



# Using Enterprise Developer in Modern Application Development

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**2017-10-02**

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# Using Enterprise Developer in Modern Application Development

Development has traditionally been one discrete element in the process of turning users' requirements into working applications. Modern application development processes enable you to move away from a process containing a number of (at best) loosely-connected, discrete steps, and instead adopt a process where each step is handled by a specialized tool, and a combination of these tools and automation result in a more seamless, repeatable, end-to-end process that enables you to build and deliver the right software at the right time.

This documentation describes modern application development in general and summarizes the role that Enterprise Developer and other tools from Micro Focus can play in modern application development. It also contains information on how you can use Enterprise Developer with the Jenkins CI server in order to implement many of the steps described in the modern application development process.



**Note:** It is important to bear in mind that even though this documentation covers all of the modern application development process, you can gain significant benefits in terms of quality and productivity by adopting any of the parts of the process in isolation.

## Related information

[Using Enterprise Developer with Jenkins](#)

## Introduction to Modern Application Development

The following sections show how modern application development differs from traditional development, outline the benefits of the different stages of a modern application development process, and show how Micro Focus tools can play a key role in your development and deployment processes.

## What is Modern Application Development?

For many years the majority of software development followed the waterfall development model. Recently, alternatives to the waterfall model have been devised and subsequently revised in an attempt to make the process of software development more able to respond quickly to changing customer needs.

In the last few years, methodologies such as DevOps and DevSecOps have come into being, bringing even more advantages over older methodologies. In general, modern application development methodologies enable you to reduce your time to market, reduce the complexity of your projects, and ensure a high-quality experience for your users.

The information in this section is concerned with modern application methodologies in general rather than with any specific methodologies. When this document refers to modern application development it is referring to any development methodology that aims to be more responsive to customer needs by automating the different parts of the process as well as the transitions between them.

## Related reference

[Agile Manifesto: Manifesto for Agile Software Development](#)

[DevSecOps: What is DevSecOps?](#)

[Micro Focus Enterprise DevOps](#)

[TechRepublic: Understanding the pros and cons of the Waterfall Model of software development](#)

## Key Concepts in Modern Application Development

Any discussion of modern application development methodologies will include reference to a number of key concepts. The following list provides a very brief summary of the key concepts that are used in this documentation.

### **Agile software development**

A set of principles guiding the production of software that focusses on the following:

- Iterative, incremental, evolutionary delivery
- Face-to-face communication
- Short feedback loops
- Use of automation to promote a focus on quality

### **Application release automation (ARA)**

The use of tools to automate the steps involved to build software and subsequently deploy it to production.

### **Automated testing**

The use of tools to control the running of tests and the comparison of the tests' outcomes with their expected outcomes.

### **Configuration management (SCM)**

The task of tracking and controlling changes made to software as it is developed. Central to the concept of configuration management is version control, which is the management of changes to files.

### **Continuous delivery (CD)**

A process whereby every code change results in the building and testing of new software that can then be deployed to production (if appropriate).

### **Continuous deployment**

A process whereby every code change results in the building and testing of new software that is then deployed to production.

### **Continuous improvement**

The process of regularly assessing a team's performance in a rollout period, evaluating what has gone well and what can be improved on.

### **Continuous integration (CI)**

The practice of ensuring that all developers' working copies of code are regularly merged into a shared trunk, and each code change results in the building and testing of new software.

### **Requirements management**

The process of gathering and managing the requirements for an application and ensuring that those requirements are used to effectively drive the efforts of the development team.

### **Unit testing**

The process where the smallest parts of an application that it is possible to test are tested individually to see if they perform as expected.

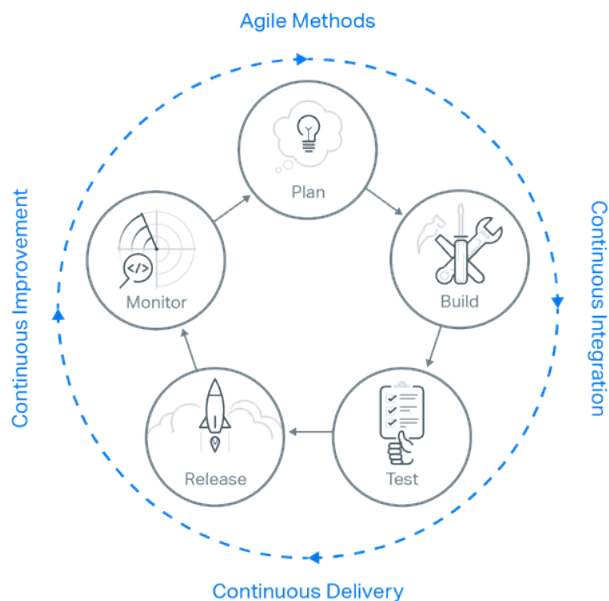
You might find some of these terms defined in a number of subtly different ways in different sources. This documentation uses the terms as they are defined here.

# Steps Involved in Modern Application Development

This section introduces a workflow diagram showing the various steps involved in a modern application development lifecycle then gives introductory information on each of the diagram's steps.

As said elsewhere, this documentation is concerned with modern application development in general rather than any specific named instance of modern application development.

The following figure shows the steps involved in the definition of modern application development used by this documentation.



The diagram shows the five main activities that make up the development process:

- Plan
- Build
- Test
- Release
- Monitor

Note that there are no start and end points to this sequence of activities. Whereas one might expect the "Release" activity to mark the end of the process, that activity is followed by the "Monitor" activity where questions are asked about improvements that could be made to the released package as well as to the development process and how it was executed. The information from the "Monitor" activity is then used as input to the "Plan" activity, and the development process continues from there.

Outside the five activities are the broader processes that have evolved to optimize the way in which the individual activities work together. These processes are as follows, and each one is covered in more detail in this documentation:

- Agile methods
- Continuous integration
- Continuous delivery
- Continuous improvement

## Related information

[Agile Methods](#)

[Continuous Integration](#)

## Agile Methods

The following sections give an overview of Agile methods, present a typical Agile development workflow, and show the benefits that Micro Focus tools can bring to the Agile development process.

### Introduction to Agile Methods

As mentioned in *Key Concepts in Modern Application Development*, agile software development (often referred to as "Agile") is a set of principles guiding the production of software that focusses on:

- Iterative, incremental, and evolutionary delivery
- Face-to-face communication
- Short feedback loops
- Automation to promote a focus on quality

These principles are laid out in a document known as the manifesto for Agile software development.

Agile is intended to be very simple and flexible but it can bring significant benefits such as:

- Increased business agility

Agile's iterative approach and short feedback loops shorten development cycles and enable you to quickly switch priorities based on changing customer requirements and market conditions.

- Delivering the right product

An Agile approach facilitates early and frequent feedback, maximizing the likelihood that the software delivered is exactly what the customer needs.

A combination of the frequent feedback and iterative approach produces another benefit. At the end of an iteration, if stakeholder feedback indicates that the software produced in that iteration is not on target to meet customer requirements, the work done in that iteration can be abandoned and developers can adopt a different approach in the next iteration. The amount of development time lost in such a case would be only one iteration, typically two weeks, which is much less than would be wasted if the same issue arose when following the waterfall model.

- Improved quality

A key principle of Agile is that testing is integrated throughout the lifecycle.

#### Related information

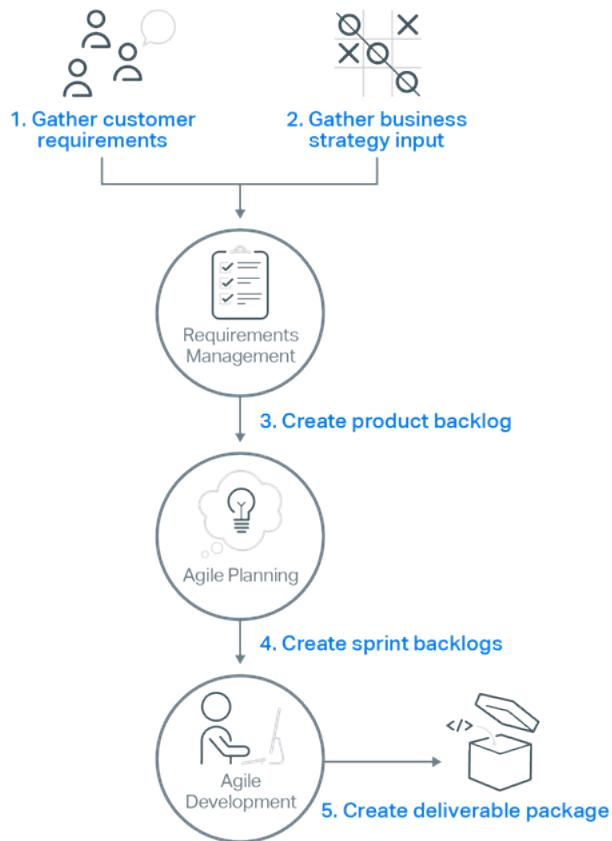
*[Key Concepts in Modern Application Development](#)*

#### Related reference

*[Manifesto for Agile Software Development](#)*

### Agile Development Workflow

The following diagram summarizes the key steps in an Agile development process:



where the numbered steps are as follows:

1. Create a list of requirements from customer feedback.
2. Create a list of requirements based on your internal needs. These can be for anything at all, including new features, bug fixes, infrastructure and systems work, or technical debt.
3. Combine your customers' requirements and your internal requirements into a product backlog. The product backlog is a prioritized list of the work that your development team will undertake to add the different items from your customers' and internal requirements.
4. Use the product backlog to create sprint backlogs, which you use to define and track the work that will be done by the development team in a series of sprints. Sprints are also often referred to as "iterations".

