

# Tutorials

RATIONAL ROSE® REALTIME

VERSION: 2002.05.00

PART NUMBER: 800-025115-000

WINDOWS/UNIX



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**PATENT**

U.S. Patent Nos. 5,193,180 and 5,335,344 and 5,535,329 and 5,835,701. Additional patents pending.

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# Preface

This manual provides introduction and concept tutorials to help you become familiar with Rational Rose RealTime.

## Audience

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This guide is intended for all readers, including managers, project leaders, analysts, developers, and testers.

## Other Resources

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- Online Help is available for Rational Rose RealTime.

Select an option from the **Help** menu.

All manuals are available online, either in HTML or PDF format. To access the online manuals, click **Rose RealTime Online Documentation** from the **Start** menu.

- For more information on training opportunities, see the Rational University Web site: <http://www.rational.com/university>.

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- Your name, telephone number, and company name
- Your computer's make and model
- Your computer's operating system and version number
- Product release number and serial number
- Your case ID number (if you are following up on a previously-reported problem)

## Contents

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This chapter is organized as follows:

- *Overview* on page 13
- *Navigating the Tutorials* on page 15
- *Printing the Tutorial* on page 15

## Overview

---

Rational Rose RealTime provides tutorials to help you learn how to use the main features of the development tool. There are two types of tutorials: *hands-on* and *concept overviews*.

The hands-on tutorials show you how to build models, while demonstrating key concepts and toolset features required when developing your own Rose RealTime models. Both the *Quickstart* and *Card Game* tutorials provide sample models that you can use to review the procedures and concepts introduced in each tutorial. These models are located in the Rose RealTime installation directory `$ROSERT_HOME/Tutorials`.

Concept tutorials are meant to provide an introduction to important Rose RealTime concepts. They expand and summarize the explanations and examples provided in the *Rational Rose RealTime Modeling Language Guide*.

If you do not know where to begin, the following table may help you find the tutorial recommended for your individual modeling experience.

<b>Tutorial</b>	<b>New Modeling Tool User</b>	<b>Rose 98 User</b>	<b>ObjecTime Developer User</b>
QuickStart Tutorial (hands-on)	X	X	
Contents (hands-on)	X	X	X
Rose RealTime Extensibility Interface Tutorials (hands-on)	X	X	X
Messages and Capsule State Machines <i>Tutorial</i> (concept overview)	X	X	
Capsule Hierarchical State Machines <i>Tutorial</i> (concept overview)	X	X	
Capsules and Capsule Roles <i>Tutorial</i> (concept overview)	X	X	X
Ports, Protocols, and Protocol Roles <i>Tutorial</i> (concept overview)	X	X	X

*QuickStart*: Create a simple "Hello World" model. This is the quickest way to get started without having to read extensively.

*Card Game*: Learn the most important features of the tool by designing, and developing a fun application in C++.

*Rose RealTime Extensibility Interface*: Learn how to write a simple script in Summit Basic and Visual Basic that will control the Rose RealTime application. Learn the basics of creating add-ins.

*Messages and Capsule State Machines*: For users who want an introduction to the basics of message passing between capsules.

*Capsule Hierarchical State Machines*: For users who want to review the basic elements of state machines and understand some of the complexities involved with hierarchical capsule state machines.

*Capsules and Capsule Roles*: For users who already understand class modeling, and want to understand the additional concepts involved when modeling with capsules.

*Ports, Protocols, and Protocol Roles*: For users who want an introduction to the use of protocols and protocol roles in a Rose RealTime model.

## Navigating the Tutorials

---

Depending on the whether you wish to complete the tutorials sequentially or jump to specific lessons, you can navigate the tutorials in two ways:

- You can view a tutorial in order without having to scroll through the Table of Contents using the **Next** and **Previous** buttons at the top and bottom of each Help window.
- You can jump to a particular topic by directly selecting it from the **Contents** window in the **Help** browser.

## Printing the Tutorial

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If you prefer working from a printed copy of the tutorial, you can find a PDF version of the tutorial chapters located in the Rose RealTime installation directory `$ROSERT_HOME/Help/rrttutor.pdf`.





## Contents

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This chapter is organized as follows:

- *Getting Started* on page 17.
- *Model Description* on page 21.
- *Creating a New Model* on page 22.
- *Creating the Logical View* on page 24.
- *Creating the Component View* on page 35.
- *Building the Component* on page 42.
- *Creating the Deployment View* on page 44.
- *Running the Component Instance* on page 46.
- *Tutorial Summary* on page 47.

## Getting Started

---

As a new Rational Rose RealTime user, this *QuickStart* tutorial gets you up-and-running in Rose RealTime as quickly as possible. Using a simple example, the tutorial guides you through the basic steps involved in constructing a model in Rose RealTime using the C++ language add-in.

**Note:** Although this tutorial is based on the C++ language, Rose RealTime also supports the Java and C languages.

In this tutorial, you learn how to:

- Construct elements in the **Logical View**, including:
  - capsules
  - capsule state diagrams
  - ports
- Build and execute a model in the Rose RealTime execution environment.

**Note:** Ensure that your environment is properly configured for your compiler. For additional information about configuring your environment, see *Installation Guide Rational Rose RealTime*.

The Rose RealTime toolset provides a complete development environment for using UML to create executable models.

The UML provides a wide range of visual modeling constructs. Not all of these constructs are directly applicable to creating a working model. Many exist for purposes of building more complex systems, communicating designs to other team members, capturing design decisions, and for organizing models, but are not strictly required to build a simple model.

Rose RealTime provides additional constructs that are based on UML modeling elements and are specialized for creating executable real-time models. In order to produce a working model, it is important to understand the model elements that must be defined, and the sequence of the elements.

Because this tutorial is geared toward the new user, the focus is only on those elements and tools that are required to create a basic executable model. If you want to construct a more complicated Rose RealTime model, you should familiarize yourself with some of the advanced elements that are outside the scope of this tutorial. For example: use cases and use case diagrams, actors, packages, sequence diagrams, collaboration diagrams, and so on.

**Note:** To complete this tutorial, you need to have Rational Rose RealTime and a compiler (such as, Visual C++ 6.0) installed on your computer.

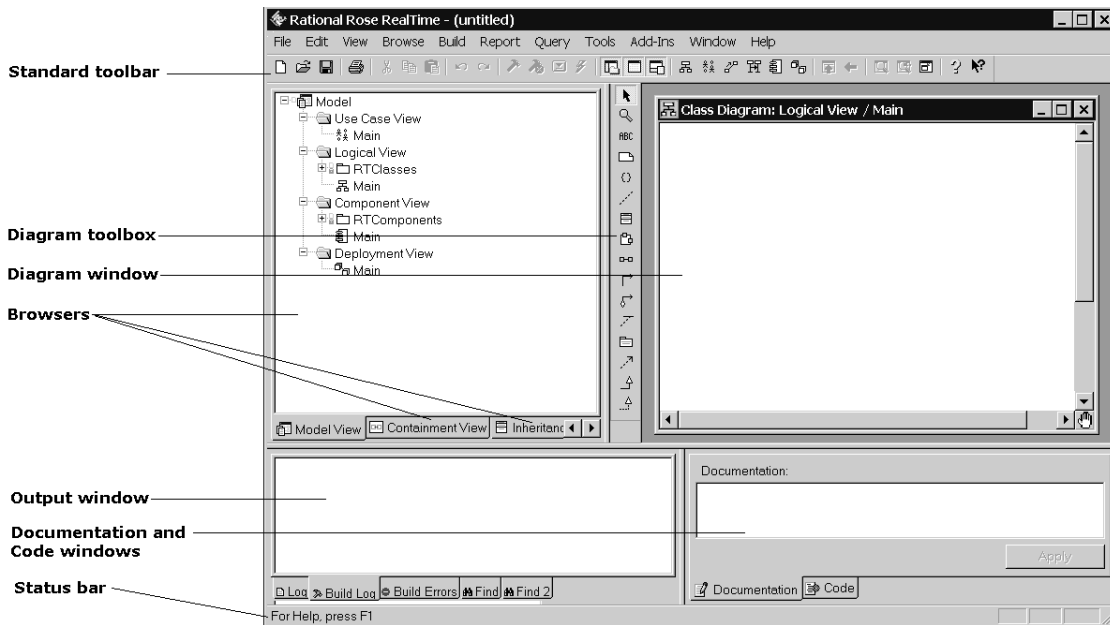
## Rose RealTime User Interface

Before proceeding with the tutorial, you need to become familiar with the main features of the Rose Realtime user interface.

**Note:** When you initially open Rose RealTime, a default set of windows appear (as illustrated below). However, you can customize the user interface to suit your modeling needs. For example, you can change where the windows are docked, or set them to free-floating. You can add or remove buttons from the toolbar, and you can show or hide the browsers.

Figure 1 shows a typical display of the Rational Rose Graphical User Interface.

**Figure 1 Rational Rose RealTime Graphical User Interface**



The main features of the Rose RealTime user interface are:

- The **Standard Toolbar** remains the same for all views and diagrams. It contains standard Windows functions as well as those specific to Rose RealTime.
- The **Diagram Toolbox** is used for adding elements to the model by drawing them on a diagram. The toolbox elements change depending on the active diagram. For example, the **Use-Case Diagram** has a tool for adding actors, but the **Component Diagram** does not have this tool.
- Browsers are hierarchical and can be expanded and contracted. When you start Rose RealTime, the **Model View**, the **Containment View**, and the **Inheritance View** browsers are docked on the left side of the interface in a stacked format. They can be set to visible/invisible, docked, or floating. To activate a specific browser, select the appropriate tab located at the bottom of the interface.

There are two additional browsers, also referred to as editors, that can be opened to perform specific tasks: the **Structure/State Diagram** Browser/Editor, and the **Run Time System (RTS)** Browser/Editor. These browsers cannot be moved.

- Rose RealTime offers four main views located on the **Model View** browser. Each view is related to a software lifecycle phase, and the diagrams are artifacts of those phases.

- **Use-Case View** shows what a system (subsystem, class, or interface) does but does not specify how the system internally performs its tasks.
- **Logical View** represents the architectural processes as the model moves from analysis, through design, and into development.
- **Component View** contains concrete representations of the system. Components realize the active and passive classes, and provide the components for building an executable model.
- **Deployment View** shows how the system is to be distributed. It defines the processors, and contains a diagram of the nodes in the system.

## Online Help

For more information about the Rose RealTime user interface, or how to complete a specific task, see the Rose RealTime online Help.

### To open the online Help:

- On the **Help** menu, click **Contents**.

The Table of Contents for Rose RealTime Online Help appears.

You can select topics from the Table of Contents or search through the index for keywords. The Help is content-sensitive, and automatically opens a **Help** window related to the tool or diagram you use.

## Sample Model

In addition to the online Help, Rose RealTime includes a sample model, QuickstartTutorial.rtmidl. You can use this model to explore the various elements of Rose RealTime, and to practice the procedures for model building and execution.

### To open the sample model:

- 1 On the **File** menu, click **Open**.
- 2 In the **Open** dialog box, locate the Rose RealTime installation directory, and select Tutorials/gstarted/QuickstartTutorial.rtmidl.
- 3 Click **Open**.

**Note:** If prompted with "Do you wish to create the default workspace?", click **No**. A workspace maintains information about the current model, open windows and window positions, etc. The workspace information is stored in a separate file (a .rtwks file).

- 4 Click **File > New** to create a new model.

## Model Description

---

In this tutorial, your goal is to create a new model with one capsule that prints "Hello world!" to the console.

This is a very simple model that could easily be accomplished in a native development environment by writing the code in the C++ programming language (see below), and then compiling the code into an executable file.

```
#include <iostream.h>

main() {
    cout << "Hello world!\n";
```

However, you will generate the equivalent executable from within the Rose RealTime modeling environment by following a basic workflow consisting of these simple tasks:

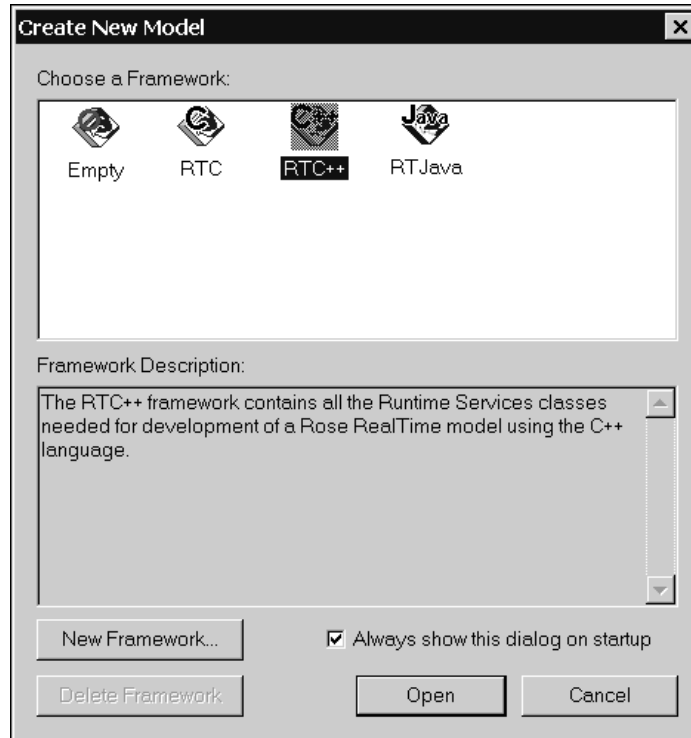
- 1 Creating a new model.
- 2 Creating the **Logical View**.
- 3 Creating the **Component View**.
- 4 Building the component.
- 5 Creating the **Deployment View**.
- 6 Running the component instance.

## Creating a New Model

---

When you start Rose RealTime, the **Create New Model** dialog box appears.

**Figure 2** Create New Model dialog



Typically, there are four frameworks listed: **Empty**, **RTC**, **RTC++**, and **RTJava**. However, you may have additional optional frameworks, such as the Gateway.

To open a model containing all the classes required for development using the C, C++, or Java language, click the framework for the specified language. The **Model View** browser appears with the packages and classes populated in the **Logical View** and **Component View**.

**Note:** The language and environment used in your model defaults to the same language that you specified in the framework. You can change the language or environment settings in the **Language/Environment** tab (**Options** dialog box, **Tools** menu).

**Note:** The **Empty** framework is useful for creating use case designs but should not be used for developing RealTime applications.

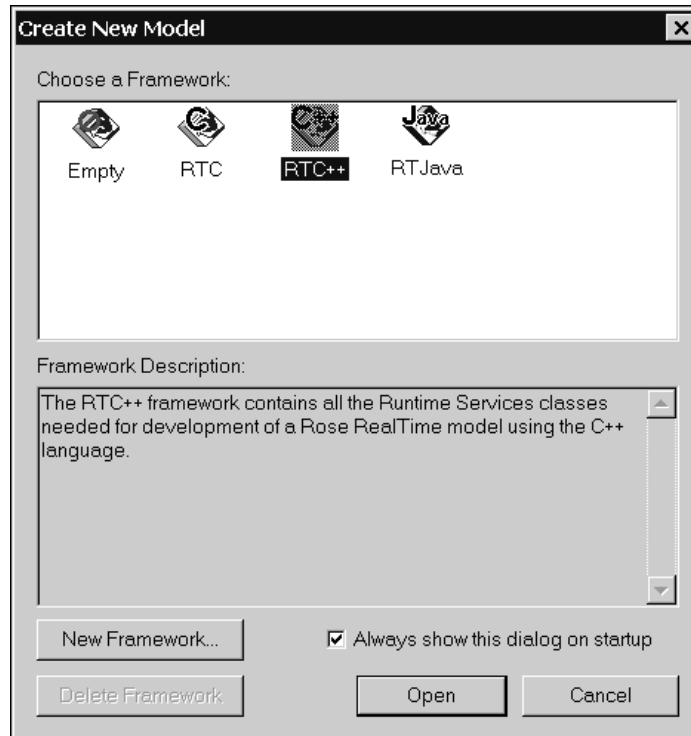
If you want to open Rose RealTime without the **Create New Model** dialog box automatically appearing, clear **Always show this dialog on startup**.

In this tutorial, you will create a model using the **C++** framework.

### To create a model and specify the default language:

- 1 Start Rose RealTime.

The **Create New Model Dialog** appears. If it does not appear, on the **File** menu, click **New**.



- 2 Double-click **RTC++**.

You are now ready to build and execute a Rose RealTime model.

## Creating the Logical View

---

Creating the **Logical View** involves discovering and creating the various classes that make up the design solution for the problem (that is, how to create a model that prints "Hello world!").

Usually, you define several classes, capsules, and protocols to create a working model. You iterate between defining the model elements, compiling and running the model to see how it works, and then fixing problems and add more functionality to the model. However, for this basic *QuickStart* tutorial, you will create only one capsule to print the "Hello world!" message to the console.

The steps involved in creating the **Logical View** are:

- Creating a capsule.
- Adding a state to a capsule.
- Drawing an initial transition.
- Adding a port to a capsule (not required when using the C language).
- Adding the detail code to a state machine.

### Creating a Capsule

Capsules are special forms of classes with some supporting mechanisms that enforce a higher degree of encapsulation and abstraction than classes. Capsules are very useful for building concurrent, event-driven systems, and are an important element in Rose RealTime.

The code required to implement this example could easily be defined in an operation on a regular class, but something needs to initiate the activity. Operations do not run by themselves. They must be invoked.

In Rose RealTime, you place the code in a capsule that is automatically invoked by the **main()** program in the Rose RealTime Services Library. The **main()** block in the Services Library creates the capsule in your model, and starts the state machine. You describe the capsule and define the state machine, and they are automatically created and executed by the Services Library.

**Note:** A model must include at least a top-level capsule that initiates behavior in the system, and results in generated code which forms the executable. In this case, your model will contain only one top-level capsule that prints "Hello world!" from within the body of its state machine.


You will create a capsule class in the **Logical View** of the **Model View** browser, and name it **HelloWorld**. This simple capsule class implements the design model.



### To create a new capsule class:

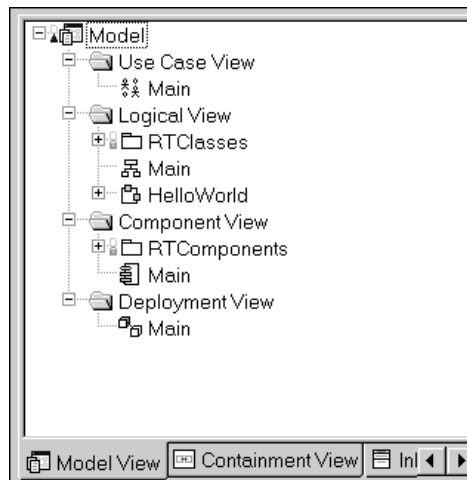
- 1 In the **Model View** browser, right-click **Logical View**, and select **New > Capsule**.

Or . . .

In the toolbox for the **Class Diagram**, select the **Capsule** button , and click on the **Class Diagram: Logical View / Main** window.

- 2 Rename the capsule **HelloWorld** and press ENTER.

On the **Model View** tab in the browser, the new capsule **HelloWorld** appears in the **Logical View** folder.



### Adding a State to a Capsule

For capsule classes, a state diagram results in a complete code implementation generated for the class. The state diagram defines the majority of a capsule class implementation. The capsule class may also have operations defined on it, but the state diagram gives the capsule its asynchronous message processing capability.

In this tutorial, you will open the **State Diagram** for the **HelloWorld** capsule, and add a state to that capsule.

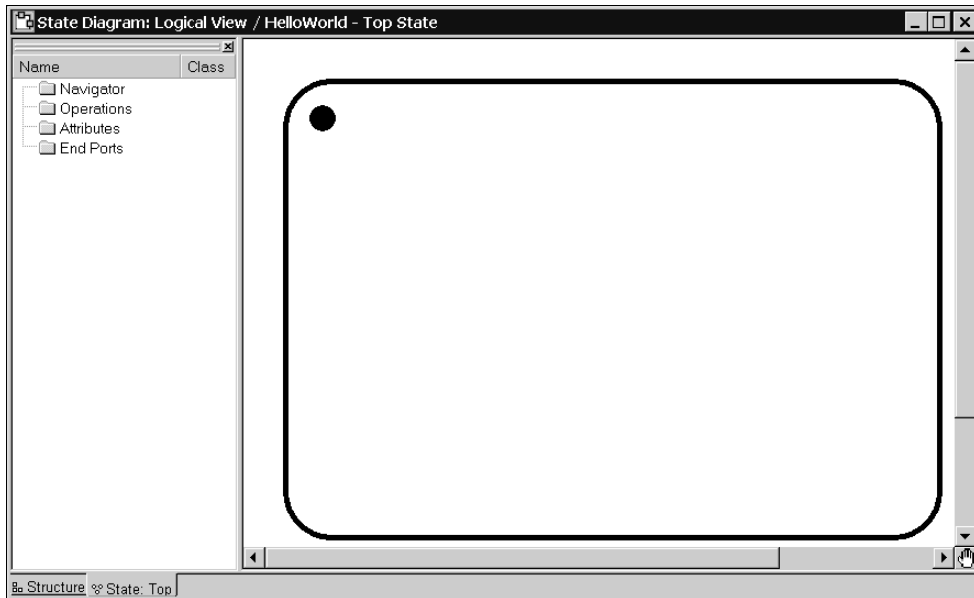
### To add a state to a capsule:


- 1 In the **Model View** browser, right-click the **HelloWorld** capsule, and click **Open State Diagram**.

Or . . .

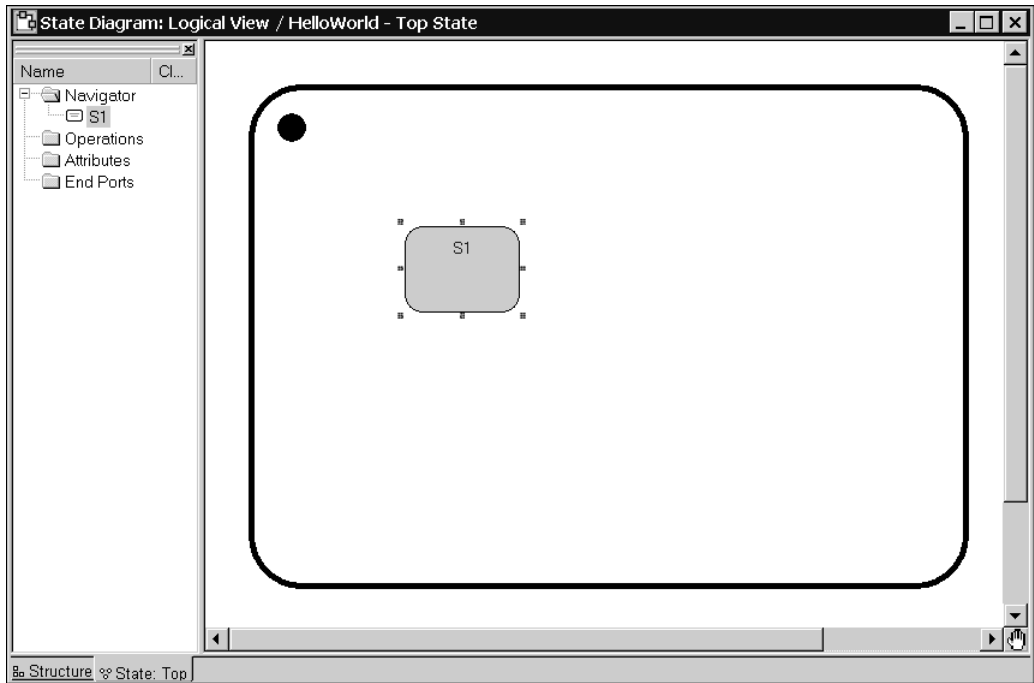
In the **Class Diagram**, right-click on the **HelloWorld** capsule and click **Open New State Diagram**.

The **State Diagram** appears.

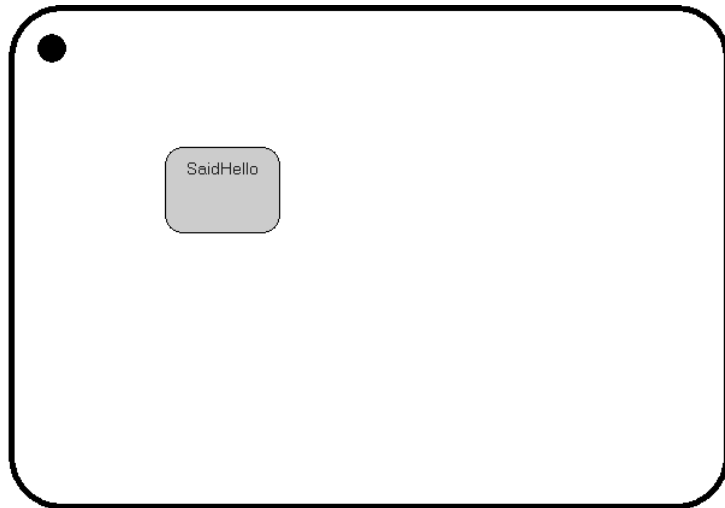


- 2 In the **Diagram** toolbox, click **State** .
- 3 Move the cross hairs into the rounded rectangle in the **State Diagram**, and click to create a new state.

A state appears with the default name **S1**.



4 Rename the state **SaidHello** and press ENTER.



The state diagram contains an *initial point*, ●, and an *initial state* called **SaidHello**. An initial point is a special point which explicitly shows the beginning of the state machine. You connect the initial point to a start state (in this case, SaidHello). Where

the start state will be the first active state in the objects state machine. The transition from the initial point to the start state, the initial transition, is the first transition taken before any other transition. Only one initial state is allowed in each state diagram.



Only one outgoing transition can exist from the initial point.

There can be several incoming transitions to the initial state. In this case the initial state acts like a junction point which forces the behavior back through the initial transition. If the initial transition is used to completely initialize an object, then any incoming transition to the initial state will effectively reset the behavior of an object without having to destroy then re-create it.

## Drawing an Initial Transition

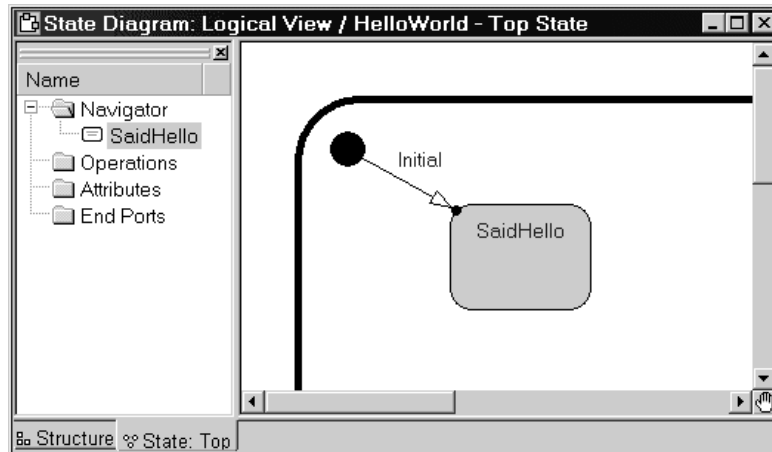
A transition is a relationship between two states, a source state and a destination state. It specifies that when an object in the source state receives a specified event and certain conditions are met, the behavior moves from the source state to the destination state. You create an **Initial Transition** that is automatically invoked at runtime when a capsule instance is created. Any action code associated with the **Initial Transition** runs when the capsule instance is created.

### To draw a transition:

- 1 In the toolbox for the **State Diagram** dialog box, click **State Transition** .
  - 2 Click and hold the left mouse button on the **Initial Point** in the state diagram, .
- The **Initial Point** is the black circle that appears in the top-left corner of the **State Diagram**.

- 3 Drag the **Transition** line to the top of the **SaidHello** state.

**Note:** The **Initial Transition** has a default name of **Initial**.



Now that you created an initial transition - a transition from the initial point to the initial state - you specified that at runtime, the SaidHello state is the first state to receive a specified event and the behavior moves from the initial point to the SaidHello state.

Next, you will create a port to communicate with the HelloWorld capsule instance by sending and receiving messages.

## Adding a Port to a Capsule

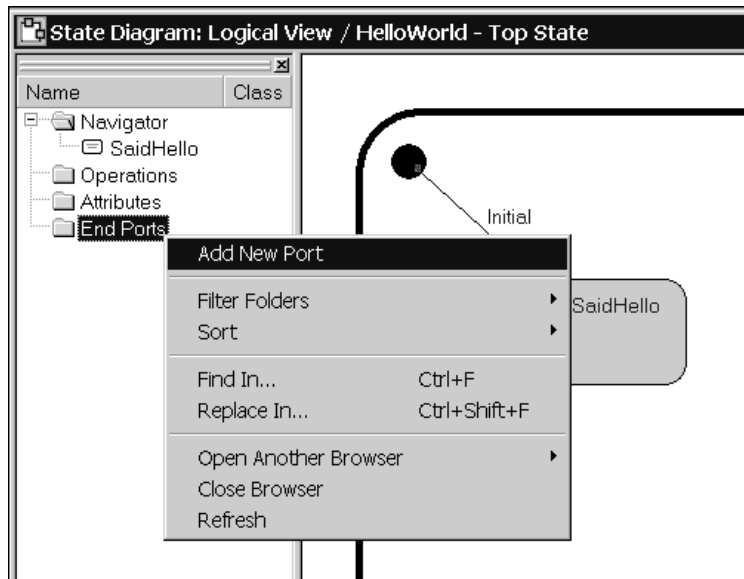
Ports are objects that communicate with capsule instances by sending and receiving messages. A port is owned by the capsule instance, and is created/destroyed with the capsule. Each port has a separate identity that is distinct from the identity and state of the associated capsule instance.

By default, new ports are public. Public ports appear on a capsule's boundary in the **Structure Diagram**, and are visible both from outside and inside the capsule. In this model, you will make a protected port. Protected ports cannot be accessed outside the capsule.

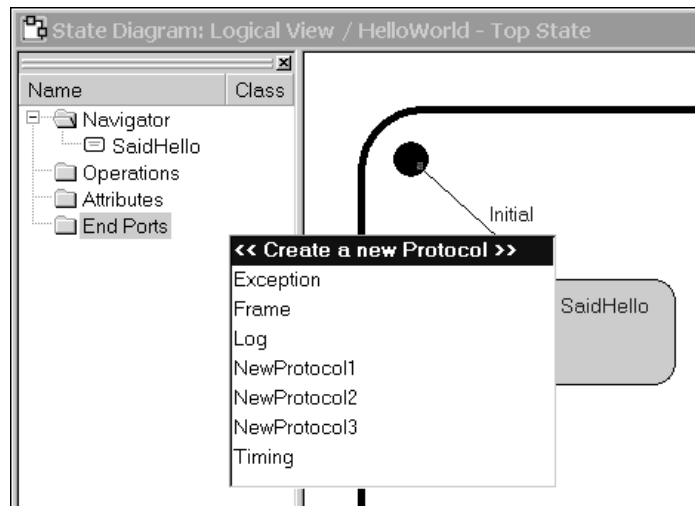
You will add a new port to the "Hello world" capsule using the built-in Log protocol.

## To add a protected port to a capsule:

- 1 In the browser to the left of the **HelloWorld Top State diagram**, right-click **End Ports**.

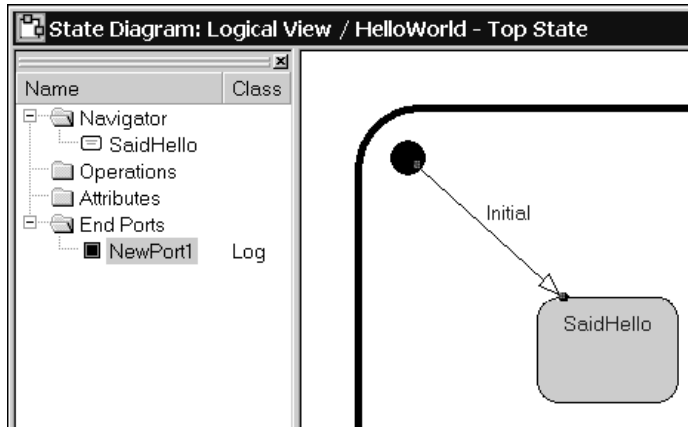


- 2 Click **Add New Port**.

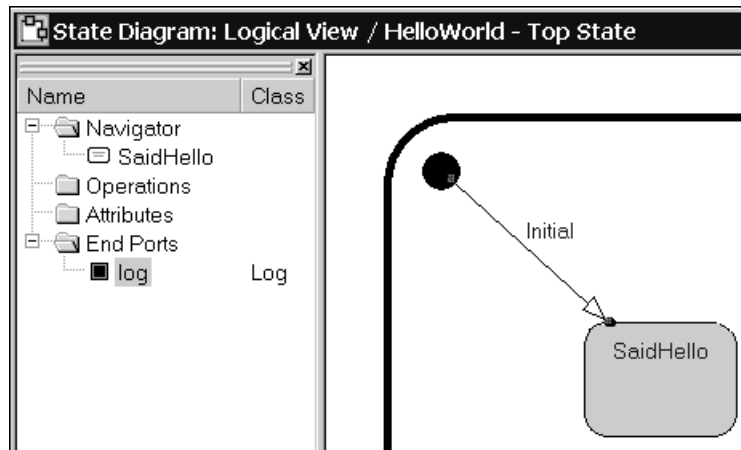


- 3 From the list of protocol classes available for the model, double-click to select **Log**.

A port appears with the default name **NewPort1**.

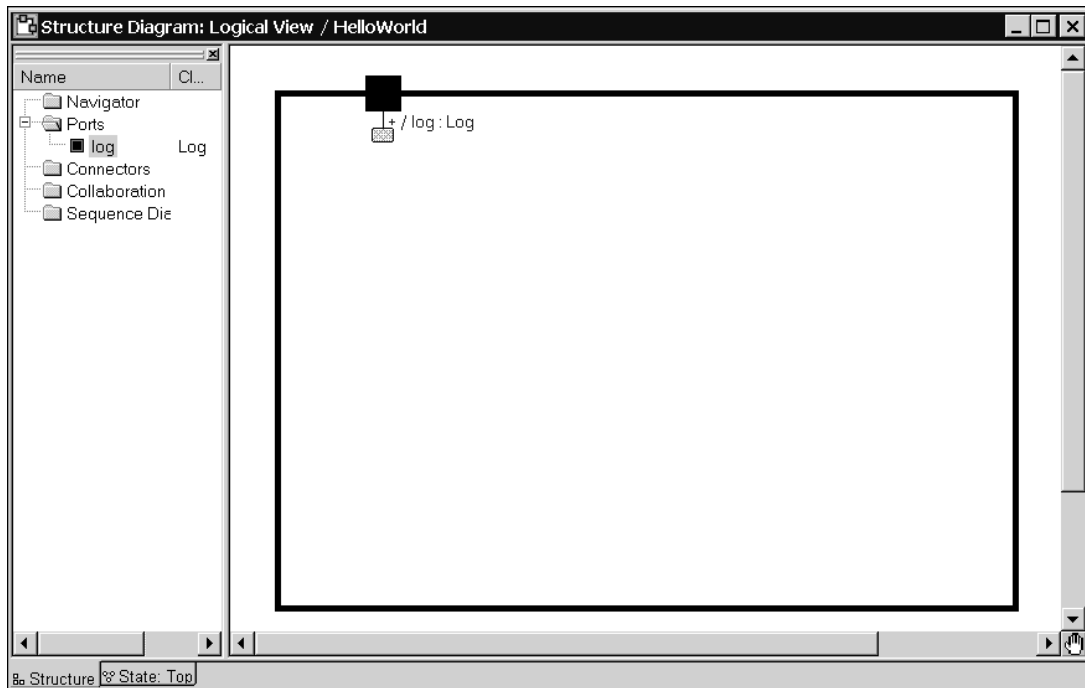


- 4 Rename the port name to **log** and press ENTER.





- 5 Click the **Structure Diagram** tab in the **Logical View** diagram for the **HelloWorld** capsule.

The **Structure Diagram** appears as the active diagram.

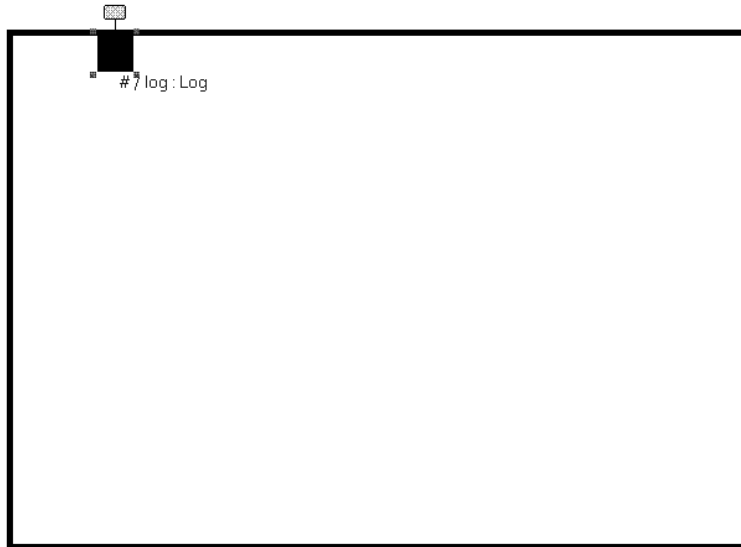


6 In the **Structure Diagram**, click the **log** port, .

7 Right-click, and click **Protected**.

Notice that the graphic for the port changes from an unprotected port, , to a protected port, .





To send and receive messages, the capsule must have end ports. The end port's protocol defines the set of messages that can be sent and received. Protected ports are not public. This means that these ports are not visible from the outside of a capsule since they are not part of the capsule's interface.

## Saving a Model

Before you continue with the tutorial, we recommend that you save your model.

### To save a model:

- 1 On the **File** menu, click **Save Model As...**
- 2 In the **File Name** box, type **HelloWorld**.
- 3 In the **Save In** box, select the folder where you want to save the model.
- 4 Click **Save**.
- 5 If prompted to create a default workspace with a HelloWorld.rtwks path name, click **Yes**.

**Note:** When you create a workspace, all components, specifications and windows in your model are saved as they exist in your model. You can also save a model without saving these specifications by using the file extension .rtmdl.

## Adding the Detail Code to a State Machine

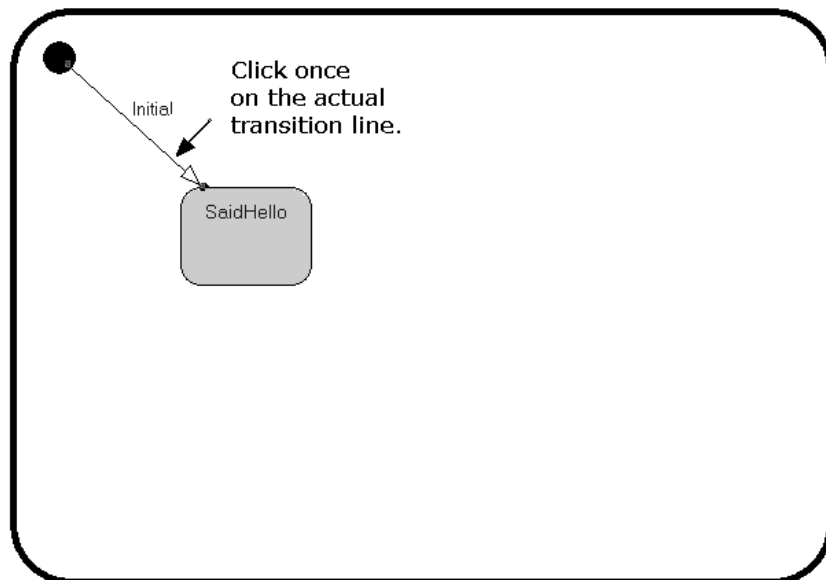
You have all the required elements in place (that is, initial state, initial transition, and log port), and you will now add detail code to the **Initial Transition**. The detail code will be executed when the **Initial Transition** is run at model execution time.

You need to add the C++ code to the state machine to implement the desired behavior. C++ code can be added as actions on transitions, choice points, and state entry or exit on capsule state diagrams that are executed at runtime. Only code added to a capsule state diagram is included in the generated code for the model. Detailed actions on protocol or data class state diagrams are not included in the generated code for those classes.

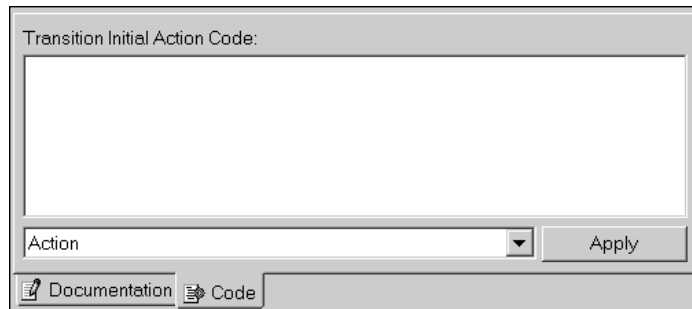
In our model, the detail code will use the Log service to write the "Hello world!" message to the console.

### To add code to the Initial Transition:

- 1 In the **State Diagram** dialog for the **HelloWorld** capsule, click the line for the **Initial Transition**.



Next, you will use the convenience of the **Code** window to add code to the transition. The **Code** window is located in the lower right-hand corner of the Rational Rose RealTime window. For example, the **Code** window for the **Initial** transition is:



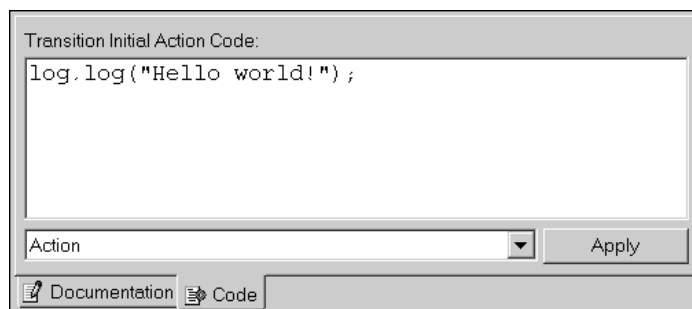
**Note:** If you prefer, you can also double-click on the **Initial** transition line to open the **Transition Specification** dialog.

- 2 In the **Code** window, select **Action** from the drop-down list.
- 3 Type the following C++ code:

```
log.log("Hello world!");
```

Ensure that you include the semi-colon at the end of the line.

Your **Code** window will look like the following:



- 4 To save the changes, click **Apply**.

## Creating the Component View

---

The **Component View** specifies how to compile various parts of the model. The primary element of the **Component View** is a component that you need to create. This component specifies the capsules and classes to compile, how to compile those elements, and the inclusions and libraries to incorporate into the build.

You must create a component for the top-level capsule in order to build and execute your model. You can draw component diagrams for situations where you have many related components or packages of components.

## Creating a Component



You will create a component by opening a series of dialog boxes so that you can become familiar with the common features of the Rose RealTime user interface. Step 1 provides with with two ways of creating a component. Choose only one method.

**Note:** You can also use the **Component Wizard** to create a component. The wizard guides you through creating and configuring a component, and running the component instance. To access the wizard, click **Component Wizard** on the **Build** menu.

### To create a component:

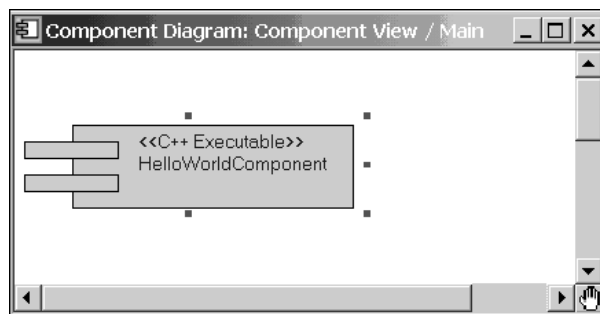
- 1 In the **Model View** tab in the browser, select **Component View**, and click **New > Component**.

Or . . .

In the **Toolbar**, select the **Browse Component Diagram** button . For the **Component View** package, select **Component Diagram: Component View / Main** in the **Component diagrams** list, and click **OK**. From the **Toolbox**, select the **Component** tool , then click in the diagram.

- 2 Rename the component **HelloWorldComponent**.

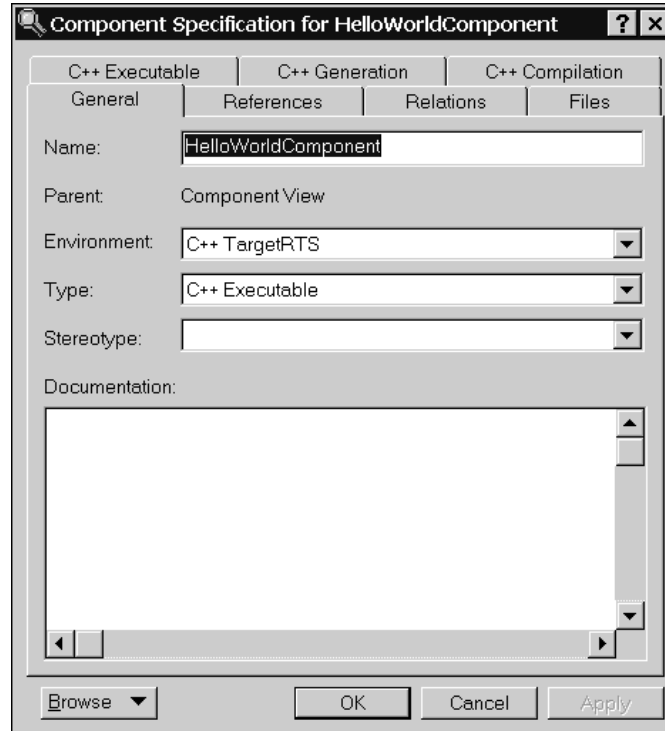
If you used the second method, you will have a visual representation of your component in the **Component Diagram** for **Main**.



For both methods, the **Model View** tab in the browser is updated to include the new component.



- 3 Double-click **HelloWorldComponent** to open the **Component Specification for HelloWorldComponent** dialog box.



- 4 Click the **General** tab if not already selected.
- 5 In the **Environment** box, select **C++ TargetRTS** if not already selected.

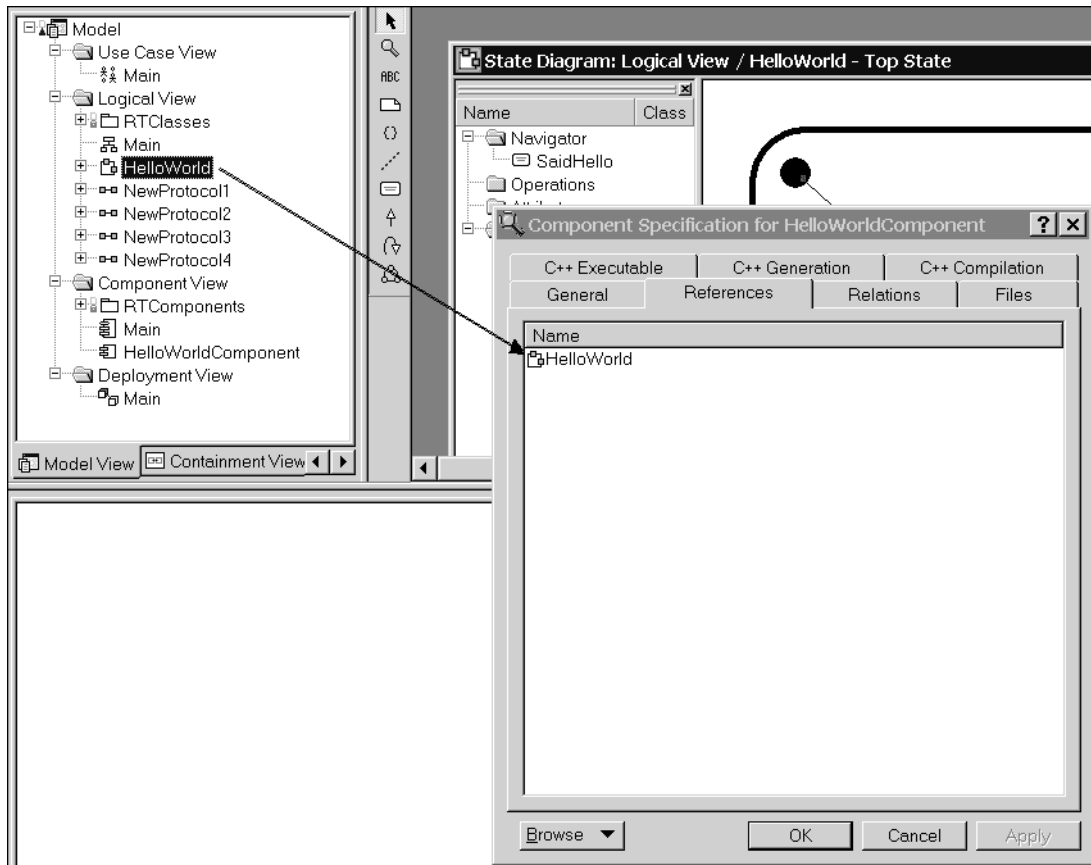
Setting the **Environment** box to C++ TargetRTS specifies that the C++ run-time system and code generation are used in the build process.

- 6 In the **Type** box, select **C++ Executable** if not already selected.

Setting the **Type** box specifies that you want to build a C++ executable version of the model.

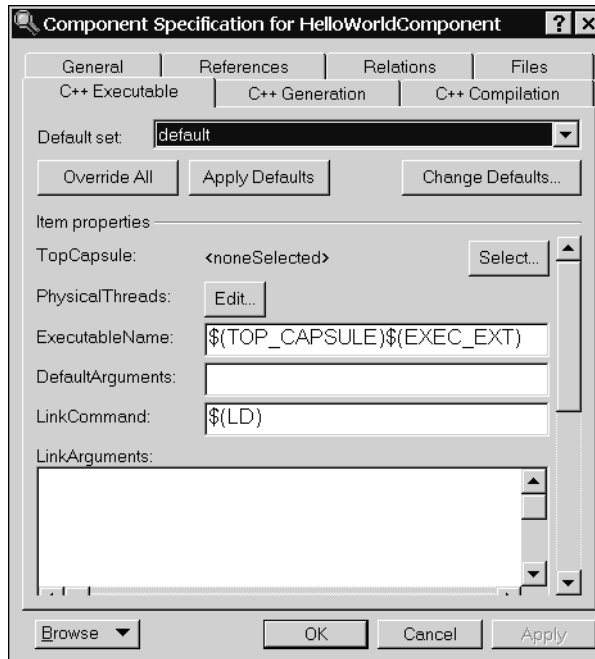
- 7 Click the **References** tab.

- 8 In the **Model View** browser, drag the **HelloWorld** capsule onto the **References** tab.  
The **HelloWorld** capsule appears in the window.



You drag the **HelloWorld** capsule onto the **References** tab because the items in the **References** tab identify what is compiled with the **HelloWorld** component.

- 9 Click the **C++ Executable** tab.



- 10 Click **Select...**

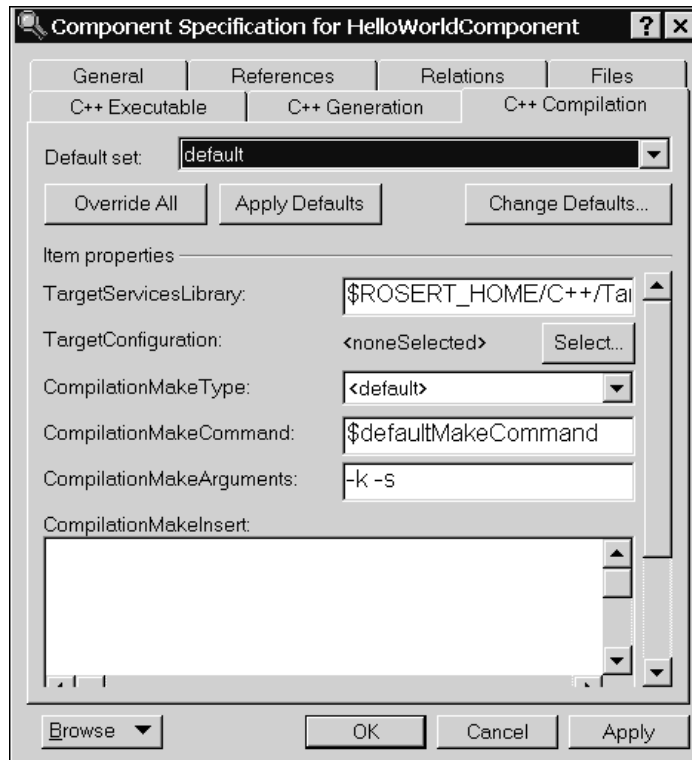
The **Select Top Capsule** dialog box appears. In this dialog box, you select the capsule that will be the top capsule in the model.

- 11 Click **HelloWorld** to designate it as the top capsule.



12 Click **OK**.

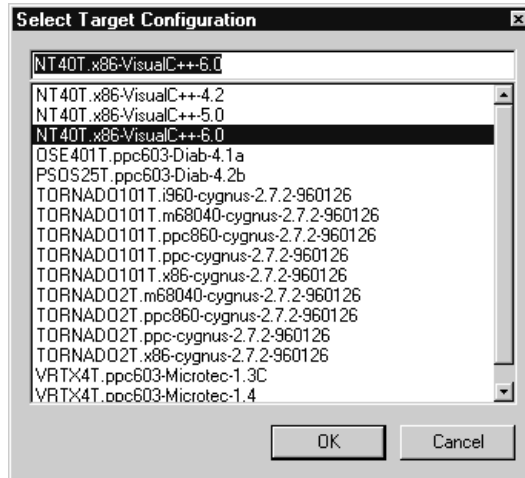
13 Click the **C++ Compilation** tab.



14 Click **Select...**



The **Select Target Configuration** dialog box appears.



A component is always created with a default configuration for your host machine. This includes a default compiler, compiler flags, linker, and so forth. In many cases, these settings are sufficient for building simple sets of classes and capsules that do not require integration with external source files, or libraries.

