Continuous Integration, Delivery and Deployment

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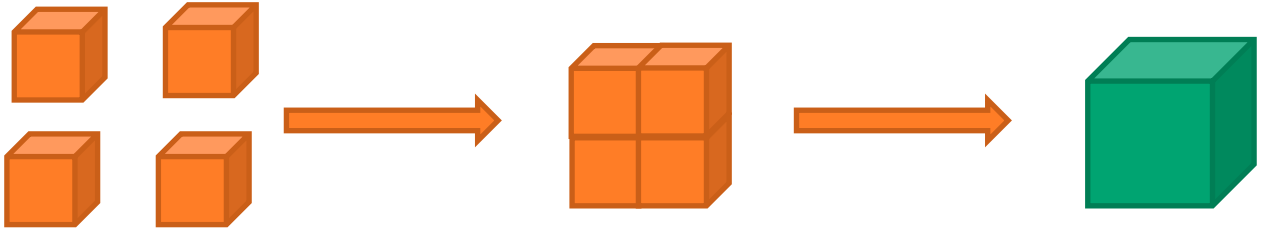
System Integration

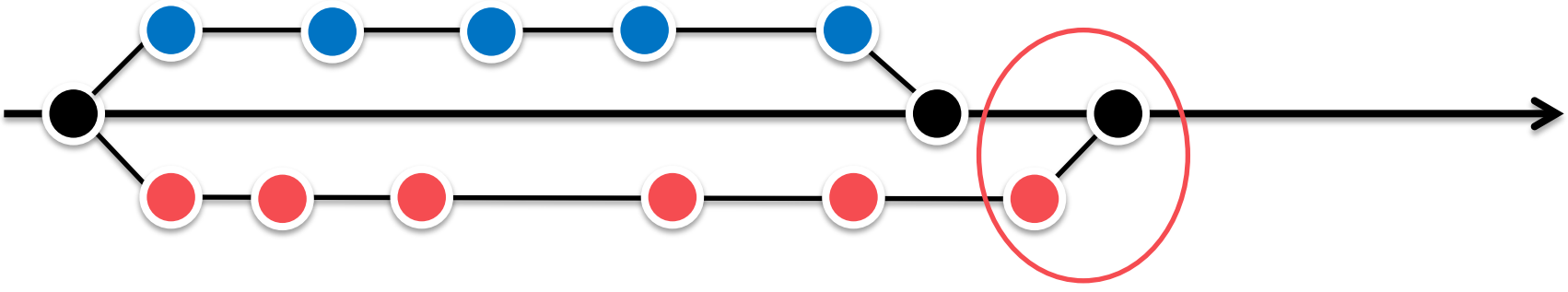
In engineering, **system integration** is defined as the process of **bringing together** the component subsystems and **ensuring that** the subsystems **function together** as a system.

https://en.wikipedia.org/wiki/System_integration



Software Integration

- System Integration
- Change Integration: Merging



Integration Conflicts

- **Merge Conflicts**
  - Detected by version control software
- **Semantic Conflicts**
  - Detected by compiler, tests and code review

http://martinfowler.com/bliki/SemanticConflict.html

Regression Testing

The purpose of **regression testing** is to ensure that **changes** have not introduced **new faults**.

Experience has shown that **as software is changed, emergence of new faults** and/or re-emergence of old faults **is quite common**.

https://en.wikipedia.org/wiki/Regression_testing

History of Software Integration and Regression Testing

- **Prehistory: Big Bang Integration**
- **1996: Daily Build and Smoke Test** (Steve McConnell)
- **2000: XP and Continuous Integration** (Kent Beck)
- **2006: Continuous Integration** (Martin Fowler)
- **2009: Continuous Deployment** (Timothy Fitz)
- **2010: Continuous Delivery** (Jez Humble & David Farley)
- **2012: Experiment System** (Holmström Olsson et al.)

Big Bang Integration

- **System Integration**
  - Develop subsystems independently, integrate when ready
- **Change Integration**
  - Develop changes in branches, merge when ready

Big Bang Integration

“We entered a huge depressing warehouse stacked full with cubes.

I was told that this project had been in development for a couple of years and was currently integrating, and had been integrating for several months.

My guide told me that nobody really knew how long it would take to finish integrating.

From this I learned a common story of software projects: integration is a long and unpredictable process.”

http://www.martinfowler.com/articles/continuousIntegration.html

Big Bang Integration

- **Development** is **simple**, because **nothing is changing**
- **Integration** is **complex** and takes **unpredictable time**

Daily Build and Smoke Test

Prospecting for programmer's gold.

IF YOU WANT TO CREATE A SIMPLE COMPUTER program consisting of only one file, you merely need to compile and link that one file. On a typical team project involving dozens, hundreds, or even thousands of files, however, the process of creating an executable program becomes more complicated and time consuming. You must "build" the program from its various components.

A common practice at Microsoft and some other shrink-wrap software companies is the "daily build and smoke test" process. Every file is compiled, linked, and combined into an executable program every day, and the program is then put through a "smoke test," a relatively simple check to see whether the product "smokes" when it runs.