The length of a sprint is typically between one and four weeks and is usually fixed for the duration of a project.

During each sprint, developers take items from the sprint backlog, work on them, and complete them by the end of the sprint.

At the end of each sprint, the items on that sprint's backlog must be completed; not just coded, but tested, documented, and integrated into a working product that could be deployed (if required).

5. Produce a deliverable product package, if required.

At the end of a sprint you return to the Agile planning stage to create the next sprint backlog.

At the end of the project you return to the requirements gathering stage to create the new product backlog.



# Agile Development and Micro Focus Development Tools

The sections *Introduction to Agile Methods* and *Agile Development Workflow* introduce the idea of Agile software development and summarize how Agile development works as a process. This section looks at the Agile development process and shows how different products available from Micro Focus fit into and add value to that process.

The diagram below shows the process presented in the topic *Agile Development Workflow* but has been updated to indicate which Micro Focus products are appropriate at different parts of the process. Although this diagram refers to Micro Focus products, the process described does not require the use of Micro Focus products, so if you are already using a third-party product for one part of the process you can continue to work with that and use Micro Focus products to integrate with it.



where the numbered steps are as follows:

1. Use Micro Focus Atlas to create a list of requirements from customer feedback.
2. Use Micro Focus Atlas to create a list of requirements based on your internal needs. These can be for anything at all, including new features, bug fixes, infrastructure or systems work, and technical debt.
3. Use Micro Focus Atlas to combine your customers' requirements and your internal requirements. Once you have combined the requirements in Atlas you can export them to Micro Focus Rhythm as a product backlog. The product backlog is a prioritized list of the work that your development team will undertake to add the different items from your customers' and internal requirements.
4. Use Micro Focus Rhythm to create sprint backlogs, which you use to define and track the work on the product backlog that will be done by the development team in a series of sprints. Sprints are also often referred to as "iterations".

The length of a sprint is typically between one and four weeks and is usually fixed for the duration of a project.

During each sprint, developers take items from the sprint backlog, work on them, and complete them by the end of the sprint.

At the end of each sprint, the items on that sprint's backlog must be completed; not just coded, but tested, documented, and integrated into a working product that could be deployed (if required).

5. Use Enterprise Developer to produce a deliverable product package, if required.

When using Enterprise Developer, developers can use the complete array of analysis, intelligence and reporting tools provided by Enterprise Analyzer to quickly gain a full understanding of the applications they are working on. Integration between Rhythm and Enterprise Developer means developers can easily work on code changes and keep Rhythm's status information up to date at the same time.

For mainframe development, using Enterprise Developer in conjunction with Enterprise Sync (another product from the Micro Focus Enterprise suite) enables you to replicate your mainframe source code to a distributed software configuration management platform, greatly increasing the effectiveness of your parallel application development.

At the end of a sprint you return to the Agile planning stage to create the next sprint backlog.

At the end of the project you return to the requirements gathering stage to create the new product backlog.

The following list gives a very brief summary of each of the Micro Focus products that play a part in the Agile development process:

- Atlas

Micro Focus Atlas is an Agile requirements and delivery platform that enables teams to create products in a much more collaborative and flexible way in comparison to other requirements management tools.

- Enterprise Analyzer

Micro Focus Enterprise Analyzer delivers a wide array of tools and content to enable you to quickly gain a thorough understanding of your applications, meaning that you reduce the amount of time it takes you to make your changes and you can have more confidence that your changes have the desired effect and do not introduce any new issues.

You can also use Enterprise Analyzer to run queries to determine if your code conforms to your in-house standards. Any code that does not conform to your standards can be flagged as an error following a commit or during the build process.

- Enterprise Developer

Micro Focus Enterprise Developer provides an integrated development environment (IDE) that streamlines mainframe COBOL and PL/I development activities. This toolset provides access, flexibility, and extensibility to modern technologies through fast integration and remote development capability.

The following features of Enterprise Developer make it an invaluable part of the Agile development process:

- Highly-compatible subsystem support (including CICS, IMS, DB2 and JES) means that you can be confident that the code you write using Enterprise Developer will run as expected on the mainframe.
- Integration with SCC-compliant source code control systems to enable you to work seamlessly with your source code.
- Integration into Eclipse provides useful debugging features such as colorization, error flagging, and intelligent copybook handling to enable you to quickly track down any issues, establish their cause, and make your edits.
- Reverse Debug and Live Recording are Technology Preview features available on Red Hat Linux x86 platforms that enable you to create a recording of an application's execution then load the recording into the debugger.

With the recording loaded into the debugger you can monitor everything that influenced the running of the program (such as all input, disk access, and keyboard strokes) and because the debugger lets

you move backwards and forwards through the execution path you can easily focus on potential causes of crashes or other unexpected behavior in the application.

- The Micro Focus Unit Testing Framework, an xUnit-style testing framework, includes much of the architecture you would expect of an xUnit framework, enabling you to create, compile, run, and debug unit tests from either the command line or the Enterprise Developer IDE.
- Core dump debugging. When an application crashes you can arrange for its state to be saved to disk, in a core dump file, which can indicate where the error occurred in the source code, the contents of memory at the time of the error, and the values of any variables and expressions set at the time. You can then use the core dump file to help debug the problems.
- Wait for attachment enables you to attach the debugger only when a particular piece of code is executed.
- Integration with Micro Focus Rhythm means that you can navigate and update your sprint backlog without even having to leave Eclipse.
- Remote debugging enables you to debug programs that are running on a different computer from the one on which you are using.
- The Consolidated Tracing Facility (CTF) produces detailed diagnostic information that can be invaluable in diagnosing problems when you can't easily attach a debugger.
- Enterprise Sync

Micro Focus Enterprise Sync integrates with Enterprise Developer to enable faster and more efficient parallel development. Replicating your mainframe source code on a distributed platform lets you take full advantage of the huge range of modern GUI-based tooling that is available to help you to adopt a modern application development process.

Using Enterprise Sync, changes made to your distributed source control are synchronized automatically with your mainframe software change management system, keeping your mainframe application source code as the primary system of record and ensuring the integrity of your software change and configuration management processes.

- Rhythm

Micro Focus Rhythm is the enterprise-class planning and tracking solution for Agile software projects.

Rhythm has been designed to integrate easily with Atlas and Enterprise Developer, as well as with third-party issue-tracking, version control and requirements management tools.

#### Related reference

[Micro Focus: Atlas data sheet](#)

[Micro Focus: Atlas online help](#)

[Micro Focus: Enterprise Analyzer data sheet](#)

[Micro Focus: Enterprise Analyzer online help](#)

[Micro Focus: Enterprise Developer data sheet](#)

[Micro Focus: Enterprise Developer online help](#)

[Micro Focus: Enterprise Sync data sheet](#)

[Micro Focus: Rhythm data sheet](#)

[Micro Focus: Rhythm online help](#)

## Continuous Integration

The following sections give an overview of continuous integration, present a typical continuous integration workflow, and show the benefits that Micro Focus tools can bring to the continuous integration process.

### Introduction to Continuous Integration

As mentioned in *Key Concepts in Modern Application Development*, continuous integration (CI) is a software development practice whereby developers on a team regularly integrate their working copies of

code to a shared repository. Once a change is integrated to the repository, the application is automatically rebuilt. Automated tests are run before and after the application is rebuilt, to check that no regressions are introduced. If any of the automated tests fail, developers can be notified automatically so that they can provide a fix.

Using continuous integration provides a number of benefits:

- Developers can find problems earlier than they would be able to if builds happened only every day or every week.
- When a problem does occur, pinpointing the cause of the problem is quicker and easier because only a small change should have been made since the last working build.
- The time taken to resolve integration issues is reduced because each change is integrated as required.
- There is always a working version of the product that contains the latest changes.

Tools that provide CI functionality are known as CI servers. There are many tools available that can be used as CI servers, but the following list shows some of the more commonly used:

- Bamboo
- Cruise Control
- Hudson
- Jenkins
- Team Foundation Server

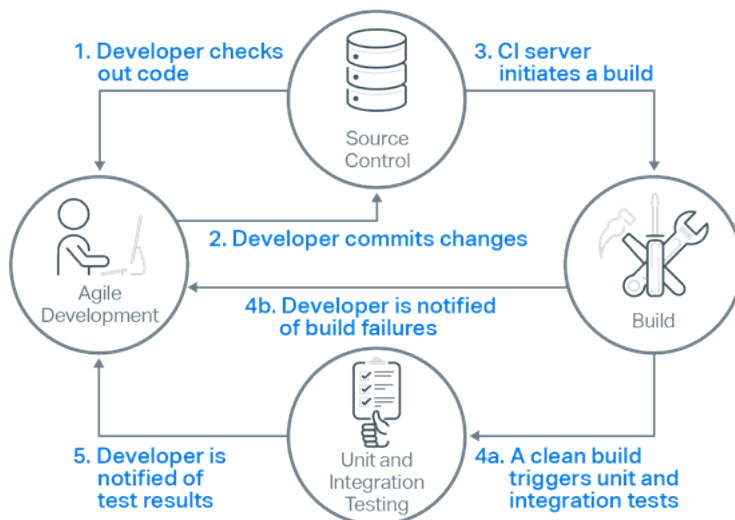
For detailed information on how to use Enterprise Developer with Jenkins, see *Using Enterprise Developer with Jenkins*.