In this dialog box, you will specify the operating system, compiler, and processor that you want to use to build and run the model.

The information is listed in the following format:

<operating system>.<processor and compiler>

For example:

- If you are running Windows 4.X on a x86 processor, and you have installed the Visual C++ 6.0 build tools, select:

NT40T.x86-VisualC++-6.0

- If you are running Solaris 5.X on a sparc processor, and you have installed the gnu 2.8.1 build tools, select:

SUN5T.sparc-gnu-2.8.1

**15** Select the configuration for your computer, and click **OK**.

**16** To save the changes, click **Apply**.

**17** To close the **Component Specification for HelloWorldComponent** dialog box, click **OK**.

## Building the Component

---

In order to build an executable of your model, you created a component, called **HelloWorldComponent**, that will be used to manage the build configuration parameters. To build the executable, you need to build (or compile) this **HelloWorldComponent** component.

### To build a component:

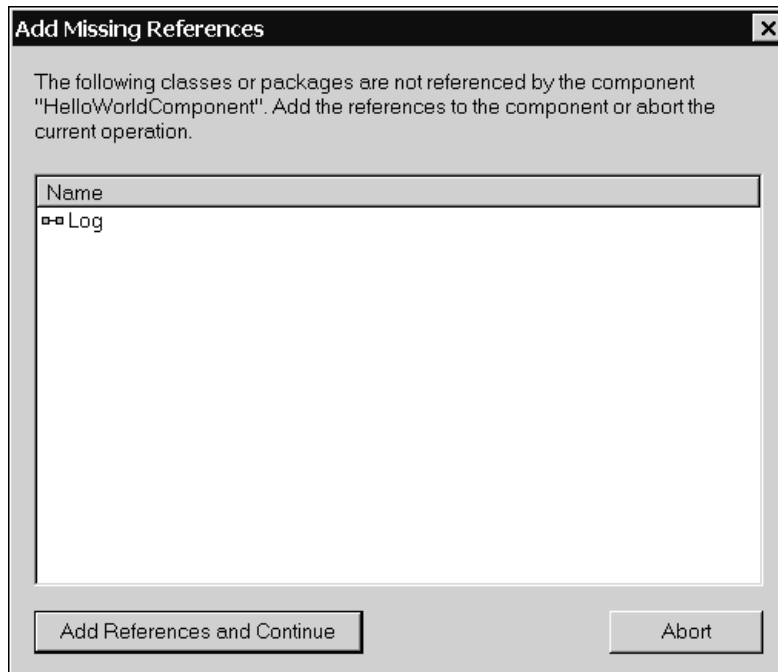
- 1 In the **Model View** browser, right-click **HelloWorldComponent**, and click **Set As Active**.

Because you will be building and running the same component and component instances often, you should configure an active component. Setting the **Set As Active** option ensures that the toolbar build icons and menu items, for the common run and build commands, become available for easy access.

The **Build Component** tool  becomes active.

- 2 Click **Build Component**.

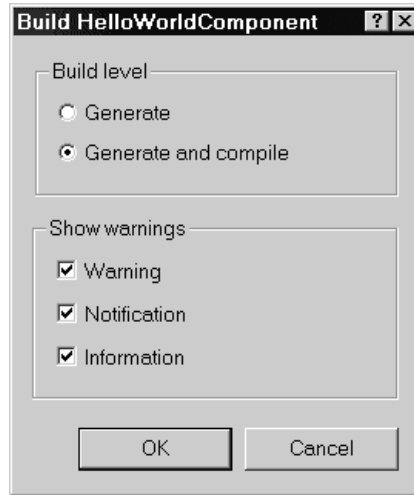
The **Add Missing References** dialog box appears.



The HelloWorldComponent component should contain all referenced classes before it is compiled. Rose RealTime checks the references, and prompts you to add any missing references that it detected.

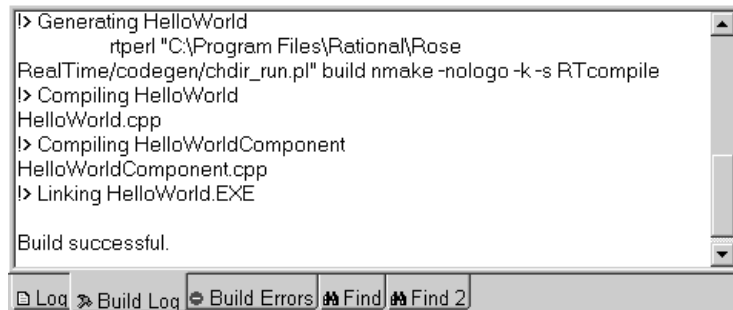
**3** Click **Add References and Continue**.

The **Build HelloWorld Component** dialog box appears.



**4** If not currently selected, click **Generate and compile**, and click **OK**.

The **Build Log** tab of the **Output Window** shows the results of code generation and compilation. When the build finishes, the **Build Log** should indicate "Build successful".



**Note:** If there are compile errors, double-click on an error message on the **Build Errors** tab. Rose RealTime opens the appropriate editor where the source of the error appears. You can then resolve any errors.

## Creating the Deployment View

---

The **Deployment View** describes the computing environment in which your model is executed, and specifies how it is deployed within the environment. The most important elements of the **Deployment View** are processors and component instances.

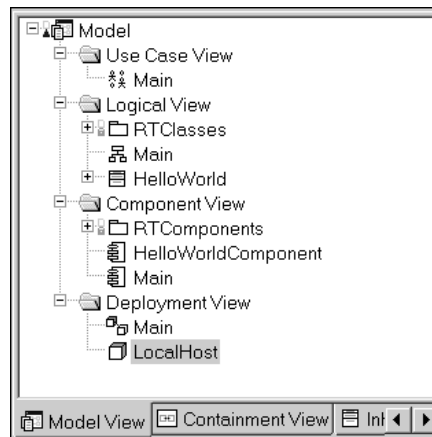
First, you define a processor on the **Deployment Diagram** that describes the computing hardware on which the model will be executed. Next, you map the component onto the processor to create a component instance. Finally, you run the model.

### Creating a Component Instance



In this tutorial, there are two ways to create a component instance: in the **Model View** tab in the browser, and using the Toolbar and Toolbox buttons. Step one shows how to use both methods. Use only one of these methods.

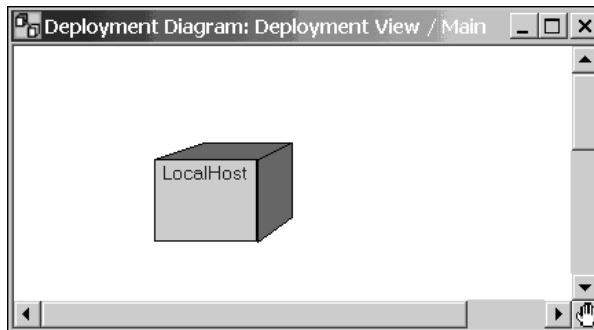
**To create a component instance:**

- 1 In the **Model View** tab in the browser, right-click **Deployment View**, and click **New > Processor**. Rename the processor **LocalHost** and press ENTER.



Or . . .

In the Toolbar, select the **Browse Deployment Diagram** button . For the **Deployment View** package, select **Deployment Diagram: Deployment View / Main** from the Deployment diagrams list, and click **OK**. In the toolbox, click the **Process** tool , and click on the diagram. Rename the processor **LocalHost** and press ENTER.

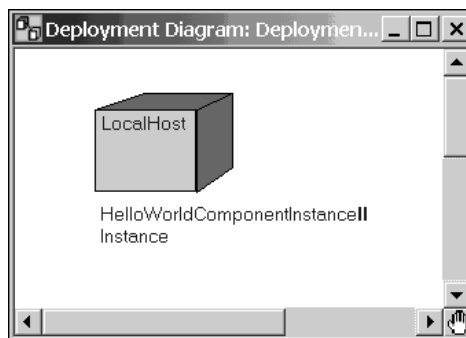


- 2 In the **Model View** tab in the browser, drag the **HelloWorldComponent** from the **Component View** folder onto **LocalHost**.

Or . . .

If you created a processor on the **Deployment Diagram** for **Main**, from the **Model View** tab in the Browser, drag the **HelloWorldComponent** from the **Component View** folder onto **LocalHost** processor in the **Deployment Diagram**.

After dragging the **HelloWorldComponent**, the **Deployment Diagram: Deployment View / Main** dialog looks like the following:



For both methods, a component instance, **HelloWorldComponentInstance** appears under **LocalHost**.



Now that you have associated a component with a processor (creating a component instance), your component instance is complete and you can now run HelloWorldComponentInstance.

Before you run the component instance, save your model (**File > Save Model**)

## Running the Component Instance

---

After you created a component instance by associating a component with a processor, you can run the component instance within Rose RealTime.

### To run a component instance:


- 1 In the **Model View** tab in the browser, right-click **HelloWorldComponentInstance** in the **Deployment View** folder, and click **Run**.
- 2 If you are prompted to build the component, click **No**.

**Note:** Since you previously built the component successfully, you do not need to build it again.

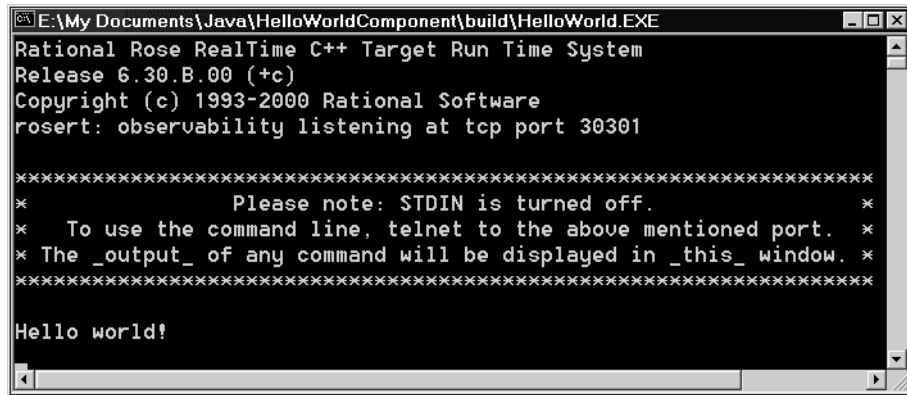
A **Runtime View** browser and a console window appear. The model output displays in the console window.

The model is ready to run.



- 3 Click **Start**  on the **Runtime View** browser.

- 4 Select the console window to make it visible in the Rose RealTime window.




```
E:\My Documents\Java\HelloWorldComponent\build\HelloWorld.EXE
Rational Rose RealTime C++ Target Run Time System
Release 6.30.B.00 (+c)
Copyright (c) 1993-2000 Rational Software
rosert: observability listening at tcp port 30301

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
*           Please note: STDIN is turned off.           *
* To use the command line, telnet to the above mentioned port. *
* The _output_ of any command will be displayed in _this_ window. *
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Hello world!
```

The "Hello world!" output appears in the console window.

- 5 To terminate the component instance, click **Shutdown**  on the **Runtime View** browser.

## Tutorial Summary

---

In the *QuickStart* tutorial, you created a capsule and constructed a system that had one capsule instance. As part of the capsule definition, you defined a log port to access the Log service for printing messages to the console window. You also defined a state machine for the capsule with a single state and an initial transition.

After creating the capsule, you defined a component and deployed the component to enable the generation, compilation, and execution of code for the model.

Finally, you ran the model. At execution time, the Rose RealTime Services Library created a single instance of the top-level capsule class in the model (in this case, the only class in the model), and then called a function to execute the initial transition of the capsule's state machine. The initial transition in turn called a function on Log port to print "Hello world!" in the console window.

After the initial transition executed, the capsule entered the **SaidHello** state where it waited to process any incoming messages. Since there is nothing else in the model, there was no further activity.

## Viewing the Generated Code

To examine the generated code, select the folder where you saved your model. In this folder, open the `HelloWorldComponent\src` folder. The `src` folder contains the generated code for your model.

## What's Next?

Try constructing some simple models of your own. Explore the online Help for information on the various modeling tools. You can also use the `QuickstartTutorial.rtmidl` for further practice on building and compiling a model.



## Contents

---

This chapter is organized as follows:

- *What You Will Learn?* on page 49
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- *Lesson 2: Creating a Use Case and Initial Capsules* on page 59
- *Lesson 3: Sequence Diagrams, Protocols, Ports, and Connectors* on page 79
- *Lesson 4: Building and Running* on page 103
- *Lesson 5: Adding Behavior to the Capsules* on page 119
- *Lesson 6: Navigating and Searching* on page 143
- *Lesson 7: Using Traces and Watches to Debug the Design* on page 144
- *Lesson 8: Class Modeling* on page 162
- *Lesson 9: Adding Card Classes to the Capsule Behavior* on page 195
- *Lesson 10: Aggregating in a State Diagram* on page 215
- *Tutorial Summary* on page 218

## What You Will Learn?

---

The *Card Game* tutorial introduces the basics of creating Rational Rose RealTime applications using the C++ Language Add-in, and demonstrates how to use the main features of Rose RealTime. You will learn the basics of how to:

- Create a new model and configure the toolset.
- Create a use case and initial design elements from the requirements statement: capsules and classes.
- Create sequence diagrams, protocols, ports, and connectors.
- Build and run a model.
- Add behavior (state diagrams) to capsules.
- Navigate and search the model.
- Use traces and watches to debug an error in a model.
- Model classes.
- Use aggregation in a state diagram.

## Why a Card Game?

Since most people know how to play cards, you can concentrate on how the tool works without having to spend time understanding the requirements of the tutorial model. Using this model, you will explore the main features of Rose RealTime.



You may also want to refer to the *C++ Reference* to understand the functionality that the language add-in provides.

## Card Game Requirements

Card game, the application you build in this tutorial, will be a simulation of a two hand (termed heads-up for a play between only two players), five card stud poker game. There are many variants of poker with many functions having to be implemented in order to simulate all possible poker variations. However, in this tutorial you will only implement a set of simple rules.

### The simulation scenario is:

- 1 The player places an ante (minimum ante is \$5).
- 2 The dealer shuffles the cards before each game to reduce the chance of you counting cards.
- 3 The dealer deals the two hands (5 cards each).
- 4 The player shows his hand to the dealer.
- 5 The dealer compares his hand to the players and decides who wins.
- 6 The dealer informs the player if he wins (with the winning bet multiplier) or if he loses.
- 7 The game restarts.

To make things simpler, only the following hands will be checked as possible winning hands:

- 1 pair
- 2 pairs
- 3 of a kind
- full house
- 4 of a kind.

In the case of a tie (that is, when the dealer and player have the same hand), the dealer wins.

## Before You Begin

---

Ensure that your environment is properly configured for your compiler. For additional information about configuring your environment, see *Installation Guide, Rational Rose RealTime*.

## Tutorial Lessons

The tutorial develops the Card Game application in ten lessons. You will start with a simple design, and add features as you complete each lesson.

---

### Card Game Tutorial Lessons

---

Lesson 1: Creating a New Model and Configuring the Toolset

Lesson 2: Creating a Use Case and Initial Capsules

Lesson 3: Sequence Diagrams, Protocols, Ports, and Connectors

Lesson 4: Building and Running

Lesson 5: Adding Behavior to the Capsules

Lesson 6: Navigating and Searching

Lesson 7: Using Traces and Watches to Debug the Design

Lesson 8: Class Modeling

Lesson 9: Adding Card Classes to the Capsule Behavior

Lesson 10: Aggregating in a State Diagram

---

Each lesson includes a set of procedures and conceptual information that guides you through the Rose RealTime modeling process.

You can also refer to the sample models included with the tutorial to explore the various elements of Rose RealTime, and to practice what you learn in the lessons. The sample models are located in the root Rose RealTime installation directory:

```
$ROSERT_HOME/Tutorials/cardgame
```

## Adding Detail Code to Operations

In this tutorial, you add source code to implement the behavior of the card classes (for example, to shuffle a deck and calculate the value of a hand). We recommend that you take the time to enter the detail code yourself. If you want to complete the tutorial faster, or only partially enter detail code for a few operations, you can import the completed classes from a sample file.

**Note:** The advantage of adding the code yourself is that you will gain experience working with the tool. Also, you will have an opportunity to practice debugging your model.

## Build Information

As you progress through the tutorial, adding code as you read, you should occasionally build the version of the model that you've been developing. After you complete Lesson 5: Adding Behavior to the Capsules, you can build the model or any capsules you need to test. You can also browse the generated source files at any point. For details on where you can find the generated C++ source files, see *Where is the Source Code Generated?* on page 114.

If you encounter problems building the model because there are too many errors reported at build time, you can continue using the finished models that are shipped with the tutorial.

## Several Ways of Doing the Same Thing

In Rose RealTime, there are several ways of accomplishing the same task. For example, to open the **Specification** dialog box for an element, you can:

- right-click on the element in a diagram or in the browser, and click **Open Specification** from the context menu

Or . . .

- click or double-click on the element in a diagram.

In Rose RealTime, you can edit models from the **Model View** tab in the browser window, from the **menu**, and from a **diagram**. In this tutorial, the detailed task instructions will only show one way of performing a task. Consult the *Rational Rose RealTime Toolset Guide* for other options. You may want to try different methods as you work through this tutorial.

Also, when specifying code, you can open the appropriate dialog box for an element, or you can use the **Code** pane to edit or view the code associated with the currently selected model element.

## Lesson 1: Creating a New Model and Configuring the Toolset

---

In this lesson, you will learn how to create a new empty model, and configure some basic toolset options.

### Suggested Reading

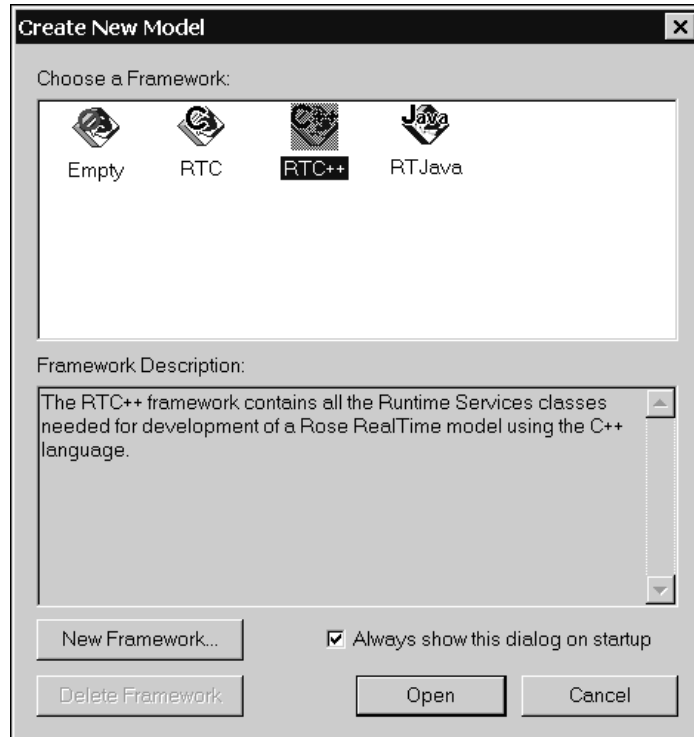
- Opening and Saving Models, (see the *Rational Rose RealTime Toolset Guide*)
- Model Browser, (see the *Rational Rose RealTime Toolset Guide*)

### Opening a New Model

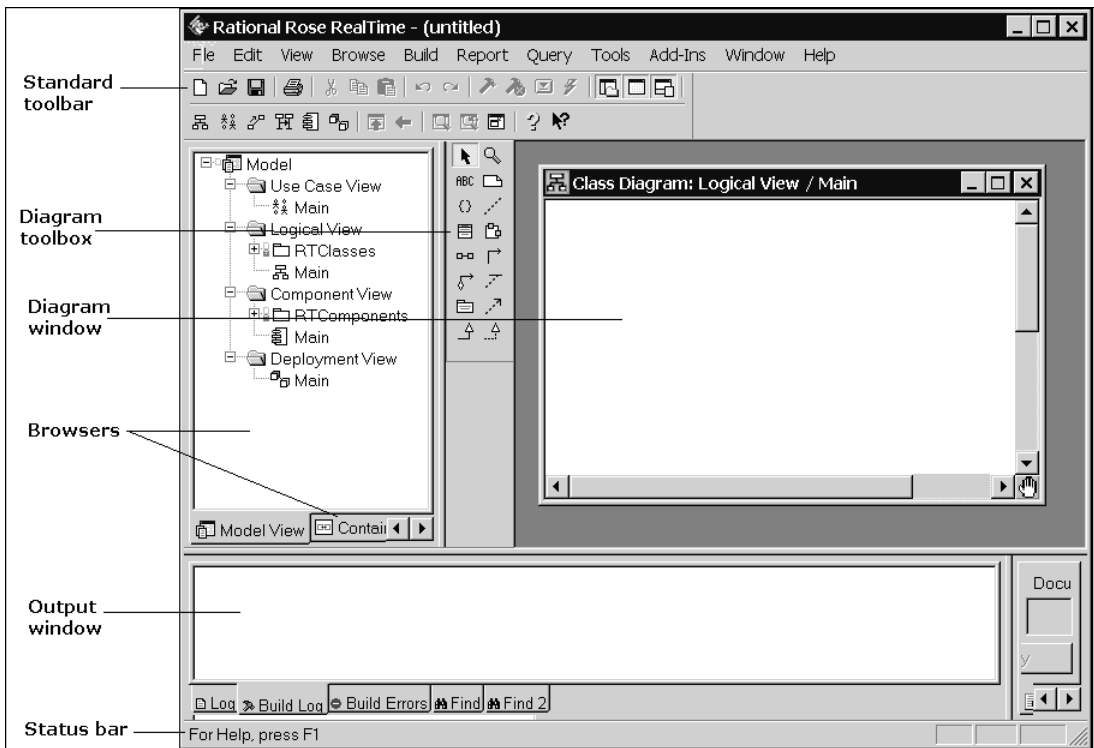
Rose RealTime allows you to work on only one model per Rose RealTime session, therefore if you were working on a previous model, save it before creating the following model for this tutorial.

1 On the **File** menu, click **New**.

If presented with the **Create New Model** dialog box, select **RTC++** and click **Open**.



Rose RealTime initializes a new empty model into the toolset. The title bar shows "Rational Rose RealTime - (untitled)" indicating that this is a new model that has not been saved to disk.



## Configuring Toolset Options

Before you start modeling, there are some user options that you may want to modify.

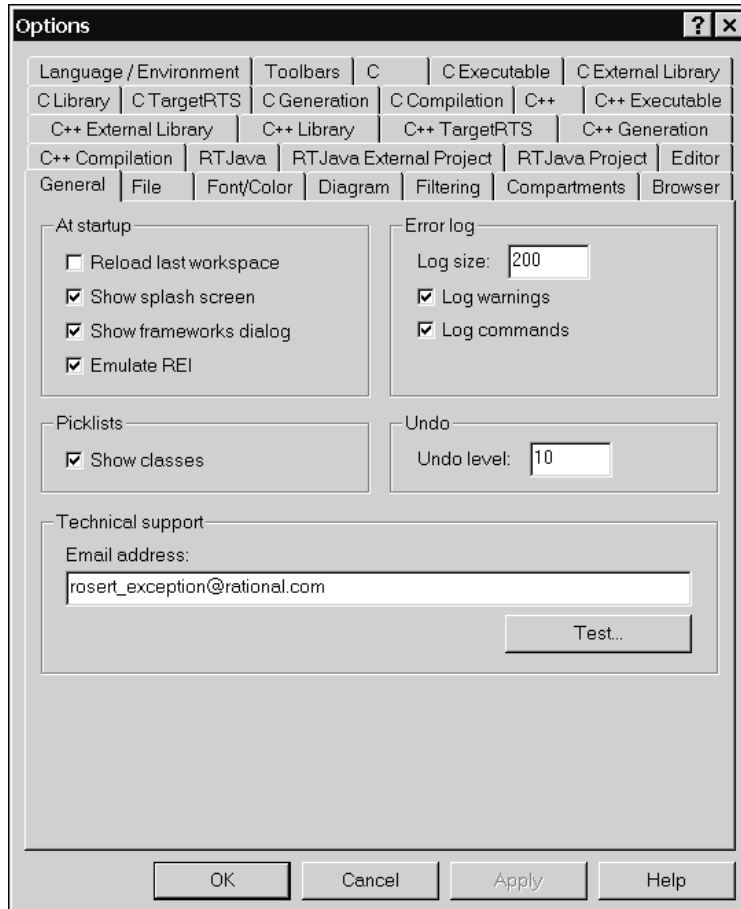
### Suggested Reading

- Options Dialog, (see the Rational Rose RealTime Toolset Guide)

## To access the Options dialog box

- 1 On the **Tools** menu, click **Options**.

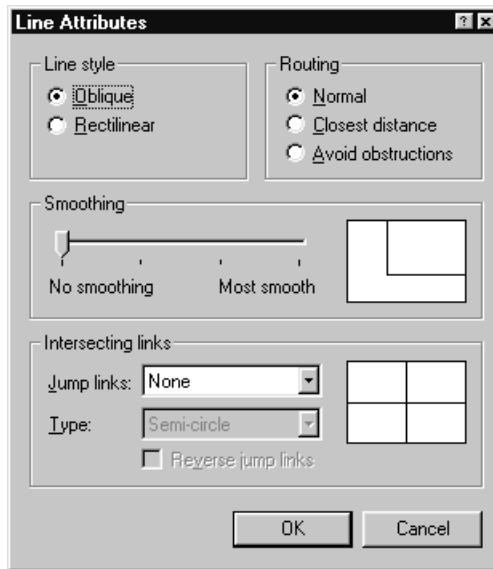
The **Options** dialog box appears.



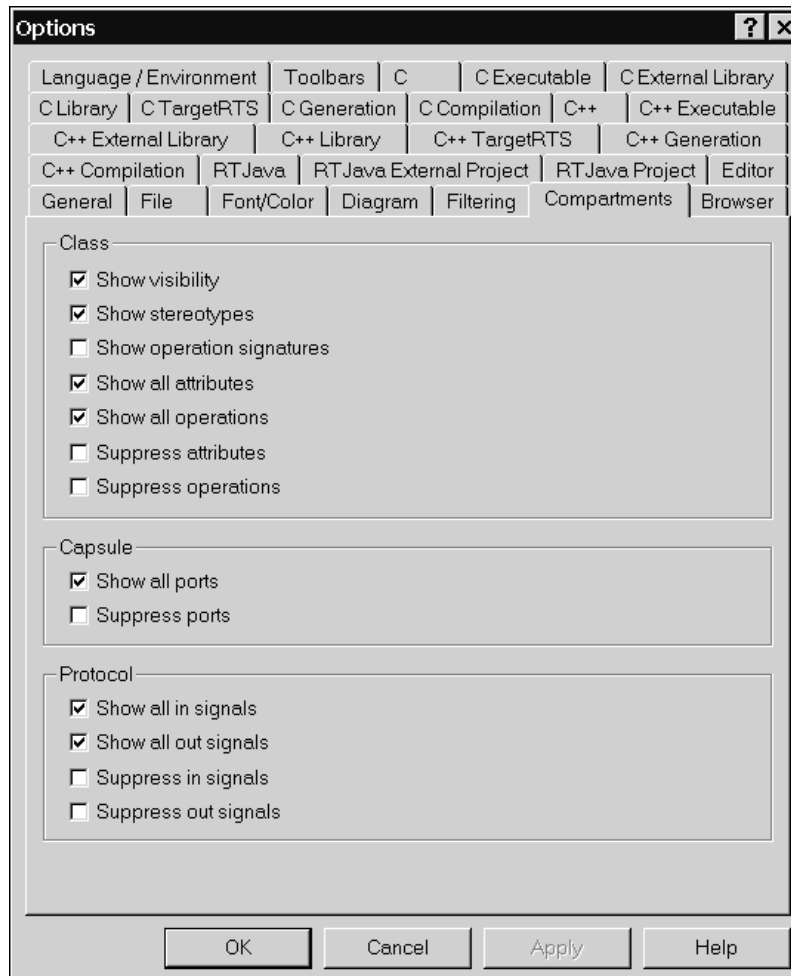
- 2 You may want to consider changing the following attributes to suit your preferences. The options are grouped by the tab on which they can be found:
  - **Font/Color:** You may want a fixed width font, or change the default diagram colors.



- Diagram: Set the default line type (oblique or rectilinear) and grid parameters. This following diagram shows the Line Attributes dialog



- Compartments: For this tutorial, all screen shots were captured using the defaults shown in the following diagram.



For the other options, you can use the defaults.

## Lesson 2: Creating a Use Case and Initial Capsules

---

In this lesson you will add the requirements for the poker simulation and start designing the application. You will:

- Add the textual requirements to a use case diagram
- Create a HeadsUpPoker use case to document the desired functionality of the simulation.
- Create three new capsules: HeadsUpPoker, Dealer, and Player.

You will use the requirements to develop your design. This includes the high-level design, the design elements, and the final implementation.

Modeling is important because it helps the development team visualize, specify, construct, and document the structure and behavior of a system's architecture. Different members of the development team can communicate their decisions unambiguously to one another.

### Suggested Reading

- Use Cases, *Rational Rose RealTime Modeling Language Guide*
- Capsules, *Rational Rose RealTime Modeling Language Guide*
- Toolboxes, *Rational Rose RealTime Toolset Guide*
- Specification dialogs, *Rational Rose RealTime Toolset Guide*

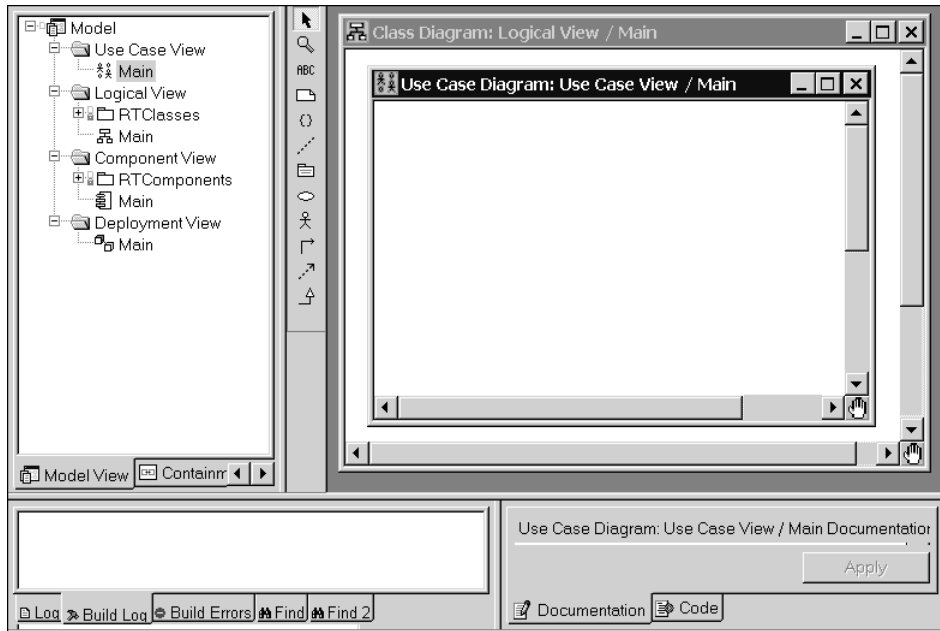
### Adding the Use Case


In this topic you will add the textual requirements and a use case. A use case is a description of a set of sequences of actions, called scenarios, that a system performs to yield an observable result of value to an actor. A use case describes what a system (subsystem, class, or interface) does but does not specify how the system internally performs its tasks. For the purposes of this tutorial, you will create a single use case that describes the main flow for the Heads Up Poker.

## To enter the textual requirements

- 1 Expand the **Use Case View** folder in the model browser and double-click on the element called **Main**.

A window with the title **Use Case Diagram: Use Case View / Main** appears.

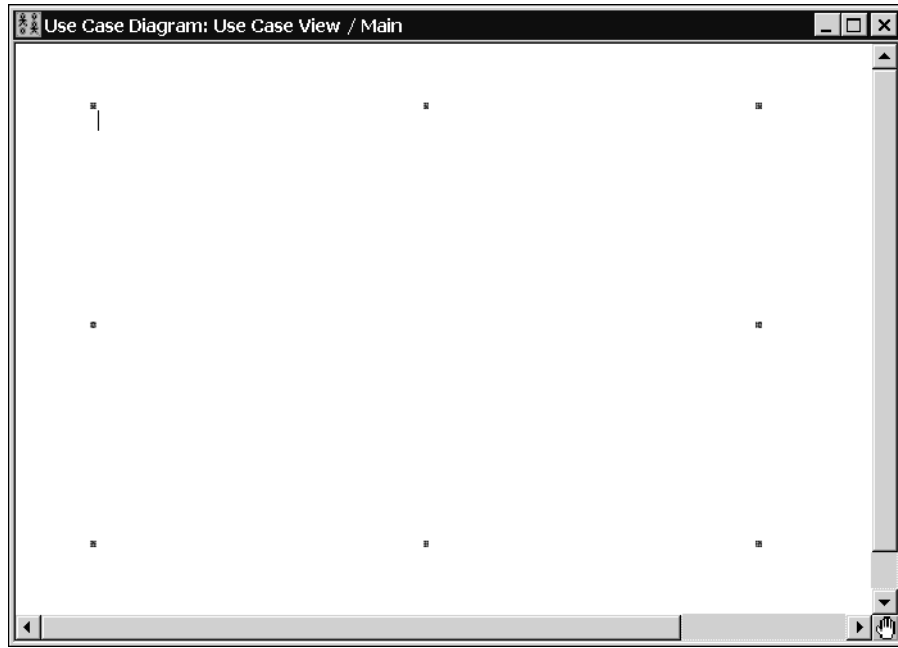


- 2 Ensure that the **Use Case Diagram: Use Case View / Main** window is the active window,
- 3 From the toolbox, select the **Text** tool .

As you move your mouse over the **Use Case Diagram**, your cursor changes to the text tool .

- 4 Left-click in the diagram, and drag (it will show as an outlined rectangle as you drag).

- 5 Release the mouse button after you have a rectangle similar to that in the following diagram (you can resize the rectangle later).



A cursor appears in the top left-hand corner of the text area.

- 6 Type the following text into the text box:

HeadsUpPoker simulation textual requirements.

HeadsUpPoker will be a simulation of a two hand (termed heads-up for a play between only two players), five (5) card stud (in draw poker games you can draw new cards from the deck after the initial cards are dealt; in stud poker games, you're stuck with the cards you get) poker game. There are many variants of poker with many functions having to be implemented in order to simulate all possible poker variations. However, this simulation requires that only the following poker hands be considered:

1 pair, 2 pairs, 3 of a kind, full house, 4 of a kind.


In case of a tie, that is when the dealer and player have the same hand the dealer wins.

The simulation should run continuously.

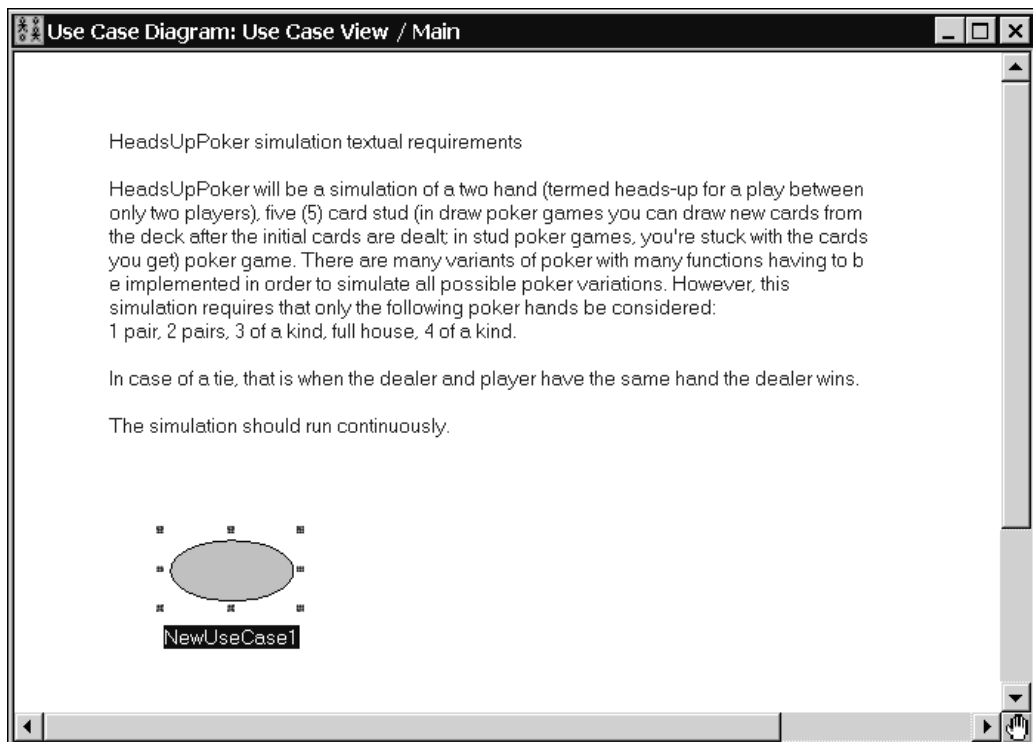
**Note:** Rose RealTime allows you to also link any kind of file to certain model elements. This can be useful in cases where the textual requirements or use cases already exist in other documents. You can attach these files to the model by using the **Files** tab that appears in most Specification dialogs.

### To create the use case

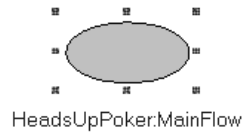
Ensure the **Use Case Diagram** window in which you entered the textual requirements is the active window.

- 1 Select the **Use Case** tool from toolbox .
- 2 Left-click in the diagram.

A use case element appears with a default name.



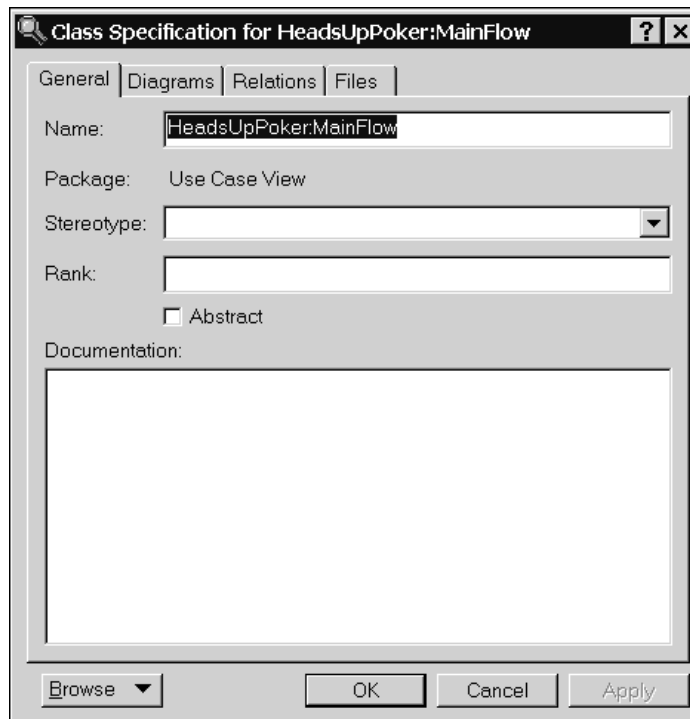
- 3 Rename the use case to **HeadsUpPoker:MainFlow**.



### Add a flow of events to the use case

- 1 Double-click on the **HeadsUpPoker:MainFlow** use case.

The **Class Specification for HeadsUpPoker:MainFlow** dialog box appears.



**2** In the **Documentation** box, type the following scenario description:

Use case starts: when the application is run

1. The Player places an ante of 5 dollars.
2. The Dealer shuffles the 52 card deck cards before each game to reduce the chance of players counting cards.
3. The Dealer deals the two hands (5 cards each) distributing cards alternating between the Player and himself. The first card is dealt to the Player.
4. The Player shows his hand to the Dealer.
5. The Dealer compares his hand to the Players and decides who wins.
6. The Dealer informs the Player if he wins (with the winning bet multiplier) or if he loses.
7. The game restarts.

Use case ends: when the application is stopped.

**3** Click **OK**.

This scenario defines **what** the simulation application must do, but not **how** to do it. Determining how to implement this simulation is independent of the requirements. In fact, there can be an unlimited number of ways to implement an application that satisfies the above requirements.



Your case diagram will look like this:

The screenshot shows a software development environment with two main windows. The top window, titled "Use Case Diagram: Use Case View / Main", displays textual requirements for a "HeadsUpPoker simulation". The requirements describe a two-hand, five-card stud poker simulation with specific hand types (1 pair, 2 pairs, 3 of a kind, full house, 4 of a kind) and rules for ties and continuous simulation. Below the text is a simple Use Case Diagram consisting of an oval labeled "HeadsUpPoker:MainFlow" with eight small square markers around it.

The bottom window is a "Class Specification for HeadsUpPoker:MainFlow" dialog. It has tabs for "General", "Diagrams", "Relations", and "Files". The "General" tab is active, showing the following fields and options:

- Name: HeadsUpPoker:MainFlow
- Package: Use Case View
- Stereotype: (empty dropdown)
- Rank: (empty text field)
- Abstract
- Documentation: A text area containing:
  - Use case starts: when the application is run
  - 1. The Player places an ante of 5 dollars.
  - 2. The Dealer shuffles the 52 card deck cards before each game to reduce the chance of players counting cards.
  - 3. The Dealer deals the two hands (5 cards each) distributing cards alternating between the Player and himself. The first card is dealt to the Player.
  - 4. The Player shows his hand to the Dealer.
  - 5. The Dealer compares his hand to the Players and decides who wins.
  - 6. The Dealer informs the Player if he wins (with the winning bet multiplier) or if he loses.
  - 7. The game restarts.
  - Use case ends: when the application is stopped.

At the bottom of the dialog are "Browse", "OK", "Cancel", and "Apply" buttons.

## Documentation Window

### Suggested Reading:

- Documentation window, (see the *Rational Rose RealTime Toolset Guide*)

In the remainder of this tutorial, you will add documentation to almost every model element you create. It is important to document the responsibilities of all elements and any additional information that would make the model more understandable.

Click on the new use case to view the flow of events in the documentation window.

## Are Elements Owned by the Class Diagram?

When you place elements on a class diagram do they exist only in the context of that diagram? The answer is yes and no. Most elements you add to a class diagram are actually added to the model (that is, they appear in the Browser window when created in a diagram). This means that a single model element can appear in several class diagrams, even on diagrams in other views. Notes and freeform text are owned by a specific diagram.

### Meaning of the Delete key in Class Diagrams

You can delete elements from the model rather than deleting from the diagram. You can delete elements owned by the diagram (such as, states, transitions, call messages, and capsule roles) using the `DELETE` key or the `CTRL+D` shortcut because they exist only in the context of the diagram in which they appear.

To delete items which are not owned by the diagram (such as, any class on a class diagram), use the `CTRL+D` shortcut. This will delete the class from the model as well as the diagram.

To delete elements which are not owned by the diagram (that is, you can see the elements in the **Model View** tab in the browser) only from the diagram and not from the model, use the `DELETE` key.

## Defining the Classes

You will define the classes and capsules that implement the HeadsUpPoker:MainFlow use case.

### Suggested Reading

- Capsules, (see the *Rational Rose RealTime Modeling Language Guide*)
- Classes, (see the *Rational Rose RealTime Modeling Language Guide*)

After the requirements have been defined, you identify a candidate set of classes capable of performing the behavior described in the use case. There are several methods that exist for finding classes from a mere statement of system behavior. It is out of the scope of this tutorial to describe them all. Within Rose RealTime, the basic transformation from the requirements to a description of how the system will work requires you to identify the domain classes from the requirements, and classify them as either classes or capsules.

## **Classes Versus Capsules**

Generally, classes in a Rose RealTime model represent stores of information in the system. They are typically used to represent the key concepts the system manages. Classes store and manage information in the system, whereas capsules provide coordinating behavior in the system. The system can perform some use cases without capsule objects particularly use cases that involve only the simple manipulation of stored information. More complex use cases generally require one or more capsules to coordinate the behavior of other objects in the system. In addition, capsules are units of concurrency with the model.

Flows of events should be encapsulated in a separate capsule when it is complex and consists of dynamic behavior (that is, when it describes the behavior of several other objects interacting in some fashion). For simple flows of events that primarily enter, retrieve and display, or modify information, a class is usually justified instead of a capsule.

Capsules also give you transparent concurrency, easy thread assignment, state diagram generation, and message passing.

## **Describing the Behavior of the Classes**

You identify the main classes and capsules from the requirements. Then, you describe the flow of events between capsules identified in the use case in a capsule structure and sequence diagrams. These two diagrams:

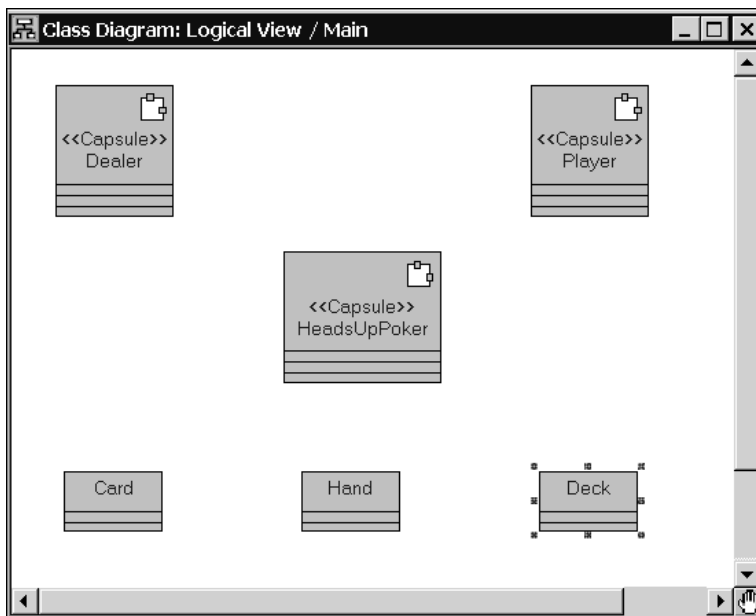
- help you identify the responsibilities of the capsules and how they interact to perform the behavior defined in the use case
- allow you to identify the ports and protocols that will be required to allow the capsules to communicate between each other

## Creating Classes and Capsules

For the **HeadsUpForker:MainFlow** use case, you will create the following classes and capsules:

- **HeadsUpPoker** (capsule) - encapsulates the flow of events described in the HeadsUpForker:MainFlow use case
- **Dealer** (capsule) - deals the cards and determines who wins
- **Player** (capsule) - initiates the simulation by placing an ante
- **Card** (class) - an individual card
- **Hand** (class) - set of 5 cards given to each participant
- **Deck** (class) - set of 52 cards from which cards are distributed to the game players

When finished adding these capsules and classes, your **Class Diagram: Logical View / Main** diagram will look like this:

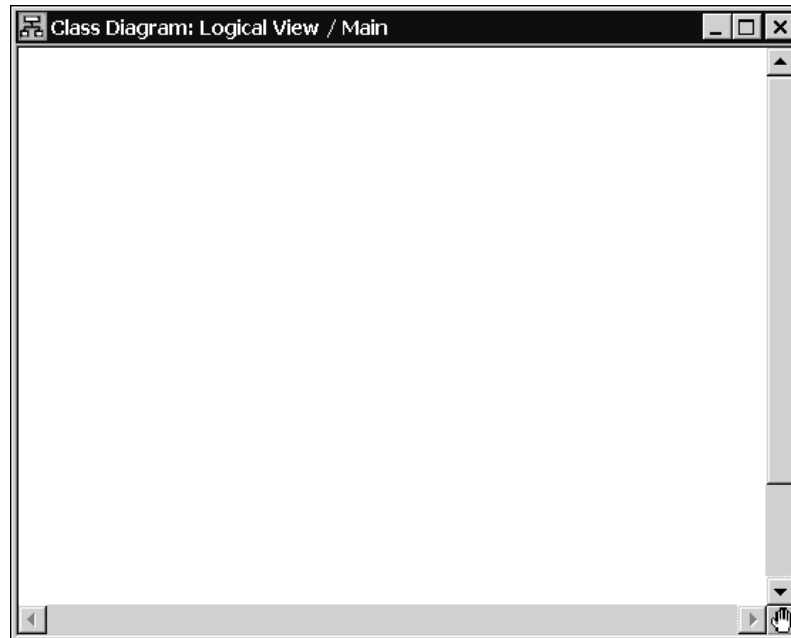



### To create capsules and classes

- 1 If the **Logical View** folder in the **Model View** tab in the browser is not expanded, click on the plus sign [+] to expand it, and double-click on the **Main** class diagram.

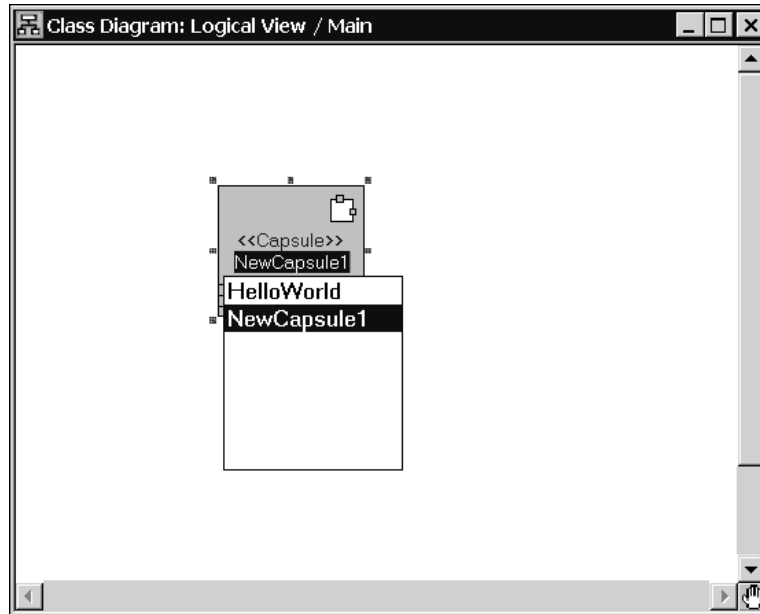
Or . . .

From the toolbar, select the **Browse Class Diagram** button , then from the **Logical View** package, select **Class Diagram: Logical View / Main** and click **OK**.



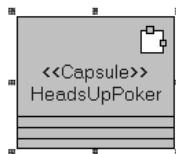
- 2 From the **Main** class diagram toolbox, click the **Capsule** tool .
- 3 Move the mouse over the diagram, and left-click in the window.

A new capsule appears in the diagram.



- 4 Rename the capsule **HeadsUpPoker**.

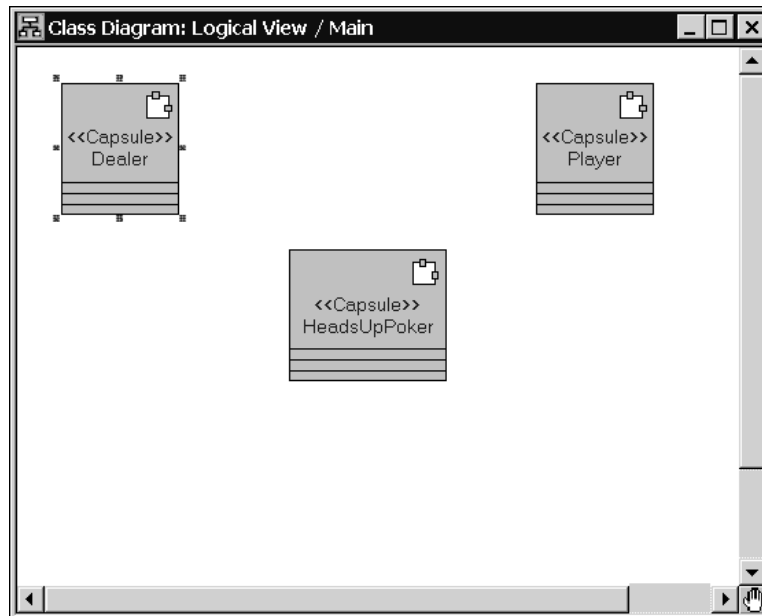
After you type the name, you may have to left-click in the diagram to exit edit mode, and to save the new name.




- 5 Repeat the above steps to add the **Player** and **Dealer** capsules.

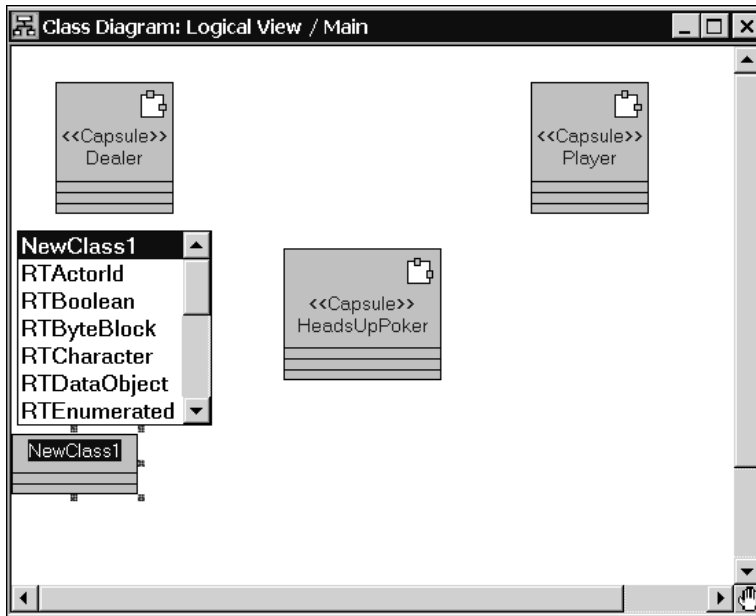
**Note:** You can change any model element's property (including the name) with the **Specification** dialog box.

When finished adding all three capsules, your **Class Diagram** will look like the following:



- 6 To add the classes, select the **Class** tool  from the **Main** class diagram toolbox.
- 7 Move the mouse over the diagram, and left-click in the window.

