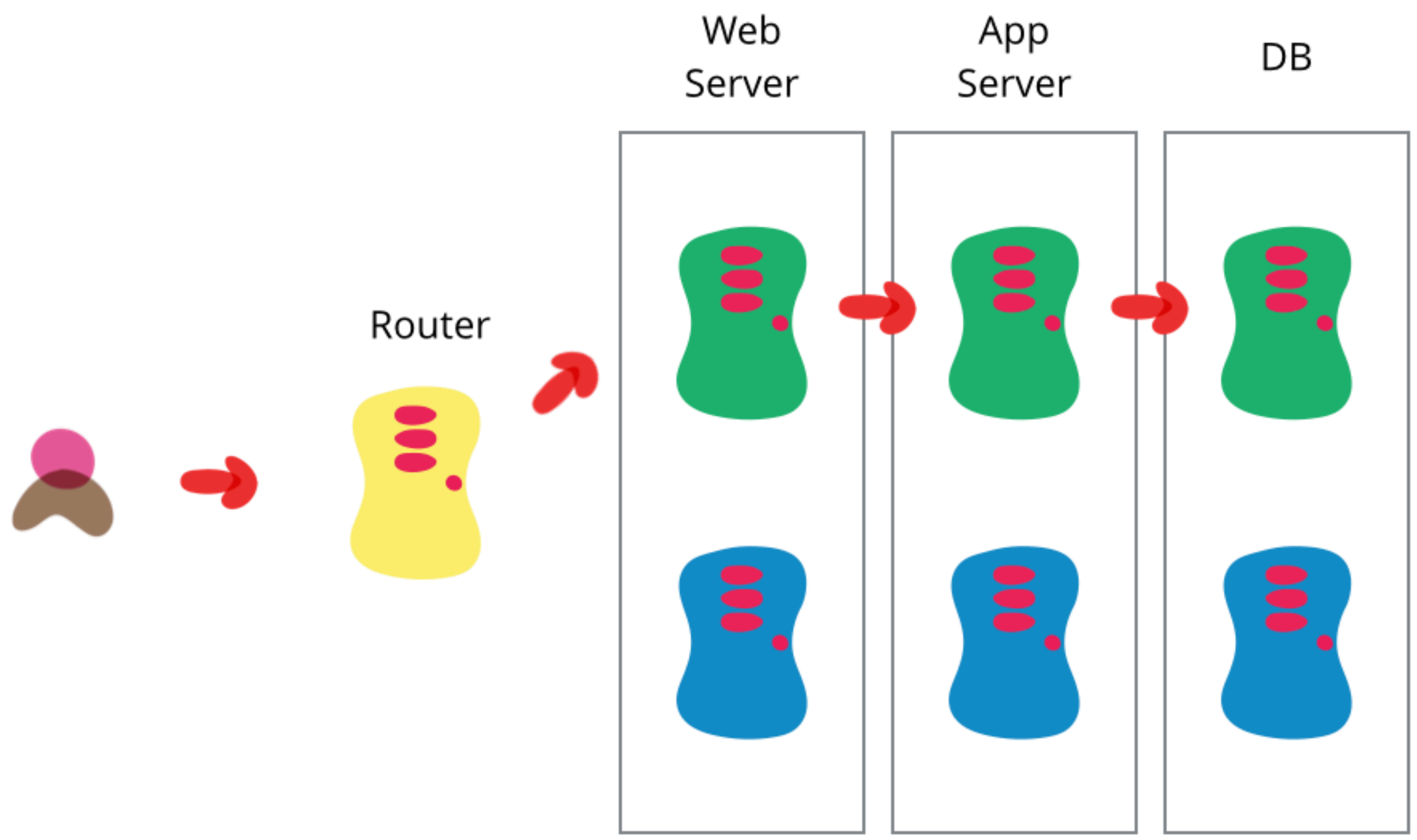
Developers working in their own branch
When feature is ready, push as 1 change to master branch
~1 week of development
~1 week of development
master branch
All changes that survived stabilizing
3 days
4 days
Weekly
Stabilize
Release Branch
All changes from week that are ready for release
release branch
production
Twice Daily
Your change doesn't go out unless you're there that day at that time to support it!
"When in doubt back out"

