GEF and Draw2d Plug-in Developer Guide > Programmer's Guide

GEF Programmer's Guide

`org.eclipse.gef`

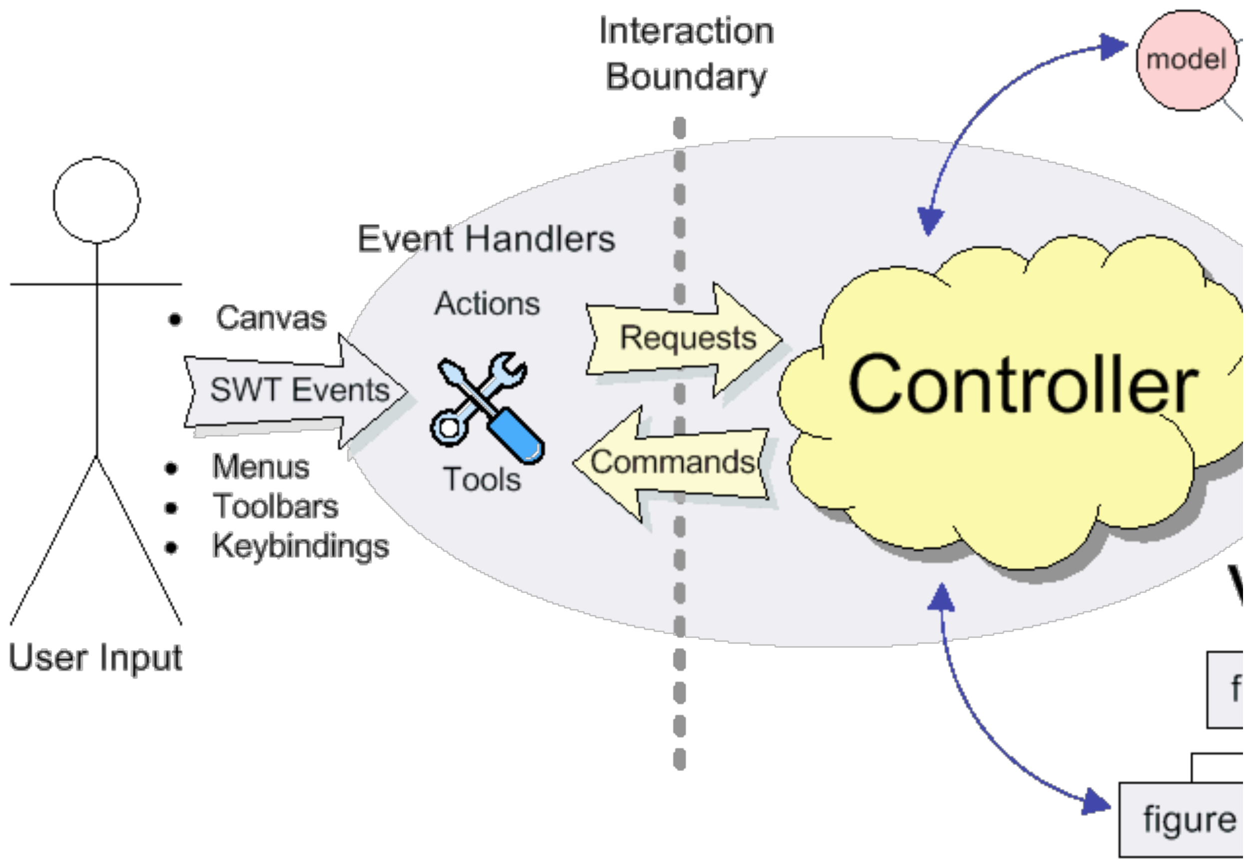
- Overview - Description of the "big picture"
- When to Use - How can GEF and the Eclipse Platform be used
- EditParts - An introduction to primary building block of GEF
- Graphical View - How to create a Graphical View of your Model
- Editing and Edit Policies - Adding editing support to your Graphical View
- Editpart Lifecycle - Interesting events to know about
- Tools and Palette
- Interactions - the GEF interactions and the players involved

Overview

Draw2d focuses on efficient painting and layout of figures. The GEF plug-in adds editing on top of Draw2d. The purpose of this framework is to:

1. Facilitate the display of any model graphically using draw2d figures
2. Support interactions from mouse, keyboard, or the Workbench
3. Provide common components related to the above

The diagram below shows a high-level view of GEF. GEF can be loosely defined as the region in the middle. The framework provides the link between an application's model and view. It also provides input handlers, such as tools and actions, that turn events into requests. Requests and Commands are used to encapsulate interactions and their effects on the model.



In MVC (model-view-controller) design, the controller is often the only connection between the view and the model. The controller is responsible for maintaining the view, and for interpreting UI events and turning them into operations on the model. These roles as they apply to GEF are described below:

Model

The model is any data that gets persisted. Any model can be used with GEF. The model must have some sort of notification mechanism. Although not technically the model, commands are closely related. A command is how the model is modified in a way that can be undone and redone by the user. In general, commands should work only on the model itself.

View (Figures/Treeitems)

The view is anything visible to the user. Both Figures and TreeItems can be used as view elements.

Controller (EditPart)

There is usually one controller per visualized model object. The controller is called an **`EditPart`**. Editparts are the link between the model and the view. They are also responsible for editing. Editparts contain helpers called *EditPolicies*, which handle the much of the editing task.

Viewers

An **`EditPartViewer`** is where editparts display their view. There are two types of viewers provided in GEF. A graphical viewer hosts figures while a tree viewer displays native treeitems. GEF viewers are similar to JFace viewers in that they manage an SWT Control. Viewers are also a selection provider, and the unit of selection is the EditPart

When can I use GEF?

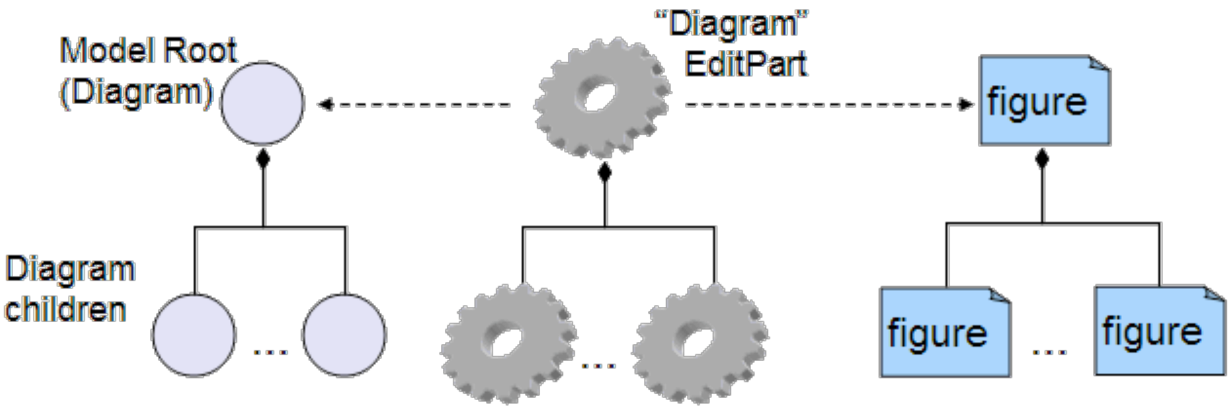
GEF can be used anywhere that you can use an SWT Control inside a Workbench. It could be an editor, a view, a wizard page, etc. Most commonly it is used inside an EditorPart and sometimes in that editor's outline page.

