CI/CD for Infrastructure & Configuration Management

with Otter + BuildMaster

inedo

Abstract & Overview

Organizations of all sizes, from the leanest startup to the stodgiest enterprise, have been using CI/CD practices to greatly improve their ability to produce and deliver software for the business. This not only yields higher-quality software produced at lower cost but allows the business to deliver ideas to market faster.

As development teams adopt CI/CD practices, they will start delivering new applications and releases faster and faster. This constantly changing software will inevitably require changes to infrastructure and configuration, but many operations teams aren't accustomed to the pace – nor do they have the proper tools – required for these constant changes.

However, trying to directly apply the CI/CD practices that are successful for applications is highly unlikely to yield success for infrastructure and configuration changes. In this guide, we will explore:

- Why and how CI/CD has been so successful for applications changes
- Infrastructure and configuration changes as a new bottleneck
- Challenges with CI/CD for infrastructure and configuration changes
- How to overcome these challenges and implement CI/CD for infrastructure

There's also a hands-on guide for how to implement this with BuildMaster and Otter.

You can do everything in this guide with BuildMaster Free and Otter Free editions!

About Inedo, Otter, and BuildMaster

We help organizations make the most out of their Windows technology and infrastructure through our Windows-native and cross-platform DevOps tools.

- BuildMaster is a tool designed to implement CI/CD and automate releases for applications.
- Otter is a tool designed to manage infrastructure.

Harnessing the power of both tools together allows users to manage infrastructure with all the benefits provided by CI/CD.

Contents

CI/CD for Applications: A Quick Refresher

Continuous Integration (CI) and Continuous Delivery (CD) refer to a set of practices that development teams can use to produce and deliver software for business teams. CI/CD practices are not uniformly defined by a standards body such as ISO, but instead are explored, implemented, integrated, and continuously refined as part of an organization's core business processes.

Although specific CI/CD processes evolve differently within each organization, all organizations tend to experience the same benefits:

- **Better** quality of software by having less defects make it to production
- **Faster** delivery of business ideas to market by enabling faster release cycles that allow software to be changed in days or weeks rather than months or quarters
- **Cheaper** implementation across the entire lifecycle, including less time spent coding, deploying, and testing software changes

These seem almost too good to be true, yet organizations of all sizes, from the leanest startup to the stodgiest enterprise, and organizations in all domains, from banking to games, are reaping these benefits.

While this guide won't dive into the details of how to implement CI/CD for applications, we will cover the key mechanisms that drive this success (pipelines) and demonstrate how you can apply CI/CD practices to infrastructure and change management.

Pipelines: The Heart of CI/CD

One of the key components of Continuous Delivery (CD) is the deployment pipeline. Pipelines model the software release process by defining the servers and environments that builds will be deployed to, as well as the manual and automatic approvals required at each stage of the process. Different applications may use different pipelines, or the same application may use different pipelines for different releases.

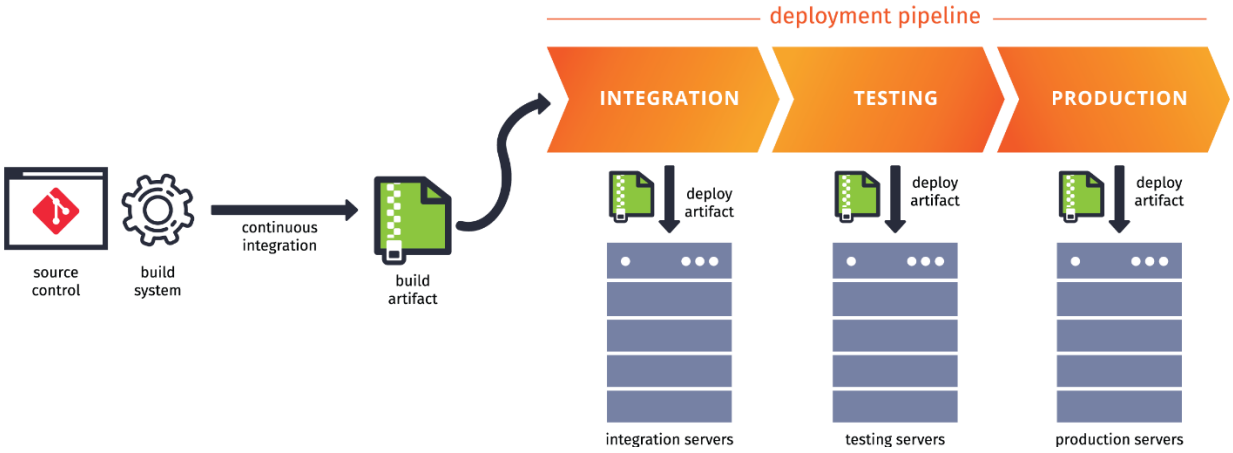
For example, a basic web application might use a pipeline with only two stages (testing and production), and simply deploy to a different folder on the same server. Another application may

require a dozen stages, each with multiple targets that go to different environments, and all sorts of automatic and human approvals to meet compliance requirements.

End-to-End Software Delivery with CI/CD

Deployment pipelines require an input (i.e. the build to deploy), and that input comes from Continuous Integration (CI). Specifically, this input is a build artifact: essentially a zip file containing the code that will deployed to each server across each environment.

When you combine CI's build artifacts and CD's deployment pipelines together, you have the essence of CI/CD: end-to-end software delivery.



The Cardinal Rules of CI/CD

Although the implementation details of a CI/CD process differ from organization to organization, they will all share a set of cardinal rules:

- **One codebase, many environments.**
    - **DO** build one version of your application that's used by all of your environments, from the same codebase or branch in source control.
    - **DON'T** build an "integration version" of the application from an integration-quality branch, then test that version and merge changes to a testing branch; then build a "testing version" for the testing environment, test and merge, all the way to production

- **Deploy the entire application or component.**
    - **DO** deploy the entire build artifact that's produced by the CI process to each environment; let your deployment tool optimize this process for you, such that unchanged files on disk are not actually copied over a network
    - **DON'T** cherry-pick files that changed between each environment as a way to mitigate risk
- **Model process with automatic and manual gates.**
    - **DO** strike a balance between automated and user testing that models the business processes and brings development and business teams together
    - **DON'T** force a fully-automated process or fully-manual process on the business users
- **Ensure traceability and auditability at every step.**
    - **DO** ensure that every production deployment can be traced back to a change in source control, and can be audited to see who approved it at different stages
    - **DON'T** bypass the process through emergencies; instead build an emergency process

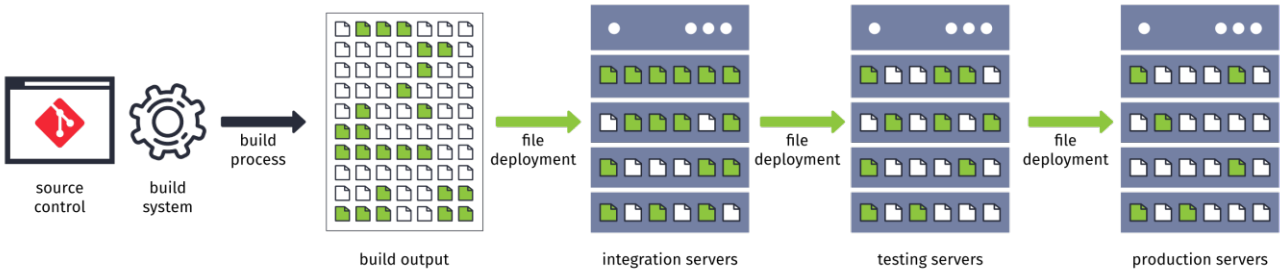
A CI/CD tool like BuildMaster (inedo.com/buildmaster) can facilitate and implement these practices.

Software Delivery without CI/CD

Without an end-to-end software delivery process, releases are often deployed by a release engineer on an ad-hoc basis, at the direction of someone on a business team or a development team. Although these deployments are usually not done manually (i.e. by logging into servers and copying files), release engineers will use a deployment tool or script that models a manual process.

Because of the inherent risk of human errors, manual delivery processes mitigate risk by not only deploying infrequently (fewer deployments means less production failures), but by cherry-picking which files to deploy. This starts by having developers use some sort of build process (either CI or manual) and specifying which files from a specific build output to deploy to the first pre-production environment.

The application is tested in the first environment. The developers then specify which files to deploy to the next environment based on which parts of the application passed testing and are therefore ready for the next stage. The process continues all the way through to production.



At each step in the process, a different set of files may be deployed to each server, and the applications in each environment are comprised of different sets of files. Ultimately, a different application is being tested in each environment, which leads to:

- **Low quality** software in production because it was difficult to test at all these levels
- **Slow** delivery of changes to production from manual and ad-hoc processes
- **Costly** implementation because of bug fixes and arduous testing/deployment processes

CI/CD Implementation Challenges

Although CI/CD can greatly improve software delivery processes, implementing it can be quite difficult. There are some technical challenges with implementing CI/CD, but the largest and most difficult-to-address challenges tend to be the required cultural and behavioral changes by the organization.

Everyone involved in the delivery process – from the release engineers, to the testers, to the business – are accustomed to the way that things are. They recognize it's suboptimal, but changing it could make things even worse, and ultimately make their lives more difficult.

Like all organizational changes, it's important to get "buy in" from those involved with the existing process, and that often involves "selling" them on the new process. With modern CI/CD tools like BuildMaster, this can be accomplished with a quick demo, and then a proof of concept.

But without CI/CD tools that allow you to easily prove not only the value of changing processes, but how relatively easy it will be to change, getting others to buy-in can be nearly impossible.

The Configuration Management Bottleneck

As development teams adopt CI/CD practices, they will start delivering new applications and releases faster and faster. This constantly changing software will inevitably require changes to infrastructure and configuration, but many operations teams aren't accustomed to the pace– nor do they have the proper tools – required for these constant changes.

Defining Configuration

"Configuration" is considered to be anything you do to a server (i.e. your infrastructure) after a fresh install of the operating system. On Windows, this includes things like:

- Adding Windows Features, such as IIS
- Creating an Application Pool
- Opening a port on the Windows Firewall
- Installing a Windows Service

Most server configuration will not have an impact on the software and applications running on the server. For example, adding IIS will have no impact on a Windows Service that you installed.

