

Model Railroad System
A collection of utilities for Model Railroaders
Programming Guides

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This document describes version 2 of the Model Railroad System package.

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Chapter 1

Introduction

This manual presents some information about how to write programs that use various parts of Model Railroad System to control and manage various aspects of operating your model railroad. The Model Railroad System includes code that interfaces with special hardware, including the PI Engineering Raildriver Console (see Chapter 3), a Bruce Chubb network of control nodes (see Chapter 5), and a Lenz XPressNet network (see Chapter 6). Also included are a collection of Tcl scripts that implement a collection of widgets that are useful for various aspects of programming utilities for a model railroad system.

Part I

Raildriver Programming (From C++ and Tcl)

Chapter 2

Direct access library for the Raildriver.

Coming soon.

Chapter 3

Writing clients for the Raildriver Server.

The PI Engineering Rail Driver Console is a working “model” of a modern locomotive control stand. It is equipped with a reverser, a throttle/dynamic brake lever, an automatic (trainline) brake, an independent (locomotive) brake, plus a collection of additional controls, buttons, and switches. This is a USB interface device. The Model Railroad System includes a hotplug daemon, written using libusb, that interfaces with this device. The hotplug subsystem launches this user-mode daemon, which connects to the Rail Driver Console through the USB interface and then listens on a TCP/IP port. Client programs can connect to the daemon through the TCP/IP port. Any number of client programs can connect and each can listen to different events. If more than one Rail Driver Console is plugged in, additional daemons are started and they will listen on different TCP/IP ports. The first daemon will listen on port 40990, and the second on port 41000 and the third on port 41010, and so on.

Command	Description
Exit	Disconnect from the server.
Clear	Clear event mask.
Mask maskbits	Add to the event mask.
Pollvalues maskbits	Get the current event state.
Led digits	Set the speedometer display
Speaker on / off	Turn the speaker on or off.

Table 3.1: Rail Driver Client Commands

Mask Name	Description
Reverser	Reverser lever event.
Throttle	Throttle / Dynamic brake lever.
Autobrake	Automatic (trainline) brake lever.
Independbrk	Independent (locomotive) brake lever.
Bailoff	Independent brake lever bailoff.
Headlight	Headlight switch.
Wiper	Wiper switch.
Digital1	Blue Buttons 1-8.
Digital2	Blue Buttons 9-16.
Digital3	Blue Buttons 17-24.
Digital4	Blue Buttons 25-28, Zoom up, Zoom down, Pan up, and Pan right.
Digital5	Pan down, Pan left, Range up, Range down, Emergency brake up, Emergency brake down, Alert, and Sand.
Digital6	Pantograph, Bell, Whistle up, and Whistle down.

Table 3.2: Rail Driver Maskbits Commands

Code	Message	Description
201	OK	Generic acknowledgment.
202	Events: maskbit [= (bits)]	One or more masked events.
299	GOODBYE	Server is about to close the connection. Sent in response to an Exit command.
502	Parse error	There was an error parsing a command.
503	message from the parser	A detailed message from the parser.
504	message: object 'something'	A detailed message from the parser.

Table 3.3: Rail Driver Server Messages

The client and server communicate by sending messages as ASCII text lines. The defined client messages are shown in Table 3.1. The maskbits define the events to listen for or to poll. They are listed in Table 3.2. The server sends messages prefixed with a three digit number. The first digit is a severity level. A severity level of 2 is informational and a severity level of 5 is error. The full set of messages sent by the server are listed in Table 3.3.

3.1 Sample Tcl Client Script

Listing 3.1: LocoTest.tcl

```

1  #!/usr/bin/tclsh8.6
   #*
   #* -----
   #*  LocoTest.tcl - Test Program for the Rail Driver Daemon.
   #*  Created by Robert Heller on Sat May 5 10:29:48 2007
6  #* -----
   #*  Modification History: $Log$
   #*  Modification History: Revision 1.3 2007/05/06 19:14:57
   #*  heller
   #*  Modification History: Lock down for 2.1.8 release candidate 1
   #*  Modification History:
11 #*  Modification History: Revision 1.1 2007/05/06 13:45:41
   #*  heller
   #*  Modification History: Lock down for 2.1.8 release candidate 1
   #*  Modification History:
   #*  Modification History: Revision 1.1 2002/07/28 14:03:50
   #*  heller
   #*  Modification History: Add it copyright notice headers
16 #*  Modification History:
   #* -----
   #*  Contents:
   #* -----
   #*
21 #*  Model RR System, Version 2
   #*  Copyright (C) 1994,1995,2002-2007 Robert Heller
   #*  D/B/A Deepwoods Software
   #*  51 Locke Hill Road
   #*  Wendell, MA 01379-9728
26 #*
   #*  This program is free software; you can redistribute it and/or modify
   #*  it under the terms of the GNU General Public License as published by
   #*  the Free Software Foundation; either version 2 of the License, or

```

10 CHAPTER 3. WRITING CLIENTS FOR THE RAILDRIVER SERVER.

```

31  ## (at your option) any later version.
31  ##
31  ## This program is distributed in the hope that it will be useful,
31  ## but WITHOUT ANY WARRANTY; without even the implied warranty of
31  ## MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
31  ## GNU General Public License for more details.
36  ##
36  ## You should have received a copy of the GNU General Public License
36  ## along with this program; if not, write to the Free Software
36  ## Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.
36  ##
41  ##
41  ##

# Global variables containing current settings.
global Direction Throttle IndepentBrake CurrentSpeed
46
# Initial speed is 0 (stopped)
set CurrentSpeed 0
# Initial direction is 0 (neutral)
set Direction 0
51 # Initial throttle setting is 0 (idle)
set Throttle 0
# Initial independent brake setting is 0 (released)
set IndepentBrake 0

56 # Constant: maximim allowed speed.
global MaximumSpeed
# Max simulated speed is 60 (mph)
set MaximumSpeed 60

61 # Alert button flag
global Alert
set Alert 0

# Tables that map lever positions to throttle and
66 # brake application values
global ThrottleValues IndepentBrakeValues

array set ThrottleValues {
71   0 0 1 0 2 0 3 0 4 0 5 0 6 0 7 0
    8 0 9 0 10 0 11 0 12 0 13 0 14 0 15 0
    16 0 17 0 18 0 19 0 20 0 21 0 22 0 23 0
    24 0 25 0 26 0 27 0 28 0 29 0 30 0 31 0
    32 0 33 0 34 0 35 0 36 0 37 0 38 0 39 0

```

```

76      40 0 41 0 42 0 43 0 44 0 45 0 46 0 47 0
      48 0 49 0 50 0 51 0 52 0 53 0 54 0 55 0
      56 0 57 0 58 0 59 0 60 0 61 0 62 0 63 0
      64 0 65 0 66 0 67 0 68 0 69 0 70 0 71 0
      72 0 73 0 74 0 75 0 76 0 77 0 78 0 79 0
      80 0 81 0 82 0 83 0 84 0 85 0 86 0 87 0
81      88 0 89 0 90 0 91 0 92 0 93 0 94 0 95 0
      96 0 97 0 98 0 99 0 100 0 101 0 102 0 103 0
      104 0 105 0 106 0 107 0 108 0 109 0 110 0 111 0
      112 0 113 0 114 0 115 0 116 0 117 0 118 0 119 0
      120 0 121 0 122 0 123 0 124 0 125 0 126 0 127 0
86      128 0 129 0 130 0 131 0 132 0 133 0 134 0 135 0
      136 0 137 0 138 0 139 0 140 0 141 0 142 0 143 0
      144 0 145 0 146 0 147 0 148 0 149 0 150 0 151 0
      152 0 153 0 154 0 155 0 156 0 157 0 158 1 159 1
      160 2 161 2 162 2 163 3 164 3 165 4 166 4 167 4
91      168 5 169 5 170 6 171 6 172 6 173 7 174 7 175 8
      176 8 177 9 178 9 179 9 180 10 181 10 182 11 183 11
      184 11 185 12 186 12 187 13 188 13 189 13 190 14 191 14
      192 15 193 15 194 16 195 16 196 16 197 17 198 17 199 18
      200 18 201 18 202 19 203 19 204 20 205 20 206 20 207 21
96      208 21 209 22 210 22 211 23 212 23 213 23 214 24 215 24
      216 25 217 25 218 25 219 26 220 26 221 27 222 27 223 27
      224 28 225 28 226 29 227 29 228 30 229 30 230 30 231 30
      232 30 233 30 234 30 235 30 236 30 237 30 238 30 239 30
      240 30 241 30 242 30 243 30 244 30 245 30 246 30 247 30
101     248 30 249 30 250 30 251 30 252 30 253 30 254 30
    }
    array set IndepentBrakeValues {
      0 30 1 30 2 30 3 30 4 30 5 30 6 30 7 30
      8 30 9 30 10 30 11 30 12 30 13 30 14 30 15 30
106     16 30 17 30 18 30 19 30 20 30 21 30 22 30 23 30
      24 30 25 30 26 30 27 30 28 30 29 30 30 30 31 30
      32 30 33 30 34 30 35 30 36 30 37 30 38 30 39 30
      40 30 41 30 42 29 43 29 44 29 45 29 46 29 47 29
      48 28 49 28 50 28 51 28 52 28 53 28 54 27 55 27
111     56 27 57 27 58 27 59 26 60 26 61 26 62 26 63 26
      64 26 65 25 66 25 67 25 68 25 69 25 70 25 71 24
      72 24 73 24 74 24 75 24 76 23 77 23 78 23 79 23
      80 23 81 23 82 22 83 22 84 22 85 22 86 22 87 22
      88 21 89 21 90 21 91 21 92 21 93 21 94 20 95 20
116     96 20 97 20 98 20 99 19 100 19 101 19 102 19 103 19
      104 19 105 18 106 18 107 18 108 18 109 18 110 18 111 17
      112 17 113 17 114 17 115 17 116 16 117 16 118 16 119 16
      120 16 121 16 122 15 123 15 124 15 125 15 126 15 127 15

```

```

121 128 14 129 14 130 14 131 14 132 14 133 13 134 13 135 13
136 136 13 137 13 138 13 139 12 140 12 141 12 142 12 143 12
144 144 12 145 11 146 11 147 11 148 11 149 11 150 11 151 10
152 152 10 153 10 154 10 155 10 156 9 157 9 158 9 159 9
160 160 9 161 9 162 8 163 8 164 8 165 8 166 8 167 8
168 168 7 169 7 170 7 171 7 172 7 173 6 174 6 175 6
126 176 6 177 6 178 6 179 5 180 5 181 5 182 5 183 5
184 184 5 185 4 186 4 187 4 188 4 189 4 190 3 191 3
192 192 3 193 3 194 3 195 3 196 2 197 2 198 2 199 2
200 200 2 201 2 202 1 203 1 204 1 205 1 206 1 207 1
208 208 0 209 0 210 0 211 0 212 0 213 0 214 0 215 0
131 216 0 217 0 218 0 219 0 220 0 221 0 222 0 223 0
224 224 0 225 0 226 0 227 0 228 0 229 0 230 0 231 0
232 232 0 233 0 234 0 235 0 236 0 237 0 238 0 239 0
240 240 0 241 0 242 0 243 0 244 0 245 0 246 0 247 0
248 248 0 249 0 250 0 251 0 252 0 253 0 254 0
136 }

# Contains the file channel connected to the daemon process
global Socket

141 # Connect to server
set Socket [socket localhost 41000]
# Line buffering
fconfigure $Socket -buffering line

146 # File event to asynchronously handle messages from the server
fileevent $Socket readable {
    # Get a line from the server.
    # If EOF, close the connection and exit.
    if {[gets $Socket line] < 0} {
151     close $Socket
        after 1000 exit
    } else {
        # Reverser lever moved? Get its setting and save in Direction
        if {$CurrentSpeed == 0 &&
156     [regexp {REVERSER=([0-9]*)} "$line" -> reverser] > 0} {
            if {$reverser < 64} {
                set Direction 1
            } elseif {$reverser > 220} {
                set Direction -1
            } elseif {$reverser < 128 && $reverser > 100} {
161     set Direction 0
                set Throttle 0
            }
        }
    }
}

```



```

    }
166     # Throttle lever moved?  Fetch its value.
    if {[regexp {THROTTLE=([0-9]*)} "$line" -> throttle] > 0} {
        if {$Direction != 0} {
            set Throttle $ThrottleValues($throttle)
        }
171     }
    # Indepent Brake lever moved?  Fetch its value.
    if {[regexp {INDEPENDBRK=([0-9]*)} "$line" -> ibrake] > 0} {
        set IndepentBrake $IndepentBrakeValues($ibrake)
    }
176     # Check for Alert button (one of the bits in DIGITAL5).
    #puts stderr "***_line=_$line"
    if {[regexp {DIGITAL5=\((.*)\)} "$line" -> d5] > 0} {
        # Alert button pressed?  Flag it.
        #puts stderr "***_d5=_$d5"
181     if {[string first Alert "$d5"] >= 0} {
            set Alert 1
        }
    }
186 }

# This proc is run every 1/2 second and simulates a locomotive.
proc Update {} {
191     # Globals
    global Direction Throttle IndepentBrake CurrentSpeed
    global MaximumSpeed
    global Socket
    global Alert

196     # Was the Alert button pressed?  If so, reset the speedometer
    # display and close the connection to the server
    if {$Alert} {
        puts $Socket "LED_000"
201     flush $Socket
        puts $Socket "Exit"
        flush $Socket
        return
    }
206     # If the reverser is not in neutral, apply the throttle's
    # acceleration.
    if {$Direction != 0} {
        incr CurrentSpeed $Throttle
    }
}

```

```

    }
211     incr CurrentSpeed -1;# Entropy (rolling friction)
    incr CurrentSpeed -$IndependBrake;# Brake Application
    # Apply the governor (speed limit)
    if {$CurrentSpeed > $MaximumSpeed} {
216         set CurrentSpeed $MaximumSpeed
    }
    # Avoid a negative speed
    if {$CurrentSpeed < 0} {set CurrentSpeed 0}
    # Format the speed for display.
    set digits [format {%2d} $CurrentSpeed]
221     regsub -all { } "$digits" {_} digits
    # Apply direction.
    if {$Direction < 0} {
        set digits "-$digits"
    } else {
226         set digits "_$digits"
    }
    # Update the speedometer.
    puts $Socket "LED_$digits"
    flush $Socket
231     # Fetch new values.
    puts $Socket "POLLVALUES_REVERSER_THROTTLE_INDEPENDBRK_DIGITAL5"
    flush $Socket

    # Sleep for 1/2 second and check again.
236     after 500 Update
}

# Initial poll
241 puts $Socket "POLLVALUES_REVERSER_THROTTLE_INDEPENDBRK_DIGITAL5"
    flush $Socket
    # Sleep for 1/2 second and check.
    after 500 Update

246 # Enter event loop.
    vwait forever

```

The Tcl script shown in Listing 3.1 is a simple Tcl program that connects to the Rail Driver daemon and simulates a locomotive, by using the reverser, throttle, and independent brake levers to set the direction, accelerate, and slow down a virtual locomotive and display its speed on the LED display on the Rail Driver console.

A connection to the Rail Driver daemon is opened on line 136 and the resulting

file channel is set to line buffering on line 138. Lines 141–179 contain a file event handler for messages coming from the daemon. This handler parses the results and updates the global state variables based on changes in the reverser, throttle, and independent brake levers. It also checks for the Alert button and sets a flag if this button is pressed. If it loses the connection to the server, it closes the connection and arranges to exit the program.

Lines 181–228 contain a procedure that is run every 1/2 second. This procedure applies updates to the virtual locomotive's state¹, taking into account the current settings of the reverser, throttle, and independent brake levers. It then sends the current state (speed) to the LED display on the Rail Driver console. It also checks the Alert flag and arranges to disconnect from the daemon when the Alert button is pressed.

¹Only its speed, contained in the global variable `CurrentSpeed`. To control an actual locomotive, this is where there would be code (eg using the `XPressNet` class library) to set the locomotive's speed.

Part II

Azatrax (From C++ and Tcl)

Chapter 4

Using the Azatrax device Interfaces.

4.1 aztrax::Azatrax Class

Listing 4.1: aztrax::Azatrax Class (simplified public interface)

```
class aztrax::Azatrax {
public:
3   ~Azatrax();
   static int NumberOfOpenDevices();
   static char ** AllConnectedDevices();
   static Azatrax *OpenDevice(const char *serialnumber,
8                               unsigned short int idProduct=0,
                               char **outmessage=NULL);

   friend class aztrax::MRD;
   friend class aztrax::SL2;
   friend class aztrax::SR4;
   enum {
13       idAzatraxVendor,
           idMRDProduct,
           idSL2Product,
           idSR4Product
   };
18   ErrorCode RestoreLEDFunction() const;
   ErrorCode Identify_1() const;
   ErrorCode GetStateData();
   uint8_t PacketCount() const;
   const char *SerialNumber() const;
23   const char *MyProduct() const;
   unsigned short int MyProductId() const;
   static unsigned short int ProductIdCode(const char *productName);
```

```
};
```

The Azatrax Interface[4] has both a C++ and a Tcl API and this chapter will cover both. Both APIs use the same underlying code¹. The API is based on the C++ classes that encapsulates the various Azatrax devices, the MRD2-S or MRD2-U (MRD class), the SR4 (the MRD class), or the SL2 (the SL2 class). Each Azatrax device has a factory set serial number.

The Azatrax class is the base class for all of the Azatrax device classes. Its constructor should not be called directly. Instead the `OpenDevice` static member should be called. This member function will return a device specific instance (at this time, one of `aztrax::MRD`, `aztrax::SR4`, or `aztrax::SL2`), depending on the type of device opened. The device will be opened based on its serial number and optionally by a specific product type. The result of `OpenDevice` function should be cast to a specific device class. It will never really be a base Azatrax class instance, since the base class has little functional usefulness. The device specific classes implement both the common functionality of the base class and all of the device specific functionality.

4.2 aztrax::MRD Class

Listing 4.2: aztrax::MRD Class (simplified public interface)

```
#define ErrorCode int
class aztrax::MRD public aztrax::Azatrax{
public:
4      enum OperatingMode_Type { NonTurnoutSeparate ,
                                NonTurnoutDirectionSensing ,
                                TurnoutSolenoid ,
                                TurnoutMotor };

    ~MRD();
9      ErrorCode SetChan1() const;
      ErrorCode SetChan2() const;
      ErrorCode ClearExternallyChanged() const;
      ErrorCode DisableExternal() const;
      ErrorCode EnableExternal() const;
14     ErrorCode RestoreLEDFunction() const;
      ErrorCode Identify_2() const;
      ErrorCode Identify_1_2() const;
      ErrorCode ResetStopwatch() const;
```

¹In fact the same shared library.


```

19      bool Sense_1 () const;
      bool Sense_2 () const;
      bool Latch_1 () const;
      bool Latch_2 () const;
      bool HasRelays () const;
      bool ResetStatus () const;
24      bool StopwatchTicking () const;
      bool ExternallyChanged () const;
      bool AllowingExternalChanges () const;
      OperatingMode_Type OperatingMode () const;
29      void Stopwatch(uint8_t &fract, uint8_t &seconds, uint8_t &minutes,
                    uint8_t &hours) const; };

```

The MRD2-S has two relays and the MRD2-U has no relays. Both devices have two sensors and a stopwatch. The class instance is connected to a device using its unique serial number, using the `aztrax::Azatrax` static method, `OpenDevice`, see Section 4.1, and Listing 4.1. This class exposes a collection of methods to send command bytes to the device, a method to retrieve the device's state data and a collection of methods to access the device's state data, once it has been retrieved.

Part III

Tcl Script Programming

Chapter 5

Using the CMR/I (Bruce Chubb) Interface.

5.1 CMri Class

Listing 5.1: CMri SNIT type (Class), simplified public interface

```
1  snit::type CMri {  
    option -baud -readonly yes -default 9600 \  
        -type {snit::enum -values {9600 19200 28800 57600 115200}}  
    option -maxtries -readonly yes -default 10000 \  
        -type {snit::integer -min 1000 -max 100000}  
6  constructor {port args} { }  
    destructor { }  
    method Inputs {ni {ua 0}} { }  
    method Outputs {ports {ua 0}} { }  
    method InitBoard {CT ni no ns ua card dl} { }  
11 }
```

The CMR/I Interface[4] has a Tcl API encoded as a Tcl SNIT type (class) that encapsulates a Bruce Chubb CMR/I[1, 3] serial “bus”, containing one or more interface nodes, which are instances of SMINI (Super Mini Node), USIC (Classic Universal Serial Interface Card), or SUSIC (Super Classic Universal Serial Interface Card). Each card has a unique 6 bit address and contains a number of input and output ports¹. The SNIT type (class) connects to a serial port which has an RS232 to RS485 conversion card that in turn connects to the RS485-based serial bus. This SNIT type (class) exposes three methods to access cards on the bus,

¹The SMINI is a self contained card with 3 input ports (24 bits) and 6 output ports (48 bits).

an initialization method to initialize the board, an input method to read the input ports, and an output method to write to the output ports. A simplified listing of this SNIT type (class) is shown in Listing 5.1.

The constructor takes the name of the port device file, with options for the BAUD rate and the maximum number of retries. The constructor opens the serial port and conditions it for unbuffered binary I/O at the specified BAUD rate. The destructor restores the port and closes it. The Inputs() method reads the contents of the input ports of a specified node and the Outputs() method writes to the output ports of a specified node. The InitBoard() method initializes a specified node. The InitBoard takes either a packed card type list (for USIC or SUSIC nodes) or a yellow bi-color LED map (for SMINI nodes), the number of input² and output³ ports, the number of yellow bi-color LED signals⁴, the card address, delay value to use⁵, and the error message pointer.

5.2 Basic usage

Listing 5.2: Using the CMR/I from Tcl

```

#
package require Cmri 2.0.0;#                               Load the CMR/I snit type.
3
# The board address of the SMINI card.
global UA
set UA 0

8
# Connect to the bus on COM3: (/dev/ttyS2), at 9600 BAUD, with
# a retry count of 10000, capturing error messages.
if {[catch {cmri::CMri CMriBus /dev/ttys0 -baud 9600 -maxtries 10000} errorMessage]}
# Handle error.
13  puts -nonewline stderr "Could not connect to CMR/I bus on /dev/ttyS2: "
    puts stderr "$errorMessage"
    rename CMriBus {}
    exit 99
    }
18

```

²Must be 3 for SMINI cards.

³Must be 6 for SMINI cards.

⁴Only used for SMINI cards.

