7 Ways to Optimize Jenkins/Hudson

Kohsuke Kawaguchi
CloudBees Architect & Jenkins/Hudson Creator
kkawaguchi@cloudbees.com | @kohsukekawa

Hudson/Jenkins is widely recognized as a core tool for developers, QA engineers, project managers, release engineers, operations and managers. It is also a crucial open source option for teams using Agile methodology, in which continuous integration is a fundamental practice.

While Jenkins is not difficult to set up and configure, you will get better results, support more projects and save administration time if you know the tips, tricks and optimal settings that can make your installation function most effectively. This white paper, written by the creator and community lead of the Jenkins/Hudson project, offers seven best practices you can use to ensure that your continuous integration environment is optimally configured. Apply these tips to make sure Jenkins is set up to expand quickly enough to meet your continuous integration needs.

Introduction

Jenkins (formerly Hudson) is the world's most popular open source Continuous Integration software, with more than 25,000 sites using it to deliver superior-quality products. Jenkins provides two critical functions that help teams improve code quality:

- Continuously build and test
- Monitor jobs

Jenkins is widely recognized as a core tool for developers, QA engineers, project managers, release engineers, operations and managers alike. You can set it up to watch for any code changes in places like SVN and Git, automatically do a build with tools like Ant and Maven, initiate tests, take actions like roll back, and notify you of any issues that arise along the way. Over the last few years, Jenkins has become the hub of the development lifecycle and has proven to be an efficient tool to deliver superior-quality code, increase productivity, and reduce costs. Teams using Agile methodology, in which continuous integration is a fundamental practice, will find Jenkins particularly useful.

This paper gives you seven easy techniques you can apply immediately to ensure a smoothly running Jenkins production server. While Jenkins is not difficult to set up and configure, you will get better results, support more projects and save administration time if you know the tips, tricks and optimal settings that can make your installation function most effectively. Even if you are already running Jenkins, it's not too late to implement these simple best practices that ensure reliable, optimized production operation.

#1: Back Up and Restore

Problem

Teams often procrastinate taking backups. When disaster hits, they are left scrambling.

Background

If you're like me or other typical folks out there, you've probably been postponing backups because you have more important things to worry about. But as you surely know, it's very important to have a backup, and better late than never!

Tips at a Glance

1. Make sure you have backups – better late than never

2. Plan disk usage – make sure it's expandable

3. For easier installation and migration, use native packages if possible

4. Do distributed builds

5. Use labels to optimize resource utilization and improve manageability

6. Make your Jenkins URL short and memorable

7. Discard old build records to keep your Jenkins instance healthy

About the Author

Kohsuke Kawaguchi is the creator and community lead of the Jenkins (formerly Hudson) continuous integration server, as well as an architect for CloudBees. He wrote the majority of Jenkins/Hudson core single-handedly and has been involved in JAXB, Metro web services stack, GlassFish v3, and RELAX NG at Sun Microsystems. Kohsuke is also known for a large number of open-source projects, such as args4j, YouDebug, com4j, Animal Sniffer, Sorcerer, wagon-svn, MSV, and Parallel JUnit extension. ***Learn more...***

In addition to disaster recovery, Jenkins backups are useful insurance against accidental configuration changes, which might be discovered long after they were made. A regular backup system lets you go back in time to find the correct settings.

Solution: Just Do It!

So don't wait, just do it! Fortunately, it's easy…

Backup Planning

Jenkins stores everything under the Jenkins Home directory, `$JENKINS_HOME`[1], so the easiest way to back it up is to simply back up the entire `$JENKINS_HOME` directory. Even if you have a distributed Jenkins setup, you do not need to back up anything on the slave side.

Another backup planning issue is whether to do backups on live instances without taking Jenkins offline. Fortunately, Jenkins is designed so that doing a live backup works fine – configuration changes are atomic, so backups can be done without affecting a running instance.

Optimizing Backups

Optimization 1: Back up a subset of $JENKINS_HOME

Although `$JENKINS_HOME` is the only directory you need to back up, there's a catch: this directory can become rather large. To save space, consider what parts of this directory you really need to back up and back them up selectively.

The bulk of your data, including your job configuration and past filed records, lives in the `/jobs` directory. The `/jobs` directory holds information pertaining to all the jobs you create in Jenkins. Its directory structure looks like this:

```
/jobs/*
– builds              (build records)
– builds/*/archive    (archived artifacts)
– workspace           (checked out workspace)
```

Don't Back These Up

The following directories contain bits that can be easily recreated, so you don't need to include these in the backup:

- `/war` (exploded war)
- `/cache` (downloaded tools)
- `/tools` (extracted tools)

The `/builds` directory stores past build records. So if you're interested in configuration only, don't back up the builds. Or perhaps you need to keep build records but can afford to throw away archived artifacts (which are actually produced binaries). You can do this excluding `builds/*/archive;` note that these artifacts can be pretty big, excluding them may introduce a substantial savings.

