Supervisory Control Language

Applying Tcl To The Realtime Arena

by

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Background

CPU's Mission

Computerized Processes Unlimited, Incorporated is an independent control system integrator serving domestic and international Oil and Gas Energy and other process industries with highly competent consulting services, project management and customized problem solving software.

Primary Projects

- the design and implementation of systems to monitor and control processes
- realtime data integration with corporate databases
- network integration

Platforms (client driven)

- Hewlett-Packard 9000/7xx running HP-UX
- Digital VAX
- PC's

Foundation requirements

A stable, extensible software foundation to build custom solutions for our clients.

Supervisory Control and Data Acquisition (SCADA)

Purpose

- Collect data from field devices and present the data in meaningful form to operators.
- Provide methods for operators to issue commands to field located controllers.
- Operator must be able to:
  - determine the state of the process easily
  - control the process instinctively

Current State of the Industry

- Current SCADA systems place extreme importance on the interactive operator display to help the operator process data from many sources and respond correctly to changes in the process.

- Small to moderate size systems are now PC based and are user configurable. Unfortunately, configuration is rigid and extensibility is limited.

- UNIX and VMS based systems are used for larger applications. These make use of the multitasking, and operator interface features. Custom integration is still required and can be complex.

Hewlett-Packard’s Realtime Application Platform (RTAP)

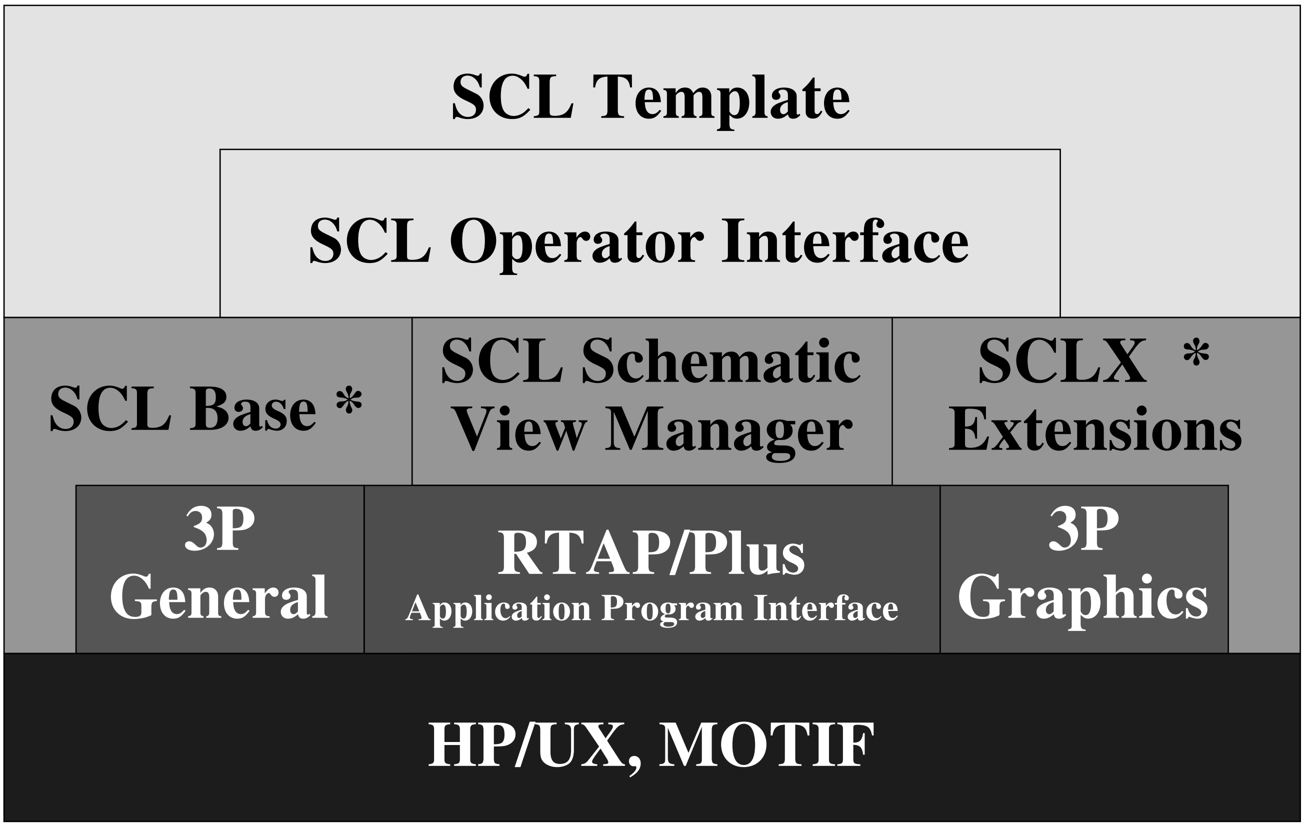
- **Provides a toolkit for building SCADA applications. Configuration is a combination of using interactive tools and C programming.**
- **Major components are:**
  - realtime database with calculation engine
  - data historian to maintain data for longer times
  - time keeper and event manager to support event processing
  - environment configuration and monitoring
  - scan system for acquiring data and issuing commands to and gathering data from remote devices
  - alarm detection, reaction, and display
  - report system for producing hard copy summary reports
  - user interface tools to support the creation and display of interactive schematics