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

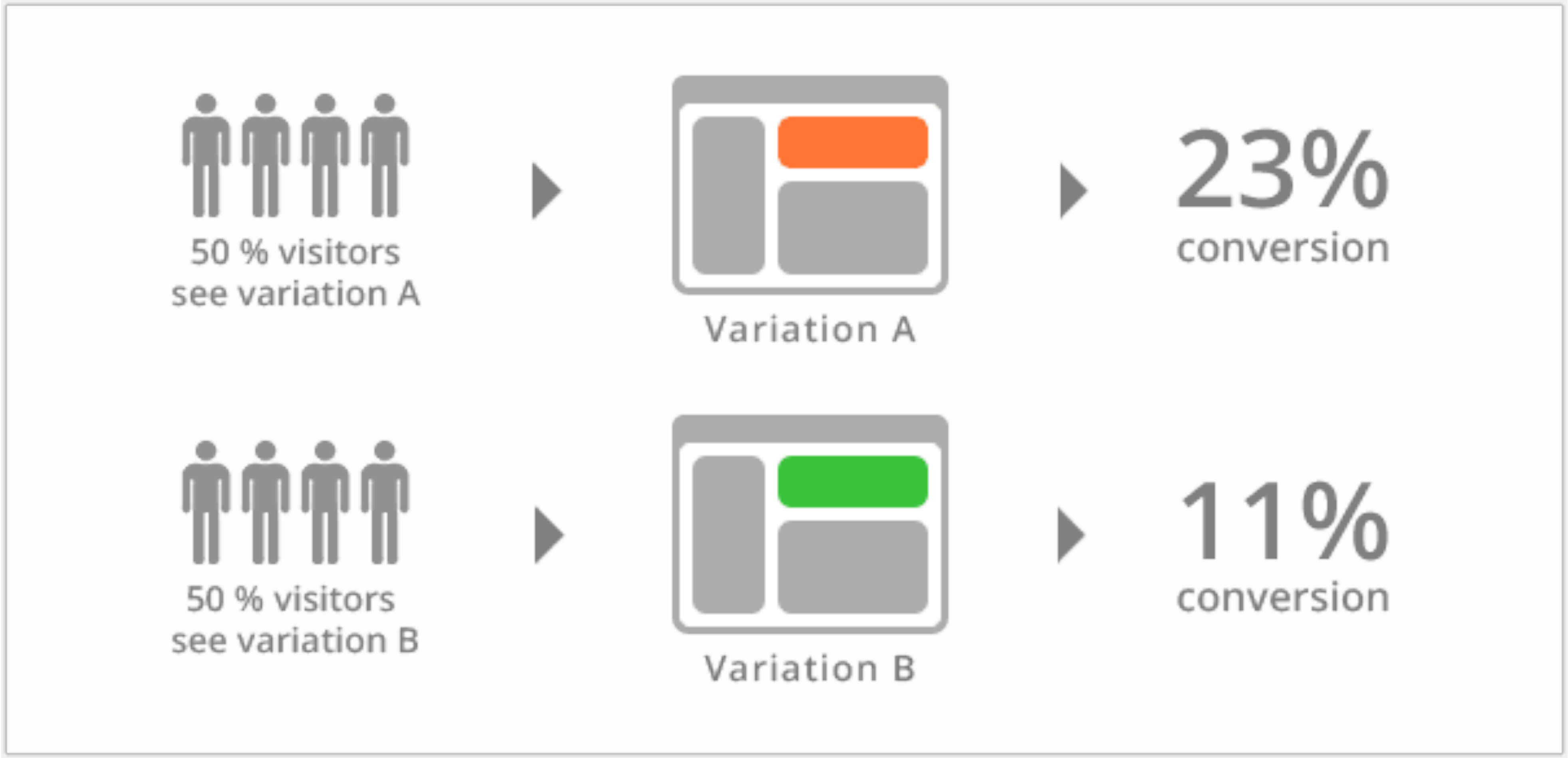
Blue-Green Deployment

- 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

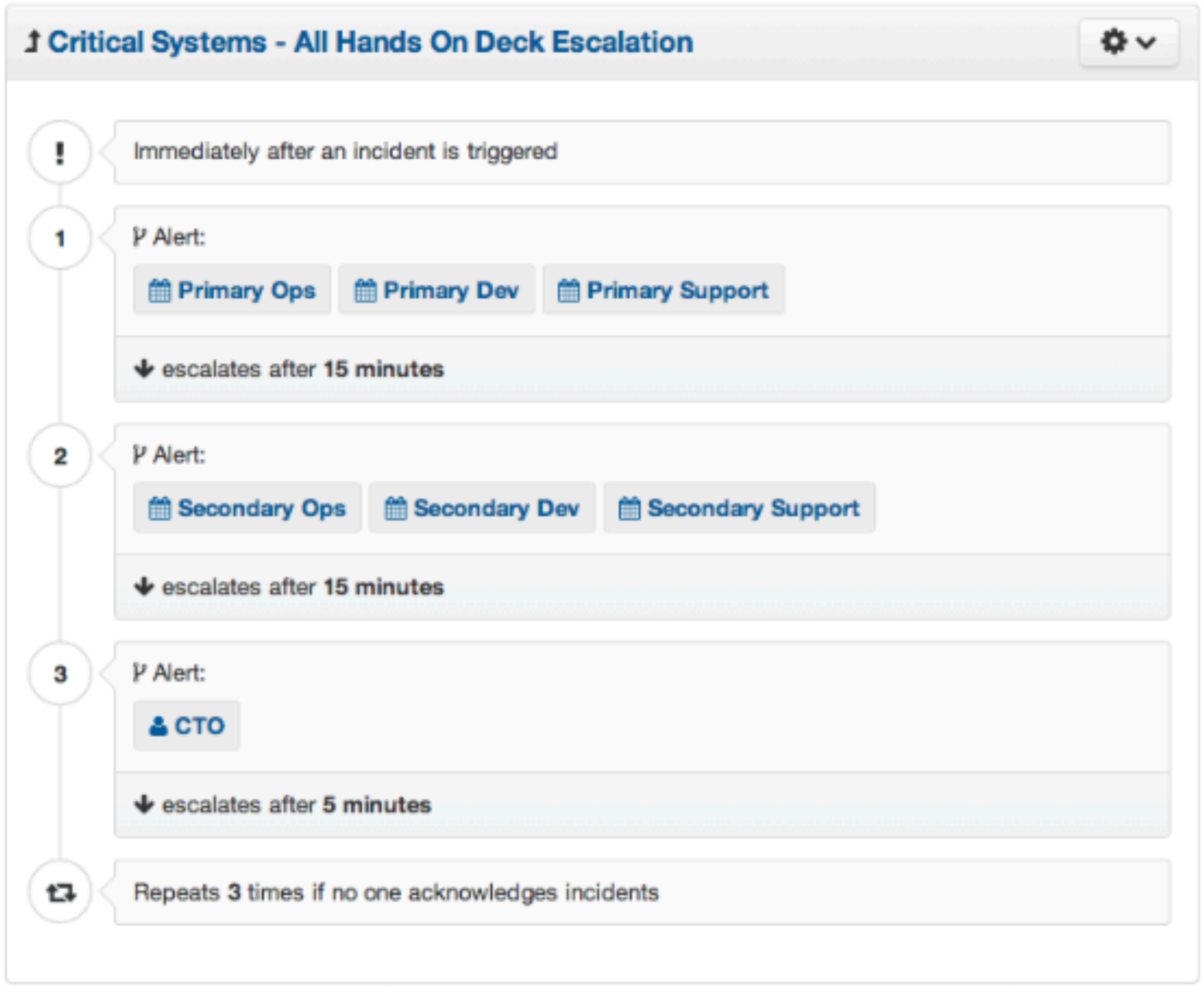


Monitoring

- 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 things go wrong