### Related information

[Key Concepts in Modern Application Development](#)  
[Using Enterprise Developer with Jenkins](#)

## Continuous Integration Workflow

The following diagram summarizes the key steps in a continuous integration process. Although the process comprises a number of different activities with integration provided between each activity, you do not have to adopt every activity in the process before you can benefit from significant gains in terms of efficiency, effectiveness, and quality. Instead, you might choose to implement this process one activity at a time, taking advantage of the benefits provided by each activity as you add and integrate it with the others.



where the numbered steps are as follows:

1. Developers check out code into their private workspaces. They then make their changes and test them locally.
2. When done, developers check in their changes into the source control repository.
3. The CI server monitors the source control repository and when it detects a change it triggers a build of the relevant sources.
4. After a successful build, the CI server performs some or all of the following activities:
  - makes deployable artefacts available for testing
  - assigns a build label to the version of the code that was just built
  - notifies the relevant team members that a successful build occurred
  - triggers unit and integration testing

At this point, the changes that were checked in at step 2 have been successfully built and a build label has been applied to the source code that was used for the build, meaning that the build could be recreated if necessary.

In the event of a build failure, the CI server sends notifications to the relevant developers who restart the process from step 1 to make the changes necessary to resolve the build errors.

5. After the unit and integration testing has taken place, the relevant team members are notified of the test results.

At this point, the changes that were checked in at step 2 have been successfully built and tested, all with little or no manual intervention.

For information on using Jenkins to perform the CI server tasks in the above list, see *Using Enterprise Developer with Jenkins*.

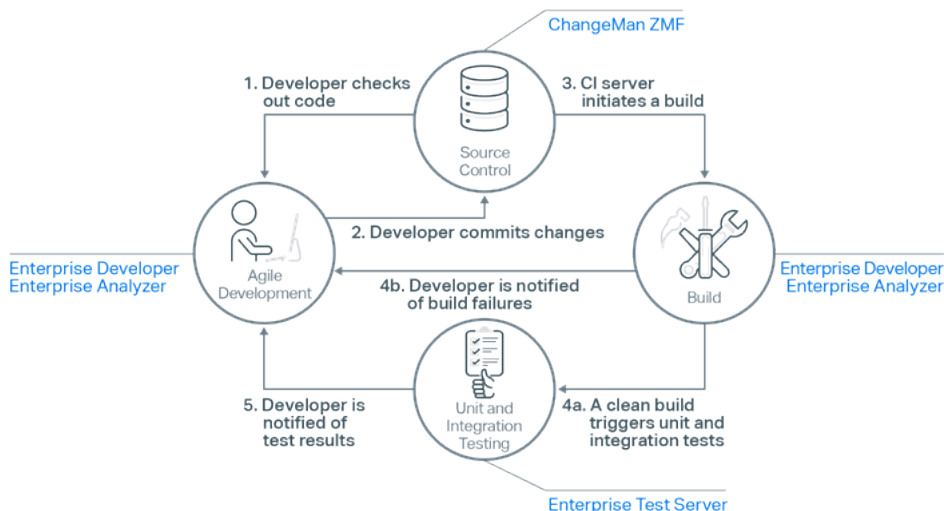
#### Related information

[Using Enterprise Developer with Jenkins](#)

## Continuous Integration and Micro Focus Development Tools

The sections *Introduction to Continuous Integration* and *Continuous Integration Workflow* introduce the idea of continuous integration and summarize how continuous integration works as a process. This section looks at the continuous integration process and shows how different products available from Micro Focus fit into and add value to that process.

The diagram below shows the process presented in the topic *Continuous Integration Workflow* but has been modified to indicate which Micro Focus products you can use at the different parts of the process. Although this diagram refers to Micro Focus products, the process described does not require the use of Micro Focus products, so if you are already using a third-party product for one part of the process you can continue to work with that and use Micro Focus products to integrate with it.



where the numbered steps are as follows:

1. Developers use Enterprise Developer to check out code into their private workspaces. They then make their changes and test them locally using Enterprise Developer's unit testing features.

This diagram illustrates the use of ChangeMan ZMF as the source code control system but you are not limited to using only that product. Enterprise Developer works with any SCC-compliant source code control system, so you can work seamlessly in Enterprise Developer with virtually any source code control system you choose to use regardless of whether it is a Micro Focus product or a third-party product.

For mainframe development, using Enterprise Developer in conjunction with Enterprise Sync (another product from the Micro Focus Enterprise suite) enables you to replicate your mainframe source code to a distributed software configuration management platform, greatly increasing the effectiveness of your parallel application development.

2. When done, developers check in their changes into the source control repository.
3. The CI server monitors the source control repository and when it detects a change it triggers a build of the relevant sources. Although the build actions are triggered by the CI server, the build actions themselves will be performed by Enterprise Developer, typically using Apache Ant or MSBuild scripts.
4. After a successful build, the CI server performs activities such as the following:
  - makes deployable artefacts available for testing
  - assigns a build label to the version of the code that was just built
  - notifies the relevant team members that a successful build occurred
  - triggers unit and integration testing to be run under Enterprise Test Server

At this point, the changes that were checked in at step 2 have been successfully built and a build label has been applied to the source code that was used for the build (so the build could be recreated if necessary).

In the event of a build failure, the CI server sends notifications to the relevant developers who restart the process from step 1, using Enterprise Developer to make the changes necessary to resolve the build errors.

5. After the unit and integration testing has taken place, the relevant team members are notified of the test results.

At this point, the changes that were checked in at step 2 have been successfully built and tested, all with little or no manual intervention.

For information on using Jenkins to perform the CI server tasks in the above list, see *Using Enterprise Developer with Jenkins*.

The following list gives a very brief summary of each of the Micro Focus products that play a part in the continuous integration process:

- ChangeMan ZMF

Micro Focus ChangeMan ZMF is a comprehensive, automated change management system for reliably implementing mainframe software changes from development to testing to production, and treats change management as a business issue by giving key stakeholders visibility into the release process. ChangeMan ZMF protects your corporate assets and helps you get more done in less time.

- Enterprise Analyzer

Micro Focus Enterprise Analyzer delivers a wide array of tools and content to enable you to quickly gain a thorough understanding of your applications, meaning that you reduce the amount of time it takes you to make your changes and you can have more confidence that your changes have the desired effect and do not introduce any new issues.

You can also use Enterprise Analyzer to run queries to determine if your code conforms to your in-house standards. Any code that does not conform to your standards can be flagged as an error following a commit or during the build process.

- Enterprise Developer

Micro Focus Enterprise Developer provides an integrated development environment (IDE) that streamlines mainframe COBOL and PL/I development activities. This toolset provides access, flexibility, and extensibility to modern technologies through fast integration and remote development capability.

Enterprise Developer includes the following features that make it a great fit for using in your CI process:

- Support for Apache Ant means that you can write scripts to enable your CI server to build and run your COBOL applications just as easily as you can build and run your COBOL applications from the Enterprise Developer IDE.
- Integration into an extensible IDE enables you to use a range of third-party functionality to work with different CI servers.
- Highly-compatible subsystem support (including CICS, IMS, DB2 and JES) means that you can be confident that the code you write using Enterprise Developer will run as expected on the mainframe.
- Integration with SCC-compliant source code control systems to enable you to work seamlessly with your source code.
- Integration into Eclipse provides useful debugging features such as colorization, error flagging, and intelligent copybook handling to enable you to quickly track down any issues, establish their cause, and make your edits.
- Reverse Debug and Live Recording are Technology Preview features available on Red Hat Linux x86 platforms that enable you to create a recording of an application's execution then load the recording into the debugger.

With the recording loaded into the debugger you can monitor everything that influenced the running of the program (such as all input, disk access, and keyboard strokes) and because the debugger lets you move backwards and forwards through the execution path you can easily focus on potential causes of crashes or other unexpected behavior in the application.

- The Micro Focus Unit Testing Framework, an xUnit-style testing framework, includes much of the architecture you would expect of an xUnit framework, enabling you to create, compile, run, and debug unit tests from either the command line or the Enterprise Developer IDE.
  - Core dump debugging. When an application crashes you can arrange for its state to be saved to disk, in a core dump file, which can indicate where the error occurred in the source code, the contents of memory at the time of the error, and the values of any variables and expressions set at the time. You can then use the core dump file to help debug the problems.
  - Wait for attachment enables you to attach the debugger only when a particular piece of code is executed.
  - Integration with Micro Focus Rhythm means that you can navigate and update your sprint backlog without even having to leave Eclipse.
  - Remote debugging enables you to debug programs that are running on a different computer from the one on which you are using.
  - The Consolidated Tracing Facility (CTF) produces detailed diagnostic information that can be invaluable in diagnosing problems when you can't easily attach a debugger.
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Micro Focus Enterprise Sync integrates with Enterprise Developer to enable faster and more efficient parallel development. Replicating your mainframe source code on a distributed platform lets you take full advantage of the huge range of modern GUI-based tooling that is available to help you to adopt a modern application development process.

Using Enterprise Sync, changes made to your distributed source control are synchronized automatically with your mainframe software change management system, keeping your mainframe application source code as the primary system of record and ensuring the integrity of your software change and configuration management processes.

- Enterprise Test Server

Micro Focus Enterprise Test Server is an IBM mainframe application test environment on Windows. It enables you to confidently test mainframe application change on scalable, low-cost commodity

hardware, and expands your test capacity to scale to meet the delivery timelines and quality standards driven by today's business requirements.

An example of a way in which Enterprise Test Server can simplify your testing is the ability to export and import execution environments. Once you have set up an Enterprise Test Server environment for testing an application you can export the definition of that environment to an XML file, where the XML definition includes details of all aspects of the Enterprise Test Server environment such as region definitions, locations of data files, and settings of environment variables. After exporting the definition you can then import it to be used during your testing, ensuring that the Enterprise Test Server environment you use in your testing is exactly the same environment as the one you know to be correct.