GEF requires the Eclipse Rich Client Platform (RCP) and the "views" plug-in (**`org.eclipse.ui.views`**), which provides property sheet support.

An Introduction to EditParts

Editparts associate their view and model, but they also form their own structure. An editpart maintains children. Usually this corresponds to a similar containment found in the model. For example, the model may consist of a diagram containing nodes. There would then be a corresponding diagram editpart which contains multiple node editpart children.

The parent-child relationship of editparts carries over into their figures. The parent's figure will contain the children's figures. Or, in some cases the parent part's view is a compound view composed of several figures, one of which is designated as the *content pane*. The figure of each child is added to the content pane. The end result is that you have three separate hierarchical data structures which are approximately parallel to each other.



Connections are the exception to this simple tree structure. Connections represent a link or association between two objects. A Draw2d connection figure is used as the view. Connections man be stored in any way in the model, but the editparts are managed by the source and target editpart at each end. A connection editpart's figure containment is also handled specially. The connection figure is added to a special layer in the diagram so that it paints above the primary layer containing non-connection parts.

There are two types of editpart implementations provided with GEF. Graphical editparts use figures as their view. Graphical editparts also add the ability to support connections, which themselves are graphical editparts. The other type is a tree editpart. Tree editparts use SWT treeitems as their view.

The responsibilities of each editpart include:

- Create and maintain a view (whether figure or treeitem)
- Create and maintain children editparts
- Create and maintain connections editparts
- Support editing of the model

Note that maintaining the view and other editparts implies that the editpart will be notified of changes in the model. Usually, the editpart hooks a listener directly to the model object(s) with which it is associated. When it receives notification, it updates its view or structure depending on the change.

As the name implies, editparts must support editing the model. But first we will focus on the initial steps of building an application, which is to display the initial model.

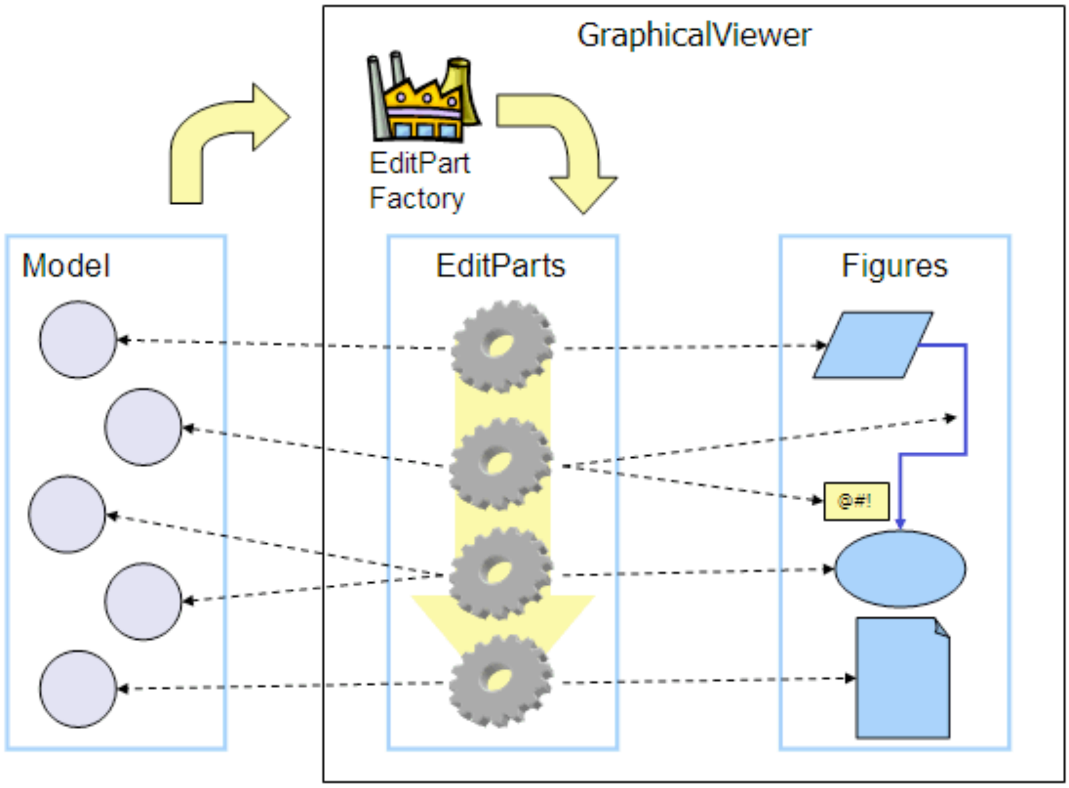
Creating a Graphical View of a Model

Once you have a model and some figures with which to view it, the next step is to put the pieces together. This means creating the editparts that are going to work with each model and figure combination. GEF's implementations are abstract and must be extended for your application. But first, we need to set up the foundation.

GEF includes the class **`ScrollingGraphicalViewer`**. This is a viewer implementation which uses a Draw2d **`FigureCanvas`**. **Most applications use this viewer** unless, for some reason, scrollbars are not needed. The next step is to decide which *root* editpart to use. Each editpart viewer requires a special editpart called the root. This editpart does not correspond to anything in the model. Its function is to setup the viewer and provide a uniform context for all of the application's "real" editparts. There are two implementations to consider using:

- **`ScalableRootEditPart`** - provides the standard set of layers and supports zoom should the application decide to expose this to the user.
- **`ScalableFreeformRootEditPart`** - similar to above, but all of the layers conform to the *freeform* interface, which allows the diagram to additionally extend into negative coordinates (to the left and up). This is the most flexible and **commonly used** root editpart.

Now we have a viewer and its root editpart, so next we'll actually set some contents into the viewer. *Contents* refers to the base model object that seeds the viewer with the graphical diagram being displayed. The viewer's **`EditPartFactory`** is then responsible for taking the contents and constructing the appropriate editpart, which is then set on the root editpart. Its figure gets added to the root's. At that point the contents editpart will construct its children editparts, reusing the viewer's factory, which in turn then create their children and/or connections, etc., until all of the editparts and their views have been created.



Implementing the Contents EditPart

So the first implementation you will need to write is the contents editpart. You'll also need to implement a factory which recognizes the contents model object and constructs this editpart. This part's figure provides the backdrop for the rest of the diagram. Usually it doesn't even need to paint, but you still need to choose the layout manager and the figure type based on the root editpart. To control which figure gets created, override **`createFigure()`**. When using a freeform root, the contents figure must implement the freeform API. The **`FreeformLayer`** figure will suffice. The layout manager is often the **`XYLayout`** or the **`FreeformLayout`**, again depending on whether the root is freeform or not.

During initialization, the contents editpart will construct its children based on the list returned when calling **`getModelChildren()`** on itself. Editparts should override this method to return the list of objects in the model for which child editparts should be created. By default, editparts go back to the viewer's factory to create each child.

