Continuous Delivery and Deployment of EPICS IOCs

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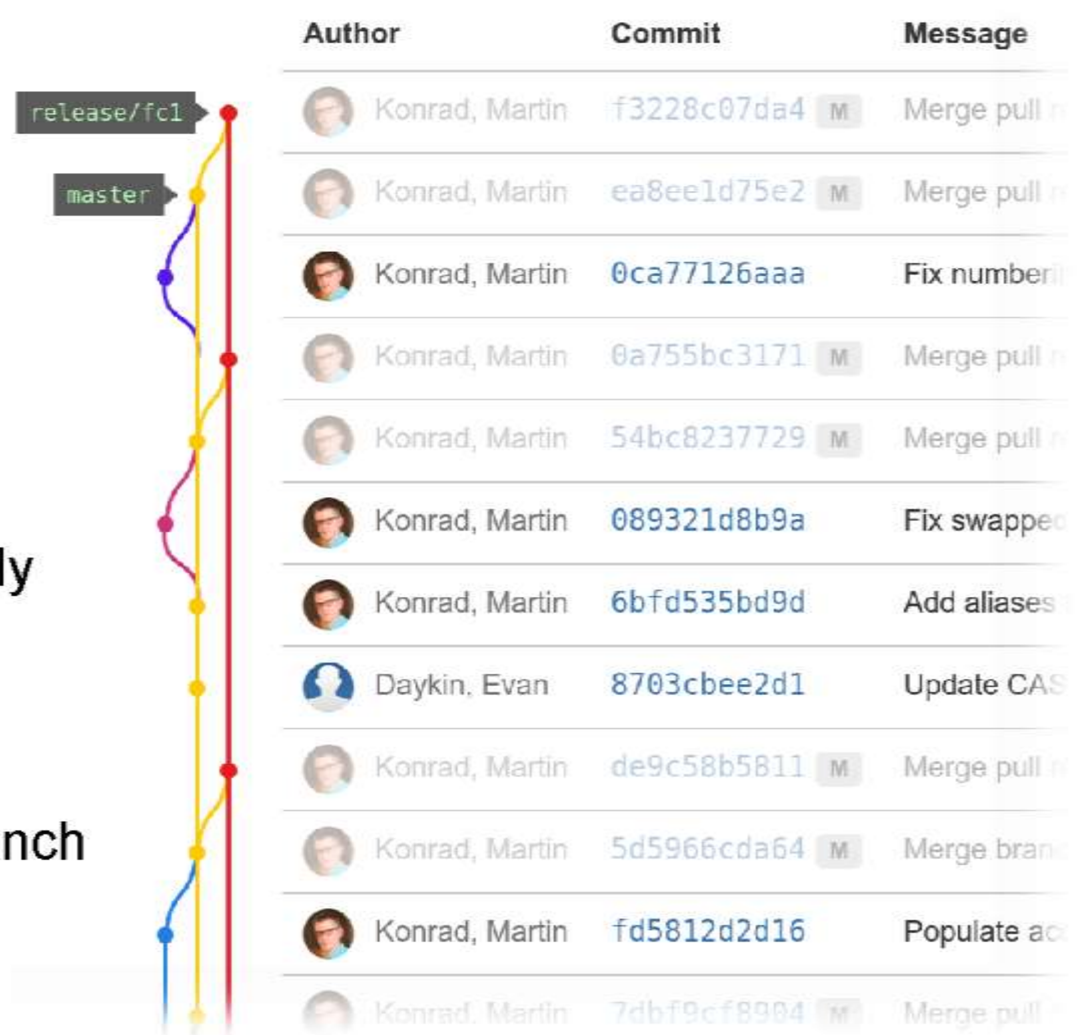
FRIB Controls Environment

Device	Interface to IOC	IOC Runs On	Quantity
Power Supplies, RF Amplifiers, Vacuum Gauges/Pumps,...	Ethernet (TCP with text protocol)	Virtual Machine	Thousands
LLRF Controllers	Ethernet (UDP)	Virtual Machine	~350
MPS Controllers	Ethernet (UDP)	Virtual Machine	~50
MTCA.4 Systems	PCIe	MTCA CPU (Intel)	~25
PLCs	Ethernet	Virtual Machine	~20 processors
Timing Master/Receiver	PCI	cPCI CPU (Intel)	2

- Almost all IOCs run on virtual machines in the data center
  - Improves availability
  - Reduces hardware cost and maintenance burden
  - Resources can be assigned flexibly
- All IOC machines run Debian GNU/Linux 8