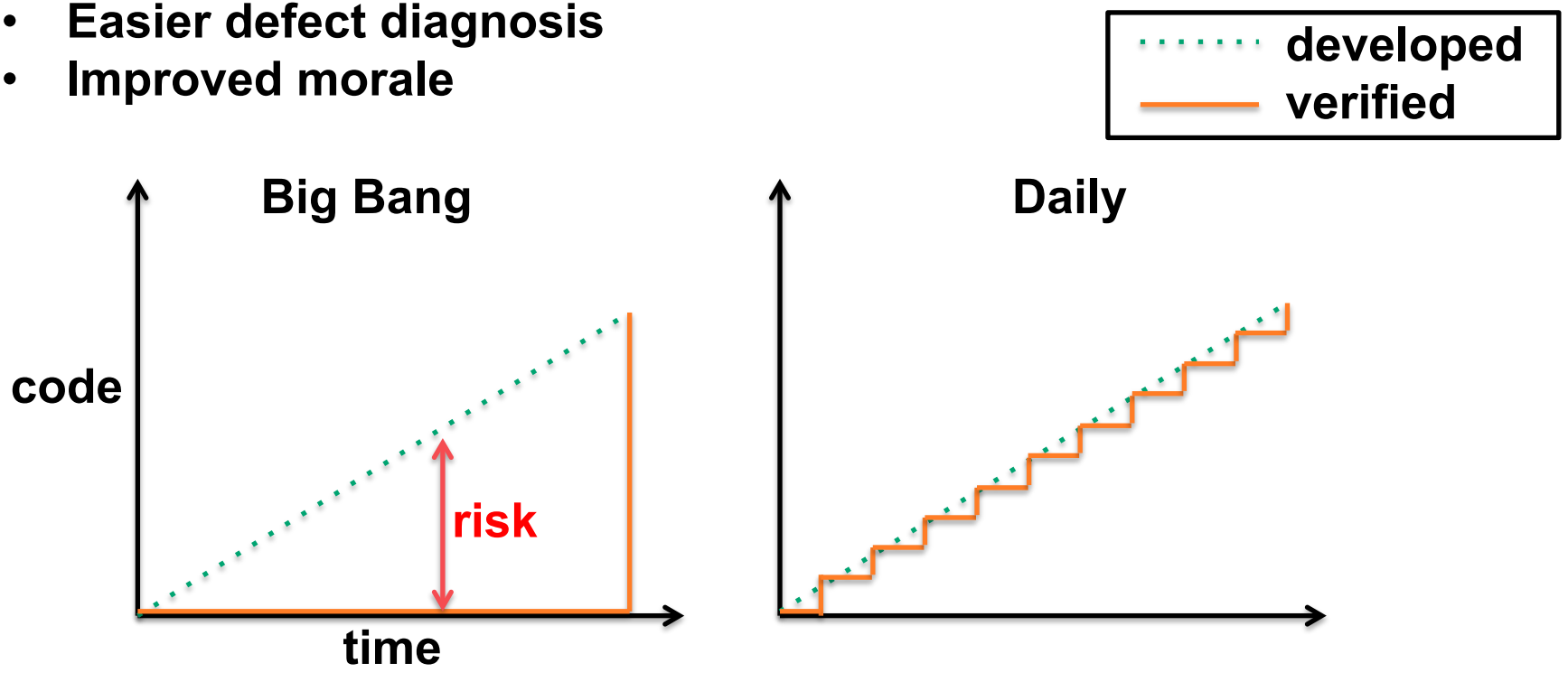
1996: Daily Build and Smoke Test

- Build and smoke test the whole software system daily
- Fix broken builds
- “Integrate… usually once every few days”

McConnell, S., 1996. Daily build and smoke test. IEEE software 143–144.

Daily Build and Smoke Test

- Minimizes integration and low quality risk
- Easier defect diagnosis
- Improved morale



Daily Build and Smoke Test

- Context of large systems
- Tests allowed to take multiple hours
- Timed builds
- Smoke tests evolve when the system evolves
- Dedicated roles take care of the build

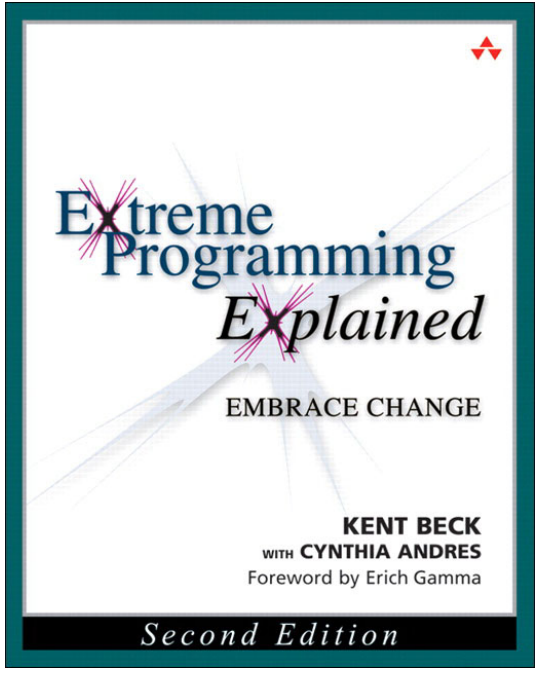
Daily Build and Smoke Test

"The smoke test should be **thorough enough** that if the build passes, you can assume that it is stable enough **to be tested more thoroughly**."