Implementing the Children EditParts

The children of the diagram, sometimes called *nodes*, usually display some information to the user. Their figures may be one of the default provided figures, a custom figure, or a composition of multiple figures. During the population of the viewer, each editpart will have its **`refreshVisuals()`** method called. This method is responsible for reflecting the model's properties in the view. Editparts must override this method based on the model and figure they work with. In complex cases this method can be factored out into several smaller helper methods. Later, when we start listening to model changes, this method or its helpers may be invoked again.

If a child of the diagram is also a parent with its own children, it needs to override **`getModelChildren()`** in the same manner that the diagram editpart did.

Adding Connection EditParts

Connections are special editparts that connect any two editparts in a diagram. An editpart is called a *node* if it can be the source or target of a connection. The connections are created and managed in a shared way by both of its *source* and *target* nodes. Each node in the diagram must override **`getModelSourceConnections()`** and **`getModelTargetConnections()`** to return the model object representing the connection. GEF then checks to see if the connection editpart has already been created (by the other node at the other end), and if not it asks the factory to create the connection editpart. The source node is responsible for activating and adding the connection figure to the diagram.

A connection editpart's figure must be a Draw2d **`Connection`**. The connection editpart attempts to set its figure's anchors by casting the source and target nodes to a **`NodeEditPart`**. The source and target must return the appropriate anchors or default anchors with bogus fixed locations will be used instead.

In many ways connections are just like other editparts. They typically have properties in their model that must be visualized. They may even themselves have children or be nodes to other connections.

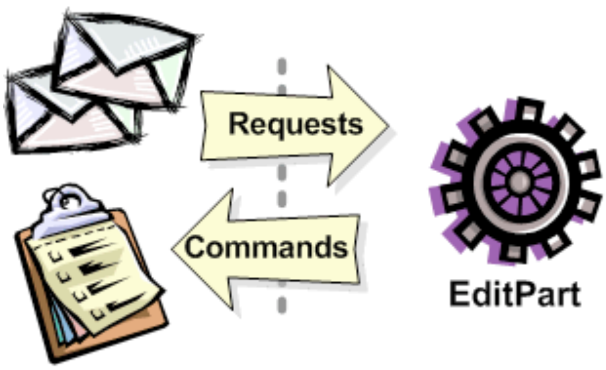
Summary

So far we have focused on just displaying a model graphically. This requires that you extend **`AbstractGraphicalEditPart`** and override behavior based on each part's model. Here is a summary of the methods discussed:

- **`createFigure()`** - this method creates the editpart's view, or figure. This method does **not** reflect the model's state in the figure. That is done in refreshVisuals()
- **`refreshVisuals()`** - this method reflects model attributes in the view. Complex editparts may further decompose this method into several helper methods.
- **`getModelChildren()`** - this method is called to determine if there are model elements for which children editparts should be created.
- **`getModelSource/TargetConnections()`** - similar to children, but model elements returned here indicate connections for which the editpart is the source or target.

Editing and EditPolicies

Once you have some editparts displayed it's time to start editing. Editing is usually the most complex task an editpart performs. Editing includes not only making changes to the model, but also showing graphical feedback during interactions with the view. To abstract away the source of interaction, GEF uses a request. Tools or other UI interpreters will create requests and then call the various API on EditPart based on the interaction. A subset of the EditPart API is shown below.



Methods on **`EditPart`** which take a **Request**:

1. **`EditPart getTargetEditPart(Request)`**
   `boolean understandsRequest(Request)`
2. **`void showSourceFeedback(Request)`**
   `void eraseSourceFeedback(Request)`
   `void showTargetFeedback(Request)`
   `void eraseTargetFeedback(Request)`
3. **`Command getCommand(Request)`**
4. **`void performRequest(Request)`**

1 The first step of editing is to decide which editparts are involved. Usually, it is some combination of the viewer's current selection and an editpart calculated based on the current mouse location. The selection can be trimmed by asking if each selected part understands a request. The part under the mouse, called the *target*, is found with the viewer's help and the **`getTargetEditPart(Request)`** method. Not all interactions have targets.

2 During interactions, especially mouse interactions and dragging, editparts are asked to show feedback based on their role in the interaction. An editpart is considered the *source* if it is the part being acted on. A *target* editpart is the part underneath the mouse. For example, when dragging a node around a diagram, the node is the source, and the diagram is the target. The node is asked to show source feedback, which might be a rectangle or some other modified representation of the node. The diagram is asked to show target feedback. When reattaching the end of a connection, a node might be showing target feedback instead. Some interactions only operate on a source.

3 The command is what eventually changes the model. Editparts are asked for a command for a given request. Commands also help determine if the interaction is possible. If there is no command, or it is not executable, the UI will indicate that the interaction is not allowed. If an editpart contributes NULL as its command, it does not prevent the interaction from occurring, unless of course no commands are provided by any of the editparts. To indicate something is not allowed, the editpart must return a command that is not executable.

4 Finally, there is a generic API telling an editpart to just "do something". This is generally something that does not immediately result in a model change. For example, opening a dialog or activating the "direct-edit" mode.

EditPolicies

Editparts don't handle editing directly. Instead, they use EditPolicies. Each editpolicy is then able to focus on a single editing task or group of related tasks. This also allows editing behavior to be selectively reused across different editpart implementations. Also, behavior can change dynamically, such as when the layouts or routing methods change.

When any of the above editing methods are called (except **`performRequest()`**), the editpart delegates to its policies to satisfy the request. Depending on the method, the editpart may stop at the first policy that handles a request, or it may allow each policy a chance to contribute. Refer to each method's javadoc for more details.

During the editpart's creation, **`createEditPolicies()`** is called and the editpart should install the appropriate policies. EditPolicies are installed using *roles*, which are nothing more than identifiers that serve as keys. GEF provides several identifiers for commonly used roles. Roles become important when an editpart needs to have its policies removed or swapped out. The rest of the time it is just a good habit. GEF also provides several policies for use with these roles. Many of these policies must be extended to fill in the missing pieces that work with the application's model. EditPolicies are discussed in more detail in the section on interactions.

Commands

Commands are passed around throughout editing. They are used to encapsulate and combine changes to the application's model.

An application has a single command stack. Commands must be executed using the command stack rather than directly calling execute.

The EditPart Lifecycle

With respect to lifecycle, editpart implementations typically only have to worry about extending activation and deactivation, which is when the editpart should add and remove its model listeners. Still, an understanding of the entire lifecycle is important.

1) Creation

The first thing that happens is creation. Most editparts will be created by the viewer's factory, which is invoked by either the viewer or the managing editpart which is typically the parent. Immediately after being created, the following methods are called:

`setModel()` - if the constructor does not take the model as an argument, it should be set immediately. Other events that followed may be based on the part's model

2) Getting Added to the Diagram

`setParent(...)` - the very first step is to tell the part its parent. This gives the part a path back to its viewer, which it might need for things like accessing the editpart registry.

`createFigure()` - Although this is a protected method, the timing of when it gets is somewhat interesting. Both the parent and the model are known at the time the figure needs to be created.

`addNotify()` - Signals the completion of the child being added to the parent. At this point, the child will do the following:

1. Register itself with the viewer using both its view and its model.
2. Create any editpolicies that it needs.
3. Refresh, meaning update first its own view, and then construct any structural elements of its own such as children or connections.