A new class appears in the diagram.



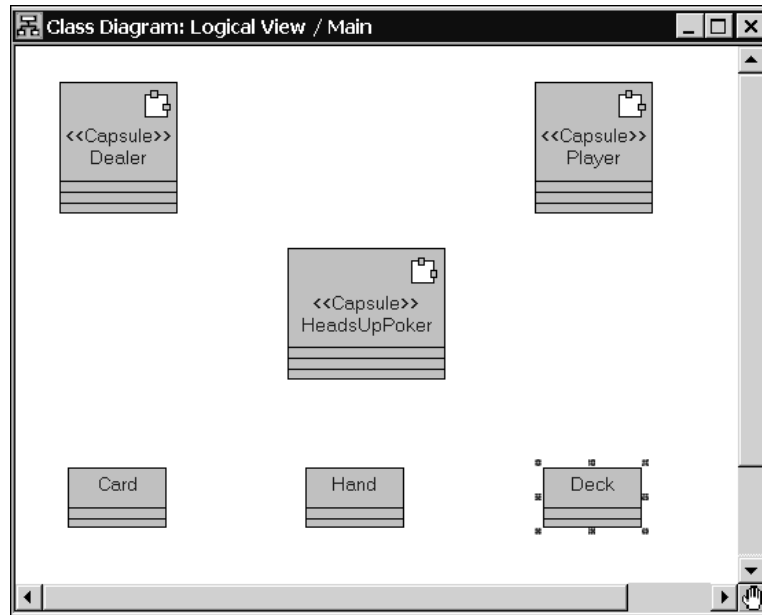
- 8 Rename the class to **Card**.

After you type the name, you may have to left-click in the diagram to exit edit mode, and save the new name.

- 9 Repeat the above steps to add the **Deck** and **Hand** classes.



When finished, your class diagram will look like this:



## RTClasses Package

The RTClasses package exists in each model and contains a set of predefined classes and protocols implemented by the Services Library. Most models require the use of one or many of these predefined classes. For example, the package contains a Timing protocol used to communicate with the timing service.

## Changing Element Types

You can change the element type within a model. For example, you initially designed something as capsule and realize that it should be a class. You can change the element to another type using the menu command **Edit > Change Into**. The menu item is context-sensitive and displays only the valid elements to which you can change the currently selected item.

**Note:** When transforming elements, information not part of the destination element is lost during the transformation. For example, when transforming a capsule to a class, the capsule roles and state diagram are not part of the converted class element.

## Creating HeadsUpPoker Capsule Structure

In this topic you create a capsule structure diagram of capsules which implement the behavior described in the use case. Then, you create a sequence diagram to show how they will interact to implement the behavior described in the flow of events.

Since the **HeadsUpPoker** capsule encapsulates the flow of events described in the use case that you are implementing, it also encapsulates all the classes and capsules necessary to implement the use case.

### Suggested Reading

- Capsules, *Rational Rose RealTime Modeling Language Guide*
- Capsule structure diagrams, *Rational Rose RealTime Modeling Language Guide*
- Sequence Diagrams, *Rational Rose RealTime Modeling Language Guide*
- Interactions, *Rational Rose RealTime Modeling Language Guide*

## Creating the HeadsUpPoker Capsule Structure

There are two main ways that you can aggregate capsules with one another:

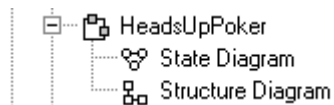
- Use the **Aggregation** tool in the class diagram
- Drag the capsule onto the structure diagram of another capsule

Since both methods are equivalent, you will use one method only. When a capsule is added to the structure of another, you are creating an attribute of the capsule called a capsule role. The capsule role has a name that describes the capsule's role in relation to the containing capsule.

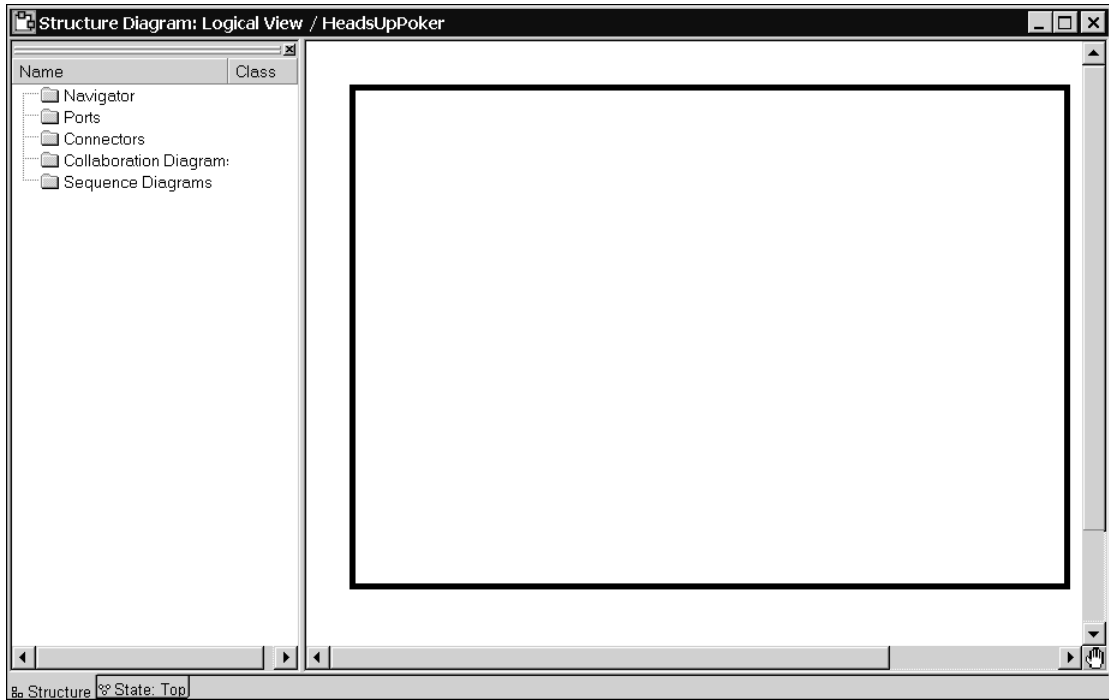
### To create the HeadsUpPoker capsule structure

- 1 From the **Model View** tab in the browser, click the plus sign [+] beside the icon to expand the **HeadsUpPoker** capsule.

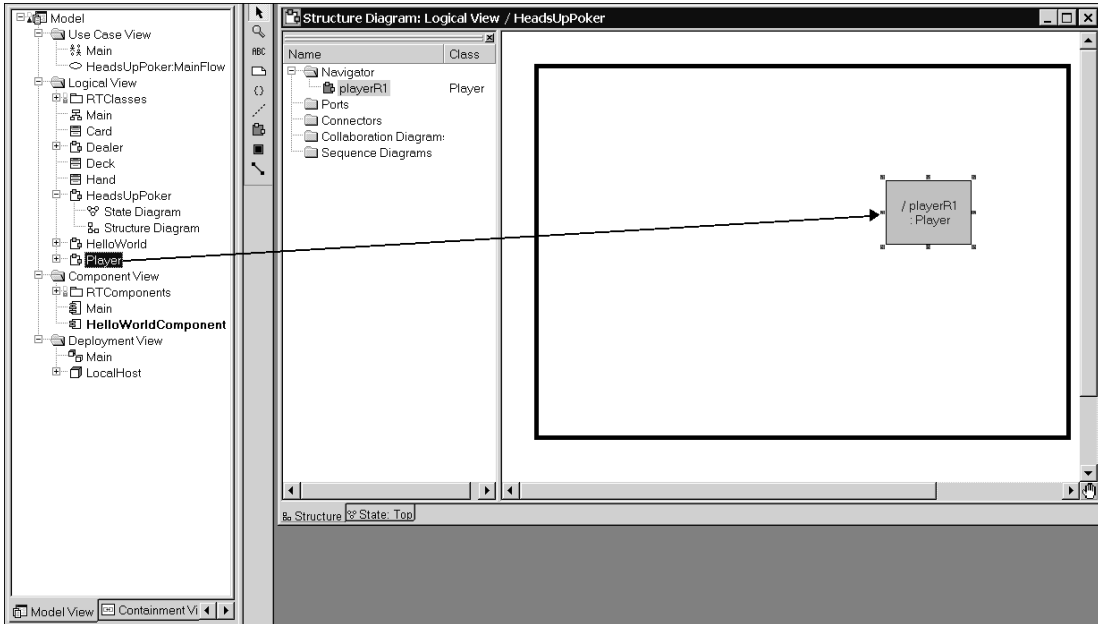
Two items appear: one representing the state diagram, and the other the structure diagram:



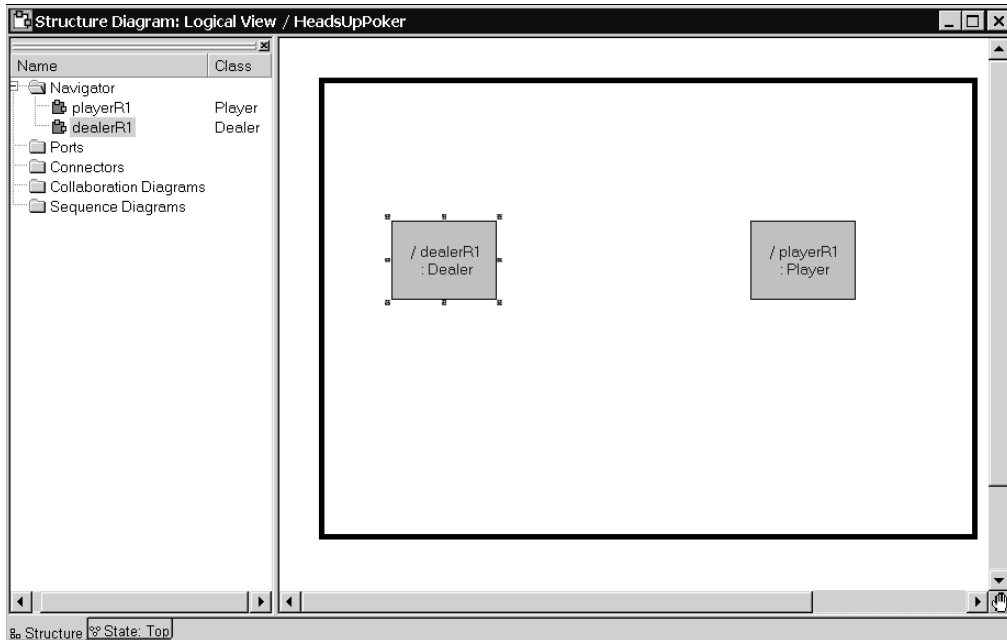
- 2 Double-click on the **Structure Diagram** icon to open the diagram window.



- 3 Drag the **Player** capsule from the **Model View** tab in the browser into the **HeadsUpPoker** structure diagram.

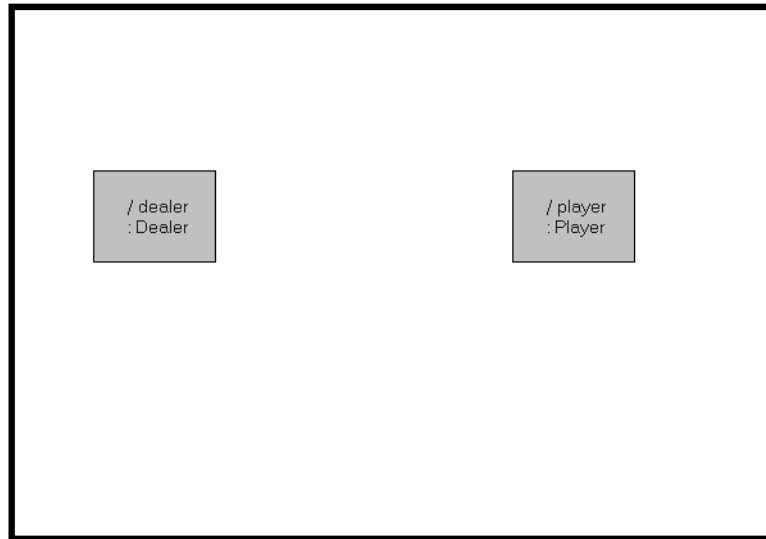


4 Repeat the above step for the **Dealer** capsule.



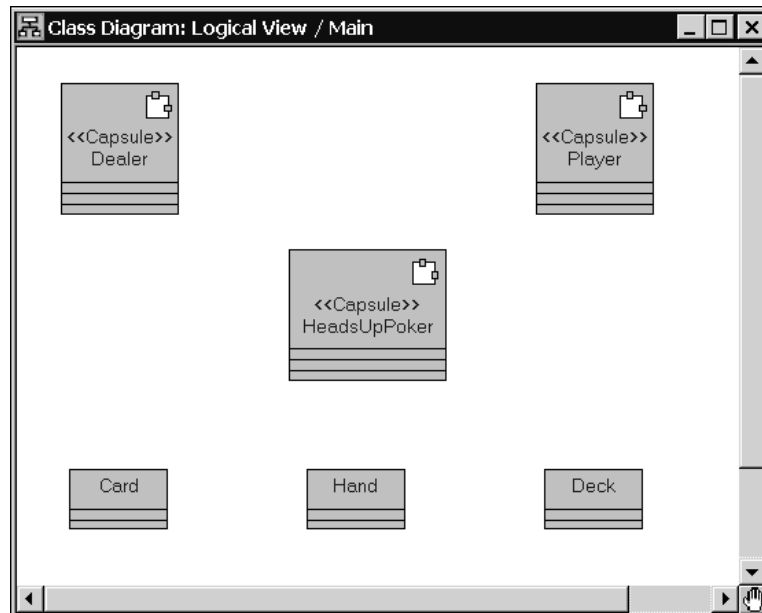
5 Double-click the **/playerR1** capsule role and rename it **player**.

- 6 Double-click the **/dealerR1** capsule role and rename it **dealer**.

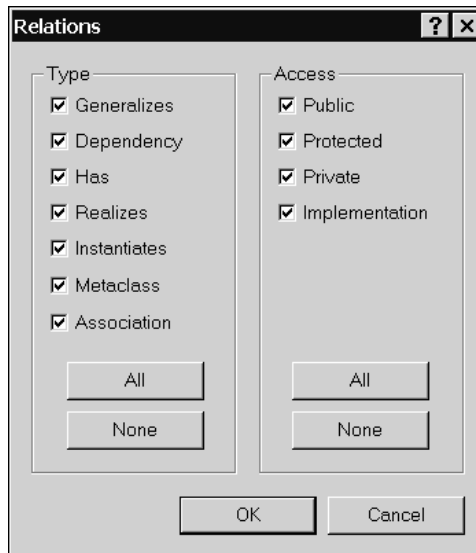


- 7 In the **Logical View** folder, double-click to open the **Class Diagram: Logical View / Main** dialog.

You should see the three capsules and three classes that you have previously created.



- 8 From the **Query** menu click **Filter Relationships**.

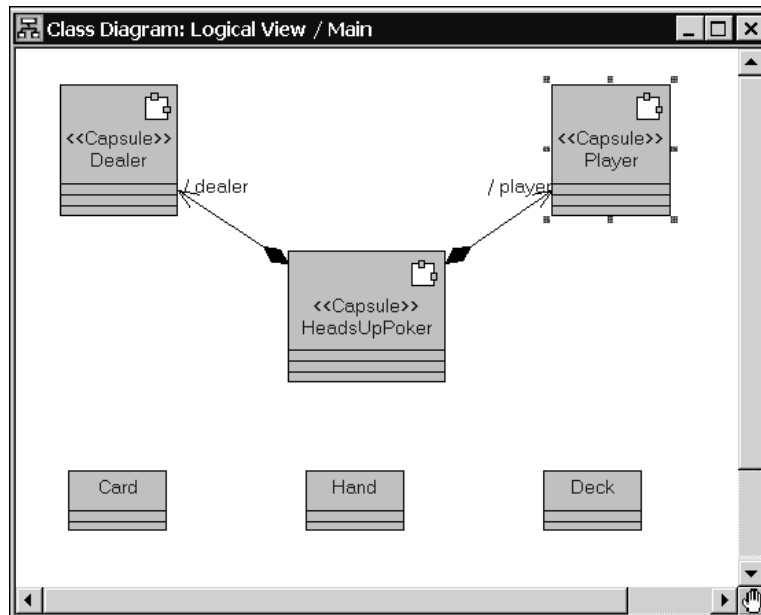


The Relations dialog allows you to control which relationships appear in diagrams. You can also use it to refresh the current diagram.

- 9 Ensure that all checkboxes in the **Type** and **Access** groups are selected.
- 10 Click **OK**.

In the **Class Diagram: Logical View / Main** diagram, you will see aggregation relationships between the **HeadsUpPoker** capsule and the **Dealer** and **Player** capsules. The capsule role names appear at the part-of end of the aggregation relationship.

If necessary, re-arrange the class diagram so that you can properly see the relationships between the capsules.



Both representations are essentially the same, with one exception. As you will see later from the **Structure Diagram**, you can interconnect capsule roles, something that is not possible in the class diagram.

Before proceeding with Lesson 3, we recommend that you save your work.

## Lesson 3: Sequence Diagrams, Protocols, Ports, and Connectors

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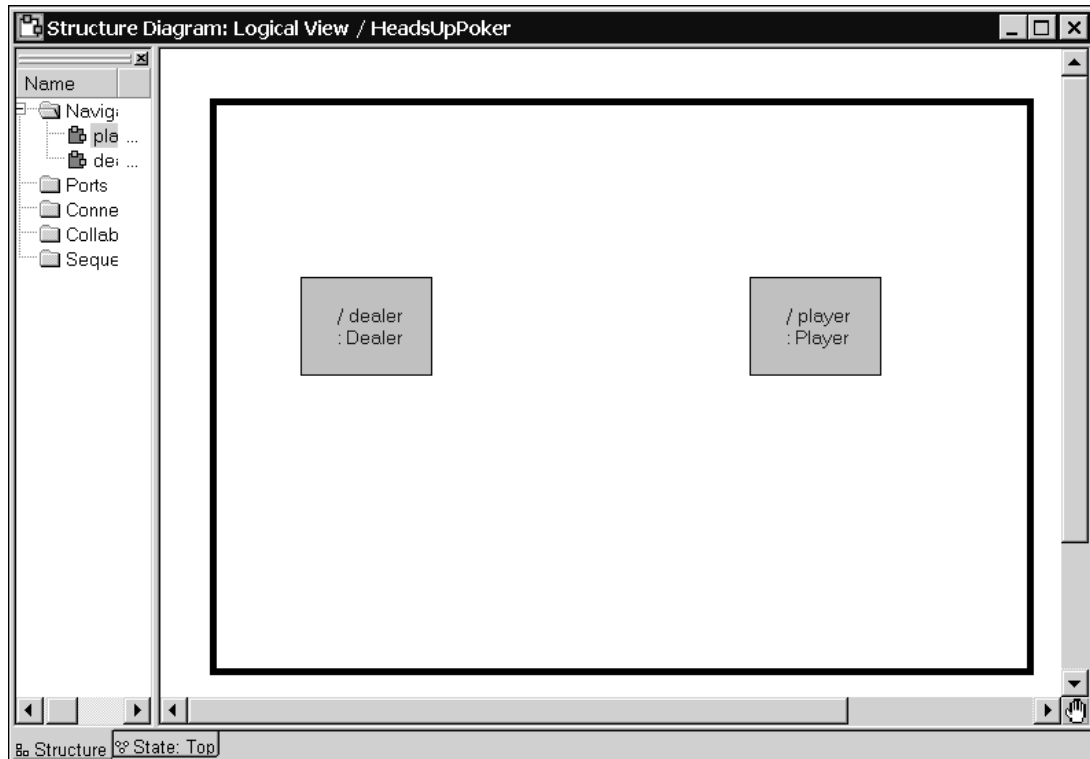
In the following lesson, you create a sequence diagram on the **HeadsUpPoker** capsule to show how its contained capsule roles interact to implement the behavior described in the **HeadsUpPoker:MainFlow** use case. This sequence diagram should highlight the important design decisions. You can also add scripts to a sequence diagram to expand and explain the interaction.

## To create the sequence diagram

- 1 In the **Model View** tab in the browser, expand **Logical View**, expand the **HeadsUpPoker** capsule, then double-click **Structure Diagram**.

Or . . .

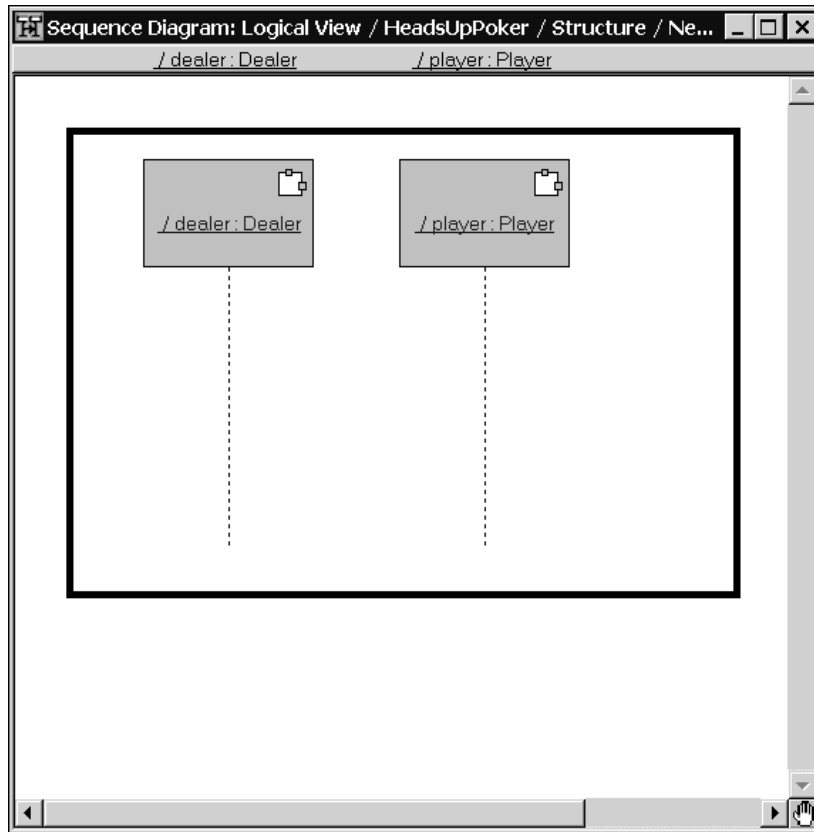
From the toolbar, select the **Browse Collaboration Diagram** button , then select **Structure Diagram: Logical View / HeadsUpPoker** from the **Logical View** package.



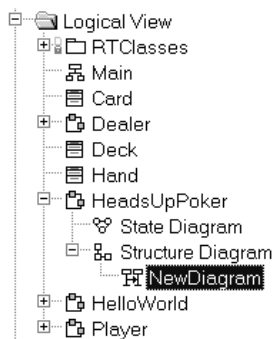
- 2 Using the **SHIFT** key, select both the outer boxes for the player and dealer capsule roles.
- 3 Right-click on an empty area within the border of the **Structure Diagram** (do not right-click on capsule roles or the back border), and click **Create Sequence Diagram**.



A new sequence diagram appears with both capsule roles already in the sequence.



The diagram appears in the **Model View** tab in the browser under the **Structure Diagram** for the **HeadsUpPoker** capsule.

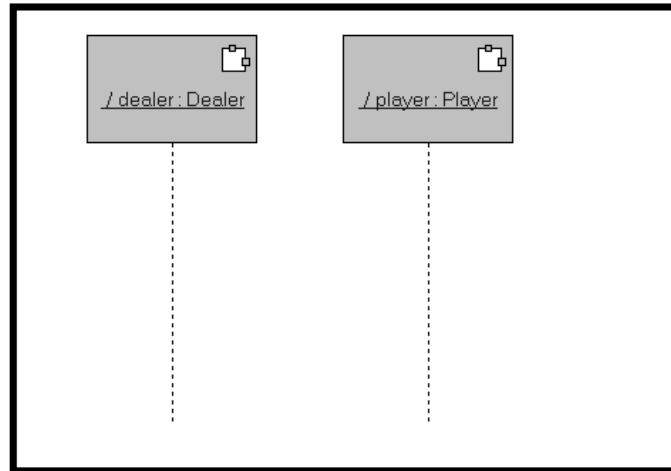



- 4 Rename **NewDiagram** to **HeadsUpPoker:MainFlow**.

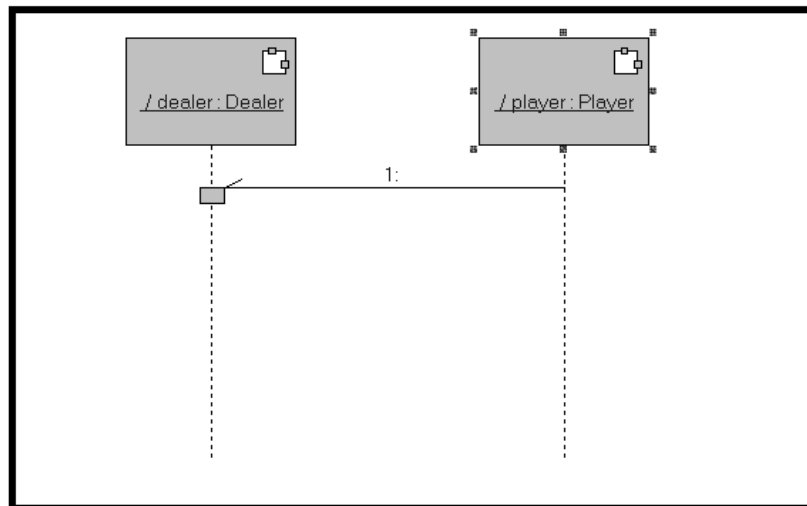
## To create the interactions in the sequence diagram

You will describe the interactions between these two capsules by referring to the flow of events described in the **HeadsUpPoker:MainFlow** use case.

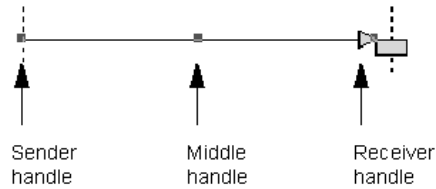
- 1 Ensure that the sequence diagram window for **HeadsUpPoker:MainFlow** is active.



- 2 Select the **Asynchronous Send Message**  tool from the toolbox.
- 3 Left-click on the player lifeline (dotted line beneath capsule role box), and drag the mouse to the dealer's lifeline.



The vertical placement of messages represents time. The direction of the messages represents the flow.



- 4 Double-click on the message line (not the label for the line) to open the **Send Message Specification** dialog box.

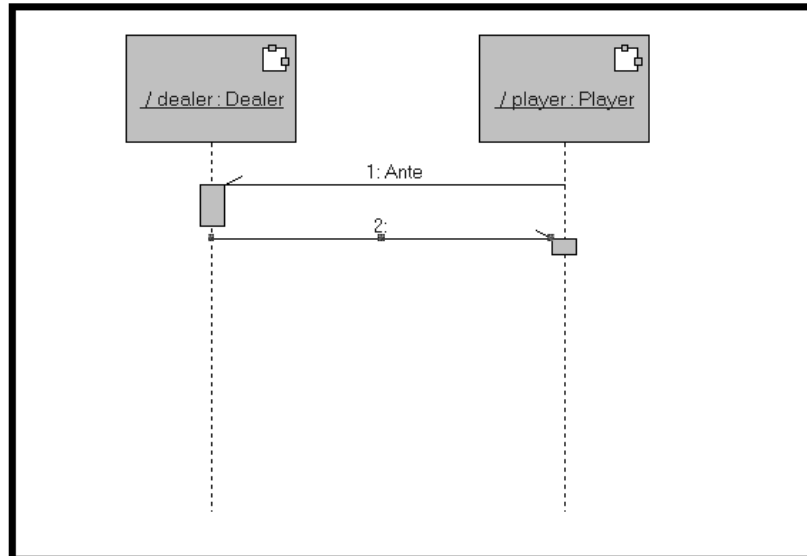


- 5 On the **General** tab, type **Ante** in the **Name** box.
- 6 Click **OK**.

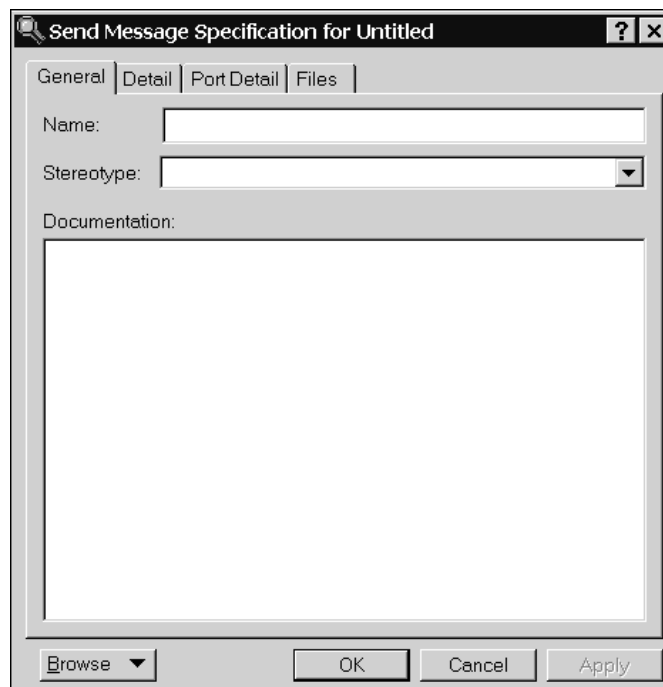
Next, you will add five messages; one message for each of the five cards that make up a hand.

- 7 Select the **Asynchronous Send Message**  tool from the toolbox.

- 8 Left-click on the dealer lifeline (dotted line beneath capsule role box), and drag the mouse to the player's lifeline.




- 9 Double-click on the message line (not the label for the line) to open the **Send Message Specification** dialog box.

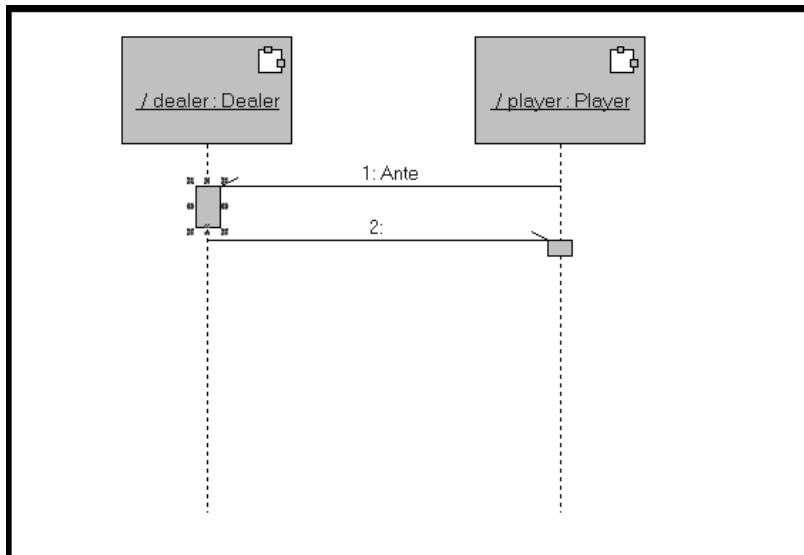


10 On the **General** tab, type **ACard** in the **Name** box.

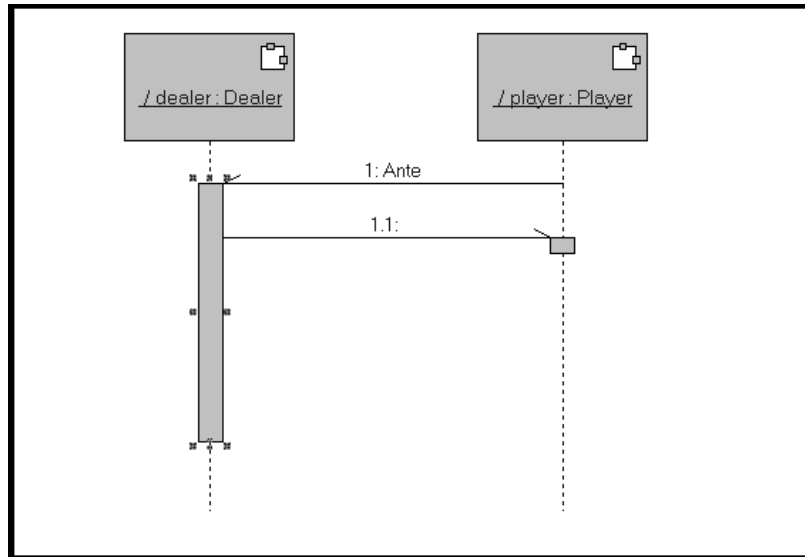
11 Click **OK**.

The Focus of Control (FOC) shows the period of time during which an object is performing an action, either directly or through an underlying procedure. The FOC is portrayed through narrow rectangles  that adorn lifelines (the dashed vertical lines descending from each object). The length of an FOC indicates the amount of time it takes for a message to be performed. When you move a message vertically, each dependent message moves vertically as well. To enlarge the FOC, select the FOC, click on a pic handle surrounding the rectangle, then drag the mouse until you change the rectangle to the desired size.

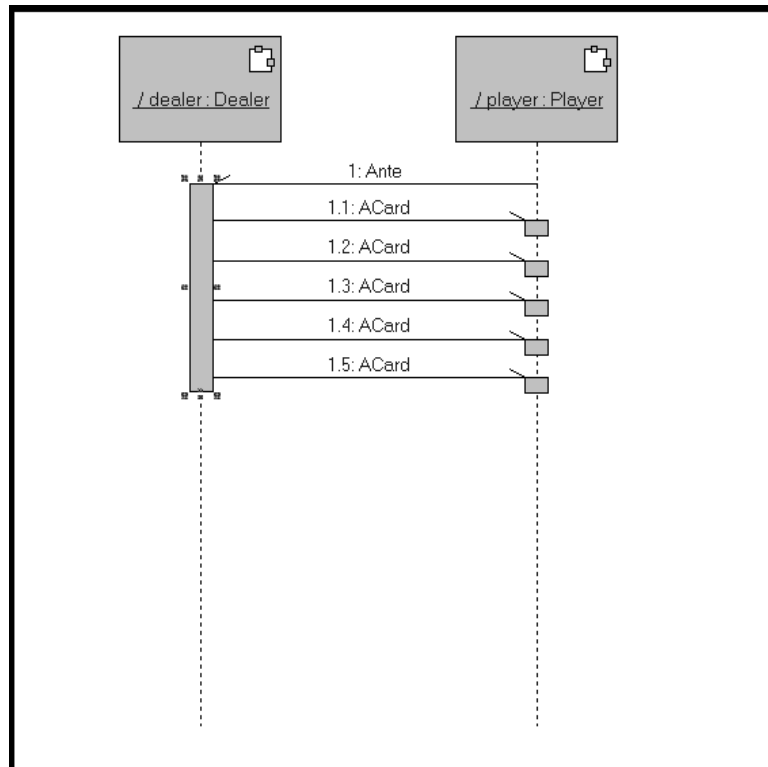
For example, you can select the FOC as in the following diagram:



Then enlarge it as in the following diagram:



12 Repeat steps 7 through 11 to add 4 additional **ACard** messages.



Next, you will create two additional messages; a message to inform the dealer role of the value of the player's hand (HandValue) and another message from the dealer role that informs the player as to whether or not they won the hand (Win).

**13** Select the **Asynchronous Send Message**  tool from the toolbox.

**14** Left-click on the player lifeline (dotted line beneath capsule role box), and drag the mouse to the dealer's lifeline.

**Note:** Resize the FOC from the last ACard message to include the sender handle for HandValue message.

**15** Double-click on the message line (not the label for the line) to open the **Send Message Specification** dialog box.

**16** On the **General** tab, type **HandValue** in the **Name** box.

**17** Click **OK**.

**18** Select the **Asynchronous Send Message**  tool from the toolbox.

**19** Left-click on the dealer lifeline (dotted line beneath capsule role box), and drag the mouse to the player's lifeline.

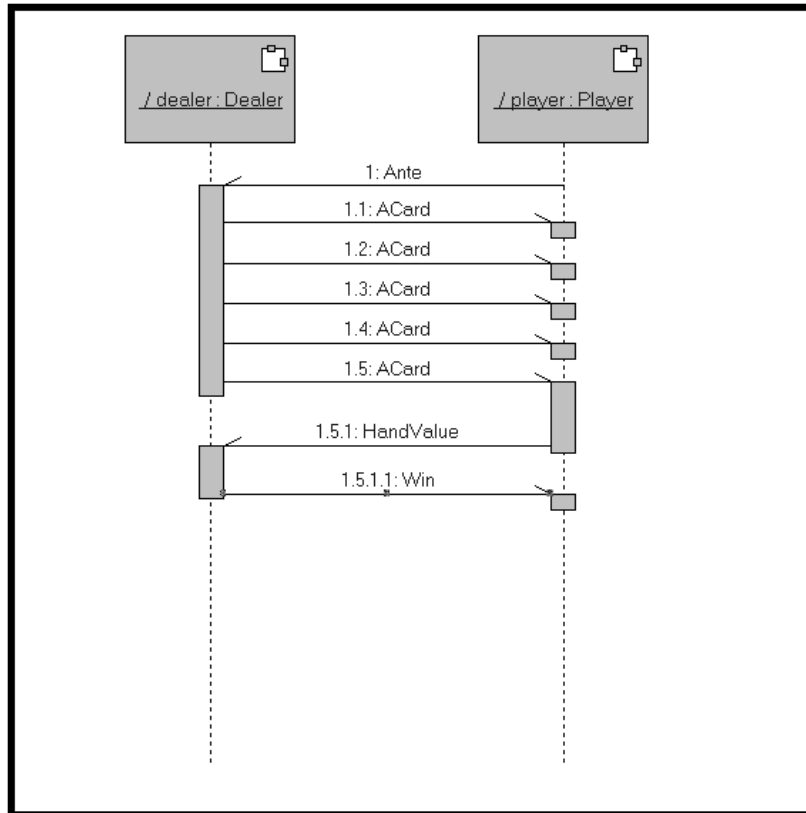
**Note:** Resize the FOC from the HandValue message to include the sender handle for Win message.

**20** Double-click on the message line (not the label for the line) to open the **Send Message Specification** dialog box.

**21** On the **General** tab, type **Win** in the **Name** box.

**22** Click **OK**.

Your **Sequence Diagram** should look like the following:



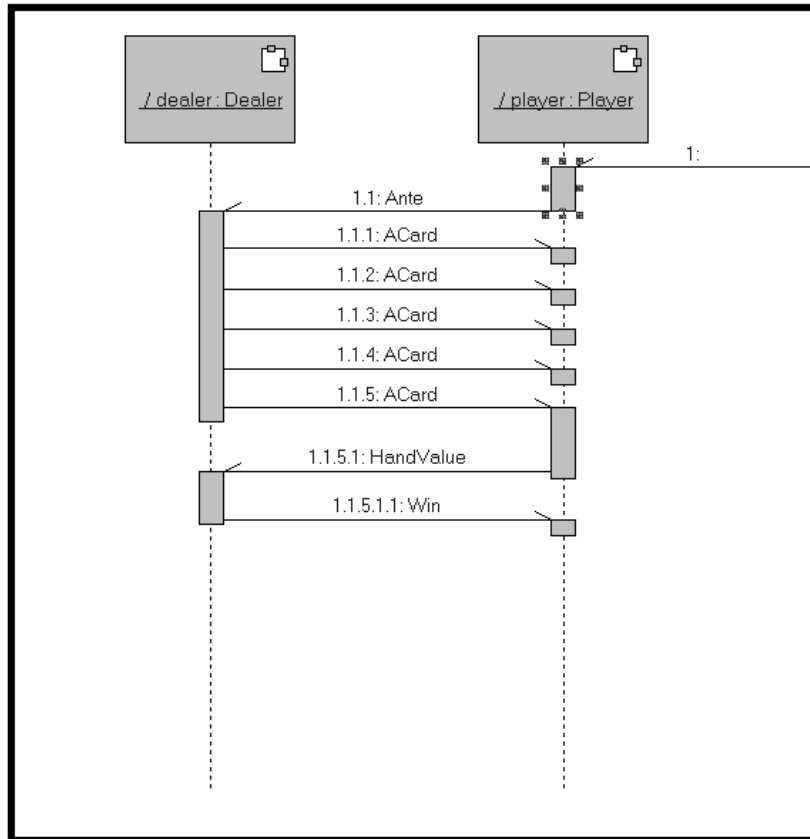
**Note:** After adding the message exchanged between the Player and Dealer you will realize that the scenario must be started somehow, either when the simulation is started (when the player capsule is instantiated) or after some other specified event occurs. For this tutorial, you will use a timer to start the simulation, this will make it possible to adjust the delay between each game and make it easier to observe the running model.

**23** Select the **Asynchronous Send Message**  tool from the toolbox.



- 24 Left-click on the black border of the sequence diagram to the left of the player role, and drag the mouse to the player lifeline (dotted line beneath capsule role box).

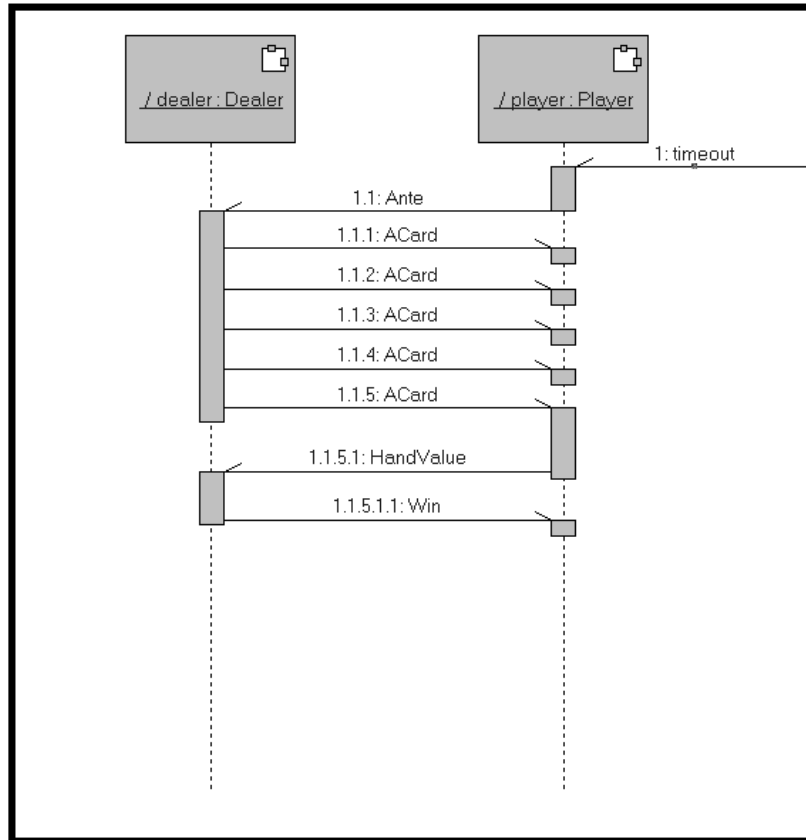
**Note:** Resize the FOC on the player lifeline to include the Ante message as in the following diagram.



**Note:** By adding this new message, the number labelling for the messages changed to one level deeper. For example, the message label 1:Ante changed to 1.1:Ante, and 1.5.1:HandValue changed to 1.1.5.1:HandValue.


- 25 Double-click on the message line (not the label for the line) to open the **Send Message Specification** dialog box.
- 26 On the **General** tab, type **timeout** in the **Name** box.
- 27 Click **OK**.

Your **Sequence Diagram** will look like the following.



Now, you may want to include some supporting text.

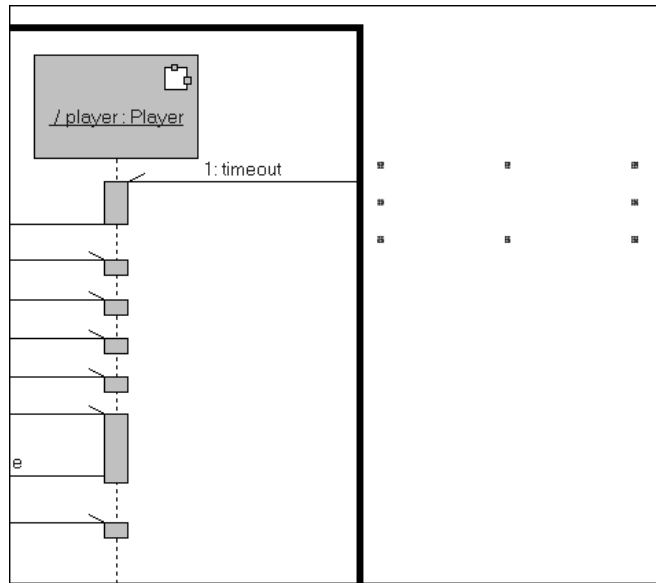
**28** Ensure that the **Sequence Diagram: Logical View / HeadsUpPoker** window is the active window.

**29** From the toolbox, select the **Text** tool .

As you move your mouse over the **Use Case Diagram**, your cursor changes to the text tool .

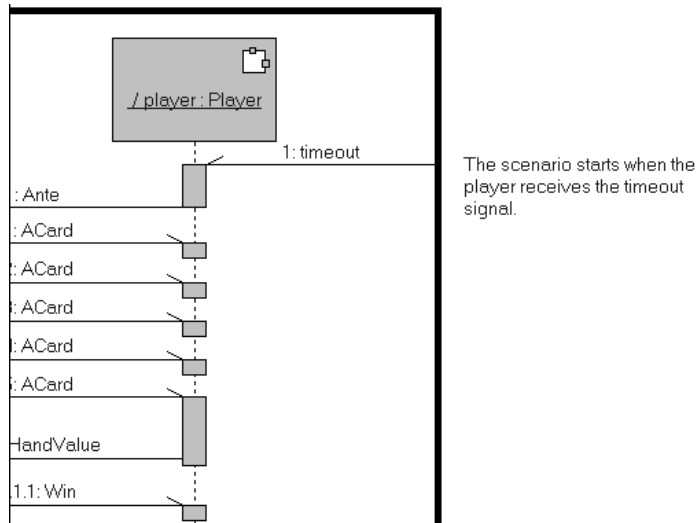
**30** Left-click in the diagram, and drag (it will show as an outlined rectangle as you drag).

- 31 Release the mouse button after you have a rectangle similar to that in the following diagram (you can resize the rectangle later).

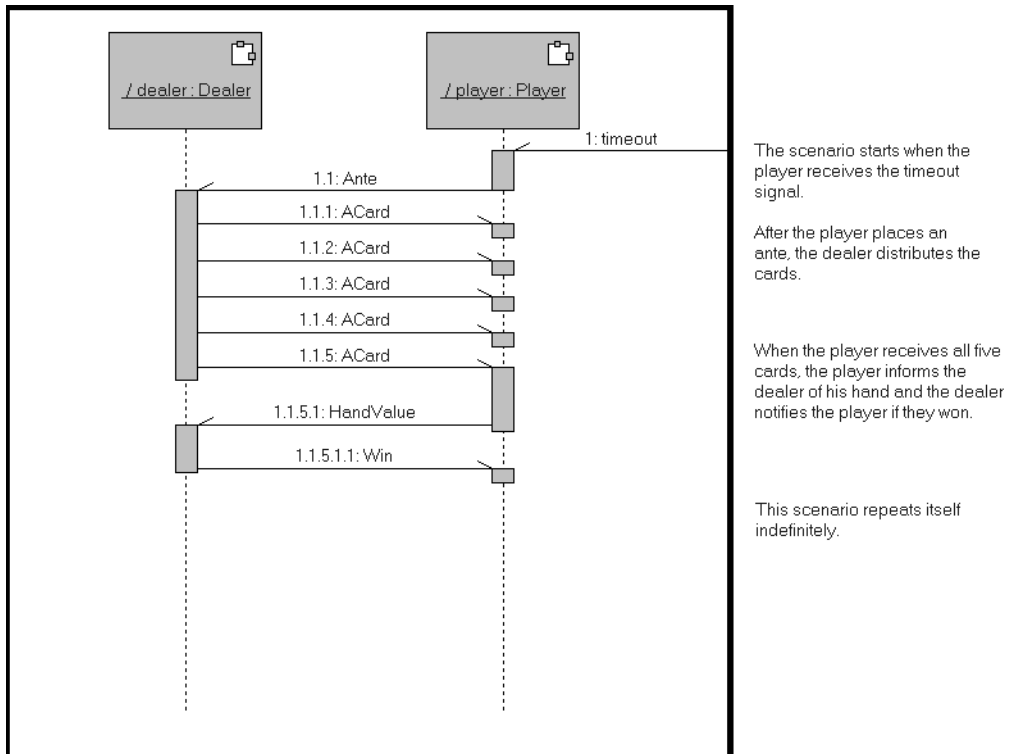


- 32 Type the following text:

The scenario starts when the player receives the timeout signal.



- 33 Create 3 more text boxes and include the text that appears in the following diagram.



## Creating the Protocol

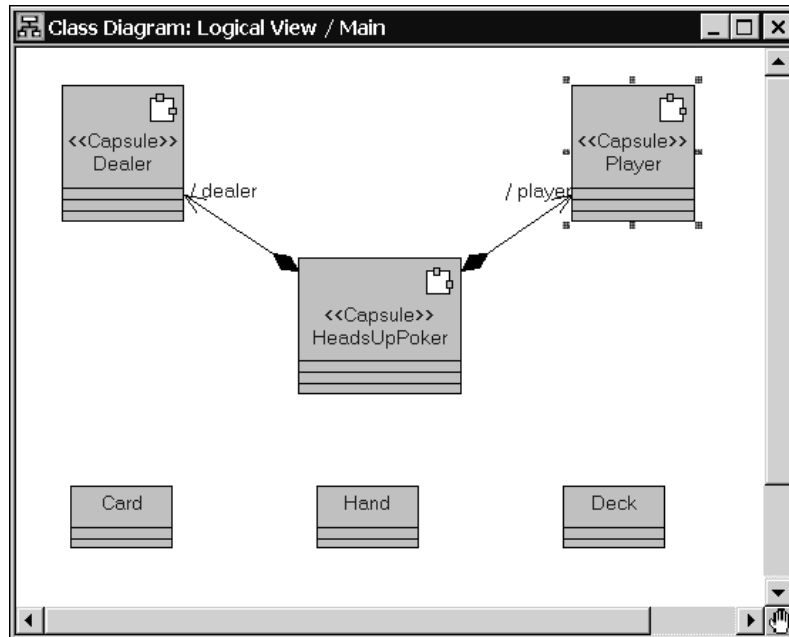
Now that you defined the classes and capsules in your design and specified the interactions, you can define the set of messages to exchange between the Dealer and Player capsules, and create ports through which they can communicate to each other.

### Suggested Reading:

- Ports, *Rational Rose RealTime Modeling Language Guide*
- Protocols, *Rational Rose RealTime Modeling Language Guide*

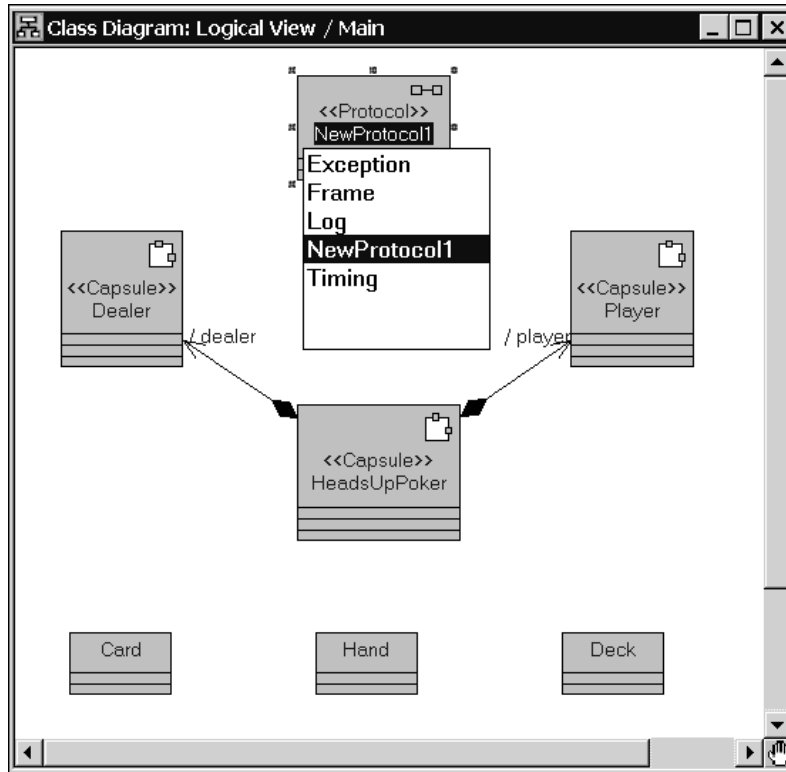
## To create the communication protocol

- 1 Open the **Main** class diagram.



- 2 Select the **Protocol** tool from the toolbox .

- 3 Create the protocol in the diagram in the same way that you created classes and capsules.



