Hasso Plattner Institut
Digital Engineering · Universität Potsdam

Application Deployment & DevOps

Scalable Software Engineering
WS 2021/22

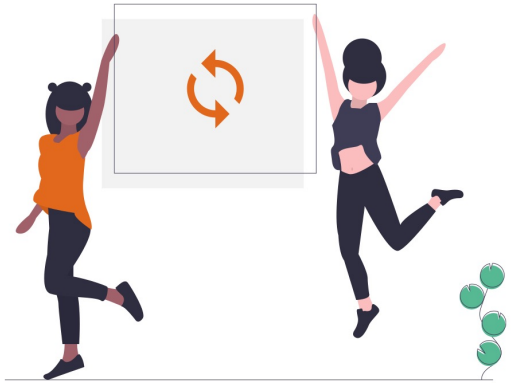
Enterprise Platform and Integration Concepts

Agenda

1. **DevOps**
2. Application Hosting Options
3. Automating Environment Setup
4. Deployment Scripting
5. Application Monitoring
6. Continuous Deployment and Scrum

IaC and DevOps

Infrastructure as Code enables DevOps teams to test applications in production-like environments early in the development cycle.

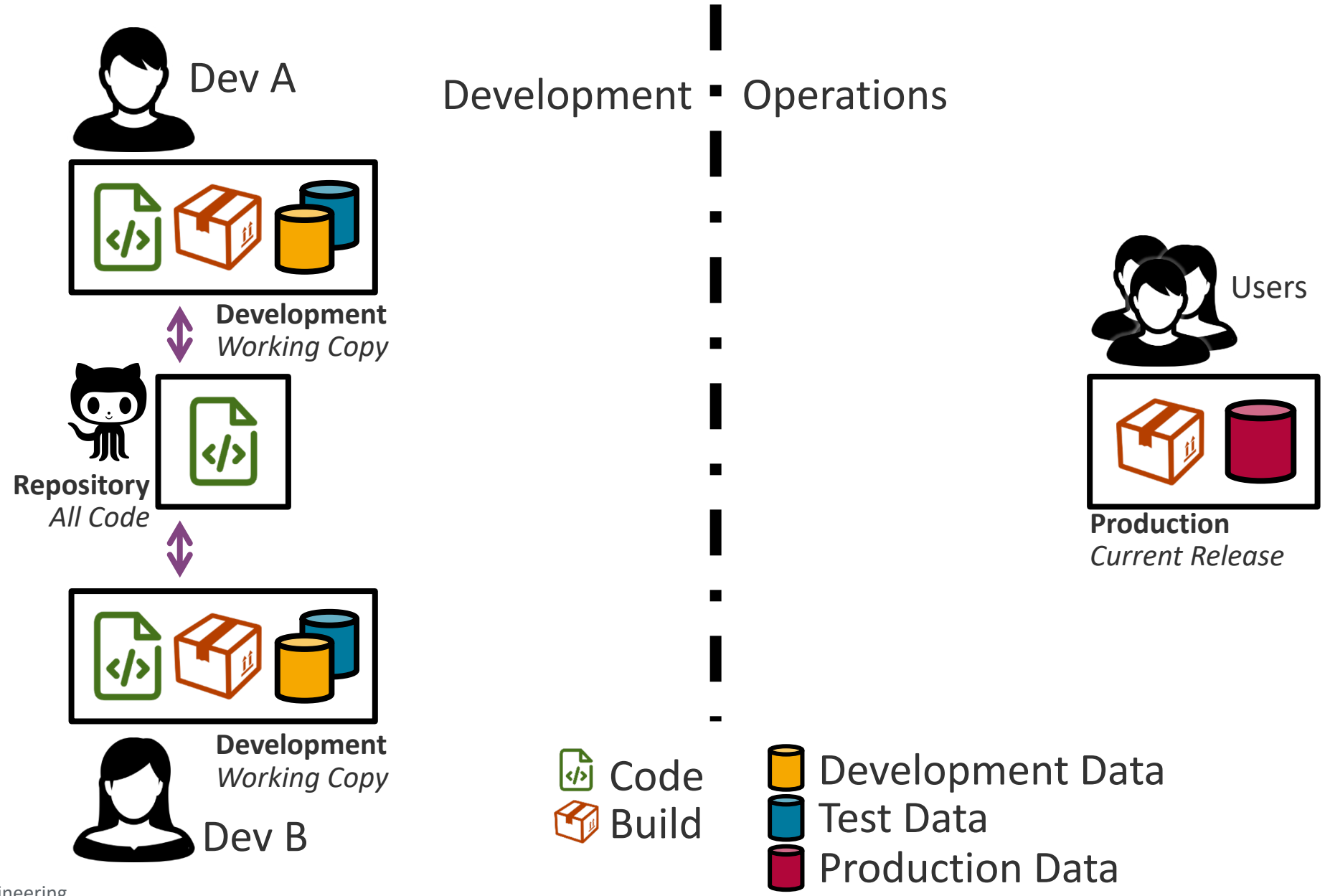


Terms

- Provisioning:
  Creating the systems that you'll need to manage later on
- Configuration management:
  actually **making systems useful**, install and configure them
- Deployment:
  Getting the work we've done **onto the systems** in question