Source Code is Under Revision Control

- All control system code is stored in a central Git version control system (VCS)
  - Development happens on feature branches
  - Merge to “master” branch when feature is complete
  - “master” gets deployed to test environment automatically
  - Release branch gets deployed to production environment
  - Branch permissions prevent accidental push to “release” branch
    - » Pull requests are enforced



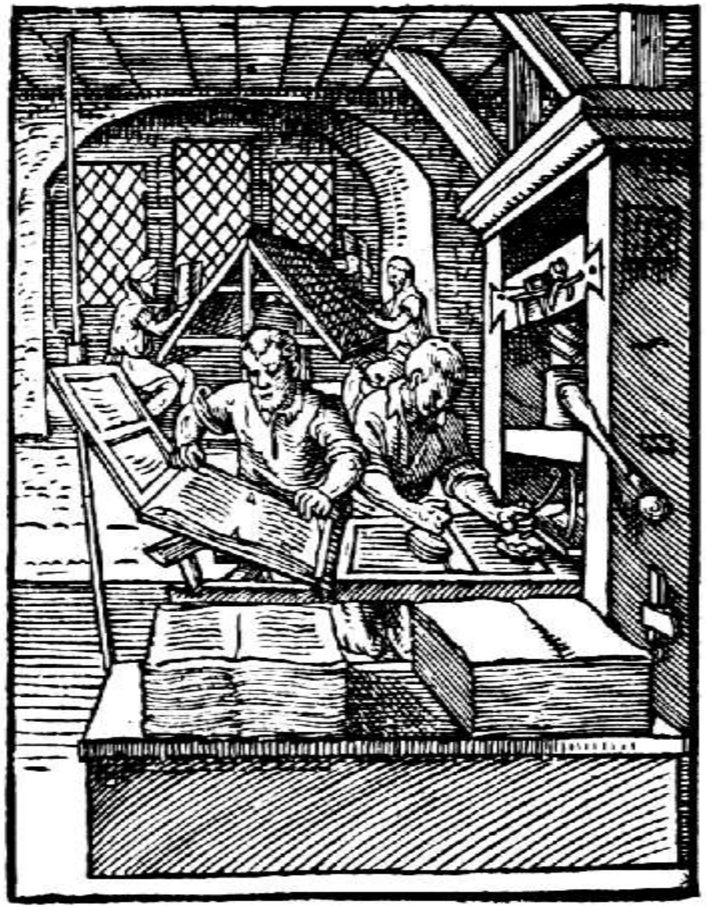
Continuous Delivery vs. Continuous Deployment

- Continuous *Deployment* (used with FRIB test environment)
  - Continuous Integration
  - Automatically deploy after each change
- Continuous *Delivery* (used with FRIB production environment)
  - Continuous Integration
  - Automatically build a candidate after each change that could *potentially* be deployed
  - Deployment process is automated but requires approval (e. g. one-click deployment or merge into a release branch to deploy)

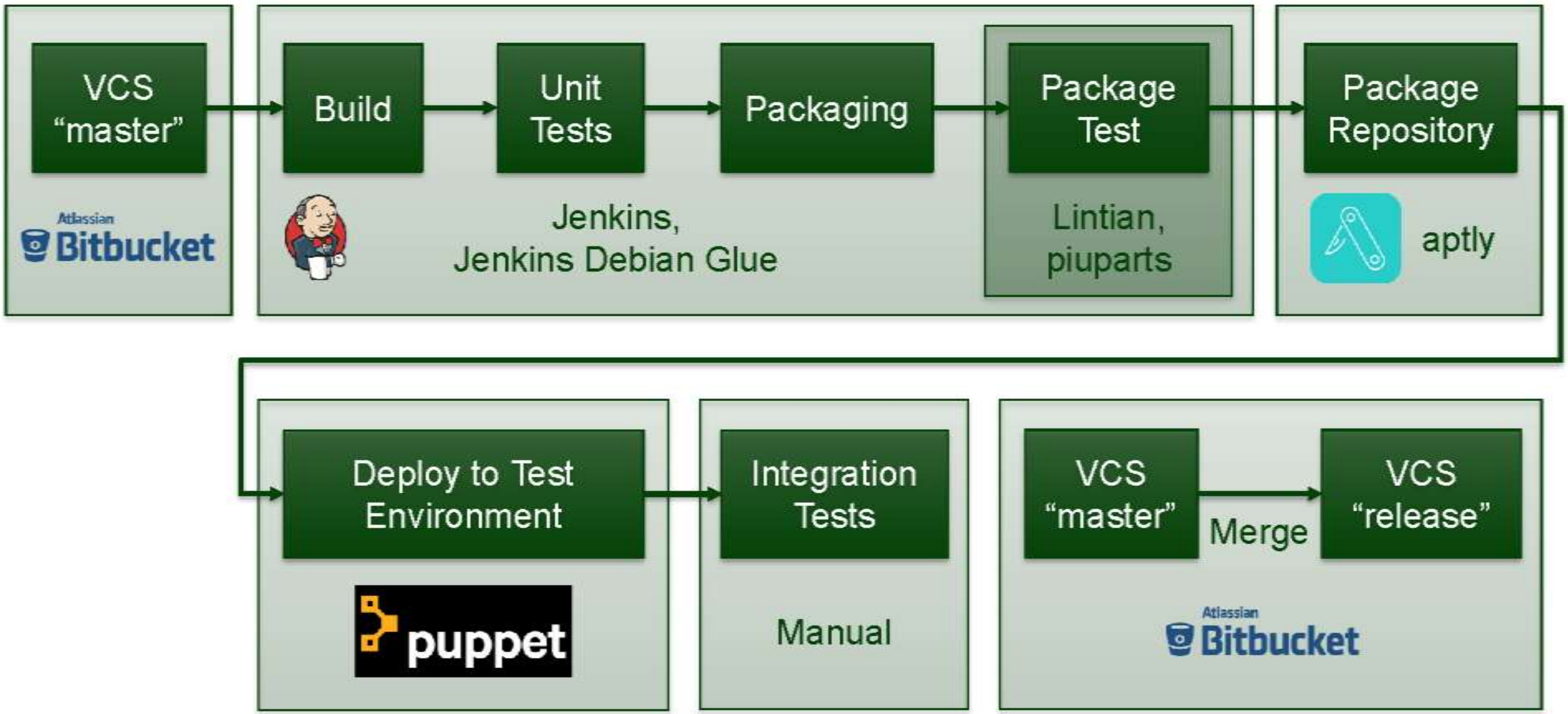
Why use Continuous Delivery?