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


Critical Systems - All Hands On Deck Escalation

Immediately after an incident is triggered

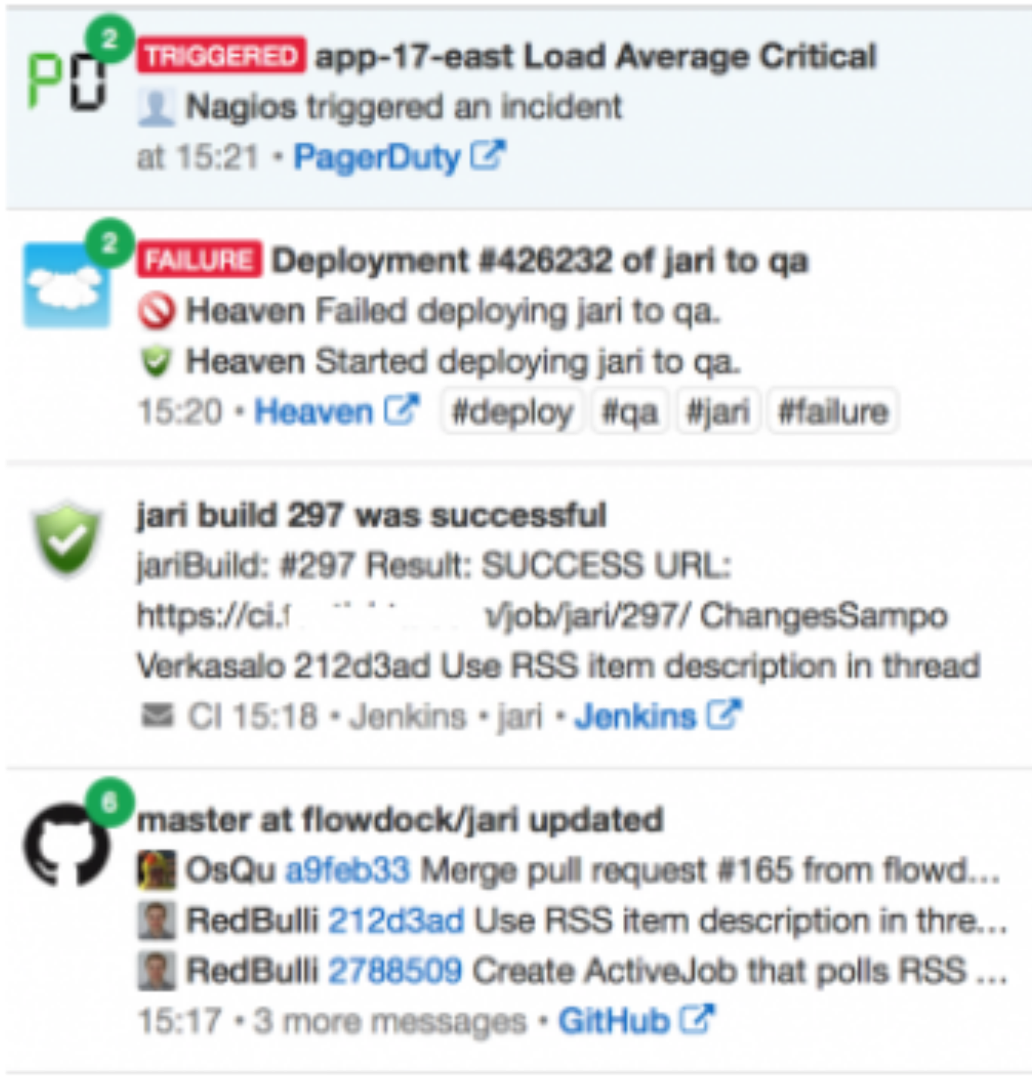
1 Alert: Primary Ops, Primary Dev, Primary Support
escalates after **15 minutes**