**Note:** The protocol was added to the **Logical View** folder in the **Model View** tab in the browser.

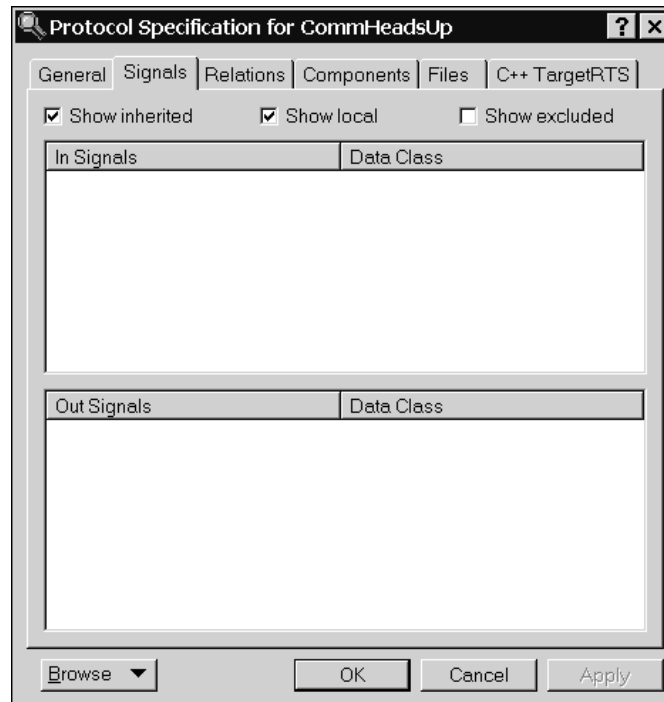
- 4 Type **CommHeadsUp** and press **ENTER**.

#### To create the set of signals for this protocol

- 1 Right-click on the protocol in the diagram, and click **Open Specification**.

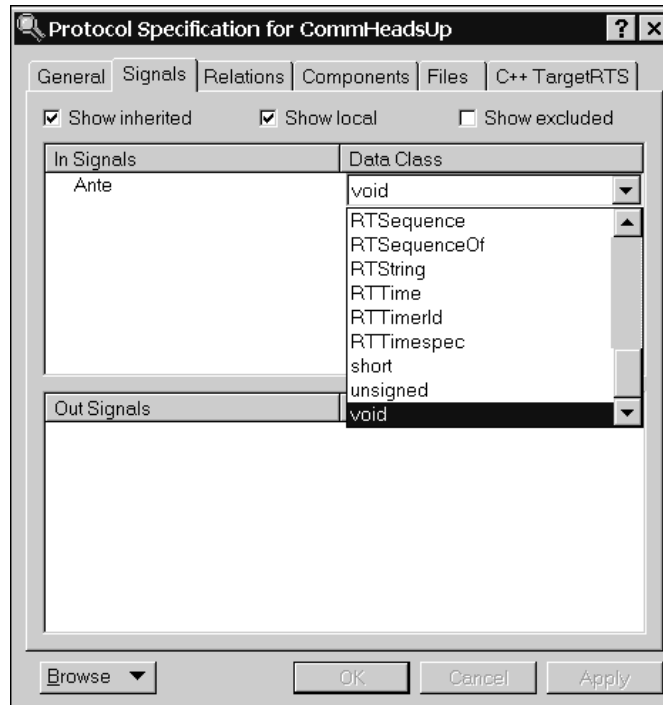
The **Protocol Specification for CommHeadsUp** dialog box appears.

- 2 Click the **Signals** tab.



- 3 Right-click in the **In Signals** pane, and click **Insert**.
- 4 Rename the signal **Ante**.
- 5 Click in the **Data Class** column opposite the **Ante** signal, and press F8.

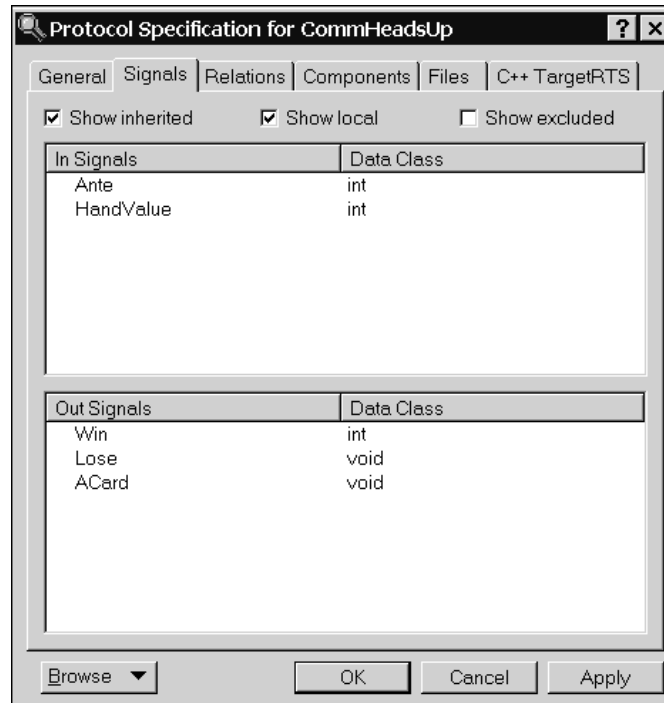
A drop down list appears with a list of all the basic types and classes in the model.



- 6 Select **int** from the list.

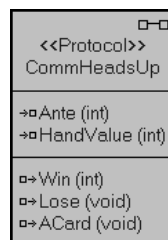


- 7 Repeat the steps above to add the following **In Signals** and **Out Signals** to the protocol:



- 8 Click **OK**.

The protocol on the **Class Diagram: Logical View / Main** changes to include these new **In** and **Out signals**.



**Note:** Later, you will add more details to this protocol as the model evolves. For example, you have not yet specified which data class to send with the **ACard** signal.

## Creating Ports and Connectors

You will create the `player_comm` and `dealer_comm` ports based on the `CommHeadsUp` protocol. You can connect the player and dealer capsule roles to allow them to communicate the signals defined in the protocol.

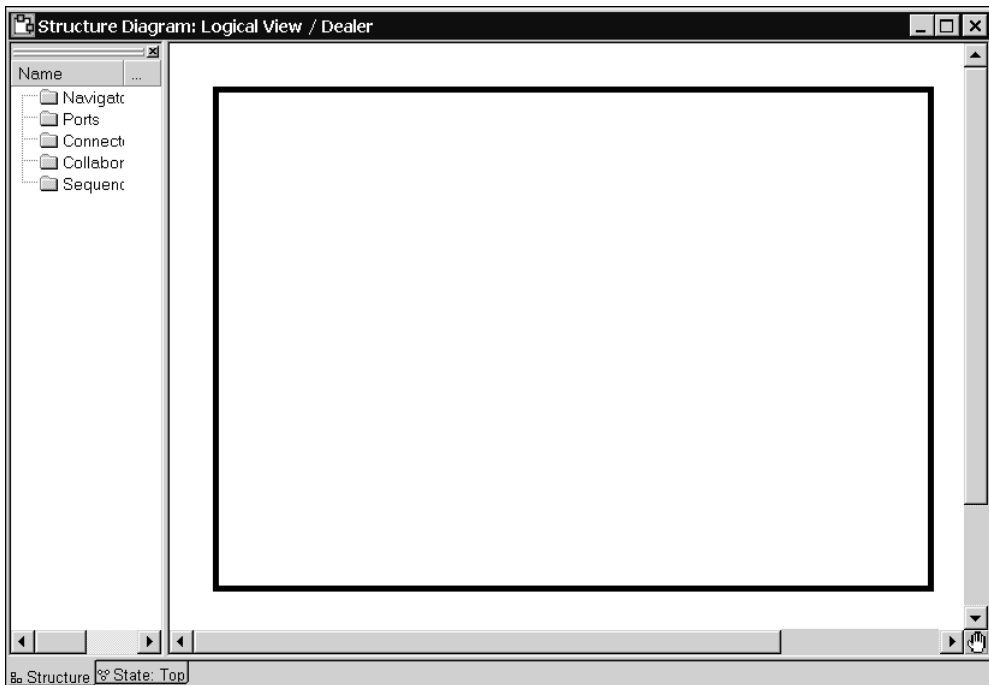
Ports are attributes of a capsule, and as such, all capsule roles of the same capsule have the same ports available. It is a common mistake to think that you should add ports to specific capsule roles.

### Suggested Reading:

- Ports, *Rational Rose RealTime Modeling Language Guide*
- Connectors, *Rational Rose RealTime Modeling Language Guide*

### To create ports

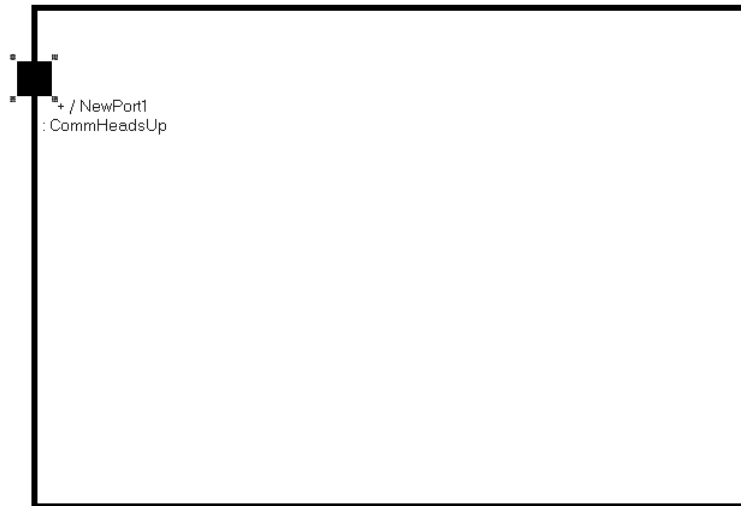
- 1 Open the **Structure Diagram** for the **Dealer** capsule.



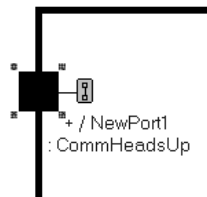
**Note:** You can double-click on a capsule role to open the capsule structure diagram of the capsule. This capsule role represents in the structure diagram.



- 2 From the **Model View** tab in the browser, drag the **CommHeadsUp** protocol to the black border of the **Dealer**'s structure diagram.

When the mouse is near the border, a dotted rectangle snaps to the border automatically. This creates a public port that is visible outside of the capsule. Release the mouse button when the dotted rectangle appears. The **Structure Diagram** will look like the following.

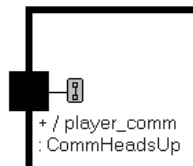


- 3 Right-click the new port, and click **End Port**.



The port graphic changes from  to  to indicate that it is an End Port. End ports provide a connection between the behavior of the capsule containing the end port and the outside world. To send and receive messages, a capsule must have end ports. The end port's protocol defines the set of messages that can be sent.

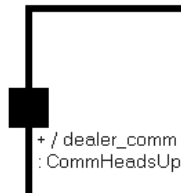
- 4 Rename the port `player_comm`.



Now, you will create a port for the **Player** capsule.

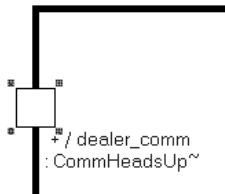
- 5 Open the **Structure Diagram** for the **Player** capsule.

- 6 From the **Model View** tab in the browser, drag the **CommHeadsUp** protocol to the black border of the **Player**'s structure diagram.
- 7 Right-click the new port, and click **End Port**.
- 8 Name the port on the player capsule **dealer\_comm**.

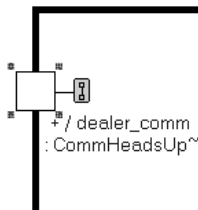


To enable communication between capsules, you must connect together the ports on their interfaces. You can only connect compatible ports together. For a port to be compatible, the out signals on each side must be a subset of the in signals on the other side.

- 9 Right-click on the **dealer\_comm** port in the **Structure Diagram** for the **Player** capsule, and click **Conjugate**.



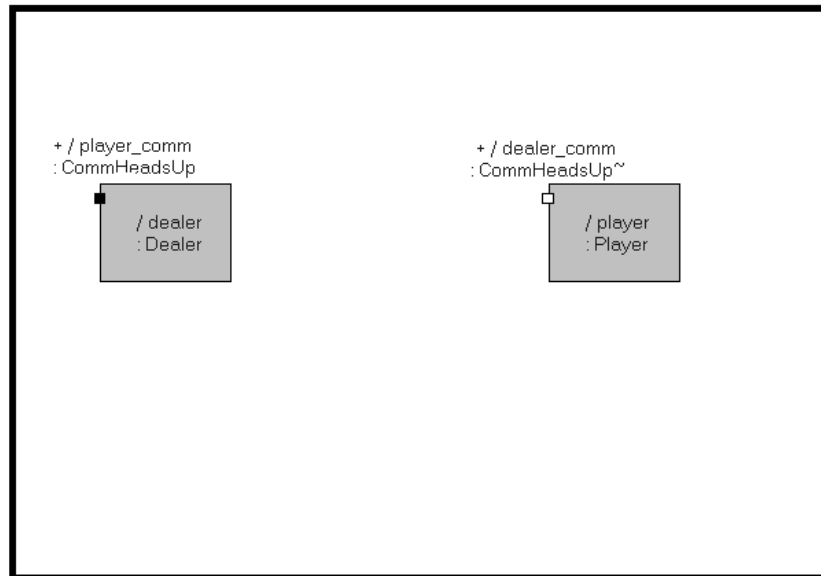
- 10 Right-click on the **dealer\_comm** port in the **Structure Diagram** for the **Player** capsule, and click **Wired** if it not currently selected.





## To connect the dealer and player capsule roles


- 1 From the **Model View** tab in the browser, open the **Structure Diagram** for the **HeadsUpPoker** capsule.


The new public ports appear on both capsule roles.



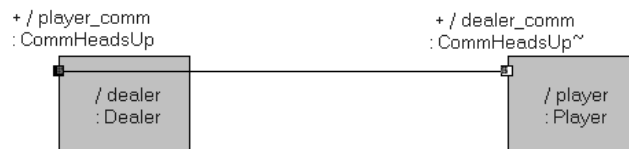
Now, you will connect these ports.

- 2 From the **Structure Diagram** toolbox, click the **Connector** tool .
- 3 Position the mouse over the port  on the **Dealer** capsule role.

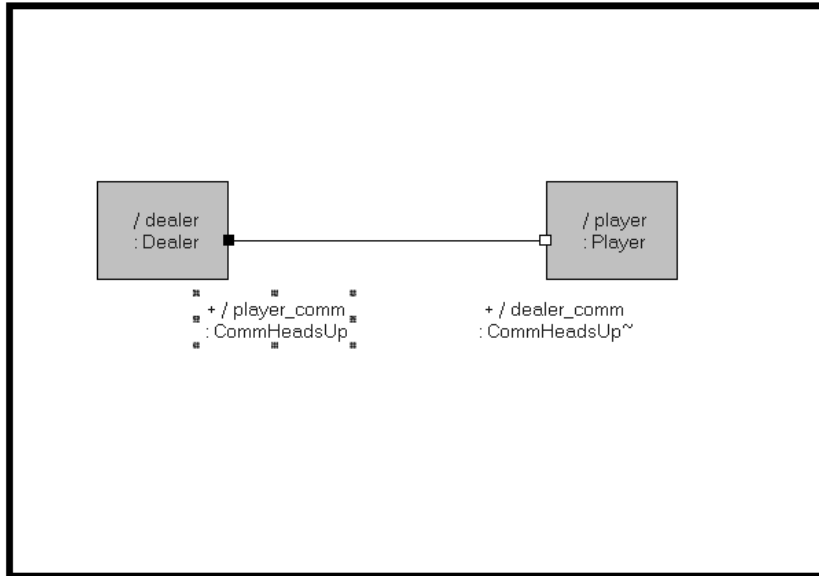
The cursor changes to .

- 4 Drag the mouse over to the conjugated port  on the **Player** capsule role, and release the mouse.

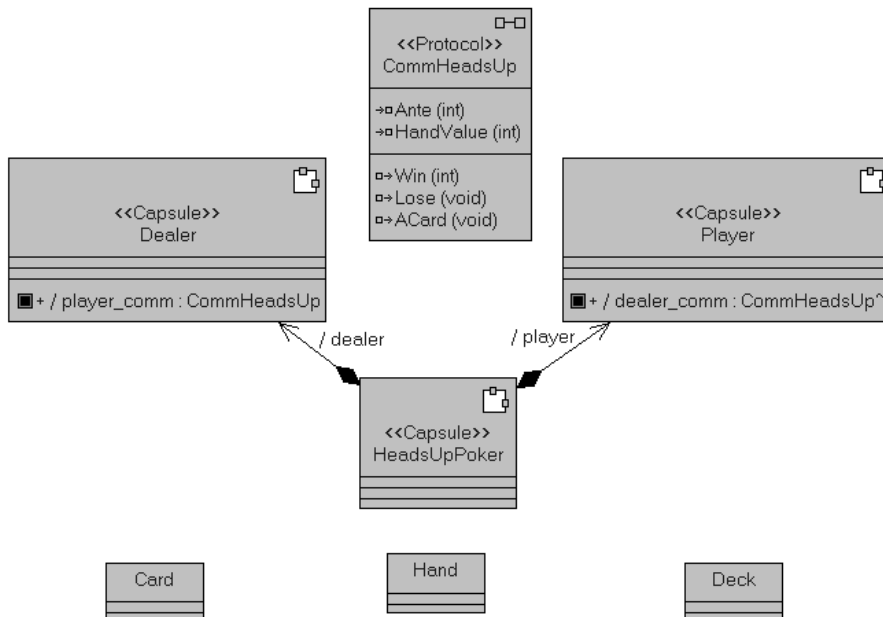
A connector appears between both capsule roles.



To make the graphic easier to view, you can move the ports along the border of the capsule roles to look like the following.



By creating these ports and connectors, the **Class Diagram: Logical View / Main** changes to include the ports on the **Dealer** and **Player** capsules and the **HeadsUpPoker** capsule.



## Documenting the Responsibilities

It is good practice to include a brief responsibility statement for each element in the design that describes what is included in the data, and the behavior of each component. Every element in a Rose RealTime model can include documentation.

### To add documentation to model elements:

- 1 In the **Model View** tab in the browser, either right-click to open the **Specification** dialog boxes for the following capsule and class elements, or select the element, then begin typing in the **Documentation** box in the **Documentation** window.

The elements and descriptive text is as follows:

---

<b>Model element</b>	<b>Type</b>	<b>Documentation text</b>
HeadsUpPoker	capsule	Encapsulates the flow of events described in the HeadsUpPoker:MainFlow use case.
Player	capsule	Interfaces with the dealer. Places an ante. Receives cards. Tells the dealer the value of the player hand.
Dealer	capsule	Interfaces with a player. Shuffles the card deck and distributes the cards. Decides who wins, and informs the player if they win or lose.
CommHeadsUp	protocol	Set of signals exchanged between the player and dealer in a HeadsUp poker game.

---

Before proceeding with Lesson 4, we recommend that you save your work.

## Lesson 4: Building and Running

---

In this lesson, you will learn how to build and run a model.

### Prototyping

One of the fundamental impacts Rose RealTime is that it encourages a highly iterative development workflow at the individual software developer level. An iterative approach:

- helps to resolve major risks before making large investments
- enables early user feedback
- makes testing and integration continuous

This iterative workflow allows developers to create prototypes, or executable versions of the system, regularly. Creating executable versions of a system early on has the following advantages:

- Allows you to validate and test the design.
- Gives you something to play with, more tangible than just boxes and diagrams.
- Helps you discover missing requirements.
- Allows you to build a working demonstration for feedback from the user.

Instead of waiting until the model is complete, you can construct a high-level model with sufficient details to validate your design approach. You can execute the model, find and fix problems, and revise the model to add more detail or to implement additional behavior.

By validating the design early, and often, you reduce the risk of not delivering the project on time. Errors at the design level are more costly to fix than implementation errors, so finding and fixing these errors early in your process will save time and effort.

**Note:** *This highly iterative approach to development is the key to making the most of Rational Rose RealTime.*

## Building a Model

You will build and run for the first time an executable version of the card game simulation. Although you have not yet added any detailed behavior, this is a good time to build and run a model.

### Suggested Reading

- Components, *Rational Rose RealTime Modeling Language Guide*
- Build basics, *Rational Rose RealTime Toolset Guide*
- Building and running models, *Rational Rose RealTime Toolset Guide*

To run your model, you need to build it, and then execute it on a processor. A component describes how to build a set of capsules and classes. The deployment of a component describes on what processor to execute the built component.



**Note:** A component can have instances. An instance of a component can be a single executable that can reside on a number of different nodes. To allow for this, specific component instances can be assigned to processors. Component instances are not shown in the component diagram, they appear in the deployment diagram.

You will create a component by opening a series of dialog boxes so that you can become familiar with the common features of the Rose RealTime user interface.

**Note:** You can also use the **Component Wizard** to quickly create, modify, and deploy a component. The wizard guides you through creating and configuring a component, and running the component instance. To access the wizard, click **Component Wizard** on the **Build** menu.

## Creating a component


The **Component View** specifies how to compile various parts of the model. The primary element of the **Component View** is a component that you need to create. This component specifies the capsules and classes to compile, how to compile those elements, and the inclusions and libraries to incorporate into the build.

You must create a component for the top-level capsule in order to build and execute your model. You can draw component diagrams for situations where you have many related components or packages of components.

### To create a component:

- 1 In the **Model View** browser, right-click **Component View**, and click **New > Component**.

Or . . .

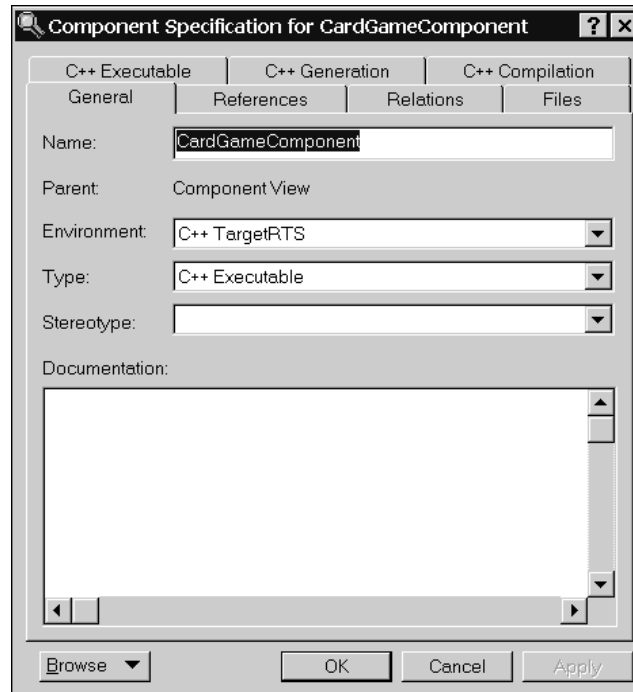
In the **Main** diagram for the **Component View**, from the toolbox, select the **Component** tool , then click on the **Main** diagram.

A component appears with the default name **NewComponent1**.



- 2 Rename the component **CardGameComponent**.

- 3 In the **Model View** tab in the browser, double-click **CardGameComponent** to open the **Component Specification for CardGameComponent** dialog box.
- 4 Click the **General** tab if not already selected.



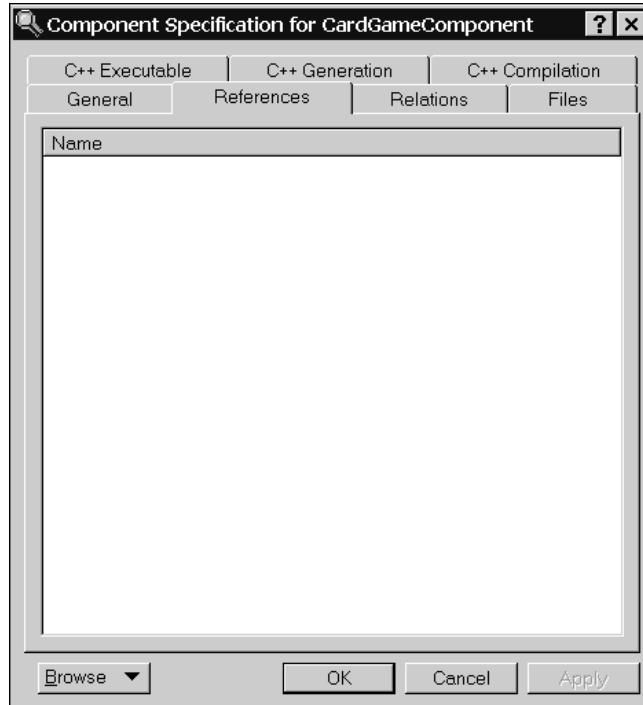
- 5 In the **Environment** box, select **C++ TargetRTS** if not already selected.

Setting the **Environment** box to C++ TargetRTS specifies that the C++ run-time system and code generation are used in the build process.

- 6 In the **Type** box, select **C++ Executable** if not already selected.

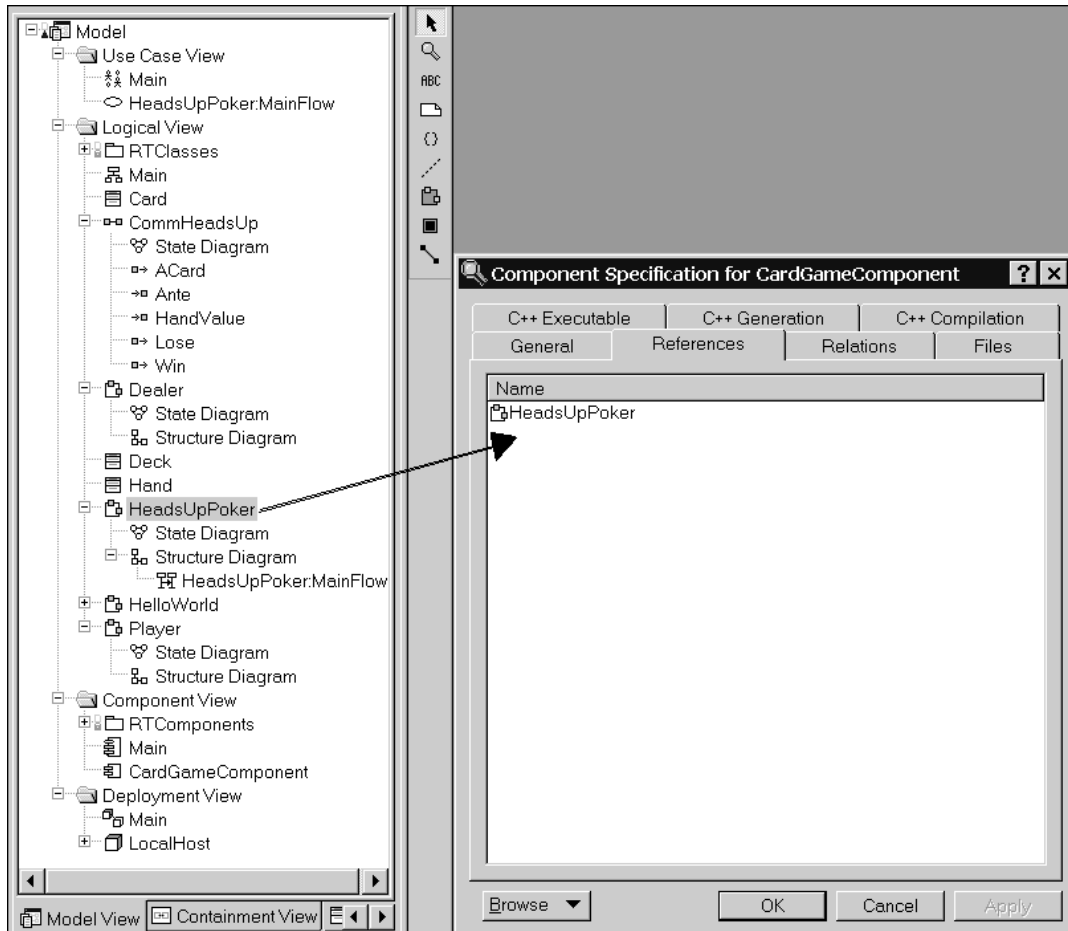
Setting the **Type** box specifies that you want to build a C++ executable version of the model.

- 7 Click the **References** tab.



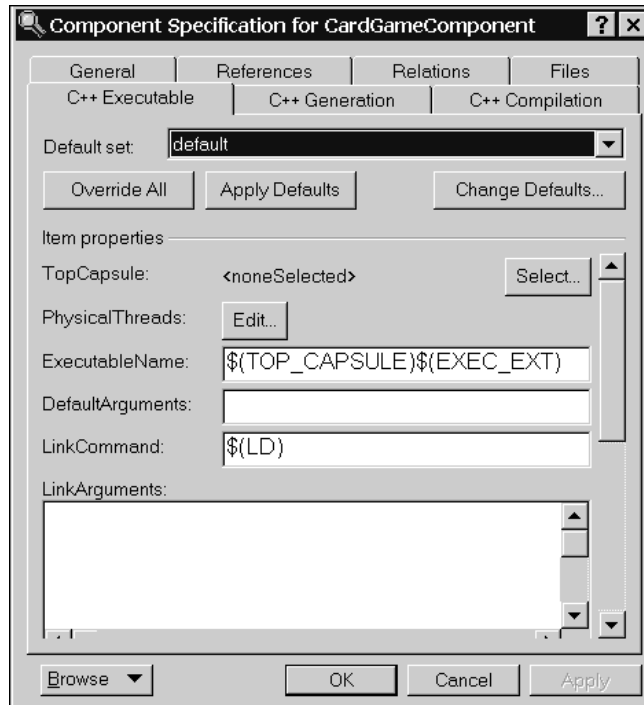
- 8 In the **Model View** tab in the browser, drag the **HeadsUpPoker** capsule onto the **References** tab.

The **HeadsUpPoker** capsule appears in the window.



You drag the **HeadsUpPoker** capsule onto the **References** tab because the items in the **References** tab identify what is compiled with the **HeadsUpPoker** component.

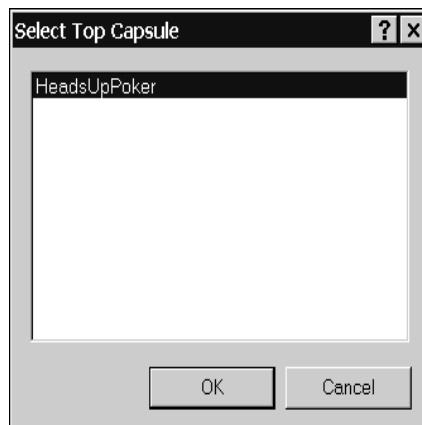
- 9 Click the **C++ Executable** tab.



- 10 Click **Select...**

The **Select Top Capsule** dialog box appears. In this dialog box, you select the capsule that will be the top capsule in the model.

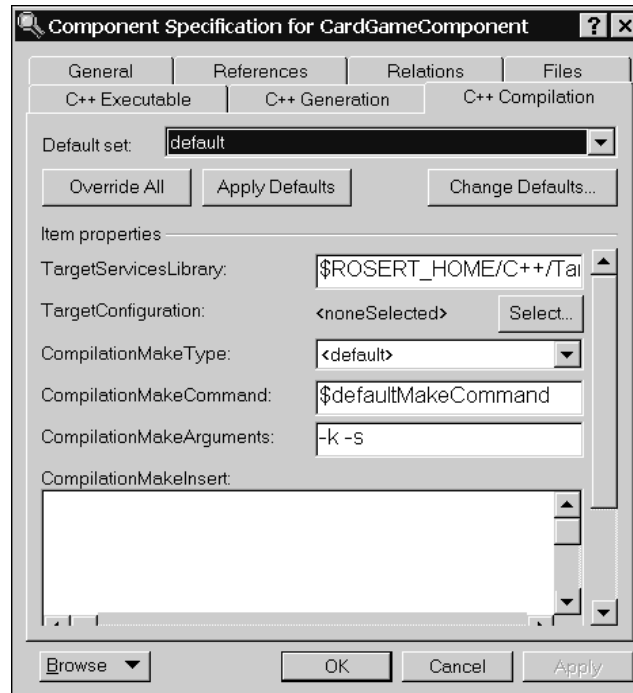
- 11 Click **HeadsUpPoker** to designate it as the top capsule.



12 Click **OK**.

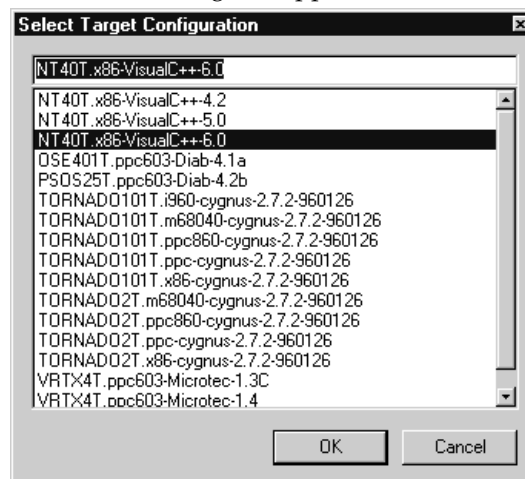
13 Click **Apply**.

14 Click the **C++ Compilation** tab.



15 Click **Select...**

The **Select Target Configuration** dialog box appears.



A component is always created with a default configuration for your host machine. This includes a default compiler, compiler flags, linker, and so forth. In many cases, these settings are sufficient for building simple sets of classes and capsules that do not require integration with external source files, or libraries.

In this dialog box, you will specify the operating system, compiler, and processor that you want to use to build and run the model.

The information is listed in the following format:

```
<operating system>.<processor and compiler>
```

For example:

- If you are running Windows 4.X on a x86 processor, and you have installed the Visual C++ 6.0 build tools, select:

```
NT40T.x86-VisualC++-6.0
```

- If you are running Solaris 5.X on a sparc processor, and you have installed the gnu 2.8.1 build tools, select:

```
SUN5T.sparc-gnu-2.8.1
```

**16** Select the configuration for your computer, and click **OK**.

**17** To save the changes, click **Apply**.

**18** To close the **Component Specification for CardGameComponent** dialog box, click **OK**.

## Creating the Deployment View


The **Deployment View** describes the computing environment in which your model is executed, and specifies how it is deployed within the environment. The most important elements of the **Deployment View** are processors and component instances.

First, you define a processor on the **Deployment Diagram** that describes the computing hardware on which the model will be executed. Next, you map the component onto the processor to create a component instance. Finally, you run the model.

### To create a processor

- 1** In the **Model View** tab in the browser, right-click **Deployment View**, and click **New > Processor**.

Or . . .

In the **Deployment View**, open the **Main** diagram, from the toolbox, select the **Processor** tool , then click on the diagram to add a processor.

A processor appears with the default name **NewProcessor**.

- 2 Rename the processor **LocalHost** and press ENTER.
- 3 In the **Model View** tab in the browser, drag the **CardGameComponent** from the **Component View** folder onto **LocalHost**.

A component instance, **CardGameComponentInstance**, is created on the processor, and appears under **LocalHost**.



Now that you associated a component with a processor (creating a component instance), your component instance is complete and you can now run **CardGameComponentInstance**.

Before you run the component instance, save your model (**File > Save Model**)

## Starting the Build

Now that you created the component (**CardGameComponent**), processor (**LocalHost**), and component instance, you can build and run the executable version of the model.

### Suggested Reading

- Build menu, *Rational Rose RealTime Toolset Guide*
- Build settings dialog, *Rational Rose RealTime Toolset Guide*
- Build log, *Rational Rose RealTime Toolset Guide*
- Starting a build, *Rational Rose RealTime Toolset Guide*
- Common build errors, *Rational Rose RealTime Toolset Guide*

### To build the **CardGameComponent**

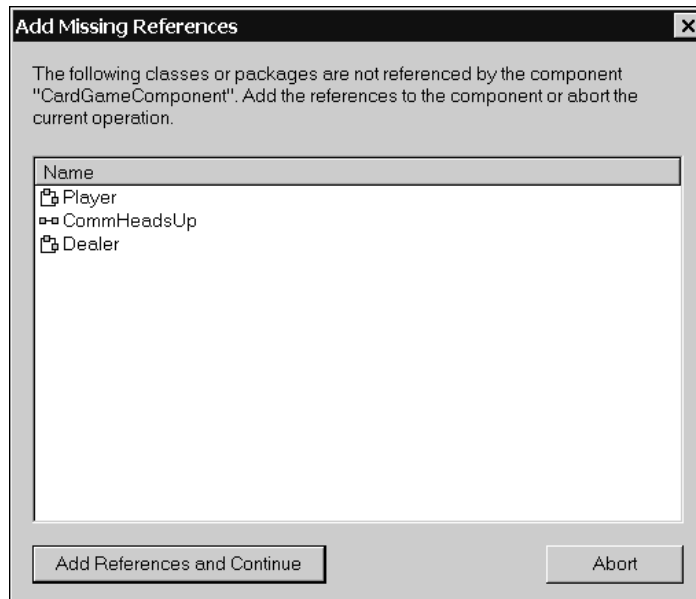
- 1 In the **Model View** tab in the browser, right-click **CardGameComponent**, and click **Set As Active**.

Because you will be building and running the same component and component instances often, you should configure an active component. Setting the **Set As Active** option ensures that the toolbar build icons and menu items, for the common run and build commands, become available for easy access.

The **Build Component** tool  becomes active.



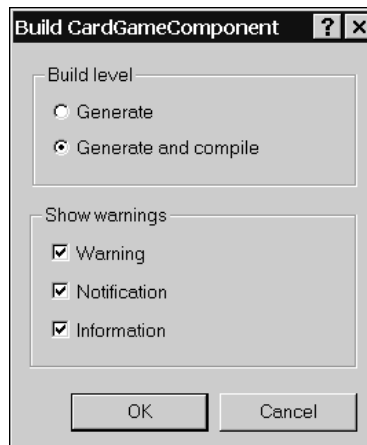
2 Click **Build Component**.



**Note:** The **CardGameComponent** component should contain all referenced classes before it is compiled. Rose RealTime checks the references, and prompts you to add any missing references that it detected.

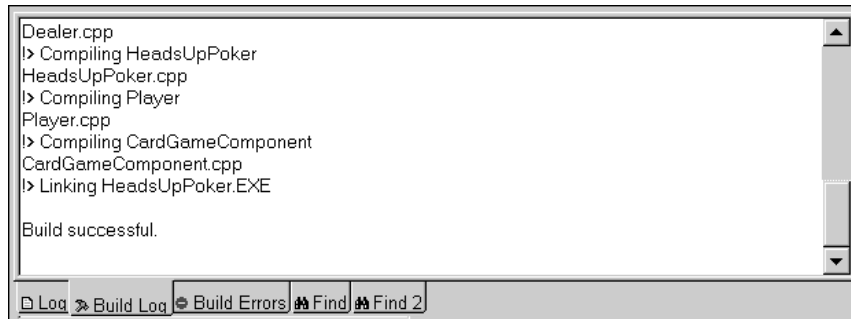
3 Click **Add References and Continue**.

The **Build CardGameComponent** dialog box appears.



4 If not currently selected, click **Generate and compile**, and click **OK**.

The **Build Log** tab of the **Output Window** shows the results of code generation and compilation. When the build finishes, the **Build Log** should indicate "Build successful".



```
Dealer.cpp
!> Compiling HeadsUpPoker
HeadsUpPoker.cpp
!> Compiling Player
Player.cpp
!> Compiling CardGameComponent
CardGameComponent.cpp
!> Linking HeadsUpPoker.EXE

Build successful.
```

The screenshot shows a window titled "Build Log" with a list of compilation steps and a "Build successful" message. The window has a standard toolbar with icons for Log, Build Log, Build Errors, Find, and Find 2.

**Note:** If there are compile errors, double-click on an error message on the **Build Errors** tab. Rose RealTime opens the appropriate editor where the source of the error appears. You can then resolve any errors.

If you do not see "Build Successful", review the topic on Common build errors. The most common error is not having one of the supported compilers for your platform installed or accessible in your path. Also, check the Rational Rose RealTime product web site for any known issues, or updates to tutorials and model examples.

## Where is the Source Code Generated?

If you wish to examine the generated code, look in the directory where you saved your model. In that directory, you should see a subdirectory labelled **CardGameComponent**. In this directory, you will see another subdirectory called **src**. This directory contains the generated code for your model. You may want to explore and examine the files in this directory.

## Running the Component Instance

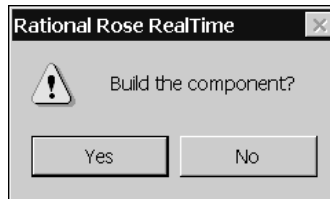
Now, you will run the built component.

### Suggested Reading

- Building and running models, *Rational Rose RealTime Toolset Guide*

## To run the component instance:

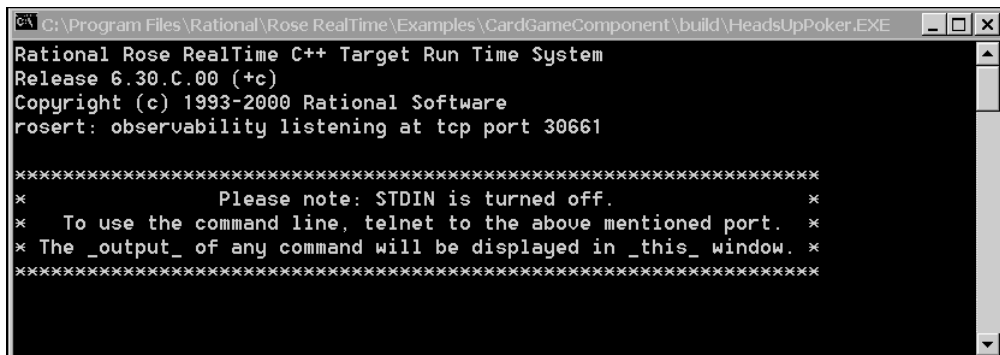
- 1 From the **Model View** tab in the browser, right-click **CardGameComponentInstance**, and click **Run**.



- 2 When prompted to rebuild the component, click **No**. You already built the component in an earlier step.

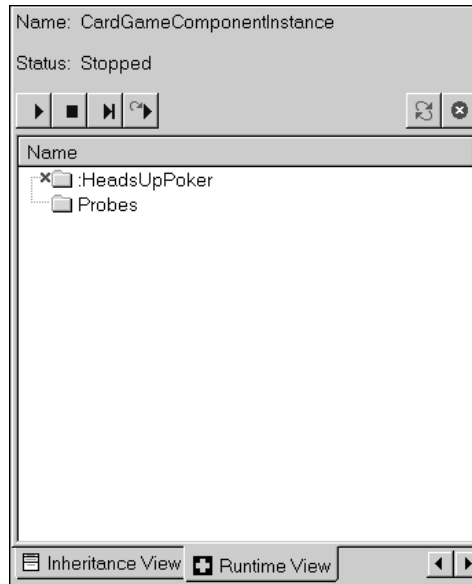
The **Build Log** appears while dependencies are recalculated. If the toolset determines that model elements changed since the last build the component is rebuilt before the component instance is run.

A console window appears showing output to `stderr` or `stdout`.




- 3 Click on any part of the toolset to make it active.

A new browser, **RTS Browser (Runtime View)**, appears on your **Model** browser. It controls the execution of a running component instance. You can run and control multiple component instances from within Rose RealTime. There is a separate **RTS Browser (Runtime View)** tab for each running instance.

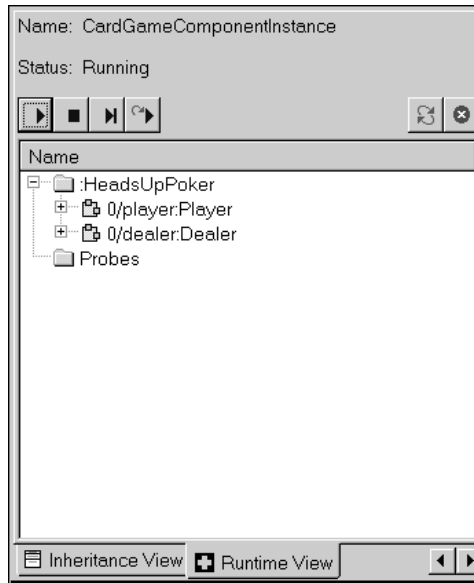


- 4 Click on the **Runtime View** tab.

The **RTS Browser** appears. The top folder shows the name of the capsule, **HeadsUpPoker**, which encapsulates the card game simulation.

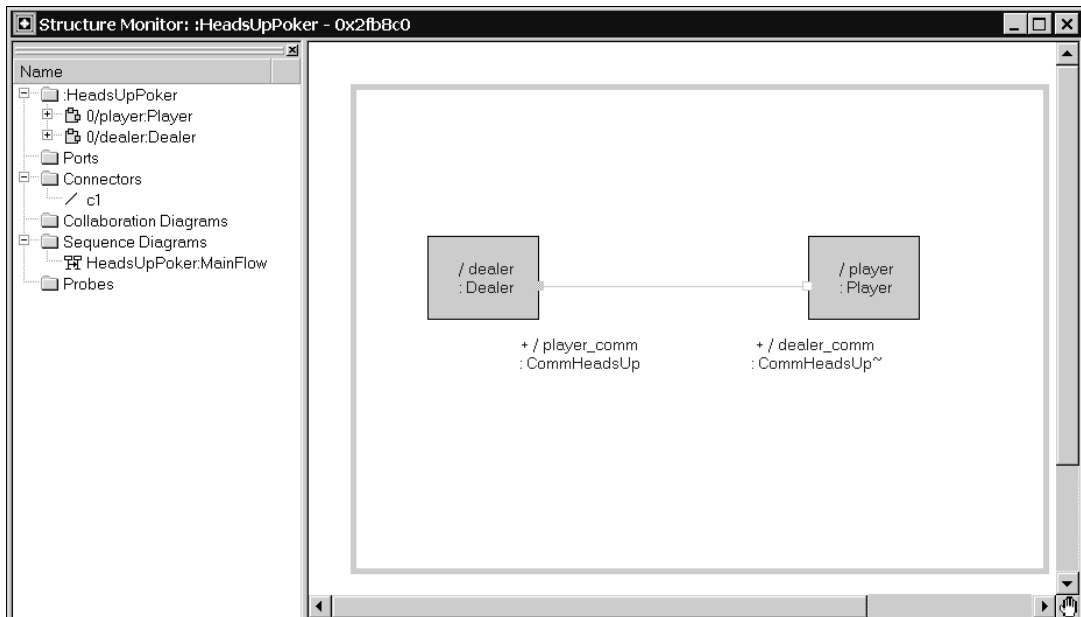
- 5 Click the **Start** button  to start the execution of the loaded component instance.

The player and dealer capsule instances display in the browser.




- 6 Right-click on the **HeadsUpPoker** capsule instance, and click **Open Structure Monitor**.

The following diagram shows a run-time view of the structure of this capsule instance.



In the next lesson, you will add detailed behavior to your card game model. Because there is no behavior in your existing model, you will stop the component instance.

- 7 To stop the component instance from running, click the **Shutdown** button .

## Review

You have now completed the following activities:

- 1 Described the requirements of the simulation in a use case.
- 2 Discovered from the requirements the initial design objects needed to implement the simulation: capsules and classes.
- 3 Described the communication paths and scenarios between capsules using sequence and structure diagrams.
- 4 Created the protocols which describe the sets of signals which are exchanged between capsules.
- 5 Build and run the model.

You used Rose RealTime to describe and develop the high-level Design of a card game simulation in a way that allows others to understand the system you are building.

The key parts of a design consist of:

- The name of the key components in the system (viewable from the **Model View** tab in the browser).
- The main responsibility of each component (captured in the **Documentation** box).
- The communication patterns between the components (captured in Structure and Sequence diagrams).

The sample model showing the completed procedures covered to this point in the tutorial is located in the Rose RealTime installation directory:

```
$ROSET_HOME/Tutorials/cardgame/cardgame_step1.rtm1.
```

Next, you will incrementally add details to the simulation, first adding behavior to the capsules, and then implementing the required card classes.

## Lesson 5: Adding Behavior to the Capsules

---

You created the major classes and capsules that make up the card game simulation, and determined how they are connected and communicate. However, the capsules and classes do not have any behavior, and do not perform a function. You will add that behavior in this lesson.

First, you will add behavior to the capsules to run the simulation to test the design. Then, you will implement the card classes to complete the simulation.

### Suggested Reading

- Creating capsule state diagrams, *Rational Rose RealTime Toolset Guide*
- State diagrams, *Rational Rose RealTime Modeling Language Guide*
- Signal events, *Rational Rose RealTime Modeling Language Guide*

### Opening Capsule State Diagrams

Capsule behavior is described in a state diagram. You do not have to create a State Diagram for a capsule, it is automatically created for each capsule.

#### To open a state diagram:

- 1 In the **Model View** tab in the browser, for the **Dealer** capsule in the **Logical View**, double-click on **State Diagram** to open the state diagram.



In the **State Diagram** editor, the state diagram is in the right pane and the **Navigator** in the left. The **Navigator** allows you to quickly access and browse capsule behavior.

## Creating the Dealer's Behavior

In this topic, you will create states, transitions, triggers, and action code to implement the first pass behavior for the **Dealer** capsule.


To determine the behavior of a capsule, review the Responsibility description of the capsule, and the Sequence diagram in which the capsule participates. These two sources indicate the messages that the capsule receives, and sends.

For example, in the **Dealer** capsule's documentation and role in the **HeadsUpPoker:Mainflow** sequence diagram, you can see that the behavior has to handle the receipt of the **Ante** and **HandValue** signals, and send out the **ACard**, **Win**, **Lose** signals.

### Suggested Reading

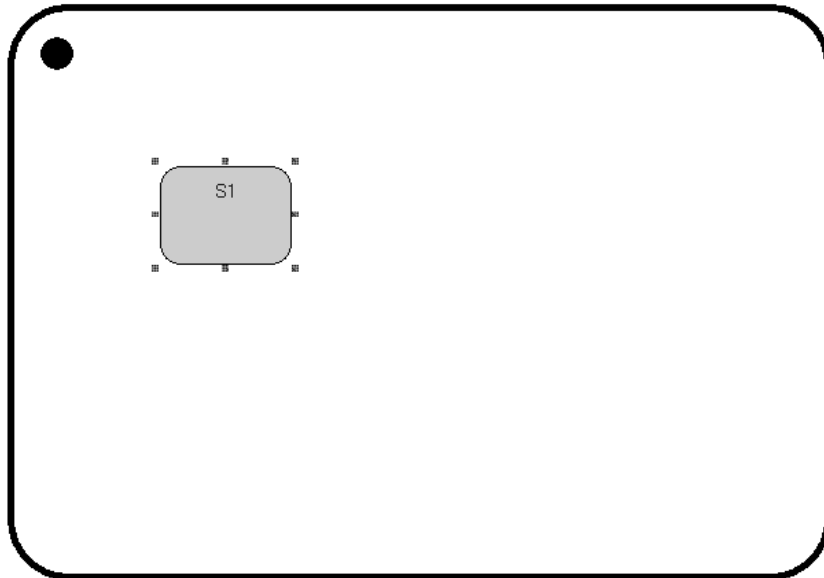
- Creating capsule state diagrams, *Rational Rose RealTime Modeling Language Guide*
- TopState, *Rational Rose RealTime Modeling Language Guide*
- Transitions, *Rational Rose RealTime Modeling Language Guide*
- States, *Rational Rose RealTime Modeling Language Guide*

### To create the Dealer states:

- 1 If not currently open, open the **State Diagram** for the **Dealer** capsule.
- 2 Click the **State** tool  from the **State Diagram** toolbox.
- 3 Move the mouse over the **State Diagram** and within the state diagram border.
- 4 Click to create a state.

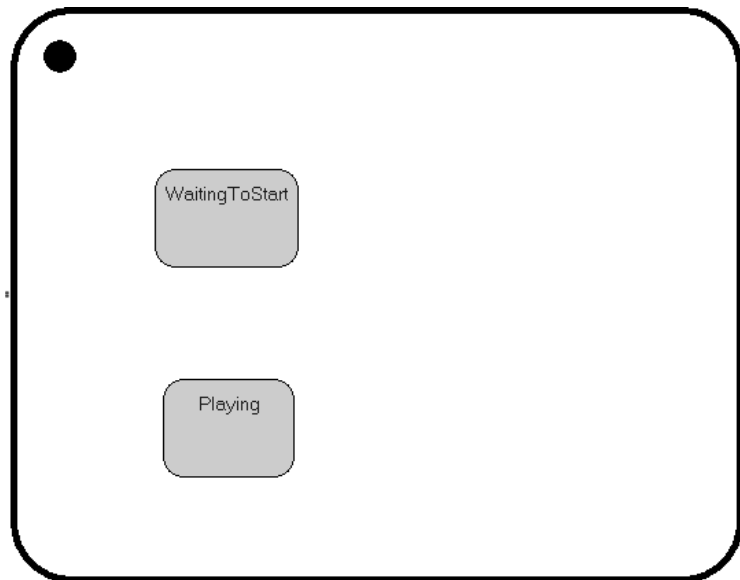



The state name is selected.



- 5 Rename the state to **WaitingToStart**.
- 6 Repeat the steps above, and create a state called **Playing**.

Your diagram should look like the following diagram.





Next, you want to create transitions. The state diagram contains an *initial point*, , and an *initial state* called **WaitingToStart**. An initial point is a special point which explicitly shows the beginning of the state machine. You connect the initial point to a start state (in this case, **WaitingToStart**). Where the start state will be the first active state in the Dealer objects state machine. The transition from the initial point to the start state, the initial transition, is the first transition taken before any other transition. Only one initial state is allowed in each state diagram. Only one outgoing transition can exist from the initial point.

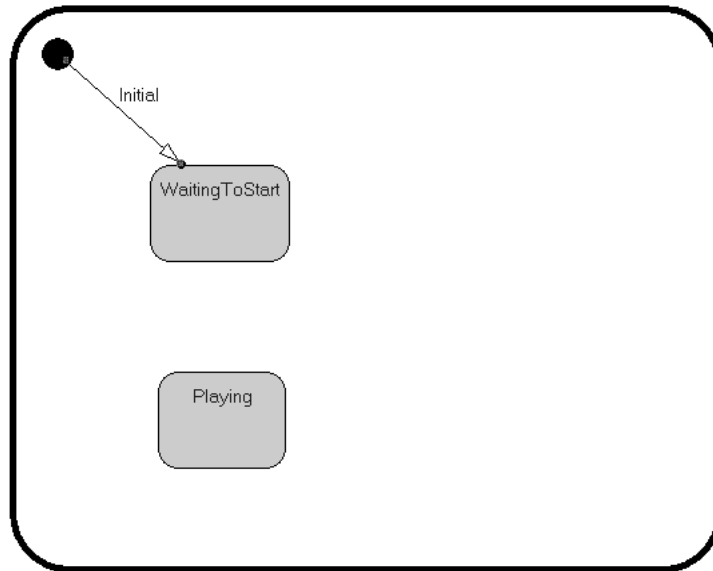
There can be several incoming transitions to the initial state. In this case the initial state acts like a junction point which forces the behavior back through the initial transition. If the initial transition is used to completely initialize an object, then any incoming transition to the initial state will effectively reset the behavior of an object without having to destroy then re-create it.

