

Software Construction



Continuous Integration

Martin Kropp
University of Applied Sciences Northwestern Switzerland
Institute for Mobile and Distributed Systems

Learning Target

You

- can explain the importance of continuous integration (CI)
- know what Continuous Integration is
- can explain the benefits of CI
- can describe a typical CI environment
- can setup and use a CI tool

Agenda

- Why Integration?
- What is Continuous Integration?
- Continuous Integration Process
- CI Infrastructure
- CI Tools

Continuous Integration, v1.2

IMVS, M. Kropp

3

Integration

*Integration is ...
Making different modules work together*

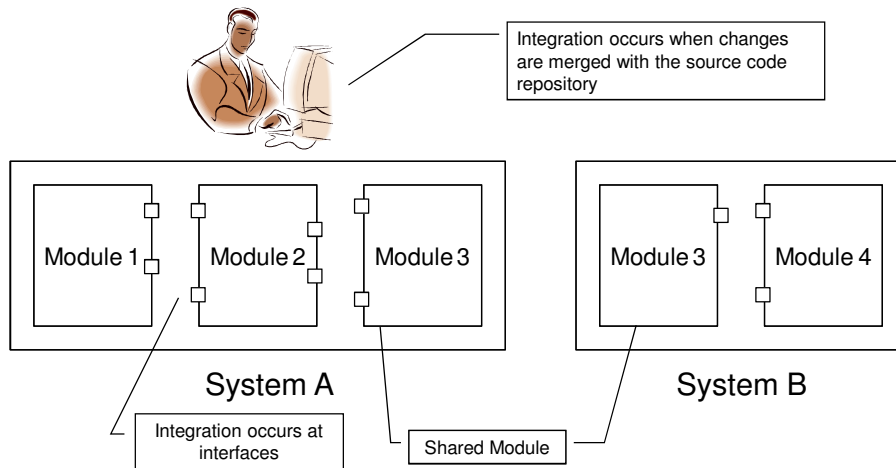
- Modularization
 - ◆ enables team development
 - ◆ makes complex systems manageable
- Modules have to work together
 - ◆ i.e. they must be **integrated**
- Integrated Modules do successfully
 - ◆ compile
 - ◆ run
 - ◆ pass test
 - ◆ deploy

Continuous Integration, v1.2

IMVS, M. Kropp

4

Integration Challenges



Continuous Integration, v1.2

IMVS, M. Kropp

5

Broken Integration

- You have a broken integration when:
 - ◆ Source code server does not build successfully
 - ◆ Shared component works in one system, but breaks others
 - ◆ Unit tests fail
 - ◆ Code quality fails (coding conventions, quality metrics)
 - ◆ Deployment fails

The earlier you can detect problems, the easier it is to resolve them

Continuous Integration, v1.2

IMVS, M. Kropp

6

Manual Integration

- Integration becomes expensive
 - ◆ if made manual (build, test, deployment, ...)
 - ◆ with too less checkin's (hours or days...)
 - ◆ If integration problems and bugs are detected too late
- Reduces desire to refactor
 - ◆ Long time between integration increases risk of merge
- IDE makes many cross-cutting changes easy

Continuous Integration, v1.2

IMVS, M. Kropp

7

What Is Continuous Integration

■ Some Definitions

"An important part of any software development process is getting **reliable builds** of the software. Despite it's importance, we are often surprised when this isn't done. We stress a **fully automated** and **reproducible build, including testing**, that **runs many times a day**. This allows each developer to integrate daily thus reducing integration problems."

Martin Fowler and Matthew Foemmel, Continuous Integration

"The macro process of object-oriented development is one of "continuous integration." ... **At regular intervals, the process of "continuous integration" yields executable releases that grow in functionality at every release.** ... It is through these milestones that management can measure progress and quality, and hence anticipate, identify, and then actively attach risks on an ongoing basis."

Grady Booch, Object-Oriented Analysis and Design with Applications

Continuous Integration, v1.2

IMVS, M. Kropp

8

Practices of Continuous Integration

- Maintain a Single Source Repository.
- Automate the Build
- Make Your Build Self-Testing
- Everyone Commits Every Day
- Every Commit Should Build the Mainline on an Integration Machine
- Keep the Build Fast
- Test in a Clone of the Production Environment
- Make it Easy for Anyone to Get the Latest Executable
- Everyone can see what's happening
- Automate Deployment