`activate()` - Indicates that the editpart should become active for editing, meaning that the model might change. The parent only activates its child if it is also active. The root is only active if the viewer has created its Control. An editpart should do the following on activation:

1. Start listening to the model. Subclasses should **extend** this method to add any necessary listeners.
2. Activate all of the editpolicies.
3. Activate all children and outgoing connection editparts.

3) Normal Use

At this point the editpart is in its normal editing state. It gets selected, shows feedback, and returns commands, etc., until it is no longer needed, meaning it is either removed from the diagram or the viewer is being disposed.

4) Becoming Garbage

`deactivate()` - the opposite of activate. Once again, subclasses should **extend** this method to remove the listeners added during activation.

The remaining steps **only** occur when the editpart gets removed, meaning its model was removed from the diagram. If the viewer is being disposed, then deactivation is the only thing that is guaranteed to occur. For this reason, activate and deactivate are the commonly extended methods while the remaining methods can usually be ignored.

`removeNotify()` - Signals that the editpart is about to incur removal. The following must happen while the editpart still has access to its surroundings:

1. Make sure the editpart is not longer selected or has focus
2. Call removeNotify on children so that they can do the same
3. Un-register the editpart from the viewer's registries
4. Remove self as source or target of any connections. Connections don't go away unless both source and target get set to null.

`setParent(null)` - The last step of removal. The parent and viewer are no longer reachable at this point.

Editparts do not come back from the grave. When a change in the model is undone, a **new** editpart is created. For this reason, commands should not reference editparts, and editparts should not contain any important state that must be restored on undo.

Tools and the Palette

A tool handles most events from a viewer. The `EditDomain` keeps track of the currently active tool. Applications may use the palette (PaletteViewer) to display multiple tools, allowing the user to change between modes such as selection, creation, etc.

How Tools Work

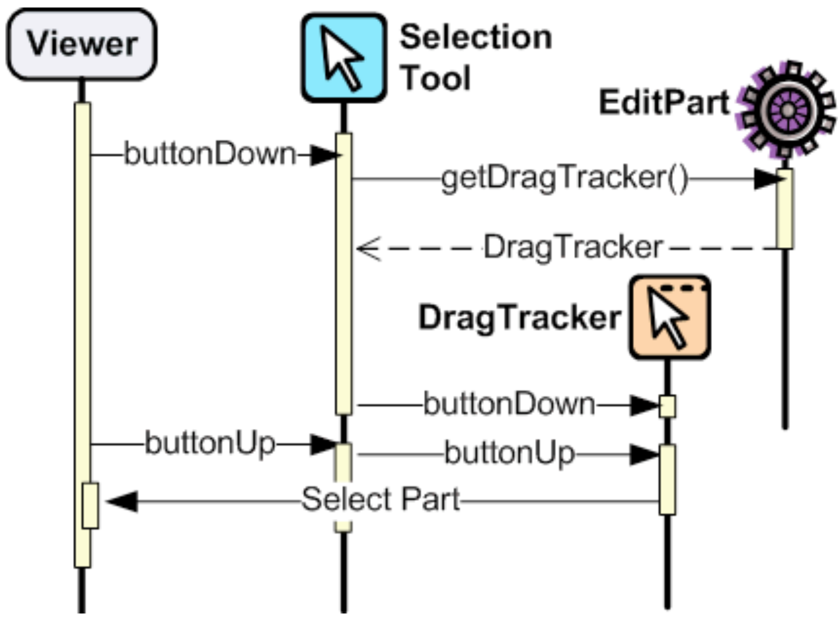
Tools are implemented like state machines. SWT events provide the input to the state machine. Based on the event and current state, a tool will perform certain actions. These actions could include:

- asking editparts to show or hide feedback
- obtaining commands from editparts
- executing a command on the command stack
- updating the mouse cursor

A tool is activated by setting it on the EditDomain. There is only one active tool for all viewers in the domain. If a palette is being used, selecting a tool in the palette will activate that tool.

The Selection Tool

The Selection Tool is the primary tool used in GEF and is often the default for an application. The selection tool is unique in its ability to delegate. Tt obtains a helper called a `DragTracker` from an editpart or handle below the mouse when a drag occurs. A drag is defined as a mouse button being pressed, its being released, and any events that occur in between. Events are forwarded to the delegate so that the drag can be handled differently based on where and how the drag originated. For example, clicking on a handle may result in resizing a shape, or moving the end of a connection. Clicking on an editpart typically drags that part to a new location or parent.



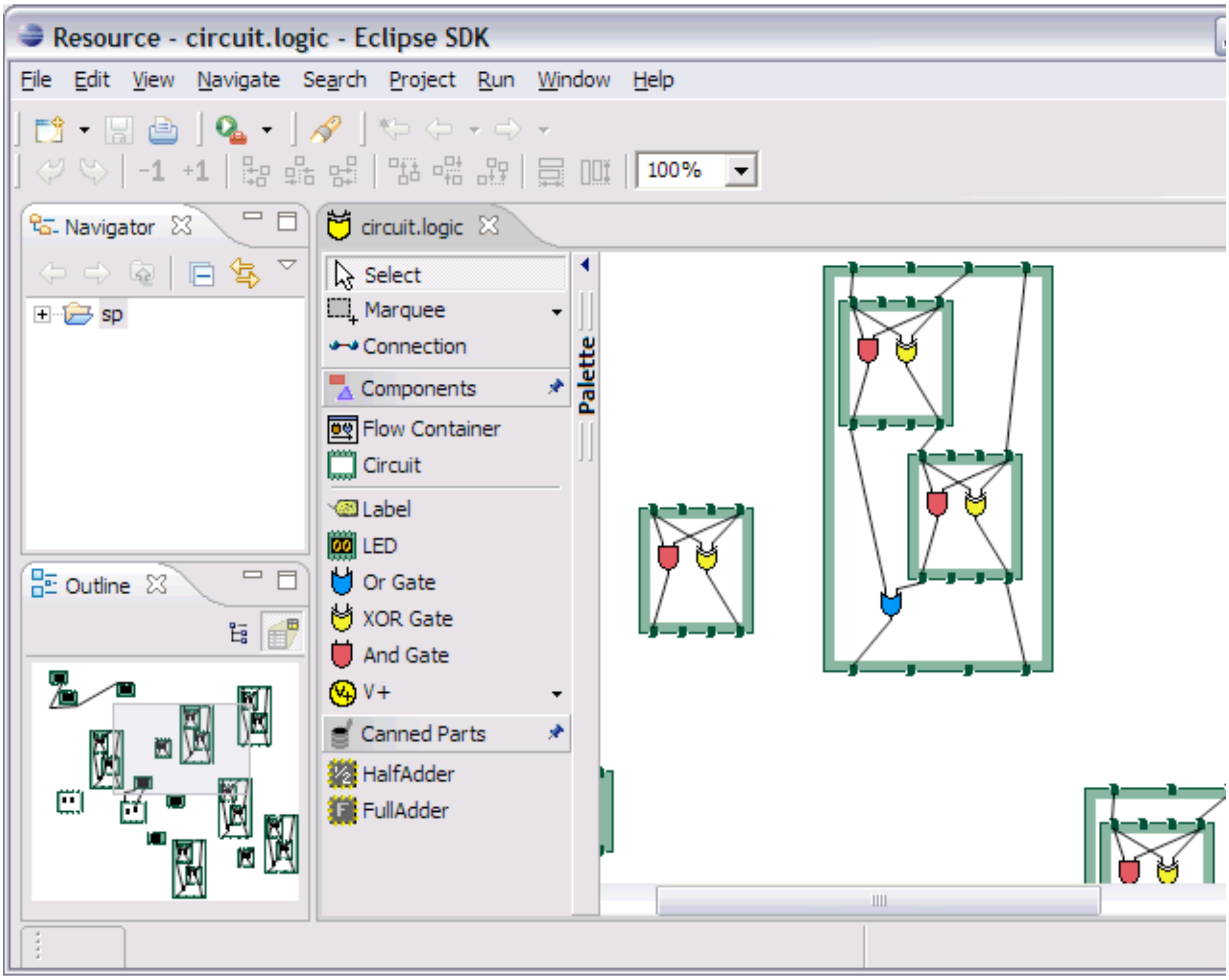
Ironically, the Selection Tool doesn't select editparts. All mouse clicks are handled as drags. When the Selection Tool receives a mouse down event over a selectable editpart, it asks for a drag tracker. The editpart returns a tracker derived from SelectEditPartTracker. The tracker also receives the mouse down event, as well as any other events, until the mouse button is released. When the tracker interprets a selection gesture, it modifies the viewer's selection. Trackers even handle events like double-click.