2 Alert: Secondary Ops, Secondary Dev, Secondary Support
escalates after **15 minutes**

3 Alert: CTO
escalates after **5 minutes**

Repeats **3** times if no one acknowledges incidents

Monitoring Dashboards

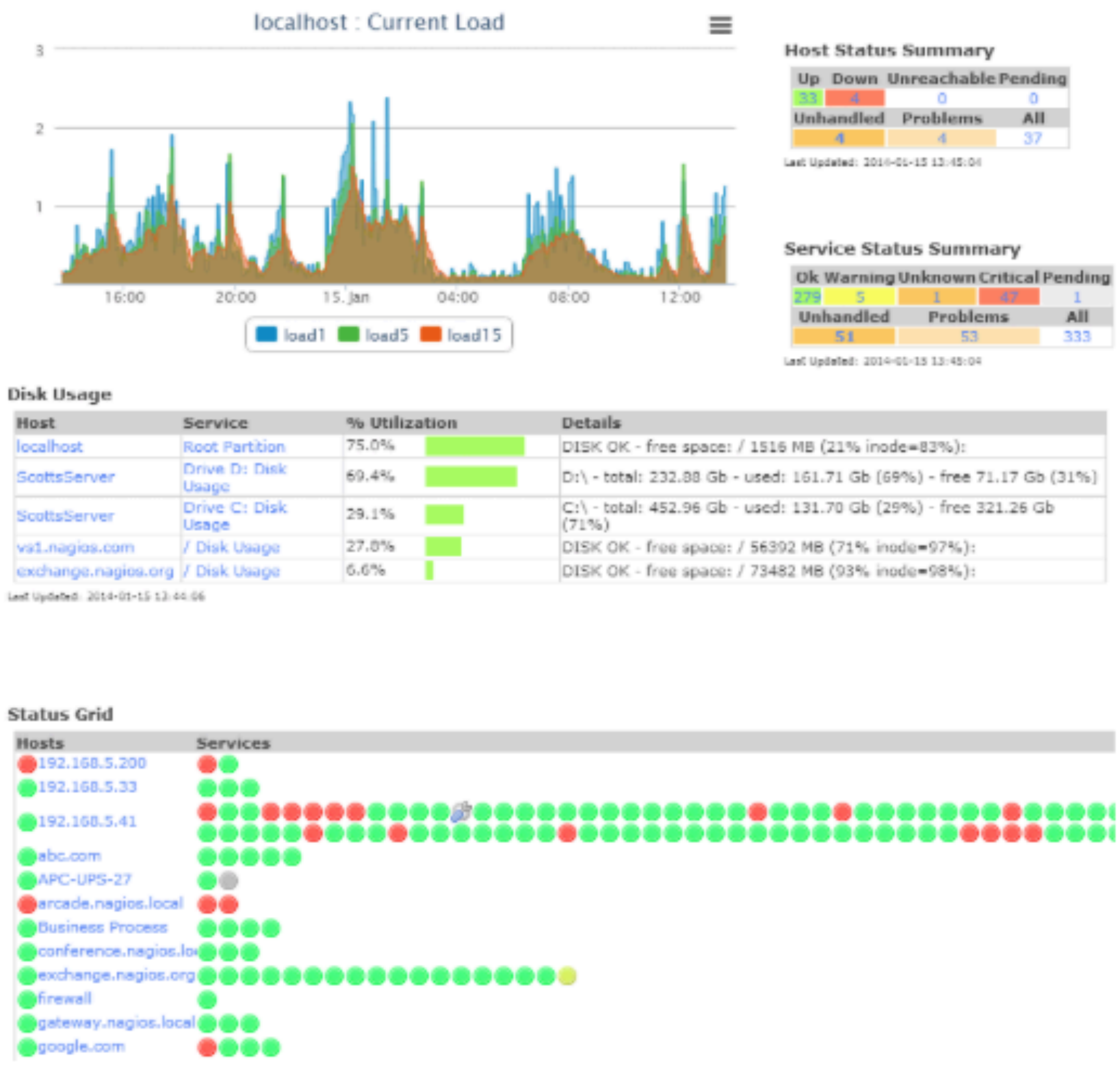


TRIGGERED app-17-east Load Average Critical
Nagios triggered an incident
at 15:21 · PagerDuty

FAILURE Deployment #426232 of jari to qa
Heaven Failed deploying jari to qa.
Heaven Started deploying jari to qa.
15:20 · Heaven #deploy #qa #jari #failure

jari build 297 was successful
jariBuild: #297 Result: SUCCESS URL: https://ci.f[illegible]v/job/jari/297/ ChangesSampo Verkasalo 212d3ad Use RSS item description in thread
CI 15:18 · Jenkins · jari · Jenkins