Finally, the workspace directory contains the files that you check out for the version control systems. Normally these directories can be safely thrown away. If you need to recover, Jenkins can always perform a clean checkout, so there's usually no need to back up your workspace.

[1] To find the `$JENKINS_HOME` location, go to the *Configure System* menu.

Optimization 2: Use OS-level Snapshots
If you want maximum consistency in your backups, use the snapshot capability in your file system. Although you can take live backups, they take a long time to run, so you run the risk of taking different data at different time points… which may or may not be a real concern. Snapshots solve this problem.

Many file systems let you take snapshots, including Linux Logical Volume Manager (LVM) and Solaris ZFS (which also lets you take incremental backups). Some separate storage devices also let you create snapshots at the storage level.

CloudBees' enhanced Jenkins product, Nectar, can also help you with snapshots and backups. Look for more information about Nectar in the Appendix.

Hands-On Training: *Mastering Continuous Integration with Jenkins*

Want to become a Jenkins expert? Check out CloudBees' Jenkins training courses!

Test your Restore!

Nothing is worse than thinking you have a backup and then when disaster hits, finding out you can't actually recover. So it's worth testing to make sure you have a proper backup.

The `JENKINS_HOME` directory is "relocate-able" – meaning you can extract it anywhere and it still works. Here's the easiest way to test a restoration:

1. Copy the backup Home directory somewhere on your machine, such as `~/backup_test`
2. Set `JENKINS_HOME` as an environment property and point to `backup_test`; for example, `export JENKINS_HOME=~/backup_test`
3. Run `java -jar jenkins.war --httpPort=9999`

This sequence of commands will pick up the new `JENKINS_HOME` with the `backup_test` directory. You can use this instance of Jenkins to make sure your backup works. Be sure to specify a random HTTP port so you don't collide with the real one – otherwise the server won't start!

#2: Plan for Disk Usage Growth Up Front

Problem

Running out of disk space as your Jenkins installation consumes more resources.

Background

As you set up Jenkins, the most important disk planning consideration is to prepare for inevitable disk usage growth. Jenkins disk usage can grow quickly, particularly when you start hosting multiple jobs.

Solution: Prepare for Disk Usage Growth

Storage is cheap, so make sure you have enough space in the short term. And because it's hard to estimate the necessary amount of storage up front, your best bet is to make sure you can grow later, which often needs some upfront planning. Note that you don't need to waste money on expensive SCSI disks, because Jenkins does not require fast disk access. Most of the disk space is used for storing bits that are rarely accessed. Spend your money on bigger devices, not faster ones.

Spanned Volume on Windows
On NTFS devices (e.g. on Windows), you can create a *spanned volume*: take an existing volume, add a new one at the end, and then make the combined volume behave as a single volume. Then it's simple to add new disks.

In this case the only planning you need to do is to put Jenkins in a separate partition when you install it, so you can convert to a spanned volume later.

LVM Volume Manager
On Linux, the LVM volume manager does something similar, but unlike Windows, you have to configure the LVM up front: set up LVM, create the Volume Group and Logical Volume, and set up a volume in your manager. One you have the first volume in LVM, you can expand the files system and add more disks later[2].

Solaris ZFS
Solaris ZFS is much more flexible and thus very easy to prepare for disk expansion. On ZFS, `$JENKINS_HOME` should be on its own file system, which allows you to easily create snapshots, backups and other nice things.

Use symlinks
If you already have Jenkins running and cannot use any of the solutions above, use symbolic links (symlinks) to ease your pain. Simply identify the jobs that take up a lot of disk space, copy those directories into separate volumes, and then symlink to those directories.

#3: Use Native Packages

Problem
Two, actually: you want to be able to simplify migration of instances to different machines, as well as start Jenkins upon machine startup.

Background
Java developers aren't always aware of some of the powerful features in their underlying operating systems, so I want to mention some highlights that will help with Jenkins. For example, developers tend to ignore the OS-specific installation packages as they start building their Jenkins environment. As the system grows, these packages help ease migrations to other machines and are also useful to start Jenkins as the machine comes up.

Solution: Use OS-specific installation packages over the default war-based installation.
In addition to the Jenkins war, Jenkins is available as OS-installable packages for Debian, RedHat/CentOS and Suse[3]. Both installing and upgrading Jenkins is much easier with these packages. So unless you have to choose a specific application server or have some special requirements on your application server,

[2] Refer to Linux docs for detailed steps.
[3] Windows installer is in the works and hopefully will be available soon.

package-based installation is highly recommended. It's also more reproducible, so if you need to move your Jenkins service into another machine, this native package installation is much easier than going through all the steps of setting up your corresponding application server.