Some configuration will directly control how your applications are run. For example, a Site's configuration in IIS will determine which port the hosted application uses, and the Application Pool's configuration will determine which identity or Windows account it will run under.

Other times, configuration will indirectly impact your applications, sometimes in undesirable ways. For example, if you enable Windows Firewall and block the port your application is listening to, then users will not be able to access the application.

Managing Infrastructure & Configuration Changes

Making an actual configuration change is easy, particularly on Windows; just perform the necessary steps in the UI, or run a PowerShell script. However, managing all of these configuration changes – whether they've already been made, or need to be made in the future – can be a challenge.

Configuration management is pretty important, if for no other reason than to rebuild the server in the event of an upgrade or hardware failure. However, it's also good for auditing purposes, and lets

others see what changed – whether for compliance reasons, or to diagnose why "something stopped working" all of a sudden.

When you have testing servers that are used to validate application changes before going into production, configuration management is critical. For example, if an Application Pool on your production server is configured to run under NETWORK SERVICE, but the testing server's Application Pool uses LOCAL SYSTEM, this could lead to difficult-to-debug production bugs and outages – which was the exact thing the testing process was designed to mitigate.

Thus, there are three important aspects to configuration management:

- **Intended state**; whether in a Word document, a configuration management database, or an "infrastructure as code" file, documenting the intended state of a server lets anyone see the server's configuration without having to log in to that server
- **Change execution**; whether it's manually, with a script, or using a change management tool, how the configuration change will actually be performed against the server
- **Change tracking**; whether using a ticketing system or email, keeping track of which changes will be made or were made, when, and by whom helps auditors and developers quickly see changes

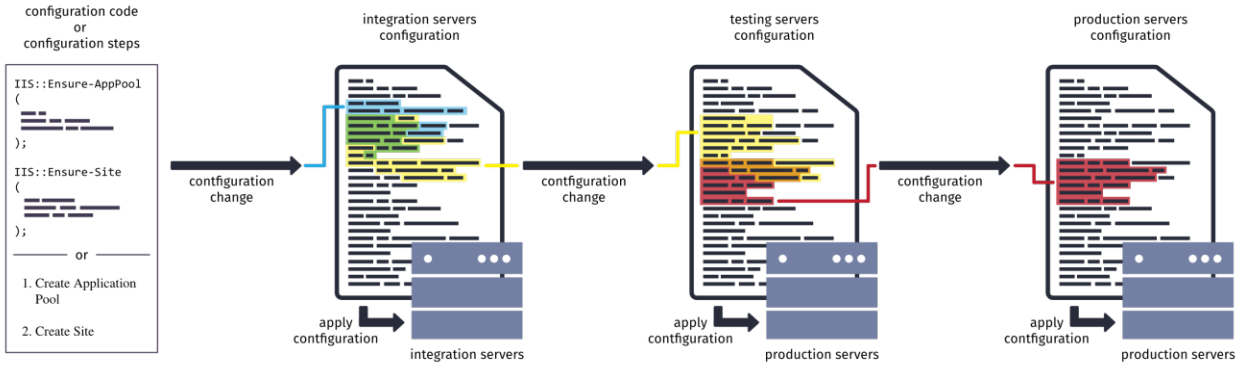
Development-driven Infrastructure & Configuration Changes

New applications and releases will often require configuration changes. For example, a new web application will need both an Application Pool and a Site in IIS with some specific settings to that application.

Configuration changes are typically made by an operations engineer on an ad-hoc basis, at the direction of a development team. Sometimes these changes are executed manually, but operations engineers may also use a configuration management tool to automate the change execution itself.

Because application changes are tested in pre-production environments prior to production, these configuration changes need to be applied to all of the servers across all of the environments that the application will use. This starts by having developers specify configuration changes (either in a script or a ticket) to apply to the first pre-production environment.

The changes are then applied and tested in the first environment. The developers then specify which configuration changes to apply to the next environment, based on which configuration performed properly and is therefore ready for the next stage. The process continues all the way through to production.



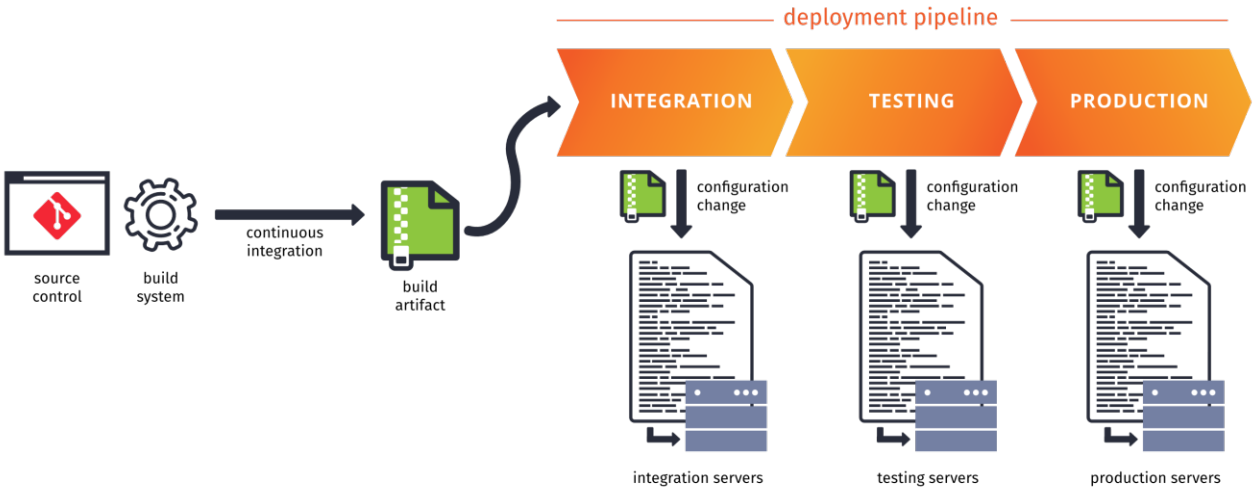
This ad-hoc, piecemeal process is very similar to the software delivery process without CI/CD, and yields the same problems:

- **Low quality** configuration in production because it was difficult to test at all these levels
- **Slow** delivery of configuration changes to production from manual and ad-hoc processes
- **Costly** implementation because of configuration fixes and arduous testing/deployment processes

However, as application releases occur more and more often and on shorter schedules, they will require more development-driven configuration changes, which will ultimately lead to a snowballing problem of lots of configuration changes that the operations team will never have the resources to manage.

Infrastructure & Configuration Deployment Pipelines

Fortunately, you can leverage deployment pipelines to deliver configuration changes. This will introduce the same benefits that development teams experienced when applying CI/CD to applications.



While the end result looks very similar to CI/CD for applications, the means of getting there is very different, and will require an advanced CI/CD platform like BuildMaster, and an advanced configuration management tool like Otter. Fortunately, this is a relatively easy process to setup and start using.

CI/CD and Infrastructure Configuration Generally Don't Mix

Trying to directly apply the CI/CD practices that your organization uses for applications is highly unlikely to yield success. There's a lot of reasons for this, both technically and culturally.

Different Missions: Development vs. Operations

Applications and infrastructure are maintained by two different teams, with two different missions.

- **Development focuses on change**. The business teams are constantly exploring new ways to change existing applications and create new ones, and development teams are constantly pushed to accelerate the change cycles
- **Operations focuses on stability**. More than anything, the business teams require that all infrastructure and applications are available without downtime, and operations teams are encouraged to avoid changes to avoid risk of failure

These teams not only use different automation tools altogether, but they have different policies for how changes are managed within those tools.

Different Auditing & Compliance

Despite these divides, a common goal of both teams is change tracking.

For development teams, this is relatively easy, even for teams with poor CI/CD tools and setups. Because source control serves as the "source of truth" for what the application code should be, even without proper traceability, you can use file dates and sizes to "backtrack" to the person who committed the code and hunt down the reason for making that change.

This approach doesn't work for infrastructure and configuration changes. There is no built-in "change record" like source control, and the "source of truth" is the actual server itself. By simply inspecting a server, there's no way of knowing when it was configured, who configured it, let alone why it was configured.

This is why operations teams tend to develop arduous change management processes, and why development teams don't quite understand why they're so important.

Different Paradigm: Applications vs. Configuration

Applications are comprised of files on disk. Updating applications simply involves replacing files on disk. You can easily backup applications by zipping up these files, and rollback to a previous version by restoring the files.

Servers, on the other hand, are much more complicated, and are updated by performing a series of steps in the UI or with a script. You can't easily backup or a restore a server, and if you want to "rollback" to a previous configuration, you have to essentially apply a different set of steps

While server configuration can be abstracted by using a "declarative configuration" script (such as OtterScript), the automation tool that processes the script performs the same steps that you would otherwise manually run. For example, consider this simple OtterScript statement:

```
IIS::Ensure-AppPool AccountsWeb ( Pipeline: Integrated );
```

Upon seeing this statement, Otter will check to see if there is an Application Pool named AccountsWeb, and create it if not. Otter will then make sure that the Application Pool's "Pipeline"

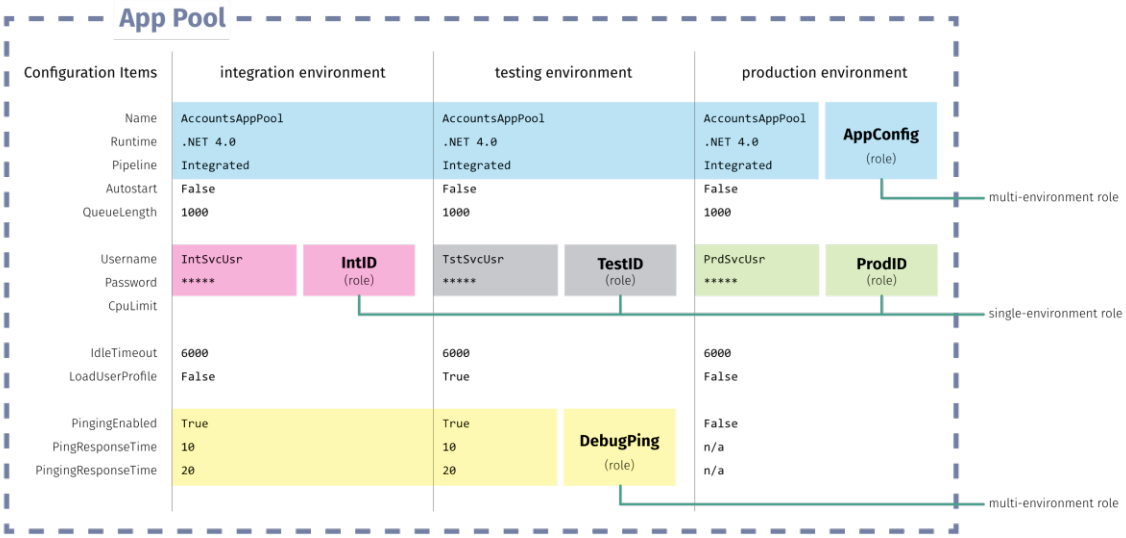
setting is configured as Integrated, and that's it: no other configuration changes are made to the AccountsWeb application pool, or any other application pool unless explicitly defined.