master at flowdock/jari updated
OsQu a9feb33 Merge pull request #165 from flowd...
RedBulli 212d3ad Use RSS item description in thre...
RedBulli 2788509 Create ActiveJob that polls RSS ...
15:17 · 3 more messages · GitHub



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

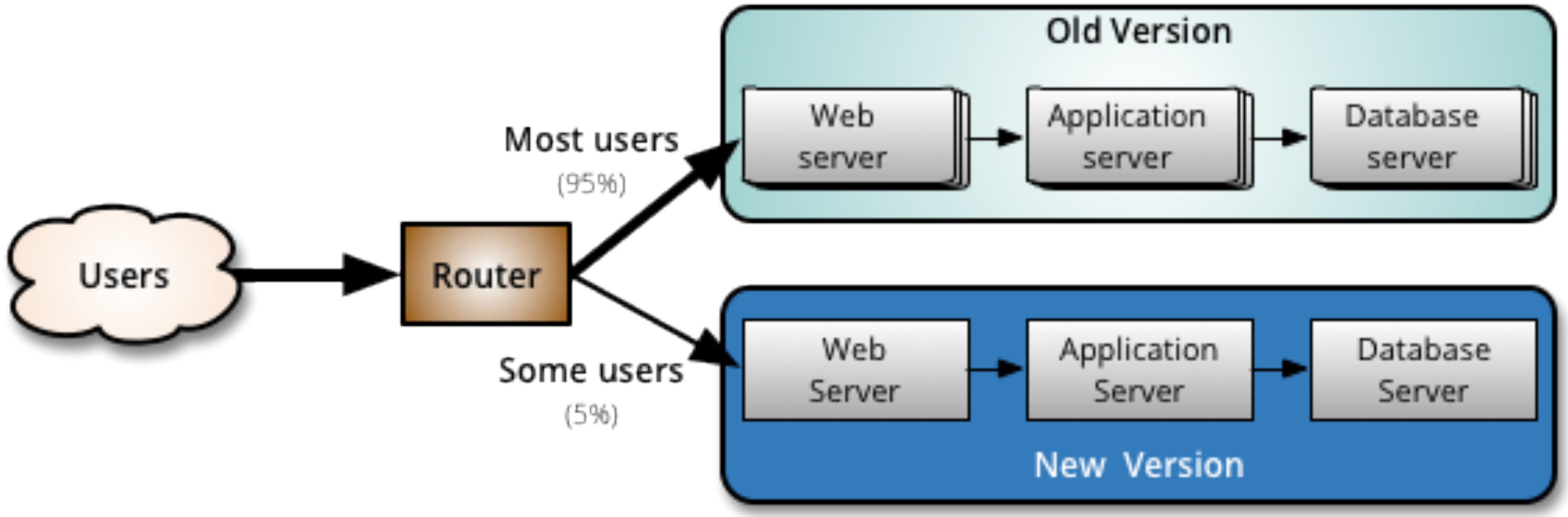
Host	Service	% Utilization	Details
localhost	Root Partition	75.0%	DISK OK - free space: / 1516 MB (21% inode=83%):
ScottsServer	Drive D: Disk Usage	69.4%	D:\ - total: 232.88 Gb - used: 161.71 Gb (69%) - free 71.17 Gb (31%)
ScottsServer	Drive C: Disk Usage	29.1%	C:\ - total: 452.96 Gb - used: 131.70 Gb (29%) - free 321.26 Gb (71%)
va1.nagios.com	/ Disk Usage	27.8%	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