Source: https://archive.fosdem.org/2018/schedule/event/deployment_provisioning_orchestration/

Development vs. Operations



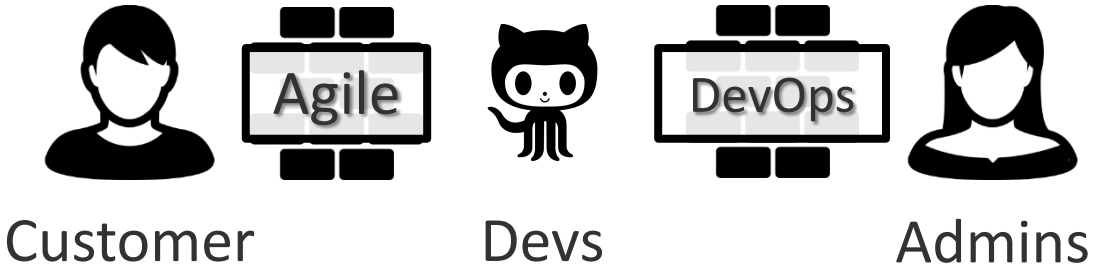
Development & Operations

Problems

- Software needs to be operated, run in production, and maintained
  - Developers vs. Admins
- **Short** development and deployment cycles
- Maintain **quality standards**

DevOps

- **Formalized** process for deployment
- Focus on communication, **collaboration**, and integration between Dev and Ops



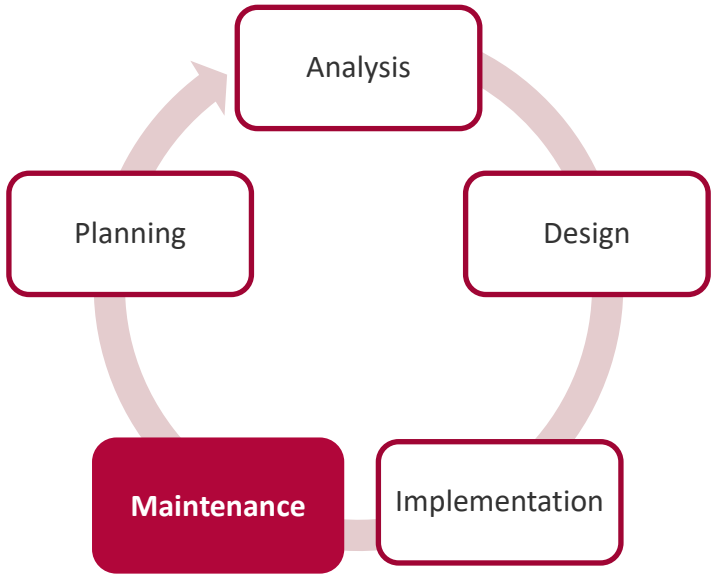
"Agile for deployment"

DevOps

Definition

- Fairly **recent** trend
- "[...] no uniform definition for [...] DevOps. [...] people use their own definitions" [Dyck, 2015]
- "There is no consensus of what concepts DevOps covers, nor how DevOps is defined" [Erich, 2017]

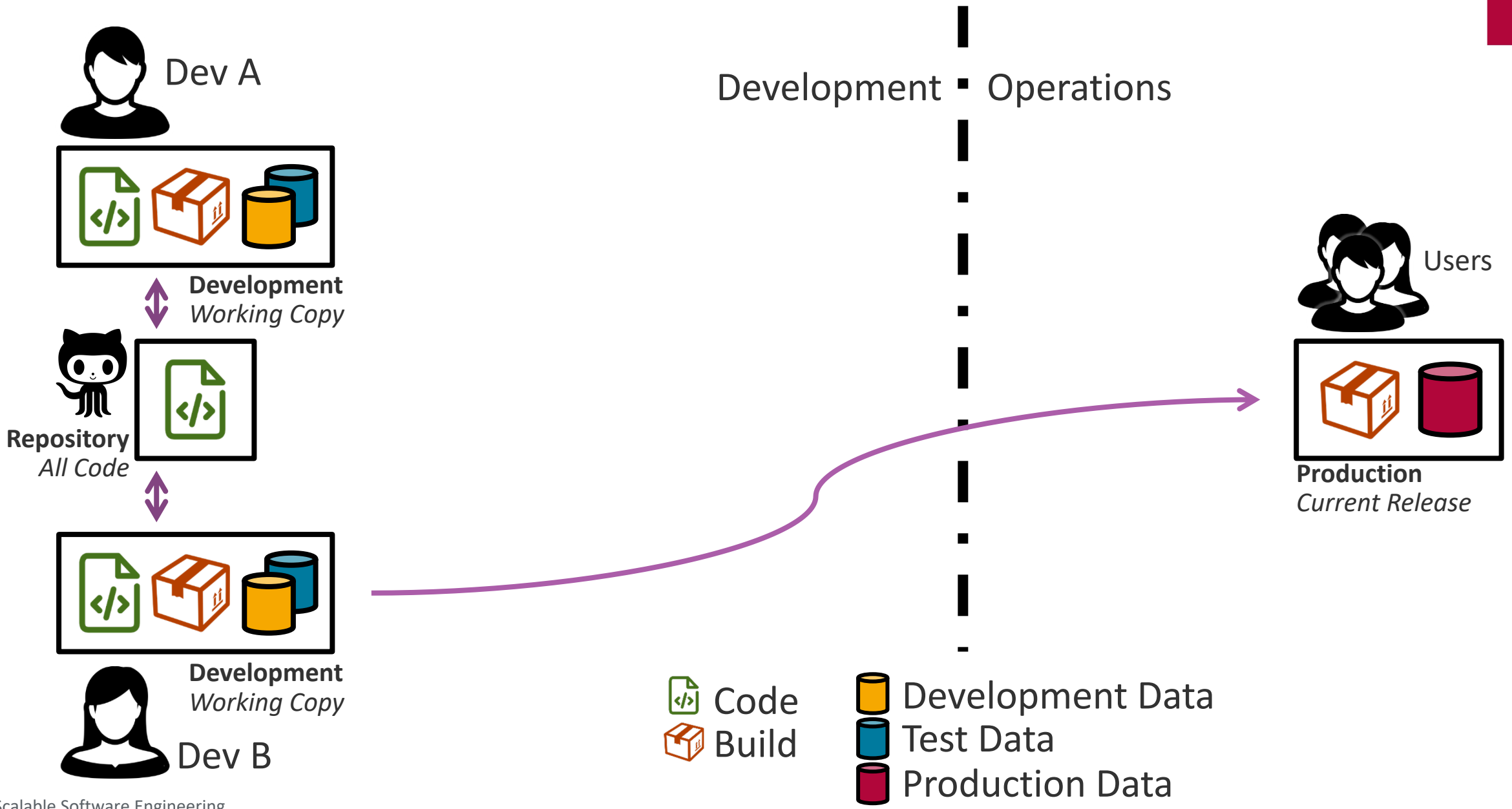
- Best practices to **shorten the application development life cycle**