### Related information

[Using Enterprise Developer with Jenkins](#)

### Related reference

[Micro Focus: Ant User Guide](#)

[Micro Focus: ChangeMan ZMF data sheet](#)

[Micro Focus: Enterprise Analyzer data sheet](#)

[Micro Focus: Enterprise Analyzer online help](#)

[Micro Focus: Enterprise Developer data sheet](#)

[Micro Focus: Enterprise Developer online help](#)

[Micro Focus: Enterprise Sync data sheet](#)

[Micro Focus: Enterprise Sync online help](#)

[Micro Focus: Enterprise Test Server data sheet](#)

[Micro Focus: Enterprise Test Server online help](#)

## Continuous Delivery

The following sections give an overview of continuous delivery, present a typical continuous delivery workflow, and show the benefits that Micro Focus tools can bring to the continuous delivery process.

### Introduction to Continuous Delivery

As mentioned in *Key Concepts in Modern Application Development*, continuous delivery (CD) is a practice where teams make use of automated processes so that any code changes result in the building and testing of new software that can then be deployed to production (if appropriate).

Continuous delivery does not mean that every code change is deployed to production. Instead, a continuous delivery environment typically includes a number of different environments for deployment, where deployments to some environments happen automatically but deployment to other environments requires some manual input or approval.

For example, a continuous delivery environment could include deployment environments for development, testing, staging, and production, where deployment happens automatically for the development and testing environments, but manual intervention is required to approve deployment to the staging or production environments.

Using continuous delivery in this way enables you to deliver application changes quickly and more reliably, leading to improved product quality and user experience.



**Note:** Continuous delivery is very similar to continuous deployment, with the only difference being the existence (or lack) of manual validation steps. With continuous delivery a code change results in automated building and testing followed by at least one manual validation step before the changes are



deployed to production, whereas with continuous deployment there are no manual validation steps, so a code change always results in automated building, testing, and deployment to production.

## Related information

[Key Concepts in Modern Application Development](#)

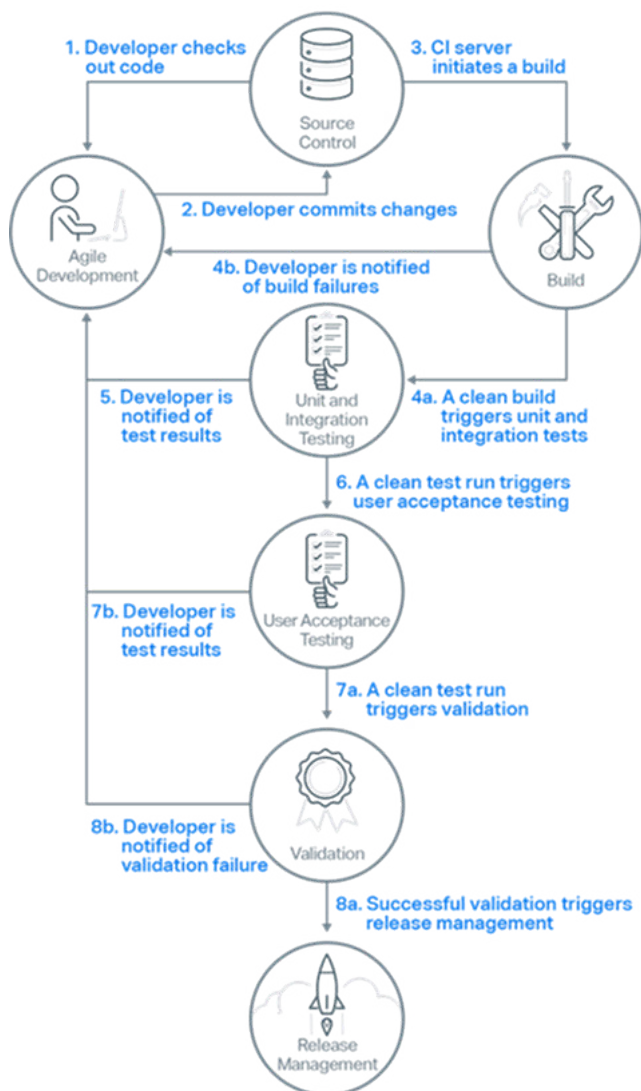
## Related reference

[Continuous Delivery: What is Continuous Delivery?](#)

# Continuous Delivery Workflow

The following diagram summarizes the steps involved in a continuous delivery process. Although the process comprises a number of different activities with integration provided between each activity, you do not have to adopt every activity in the process before you can benefit from significant gains in terms of efficiency, effectiveness, and quality. Instead, you might choose to implement this process one activity at a time, taking advantage of the benefits provided by each activity as you add and integrate it with the others.

Note that because continuous delivery is effectively an extension of the continuous integration process, the first five steps in this diagram are the same as the steps in the diagram presented in *Continuous Integration Workflow*.



where the numbered steps are as follows:

1. Developers check out code into their private workspaces. They then make their changes and test them locally.
2. When done, developers check in their changes into the source control repository.
3. The CI server monitors the source control repository and when it detects a change it triggers a build of the relevant sources.
4. After a successful build, the CI server performs some or all of the following activities:
  - makes deployable artefacts available for testing
  - assigns a build label to the version of the code that was just built
  - notifies the relevant team members that a successful build occurred
  - triggers unit and integration testing

At this point, the changes that were checked in at step 2 have been successfully built and a build label has been applied to the source code that was used for the build, meaning that the build could be recreated if necessary.

In the event of a build failure, the CI server sends notifications to the relevant developers who restart the process from step 1 to make the changes necessary to resolve the build errors.

5. After the unit and integration testing has taken place, the relevant team members are notified of the test results.

At this point, the changes that were checked in at step 2 have been successfully built and tested, all with little or no manual intervention.

6. After the unit and integration testing has completed successfully, the CI server triggers the running of more comprehensive, automated acceptance tests.
7. If the acceptance tests all pass, a decision is made whether or not to release.

If the acceptance tests result in failures, the CI server sends notifications to the relevant developers who restart the process from step 1 to make the changes necessary to resolve the test failures.

8. If the validation decision is to release, release management is triggered. This results in the built package being released or deployed to the appropriate environment.

If the validation decision is not to release, the relevant team members are notified and development work continues as normal.

For information on using Jenkins to perform the CI server tasks in the above list, see *Using Enterprise Developer with Jenkins*.

## Related information

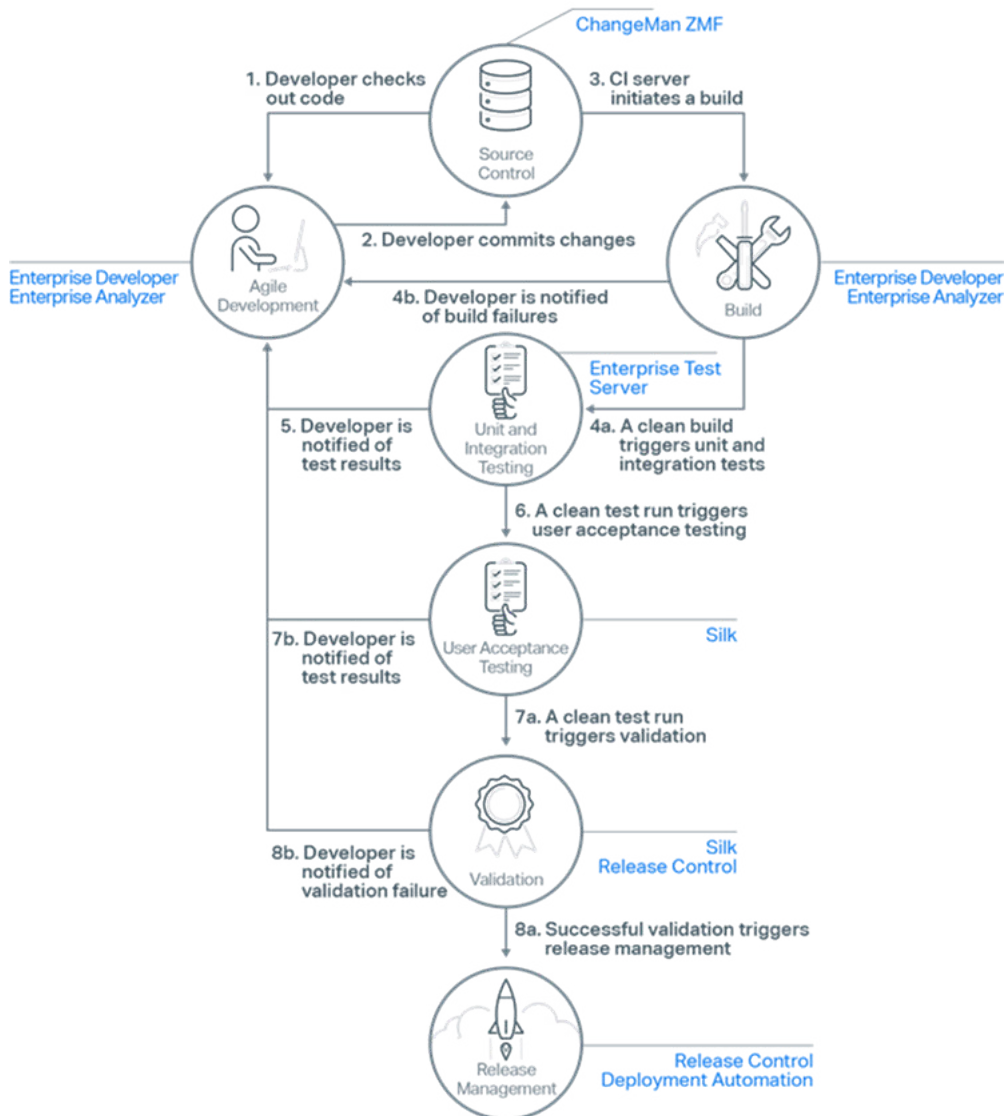
[Continuous Integration Workflow](#)  
[Using Enterprise Developer with Jenkins](#)

# Continuous Delivery and Micro Focus Development Tools

The sections *Introduction to Continuous Delivery* and *Continuous Delivery Workflow* introduce the idea of continuous delivery and summarize how continuous delivery works as a process. This section looks at the continuous delivery process and shows how different products available from Micro Focus fit into and add value to that process.