A transition is a relationship between two states, a source state and a destination state. It specifies that when an object in the source state receives a specified event and certain conditions are met, the behavior moves from the source state to the destination state. You create an **Initial Transition** that is automatically invoked at runtime when a capsule instance is created. Any action code associated with the **Initial Transition** runs when the capsule instance is created.

### To create the transitions

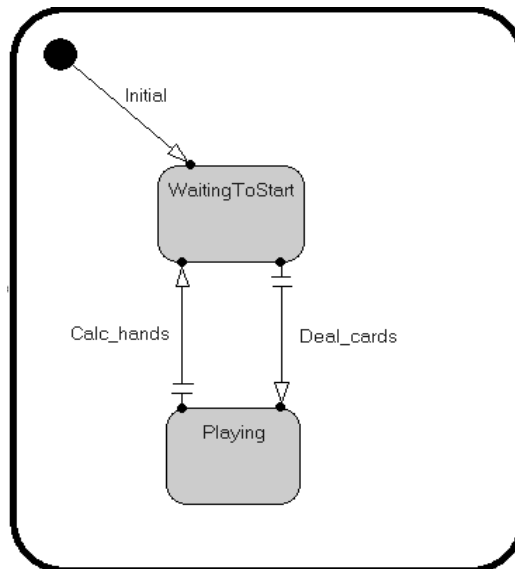
- 1 From the **State Diagram** toolbox, click the **State Transition** tool .
- 2 Click and hold the left mouse button on the **Initial Point** in the state diagram, .  
The **Initial Point** is the black circle that appears in the top-left corner of the **State Diagram**.
- 3 Drag the **State Transition** tool to the top of the **WaitingToStart** state.

The **Initial Transition** has a default name of **Initial**.



**Note:** You can resize the black border of the State Diagram by selecting it, then click and hold your mouse over a pic handle and change the size.

- 4 Repeat the steps above and create the transitions as shown in the following state diagram.



**Note:** You can change the position of the transition lines and the labels for the transitions by selecting and moving the object.

You will notice that the transition lines are broken  $\frac{\perp}{\top}$ . This broken line means that these transitions do not have a trigger defined. A trigger defines which events from which ports cause the transition to be taken. The trigger is associated with the port on which the triggering event is expected to arrive. Moreover, a transition can have multiple triggers such that an event that satisfies any one of the triggers causes the transition to be taken.

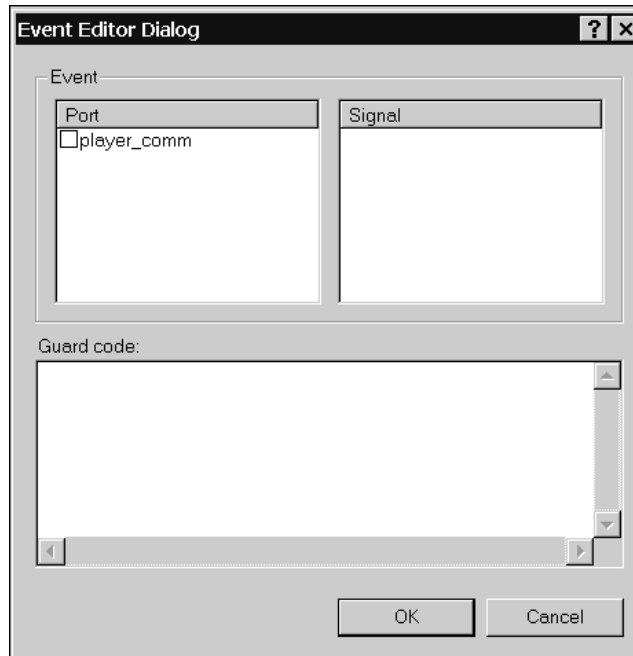
**To create the triggers:**

- 1 Double click on the **Deal\_cards** transition line.  
The **Transition Specification** dialog box appears.
- 2 Click the **Triggers** tab.



- 3 Right-click in the list area, and click **Insert**.

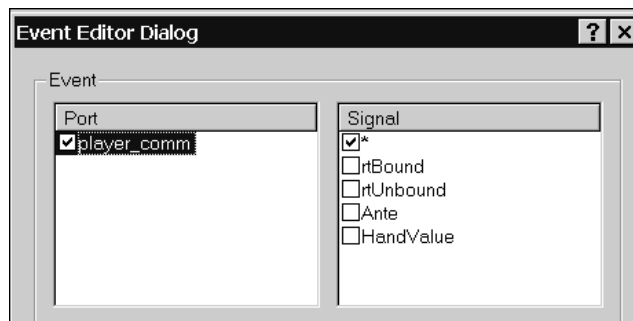
The **Event Editor Dialog** appears.



Use this dialog to define the ports and signals that trigger this particular transition to be taken.

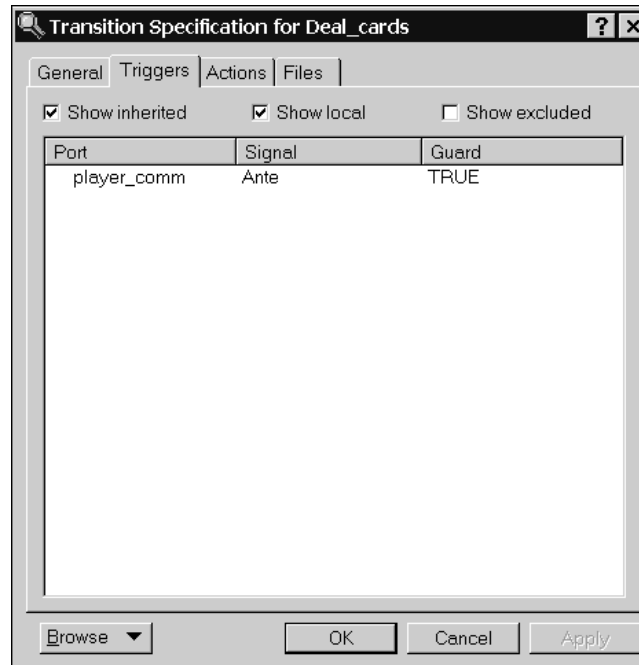
- 4 In the **Port** list, select the **player\_comm** port.

The incoming signals defined for this port automatically appear in the **Signal** list.



- 5 In the **Signal** list, select the **Ante** signal.

- 6 Click **OK**.



The trigger you defined now appears on the **Triggers** tab of the **Transition Specification** dialog box.

- 7 Click **OK**.
- 8 Repeat the steps above to create a trigger for the **Calc\_hands** transition using the following:

<b>Port</b>	<b>Signal</b>
player_comm	HandValue

The **Transition Specification** for the Calc\_hands transition looks like the following.



- 9 Click **OK** to close the **Transition Specification** for **Calc\_hands**.

### To create the actions

Actions are the things the behavior does when a transition is taken. They represent executable atomic computations that are written as statements in a detail-level programming language (that is, in C++) and incorporated into a state machine. Actions are atomic, in that they cannot be interrupted by the arrival of a higher priority event. An action runs to completion.

- 1 Double-click on the **Deal\_cards** transition line.  
The **Transition Specification** dialog box appears.
- 2 Click the **Actions** tab.

**3** In the **Code** box, type the following:

```
// distribute hands to player and dealer
for( int i = 0; i < 5; i++ )
{
    player_comm.ACard().send();

    // will add code here later to take
    // a card for the dealers hand
}
```

**Note:** C++ is case-sensitive. Ensure that you type the code exactly as shown to avoid any errors.



When **Deal\_Cards** transition is taken, the dealer sends the **ACard** signal out the **player\_comm** port. A total of five cards are sent. This is the first iteration of the behavior. After you develop the card classes, you can send actual cards to the player and take cards for the dealers hand. This level of detail code allows you to run the simulation, and to observe the interactions between the player and dealer capsules.



4 Click **OK**.

5 Repeat the above steps and type the following code for the **Calc\_hands** transition:

```
// receive the hand value from the player
int hand_value = *rtdata;
int bet_multi = 2;
// for now, always let the player win twice
// their bet value.
//Will add code here to compare
// the two hands.
player_comm.Win( bet_multi ).send();
```



6 Click **OK**.

In the **Calc\_hands** transition, the dealer uses the **rtdata** argument to extract the data sent with the signal. The **rtdata** parameter is available to all transition code and is a casted version of the data in a message. The **rtdata** parameter is casted to the highest common superclass of the possible data classes for the given code segment. In this

case, the **CommHeadsUp** protocol tells us that the **HandValue** signal is accompanied by an integer representing the value of the players hand. For now, you will let the player win all the games.

## Creating the Player's Behavior

The player's behavior is more involved than the dealers behavior because the player starts the simulation at some interval, and counts the value of their cards.

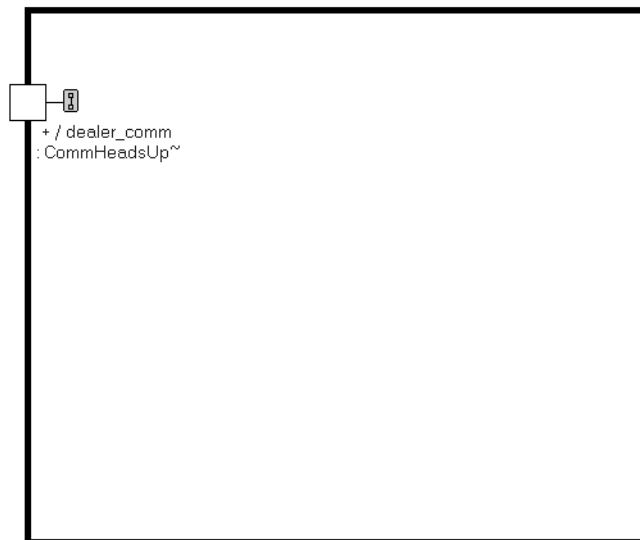
### Suggested Reading

- Functionality of the language add-in, *Rational Rose RealTime C++ Reference*.

### To create a timing port:

The player will initiate the flow of events. To control the amount of time elapsed between games, you will use a timer to have an interval of two seconds between each game to help you debug and observe the simulation while it runs.

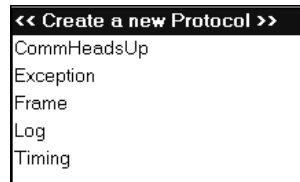
- 1 Open the **Structure Diagram** for the **Player** capsule.



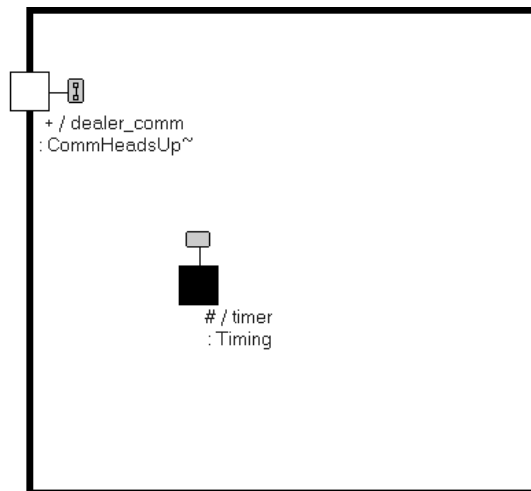
- 2 From the capsule **Structure Diagram** toolbox, select the **Port** tool .

- 3 In the **Structure Diagram**, left-click inside the black border to add the port.

**Note:** Do not click on the black border. Clicking on the border makes the port *public*, clicking inside the border makes the port *private*.




- 4 Double-click to select the **Timing** protocol from the list of available protocol classes.
- 5 Rename the port to **timer**.

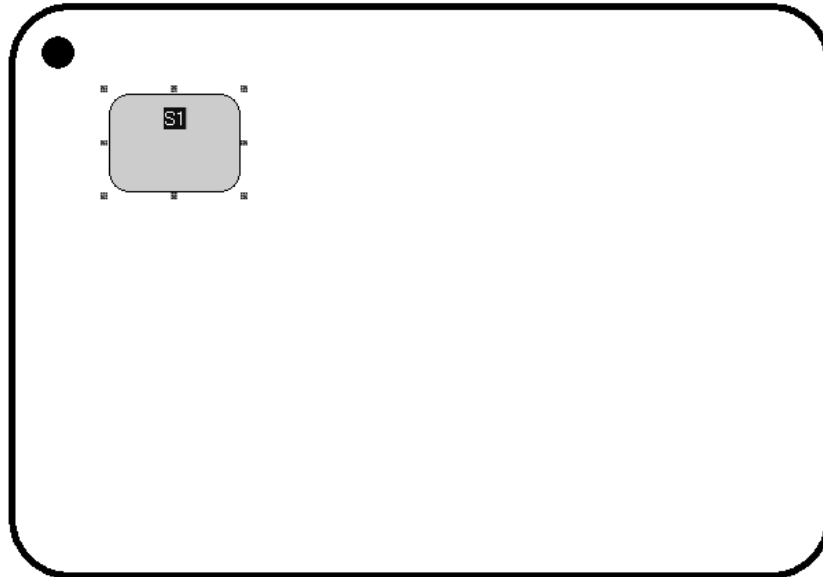


## Creating the State Diagram

You will create the behavior for the **Player** capsule. As with the **Dealer** capsule, you will create the appropriate states and transitions and label them. Your completed State Diagram for the Player capsule will look like the following diagram.

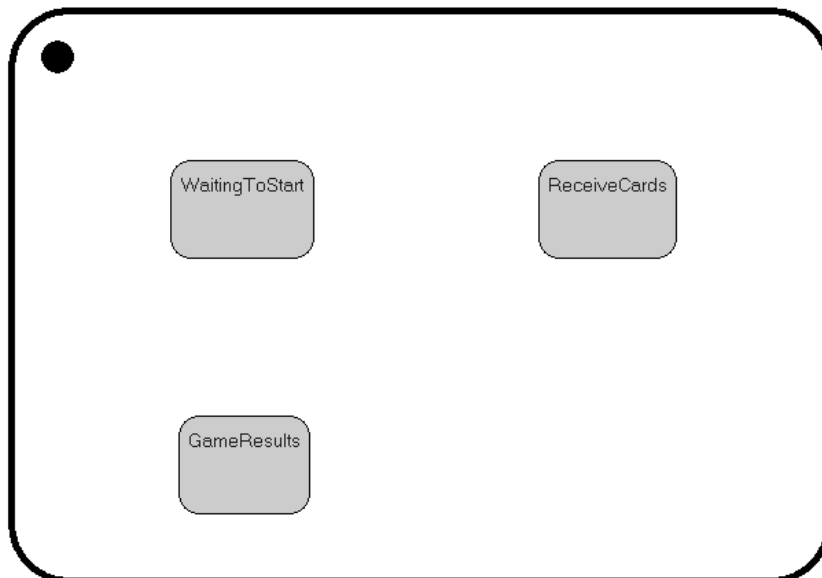
- 1 If not currently open, open the **State Diagram** for the **Player** capsule.
- 2 Click the **State** tool  from the **State Diagram** toolbox.
- 3 Move the mouse over the **State Diagram** and within the state diagram border.

- 4 Click to create a state.



- 5 Rename the state to **WaitingToStart**.
- 6 Repeat the steps above, and create two additional states called **ReceiveCards** and **GameResults**.

Your diagram should look like the following.




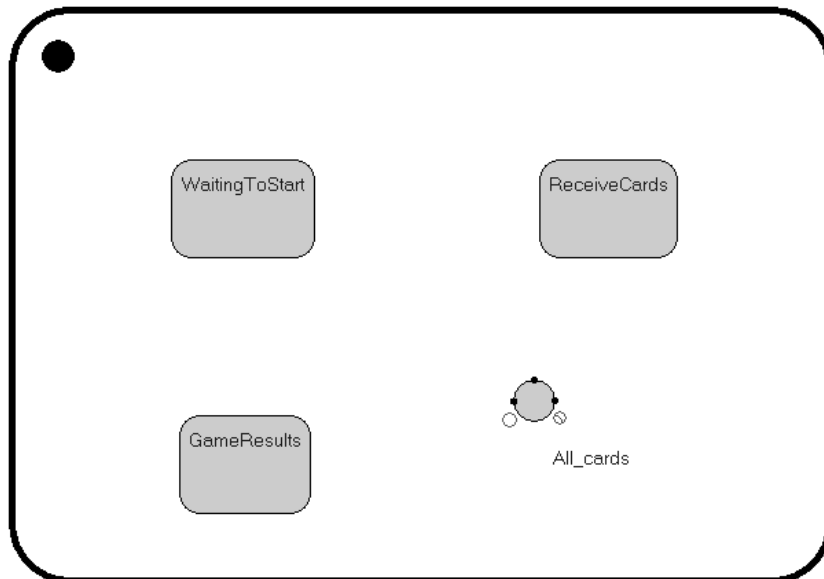
Next, you will create a choice point.

### To create a choice point:

Choice points allow a single transition to be split into two outgoing transition segments, each of which can terminate on a different state. The decision of which branch to take is made after the transition is taken.



Each choice point has an associated boolean predicate that is evaluated after the incoming transition action is executed. Depending on the truth value of this predicate, either the True or the False branch is taken.

- 1 From the **State Diagram** toolbox, click the **Choice Point** tool .
- 2 Click in the diagram to add a choice point.
- 3 Rename the choice point to **All\_cards**.

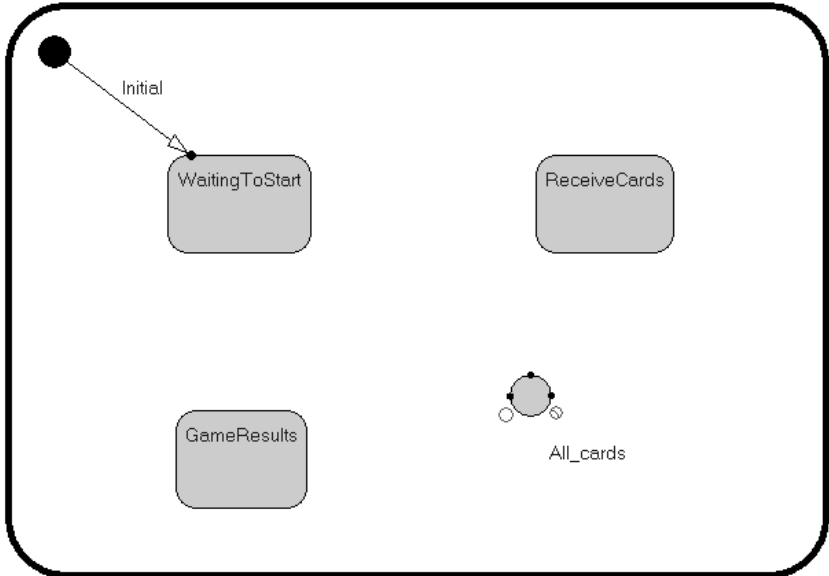


**Note:** You can rotate the choice point by grabbing one of its pic handles and turning. You can change the True and False branches using the popup menu.

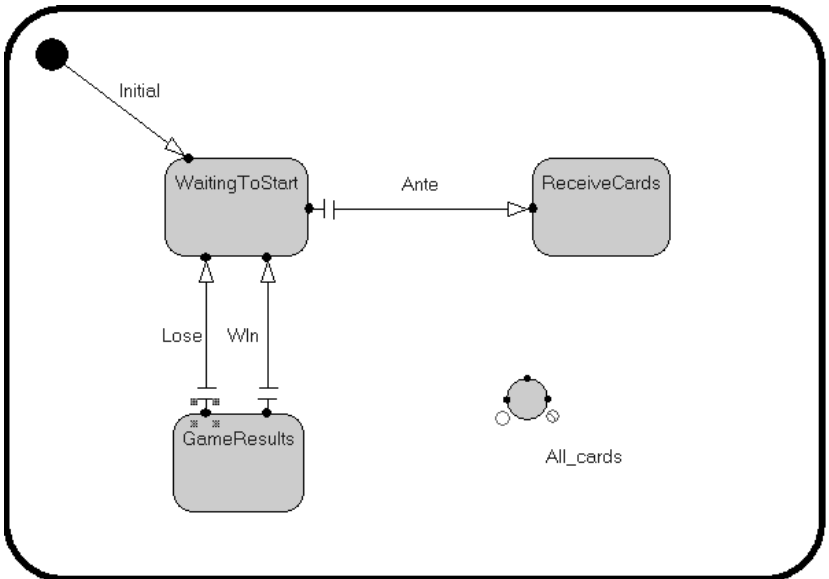
Next, you want to create transitions.

- 1 From the **State Diagram** toolbox, click the **State Transition** tool .
- 2 Click and hold the left mouse button on the **Initial Point** in the state diagram, .
- 3 Drag the **State Transition** tool to the top of the **WaitingToStart** state.

The **Initial Transition** has a default name of **Initial**.

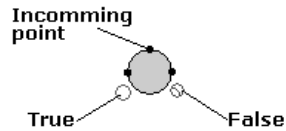


4 Repeat the steps above and create the transitions as shown in the following State Diagram.



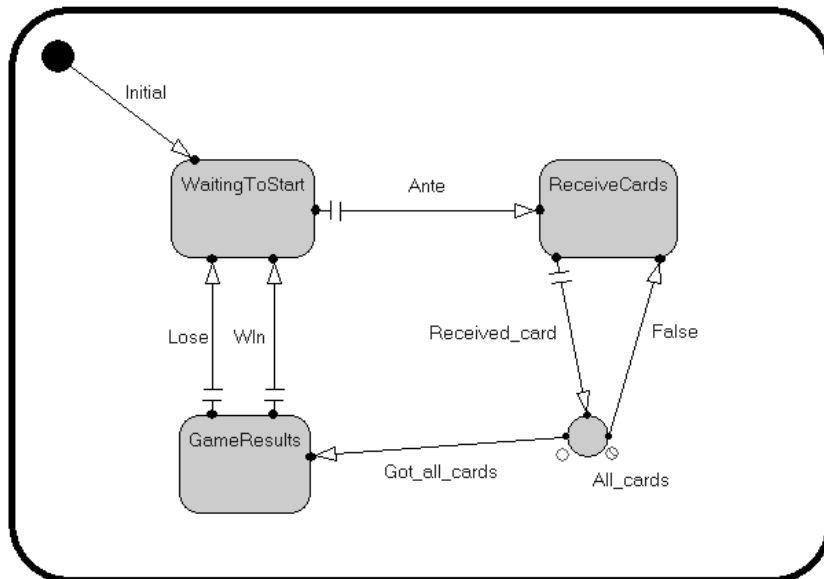
**Note:** You can change the position of the transition lines and the labels for the transitions by selecting and moving the object.

Now, you will add the transition lines to and from the choice point. A choice point is rendered as a circle with one incoming point, and two outgoing for the True and False transitions. The choice point is shown with a 'C' in the middle if the boolean predicate is defined.



5 Add the transitions for the choice point.

Your **State Diagram** for the **Player** capsule looks like the following.



You will notice that some transition lines are broken  $\perp$ . This broken line means that these transitions do not have a trigger defined.

**To create the triggers:**

- 1 Double click on the **Ante** transition line.  
The **Transition Specification** dialog box appears.
- 2 Click the **Triggers** tab.

- 3 Right-click in the list area, and click **Insert**.

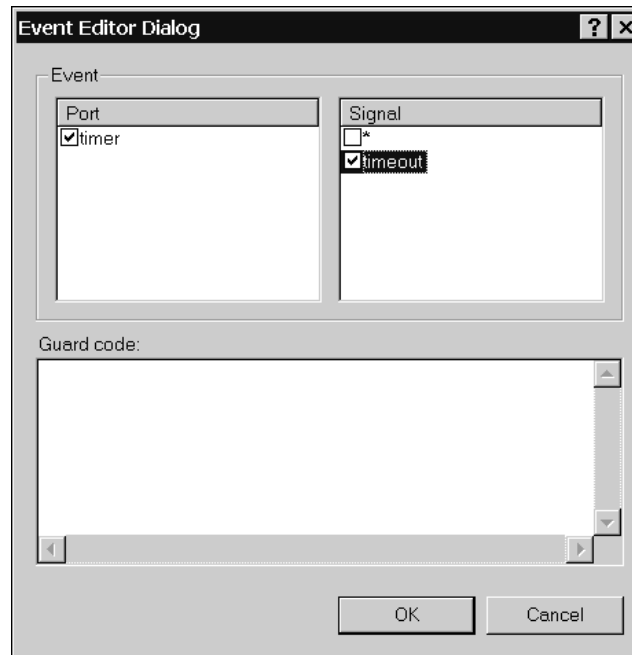
The **Event Editor Dialog** appears.

Use this dialog to define the ports and signals that trigger this particular transition to be taken.

- 4 In the **Port** list, select the **timer** port.

The incoming signals defined for this port automatically appear in the **Signal** list.

- 5 In the **Signal** list, select the **timeout** signal.



- 6 Click **OK**.

- 7 Click **OK**.



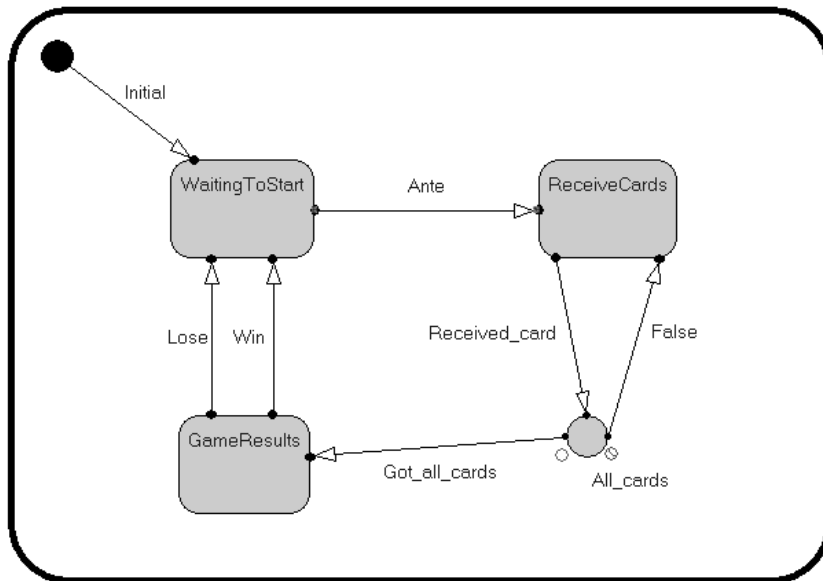
- 8 Repeat steps 1 through 7 to create triggers for the following transitions:

Transition	Port	Signal
Received_card	dealer_comm	ACard
Win	dealer_comm	Win
Lose	dealer_comm	Lose

**Note:** Transitions out of the choice point do not require triggers. They belong to the same transition chain as the transition incoming to the choice point.

Verify that there are no broken transition lines. If you have a broken transition, check that you have defined a trigger for a transition.

You **State Diagram** should look like the following:



## Adding Attributes

The Player's attributes manage the data required to track the bet, the winnings, and the number of cards received. These attributes can be accessed in the action code of the capsule state diagram and in its operations (very similar to how classes attributes are available in its operations).

<b>Attribute</b>	<b>Description</b>
_bet	Stores the amount of money (rounded up to the dollars) that the player bets for each hand.
_money	Stores the money for the player. The player starts with \$150. This value is updated after each hand to reflect either a win or a loss.
_ncards	Stores the number of cards the player receives. This attribute helps the player know when they have received all five cards.

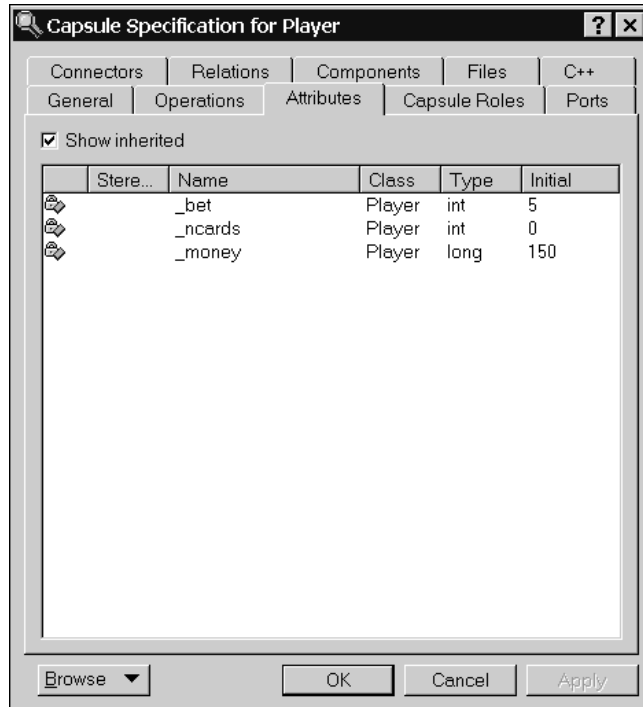
### To add Attributes:

**Note:** The following steps show you how to add an attribute using the Specification dialogs; however, you can also use the Attribute wizard. Right-click on a capsule and click **Attribute Tool**.

- 1 Open the **Specification** dialog box for the **Player** capsule.
- 2 Click the **Attributes** tab.
- 3 Right-click in the **Attributes** list, and click **Insert**.
- 4 Type **\_bet** and press ENTER.
- 5 Press TAB twice to advance to the **Type** column.
- 6 Press F8 and select **int** from the list.
- 7 Press TAB to advance to the **Initial** column.
- 8 Press F8, type **5**, and press ENTER.
- 9 Click **Apply**.
- 10 Repeat steps 3 through 9 to add the following attributes:

<b>Name</b>	<b>Type</b>	<b>Initial</b>
_ncards	int	0
_money	long	150

The Capsule Specification dialog box looks like the following:



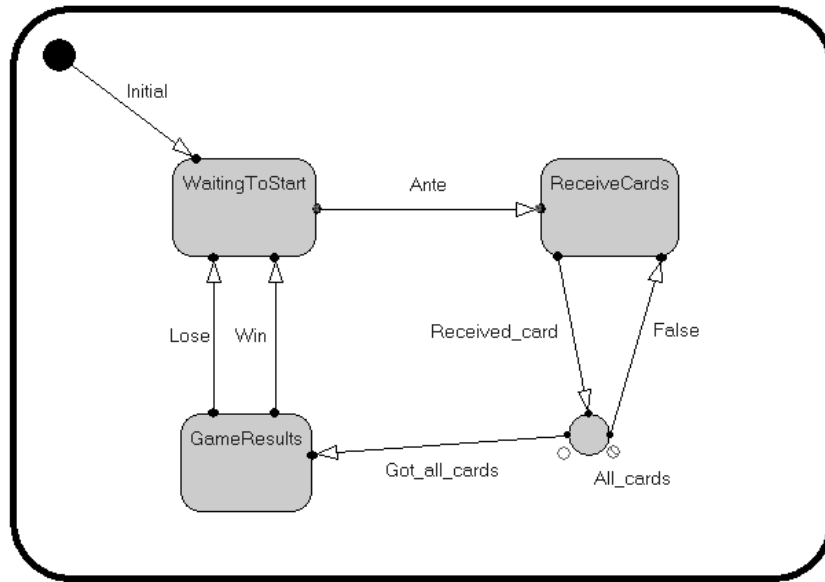
11 Click OK.

## Creating the Actions

The player capsule starts the flow of events by sending an Ante signal to the dealer. The player must then receive the five cards from the dealer, and reply with the value of his hand. Depending on the outcome of the game, he will receive a Win or Lose signal. If he wins, the dealer sends the bet multiplier that is used to calculate how much was won.

## To add a state entry action:

- 1 Open the **State Diagram** for the **Player** capsule.



- 2 Right-click on the **WaitingToStart** state, click **Open Specification**, then click the **Entry Actions** tab.

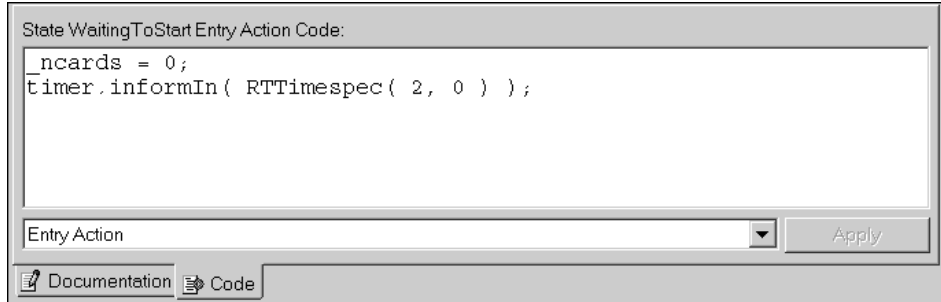
Or ...

Click the **WaitingToStart** state, on the **Code** tab in the documentation window, select **Entry Action** from the drop-down list.

- 3 Type the following code in the **Code** box:

```
_ncards = 0;
timer.informIn( RTTimespec( 2, 0 ) );
```

If you used the Code tab in the documentation window, your window will look like the following:



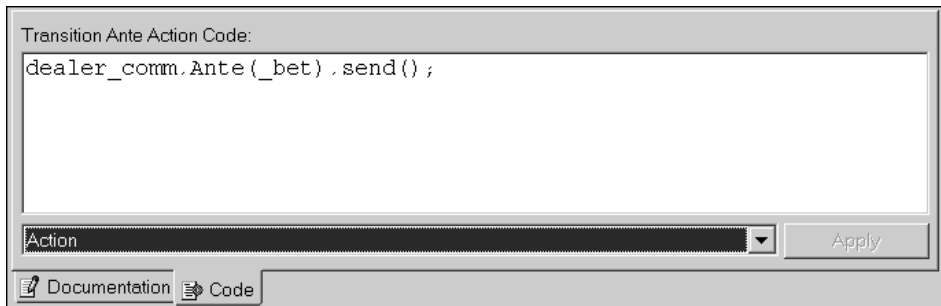
State entry actions are executed every time a transition is taken which terminates on the state. The `_ncards` attribute resets for each game. The `timer` requests that one time-out message be sent to this capsule in two seconds; this enables the simulation to run continuously.

- 4 Click **Apply**.

#### To add a transition action for Ante:

- 1 Click the **Ante** transition line.
- 2 On the **Code** tab, select **Action** from the drop-down list.
- 3 Type the following in the **Code** box:

```
dealer_comm.Ante(_bet).send();
```



By adding this code, you specify that the player starts the game by sending an ante to the dealer.

- 4 Click **Apply**.

### To add a transition action for Got\_all\_cards:

- 1 Click on the **Got\_all\_cards** transition line.
- 2 On the **Code** tab, select **Action** from the drop-down list.
- 3 Type the following code in the **Code** box:

```
// Will have to update to send the real hand value  
dealer_comm.HandValue(2).send();
```

- 4 Click **Apply**.

**Note:** The card classes are not developed, so you will send a dummy hand value to the dealer. You will have to update this code after you develop the card classes.

### To add a transition action for Win:

- 1 Click on the **Win** transition line.
- 2 On the **Code** tab, select **Action** from the drop-down list.
- 3 Type the following in the **Code** box:

```
// Update winnings from bet and win multiplier  
// sent from dealer.  
_money += _bet * (*rtdata);
```

- 4 Click **Apply**.

If the player wins, the dealer sends the bet multiplier to calculate the amount of money relative to the bet that the player has won.

### To add a transition action for Lose:

- 1 Click on the **Lose** transition line.
- 2 On the **Code** tab, select **Action** from the drop-down list.
- 3 Type the following code in the **Code** box:

```
// update for loss  
_money -= _bet;
```

- 4 Click **Apply**.

By adding this code, you specify that if the player loses, subtract the bet from total money for the player.

### To add a action for the **All\_cards** choice point:

Each choice point has an associated boolean predicate that is evaluated after the incoming transition action is executed. Depending on the truth value of this predicate, one or the other branch is taken. Modify the predicate for the **All\_cards** choice point:

- 1 Click on the **All\_cards** choice point.
- 2 On the **Code** tab, select **Condition** from the drop-down list.
- 3 Type the following code:

```
return( ++_ncards < 5 );
```

This code forces the branch to take the False transition until the player receives all five cards.

- 4 Click **Apply**.

Before proceeding with the next lesson, we recommend that you save and build your model. For details on building the model, see Lesson 4: Building and Running. If you encounter any errors, review this lesson and fix any errors until you receive the message "Build successful" in the **Log** window.

## Review

The **Player** and **Dealer** capsules are not complete. Later, you will add code to complete the Transition actions. The capsules are complete enough to allow you to build, run, and debug the simulation.

## Lesson 6: Navigating and Searching

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As the size of your model increases, you may need to start navigating and searching. In this lesson, you will do some reading to become familiar with the navigation and search tools available within Rose RealTime.

To obtain a working knowledge of a model, you must find key elements, such as, capsules, attributes, operations, classes, code statements, and so on. You must then navigate through the code and/or structures to find other occurrences, establish the hierarchy, and get a general understanding of the flow of the design.

### Suggested Reading

- The Find dialog, *Rational Rose RealTime Toolset Guide*
- The Code window, *Rational Rose RealTime Toolset Guide*
- Model Browser, *Rational Rose RealTime Toolset Guide*
- The Browse menu, *Rational Rose RealTime Toolset Guide*

## Lesson 7: Using Traces and Watches to Debug the Design

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In this topic, you will learn how to use the monitors, traces, and watches features. You can use these tools to help debug Rose RealTime models.

A very powerful feature of Rose RealTime is the ability to observe a running component instance at the model level. This high-level debugging is not what most developers are familiar with. Typically, developers converted design models to source code, and when it was compiled and run, the only way to trace the execution was at the source code level. The design model representation was not useful.

In Rose RealTime, you can see the triggered transitions, active states in the state diagram monitors, and watch the dynamic structure animate in the structure monitor. In addition, you can use probes to trace the messages being passed in the system.

### Suggested Reading

- Summary of the observability options, *Rational Rose RealTime Toolset Guide*

### Rebuilding the Model

You can use the same component, component instances, and processor that you had created previously. Now it is time to rebuild the **CardGameComponent**. For details on building the model, see *Lesson 4: Building and Running* on page 103.


When you rebuild the **CardGameComponent**, all changes made to the model are regenerated and recompiled into a new executable.



Errors may be reported during the build. This is not a problem. Read the error as shown in the **Build Errors** pane in the output window, and then double-click on the error to bring you to the element that caused the error. (C++ syntax errors are a common type of error.) Correct any errors and then rebuild the model.

## Setting Up the Runtime Windows

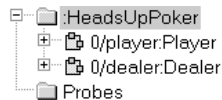
First, you want to run your model.

- 1 On the **Model View** tab in the browser, expand **Deployment View**, then expand **LocalHost**.
- 2 Right-click **CardGameComponentInstance** and click **Run**.
- 3 If you are prompted to build the component, click **Yes**.
- 4 After running the executable (component instance), the **RTS Browser** appears.
- 5 Click the **Step** button  to initialize the model.

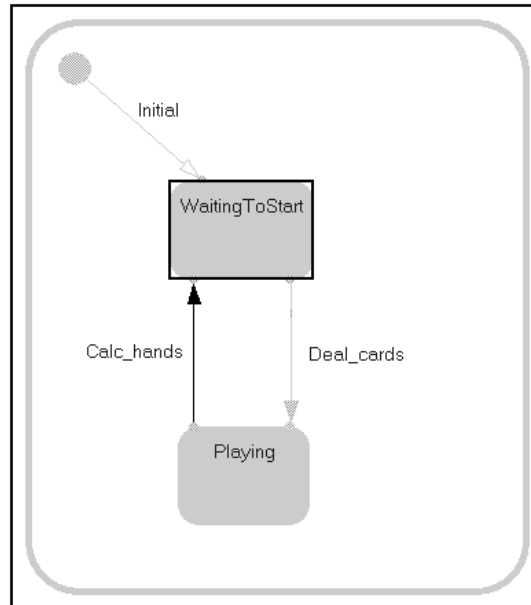
Clicking the **Step** button allows the delivery of one message in the component instance runs allows the current executing transition to finish, the next message is delivered, then it either pauses or stops.

### To open the State monitor:

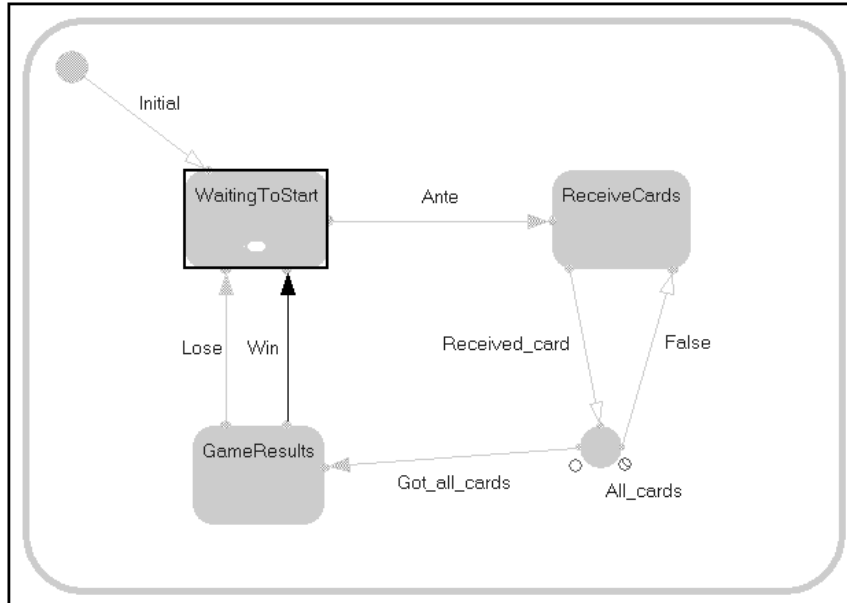
- 1 From the **RTS Browser** pane on the **Runtime View** tab in the **Model** browser, click the Start button  , and expand the **HeadsUpPoker** (capsule instance) folder.



- 2 Right-click on the **Dealer** capsule instance, and click **Open State Monitor**.



- 3 Right-click on the **Player** capsule instance, and click **Open State Monitor**.



These windows show you read-only views of the capsule instance behavior, and they animate to show you the current state and last transition taken by the capsule instance while it runs.

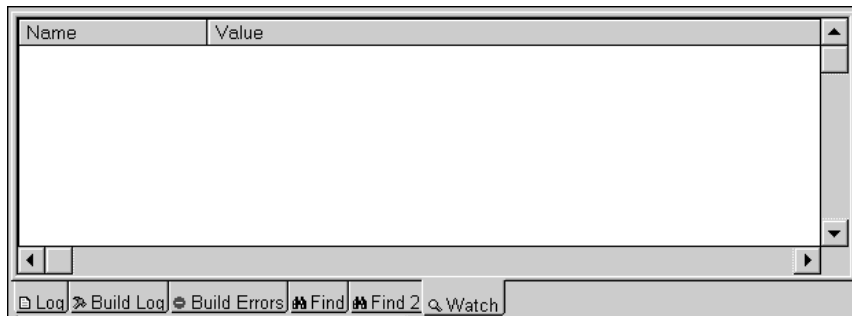
Organize the monitor windows, you can use the zoom tool to resize. Try and organize your desktop so that you can see both **State Monitor** diagrams at the same time.

For both capsules, there is a black rectangular outline around the **WaitingToStart** states; it is the first state.

### To open the Watch window:

- 1 From the **View** menu, click **Output** so that it is selected.

The **Watch** window appears in the output window. The window has two columns: **Name** and **Value**.

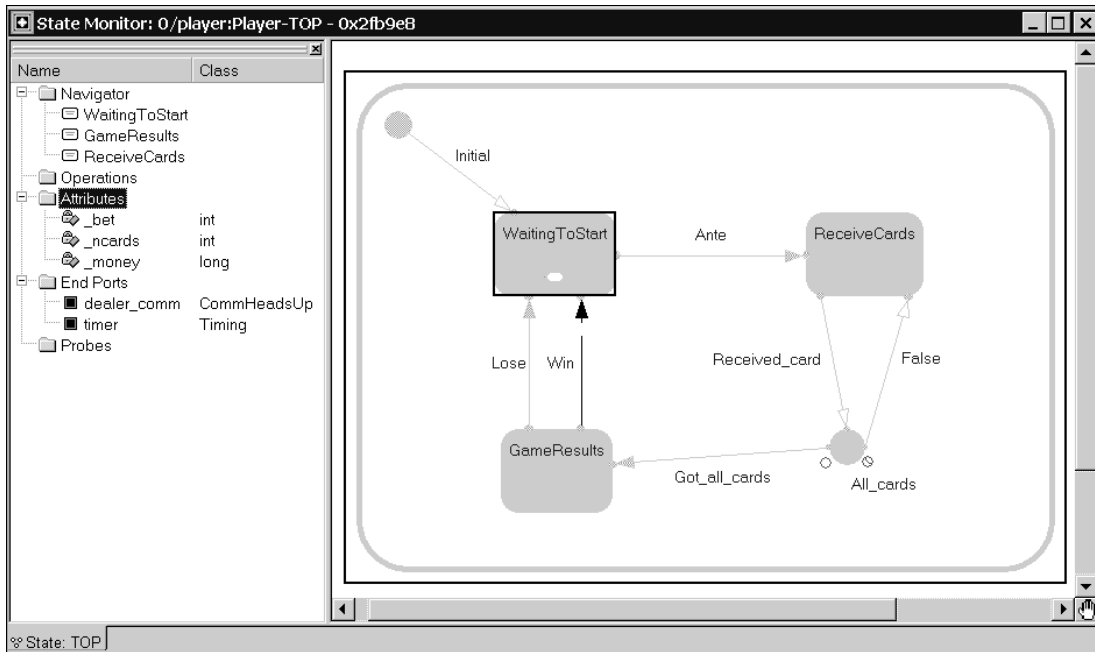


**Note:** Use the **Watch** window to specify attributes that you want to watch while debugging your running component instance. You can also modify the value of a variable using the **Watch** window.

You will place watches on three attributes for the Player capsule instance.

- 2 From the browser in the **Player** State Monitor, expand the **Attributes** folder located in the left hand pane.

There are three attributes listed: `_bet`, `_ncards`, and `_money`.



- 3 Drag each attribute individually from the **Attributes** folder into the **Watch** window.

The attributes appear in the window. The value is not updated until the component instance starts.

Name	Value
_bet	5
_ncards	1
_money	7860

619x226

Log Build Log Build Errors Find Find 2 Watch

### To open a capsule instance Trace

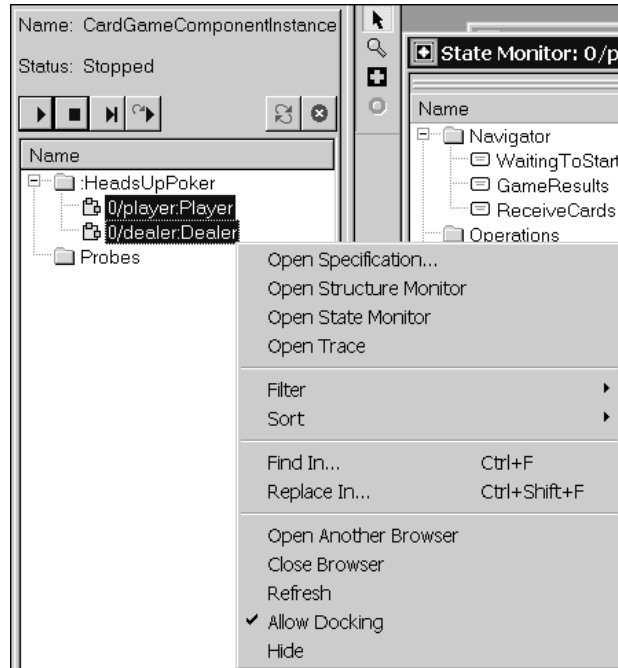
You can trace messages sent between a set of capsule instances. Typically, when a message fails to flow through a set of capsules as expected, it is important to see where the message flow was first in error. To debug these kinds of errors, first use Capsule instance traces to look at the messages originating and terminating from the capsules in the message flow.

For the purposes of this lesson, you want to open a trace on the **Player** and **Dealer** capsule instances.

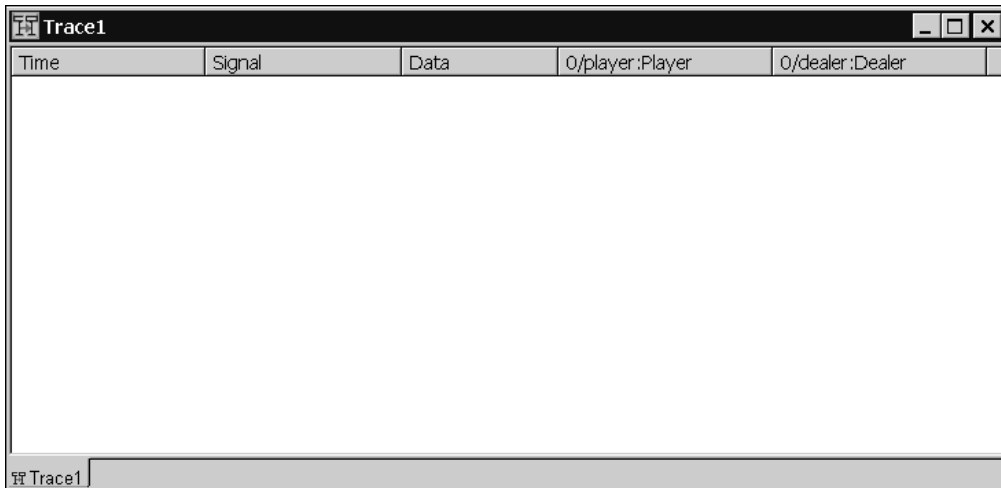
- 1 On the **Runtime View** tab, from the **RTS browser**, select the **Player** and **Dealer** capsule instances.

**Note:** You may have to click the **Stop** button  to select both capsules.

- 2 Right-click, and select **Open Trace**.



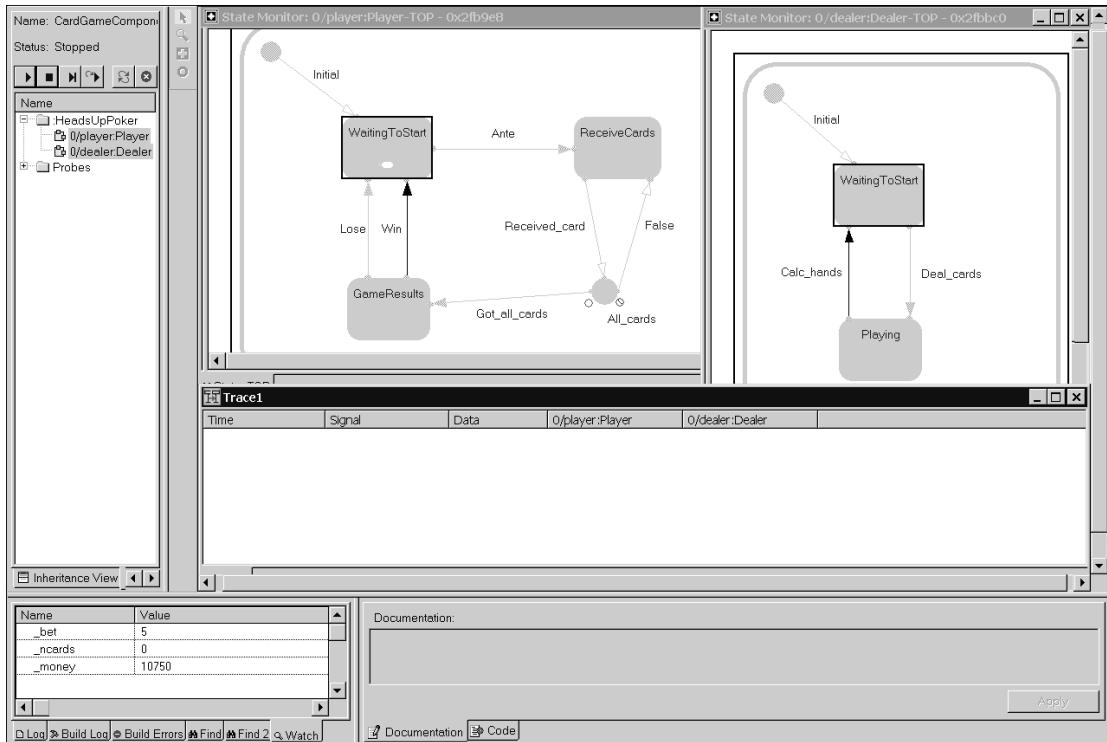
Initially, the **Trace** window looks like the following:




- 3 Resize the **Trace** window so that it fits your screen.
- 4 To resize the columns, right-click on the top column (the one with the titles) and select **Adjust Columns** from the menu.

The columns resize to fit the current window size.

**Note:** Messages appear in the **Trace** window after the component instance starts.



## To start the component instance

- 1 Press the **Start** button  in the **RTS Browser (Runtime View tab in the Model browser)** window to start the component instance.


The Trace1 window shows the following messages:

Time	Signal	Data	0/player:Player	0/dealer:Dealer
5779.171000021	ACard	void	dealer_comm-In	player_comm-Out
5779.171000023	ACard	void	dealer_comm-In	player_comm-Out
5779.171000025	ACard	void	dealer_comm-In	player_comm-Out
5779.437000016	HandValue	int 2	dealer_comm-Out	player_comm-In
5779.640000009				<:TOP:WaitingToSta..
5779.640000005	Win	int 2	dealer_comm-In	player_comm-Out
5779.718000007	informIn	RTTimespec{t...	timer-Out	player_comm-Out
5779.718000010				<:TOP:WaitingToSta...