[Dyck, 2015] Dyck, Andrej; Penners, Ralf; Lichter, Horst (19 May 2015). "Towards Definitions for Release Engineering and DevOps". Proceedings of the 2015 IEEE/ACM 3rd International Workshop on Release Engineering. IEEE.

[Erich, 2017] Erich, F.M.A.; Amrit, C.; Daneva, M. (June 2017). "A Qualitative Study of DevOps Usage in Practice". Journal of Software: Evolution and Process. 29 (6).

Not DevOps


Dev A
Development
Working Copy
Repository
All Code
Development
Working Copy
Dev B
Development
Operations
Users
Production
Current Release
Code
Build
Development Data
Test Data
Production Data

Terminology

Release

- **Planned state** of the application
- Set of requirements
- Examples
  - Next big version with new shiny features
  - Urgent hotfix
  - Anything in-between

Version

- Could be anything
- A release has a **version number**

Terminology

Build

- Attempt to implement a release
  - **Snapshot** of application
- Often the output of the build tool
  - Not: the build script/tool/process
- Version number is
  “<Release Number>.<Build Number>”

Terminology

Environment

- A system on which the application can be deployed and used

To promote

- To deploy a build on the **next** environment

To release

- To promote a build to **production**
- Thereby finishing the release

Overview of Environments

Development

managed by developers

Development

- Where the developers work
- One per developer (if possible)