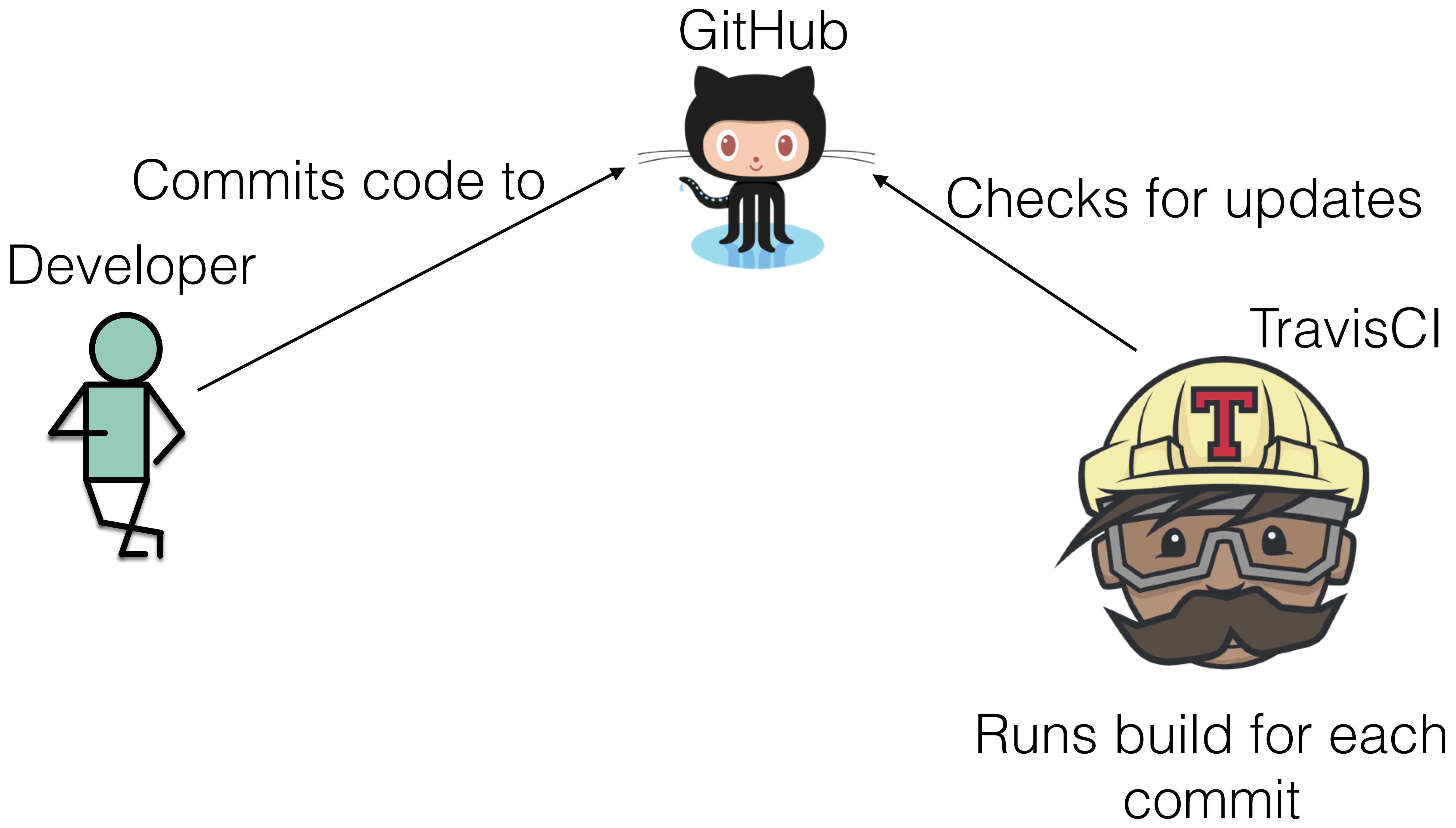
Build Tools

- Need to be able to automate construction of our executable software… Example:
    - “Install d3 with bower with grunt with npm with brew.” *phew*
- We'd like a general method for describing and executing build tasks:
    - Minify my code
    - Run my tests
    - Generate some documentation
    - Deploy to staging
- Ensure that builds are repeatable, reproducible and standard