The native packages come with an `init` script, where a daemon starts up Jenkins after you boot the machine and runs the Jenkins process.

Configuration files follow the OS level conventions, and boot-up parameters for Jenkins are located in these files:

- `etc/default/Hudson` for Debian
- `etc/sysconfig/Hudson` for RPM

#4: Take Advantage of Distributed Builds

Problem

You will eventually outgrow the ability to run builds on just one machine; as well, single systems do not take advantage of the full power of Jenkins.

Background

I am always surprised at how people make do with a single-system Jenkins, but I can promise you will grow beyond a single system… the real question is *when*.

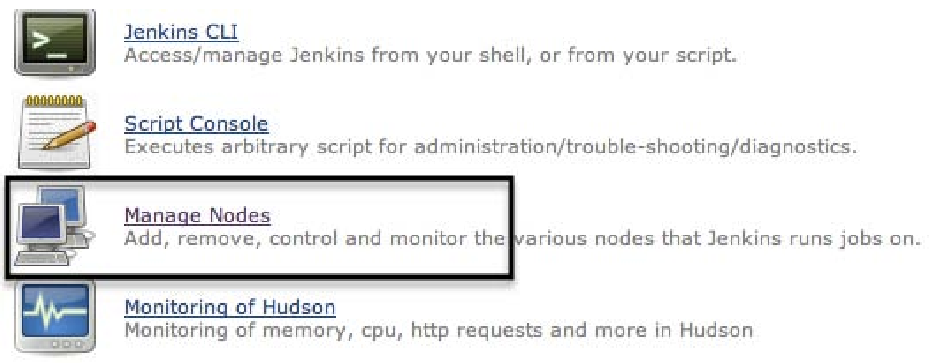
Solution: Do Distributed Builds!

One best practice I can't recommend enough is to try out Jenkins' distributed builds. Dealing with the amount of compression load is not the only reason to use distributed builds. You also need isolation between builds. For example, when your tests depend on local resources like a local database or particular TCP/IP port, you can't use the same machine to run tests that access those resources. And while you can always work around these problems by tweaking your build script and tests and such, it's much easier if you have multiple boxes that provide natural isolation.

Another driving factor for distributed builds is that if you're testing against multiple platforms, you often want to have more diversity in the environment. This situation inherently calls for multiple systems.

To get started with distributed builds and create Jenkins slaves to connect to your master, do the following:

1. Choose *Manage Hudson*, then *Manage Nodes* (*or* just click *Build Executor Status*).


Jenkins CLI
Access/manage Jenkins from your shell, or from your script.

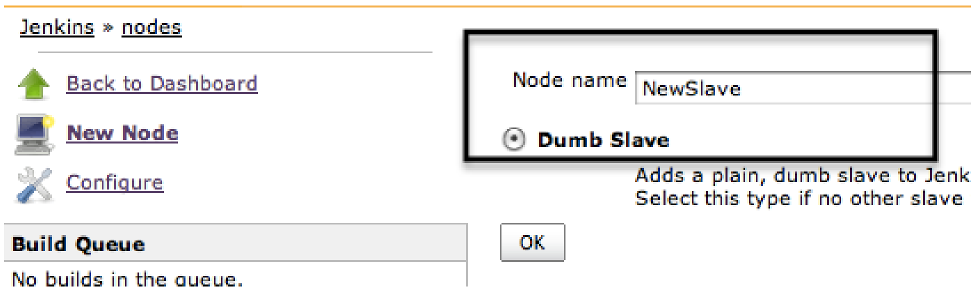
Script Console
Executes arbitrary script for administration/trouble-shooting/diagnostics.

Manage Nodes
Add, remove, control and monitor the various nodes that Jenkins runs jobs on.

Monitoring of Hudson
Monitoring of memory, cpu, http requests and more in Hudson

Figure 1: Managing nodes

2. Create a new node and name it (e.g. NewSlave, as show in Figure 2).
    - The screen in Figure 3 appears. Here you can enter configuration information for the Jenkins master to connect to the slave.
    - The Master will bring up the slave and then start allocating jobs to it.


Jenkins » nodes

Back to Dashboard
New Node
Configure

Build Queue
No builds in the queue.