For more on the selection tool and trackers, see the section on Selection Interaction.

Palette

GEF's **`PaletteViewer`** provides an SWT Control allowing the user to select which Tool is active. It can also be a drag source for dragging object from the palette directly into the diagram. Use of the palette is optional, but common.

The palette can be placed anywhere, including inside the editor. GEF provides a Workbench View for hosting the Palette. Also, a custom Composite, the **`FlyoutPaletteComposite`**, will manage the placement of the PaletteViewer beside a primary Control. This composite is used as the editor's primary control in the Logic Example, shown below:



The PaletteViewer displays a Palette model, which starts with the **`PaletteRoot`**. The root organizes the contents using either drawers, which open and close, or groups, which do not. Each grouping element then contains Palette Entries. An Entry defines either a tool or template for the User. Templates are described below in Creation.

The Palette provides several display modes, such as icon-only. You can also provide a customizer to allow the user to modify or create palette content.

Types of Interactions in GEF

This section discusses the various types of interactions that are included in the framework, and which parts of the framework are involved in supporting the interaction. An interaction can be anything that affects the model or the UI state. Many interactions are graphical but some are not. An interaction may include:

- Invoking some Action (usually displayed on the toolbar, menubar, or popup)
- Clicking on something
- Clicking and dragging something
- Hovering over something (pausing the mouse for a certain time)
- Dropping something dragged from another source (native Drag-N-Drop)
- Pressing certain keys

This section discusses the participants involved in each interaction and what they do. This can include:

- Tools which process input.
- Actions which are invoked.
- The IDs and instances of Requests that are sent to editparts by tools or actions. ID's are defined on the **`RequestConstants`** class.
- The EditPolicy roles designated to handle specific types of requests. These are just constants defined on the EditPolicy interface.

- Any EditPolicy implementations provided in GEF for use with the interaction.

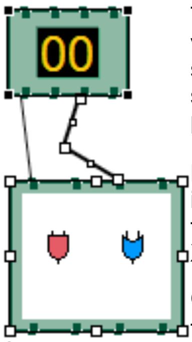
Selection

Tools	Requests	Edit Policies and Roles	Actions
SelectionTool MarqueeTool SelectEditPartTracker	SelectionRequest DirectEditRequest REQ_SELECTION_HOVER REQ_OPEN	SelectionEditPolicy DirectEditPolicy SELECTION_FEEDBACK_ROLE	SelectAllAction
*GraphicalViewerKeyHandler	REQ_DIRECT_EDIT		

No interaction is more basic or universal than selecting items in a viewer. Most of the interactions discussed here operate on what is currently selected. Yet, selection is a complex topic and there are several steps involved. The Selection Tool was briefly discussed in the above section on tools.

Let's first define selection. Selection is a List of EditParts maintained by an EditPartViewer. Changes to the selection are made by invoking methods on the viewer, and not by modifying the list directly. The selection is never empty. If the selection is cleared, the viewer's *contents* editpart becomes the selection. The last editpart in the list is considered the *primary* selection.

Closely related to selection is *focus*. Focus is a single editpart maintained by the EditPartViewer. Focus is used when manipulating selection via keyboard. By moving focus, the user can navigate from one editpart to another without changing the current selection. The user can add/remove the focused editpart from the selection. If focus is not explicitly set, it is the same as the primary selected part.



Selection Handles

The editpart is responsible for showing its selected and focused state to the user. The viewer tells editparts when they are selected, focused, or have primary selection. Typically, selection is shown by one or more EditPolicies adding selection handles. The handles shown here on the LED and circuit parts were added by **`ResizableEditPolicy`**. The black handles indicate primary selection.

Because selection handles are related to how a part can be dragged or sized, which in turn is related to the containing figure's layout manager, it is usually the parent part's editpolicy that installs a policy on the children for displaying the appropriate handles. For example, an XYLayoutEditPolicy would install a ResizableEditPolicy on each child of its host editpart.

Connections may **`WireEditPart`** in the Logic Example also changes its figure's line width to help indicate selection. Handles for connections are contribute by both **`EndpointEditPolicy`** and **`BendpointEditPolicy`**.

Selection Targeting and Feedback

For selection to occur, the Selection Tool must first target an editpart using a **`SelectionRequest`**. In rare cases, an editpart is not selectable and targeting "falls through", hitting the editpart below. During this continuous mouse targeting, the Selection Tool invokes showFeedback() on the current target editpart by passing it a **`SelectionRequest`** of type REQ_SELECTION. It is recommended that most applications ignore this request since showing and hiding feedback as the mouse moves across a diagram can be very distracting to the user. For this reason, there is an additional feedback request sent with the type REQ_SELECTION_HOVER whenever the user pauses the mouse over an editpart. Often an editpart will display a popup shell similar to a tooltip displaying additional information about the part. The SELECTION_FEEDBACK_ROLE identifier can be used when installing policies which show such feedback.

A benefit to using these feedback requests is that the Selection Tool is smart about asking parts to erase feedback. For example, if the user starts dragging, you would not want a popup message to stay around. Also, selection feedback will not occur when other tools are active.

Selection via a DragTracker

Once the user actually presses down on the mouse, the selection target will be asked for a **`DragTracker`**. To allow selection, return a **`SelectEditPartTracker`** or its subclass **`DragEditPartsTracker`**, depending on whether dragging is permitted. These trackers will modify selection at the appropriate time, taking into consideration the SHIFT and CTRL modifier keys.

The contents editpart should **never** be selected by a tracker. The reason being that it should never be part of a multiple selection. Therefore, it should return either a **`DeselectAllTracker`**, or the **`MarqueeDragTracker`**. Remember, the selection is never empty so the contents part will be the selection when all other parts are not selected.