Messages appear in the **Trace** window, and the **Value** fields for the attributes appear in the **Watch** window. Since you implemented the simulation so that the player always wins, the player's value for **money** will increase.

- 2 Double-click in the **Value** column for the **\_bet** attribute in the **Watch** window, and change the value to 10000.

This modifies the value of that attribute in the running instance, and you can see that the player wins more money.

- 3 Click the **Shutdown** button  to terminate the component instance.

## Problems with the Player Capsule

An error was purposely introduced in the behavior of the player capsule. In this topic, you will debug and fix this error.

When you ran the component instance, a console window appeared. You will use output from this console window, and use probes and traces to find the error.

If you do not have the **CardGameComponentInstance** running and started, do so now.

### Suggested Reading

- Probes, *Rational Rose RealTime Toolset Guide*

This topic highlights a very powerful feature of Rose RealTime. You can build any capsule independently in order to run and debug it. Since the **Player** and **Dealer** capsules do not run individually, they do not encapsulate a flow of events; they are part of one. When they are built and run, they will not do anything unless you simulate messages that it expects to trigger behavior. All behavior in a capsule is triggered by received messages; therefore, when a capsule is run by itself, or out of context of its flow of events, you have to generate these messages to test its behavior.

## Unexpected Messages

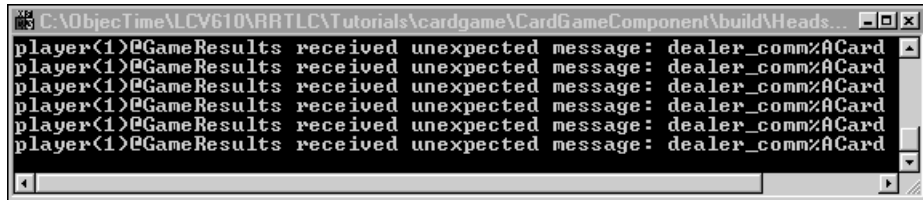
Ensure the component instance is started, then observe the behavior monitors for the player and dealer instances. Is the behavior what you expected? Now look at the **Trace** window. Are all the messages that you expect there?

If you examine the results closely, you will notice that the **Player** instance is not actually receiving all five cards. The **Player** should receive five cards, and then send the hand value to the dealer. However, the **Player** only receives one card, and the four others are being ignored.



## Warning Message for No Defined Trigger?

At runtime, if a capsule does not have a trigger for a message it receives, (that is, when a capsule receives a message that cannot be processed in the current state), a warning message is printed to **stdout** in the console windows, as follows:



```
C:\ObjecTime\LCV610\BRTLCTutorials\cardgame\CardGameComponent\build\Heads...
player(1)@GameResults received unexpected message: dealer_comm%ACard
player(1)@GameResults received unexpected message: dealer_comm%ACard
player(1)@GameResults received unexpected message: dealer_comm%ACard
player(1)@GameResults received unexpected message: dealer_comm%ACard
player(1)@GameResults received unexpected message: dealer_comm%ACard
```

The Services Library prints this warning when a capsule instance receives a message and there is no transition event defined from the current state which can handle the event.

In this case, messages printed to the console indicate that the **Player** instance is in the **GameResults** state when it received the **ACard** signal on the **dealer\_comm** port. This occurred several times.

## Building the Player Capsule

In this topic, you create a component and component instance to build and run the **Player** capsule. This allows you to run the **Player** capsule to investigate the unexpected message.

### To create the component and component instance

- Create a component named **PlayerComponent** with the **Player** capsule as the top level capsule. Follow the instructions in the topic *To create a component*: on page 105.
- Create a component instance of the **PlayerComponent**. Follow the instructions in the topic *To build the CardGameComponent* on page 112.

### To build the PlayerComponentInstance


Build the **PlayerComponent** in the same way that you built the **CardGameComponent**. Right-click the component, and click **Build**.

For additional information on building a component instance, see *To build the CardGameComponent* on page 112.

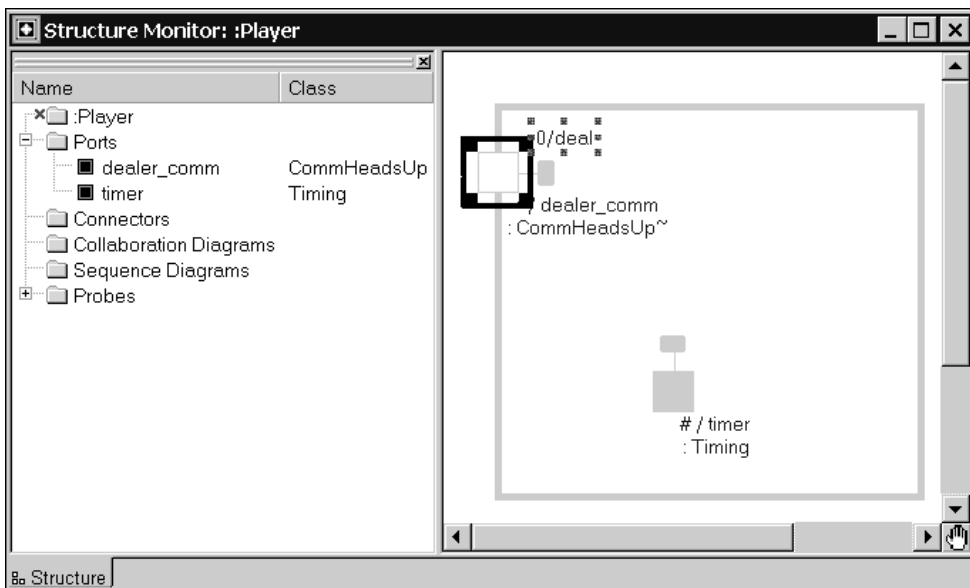
## Debugging the Player Capsule

To debug the **Player** capsule, run it then inject messages into the **dealer\_comm** port to observe the player capsule instance behavior.

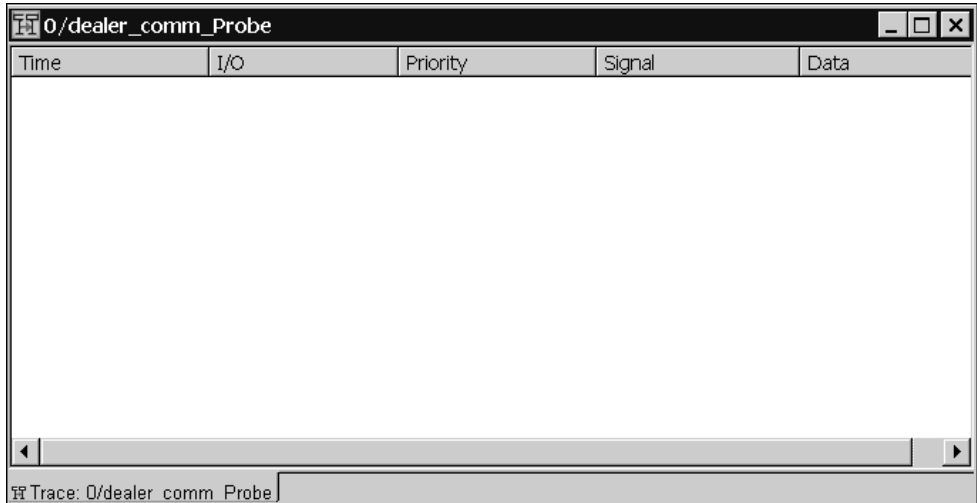
### To trace and inject messages:

- 1 Build, then run the **PlayerComponentInstance**. For instructions on building and running a component instance, see *To build the CardGameComponent* on page 112 and *To run the component instance:* on page 115.
- 2 Open the **Structure Monitor** diagram for the **Player** capsule.
- 3 Select the **Probe** tool  from the **Structure Monitor** toolbox.
- 4 Position the cursor over the **dealer\_comm** port in the **Structure Monitor** diagram, and left-click.

This creates a port on the **dealer\_comm** port.

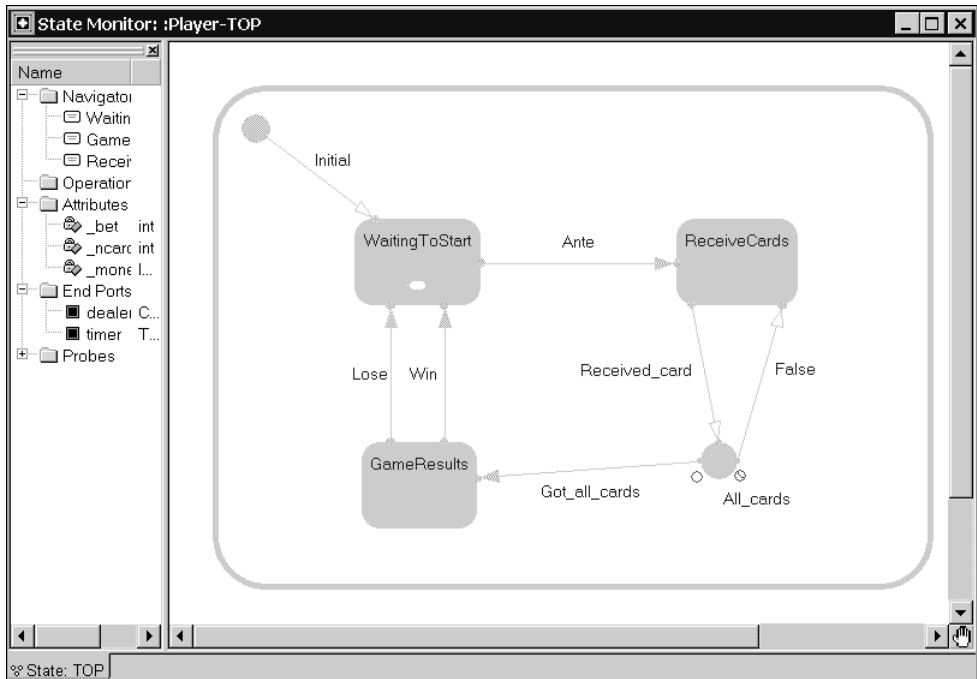



- 5 Select the probe, right-click, and click **Open Trace**.



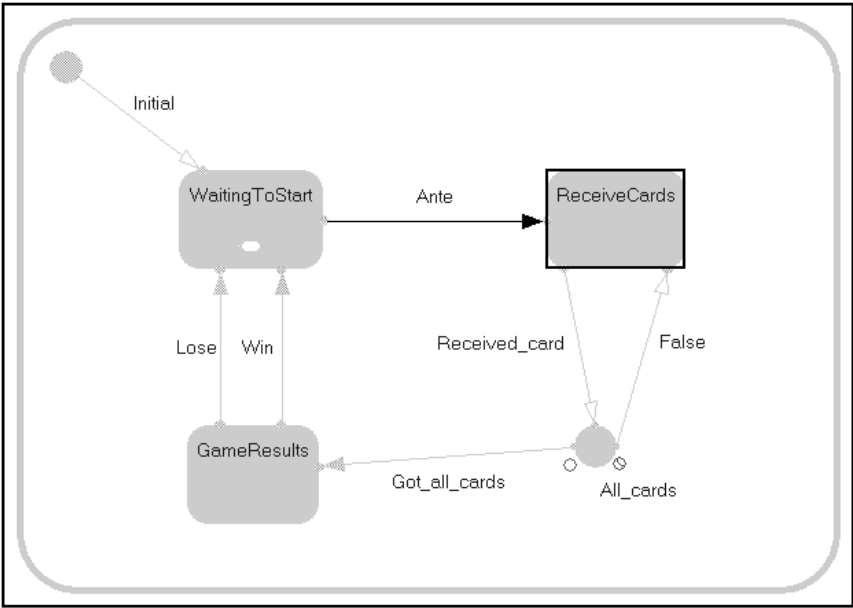
A **Trace** window shows all messages that pass through (in or out) of a port.

- From the **Runtime View** tab, right-click on **Player** and click **Open State Monitor**.

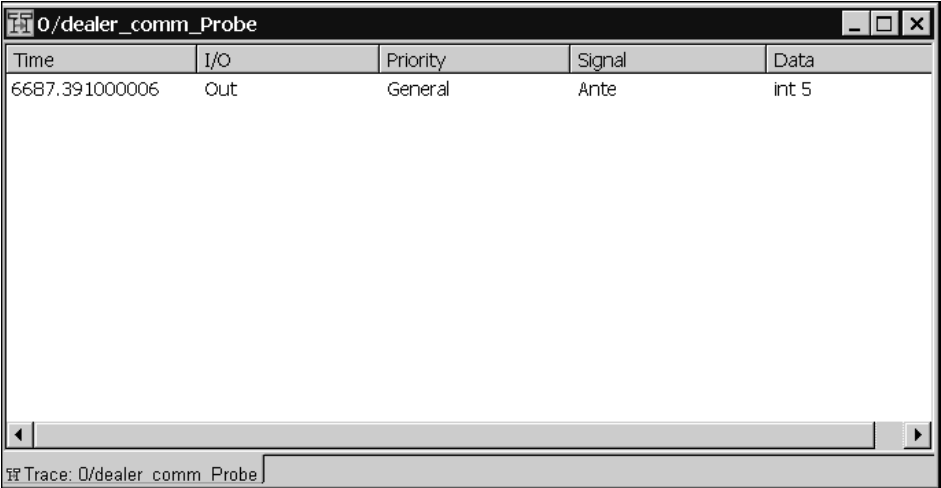


- From the **Runtime View** tab, click the **Start** button  to start the execution of the loaded component instance.

After a two second delay, the state changes from **WaitingToStart** to **ReceiveCards** in the State Monitor diagram for Player.



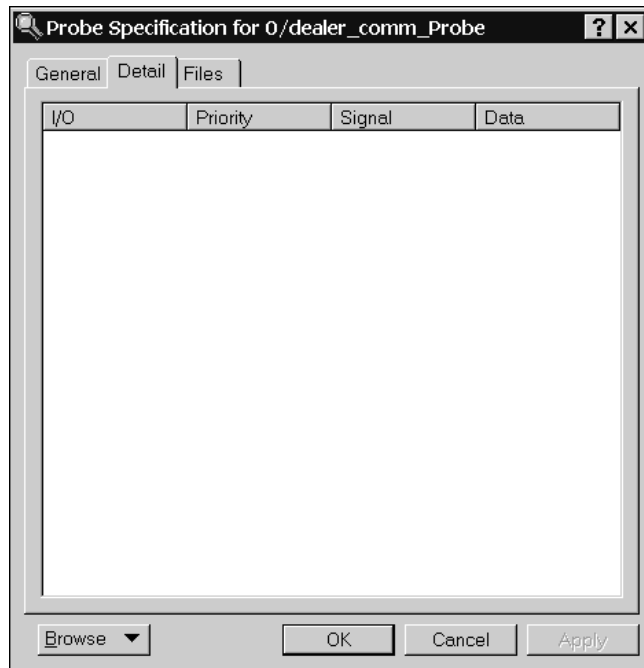
A message appears in the **Trace** window with signal **Ante**.



The Player remains in the **ReceiveCards** state until receiving cards from the **dealer\_comm** port. Since a dealer instance is not running, you will inject messages into the player instance.

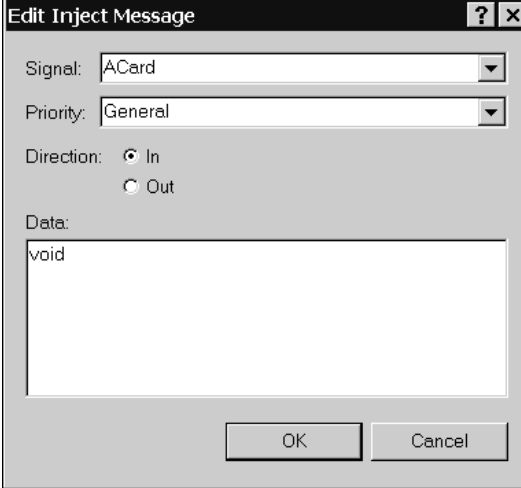
- 8 In the **Structure Monitor** dialog for the **Player** capsule instance, select the probe, right-click and click **Open Inject**.

The **Probe Specification** dialog box appears with the **Detail** page active.



- 9 Right-click in the list, and click **Insert**.  
The **Edit Inject Message** dialog box appears.

- 10 From the **Signal** box, select the **ACard** signal, and set the **Direction** to **In**.



The image shows a dialog box titled "Edit Inject Message". It contains the following fields and controls:

- Signal:** A dropdown menu with "ACard" selected.
- Priority:** A dropdown menu with "General" selected.
- Direction:** Radio buttons for "In" (selected) and "Out".
- Data:** A text area containing the text "void".
- Buttons:** "OK" and "Cancel" buttons at the bottom.

- 11 Click **OK**.

You created the specification for an inject message that appears in the inject list of the **Probe Specification** dialog box.

- 12 In the **Probe Specification** dialog box, select the inject message, right-click, and click **Inject**.

The state monitor shows the behavior moving from the **ReceiveCards** state to the **GameResults**. This is incorrect, and is a symptom of the problem with the **Player** capsule. The **Player** capsule should remain in the **ReceiveCards** state until it receives five cards. Instead, it only receives one card before it changes state.

This indicates that there is an error with the logic in the choice point. In the next steps, you will correct the error and test the changes.

**Note:** Ensure that the **PlayerComponentInstance** component instance is running. You can check the status by looking at the **Status** field at the top of the **RTS Browser** on the **Runtime View** tab: the status should indicate **Running**.

## To correct the error in the Player capsule:

- 1 Without stopping or shutting down the **Player** capsule instance, double-click on the **All\_cards** choice point in the **State Monitor** dialog for the **Player** capsule.

The **Choice Point Specification** dialog box appears.

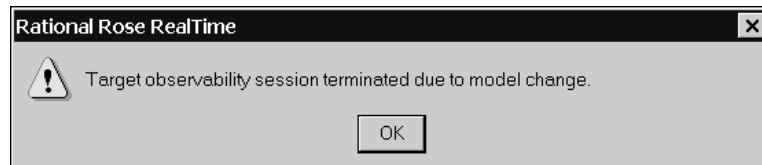


- 2 If not currently selected, click the **Condition** tab.
- 3 Replace the code with:

```
return( ++_ncards >= 5 );
```

- 4 Click **OK**.

A dialog appears indicating that you have changed the model and the component instance must be shut down.




- 5 Click **OK**.

The **RTS Browser** closes.

- 6 In the **Model View** tab in the browser, right-click the **PlayerComponentInstance** in **LocalHost** under **Deployment View**, then click **Run**.

The changes you made earlier force the re-compilation of the **Player** capsule.

- 7 Click **Yes** when queried to recompile the component.
- 8 From the **Runtime View** tab, click the **Start** button  to start the execution of the loaded component instance.

Now, you will inject five **ACard** messages into the player instance to ensure that the capsule behaves as expected.

- 9 In the **Runtime View** tab in the browser, right-click **Player** and select **Open Structure Monitor**.
- 10 On the probe you created earlier, right-click and select **Open Inject**.
- 11 On the **Detail** tab, right-click on the **In** message.
- 12 Click **Inject**.
- 13 Repeat steps 11 and 12 four more times, for a total of five inject messages.

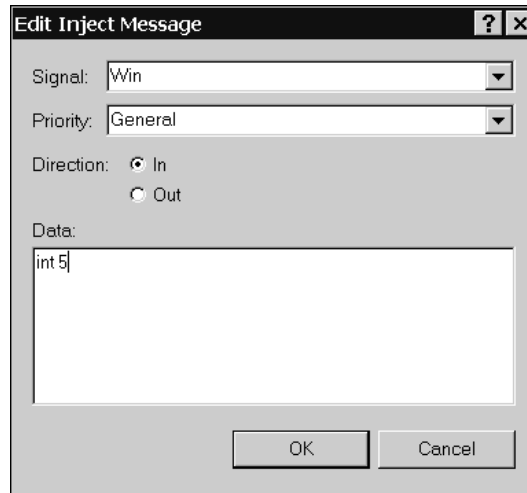
After you inject five cards, the **Player** capsule instance changes to the **GameResults** state. You will now inject a **Win** message.

If you look at the State Diagram, the current state is **GameResults**. Now, you will create a **Win** inject message to test the **Win** transition and complete one hand of the **HeadsUp** poker game.

- 14 In the **Structure Diagram** for the **Player** capsule, right-click on the probe you created earlier, then select **Open Inject**.
- 15 On the **Detail** tab of the **Probe Specification** dialog box, right-click and select **Insert**.



16 In the **Signal** box, select **Win**.



17 In the **Data** box, delete **void** and type:

```
int 5
```

This inject message requires an integer data value that represents the bet multiplier.


18 Click **OK**.

19 On the **Probe Specification** dialog box, select the **Win** signal, right-click and select **Inject**.

You can see the **Win** transition being taken. If you have a watch on the **\_money** attribute, you can see that value is updated correctly to reflect the fact that the player has won.

## Verifying the Fix

You have located and fixed the error with the **Player** capsule. You should now run the simulation and verify that it works as expected. Ensure that unexpected message warnings no longer appear in the console window. Try injecting a **Lose** message to verify that the **\_money** attribute is updated correctly when the player loses.

**Note:** When you finish testing your model, in the **Runtime View** tab of the browser, click the **Shutdown** button . Also, close the **State Monitor**, **Structure Monitor**, **Trace**, and **Probe Specification** dialog boxes.

## Review

In this lesson, you learned how to:

- Use the observability features of the toolset that enable you to debug and test a running process built with Rose RealTime at the model level. Instead of stepping through the generated source code, Rose RealTime shows you a view of the structure diagrams and state diagrams of the running capsule instances.
- Build, run, and test individual capsules at any time. This is very useful for unit testing parts of your design, or trying to isolate a problem.
- Expand the initial analysis and design model and added detailed design components to your model. That includes state diagrams and source code.
- Test the design before starting to expand the implementation details.

The sample model (showing the completed procedures covered to this point in the tutorial) is located in the Rose RealTime installation directory:

```
$ROSERT_HOME/Tutorials/cardgame/cardgame_step2.rtml.
```

Next, you will create and integrate the card classes used by the **Player** and **Dealer** capsules, and used to complete the implementation of the **HeadsUp** poker simulation.

Before continuing with the next lesson, we recommend that you save your work.

## Lesson 8: Class Modeling

---

In this lesson, you will create the structure and behavior for the classes identified from the main use case. This is not an UML tutorial. This tutorial assumes that you have a basic understanding of the UML concepts such as classes, relationships, multiplicity, and polymorphism.

In a previous lesson, you created the main classes, **Card**, **Deck**, and **Hand**, but you have not yet added any details to them. You will be implementing the following class structure in this lesson:

---

<b>Class</b>	<b>Description</b>
Card	Represents a playing card with a suit and rank.  Suit values are: 1 - 4 (Heart, Club, Spade, Diamond)  Rank values are: 1 - 13 (Ace-King)
CardList	Responsible for providing basic memory and access services for a list of cards of any size.
Hand	A hand refers to the cards a player holds in a card game. A hand is a general concept and alone does not represent a specific game hand. It should be specialized for each particular game.  A hand knows how to determine its game value.
Deck	A deck refers to the cards the dealer holds and distributes in a card game. The deck can be shuffled and re-ordered.
PokerHand	Is a specialized hand for poker games. It knows how to evaluate the value of a poker hand. This kind of hand can contain a maximum of five cards.

---

## Importing Classes

To implement the classes, you will add detail code to the classes.

**Note:** If you are **already familiar** with class modeling (for example, if you are an experienced Rose user), you have the option of importing the completed classes into the model. We recommend that you read the tutorial (without having to create the classes and enter the detail level code) because there are some added properties that are specific to Rose RealTime for associations and classes.

### To import classes (only for those familiar with class modeling):

- 1 On the **Model View** tab in the browser, right-click on the **Logical View** folder.
- 2 On the **File** menu, click **Import**.
- 3 Locate the directory that contains the tutorial model, and select the `card_classes.rtptl` file.
- 4 Click **OK**.

The classes in the file are merged into the model. Since you already have classes in your model that have the same names as those being imported, the classes you imported into your model are renamed. If you open the log window, you can see which classes were renamed by the import operation. Delete the classes that you had originally created, and rename the imported classes.

**Note:** The imported classes are contained in their own package, called **CardDefinitions**.

If you import the classes, see *Review* on page 194, and then continue with *Lesson 9: Adding Card Classes to the Capsule Behavior* on page 195.

## Creating a Package


A package is a collection of classes, relationships, use-case realizations, diagrams, and other packages. A package structures the model by dividing it into smaller parts. Packages are used primarily for model organization, and serve as a unit of configuration management. By grouping design model elements into packages, and showing how those groupings relate to one another, it is easier to understand the overall structure of the model.

You will create a package to organize the card classes that will be created.

### To create the package:

- 1 In the **Model View** tab in the browser, right-click on the **Logical View** package, and click **New > Package**

**Or. . .**

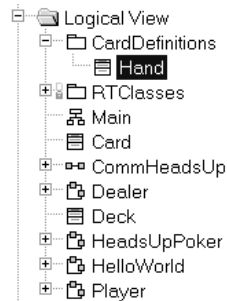
From the toolbox, select the Package button  and click on the diagram.

- 2 Rename the package to **CardDefinitions**.

### To move the classes to the new package:

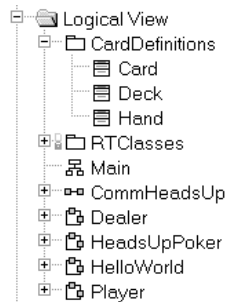
- 1 In the **Model View** tab in the browser, left-click on the **Hand** class and drag the class over top of the **CardDefinitions** package in the **Logical View** folder.

The class element moved to the new package.



- 2 Repeat the previous steps for the **Deck** and **Card** classes.

When finished, your **Logical View** folder will look like the following:



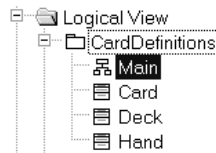
### To create a class diagram for the new package:

You may want to have at least one class diagram per package to describe the contents of the package.

- 1 Right-click on the **CardDefinitions** package, and click **New > Class Diagram**.

A new class diagram is created, with a default name of **NewDiagram**.

- 2 Rename the Class Diagram to **Main**.



## Creating the Initial Class Structure

Each class works together to carry out more behavior than individual classes. From the class descriptions, you can understand the responsibilities of each class. Now, you will specify the relationships between the classes and design how the classes will work together.

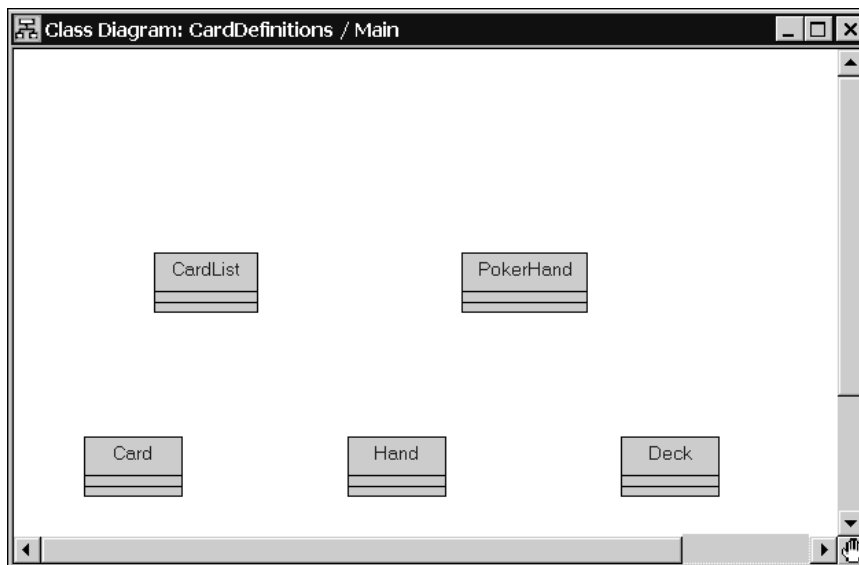
### Suggested Reading:

- The Class Diagram, *Rational Rose RealTime Toolset Guide*
- Creating associations, *Rational Rose RealTime Toolset Guide*

### To populate the class diagram:

- 1 On the **Model View** tab in the browser, expand the **CardDefinitions** package, then double-click **Main** to open the **Class Diagram** window.
- 2 Drag the **Hand** class from the **Model View** tab on to the **Class Diagram** window.
- 3 Repeat the previous step for the **Deck** and **Card** classes.
- 4 From the Toolbox, select the **Class** tool and create two new classes called **CardList** and **PokerHand**.

When finished, your **Class Diagram** for the **CardDefinitions** package will look like the following:




## Creating Relationships Between Classes

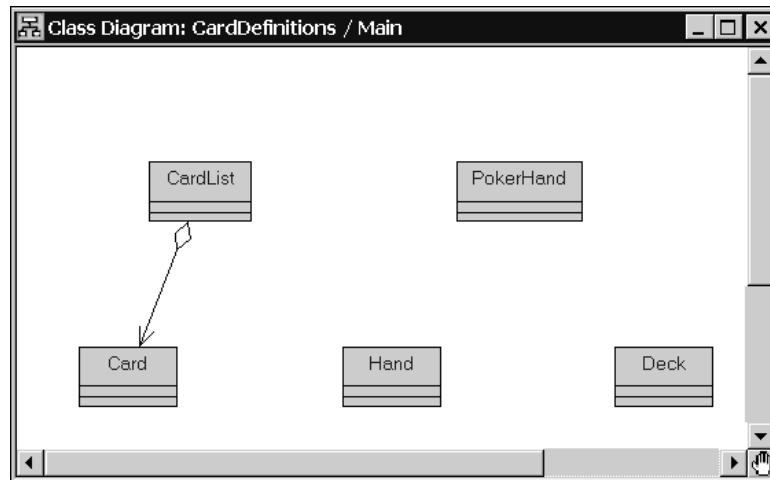
In this topic you will create associations between the card game classes. An association is a structural relationship used to connect one element to another. Associations can be used during analysis to initially identify general relationships between classes. As your model evolves, you will add additional properties to associations to make them more specific.


Aggregation relationships are a form of association relationship that indicate one class (the contained class) is a part-of another class (the container, or aggregate class).

### To create an aggregation between **Card** and **CardList**:

- 1 From the **Class Diagram** toolbox, select the **Unidirectional Aggregate Association** tool .
- 2 Click on the **CardList** class, and drag the mouse to the **Card** class.

An aggregation relationship is created between the two classes. The **Card** class is the part and the **CardList** the whole.

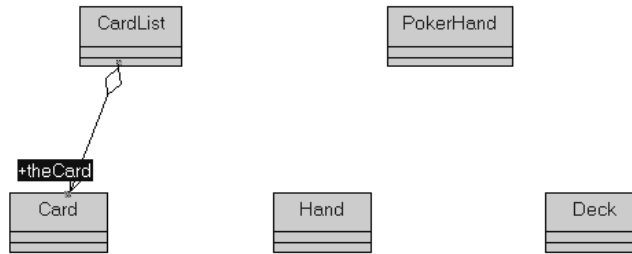


- 3 Right-click on the association end  nearest to the **CardList** class, and clear **Navigable** if it is selected.

The arrow appears that near the **Card** class means that it is not possible to navigate from the **Card** class to the **CardList** class using the association.

- 4 Right-click on the association end near **Card**, and click **End Name**.

A text box near the association end initialized with a default end name.



**5** Rename to **\_contents**.

By default, when an end is named, association, aggregation, and composition relationships are represented in the code as an attribute in the client class. The code generation does not generate attributes for ends which are not named.

**6** Right-click on the association end near **Card**, and click **Protected**.


Protected means that it is visible to this class, any subclasses of this class, and any designated friend classes.

**7** Right-click on the association end near **CardList**, and ensure that **Aggregation > Aggregate** is selected.

Only use aggregation for a composition relationship between classes, where one class is composed of other classes, where the "parts" are incomplete outside the context of the whole.

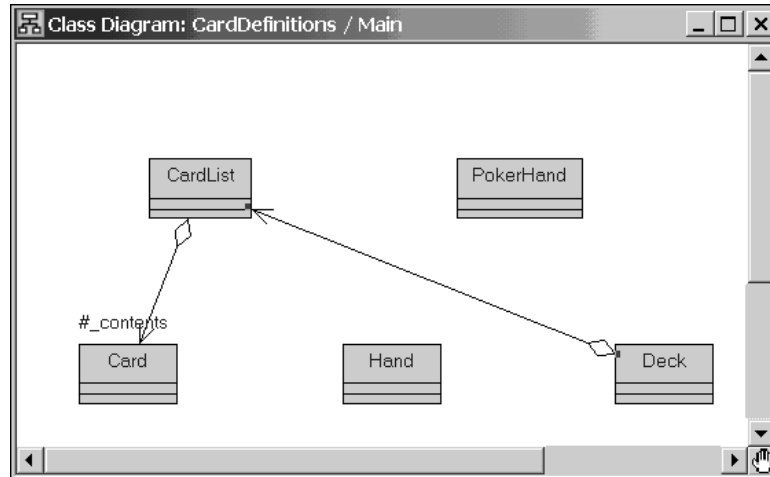
Next, you will create an aggregation relationship between the CardList class and the Deck class. You want to create this relationship because the cards selected for a Player's hand are a subset of the cards from a deck.

**To create an aggregation between CardList and Deck**

- 1 Select the **Unidirectional Aggregate Association** tool .
- 2 Click on the **Deck** class, and drag the mouse to the **CardList**.

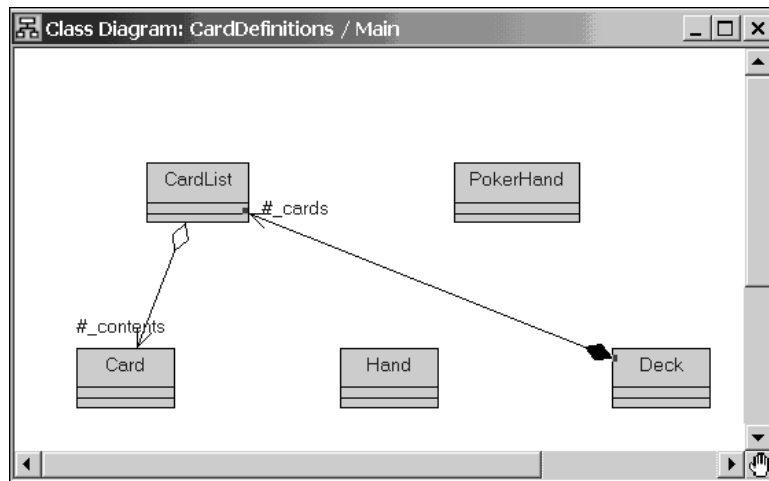


An aggregation relationship is created where **Deck** is the whole-part and **CardList** is the part-of.




- 3 Right-click on the association end closest to the **CardList** class, and click **End Name**.
- 4 Rename the end name to **\_cards**.
- 5 Right-click on the association end near **CardList**, and click **Protected** so that it is checked.
- 6 Right-click on the association end near **Deck**, and click **Aggregation > Composite**.  
Composition is a form of aggregation with strong ownership and coincident lifetime of the part with the aggregate. By implication, a composite aggregation forms a "tree" of parts, with the root being the aggregate, and the "branches" the parts.
- 7 Right-click on the association end near **Deck**, and clear **Navigable** if it is currently set.

Your **Class Diagram** for **CardDefinitions** will look like the following:

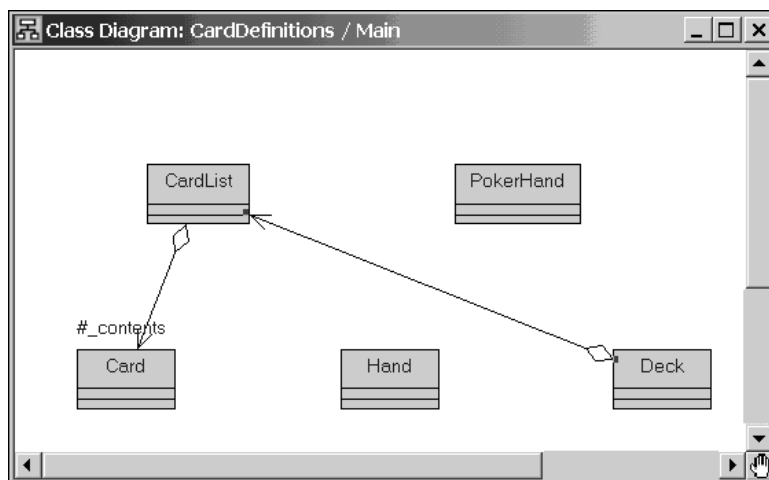


### To create an aggregation between **CardList** and **Hand**

Now, you will create an association between **CardList** and **Hand**.

- 1 Select the **Unidirectional Aggregate Association** tool .
- 2 Click on the **Hand** class, and drag the mouse to the **CardList**.

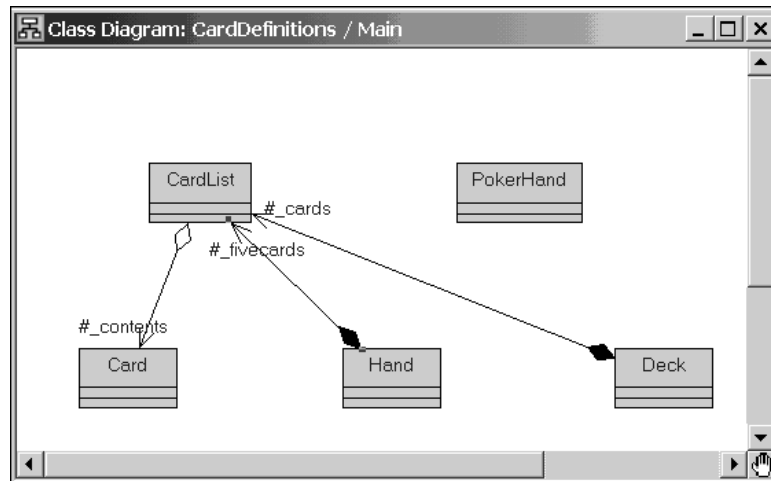
An aggregation relationship is created where **Hand** is the whole-part and **CardList** is the part-of.




- 3 Right-click on the association end closest to the **CardList** class, and click **End Name**.
- 4 Rename the end name to **\_fivecards**.

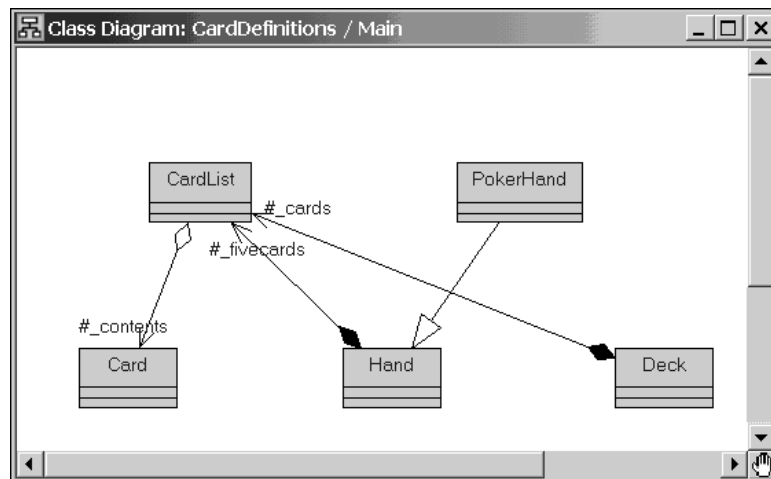
- 5 Right-click on the association end near **CardList**, and click **Protected** so that it is checked.
- 6 Right-click on the association end near **Hand**, and click **Aggregation > Composite**.
- 7 Right-click on the association end near **Hand**, and clear **Navigable** if it is currently set.

When finished, your class diagram will look like the following:



### To create a generalization between Hand and PokerHand

- 1 Select the **Generalization** tool .
- 2 Click on the **PokerHand** class, and drag the mouse to the **Hand** class.



A generalization relationship is created between the two classes. The **Hand** class is the super class and the **PokerHand** the subclass.

## Adding Attributes to the Card Class

The card class represents a playing card, and is identified by a suit (Heart, Diamond, Spade, Club) and rank (Ace through King).

### To create the suit and rank attributes

- 1 From the **Class Diagram** for **CardDefinitions**, double-click the **Card** class.

The **Class Specification for Card** dialog box appears.

- 2 Click the **Attributes** tab.

- 3 Right-click in the **Attributes** list, and click **Insert**.

A new attribute appears in the list.

- 4 Rename the attribute to **rank**.

- 5 Use the **TAB** key to move to the **Type** column, press **F8**, then select **int**.

- 6 Tab to the **Initial** column, press **F8**, then type **0**.

- 7 Right-click on the **rank** attribute, and click **Open Specification**.

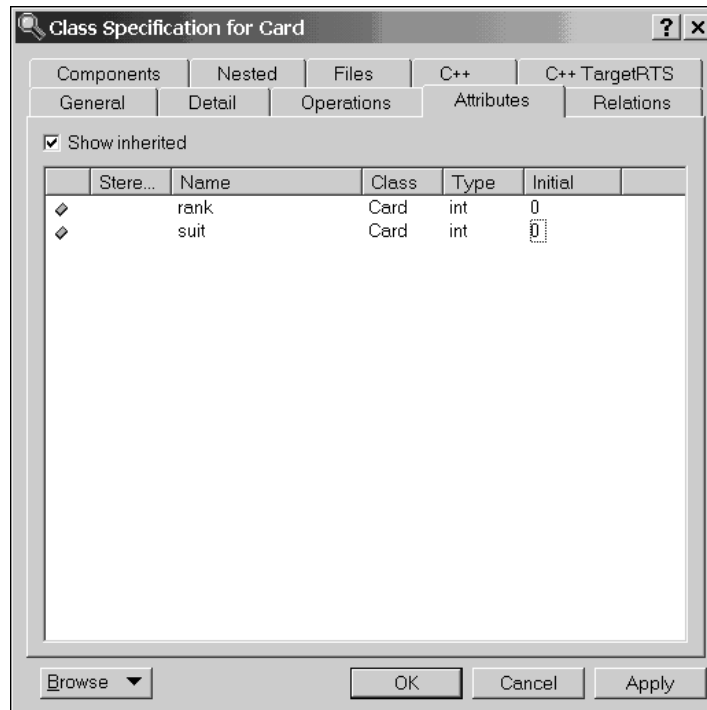
- 8 Click the **General** tab.

- 9 In the **Visibility** area, select **Public**.

- 10 Click **OK**.

- 11 Repeat steps 3 through 10 to create a **suit** attribute of type **int**. Set the initial value to **0**.

When finished, the **Attributes** tab on the **Class Specification** for **Card** dialog box will look like the following:



12 Click OK.

## Adding Details to the CardList Class

The responsibility of the **CardList** class is to manage the memory and access to a list of cards of any size. The **Hand** and **Deck** classes require card lists of different sizes.

The following table describes the attributes and operations that you will create to implement the behavior of the **CardList** class.

**Note:** Previously, you created a relationship between **CardList** and **Card** with the association end name of **\_contents**. When the C++ code generator generates the source code, it creates an attribute in the **CardList** class named **\_contents**.

The following table identifies the attributes and operations that you will create.

<b>Attribute/ Operation</b>	<b>Description</b>
<code>_size</code>	This attribute holds the number of cards that the list contains.
<code>CardList</code>	The <code>CardList</code> constructors allocate memory and initialize the list of cards.
<code>~CardList</code>	The <code>CardList</code> destructor returns the memory allocated for the cards.
<code>size()</code>	Returns the value of the private <code>_size</code> attribute.
<code>operator[]</code>	Allows access to the cards in the list.
<code>operator=</code>	Allows assigning a card list to another.

**Note:** The following steps show you how to add attributes and operations using the Specification dialogs; however, you can also use the Attribute and Operation wizards. Right-click on an element, such as a class or capsule) and click **Attribute Tool** to add or modify an attribute, or click **Operation Tool** to add or modify an operation.

#### To create the attribute `_size`:

- 1 In the **Model View** tab of the browser, expand **Logical View** and double-click **CardList**.  
The **CardList Specification** dialog box appears.
- 2 Click the **Attributes** tab.
- 3 Right-click in the **Attributes** list, and click **Insert**.  
A new attribute appears in the list.
- 4 Rename the attribute to `_size`.
- 5 Use the **TAB** key to move to the **Type** column, press **F8**, then select **int**.
- 6 Tab to the **Initial** column, press **F8**, then set the initial value to **0**.

#### To create the `CardList` constructors

The **CardList** class will have two constructors, a default constructor and a copy constructor. By default, Rose RealTime generates default constructors, destructors, and assignment operators for classes (configured in the **C++** tab). You may have to write your own version of these operations because they have specialized behavior

that cannot be automatically generated by the code generator. When you define these operations, the code generator determines that you created your own, and does not generate default versions of these operations.

Since the **CardList** class will contain a pointer to a list of **Card** objects, you will create the copy constructor, destructor, and assignment operator operations, with no memory leaks.

- 1 In the Class Diagram for CardDefinitions, double-click the CardList class.

The **CardList Specification** dialog box appears.

- 2 Click the **Operations** tab.
- 3 Right-click in the **Operations** list, and click **Insert**.

A new operation appears in the list.

- 4 Rename the operation to **CardList**.
- 5 Double-click on the **CardList** operation.

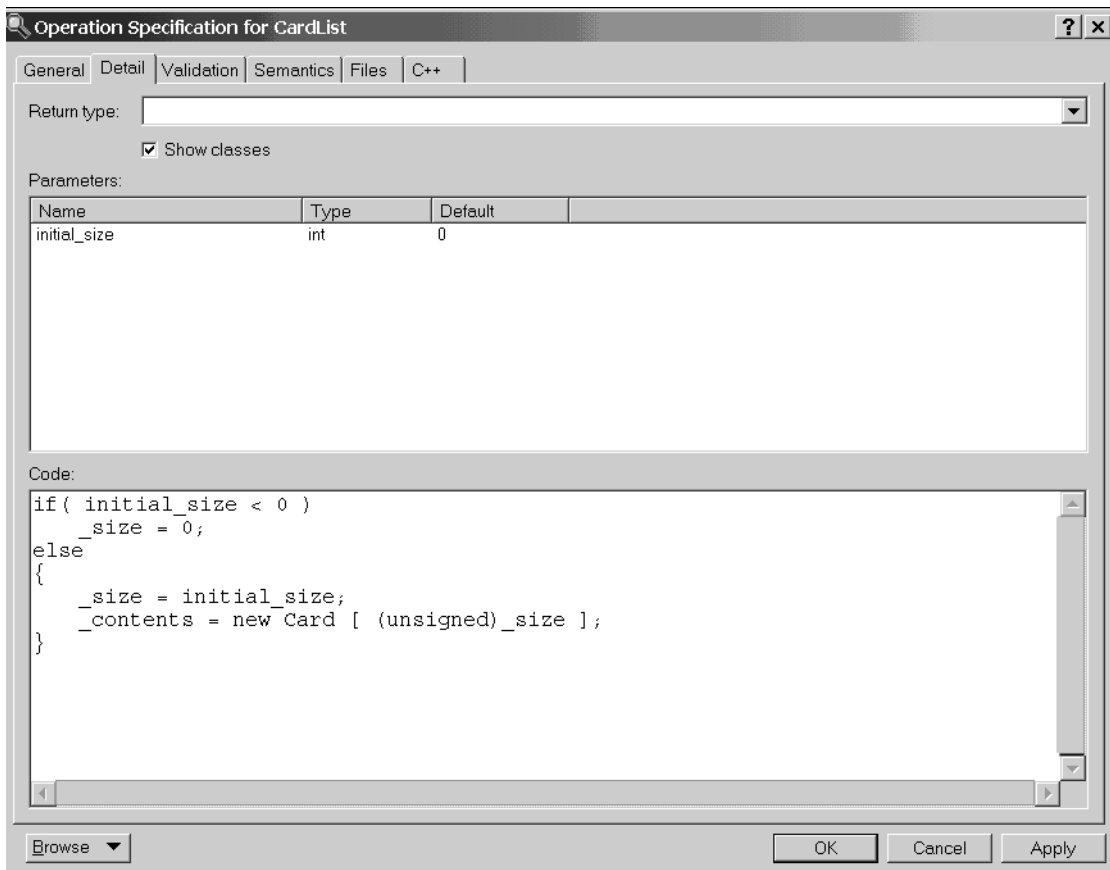
The **Operation Specification** dialog box appears.

- 6 Click the **Detail** tab.
  - 7 Right-click in the parameters list, and click **Insert**.
- A new parameter appears in the list.

- 8 Rename the parameter to **initial\_size**.
- 9 Press TAB to advance to the **Type** column, press F8, then select **int**.
- 10 Press TAB to advance to the **Default** column, press F8, then type **0**.
- 11 In the **Code** box, type the following C++ code:

```
if( initial_size < 0 )
    _size = 0;
else
{
    _size = initial_size;
    _contents = new Card [ (unsigned)_size ];
}
```

When finished, your **Detail** tab will look like the following:



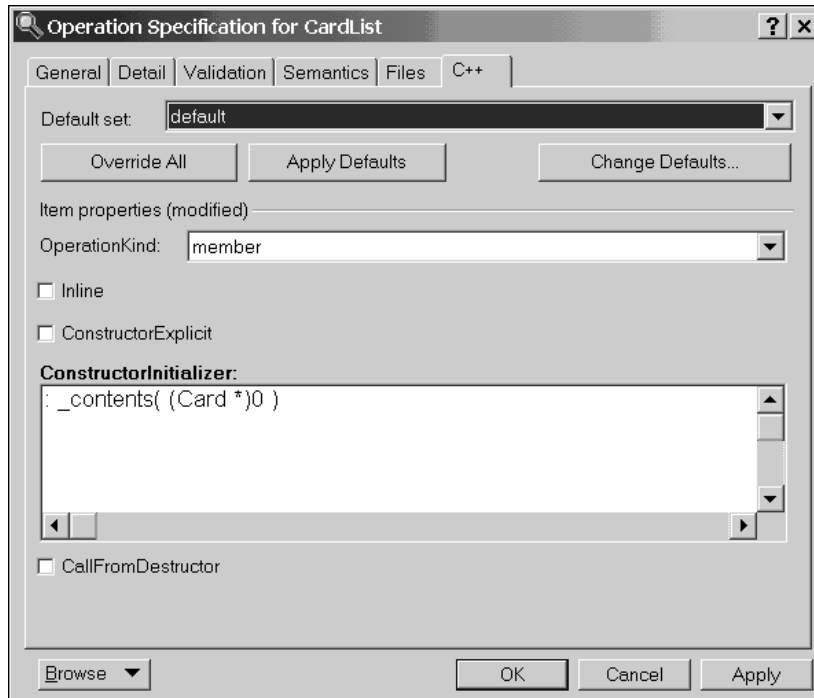
12 Click the **C++** tab.



13 Type the following into the **ConstructorInitializer** box:

```
: _contents ( (Card *)0 )
```

**Note: ConstructorInitializer** provides the initialization parameters for this operation if it is a constructor. It controls the initialization of parent classes and member variables. Be sure to add the colon to start the initializer list.



14 Click **OK** to save the changes, and to return to the **Operations** tab for **CardList**.

Next, you will create the copy constructor with one parameter called **other** of type **const CardList &**.

15 On the **Operations** tab, right-click and click **Insert**.

A new operation appears in the list.

16 Rename the operation to **CardList**.

17 Double-click on the **CardList** operation.

The **Operation Specification** dialog box appears.

18 Click the **Detail** tab.

19 Right-click in the parameters list, and click **Insert**.

A new parameter appears in the list.

**20** Rename the parameter to **other**.

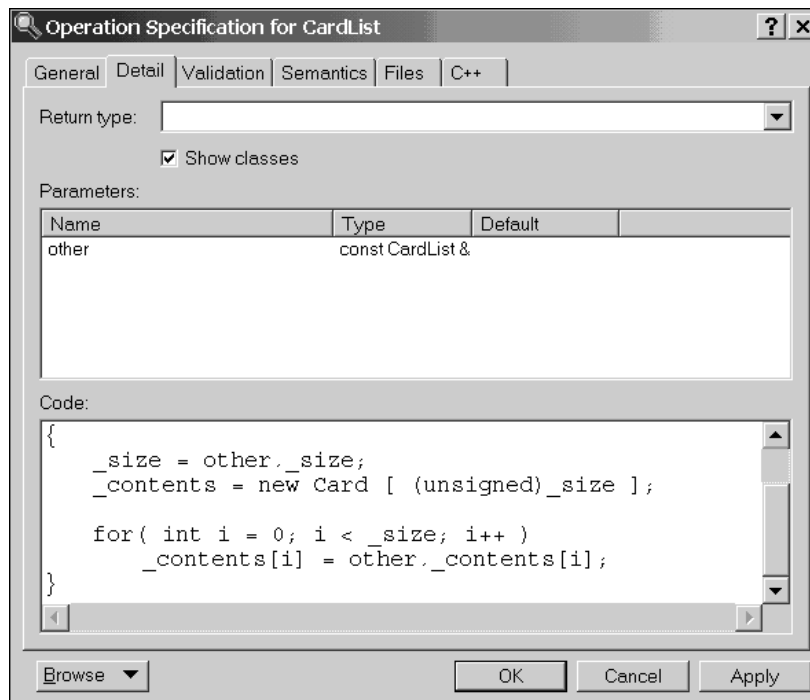
**21** Press TAB to advance to the **Type** column, press F8, then type **const CardList &**.

**22** In the **Code** box, type the following C++ code to the copy constructor:

```
if( other._size < 0 )
    _size = 0;
else
{
    _size = other._size;
    _contents = new Card [ (unsigned)_size ];

    for( int i = 0; i < _size; i++ )
        _contents[i] = other._contents[i];
}
```

The **Detail** tab will look like the following:



23 Click the **C++** tab.

24 Type the following into the **ConstructorInitializer** box for this copy constructor:

```
: _contents( (Card *)0 )
```

25 Click **OK** to save the changes, and to return to the **Operations** tab for **CardList**.

#### To create the destructor:

Because memory is allocated when a **CardList** is created, it is important to free that memory in the destructor.