"The standard needs to set a quality level that's strict enough to **keep showstopper defects out** but lenient enough to **disregard trivial defects**, an undue attention to which could **paralyze progress**."

2000: Extreme Programming

- **Holistic software development methodology**
- **Continuous Integration, one of the many practices**



Beck, K., 2000. Extreme programming explained: embrace change. Addison-Wesley Professional.

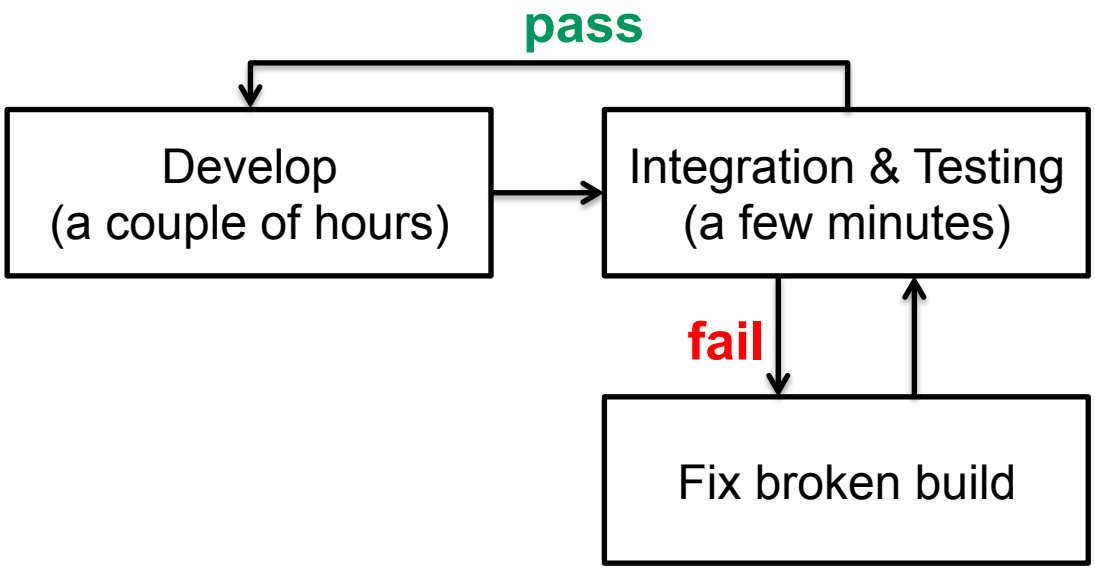
Extreme Programming and Continuous Integration

“No code sits unintegrated for more than **a couple of hours**.”

“At the end of every development episode, the code is integrated and **all the tests** must run at 100%.”

“You need **a reasonably complete** test suite that runs in **a few minutes**.”

Continuous Integration



2006: Continuous Integration Extended

- Single source repository
- Integration machine
- Fix broken builds immediately
- Keep the build fast (10 minutes)
- Test in a clone of the production environment
- Automate deployment

http://www.martinfowler.com/articles/continuousIntegration.html

2009: Continuous Deployment

“The high level of our process is dead simple: **Continuously integrate** (commit early and often). On commit automatically **run all tests**. If the tests pass **deploy to the cluster**. If the deploy succeeds, repeat.”

http://timothyfitz.com/2009/02/08/continuous-deployment/
http://timothyfitz.com/2009/02/10/continuous-deployment-at-imvu-doing-the-impossible-fifty-times-a-day/

Continuous Deployment

"So what magic happens in our test suite that **allows us to skip having a manual Quality Assurance** step in our deploy process? The magic is in the **scope, scale and thoroughness**. It's a thousand test files and counting. **4.4 machine hours of automated tests** to be exact."

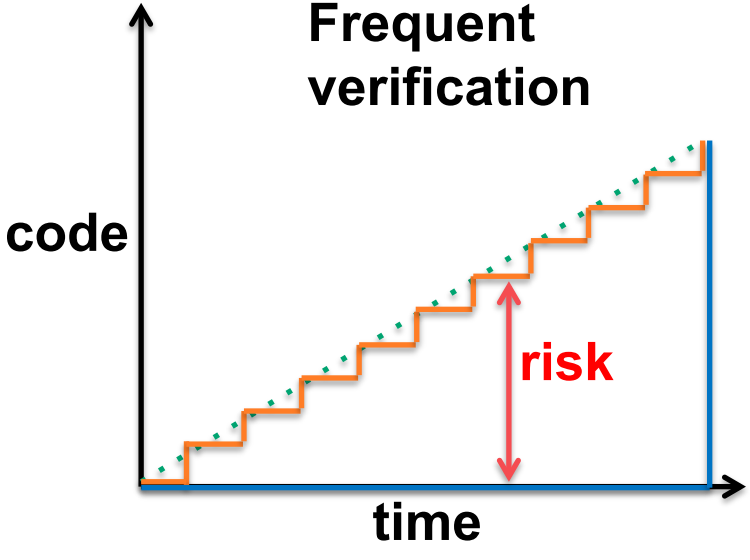
"Great test coverage is not enough. Continuous Deployment requires much more than that. Continuous Deployment means running all your tests, all the time. That means **tests must be reliable**."

