TIBCO BusinessWorks™ Container Edition Concepts

Software Release 2.3.1
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Important Information

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Product-Specific Documentation

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The following documents for this product can be found on the TIBCO Documentation site:

- Concepts
- Installation
- Getting Started
- Application Development
- Bindings and Palettes Reference
- Samples
- Error Codes
- Migration
- Conversion
- REST Implementation
- Application Monitoring and Troubleshooting

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Overview

TIBCO BusinessWorks™ Container Edition is an integration product suite for enterprise, web, and mobile applications.

The software allows you to create services and integrate applications using a visual, model-driven development environment, and then deploy them in the TIBCO BusinessWorks™ Container Edition runtime.

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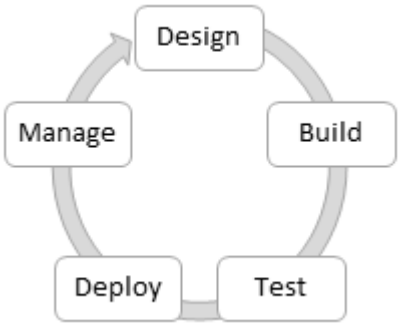


It uses the Eclipse graphical user interface (GUI) provided by TIBCO Business Studio™ Container Edition to define business processes and generate deployable artifacts in the form of archive files.

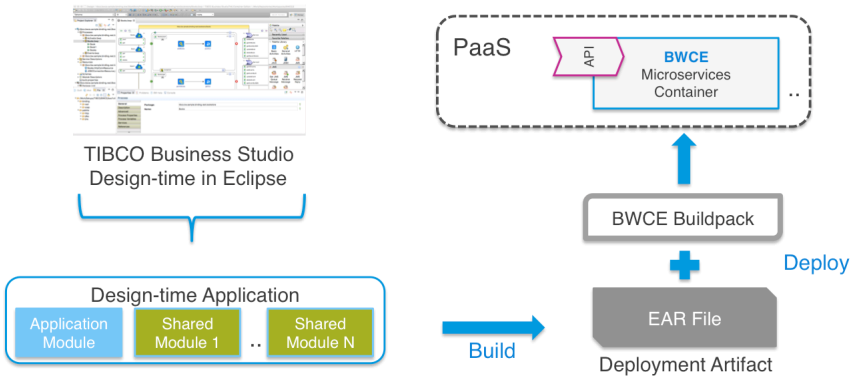
TIBCO BusinessWorks™ Container Edition addresses business problems of varying complexity using any of the following integration styles:

- **Batch-oriented** - provides non real-time integration for endpoints such as databases or files, and uses records for data abstraction.
- **Process-oriented** - provides real-time integration for endpoints such as application APIs and adapters, and uses APIs, objects, and messages for data abstraction.
- **Service-oriented** - provides real-time integration for endpoints such as web services and APIs, and uses services and messages for data abstraction.
- **Resource-oriented** - provides real-time integration for endpoints such as mobile or web applications and APIs, and uses resources for data abstraction.

Key Concepts

This guide provides an overview of the key concepts that you may encounter when working with the product. Some of these concepts are applicable to design perspective or runtime perspective alone, while some are applicable to both perspectives.

TIBCO BusinessWorks™ Container Edition consists of a design time environment where you develop applications that implement business logic and the runtime environment where you execute the applications.



TIBCO BusinessWorks™ Container Edition is based on open architecture, flexibility, modularity, and support for standards.

Flexibility

TIBCO BusinessWorks™ Container Edition is designed to make it easy to add, upgrade, and swap business components.

Its flexible architecture is demonstrated by:

- A zero coding model that allows you to select and drop activities onto the Process Editor and configure the activities in the UI.
- Ability to build tightly coupled and loosely coupled services.
- Ability to build strongly typed and loosely typed service implementations.
- Ability to specify application configuration to be either hard-coded or late-bound.
- Encapsulation of configuration data, thus minimizing the configuration properties exposed by the application.

Openness and Extensibility

Openness and extensibility features include:

- Public APIs which allow you to develop custom activities and XPath functions.
- Integration with standard Java classes and OSGi Java services to supplement the process or model driven approach.
- Extensible Eclipse-based design-time.
- Extensible OSGi based runtime.

Modularity

Modularity of the product supports:

- Large teams and distributed development through modular constructs.
- Increased visibility and traceability metadata, such as Name, Version, Exported Functionality, and Dependencies.
- Reusability with a consistent model across different technologies: Processes, Java Classes, XSDs, WSDLs, and shared resources.

Standards-based

Supported standards include:

- Protocols and API: SOAP, JSON and REST, WSDL, HTTP, HTTPS, JMS, JDBC
- Data representation and transformation: Native support for XML, XSD, XPath, JSON, XSLT
- Others: JNDI

Layout of the Concepts Guide

The guide presents the design time, run time, and administration concepts that are useful to developers and administrators. These concepts are described in the following sections:

- **General Concepts**: Explains the essential concepts such as applications, application modules, shared modules, processes, activities, transitions, and shared resources.
- **Additional General Concepts**: Explains additional concepts that can be used when developing applications such as groups, properties, services, components, and event handlers.
- **Design Time Concepts**: Introduces the design-time environment, TIBCO BusinessWorks™ Container Edition.
- **Runtime Concepts**: Explains the runtime concepts such as process instances, and jobs.

Sections that map concepts to bundled samples aim to enhance your understanding of the concepts by mapping them to ready samples that can be viewed and executed.

General Concepts

TIBCO BusinessWorks™ Container Edition applications developed to solve business problems can range from simple to very complex solutions. These applications are packaged in deployable artifacts in the form of archive files. Understanding the general concepts is essential to both developers and administrators.

Applications

An application is a collection of one or more modules and can be executed in the runtime. Applications are developed using TIBCO Business Studio™ Container Edition.

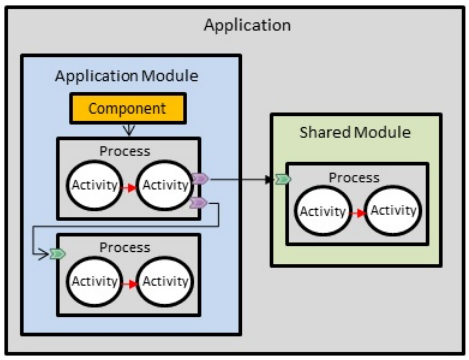
An application contains one application module, which in turn consists of one or more business processes. It can be executed in the runtime. Applications are developed using TIBCO Business Studio™ Container Edition.

Applications are developed using many features available in the product and can range from simple to very complex ones. An TIBCO BusinessWorks™ Container Edition application contains one application module, which in turn consists of one or more processes that define the business logic, and zero or more shared modules. A process that is responsible for initiating the business logic at runtime is used to implement a *component* in an application module.

TIBCO BusinessWorks™ Container Edition applications can also contain OSGi bundles that do not contain TIBCO BusinessWorks™ Container Edition artifacts. For example, you can create an application that contains a Java OSGi bundle, which is also referred to as a *Java module*.

The term module is used interchangeably with OSGi bundle.

Elements of TIBCO BusinessWorks™ Container Edition Applications



Once an application is developed, you can either run or debug directly in TIBCO Business Studio™ Container Edition, or generate a deployable artifact (an archive file) that can be deployed later in the runtime environment. The deployment artifact is the only artifact that is handed over from the design-time to the runtime environment.

Modules

A module is an Eclipse project that is configured for TIBCO BusinessWorks™ Container Edition.