⁵Only used for older USIC cards.

```

# Initialize SMINI board
if {[catch {CMriBus InitBoard {0 0 0 0 0 0} 3 6 0 $UA SMINI 0} result]} {
    set errorMessage [lindex $result 1]
    # Handle error.
23     puts -nonewline stderr "Could not initialize SMINI card at UA"
    puts stderr "$UA: $errorMessage"
    rename CMriBus {}
    exit 99
}
28
# Initialize port buffer
#     Turn all bits of port 0 on
#     Turn all of the even bits of port 1 on
#     Turn all of the odd bits of port 2 on
33 #     Turn the lower nibble of port 3 on
#     Turn the upper nibble of port 4 on
#     Leave port 5 off
    set Outputs {0xFF 0xAA 0x55 0x0F 0xF0 0}
# Write to SMINI ports
38 if {[catch {CMriBus Outputs $Outputs $UA} result]} {
    # Handle error.
    puts -nonewline stderr "Could not write to the output ports of"
    puts stderr "SMINI card at UA $UA: $result"
    rename CMriBus {}
43     exit 99
}

# Read SMINI ports
if {[catch {CMriBus Inputs 3 $UA} result]} {
48     puts -nonewline stderr "Could not read from the input ports of"
    puts stderr "SMINI card at UA $UA: $result"
    rename CMriBus {}
    exit 99
}
53
set Inputs $result

foreach p {0 1 2} v $Inputs {
    puts "Port $p = $v"
58 }

rename CMriBus {}
exit

```

The program shown in Listing 5.2 opens a connection to a CMR/I bus with a

SMINI card (Line 10 of Listing 5.2). It then initialize the SMINI card (Line 20 of Listing 5.2), write to the output ports of the SMINI card (Line 38 of Listing 5.2), and then then read from the input ports of the SMINI card (Line 48 of Listing 5.2). Finally, the serial port is closed when the instance is deleted (Line 62 of Listing 5.2) and the program exits. While this is valid program, it is not particularly useful in a Model Railroad control context. More typically, the program would have a loop around the I/O functions, repeatedly reading the inputs, which would typically contain information about the state of CTC panel controls, track switches (turnouts), and block occupancy detectors, and code to set the outputs, which would control turnouts (via switch machines), track side signals, and CTC panel lamps⁶. A more realistic program is shown in skeleton form in Listing 5.3.

5.3 Advanced usage

Listing 5.3: Using the CMR/I from Tcl, more realistic version

```
#
package require Cmri 2.0.0;#                               Load the CMR/I shared library.

4 # The board address of the SMINI card.
  global UA
  set UA 0

9 # Connect to the bus on COM3: (/dev/ttyS2), at 9600 BAUD, with
  # a retry count of 10000, capturing error messages.
  if {[catch {cmri::CMri CMriBus /dev/ttys0 -baud 9600 -maxtries 10000} errorMessage]} {
    # Handle error.
    puts -nonewline stderr "Could not connect to CMR/I bus on /dev/ttyS2:_"
14  puts stderr "$errorMessage"
    rename CMriBus {}
    exit 99
  }

19 # Initialize SMINI board
  if {[catch {CMriBus InitBoard {0 0 0 0 0 0} 3 6 0 $UA SMINI 0} result]} {
    set errorMessage [lindex $result 1]
    # Handle error.
    puts -nonewline stderr "Could not initialize SMINI card at UA_"
```

⁶See Chapter 11 for information about programming CTC Panels on a computer screen using Tcl/Tk.

5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES

```

24  puts stderr "$UA:_$errorMessage"
    rename CMriBus {}
    exit 99
}

29  while {1} {
    # Read SMINI ports
    if {[catch {CMriBus Inputs 3 $UA} errorMessage]} {
        puts -nonewline stderr "Could not read from the input ports of_"
        puts stderr "SMINI card at UA_$UA:_$errorMessage"
34  } else {
        set Inputs $result
        # Process Input ports, generating values for the output ports
        # (Process code goes here)
        # Write to SMINI ports
39  if {[catch {CMriBus Outputs $Outputs $UA} errorMessage]} {
            # Handle error.
            puts -nonewline stderr "Could not write to the output ports of_"
            puts stderr "SMINI card at UA_$UA:_$errorMessage"
44  }
        }
    after 1000;# Sleep for one second
}
rename CMriBus {}
exit

```

5.4 Translations from The C/MRI User's Manual V3.0 Examples

I have translated selected example programs from The C/MRI User's Manual V3.0[2]. The source code files are included in the documentation directory.

5.4.1 From Chapter 9: SMINI Application Examples

Listing 5.4: Figure 9-5, Tcl Translation

```

# $Id: fig9-5.tcl 1465 2013-03-17 15:24:03Z heller $
2
# Load MRR System packages
# Add MRR System package Paths
lappend auto_path /usr/local/chare/MRRSystem;# Tcl packages

```

```

package require Cmri 2.0.0;#           Load the CMRI package

7  # REM**DEFINE CONSTANTS FOR PACKING AND UNPACKING I/O BYTES
  #      B0 = 1: B1 = 2: B2 = 4: B3 = 8: B4 = 16: B5 = 32: B6 = 64: B7 = 128
  #      W1 = 1: W2 = 3: W3 = 7: W4 = 15: W5 = 31: W6 = 63: W7 = 127

12 # Bit shift constants
   #
   set B0 0
   set B1 1
   set B2 2
17 set B3 3
   set B4 4
   set B5 5
   set B6 6
   set B7 7

22 # Bit mask constants
   #
   set W1 0x01
   set W2 0x03
27 set W3 0x07
   set W4 0x0f
   set W5 0x1f
   set W6 0x3f
   set W7 0x7f

32

   # REM**DEFINE BLOCK OCCUPATION CONSTANTS
   #      CLR = 0           'Clear'
   #      OCC = 1           'Occupied'

37 set CLR 0
   set OCC 1

   # REM**DEFINE SIGNAL ASPECTS
42 #      DRK = 0           'Dark 00'
   #      GRN = 1           'Green 01'
   #      RED = 2           'Red 10'

   set DRK 0           # Dark 00
47 set GRN 1           # Green 01
   set RED 2           # Red 10

   set UA 0;#           Address of our SMINI card

```

5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES31

```

52 # PRINT "SIGNALING LOOP TRACK USING SMINI WITH 2-ASPECT COLOR LIGHT SIGNALS"

puts "SIGNALING_LOOP_TRACK_USING_SMINI_WITH_2-ASPECT_COLOR_LIGHT_SIGNALS"

# REM**INITIALIZE SMINI**
57 # UA = 0 'USIC NODE ADDRESS
# COMPORT = 2 'PC SERIAL COMMUNICATIONS PORT = 1, 2, 3 OR 4
# BAUD100 = 96 'BAUD RATE OF 9600 DIVIDED BY 100
# DL = 0 'USIC TRANSMISSION DELAY
# NDP$ = "M" 'NODE DEFINITION PARAMETER
62 # NS = 0 'NUMBER OF 2-LEAD SEARCHLIGHT SIGNALS
# NI = 3 'NUMBER OF INPUT PORTS
# NO = 6 'NUMBER OF OUTPUT PORTS
# MAXTRIES = 10000 'MAXIMUM READ TRIES BEFORE ABORT INPUTS
# GOSUB INIT 'INVOKE INITIALIZATION SUBROUTINE
67
#*****
#* Initialize bus *
#*****
# Connect to the bus on COM2: (/dev/ttyS1), at 9600 BAUD, with
72 # a retry count of 10000, capturing error messages.
if {[catch {cmri::CMri bus /dev/ttyS1 -baud 9600 -retries 10000} result]} {
    set errorMessage $result
    # Handle error.
    puts -nonewline stderr "Could_not_connect_to_CMR/I_bus_on_/dev/ttyS1:_"
77    puts stderr "$errorMessage"
    rename bus {}
    exit 99
}
#*****
82 #* Initialize board *
#*****
if {[catch {bus InitBoard {0 0 0 0 0 0} 3 6 0 $UA SMINI 0} result]} {
    set errorMessage $result
    # Handle error.
87    puts -nonewline stderr "Could_not_initialize_SMINI_card_at_UA_"
    puts stderr "$UA:_$errorMessage"
    rename bus {}
    exit 99
}
92
# PRINT "NODE INITIALIZATION IS COMPLETE - CHECK LED BLINK RATE"
# PRINT " AND PRESS ANY KEY TO CONTINUE"
# SLEEP

```

```

97 puts "NODE_INITIALIZATION_IS_COMPLETE--CHECK_LED_BLINK_RATE"
puts "AND_PRESS_ANY_KEY_TO_CONTINUE"
gets stdin

#BRTL:      '*****BEGIN REAL TIME LOOP*****
102 while {true} {

# REM**READ INPUT BYTES FROM SMINI's 3 INPUT PORTS
# GOSUB INPUTS      'Input bytes are stored as IB(1), IB(2), IB(3)
107     if {[catch {bus Inputs 3 $UA} result]} {
        set errorMessage $result
        puts -nonewline stderr "Could not read from the input ports of"
        puts stderr "SMINI card at UA:$UA: $errorMessage"
112     break
    }
    set Inputs $result

#
# REM**UNPACK INPUTS
117 # BK(1) = IB(1) \ B0 AND W1      'CARD 2 PORT A
# BK(2) = IB(1) \ B1 AND W1
# BK(3) = IB(1) \ B2 AND W1
# BK(4) = IB(1) \ B3 AND W1
# BK(5) = IB(1) \ B4 AND W1
122 # BK(6) = IB(1) \ B5 AND W1

        set BK(0) [expr {[lindex $Inputs 0] << $B0 & $W1}];# CARD 2 PORT A
        set BK(1) [expr {[lindex $Inputs 0] << $B1 & $W1}]
        set BK(2) [expr {[lindex $Inputs 0] << $B2 & $W1}]
127     set BK(3) [expr {[lindex $Inputs 0] << $B3 & $W1}]
        set BK(4) [expr {[lindex $Inputs 0] << $B4 & $W1}]
        set BK(5) [expr {[lindex $Inputs 0] << $B5 & $W1}]

#
# REM**INITIALIZE ALL SIGNALS TO GREEN
132 # FOR I = 1 TO 6: SE(I) = GRN: SW(I) = GRN: NEXT I

        for {set i 0} {$i < 6} {incr i} {set SE($i) $GRN;set SW($i) $GRN}

#
137 # REM**CHECK IF BLOCK OCCUPIED THEN SET SIGNALS LEADING INTO BLOCK RED
# IF BK(1) = OCC THEN SE(6) = RED: SW(2) = RED
# IF BK(2) = OCC THEN SE(1) = RED: SW(3) = RED
# IF BK(3) = OCC THEN SE(2) = RED: SW(4) = RED

```

5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES33

```

#      IF BK(4) = OCC THEN SE(3) = RED: SW(5) = RED
142 #      IF BK(5) = OCC THEN SE(4) = RED: SW(6) = RED
#      IF BK(6) = OCC THEN SE(5) = RED: SW(1) = RED

      if {$BK(0) == $OCC} {set SE(5) $RED;set SW(1) $RED}
      if {$BK(1) == $OCC} {set SE(0) $RED;set SW(2) $RED}
147  if {$BK(2) == $OCC} {set SE(1) $RED;set SW(3) $RED}
      if {$BK(3) == $OCC} {set SE(2) $RED;set SW(4) $RED}
      if {$BK(4) == $OCC} {set SE(3) $RED;set SW(5) $RED}
      if {$BK(5) == $OCC} {set SE(4) $RED;set SW(0) $RED}

152 #
# REM**IMPLEMENT APPROACH LIGHTING BY SETTING SIGNALS TO DARK...
# REM**      ...IF BLOCK APPROACHING SIGNAL IS CLEAR
#      FOR I = 1 TO 6
#          IF BK(I) = CLR THEN SE(I) = DRK: SW(I) = DRK
157 #      NEXT I

      for {set i 0} {$i < 6} {incr i} {
          if {$BK(i) == $CLR} {set SE(i) $DRK; set SW(i) $DRK}
      }

162 #
# REM**PACK OUTPUT BYTES
#      OB(1) = SE(1)                                'SMINI CARD 0 PORT A
#      OB(1) = SW(1) * B2 OR OB(1)
167 #      OB(1) = SE(2) * B4 OR OB(1)
#      OB(1) = SW(2) * B6 OR OB(1)

# SMINI CARD 0 PORT A
172  set Outputs [expr {$SE(0) |
                        $SW(0) << $B2 |
                        $SE(1) << $B4 |
                        $SW(1) << $B6}]

#
177 #      OB(2) = SE(3)                                'SMINI CARD 0 PORT B
#      OB(2) = SW(3) * B2 OR OB(2)
#      OB(2) = SE(4) * B4 OR OB(2)
#      OB(2) = SW(4) * B6 OR OB(2)

182  # SMINI CARD 0 PORT B
      lappend Outputs [expr {$SE(2) |
                              $SW(2) << $B2 |
                              $SE(3) << $B4 |

```

```

                                $SW(3) << $B6}]
187 #
#      OB(3) = SE(5)                                'SMINI CARD 0 PORT C
#      OB(3) = SW(5) * B2 OR OB(3)
#      OB(3) = SE(6) * B4 OR OB(3)
192 #      OB(3) = SW(6) * B6 OR OB(3)

# SMINI CARD 0 PORT C
lappend Outputs [expr {$SE(4) | \
                                $SW(4) << $B2 | \
197                                $SE(5) << $B4 | \
                                $SW(5) << $B6}]

lappend Outputs 0 0 0; # SMINI CARD 1 PORTs A, B, C
#
202 # REM**WRITE OUTPUT BYTES TO SMINI's 6 OUTPUT PORTS
#      GOSUB OUTPUTS

if {[catch {bus Outputs $Outputs $UA} result]} {
    set errorMessage $result
207 # Handle error.
    puts -nonewline stderr "Could not write to the output ports of "
    puts stderr "SMINI card at UA:$UA: $errorMessage"
    break
}

212 #
# REM**RETURN TO BEGINNING OF REAL-TIME LOOP
#      GOTO BRTL
}

```

5.4.2 From Chapter 12: SUSIC/USIC Application Examples

Listing 5.5: Figure 12-13, Tcl Translation

```

2 # Load MRR System packages
# Add MRR System package Paths
lappend auto_path /usr/local/share/MRRSystem;# Tcl packages
package require Cmri 2.0.0;# Load the CMRI package

7 # REM**SUSIC SINGLE-NODE SYSTEM USING 3-ASPECT COLOR LIGHT SIGNALS**
# REM**DEFINE VARIABLE TYPES AND ARRAY SIZES
#      DEFINT A-Z
#      DIM OB(60), IB(60), TB(80), CT(15)

```

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```
#
12 # REM**DEFINE CONSTANTS FOR PACKING AND UNPACKING I/O BYTES
#     B0 = 1: B1 = 2: B2 = 4: B3 = 8: B4 = 16: B5 = 32: B6 = 64: B7 = 128
#     W1 = 1: W2 = 3: W3 = 7: W4 = 15: W5 = 31: W6 = 63: W7 = 127

# Bit shift constants
17 #
    set B0 0
    set B1 1
    set B2 2
    set B3 3
22 set B4 4
    set B5 5
    set B6 6
    set B7 7

27 # Bit mask constants
#
    set W1 0x01
    set W2 0x03
    set W3 0x07
32 set W4 0x0f
    set W5 0x1f
    set W6 0x3f
    set W7 0x7f

37 #
# REM**DEFINE BLOCK OCCUPATION CONSTANTS
#     CLR = 0      'Clear
#     OCC = 1      'Occupied

42 set CLR 0
    set OCC 1

#
# REM**DEFINE SIGNAL ASPECTS – Single Head
47 #     DRK = 0      'Dark      000
#     GRN = 1      'Green      001
#     YEL = 2      'Yellow     010
#     RED = 4      'Red        100

52 set DRK 0;# Dark      000
    set GRN 1;# Green     001
    set YEL 2;# Yellow    010
    set RED 4;# Red       100
```

```

57 #
# REM**DEFINE SIGNAL ASPECTS – Double Head
#   GRNRED = 17   'Green over red    10001
#   YELRED = 18   'Yellow over red   10010
#   REDYEL = 12   'Red over yellow   01100
62 #   REDRED = 20   'Red over red     10100

set GRNRED 0x11;# Green over red    10001
set YELRED 0x12;# Yellow over red   10010
set REDYEL 0x0c;# Red over yellow   01100
67 set REDRED 0x14;# Red over red     10100

#
# REM**DEFINE SIGNAL ASPECTS – Triple Head
#   REDREDRED = 84 'Red over red over red 1010100
72 #   REDREDYEL = 52 'Red over red over yellow 0110100
#   REDYELRED = 76 'Red over yellow over red 1001100
#   YELREDRED = 82 'Yellow over red over red 1010010
#   GRNREDRED = 81 'Green over red over red 1010001

77 set REDREDRED 0x54;# Red over red over red 1010100
set REDREDYEL 0x34;# Red over red over yellow 0110100
set REDYELRED 0x4c;# Red over yellow over red 1001100
set YELREDRED 0x52;# Yellow over red over red 1010010
set GRNREDRED 0x51;# Green over red over red 1010001
82

#
# REM**DEFINE TURNOUT POSITION
# REM**Constants provided below assume SMC card connected between
# REM**switchmotors and a single output pin on DOUT32 cards. See
87 # REM**other examples for direct connections using 2 output pins
#   TUN = 0
#   TUR = 1

set TUN 0
92 set TUR 1

#
# REM**DEFINE PUSHBUTTON AND TOGGLE POSITIONS
#   PBP = 1   'Pushbutton pressed
97 #   TGR = 1   'Toggle reverse position
#   TGN = 0   'Toggle normal position

set PBP 1;# Pushbutton pressed

```


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```

    set TGR 1;# Toggle reverse position
102 set TGN 0;# Toggle normal position

#
# REM**DEFINE DIRECTION-OF-TRAFFIC RUNNING ON SINGLE TRACK
#     NDT = 0      'No direction-of-traffic defined on single track
107 #     EBD = 1      'EastBound Direction
#     WBD = 2      'WestBound Direction

    set NDT 0;# No direction-of-traffic defined on single track
    set EBD 1;# EastBound Direction
112 set WBD 2;# WestBound Direction

    set UA 0      /* Address of our SUSIC card. */

#
117 # REM**INITIALIZE DIRECTION-OF-TRAFFIC VARIABLES TO NO DIRECTION-OF-TRAFFIC
#     DOT1 = NDT: DOT2 = NDT: DOT3 = NDT
#         set DOT1 $NDT; set DOT2 $NDT; set DOT3 $NDT

#
122 # PRINT "SINGLE NODE RAILROAD EXAMPLE USING 3-ASPECT COLOR LIGHT SIGNALS"
#

        puts "SINGLE_NODE_RAILROAD_EXAMPLE_USING_3-ASPECT_COLOR_LIGHT_SIGNALS"

127 # REM**INITIALIZE SUSIC
#     UA = 0      'USIC NODE ADDRESS
#     COMPORT = 3    'PC SERIAL COMMUNICATIONS PORT = 1, 2, 3 OR 4
#     BAUD100 = 192    'BAUD RATE OF 19200 DIVIDED BY 100
#     DL = 0      'USIC TRANSMISSION DELAY
132 #     NDP$ = "X"    'NODE DEFINITION PARAMETER
#     NS = 2      'NUMBER OF CARD SETS OF 4 (OIIO OOX)
#     CT(1) = 150    'CARD TYPE SET OF (OIIO)
#     CT(2) = 10     'CARD TYPE SET OF (OOX)
#     NI = 8      'NUMBER OF INPUT PORTS
137 #     NO = 16     'NUMBER OF OUTPUT PORTS
#     MAXTRIES = 10000 'MAXIMUM READ TRIES BEFORE ABORT INPUTS
#     GOSUB INIT    'INVOKE INITIALIZATION SUBPROGRAM

#*****
142 #* Initialize bus *
#*****
# Connect to the bus on COM2: (/dev/ttyS1), at 19200 BAUD, with
# a retry count of 10000, capturing error messages.

```

```

147  if {[catch {cmri::CMri bus /dev/ttyS1 -baud 19200 -retries 10000} errorMessage]}
      # Handle error.
      puts -nonewline stderr "Could not connect to CMR/I bus on /dev/ttyS1:"
      puts stderr "$errorMessage"
      rename bus {}
      exit 99
152  }
      #*****
      #* Initialize board *
      #*****
      set CT [list 0x96 0x0A]
157      # 10010110
      #  O I I O
      # 00001010
      #  X X O O
      if {[catch {bus InitBoard $CT 8 16 0 $UA SUSIC 0} result]} {
162      # Handle error.
      puts -nonewline stderr "Could not initialize SUSIC card at UA"
      puts stderr "$UA: $result"
      rename bus {}
      exit 99
167  }
      #
      #      PRINT "NODE INITIALIZATION IS COMPLETE - CHECK LED BLINK RATE"
      #      PRINT "      AND PRESS ANY KEY TO CONTINUE"
      #      SLEEP
172
      puts "NODE INITIALIZATION IS COMPLETE - CHECK LED BLINK RATE"
      puts "      AND PRESS ANY KEY TO CONTINUE"
      gets stdin
177  #
      #BRTL: '*****BEGIN REAL TIME LOOP*****

      while {true} {

182  # REM**READ AND UNPACK INPUTS
      #      GOSUB INPUTS
          if {[catch {bus Inputs 8 $UA} result]} {
              puts -nonewline stderr "Could not read from the input ports of"
              puts stderr "SUSIC card at UA $UA: $result"
187              break
          }
          set Inputs $result

```

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```

#      BK1 = IB(1) \ B0 AND WI      'CARD 1 PORT A
192 #      BK2 = IB(1) \ B1 AND WI
#      BK3 = IB(1) \ B2 AND WI
#      BK4 = IB(1) \ B3 AND WI
#      BK5 = IB(1) \ B4 AND WI
#      BK6 = IB(1) \ B5 AND WI
197 #      OS1 = IB(1) \ B6 AND WI
#      BK7 = IB(1) \ B7 AND WI

      set tempByte [lindex $Inputs 0];#      CARD 1 PORT A
202      set BK1 [expr {$tempByte >> $B0 & $W1}]
      set BK2 [expr {$tempByte >> $B1 & $W1}]
      set BK3 [expr {$tempByte >> $B2 & $W1}]
      set BK4 [expr {$tempByte >> $B3 & $W1}]
      set BK5 [expr {$tempByte >> $B4 & $W1}]
      set BK6 [expr {$tempByte >> $B5 & $W1}]
207      set OS1 [expr {$tempByte >> $B6 & $W1}]
      set BK7 [expr {$tempByte >> $B7 & $W1}]

#
#      BK8 = IB(2) \ B0 AND WI      'CARD 1 PORT B
212 #      OS2 = IB(2) \ B1 AND WI
#      BK9 = IB(2) \ B2 AND WI
#      BK10 = IB(2) \ B3 AND WI
#      OS3 = IB(2) \ B4 AND WI
#      BK11 = IB(2) \ B5 AND WI
217 #      OS4 = IB(2) \ B6 AND WI
#      BK13 = IB(2) \ B7 AND WI

      set tempByte [lindex $Inputs 1];#      CARD 1 PORT B
222      set BK8 [expr {$tempByte >> $B0 & $W1}]
      set OS2 [expr {$tempByte >> $B1 & $W1}]
      set BK9 [expr {$tempByte >> $B2 & $W1}]
      set BK10 [expr {$tempByte >> $B3 & $W1}]
      set OS3 [expr {$tempByte >> $B4 & $W1}]
      set BK11 [expr {$tempByte >> $B5 & $W1}]
227      set OS4 [expr {$tempByte >> $B6 & $W1}]
      set BK13 [expr {$tempByte >> $B7 & $W1}]

#
#      BK14 = IB(3) \ B0 AND WI      'CARD 1 PORT C
232 #      OS5 = IB(3) \ B1 AND WI
#      BK15 = IB(3) \ B2 AND WI
#      BK20 = IB(3) \ B3 AND WI
#      BK16 = IB(3) \ B4 AND WI

```

```

#      BK17 = IB(3) \ B5 AND W1
237 #      OS6 = IB(3) \ B6 AND W1
#      BK18 = IB(3) \ B7 AND W1

      set tempByte [lindex $Inputs 2];#      CARD 1 PORT C
242      set BK14 [expr {$tempByte >> $B0 & $W1}]
      set OS5 [expr {$tempByte >> $B1 & $W1}]
      set BK15 [expr {$tempByte >> $B2 & $W1}]
      set BK20 [expr {$tempByte >> $B3 & $W1}]
      set BK16 [expr {$tempByte >> $B4 & $W1}]
      set BK17 [expr {$tempByte >> $B5 & $W1}]
247      set OS6 [expr {$tempByte >> $B6 & $W1}]
      set BK18 [expr {$tempByte >> $B7 & $W1}]