Node name: NewSlave

Dumb Slave
Adds a plain, dumb slave to Jenk
Select this type if no other slave

OK

Figure 2: Creating a new node

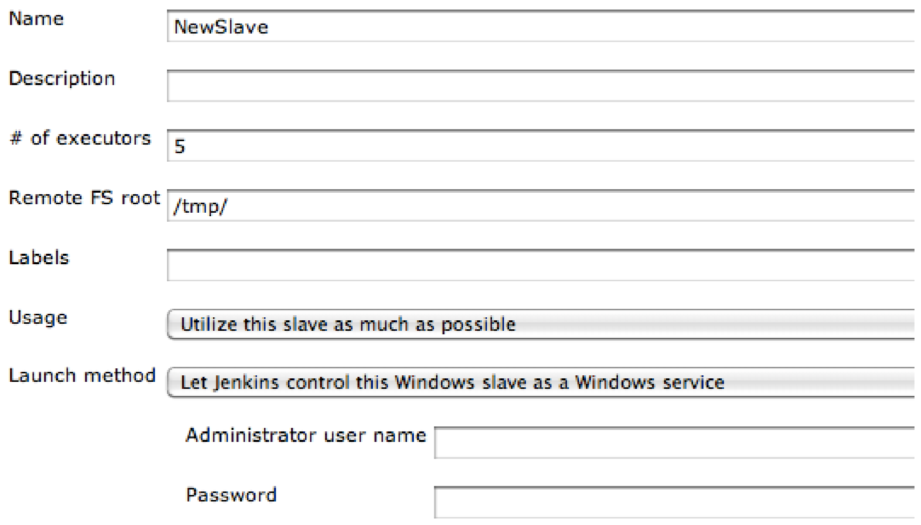

Name	NewSlave
Description	
# of executors	5
Remote FS root	/tmp/
Labels	
Usage	Utilize this slave as much as possible
Launch method	Let Jenkins control this Windows slave as a Windows service
Administrator user name	
Password	

Figure 3: Configuring a new node

And that's it! Now you have a cluster of machines onto which Jenkins can delegate the load.

Bonus Tip: Slave Reconnectivity

Once you're doing distributed builds, let the masters launch the slaves if you can. Allow the Jenkins master to proactively talk to the slave and then bring the instance up. This way there is no intervention from the client side; the master will bring up the slaves as it allocates jobs or bring the slave online if the slave machine goes down. Jenkins also supports cases where the slave should initiate connection back to master.

To set connectivity, specify the "Launch method" option as you configure settings for a new slave (as shown in Figure 3). You have four options:

- *Let Jenkins control this Windows slave as a Windows service*: Used on Windows to start Windows services remotely. Jenkins uses DCOM to start the slave services.
- *Launch slave agents on Unix via SSH*: Jenkins remotely logs into the slave machine from the master and starts the slave.
- *Launch slave via an execution of command on the Master*: User needs to write a script that Jenkins can use after it logs into the slave (typical expectation is that the user will provide access to `slave.jar`). This option is used when the master has access to the slave using SSH or RSH.
- *Launch slave agents via JNLP*: Used when slaves have to initiate contact with the master. Jenkins uses the JNLP protocol to launch.

Save Time with Public Key Authentication

I also recommend taking advantage of Jenkins' SSH public key authentication. By setting up the public key mechanism, you can log in from one system to another without ever typing your password. This time-saver is useful for Jenkins and all kinds of administration or automated tasks. For example, if you want to write a script in these multiple systems, for example to copy files, it's imperative you are able to do that without requiring a password from the console. Setting up SSH public key authentication is very easy and only takes about five minutes, so do it if you haven't already.

#5: Use Labels

Problem

Managing a diverse set of platforms and machines easily, and making machines interchangeable.

Background

A CI environment is a mixed bag of machines, platforms and operating systems. You need the utmost flexibility in managing these machines, you want your build machines to be interchangeable, and in general you don't want to tie builds to a specific build machine. But sometimes you need more diversity in the build cluster. Your machines might not be entirely homogeneous and you still need a way to identify some subset of them; for example, you might need a certain job to run on Linux instead of Windows.

Solution: Make use of Labels

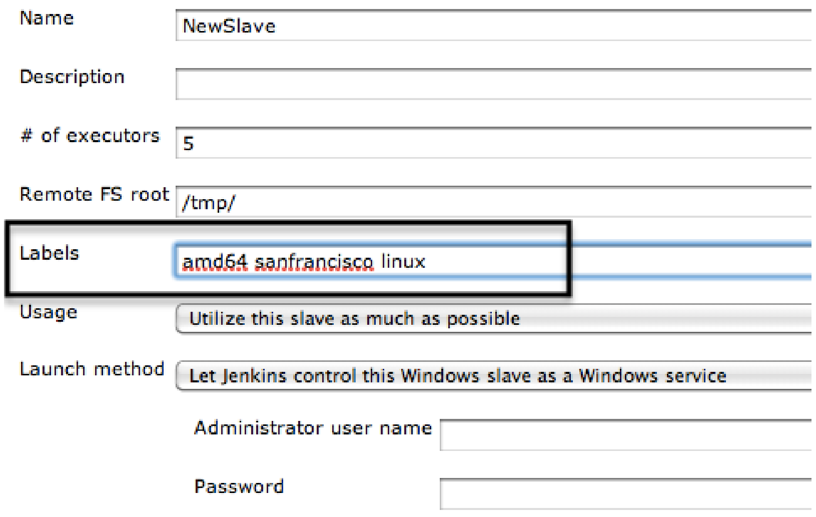
A very useful but under-used Jenkins feature is *labels*. Labels are simply tags you can assign to nodes to describe their capacities. Some typical useful labels include