The diagram below shows the process presented in the section *Continuous Delivery Workflow* but has been updated to indicate which Micro Focus products are appropriate at different parts of the process. Although this diagram refers to Micro Focus products, the process described does not require the use of Micro Focus products, so if you are already using a third-party product for one part of the process you can continue to work with that and use Micro Focus products to integrate with it.

Note that because continuous delivery is effectively an extension of the continuous integration process, the first five steps in this diagram are the same as the steps in the diagram presented in *Continuous Integration and Micro Focus Development Tools*.



where the numbered steps are as follows:

1. Developers use Enterprise Developer to check out code into their private workspaces. They then make their changes and test them locally using Enterprise Developer's unit testing features.

This diagram illustrates the use of ChangeMan ZMF as the source code control system but you are not limited to using only that product. Enterprise Developer works with any SCC-compliant source code control system, so you can work seamlessly in Enterprise Developer with virtually any source code control system you choose to use regardless of whether it is a Micro Focus product or a third-party product.

For mainframe development, using Enterprise Developer in conjunction with Enterprise Sync (another product from the Micro Focus Enterprise suite) enables you to replicate your mainframe source code to a distributed software configuration management platform, greatly increasing the effectiveness of your parallel application development.

2. When done, developers check in their changes into the source control repository.

3. The CI server monitors the source control repository and when it detects a change it triggers a build of the relevant sources. Although the build actions are triggered by the CI server, the build actions themselves will be performed by Enterprise Developer, typically using Apache Ant or MSBuild scripts.
4. After a successful build, the CI server performs activities such as the following:
  - makes deployable artefacts available for testing
  - assigns a build label to the version of the code that was just built
  - notifies the relevant team members that a successful build occurred
  - triggers unit and integration testing to be run under Enterprise Test Server

At this point, the changes that were checked in at step 2 have been successfully built and a build label has been applied to the source code that was used for the build (so the build could be recreated if necessary).

In the event of a build failure, the CI server sends notifications to the relevant developers who restart the process from step 1, using Enterprise Developer to make the changes necessary to resolve the build errors.

5. After the unit and integration testing has taken place, the relevant team members are notified of the test results.

At this point, the changes that were checked in at step 2 have been successfully built and tested, all with little or no manual intervention.

6. After the unit and integration testing has completed successfully, the CI server triggers the running of more comprehensive, automated acceptance tests using Micro Focus Silk.

For mainframe-hosted applications your testing at this stage should include testing your changes on the mainframe in addition to the testing done on your Windows workstations.

7. If the acceptance tests all pass, a decision is made whether or not to release.

If the acceptance tests results in failures, the CI server sends notifications to the relevant developers who restart the process from step 1 to make the changes necessary to resolve the test failures.

8. If the validation decision is to release, use Micro Focus Deployment Automation or Micro Focus Release Control to release or deploy the built package to the appropriate environment.

If the validation decision is not to release, the relevant team members are notified and development work continues as normal.

For information on using Jenkins to perform the CI server tasks in the above list, see *Using Enterprise Developer with Jenkins*.

The following list gives a very brief summary of each of the Micro Focus products that play a part in the continuous delivery process:

- ChangeMan ZMF

Micro Focus ChangeMan ZMF is a comprehensive, automated change management system for reliably implementing mainframe software changes from development to testing to production, and treats change management as a business issue by giving key stakeholders visibility into the release process. ChangeMan ZMF protects your corporate assets and helps you get more done in less time.

- Deployment Automation

Micro Focus Deployment Automation simplifies and automates the deployment of your software. It supports continuous delivery and production deployments by seamlessly enabling deployment pipeline automation, reducing cycle times, and providing rapid feedback. With Deployment Automation, you will be able to deliver high-quality, valuable software in an efficient, fast, and reliable manner.

- Enterprise Analyzer

Micro Focus Enterprise Analyzer delivers a wide array of tools and content to enable you to quickly gain a thorough understanding of your applications, meaning that you reduce the amount of time it takes you to make your changes and you can have more confidence that your changes have the desired effect and do not introduce any new issues.

You can also use Enterprise Analyzer to run queries to determine if your code conforms to your in-house standards. Any code that does not conform to your standards can be flagged as an error following a commit or during the build process.

- Enterprise Developer

Micro Focus Enterprise Developer provides an integrated development environment (IDE) that streamlines mainframe COBOL and PL/I development activities. This toolset provides access, flexibility, and extensibility to modern technologies through fast integration and remote development capability.

Enterprise Developer includes the following features that make it particularly suitable for using in your continuous delivery process:

- Support for Apache Ant means that you can write scripts to enable your CI server to build and run your COBOL applications just as easily as you can build and run your COBOL applications from the Enterprise Developer IDE.
- Integration into an extensible IDE enables you to use a range of third-party functionality to work with different CI servers.
- Highly-compatible subsystem support (including CICS, IMS, DB2 and JES) means that you can be confident that the code you write using Enterprise Developer will run as expected on the mainframe.
- Integration with SCC-compliant source code control systems to enable you to work seamlessly with your source code.
- Integration into Eclipse provides useful debugging features such as colorization, error flagging, and intelligent copybook handling to enable you to quickly track down any issues, establish their cause, and make your edits.
- Reverse Debug and Live Recording are Technology Preview features available on Red Hat Linux x86 platforms that enable you to create a recording of an application's execution then load the recording into the debugger.

With the recording loaded into the debugger you can monitor everything that influenced the running of the program (such as all input, disk access, and keyboard strokes) and because the debugger lets you move backwards and forwards through the execution path you can easily focus on potential causes of crashes or other unexpected behavior in the application.

- The Micro Focus Unit Testing Framework, an xUnit-style testing framework, includes much of the architecture you would expect of an xUnit framework, enabling you to create, compile, run, and debug unit tests from either the command line or the Enterprise Developer IDE.
  - Core dump debugging. When an application crashes you can arrange for its state to be saved to disk, in a core dump file, which can indicate where the error occurred in the source code, the contents of memory at the time of the error, and the values of any variables and expressions set at the time. You can then use the core dump file to help debug the problems.
  - Wait for attachment enables you to attach the debugger only when a particular piece of code is executed.
  - Integration with Micro Focus Rhythm means that you can navigate and update your sprint backlog without even having to leave Eclipse.
  - Remote debugging enables you to debug programs that are running on a different computer from the one on which you are using.
  - The Consolidated Tracing Facility (CTF) produces detailed diagnostic information that can be invaluable in diagnosing problems when you can't easily attach a debugger.
- Enterprise Sync

Micro Focus Enterprise Sync integrates with Enterprise Developer to enable faster and more efficient parallel development. Replicating your mainframe source code on a distributed platform lets you take full advantage of the huge range of modern GUI-based tooling that is available to help you to adopt a modern application development process.

Using Enterprise Sync, changes made to your distributed source control are synchronized automatically with your mainframe software change management system, keeping your mainframe application source code as the primary system of record and ensuring the integrity of your software change and configuration management processes.

- Enterprise Test Server

Micro Focus Enterprise Test Server is an IBM mainframe application test environment on Windows. It enables you to confidently test mainframe application change on scalable, low-cost commodity hardware, and expands your test capacity to scale to meet the delivery timelines and quality standards driven by today's business requirements.

An example of a way in which Enterprise Test Server can simplify your testing is the ability to export and import execution environments. Once you have set up an Enterprise Test Server environment for testing an application you can export the definition of that environment to an XML file, where the XML definition includes details of all aspects of the Enterprise Test Server environment such as region definitions, locations of data files, and settings of environment variables. After exporting the definition you can then import it to be used during your testing, ensuring that the Enterprise Test Server environment you use in your testing is exactly the same environment as the one you know to be correct.

- Release Control

Micro Focus Release Control enables you to plan, control, and automate your release processes from definition to deployment with a visual release calendar and automated approval process. The automation and integration features that Release Control offers result in improved visibility and tracking, and adherence to your compliance and control procedures.

- Silk

Micro Focus Silk Test enables you to maintain rigorous quality standards and accelerate application testing on any device and platform. Using Silk Test you can standardize validation efforts by testing web, mobile, rich-client, and enterprise applications with a single, powerful test automation solution.

Micro Focus Silk Central unifies test assets into one planning, tracking, reporting, and execution hub, enabling you to define quality goals, schedule manual and automated functional and performance tests, and view results in a centralized dashboard.