1 On the **Operations** tab, right-click and click **Insert**.

A new operation appears in the list.

2 Rename the operation to **~CardList**.

3 Double-click on the **~CardList** operation.

The **Operation Specification** dialog box appears.

4 Click the **Detail** tab.

The destructor takes no arguments and does not return a value.

5 In the **Code** box, type the following C++ code to the copy destructor:

```
delete [] _contents;
```

6 Click **OK** to save the changes, and to return to the **Operations** tab for **CardList**.

#### To create the remaining CardList operations:

1 On the **Operations** tab, right-click and click **Insert**.

A new operation appears in the list.

2 Rename the operation to **size**.

3 Double-click on the **size** operation.

The **Operation Specification** dialog box appears.

4 Click the **General** tab.

5 Click **Query** to make this operation **const**.

Selecting Query indicates that the operation is read-only and does not modify the object's state.

6 Click the **Detail** tab.

7 In the **Return Type** box, select **int**.

8 In the **Code** box, type the following C++ code:

```
return _size;
```

9 Click **OK** to save the changes, and return to the **Operations** tab for **CardList**.

10 On the **Operations** tab, right-click and click **Insert**.

A new operation appears in the list.

11 Rename the operation to **operator[]**.

12 Double-click on the **operator[]** operation.

The **Operation Specification** dialog box appears.

13 Click the **Detail** tab.

14 In the **Return Type** box, type **Card &**.

15 Right-click in the parameters list, and click **Insert**.

A new parameter appears in the list.

16 Rename the parameter to **index**.

17 Press **TAB** to advance to the **Type** column, press **F8**, then type **const int**.

18 In the **Code** box, type the following C++ code:

```
return _contents[ index ];
```

19 Click **OK** to save the changes, and to return to the **Operations** tab for **CardList**.

20 On the **Operations** tab, right-click and click **Insert**.

A new operation appears in the list.

21 Rename the operation to **operator=**.

22 Double-click on the **operator=** operation.

The **Operation Specification** dialog box appears.

23 Click the **Detail** tab.

24 In the **Return Type** box, type **CardList &**.

25 Right-click in the parameters list, and click **Insert**.

A new parameter appears in the list.

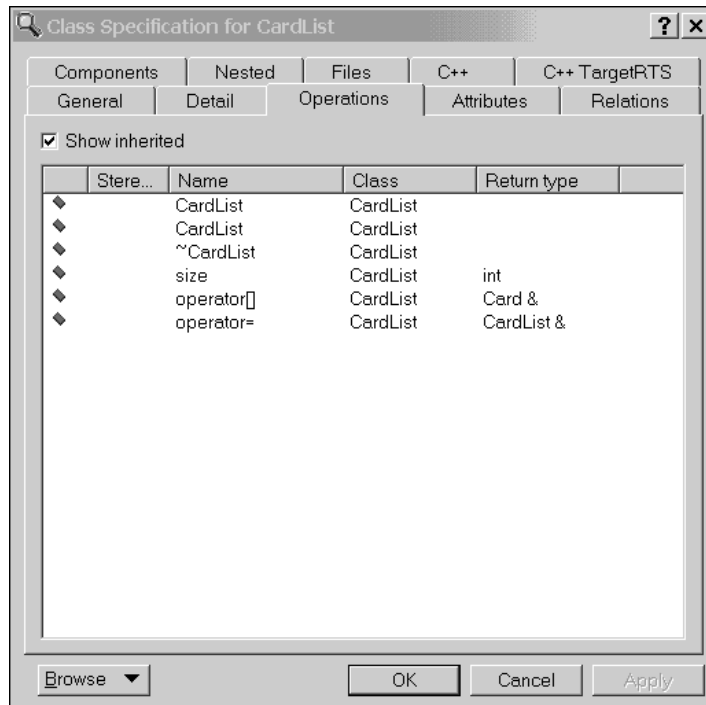
26 Rename the parameter to **rhs**.

27 Press **TAB** to advance to the **Type** column, press **F8**, then type **const CardList &**.

**28** In the **Code** box, type the following C++ code:

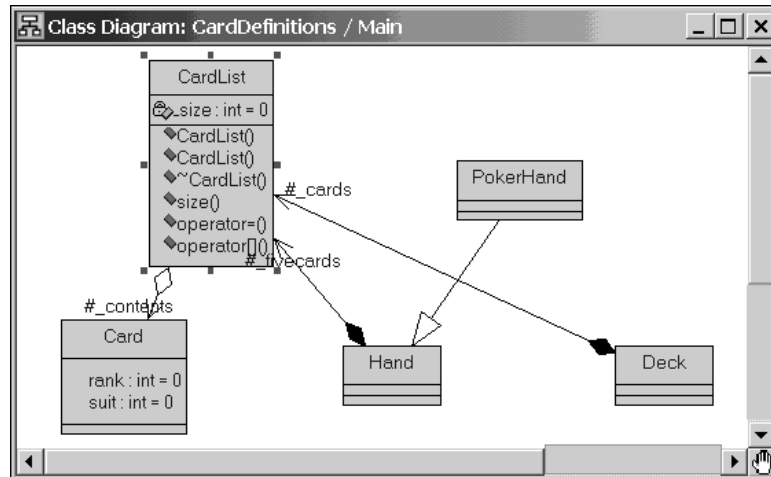
```
if( this != &rhs )
{
    delete [] _contents;
    _size      = rhs._size;
    _contents = new Card [ (unsigned)_size ];
    for( int i = 0; i < _size; ++i )
        _contents[i] = rhs._contents[i];
}
return *this;
```

When finished, your Class Specification for CardList will look like the following:



**29** Click **OK**.

The **Class Diagram** for **CardDefinitions** looks like the following:



**Note:** At this point in the lesson, we recommend that you save, then build your model. If there are compile errors, double-click on an error message on the **Build Errors** tab. Rose RealTime opens the appropriate editor where the source of the error appears. You can then resolve any errors.

## Generating Code for the Association Ends

An association is a relationship among two or more classes. Code can be produced to efficiently traverse the relationship in neither, one, or both directions.

The end of each association is called an **association end** or an **end**. You can label ends with an identifier that describes the role that an associate class plays in the association. An end has both model and language properties that affect the generated code which traverses to that end. For example, marking an end *navigable* means that traversal from the opposite role's class to this end's class is to be implemented. Relative to a given direction of traversal, the ends may be designated as the client end and the supplier end, respectively. Of course, these designations are exchanged when considering traversal in the opposite direction.

By default, an association relationship is represented in code as an **attribute**. In the simplest case, when each client class is associated with exactly one supplier class, the default code that is generated consists of an implementation attribute with a type that is the supplier class and the name is based on the value of the association end name property.

A number of factors affect the actual code generated for an association relationship. The type of the data member is affected by:

- The cardinality and **containment** adornments of the association relationship.
- Visibility adornments.
- The containment of the association in the target class can be by value (composition) or by reference (aggregation).

## Encoding and Decoding by the Services Library

The **CardList** class implements the correct behavior, and is well-formed (that is, no memory leaks). However, there is one thing missing.

When running a model, it is often useful to observe the value of attributes, and modify them at runtime. To allow this, the Services Library must know how to encode and decode the object. It does this by using the classes type descriptor that describes the contents of the class to the Services Library.

### Suggested Reading

- Watch window, *Rational Rose RealTime Toolset Guide*
- Type descriptors, *Rational Rose RealTime C++ Reference*

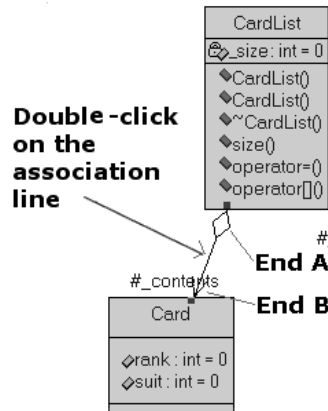
## Encoding and Decoding

The Services Library can encode and decode objects that do not contain attributes that are pointers. However, when attributes are pointers, the Services Library can not determine how many objects are pointed to by the pointer. For classes with pointers to encode and decode, you must include a special operation to inform the Services Library at runtime how many objects are referenced by the pointer.

Since the **CardList** class contains an attribute **\_contents** that is a pointer to a **Card** object (modeled via the aggregation which was set by reference), you must define this special operation.

To create the special operation on the `_contents` association end:

- 1 Double-click the association line between the **Card** and **CardList** class to open the **Association Specification** dialog for the association.



- 2 Click the **C++ TargetRTS B** tab.

Effect on generated code: The end name is generated as a member of the class at the other end of the association. That is, if the class at End A is **Class A** and the class at End B is **Class B**, and the name of End A is **foo**, then **Class B** will have a member named **foo** of type **Class A**.

- 3 In the **NumElementsFunctionBody** box, type the following code:

```
return( source->size() );
```

**NumElementsFunctionBody** provides the body of the function which calculates the number of objects the pointer points to. If the body is empty, the pointer is assumed to point to only one object. This function is required to make attributes which are pointers to arrays observable in the execution monitors.

- 4 Click **OK**.

## NumElementsFunctionBody code

The code entered into this property is added to an operation created by the code generator:

```
int _rtg_nefb_CardList__contents( const RTTypeModifier * modifier,
const CardList * source )
{
    return( source->size() );
}
```



The name of the operation is different for each attribute or association end that has the **NumElementsFunctionBody** defined. However, the signature is always defined the same way. The operation must return an **int** that represents the number of objects referenced by the pointer, and has a parameter called **source** that points to the object of the class that contains the attribute.

For the **CardList** class, you used the **size()** operation to return to the number of card objects the **\_contents** pointer references.

## Adding Details to the Deck Class

The following table describes the attributes and operations that you will create to implement the behavior of the Deck class.

<b>Attribute/ Operation</b>	<b>Description</b>
<code>_top</code>	Tracks the index of the next card taken from the deck.
<code>Deck</code>	The Deck constructor creates a deck with a specified number of cards.
<code>shuffle</code>	Shuffles the cards in the deck (for any size of deck).
<code>init</code>	Orders all cards in the deck by suit, then by rank.
<code>get</code>	If the deck is not empty, it removes a card from the top of the deck.
<code>size</code>	Returns the initial size of the deck.

### To create the Deck attribute and operations

- 1 In the **Model View** tab in the browser, under **Logical View**, expand **CardDefinitions** and double-click on **Main** to open the **Class Diagram**.

Or...

From the Toolbar, select the **Browse Class Diagram** button , then select **CardDefinitions** from the list.

- 2 Double-click the **Deck** class.
- 3 Click the **Attributes** tab.
- 4 Right-click and click **Insert**.
- 5 Rename the attribute to **\_top**.
- 6 Press TAB to advance to the **Type** column, press F8, then select **int**.

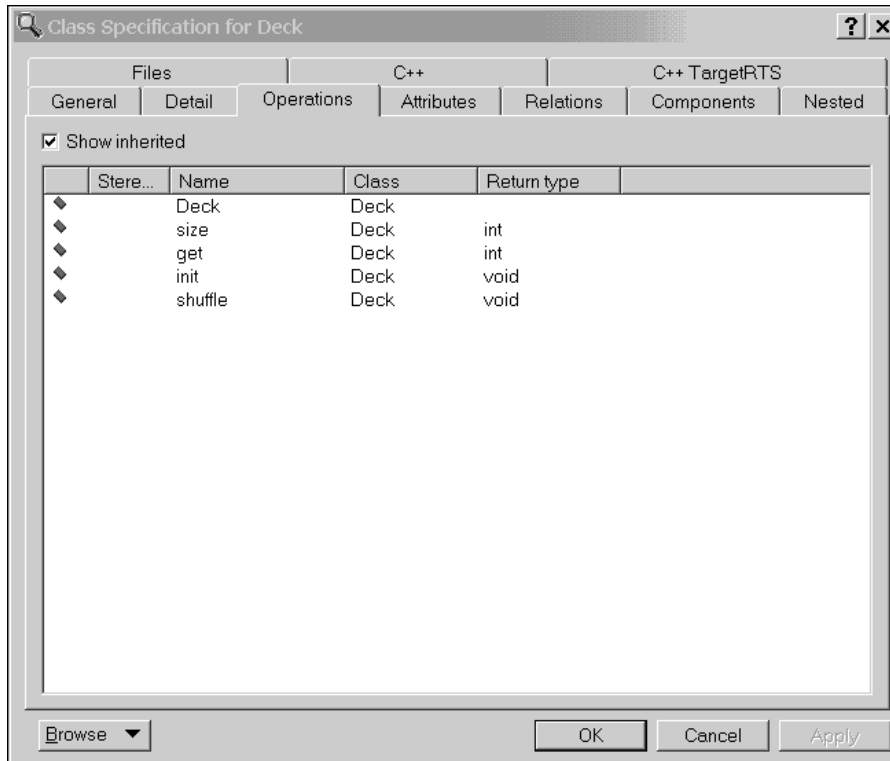
- 7 Press TAB to advance to the **Initial** column, press F8, then type 0.
- 8 Click the **Operations** tab.
- 9 Right-click and click **Insert**.
- 10 Rename the operation to **Deck**.
- 11 Double-click the **Deck** operation.
- 12 Click the **Detail** tab.
- 13 In the **Parameters** box, right-click and click **Insert**.
- 14 Rename the parameter to **initial\_size**.
- 15 Press TAB to advance to the **Type** column, press F8, then select **int**.
- 16 Click the **C++ tab** for Operations.
- 17 In the **Constructor/Initializer** box, type the following code:  

```
: _cards( initial_size ), _top( 0 )
```
- 18 Click **OK**.
- 19 Follow steps 8 through 18 and add these operations:

Operation name	Return Type	Parameters	Parameter type	Code
size	int			return _cards.size();
get	int	card	Card &	if( _top == size() ) return 0;  card = _cards[ _top++ ];  return 1;
init	void			int suit = 1;  for( int start = 0 ; start < size() ; start++ ) { _cards[ start ].rank = (start % 13) + 1; _cards[ start ].suit = suit;  if( _cards[ start ].rank == 13 ) suit++; }  _top = 0;

<b>Operation name</b>	<b>Return Type</b>	<b>Parameters</b>	<b>Parameter type</b>	<b>Code</b>
shuffle	void			<pre> // suffle any size of card deck int swap = 150; int index1, index2; Card temp; int split = size() / 2;  init();  srand( (unsigned)time( NULL ) );  for( int i = 0 ; i &lt; swap ; i++ ) { // pick two random cards index1 = rand() % split; index2 = rand() % (split * 2);  // swap cards temp      = _cards[ index1 ]; _cards[ index1 ] = _cards[ index2 ]; _cards[ index2 ] = temp; } </pre>

When finished, your **Class Specification for Deck** dialog box will look like the following:



20 Click **OK**.

## Adding Details to the Hand Class

The following table describes the attributes and operations that you will create to implement the behavior of the **Hand** class.

<b>Attribute/ Operation</b>	<b>Description</b>
add	Adds a card to the Hand at a specified offset within the hand.
get	Returns the specified card (at an offset within the hand) .
Hand	The hand constructor creates a card hand with a specified number of cards.
size	Returns the number of cards in the hand.
value	It is meant to be overridden by subclasses to return the value of a given hand, which depends on the card game being played.

## To create the Hand operations

- 1 In the **Class Diagram** for **CardDefinitions**, double-click the **Hand** class.
- 2 Click the **Operations** tab.
- 3 Right-click and click **Insert**.
- 4 Rename the operation to **add**.
- 5 Double-click the **add** operation.
- 6 Click the **Detail** tab.
- 7 In the **Return Type** box, select **int**.
- 8 In the **Parameters** box, right-click and click **Insert**.
- 9 Rename the parameter to **card**.
- 10 Press TAB to advance to the **Type** column, press F8, then type **const Card &**.
- 11 In the **Parameters** box, right-click and click **Insert**.
- 12 Rename the parameter to **index**.
- 13 Press TAB to advance to the **Type** column, press F8, then select **int**.
- 14 In the **Code** box, type the following code:

```
if( index >= _fivecards.size() )
    return 0;
else
    _fivecards[ index ] = card;
return 1;
```
- 15 Click the **General** tab.
- 16 In the **Visibility** area, select **Public**.
- 17 Click **OK**.
- 18 Follow the steps above to add the following operations to the **Hand** class:

Name	Return Type	Parameter name	Parameter type	Code	General tab settings
get	Card &	index	int	return _fivecards[ index ];	Public
Hand		initial_size	int		
size	int			return _fivecards.size();	Public Query
value	int			return 0;	Public Polymorphic

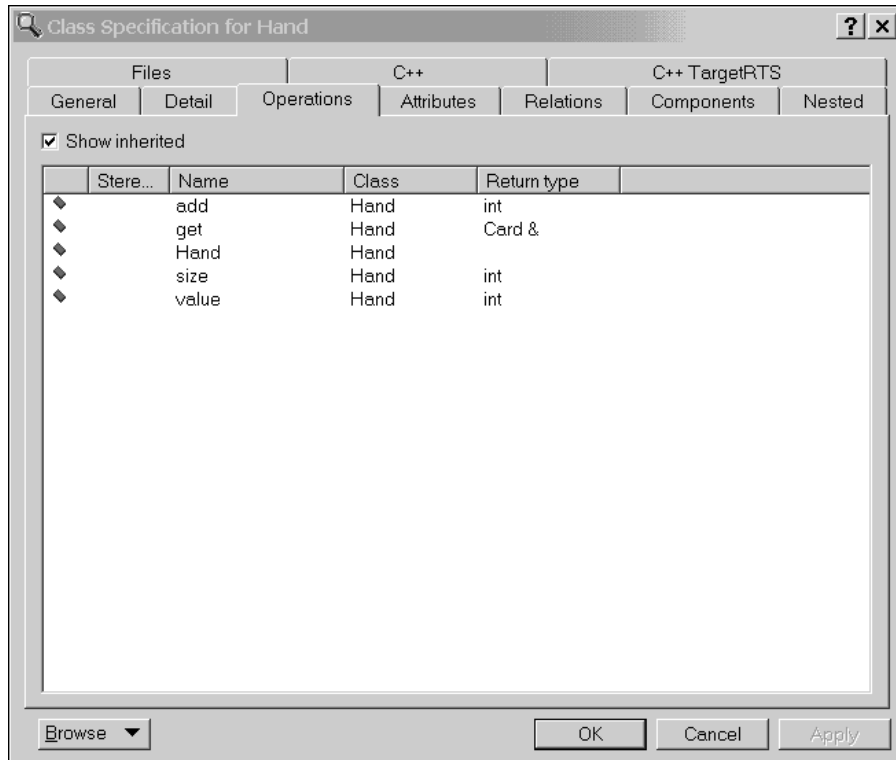
**Note:** Setting the size operation to **Query** makes the operation **const**. Setting the value operation to **Polymorphic** makes the operation virtual.

**19** Double-click the **Hand** operation and click the **C++** tab.

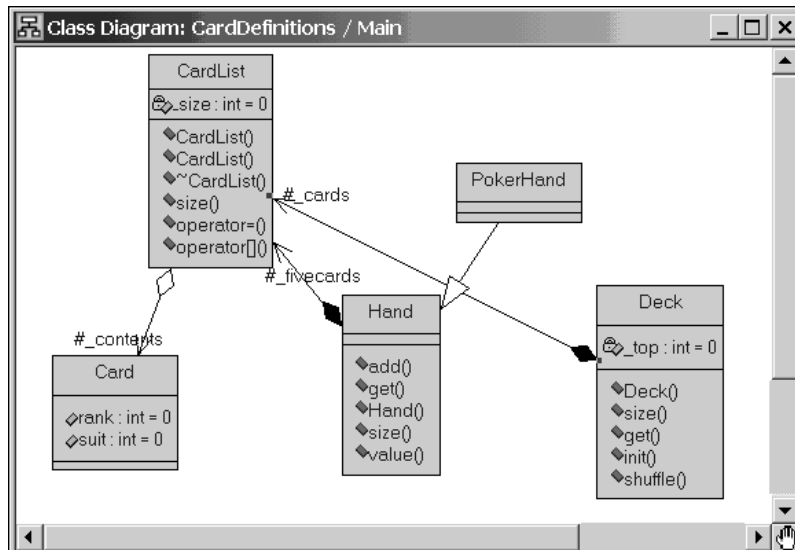
**20** Set the **ConstructorInitializer** property to:

```
: _fivecards( initial_size )
```

When completed the **Class Specification** for **Hand** dialog box will look like the following:



The **Class Diagram** for **CardList** looks like the following:



## Adding Details to the PokerHand Class

The following table describes the attributes and operations that you will create to implement the behavior of the **PokerHand** class.

<b>Attribute/ Operation</b>	<b>Description</b>
PokerHand	The PokerHand constructor creates a hand that contains five cards.
value	Overrides the virtual Hand operation to calculate the value of a five card poker hand with no wild cards.

### To create the PokerHand operations

1 In the **Class Diagram** for **CardDefinitions**, double-click the **PokerHand** class.

2 Click the **Operations** tab.

3 Right-click and click **Insert**.

4 Rename the operation to **PokerHand**.

5 Double-click the **PokerHand** operation.

6 Click the **C++** tab.

7 Set the **ConstructorInitializer** property to:

```
: Hand( 5 )
```

8 Click **OK**.

9 On the **Operations** tab, right-click and click **Insert**.

10 Rename the operation to **value**.

**Note:** The **Operations** tab already contains an operation called value. The existing value operation is for the **Hand** class. The value operation that you are adding is for the **PokerHand** class.

11 Double-click the **value** operation.

12 Click the **Detail** tab.

13 In the **Return Type** box, select **int**.



**14** In the **Code** box, type the following code:

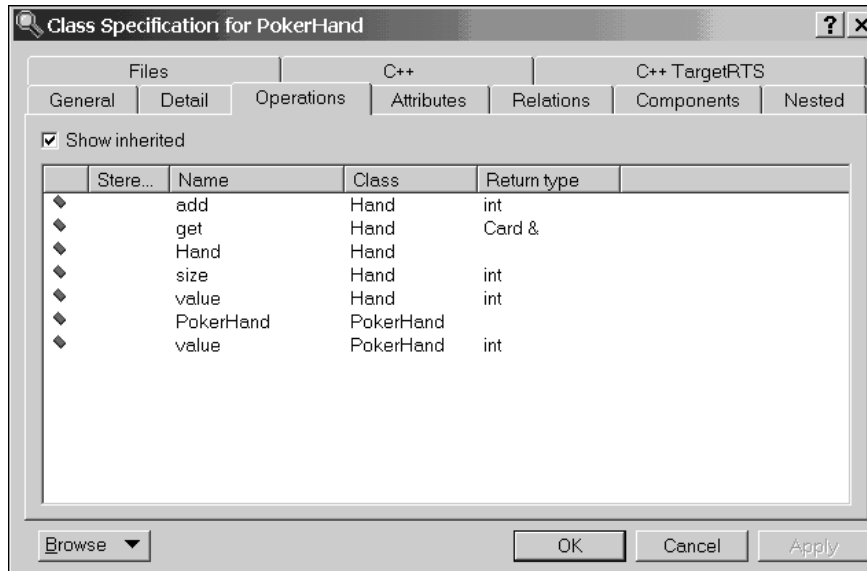
```
// Evaluates a hand and returns the following results:  
// 1 - one pair  
// 2 - two pairs  
// 3 - three of a kind  
// 4 - full house  
// 6 - four of a kind  
  
int result = 0;  
for( int i = 0 ; i < size() ; i++ )  
{  
    for( int j = i + 1; j < size() ; j++ )  
    {  
        if( _fivecards[i].rank == _fivecards[j].rank )  
            result++;  
    }  
}  
return result;
```

**15** Click the **General** tab.

**16** In the **Options** area, select **Polymorphic** to make this operation virtual.

**17** Click **OK**.

The Class Diagram for CardList looks like the following:



**Note:** We recommend that you save, then build your model. If there are compile errors, double-click on an error message on the **Build Errors** tab. Rose RealTime opens the appropriate editor where the source of the error appears. You can then resolve any errors.

## Review

The goal of Lesson 8 was to create the classes used by the **Dealer** and **Player** capsules to implement the card simulation. The classes represent the information used in the system, namely the data that describes the cards used in a card game.

Rose RealTime allowed you to add all implementation details to the classes from within the toolset.

The key points to remember when class modeling are:

- **Classes must be well-formed.** The developer is responsible for ensuring that their classes do not leak memory. Rose RealTime can generate default copy constructors, assignment operators, and destructors for classes. However, these default operations only work with simple classes, that is, classes without pointers (dynamic memory). Most often, you will have to implement the copy constructor, assignment operator, and destructor.

- **NumFunctionElementsBody** must be defined for all pointer (by reference) attributes/association ends observed at runtime. This allows the Services Library to decode the objects references by the pointer.
- **ConstructorInitializer** allows you to add attributes to the initializer list of any constructor.
- **Association ends** that are named are generated as attributes of the target class. If a navigable association end is not named, the code generator does not generate an attribute.

The sample model showing the completed procedures covered to this point in the tutorial is located in the Rose RealTime installation directory:

```
$ROSERT_HOME/Tutorials/cardgame/cardgame_step3.rtm1.
```

Next, you will use these classes to finish the card game simulation.

## Lesson 9: Adding Card Classes to the Capsule Behavior

---

In the first iteration of the card game simulation, you did not use any cards. The Dealer and Player simply exchanged signals with no data. You will extend the capsule behavior to use the newly developed card classes. The **ACard** signal was originally sent without data, but now the Player and Dealer capsules will send cards to one another.

### To add the Card class to the ACard signal:

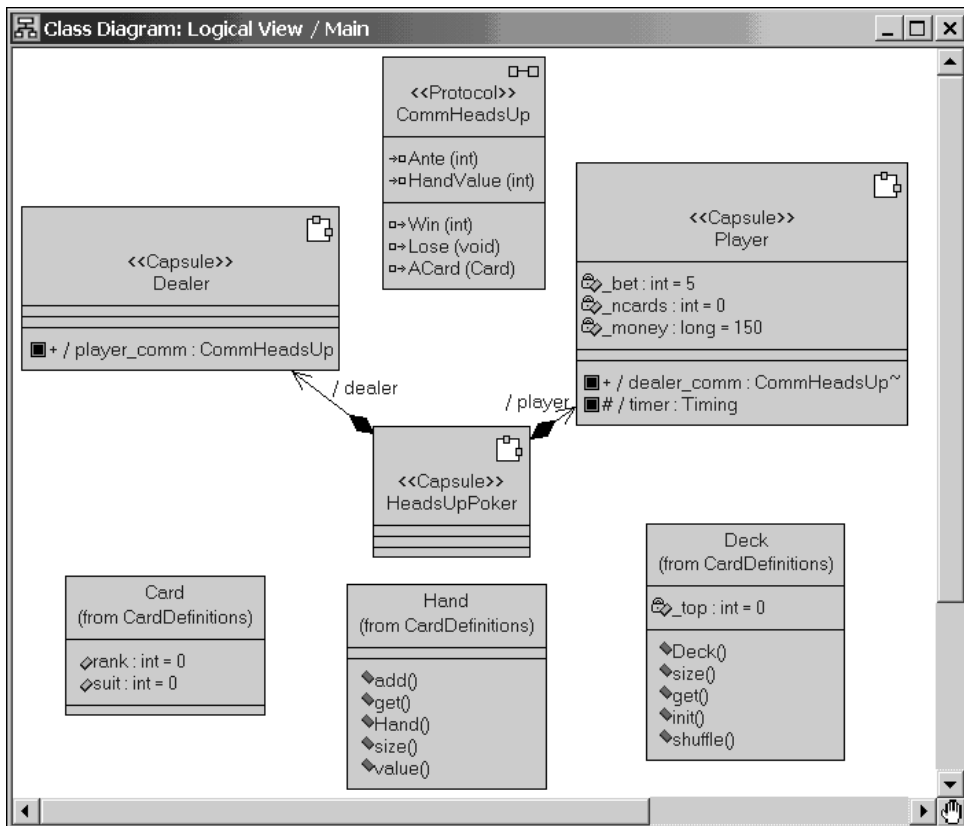
- 1 Open the **CommHeadsUp** protocol (Logical View), and click the **Signals** tab.
- 2 In the **Data Class** column for the **ACard** out signal, press F8 and change the data class from **void** to **Card**.
- 3 Click **OK**.

### Completing the Dealer Capsule Behavior

In the scenario description of the use case defined for the card game simulation, the Dealer poses the deck from where the cards are dealt, as well as the Dealer hand.

## To add the deck and hand attributes to the Dealer:

- 1 Open the **Capsule Specification for Dealer** dialog box.



- 2 Click the **Attributes** tab.
- 3 Insert an attribute called `_hand` of type **Hand \*** that has an initial value of **(Hand \*)0**.
- 4 Insert an attribute called `_deck` of type **Deck** that has an initial value of **52**.

Adding the initial value to a capsule attribute initializes the attributes when the capsule is created.

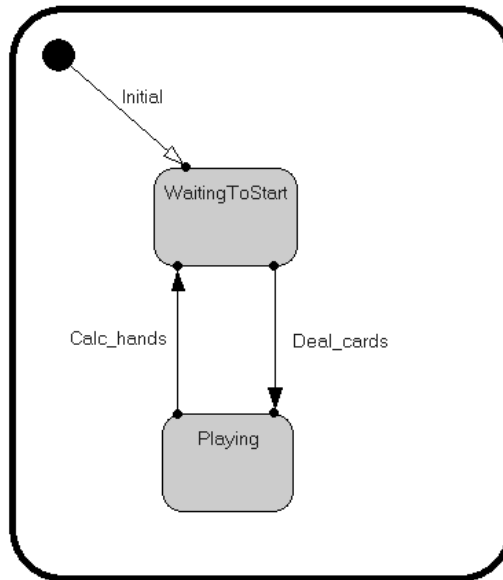


5 Click **OK**.

### To modify the state diagram (behavior)

Previously, only empty signals were sent from the Dealer to the Player. You will modify the Dealer's **State Diagram** to use the **Deck** and **Hand** classes to send cards from the deck, and to also maintain the Dealer hand. At the end of each game the Player sends the value of his hand to the Dealer. The Dealer then decides who wins based on the value of both hands.

- 1 Open the **State Diagram** for the **Dealer** capsule.



- 2 Double-click the **Initial** transition line, and click the **Actions** tab.
- 3 In the **Code** window at the bottom right, type the following code to initialize a new **PokerHand** and shuffle the deck:  

```
_hand = new PokerHand;
_deck.shuffle();
```
- 4 Click **OK**.

Now, you will use the **Code** window in the lower right-hand corner to perform the same task of adding code to transitions rather than using the **Specification** dialogs.

- 5 Select the **Deal\_cards** transition line.
- 6 In the **Code** window, select **Action** from the drop-down list if it is not currently selected.
- 7 In the **Code** window, replace the existing code with the following code that determines who deals the cards:

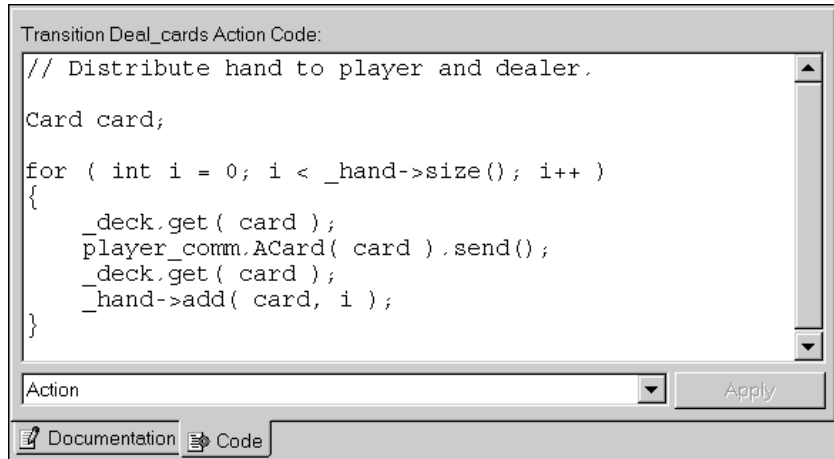
```
// distribute hands to player and take one for myself
Card card;
for( int i = 0; i < _hand->size(); i++ )
{
    _deck.get( card );
    player_comm.ACard( card ).send();
}
```

```

    _deck.get( card );
    _hand->add( card, i );
}

```

Your **Code** window will look like the following:



**8** Click **Apply**.

**Note:** You can either use the **Code** window or the **Specification** dialogs to type code for the remaining transitions. The tutorial lesson will continue using the **Specification** dialogs.

**9** Double-click the **Calc\_hands** transition line, and click the **Actions** tab.

**10** In the **Code** box, replace the existing code with the following code that determines who won the game:

```

// compare the players hand to ours. If the Player has a better
// hand then the Player wins; otherwise, the Dealer wins.
if( *rtdata > _hand->value() )
    player_comm.Win(2).send();
else
    player_comm.Lose().send();

// shuffle deck for next game
_deck.shuffle();

```

**11** Click **OK**.

## Adding a Destructor to the Dealer Capsule

Because the **Dealer** capsule allocates memory from the heap using the new operation, you must return the memory. You will add a destructor operation to the **Dealer** capsule. The destructor on the capsule is called when a capsule instance is destroyed.

### To add a destructor operation

- 1 Open the **Capsule Specification for Dealer** dialog , and click the **Operations** tab.
- 2 Right-click, select **Insert**, and rename the operation to **~Dealer**. Do not specify a return type.
- 3 Double-click the **~Dealer** operation.
- 4 In the **Code** box on the **Detail** tab, type the following code:

```
delete _hand;
```
- 5 Click **OK**.
- 6 Click **OK**.

## Completing the Player Capsule Behavior

The player receives cards from the Dealer that become the Player's hand. You will modify the Player capsule to have a hand, and to give cards to the hand as they are received from the Dealer.

### To add the Hand attribute to the player:

- 1 Open the **Capsule Specification for Player** dialog, and click the **Attributes** tab.
- 2 Insert an attribute called **\_hand** of type **Hand \*** that has an initial value of **(Hand \*)0**.  
Adding the initial value to a capsule attribute initializes the attributes when the capsule is created.
- 3 Click **OK**.

### To modify the state diagram (behavior)

Only empty signals were sent from the Dealer to the Player. Now, you will modify the Player's **State Diagram** to use the **Hand** classes to hold the cards sent from the Dealer. At the end of each game, the Player sends the value of his hand to the Dealer.

- 1 Open the **State diagram** for the **Player** capsule.
- 2 Double-click the **Initial** transition line, and click the **Actions** tab.



3 In the Code box, type the following code to initialize a new PokerHand:

```
_hand = new PokerHand;
```

4 Click **OK**.

5 Double-click the **Received\_card** transition line, and click the **Actions** tab.

6 In the **Code** box, replace the existing code with the following code that receives a card, and add the value to the hand:

```
_hand->add( *rtdata, _ncards++ );
```

7 Click **OK**.

8 Double-click the **All\_cards** Choice Point, and click the **Condition** tab.

9 In the Code box, replace the existing code with the following code that determines whether the player received all cards from the Dealer:

```
return( _ncards >= _hand->size() );
```

10 Click **OK**.

11 Double-click the **Got\_all\_cards** transition line, and click the **Actions** tab.

12 In the **Code** box, replace the existing code with the following code that sends the value of the Player's hand to the Dealer:

```
// Send the value of the hand to the Dealer  
dealer_comm.HandValue( _hand->value() ).send();
```

13 Click **OK**.

## Using Attributes Versus Aggregations

You could have used aggregation between the capsules and the card classes instead of creating attributes. The decision of using associations versus attributes depends on your project guidelines.

## Adding Dependencies

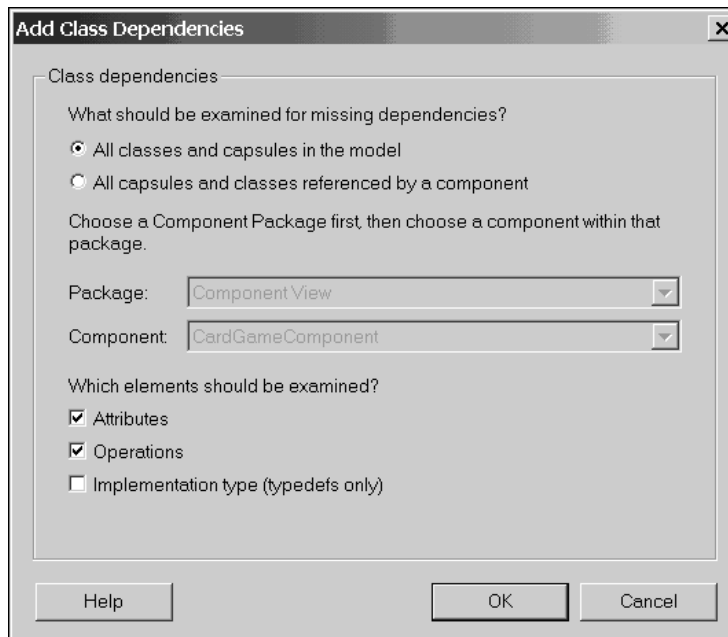
Before you can compile the model, you have to explicitly add dependencies between the capsules and classes. A dependency specifies that a class or capsule uses a target class. Dependency relationships are converted to C++ as either forward references or inclusions in header and implementation files.

The **Add Dependencies** add-in can search a set of classes and capsules looking at attribute types, operation return values, and parameters and can automatically create dependencies. There are some dependencies that the add-in cannot find (such as, code dependencies).

If you compiled the model now, the compiler would report that certain types are not defined. When you are programming, if an inclusion or forward reference is missing, the compiler cannot resolve certain symbols defined in other files.

### To add the dependencies:

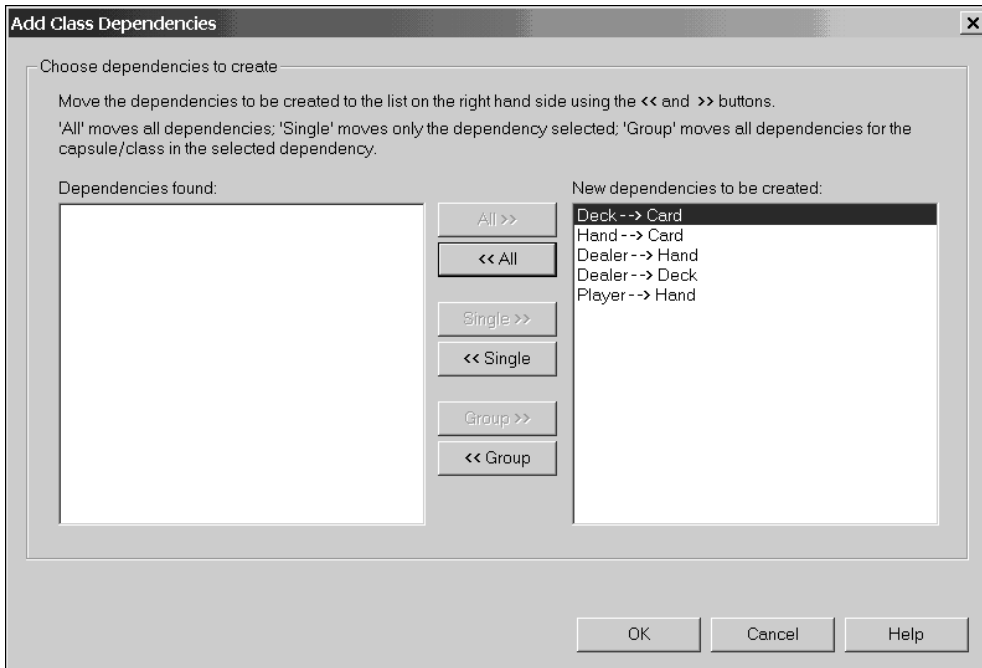
- 1 On the **Build** menu, click **Add Class Dependencies** to create the dependencies.
- 2 In the **Add Class Dependencies** dialog box, select **All classes and capsules in the model**.
- 3 In the **Which elements should be examined?** box, click **Attributes** and **Operations** only.



4 Click **OK**.

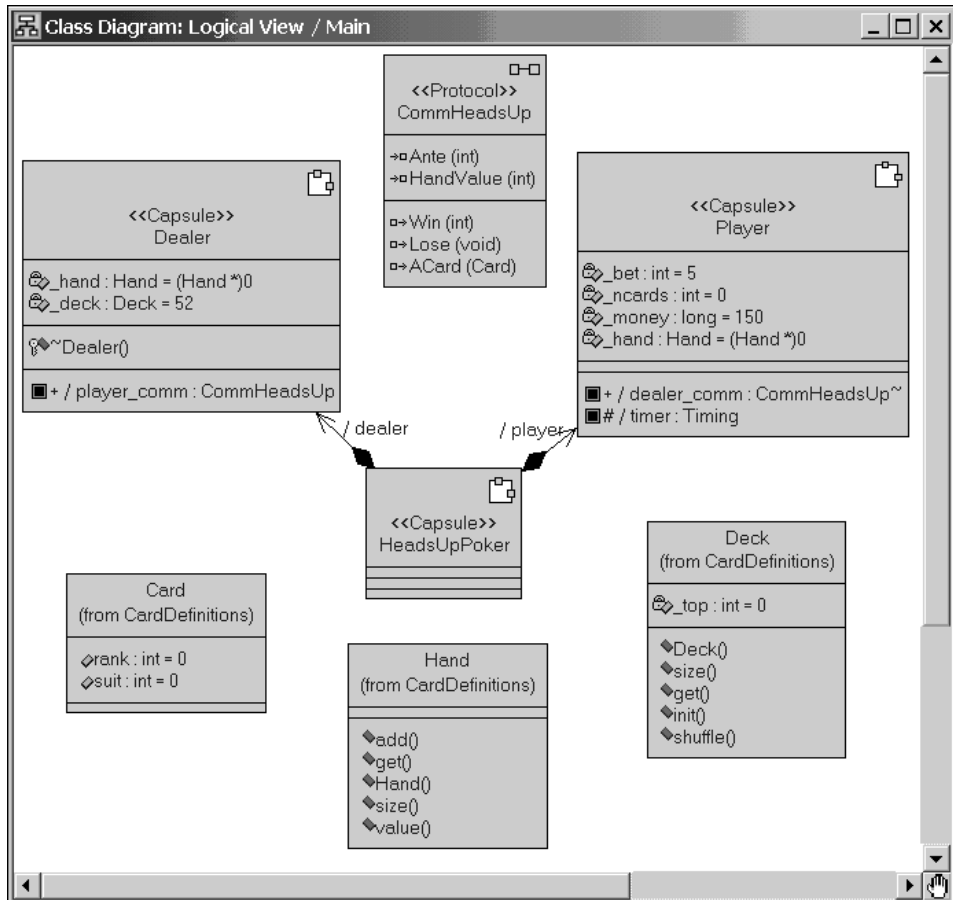
A second **Add Class Dependencies** dialog box appears.

5 Click **ALL >>** to select all dependencies.

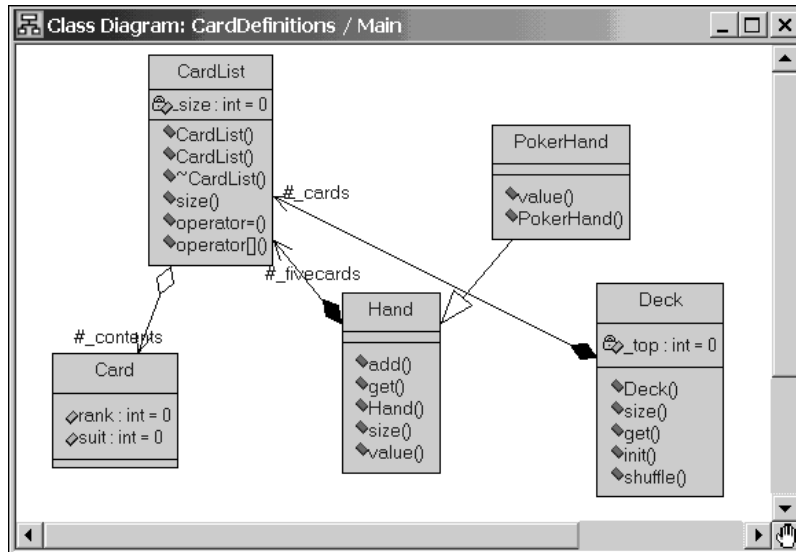


6 Click **OK**.

**Note:** The dependencies are added to the model by the **Add Class Dependencies** add-in. *However they are not automatically added to class diagrams.* When working with a model in source control or on a large model, you do not necessarily want to check out or modify diagrams because you add dependencies. In this tutorial, you will add dependencies to the diagrams to show that they have been created.



- 7 Open the **Main** class diagram in the **CardDefinitions** package.



- 8 On the **Query** menu, click **Filter Relationships**.

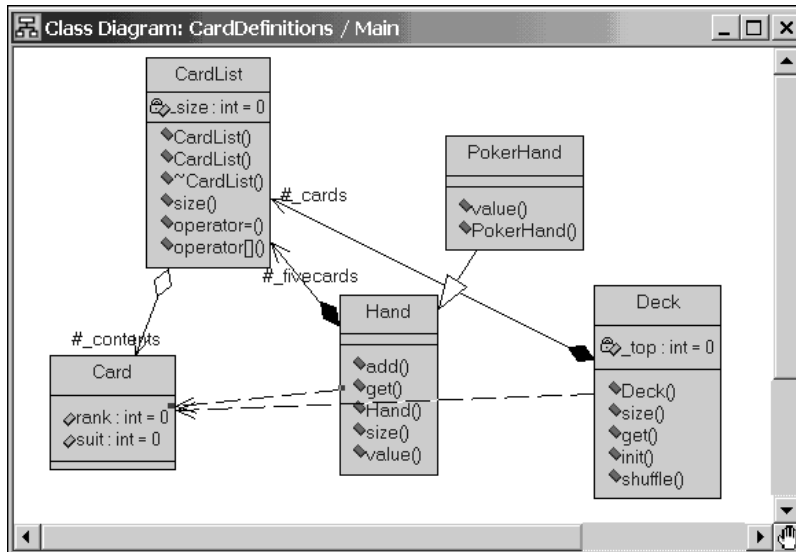
The **Relations** dialog appears.

- 9 In the **Type** box, ensure that **Dependency** is selected.




- 10 Click **OK**.

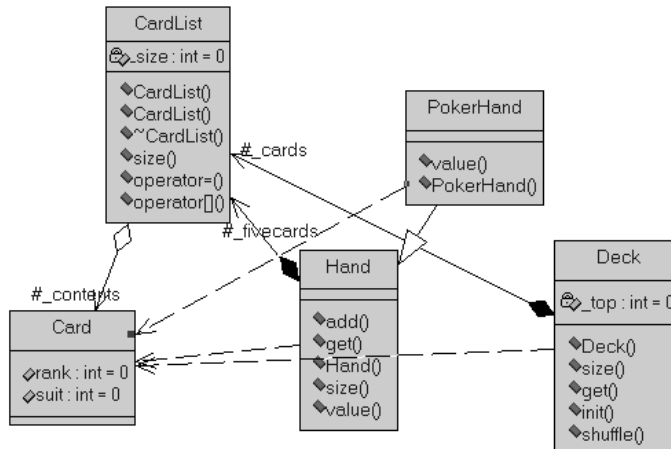
There were two dependencies created: **Deck** to **Card**, and **Hand** to **Card**.



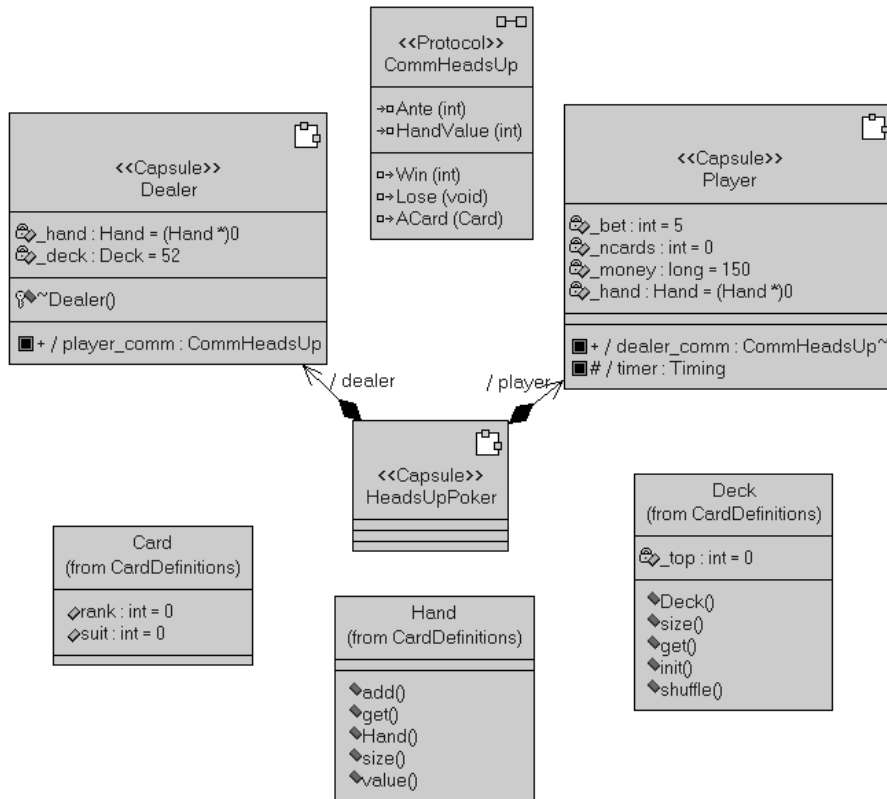
**Note:** There is a dependency that **was not** created by the **Add Class Dependency** add-in. This dependency is between the **PokerHand** and **Card** class.


- 11 In the Toolbox, click the **Dependency** tool .
- 12 Click the **PokerHand** class and drag the mouse to the **Card** class to create a dependency between the **PokerHand** and **Card** class.


Your **Class Diagram** will look like this:



13 Open the **Main** class diagram directly contained in the **Logical View** package.



14 From the Toolbox, select the **Class** tool , and add a **PokerHand** class to the diagram.

15 From the Toolbox, select the **Dependency** tool , and create a dependency between ALL of the following:

- the **Dealer** capsule and the **Card** class
- the **Dealer** capsule and the **PokerHand** class
- the **Player** capsule and the **PokerHand** class

Now, you can use **Filter Relationships** to crete the other dependencies.

16 On the **Query** menu, select **Filter Relationships**.

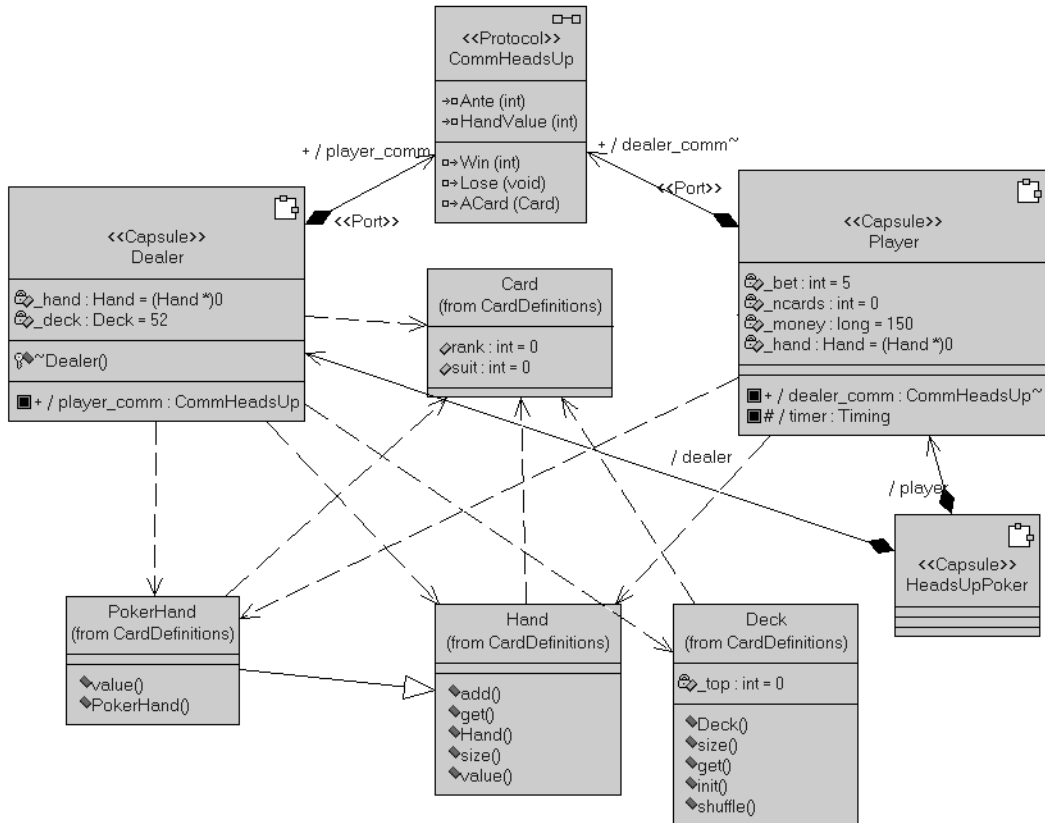
17 Click **OK**.



The **Add Class Dependencies** add-in created the dependency between the **Dealer** and the **Deck** using the default C++ properties. Since the `_deck` attribute is declared by value in the **Dealer** capsule, you must specify the dependency between **Dealer** and **Deck** as **Inclusion** in the header, and **None** in the implementation.

**Ensure that your diagram contains *all* of the dependencies contained in the following diagram.**

**Note:** The objects in the following diagram were rearranged to make the diagram easier to read.



**Note:** The C++ compiler needs to know the size of the **Deck** class within the **Dealer** capsule during compilation. Forward references can only be used when attributes are declared as pointers.