Integration

- Runs all tests
- A try-out version

Quality Assurance

- Professional manual testing

Operations

managed by admins

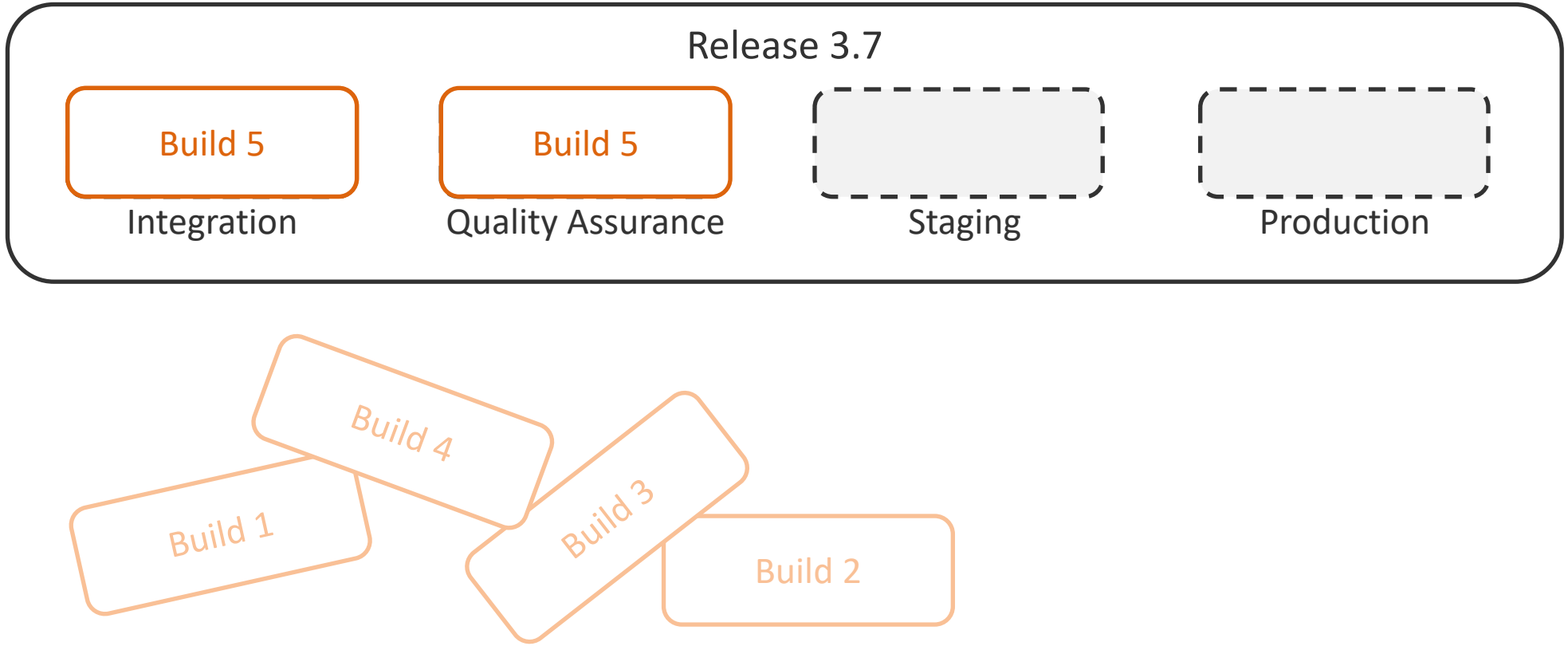
Staging

- Clone of production system
- Final rehearsal