Goals of the SCL Project

- **Develop a product that would allow CPU to become more effective at system integration**
- **Provide complete development and configuration environment**
  - Support custom configuration/application by engineer/technician
- **Leverage work done by others**
  - RTAP/Plus
  - Other third party products
  - Public domain products
- **Extensible by:**
  - CPU
  - Third parties
  - Users
- **Provide appropriate interface for different levels of users**

The SCL Family

A Layer Diagram



SCL Template

SCL Operator Interface

SCL Base *

SCL Schematic View Manager

SCLX * Extensions

3P General

RTAP/Plus Application Program Interface

3P Graphics

HP/UX, MOTIF

Peer Type Extensibility

SCL(X) Interpreter

PARSER

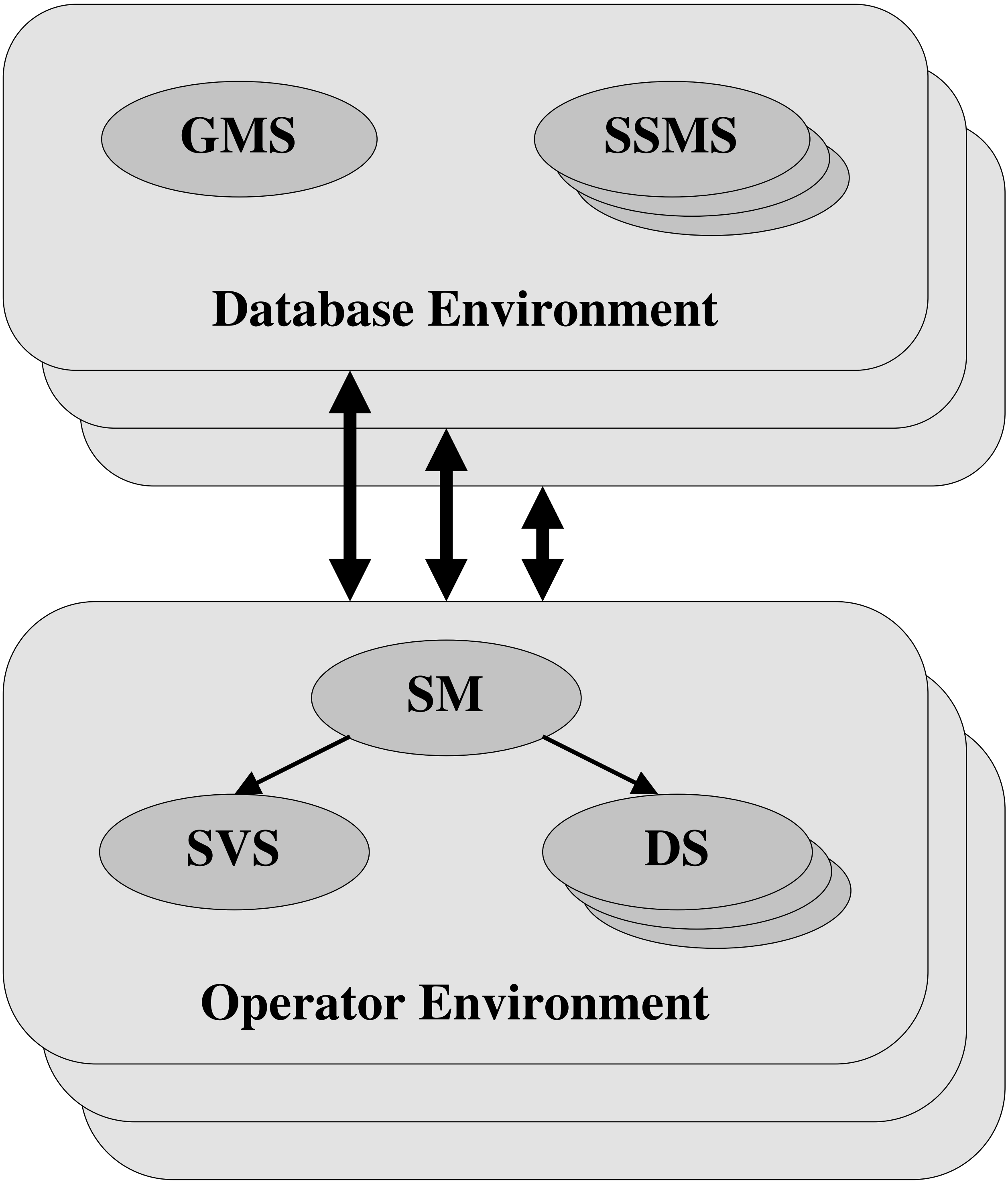
Extensions Made in "C"