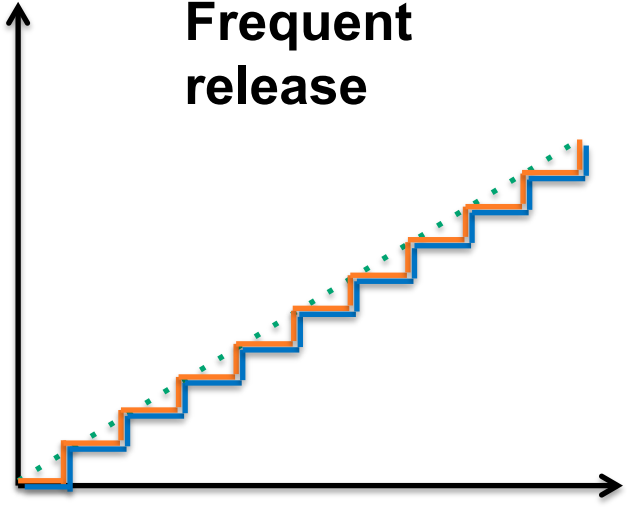
Continuous Deployment

- **Context of cloud systems**
- **Problems in production will always happen**
- **How to mitigate the problems?**
  - Smaller releases have smaller scope and are easier to debug
  - Automated deployments allow fast fixing
  - Deploy to a subset of users first to mitigate problem scope
- **Production can be monitored and reverted automatically**

Continuous Deployment

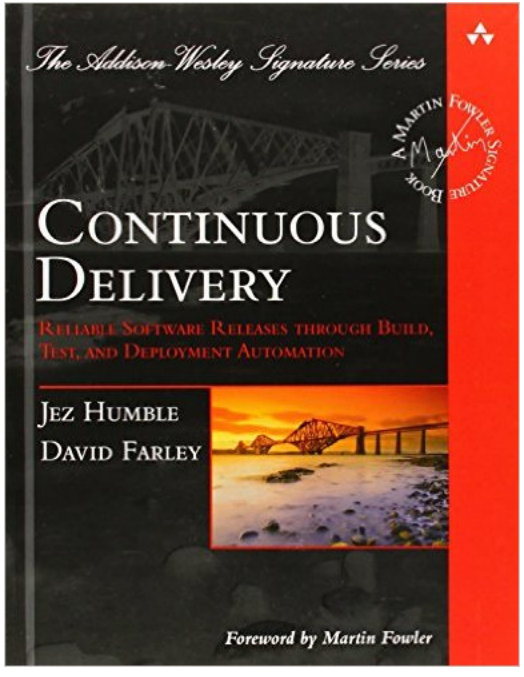
- Minimizes release risk
- Easier defect diagnosis
- Improved morale





2010: Continuous Delivery

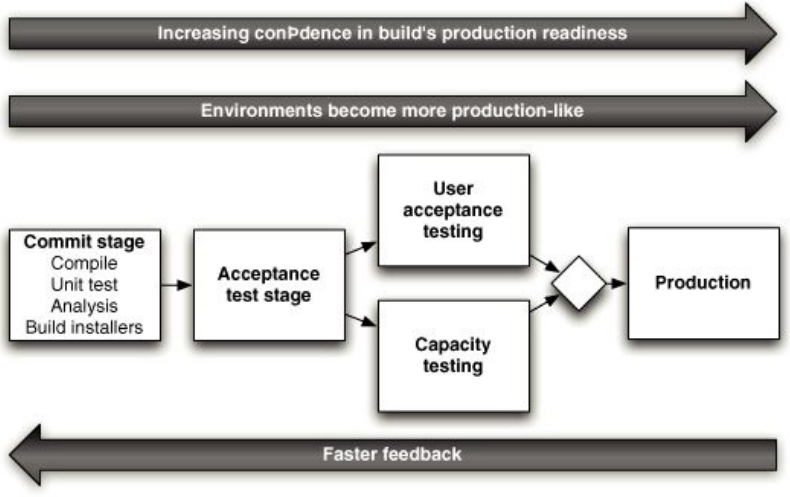
- **Every change should be releasable…**
- **...but not necessarily released automatically**
- **Allows human verification**

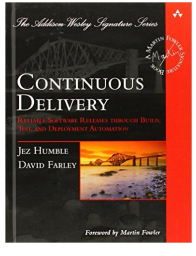


Humble, J., Farley, D., 2010. Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation. Addison-Wesley Professional.