- Operating system
- 32 vs. 64-bit
- Additional infrastructure that exists only on certain machines (for example, WebSphere)
- Machine's geographical location

Assign labels on the build machines themselves; then on the job side, specify that the job needs to run in a certain place based on label criteria. Instead of tying jobs to individual build machines, labels give Jenkins flexibility to choose where to run the builds, which results in better resource utilization and promoting manageability.

Using labels is so easy that even the Marketing team figured it out:

1. Select a Slave machine and choose *Configure.*
2. Specify a label in the *Labels* field.
3. Create a new job, name it and fill out any other necessary parameters, and click *OK.*
4. Click the checkbox, *Restrict where this project can be run* (for example `amd64`, `linux` and `sanfrancisco`).
5. Fill in the *Label Expression* that matches the label on your Slave machine (or any label).
6. Click *Save* and then run the build. It will only run on machines whose labels match the job configuration.



Name	NewSlave
Description	
# of executors	5
Remote FS root	/tmp/
Labels	amd64 sanfrancisco linux
Usage	Utilize this slave as much as possible
Launch method	Let Jenkins control this Windows slave as a Windows service
Administrator user name	
Password	

Figure 4: Configuring labels

One final reason to use labels: if a machine goes down, Jenkins has the flexibility to shift the load to another machine with a compatible label, which gives you time to diagnose and fix the problem. This way you can increase the level of service of your cluster to your users without service disruption.

#6: Use a Memorable URL for Jenkins

Problem

Jenkins is most useful if development teams refer to it often. Using an IP address or mangled name for the running instance of Jenkins makes it hard to remember and inhibits team adoption.

Background

If your users can’t see Jenkins, much of the benefit is lost. In some places, Jenkins is referred to by IP address, but that’s hard to remember.

A Few Solutions

Invest in an Easy-to-Remember URL

The point of the continuous integration server is to become visible, so if Jenkins has a long URL that is hard to remember, your team won’t use it as much.

BAD: http://sca12-3530-sca.cloudbees.com:8080/hudson

GOOD: http://jenkins.cloudbees.com

Use the Service Name

Although your machine may already have hosting, you don’t have to use it. In fact, it’s often a bad idea to use the primary machine name to point to a particular service, because the service might move later to another system. So instead of using the primary machine name, use the host alias.

If your IT operation guys aren’t helping you create a host alias, you can also use the external dynamic DNS services. Your hosting will be visible outside, but your machine won’t be, so this method is still secure. Using the Service name makes your Jenkins relocatable: if you later move Jenkins to a more powerful machine – or are running multiple services on a single system, and later decide that both services need to move to respective machines – you can execute the move without disrupting the services.

Run Jenkins on Port 80 with Other Apps

Another useful tip: it’s worthwhile to run Jenkins on the default port (80) instead of a custom port (like 8080) – then you don’t have to specify the port number. You can do this on Unix systems through Apache *reverse proxy*.

In reverse proxy, the browser talks to Apache and Apache forwards the HTTP request to Jenkins, which is running on a custom port like 8080. Another benefit here is you can run Jenkins as non-root user.

On Windows, it’s harder to share port 80, but now you can install a free IIS7 module called *URL Rewrite + ARR*, which lets you achieve the same thing

Don’t Use the Appserver Context Root to Jenkins as a Way to Remember the Jenkins URL

By default in many application servers, if you deploy the Jenkins war, you get a default context-root `/Jenkins`. This is redundant – use a virtual host to distinguish multiple apps, not the `/Jenkins` context path.

#7: Prevent Build Record Sprawl

Problem

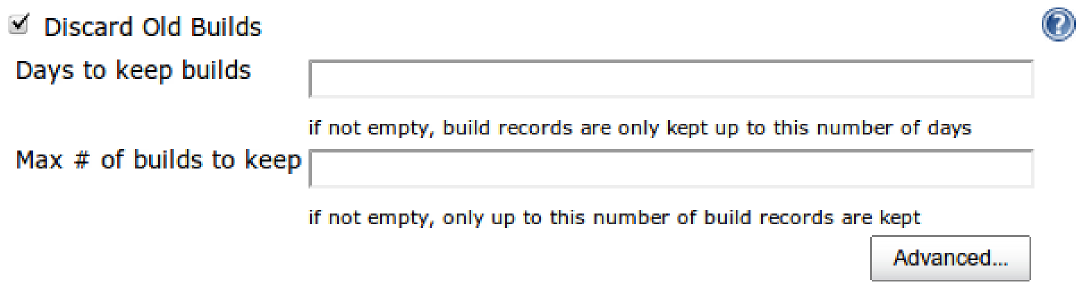
Build records can accumulate quickly. Keeping too many around increases memory usage and impacts startup times.