Compare this to an application deployment; whenever you deploy a file, the entire file is replaced, not a "line item" within the file.

Different Configuration for Different Environments

Even if they're running the exact same applications, servers are inherently different and will often require different configuration. This is especially true for servers in different environments, such as production and pre-production testing environments.

Some sets of configuration (i.e. configuration roles) will be identical across all environments, such as the core requirements for a particular application. Other configuration may only be used in pre-production environments (like debug settings), or may be unique per environment (like identities):



The "different configuration for different environments" fundamentally clashes with the "one codebase, many environments" cardinal rule of CI/CD.

Different Types of Configuration Changes

A lot of infrastructure and configuration changes will occur outside of application release cycles, such as operating system patches, security hardening, monitoring, and so on. These types of changes impact all software running on the server, including third-party applications and services.

Because these configuration changes may impact server performance, they are tested in a similar manner to application changes prior to being applied to production. Operations teams will want to use the same processes to test all types of configuration changes, which is often difficult to adapt for fast-paced application release changes.

Adapting CI/CD Pipelines for Infrastructure

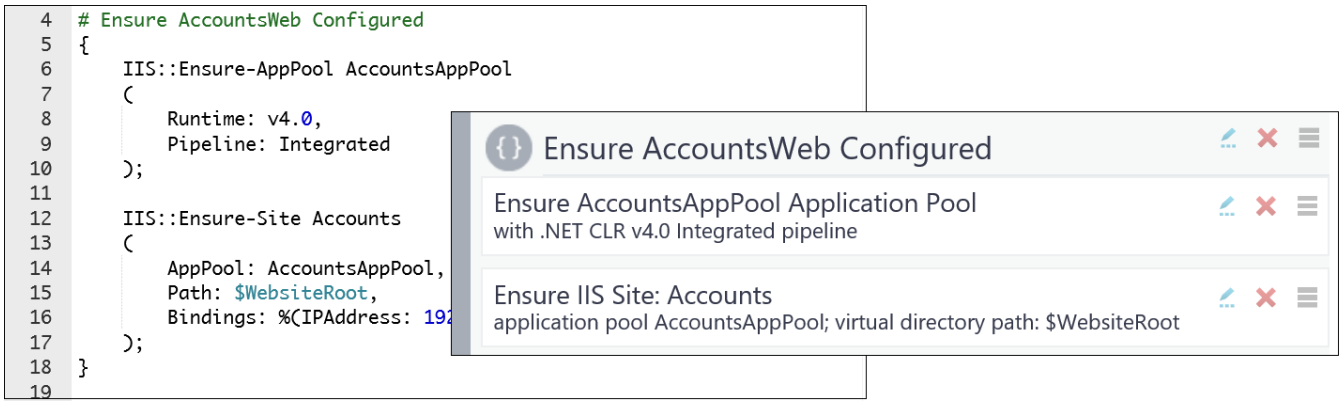
Although there are a lot of technical differences between applications (code) and infrastructure (configuration), one of the hardest things to overcome when adapting CI/CD is the mental model. Operations teams will need to be comfortable with "infrastructure as code", and development teams will need understand that "infrastructure as code" isn't actually code.

Declarative Configuration Management

Although there's a lot of ways you can manage server configuration, from arduous, hand-crafted spreadsheets to heavy-handed configuration management databases, the concept of "Declarative Configuration Management" has evolved as the best way to keep track of constantly and rapidly changing configuration.

Declarative configuration management allows you to define the desired end state, not the steps required to attain it. This "Desired configuration" approach was pioneered over a decade ago with open-source tools for Linux such as Chef and Puppet. These tools allow infrastructure-savvy developers to paint a picture of a successfully running application for code-savvy operations engineers.

As a Windows-native DevOps tool, Otter has brought this approach to Windows and makes it easy for both development and operations teams to understand and change configuration. Here's what a declarative configuration plan for a simple web application looks like using OtterScript:



While the approach is similar to Linux-native tools, OtterScript lets you switch back-and-forth between visual and text modes.

When this configuration plan is applied against a server, Otter will *ensure* that the desired configuration exists, and either create the necessary Application Pool and Website, or update it to match the specified configuration. Otter also tightly integrates with PowerShell DSC, allowing you to use DSC Resources to configure virtually everything on a Windows server.

The key benefit of declarative configuration is that you don't need to worry about the actual configuration on the server; simply change the configuration plan, and the server's configuration will be changed to match the plan.

Server Roles

A server role is essentially an OtterScript configuration plan, and it's used to define a specific set of configuration that can be assigned to any number of servers. Roles are used to describe any type of configuration, from application-driven settings to security hardening or compliance policies.

For example, you may have an `iis-server` role that ensures IIS is enabled as a Windows feature, as well as an `accounts-web` role that ensures a specific web application is configured properly. The `iis-server` role would be applied to all web application servers, while `accounts-web` would only be applied to servers that run the AccountsWeb application.

Although servers in each environment will often have different configuration, you should generally avoid creating environment-specific roles, especially for application-based configuration. This is because environments are generally used to test and validate changes before production, but if you're not applying the exact same set of configuration (i.e. a roles) to these environments, then

you're not really testing the same things. This largely defeats the purpose of pre-production testing.

For example, if the AccountsWeb application is stored in different paths on production and testing servers, you should not create `accounts-web-test` and `accounts-web-prod` roles, but instead use a variable like `$WebsiteRoot`, and then configure that variable value on each server.

Infrastructure as Code

Role configuration plans are defined using OtterScript and stored as text files. These roles will not only depend on other roles, but will use assets like OtterScript modules, PowerShell/shell scripts, and configuration files. All of these still remain declarative in nature, which means that when you edit a configuration role, the server's configuration will be updated to match the role's configuration plan.

This technique is generally referred to as "infrastructure as code". While all of these files aren't traditional application code, you can store them in a source control (Git) repository for versioning and change tracking purposes. This also allows your source control repository to be the "source of truth" for infrastructure and configuration changes.

Rafts & Related Configuration

Otter can bundle roles and related configuration assets into an abstract file system called a raft. For example, you could bundle all of the required configuration for a particular set of applications that are maintained by a single development team into a raft that they have permission to maintain.

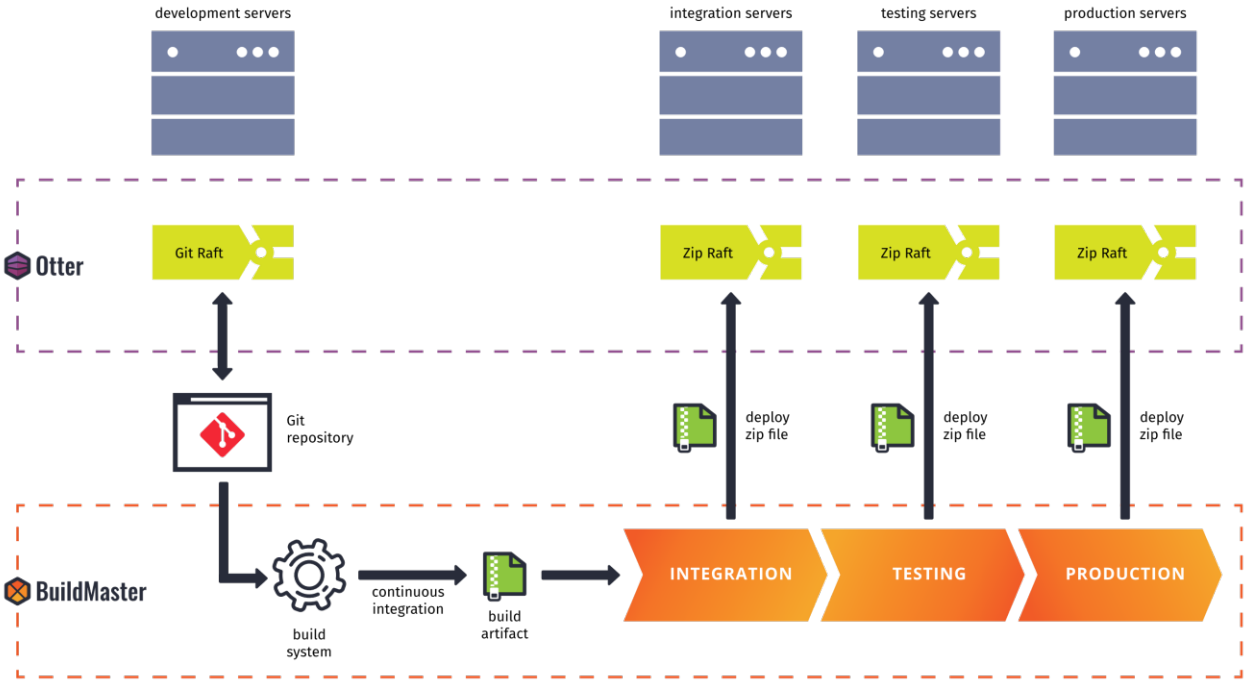
These rafts can be backed by a Git repository, which means that changes made to raft files from within the Otter UI will automatically be committed to the Git repository. You can also commit changes to the Git repository outside of Otter, and Otter will then apply those changes to servers as configured.