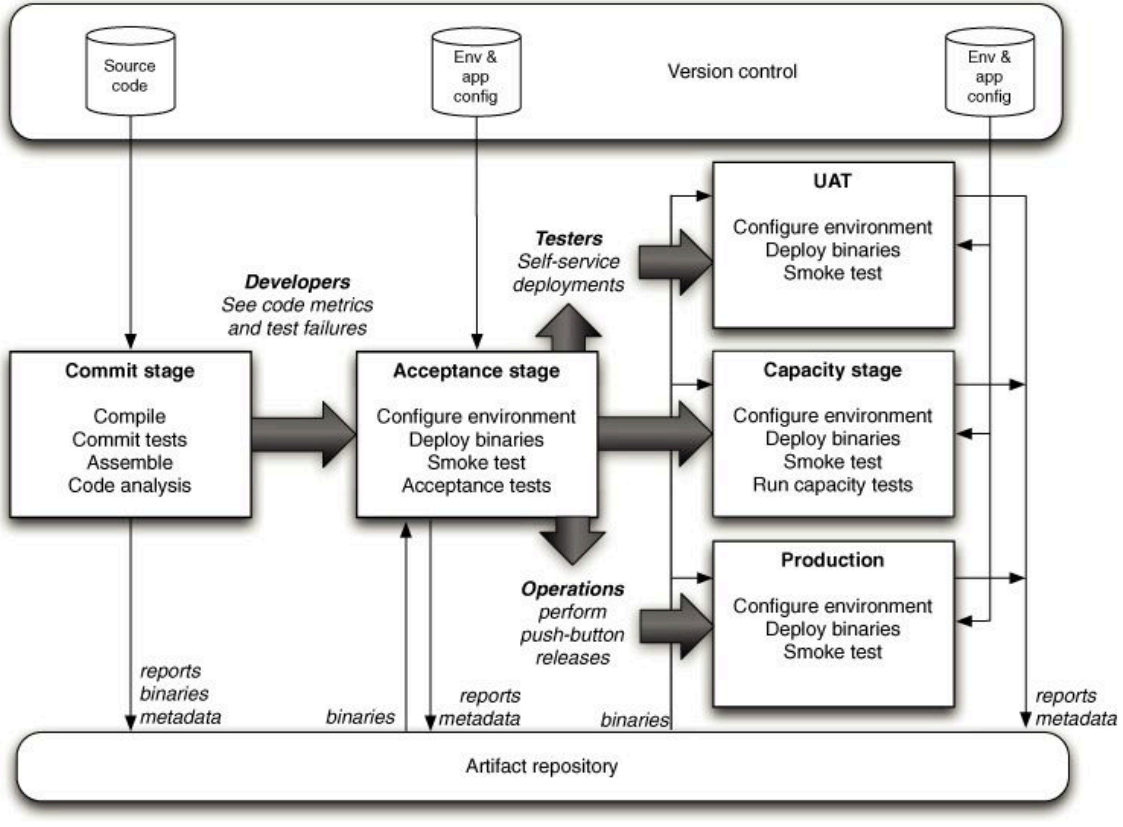
Continuous Delivery

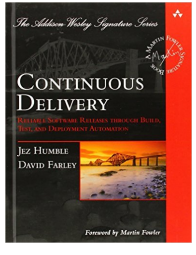
Deployment Pipeline





Continuous Delivery





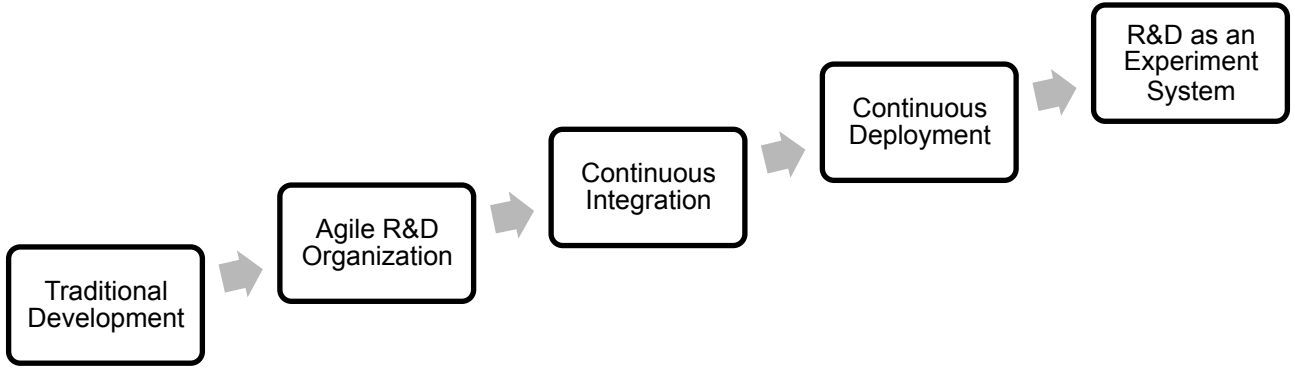
Continuous Delivery

You're doing continuous delivery when:

- Your software is **deployable** throughout its lifecycle
- Your team **prioritizes** keeping the software deployable over working on new features
- Anybody can get fast, **automated feedback** on the production readiness of their systems any time somebody makes a change to them
- You can perform **push-button deployments** of any version of the software to any environment on demand

http://martinfowler.com/bliki/ContinuousDelivery.html

2012: Experiment System



Olsson, H.H., Alahyari, H., Bosch, J., 2012. Climbing the "Stairway to Heaven" – A Multiple-Case Study Exploring Barriers in the Transition from Agile Development Towards Continuous Deployment of Software, in: Proceedings of the 2012 38th Euromicro Conference on Software Engineering and Advanced Applications. Washington, DC, USA, pp. 392–399.