Build Servers

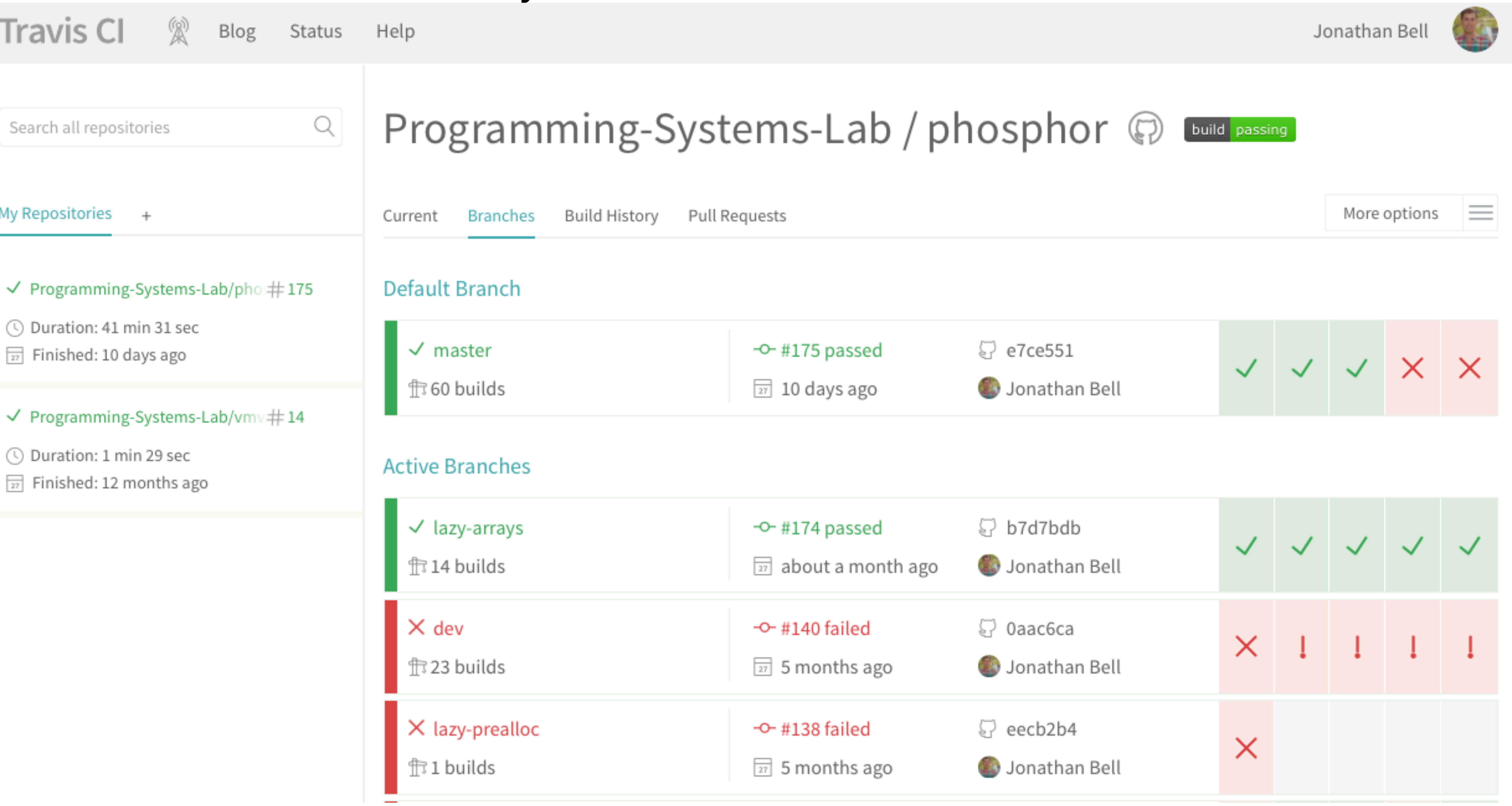
- Once we have a standard mechanism for describing how to build our code, no reason to only build it on our own machine
- Continuous Integration servers run these builds in the cloud
    - Bamboo, Hudson/Jenkins, TravisCI
- Easy to use - typically monitors your source repository for changes, then runs 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
Developer
Checks for updates
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