Two types of modules are supported:

- Application Modules: The smallest resource that is named, versioned, and packaged as part of an application and is executed in the TIBCO BusinessWorks™ Container Edition runtime. An application module cannot be deployed by itself in the TIBCO BusinessWorks™ Container Edition runtime; it must be packaged as part of an application.

- Shared Modules: The smallest resource that is named, versioned, and packaged as part of an application and can be used by other modules that are part of the same application. A shared module cannot be deployed by itself; it must be included as part of an application module.

Application Modules

The smallest resources that is named, versioned, and packaged as part of an application and is executed in the TIBCO BusinessWorks™ Container Edition runtime.

An application module typically contains one or more TIBCO BusinessWorks™ Container Edition processes. An application module is configured and represented in TIBCO Business Studio™ Container Edition, and can be used by multiple applications. Each application module contains metadata that is associated with it, such as name, version, dependencies and so on.

An application module can include the following resources:

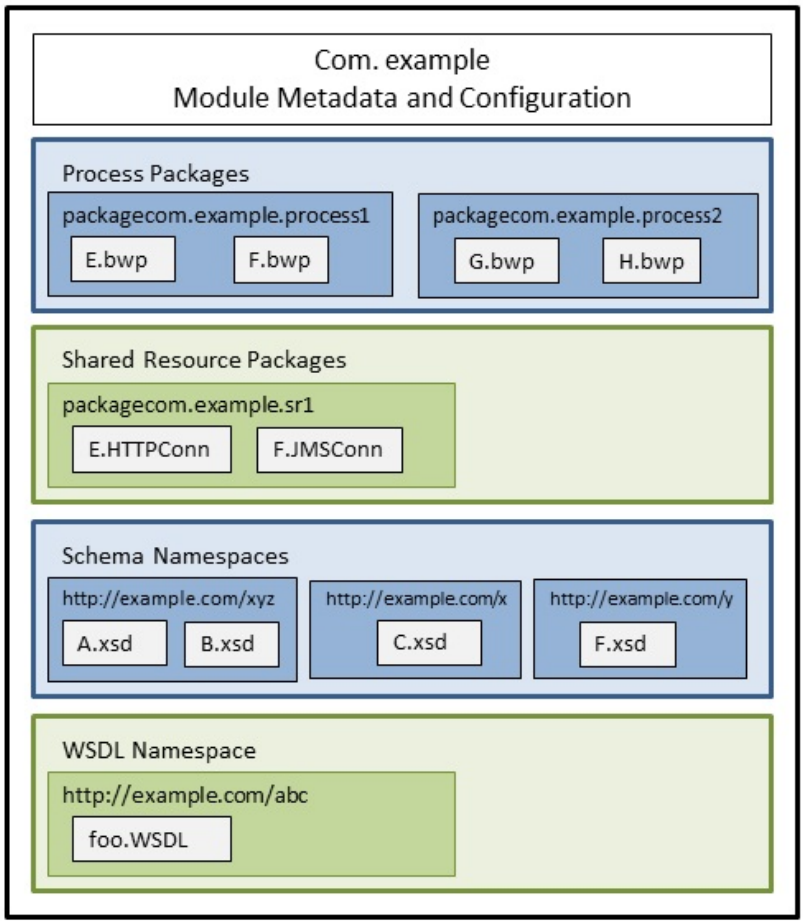
- **Processes:** Processes capture and represent the flow of business information between different data sources and destinations. Processes are contained within a process package. An application module can contain one or more process packages, and each of the process packages can contain one or more processes.
- **Service descriptors:** Service descriptors consist of Swagger files and WSDL files that provide the name of the service, interface, list of operations offered by the service, the parameters expected by the operations, and the return types.
- **Resources:** Resources are reusable configuration data that can be shared within an application. For example, Shared Resources.
- **Schemas:** Schemas define elements and attributes which can be used to define structured data.
- **Components**: The main process that is responsible for initiating the execution of the application logic is represented by a component. When the application logic is spread across multiple processes, there can be one or more components in the application module.
- **Module Descriptors**: Module descriptors provide information about the application module such as module overview, configuration properties, dependencies, components, and shared variables.

  The Component section in the Module Descriptor allows you to configure the components for this specific application module.
- **src:** Default source directory created when the project is Java enabled. A project can contain multiple source directories which are used to contain the Java classes and packages.
- **JRE System Library:** If your project is Java enabled, TIBCO Business Studio™ Container Edition includes the required JAR files in this folder.

Application modules can depend on shared modules, which can contain processes, schemas, JSON and WSDL files that can be used by a process in the application module.

The application modules cannot export their functionality to other modules.

Structure of an Application Module

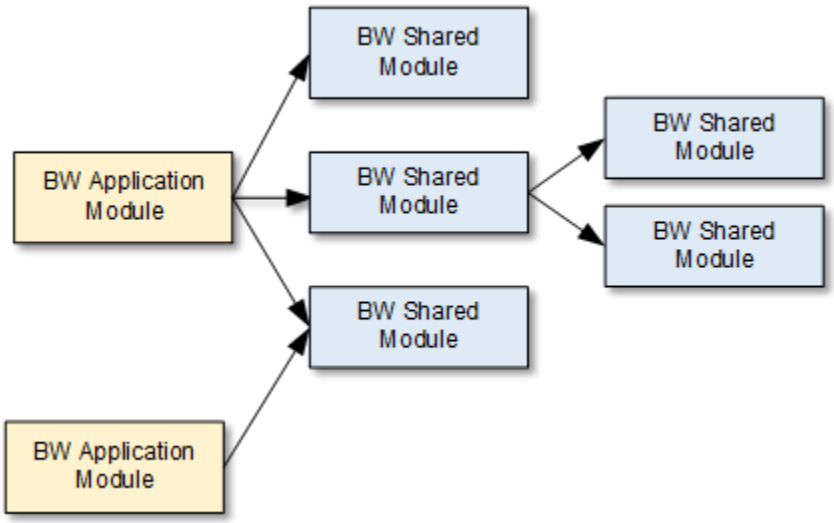


Shared Modules

The smallest unit of resources that is named, versioned and packaged as part of an application and can be used by other modules that are part of the same application.

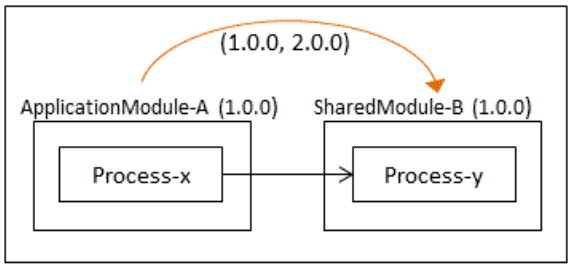
Shared modules export their functionality (processes, shared resources, and schema namespaces) to application modules or to other shared modules. This means that other modules in the system may depend on a shared module for this information.

Relationship Between Application Modules and Shared Modules

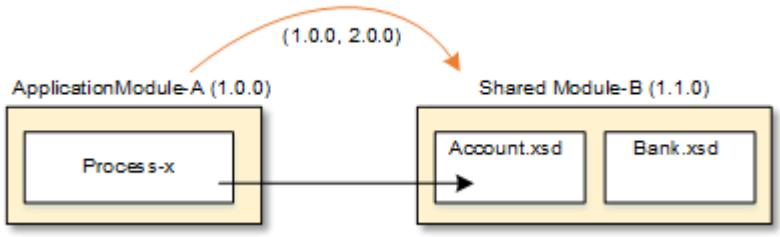


Shared modules can depend only on other shared modules and cannot depend on application modules.

At a module level, a process can reference another process in a different module.