SCL Base	*RTAP/Plus*	*X Windows*	*SVM (UIP)*	*Other CPU*	*Third Party*
File Access Lists Keyed Lists Math Strings Unix XPG/3	Alarms Database Data Historian Event Manager Environment Plot Display Scan System Time Keeper Watchdog	Buttons Labels Menus Graphics Icons Entry etc.	Schematics Symbols X-events Menus Messages	Dialogs Widgets TBD	SYBASE Plotting Widgets TBD

Extensions Made in SCL

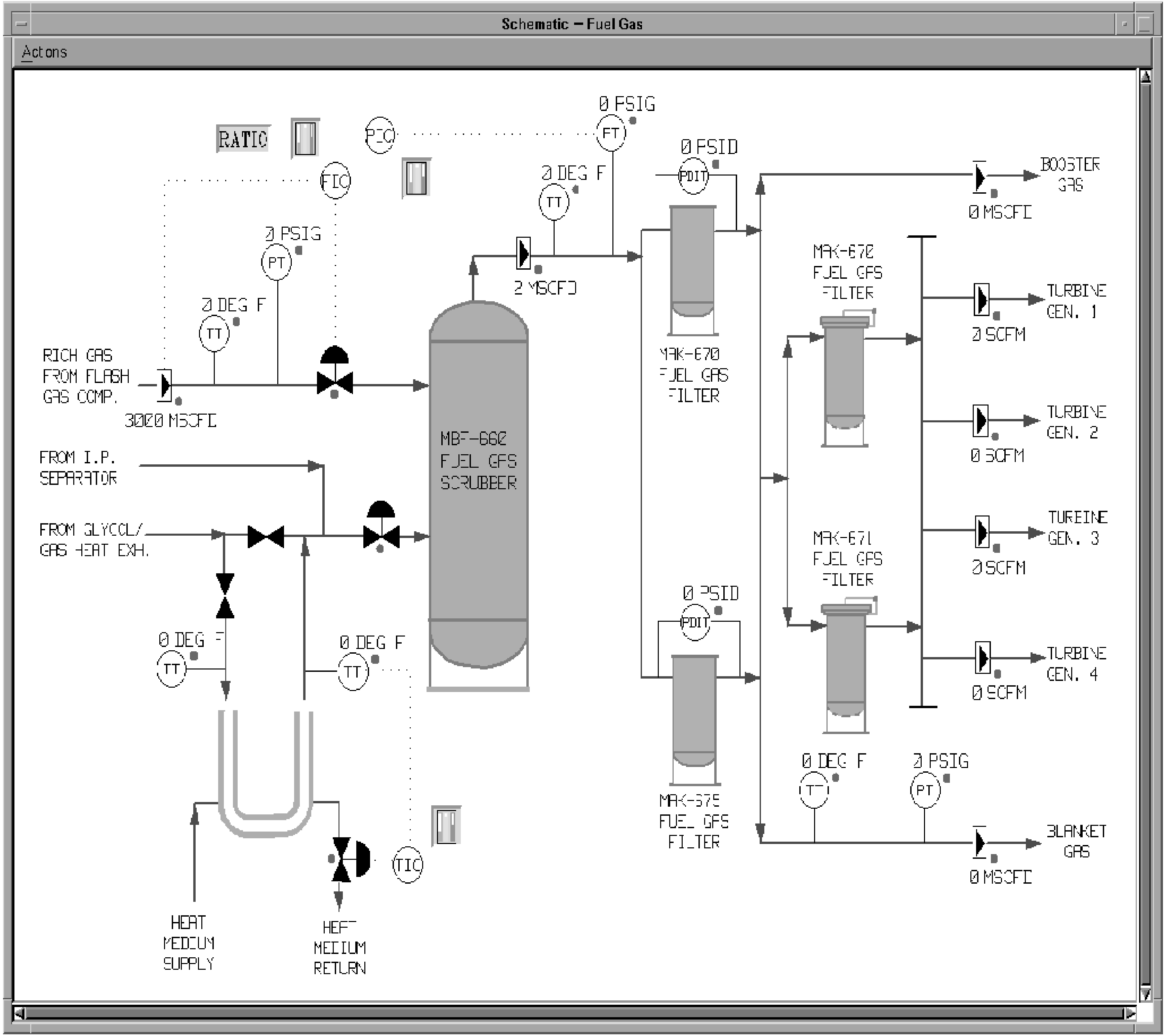
Option Parsing	Point Read	Gauge Vector Levelmeter	Config Macros	Point Methods	TBD