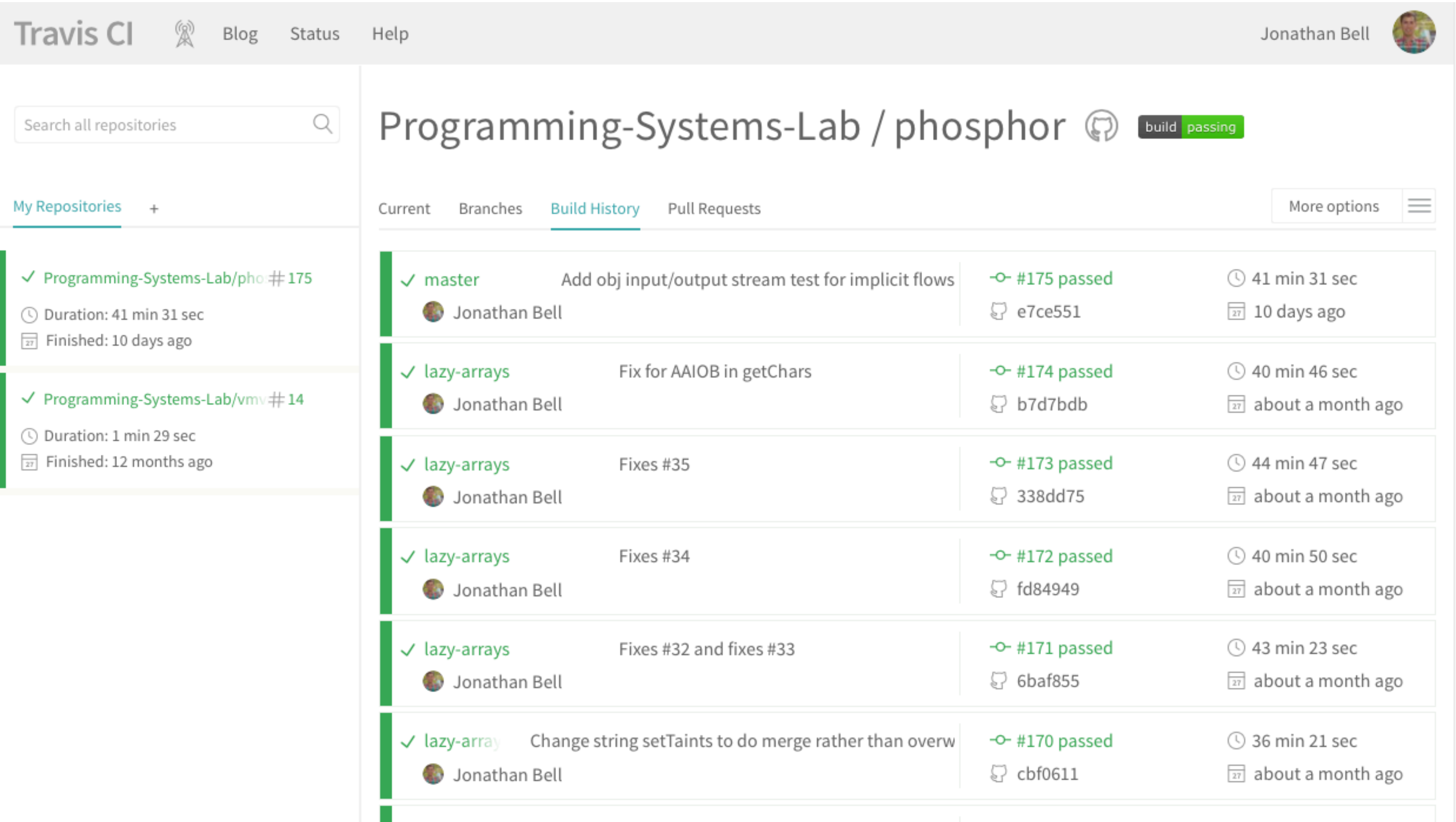
✓ master 60 builds	#175 passed 10 days ago	e7ce551 Jonathan Bell	✓	✓	✓	✗	✗

Active Branches

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

TravisCI

- Can also see status per-commit



Programming-Systems-Lab / phosphor

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Duration: 41 min 31 sec
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Duration: 1 min 29 sec
Finished: 12 months ago

Branch	Commit message	Author	Build	Commit	Duration	Finished
✓ master	Add obj input/output stream test for implicit flows	Jonathan Bell	#175 passed	e7ce551	41 min 31 sec	10 days ago
✓ lazy-arrays	Fix for AAIOB in getChars	Jonathan Bell	#174 passed	b7d7bdb	40 min 46 sec	about a month ago
✓ lazy-arrays	Fixes #35	Jonathan Bell	#173 passed	338dd75	44 min 47 sec	about a month ago
✓ lazy-arrays	Fixes #34	Jonathan Bell	#172 passed	fd84949	40 min 50 sec	about a month ago
✓ lazy-arrays	Fixes #32 and fixes #33	Jonathan Bell	#171 passed	6baf855	43 min 23 sec	about a month ago
✓ lazy-arra	Change string setTaints to do merge rather than overw	Jonathan Bell	#170 passed	cbf0611	36 min 21 sec	about a month ago

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