A process can also reference a WSDL or a schema defined in a different shared module. Schemas that are intended to be exported from a shared module must be contained in the Schemas special folder.



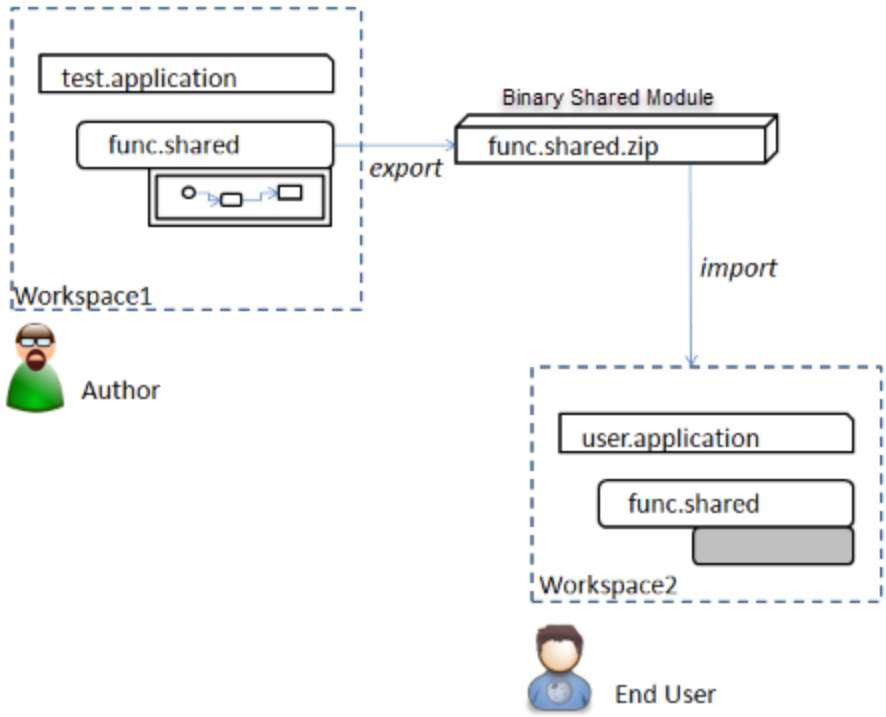
Two modules with the same package names cannot be used in the same application. Package names must remain unique across multiple shared modules and applicaiton modules within an application. If an application contains two packages with the same name, rename one of the packages, or remove a package from the application.

Binary Shared Modules

Binary shared modules are essentially shared modules that you create to hide the implementation details of a shared module from the consumers of the module. A binary shared module is compiled into a binary format for use by another application.

A binary shared module can be used like any other shared module, except its end user must use it as is without the ability to modify it in any way. When imported into a project, the end user will not be able to see its process diagram or the implementation details of other artifacts within the module.

Binary shared modules serve as a good vehicle when you have a standalone functionality that you want to share without exposing its details.



See "Creating a Binary Shared Module" and "Using a Binary Shared Module" in the *Application Development* guide for more details about creating and using binary shared modules.

Processes

Processes capture and describe the flow of business information in an enterprise between different data sources and destinations.

Processes are comprised of activities that accomplish tasks. The flow of data between activities in a process is represented using transitions, conditions, and mappings. TIBCO Business Studio™ Container Edition provides design palettes containing activities and transitions that can be used to develop business processes.

Parent Process

A process can call another process. The calling process is referred to as a *caller process* or a *parent process*.

Subprocesses

A process can be also called by another process. The called process is referred to as a **subprocess** or a *child process*. A parent process can call a subprocess into two ways: inline and non-inline. At runtime, *inline subprocesses* are executed on the same engine thread as the caller process while the *non-inline subprocesses* use different engine threads and are executed on the new threads.

Component Process

The execution of a process is triggered by various events. Often the business logic that is designed to react to a particular event is spread across multiple processes. One of the processes is special and it reacts to the original event and triggers the execution of the other processes. This special process is referred to as the *component process* or *main process*. A component process is responsible for initiating the job at run time.

A component process is designed to react to various events and these events are triggered by Processes and Bindings.

Process Services

A process can provide services to other processes. A process service exposes the operations provided by the process and is implemented using a WSDL or a JSON file. When the process is implemented by a component, the process services are exposed as component services, which then need to be configured using bindings.

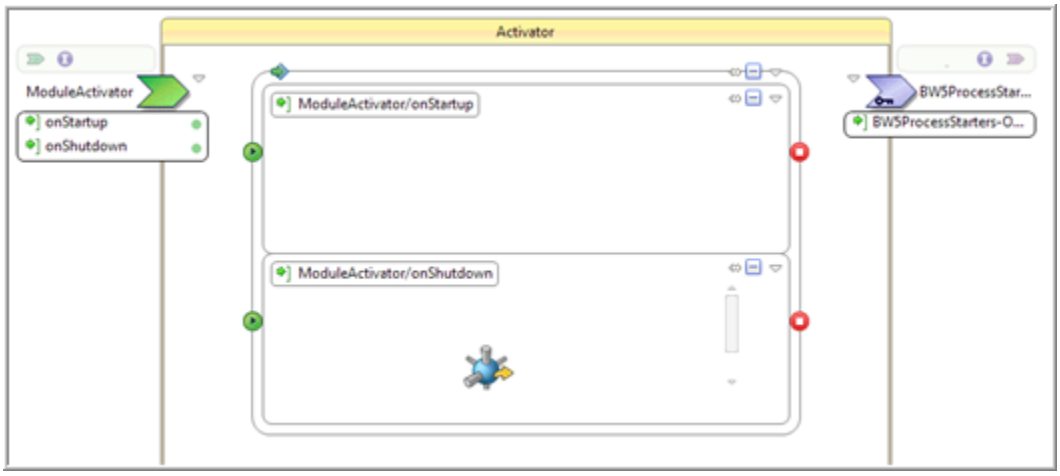
Process References

A process can consume services provided by other processes or by external service providers. A process reference exposes the operations consumed by the process and is implemented using a WSDL or a JSON file. A process reference can be configured to invoke a process or a external service.

When the process is implemented by a component, the process references that are not configured to call a process or an external service through a binding are exposed as component references, which then need to be configured using bindings.

Activator Process

An activator process is a special process that can be used to perform pre-processing and post-processing tasks when the application is started and stopped respectively. The activator process contains a process service with two operations: OnStartup and OnShutDown.



The OnStartup operation is called when an application is started, but before executing any other processes in the application. The OnStartup operation can be used to implement any pre-processing tasks that must be performed for the application before the regular processing starts. For example, the OnStartup operation can be used to check if the database tables required by an application exist, and then create them if they do not exist. Furthermore, if this process instance faults due to an unhandled exception, the application is not started.

The OnShutDown operation is called when an application is stopped, but after stopping and completing all other processes in the application. The OnShutDown operation can be used to implement any post-processing tasks that must be performed for the application after the regular processing is complete. For example, the OnShutDown operation can be used to send an email to administrators notifying them that the application is being stopped.

The activator process can only be configured for an application module and there can be only one activator process per application module. However, the activator process can invoke one or more sub-processes.

For information on how to create an activator process, see section "Creating an Activator Process" in the *Application Development* guide.

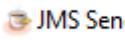
A simple business process can be developed by adding activities in sequence, and then connecting the activities using transitions with or without conditions. Developing a complex business process typically involves developing a component process and one or more subprocesses. Use of subprocesses makes the complex business process easier to understand and debug. At runtime, in-line subprocesses do not create a new job, but are executed on the job created by their calling process.