Other Selection Requests

Editparts may be asked to perform two additional Requests that are related to selection. These requests are related to selection in that they are interactions associated with clicking the primary mouse button. The first is a double-click, which is called an *open* (REQ_OPEN). This interaction can be used for editparts that can be opened, expanded, or may display a dialog. The other interaction is called a *direct edit* (REQ_DIRECT_EDIT). An example of direct editing is when the user wishes to modify the text of a label. The user must first select the part, and then click on it again after it is selected. After a brief delay (used to rule out a double-click), the request is sent.

Selection Actions

GEF provides a `SelectAllAction`. Given a viewer, this action selects all of the contents part's children when invoked.

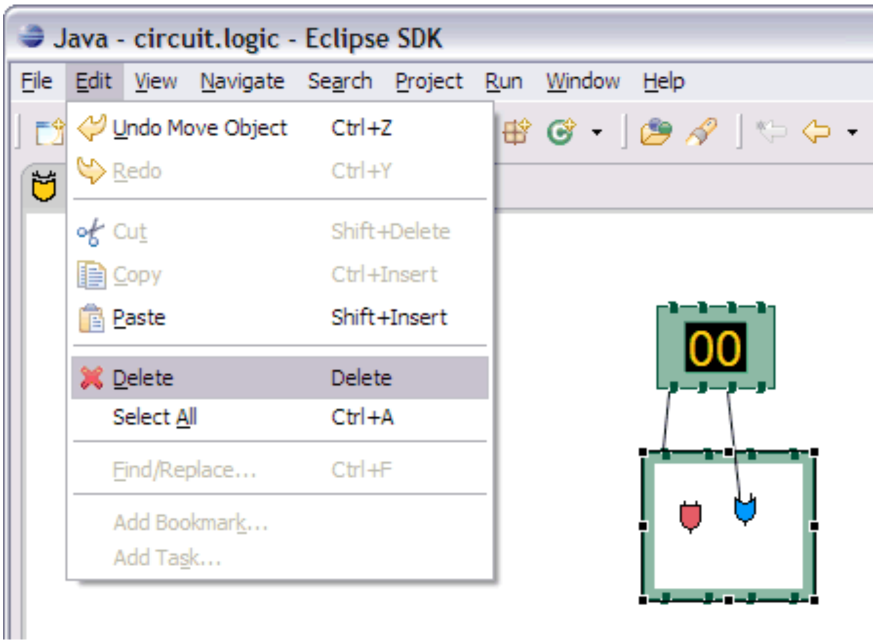
Selection using the Keyboard

Keyboard selection is supported in graphical viewers by installing a `GraphicalViewerKeyHandler`. The key handler only receives key events sent to it by the current tool. The Selection Tool forwards key forwards the events necessary for selection.

Drag trackers are not needed inside GEF's TreeViewer. The native tree handles selection already, and dragging of treeitems is processed internally using native DND.

Basic Model Operations (Delete)

Tools	Requests	Edit Policies and Roles	Actions
	REQ_DELETE	COMPONENT_ROLE CONNECTION_ROLE RootComponentEditPolicy	DeleteAction



The only universal interaction that all GEF applications should support is delete. The workbench places a global delete action on the edit menu. All applications should register a handler such as the included DeleteAction.

The DeleteAction sends a `GroupRequest` of type REQ_DELETE to the viewer's current selection. All editparts should have an editpolicy which either supports or prevents delete from occurring.

Every editpart is either a component or a connection. A component is a basic editpart that is the child of a parent. A connection is slightly different because it is owned by its source and target.

The COMPONENT_ROLE key is used when installing an editpolicy on a component editpart. Applications can extend the provided `ComponentEditPolicy` to fill in the commands for deletion. The `RootComponentEditPolicy` should be used on the contents editpart. This policy prevents the diagram itself from being deleted. Here, "root" refers to the model root and is not related to the viewer's root editpart.

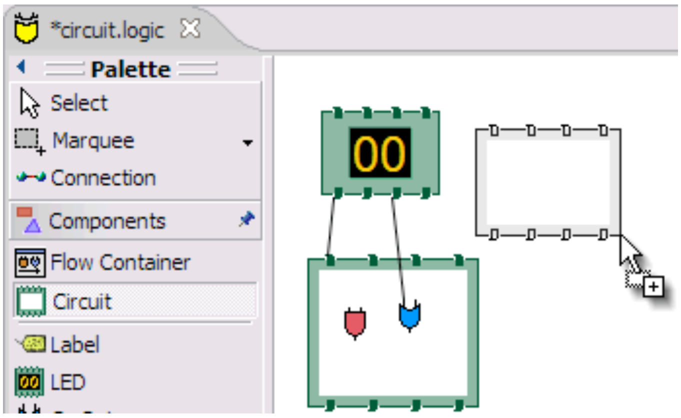
The CONNECTION_ROLE key is used when installing a policy on a connection editpart. Applications can extend the provided `ConnectionEditPolicy` to fill in the command for deletion.

These editpolicies should handle the tasks most closely associated with the model. In the logic example, this role is responsible for the LED's increment and decrement behavior, which adds or subtracts one from the LED's value.

Implementing the command that performs delete can be difficult, especially when connections are involved. The command must consider whether the object being deleted has connections, or if children of the object being deleted have connections, and delete the connections as well. But, you don't want to delete the same connection twice in cases where both source and target nodes are being deleted as part of multiple selection. The logic example's delete command addresses all of these concerns.

Creation

Tools	Requests	Edit Policies and Roles	Actions
CreationTool TemplateTransferDropTargetListener TemplateTransferDragSourceListener	REQ_CREATE Create	CONTAINER_ROLE LAYOUT_ROLE TREE_CONTAINER_ROLE ContainerEditPolicy LayoutEditPolicy	CopyTemplateAction PasteTemplateAction



A **`CreateRequest`** is used to ask an editpart to create a new child. The request is identified by the ID REQ_CREATE. Creation can occur through three different methods: clicking, dragging, or pasting. The request provides the location, object, and object type being created. The object and its type are provided by a **`CreationFactory`**. The request hides the factory and provides access to the created object directly, caching it in case multiple editpolicies all need access to the created object. In some cases, the request will contain a size attribute.

Producing CreateRequests

The creation tool provides a "loaded cursor" mode which will attempt to create an object at the mouse location when clicking. If the mouse is pressed and dragged, the tool will track the size of the rectangle defined by the user. The creation tool can be placed on the palette using a **`CreationToolEntry`**. When the mouse is released, the tool will either repeat the process or switch back to the default tool.

Creation can also be performed using native Drag-and-Drop. The drag source can be anything, but it is typically the PaletteViewer. A palette entry taking a *template* is added to the palette. The **`TemplateTransfer`** is used to transfer the template, which is just an Object, from the drag source to the drop target. A TemplateTransferDragSourceListener must be added to the PaletteViewer. Similarly, the viewer must have a TemplateTransferDropTargetListener. Since a template is model-specific, the application must extend the drop target listener to convert the template into a CreationFactory for the request.

A special palette entry called the **`CombinedTemplateCreationEntry`** supports both the creation tool and drag-and-drop style of creation.

Consuming CreateRequests

The target editpart is responsible for showing feedback and returning the command for creation. GEF provides two types of policies for handling creation. One type of policy is specific for the view in which creation occurs, either graphical or tree-based. This edit policy corresponds to either the LAYOUT_ROLE or the TREE_CONTAINER_ROLE.