Rafts in Otter can also be backed by a zip file, which means that they would be read-only and un-editable from the Otter UI. While this can be seen as a hinderance in some cases, they allow you to enforce the same rules you would for an application deployed to a server: no piecemeal editing of files.

CI/CD for Infrastructure

Once you have your infrastructure code in a Git repository, you can use a tool like BuildMaster to retrieve that code from that repository and then create a build artifact from it. BuildMaster can then use a pipeline to deploy those build artifacts to the Otter server to use a zip-based raft.

Ultimately, the CI/CD for Infrastructure pipeline looks very close to the CI/CD for Applications pipeline.



Like CI/CD for Applications, you should always use a pipeline to deploy changes. This means starting in source control and deploying those changes through all of the environments. If you need emergency changes that bypass most of the testing processes, then you can simply build an emergency pipeline and use that.

CI/CD for Infrastructure & Configuration Management

Hands-on with Otter + BuildMaster

BuildMaster is a tool designed to implement CI/CD and automate releases for applications. Otter is a tool designed to manage infrastructure. Harnessing the power of both tools together allows users to manage infrastructure with all the benefits provided by CI/CD.

You can do everything in this guide with BuildMaster Free and Otter Free editions!

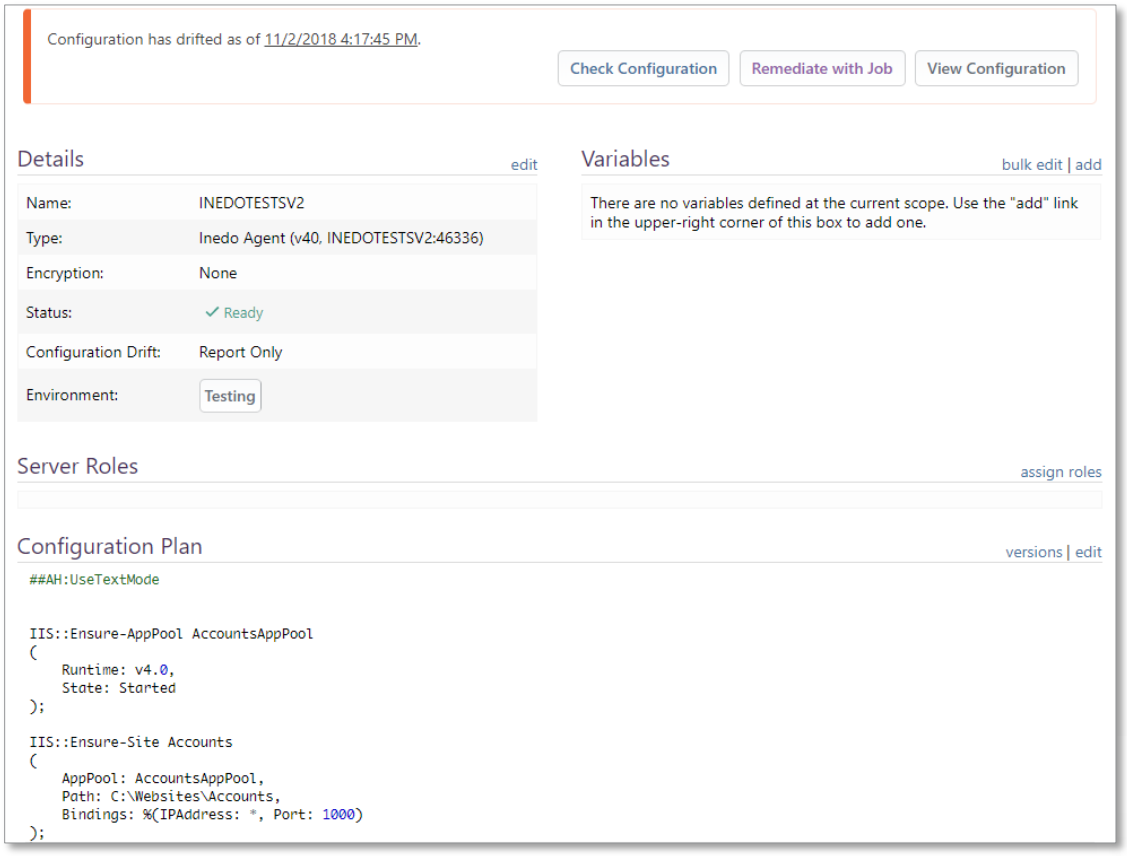
Contents

Basic Set-up: Versioned Configuration Management with Otter

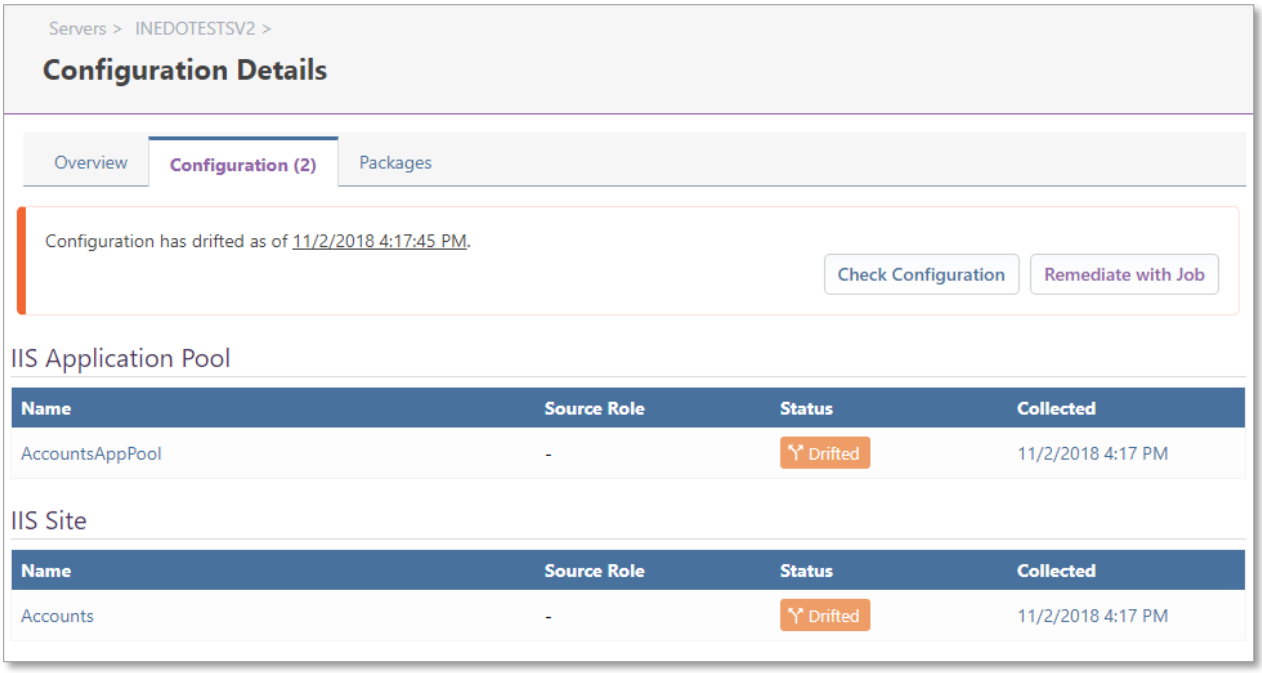
Otter manages full server infrastructure via the “Infrastructure as Code”, or IaC, paradigm. Effectively, OtterScript is the DSL used to define infrastructure on either a server directly or a server role (which can be assigned to any number of servers), and any server or role in Otter can be configured to automatically remediate drift, or to facilitate change tracking by monitoring drift only.

This infrastructure code and related resources (e.g. servers, variables, orchestration plans) are stored in a “raft”, an extensible filesystem of sorts. By default, these resources are stored in the Otter database, but another common raft is the Git raft, which transforms any changes to OtterScript into commits within Git. This opens the door to all the benefits provided by a full source control management system including complete version history, diff reports, ability to edit outside of Otter, and more.

In the following figure, we will see a basic configuration of a server in the Testing environment:



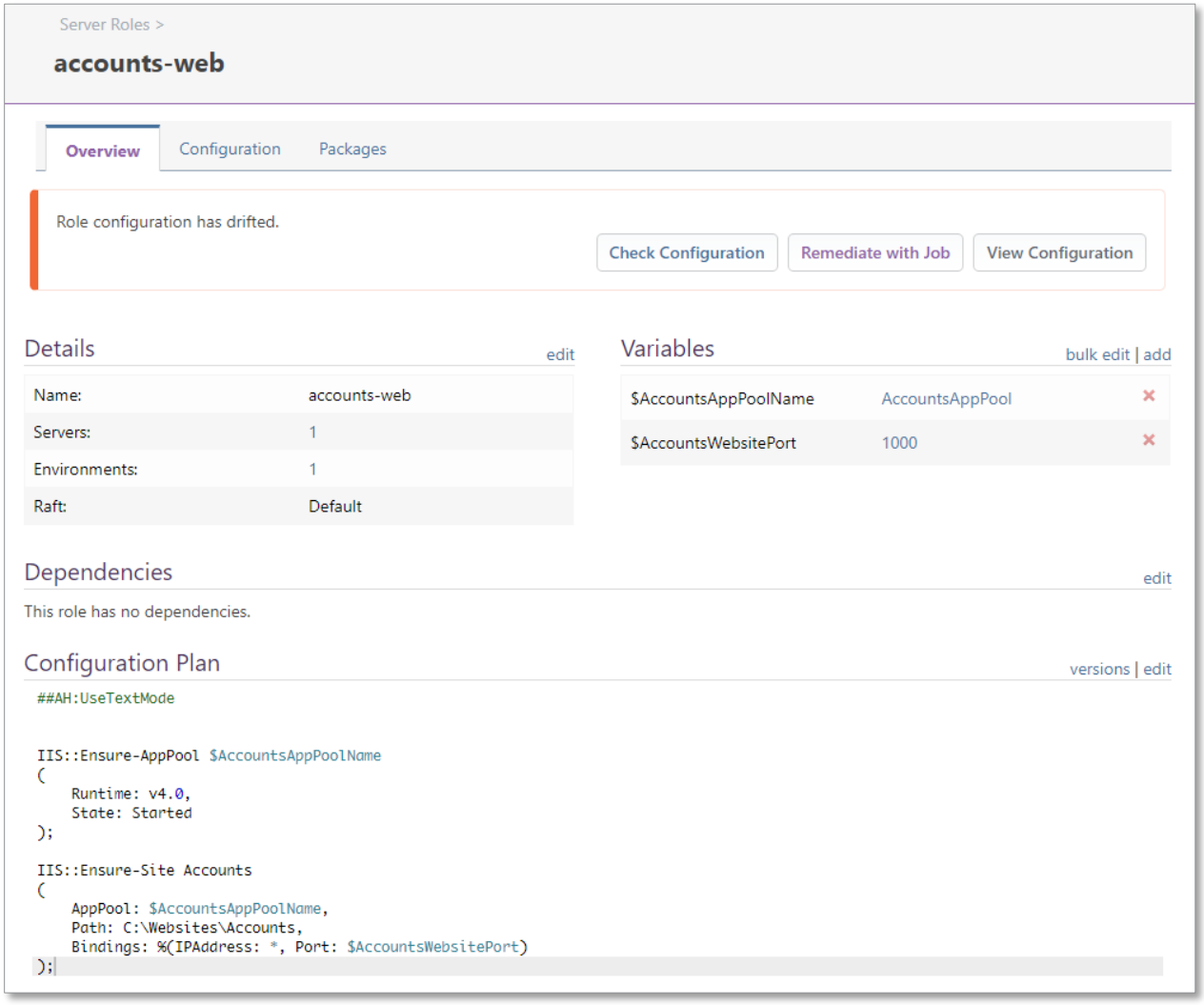
Otter notes that “Configuration has drifted” for this server because either the specified application pool or site under the “Configuration Plan” does not exist on that server, detailed further under the “Configuration” tab:



By choosing the option to “Remediate with Job”, Otter will create both the application pool and site on the test server. Alternatively, configuring the server to “automatically remediate” will fall more in line with more traditional IaC tools by simply installing the missing resources the moment they are detected missing.

Changing Configuration without CI/CD

While changing the configuration of a single server is interesting, it is much more interesting to propagate these changes across multiple servers and/or environments. In Otter, this is achieved with server roles. Instead of declaring the infrastructure directly on the server itself, a new role would be created and the infrastructure definitions assigned there:



An interesting note from this role configuration is the usage of variables to define the application pool name and its associated site's port. These configured values act as the default, but any server associated with this role may override that value simply by adding a variable value with the same name. A common example of a port change across environments like this is when SSL is enabled on the testing/staging/production servers, but not the development server.

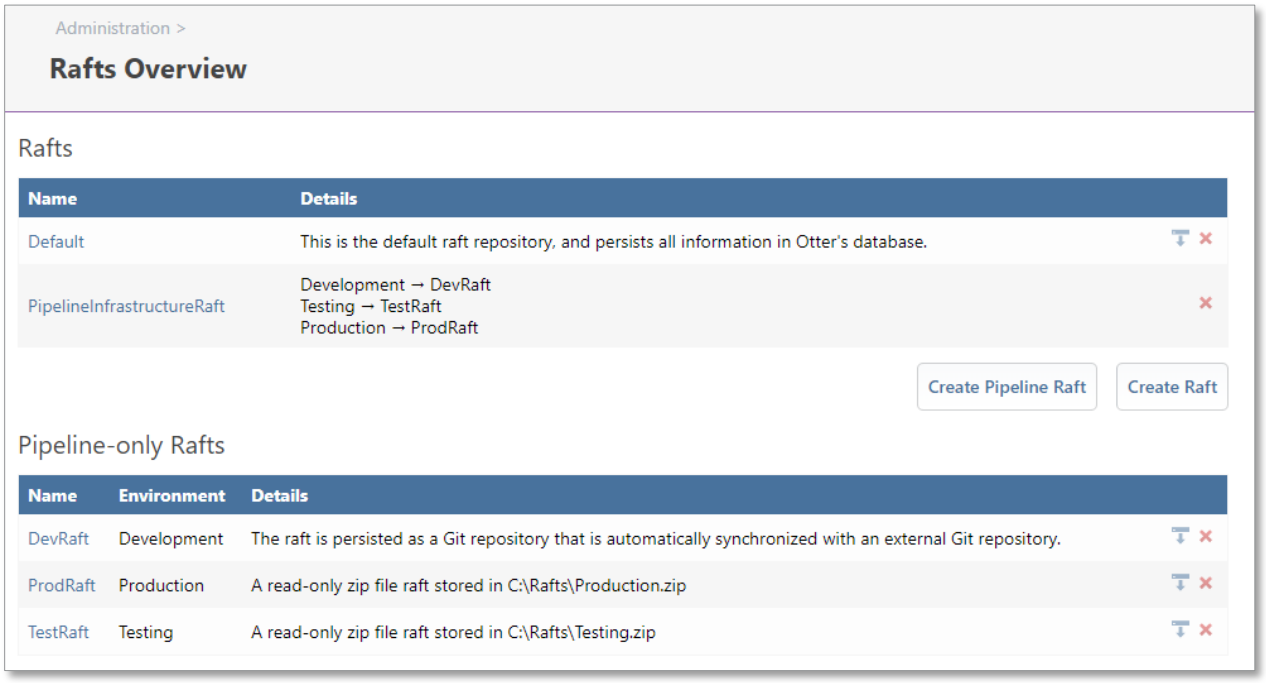
With Otter alone, a pipeline can be mimicked by applying a server role to a server in a later environment upon deployment to that stage of the pipeline. This is effective if the role is ultimately defined correctly on the first attempt at a release, but as both software developers and release managers alike are aware, this sort of perfection is hardly ever based in reality.

If, for example, the “pipeline mode” of the application pool were required to change from Classic to Integrated mode, updating the server role’s configuration would update all servers associated with that role, regardless if testing was performed in earlier environments in the pipeline. While one relatively small change like this typically does not cause infrastructure problems, if several small changes are combined, it becomes exponentially more difficult to track what was changed versus what was tested.

CI/CD Set-up: Infrastructure Pipelines with Otter + BuildMaster

By allowing BuildMaster to orchestrate Otter changes within the context of its own pipelines, a complete CI/CD pipeline can be realized without slowing the cycle of development or deployment. At a high-level, the process inherits the benefits of Git rafts for development environments (the equivalent of CI for infrastructure), and artifact creation and promotion for later environments (the equivalent of deployment pipelines). The artifacts themselves are read-only zip file rafts, which then become associated with a release, and promoted through pipeline stages as the release cycle dictates, keeping infrastructure in line with application code.

The first step of the setup involves creating a set of "pipeline-only" rafts in Otter and then associating them with a pipeline raft, which is essentially a pointer to a different raft depending on environment:



The "DevRaft" in this example is a Git raft and represents the infrastructure of the Development environment. The others two are read-only zip file rafts.

From the BuildMaster standpoint, the setup involves configuring an application that captures the infrastructure from Git at a certain point in time into an artifact (which itself is simply a zip file). An example pipeline JSON for this application is:

```
{
  "Name": "Infrastructure-CI-CD",
  "Description": "Pipeline that captures infrastructure from Git, represented by
the DevRaft in Otter",
  "Color": "#9163aa",
  "EnforceStageSequence": true,
  "Stages": [
    {
      "Name": "Build",
      "Targets": [
        {
          "PlanName": "Capture Git Infrastructure",
          "EnvironmentName": "Build",
              "DefaultServerContext": "Specific",
              "ServerNames": ["localhost"]
        }
      ]
    },
    {
      "Name": "Testing",
      "Targets": [
        {
          "PlanName": "Deploy",
          "EnvironmentName": "Testing",
              "DefaultServerContext": "Specific",
              "ServerNames": ["ottersv1"]
        }
      ]
    },
    {
      "Name": "Production",
      "Targets": [
        {
          "PlanName": "Deploy",
          "EnvironmentName": "Production",
              "DefaultServerContext": "Specific",
              "ServerNames": ["ottersv1"]
        }
      ]
    }
  ]
}
```