## Related information

[\*Continuous Integration and Micro Focus Development Tools  
Using Enterprise Developer with Jenkins\*](#)

## Related reference

[\*Micro Focus: Ant User Guide\*](#)  
[\*Micro Focus: ChangeMan ZMF data sheet\*](#)  
[\*Micro Focus: Deployment Automation data sheet\*](#)  
[\*Micro Focus: Enterprise Analyzer data sheet\*](#)  
[\*Micro Focus: Enterprise Analyzer online help\*](#)  
[\*Micro Focus: Enterprise Developer data sheet\*](#)  
[\*Micro Focus: Enterprise Developer online help\*](#)  
[\*Micro Focus: Enterprise Sync data sheet\*](#)  
[\*Micro Focus: Enterprise Sync online help\*](#)  
[\*Micro Focus: Enterprise Test Server data sheet\*](#)  
[\*Micro Focus: Enterprise Test Server online help\*](#)  
[\*Micro Focus: Release Control data sheet\*](#)  
[\*Micro Focus: Silk Central data sheet\*](#)  
[\*Micro Focus: Silk Test data sheet\*](#)

# Continuous Improvement

Continuous improvement is strongly linked to one of the principles of the Agile manifesto which states that "At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly". The improvements you want to achieve can be split into two distinct areas:

- Improvements to the software being produced.

The following sources of information could all be used to help you target improvements to your software:

- Test failures. If a particular area of code regularly causes test failures, is there the potential to redesign that section of the code? Test failures would be flagged by the unit and integration testing carried out in the continuous integration and continuous delivery processes of the modern application development process as well as by the acceptance testing carried out in the continuous delivery process.
- Code coverage. The code coverage capabilities of Enterprise Developer will highlight any areas of your code that aren't being executed as part of your testing, giving you the opportunity to update your tests to ensure that every line of code is thoroughly tested.
- Customer feedback. Any feedback that you get from your customers about your software can be fed into the requirements gathering step of the Agile development process, giving you the opportunity to assess the feedback and quickly make changes based on it if appropriate. The rapid iterative nature of Agile development ensures that any changes you do make will quickly be delivered to the customer.
- Improvements to the process used to produce the software.

A convenient opportunity for a team to have this discussion is the sprint retrospective that is a part of the Agile development process. There is no fixed format to determine exactly what is discussed at a sprint retrospective, but in general, variants of the following questions are asked:

- What went well?
- What didn't go well?

The scope of these questions is not limited to code-writing activities but covers the whole development process, so from requirements gathering to release. For any aspects of operation that are deemed to have not gone well, solutions can be discussed, and any changes can be implemented for future sprints. If substantial changes are required, they can be handled in the same way as any other requirements, with a tool such as Micro Focus Atlas.

As sprints are very short, typically two weeks, any changes that are made to the process will be put into practice very quickly, and future sprint retrospectives will provide opportunities to discuss if the changes made had the desired effect or if further changes need to be made.

## Related information

[Agile Manifesto: Principles Behind the Agile Manifesto](#)

# Using Enterprise Developer with Jenkins

This section of the documentation contains information that you need to know to in order to use Enterprise Developer 3.0 in conjunction with Jenkins version 2.60.1<sup>1</sup>. It includes information on what software you need to install, how to configure Enterprise Developer and Jenkins to get the most from them working together, and tips and guidance for using Enterprise Developer alongside Jenkins.

General information about using Enterprise Developer in a modern application development process is included in *Introduction to Modern Application Development*.



**Note:** For full details about how to use Jenkins, see the Jenkins user documentation.

## Related information

[Introduction to Modern Application Development](#)

## Related reference

[Jenkins user documentation](#)

## Overview of Jenkins

Jenkins is a continuous integration (CI) server that supports a wide range of tools and technologies. Adopting a CI process ensures that all developers' working copies of code are regularly merged into a shared trunk. Once a change is integrated to the repository, the product is automatically rebuilt and tested.

With Jenkins you can automate a number of day-to-day tasks such as checking out the sources from source control, building, code analysis, and different levels of testing and deployment.

By setting up Jenkins to run these tasks each time a developer has changed the source code, you can detect any defects much faster meaning that you maintain your applications' quality and reduce time to market.

Jenkins is highly configurable, and there are numerous plugins available that provide access to a range of tools including source control, shell and batch scripts. Jenkins works on multiple platforms, supports Java and integrates with other corporate systems.

### Using Projects and Pipelines

Jenkins supports two methods of specifying commands - simple projects and pipelines.

Earlier versions of Jenkins only provided projects (previously known as jobs) for managing your tasks. Projects need to be created and configured manually in the UI and, if you need to create multiple projects, could require more maintenance work. Configuring projects is independent from your code.

More recent versions of Jenkins also support pipelines where all build, test, analysis and deployment tasks are stored in a single pipeline and saved as a Jenkinsfile. Micro Focus recommends using pipelines as they are suitable for organizing complex activities running on multiple machines. Storing a pipeline in a file format also means you can follow common CI best practices and save the pipeline in your source control code system with the rest of your code as another artefact.

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<sup>1</sup> The examples in this section of the documentation have been tested with the specified versions of Enterprise Developer and Jenkins. The concepts described would still apply to earlier or later releases of the two products, however, some specific releases might require changes to the Jenkins configuration.



For simplicity, the examples in this guide are created using projects and not pipelines. For details about the pipeline syntax, see the Jenkins user documentation.

#### Related reference

[Jenkins user documentation](#)

## Terminology

This documentation uses a number of terms as defined in the Jenkins UI. For a full list of the Jenkins terms, see the Jenkins user documentation.

- Agent** A machine which connects to a Jenkins master and executes tasks when directed by the master.<sup>2</sup>
- Job** A deprecated term, synonymous with project.
- Master** The central, coordinating machine which stores configuration, loads plugins, and renders the various user interfaces for Jenkins.<sup>3</sup>
- Node** A machine which is part of the Jenkins environment and capable of executing pipelines or projects. Both the master and agents are considered to be nodes.
- Pipeline** A user-defined model of a continuous delivery pipeline.<sup>4</sup>
- Plugin** An extension that provides additional functionality that is not provided by standard Jenkins.
- Project** A user-configured description of work which Jenkins should perform, such as building a piece of software.

#### Related reference

[Jenkins user documentation](#)

## Scenarios for Using Jenkins with Enterprise Developer

You can integrate Jenkins into your continuous integration environment in a variety of different ways. The approach that you decide to implement depends on your particular development process.

### Using a Master and Agent Machines

The simplest scenario is to install Jenkins on the same machine where you build and test your source code.

Real-world development and delivery processes typically require a more complex scenario than this, however, and you often need to ensure that your applications operate as expected on a variety of different platforms. You can use Jenkins to its full potential in a multiple machine environment where Jenkins is installed on one machine (master) and controls a number of tasks that execute on various other machines (agents).

---

<sup>2</sup> Agent machines are also referred to as Slaves.

<sup>3</sup> Typically, this is the machine that has Jenkins installed. The actual work specified in a project would then be performed on one or more agent machines (slaves).

<sup>4</sup> The examples in this documentation are created using projects and not pipelines.

## Automating Your Processes

You can use Jenkins to automatically start the next task in your application development process when the previous one has completed successfully. For example, this is how you can create a sequence of projects:

1. Your projects examine the source code control system and trigger a checkout and build after a developer commits a change.
2. At the end of a successful build, Jenkins can trigger other projects such as ones that run the MFUnit tests or copy the executables to another location for additional testing or deployment.

# Software Requirements

The examples in this documentation are created with the software versions specified below:

- Jenkins 2.60.1 - see the Jenkins user documentation for information about the software prerequisites. In a scenario where you have a master and a number of agent machines, Jenkins must be installed on the master machine. You can obtain Jenkins from the Jenkins download page.
- Enterprise Developer 3.0 for either Eclipse or Visual Studio - see the product's release notes for any software prerequisites.

In a scenario where you have a master and a number of agent machines, Enterprise Developer must be installed on each agent machine. You can obtain Enterprise Developer from Micro Focus SupportLine.

- Apache Ant 1.9.4 - this is required if you are working with COBOL applications created with Enterprise Developer for Eclipse. Download Ant from the Apache Ant Web site.

The rest of this documentation assumes that you have installed and licensed the specified software as required.

### Related reference

[Apache Ant Web site](#)  
[Enterprise Developer 3.0 release notes](#)  
[Jenkins download page](#)  
[Jenkins user documentation](#)  
[Micro Focus SupportLine](#)

# Installing and Configuring Jenkins

The following is a brief overview of how to install and configure Jenkins and how to create a project.

## Installing and Accessing Jenkins

Jenkins is supported on a variety of platforms. See the Jenkins user documentation for detailed instructions on how to install and start it on the platform that you will be using it on.

You can access Jenkins from any machine using `http://<mymachine>:8080`, where `<mymachine>` is the name of the machine where Jenkins is installed.

## Configuring Jenkins

You can specify general Jenkins options by clicking **Manage Jenkins** in the Home page of the Jenkins interface.

Use plugins to extend Jenkins and to enable support for tools or systems - click **Manage Plugins**. Use this page to check which plugins are installed and to install or update any as required. Widely-used plugins include those used for source control systems (such as Git and Subversion). Other plugins you might find useful include:

- Conditional Buildstep
- Copy Artifact
- JUnit Attachments and xUnit
- Node and Label Parameter
- PowerShell
- SCTMExecutor - works with Micro Focus MFUnit support and Micro Focus Silk Central
- vSphere - if you are using agent machines that are stored in VMWare vSphere
- Warnings Plug-in

### Creating a Project

Click **New Item** in the Home page of Jenkins interface to create a project such as a freestyle project.