Background

Keeping build records under control is related to the disk planning we discussed in Tip #1. If possible, it's best to discard all build records. Keeping too many negatively impacts the startup time of Jenkins and gradually increases memory usage over time. Some jobs in some environments really do require you to keep all the build records (for example, if you're doing a release of Jenkins, you don't want to lose those records). But for most jobs, you can throw all the records away. Since you're probably running serial continuous integration builds on Jenkins, it's not useful to have records of all the CI builds since inception.

Solution: Keep only a subset of build records around

You can set Jenkins up to clean house by checking *Discard Old Builds* in the *Configure* menu and filling in one or both of this option's two text boxes. You can choose to throw the old records away if they are more than 30 days old, or you can choose to keep only the last X records and discard everything else.


☑ Discard Old Builds

Days to keep builds

if not empty, build records are only kept up to this number of days

Max # of builds to keep

if not empty, only up to this number of build records are kept

Figure 5: Configuring Jenkins to discard old builds

The whole point of controlling your build records is to avoid unbounded consumption. Sometimes you want to keep some records for a while so people can look at problems when there are failures… so don't make the number too low. You really just need to have a fixed cap; 50 or 100 is a good number. Note that you can configure build record housekeeping on a per-project basis.

Another way to keep specific records is to use the fingerprinting feature, which allows you to create an association between jobs. As you enable fingerprinting, you can enable Jenkins to keep a build log of dependencies – this captures all the upstream build log dependencies.

And there you have it – seven ways you can get the best performance from your Jenkins CI server! Of course, if you want to save time and money and optimize performance even further, CloudBees will be happy to manage your Jenkins for you in the cloud with DEV@cloud, or provide ongoing support and enhanced features through our Nectar subscription service…

Jenkins and CloudBees

CloudBees is the only cloud company focused on servicing the complete develop-to-deploy lifecycle of Java web applications in the cloud – where customers do not have to worry about servers, virtual machines or IT staff. We are also the world's premier experts on Jenkins/Hudson and are dedicated to helping teams make the most of their Jenkins continuous integration servers.

Nectar , CloudBees' on-premise, fully-supported enterprise Jenkins package, gives you…

- Ongoing support from the Jenkins experts
- VMware scaling for your Jenkins environment
- Enterprise features that extend Jenkins for large and mission-critical installations
- Seamless rollover to cloud-based Jenkins during peak usage times and easy transition to cloud-based production deployment, through integration with CloudBees DEV@Cloud and RUN@Cloud (*coming soon*)

DEV@cloud, affectionately known as "Jenkins as a Service," lets you…

- Scale your Jenkins environment with the power of the Cloud – start building immediately in a fully-tested, robust environment, and grow when you need to grow
- Ease your Jenkins management overhead – spend your time writing code, not maintaining servers
- Speed your Jenkins builds – access to unlimited build agents whenever you need them
- Save money with on-demand Jenkins Service – only pay for what you use

In addition to providing build capabilities in the cloud, the CloudBees platform also includes RUN@cloud, which lets teams seamlessly deploy these applications to cloud production.

Please get in touch with us if you'd like more information about Nectar, DEV@cloud, or Jenkins in general – we'd be delighted to help you!

Phone: +1 617 500 7547
Email: sales@cloudbees.com
Twitter: @CloudBees

Appendix A: Additional Jenkins / Hudson Resources

Videos on CloudBees Services
http://cloudbees.com/support.cb

Webinar: 7 Ways to Optimize Hudson for Production
In this webinar, Kohsuke covers the best practices in this white paper in even more detail, complete with demos.
http://cloudbees.com/support.cb

Bonus Jenkins Q&A with Kohsuke
http://cloudbees.com/webinars/FAQ-Hudson-7WaysToOptimizeHudson.cb

Jenkins/Hudson Training
"Mastering Continuous Integration with Jenkins" training brings CloudBees' expertise in Jenkins/Hudson to everyone.
http://cloudbees.com/training.cb

Nectar
Supported and Enhanced Jenkins
http://nectar.cloudbees.com/

Dev@Cloud
Jenkins as a Service
https://grandcentral.cloudbees.com/account/signup

Join the Ecosystem
Sign up here to receive the latest updates news from the Bee Hive
http://www.cloudbees.com/company.cb