#
#      TF12 = IB(4) \ B0 AND W1      'CARD 1 PORT D
252 #      PB1 = IB(4) \ B1 AND W1
#      PB2 = IB(4) \ B2 AND W1
#      PB3 = IB(4) \ B3 AND W1
#      PB4 = IB(4) \ B4 AND W1
#      PB5 = IB(4) \ B5 AND W1
257 #      PB6 = IB(4) \ B6 AND W1
#      TG6 = IB(4) \ B7 AND W1

      set tempByte [lindex $Inputs 3];#      CARD 1 PORT D
262      set TF12 [expr {$tempByte >> $B0 & $W1}]
      set PB1 [expr {$tempByte >> $B1 & $W1}]
      set PB2 [expr {$tempByte >> $B2 & $W1}]
      set PB3 [expr {$tempByte >> $B3 & $W1}]
      set PB4 [expr {$tempByte >> $B4 & $W1}]
      set PB5 [expr {$tempByte >> $B5 & $W1}]
267      set PB6 [expr {$tempByte >> $B6 & $W1}]
      set TG6 [expr {$tempByte >> $B7 & $W1}]

#
#      TG7 = IB(5) \ B0 AND W1      'CARD 2 PORT A
272 #      TG8 = IB(5) \ B1 AND W1
#      TG9 = IB(5) \ B2 AND W1
#      TG10 = IB(5) \ B3 AND W1
#      TG11 = IB(5) \ B4 AND W1

277      set tempByte [lindex $Inputs 4];#      CARD 2 PORT A
      set TG7 [expr {$tempByte >> $B0 & $W1}]
      set TG8 [expr {$tempByte >> $B1 & $W1}]
      set TG9 [expr {$tempByte >> $B2 & $W1}]

```

5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES41

```

282      set TG10 [expr {$tempByte >> $B3 & $W1}]
      set TG11 [expr {$tempByte >> $B4 & $W1}]

#
# REM**ALIGN PUSHBUTTON CONTROLLED TURNOUTS IN BUTTE IF OS1 IS CLEAR
# IF OS1 = OCC THEN GOTO TOGGLES
287 # IF PB1 = PBP THEN SM4 = TUN: SM5 = TUN: TK = 1: GOTO TOGGLES
# IF PB2 = PBP THEN SM4 = TUR: SM5 = TUN: TK = 2: GOTO TOGGLES
# IF PB3 = PBP THEN SM5 = TUR: SM3 = TUR: TK = 3: GOTO TOGGLES
# IF PB4 = PBP THEN SM5 = TUR: SM3 = TUN: SM2 = TUN: TK = 4: GOTO TOGGLES
# IF PB5 = PBP THEN
292 # SM5 = TUR: SM3 = TUN: SM2 = TUR: SM1 = TUR: TK = 5: GOTO TOGGLES
# END IF
# IF PB6 = PBP THEN SM5 = TUR: SM3 = TUN: SM2 = TUR: SM1 = TUN: TK = 6

      if {$OS1 != $OCC} {
297         if {$PB1 == $PBP} {
            set SM4 $TUN; set SM5 $TUN; set TK 1
        } elseif {$PB2 == $PBP} {
            set SM4 $TUR; set SM5 $TUN; set TK 2
        } elseif {$PB3 == $PBP} {
302         set SM5 $TUR; set SM3 $TUR; set TK 3
        } elseif {$PB4 == $PBP} {
            set SM5 $TUR; set SM3 $TUN; set SM2 $TUN; set TK 4
        } elseif {$PB5 == $PBP} {
            set SM5 $TUR; set SM3 $TUN; set SM2 $TUR; set SM1 $TUR; set TK 5
307         } elseif {$PB6 == $PBP} {
            set SM5 $TUR; set SM3 $TUN; set SM2 $TUR; set SM1 $TUN; set TK 6
        }
      }

312 #
# REM**ALIGN TOGGLE CONTROLLED TURNOUTS IF OS SECTIONS ARE CLEAR
#TOGGLES:
# IF OS2 = CLR THEN SM6 = TG6
317 # IF OS3 = CLR THEN SM7 = TG7
# IF OS4 = CLR THEN SM8 = TG8: SM9 = TG9
# IF OS5 = CLR THEN SM10 = TG10
# IF OS6 = CLR THEN SM11 = TG11

322      if {$OS2 == $CLR} {set SM6 $TG6}
      if {$OS3 == $CLR} {set SM7 $TG7}
      if {$OS4 == $CLR} {set SM8 $TG8; set SM9 $TG9}
      if {$OS5 == $CLR} {set SM10 $TG10}

```

```

    if {$OS6 == $CLR} {set SM11 $TG11}
327 #
# REM**WHEN AN OS SECTION BECOMES OCCUPIED AND OPPOSING DIRECTION-
# REM**OF-TRAFFIC IS NOT LOCKED-IN THEN SET DIRECTION-OF-TRAFFIC
# REM**FOR SECTION OF SINGLE TRACK TO DIRECTION OF MOVEMENT
332 # IF OS1 = OCC AND DOT1 <> WBD THEN DOT1 = EBD
# IF OS2 = OCC AND DOT1 <> EBD THEN DOT1 = WBD
# IF OS3 = OCC AND DOT2 <> WBD THEN DOT2 = EBD
# IF OS4 = OCC AND DOT2 <> EBD THEN DOT2 = WBD
# IF OS5 = OCC AND DOT3 <> WBD THEN DOT3 = EBD
337 # IF OS6 = OCC AND DOT3 <> EBD THEN DOT3 = WBD

    if {$OS1 == $OCC && $DOT1 != $WBD} {set DOT1 $EBD}
    if {$OS2 == $OCC && $DOT1 != $EBD} {set DOT1 $WBD}
    if {$OS3 == $OCC && $DOT2 != $WBD} {set DOT2 $EBD}
342 if {$OS4 == $OCC && $DOT2 != $EBD} {set DOT2 $WBD}
    if {$OS5 == $OCC && $DOT3 != $WBD} {set DOT3 $EBD}
    if {$OS6 == $OCC && $DOT3 != $EBD} {set DOT3 $WBD}

# REM**RETAIN DIRECTION-OF-TRAFFIC WHILE SINGLE TRACK IS OCCUPIED
347 #DT1: IF OS1 = OCC THEN GOTO DT2
# IF BK7 = OCC THEN GOTO DT2
# IF BK8 = OCC THEN GOTO DT2
# IF OS2 = OCC THEN GOTO DT2
# DOT1 = NDT 'All trackage clear so set DOT1 to no direction-of-traffic
352

    if {$OS1 != $OCC &&
        $BK7 != $OCC &&
        $BK8 != $OCC &&
        $OS2 != $OCC} {
357 set DOT1 $NDT; #All trackage clear so set DOT1 to no direction-of-traf
    }

#
#DT2: IF OS3 = OCC THEN GOTO DT3
362 # IF BK11 = OCC THEN GOTO DT3
# IF OS4 = OCC THEN GOTO DT3
# DOT2 = NDT 'All trackage clear so set DOT2 to no direction-of-traffic

    if {$OS3 != $OCC &&
        $BK11 != $OCC &&
        $OS4 != $OCC} {
367 set DOT2 $NDT; #All trackage clear so set DOT2 to no direction-of-traf
    }

```

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```

372 #
#DT3: IF OS5 = OCC THEN GOTO DOTCMP
# IF BK15 = OCC THEN GOTO DOTCMP
# IF BK16 = OCC THEN GOTO DOTCMP
# IF BK17 = OCC THEN GOTO DOTCMP
377 # IF OS6 = OCC THEN GOTO DOTCMP
# DOT1 = NDT 'All trackage clear so set DOT3 to no direction-of-traffic

    if {$OS5 != $OCC &&
        $BK15 != $OCC &&
382     $BK16 != $OCC &&
        $BK17 != $OCC &&
        $OS6 != $OCC} {
        set DOT3 $NDT; #All trackage clear so set DOT3 to no direction-of-traffic
    }
387 #DOTCMP:
#
# REM*****
# REM*****
392 # REM**CALCULATE EASTBOUND SIGNALS**
# REM*****
# REM*****
#
# REM**Calculate SIG20RABC
397 #SIG20R:
# SIG20RABC = REDREDRED
# IF OS6 = OCC THEN GOTO SIG18R
# IF SM11 = TUN AND TF12 = TGR THEN SIG20RABC = REDREDYEL: GOTO SIG18R
# IF BK18 = OCC THEN GOTO SIG18R
402 # IF SM11 = TUN THEN SIG20RABC = YELREDRED ELSE SIG20RABC = REDYELRED

    set SIG20RABC $REDREDRED
    if {$OS6 != $OCC} {
        if {$SM11 == $TUN && $TF12 == TGR} {
407         set SIG20RABC $REDREDYEL
        } else {
            if {$BK18 != $OCC} {
                if (SM11 == TUN) {
                    set SIG20RABC $YELREDRED
412                 } else {
                    set SIG20RABC $REDYELRED
                }
            }
        }
    }

```

```

417     }
    }

#
#  REM**Calculate SIG18RA
#SIG18R:
422 #    SIG18RA = RED
#    IF DOT3 = WBD THEN GOTO SIG16R
#    IF BK17 = OCC THEN GOTO SIG16R
#    SIG18RA = YEL
#    IF SIG20RABC = REDREDRED THEN GOTO SIG16R
427 #    SIG18RA = GRN
#

    set SIG18RA $RED
    if {$DOT3 != $WBD && $BK17 != $OCC} {
432        set SIG18RA $YEL
        if {$SIG20RABC != $REDREDRED} {set SIG18RA $GRN}
    }

437 #  REM**Calculate SIG16RA
#SIG16R:
#    SIG16RA = RED
#    IF DOT3 = WBD THEN GOTO SIG14R
#    IF BK16 = OCC THEN GOTO SIG14R
442 #    SIG16RA = YEL
#    IF SIG18R = RED THEN GOTO SIG14R
#    SIG16RA = GRN

    set SIG16RA $RED
447    if {$DOT3 != $WBD && $BK16 != $OCC} {
        set SIG16RA $YEL
        if {$SIG18RA != $RED} {set SIG16RA $GRN}
    }

452 #
#  REM**Calculate SIG14RA and SIG14RC
#SIG14R:
#    SIG14RA = RED: SIG14RC = RED
#    IF DOT3 = WBD THEN GOTO SIG12R
457 #    IF OS5 = OCC THEN GOTO SIG12R
#    IF BK15 = OCC THEN GOTO SIG12R
#    SIG14R = YEL
#    IF SIG16RA = RED THEN GOTO SIG12R

```


5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES45

```

#      SIG14R = GRN
462 #      IF SM10 = TUN THEN SIG14RA = SIG14R ELSE SIG14RC = SIG14R

      set SIG14RA $RED; set SIG14RC $RED
      if {$DOT3 != $WBD &&
        $OS5 != $OCC &&
467      $BK15 != $OCC} {
        set SIG14R $YEL
        if {$SIG16RA != $RED} {set SIG14R $GRN}
        if {$SM10 == $TUN} {set SIG14RA $SIG14R} else {set SIG14RC $SIG14R}
      }
472
#
#      REM**Calculate SIG12RABC
#SIG12R:
#      SIG12RABC = REDREDRED
477 #      IF OS4 = OCC THEN GOTO SIG8R
#      IF SM8 = TUR THEN GOTO SM8REV
#      IF BK13 = OCC THEN GOTO SIG8R
#      SIG12RABC = YELREDRED
#      IF SIG14RA = RED THEN GOTO SIG8R
482 #      SIG12RABC = GRNREDRED: GOTO SIG8R
#SM8REV:
#      IF SM9 = TUR THEN SIG12RABC = REDREDYEL: GOTO SIG8R
#      IF BK14 = OCC THEN GOTO SIG8R
#      SIG12RABC = REDYELRED
487

      set SIG12RABC $REDREDRED
      if {$OS4 != $OCC} {
        if {$SM8 != $TUR} {
492          if {$BK13 != $OCC} {
            set SIG12RABC $YELREDRED
            if {$SIG14RA != $RED} {set SIG12RABC $GRNREDRED}
          }
        } else {
497          # SM8REV:
          if {$SM9 == $TUR} {
            set SIG12RABC $REDREDYEL
          } elseif {$BK14 != $OCC} {
            set SIG12RABC $REDYELRED
502          }
        }
      }
    }
  }

```

```

507 #
# REM**Calculate SIG8RA and SIG8RC
#SIG8R:
# SIG8RA = RED: SIG8RC = RED
# IF DOT2 = WBD THEN GOTO SIG6R
512 # IF OS3 = OCC THEN GOTO SIG6R
# IF BK11 = OCC THEN GOTO SIG6R
# SIG8R = YEL
# IF SIG12RABC = REDREDRED THEN GOTO SIG6R
# SIG8R = GRN
517 # IF SM7 = TUN THEN SIG8RA = SIG8R ELSE SIG8RC = SIG8R

      set SIG8RA $RED; set SIG8RC $RED
      if {$DOT2 != $WBD && $OS3 != $OCC && $BK11 != $OCC} {
        set SIG8R $YEL
522      if {$SIG12RABC != $REDREDRED} {set SIG8R $GRN}
        if (SM7 == TUN) {set SIG8RA $SIG8R} else {set SIG8RC $SIG8R}
      }

527 #
# REM**Calculate SIG6RAB
#SIG6R:
# SIG6RAB = REDRED
# IF OS2 = OCC THEN GOTO SIG4R
532 # IF SM6 = TUR THEN GOTO SM6REV
# IF BK9 = OCC THEN GOTO SIG4R
# SIG6RAB = YELRED
# IF SIG8RA = RED THEN GOTO SIG4R
# SIG6RAB = GRNRED: GOTO SIG4R
537 #
#SM6REV:
# IF BK10 = OCC THEN GOTO SIG4R
# SIG6RAB = REDYEL

542      set SIG6RAB $REDRED
      if {$OS2 != $OCC} {
        if {$SM6 != $TUR} {
          if {$BK9 != $OCC} {
            set SIG6RAB $YELRED
547          if {$SIG8RA != $RED} {set SIG6RAB $GRNRED}
          }
        } else {
          # SM6REV:

```

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```

552         if {$BK10 != $OCC} {set SIG6RAB $REDYEL}
        }
    }

#
# REM**Calculate SIG4RA
557 #SIG4R:
#     SIG4RA = RED
#     IF DOT1 = WBD THEN GOTO SIG2R
#     IF BK8 = OCC THEN GOTO SIG2R
#     SIG4RA = YEL
562 #     IF SIG6RAB = REDRED THEN GOTO SIG2R
#     SIG4RA = GRN

        set SIG4RA $RED
        if {$DOT1 != $WBD && $BK8 != $OCC} {
567         set SIG4RA $YEL
            if {$SIG6RAB != $REDRED} {set SIG4RA $GRN}
        }

#
572 # REM**Calculate Red Butte exit signals
# REM**Initialize all exit signals to RED
#SIG2R:
#     set SIG2RA $RED: SIG2RB = RED: SIG2RC = RED
#     SIG2RD = RED: SIG2RE = RED: SIG2RF = RED
577 #
# REM**Calculate exit signal value for aligned track
#     EXITSIG = RED
#     IF DOT1 = WBD THEN GOTO SIGECMP
#     IF OS1 = OCC THEN GOTO SIGECMP
582 #     IF BK7 = OCC THEN GOTO SIGECMP
#     EXITSIG = YEL
#     IF SIG4RA = RED THEN GOTO EXSIG
#     EXITSIG = GRN
#
587 # REM**Set track aligned exit signal to calculated signal value
#EXSIG:
#     IF TK = 1 THEN SIG2RA = EXITSIG
#     IF TK = 2 THEN SIG2RB = EXITSIG
#     IF TK = 3 THEN SIG2RC = EXITSIG
592 #     IF TK = 4 THEN SIG2RD = EXITSIG
#     IF TK = 5 THEN SIG2RE = EXITSIG
#     IF TK = 6 THEN SIG2RF = EXITSIG
#SIGECMP:

```

```

597      set SIG2RA $RED; set SIG2RB $RED; set SIG2RC $RED
      set SIG2RD $RED; set SIG2RE $RED; set SIG2RF $RED
      set EXITSIG $RED
      if {$DOT1 != $WBD && $OS1 != $OCC && $BK7 != $OCC} {
602          set EXITSIG $YEL
          if {$SIG4RA != $RED} {set EXITSIG $GRN}
      }
      switch $TK {
          1 {set SIG2RA $EXITSIG}
          2 {set SIG2RB $EXITSIG}
607          3 {set SIG2RC $EXITSIG}
          4 {set SIG2RD $EXITSIG}
          5 {set SIG2RE $EXITSIG}
          6 {set SIG2RF $EXITSIG}
      }
612
      #
      # REM*****
      # REM*****
      # REM**CALCULATE WESTBOUND SIGNALS**
617      # REM*****
      # REM*****
      #
      # REM**Calculate SIG2LAB (entrance signal into staging)
      #SIG2L:
622      # SIG2LAB = REDRED
      # IF OS1 = OCC THEN GOTO SIG4L
      # IF TK = 1 AND BK1 = CLR THEN SIG2LAB = YELRED: GOTO SIG4L
      # IF TK = 2 AND BK2 = CLR THEN SIG2LAB = REDYEL: GOTO SIG4L
      # IF TK = 3 AND BK3 = CLR THEN SIG2LAB = REDYEL: GOTO SIG4L
627      # IF TK = 4 AND BK4 = CLR THEN SIG2LAB = REDYEL: GOTO SIG4L
      # IF TK = 5 AND BK5 = CLR THEN SIG2LAB = REDYEL: GOTO SIG4L
      # IF TK = 6 AND BK6 = CLR THEN SIG2LAB = REDYEL

      set SIG2LAB $REDRED
632      if {$OS1 != $OCC} {
          if {$TK == $1 && $BK1 == $CLR} {
              set SIG2LAB $YELRED
          } elseif {$TK == $2 && $BK2 == $CLR} {
              set SIG2LAB $REDYEL
          } elseif {$TK == $3 && $BK3 == $CLR} {
637              set SIG2LAB $REDYEL
          } elseif {$TK == $4 && $BK4 == $CLR} {
              set SIG2LAB $REDYEL
          }
      }

```

5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES49

```

        } elseif {$TK == $5 && $BK5 == $CLR} {
642      set SIG2LAB $REDYEL
        } elseif {$TK == $6 && $BK6 == $CLR} {
          set SIG2LAB $REDYEL
        }
      }
647
#
# REM**Calculate SIG4LA
#SIG4L:
#   SIG4LA = RED
652 #   IF DOT1 = EBD THEN GOTO SIG6L
#   IF BK7 = OCC THEN GOTO SIG6L
#   SIG4LA = YEL
#   IF SIG2LAB = REDRED THEN GOTO SIG6L
#   SIG4LA = GRN
657
      set SIG4LA $RED
      if {$DOT1 != $EBD && $BK7 != $OCC} {
        set SIG4LA $YEL
        if {$SIG2LAB != $REDRED} {set SIG4LA $GRN}
662      }

#
# REM**Calculate SIG6LA and SIG6LC
#SIG6L:
667 #   SIG6LA = RED: SIG6LC = RED
#   IF DOT1 = EBD THEN GOTO SIG8L
#   IF OS2 = OCC THEN GOTO SIG8L
#   IF BK8 = OCC THEN GOTO SIG8L
#   SIG6L = YEL
672 #   IF SIG4LA = RED THEN GOTO SIG8L
#   SIG6L = GRN
#   IF SM6 = TUN THEN SIG6LA = SIG6L ELSE SIG6LC = SIG6L
#
677
      set SIG6LA $RED; set SIG6LC $RED
      if {$DOT1 != $EBD && $OS2 != $OCC && $BK8 != $OCC} {
        set SIG6L $YEL
        if {$SIG4LA != $RED} {set SIG6L $GRN}
        if {$SM6 == $TUN} {set SIG6LA $SIG6L} else {set SIG6LC $SIG6L}
682      }

# REM**Calculate SIG8LAB

```

```

#SIG8L:
687 #   SIG8LAB = REDRED
#   IF OS3 = OCC THEN GOTO SIG12L
#   IF SM7 = TUR THEN GOTO SM7REV
#   IF BK9 = OCC THEN GOTO SIG12L
#   SIG8LAB = YELRED
692 #   IF SIG6LA = RED THEN GOTO SIG12L
#   SIG8LAB = GRNRED: GOTO SIG12L
#SM7REV:
#   IF BK10 = OCC THEN GOTO SIG12L
#   SIG8LAB = REDYEL
697
      set SIG8LAB $REDRED
      if {$OS3 != $OCC} {
        if {$SM7 != $TUR} {
          if {$BK9 != $OCC} {
702             set SIG8LAB $YELRED
              if {$SIG6LA != $RED} {set SIG8LAB $GRNRED}
          }
        } else {
          # SM7REV:
707             if {$BK10 != $OCC} {set SIG8LAB $REDYEL}
        }
      }
    }

#
712 # REM**Calculate SIG12LA, SIG12LC and SIG12LD
#SIG12L:
#   SIG12LA = RED: SIG12LC = RED: SIG12LD = RED
#   IF DOT2 = EBD THEN GOTO SIG14L
#   IF OS4 = OCC THEN GOTO SIG14L
717 #   IF BK11 = OCC THEN GOTO SIG14L
#   SIG12L = YEL
#   IF SIG8LAB = REDRED THEN GOTO SIG14L
#   SIG12L = GRN
#   IF SM8 = TUN THEN SIG12LA = SIG12L: GOTO SIG14L
722 #   IF SM9 = TUN THEN SIG12LC = SIG12L ELSE SIG12LD = SIG12L

      set SIG12LA $RED; set SIG12LC $RED; set SIG12LD $RED
      if {$DOT2 != $EBD && $OS4 != $OCC && $BK11 != $OCC} {
        set SIG12L $YEL
727         if {$SIG8LAB != $REDRED} {set SIG12L $GRN}
        if {$SM8 == $TUN} {
          set SIG12LA $SIG12L
        } elseif {$SM9 == $TUN} {

```

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```

732         set SIG12LC $SIG12L
           } else {
             set SIG12LD $SIG12L
           }
        }

737      #
      #  REM**Calculate SIG14LAB
      #SIG14L:
      #    SIG14LAB = REDRED
742      #    IF OS5 = OCC THEN GOTO SIG16L
      #    IF SM10 = TUR THEN GOTO SM10REV
      #    IF BK13 = OCC THEN GOTO SIG16L
      #    SIG14LAB = YELRED
      #    IF SIG12LA = RED THEN GOTO SIG16L
747      #    SIG14LAB = GRNRED: GOTO SIG16L
      #SM10REV:
      #    IF BK14 = OCC THEN GOTO SIG16L
      #    SIG14LAB = REDYEL

752      set SIG14LAB $REDRED
      if {$OS5 != $OCC} {
        if {$SM10 != $TUR} {
          if {$BK13 != $OCC} {
            set SIG14LAB $YELRED
757            if {$SIG12LA != $RED} {set SIG14LAB $GRNRED}
          }
        } else {
          # SM10REV
          if {$BK14 != $OCC} {set SIG14LAB $REDYEL}
762        }
      }

      #
      #  REM**Calculate SIG16LA
767      #SIG16L:
      #    SIG16LA = RED
      #    IF DOT3 = EBD THEN GOTO SIG18L
      #    IF BK15 = OCC THEN GOTO SIG18L
      #    SIG16LA = YEL
772      #    IF SIG14LAB = REDRED THEN GOTO SIG18L
      #    SIG16LA = GRN

      set SIG16LA $RED

