# Writing A New Widget Class Using C and Tk

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## Outline

- What does Tk do for widget writers?
- Widget basics: data structures, etc.
- Six procedures to write:
  - Create
  - Configure
  - Display
  - Widget command
  - Event handler
  - Destroy
- Example: trivial ‘‘square’’ widget.

## What Does Tk Do For You?

1. **Window names:** `.a.b.c`

2. **Caching (efficiency, convenience):**
   - Window information (size, parent, etc.).
   - X resources (colors, fonts, GCs, etc.).

3. **Protocol intermediary**:
   - Event dispatching.
   - Geometry management.
   - Selection protocols.
   - Keyboard focus.
   - Window manager.
   - Error handling.



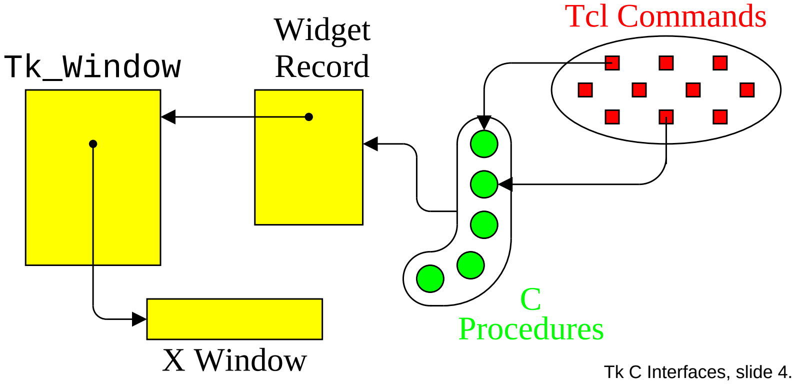
## The Structure of a Widget

**Data structures for each widget:**

- **`Tk_Window`** managed by Tk.
- Widget record managed by widget code.

**C code for widget class:**

- Tcl class command to create widgets.
- Tcl widget command to manipulate widgets.
- Supporting C procedures (e.g. redisplay).



## Philosophy: Widgets Are Reactive

- User is in control, not Tk or widget or application.

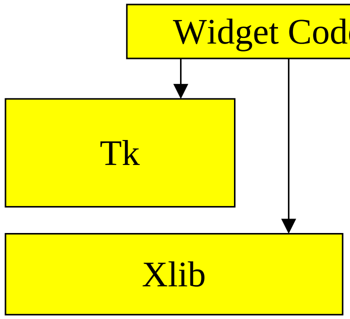
- Widget code is event-driven: responds to events around it.

- Procedures in widget are invoked when events occur, e.g.:
  - Tcl command invoked.
  - Window needs to be redrawn.
  - Window destroyed.



## Tk and Xlib

**When should widget call Tk, when Xlib?**




**Call Xlib only to draw on screen.**

**Call Tk for everything else:**

- Creating windows.
- Manipulating windows (map, resize, etc.).
- Managing events.
- Allocating resources (colors, GCs, etc.).

## Example: Square Widget

- Displays colored square on background.
- Widget command allows square to be moved, resized:

```
.s position 20 30
.s size 10
```

- Can write fancier behaviors in Tcl:
  - Drag square with mouse.
  - Animate.



## Creating a Widget

- Procedure **`Tk_SquareCmd`**.
- Invoked with Tcl command named after class:

```
square .s -fg RoyalBlue1
```

- Class command registered in main program:

```
Tcl_CreateCommand(interp, "square",
    Tk_SquareCmd, ...);
```

- Create **`Tk_Window`** object (variable **`tkwin`** holds handle).
- Initialize widget record (**`squarePtr`**), set up callbacks.
- Register widget command.
- Configure widget using command-line arguments.
- Don’t map window: geometry manager will do it.

## Delayed Window Creation

- X window isn't created immediately by **`Tk_CreateWindowFromPath`**.
- **`Tk_WindowId(tkwin)`** returns **`None`**.
- Window creation occurs when window mapped by **`Tk_MapWindow`**.
- Delay saves overhead (can reconfigure without involving X server).
- Can force creation of X window with **`Tk_MakeWindowExist`**.