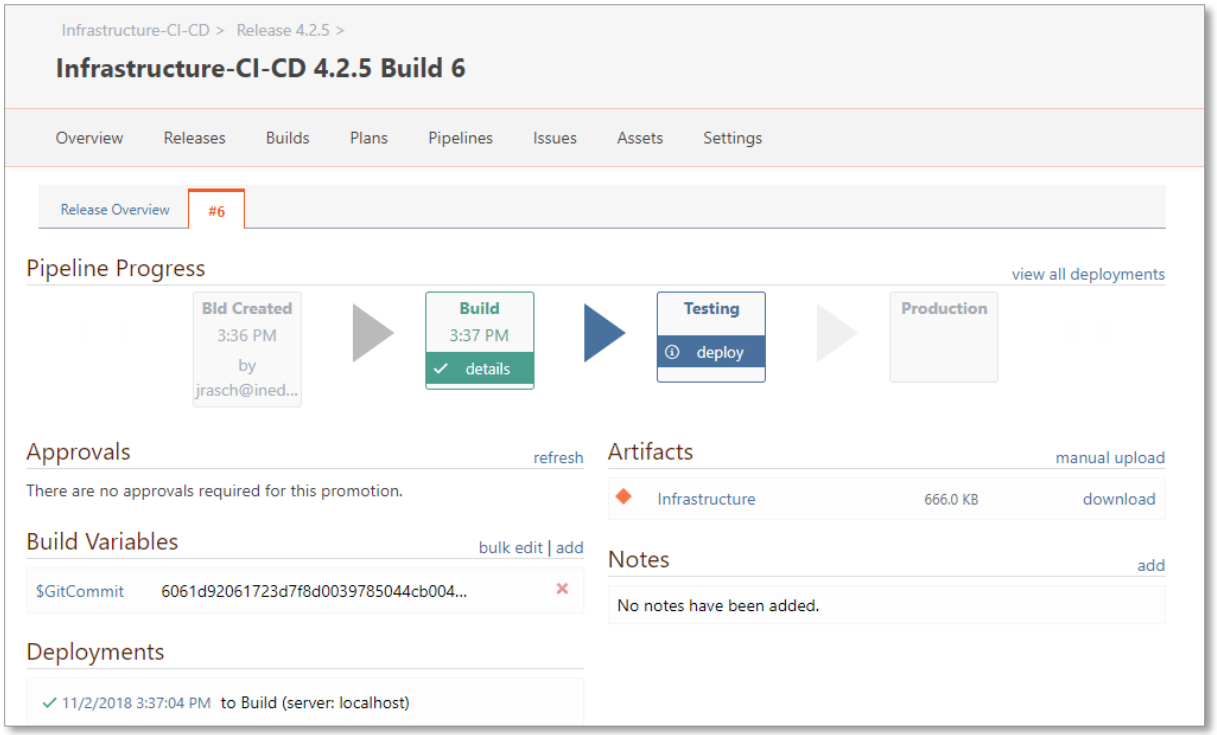
The “Capture Git Infrastructure” plan is defined as:

```
GitHub-GetSource
(
    Credentials: GitHubInedoBuilds,
    Organization: Inedo,
    Repository: OtterRaftTest,
    DiskPath: ~\Infrastructure,
    Branch: infrastructure-ci-cd,
    CommitHash => $commit
);

Set-ReleaseVariable GitCommit
(
    Value: $commit,
    Build: $BuildNumber
);

Create-Artifact Infrastructure
(
    From: ~\Infrastructure,
    Exclude: .git**
);
```

Now, when a build of this application is created in BuildMaster, the infrastructure that was defined in Git becomes an artifact, along with the Git commit it was pulled from:



This build can now be deployed through the pipeline using a “Deploy” plan defined as follows:

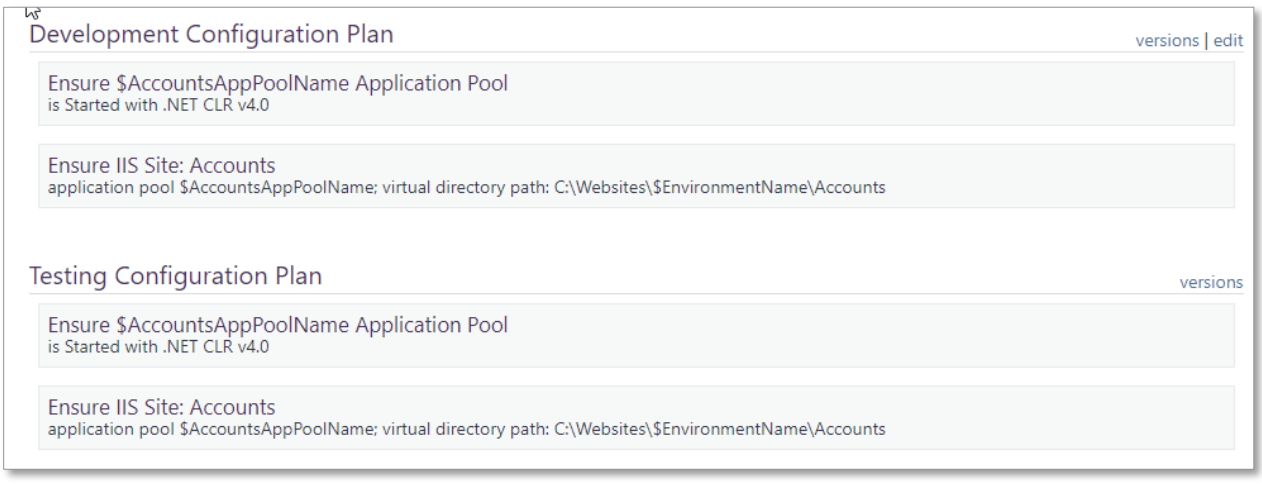
```
Deploy-Artifact Infrastructure
(
    To: C:\Rafts,
    DeployAsZipFile: true
);

Rename-File
(
    From: C:\Rafts\Infrastructure.zip,
    To: C:\Rafts\$EnvironmentName.zip,
    Overwrite: true
);
```

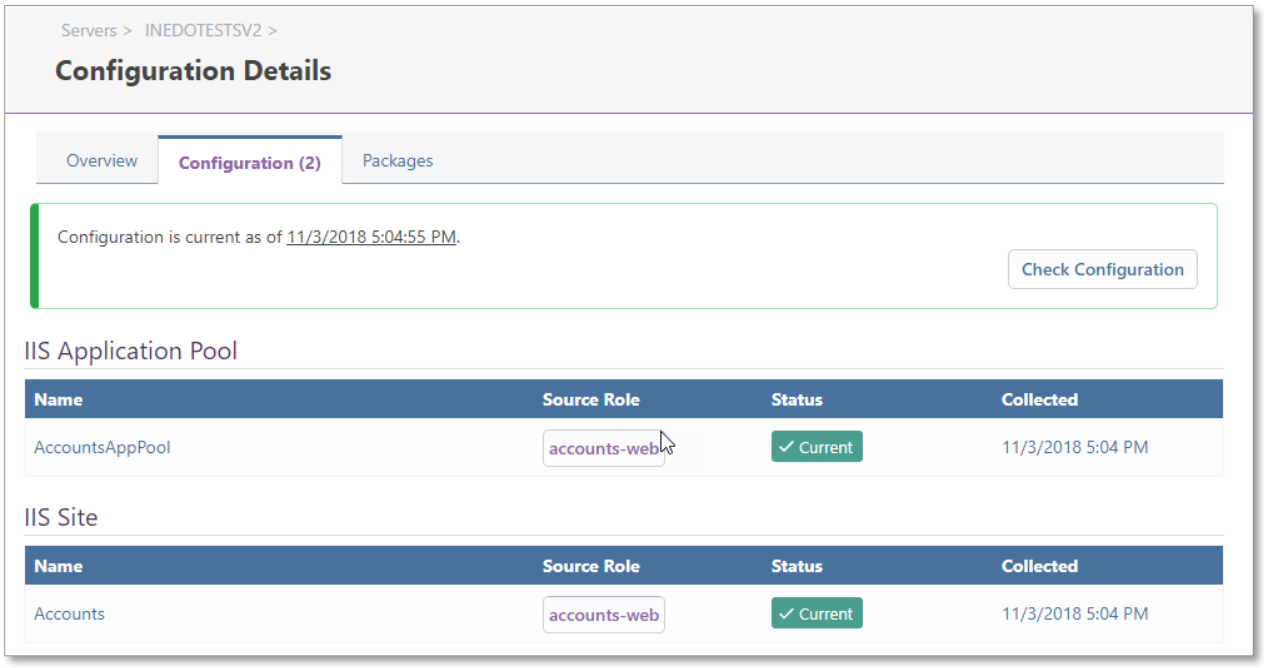
In Otter, we set the “accounts-web” role to use the “PipelineInfrastructureRaft” created earlier, and infrastructure is now ready to be promoted through a pipeline.

Changing Configuration with CI/CD

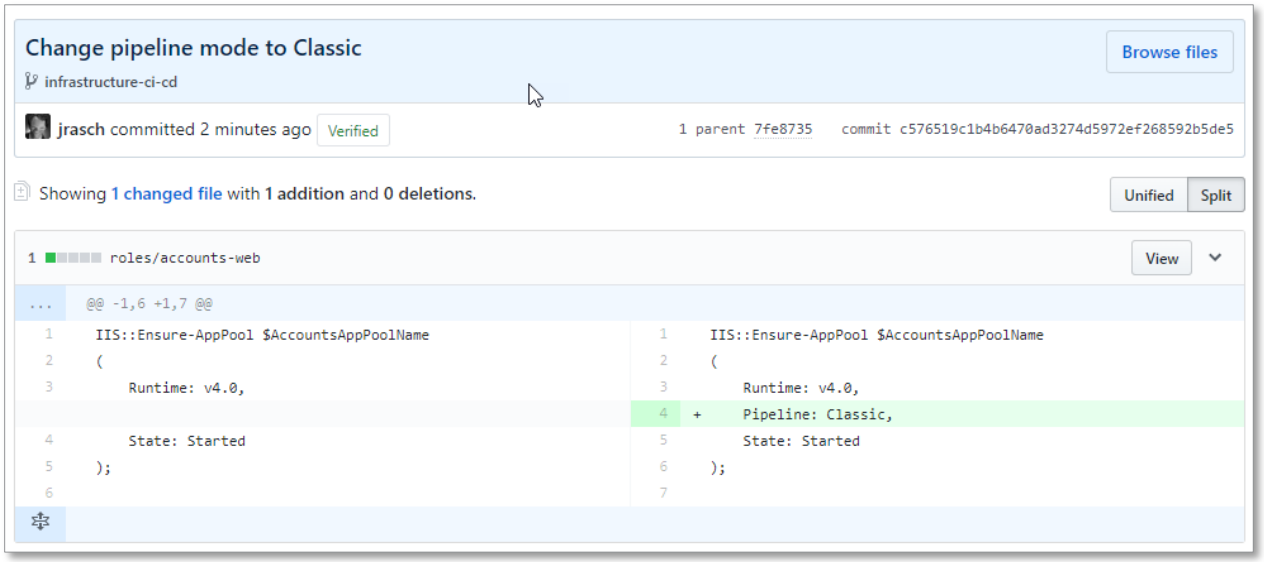
In the following example, we will demonstrate the process of applying a configuration change to an application pool and IIS site through a pipeline. First, we will note the role’s specified configuration is the same for the Development (i.e. direct from Git) and Testing (i.e. from the zip file) pipeline rafts:



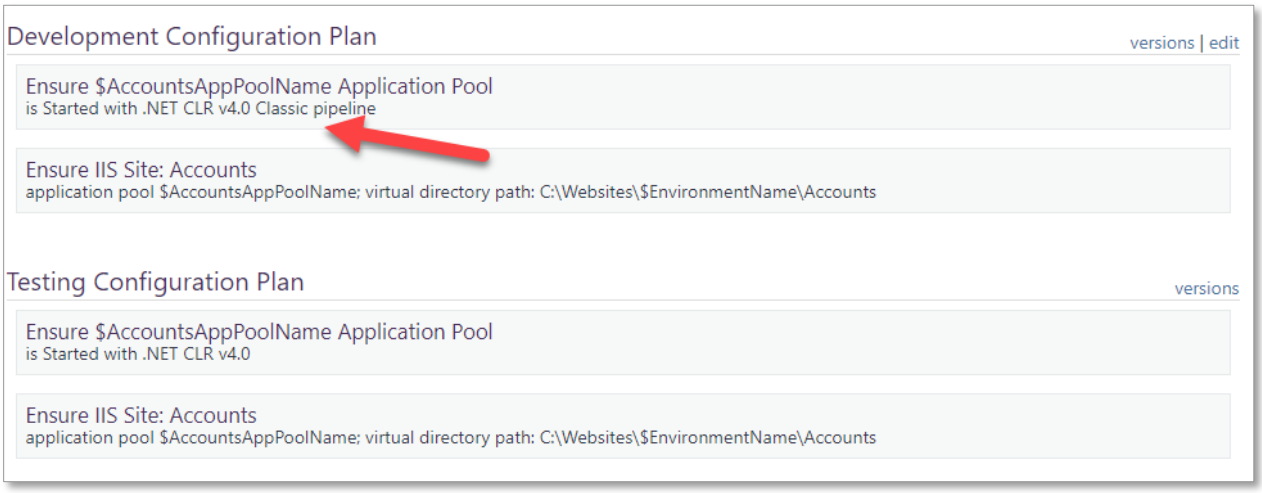
Second, we will note that the test server is up-to-date with the Testing configuration of the role:



Now we will make a configuration change directly to the Development environment, this time by editing configuration within Git instead of in Otter:

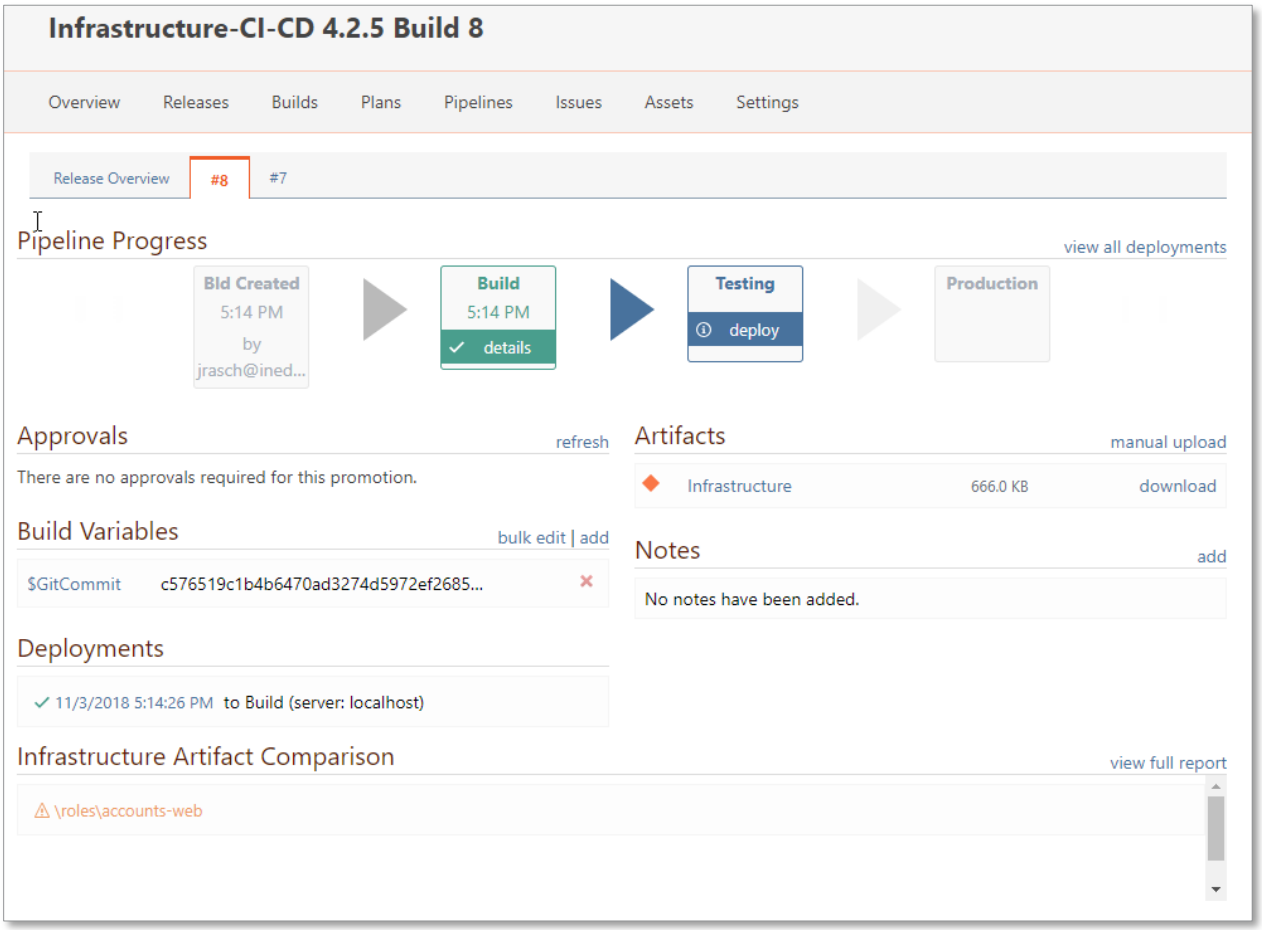


Once committed, this change is immediately reflected in Otter itself on the “accounts-web” role:

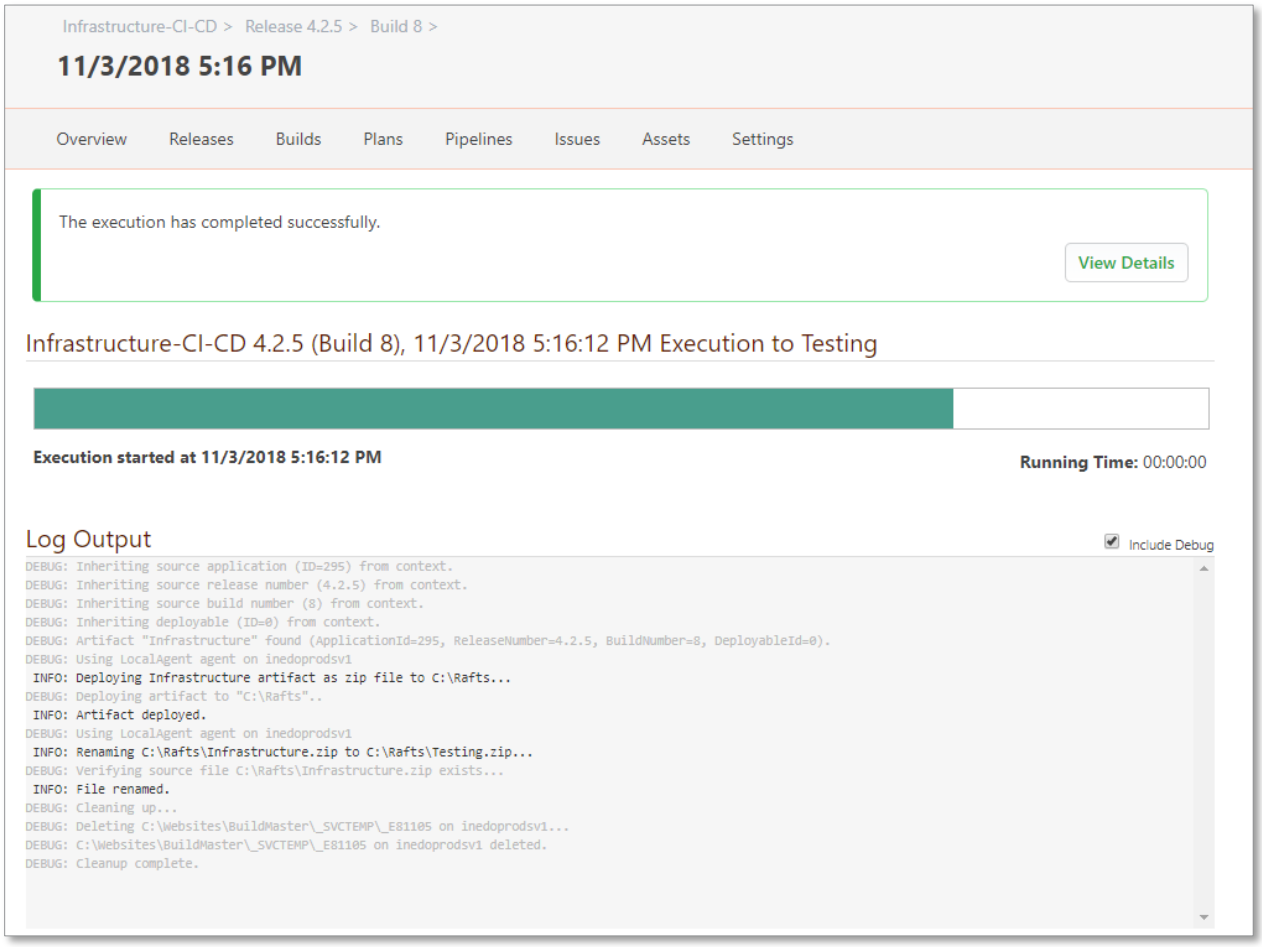


Note that the Testing configuration plan has not changed, and thus, the server associated with the Testing environment still appears as non-drifted.