```

```

777         if {$DOT3 != $EBD && $BK15 != $OCC} {
            set SIG16LA $YEL
            if {$SIG14LAB != $REDRED} {set SIG16LA $GRN}
        }

#
782 # REM**Calculate SIG18LA
#SIG18L:
#     SIG18LA = RED
#     IF DOT3 = EBD THEN GOTO SIG20L
#     IF BK16 = OCC THEN GOTO SIG20L
787 #     SIG18LA = YEL
#     IF SIG16LA = RED THEN GOTO SIG20L
#     SIG18LA = GRN

        set SIG18LA $RED
792         if {$DOT3 != $EBD && $BK16 != $OCC} {
            set SIG18LA $YEL
            if {$SIG16LA != $RED} {set SIG18LA $GRN}
        }

#
797 # REM**Calculate SIG20LA, SIG20LB and SIG20LD
#SIG20L:
#     SIG20LA = RED; SIG20LB = RED; SIG20LD = RED
#     IF DOT3 = EBD THEN GOTO SIGWCMP
802 #     IF OS6 = OCC THEN GOTO SIGWCMP
#     IF BK17 = OCC THEN GOTO SIGWCMP
#     SIG20L = YEL
#     IF SIG18LA <> RED THEN SIG20L = GRN
#     IF SM11 = TUR THEN SIG20LB = SIG20L: GOTO SIGWCMP
807 #     IF TF12 = TGR THEN SIG20LD = SIG20L ELSE SIG20LA = SIG20L
#SIGWCMP:

        set SIG20LA $RED; set SIG20LB $RED; set SIG20LD $RED
812         if {$DOT3 != $EBD && $OS6 != $OCC && $BK17 != $OCC} {
            set SIG20L $YEL
            if {$SIG18LA != $RED} {set SIG20L $GRN}
            if {$SM11 == $TUR} {
                set SIG20LB $SIG20L
            } elseif {$TF12 == $TGR} {
817                 set SIG20LD $SIG20L
            } else {
                set SIG20LA $SIG20L
            }
        }

```


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```

822     }

#
# REM**PACK AND WRITE OUTPUT BYTES
#     OB(1) = SIG2LAB                                'CARD 0 PORT A
827 #     OB(1) = SIG2RA * B5 OR OB(1)

        set Outputs [expr {$SIG2LAB | \
                            $SIG2RA << $B5}];      # CARD 0 PORT A

832 #
#     OB(2) = SIG2RB                                'CARD 0 PORT B
#     OB(2) = SIG2RC * B3 OR OB(2)
#     OB(2) = SM1 * B6 OR OB(2)
#     OB(2) = SM2 * B7 OR OB(2)
837
        lappend Outputs [expr {$SIG2RB | \
                                $SIG2RC << $B3 | \
                                $SM1    << $B6 | \
                                $SM2    << $B7}];    #CARD 0 PORT B

842 #
#     OB(3) = SIG2RD                                'CARD 0 PORT C
#     OB(3) = SIG2RE * B3 OR OB(3)
#     OB(3) = SM3 * B6 OR OB(3)
#     OB(3) = SM4 * B7 OR OB(3)
847
        lappend Outputs [expr {$SIG2RD | \
                                $SIG2RE << $B3 | \
                                $SM3    << $B6 | \
                                $SM4    << $B7}];    #CARD 0 PORT C

852 #
#     OB(4) = SIG2RF                                'CARD 0 PORT D
#     OB(4) = SIG4LA * B3 OR OB(4)
#     OB(4) = SM5 * B6 OR OB(4)
#     OB(4) = SM6 * B7 OR OB(4)
857
        lappend Outputs [expr {$SIG2RF | \
                                $SIG4LA << $B3 | \
                                $SM5    << $B6 | \
                                $SM6    << $B7}];    #CARD 0 PORT D

862 #
#     OB(5) = SIG6RAB                                'CARD 3 PORT A
#     OB(5) = SIG4RA * B5 OR OB(5)

```

```

867      lappend Outputs [expr {$SIG6RAB | \
                                $SIG4RA << $B5}];          #CARD 3 PORT A
#
#      OB(6) = SIG6LA          'CARD 3 PORT B
#      OB(6) = SIG6LC * B3 OR OB(6)
#      OB(6) = SM7 * B6 OR OB(6)
872 #      OB(6) = SM8 * B7 OR OB(6)

      lappend Outputs [expr {$SIG6LA | \
                                $SIG6LC << $B3 | \
                                $SM7 << $B6 | \
                                $SM8 << $B7}];          #CARD 3 PORT B
#
#      OB(7) = SIG8LAB          'CARD 3 PORT C
#      OB(7) = SIG8RA * B5 OR OB(7)

882      lappend Outputs [expr {$SIG8LAB | \
                                $SIG8RA << $B5}];          #CARD 3 PORT C
#
#      OB(8) = SIG8RC          'CARD 3 PORT D
#      OB(8) = SIG12LA * B3 OR OB(8)

887      lappend Outputs [expr {$SIG8RC | \
                                $SIG12LA << $B3}];          #CARD 3 PORT D
#
#      OB(9) = SIG12RABC          'CARD 4 PORT A
892 #      OB(9) = SM9 * B7 OR OB(9)

      lappend Outputs [expr {$SIG12RABC | \
                                $SM9 << $B7}];          #CARD 4 PORT A
#
#      OB(10) = SIG12LC          'CARD 4 PORT B
#      OB(10) = SIG12LD * B3 OR OB(10)
#      OB(10) = SM10 * B6 OR OB(10)
#      OB(10) = SM11 * B7 OR OB(10)

902      lappend Outputs [expr {$SIG12LC | \
                                $SIG12LD << $B3 | \
                                $SM10 << $B6 | \
                                $SM11 << $B7}];          #CARD 4 PORT B
#
#      OB(11) = SIG14LAB          'CARD 4 PORT C
#      OB(11) = SIG14RA * B5 OR OB(11)

      lappend Outputs [expr {$SIG14LAB | \

```

5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES55

```

912 #                                     $SIG14RA << $B5}];           #CARD 4 PORT C
#
#      OB(12) = SIG14RC                      'CARD 4 PORT D
#      OB(12) = SIG16LA * B3 OR OB(12)

917      lappend Outputs [expr {$SIG14RC | \
                                     $SIG16LA << $B3}];           #CARD 4 PORT D
#
#      OB(13) = SIG16RA                      'CARD 5 PORT A
#      OB(13) = SIG18LA * B3 OR OB(13)

922      lappend Outputs [expr {$SIG16RA | \
                                     $SIG18LA << $B3}];           #CARD 5 PORT A
#
#      OB(14) = SIG18RA                      'CARD 5 PORT B
#      OB(14) = SIG20LA * B3 OR OB(14)

927      lappend Outputs [expr {$SIG18RA | \
                                     $SIG20LA << $B3}];           #CARD 5 PORT B
#
#      OB(15) = SIG20RABC                    'CARD 5 PORT C

932      lappend Outputs $SIG20RABC; #CARD 5 PORT C
#
#      OB(16) = SIG20LB                      'CARD 5 PORT D
#      OB(16) = SIG20LD * B3 OR OB(16)

937      lappend Outputs [expr {$SIG20LB | \
                                     $SIG20LD << $B3}];           #CARD 5 PORT D
#
#      GOSUB OUTPUTS          'INVOKE OUTPUTS SUBROUTINE

942      if {[catch {bus Outputs $Outputs $UA} result]} {
#      Handle error.
#      puts -nonewline stderr "Could not write to the output ports of"
#      puts stderr "SUISC card at UA:$UA:$result"
947      break
    }

#
#      REM**RETURN TO BEGINNING OF REAL-TIME LOOP
952 #      GOTO BRTL
}

```

5.4.3 From Chapter 14: Distributed Application Examples

Listing 5.6: Figure 14-5, Tcl Translation

```

# $Id: fig14-5.tcl 1465 2013-03-17 15:24:03Z heller $

#      DEFINT A-Z
#      DECLARE SUB INIT ()
5 #      DECLARE SUB OUTPUTS ()
#      DECLARE SUB INPUTS ()
#      DECLARE SUB RXBYTE ()
#      DECLARE SUB TXPACK ()
# REM**MULTI-NODE EXAMPLE USING 3-ASPECT COLOR LIGHT SIGNALS**
10 # REM**GLOBALIZE SERIAL PROTOCOL HANDLING VARIABLES
#      DIM SHARED OB(60), IB(60), CT(15), TB(80)
#      COMMON SHARED UA, COMPORT, BAUD100, NDP$, DL, NS, NI, NO, MAXTRIES
#      COMMON SHARED INBYTE, ABORTIN, INTRIES, INITERR, PA, LM, MT

15 # Load MRR System packages
# Add MRR System package Paths
lappend auto_path /usr/local/share/MRRSystem;# Tcl packages
package require Cmri 2.0.0;#      Load the CMR/I package

20 #
# REM**INITIALIZE CONSTANTS FOR PACKING AND UNPACKING I/O BYTES
#      B0 = 1: B1 = 2: B2 = 4: B3 = 8: B4 = 16: B5 = 32: B6 = 64: B7 = 128
#      W1 = 1: W2 = 3: W3 = 7: W4 = 15: W5 = 31: W6 = 63: W7 = 127

25 # REM**SUSIC SINGLE-NODE SYSTEM USING 3-ASPECT COLOR LIGHT SIGNALS**
# REM**DEFINE VARIABLE TYPES AND ARRAY SIZES
#      DEFINT A-Z
#      DIM OB(60), IB(60), TB(80), CT(15)
#

30 # REM**DEFINE CONSTANTS FOR PACKING AND UNPACKING I/O BYTES
#      B0 = 1: B1 = 2: B2 = 4: B3 = 8: B4 = 16: B5 = 32: B6 = 64: B7 = 128
#      W1 = 1: W2 = 3: W3 = 7: W4 = 15: W5 = 31: W6 = 63: W7 = 127

# Bit shift constants
35 #
set B0 0
set B1 1
set B2 2
set B3 3
40 set B4 4
set B5 5
set B6 6

```

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```
set B7 7

45 # Bit mask constants
#
set W1 0x01
set W2 0x03
set W3 0x07
50 set W4 0x0f
set W5 0x1f
set W6 0x3f
set W7 0x7f

55 #
# REM**DEFINE BLOCK OCCUPATION CONSTANTS
# CLR = 0 'Clear
# OCC = 1 'Occupied

60 set CLR 0
set OCC 1

#
# REM**DEFINE SIGNAL ASPECTS – Single Head
65 # DRK = 0 'Dark 000
# GRN = 1 'Green 001
# YEL = 2 'Yellow 010
# RED = 4 'Red 100

70 set DRK 0;# Dark 000
set GRN 1;# Green 001
set YEL 2;# Yellow 010
set RED 4;# Red 100

75 #
# REM**DEFINE SIGNAL ASPECTS – Double Head
# GRNRED = 17 'Green over red 10001
# YELRED = 18 'Yellow over red 10010
# REDYEL = 12 'Red over yellow 01100
80 # REDRED = 20 'Red over red 10100

set GRNRED 0x11;# Green over red 10001
set YELRED 0x12;# Yellow over red 10010
set REDYEL 0x0c;# Red over yellow 01100
85 set REDRED 0x14;# Red over red 10100

#
```

```

# REM**DEFINE SIGNAL ASPECTS – Triple Head
# REDREDRED = 84 'Red over red over red 1010100
90 # REDREDYEL = 52 'Red over red over yellow 0110100
# REDYELRED = 76 'Red over yellow over red 1001100
# YELREDRED = 82 'Yellow over red over red 1010010
# GRNREDRED = 81 'Green over red over red 1010001

95 set REDREDRED 0x54;# Red over red over red 1010100
set REDREDYEL 0x34;# Red over red over yellow 0110100
set REDYELRED 0x4c;# Red over yellow over red 1001100
set YELREDRED 0x52;# Yellow over red over red 1010010
set GRNREDRED 0x51;# Green over red over red 1010001

100 #
# REM**INITIALIZE TURNOUT POSITION CONSTANTS
# REM**Constants assume direct connection to output pins (not using SMC)
# REM**See other examples for using SMC card with one I/O line per machine
105 # TUN = 1 '01
# TUR = 2 '10

set TUN 0
set TUR 1

110 #
# REM**DEFINE PUSHBUTTON AND TOGGLE POSITIONS
# PBP = 1 'Pushbutton pressed
# TGR = 1 'Toggle reverse position
115 # TGN = 0 'Toggle normal position

set PBP 1;# Pushbutton pressed
set TGR 1;# Toggle reverse position
set TGN 0;# Toggle normal position

120 #
# REM**DEFINE DIRECTION-OF-TRAFFIC RUNNING ON SINGLE TRACK
# NDT = 0 'No direction-of-traffic defined on single track
# EBD = 1 'EastBound Direction
125 # WBD = 2 'WestBound Direction

set NDT 0;# No direction-of-traffic defined on single track
set EBD 1;# EastBound Direction
set WBD 2;# WestBound Direction

130 #
# REM**INITIALIZE DIRECTION-OF-TRAFFIC VARIABLES TO NO DIRECTION-OF-TRAFFIC

```

5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES59

```

#      DOT1 = NDT; DOT2 = NDT; DOT3 = NDT
#      set DOT1 $NDT; set DOT2 $NDT; set DOT3 $NDT
135
#
#      PRINT "MULTIPLE NODE EXAMPLE USING 3-ASPECT COLOR LIGHT SIGNALS"

#      puts "MULTIPLE_NODE_RAILROAD_EXAMPLE_USING_3-ASPECT_COLOR_LIGHT_SIGNALS"
140
#
#      REM**INITIALIZE GENERAL SERIAL PROTOCOL PARAMETERS (same for all nodes)
#      COMPORT = 3      'PC SERIAL COMMUNICATIONS PORT = 1, 2, 3 OR 4
#      BAUD100 = 192    'BAUD RATE OF 19200 DIVIDED BY 100
145 #      DL = 0          'USIC TRANSMISSION DELAY
#      MAXTRIES = 10000 'MAXIMUM READ TRIES BEFORE ABORT INPUTS
#      Connect to the bus on COM3: (/dev/ttyS2), at 19200 BAUD, with
#      a retry count of 10000, capturing error messages.
#      if {[catch {cmri::CMri bus /dev/ttyS2 -baud 19200 -retries 10000} result]} {
150 #      Handle error.
#      puts -nonewline stderr "Could_not_connect_to_CMRI_bus_on_/dev/ttyS2:_"
#      puts stderr "$result"
#      rename bus {}
#      exit 99
155 }
#
#      REM**INITIALIZE NODE 0 (SMINI)
#      UA = 0          'USIC NODE ADDRESS
#      NDP$ = "M"      'NODE DEFINITION PARAMETER
160 #      NS = 0          'NUMBER OF 2-LEAD SEARCHLIGHT SIGNALS
#      NI = 3          'NUMBER OF INPUT PORTS
#      NO = 6          'NUMBER OF OUTPUT PORTS
#      CALL INIT        'INVOKE INITIALIZATION SUBROUTINE
#      set UA 0
165 #      if {[catch {bus InitBoard {} 3 6 0 $UA SMINI 0} result]} {
#      Handle error.
#      puts -nonewline stderr "Could_not_initialize_SMINI_card_at_UA_"
#      puts stderr "$UA:_$result"
#      rename bus {}
170 #      exit 99
#
#
#      REM**INITIALIZE NODE 1 (SMINI)
#      UA = 1          'USIC NODE ADDRESS
175 #      NDP$ = "M"      'NODE DEFINITION PARAMETER
#      NS = 0          'NUMBER OF 2-LEAD SEARCHLIGHT SIGNALS
#      NI = 3          'NUMBER OF INPUT PORTS

```

```

#      NO = 6                      'NUMBER OF OUTPUT PORTS
#      CALL INIT                  'INVOKE INITIALIZATION SUBROUTINE
180 set UA 1
    if {[catch {bus InitBoard {} 3 6 0 $UA SMINI 0} result]} {
        # Handle error.
        puts -nonewline stderr "Could not initialize SMINI card at UA"
        puts stderr "$UA: $result"
185     rename bus {}
        exit 99
    }
#
# REM**INITIALIZE NODE 2 (SMINI)
190 #      UA = 2                  'USIC NODE ADDRESS
#      NDP$ = "M"                'NODE DEFINITION PARAMETER
#      NS = 0                    'NUMBER OF 2-LEAD SEARCHLIGHT SIGNALS
#      NI = 3                    'NUMBER OF INPUT PORTS
#      NO = 6                    'NUMBER OF OUTPUT PORTS
195 #      CALL INIT              'INVOKE INITIALIZATION SUBROUTINE
    set UA 2
    if {[catch {bus InitBoard {} 3 6 0 $UA SMINI 0} result]} {
        # Handle error.
        puts -nonewline stderr "Could not initialize SMINI card at UA"
200     puts stderr "$UA: $result"
        rename bus {}
        exit 99
    }
#
205 # REM**INITIALIZE NODE 3 (SMINI)
#      UA = 3                    'USIC NODE ADDRESS
#      NDP$ = "M"                'NODE DEFINITION PARAMETER
#      NS = 0                    'NUMBER OF 2-LEAD SEARCHLIGHT SIGNALS
#      NI = 3                    'NUMBER OF INPUT PORTS
210 #      NO = 6                  'NUMBER OF OUTPUT PORTS
#      CALL INIT                  'INVOKE INITIALIZATION SUBROUTINE
    set UA 3
    if {[catch {bus InitBoard {} 3 6 0 $UA SMINI 0} result]} {
        # Handle error.
215     puts -nonewline stderr "Could not initialize SMINI card at UA"
        puts stderr "$UA: $result"
        rename bus {}
        exit 99
    }
#
220 # REM**INITIALIZE NODE 4 (SUSIC)
#      UA = 4                    'USIC NODE ADDRESS

```


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```

#      NDP$ = "X"          'NODE DEFINITION PARAMETER
#      NS = 1              'NUMBER OF CARD SETS OF 4
225 #      CT(1) = 6        'CARD TYPE ARRAY ELEMENT FOR GROUPING OF OIXX
#      NI = 4              'NUMBER OF INPUT PORTS
#      NO = 4              'NUMBER OF OUTPUT PORTS
#      CALL INIT           'INVOKE INITIALIZATION SUBROUTINE
set UA 4
230 if {[catch {bus InitBoard {0x06} 4 4 0 $UA SUSICI 0} result]} {
    # Handle error.
    puts -nonewline stderr "Could not initialize SUSIC card at UA."
    puts stderr "$UA: $result"
    rename bus {}
235     exit 99
}
#
#BRTL: '*****BEGIN REAL TIME LOOP*****

240 while {true} {

    # REM**READ AND UNPACK INPUTS FOR NODE 0 (SMINI)
    #      UA = 0: NI = 3
    #      CALL INPUTS
245 #      BK1 = IB(1)\B0 AND WI      'NODE 0 CARD 2 PORT A
    #      BK2 = IB(1)\B1 AND WI
    #      BK3 = IB(1)\B2 AND WI
    #      BK4 = IB(1)\B3 AND WI
    #      BK5 = IB(1)\B4 AND WI
250 #      BK6 = IB(1)\B5 AND WI
    #      OS1 = IB(1)\B6 AND WI
    #      BK7 = IB(1)\B7 AND WI

    set UA 0
255    if {[catch {bus Inputs 3 $UA} result]} {
        puts -nonewline stderr "Could not read from the input ports of "
        puts stderr "SMINI card at UA.$UA: $result"
        break
    }
260    set Inputs $result
    set tempByte [lindex $Inputs 0];#      NODE 0 CARD 2 PORT A
    set BK1 [expr {$tempByte >> $B0 & $W1}]
    set BK2 [expr {$tempByte >> $B1 & $W1}]
    set BK3 [expr {$tempByte >> $B2 & $W1}]
265    set BK4 [expr {$tempByte >> $B3 & $W1}]
    set BK5 [expr {$tempByte >> $B4 & $W1}]
    set BK6 [expr {$tempByte >> $B5 & $W1}]

```

```

    set OS1 [expr {$tempByte >> $B6 & $W1}]
    set BK7 [expr {$tempByte >> $B7 & $W1}]

270
#
# REM**READ AND UNPACK INPUTS FOR NODE 1 (SMINI)
#   UA = 1: NI = 3
275 #   CALL INPUTS
#   BK8 = IB(1)\B0 AND W1      'NODE 1 CARD 2 PORT A
#   OS2 = IB(1)\B1 AND W1
#   BK9 = IB(1)\B2 AND W1
#   BK10 = IB(1)\B3 AND W1
280 #   OS3 = IB(1)\B4 AND W1
#   BK11 = IB(1)\B5 AND W1

    set UA 1
    if {[catch {bus Inputs 3 $UA} result]} {
285         puts -nonewline stderr "Could not read from the input ports of "
        puts stderr "SMINI card at UA:$UA: $result"
        break
    }
    set Inputs $result
290    set tempByte [lindex $Inputs 0];#      NODE 1 CARD 2 PORT A
    set BK8 [expr {$tempByte >> $B0 & $W1}]
    set OS2 [expr {$tempByte >> $B1 & $W1}]
    set BK9 [expr {$tempByte >> $B2 & $W1}]
    set BK10 [expr {$tempByte >> $B3 & $W1}]
295    set OS3 [expr {$tempByte >> $B4 & $W1}]
    set BK11 [expr {$tempByte >> $B5 & $W1}]

#
# REM**READ AND UNPACK INPUTS FOR NODE 2 (SMINI)
300 #   UA = 2: NI = 3
#   CALL INPUTS
#   OS4 = IB(1)\B0 AND W1      'NODE 2 CARD 2 PORT A
#   BK13 = IB(1)\B1 AND W1
#   BK14 = IB(1)\B2 AND W1
305 #   OS5 = IB(1)\B3 AND W1
#   BK15 = IB(1)\B4 AND W1
#   BK20 = IB(1)\B5 AND W1

    set UA 2
310    if {[catch {bus Inputs 3 $UA} result]} {
        puts -nonewline stderr "Could not read from the input ports of "
        puts stderr "SMINI card at UA:$UA: $result"
    }

```

5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES63

```

        break
    }
315    set Inputs $result
    set tempByte [lindex $Inputs 0];#          NODE 2 CARD 2 PORT A
    set OS4  [expr {$tempByte >> $B0 & $W1}]
    set BK13 [expr {$tempByte >> $B1 & $W1}]
    set BK14 [expr {$tempByte >> $B2 & $W1}]
320    set OS5  [expr {$tempByte >> $B3 & $W1}]
    set BK15 [expr {$tempByte >> $B4 & $W1}]
    set BK20 [expr {$tempByte >> $B5 & $W1}]
#
# REM**READ AND UNPACK INPUTS FOR NODE 3 (SMINI)
325 #   UA = 3: NI = 3
#   CALL INPUTS
#   BK16 = IB(1)\B0 AND WI      'NODE 3 CARD 2 PORT A
#   BK17 = IB(1)\B1 AND WI
#   OS6 = IB(1)\B2 AND WI
330 #   BK18 = IB(1)\B3 AND WI
#   TF12 = IB(1)\B4 AND WI

    set UA 3
    if {[catch {bus Inputs 3 $UA} result]} {
335        puts -nonewline stderr "Could not read from the input ports of "
        puts stderr "SMINI card at UA:$UA: $result"
        break
    }
    set Inputs $result
340    set tempByte [lindex $Inputs 0];#          NODE 3 CARD 2 PORT A
    set BK16 [expr {$tempByte >> $B0 & $W1}]
    set BK17 [expr {$tempByte >> $B1 & $W1}]
    set OS6  [expr {$tempByte >> $B2 & $W1}]
    set BK18 [expr {$tempByte >> $B3 & $W1}]
345    set TF12 [expr {$tempByte >> $B4 & $W1}]
#
# REM**READ AND UNPACK INPUTS FOR NODE 4 (SUSIC)
#   UA = 4: NI = 4
#   CALL INPUTS
350 #   PB1 = IB(1)\B0 AND WI      'NODE 4 CARD 1 PORT A
#   PB2 = IB(1)\B1 AND WI
#   PB3 = IB(1)\B2 AND WI
#   PB4 = IB(1)\B3 AND WI
#   PB5 = IB(1)\B4 AND WI
355 #   PB6 = IB(1)\B5 AND WI
#   TG6 = IB(1)\B6 AND WI
#   TG7 = IB(1)\B7 AND WI

```