The other type of edit policy is specific to only the model, should applications wish to separate out the potion that is shared between graphical and non-graphical creation. In most cases, any kind of shared logic is in the command implementations, making this type of policy unnecessary.

A **`LayoutEditPolicy`** handles the process of creation based on the container's layout manager. For example, if the XYLayout is being used, then the resulting Command will need to associate an (x, y, w ,h) constraint with the created child. Layouts that don't use constraints would require that the index of the drop location be determined. GEF provides abstract policies for the basic layout types.

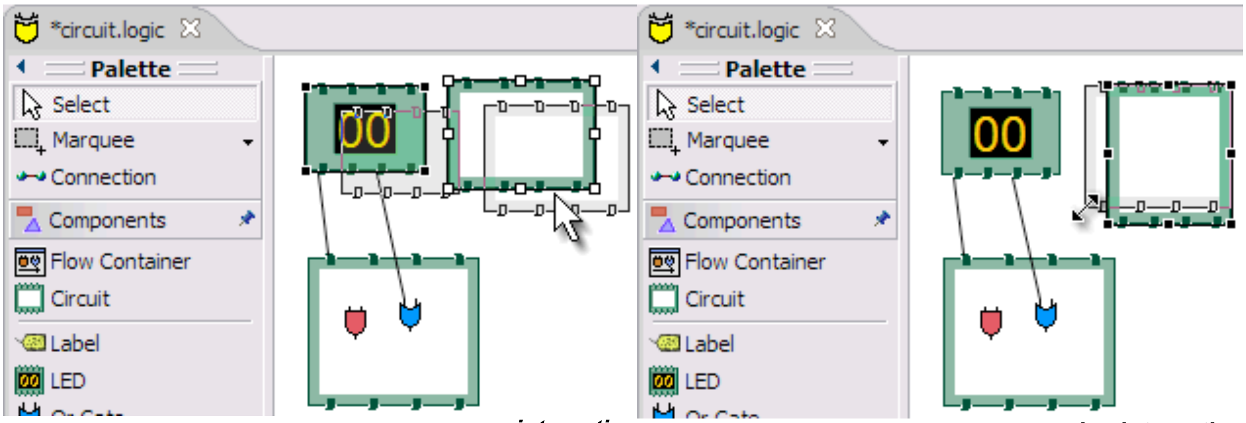
The **`TreeContainerEditPolicy`** is used for supporting creation in a tree-based viewer. The policy is responsible for determining the index of creation and showing feedback.

The **PasteTemplateAction** can be used to create objects without the mouse. This is important for accessibility. The **CopyTemplateAction** is added to the Palette. When the user invokes this action, an internal mechanism copies the transfer so that it can be pasted in a viewer. When paste occurs, the PasteTemplateAction retrieves the template object, constructs a CreateRequest, and sends it to the selected editpart. Mouse location is not available in this interaction. Paste is only enabled when the selection is exactly one editpart.

When a creation command is redone, it must restore the original child that was created the first time it was executed. If it creates a new object, then subsequent commands will fail on redo when they try to modify the originally created child.

Moving and Resizing

Tools	Requests		Edit Policies and Roles	Actions
DragEditPartsTracker	ChangeBoundsRequest		LayoutEditPolicy	AlignmentAction
ResizeTracker	AlignmentRequest		ResizableEditPolicy	MatchSizeAction
	REQ_MOVE	REQ_CLONE	ContainerEditPolicy	
	REQ_ADD	REQ_ALIGN		
	REQ_ORPHAN	REQ_RESIZE		



move interaction *resize interaction*

The DragEditPartsTracker extends basic selection behavior to allow the selected parts to be dragged within their graphical viewer. Dragging the selected parts can result in three potential interactions: move, reparent, and clone. All three use the **ChangeBoundsRequest**, which extends GroupRequest to include a size delta, move delta, and mouse location.

While dragging the selection, if the tracker targets the part's original parent, the request is typed as **REQ_MOVE**. If the target changes, the interaction becomes a reparent. For a reparent, a request of type **REQ_ORPHAN** is sent to the old parent, while the new target is sent a request of type **REQ_ADD**. When the CTRL key is pressed (ALT on the Mac), the operation is always a **REQ_CLONE**, which is only sent to the target part.

All of these requests are related in that they require the target to process a rectangle and a mouse location. The LayoutEditPolicy is responsible for handling each of these request types. For layouts which use constraints, each part's original bounds is taken and modified by the size and move deltas to determine a new bounds, for which a corresponding constraint is found. For index-based layouts, the mouse location is used to establish the new index.

A **ContainerEditPolicy** can optionally be used to contribute additional commands (not related to the layout) during ADD, ORPHAN, and CLONE requests.

Resizing

Resizing falls under the same category as changing bounds. Note that when resizing either the top or left sides, the location of the part is also changed. Resizing only makes sense for layouts with constraints, such as XYLayout. The **ResizableEditPolicy** adds up to eight resize handles to its host. When the Selection Tool is clicked on one of these resize handles, a **ResizeTracker** performs a resize on the selected parts understanding "resize". SHIFT and CTRL key modifiers can be used to constrain the resize operation.

The types of handles available on an editpart depend on the layout manager in which its figure is placed. For example, parts inside a table might have handles for adjusting insets, padding, column span, or other attributes. Some layouts don't need any handles, but four corner handles should be added just to indicate selection. Dragging these handles would be the same as dragging the part itself.

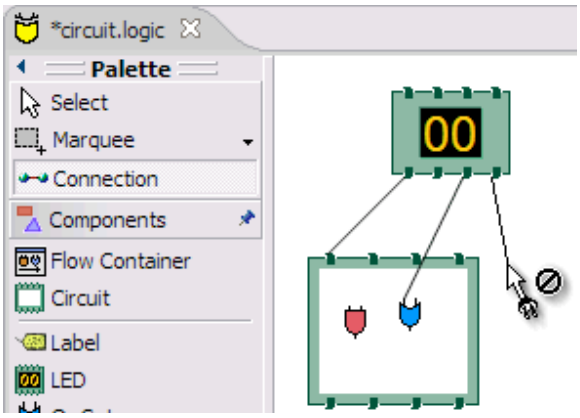
Because of the relationship between handles and layouts, it is recommended that the **`PRIMARY_DRAG_ROLE`** editpolicy be installed by the parent's **`LayoutEditPolicy`**, which defines abstract methods for this purpose. If a container changes layout managers during editing, typically the layout policy gets swapped with one for the new layout manager. The new policy then replaces the stale **`PRIMARY_DRAG_ROLE`** policies on each child.

The **`MatchSizeAction`** matches the size of the selected parts to that of the primary selected part's size. This action is implemented in a way similar to manually resizing the individual parts, and it uses the same request and type.

The **`AlignmentAction`** uses an **`AlignmentRequest`**, which extends ChangeBoundsRequest. When using a ChangeBoundsRequest, the part's current placement in the Control (in absolute coordinates) is passed to the request, which then returns a modified version. Using this pattern, alignment is able to adjust each part's rectangle by different amounts. In most cases, alignment can be treated no differently than a move. This action aligns all selected parts with one of the edges of the primary selected part.