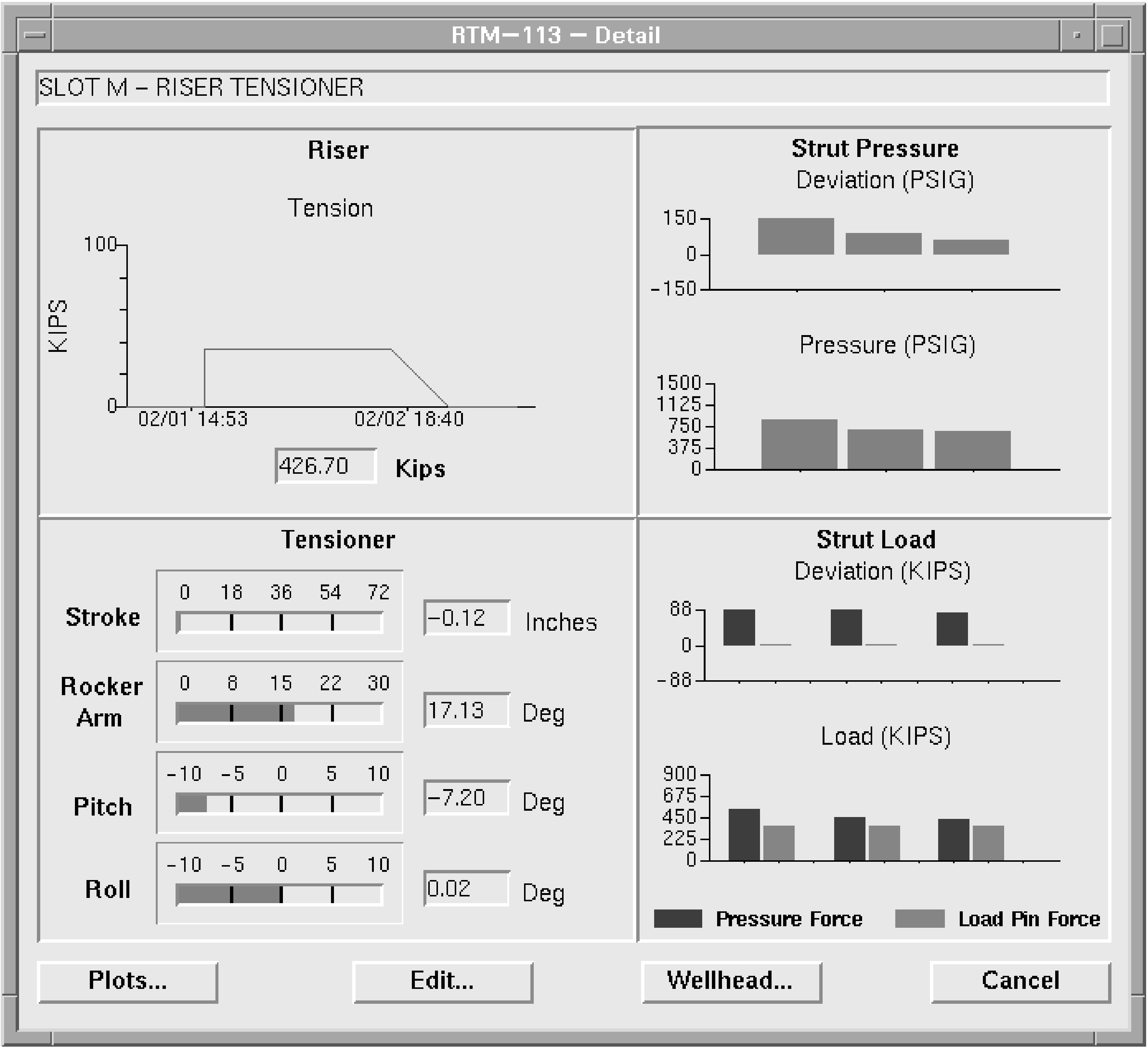
SCL Plus Process Model



Typical Screens

- **Process schematic**
- **Detail panel**
- **Plot panel**
- **"Layered" detail panel**


Schematic – Fuel Gas
Actons
RATIO
PIC
FIC
0 PSIG
FT
0 DEG F
TT
0 PSIG
PT
0 DEG F
TT
RICH GAS
FROM FLASH
GAS COMP.
3000 MSCFI
2 MSCFD
0 PSID
PDIT
MBF-660
FJEL GFS
SCRUBBER
FROM I.P.
SEPARATOR
FROM GLYCOL/
GAS HEAT EXH.
0 DEG F
TT
0 DEG F
TT
TIC
HEAT
MEDIUM
SUPPLY
HEAT
MEDIUM
RETURN
MAK-670
FUEL GAS
FILTER
0 PSID
PDIT
MAK-675
FUEL GFS
FILTER
MAK-670
FJEL GFS
FILTER
MAK-671
FJEL GFS
FILTER
0 DEG F
TT
0 PSIG
PT
BOOSTER
GAS
0 MSCFI
TURBINE
GEN. 1
0 SCFM
TURBINE
GEN. 2
0 SCFM
TURBINE
GEN. 3
0 SCFM
TURBINE
GEN. 4
0 SCFM
BLANKET
GAS
0 MSCFI