```

#
#   TG8 = IB(2)\B0 AND W1      'NODE 4 CARD 1 PORT B
360 #   TG9 = IB(2)\B1 AND W1
#   TG10 = IB(2)\B2 AND W1
#   TG11 = IB(2)\B3 AND W1

      set UA 4
365      if {[catch {bus Inputs 4 $UA} result]} {
          puts -nonewline stderr "Could not read from the input ports of "
          puts stderr "SUSIC card at UA:$UA:$result"
          break
      }
370      set Inputs $result
      set tempByte [lindex $Inputs 0];#          NODE 4 CARD 1 PORT A
      set PB1 [expr {$tempByte >> $B0 & $W1}]
      set PB2 [expr {$tempByte >> $B1 & $W1}]
      set PB3 [expr {$tempByte >> $B2 & $W1}]
375      set PB4 [expr {$tempByte >> $B3 & $W1}]
      set PB5 [expr {$tempByte >> $B4 & $W1}]
      set PB6 [expr {$tempByte >> $B5 & $W1}]
      set TG6 [expr {$tempByte >> $B6 & $W1}]
      set TG7 [expr {$tempByte >> $B7 & $W1}]
380      set tempByte [lindex $Inputs 0];#          NODE 4 CARD 1 PORT B
      set TG8 [expr {$tempByte >> $B0 & $W1}]
      set TG9 [expr {$tempByte >> $B1 & $W1}]
      set TG10 [expr {$tempByte >> $B2 & $W1}]
      set TG11 [expr {$tempByte >> $B3 & $W1}]
385 #
#   REM**ALIGN PUSHBUTTON CONTROLLED TURNOUTS IN BUTTE IF OS1 IS CLEAR
#   IF OS1 = OCC THEN GOTO TOGGLES
#   IF PB1 = PBP THEN SM4 = TUN: SM5 = TUN: TK = 1: GOTO TOGGLES
#   IF PB2 = PBP THEN SM4 = TUR: SM5 = TUN: TK = 2: GOTO TOGGLES
390 #   IF PB3 = PBP THEN SM5 = TUR: SM3 = TUR: TK = 3: GOTO TOGGLES
#   IF PB4 = PBP THEN SM5 = TUR: SM3 = TUN: SM2 = TUN: TK = 4: GOTO TOGGLES
#   IF PB5 = PBP THEN
#       SM5 = TUR: SM3 = TUN: SM2 = TUR: SM1 = TUR: TK = 5: GOTO TOGGLES
#   END IF
395 #   IF PB6 = PBP THEN SM5 = TUR: SM3 = TUN: SM2 = TUR: SM1 = TUN: TK = 6

      if {$OS1 != $OCC} {
          if {$PB1 == $PBP} {
              set SM4 $TUN; set SM5 $TUN; set TK 1
400          } elseif {$PB2 == $PBP} {
              set SM4 $TUR; set SM5 $TUN; set TK 2
          } elseif {$PB3 == $PBP} {

```

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```

        set SM5 $TUR; set SM3 $TUR; set TK 3
    } elseif {$PB4 == $PBP} {
405     set SM5 $TUR; set SM3 $TUN; set SM2 $TUN; set TK 4
    } elseif {$PB5 == $PBP} {
        set SM5 $TUR; set SM3 $TUN; set SM2 $TUR; set SM1 $TUR; set TK 5
    } elseif {$PB6 == $PBP} {
        set SM5 $TUR; set SM3 $TUN; set SM2 $TUR; set SM1 $TUN; set TK 6
410    }
    }
}

#
415 # REM**ALIGN TOGGLE CONTROLLED TURNOUTS IF OS SECTIONS ARE CLEAR
#TOGGLES:
#     IF OS2 = CLR THEN SM6 = TG6
#     IF OS3 = CLR THEN SM7 = TG7
#     IF OS4 = CLR THEN SM8 = TG8: SM9 = TG9
420 #     IF OS5 = CLR THEN SM10 = TG10
#     IF OS6 = CLR THEN SM11 = TG11

        if {$OS2 == $CLR} {set SM6 $TG6}
        if {$OS3 == $CLR} {set SM7 $TG7}
425     if {$OS4 == $CLR} {set SM8 $TG8; set SM9 $TG9}
        if {$OS5 == $CLR} {set SM10 $TG10}
        if {$OS6 == $CLR} {set SM11 $TG11}

#
430 # REM**WHEN AN OS SECTION BECOMES OCCUPIED AND OPPOSING DIRECTION-
# REM**OF-TRAFFIC IS NOT LOCKED-IN THEN SET DIRECTION-OF-TRAFFIC
# REM**FOR SECTION OF SINGLE TRACK TO DIRECTION OF MOVEMENT
#     IF OS1 = OCC AND DOT1 <> WBD THEN DOT1 = EBD
#     IF OS2 = OCC AND DOT1 <> EBD THEN DOT1 = WBD
435 #     IF OS3 = OCC AND DOT2 <> WBD THEN DOT2 = EBD
#     IF OS4 = OCC AND DOT2 <> EBD THEN DOT2 = WBD
#     IF OS5 = OCC AND DOT3 <> WBD THEN DOT3 = EBD
#     IF OS6 = OCC AND DOT3 <> EBD THEN DOT3 = WBD

440     if {$OS1 == $OCC && $DOT1 != $WBD} {set DOT1 $EBD}
        if {$OS2 == $OCC && $DOT1 != $EBD} {set DOT1 $WBD}
        if {$OS3 == $OCC && $DOT2 != $WBD} {set DOT2 $EBD}
        if {$OS4 == $OCC && $DOT2 != $EBD} {set DOT2 $WBD}
        if {$OS5 == $OCC && $DOT3 != $WBD} {set DOT3 $EBD}
445     if {$OS6 == $OCC && $DOT3 != $EBD} {set DOT3 $WBD}

# REM**RETAIN DIRECTION-OF-TRAFFIC WHILE SINGLE TRACK IS OCCUPIED

```

```

#DT1: IF OS1 = OCC THEN GOTO DT2
#      IF BK7 = OCC THEN GOTO DT2
450 #      IF BK8 = OCC THEN GOTO DT2
#      IF OS2 = OCC THEN GOTO DT2
#      DOT1 = NDT 'All trackage clear so set DOT1 to no direction-of-traffic

      if {$OS1 != $OCC &&
455         $BK7 != $OCC &&
         $BK8 != $OCC &&
         $OS2 != $OCC} {
      set DOT1 $NDT; #All trackage clear so set DOT1 to no direction-of-traffic
    }
460 #
#DT2: IF OS3 = OCC THEN GOTO DT3
#      IF BK11 = OCC THEN GOTO DT3
#      IF OS4 = OCC THEN GOTO DT3
465 #      DOT2 = NDT 'All trackage clear so set DOT2 to no direction-of-traffic

      if {$OS3 != $OCC &&
         $BK11 != $OCC &&
         $OS4 != $OCC} {
470         set DOT2 $NDT; #All trackage clear so set DOT2 to no direction-of-traffic
      }

#
#DT3: IF OS5 = OCC THEN GOTO DOTCMP
475 #      IF BK15 = OCC THEN GOTO DOTCMP
#      IF BK16 = OCC THEN GOTO DOTCMP
#      IF BK17 = OCC THEN GOTO DOTCMP
#      IF OS6 = OCC THEN GOTO DOTCMP
#      DOT1 = NDT 'All trackage clear so set DOT3 to no direction-of-traffic
480
      if {$OS5 != $OCC &&
         $BK15 != $OCC &&
         $BK16 != $OCC &&
         $BK17 != $OCC &&
485         $OS6 != $OCC} {
      set DOT3 $NDT; #All trackage clear so set DOT3 to no direction-of-traffic
    }

#DOTCMP:
490 #
# REM*****
# REM*****

```

5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES67

```

# REM**CALCULATE EASTBOUND SIGNALS**
# REM*****
495 # REM*****
#
# REM**Calculate SIG20RABC
#SIG20R:
# SIG20RABC = REDREDRED
500 # IF OS6 = OCC THEN GOTO SIG18R
# IF SM11 = TUN AND TF12 = TGR THEN SIG20RABC = REDREDYEL: GOTO SIG18R
# IF BK18 = OCC THEN GOTO SIG18R
# IF SM11 = TUN THEN SIG20RABC = YELREDRED ELSE SIG20RABC = REDYELRED

505 set SIG20RABC $REDREDRED
    if {$OS6 != $OCC} {
        if {$SM11 == $TUN && $TF12 == TGR} {
            set SIG20RABC $REDREDYEL
        } else {
510         if {$BK18 != $OCC} {
            if (SM11 == TUN) {
                set SIG20RABC $YELREDRED
            } else {
515                 set SIG20RABC $REDYELRED
            }
        }
    }
}

520 #
# REM**Calculate SIG18RA
#SIG18R:
# SIG18RA = RED
# IF DOT3 = WBD THEN GOTO SIG16R
525 # IF BK17 = OCC THEN GOTO SIG16R
# SIG18RA = YEL
# IF SIG20RABC = REDREDRED THEN GOTO SIG16R
# SIG18RA = GRN
#

530 set SIG18RA $RED
    if {$DOT3 != $WBD && $BK17 != $OCC} {
        set SIG18RA $YEL
        if {$SIG20RABC != $REDREDRED} {set SIG18RA $GRN}
535    }

```

```

# REM**Calculate SIG16RA
#SIG16R:
540 # SIG16RA = RED
# IF DOT3 = WBD THEN GOTO SIG14R
# IF BK16 = OCC THEN GOTO SIG14R
# SIG16RA = YEL
# IF SIG18R = RED THEN GOTO SIG14R
545 # SIG16RA = GRN

      set SIG16RA $RED
      if {$DOT3 != $WBD && $BK16 != $OCC} {
        set SIG16RA $YEL
550      if {$SIG18RA != $RED} {set SIG16RA $GRN}
      }

#
# REM**Calculate SIG14RA and SIG14RC
555 #SIG14R:
# SIG14RA = RED: SIG14RC = RED
# IF DOT3 = WBD THEN GOTO SIG12R
# IF OS5 = OCC THEN GOTO SIG12R
# IF BK15 = OCC THEN GOTO SIG12R
560 # SIG14R = YEL
# IF SIG16RA = RED THEN GOTO SIG12R
# SIG14R = GRN
# IF SM10 = TUN THEN SIG14RA = SIG14R ELSE SIG14RC = SIG14R

565      set SIG14RA $RED; set SIG14RC $RED
      if {$DOT3 != $WBD &&
        $OS5 != $OCC &&
        $BK15 != $OCC} {
        set SIG14R $YEL
570      if {$SIG16RA != $RED} {set SIG14R $GRN}
        if {$SM10 == $TUN} {set SIG14RA $SIG14R} else {set SIG14RC $SIG14R}
      }

#
575 # REM**Calculate SIG12RABC
#SIG12R:
# SIG12RABC = REDREDRED
# IF OS4 = OCC THEN GOTO SIG8R
# IF SM8 = TUR THEN GOTO SM8REV
580 # IF BK13 = OCC THEN GOTO SIG8R
# SIG12RABC = YELREDRED
# IF SIG14RA = RED THEN GOTO SIG8R

```


5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES69

```

#      SIG12RABC = GRNREDRED: GOTO SIG8R
#SM8REV:
585 #      IF SM9 = TUR THEN SIG12RABC = REDREDYEL: GOTO SIG8R
#      IF BK14 = OCC THEN GOTO SIG8R
#      SIG12RABC = REDYELRED

590      set SIG12RABC $REDREDRED
      if {$OS4 != $OCC} {
        if {$SM8 != $TUR} {
          if {$BK13 != $OCC} {
            set SIG12RABC $YELREDRED
595          if {$SIG14RA != $RED} {set SIG12RABC $GRNREDRED}
          }
        } else {
          # SM8REV:
          if {$SM9 == $TUR} {
600          set SIG12RABC $REDREDYEL
          } elseif {$BK14 != $OCC} {
            set SIG12RABC $REDYELRED
          }
        }
      }
605  }

#
# REM**Calculate SIG8RA and SIG8RC
610 #SIG8R:
#      SIG8RA = RED: SIG8RC = RED
#      IF DOT2 = WBD THEN GOTO SIG6R
#      IF OS3 = OCC THEN GOTO SIG6R
#      IF BK11 = OCC THEN GOTO SIG6R
615 #      SIG8R = YEL
#      IF SIG12RABC = REDREDRED THEN GOTO SIG6R
#      SIG8R = GRN
#      IF SM7 = TUN THEN SIG8RA = SIG8R ELSE SIG8RC = SIG8R

620      set SIG8RA $RED; set SIG8RC $RED
      if {$DOT2 != $WBD && $OS3 != $OCC && $BK11 != $OCC} {
        set SIG8R $YEL
        if {$SIG12RABC != $REDREDRED} {set SIG8R $GRN}
        if (SM7 == TUN) {set SIG8RA $SIG8R} else {set SIG8RC $SIG8R}
625  }

```

```

#
# REM**Calculate SIG6RAB
630 #SIG6R:
#   SIG6RAB = REDRED
#   IF OS2 = OCC THEN GOTO SIG4R
#   IF SM6 = TUR THEN GOTO SM6REV
#   IF BK9 = OCC THEN GOTO SIG4R
635 #   SIG6RAB = YELRED
#   IF SIG8RA = RED THEN GOTO SIG4R
#   SIG6RAB = GRNRED: GOTO SIG4R
#
#SM6REV:
640 #   IF BK10 = OCC THEN GOTO SIG4R
#   SIG6RAB = REDYEL

      set SIG6RAB $REDRED
      if {$OS2 != $OCC} {
645         if {$SM6 != $TUR} {
            if {$BK9 != $OCC} {
                set SIG6RAB $YELRED
                if {$SIG8RA != $RED} {set SIG6RAB $GRNRED}
            }
650         } else {
            # SM6REV:
            if {$BK10 != $OCC} {set SIG6RAB $REDYEL}
        }
      }
655
#
# REM**Calculate SIG4RA
#SIG4R:
#   SIG4RA = RED
660 #   IF DOT1 = WBD THEN GOTO SIG2R
#   IF BK8 = OCC THEN GOTO SIG2R
#   SIG4RA = YEL
#   IF SIG6RAB = REDRED THEN GOTO SIG2R
#   SIG4RA = GRN
665
      set SIG4RA $RED
      if {$DOT1 != $WBD && $BK8 != $OCC} {
          set SIG4RA $YEL
          if {$SIG6RAB != $REDRED} {set SIG4RA $GRN}
670      }

#

```

5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES71

```

# REM**Calculate Red Butte exit signals
# REM**Initialize all exit signals to RED
675 #SIG2R:
#     set SIG2RA $RED; SIG2RB = RED; SIG2RC = RED
#     SIG2RD = RED; SIG2RE = RED; SIG2RF = RED
#
# REM**Calculate exit signal value for aligned track
680 #     EXITSIG = RED
#     IF DOT1 = WBD THEN GOTO SIGECMP
#     IF OS1 = OCC THEN GOTO SIGECMP
#     IF BK7 = OCC THEN GOTO SIGECMP
#     EXITSIG = YEL
685 #     IF SIG4RA = RED THEN GOTO EXSIG
#     EXITSIG = GRN
#
# REM**Set track aligned exit signal to calculated signal value
#EXSIG:
690 #     IF TK = 1 THEN SIG2RA = EXITSIG
#     IF TK = 2 THEN SIG2RB = EXITSIG
#     IF TK = 3 THEN SIG2RC = EXITSIG
#     IF TK = 4 THEN SIG2RD = EXITSIG
#     IF TK = 5 THEN SIG2RE = EXITSIG
695 #     IF TK = 6 THEN SIG2RF = EXITSIG
#SIGECMP:

    set SIG2RA $RED; set SIG2RB $RED; set SIG2RC $RED
    set SIG2RD $RED; set SIG2RE $RED; set SIG2RF $RED
700    set EXITSIG $RED
    if {$DOT1 != $WBD && $OS1 != $OCC && $BK7 != $OCC} {
        set EXITSIG $YEL
        if {$SIG4RA != $RED} {set EXITSIG $GRN}
    }
705    switch $TK {
        1 {set SIG2RA $EXITSIG}
        2 {set SIG2RB $EXITSIG}
        3 {set SIG2RC $EXITSIG}
        4 {set SIG2RD $EXITSIG}
710        5 {set SIG2RE $EXITSIG}
        6 {set SIG2RF $EXITSIG}
    }

#
715 # REM*****
# REM*****
# REM**CALCULATE WESTBOUND SIGNALS**

```

```

# REM*****
# REM*****
720 #
# REM**Calculate SIG2LAB (entrance signal into staging)
#SIG2L:
# SIG2LAB = REDRED
# IF OS1 = OCC THEN GOTO SIG4L
725 # IF TK = 1 AND BK1 = CLR THEN SIG2LAB = YELRED: GOTO SIG4L
# IF TK = 2 AND BK2 = CLR THEN SIG2LAB = REDYEL: GOTO SIG4L
# IF TK = 3 AND BK3 = CLR THEN SIG2LAB = REDYEL: GOTO SIG4L
# IF TK = 4 AND BK4 = CLR THEN SIG2LAB = REDYEL: GOTO SIG4L
# IF TK = 5 AND BK5 = CLR THEN SIG2LAB = REDYEL: GOTO SIG4L
730 # IF TK = 6 AND BK6 = CLR THEN SIG2LAB = REDYEL

      set SIG2LAB $REDRED
      if {$OS1 != $OCC} {
        if {$TK == $1 && $BK1 == $CLR} {
735          set SIG2LAB $YELRED
        } elseif {$TK == $2 && $BK2 == $CLR} {
          set SIG2LAB $REDYEL
        } elseif {$TK == $3 && $BK3 == $CLR} {
          set SIG2LAB $REDYEL
740        } elseif {$TK == $4 && $BK4 == $CLR} {
          set SIG2LAB $REDYEL
        } elseif {$TK == $5 && $BK5 == $CLR} {
          set SIG2LAB $REDYEL
        } elseif {$TK == $6 && $BK6 == $CLR} {
745          set SIG2LAB $REDYEL
        }
      }
}

#
750 # REM**Calculate SIG4LA
#SIG4L:
# SIG4LA = RED
# IF DOT1 = EBD THEN GOTO SIG6L
# IF BK7 = OCC THEN GOTO SIG6L
755 # SIG4LA = YEL
# IF SIG2LAB = REDRED THEN GOTO SIG6L
# SIG4LA = GRN

      set SIG4LA $RED
760      if {$DOT1 != $EBD && $BK7 != $OCC} {
        set SIG4LA $YEL
        if {$SIG2LAB != $REDRED} {set SIG4LA $GRN}
      }

```

5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES73

```

    }

765 #
    # REM**Calculate SIG6LA and SIG6LC
    #SIG6L:
    #     SIG6LA = RED: SIG6LC = RED
    #     IF DOT1 = EBD THEN GOTO SIG8L
770 #     IF OS2 = OCC THEN GOTO SIG8L
    #     IF BK8 = OCC THEN GOTO SIG8L
    #     SIG6L = YEL
    #     IF SIG4LA = RED THEN GOTO SIG8L
    #     SIG6L = GRN
775 #     IF SM6 = TUN THEN SIG6LA = SIG6L ELSE SIG6LC = SIG6L
    #

    set SIG6LA $RED; set SIG6LC $RED
    if {$DOT1 != $EBD && $OS2 != $OCC && $BK8 != $OCC} {
780     set SIG6L $YEL
        if {$SIG4LA != $RED} {set SIG6L $GRN}
        if {$SM6 == $TUN} {set SIG6LA $SIG6L} else {set SIG6LC $SIG6L}
    }

785 # REM**Calculate SIG8LAB
    #SIG8L:
    #     SIG8LAB = REDRED
    #     IF OS3 = OCC THEN GOTO SIG12L
790 #     IF SM7 = TUR THEN GOTO SM7REV
    #     IF BK9 = OCC THEN GOTO SIG12L
    #     SIG8LAB = YELRED
    #     IF SIG6LA = RED THEN GOTO SIG12L
    #     SIG8LAB = GRNRED: GOTO SIG12L
795 #SM7REV:
    #     IF BK10 = OCC THEN GOTO SIG12L
    #     SIG8LAB = REDYEL

    set SIG8LAB $REDRED
800     if {$OS3 != $OCC} {
        if {$SM7 != $TUR} {
            if {$BK9 != $OCC} {
                set SIG8LAB $YELRED
                if {$SIG6LA != $RED} {set SIG8LAB $GRNRED}
805            }
        } else {
            # SM7REV:

```

```

      if {$BK10 != $OCC} {set SIG8LAB $REDYEL}
    }
810  }

#
# REM**Calculate SIG12LA, SIG12LC and SIG12LD
#SIG12L:
815  # SIG12LA = RED: SIG12LC = RED: SIG12LD = RED
# IF DOT2 = EBD THEN GOTO SIG14L
# IF OS4 = OCC THEN GOTO SIG14L
# IF BK11 = OCC THEN GOTO SIG14L
# SIG12L = YEL
820  # IF SIG8LAB = REDRED THEN GOTO SIG14L
# SIG12L = GRN
# IF SM8 = TUN THEN SIG12LA = SIG12L: GOTO SIG14L
# IF SM9 = TUN THEN SIG12LC = SIG12L ELSE SIG12LD = SIG12L

825  set SIG12LA $RED; set SIG12LC $RED; set SIG12LD $RED
    if {$DOT2 != $EBD && $OS4 != $OCC && $BK11 != $OCC} {
      set SIG12L $YEL
      if {$SIG8LAB != $REDRED} {set SIG12L $GRN}
      if {$SM8 == $TUN} {
830        set SIG12LA $SIG12L
      } elseif {$SM9 == $TUN} {
        set SIG12LC $SIG12L
      } else {
        set SIG12LD $SIG12L
835      }
    }
  }

#
840  # REM**Calculate SIG14LAB
#SIG14L:
# SIG14LAB = REDRED
# IF OS5 = OCC THEN GOTO SIG16L
# IF SM10 = TUR THEN GOTO SM10REV
845  # IF BK13 = OCC THEN GOTO SIG16L
# SIG14LAB = YELRED
# IF SIG12LA = RED THEN GOTO SIG16L
# SIG14LAB = GRNRED: GOTO SIG16L
#SM10REV:
850  # IF BK14 = OCC THEN GOTO SIG16L
# SIG14LAB = REDYEL