From <http://martinfowler.com/articles/continuousIntegration.html>

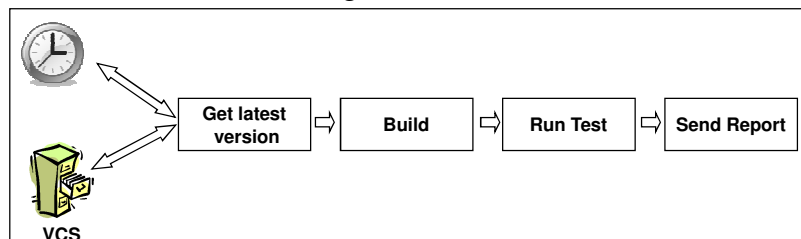
Continuous Integration, v1.2

IMVS, M. Kropp

9

Embrace Continuous Integration

- What is Continuous Integration



- Integration server monitors source repository
 - ◆ Rebuilds with every change
 - ◆ Runs all unit and acceptance tests
 - ◆ Publishes build results
 - ◆ Notifies developers if build breaks
 - ◆ Labels successful builds in source repository

Continuous Integration, v1.2

IMVS, M. Kropp

10

Continuous Integration Prerequisites

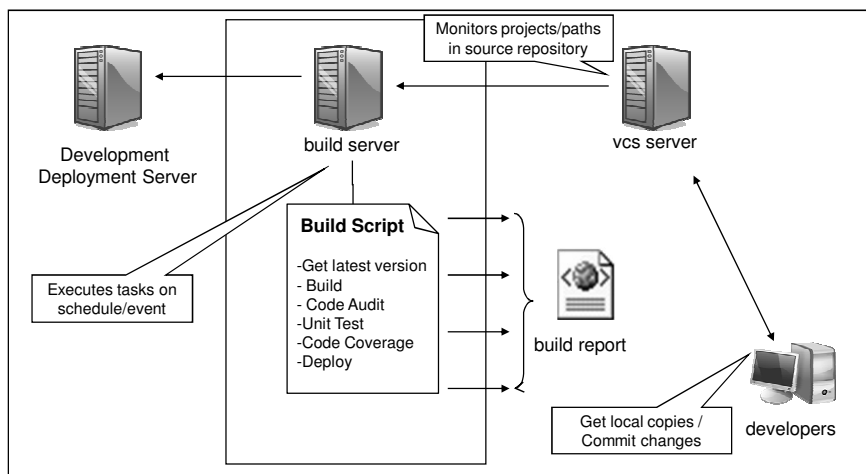
- Tools needed
 - ◆ VCS server
 - ◆ Build server
 - ◆ Deployment Server
 - ◆ Automation tools
 - ◆ CI tools
- Work Process
 - ◆ Commit/Update often (each change)
 - ◆ Run often
 - ◆ Write test
 - ◆ Run test often
 - ◆ Common code ownership

Continuous Integration, v1.2

IMVS, M. Kropp

11

Continuous Integration Infrastructure



Continuous Integration, v1.2

IMVS, M. Kropp

12

Realizing Continuous Integration

- Monitors a VCS repository for changes
 - ◆ CVS = check for commits in the repository since last build time
 - ◆ If changes are found, then on a schedule start the build
- Build your application
 - ◆ through your existing Ant or Maven scripts
- Run your xUnit Test suite
- Run code audit tools
 - ◆ Checkstyle, code coverage, ...
- Report on the build results
 - ◆ send formatted email notifications
 - ◆ publish results to a website
- (Optionally) publish the application
- Configuration is through a central XML file

Continuous Integration, v1.2

IMVS, M. Kropp

13

What is a Successful Build?

- When is your build successful?
 - ◆ When it compiles?
 - ◆ When all the unit-tests have run?
 - ◆ When it has been deployed?

- In fact, every failure is a success
 - ◆ You have exposed a potential problem – **early!**

Continuous Integration, v1.2

IMVS, M. Kropp

14

The Agile Process

- Continuous Integration is only one aspect of an overall process. For it to work best, you need to:
 - **Plan iteratively**
 - ◆ schedule regular releases with evolving levels of functionality (CRs)
 - ◆ be wary of inflexible Change Control Boards!
 - **Implement incrementally**
 - ◆ identify and implement small work tasks
 - ◆ refactor if necessary!
 - **Report proactively**
 - ◆ identify exactly the contents (CIs) of any build, in both file and content
 - ◆ automate reports!