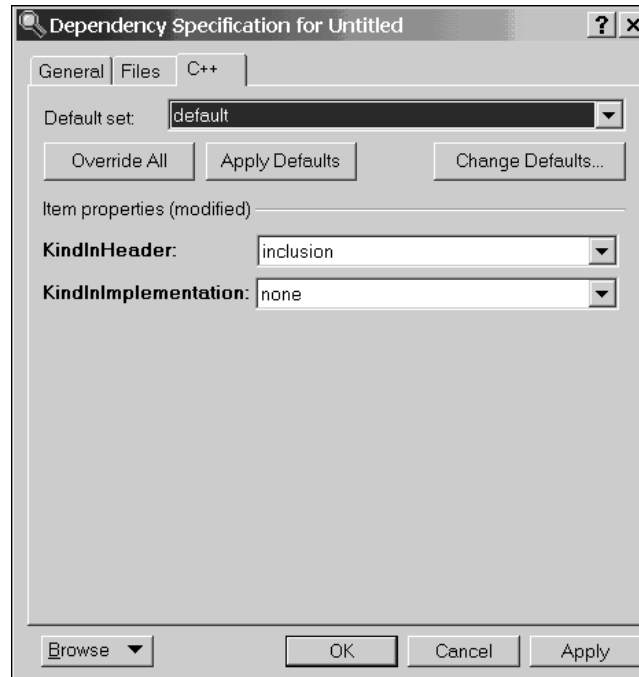
**18** Double-click on the dependency between the **Dealer** capsule and the **Deck** class.

The **Dependency Specification** dialog box appears.

**19** Click the **C++** tab.

20 In the **KindInHeader** box, select **inclusion**.

21 In the **KindInImplementation** box, select **none**.



22 Click **OK**.

## Dependency Properties

A dependency is converted by the code generator as an `#include` or forward reference directive in either the header or implementation files generated for the class or capsule. By default, a dependency generates a forward reference in the header file and an inclusion in the implementation. This kind of dependency is the most conservative in terms of keeping compilation dependencies to a minimum.

You can change how a dependency is generated (either as an include directive or a forward reference) from the dependency relationship properties in the **C++** tab.

## Adding Inclusions

For the implementation of the **Deck**, you used services included in the system header files `time.h` and `stdlib.h`. You need to include those in the **Component Specification** so that when the component compiles, the header files are included.

Adding inclusions at the component level adds system-wide dependencies to your model. This may not be desirable because of the compile dependencies that it causes. An alternative to adding include directives to the component is to add them to capsules or classes.

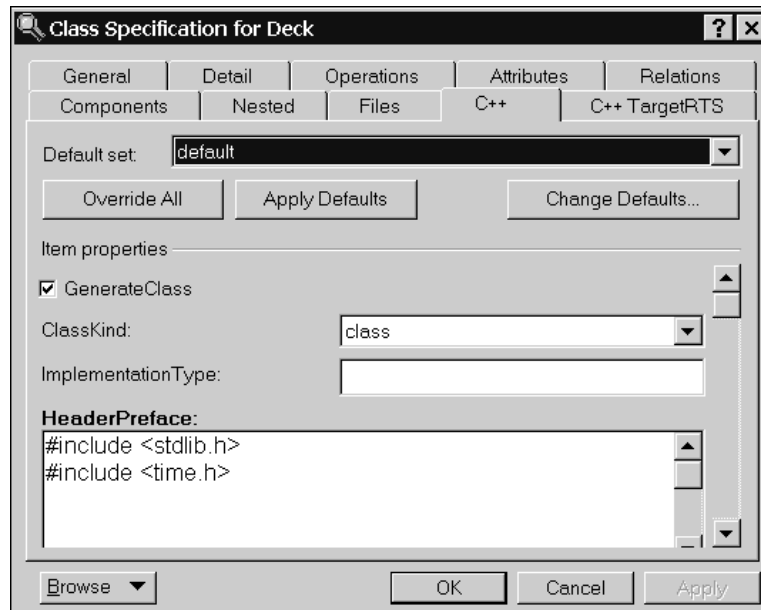
**Note:** Add include directives to the **C++** tab on both capsules and classes. Enter the `#include` directives in the **HeaderPreface** property.

### To add capsule or class scoped inclusions:

- 1 Open the **Class Specification for Deck** dialog box, and click the **C++** tab.
- 2 In the **HeaderPreface** box, type the following `#include` statements.

```
#include <stdlib.h>
#include <time.h>
```

Your **Class Specification for Deck** dialog box will look like the following.



- 3 Click **OK**.

We recommend that you save your model at this time.

## Building and Running the Card Game

Following the steps detailed in *Lesson 4: Building and Running* on page 103 and in *Lesson 7: Using Traces and Watches to Debug the Design* on page 144, build the **CardGameComponent**, and run the component instance.

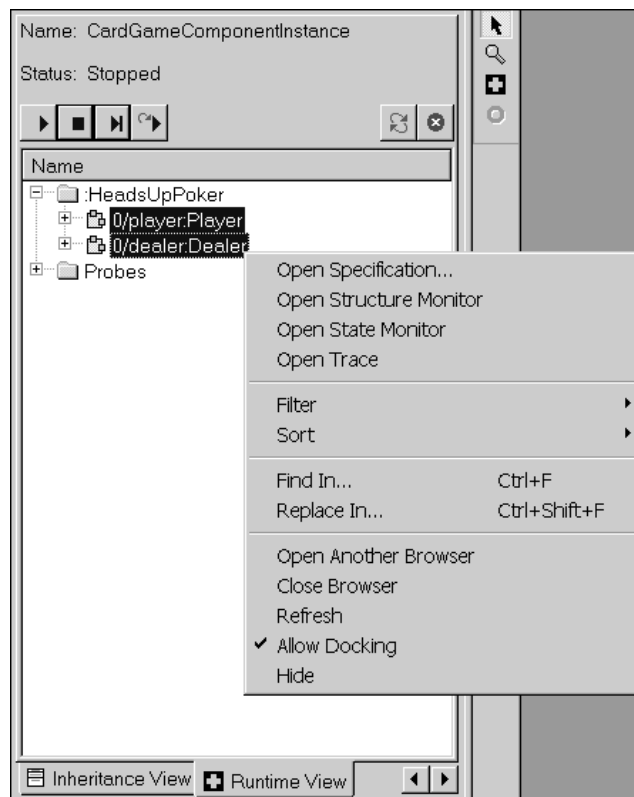
Create watches on the **\_hand** attributes to verify that cards are being dealt to both the **Player** and **Dealer**, and trace the messages exchanged between the two capsule instances.

**Note:** You can make changes to model elements while a component instance is running, however, Rose RealTime will shutdown after you make the change.

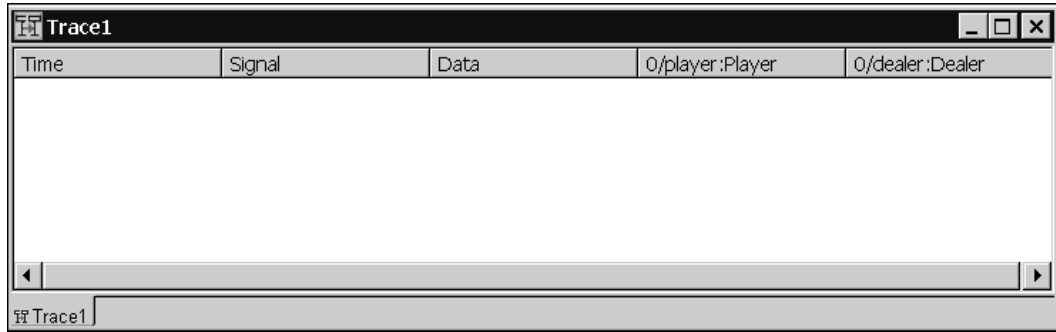
Now, try creating a trace on component instances to show messages being exchanged between the capsule instances.

### To observe messages exchanged between capsule instances:




- 1 On the **Runtime View** tab in the browser, select the **Player** and **Dealer** instances, right-click, then click **Open Trace**.



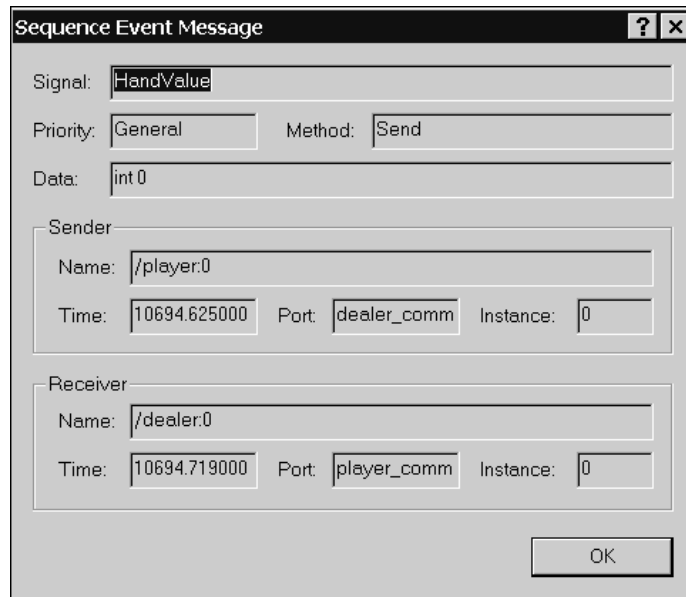
The **Trace** window displays.



A capsule trace window is a type of message trace that shows capsule instances with messages listed in separate columns for recording event flow between instances. The left column displays the time at which the message occurred, the subsequent columns display the source and destination ports, the signal name, optional data, and the capsule instances.

- 2 Either click the **Start** button, , or the **Step** button, , to begin.
- 3 In the **Trace** window, select a signal.  
**Note:** If you clicked the **Start** button, you can click the **Stop** button  to pause the execution of the component instance.
- 4 Right-click and click **Open Specification**.

The **Sequence Event Message** dialog box for the selected signal appears.



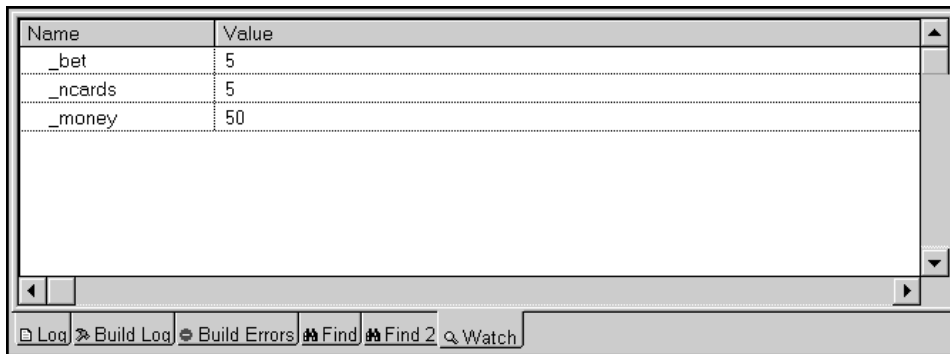
The dialog box titled "Sequence Event Message" contains the following fields:

- Signal: HandValue
- Priority: General
- Method: Send
- Data: int 0
- Sender:
  - Name: /player:0
  - Time: 10694.625000
  - Port: dealer\_comm
  - Instance: 0
- Receiver:
  - Name: /dealer:0
  - Time: 10694.719000
  - Port: player\_comm
  - Instance: 0

An OK button is located at the bottom right of the dialog.

You can view any **Sender** and **Receiver** information for your selected signal.

Also, take note of the value of **\_money** in the **Watch** window. Depending on whether the **Player** wins or loses, the value increases or decreases for each hand.



Name	Value
_bet	5
_ncards	5
_money	50

The Watch window includes a toolbar at the bottom with icons for Log, Build Log, Build Errors, Find, Find 2, and Watch.

## Trace Summary

Typically when a message fails to flow through a set of capsules as expected, it is important to see where the message flow was first in error. To debug these kinds of errors, we can first use capsule instance traces to look at the messages originating and terminating from the capsules in the message flow. If the messages are incorrect and the fault origination cannot be identified, you can then place probes on specific ports

in a composite capsule. Based on whether the messages are still faulty, you can narrow down the cause of the error by further subdivision. Once the faulty capsule has been identified, it is valuable to place traces and message breakpoints on the state machine.

## Fixing compilation errors

When building a component instance, a common error is missing dependencies. Ensure that you create all the proper dependencies, and then check for any syntax errors.

## Review

The sample model showing the completed procedures covered to this point in the tutorial is located in the Rose RealTime installation directory:

```
$ROSBERT_HOME/Tutorials/cardgame/cardgame_step4.rtm1.
```

## Lesson 10: Aggregating in a State Diagram

---

State diagrams are hierarchical which allows modeling of complex state machines by abstracting detailed behavior into multiple levels. A state that does not contain a substate is a *simple state*. A state that has substates is a *composite state*. States may be nested to any level.

You can create capsule State Diagrams by defining simple behavior that is expanded a little at a time. If you want to hide some of the details of the behavior, Rose RealTime allows you to aggregate elements from the state diagram into composite states.

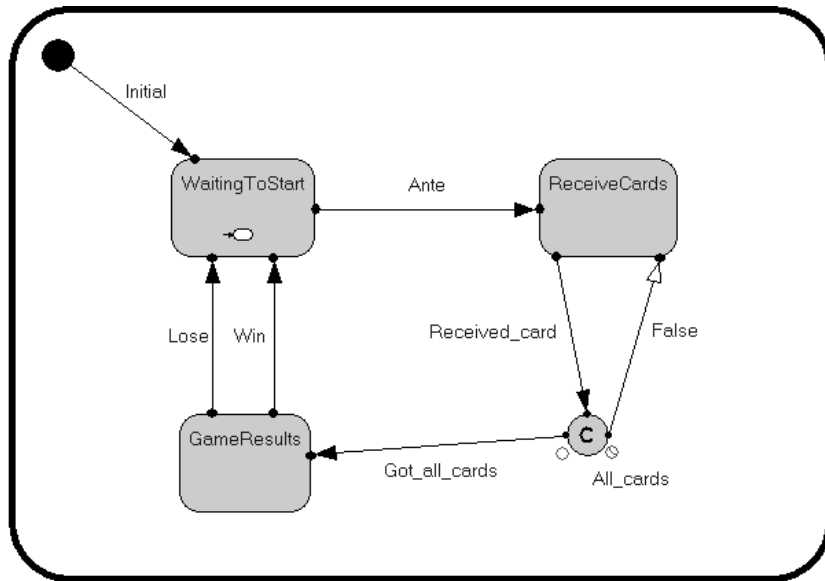
In this lesson, you will simplify the Player's state diagram by hiding the receiving cards logic into a composite state. This will make the top level state diagram easier to understand by hiding details about the behavior of actually receiving cards. Both state diagrams will remain identical in function. If a state diagram shows too many details (states and choices points) at the same level, it can become difficult to understand.

### Aggregating the Receiving Behavior

Your goal is to abstract the choice point into one top level state named **ReceivingCards**. The Player's top level behavior is composed of only three states.

## To create the composite state

- 1 Open the **State Diagram** for the **Player** capsule.

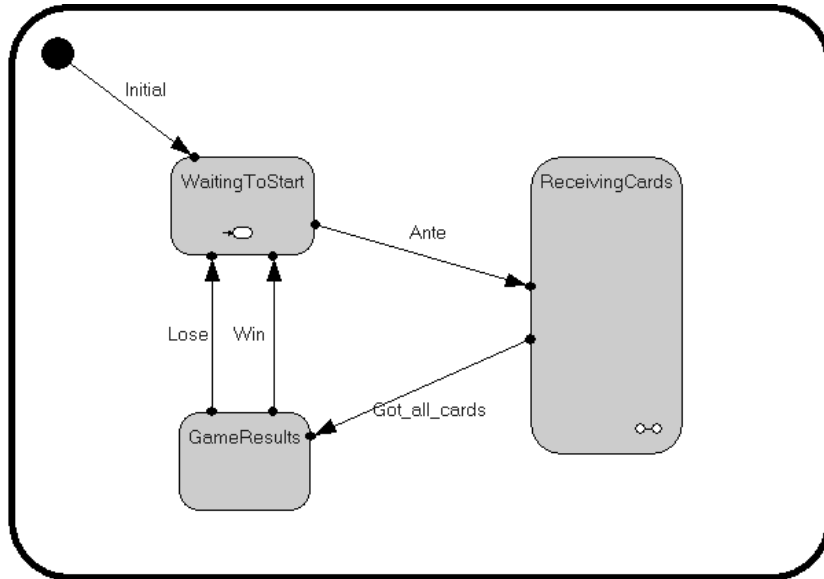


- 2 Multi-select the elements to aggregate by pressing the **CTRL** key and, at the same time, select the **ReceiveCards** state and the **All\_cards** choice point.
- 3 On the **Parts** menu, click **Aggregate**.

A composite state appears (the selected elements are removed from this state diagram) called **S1**.

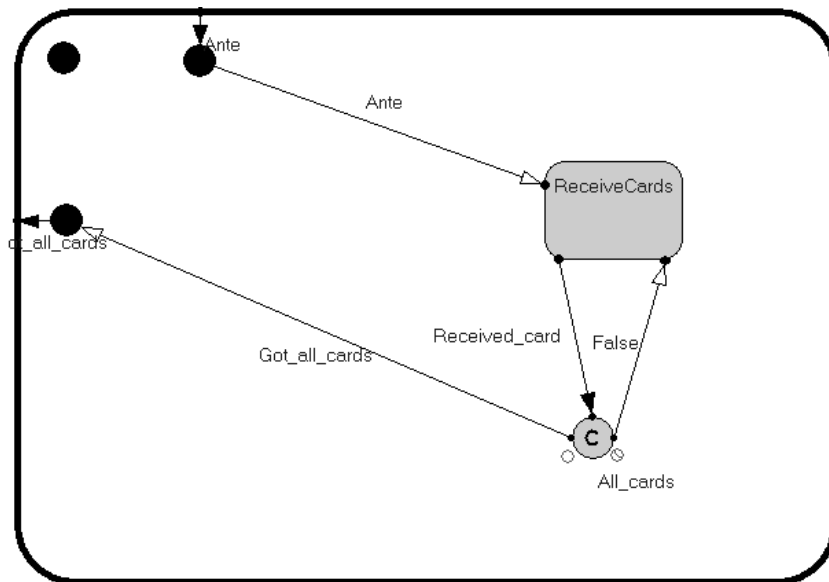


4 Rename the state to **ReceivingCards**.



**Note:** A composite state icon appears in the bottom right-hand corner of the state indicating that the state contains sub-states.

- 5 Double-click on the new **ReceivingCards** state to view the state diagram.



**Note:** The elements that you chose to aggregate are part of the **ReceivingCards** state. Both state diagrams remain functionally equivalent.

## Review

The sample model showing the completed procedures covered in this tutorial is located in the Rose RealTime installation directory:

`$ROBERT_HOME/Tutorials/cardgame/cardgame_step2.rtm1.`

## Tutorial Summary

---

In this tutorial, you learned how to use the main features of Rose RealTime to build a model.

You may want to explore Rose RealTime further by:

- Expanding the card game model, and adding more players so that you can play multiple games at the same time. You may want to add dynamic structure and replication. The possibilities are endless.
- Customizing Rose RealTime. For details, see the Rose RealTime Extensibility Interface Tutorials.
- Looking at the Examples. They show common design patterns used in beginner and intermediate level models.

## Contents

---

This chapter is organized as follows:

- *RRTEI Tutorial Overview* on page 219
- *Creating a Summit Basic Script* on page 221
- *Creating a Visual Basic Add-in* on page 225
- *Creating an Add-in Which Extends the Context Menus* on page 231

## RRTEI Tutorial Overview

---

This small set of tutorials describe the complete set of steps to follow to use the Rational Rose RealTime Extensibility Interface (RRTEI) to extend and customize the capabilities of the toolset. There are two ways of extending Rose RealTime:

- writing Basic Scripts
- using the Automation object to access the RRTEI from within another application.

Both methods are explained in the following tutorials:

- Scripting language: *Creating a Summit Basic Script* on page 221.
- Automation: *Creating a Visual Basic Add-in* on page 225.
- Automation: *Creating an Add-in Which Extends the Context Menus* on page 231.

**Note:** The automation interface provided with Rose RealTime is implemented using Microsoft Windows technology and can only be used on Windows platforms. The scripting language can be used on both UNIX and Windows.

These tutorials show Rose RealTime users how to extend the toolset for their individual needs.

The following tutorials assume that you have some knowledge of the RRTEI. The RRTEI is a public interface to the Rose RealTime meta model, or internal representation of a model, which is from where you can extract and manipulate information in a model.

## Basic Scripts

The Rose RealTime scripting language is an extension of the Summit BasicScript. The extensions allow you to automate specific functions of Rose RealTime using the RRTEI interface. The script editor runs within the Rose RealTime user interface.

## Automation

Rose RealTime automation works in two ways:

- Using Rose RealTime as an automation controller that allows you to call an OLE automation object from within a Basic Script. For example, to execute functions in an application such as Microsoft Word or Microsoft Excel.
- Using Rose RealTime as an automation server that allows other applications to call functions in the RRTEI to control Rose RealTime. This can be done from any OLE-compliant development tool, such as, Visual Basic, Visual C++, and so on.

**Note:** The tutorials use Rose RealTime as an automation server.

## Previewing the Tutorials

The directory \$ROBERT\_HOME/Tutorials/rrtei contains one subdirectory for each of the RRTEI tutorials. In each folder, you will find examples of what will be developed in the tutorials.

To preview each add-in, do the following:

- 1 In each subdirectory there is a file of type **.reg**. Double-click on this file to update the registry with the settings for the add-in.

**Note:** The **.reg** files provided with the tutorials assume that Rose RealTime is installed in the default location, C:\Program Files\Rational\Rose RealTime\6.4. If you installed the tool in another location you must open the **.reg** file with a text editor and replace all path occurrences with the correct installation directory.

- 2 For the Automation examples to work, open and compile the Visual Basic project (**.vbp**). This will create and register a DLL file. The automation tutorials are located in the **vbaddin** and **contextmenu** directories.

For the BasicScript example, in the **summit** directory, you must first compile the script to **.ebx** format. See the tutorial for instructions on how to do this.

- 3 Re-start Rose RealTime.
- 4 Read each tutorial to find out what each add-in does.

## Creating a Summit Basic Script

---

The script you will create automates several steps required to create a capsule in Rational Rose RealTime. The script allows users to create capsules which already contain one state and an initial transition.

### To create a Summit Basic script:

- 1 Use the Basic Script editor to write the script (you can also optionally use the dialog editor to create dialogs).
- 2 Run and test the script from within the Basic Script environment.
- 3 Compile the script to an .ebx file.
- 4 Create a menu file for the script.
- 5 Add entries to the registry to inform Rose RealTime to add the menu items to its main menu.

## Writing a Script

The script you will write will prompt the user for a capsule name and then use the RRTEI to create a new capsule and add an initial transition and a state to the state diagram of this newly created capsule.

- 1 Start Rational Rose RealTime.
- 2 Click **Tools > New Script**.
- 3 Type in the following lines of Basic code, or cut and paste from this document:

```
' This script creates one or more capsules within the
' root Logical View package. It will only create a capsule
' if there is no existing capsule with that name. To use
' this script, run it, and repeatedly enter capsule
' names into the pop up dialog. When you are finished press
' the Cancel button. Each capsule created will have one
' state called "Ready", with an Initial transition.
```

```

' Create capsule details
Sub CreateCapsuleDetails(theCapsule As RoseRT.Capsule)
    Dim theFsm As RoseRT.StateMachine
    Dim theTopState As RoseRT.CompositeState
    Dim theState As RoseRT.CompositeState
    Dim theTransition As RoseRT.Transition
    Set theFsm = theCapsule.StateMachine
    Set theTopState = theFsm.Top
    Set theState = theTopState.AddState(rsNormalState)
    theState.Name = "Ready"
    Set theTransition = theTopState.AddTransition("Initial",
rsTrueSourceRegion, "Ready")
End Sub

' Create a capsule within a given package
Sub CreateACapsule (thePackage As RoseRT.LogicalPackage, capsuleName
As String)
    If thePackage.Capsules.FindFirst(capsuleName) = 0 Then
        Dim theCapsule As RoseRT.Capsule
        Set theCapsule = thePackage.AddCapsule(capsuleName)
        CreateCapsuleDetails theCapsule
    End If
End Sub

' Create one or more capsules within the root
' LogicalView package

Sub CreateCapsules (theModel As RoseRT.Model)
    Dim thePackage As RoseRT.LogicalPackage
    Set thePackage = theModel.RootLogicalPackage
    capsuleName$ = askBox$( "Capsule" )
    While capsuleName$ <> ""
        CreateACapsule thePackage, capsuleName$
        capsuleName$ = askBox$( "Capsule" )
    Wend
End Sub

```

```
' Main
Sub Main
    CreateCapsules RoseRTApp.CurrentModel
End Sub
```

- 4 Select **File > Save Script As** to save the new script. Name it **CreateCapsules.ebs**.

## Running and Testing a Script

- 1 Click the **Start** button at the top of the Basic Script edit window.
- 2 Enter one or more capsule names.
- 3 Click **Cancel**.

Verify that each capsule state diagram contains one state with an initial transition.

## Compiling a Script

Select **File > Edit Path Map**. Note which directory is mapped to the **\$SCRIPT\_PATH** symbol, and which is mapped to **\$ROSE\_HOME**.

With the script edit window selected, select **Debugger > Compile** to compile the script file. Name the compiled script **CreateCapsules.ebx**, and save it to the Rational Rose RealTime **\$SCRIPT\_PATH** directory.

## Creating a Menu File

You should add a menu item to the Rose RealTime main menu that will invoke your compiled script. To create a menu entry first you have to create a menu file. This is a simple text file containing the following:

```
Menu Tools
{
    Separator
    option "Create C&apsules"
    {
        RoseScript $SCRIPT_PATH/CreateCapsules.ebx
    }
}
```

The **RoseScript** keyword tells Rose RealTime that this item represents a compiled Basic Script. You can add the menu item to any of the Rose RealTime main menus. The **Menu <name>** tag in the menu file indicates under which main menu this new menu item should be added.

Save this file with the name **CreateCapsules** with the extension **.mnu**.

## Adding Entries to the Registry

Next you have to update the Rose RealTime registry to inform the toolset about the script. You can use **regedit** to directly edit the registry or create a **.reg** file, and double-click it to add the entries to the registry. Below is a sample **.reg** file that you can use as a reference:

```
REGEDIT4

[HKEY_LOCAL_MACHINE\SOFTWARE\Rational Software\Rose
RealTime\6.4\AddIns\CreateCapsules]

"Active"="Yes"

"HelpFileName"="CreateCapsules.htm"

"RoseRTAddIn"="Yes"

"Version"="1.0"

"InstallDir"="C:/Program Files/Rational/Rose
RealTime/6.4/Tutorials/rrtei/summit"

"MenuFile"="CreateCapsules.mnu"
```

---

Key	Description
Active	A <b>Yes</b> indicates that this add-in should be enabled in the Tool menu. (It also indicates that the add-in should receive special event notifications when Rose RealTime starts and stops).
HelpFileName	The name of the HTML help file that corresponds to a specific help topic, if necessary.
RoseRTAddIn	A <b>Yes</b> indicates that add-in was created using the RRTEI. Omitting this entry or an entry with a No value indicates that this is a Rose REI add-in. To run Rose add-ins, Rose RealTime has to be started in emulation mode.
Version	The version to display in the Add-Ins manager dialog.
InstallDir	The directory where Rose RealTime can find the menu file.
MenuFile	The name of the file with the menu commands. This file specifies the menu entry name for the Tools menu, and the method to invoke in the automation server.

---

**Note:** When specifying a path in a registry entry, use the UNIX path separator "/", or use double DOS path separator "\\ ". Not doing so will prevent the registry entry from being created.



## Runing and Testing the Script from the Menu

Update the registry then restart Rose RealTime. Ensure that the menu item was correctly added to the main menu.

Ensure that your script is run when the menu item is selected.

### Troubleshooting

If Rose RealTime has problems loading the add-in it will display any errors in the log. The most common errors are typos in the registry entries and menu file. This usually causes the **.ebx** and **.mnu** files not to be found. Remember that you have to restart Rose RealTime every time you change the registry settings.

## Creating a Visual Basic Add-in

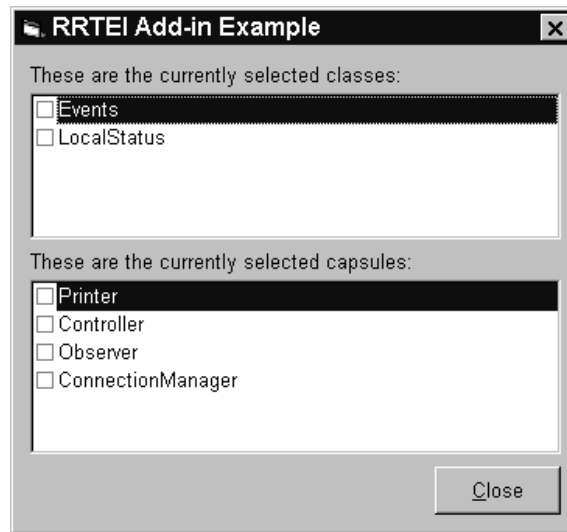
---

By following a few well defined steps you can easily create a complete Visual Basic add-in. These add-ins are compiled as Active X DLLs and when registered with Rose RealTime are loaded and invoked by the toolset.

### To create a Rose RealTime add-in with Visual Basic:

- Create an ActiveX DLL with a public interface and sub that accepts a **RoseRTApplication** object reference as a parameter.
- Add a few entries in the Registry to let Rose RealTime know about the new add-in.
- Create a menu file that calls the add-in from a new menu item you can add to the main menu.

The add-in you create in this tutorial will query the model and find which classes and capsules are selected in a diagram. The add-in will then add the names of the selected items to list boxes that will be displayed in a dialog box.



**Note:** This is not a tutorial on using Microsoft Visual Basic. It is assumed that you have some basic knowledge of the environment and language.

## Creating the Active X DLL

Load Microsoft Visual Basic (version 5 or 6) and from the **New Project** dialog chose to create an **Active X DLL** project. This will create a new project named **Project1** with a class module called **Class1**.

- 1 Rename the **Project1** to **rrtei\_intro\_tutorial**.
- 2 Rename the **Class1** to **clsMain**.

These names are important because they will determine the DLL name and the class name that you will register with the add-in manager.

- 3 Make sure that the **Instancing** property on the **clsMain** class module is set to **MultiUse**.

This value specifies whether you can create instances of a public class outside a project, and if so, how it will behave.

- 4 Select **Project > References**.

A dialog box appears listing all the references (type libraries) that are registered on your machine.

5 Select **RoseRT**.

This will allow you to get drop-down hints when editing code and also to easily browse the RoseRT type library. The type library contains all the classes, properties, and methods that you can access from the RRTEI. To browse the contents of the RoseRT type library (this is very useful) press **F2** or chose **View > Object Browser** then select the RoseRT library from the drop-down list in the top left corner of the dialog box.

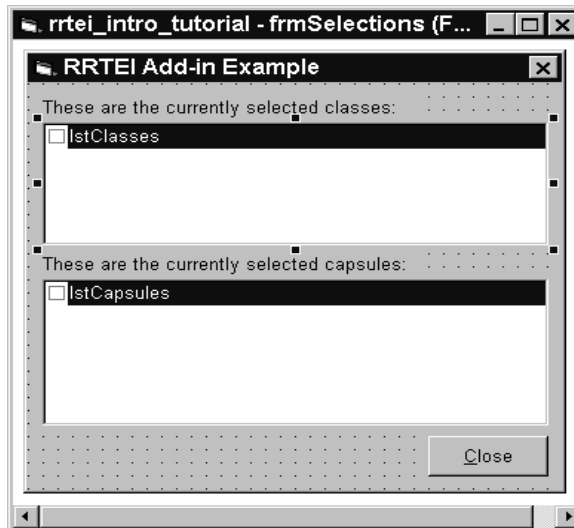
**Note:** Rose RealTime must be installed on your machine to access the type library.

6 Create a public sub called **RunRRTEITutorial** on the clsMain class.

```
Public Sub RunRRTEITutorial(theRTApp As RoseRT.Application)
...
End Sub
```

This **Sub** takes one parameter of type **RoseRT.Application**. This is the operation that will be invoked when your add-in is called from Rose RealTime.

7 Then create a new form called **frmSelections** that has two list boxes named **lstClasses** and **lstCapsules**. You can create something similar to:



8 Add code to unload the form when the Close button is pressed:

```
Private Sub CloseCommand2_Click()
    Unload Me
End Sub
```

- 9 Add the code to the **RunRRTEITutorial** sub that will populate the list boxes in the frmSelections form.

```
Public Sub RunRRTEITutorial(theRTApp As RoseRT.Application)
    ' create a form object
    Dim mainForm As New frmSelections
    ' initialize local vars
    Dim theModel As Model
    Dim SelectedClasses As ClassCollection
    Dim SelectedCapsules As CapsuleCollection
    Dim aClass As Class
    Dim aCapsule As Capsule

    ' get the list of selected capsules and classes
    Set theModel = theRTApp.CurrentModel
    Set SelectedClasses = theModel.GetSelectedClasses
    Set SelectedCapsules = theModel.GetSelectedCapsules

    ' populate the lists on the frmSelections form
    mainForm.lstClasses.Clear
    For i = 1 To SelectedClasses.Count
        Set aClass = SelectedClasses.GetAt(i)
        mainForm.lstClasses.AddItem aClass.Name
    Next i
    mainForm.lstCapsules.Clear
    For i = 1 To SelectedCapsules.Count
        Set aCapsule = SelectedCapsules.GetAt(i)
        mainForm.lstCapsules.AddItem aCapsule.Name
    Next i

    ' display the form
    mainForm.Show vbModal
End Sub
```

You create an instance of the frmSelections form. Then you get a reference to the model instance from the Application object passed to the sub by Rose RealTime when the add-in was called. By calling the **GetSelectedClasses** and **GetSelectedCapsules** operations on the model reference, you can get the collection of classes and capsules which are selected. Then the list boxes are populated and the form is displayed.

- 10 Build the add-in DLL file by selecting **File > Make rrtEI\_intro\_tutorial.dll**.

This will compile the DLL and register it in the Windows registry.

## Creating the Add-in Menu File

You now want to create the menu file. You can extend the menu system with custom items that invoke compiled Basic Scripts or add-ins. To create a menu entry first, you have to create a menu file. This is a simple text file containing the following:

```
Menu Tools
{
  Separator
  option "Run RRTEI &Tutorial Add-in"
  {
    InterfaceEvent rrtEI_intro_tutorial RunRRTEITutorial
  }
}
```

The InterfaceEvent keyword tells Rose RealTime that this item represents an add-in which is specified in the registry under the AddIns key. The second parameter indicates the name of the subkey under AddIns where the name of the automation server (OLEServer) for the add-in can be found. The third parameter is the name of the operation to call on the OLEServer described in the registry. You can therefore have several entry points implemented in the same add-in DLL.

The menu file should be placed in the directory specified by the **InstallDIR** registry entry, and must have the name specified by the **MenuFile** entry.

## Adding Entries to the Registry

Next you have to update the Rose RealTime registry to let the toolset know about the add-in. You can use regedit to directly edit the registry or create a **.reg** file, and double-click it to add the entries to the registry. Below is a sample **.reg** file that you can use as a reference:

```
REGEDIT4

[HKEY_LOCAL_MACHINE\SOFTWARE\Rational Software\Rose
RealTime\6.3\AddIns\rrtei_intro_tutorial]

"Active"="Yes"

"HelpFileName"="tutorial.htm"

"RoseRTAddIn"="Yes"

"Version"="1.0"

"InstallDir"="C:/Program Files/Rational/Rose
RealTime/6.4/Tutorials/rrtei/vbaddin"

"MenuFile"="rrtei_intro_tutorial.mnu"

"OLEServer"="rrtei_intro_tutorial.clsMain"
```

---

<b>Key</b>	<b>Description</b>
Active	A <b>Yes</b> indicates that this add-in should be enabled in the Tool menu. (It also indicates that the add-in should receive special event notifications when Rose RealTime starts and stops).
HelpFileName	The name of the HTML help file that corresponds to a specific help topic, if necessary.
RoseRTAddIn	A <b>Yes</b> indicates that add-in was created using the RRTEI. Omitting this entry or an entry with a No value indicates that this is a Rose REI add-in. To run Rose add-ins, Rose RealTime has to be started in emulation mode.
Version	The version to display in the Add-Ins manager dialog.
InstallDir	The directory where Rose RealTime can find the menu file.
MenuFile	The name of the file with the menu commands. This file specifies the menu entry name for the Tools menu, and the method to invoke in the automation server.
OLEServer	The name of the registered automation server (ActiveX DLL) and the name of the interface to associate with this add-in. This is also called the ProgID.

---

## Testing the New Add-in

After you have completed all the previous steps, run Rose RealTime and then select **Add-Ins > Add-In Manager...** You should see your add-in listed with the version number you entered into the registry.

Create a couple of classes and capsules and place them on a class diagram. Then multi-select the elements (using the Ctrl key while selecting the elements), and select **Tools > Run RRTEI Tutorial** (or whatever name you gave the menu entry). A dialog box appears with the classes and capsules list updated with the names of the selected elements in the current diagram.

**Note:** You can test the add-in from within Visual Basic by setting "Start Program" VB project's property on the debugging tab to "RoseRT". Then press the start button in Visual Basic and Rose RealTime will be started automatically.

## Common Problems

The most common problem is that your registry entries (InstallDir, OLEServer) are incorrect. If any of these entries are wrong either the Add-In won't register when Rose RealTime loads or the Add-In will not run when you select the menu item. Ensure that you have the following names correct:

- **Registry key name entry under the Addin subfolder:** used in the .mnu file.
- **DLL name (usually the same as your VB project name):** used as the first parameter in the OLEServer registry key.
- **Class name in which your add-in entry sub is declared:** used as the second parameter in the OLEServer registry key.
- **Procedure name which should be invoked by Rose RealTime to run the add-in:** used in the .mnu file.

The next common problem is that run-time errors occur while your add-in is executing. Rose RealTime will report the error. Try and trap and report errors from within your add-in.

## Creating an Add-in Which Extends the Context Menus

---

When you right-click in Rational Rose RealTime, the system displays a shortcut menu. The commands displayed on the shortcut menu are determined by where you click the mouse and what items are selected in the diagram or browser. You can take advantage of this feature so that your add-in user sees your shortcut menu items when they right-click.

## Benefits

- Provides shortcut access to an add-in.
- Ability to create one shortcut menu item that works for items selected in the browser as well as in a diagram (you do not have to create one menu item for items selected in the browser and another menu item for items selected in the diagram).
- Can add submenus.
- Can control the state in which the context menu appears (disabled, checked ...).

## Limitations

The position on the shortcut menu where your menu item displays is controlled by Rational Rose RealTime. If you have more than one item on the shortcut menu, however, you can control the order in which those items display by adding the items (using the `AddContextMenuItem` method) in the order in which you want the menu items displayed.

## How Context Menus Work

Using context menus is fairly simple once you understand the events generated by Rose RealTime and the objects and operations available in the RRTEI that support adding and removing context menus.

The main flow of events that occurs when an add-in uses context menus in Rose RealTime are:

- 1 Add-in designer first decides to which model elements shortcuts should be added. Then, it decides on unique names called the **internal name** for each of the menu items. The internal name is what Rose RealTime will pass to your add-in when a menu item is selected.
- 2 When Rose RealTime is started, it issues the **OnActivate** event to your add-in. Your add-in would create all the context menus it requires using the **Addin::AddContextMenuItemForClass** operation at this time.
- 3 When the user right-clicks on an element for which your add-in has added a context menu, Rose RealTime issues the **OnEnableContextMenuItemsForClass** before the context menu is shown. In this operation, your add-in has the option of changing the state of any of the menu items before they are shown.
- 4 When the user selects an add-in menu item from the context menu, Rose RealTime issues the **OnSelectedContextMenuItem** event to your add-in. The **internal name** is passed with the **OnSelectedContextMenuItem** event as is used to determine which menu item has been selected.



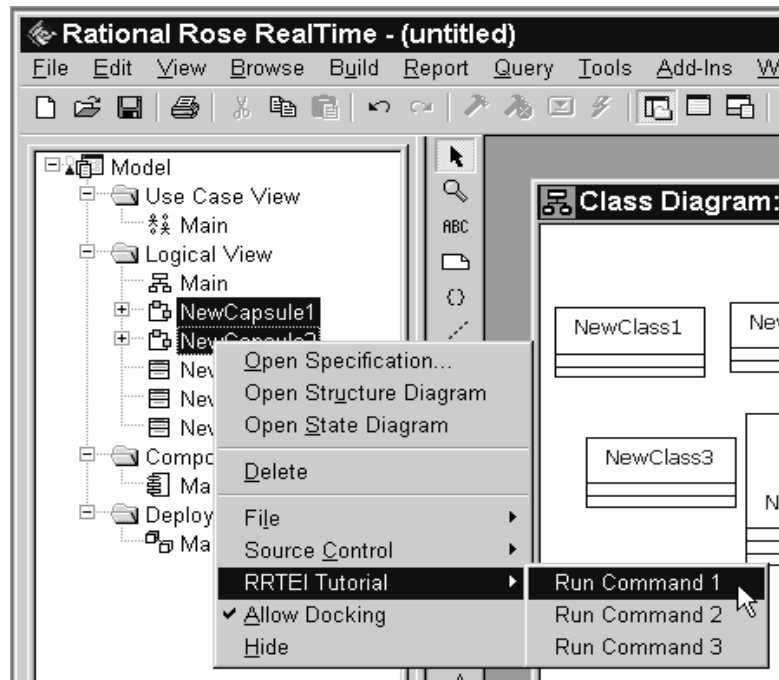
## Menus Associated with Default or Specific Elements

The default context menu is the shortcut menu that is displayed when there are multiple selections of different types of items. You either create a context menu for a specific type of element or for the default.

When creating a context menu, you assign it to a model element by referring to the element name. For example, to create a context menu for a capsule, you would pass the "Capsule" string to the **AddContextMenuForClass** function.

## Creating the ActiveX DLL

In this tutorial, you will create a simple add-in which adds a submenu called **RRTEI Tutorial** and three menu items to the Capsule context menu. The first menu item will only be enabled if more than one capsule is selected in the model when the context menu appears.



**Note:** The steps for setting-up and configuring a Visual Basic project for an add-in were covered in the previous tutorial. For information, see [Creating a Visual Basic Add-in](#).

## Creating a New Visual Basic Project

Open Visual Basic and create a new **ActiveX DLL** project. Then rename the project to **rrtei\_contextmenu\_tutorial** and the class module to **clsMain**.

Add a reference to the **RoseRT** type library.

## Adding Module Variables

Open the **clsMain** module and add the following variables and constants to the module file:

```
' global vars
Dim MyAddin_ As RoseRT.AddIn
Dim MyMenuItems_(3) As RoseRT.ContextMenuItem

' context menu internal names used to identify individual menu items
Const CMID_COMMAND1 As String = "command1"
Const CMID_COMMAND2 As String = "command2"
Const CMID_COMMAND3 As String = "command3"
```

The first variable **MyAddin\_** is used to keep a reference to this add-in for quick access in other functions. The **MyMenuItems\_(3)** array holds references to all the new menu items that will be added. This again allows quick access to the menu items.

The constants represent the declaration of the **internal names** that will be used for the menu items. These internal names will be used when a menu item is created and when an item is selected. The internal name will be passed to the **OnSelectedItem** function to identify which menu item has been pressed.

## Adding the OnActivate Function

This function is called when the add-in is initialized. This is the time to create the new context menu items. Add the **OnActivate** function to the **clsMain** module:

```
Sub OnActivate(pRoseApp As RoseRT.Application)
    Dim aContextMenu As RoseRT.ContextMenuItem
    Dim AddIns As RoseRT.AddInCollection
    Set AddIns = pRoseApp.AddInManager.AddIns

    ' find the add-in
    Set MyAddin_ = AddIns.GetFirst("rrtei_contextmenu_tutorial")
```

```

If MyAddin_ Is Nothing Then
    MsgBox ("Error cannot add context menus")
    Exit Sub
End If

' Build the context menu
Set aContextMenu = MyAddin_.AddContextMenuForClass("Capsule",
"Submenu RRTEI Tutorial", "")

Set MyMenuItems_(1) =
MyAddin_.AddContextMenuForClass("Capsule", "Run Command 1",
CMID_COMMAND1)

Set MyMenuItems_(2) =
MyAddin_.AddContextMenuForClass("Capsule", "Run Command 2",
CMID_COMMAND2)

Set MyMenuItems_(3) =
MyAddin_.AddContextMenuForClass("Capsule", "Run Command 3",
CMID_COMMAND3)

Set aContextMenu = MyAddin_.AddContextMenuForClass("Capsule",
"EndSubmenu", "")
End Sub

```

The first part of the function simply tries to obtain a reference to the add-in object that represents this add-in within the Rose RealTime application object. The add-in is searched by name.

Next the add-in reference is used to call the **AddContextMenuForClass** operation to add the menu items. The menu item references are saved on the **MyMenuItems\_(3)** array for use later on. See the RRTEI reference for a description of the parameters that are passed to the **AddContextMenuForClass** function.

### **Adding the OnEnableContextMenuItemsForClass Function**

This function will be called prior to the context menu for the class is displayed. This is the time to change the status of any of the menu items that have been added. For example, depending on the elements that have been selected at the time the right-click occurs. For this tutorial you will only enable the first menu item if more than one element was selected at the time the context menu is selected.

Add the following code:

```

Function OnEnableContextMenuItemsForClass(pRoseApp As
RoseRT.Application, items As RoseRT.ControllableElementCollection) As
Boolean

```

```

Dim cmItem As RoseRT.ContextMenuItem
Dim cmCollection As RoseRT.ContextMenuItemCollection

' activate this menu item only if two or more model elements are
selected
If items.Count > 1 Then
    MyMenuItems_(1).MenuState = RoseRT.rsEnabled
    OnEnableContextMenuItemsForObjects = True
Else
    MyMenuItems_(1).MenuState = RoseRT.rsDisabled
    OnEnableContextMenuItemsForObjects = False
End If
End Function

```

The **OnEnableContextMenuItemsForClass** function's second parameter is a collection of elements that are selected when the user requested the context menu. This collection determines if the first menu item is enabled or disabled. Since we had already saved references to the added menu items, we can change the **MenuState** property of the menu item object.

### Adding the OnSelectedContextMenuItem Function

This function will be called when one of the add-in menu items is selected. The function is passed an internal name as a parameter which is used to determine which menu item has been selected. In this tutorial you will simply display a message box with the internal name followed by the names of the model elements that are selected when the menu item is selected.

```

Function OnSelectedContextMenuItemForObjects(pRoseApp As
RoseRT.Application, InternalName As String, items As
RoseRT.ControllableElementCollection) As Boolean

    Dim msg As String
    msg = InternalName + ": "

    Dim i As Integer
    Dim myElement As RoseRT.ControllableElement

    For i = 1 To items.Count Step 1
        Set myElement = items.GetAt(i)
        msg = msg + myElement.Name + " "
    Next i

```

```

Next
MsgBox (msg)
OnSelectedContextMenuItemsForObjects = True
End Function

```

The list of selected elements is passed to the function as a **ControllableElementCollection**. You would typically use this and the **internal name** to decide what action to take.

### Building the Add-in

The last step is to build the add-in DLL file by selecting **File > Make rrtei\_contextmenu\_tutorial.dll**. This will compile the DLL and register it in the Windows registry.

## Adding Entries to the Registry

Next you have to update the Rose RealTime registry to let the toolset know about the add-in. You can use regedit to directly edit the registry or create a **.reg** file, and double-click to add the entries to the registry. Below is a sample **.reg** file that you can use as a reference:

```

REGEDIT4

[HKEY_LOCAL_MACHINE\SOFTWARE\Rational Software\Rose
RealTime\6.4\AddIns\rrtei_contextmenu_tutorial]
"Active"="Yes"
"Version"="1.0"
"LanguageAddIn"="No"
"OLEServer"="rrtei_contextmenu_tutorial.clsMain"
"RoseRTAddin"="Yes"

[HKEY_LOCAL_MACHINE\SOFTWARE\Rational Software\Rose
RealTime\6.4\Addins\rrtei_contextmenu_tutorial\Events]
"OnActivate"="Interface"

```

The events subkey is used to tell Rose RealTime that we want to receive the **OnActivate** event when the add-in is registered in Rose RealTime.

## Testing the New Add-in

You don't have to create a menu file, but you could, since the menu items for this tutorial are all dynamically created. You could optionally add the same commands to the main menu to allow users several ways of invoking your add-in.

Once you have completed all the previous steps, run Rose RealTime and then select **Add-Ins > Add-In Manager...** You should see your add-in listed with the version number you entered into the registry.

Next, create a couple of capsules. Multi-select the elements (using the Ctrl key while selecting the elements) in the model browser or in the diagram and right-click. You should see the **RRTEI Tutorial** submenu on the context menu. Select one of the commands that you have added. Also, test that when the context menu is selected and only one capsule is selected, the first command is disabled. And that it is enabled when more than one is selected.

## Contents

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This chapter is organized as follows:

- *Overview* on page 239
- *Messages and Capsule State Machines* on page 240
- *Capsule Hierarchical State Machines* on page 241
- *Capsules and Capsule Roles* on page 241
- *Ports, Protocols, and Protocol Roles* on page 241

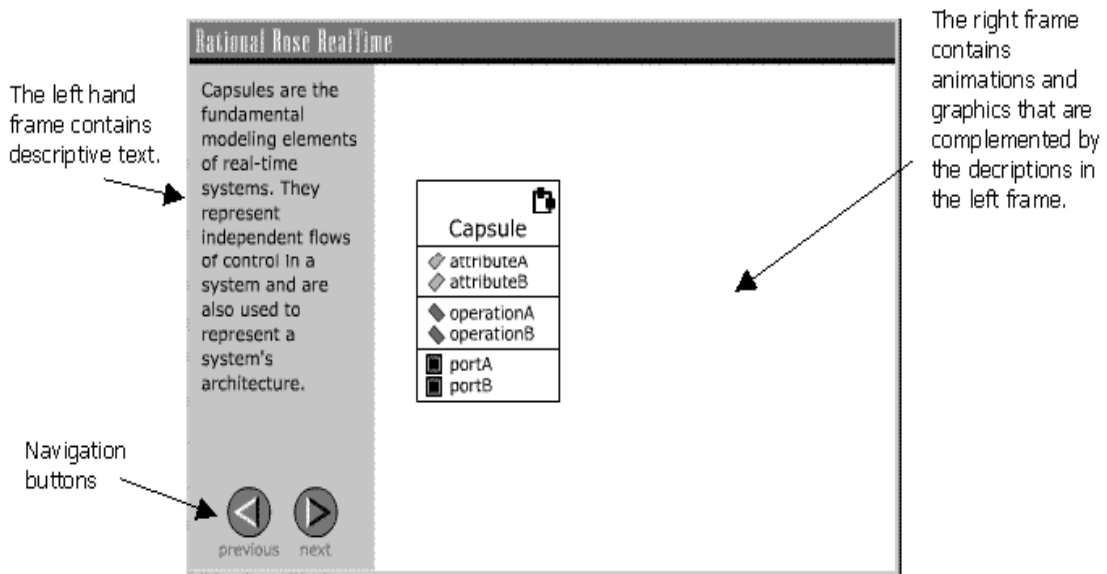
## Overview

---

The *Concept* tutorials provide an introduction to the important Rational Rose RealTime concepts. They expand and summarize the explanations and examples given in the *Rational Rose RealTime Modeling Language Guide*.

**Note:** The *Concept* tutorials are presented as Shockwave animations that you activate from the online help. To view the tutorials, you must install the Shockwave plug-in. The tutorials are displayed in the Help browser with text shown on the left side of the window, with graphics and animations on the right. You control the tutorial by using the navigation buttons at the bottom of the left-hand frame.

**Figure 3 Tutorial Window**



**Note:** These tutorials cannot be viewed with the UNIX Help viewer. You can install the UNIX Netscape plug-in from Shockwave, and load the tutorials using a Netscape 4.X browser. For more information, see [\\$ROSERT\\_HOME/Tutorials/unix/index.htm](#).

## Messages and Capsule State Machines

**Note:** This tutorial introduces you to the basics of message passing between capsules. If you do not see the tutorial window, install the Shockwave plug-in. These tutorials cannot be viewed with the Unix help viewer. You can download the Unix Netscape plug-in from Shockwave and load the tutorials using a Netscape 4.X browser. See [\\$ROSERT\\_HOME/Tutorials/unix/index.htm](#) for more information.



## Capsule Hierarchical State Machines

---

This tutorial reviews the basic elements of state machines and explains some of the complexities involved with hierarchical capsule state machines.

**Note:** If you do not see the tutorial window, install the Shockwave plug-in. These tutorials cannot be viewed with the Unix help viewer. You can download the Unix Netscape plug-in from Shockwave and load the tutorials using a Netscape 4.X browser. See [\\$ROSERT\\_HOME/Tutorials/unix/index.htm](#) for more information.

## Capsules and Capsule Roles

---

This tutorial is intended for those users who are familiar with class modeling and who want to understand the additional concepts involved when modeling with capsules. The tutorial outlines the differences and similarities between class and structure diagrams.

**Note:** If you do not see the tutorial window, install the Shockwave plug-in. These tutorials cannot be viewed with the Unix help viewer. You can download the Unix Netscape plug-in from Shockwave and load the tutorials using a Netscape 4.X browser. See [\\$ROSERT\\_HOME/Tutorials/unix/index.htm](#) for more information.

## Ports, Protocols, and Protocol Roles

---

**Note:** This tutorial is intended for those users who want an introduction to protocols and protocol roles in a Rose RealTime model. If you do not see the tutorial window, install the Shockwave plug-in. These tutorials cannot be viewed with the Unix help viewer. You can download the Unix Netscape plug-in from Shockwave and load the tutorials using a Netscape 4.X browser. See [\\$ROSERT\\_HOME/Tutorials/unix/index.htm](#) for more information.



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