See Design Time Concepts for details about the TIBCO Business Studio™ Container Edition development environment.

Activities

Activities are the individual units of work in a process.

Activities generally interact with an external system and perform a task. Activities that perform similar tasks are grouped in an entity called a *palette*. TIBCO Business Studio™ Container Edition provides various technology specific palettes that allows you to build a business process.

Each activity in a palette is represented by an icon. For example, the database update activity is represented by the icon  . Often an activity icon is also decorated with an additional symbol such as a green or a yellow pause sign to indicate the activity waits for an event, an arrow to indicate the direction of the data flow, and so on. For example, the arrow sign in the JMS Send Message icon (

) indicates data is being sent by this activity.

Detailed descriptions of palettes are available in the *Bindings and Palettes Reference* guide.

Activities can be classified into two types:

- **Regular Activities** perform a specific task. Regular activities can have input and output in addition to their configuration. Activities can also state the faults they can throw at runtime. This allows the TIBCO BusinessWorks™ Container Edition process to be designed to handle these faults and perform the necessary actions. Regular activities can be further classified into synchronous and asynchronous activities.

  Synchronous activities are *blocking*. They block the execution of the process until the activity task is complete.

  Asynchronous activities are *non-blocking*. They perform a task asynchronously without blocking the execution of a process.

- **Process Starter Activities** are configured to react to events. They trigger the execution of a process when the event occurs. Process starter activities can have only outputs in addition to their configuration. For example, the HTTP Receive process starter activity starts a process when an HTTP request is received.

See Design Time Concepts for details about the TIBCO Business Studio™ Container Edition development environment.

Palettes

Palettes group activities that perform similar tasks. TIBCO Business Studio Container Edition provides various technology specific palettes that provide quick access to activities when building a process.

Palettes are typically located to the right of the **Process Editor** in TIBCO Business Studio Container Edition . Depending on the process being designed and the stage of process development, you can focus on the activities available under appropriate palettes.

In TIBCO Business Studio Container Edition , the **Palette** views displays the list of activities contained in a palette and allows you to perform the following actions:

- Search for activities in palettes.

- Use multiple palettes and save them as grouped palette sets.
- Save palettes, or the grouped palette sets, as favorites.
- View recently used palettes.
- Create virtual palettes, which means that some activities can be taken from unrelated palettes. This activity is called a custom shortcut.

See Design-time Concepts for details about the TIBCO Business Studio Container Edition development environment.

Transitions

Transitions can be added to activities and groups in a process. They represent the flow of execution from one activity or group to another.

In TIBCO Business Studio Container Edition , transitions are displayed as an arrow between two resources in a process. Transitions are unidirectional and cannot connect to a previously executed activity or group. The control flow in a process must proceed sequentially, beginning with the starting activity or group and ending with the last activity or group in the process.

Transitions can have a one-to-many relationship with the activities. In a process, one activity can simultaneously transition to multiple activities or groups. For example, if the shipping schedule indicates a delay in shipping an order, you want to notify the customer and enter the information into the customer service system. However, if there is no delay, you want to enter the information into the customer service system without notifying the customer.

Transitions can fall into one of the following categories:

- **Transitions Without Conditions**: Control automatically flows from one activity or group to the next without any conditions.
- **Transitions With Conditions**: When an activity or group completes processing, conditions specified on the transitions originating from that activity or group are evaluated to determine whether the transition to the next activity or group should be taken or not. All transitions whose conditions are met will be taken.
- **Error Transitions:** Special transitions that specify the activities or groups to execute in case of an error. When configuring an activity or group, you can select one transition to take from the specified activity or group and the activities or groups to be executed following the error transition.

See Design-time Concepts for details about the TIBCO Business Studio Container Edition development environment.

Shared Resources

Shared resources are resources that contain common configuration data that can be referenced from multiple places.

You can define a shared resource and then reference it from multiple activities in the same or different process. For example, you can define a **JDBC Connection** resource and then use it in any of the **JDBC** activities in your process to connect to the database.

Shared resources such as JDBC Connection, JMS Connection, HTTP Connection, are available at design-time. At runtime, the referencing activities and event sources have full access to their instances and configuration.

Shared resources can be grouped in packages, similar to the way process packages and Java packages are presented in the file system.

When defined in an application module, shared resources are not visible to processes outside the application module. However, when defined in a shared module, they are visible to processes outside the shared module.

Shared Variables

Shared variables are used to define data for modules and jobs. There are two types of shared variables: job shared variables and module shared variables. They are stored separately.

Job Shared Variables

Job shared variables are used to share data within a job such as between a parent and child process instance. At runtime, the engine allocates a new variable for each job and the value of that variable is not visible outside the job to which it was allocated.

Module Shared Variables

Module shared variables are used to share data across all processes in a module. The module shared variable is visible to all process instances within the same module.

The key difference between a job shared and a module shared variable is that when jobs expand across module boundaries, a job shared variable is visible outside the module it was set in, while the module shared variable is visible only inside the module in which it was set.

Additional General Concepts

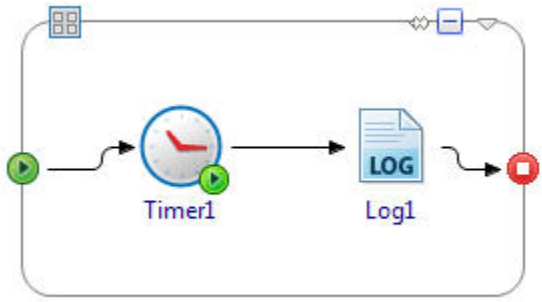
This section introduces the following additional concepts that help build complex business processes.

Groups

Groups consist of one or more activities that are assembled together and executed according to their type.

Groups enable you to put one or more activities together and configure the group as needed. For example, defining a single error condition for the group, or creating a group as a transaction that commits to a database only when all the activities in the group are completed.

Every group contains a GroupStart element on the left and a GroupEnd element on the right.



Groups can be classified into two categories: groups with conditions (repetitive groups) and groups without conditions (non-repetitive groups).

Groups Without Conditions (Non-repetitive)

The following types of groups do not require any conditions to be defined for their execution:

- **Scope** : A scope is a simple group that has no custom behavior. It can define local variables and can also contain fault handlers and event handlers. A scope with a single activity can be defined if you need to handle faults or catch exceptions specific to an individual activity.
- **Critical Section** : Critical Section groups are used to synchronize jobs so that only one job is acting on the group of activities at any given time. Any concurrently running job that contains a corresponding critical section waits until the job currently executing the critical section completes. Critical section groups are useful to control concurrent access to shared variables. While a critical section group can be used to synchronize jobs within a process, module shared variables help synchronize jobs for multiple processes.

Groups With Conditions (Repetitive)

Loops are groups with conditions which follow a pattern at runtime: initialize the loop, update the loop at each iteration, and test conditions for the loop to stop iterating. The following types of loops are available:

- **For Each** : For Each is used to loop for a specific number of iterations with a counter ranging from a start value to an end value.

- **Iterate** : This loop has a simple index variable that can be used to count each iteration and the loop executes for the number of iterations specified.
- **Repeat** : This loop has a simple index variable that can be used to count each iteration and has a conditional expression to determine when to stop. The loop executes at least once and a test for the specified condition is performed at the end of the loop. The Repeat loop continues to execute until the condition evaluates to true.
- **Repeat on Error** : This loop involves a retry mechanism: if any activity in the loop throws a fault, the condition expression is evaluated to determine if the loop should be repeated. An index allows the condition to be based on the number of previous attempts, but any condition expression may be used.
- **While** : This loop has a simple index variable that can be used to count each iteration. It has a conditional expression to determine when to stop. The condition for the While loop is tested at the beginning of each iteration. The loop may never be executed if the condition is initially false: it continues to execute as long as the condition holds true, and stops when the condition becomes false.