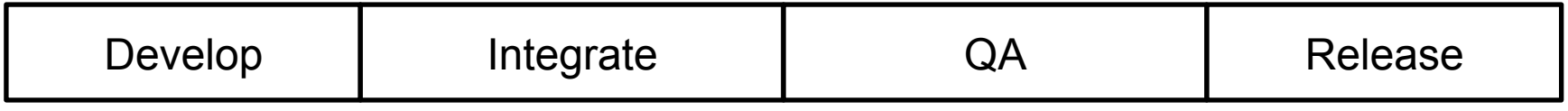
Experiment System

"actual deployment of software functionality is seen as a way of **experimenting and testing** what the customer needs"

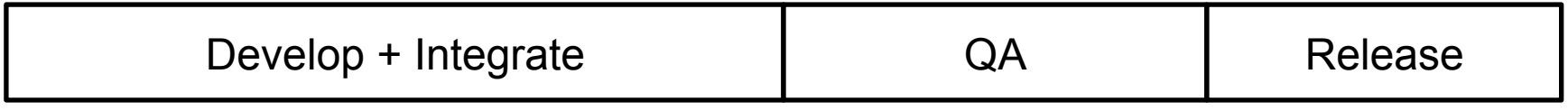
- **Beyond regression testing and integration**
- **Avoid software bloat**

Delivery Activities

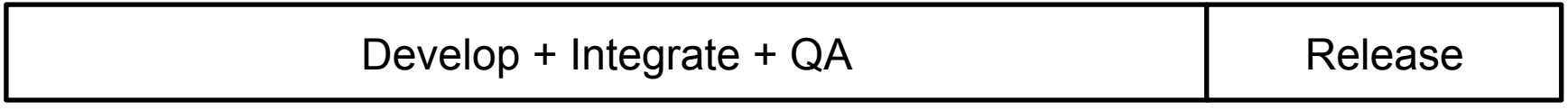
Waterfall



Continuous Integration



Continuous Delivery



Continuous Deployment

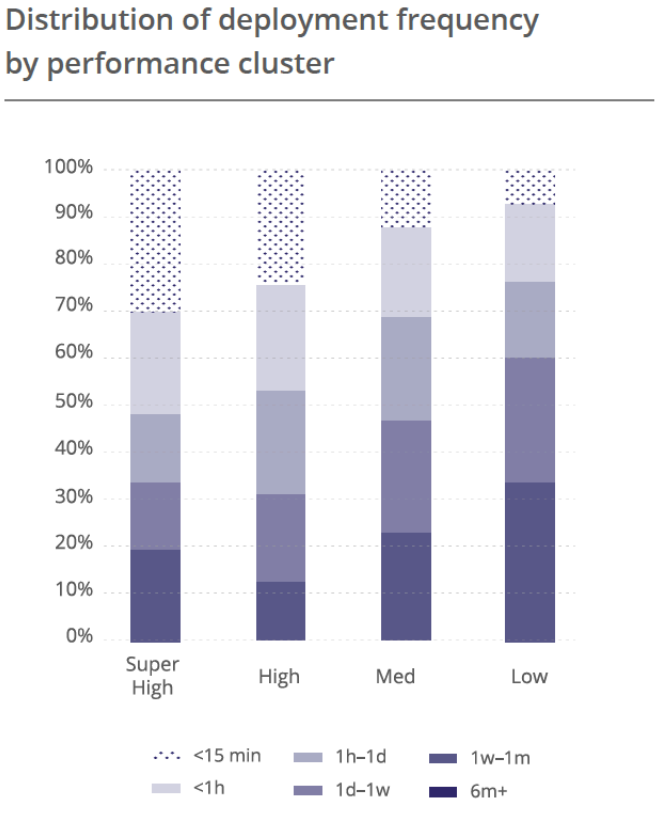
Develop + Integrate + QA + Release

Practitioner surveys

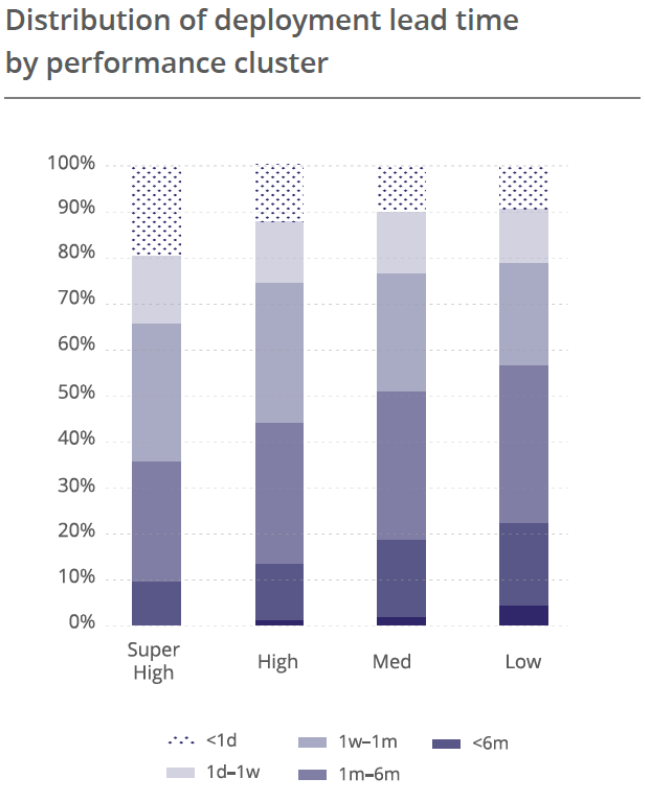
- **2015 State of DevOps Report**
  - ~5000 respondents
- **2013 Continuous Delivery: A Maturity Assessment Model**
  - ~300 respondents

https://puppetlabs.com/2015-devops-report
http://info.thoughtworks.com/Continuous-Delivery-Maturity-Model.html