Use the project's configuration page (click **Configure**) to modify various aspects of what it does. Some aspects that might be appropriate for your build system are:

- **Restrict where this project can be run** - use this to specify the agents (such as remote machines) where the work should be performed.
- **Source Code Management** - enter details of where your project is in source control. There are plugins available that allow Jenkins to work with most major source control systems.
- **Build Triggers** - define events that automatically start the execution of the project.
- **Build** - specify what the project should do such as executing Windows or UNIX commands, or Ant scripts.
- **Post-build Actions** - specify the commands that the project should perform upon completion. These could be emailing reports, compiling build results, or triggering other projects based on the output of the current one.

### Related reference

[Jenkins user documentation](#)

## Advanced Configuration

The following sections provide guidance on how to specify more advanced configuration details to integrate Jenkins even more closely with your Enterprise Developer development process.

### Configuring Email Reporting

You can configure Jenkins so that it sends reports at the end of a build or a test, for example a report listing any test failures.

To configure Jenkins to send email notifications:

1. Click **Manage Jenkins** in the Jenkins Home page.
2. Click **Configure System**.
3. Specify an SMTP server, any recipients and any other required details such as whether to always to send an email or to only email about build failures - see the **Extended E-mail Notification** and **E-mail Notification** lists.

To enable email notifications for a project:

1. Navigate to the configuration area of your project.
2. In the **Post-build Actions** section, click **Add post-build action**.
3. Add **Editable Email Notification** and **E-mail Notification** and specify a recipient email and other settings as required.

4. For the **Editable Email Notification**, click **Advanced** and configure email as well as what triggers it (such as when a certain failure has occurred).

## Use Sources from Source Control

You can configure Jenkins to access the sources you store in a source control system, of which there are many types. The simplest way to do this is to use a file system watcher which triggers an action when a change occurs in the source control repository.

To enable Jenkins to access the source control, install a required plugin:

1. In the Jenkins Home page, click **Manage Jenkins > Manage Plugins**, and then click the **Available** tab.
2. Locate **File system SCM**, and then install the required plugin by enabling the check box and clicking **Install**.
3. Restart Jenkins (you can select **Ctrl+C** in the command window that is running Jenkins and then start Jenkins again).

The following example shows how to configure your project to access the sources from Subversion:

1. Navigate to the project's configuration area.
2. Under **Source Code Management**, click **Subversion**.
3. In the **Repository URL** area, specify the URL path of the source control that you want to work with.
4. Specify the credentials and a local check-out directory as required.
5. Click **Apply** to save the configuration.

You have now created a source configuration for your project, but you also need to change the **Build Triggers** section to tell Jenkins to monitor that location.

## Triggering Builds Automatically

Jenkins supports triggers to automatically start running your projects. You can use various events as triggers - a successful build started by another project, detecting a change in the code following a commit in the SCM system, or a change as a result of monitoring a URL or a network locations to name a few.

You specify triggers in the **Build Triggers** section of the project's configuration. For example:

- **Build after other projects are built** - starts execution after successfully building another project.
- **Poll SCM** - starts execution after a commit to a source code control system. Alternatively, instead of building on a source code change, you could specify that the project is to be executed at a scheduled time.

## Creating Environment Variables

There are different ways to specify environment variables in Jenkins. To specify an environment variable that applies globally, go to the Jenkins configuration pages. You can also specify environment variables that only apply to individual nodes, or ones that are set as an external step before starting Jenkins.

In a scenario where you have Enterprise Developer installed on multiple platforms on agent machines, using environment variables for common installation paths can greatly simplify the creation of new projects.

For example, you can have an environment variable for the Enterprise Developer installation directory on Windows, and another one for the corresponding location on UNIX. Other environment variables could point to locations such as the installation location of Eclipse, the default source code control system check-out folder, the workspace directory, or the location of the samples.

To set global environment variables in Jenkins:

1. From the Jenkins Home page, click **Manage Jenkins**.
2. Click **Configure System**.

3. In the **Global properties** section, check **Environment variables**.
4. Click **Add** and set any environment variables for paths that might be the same across a number of slave machines.

To set environment variables for a node:

1. In the configuration page of the node, check **Environment variables** in the **Node Properties** section.
2. Click **Add** and specify any environment variables as required.

#### Related information

[Best practices - Environment Variables](#)

## Using Agents

You can have Jenkins installed on one machine, known as a master, and use it to run projects that control your day-to-day development processes on other machines, known as agents. This can be very helpful if you need to ensure that your applications run correctly on a variety of different test configurations.



**Note:** An agent can either be a physical or a virtual machine.

The process of setting up agents in Jenkins is as follows:

1. In Jenkins on the master, create a node that defines a connection to the machine you want to use as an agent. See the example below for instructions.
2. On the agent, open the Jenkins UI. Open the page for the node and follow the link to launch a Jenkins agent which will establish a connection between Jenkins on the master machine and the agent machine.
3. In Jenkins on the master, create a project and configure it to execute on the agent.

#### Example of Creating Agent Machines

The following example shows how to create a connection to an agent machine which is stored in a vSphere cloud. This requires that you install the vSphere plugin in Jenkins.

Ensure that Jenkins is connected to the vSphere cloud:

1. From the Jenkins Home page, click **Manage Jenkins**.
2. Click **General**.
3. Under the **Cloud** section, click **Add new cloud > vSphere cloud**.
4. Specify the configuration and login details for connecting to the vSphere host that contains your virtual machines.

To create a connection to an agent machine, first create a node in Jenkins as follows:

1. Click **Manage Jenkins**.
2. Click **Manage Nodes**.

This opens the **Nodes** page showing the machine that has Jenkins installed as the master.

3. Click **New Node**.
4. Specify a name for the node and click **Permanent Agent**, then click **OK**.
5. Fill in the details as required - for example, specify a **Remote root directory** if this is needed for checking out sources on the agent.
6. Click **Save**.

To configure the agent to connect to the master:

1. On the agent machine, load the Jenkins Home page (<http://mastermachine:8080>).
2. From the Jenkins Home page, click the node for the machine that appears under the Build Execution Status box.

3. From the Jenkins page for the node, click **Launch** to start the agent that connects the machine to Jenkins.

Configure an existing project to execute on the agent as follows:

1. On the master machine, go to the project configuration page.
2. Check **Restrict where this project can be run** in the **General** section.
3. In the **Label Expression**, specify the name of the node that you just created and connected to.
4. Save the project.

Next time you build the project, it will execute on the agent.

## Using Jenkins to Build COBOL Applications

The following sections describe aspects of Enterprise Developer's behavior that you need to configure to enable your Enterprise Developer system to work with Jenkins.

In a Jenkins environment you often use Jenkins installed on a master machine to control processes that execute on a number of other machines (agents) running different operating systems that also have Enterprise Developer installed. In such configurations, it is useful to have the same Enterprise Developer configuration settings on all agents.

Micro Focus recommends that you install Enterprise Developer using the same default settings and locations on all Windows and UNIX machines where you will execute your build, test, analysis and deployment tasks. This will make it easier to configure your Jenkins projects.

## Setting up the Environment

In most cases, your Jenkins projects execute tasks in a command line environment and not inside the Enterprise Developer IDE. This means that the COBOL environment is not automatically preconfigured as it would be if you used the IDE. As a result, when you use Jenkins projects you typically need to manually set the COBOL environment for your projects.



**Note:** If you use scripts to build your applications, then the scripts might already include the commands for setting the COBOL environment. In this case, you do not need to specify the environment in Jenkins - you only need to configure Jenkins to run the scripts.

To configure the environment for applications created with Enterprise Developer for Eclipse:

1. Ensure Enterprise Developer is installed on the machine you are going to use to build, test or analyze the COBOL sources.
2. In Jenkins, go to the **Build** section of your project's configuration.
3. Depending on the platform where your project executes, add either a Windows batch command (Windows) or a shell (UNIX) build step
4. Specify the following commands in the step, each one on a new line:

- a. (Windows) Invoke the Enterprise Developer `setupenv.bat` file to sets the required environment variables:

```
call "product-install-dir\setupenv.bat"
```

(UNIX) Call the `cobsetenv` script:

```
./opt/MicroFocus/EnterpriseDeveloper/bin/cobsetenv
```

This sets the following environment variables - COBDIR, PATH, CLASSPATH and LD\_LIBRARY\_PATH (or LIBPATH on AIX).

- b. Set the `JAVA_HOME` environment variable:

- Windows:


```
set JAVA_HOME=JDKInstallDir
```

- UNIX:


```
export JAVA_HOME=java-install-dir
export PATH=$PATH:java-install-dir/bin
```

- c. Specify the required Ant options:

```
set ANT_OPTS=-Xmx1024m
```

 **Tip:** If your projects execute any tasks on agent machines, you can set `JAVA_HOME` from the configuration page of the node for that machine.

See the Enterprise Developer product help for more command line options you can specify.


 **Tip:** Optionally, you can create a file that includes all of the required environment variables and configure your project to use it. To do this, you first need to obtain a list of all environment variables that are set in Enterprise Developer:

1. From an Enterprise Developer command prompt, execute the following command:

```
cblprompt.exe -j
```

This displays a list of the environment variables set for Enterprise Developer in the command prompt.

2. Save the list to a file on your machine such as `env.properties`.

 **Tip:** Next, configure your project to use the variables specified in this file:

1. Install the Environment Injector plugin in Jenkins.
2. In the configuration area of your project, navigate to the **Build Environment** section.
3. Check **Prepare an environment for the run**.
4. In the **Properties File Path** section, specify the full path to the `env.properties` file.

## Making mfant.jar Available to Enable Building

Eclipse COBOL project files, `.cobolBuild`, are Ant scripts that use a number of custom Micro Focus tasks defined in the `mfant.jar` file. Each Eclipse project has its own `.cobolBuild` file which you need to compile when building the application that they all form.