Connection Creation

Tools	Requests	Edit Policies and Roles	Actions
ConnectionCreationTool ConnectionDragCreationTool	CreateConnectionRequest REQ_CONNECTION_START REQ_CONNECTION_END	GraphicalNodeEditPolicy NODE_ROLE	



The **`ConnectionCreationTool`** is used to create a new connection between nodes. This interaction requires the user to activate the tool (typically using the palette), and then click on two editparts supporting connections. The creation can be aborted by pressing the ESC key. The **`ConnectionDragCreationTool`** is similar, but the interaction is a single mouse drag. This tool can be returned as the drag tracker from a handle or even an editpart in some cases.

The process is separated into two parts. The first part is defining the *source* of the connection. The source is a node, but it may also include a specific "port" on that node. The tool uses a **`CreateConnectionRequest`** identified by REQ_CONNECTION_START to determine the target editpart and ask it for a command. However, this is only the first half of creating the connection, so the command is not complete yet. The tool will not attempt to execute this command or even ask if it is executable. This command is only used to pass information to the target editpart.

The second part is to define the target node for the connection. The tool uses the same request but retypes it as REQ_CONNECTION_END. The command returned by the source node is now stored on the request and passed during the second part of the interaction. The target is asked for the final command that performs the entire creation of the connection. Any command can be returned at this point, including the command provided on the request, updated with the target node information. At this point, enablement will be determined by asking the command if it can be executed. Creation ends by executing the command.

During the first and second steps, the editpart being targeted as the source or target node is asked to show **target** feedback. The editpart might visually highlight various attachment points or simply indicate that it is the target.

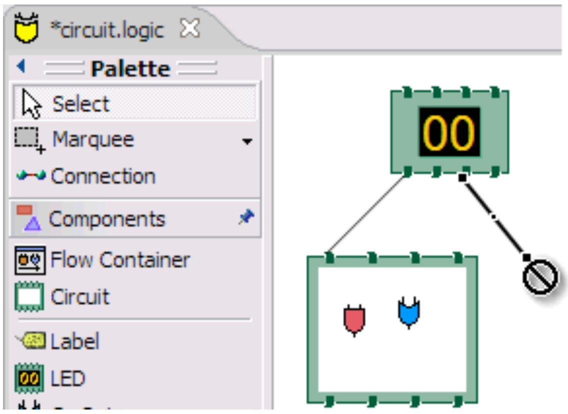
The source node editpart is also asked to show **source** feedback during creation. The provided **`GraphicalNodeEditPolicy`** can be used to display creation feedback. This policy will create a connection feedback figure, and set its anchors using the **`NodeEditPart`** interface. This mix-in interface for **`GraphicalEditPart`** is used both during creation feedback, and when the connection's editpart is created, to provide anchor points.

The "source" and "target" nodes should not be confused with "source" and "target" feedback. For feedback, "source" simply means show the feedback for the connection, while "target" means highlight the mouse target.

Editing Connections

Tools	Requests	Edit Policies and Roles	Actions
ConnectionEndpointTracker	ReconnectRequest REQ_RECONNECT_SOURCE REQ_RECONNECT_TARGET	ConnectionEndpointEditPolicy ENDPOINT_ROLE GraphicalNodeEditPolicy	

Tools	Requests	Edit Policies and Roles	Actions
		NODE_ROLE	



By dragging the endpoints of an existing connection, its source or target can be changed. This includes changing "ports" on the same node editpart. This interaction is called reconnecting.

A connection adds handles at its endpoints by installing a **`ConnectionEndpointEditPolicy`** with the ENDPOINT_ROLE. Each of these handles returns a tracker for reconnecting the corresponding end of the connection. This policy is also responsible for showing the connections feedback during the interaction. This policy does not return commands and therefore is not abstract. The reconnect command comes from the new target node.

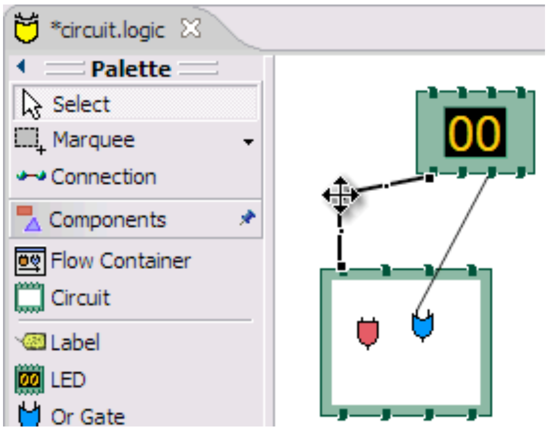
As the source or target endpoint is dragged, the tracker sends source feedback requests to the connection, and target feedback requests to the current target if there is one. The tracker uses a **`ReconnectRequest`** typed as either a source or target reconnect.

The target node's GraphicalNodeEditPolicy is responsible for showing target feedback and returning the actual command to perform the reconnect. As with creation, the target editpart should implement the **`NodeEditPart`** interface, which allows the ConnectionEndpointEditPolicy to snap the feedback to the nodes anchor(s).

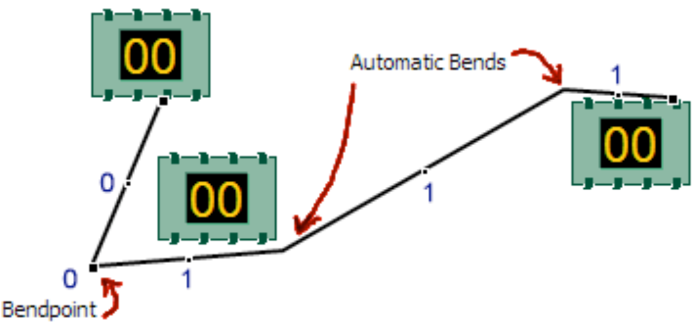
Bending Connections

Tools	Requests	Edit Policies and Roles	Actions
ConnectionBendpointTracker	BendpointRequest REQ_MOVE_BENDPOINT REQ_CREATE_BENDPOINT	BendpointEditPolicy CONNECTION_BENDPOINTS_ROLE	

Certain connection routers accept routing constraints (typically a list of **`BendPoints`**). Install a **`BendpointEditPolicy`** using the **`CONNECTION_BENDPOINTS_ROLE`** for editing the connections routing constraints. This editpolicy requires a router that takes a List of BendPoints. During selection, the policy will add normal handles to existing bendpoints on the connection. It adds smaller handles where the user can create new bendpoints.



Each handle provides a **`ConnectionBendpointTracker`**. This tool sends a **`BendpointRequest`** back to the connection editpart for showing feedback and obtaining the command to perform the bend. For existing bendpoints, the request is typed as **`REQ_MOVE_BENDPOINT`**, otherwise it is **`REQ_CREATE_BENDPOINT`**. It is up to the editpolicy to determine when moving a bendpoint back to its natural placement should result in its removal.



This picture shows a selected connection in the Logic Example with a single Bendpoint. The **`ShortestPathConnectionRouter`** has inserted additional bends in the connection to avoid figures. The handles for creating and moving bendpoints are labeled with the index that the BendpointRequest will contain. The index is the same as the current (or eventual) index of the bendpoint in the routing constraint's List.