See Design Time Concepts for details about the TIBCO Business Studio™ Container Edition development environment.

Shared Variables

Shared variables are used to save the state, either at the module level or for the duration of a job.

Using shared variables, you can share data across process instances associated with a module or a job. A process instance can read or update the data stored in a shared variable. The shared variable data updated by one process instance is accessible to other process instances of a Module or Job.

There are two types of shared variables: module shared variables and job shared variables. Both module and job shared variables are defined at the module level and can be accessed in a process using the activities Set Shared Variable and Get Shared Variable. Refer to *Using Shared Variables* in the *Application Development* guide for details on how to define and use shared variables.

Module Shared Variables

Module shared variables are used to share the state at a module level and are visible to all process instances created from the processes that are within a module. Module shared variables can be read and updated by the process instances during execution. Once the value is updated, the new value is available to all the process instances created from the processes that are within the module. Consider an example where the exchange rates are updated daily and the updated exchange rates should be accessible to all processes in a module. You can create a module shared variable to hold the exchange rate and use one process in the module for updating the exchange rate. All other processes in the module that require the exchange rate can retrieve the current value through the module shared variable.

Job Shared Variables

Job shared variables are used to share the state at the job level for the duration of a job. A copy of the job shared variable is created for each new job and it is accessible to all process instances associated with the job. Job shared variables can be used to share data between all process instances of a job without creating an input or output schema for the called process.

Sharing Job Shared Variables Between Inline and Non-Inline Processes

Inline subprocess are executed as part of the caller (parent) process job and hence the current value of the job shared variable is passed from the caller process to the inline subprocess. Non-inline subprocesses spawn a new thread and are not executed on the same job as the caller process. Hence a

non-inline subprocess obtains a copy of the job shared variable and does not obtain the current value of the job shared variable from the caller process.

At runtime, the engine allocates a new job shared variable for each new job and the value of that variable is visible only to that job.

Shared Variable Synchronization

Multiple process instances can potentially access or update a shared variable at the same time. For example, a module shared variable can be accessed by multiple jobs concurrently. Without a synchronization mechanism, a process instance could update the value of a shared variable while another process instance is trying to read the value. This could result in an unpredictable value for the shared variable.

Critical Section groups can be used to synchronize access to shared variables. A Critical Section group allows only one process instance to execute the Critical Section group and its contents at a given time. To synchronize shared variables, use a Critical Section group to contain the activities that access the shared variables (Set Shared Variable and Get Shared Variable). Once a process instance begins executing a Critical Section group, other concurrently running process instances that are associated with that Critical Section group wait at the start of the group until the currently running process instance exits the critical section group. This ensures that the value of the shared variable is not modified while another process instance is accessing it. To synchronize multiple critical section groups, use a shared lock. The shared lock can be defined using a module or a job shared variable.

Properties

Properties are used to define configuration. Depending on where and how they are defined and qualified, properties can be classified into application properties, module properties, shared module properties, and process properties. The values for all three kinds of properties can be of one of the six primitive types (Boolean, Integer, DateTime, Long, Password, or String) or one of the available default shared resource type. These values are static and cannot be changed once an application has started execution. These values can only be changed at design time or deployment time.

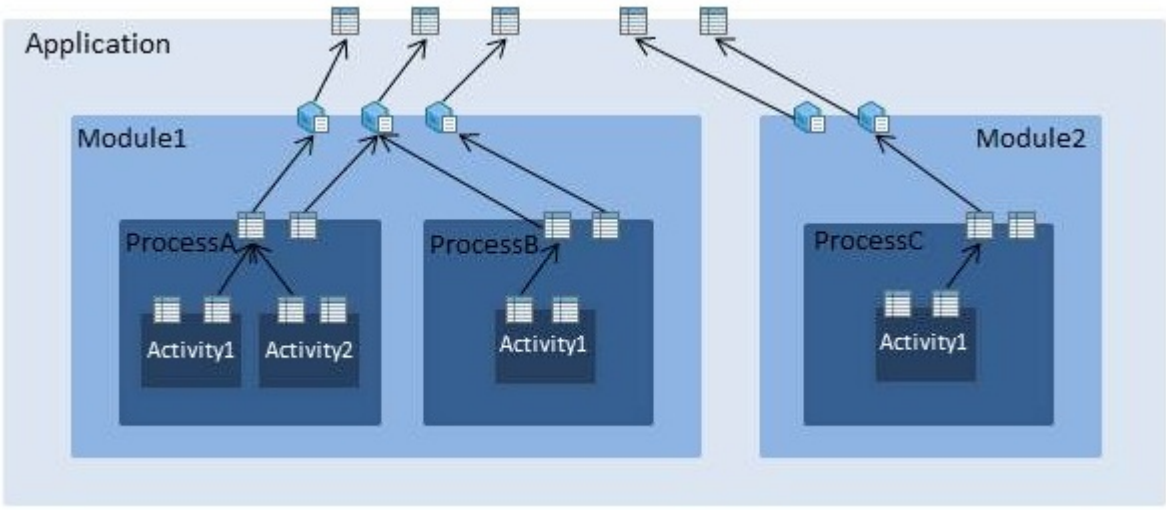
The three levels of properties are hierarchical: application properties are in the outer most scope, followed by module properties, followed by process properties.

Properties defined in the inner layer can reference a property defined at its parent layer. For example, a process property can reference a module property instead of providing a literal value. Similarly, a module property value can be defined by literal values or source from its parent scope application property. Private properties are not visible to the encapsulating layers.

Any process property or module property that you define is available both in the activity configuration page and is also available to use as an input to an activity (from the **Data Source** tab of the **Input** tab for the activity).

The following diagram illustrates the relationship between the different types of properties:

Relationship Between Properties



Features of Process, Module, Shared Module, and Application Properties

	Scope/Visibility	Values	Additional Information
Process Properties	Visible within a process.	Literal, module property reference, or a shared resource reference.	Literal values cannot be modified at the module or application level.
Module Properties	• Visible within the module.	• Literal or a shared resource reference.	Cannot be assigned to an activity directly. You need to reference a module property from a process property, and then reference the process property from the activity.

	Scope/Visibility	Values	Additional Information
Shared Module Properties	• Visible within the module. • Visible within projects that contain dependencies to the Shared Module that the Shared Module Property came from.	• Literal or a shared resource reference.	• Shared Module Properties are module properties that come from a Shared Module. • Cannot be assigned to an activity directly. You need to reference a module property from a process property, and then reference the process property from the activity. • Can be used for activities, process properties, shared resources, and SOAP Bindings.
Application Properties	• Only available for an application and visible within the application.	• Literal. • Profiles can be used to specify a new set of values for the same application.	• Overrides module properties, thus enabling you to use different values for the same module. • Cannot add new properties at application level.

See Design-time Concepts for details about the TIBCO Business Studio™ development environment.

Fault Handlers

Errors (or faults) can occur when executing a process. Fault handlers allow you to catch faults or exceptions and create fault-handling procedures to deal with potential runtime errors in your process definitions.