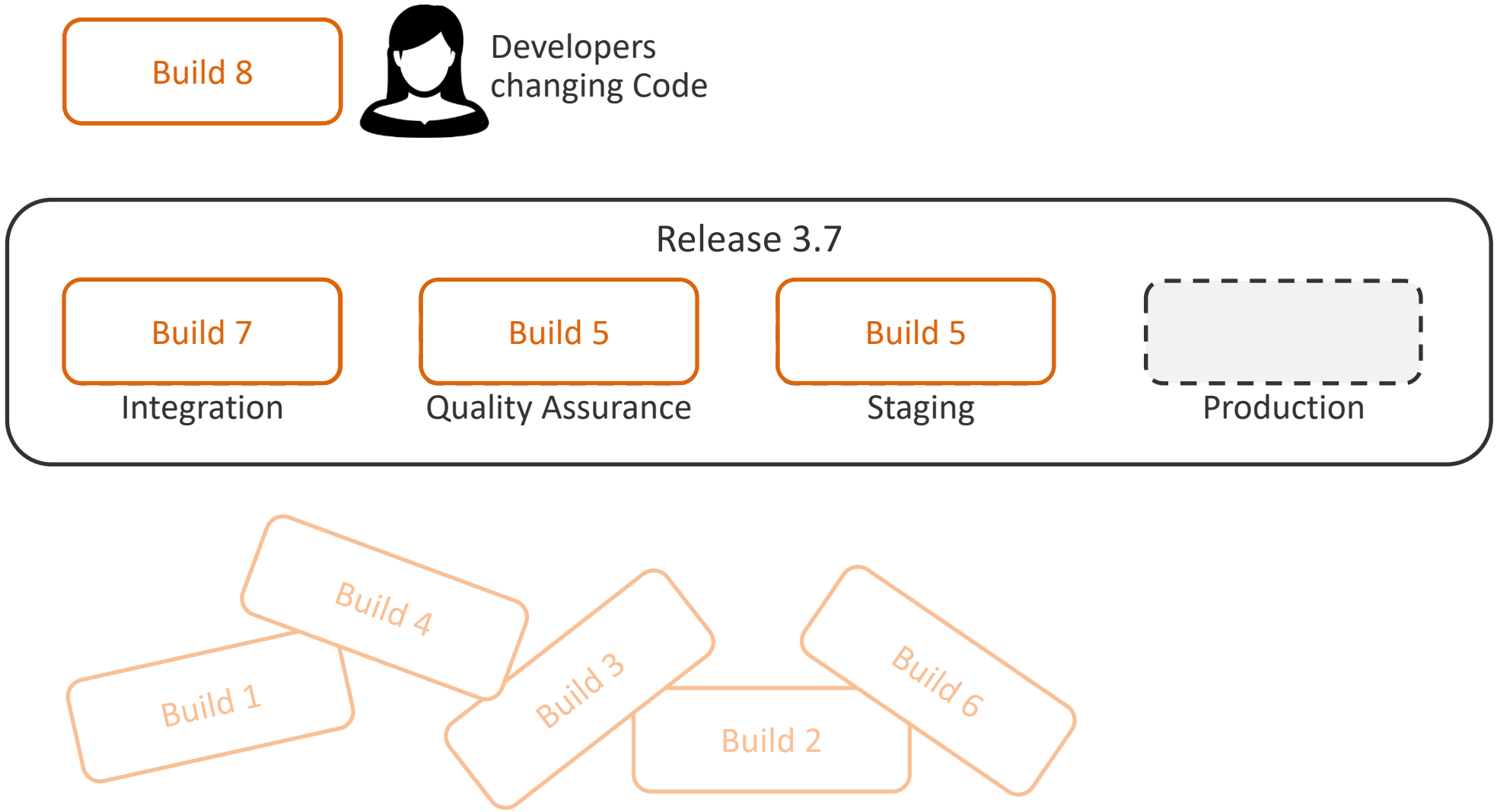
Production

- The live system
- Failures are expensive here

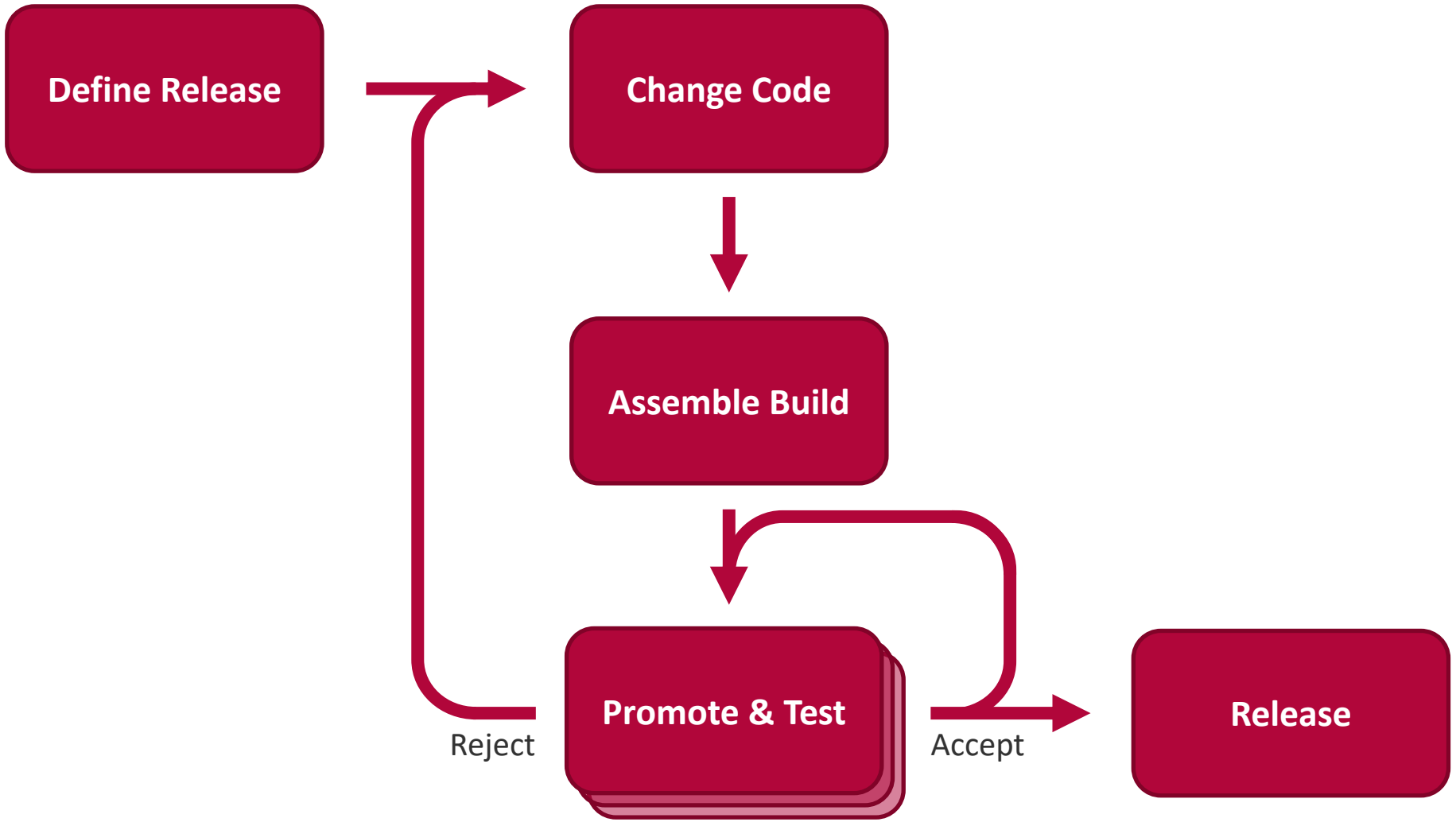
Example


Release 3.7
Build 5
Integration
Build 5
Quality Assurance
Staging
Production
Build 4
Build 1
Build 3
Build 2