Survey: deployment frequency

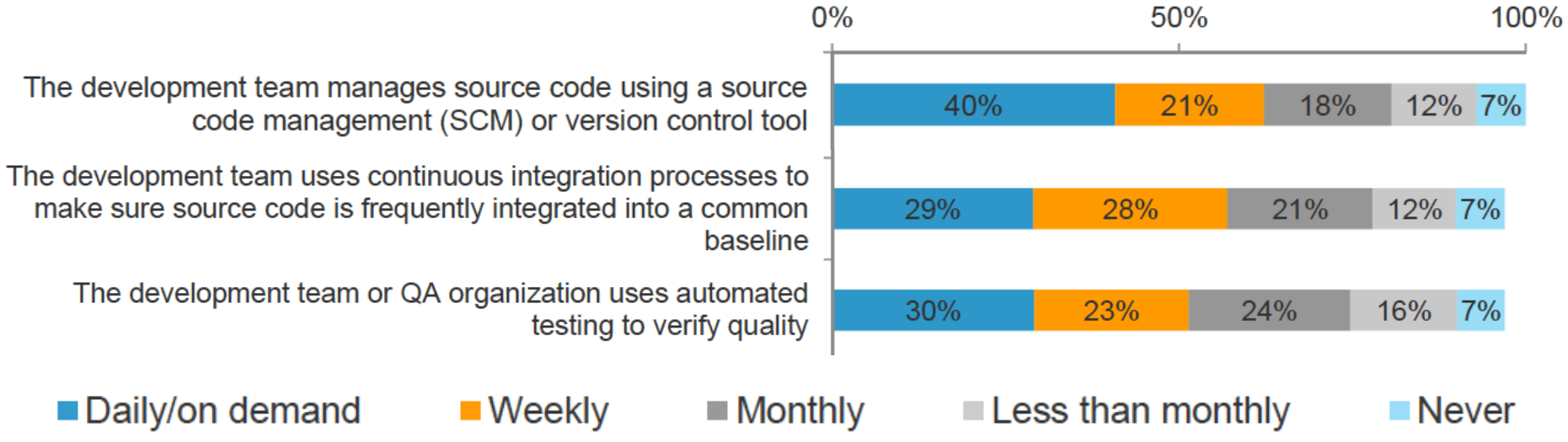


Survey: deployment lead time



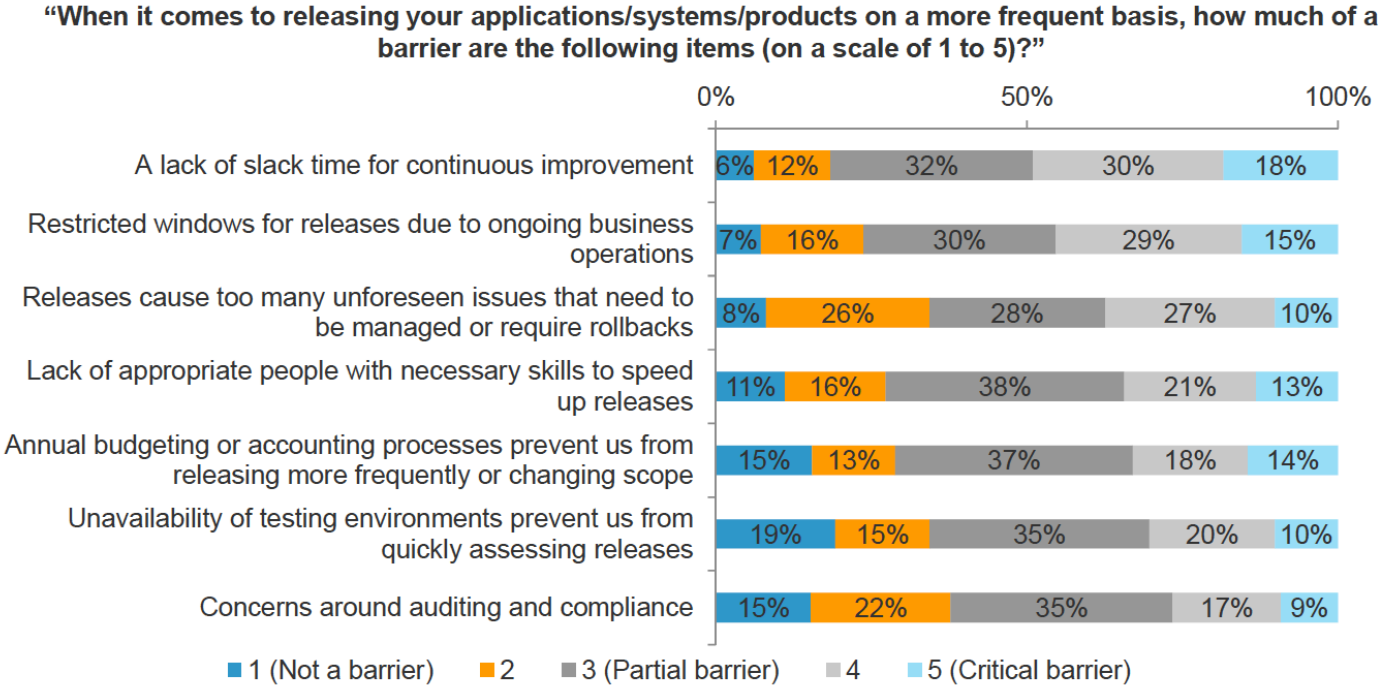
Survey: practices

"Please rate your development organization's frequency of use of the following software development practices on a scale of 1 to 5."



http://info.thoughtworks.com/Continuous-Delivery-Maturity-Model.html

Survey: barriers



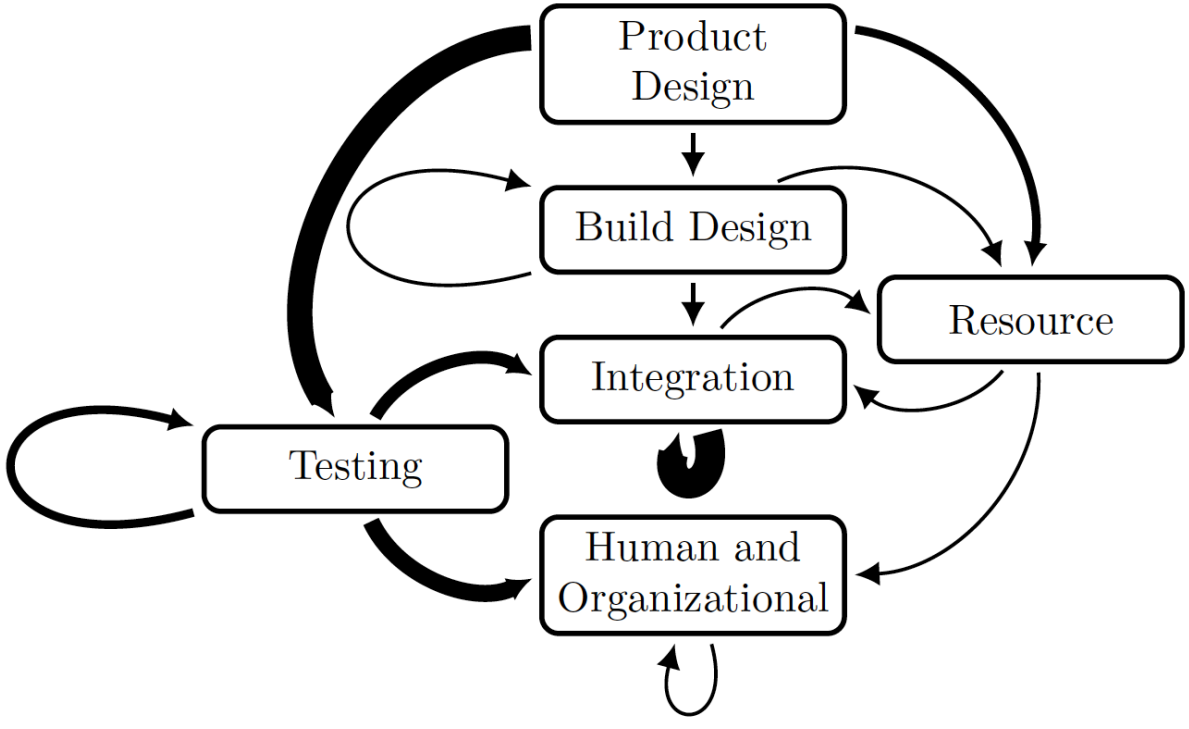
http://info.thoughtworks.com/Continuous-Delivery-Maturity-Model.html

Problems when adopting continuous delivery

- **Build design**
  - Complex build, inflexible build
- **Product design**
  - Modularization, internal dependencies, database schema changes, unsuitable architecture
- **Integration**
  - Large commits, broken build, merge conflicts, work blockage, long-running branches…
- **Testing**
  - Ambiguous test result, flaky tests, untestable code, time-consuming testing, UI testing…
- **Release**
  - Customer data preservation, documentation, feature discovery, marketing, more deployed bugs
- **Human & Organization**
  - Lack of discipline, more pressure, lack of motivation, lack of experience, team coordination…
- **Resources**
  - Effort, insufficient hardware resources, network latencies

Laukkanen, E., Itkonen, J., Lassenius, C., 2015. Problems, Causes and Solutions When Adopting Continuous Delivery - A Systematic Literature Review. Manuscript in preparation.

Problems are connected



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What to consider

- **Value of fast release cycle**
  - Competitive market
  - Product ambiguity
- **Cost of fast release cycle**
  - Competences, legacy code, infrastructure, maintenance
- **How often can you release**
  - Cost of release
- **How long can quality assurance take**
  - Cost of production bugs

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Thanks!

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