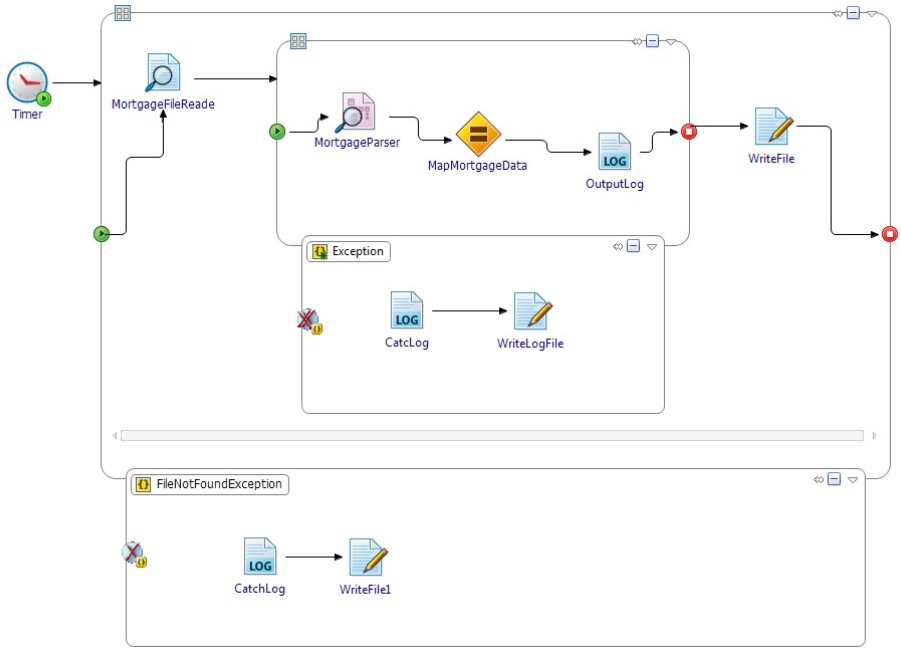
Fault handlers are the recommended way to catch faults or exceptions in a process. Two types of fault handlers are available: **Catch Specific Fault** and **Catch All Faults**.

Fault handlers are defined at the scope level, allowing you to catch faults or exceptions thrown by activities within a scope. To catch faults or exceptions specific to an individual activity, you need to define a new scope for that individual activity and attach a fault handler to the new scope.

At runtime, once a fault handler is executed, the associated scope will not complete due to the error thrown. If a fault is not thrown in the fault handler, the process execution continues with the first activity that follows the scope. If a fault is thrown in the fault handler, then the engine looks for an enclosing scope that is designed to handle the fault. If one is found, the engine executes it. Once the enclosing fault handler finishes its execution, the engine executes the next activity following the scope. If no fault handlers are found in the enclosing scopes, then the job terminates with a fault.

Consider the fault handlers defined in the sample process.

Sample Fault Handlers



If an exception is caught in the inner scope, the exception is logged to a file and the scope is completed. The process execution then continues to the WriteFile activity, which is the next activity in the process. If an exception is caught in the outer scope, the exception is logged and the scope is completed. The process execution completes successfully as there are no following activities to be processed. An Exit activity inside the fault handler will return the control out of the scope and the process.

Error Transitions can also be used to handle error conditions by using them to specify transition to take in case of an error.

Components

Components implement a process and provide information to the runtime on how to instantiate the process.

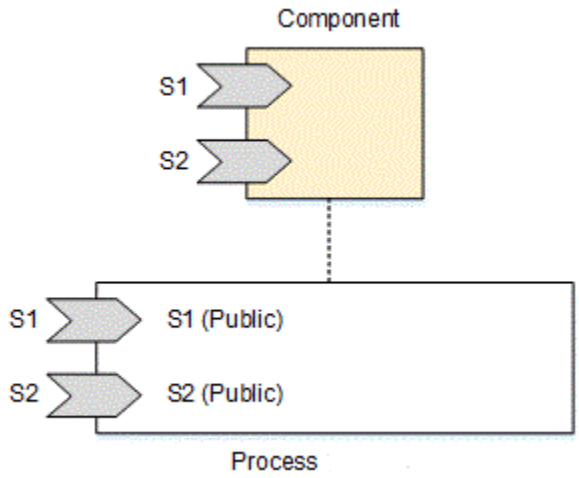
Components are generated only for main processes and each main process initialized by the engine must have a component associated with it. Components are required only by main processes that are responsible to initiate the business logic. Subprocesses do not require components as they are called by another parent process.

Component Services

Component services describe the binding information to receive an invocation from an external consumer.

When a component implements a process that has a service, that process service is exposed as a component service. The component service then must be configured using bindings such as SOAP and REST.

The service-centric architecture supports self-contained services. Each service is configured separately and can be deployed on a different machine. If one machine goes down, all other parts of the process can continue to run. This loosely-coupled architecture makes it easy to change individual components as needed.



Component References

Component references describe the binding information required to invoke an external service.

When the component implements a process that has a reference, then the process reference is exposed as a component reference. When configuring to invoke an external service, the binding information that contains protocol details is not part of the process. The service consumer needs to create a component that is an implementation of that process, then configure the binding along with protocol details. The Invoke Operation activity or a reference can be used to invoke a service.

References have the following characteristics:

- They can be public or private. Public references are visible from outside of the process.
- They always reference one interface or port type.

Based on the availability of the target service name at design-time, you can use either static references or dynamic references. Static references can be used when the target service name is available at design-time and dynamic references are available when the target service name is not available at design-time. This applies to target services developed as a part of TIBCO BusinessWorks™ Container Edition as well as external target services.

Services

TIBCO BusinessWorks™ Container Edition can function both as a server and a client in a web services interaction. Services and references are defined at the process level while the bindings are created at the component level.

The supported service classes are:

- REST (Representational State Transfer)-compliant services, where the primary purpose of the service is to manipulate XML representations of web resources using a uniform set of stateless operations. When using a stateless operation, the state is managed by the job itself instead of by the engine.
- SOAP services, which are used for exchanging information in the implementation of web services relying on XML message format sent over HTTP and JMS.

Web services are typically associated with the following characteristics:

- **Interfaces** that describe the operations available within a service. An interface is analogous to a port type in a WSDL file. Each interface can contain multiple operations.
- **Operations** define an action that can be performed by the service and the way the message is encoded.

- **Transport** used for communication such as HTTP or JMS.
- **Schema** used for message exchanges such as XSD.

Operations

Operations define the action that can be performed by the process. Multiple operations are supported in a process with multiple inputs, outputs, and faults.

There are two types of message exchange operations: one-way operations and request-response operations.

SOAP Services

SOAP services are web services that use SOAP as the standard communication protocol for XML-based message exchanges.

The standard HTTP protocol makes it easier for SOAP model to tunnel across firewalls and proxies without any modifications to the SOAP protocol.

- The Web Services Description Language (WSDL) contains and describes the common set of rules to define the messages, bindings, operations and location of the Web service. A WSDL file is a sort of formal contract to define the interface that the Web service offers.
- SOAP services require less coding than when designing REST services. For example, transactions, security, coordination, addressing, and trust are defined by the WSDL specification. Most real-world applications are not simple and support complex operations, which require contextual information to be maintained. Application developers do not need to worry about writing this code into the application layer themselves.
- SOAP supports several technologies, including WSDL and XSD.

REST Services

Representational State Transfer (REST) is an architectural style of the World Wide Web that is used in building services for distributed systems and networked applications. RESTful APIs are increasingly preferred for enterprise, web and mobile integration use cases.

The key abstraction of information in REST is a resource, with focus on the roles of components, the constraints upon their interaction with other components, and their interpretation of significant data elements. REST ignores the details of component implementation and protocol syntax.