```

5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES75

```

      set SIG14LAB $REDRED
      if {$OS5 != $OCC} {
855         if {$SM10 != $TUR} {
            if {$BK13 != $OCC} {
                set SIG14LAB $YELRED
                if {$SIG12LA != $RED} {set SIG14LAB $GRNRED}
            }
860         } else {
            # SM10REV
            if {$BK14 != $OCC} {set SIG14LAB $REDYEL}
        }
    }
865
#
# REM**Calculate SIG16LA
#SIG16L:
# SIG16LA = RED
870 # IF DOT3 = EBD THEN GOTO SIG18L
# IF BK15 = OCC THEN GOTO SIG18L
# SIG16LA = YEL
# IF SIG14LAB = REDRED THEN GOTO SIG18L
# SIG16LA = GRN
875
      set SIG16LA $RED
      if {$DOT3 != $EBD && $BK15 != $OCC} {
          set SIG16LA $YEL
          if {$SIG14LAB != $REDRED} {set SIG16LA $GRN}
880      }

#
# REM**Calculate SIG18LA
#SIG18L:
885 # SIG18LA = RED
# IF DOT3 = EBD THEN GOTO SIG20L
# IF BK16 = OCC THEN GOTO SIG20L
# SIG18LA = YEL
# IF SIG16LA = RED THEN GOTO SIG20L
890 # SIG18LA = GRN

      set SIG18LA $RED
      if {$DOT3 != $EBD && $BK16 != $OCC} {
          set SIG18LA $YEL
895         if {$SIG16LA != $RED} {set SIG18LA $GRN}
      }

```

```

#
# REM**Calculate SIG20LA, SIG20LB and SIG20LD
900 #SIG20L:
#   SIG20LA = RED: SIG20LB = RED: SIG20LD = RED
#   IF DOT3 = EBD THEN GOTO SIGWCMP
#   IF OS6 = OCC THEN GOTO SIGWCMP
#   IF BK17 = OCC THEN GOTO SIGWCMP
905 #   SIG20L = YEL
#   IF SIG18LA <> RED THEN SIG20L = GRN
#   IF SM11 = TUR THEN SIG20LB = SIG20L: GOTO SIGWCMP
#   IF TF12 = TGR THEN SIG20LD = SIG20L ELSE SIG20LA = SIG20L
#SIGWCMP:
910
#   set SIG20LA $RED; set SIG20LB $RED; set SIG20LD $RED
#   if {$DOT3 != $EBD && $OS6 != $OCC && $BK17 != $OCC} {
#       set SIG20L $YEL
#       if {$SIG18LA != $RED} {set SIG20L $GRN}
915 #       if {$SM11 == $TUR} {
#           set SIG20LB $SIG20L
#       } elseif {$TF12 == $TGR} {
#           set SIG20LD $SIG20L
#       } else {
920 #       set SIG20LA $SIG20L
#       }
#   }
#
# REM**PACK AND WRITE OUTPUT BYTES FOR NODE 0 (SMINI)
925 #   OB(1) = SIG2LAB           'NODE 0 CARD 0 PORT A
#   OB(1) = SIG2RA * B5 OR OB(1)

#       set Outputs [expr {$SIG2LAB | $SIG2RA << $B5}];
#NODE 0 CARD 0 PORT A

930 #
#   OB(2) = SIG2RB           'NODE 0 CARD 0 PORT B
#   OB(2) = SIG2RC * B3 OR OB(2)
#   OB(2) = SM1 * B6 OR OB(2)

935 #       lappend Outputs [expr {$SIG2RB | \
#                               $SIG2RC << $B3 | \
#                               $SM1 << $B6}];           #NODE 0 CARD 0 PORT B
#
#   OB(3) = SIG2RD           'NODE 0 CARD 0 PORT C
940 #   OB(3) = SIG2RE * B3 OR OB(3)
#   OB(3) = SM2 * B6 OR OB(3)

```


5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES77

```

    lappend Outputs [expr {$SIG2RD | \
                                $SIG2RE << $B3 | \
                                $SM2 << $B6}];          #NODE 0 CARD 0 PORT C
945 #
#   OB(4) = SIG2RF                                     'NODE 0 CARD 1 PORT A
#   OB(4) = SM3 * B3 OR OB(4)
#   OB(4) = SM4 * B5 OR OB(4)
950
    lappend Outputs [expr {$SIG2RF | \
                                $SM3 << $B3 | \
                                $SM4 << $B5}];          #NODE 0 CARD 1 PORT A
#
955 #   OB(5) = SM5                                     'NODE 0 CARD 1 PORT B

    lappend Outputs $SM5;#
NODE 0 CARD 1 PORT B

#   UA = 0: NO = 6
960 #   CALL OUTPUTS

    set UA 0
    if {[catch {bus Outputs $Outputs $UA} result]} {
        # Handle error.
965         puts -nonewline stderr "Could not write to the output ports of"
        puts stderr "SMINI card at UA:$UA: $result"
        break
    }

970

#
# REM**PACK AND WRITE OUTPUT BYTES FOR NODE 1 (SMINI)
#   OB(1) = SIG4LA                                     'NODE 1 CARD 0 PORT A
975 #   OB(1) = SIG4RA *B3 OR OB(1)
#   OB(1) = SM6 * B6 OR OB(1)

    set Outputs [expr {$SIG4LA | \
                                $SIG4RA << $B3 | \
                                $SM6 << $B6}];          #NODE 1 CARD 0 PORT A
980

#
#   OB(2) = SIG6RAB                                     'NODE 1 CARD 0 PORT B
#   OB(2) = SIG6LA * B5 OR OB(2)
985
```

```

#          lappend Outputs [expr {$SIG6RAB | \
#                               $SIG6LA << $B5}];          #NODE 1 CARD 0 PORT B
#
#          OB(3) = SIG6LC          'NODE 1 CARD 0 PORT C
990 #          OB(3) = SIG8RA * B3 OR OB(3)
#          OB(3) = SM7 * B6 OR OB(3)
#
#          lappend Outputs [expr {$SIG6LC | \
#                               $SIG8RA << $B3 | \
#                               $SM7      << $B6}];          #NODE 1 CARD 0 PORT B
#
#          OB(4) = SIG8LAB          'NODE 1 CARD 1 PORT A
#          OB(4) = SIG8RC * B5 OR OB(4)
1000 #          lappend Outputs [expr {$SIG8LAB | \
#                               $SIG8RC << $B5}];          #NODE 1 CARD 1 PORT A
#          UA = 1: NO = 6
#          CALL OUTPUTS
1005 #          set UA 1
#          if {[catch {bus Outputs $Outputs $UA} result]} {
#              # Handle error.
#              puts -nonewline stderr "Could not write to the output ports of "
#              puts stderr "SMINI card at UA:$UA: $result"
1010 #              break
#          }
#
1015 #          REM**PACK AND WRITE OUTPUT BYTES FOR NODE 2 (SMINI)
#          OB(1) = SIG12RABC          'NODE 2 CARD 0 PORT A
#
#          set Outputs $SIG12RABC;          #NODE 2 CARD 0 PORT A
1020 #
#          OB(2) = SIG12LA          'NODE 2 CARD 0 PORT B
#          OB(2) = SIG12LC * B3 OR OB(2)
#          OB(2) = SM8 * B6 OR OB(2)
1025 #
#          lappend Outputs [expr {$SIG12LA | \
#                               $SIG12LC << $B3 | \
#                               $SM8      << $B6}];          #NODE 2 CARD 0 PORT B
#
1030 #          OB(3) = SIG12LD          'NODE 2 CARD 0 PORT C

```

5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES79

```

#      OB(3) = SIG14RA * B3 OR OB(3)
#      OB(3) = SM9 * B6 OR OB(3)

1035      lappend Outputs [expr {$SIG12LD | \
                                $SIG14RA << $B3 | \
                                $SM9      << $B6}];      #NODE 2 CARD 0 PORT C
#
#      OB(4) = SIG14LAB      'NODE 2 CARD 1 PORT A
#      OB(4) = SIG14RC * B5 OR OB(4)
1040
#      lappend Outputs [expr {$SIG14LAB | \
                                $SIG14RC << $B5}];      #NODE 2 CARD 1 PORT A
#
#      OB(5) = SIG16LA      'NODE 2 CARD 1 PORT B
1045 #      OB(5) = SIG16RA * B3 OR OB(5)
#      OB(5) = SM10 * B6 OR OB(5)

#      lappend Outputs [expr {$SIG16LA | \
                                $SIG16RA << $B3 | \
                                $SM10      << $B6}];      #NODE 2 CARD 1 PORT B
1050
#      UA = 2: NO = 6
#      CALL OUTPUTS

#      set UA 2
1055      if {[catch {bus Outputs $Outputs $UA} result]} {
#      Handle error.
#      puts -nonewline stderr "Could not write to the output ports of_"
#      puts stderr "SMINI card at UA_$UA:_$result"
#      break
1060      }

#
#      REM**PACK AND WRITE OUTPUT BYTES FOR NODE 3 (SMINI)
#      OB(1) = SIG18LA      'NODE 3 CARD 0 PORT A
1065 #      OB(1) = SIG18RA * B3 OR OB(1)
#      OB(1) = SM11 * B6 OR OB(1)

#      set Outputs [expr {$SIG18LA | \
                                $SIG18RA << $B3 | \
                                $SM11      << $B6}];      #NODE 3 CARD 0 PORT A
1070
#
#      OB(2) = SIG20RABC      'NODE 3 CARD 0 PORT B
1075      lappend Outputs $SIG20RABC;      #NODE 3 CARD 0 PORT B

```

```

#
# OB(3) = SIG20LA
# OB(3) = SIG20LB * B3 OR OB(3)      'NODE 3 CARD 0 PORT C

1080      lappend Outputs [expr {$SIG20LA | \
                                SIG20LB << $B3}];      #NODE 3 CARD 0 PORT C

#
# OB(4) = SIG20LD      'NODE 3 CARD 1 PORT A

1085      lappend Outputs $SIG20LD;      #NODE 3 CARD 1 PORT A
# UA = 3: NO = 6
# CALL OUTPUTS

      set UA 3
1090      if {[catch {bus Outputs $Outputs $UA} result]} {
          # Handle error.
          puts -nonewline stderr "Could not write to the output ports of"
          puts stderr "SMINI card at UA:$UA:$result"
          break
1095      }

#
# REM**PACK AND WRITE OUTPUT BYTES FOR NODE 4 (SUSIC)
# OB(1) = DOT1      'NODE 4 CARD 0 PORT A
# OB(1) = DOT2 * B2 OR OB(1)
1100 # OB(1) = DOT3 * B4 OR OB(1)
# OB(1) = BK1 * B6 OR OB(1)
# OB(1) = BK2 * B7 OR OB(1)

      set Outputs [expr {$DOT1 | \
1105      $DOT2 << $B2 | \
      $DOT3 << $B4 | \
      $BK1 << $B6 | \
      $BK2 << $B7}];      #NODE 4 CARD 0 PORT A

1110 #
# OB(2) = BK3 * B0 OR OB(2)      'NODE 4 CARD 0 PORT B
# OB(2) = BK4 * B1 OR OB(2)
# OB(2) = BK5 * B2 OR OB(2)
# OB(2) = BK6 * B3 OR OB(2)
1115 # OB(2) = OS1 * B4 OR OB(2)
# OB(2) = BK7 * B5 OR OB(2)
# OB(2) = BK8 * B6 OR OB(2)
# OB(2) = OS2 * B7 OR OB(2)

1120      lappend Outputs [expr {$BK3 | \

```

5.4. TRANSLATIONS FROM THE C/MRI USER'S MANUAL V3.0 EXAMPLES81

```

1125      $BK4 << $B1 | \
      $BK5 << $B2 | \
      $BK6 << $B3 | \
      $OS1 << $B4 | \
      $BK7 << $B5 | \
      $BK8 << $B6 | \
      $OS2 << $B7}]; #NODE 4 CARD 0 PORT B

#
#      OB(3) = BK9 * B0 OR OB(3)      'NODE 4 CARD 0 PORT C
1130 #      OB(3) = BK10 * B1 OR OB(3)
#      OB(3) = OS3 * B2 OR OB(3)
#      OB(3) = BK11 * B3 OR OB(3)
#      OB(3) = OS4 * B4 OR OB(3)
#      OB(3) = BK13 * B5 OR OB(3)
1135 #      OB(3) = BK14 * B6 OR OB(3)
#      OB(4) = OS5 * B7 OR OB(4)

      lappend Outputs [expr {$BK9 | \
1140      $BK10 << $B1 | \
      $OS3 << $B2 | \
      $BK11 << $B3 | \
      $OS4 << $B4 | \
      $BK13 << $B5 | \
      $BK14 << $B6 | \
1145      $OS5 << $B7}]; #NODE 4 CARD 0 PORT C

#
#      OB(4) = BK15 * B0 OR OB(4)      'NODE 4 CARD 0 PORT D
#      OB(4) = BK16 * B1 OR OB(4)
#      OB(4) = BK17 * B2 OR OB(4)
1150 #      OB(4) = OS6 * B3 OR OB(4)
#      OB(4) = BK18 * B4 OR OB(4)

      lappend Outputs [expr {$BK15 | \
1155      $BK16 << $B1 | \
      $BK17 << $B2 | \
      $OS6 << $B3 | \
      $BK18 << $B4}]; #NODE 4 CARD 0 PORT D

#      UA = 4: NO = 4
#      CALL OUTPUTS
1160      set UA 4
      if {[catch {bus Outputs $Outputs $UA} result]} {
        # Handle error.
        puts -nonewline stderr "Could not write to the output ports of"
1165        puts stderr "SUISC card at UA:$UA: $result"

```

```

                                break
                                }
#
#  REM**RETURN TO BEGINNING OF REAL-TIME LOOP
1170 #  GOTO BRTL

}
```

Chapter 6

XPressNet Programming

Chapter 7

Creating Splash Windows

Splash windows are windows that are displayed during program startup and generally feature a company or program logo, some introductory text and a progress meter and status text area describing the program startup and initialization progress.

7.1 Creating a Splash Window

Listing 7.1: Snit spash widget creation

```
spash widgetpath [ options... ]
```

The splash widget is implemented as a Snit widget type and are created with the spash procedure. This widget takes eight options:

- troughcolor** The color to use for the progressbar's trough.
- titleforeground** The foreground color for the title text area.
- statusforeground** The foreground color for the status text area.
- background** The overall background color.
- progressbar** Whether or not to include a progress bar.
- image** The image to display as the main feature of the spash screen (typically a company logo or product image).
- icon** A small image to display next to the title text.

-title Text to display above the main splash image.

The splash widget defines four public methods:

update This method takes two arguments, `statusMessage` `percentDone`, which supply the text for the status message and the percent of the startup that has completed. If the completion done percentage is 100, the splash screen’s “click to destroy” function is enabled.

enableClickDestroy This method enables the splash screen’s “click to destroy” function.

hide This method hides (withdraws) the splash window.

show This method shows (unwithdraws) the splash window.

7.2 Typical usage

Listing 7.2: Typical usage

```

image create photo DeepwoodsBanner -format gif \
    -file [file join $CommonImageDir DeepwoodsBanner.gif]
# Deepwoods banner image. Used in the splash screen.
# [index] DeepwoodsBanner!image
5
proc SplashScreen {} {
    # Build the ‘‘Splash Screen’’ — A popup window that
    # tells the user what we are all about. It gives the
    # version and brief copyright information.
10    #
    # The upper part of the splash screen gives the brief
    # information, with directions on how to get detailed
    # information. The lower part contains an image banner
    # for Deepwoods Software.
15    # [index] SplashScreen!procedure

    splash .mrrSplash \
        -title {Sample Code Program — sample code for
        Programming Guide, Copyright (C) 2005 Robert Heller D/B/A
20    Deepwoods Software Model Railroad Timetable Chart Program
        comes with ABSOLUTELY NO WARRANTY; for details select
        ‘Warranty...’ under the Help menu. This is free software,
```

```

and you are welcome to redistribute it under certain
conditions; select 'Copying...' under the Help menu.} \
25     -image DeepwoodsBanner -background {#2ba2bf} \
        -titleforeground white -statusforeground {black}
    }

    proc SplashWorkMessage {message percent} {
30     .mrrSplash update "$message" $percent
        update idle
    }

    wm withdraw .;# Withdraw the main window.
35     SplashScreen;# Create the splash screen.
        update idle;# Flush pending idle events.

    catch {SplashWorkMessage {Creating Main Window} 11}

40     # Create the main window...

    catch {SplashWorkMessage {Create CTC Panel} 22}

    # Create the CTC Panel...
45     catch {SplashWorkMessage {Create Configuration} 33}

    # Create the Configuration...

50     catch {SplashWorkMessage {Done} 100}

```

Listing 7.2 shows how a splash window is typically created and updated. The procedure in lines 6-28 creates the splash window and the procedure in lines 29-32 updates the status text area and progress bar. After withdrawing the main window, the splash window is created and drawn (lines 34-36). As progress is made during program startup, the splash window is updated (lines 38, 42, 46, and 50). When the percent completed is set to 100, the splash window can be removed when the user left-clicks anywhere on it. The splash window this code creates is shown in Figure 7.1.



Figure 7.1: Sample Splash Screen

Chapter 8

Creating Main Windows

To aid in creating standardized main windows with some common “trimmings”, the Model Railroad System includes a package that enhances and extends the BWidget MainWindow widget. The enhanced main window widget is a Snit widget adaptor that adds a BWidget ScrolledWindow, an enhanced PanedWindow, a ButtonBox, and “slideouts”¹ to the body of the BWidget MainWindow. Along with the enhanced main window, there is also code available for a standardized menu bar².

8.1 What is in an enhanced Main Window?

An enhanced Main Window is a BWidget MainWindow, with an enhanced PanedWindow, with a ScrolledWindow on the left and a vertical ButtonBox on the right, with zero or more optional “slideouts” to the right of the vertical ButtonBox. The ScrolledWindow can contain any scrollable widget, such as a text window (for log output), a canvas (for graphical output), a ListBox or Tree widget, or a ScrolledFrame. The vertical ButtonBox can be used for a vertical collection of command buttons.

8.1.1 Slideouts

Slideouts are additional frames that can be “slid” out (exposed to the right) as needed and then slid back in (withdraw from view) when no longer needed. Useful

¹See Section 8.1.1 for more information about slideouts.

²See Section 8.1.2 for more information about the standardized menu bar.

for GUI elements that don't need to be displayed all of the time. Any number of these slideouts can be created and any subset of them can be displayed at any time.

8.1.2 Standard Menu Bars

The BWStdMenuBar package defines code for a standardized menu bar containing a File, Edit, View, Options, and Help drop down menus. The File, Edit, and Help menus are populated with standard menu items.

8.2 Creating a typical Main Window

Listing 8.1: Creating a Main Window

```

**
**

4  package require Tk
   package require snit
   package require snitStdMenuBar;#           Standard Menu Bar
   package require HTMLHelp 2.0;#           Help package
   package require MainWindow;#             Main Window package
9
   namespace eval SampleCode {}

   proc SampleCode::SampleCodeMain {} {

14   wm protocol . WM_DELETE_WINDOW {SampleCode::CarefulExit}
      wm title . "Sample_Code"

      variable Main;#           Main window
      variable MainWindow;#     Main display area
19   variable CanvasWindow;#     Canvas window

      # Create the main window
      pack [set Main [mainwindow .main -dontwithdraw no]] \
          -expand yes -fill both
24   # Create and show a toolbar --
      #   this toolbar will mirror the File menu
      $Main toolbar add tools
      $Main toolbar show tools
      # Disable the unused File menu items
29   $Main menu entryconfigure file New -state disabled

```

```

$Main menu entryconfigure file Open... -state disabled
$Main menu entryconfigure file Save -state disabled
$Main menu entryconfigure file {Save As...} -state disabled
$Main menu entryconfigure file Print... -state disabled
34 # Bind Close and Exit menu items to the exit function
# and create an exit button.
$Main menu entryconfigure file Close -command SampleCode::CarefulExit
$Main menu entryconfigure file Exit -command SampleCode::CarefulExit
$Main toolbar addbutton tools close -image CloseButtonImage \
39 -command SampleCode::CarefulExit
set MainWindow [$Main scrollwindow getframe]
# Create a canvas window
set CanvasWindow [canvas $MainWindow.canvas -background white]
$Main scrollwindow setwidget $CanvasWindow
44 # Add a 'slideout'
variable Slideout [$Main slideout add sampleslide]
# Add some buttons to the Button box
$Main buttons add ttk::button showslide \
- text "Show_Slideout" \
49 -command "$Main_slideout_show_sampleslide"
$Main buttons add ttk::button hideslide \
- text "Hide_Slideout" \
-command "$Main_slideout_hide_sampleslide"
$Main buttons add ttk::button testB1 \
54 - text "Test_Button_1" \
- command {tk_messageBox -type ok \
- icon info \
- message "Testing"}

59 $Main menu delete help "On_Keys..."
$Main menu delete help "Index..."
$Main menu add help command \
- label "Reference_Manual" \
- command "HTMLHelp_help_{Sample_Reference}"
64 $Main menu entryconfigure help "On_Help..." \
- command "HTMLHelp_help_Help"
$Main menu entryconfigure help "Tutorial..." \
- command "HTMLHelp_help_{Sample_Tutorial}"
$Main menu entryconfigure help "On_Version" \
69 - command "HTMLHelp_help_Version"
$Main menu entryconfigure help "Copying" \
- command "HTMLHelp_help_Copying"
$Main menu entryconfigure help "Warranty" \
- command "HTMLHelp_help_Warranty"
74

```

```

HTMLHelp setDefaults "$::HelpDir" "index.html#toc"
79 }

proc SampleCode::CarefulExit {{ask 1}} {
    if {$ask} {
        set ans [tk_messageBox -type yesno -icon question -message {Really Exit?}]
84    } else {
        set ans 1
    }
    if {!$ans} {return}
    exit
89 }

package provide SampleCodeMain 1.0

```

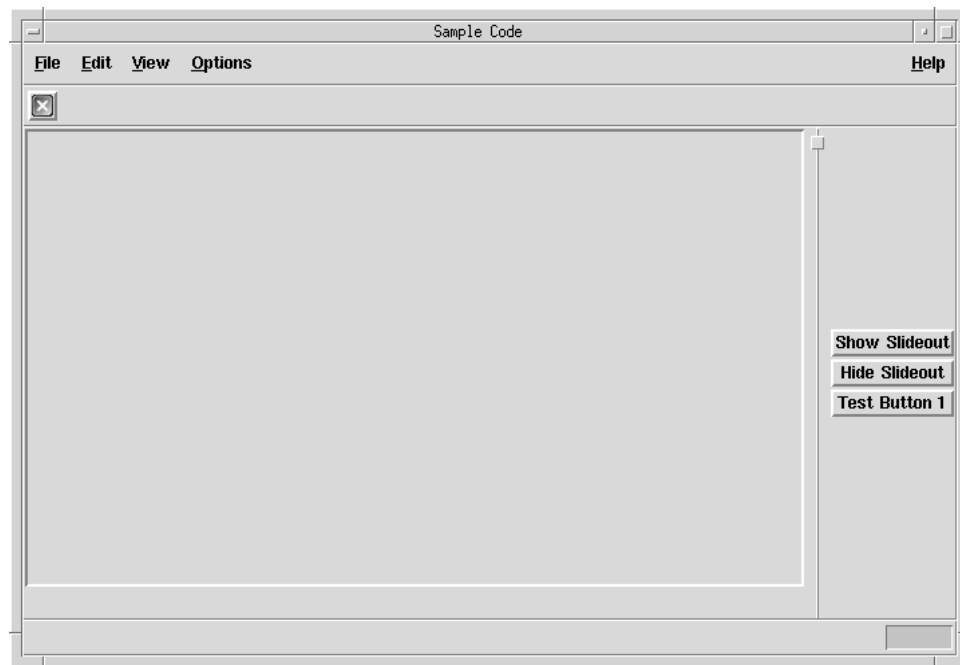


Figure 8.1: Sample Main Window, slideout hidden

Listing 8.1 contains code to create a basic Main Window with a canvas window,

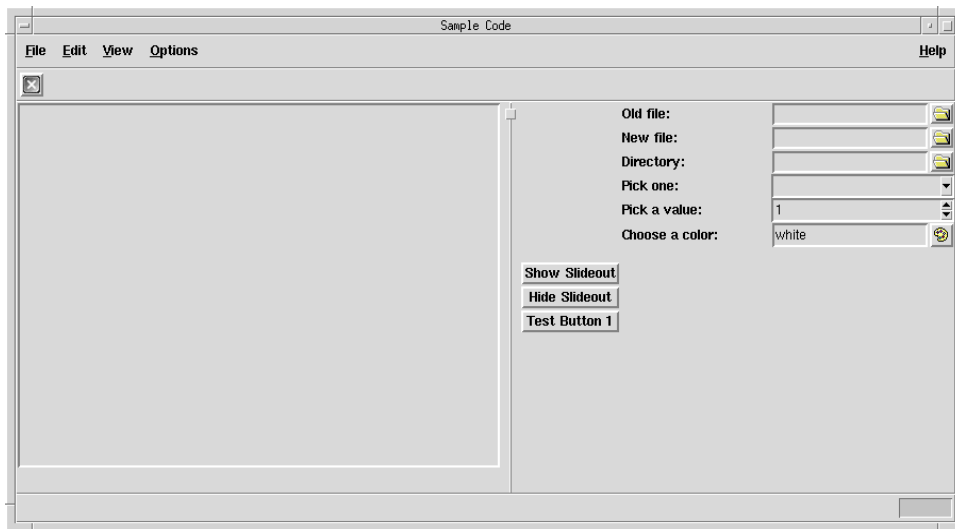


Figure 8.2: Sample Main Window, slideout shown

simple set of command buttons, and a slideout³. The window this code creates is shown in Figures 8.1 and 8.2.