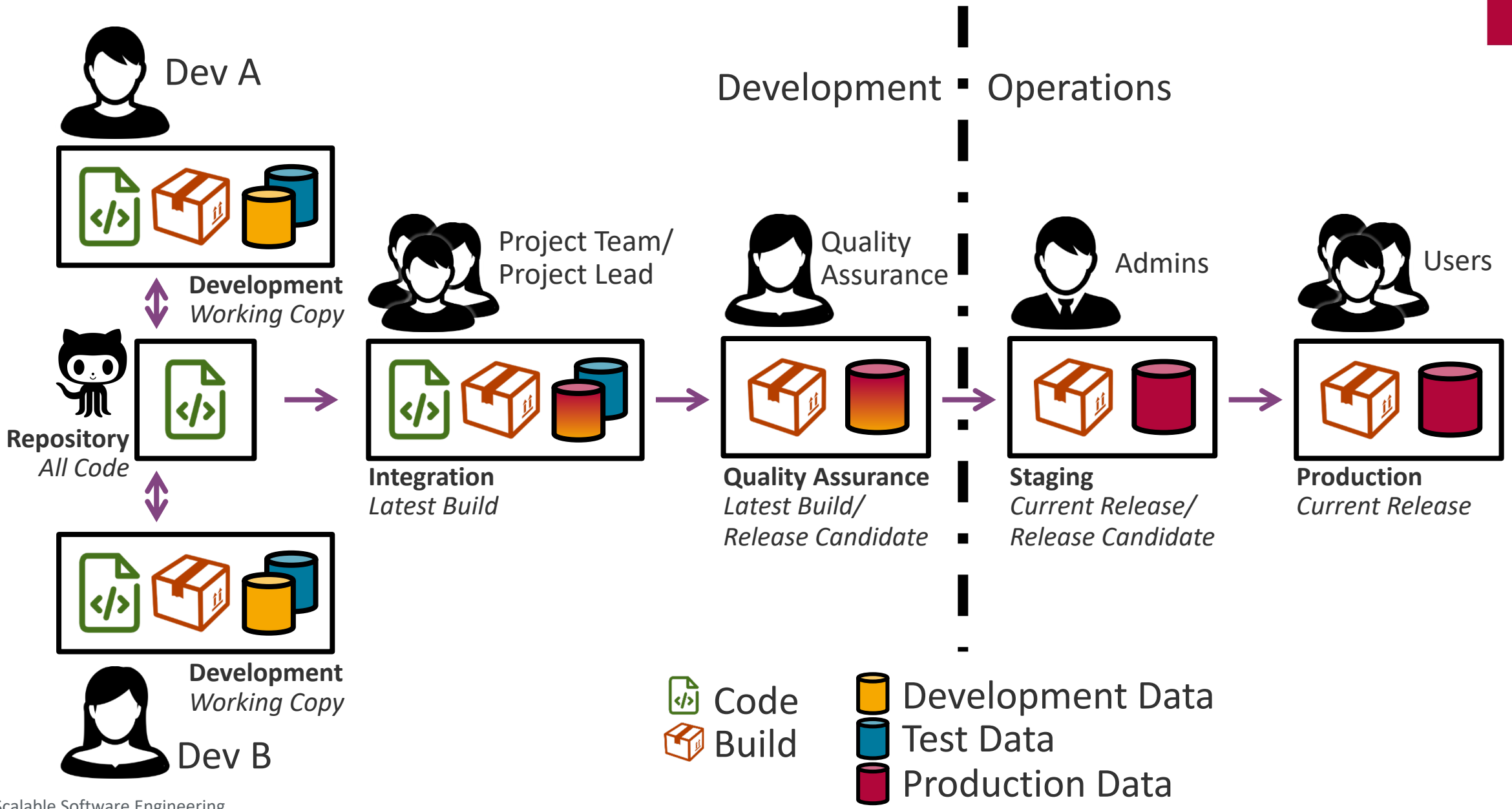
Example


Build 8
Developers changing Code
Release 3.7
Build 7
Integration
Build 5
Quality Assurance
Build 5
Staging
Production
Build 4
Build 1
Build 3
Build 2
Build 6

Workflow


Define Release
Change Code
Assemble Build
Promote & Test
Reject
Accept
Release

DevOps


Dev A
Development
Working Copy
Repository
All Code
Development
Working Copy
Dev B
Project Team/
Project Lead
Integration
Latest Build
Quality
Assurance
Quality Assurance
Latest Build/
Release Candidate
Development
Operations
Admins
Staging
Current Release/
Release Candidate
Users
Production
Current Release
Code
Build
Development Data
Test Data
Production Data

Implications

Builds are immutable

- If changed, previous testing was pointless
- Even the smallest change has to go through all environments

Many systems required

- Each environment has to be maintained
- Automation?

Deployment overhead

- Manual steps are opportunities for human failure
- Automation?

Remainder of this lecture

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Application Hosting

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Enterprise Platform and Integration Concepts

Image by *@EthicsInBricks* on Twitter: https://twitter.com/EthicsInBricks/status/1431239790897385477 (with permission)

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1. DevOps
2. **Application Hosting Options**
3. Automating Environment Setup
4. Deployment Scripting
5. Application Monitoring
6. Continuous Deployment and Scrum

Application Hosting Options

Choice of hosting options is driven by a variety of parameters

- Initial setup effort, cost, and required expertise
- Operational costs and effort
- Targeted service level agreements (SLAs)
- Legal considerations (data privacy, liability, etc.)

Platform as a Service (Paas)

Providers deliver OS, execution environment, database, web server, monitoring, etc.