## Configure Procedure

- Procedure **`ConfigureSquare`**.
- Processes **`argc`**/**`argv`**, modifies widget record, schedules widget redisplay.
- Called from both class command and widget command.
- Almost all of work done by Tk library procedure **`Tk_ConfigureWidget`**.
- Class provides table of configuration options: **`configSpecs`**.
- ConfigureSquare must also call **`Tk_GeometryRequest`** to set desired size.

## Display Procedure

- Procedure **`DisplaySquare`**.

- Redisplay is delayed:
  - Don't redisplay immediately (could result in multiple redisplays).
  - Instead, record what must be redrawn (for simple widgets, all or nothing).
  - Do actual redisplay when all pending work is finished: use **`Tk_DoWhenIdle()`**.

- Tk provides support for 3-D effects:
  - **`Tk_3DBorder`** data type.
  - **`Tk_Fill3DRectangle()`**, etc.

- Double-buffering with pixmap to avoid flashing.



## Widget Command Procedure

- Procedure **`SquareWidgetCmd`**.

- Decodes **`argv[1]`**, executes one of several commands.

- Potentially modifies widget record.

- Arranges for redisplay if necessary.

**Only provides primitive operations; complex features are implemented with Tcl scripts.**

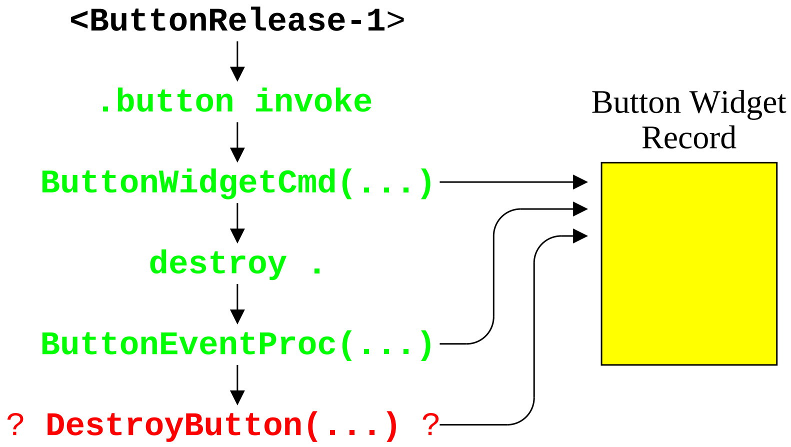
## Event-Handling Procedure

- Procedure `SquareEventProc`.
- Most events (e.g. `ButtonPress`) handled with Tcl bindings (more flexible).
- Most widgets need C code only for `Expose`, `DestroyNotify`, maybe `ConfigureNotify`.
- Handler set up during widget creation by calling `Tk_CreateEventHandler`.



## Destroy Procedure

- Procedure **`DestroySquare`**.
- WARNING! Can’t always clean up immediately: widget record may be in use by nested procedure.




- Solution: must delay destruction.

## Delayed Window Destruction

- Tk implements short-term reference counts.
  E.g. in **`ButtonWidgetCmd`**:

```
Tk_Preserve((ClientData) butPtr);
...
Tcl_Eval(interp, butPtr->cmd, ...);
...
Tk_Release((ClientData) butPtr);
return result;
```

- Don’t call destruction procedure directly:
  E.g. in **`ButtonEventProc`**:

```
if (eventPtr->type == DestroyNotify) {
    ...
    Tk_EventuallyFree((ClientData)
        butPtr, DestroyButton);
}
```

- **`DestroyButton(butPtr)`** is invoked:
  - Immediately if (no **`Tk_Preserve`**’s pending).
  - During last **`Tk_Release`** call.



## Things To Remember

- Event-driven style of programming.
- Delayed operations:
  - Creation of X window.
  - Redisplay.
  - Destruction of widget record.
- Work within Tcl framework: focus on primitives.
- Use Tk caches, configuration support.

**Don’t build from scratch: modify an existing widget.**