³See Chapter 9 for the code used to populate the slideout.

Chapter 9

An Assortment of LabelFrame Based Widgets.

Included with the Model Railroad system are four packages that define a collection of BWidget LabelFrame based widgets. These widgets are much like the BWidget LabelEntry widget, except that instead of a plain Entry widget, they have other, more specialized widgets.

The four packages are:

1. BWFileEntry defines the FileEntry widget, which is meant to enter file and directory names.
2. BWLabelComboBox defines the LabelComboBox widget, which has a ComboBox widget instead of an Entry widget.
3. BWLabelSpinBox defines the LabelSpinBox widget, which has a SpinBox widget instead of an Entry widget.
4. LabelSelectColor defines the LabelSelectColor widget, which is meant to select a color.

Listing 9.1: Using the LabelFrame based widgets

```
# $Id: SampleCodeSlideout.tcl 1709 2014-05-21 16:02:04Z heller $  
  
package require LabelFrames;# Label<mumble> (LabelEntry, LabelSpinBox, LabelComboBox)  
5 # Populate the sample slideout with various LabelEntry like
```

96 CHAPTER 9. AN ASSORTMENT OF LABELFRAME BASED WIDGETS.

*# Widgets. These widgets all have a Label and some kind of
Entry-like widget for gathering some sort of user input.*

```

10 namespace eval SampleCode {}
   proc SampleCode::SampleCodeSlideout {} {
       variable Slideout

       # FileEntry widgets are used to get file and directory
15   # names. There are three types: old (existing) files,
       # generally for use as input files, new files for saving
       # information to, and directories (folders).
       #
       # First an old file:
20   pack [FileEntry $Slideout.oldfile \
           -label "Old_file:" -labelwidth 20\
           -filedialog open -defaultextension .text \
           -filetypes {
25               {{Text Files} {.text .txt} TEXT}
               {{All Files} *          }}] \
           -fill x
       # Second a new file:
       pack [FileEntry $Slideout.newfile \
           -label "New_file:" -labelwidth 20\
30       -filedialog save -defaultextension .text \
           -filetypes {
               {{Text Files} {.text .txt} TEXT}
               {{All Files} *          }}] \
           -fill x
35   # Finally, a directory:
       pack [FileEntry $Slideout.directory \
           -label "Directory:" -labelwidth 20\
           -filedialog directory] -fill x
       # A LabelComboBox would be used for selecting
40   # from a list of values.
       pack [LabelComboBox $Slideout.combo \
           -label "Pick_one:" -labelwidth 20\
           -values {A B C D}] -fill x
       # A LabelSpinBox would be usually be used for
45   # selecting a number from a range.
       pack [LabelSpinBox $Slideout.spin \
           -label "Pick_a_value:" -labelwidth 20\
           -range {1 10 1}] -fill x
       # A LabelSelectColor would be used to select a
50   # color.
       pack [LabelSelectColor $Slideout.color \

```

```

    -label "Choose_La_color:" -labelwidth 20] \
    -fill x
55 }
package provide SampleCodeSlideout 1.0

```

Listing 9.1 contains code to create each of the LabelFrame widgets. The window this code helped to create is shown in Figure 8.2

Chapter 10

HTMLHelp

10.1 About

The HTMLHelp widget is a help dialog that display program documentation coded in a simple subset of HTML. There is limited support for Cascading Style Sheets. There is a support for searching and there is a simple history stack.

10.2 Using the HTMLHelp widget

The HTMLHelp is a SNIT widgetadaptor based on the BWidget Dialog widget. It takes these options:

- textwidth** The width of the help text component (see -width of the text widget).
- width** The width of the HTMLHelp (see -width of the Dialog widget).
- height** The height of the HTMLHelp (see -height of the Dialog widget).
- side** The side to place the pane slider button. Can be top (the default) or bottom (see -side of the PanedWindow widget). This is a read only option.
- helpdirectory** The name of the directory where the HTML code lives. This is a read only option. There is no default value and this option must be specified. (But see below for the typemethod setDefaults.)
- tableofcontents** The name of the HTML file in the help directory that contains the Table Of Contents. This is a read only option. There is no default

value and this option must be specified. (But see below for the `typemethod` `setDefault`s.)

There is one public method available:

```
$HTMLHelpObject helptopic topicstring
```

This method searches the table of contents for a hyperlink with the specified help topic string as the link text (case folded search) and opens the HTMLHelp dialog with the page specified by the link associated with this text.

There are two public `typemethod`s available:

```
HTMLHelp::HTMLHelp setDefaults helpdir tocfile
```

This method sets the default values for the `-helpdirectory` and `-tableofcontents` options.

```
HTMLHelp::HTMLHelp help topicstring
```

This `typemethod` just calls the `helptopic` method for a default help dialog object. If a default help does not exist, it is created, using the default values set by the `setDefault`s `typemethod`.

10.3 Creating Help text with L^AT_EX and tex4ht

Help text HTML files can be generated using L^AT_EX and tex4ht. You need be sure you include a table of contents (`\tableofcontents`) and use the `htlatex` command with `html,4,info` as its second parameter. The former creates the index for the left column and the latter breaks the file up into one file for each section. Be sure to include a chapter or section titled “Help”¹, since this is used as the topic text for the HTMLHelp dialog itself. Generally you would write a chapter, section or subsection for each help topic you expect to have for your application – that is for all of the Help buttons on dialogs and Help menu items on main windows².

¹A sample chapter is included with the development code as `Help.tex`.

²See `SampleCode.tex` for a sample documentation L^AT_EX source file.

Chapter 11

Creating CTC Panels

Version 2 of the CTC Panel code is covered in this chapter. Version 1 is deprecated and is included only for older applications.

11.1 Creating a CTCPanel and creating objects to populate it.

Listing 11.1: CTCPanel::CTCPanel procedure

```
CTCPanel::CTCPanel widgetpath [ options... ]
```

CTCpanels are implemented with a Snit widget type and are created with the CTCPanel::CTCPanel procedure, as shown in Listing 11.1. This widget takes four options:

-schematicbackground The background color of the schematic display. Defaults to black.

-controlbackground The background color of the control display. Defaults to darkgreen.

-width The total width of the megawidget.

-height The total height of the megawidget.

Listing 11.2: CTCPanel::CTCPanel creating objects

```
$CTCPanelObject create type name [ options... ]
```

Method	Description
getv	Gets the current value of the object.
setv	Set the value of the object.
geti	Gets the value of the specified indicator.
seti	Sets the value of the specified indicator.
itemcget	Gets the value of a specified option of the object.
itemconfigure	Sets the value of a specified option of the object.
exists	Tests to see if the object exists.
delete	Deletes the specified object.
move	Moves the specified object a relative distance.
class	Returns the class (or type) of the object.
invoke	Executes a script bound to an object.
coords	Returns the coordinates of a specified terminal element of the object.
print	Writes a scriptlet to re-create the object to the specified output stream.

Table 11.1: Object methods

The panel includes its own scrollbars, including a shared horizontal scrollbar. Items displayed on the CTCPanel (either as schematic trackwork in the schematic display or as control items in the control display) are created with the `create` command, as shown in Listing 11.2. Each object has a unique name, a value, zero or more indicators, and zero or more options. The CTCPanel widget defines thirteen methods that take an object name, as shown in Table 11.1.

11.2 Control Points

Objects on a CTCPanel are grouped into named Control Points. A Control Point defines one (or more) trackwork elements and their corresponding control panel elements. In the simplest case a control point might include a Switch (turnout), a SIGPlate, a SWPlate, and a CodeButton, with the SWPlate controlling the Switch and the SIGPlate controlling the signals surrounding the Switch.

11.3 Object values and invocation

Many objects have an associated value. Generally, these values represent state information and these values (or states) correspond to different scripts bound to the object. For example trackwork switches (turnouts) define their state as being normal (points aligned for the main line) or reversed (points aligned for the branch line).

Also many objects have `—command` options, which define scriptlets to invoke under certain conditions. One (or more) of these scriptlets are executed (at the global level) when the object is invoked. Generally, trackwork objects are invoked to acquire state information (such as occupancy or point state feedback) from input ports bits (such as read from a Chubb CMR/I serial bus), and control objects are invoked to read and effect control panel settings by setting output port bits for trackwork control and signals. Generally, the `—command` bound to a code button will in turn invoke all of the objects associated with the control point the code button manages.

All trackwork objects have an `—occupiedcommand` option, which is a script to run to fetch the object's occupied state. The `invoke` method always returns the occupied state (always false for objects that are not trackwork objects). Trackwork with movable points should not have their points moved which a train is occupying the trackwork! Generally, if any of the trackwork of a control point is occupied,

the control point's code button should not invoke any of the control elements.

11.4 Sample CTCPanel and the code to create it.

Listing 11.3: Creating a CTC Panel

```

**
**

package require CTCPanel 2.0;# Include CTCPanel V2.0
5
namespace eval SampleCode::CTCPanel {}
# Procedure bound to the switch plate commands.
proc SampleCode::CTCPanel::SetSwitchSP1 {state} {
    variable CTCPanel
10    # Just move the switch's points.
    $CTCPanel setv IndustrySwitch $state
    # And set the indicators.
    switch $state {
        Normal {
15            $CTCPanel seti SP1Switch N on
            $CTCPanel seti SP1Switch R off
        }
        Reverse {
20            $CTCPanel seti SP1Switch R on
            $CTCPanel seti SP1Switch N off
        }
    }
}
# Procedure bound to the signal plate commands
25 proc SampleCode::CTCPanel::SetSignalSP1 {state} {
    variable CTCPanel
    # Set the signal indicator lamps.
    switch $state {
        Left {
30            $CTCPanel seti SP1Signal L on
            $CTCPanel seti SP1Signal R off
            $CTCPanel seti SP1Signal C off
        }
        Right {
35            $CTCPanel seti SP1Signal L off
            $CTCPanel seti SP1Signal R on
            $CTCPanel seti SP1Signal C off
        }
    }
}

```

```

    Center {
40      $CTCPanel seti SP1Signal L off
        $CTCPanel seti SP1Signal R off
        $CTCPanel seti SP1Signal C on
    }
  }
45 }
# Procedure bound to the code button
proc SampleCode::CTCPanel::CodeSP1 {} {
    variable CTCPanel
    # Check if the switch is occupied
    # (and fetch any state feedback).
50    if {[$CTCPanel invoke IndustrySwitch]} {
        # Switch is occupied: controls are disabled.
        $CTCPanel setv SP1Signal Center
        $CTCPanel invoke SP1Signal
55    return false
    } else {
        # If the switch is not occupied, invoke
        # the switch and signal plates.
        $CTCPanel invoke SP1Switch
60    $CTCPanel invoke SP1Signal
        return true
    }
}
# procedure to show the CTC Panel.
65 proc SampleCode::CTCPanel::ShowCTCPanel {} {
    variable CTCPanelTL
    wm deiconify $CTCPanelTL
}

70 proc SampleCode::CTCPanel::SampleCodeCTCPanel {} {
    $::SampleCode::Main menu add view command \
        -label CTCPanel \
        -command ::SampleCode::CTCPanel::ShowCTCPanel
75
    # Create the CTC Panel on a new, transient toplevel.
    # Toplevel where Sample CTCPanel lives
    variable CTCPanelTL ${::SampleCode::Main}.ctcPanelTop
    toplevel $CTCPanelTL
80    wm withdraw $CTCPanelTL
    wm transient $CTCPanelTL [wininfo toplevel ${::SampleCode::Main}]
    wm title $CTCPanelTL "Sample_CTC_Panel"
    wm protocol $CTCPanelTL WM_DELETE_WINDOW "wm withdraw $CTCPanelTL"

```

```

# Create a main window
85  set panelMain [MainFrame ${CTCPanelTL}.main]
# With a toolbar
set panelToolbar [$panelMain addtoolbar]
# Close button
pack [ttk::button $panelToolbar.close \
90      -image CloseButtonImage \
        -command "wm withdraw $CTCPanelTL"] \
    -side right
pack $panelMain -fill both -expand yes
# Create a CTC Panel
95  variable CTCPanel [::CTCPanel::CTCPanel \
        [$panelMain getframe].panel \
        -width 400]
pack $CTCPanel -fill both -expand yes

100  # Populate the CTC Panel:

# Control Point Block14:
# Just a block of the main line to the west.
$CTCPanel create StraightBlock MainWest \
105      -x1 10 -x2 150 -y1 50 -y2 50 \
        -controlpoint Block14 \
        -label "Block_14" -position above

# Control Point SP1:
110  # The Switch itself.
$CTCPanel create Switch IndustrySwitch \
        -x 150 -y 50 -controlpoint SP1 \
        -label "SP1"

115  # The Switch Plate
$CTCPanel create SWPlate SP1Switch \
        -x 150 -y 75 -controlpoint SP1 \
        -label "SP1" \
        -normalcommand \
120      "::SampleCode::CTCPanel::SetSwitchSP1_Normal" \
        -reversecommand \
        "::SampleCode::CTCPanel::SetSwitchSP1_Reverse"

# The signal plate
125  $CTCPanel create SIGPlate SP1Signal -x 150 -y 150 \
        -controlpoint SP1 \
        -label "SP1" \
        -leftcommand \

```

```

130         "::SampleCode::CTCPanel::SetSignalSP1_Left" \
        -rightcommand \
        "::SampleCode::CTCPanel::SetSignalSP1_Right" \
        -centercommand \
        "::SampleCode::CTCPanel::SetSignalSP1_Center"

135 # The code button
$CTCPanel create CodeButton SP1Code -x 250 -y 150 \
        -controlpoint SP1 \
        -command "::SampleCode::CTCPanel::CodeSP1"

140 # A label for the control point
$CTCPanel create CTCLabel SP1Label -x 200 -y 200 \
        -controlpoint SP1 -label "SP1"

# Initialize the control point
145 ::SampleCode::CTCPanel::CodeSP1

# Control Point Block15:
# Just a block of the main line east.
set mel [$CTCPanel coords IndustrySwitch Main]
150 set mex1 [lindex $mel 0]
set mey [lindex $mel 1]
set mex2 [expr {$mex1 + 150}]
$CTCPanel create StraightBlock MainEast \
        -x1 $mex1 -x2 $mex2 -y1 $mey -y2 $mey -controlpoint Block15 \
155        -label "Block_15" -position above

# Control Point Spur1:
# An industrial spur.
160 set is1 [$CTCPanel coords IndustrySwitch Divergence]
set isx1 [lindex $is1 0]
set isy [lindex $is1 1]
set isx2 [expr {$isx1 + 150}]
$CTCPanel create StraightBlock IndustrySpur \
165        -x1 $isx1 -x2 $isx2 -y1 $isy -y2 $isy \
        -controlpoint Spur1 -label "Spur_1"

}

170 package provide SampleCodeCTCPanel 1.0

```

The Tcl code in Listing 11.3 creates a simple CTC Panel¹. The CTC Panel itself

¹See [4], Section 1.4 for a complete list of available panel elements.

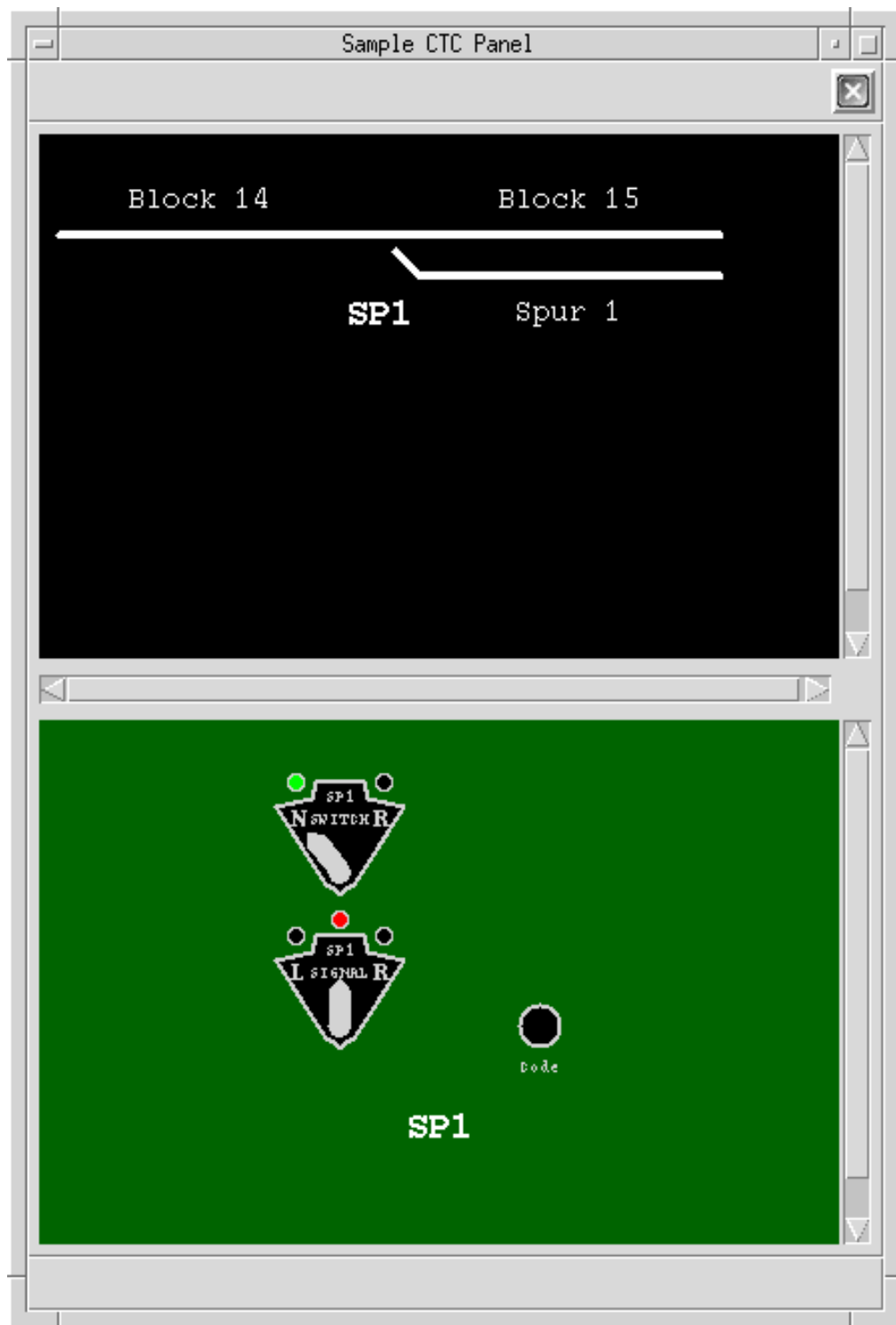


Figure 11.1: Sample CTC Panel Screen Shot

is created at line 61 Lines 67–192 populate the panel with both control panel elements and track schematic elements. The panel is shown in Figure 11.1.

This CTC Panel features a switch (turnout) off the main line to an industrial spur. There is one actual control point, named SP1, and three blocks, two for the mainline blocks and one for the industrial spur. I have put each block into a separate logical control point as a organizational convenience. The control point SP1 contains one piece of trackwork, the switch, and four control panel items, a switch plate, a signal plate, a code button, and a label. The code does not interact with an actual layout. Normally, the `–occupiedcommand` options of the trackwork elements would define code to read block occupancy detectors and the `–statecommand` of the switch would define code to read the switch’s point position feedback sensors². The code for the switch plate (procedure `SetSwitchSP1`) would just set the output bits to activate the switch’s switch machine. The signal plate code (procedure `SetSignalSP1`) would also set the output bits to update the aspects of the signals protecting the switch.

²Using the CMR/I (Bruce Chubb) Interface, as described in Chapter 5, for example.

Chapter 12

Managing preferences or configuration options

The `ReadConfiguration` package provides functions for reading, writing, and editing preferences or configuration options. The procedure `ReadConfiguration::ReadConfiguration` reads in a configuration or preferences file. The `ReadConfiguration::WriteConfiguration` procedure writes a configuration or preferences file, and the snit macro `ReadConfiguration::ConfigurationType` creates a snit type to hold a set of configuration options or preferences.

12.1 Configuration or preferences files

Each logical line can contain either an unnamed value (an anonymous configuration option) or a name value pair. The value can be either a scalar value or a brace enclosed list of alternating keys and values. Tcl bracing, quoting, and comment conventions are used in this file.

Both `ReadConfiguration::ReadConfiguration` and `ReadConfiguration::WriteConfiguration` take the same two arguments—a filename and the name of an array variable to receive or provide the preferences.

12.2 A complete Snit type object to hold and manage preferences

Listing 12.1: Creating a configuration object

```

##
##

5 package require ReadConfiguration;#      Load configuration code

namespace eval SampleCode::Configuration {
    # Create the configuration object.
    snit::type Configuration {
10      ReadConfiguration::ConfigurationType \
        {{Scratch Folder} scratchfolder directory {~/.scratchfolder} {}} \
        {{Layout Name} {layout name} string {My Layout} {}} \
        {{Layout Scale} {layout scale} enumerated {H0} {Z N H0 0 G}} \
        {{Layout Width} {layout width} integer 96 {10 200}} \
15      {{Layout Height} {layout height} integer 48 {10 200}} \
        {{Background Color} backgroundcolor color white {}}
    }
}

20 proc SampleCode::Configuration::SampleCodeRC {} {
    # Add menu items
    $::SampleCode::Main menu add options command \
        -label "Edit_Configuration" \
        -command "::SampleCode::Configuration::Configuration_edit"
25    $::SampleCode::Main menu add options command \
        -label "Save_Configuration" \
        -command "::SampleCode::Configuration::Configuration_save"
    $::SampleCode::Main menu add options command \
        -label "Load_Configuration" \
30    -command "::SampleCode::Configuration::Configuration_load"
}

package provide SampleCodeRC 1.0

```

The macro `ReadConfiguration::ConfigurationType` can be used to create an ensemble command to hold the preferences or configuration options for your program. This macro generates a Snit type that include type methods to load, save, edit, and access preference or configuration options. Typical code to use this macro is shown in Listing 12.1 and the dialog box this macro generates is shown in Figure 12.1.

