Tool Command Language

TCL

• Scripting language for developing & using GUIs
• Allows generic programming
  – variables, loops, procedures
• Embeddable into an application
• Extensible
• Interpreter written in C called Wish
  – Advantages? Disadvantages?

What is the Wish Interpreter?

• Read - Eval - Print Loop
  – You type in a function, interpreter “reads” it
  – Interpreter immediately “evaluates” it
  – produces a result
  • error message
  • result of evaluation
• Has a memory which you add to or change
• Can’t print out or save the source listing
• Advantage: Can immediately test the result of a function
Four Basic Things about Tcl

1. Consistent Syntax
   - procname ?argument? ?argument?
   - where procname is a function, command or procedure
   - ?argument? is a series of arguments to pass to the function.
     - % set a 15
       15 ← this is the return value of the "set" function.
     - % expr 4 + 5 + 2
       11 ← return value.

2. To evaluate a command and return the value "inline" use brackets []
   - % set a [expr 5 + 7]
     12

Four Basic Things about Tcl cont.

3. To evaluate a variable, put a $ in front of its name
   - % puts "hello world"
     hello world
   - % set a [expr 11 + 12]
     23
   - % puts "The value of a is $a"
     The value of a is 23

Four Basic Things about Tcl cont.

4. To prevent variables from being evaluated, enclose them in curly braces {}
   - % set a hello
     hello
   - % set b "$a world"
     hello world
   - % set c {"$a world"
     $a world
   - % set d {"a string with quotes"
     "a string with quotes"
   - Seems simple, but can get very complex when you nest them in "lists"
More about Tcl

- Can define a new procedure
  proc name args body
- Control structure
  - "If then else"
  - "for", "foreach", "while"
  - "catch" traps errors
- Variables
  - either string or list
  - use of global variables common

Toolkit for Tcl

TK
- Cross-Platform UI Widgets
  - X Window, Microsoft Windows, Mac
- Can program widgets with Tcl scripts
- Written in C
- Extensible
  - new UI widgets
  - new geometry managers

Programming in Tk

- Create instance of widget class
- Specify attributes of widget instance
- Arrange with geometry manager
- Bind actions to widget events
More on Tk

- Class hierarchy of widgets
  - UNIX Motif look & feel; each widget is an X window
- Tcl script invoked when event occurs
  - allows application specific code
  - Example: if left mouse button pressed when cursor over a Button widget, then exit.

More on Tk

- 4 Types of special commands
  - creating & destroying widgets
  - widget command: change color, etc. “.b”
  - geometry management: size & location widgets on screen “packer”, “placer”, “grid”
  - interconnecting widgets within and between applications
    - Example: scrollbar changes canvas view

Tcl/Tk

Benefits

- Rapid development
  - interpreter wish (windowing shell)
  - higher level language than C, C++ or Motif Tk
    - 1/10 less time to code
    - easier to learn
- Can call Java or C programs
- Can “glue” together many library packages
- Convenience
  - cross-platform
  - shareware, freeware
  - supported by SUN
**Tcl/Tk**

**Disadvantages**

- Interpreter creates slow code
  - 8.0 has compiler
- Replace with Java?
  - probably not: Tcl/Tk is much faster to learn and code
- Not multi-threaded
  - working on it
- Text oriented
  - GuiBuilders available: SpecTcl (see /local/apps/tcltk/SpecTcl-1.1 directory and Visual Tcl)

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**Implicit Main Event Loop**

**Tcl/Tk**

- Each Tk widget is a window
- Each widget has pre-defined event handlers
  - Example: Button widget responds to mouse button
- Can attach a Tcl script to an event handler to process application semantics for widget
  - Example: Bind command
- Other events in event queue
  - "after" generates timer event (used for animation, etc.)
  - "fileevent" when file descriptor becomes readable or writable
  - Process redraws after input events

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**Tcl/Tk Event Processing**

**Countdown Program Example**

```tcl
label .countdown text "Ready"
pack .countdown -padx 4 -pady 4
button .launch -text "Launch" -command {
  for {set i 10} {($i >= 0) (incr i -1)} {
    .countdown configure -text $i
    after 1000
  }
}
pack .launch -padx 4 -pady 4

(This has bugs. Can you find them?)
```
**Expected Output of Countdown Program**

```
launch Ready
Launch

Launch 10
Launch

Launch 9
Launch
```

**Actual Output of Countdown Program**

```
launch Ready
Launch

Launch 0
Launch
```
Why?

• Process redraws after input events
• To get expected output, add update command

```tcl
button .launch -text Launch -command {
    for {set i 10} {i >= 0} {incr i -1} {
        .countdown configure -text $i
        update
        after 1000
    }
}
```

Another quirk of Tcl/Tk event processing

```tcl
proc wait_for_click {win} {    ; # BUG ALERT!
    set x 0
    bind $win <ButtonPress-1? {set x 1}
    bind $win <ButtonPress-2? {set x 2}
    vwait x
    return $x
}
```

What is the result? after mouse click get 0

Why? Any code invoked from event loop is executed at global level!!!

Why?

• Any code invoked from event loop is executed at global level!!!
• There are two variables called "x"

```tcl
proc wait_for_click {win} {    ; # BUG ALERT!
    set x 0
    bind $win <ButtonPress-1? {set x 1}
    bind $win <ButtonPress-2? {set x 2}
    vwait x
    return $x
}
```
Solution

• To make program work properly, declare “x” global within the procedure

• Caution!!! This same logic applies to any script that is invoked from the event loop
  – “after”
  – “fileevent”
  – “-command”

Widget Composite Objects

• Composite Object can have children
  – not a subclass-class relation, i.e. not specializations
  – instead, part-whole relation
  – Containers

More on Composite Objects

  – Composite object allows run-time hierarchy in which position of child is specified relative to parent, therefore movement occurs automatically
  – “Container” object has size, position, children, but no interaction of its own
    • Example: “Frame” in Tcl/Tk
  – Containers can be children of other containers
  – Event propagation by parent notification
    • If user generates move event that is not of interest to a particular object, it gets passed up the hierarchy
    • Example: move to dialog box passed to container which is parent
Composite Object
Tcl/Tk Dialog Box

Tcl/Tk Geometry Managers

- "packer" for layouts with rows and columns
- "placer" for layouts with fixed position slaves relative or absolute to master
- "grid" part of the canvas widget, allows mixing embedded widgets with other elements such as lines and text

Packer

- Arranges slaves by positioning them one at a time in the master window, working from edges toward center
  - Maintains a packing list for a given master window
  - Packer arranges the slaves by processing the list in order
  - Current slave is positioned by
    - allocate a parcel of unused space
    - stretch the slave
    - position in the parcel
Packer Process

1) Available Space

2) Parcel for slave

3) Available Space

Packer Options

- **-side**
  - button .ok -text OK
  - button .cancel -text Cancel
  - button .help -text Help
  - pack .ok .cancel .help -side left
  - pack .ok .cancel .help -side top

Other Packer Options

- **-padx & -pady**
  - specifies extra space (distance) outside slave
- **-ipadx & -ipady**
  - specifies extra space (distance) inside slave
- **-expand**
  - slave’s parcel grows to absorb extra space left over in master
- **-fill**
  - whether and how to grow slave if its parcel is larger than the slave’s requested size