In order to build such projects with Jenkins, you need to specify the location of the `mfant.jar` file to Apache Ant using ant's `-lib` command line option. You need to specify this in the **Build** section of the Jenkins project's configuration:

- On Windows:

```
call ant -lib "%ProgramFiles(x86)%\Micro Focus\Enterprise Developer\bin\mfant.jar" -f .cobolBuild
```

On UNIX:

```
call ant -lib $COBDIR/lib/mfant.jar -f .cobolBuild
```

## Specifying the Location of Linked Folders

If your COBOL applications developed in Enterprise Developer for Eclipse use linked folders, you need to specify their location in the Jenkins project's configuration in order for them to be available at build time.

To specify the location of linked folders:

1. Establish the linked folders that your project is using. To do this:
  - a. Build your application in Enterprise Developer.
  - b. Check the console log and note the `printLocations` locations at the start of the console output.

These are the locations of the linked folders.

2. When adding the command for building the `.cobolBuild` file to the Jenkins project configuration, specify any linked folders using the following syntax:

```
-Dlinkedfolder.folderName=folderLocation
```

## Examples

### Example - Building COBOL Programs

The following example shows how to use Jenkins projects to build COBOL source code.

You are going to use Enterprise Developer and one of the MFUnit Airport samples to see how to use Jenkins to build a COBOL application. The sample is stored in the `\COBOL\AirportMFUnitDemo` subfolder in the location of the Enterprise Developer samples (which is `c:\users\Public\Documents\Micro Focus\Enterprise Developer\Samples\COBOL\AirportMFUnitDemo` by default).

#### Example of Building COBOL Programs with an Eclipse Project

Before you create a Jenkins project, ensure that the following software is installed on the machine where you will build the sample:

- Enterprise Developer for Eclipse
- Apache Ant

To create a Jenkins project for building the sample:

1. Create a new freestyle project.
2. Configure the project to work with COBOL - see *Setting up the Environment*.
3. In the **Build** section of the project's configuration, specify the command that will build your COBOL project:

```
cd C:\Users\Public\Documents\Micro Focus\Enterprise Developer\Samples
\Eclipse\cobol\AirportDemo
call ant -f .cobolProj
```

4. Click **Apply** and then **Save**.
5. Click **Build** to build the project.

See *To Build a Project Using Apache Ant* in the Enterprise Developer documentation for some useful Ant options you can use to build your projects.

#### Related information

[Setting up the Environment](#)

### Example - Integrating Code Analysis

The following example demonstrates how to configure Jenkins to perform code analysis of COBOL projects created with Enterprise Developer.

#### Example with an Eclipse Project

Before you configure Jenkins, you need to do the following:

- Ensure Enterprise Developer for Eclipse and Apache Ant are installed on the machine on which code analysis will be performed - see *Software Requirements*. You use Apache Ant to build and analyze COBOL projects.



- Configure your COBOL projects for code analysis in Enterprise Developer. See *Performing Code Analysis when Building a Project in the IDE* in the Enterprise Developer documentation for more information.

To integrate code analysis in Jenkins:

1. Create a freestyle project.
2. Configure the project to work with COBOL - see *Setting up the Environment*.
3. In the **Build** section of the project's configuration, specify the command that will perform code analysis of your COBOL application:

```
call ant -f .cobolBuild build.and.analyze -DanalysisFailOnError=true
```

Where `.cobolBuild` is the Eclipse project file of the application you are going to analyze.

For example, the full set of commands for the Jenkins project might look similar to the following:

```
rem set the COBOL environment:
call "product-install-dir\SetupEnv.bat"
rem locate the mfant.jar file that includes the definitions of the Micro
Focus Ant tasks for analyzing code, and build and analyze the application
defined by the .cobolBuild project file:
call ant -lib "%ProgramFiles(x86)%\Micro Focus\Enterprise Developer\bin
\mfant.jar" -f .cobolBuild build.and.analyze -DanalysisFailOnError=true
```

Where:

- `product-install-dir` is the Enterprise Developer installation directory.



#### Tip:

- See *Performing Code Analysis from the Command Line* in the Enterprise Developer documentation for all available code analysis options.
- You can use various plugins to customize the reports from code analysis. For example, you can install the free Log Parser Plugin to provide better formatting of the reports.

### Related information

[Setting up the Environment](#)

[Software Requirements](#)

## Example - Running MFUnit Tests

The following example demonstrates how you can configure Jenkins to run MFUnit tests against a COBOL application.

Enterprise Developer for Eclipse must be installed on the machine where you will run the MFUnit tests. You are going to use one of the samples stored in the `\COBOL\AirportMFUnitDemo` subfolder in the location of the Enterprise Developer samples (`%PUBLIC%\Documents\Micro Focus\Enterprise Developer\Samples`).

1. Create a Jenkins project.
2. Configure the project to work with COBOL - see *Setting up the Environment*.
3. In **Build** section of the project's configuration, enter the following commands to copy the samples files to the workspace:

- On Windows:

```
copy "C:\Users\Public\Documents\Micro Focus\Enterprise Developer\Samples
\mfunit\*" %WORKSPACE% cd %WORKSPACE%
call examples.bat
```

- On UNIX:

```
cp /opt/microfocus/xxxxxxx cd $WORKSPACE examples.sh
```

#### 4. Build your project.

After the project build completes, there is a blue icon next to the project on the Jenkins Home page which indicates that the build was successful. This, however, is not correct.

#### 5. Check the project's console output.

In the text output you'll see that some tests failed even though the blue indicator in the previous step suggests that everything ran successfully:

```
Micro Focus COBOL - mfulun Utility
Unit Testing Framework for Windows/Native/32

Options : verbose=true,process=separate,junit=true,printfile=true
Fixture filename : MFUTASCI.dll
Preparing test case : MFUTASCI
Executing test case : MFUTASCI
Completed test case : MFUTASCI - Failed
Generating junit xml : TEST-MFUTASCI.xml
Generating report : MFUTASCI-report.txt

Test Run Summary
Overall Result          : Failed
Tests run               : 1
Tests passed           : 0
Tests failed           : 1
Total execution time   : 3
```

Although the tests ran to completion, there were a number of test failures that should have caused this build to fail.

You now need to enable test reporting.

6. In the project's configuration page, navigate to the **Post-Build actions** section.
7. Click **Add post-build action > Publish Junit test result report**.
8. In **Test report XMLs**, enter **\*.xml** and then save the configuration.
9. Build the project again.

Note that this time the icon indicating status has turned yellow. This indicates that the build ran to completion but there were some test failures.

#### Related information

[Setting up the Environment](#)

## Best Practices When Using Jenkins

This section includes some best practices that you might want to adopt when working with Enterprise Developer and Jenkins. Although you do not have to adopt the processes described here, Micro Focus recommends that you do as they are known to be successful in helping to create an efficient and effective development process.

## Using Jenkins With Source Control

Micro Focus recommends that you adopt some common best practices in your commit and build process such as:

- Deliver small changes of code by checking in your code frequently. This ensures that if build problems occur, it is easier to pin-point the exact reason for them.
- Do not check in any changes that are not tested or such that contain any errors.
- Do not check in any new changes before fixing the error that caused a Jenkins build failure.

## Specifying any Environment Variables in a Project's Configuration

Specifying required environment variables within a Jenkins project's configuration makes the project more portable between different operating systems and reduces the changes of any external factors causing the build to fail.

Using this approach might mean that there could be some duplication in projects so choose the best method depending on how your particular project runs.

## Creating Separate Projects for Building and Testing Your Code

A large benefit of continuous integration is receiving feedback quickly on whether a source code commit has introduced any failures. As such it can often be better to use separate projects for your build and test tasks. In this way, if a build fails, Jenkins will not attempt to run any tests and you will receive an error report much faster.

## Using Pipelines to Build Your Applications

When you organize your build, test, code analysis and deployment tasks with Jenkins, Micro Focus recommends that you use pipelines in preference to projects.

You can save your pipelines as Jenkinsfiles and store them in your source code control system alongside your code. This means you can use different build instructions in the Jenkinsfile for the different branches of your code that represent the versions of the application. You only configure Jenkins once to use the sources from a particular branch in the source code control system and Jenkins will read the instructions in the pipeline about how to build your application.

## Troubleshooting

The following sections describe some issues that you might encounter when using Jenkins with Enterprise Developer with suggested workarounds.

### Ant Error "Can't find mfant.jar" When Building COBOL Projects

If you receive this error when building any of your COBOL projects the most likely cause is that you have not specified the location of `mfant.jar` to Ant.

To resolve this error perform the operation described in *Making mfant.jar Available to Enable Building*.

#### Related information

[Making mfant.jar Available to Enable Building](#)

### COBOL Projects Don't Build

If some of your COBOL projects build successfully but others fail unexpectedly, it suggests that the problem is with the project (or a project-based configuration in either Enterprise Developer or Jenkins) rather than with the build system itself.

To investigate what the possible causes might be:

- Open the COBOL project inside the IDE supplied with Enterprise Developer and ensure that it builds correctly.
- Check the Jenkins project's configuration and any of the build steps defined in it.

## A Build Failure isn't Reported as a Failure

You can do one of the following to check why failures are not reported:

- Check the Jenkins configuration and the project configuration to ensure that any errors will be reported correctly. See *Configuring Email Reporting*.
- Check the project's console log for any error messages.
- Build your application inside the Enterprise Developer IDE and check whether any errors are reported.

### Related information

[Configuring Email Reporting](#)