12.2. A COMPLETE SNIT TYPE OBJECT TO HOLD AND MANAGE PREFERENCES113

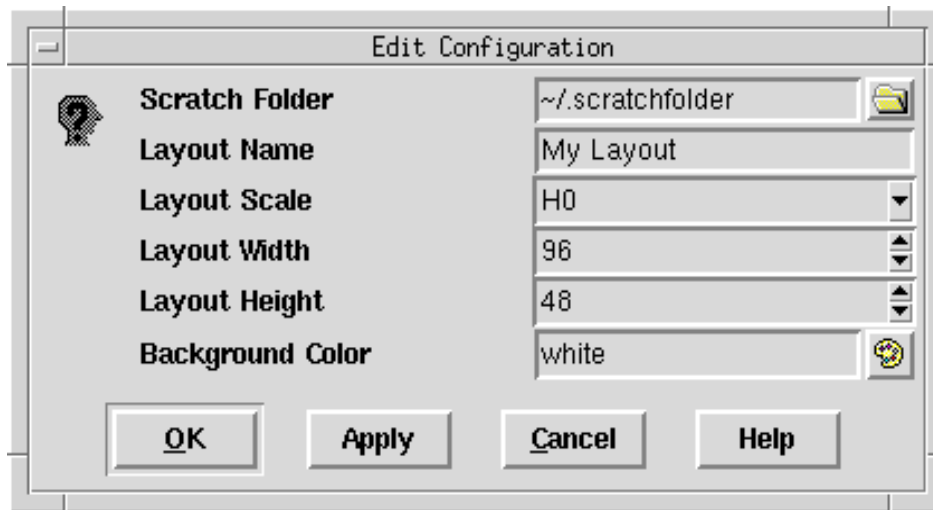


Figure 12.1: Editing a set of preferences

Chapter 13

Using the Graphics Support Code.

Version 2 of the Graphics Support is covered in this chapter. Version 1 is deprecated and is included only for older applications.

The `grsupport` package defines the constants π and $\frac{\pi}{2}$, a procedure to convert degrees to radians, plus a collection of Snit macros that define common validating methods that are useful when defining Snit types.

Listing 13.1: Graphics Support package examples

```

package require snit;# Load the snit package
package require Tk;# Load the Tk package
package require tile;# BWidget Code
package require grsupport 2.0;# Load V2 Graphics Support package.
5
snit::type Circle {
    # Snit type for drawing circles.

    #*****
10    # Type variables:
    #*****
    typevariable _MenuId 0;# Ever increasing id for menus

    #*****
15    # Type methods:
    #*****
    typemethod _GenerateMenuPath {} {
        # Create a unique menu path.
        incr _MenuId
20    return "circleMenu$_MenuId"
    }
    typemethod bindtocanvas {canvas sequence {extracode {}}} {

```

```

# Bind circle creation to a canvas.
bind $canvas $sequence \
25     [mytypemethod _CreateCircle \
        $canvas %x %y "$extracode"]
}
typemethod _CreateCircle {canvas mx my extracode} {
    $type create %%AUTO%% $canvas \
30        -x [$canvas canvasx $mx] \
        -y [$canvas canvasy $my] \
        -extracode "$extracode"
}

35 #*****
# Methods:
#*****
GRSupport::VerifyDoubleMethod;# Verify double valued options.
GRSupport::VerifyColorMethod;# Verify color valued options.
40 method _ConfigureXY {option value} {
    # Method to configure X or Y.
    # <in> option The name of the option to configure.
    # <in> value The new value.
    # [index] _ConfigureXY!method
45
    set oldx $options(-x)
    set oldy $options(-y)
    set options($option) $value
    set dx [expr {$options(-x) - $oldx}]
50    set dy [expr {$options(-y) - $oldy}]
    $canvas move $selfns $dx $dy
    set x $options(-x)
    set y $options(-y)
    set size $options(-size)
55    set sx [expr {$x + $size}]
    set sy [expr {$y + $size}]
    set centerX [expr {$x + ($size * 0.5)}]
    set centerY [expr {$y + ($size * 0.5)}]
}
60 method _ConfigureSize {option value} {
    # Method to configure size.
    # <in> option The name of the option to configure.
    # <in> value The new value.
    # [index] _ConfigureSize!method
65
    set deltaSize [expr {double($value) / double($options($option))}]
    set options($option) $value

```



```

$canvas scale $selfns $centerX $centerY \
                                $deltaSize $deltaSize
70  foreach {x y sx sy} [$canvas coords $selfns] {break}
    set options(-x) $x
    set options(-y) $y
}
method _ConfigureFillColor {option value} {
75  # Method to configure a fill color.
    # <in> option The name of the option to configure.
    # <in> value The new value.
    # [index] _ConfigureFillColor!method

80    set options($option) $value
    set tag $selfns
    catch {$canvas itemconfigure ${tag}$option -fill "$value"}
}
method _ConfigureOutlineColor {option value} {
85  # Method to configure an outline color.
    # <in> option The name of the option to configure.
    # <in> value The new value.
    # [index] _ConfigureOutlineColor!method

90    set options($option) $value
    set tag $selfns
    catch {$canvas itemconfigure ${tag}$option -outline "$value"}
}
method Circumfrence {} {
95  # Method to return the circumfrence of the circle.
    # Uses PI from the Graphics Support library.
    return [expr {options(-size) * $::GRSupport::PI}]
}
# Methods bound to events for circles: resizing, moving, and a popup menu
100 # for changing colors and deleting
method _StartResize {mx my} {
    set rx [expr {[ $canvas canvasx $mx] - $centerX}]
    set ry [expr {[ $canvas canvasy $my] - $centerY}]
    set Rdx [expr {sqrt($rx*$rx + $ry*$ry)}]
105    set RorgSize $options(-size)
}
method _Resize {mx my} {
    set x [expr {[ $canvas canvasx $mx] - $centerX}]
    set y [expr {[ $canvas canvasy $my] - $centerY}]
110    set dxy [expr {sqrt($x*$x + $y*$y)}]
    set dsize [expr {($dxy - $Rdx)*2.0}]
    $self configure -size [expr {$RorgSize + $dsize}]
}

```

```

        if {[string length "$options(-extracode)"] > 0} {
            uplevel #0 "$options(-extracode)"
115     }
    }
    method _StopResize {mx my} {
        catch {unset Rdx}
        catch {unset RorgSize}
120    }
    method _StartMove {mx my} {
        set Mx [expr {[$canvas canvasx $mx] - $options(-x)}]
        set My [expr {[$canvas canvasy $my] - $options(-y)}]
    }
125    method _Move {mx my} {
        set x [expr {[$canvas canvasx $mx] - $Mx}]
        set y [expr {[$canvas canvasy $my] - $My}]
        $self configure -x $x -y $y
        if {[string length "$options(-extracode)"] > 0} {
130            uplevel #0 "$options(-extracode)"
        }
    }
    method _StopMove {mx my} {
        catch {unset Mx}
135        catch {unset My}
    }
    method _PostMenu {X Y} {
        $menupath post $X $Y
    }
140    method _setColor {opt menulab} {
        set newcolor [SelectColor $colormenupath -parent $canvas \
            -color "$options($opt)" -type popup]
        if {[string length "$newcolor"] > 0} {
            $self configure $opt "$newcolor"
145            $menupath entryconfigure "$menulab" -foreground "$newcolor"
        }
        $menupath unpost
    }
    method _delete {} {
150        $self destroy
    }
    #*****
    # Variables:
    #*****
155    variable canvas;#      Canvas the circle is drawn on.
    variable sx;#          Right side of circle.
    variable sy;#          Bottom side of circle.

```

```

variable centerX;#      Center of circle (X).
variable centerY;#      Center of circle (Y).
160 variable menupath;#    Our popup menu
variable colormenupath;#  Our ColorSelect popup menu
variable Rdx;#           Resizing variable
variable RorgSize;#      Resizing variable
variable Mx;#            Moving variable
165 variable My;#          Moving variable

#*****
# Options:
#*****
170 # Upper left corner (x,y).
    option -x -default 0 -validatemethod _VerifyDouble \
        -configuremethod _ConfigureXY
    option -y -default 0 -validatemethod _VerifyDouble \
        -configuremethod _ConfigureXY
175 # Size (diameter) of circle.
    option -size -default 100 -validatemethod _VerifyDouble \
        -configuremethod _ConfigureSize

# Color of the circle.
    option -outline -default black -validatemethod _VerifyColor \
180         -configuremethod _ConfigureOutlineColor
    option -fill -default black -validatemethod _VerifyColor \
        -configuremethod _ConfigureFillColor

# Extra code to run after creating, moving, resizing, and deleting circles.
    option -extracode -default {} -readonly yes
185 #*****
# Constructor: draw the circle.
#*****
constructor {_canvas args} {
    set canvas $_canvas
190    set tag $selfns
    catch {$canvas delete $tag}
    $self configurelist $args
    set x $options(-x)
    set y $options(-y)
195    set size $options(-size)
    set sx [expr {$x + $size}]
    set sy [expr {$y + $size}]

    set menupath $canvas.[ $type _GenerateMenuPath]
200    set colormenupath $canvas.colormenu$_MenuId
    menu $menupath -tearoff no
    $menupath add command -label {Fill Color} \

```

```

                                -foreground "$options(-fill)" \
                                -command [mymethod _setColor \
205                                -fill {Fill Color}]
$menupath add command -label {Outline Color} \
                                -foreground "$options(-outline)" \
                                -command [mymethod _setColor \
                                -outline {Outline Color}]
210 $menupath add command -label {Delete} \
                                -command [mymethod _delete]
bind $menupath <Escape> "$menupath_unpost"

$canvas create oval $x $y $sx $sy \
215     -outline "$options(-outline)" \
     -fill     "$options(-fill)" \
     -width    2 \
     -tag      [list $tag ${tag}-fill \
                    ${tag}-outline]
220 $canvas bind $tag <Shift-ButtonPress-2> \
     [mymethod _StartResize %x %y]
$canvas bind $tag <Shift-Button2-Motion> \
     [mymethod _Resize %x %y]
$canvas bind $tag <Shift-ButtonRelease-2> \
225     [mymethod _StopResize %x %y]
$canvas bind $tag <ButtonPress-2> \
     [mymethod _StartMove %x %y]
$canvas bind $tag <Button2-Motion> \
     [mymethod _Move %x %y]
230 $canvas bind $tag <ButtonRelease-2> \
     [mymethod _StopMove %x %y]
$canvas bind $tag <ButtonPress-3> \
     [mymethod _PostMenu %X %Y]
    if {[string length "$options(-extracode)"] > 0} {
235        uplevel #0 "$options(-extracode)"
    }
}
#*****
# Destructor: remove the circle.
240 #*****
destructor {
    catch {$canvas delete $selfns}
    catch {destroy $menupath}
    if {[string length "$options(-extracode)"] > 0} {
245        uplevel #0 "$options(-extracode)"
    }
}

```

```
}
```

250

```
package provide SampleCodeCircle 1.0
```

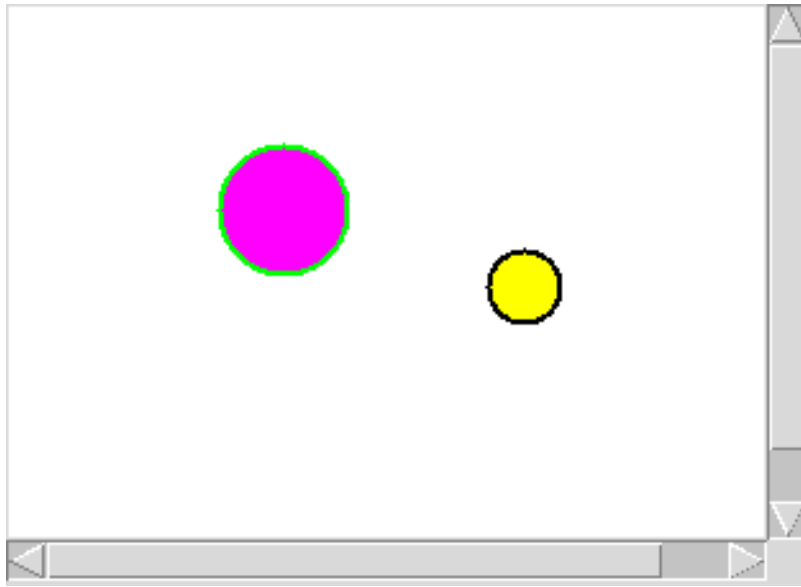


Figure 13.1: Circles drawn with the Circle type.

Listing 13.1 shows some code that uses the Graphics Support package. This code defines a Snit type named Circle, which extends the oval item type for canvas drawing. The type draws an oval, and then binds several events to the oval. Figure 13.1 shows a pair of circles drawn with the code in Listing 13.1.

This code uses several constants and macros defined in the Graphics Support package, including code to verify option values and the constant π .

Chapter 14

Using the Panel Instruments Widgets

Listing 14.1: Using the Panel Instrument based widgets

```
# $Id: SampleCodeInstrumentPanel.tcl 1709 2014-05-21 16:02:04Z heller $

4 package require Instruments 2.0

namespace eval SampleCode {
}
9 proc SampleCode::ToggleInstrumentPanelSlide {} {
    variable InstrumentPanelSlideState
    variable Main
    $Main slideout $InstrumentPanelSlideState instrumentPanel
}
14 proc SampleCode::UpdateRTClock {} {
    variable Clock
    scan [::clock format [::clock scan now] -format %R] \
        {%2d:%2d} hour minute
    $Clock settime $hour $minute
    after 60000 SampleCode::UpdateRTClock
19 }
proc SampleCode::UpdateFastClock {} {
    variable fastHours
    variable fastMinutes
    variable realMillisecsPerFastMinute
24 variable FastClock
    incr fastMinutes
    if {$fastMinutes > 59} {
```

```

        incr fastHours
        set fastMinutes 0
29      if {$fastHours > 12} {
            set fastHours 1
        }
    }
    $FastClock settime $fastHours $fastMinutes
34    after $realMillisecsPerFastMinute SampleCode::UpdateFastClock
}

proc SampleCode::SampleCodeInstrumentPanel {} {
    variable Main
39    variable InstrumentPanelSlide [$Main slideout add instrumentPanel]
    variable InstrumentPanelSlideState hide
    $Main menu add view checkbutton -label "Instrument_Panel" \
        -variable ::SampleCode::InstrumentPanelSlideState \
        -onvalue show -offvalue hide \
44    -command ::SampleCode::ToggleInstrumentPanelSlide
    set sw [ScrolledWindow $InstrumentPanelSlide.sw \
        -scrollbar both -auto both]
    pack $sw -expand yes -fill both
    variable InstrumentPanelCanvas [canvas $sw.canvas \
49        -width 200 \
        -height 500 \
        -borderwidth 0 \
        -relief flat \
        -background white]
54    $sw setwidget $InstrumentPanelCanvas

    variable Voltmeter [Instruments::DialInstrument \
        create volts \
        $InstrumentPanelCanvas -x 5 -y 5 -size 90 \
59    -maxvalue 20 -label "Track_Volts" \
        -scaleticksinterval 1]

    variable Ampmeter [Instruments::DialInstrument \
        create amps \
64    $InstrumentPanelCanvas -x 105 -y 5 -size 90 \
        -maxvalue 10 -label "Track_Amps" \
        -scaleticksinterval 1]

    variable Clock [Instruments::AnalogClock \
69    create clock $InstrumentPanelCanvas \
        -x 5 -y 125 -size 90 \
        -label {Real Time}]

```



```

74     variable FastClock [Instruments::AnalogClock \
        create fastclock $InstrumentPanelCanvas \
            -x 105 -y 125 -size 90 \
            -label {Fast Clock}]

    UpdateRTClock
79     variable fastHours 12
    variable fastMinutes 0
    variable FTFactor 8
    variable realMillisecsPerFastMinute [expr {(60*1000)/$FTFactor}]
    UpdateFastClock
84 }

package provide SampleCodeInstrumentPanel 1.0

```

Listing 14.1 contains code to create some of the panel instrument widgets. The window this code helped to create is shown in Figure 14.1. Several typical panel instruments are shown with the code to create them.

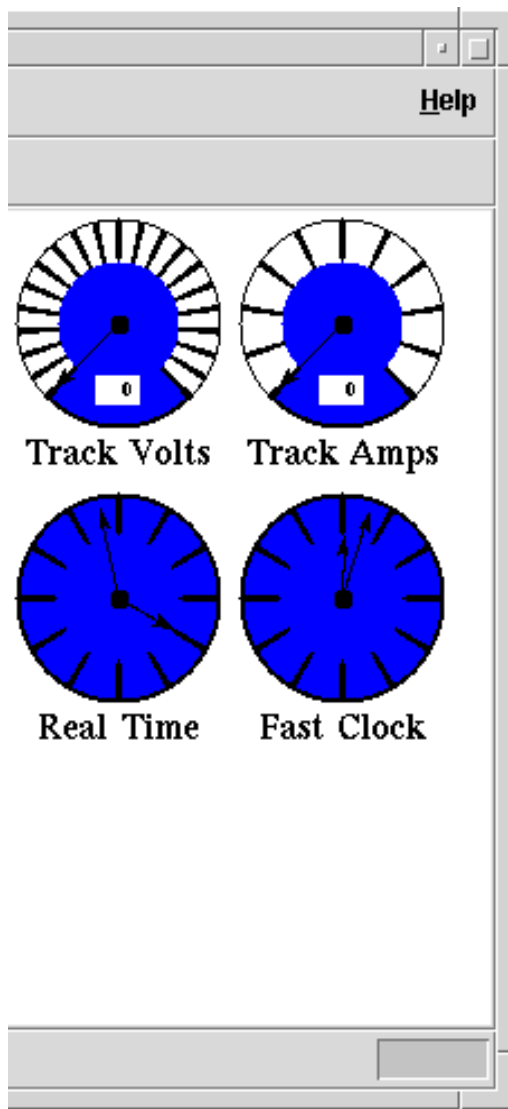


Figure 14.1: Some Panel Instruments

Chapter 15

Using the Oval Widgets

Chapter 16

Various LCARS Widgets

Chapter 17

Creating StarKits and StarPacks

Listing 17.1: Makefile fragment for building a StarPack

```

2      SampleCode_Version.h
      -rm -rf SampleCode/
      $(DOXYGEN) Doxyfile.SampleCode
      -rm -f SampleCode/pages.html

EXTRA_DIST += SampleCode.tcl $(SampleCodePackages) SampleCode.h \
7          Doxyfile.SampleCode.in

SampleCode${EXEEXT}: SampleCode.tcl $(SampleCodeScripts) $(SampleCodeHelpDep) \
      $(SampleCodePackages)
12      -rm -rf SampleCode.kit
      -rm -rf SampleCode.vfs
      $(TCLKIT) $(top_srcdir)/BuildScripts/sdx.kit qwrap $(srcdir)/SampleCode.tcl
      $(TCLKIT) $(top_srcdir)/BuildScripts/sdx.kit unwrap SampleCode.kit
      -rm -rf SampleCode.kit
      $(UNZIP) -qq -d SampleCode.vfs/lib \
17          $(top_srcdir)/BuildData/bwidget-1.9.6.zip
      $(TCLKIT) $(top_srcdir)/BuildScripts/AddKitDir.kit SampleCode \
          lib $(SNITLIB)
      $(TCLKIT) $(top_srcdir)/BuildScripts/AddKitFile.kit SampleCode \
          lib/Common $(SampleCodeScripts)
22      $(TCLKIT) $(top_srcdir)/BuildScripts/MakePkgIndex.kit SampleCode \
          Common

```

The Makefile fragment shown in Listing 17.1 builds a StarPack. It starts by removing any existing kit or kit directory¹. Then it uses the SDX qwrap and unwrap

¹Basically, cleaning up from a previously failed build.

commands to create a base level kit directory. It then uses helper kits to populate this directory with additional scripts and data files, then finally wraps the resulting directory into a StarPack with the SDX wrap command (the `--runtime` option makes this a StarPack rather than a StarKit).

17.1 Helper programs included with the Model Railroad System

Three tclkits are included with the Model Railroad System to help you build your own programs using elements of the Model Railroad System Tcl/Tk library of packages:

AddKitDir.kit This kit adds a symbolic link to a directory in a kit directory tree. This is a “lazy” copy of a directory that is usually a directory containing a Tcl/Tk package.

AddKitFile.kit This kit adds one or more files to a directory in a kit directory tree.

MakePkgIndex.kit This kit runs the Tcl command `pkg_mkIndex` on a directory under the `lib` directory in a kit directory tree.

These tclkits help with some of the common tasks involved in build StarKits and StarPacks.

17.1.1 AddKitDir.kit – Add a directory to a StarKit or StarPack

This kit does a “lazy” copy² of a directory to a StarKit’s or StarPack’s `vfs`³ directory. It takes three parameters: the name of the kit (without the `.kit` or `.vfs` extension), the relative path to the parent directory, and the path to the directory to add. A symbolic link, using the tail of the directory path to add, is made in the StarKit’s or StarPack’s `.vfs` directory under the relative path specified.

Listing 17.2: Adding a directory to a kit.

```
tclkit AddKitDir.kit MyProgram lib /usr/share/bwidget1.8.0
```

²Simply a symbolic link.

³Virtual File System.

The example in Listing 17.2 adds a symbolic link named `bwidget1.8.0` to `/usr/share/bwidget1.8.0` in `MyProgram.vfs/lib/`. When the kit is wrapped, the `sdx` program will make a deep copy of this directory into the resultant kit or pack.

17.1.2 AddKitFile.kit – Add files to a StarKit or StarPack

This kit copies one or more files to a directory in a StarKit's or StarPack's `vfs` directory. It takes three or more parameters: the name of the kit (without the `.kit` or `.vfs` extension), the relative path to directory to add files to⁴, and one or more files to copy.

Listing 17.3: Adding files to a kit.

```
tclkit AddKitFile.kit MyProgram lib/packages mypackage1.tcl \
                             mypackage2.tcl myextension.so
```

The example in Listing 17.3 adds the files `mypackage1.tcl`, `mypackage2.tcl`, and `myextension.so` to the directory `MyProgram.vfs/lib/packages`.

17.1.3 MakePkgIndex.kit – Create a pkgIndex.tcl file for a directory in a StarKit or StarPack

This kit runs `pkg_mkIndex` on a directory under the `lib` directory in a StarKit's or StarPack's `vfs` directory. It takes two parameters: the name of the kit (without the `.kit` or `.vfs` extension) and the directory under the `lib` directory to run `pkg_mkIndex` over.

Listing 17.4: Creating the `pkgIndex.tcl` for a directory of packages in a kit.

```
tclkit MakePkgIndex.kit MyProgram packages
```

The example in Listing 17.4 runs `pkg_mkIndex` over the directory `MyProgram.vfs/lib/packages`.

⁴The directory is created if it does not already exist.

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