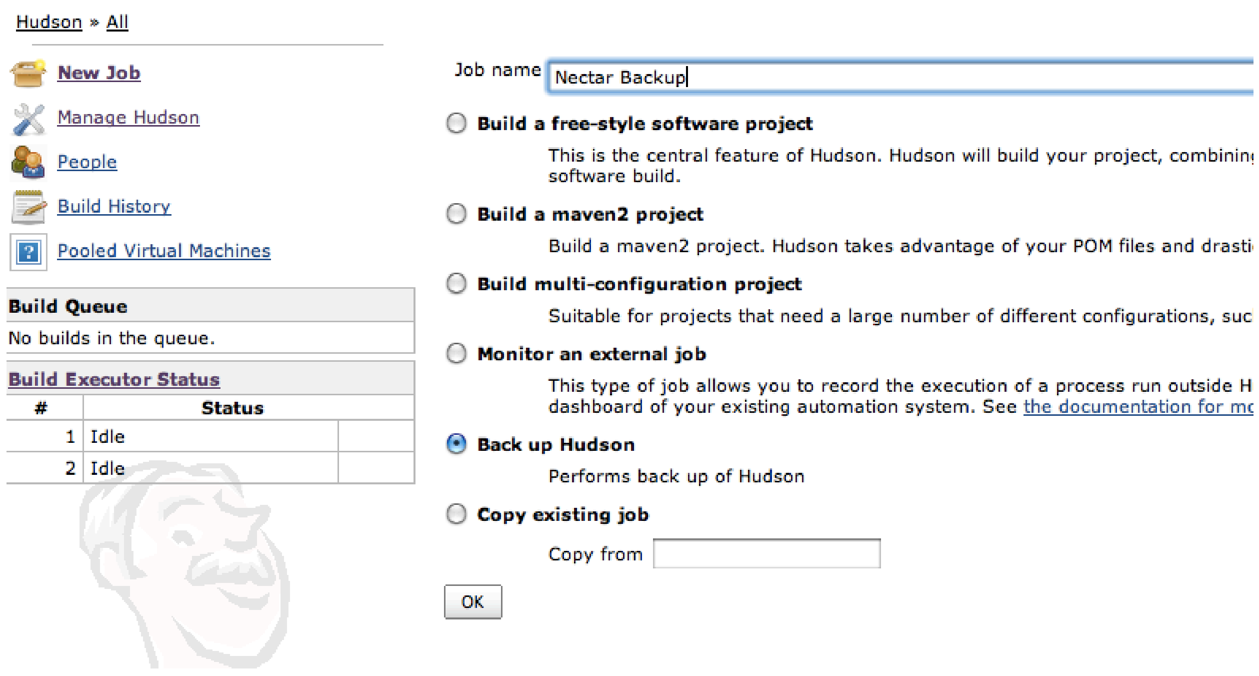
CloudBees on YouTube
Tune in as the Bees continue to post new videos…
http://www.youtube.com/user/CloudBeesTV

CloudBees Blog
Keep apprised of industry changes and learn the latest tips from the hive…
http://blog.cloudbees.com

Appendix B: Easier backups with CloudBees Nectar

Nectar is CloudBees' supported Jenkins/Hudson product. In addition to providing premium support to companies who run mission-critical systems with Jenkins, Nectar delivers additional plug-ins that are available only through CloudBees.

Jenkins backup functionality is one such feature. As mentioned in Tip 1, taking backups is crucial. Nectar's Backup plug-in greatly simplifies the job of doing backups: just create a backup by creating a new type of job called *Back up Hudson*.



Hudson » All

- New Job
- Manage Hudson
- People
- Build History
- Pooled Virtual Machines

Build Queue

No builds in the queue.

Build Executor Status

#	Status	
1	Idle	
2	Idle	

Job name: Nectar Backup

○ **Build a free-style software project**

This is the central feature of Hudson. Hudson will build your project, combinin
software build.

○ **Build a maven2 project**

Build a maven2 project. Hudson takes advantage of your POM files and drasti

○ **Build multi-configuration project**

Suitable for projects that need a large number of different configurations, suc

○ **Monitor an external job**

This type of job allows you to record the execution of a process run outside H
dashboard of your existing automation system. See the documentation for mo