Advantages

- Minimal effort and knowledge required for setup
- Only platform development knowledge (e.g. Python, Ruby) needed, no need for hardware / OS maintenance
- Possibility to scale up quickly and easily

Disadvantages

- Usually fixed environment with little variation points
- Provider SLA targets might differ from yours, e.g. downtime, response times
- Limited technical support

Examples: Heroku, Azure Compute, Google App Engine

Infrastructure as a Service (IaaS)

Providers deliver virtual private servers (VPS) with requested configuration
Setup of execution environment, database servers, etc. is up to customers

Advantages

- Flexibility regarding execution environment
- Avoid management of underlying hardware
- Dynamic on-demand scaling of resources

Disadvantages

- Server administration know-how and efforts required
- It's still a VM: Potential performance drops, Disk I/O, etc.

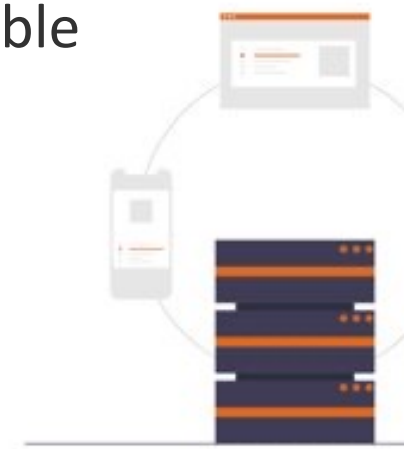
Examples: Amazon EC2, Google Compute Engine, Rackspace Cloud, DigitalOcean

Dedicated Hosting

Providers allocate *dedicated* hardware, classical approach

Advantages

- Complete control over server, down to bare metal, full power always available
- No virtualization-related performance issues
- More control over network configuration
- Dedicated SLAs



Disadvantages (compared to IaaS)

- No easy scaling of resources
- Administration efforts for servers, e.g. monitor disk failures

Examples: Hetzner, OVH, Rackspace, Host Europe

Own datacenter

You host your own servers

Advantages

- Complete control over data, security, operations, network etc.
- Custom designed servers possible
- Add cabinets in available space with low cost

Disadvantages

- Huge upfront costs, e.g. space, cooling, fiber, hardware
- Expanding the space of the datacenter is expensive
- Provide around the clock support, monitoring, personnel, etc.
- Not feasible for small companies

Examples: Google, Facebook

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1. DevOps
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3. Automating Environment Setup
   - **Virtualization**
   - Configuration Management
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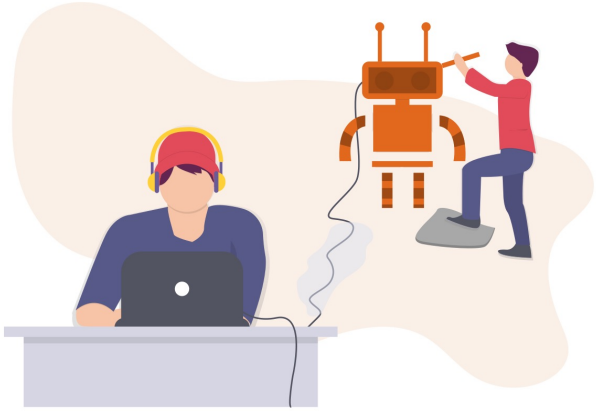
Setting up an Environment

Main challenges in preparing infrastructure:

- Minimize the effort required to repeatedly setup identical execution environments
- Without relying on “administration gurus”



Solutions:

- *DevOps*, i.e. a strong collaboration between the development and the operations team
- A strong bias towards **automation**

Where to Start With "Deploying"?

- Hosted solutions aren't always feasible for initial experiments
- Maintaining local installs of server stacks in different versions can get cumbersome
- Development vs. production environment differences result in *"it works on my machine"* problems
- Don't want to force all developers to use same development environment (e.g. choice of OS)

Possible solution: Virtualization / Containerization

- "Deploy" on your local OS for development
- Provision a virtual machine, build a container

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   - Virtualization
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Next Step: Automate VM Setup

Virtualization software provides and provisions a VM

Configuration management tools configure it, e.g. install required software

Why not configure manually?

- Error prone, repetitive tasks
- Documentation has to be kept up-to-date
- Explicit knowledge transfer required if admin changes

One config management tool example: Chef (http://chef.io, https://github.com/chef/chef)

- Formalize software install and configuration state into *recipes*
- Shared recipes (https://supermarket.chef.io/cookbooks)
- Ensure software and dependencies are installed
- Ensure that files, packages, and services are in the prescribed state

Configuration Management

Using configuration management tools, you can:

- Define the required packages for all required servers
- Install and configure necessary services
- Create directory structures
- Create custom configuration files (e.g., database.yml)

Also possible:

- Templates to create different files based on variables
- Creating various environments (e.g. staging vs. production)
- Central management of configuration files that are automatically transferred to clients

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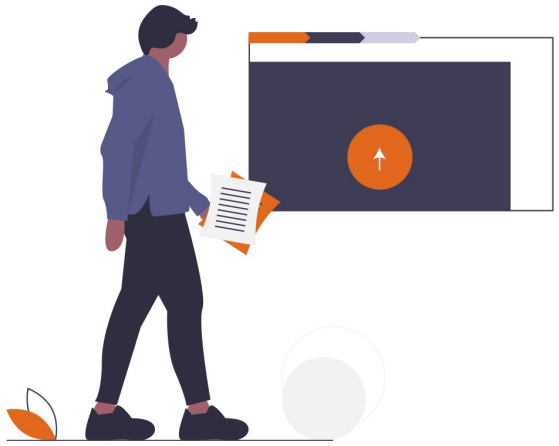
Deploying as Part of the Dev Process

Necessary steps after the server is available:

- Checkout code
- Install or update dependencies (i.e. gems)
- Run database migrations, restart application servers
- Restart index servers, setup new Cron jobs, etc.