- Overall we do not expect to save a significant amount of development time, but…
- Allows faster turn-around times
- More predictable (reproducible)
- Helps to catch issues before code is deployed to production system
- Full traceability
- Less risk of breaking something (we can always roll back)

➔ Facilitates team work

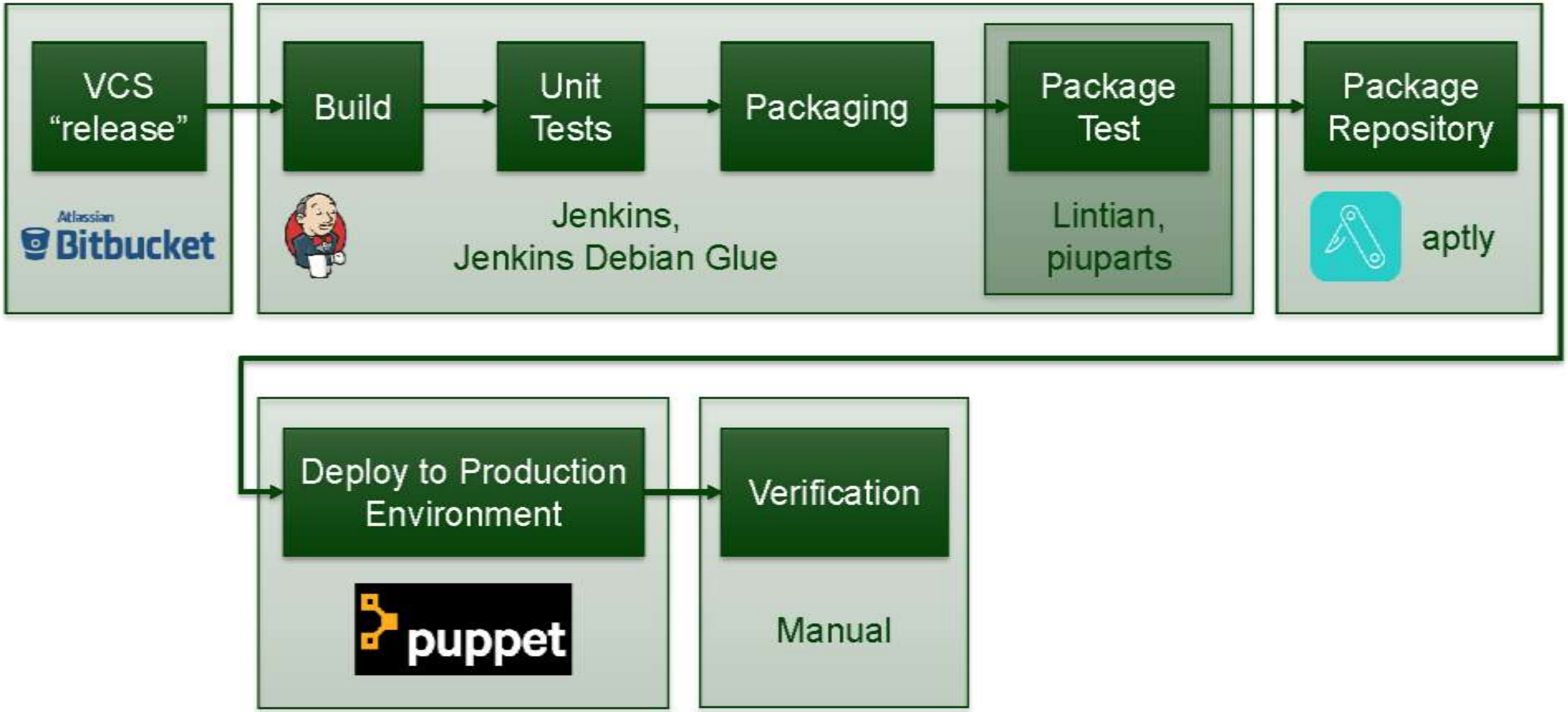


Continuous Delivery Pipeline for Test Environment



- Merge to "release" branch initiates deployment to production system

Continuous Delivery Pipeline for Production Environment



- Requires manual decision to deploy, but fully automatic from there

Deploying IOCs with Puppet: Motivation

- The FRIB approach
  - Deploy EPICS base and support modules as Debian packages
  - Build IOCs on the target machine
    - » Allows tweaking of IOC database in the production environment
- Challenges
  - Hundreds of IOCs, maintained by multiple engineers
    - » Consistency is important
  - Wide variety of IOCs require flexible deployment solution
  - Steps for setting up an FRIB IOC evolve over the years
  - Typical problems include
    - » New revision of IOC database gets pulled from Git repo but IOC maintainer forgets to restart IOC
    - » New version of support module gets deployed but IOC doesn't get rebuild
    - » Out of disk space due to missing logrotate configuration for procServ log files

EPICS Soft-IOC Puppet Module

- Features
  - IOC directory can come from any source
  - Automatically builds and restarts IOC if something has changed
  - Runs IOCs as a daemon with
    - » systemd
    - » System-V-style init scripts
  - Provides access to IOC shell via procServ
  - Supports multiple IOCs on the same machine
  - By default runs IOC process with limited user privileges
  - Rotates procServ log files
  - Lots of configuration options including
    - » Setting environment variables like EPICS_CA_MAX_ARRAY_BYTES
    - » Managing autosave directories