[✓] **Back up Hudson**

Performs back up of Hudson

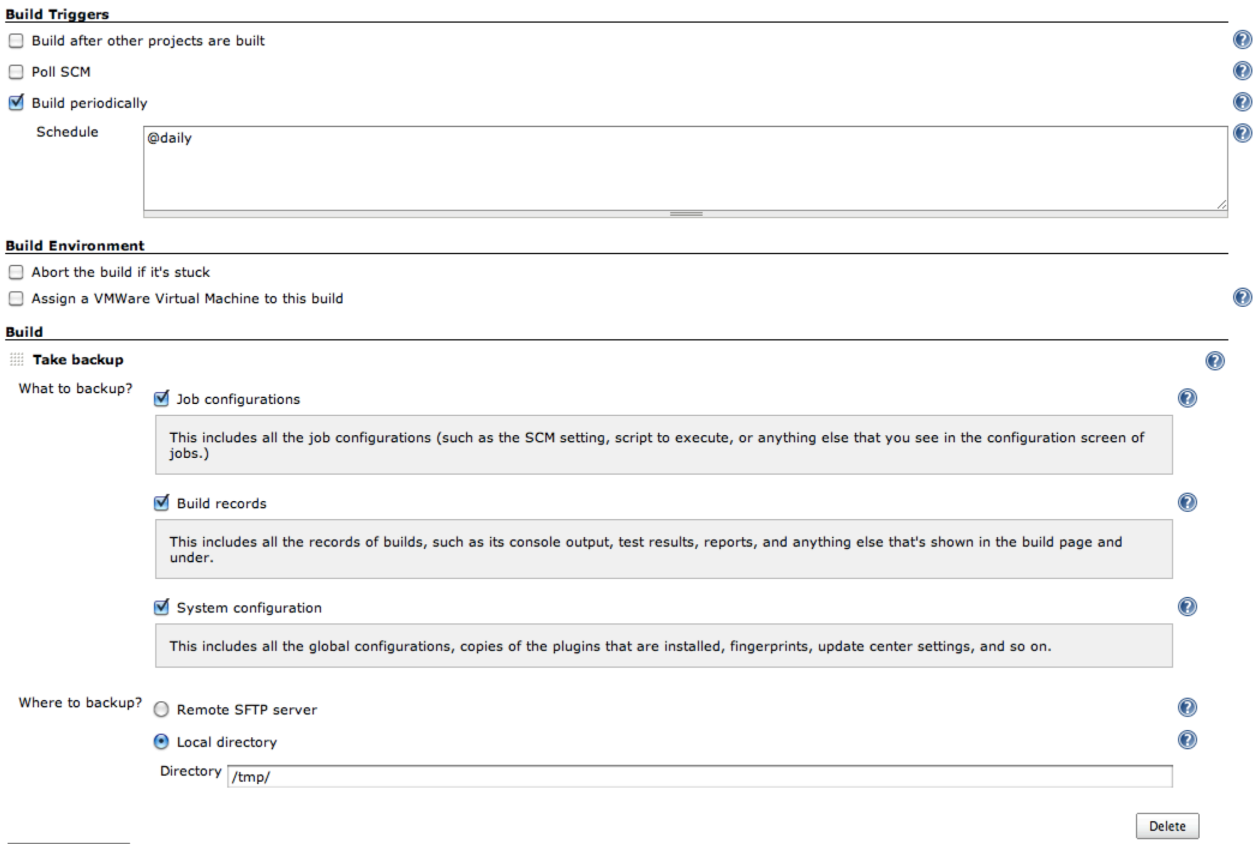
○ **Copy existing job**

Copy from

OK

Figure A: Nectar's Back up Hudson *job type*

Selecting the *Back up Hudson* option brings up additional configuration options on the Job Configuration page. Here you can choose to back up job configurations, build records, system configurations or any combination thereof. You don't have to write scripts or cron jobs to perform these backups, as you would if implementing Tip 1 without Nectar. In addition, since a backup job is a Jenkins job, you can easily relocate the configuration to a different system if required – no porting of shell scripts! Figure B below shows how to use the Jenkins *Build Periodically* feature to do a daily backup of *all* the configuration information, which includes *Job Configurations*, *Build Records* and *System Configuration*. We could also have easily chosen to back up a subset of information as outlined in Tip 1.



Build Triggers

- [ ] Build after other projects are built
- [ ] Poll SCM
- [x] Build periodically

Schedule: @daily

Build Environment

- [ ] Abort the build if it's stuck
- [ ] Assign a VMWare Virtual Machine to this build

Build

Take backup

What to backup?

- [x] Job configurations

  This includes all the job configurations (such as the SCM setting, script to execute, or anything else that you see in the configuration screen of jobs.)

- [x] Build records

  This includes all the records of builds, such as its console output, test results, reports, and anything else that's shown in the build page and under.

- [x] System configuration

  This includes all the global configurations, copies of the plugins that are installed, fingerprints, update center settings, and so on.

Where to backup? Remote SFTP server [✓ Local directory]

Directory: /tmp/

Figure B: Back up configuration

In addition to premium support and automated back-up capability, Nectar also includes auto-scaling for VMWare and many other features. Contact CloudBees to learn more!