Remember: Automation!

- **CI solutions** support deploying to hosting providers
  - Deploy after all the tests pass
  - Deploy as updates are made
- Dedicated config management tools
  - Explicit control over what is set up

Deployment with CI

Example: Travis CI Continuous Integration and Deployment Workflow:

1. `before_install`
2. `install`
3. `before_script`
4. `script`
5. `after_success` or `after_failure`
6. `after_script`
7. `before_deploy`
8. `deploy`
9. `after_deploy`

tests are run — 4.

optional steps — 7. – 9.

Non-zero exit-status here: build *failed. Not* deployed.

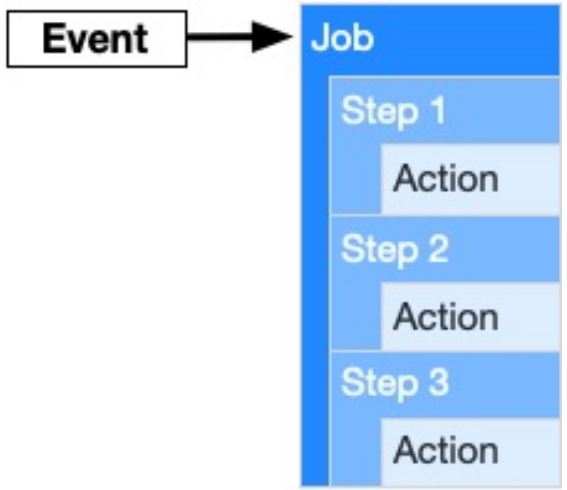
Otherwise: deployed in deploy step.

http://docs.travis-ci.com/user/build-lifecycle/

GitHub Actions

Automate, customize, and execute your software development workflows in your repository

- Create own actions or use community actions
- Event-driven (e.g. pull request creation executes testing script)
- Workflow: automated procedure added to your repository
  - Consist of one or more jobs (set of steps)
  - Scheduled or triggered by an event
  - Actions are standalone commands that are combined into steps to create a job



https://docs.github.com/en/free-pro-team@latest/actions/learn-github-actions/introduction-to-github-actions

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Monitoring Servers & Applications

Keep an eye on server and health and applications:

- **Monitor in production**
  - This is where errors are most costly
  - Revenue loss, support tickets
- **Issue alerts**
  - When components fail
  - When predefined thresholds are exceeded
- Examples:
  - Regular HTTP GET requests (e.g. https://uptimerobot.com/)
  - Monitor infrastructure, down to switches and services (e.g. http://nagios.org)

Monitoring Servers & Applications

Monitor application errors and performance bottlenecks:

- Monitor errors that happen at runtime
  - In production
  - Discovered by users
- Notifications on application errors or slow downs

Examples:

- Errbit—Collect and organize errors (https://github.com/errbit/errbit)
- New Relic—Performance monitoring, response times, SQL (http://newrelic.com/)

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Deploying 50 times a day?

Continuous Delivery

Advantages:

- Users get a sense of “something happening”, short feedback loops
- Business value of features immediately present
- Deploy scripts used often, less likely to contain errors
- Reduced amount of code changes per release → faster fixes, less downtime

Prerequisites/Disadvantages:

- Only feasible with extensive set of *good* tests
- Tests / deployment need to run fast *(Continuous Integration)*
- Additional training for developers *(DevOps)* required
- May not be feasible for applications that require planning or long-term support (e.g. operating systems)

Operating systems feature CD (rolling releases) and classical (LTS releases)

Continuous Deployment vs. Scrum

How do 50 deployments a day fit into Scrums notion of Sprints?

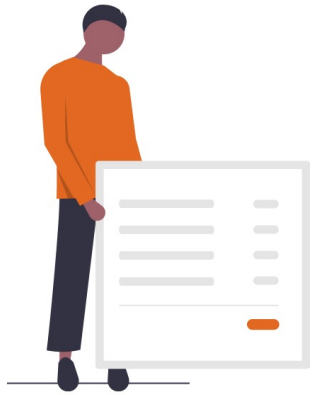
Some ideas (let's discuss):

- Intermediate Reviews for individual stories by the PO
  - At sprint review, each finished story is already running in production
  - Review meetings become shorter, more of a high level overview
- Get faster feedback from stakeholders for next Scrum meeting
- Deploying to staging or testing systems becomes part of the definition of done
- Acceptance of features not only based on PO approval but stakeholder approval?
  - A/B testing?
- "Working software is the primary measure of progress"—*Agile Manifesto*
  - Is software that is not deployed *working*? *(DevOps)*

Summary

Deployment & DevOps

- DevOps Concepts
- Application Hosting Options
- Automating Environment Setup
- Deployment Scripting
- Application Monitoring
- Continuous Deployment and Scrum



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Fröhliche Jahresendszeit!
Bis nächstes Jahr!

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