    - » CA security configuration

Example

```
$iocbase = '/epics/iocs'

package { 'epics-asyn-dev':
  ensure => latest,
}

class { 'epics_softioc':
  iocbase => $iocbase,
}

vcsrepo { "${iocbase}/vacuum-ioc":
  ensure   => latest,
  provider => git,
  source   => 'git://example.com/vacuum-ioc.git',
}

epics_softioc::ioc { 'vacuum-ioc':
  ensure    => running,
  enable    => true,
  bootdir   => 'iocBoot/iocvacuum',
  subscribe => [
    Package['epics-asyn-dev'],
    Vcsrepo["${iocbase}/vacuum-ioc"],
  ],
}
```

Install support packages

Ensure EPICS Base, procServ etc. are installed

Configure IOC process (use multiple of these sections to run multiple IOCs on the same machine)

Example [2]

- Use facility-wide defaults to reduce typing

```
Epics_softioc::Ioc {
  ensure     => running,
  enable     => true,
  log_server => 'logserver.example.com',
}

epics_softioc::ioc { 'vacuum-ioc':
  bootdir   => 'iocBoot/iocvacuum',
  subscribe => [
    Vcsrepo["${iocbase}/vacuum-ioc"],
    Package['epics-stream-dev'],
  ],
}
```

Experience

- Works very smoothly
- Saves quite some time when upgrading many IOCs at the same time
- For most use cases we rebuild and restart IOCs automatically after upgrading database files or support modules
  - Thus we always know that we are running the latest version
    - Avoids surprises when an IOC needs to be restarted later
  - It took a while until all engineers were comfortable with this behavior

Summary

- FRIB uses
  - Continuous Deployment with test environment
  - Continuous Delivery with production environment
- Libraries are being build as Debian packages on CI server
- IOCs are being build on the target machine
- EPICS Soft-IOC Puppet module automates deployment of IOCs
  - It's generic (no FRIB-specific functionality)
  - It's free software
    - » https://forge.puppet.com/mark0n/epics_softioc
    - » https://github.com/frib-high-level-controls/mark0n-epics_softioc