The supported features of the REST architectural style are:

- **Client-server architecture**: Provides a separation of implementation details between clients and servers.
- **Stateless communication**: Ensures that each request contains all of the information required to understand it independently of any stored context on the server.
- **Cacheability**: Provides an option to the client to cache response data and reuse it later for equivalent requests, thus partially eliminating some client-server interactions. This results in improved scalability and performance.

BusinessWorks Container Edition currently allows the following HTTP operations to be performed on resources: GET, PUT, DELETE, and POST. Both XML and JSON are supported as data serialization formats along with support for definition of custom status codes, key-value parameters, and query parameters.

Policies

A policy is a set of constraints that you can define and apply in TIBCO Business Studio Container Edition to manage and enforce cross-functional requirements within your TIBCO BusinessWorks Container Edition application such as security, monitoring, and compliance.

You can add policies to activities and bindings in a process to influence or alter actions in the process flow. For example, you can add a policy on an existing **HTTP Receiver** activity in your application to ensure that user credentials are authenticated, or verified as correct, before the message can continue moving through the process flow. Any request messages that cannot be authenticated are rejected, redirected, or handled in accordance to policy details.

The following policies are examples of policies provided in TIBCO BusinessWorks Container Edition :

Basic Authentication

Validates the user name and password credentials stored in the HTTP header of REST, SOAP, or pure HTTP request messages.

Basic Credential Mapping

Automatically attaches appropriate credentials to request messages before they reach services.

Web Services Security Provider (WSS Provider)

Acts on the server side to ensure the security of a message by enforcing confidentiality, integrity, and time stamping.

Web Services Security Consumer (WSS Consumer)

Acts on the reference side to ensure the security of a message by enforcing confidentiality, integrity, and time stamping.

Policy Definitions and Concepts

The following definitions and concepts are used to describe policies and policy management.

Policy

A policy is set of constraints that you can define and apply in TIBCO Business Studio Container Edition to manage and enforce cross-functional requirements within your application such as security, monitoring, and compliance. You can add policies to activities and bindings in a process to influence or alter actions in the process flow.

Policy Types

Policies that are related or perform similar functions are categorized under policy types. Policies that can be applied to the HTTP layer of SOAP, REST, and pure HTTP services are categorized under the HTTP Security policy type. Policies that can be applied to the SOAP layer are categorized under the SOAP Security policy type.

Activities

An activity is the individual unit of work in a process. You can add policies to activities to influence or alter actions in a process flow. For more information about activities, refer to the section "Application Development" in the *Getting Started* guide.

Bindings

A binding is used to establish a connection between SOA Services and their consumers. There are two types of binding components:

- Service Binding, which is used to create and expose a service to the external world. The service can contain one or more operations. Once exposed, the service can be consumed by its clients.
- Reference Binding, which is used to create a client that can connect and communicate to an external service.

You can add policies to bindings to manage, modify and secure message exchanges on the consumer side and provider side. For more information about the types of bindings offered in the workspace, refer to the section "Binding" in the *TIBCO ActiveMatrix BusinessWorks Concepts* guide.

Policy Association

When you add a policy on an activity or a binding, the relationship you create between the resources is called a policy association. At runtime, policies are enforced on the activities and their associated bindings.

Shared Resources

Policies reference shared resources. You can manage and configure shared resources in your workspace. The following table describes shared resources that each policy might reference.

Policy	Shared Resource
Basic Authentication	• LDAP Authentication • XML Authentication
Basic Credential Mapping	• Identity Provider
WSS Provider	• Subject Provider • Keystore Provider • Trust Provider • WSS Authenticatation
WSS Consumer	• Identity Provider • Keystore Provider • Trust Provider • Subject Provider • WSS Authenticatation

You can define a shared resource and then reference it from a single policy or multiple policies. For example, you could use a single **Keystore** resource in the WSS Provider policy and the WSS Consumer policy.

Governance Agent

The governance agent is a ActiveMatrix BusinessWorks™ run time component that dynamically enforces policies during runtime. A governance agent must be enabled on an appnode to enforce policies applied to BusinessWorks applications. For instructions on enabling the governance agent,

refer to the section "Enabling the Governance Agent" in the *TIBCO ActiveMatrix BusinessWorks Administration* guide.

Mapping Concepts to a Sample: Managing Books for a Bookstore

The concepts introduced in sections General Concepts and Additional General Concepts enable you to understand and design a resource-oriented solution such as the Bookstore example.

Pre-requisites

The Bookstore sample requires the concepts introduced in the following sections:

- General Concepts
- Additional General Concepts

After going through these sections, you should be able to understand and execute a resource-oriented solution such as the sample to manage books for a bookstore.

Bookstore Sample

The bookstore sample uses a RESTful service to add, delete, update, retrieve books from bookstore. The following REST methods are used:

- POST - Posts books to the bookstore
- GET - Get books from the bookstore
- PUT - Updates books to the bookstore
- DELETE - Deletes books from the bookstore

The Bookstore sample project is shipped with the product and can be accessed in TIBCO Business Studio™ Container Edition from **Help > BusinessWorks Samples**.

Next Steps

After completing this section, you should be able to design resource-oriented processes with minimal assistance.

Design-time Concepts

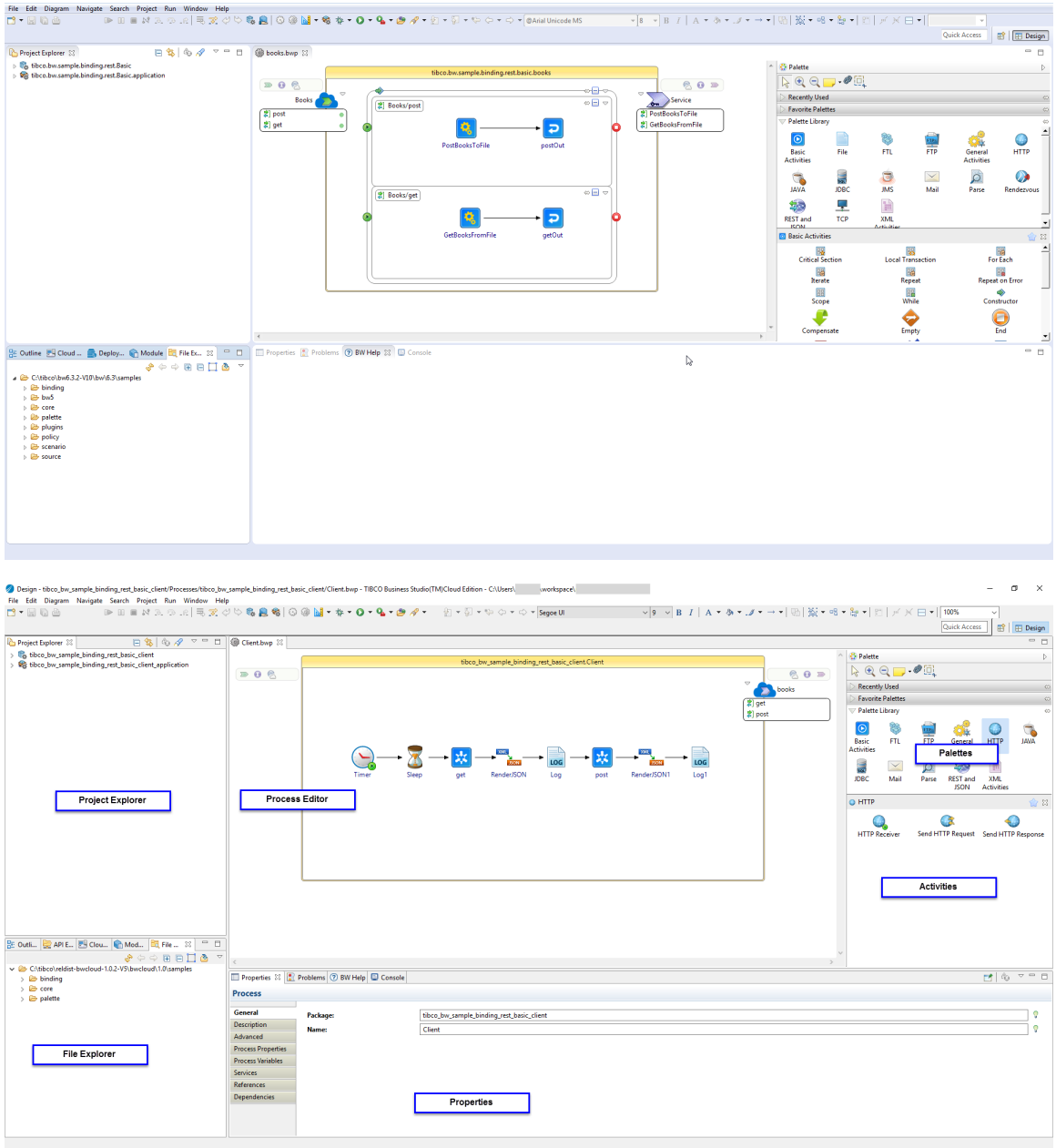
Design-time concepts introduces TIBCO Business Studio Container Edition , an Eclipse-based integration development environment that is used to design, test, and deploy applications.