Continuous Integration, v1.2

IMVS, M. Kropp

15

CI Benefits

Reduced Risks

- Always aware of current status of the project
- Less time spent investigating integration bugs
 - ◆ Integration testing performed early
 - ◆ Integration bugs caught early
- Less time wasted because of broken code in version control system
 - ◆ Broken builds caught early
- Prove your system can build!
- Increase code quality with additional tasks
- Discover potential deployment issues

Continuous Integration, v1.2

IMVS, M. Kropp

16

CI Obstacles

- Tough to move an existing system into CI
- Systems that rely on “server” components (BizTalk, Sharepoint, etc.)
- Db-based systems need to be up-to-dated

Continuous Integration, v1.2

IMVS, M. Kropp

17

A CI Tool: CruiseControl

Project	Current status	Last build result	Last build time	Last successful build time	Last label	Force build
ProviderLookup	waiting for next time to build since 04/24/2006 15:41:28	passed	04/18/2006 12:12:47	04/18/2006 12:12:47	build 14	Force
RSSAdmin	idle since 04/24/2006 15:40:26	passed	04/18/2006 15:45:55	04/18/2006 15:45:55	build 17	Force
connectfour	waiting for next time to build since 02/28/2006 09:45:01	passed	02/20/2006 15:59:36	02/20/2006 15:59:36	build 1	Force
integration	(build status file not found)	passed	03/28/2006 12:31:07	03/28/2006 12:31:07	build 15	Force
Total	4					
Passed	4	100%				

listing generated at 15:42

Continuous Integration, v1.2

IMVS, M. Kropp

18

Monitoring

- CruiseControl
 - ◆ Continuous Integration Server
 - ◆ Integrates building, unit tests, code coverage, analysis,
 - ◆ Provides the ability to hook in almost any output.
 - ◆ Gives instant knowledge of status of builds.
 - ◆ Provides dashboard like integration for multiple projects

Continuous Integration, v1.2

IMVS, M. Kropp

19

CruiseControl Build Status

cruisecontrol
continuous integration toolkit

Project: ProviderLookup

waiting for next time to build since 04/24/2006 15:52:47

Latest Build

Date	Time	Status
04/18/2006	12:12:47	(build 14)
04/18/2006	10:57:01	(build 13)
04/18/2006	10:55:08	(build 12)
04/18/2006	10:53:08	(build 11)
04/18/2006	10:51:45	(build 10)
04/18/2006	10:34:05	(build 9)
03/29/2006	07:29:33	(build 8)
03/29/2006	06:42:53	(build 7)
03/29/2006	19:42:47	(build 6)
03/23/2006	13:55:59	(build 5)

BUILD COMPLETE - build.14

Date of build: 04/18/2006 12:12:47
Time to build: 1 minute 3 seconds

Build Artifacts

Errors/Warnings: (2)

Test com.bogcode.gentiva.ccc.provider.AllTests FAILED

The execution of reports is complete. Reports are available in /reports

Unit Tests: (14)

Test Name	Status
error testLog	AllTests
error testGetPlanShortNames	AllTests
error testGetServiceAndUOWs	AllTests
error testGetCategoryList	AllTests
error testSearchProvider_StateServiceUOWPlan	AllTests
error testSearchProvider_ZipServiceUOWPlan	AllTests
error testSearchProvider_StateServiceUOW	AllTests
error testSearchProvider_ZipServiceUOW	AllTests
error testSearchProvider_StateService	AllTests
error testSearchProvider_ZipService	AllTests
error testSearchProvider_StateCat	AllTests
error testSearchProvider_ZipCat	AllTests
error testSearchProvider_State	AllTests
error testSearchProvider_Zip	AllTests

Continuous Integration, v1.2

IMVS, M. Kropp

20

Cruise Control Components

- CI Server
 - ◆ Monitors the cvs
 - ◆ Executes the build script
- Configuration File
- Dashboard
 - ◆ Build report viewer
- Email Notification

Continuous Integration, v1.2

IMVS, M. Kropp

21

CI Add Ons

- Code Coverage Cobertura
 - ◆ Works with JUnit or any Java classes
 - ◆ Uses instrumentation within Ant or the command line
 - ◆ Integrated into build process via <cobertura-instrument> task
- Dependency Management with IVY
 - ◆ Similar like Maven
 - ◆ Ant based

Continuous Integration, v1.2

IMVS, M. Kropp

22

Some Popular CI Tools

- Cruise Control (OS)
 - ◆ <http://cruisecontrol.sourceforge.net/>
- Anthill Pro (Com)
 - ◆ <http://www.anthillpro.com/>
- Continuum (OS)
 - ◆ <http://maven.apache.org/continuum/>
- Pulse (Com)
 - ◆ <http://www.zutubi.com/>
- Lintbuild (OS)
 - ◆ <http://lintbuild.javaforge.com/>
- ParaBuild Server (Com)
 - ◆ <http://www.viewtier.com/index.htm>

Resources

- Martin Fowler about CI
<http://www.martinfowler.com/articles/continuousIntegration.html>
- Wiki
<http://c2.com/cgi/wiki?ContinuousIntegration>

Summary

- Continually integrate and test to reduce risk
- Detect problems early
- Always have a deployable build
- Generate metrics to guide project management
- Continuous Integration is:
 - ◆ A good practice in any software development method
 - ◆ Vital for agile development