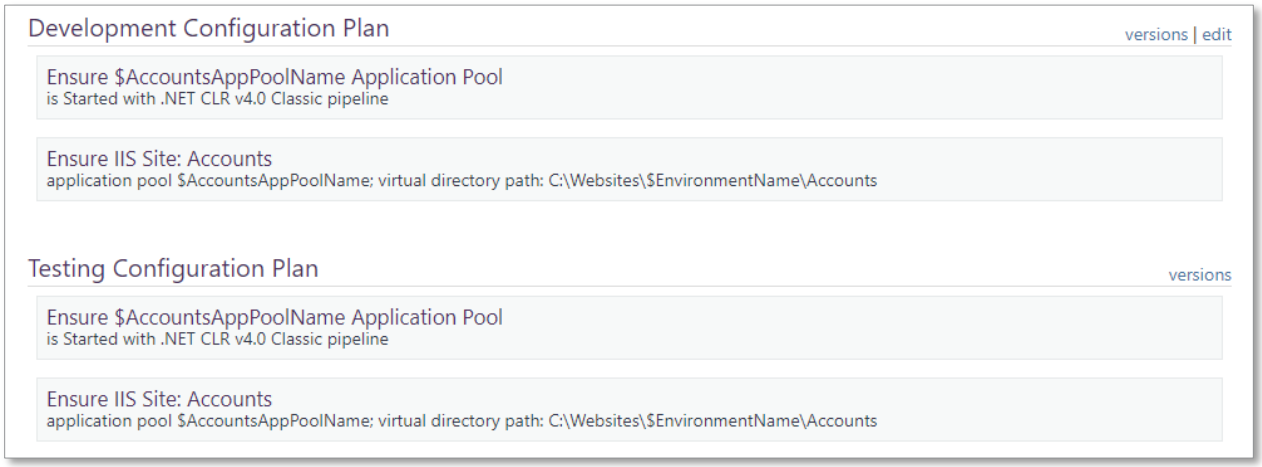
Now we will capture this infrastructure configuration by simply creating a new build in BuildMaster:



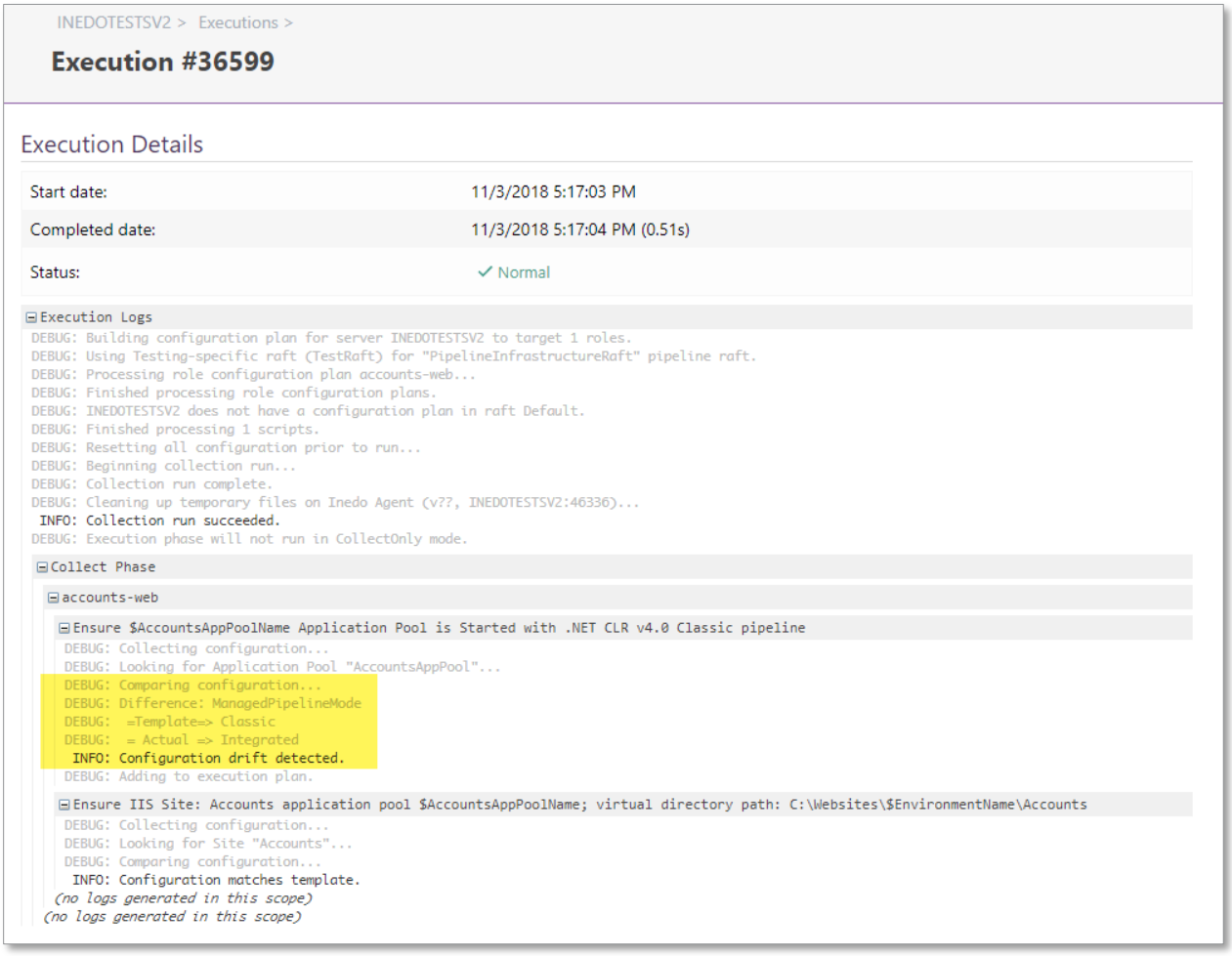
And to apply it to the testing environment by deploying to the Testing stage:



Referring back to Otter, the Testing configuration plan now matches the configuration plan of the Development environment:

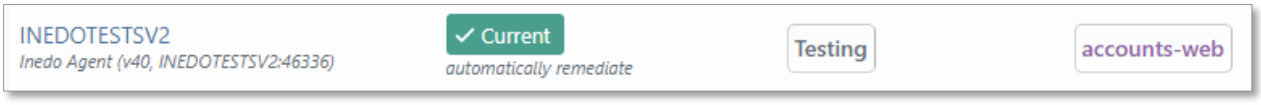


Further, any server associated with this role in the Testing environment is now considered drifted because the application pools as configured on the server are set to Integrated mode, as confirmed by both the server role and server overview pages. The collection log also details the drift:



As mentioned earlier in the setup instructions, we could also change the server's auto-remediation settings from "Report Only":

to "Automatically Remediate", and Otter will remediate the server without any intervention required from the user once the infrastructure artifact is promoted to Testing:

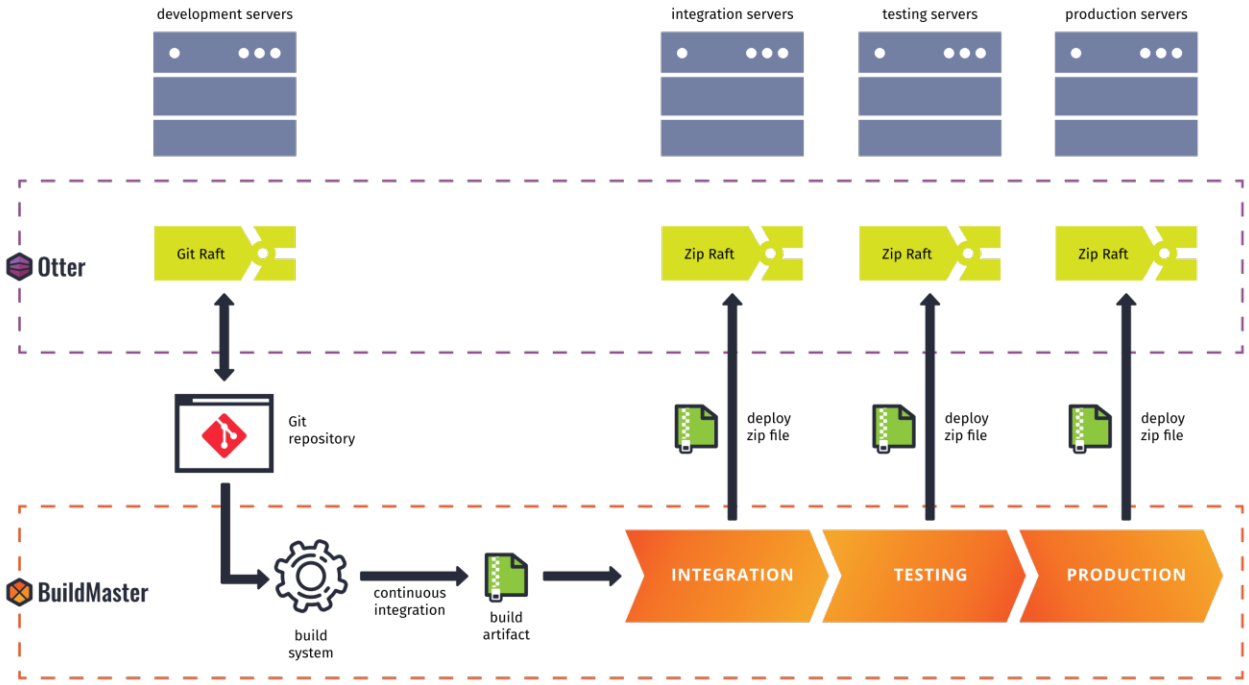


Next Steps

This guide introduced the following topics surrounding CI/CD for infrastructure:

- Why and how CI/CD has been so successful for applications changes
- Infrastructure and configuration changes as a new bottleneck
- Challenges with CI/CD for infrastructure and configuration changes
- How to overcome these challenges and implement CI/CD for infrastructure
- How to actually implement CI/CD for Infrastructure with Otter + BuildMaster

CI/CD for infrastructure is an advanced practice, and if you're not already using a CI/CD tool for applications delivery like BuildMaster, as well as a configuration management tool like Otter, you should start implementing those practices, and work your way towards continuously improving.



Remember, you can implement everything using Otter Free and BuildMaster Free editions and downloading/installing just takes a few minutes. Get started today!


inedo