TIBCO Business Studio Container Edition provides Eclipse extensions such as editors, palettes, and so on.

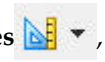
TIBCO Business Studio Container Edition Development Environment

TIBCO Business Studio Container Edition provides a workbench that can be used to create, manage, and navigate resources in your workspace. A *workspace* is the central location on your machine where all the data files are stored.

TIBCO Business Studio Container Edition Workbench



The workbench consists of:

- **Menu:** Contains menu items such as **File**, **Edit**, **Navigate**, **Search**, **Project**, **Run**, **Window**, and **Help**.
- **Toolbar:** Contains buttons for the frequently used commands such as **New**  , **Save** , **Enable/Disable Business Studio capabilities**  , **Create a new Application Module**  , **Create a new Shared Module**  , **Debug**  , **Run**  , and so on.
- **Perspectives**: Contain an initial set and layout of views that are needed to perform a certain task. TIBCO Business Studio Container Edition launches the **Design** perspective by default. You can change the perspective from the menu **Window** > **Open Perspective** > ***<perspective_name>***.
- **Views**: Display resources and allow for navigation in the workbench. For example, the **Project Explorer** view displays the applications, modules, and other resources in your workspace, and the **Properties** view displays the properties for the selected resource. You can open a view from the menu **Window** > **Show View** > ***<view_name>***.
- **Editors**: Provide a canvas to configure, edit, or browse a resource. Double-click on a resource in a view to open the appropriate editor for the selected resource. For example, double-click a process (`MortgageAppConsumer.bwp`) in the **Project Explorer** view to open the process in the editor.
- **Palettes**: Palettes group activities that perform similar tasks and provide quick access to activities when building a process. See Palettes for details.

Explorers

TIBCO Business Studio Container Edition consists of the following tabs in its left pane:

- **Project Explorer**: Displays the logical view of your entire workspace with all the projects and the processes, service descriptors, resources, schemas, and module descriptors for each project
- **API Explorer**: Displays a connected view of the TIBCO BusinessWorks Container Edition - API Modeler residing in the cloud. You can also view the APIs residing locally on your machine from the API Explorer. Use the Settings dialog in the API Explorer to filter the APIs you want to access
- **File Explorer**: Displays a view of selected folders in your local file system
- **Outline** tab: Displays a tree structure of the details of a selected artifacts in an editor
- **Module** tab: Displays the module properties and shared variables used in the module

Testing and Debugging

TIBCO Business Studio Container Edition bundles some of the runtime components so that you can run and debug an application in the design-time environment.

The menu option **Run** > **Debug** or the icon  on the tool bar enable you to debug an application.

The menu option **Run** > **Run** or the icon  on the tool bar enable you to run an application.

Run configurations specify information such as:

- Bundles to be executed.
- Arguments such as the target operating system, target architecture, target web services, and so on.
- Settings that define the Java Runtime Environment including the Java executable, runtime JRE, configuration area and so on.
- Tracing criteria for the OSGi JAR file, if needed.
- Common options such as choosing to save the results either as local files or as shared files, and also to display them in the menus (**Debug** and/or **Run**). It also allows to define encoding for the result files.

Once created, an application can be run using a specific configuration. If a run configuration is not specified, the project displayed in the editor area is launched by default.

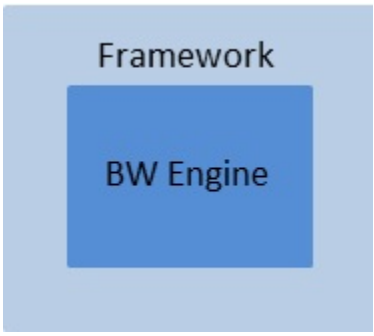
Runtime Concepts

Runtime refers to the AppNode and the TIBCO BusinessWorks™ Container Edition engine that host and execute TIBCO BusinessWorks™ Container Edition application.

AppNode

An *AppNode* (also called *bwappnode*) is an operating system process (JVM) that hosts and executes TIBCO BusinessWorks™ Container Edition application. An AppNode consists of two key layers: the OSGI Framework and TIBCO BusinessWorks™ Container Edition Engine. The high level architecture of an AppNode is shown in the following figure:

Application Node Architecture



The framework layer performs application life cycle operations, ensures that dependencies required by the application are satisfied. The engine layer is responsible for the executing the application. The engine is multi-threaded and can execute multiple jobs for the same application concurrently.

At runtime, an AppNode launches the framework to validate and identify dependencies. After the framework validates the modules and the application is deployed, TIBCO BusinessWorks™ Container Edition engine starts the underlying processes.

The binary file named `bwappnode` is packaged under the *`TIBCO_HOME`*`/bwce/version/bin` directory.

Process Instance

Execution of any process creates an execution scope for the activities that are a part of the process and this scope is called a *process instance*. Each process instance has a unique id which is referred to as "*ProcessInstanceId*".

The execution of a process is triggered by various events. For example, events can be generated by a Timer that is scheduled to trigger at specific time intervals, or by changes that occur in the file system, or by messages that are sent by a client over a specific protocol (HTTP, JMS, etc), or simply by messages sent by other processes.

The TIBCO BusinessWorks™ Container Edition engine is a multi-threaded engine capable of triggering the execution of the same process multiple times, concurrently, once for each event. When the events that trigger the execution of a process occur concurrently, the engine executes the same process multiple times, concurrently, once for each event. And for each execution, the engine creates a process instance that provides an execution scope for the activities that are a part of the process.

Job

Execution of a component process is called a *job*. Each job has an unique ID referred to as "*JobId*".

When the business logic is spread across multiple processes, multiple process instances are created and executed in conjunction with a particular event. Even though these are separate process instances they work together and can be executed as part of the same job. A job can spawn multiple process instances

and can provide the execution context for activities that are part of multiple processes. The engine always executes a job in one engine thread.

All of the process instances that are part of the same job will have the same JobId. A component process instance and all of its in-line subprocess instances are also considered to be a part of the same job. Non in-line subprocesses spawn a new engine thread and are executed on a different job.