RTM—113 — Detail

SLOT M – RISER TENSIONER

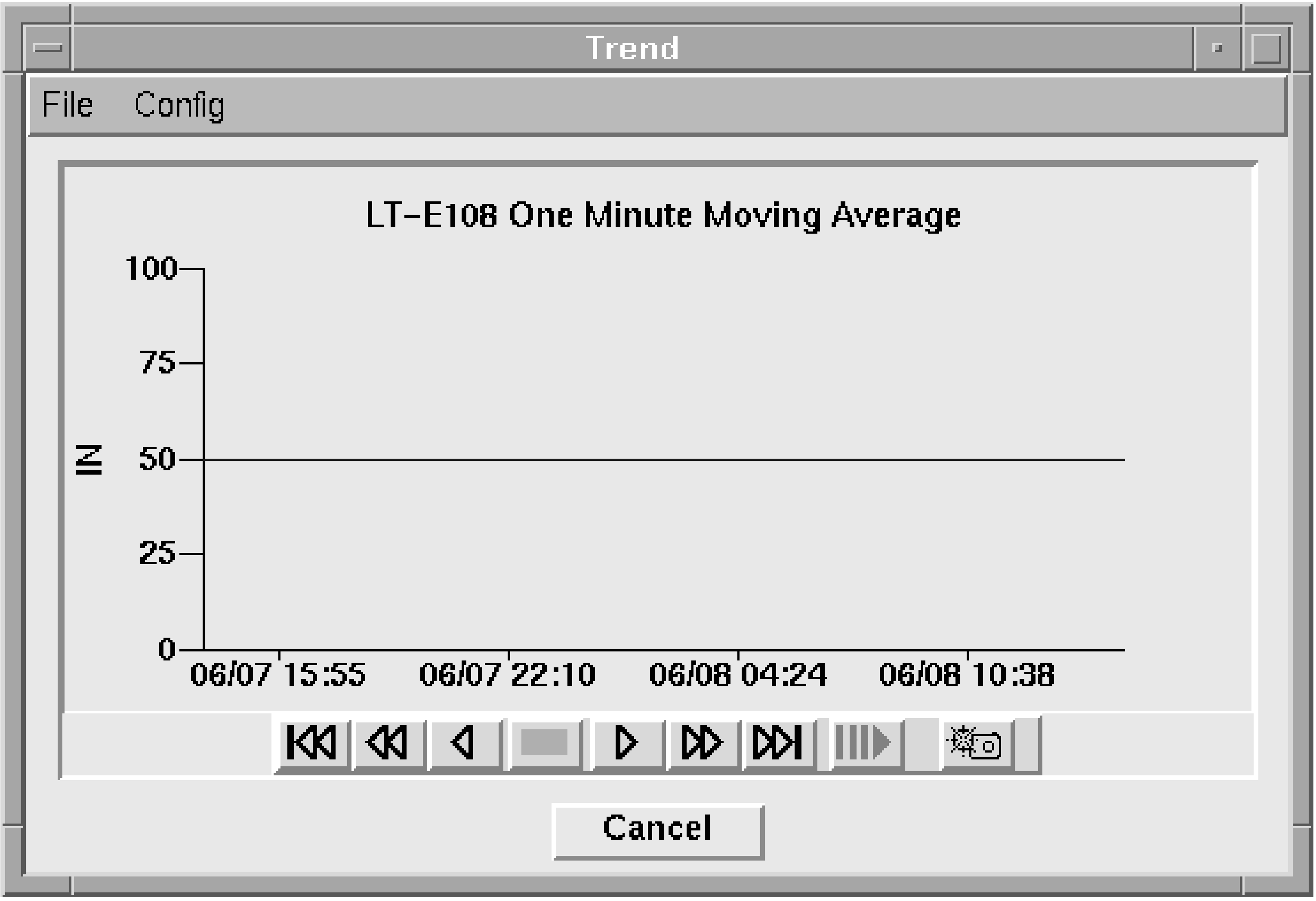
Riser Tension: 426.70 Kips

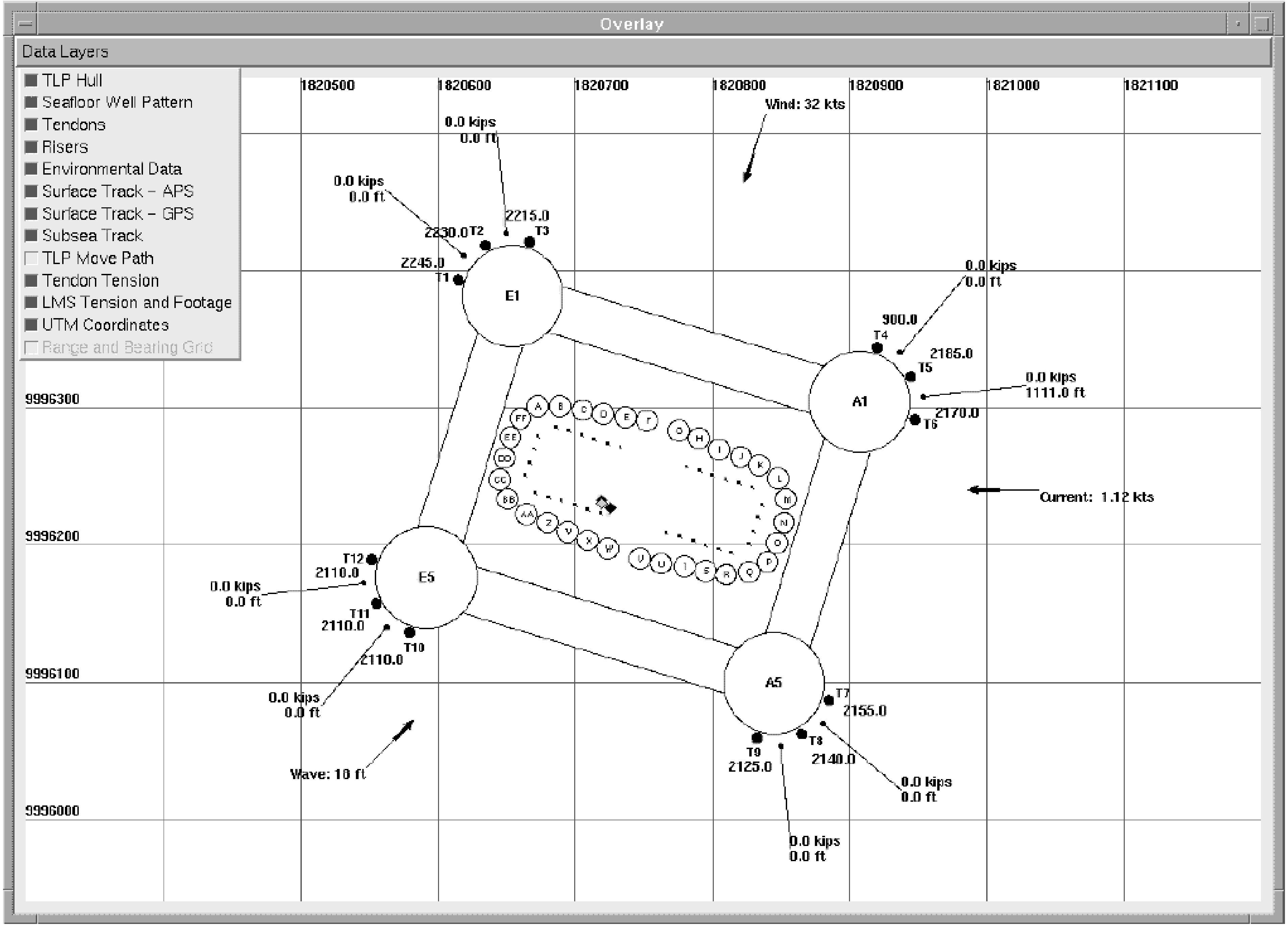
Stroke: −0.12 Inches

Rocker Arm: 17.13 Deg

Pitch: −7.20 Deg

Roll: 0.02 Deg


Trend
File
Config
LT–E108 One Minute Moving Average
100
75
50
25
0
IN
06/07 15:55
06/07 22:10
06/08 04:24
06/08 10:38
Cancel



■ TLP Hull
■ Seafloor Well Pattern
■ Tendons
■ Risers
■ Environmental Data
■ Surface Track – APS
■ Surface Track – GPS
■ Subsea Track
□ TLP Move Path
■ Tendon Tension
■ LMS Tension and Footage
■ UTM Coordinates
□ Range and Bearing Grid

CPU's TCL Activity

C Code:

27,000 lines

Tcl/Tk Code:

120,000 lines

Conclusion

- **SCL has allowed CPU to become more effective at integrating systems.**
  - drastically reduced development time by:

    almost eliminating C code programming

    eliminating linking and compiling

    reducing the need for the script writer to be concerned with memory allocation and other operating system "baggage"
  - greater reusability of applications since libraries are easier to build and maintain
  - debugging and testing is made simpler by the interactive interface
  - all of the above results in a substantially reduced turnaround time

Desired Future Directions for Tcl/Tk

- **Better support for multiple interpreters**
  - Multiple interpreter support for Tk
  - Standard method of resolving signals when using multiple interpreters
- **Further development of canvas**
  - partial fill of objects
  - drawing tool for creating objects and defining bindings
- **Compiler**
- **Windows NT**
- **Continued unencumbered license (no Copy Left)**

Appendix A

SCL RTAP Extensions

Alarm System

rrtas_alarm_ac
rtas_close
rtas_config_connection
rtas_open
rtas_update_msg

Database

rtdb_close
rtdb_config *item*
ADD_NULL_PT, ADD_SCALAR, ADD_TABLE, ADD_VECTOR, ALIAS, ATTR_NAME, CATEGORIES, COPY_ATTR, COPY_BRANCH, COPY_POINT, DEFINITION, DEL_ATTR, DEL_BRANCH, DEL_BR_CHK, EXP_ORDER, GROUPS, MOVE_POINT, PT_CLASS, PT_NAME, RESIDENCE, SET_RECORD_CNT
rtdb_control *item*
CE_ORDER, DISABLE_SNAPS, ENABLE_SNAPS, LOCK_PT, REL_CFI, RUN_CE, SET_CFI, SET_CWP, SET_USAGE, SNAPSHOT, UNLOCK_PT, XFER_LOCK_PT
rtdb_match_pts
rtdb_multi_read,
rtdb_multi_write
rtdb_open
rtdb_query *item*
ALIAS, ALPHA_ATTRS, ATTRIBUTE, ATTR_ACCESS, ATTR_CNT, ATTR_NAMES, ATTR_ORDER, CATEGORIES, CATEG_NAMES, CE_DEP_REF, CE_DEP_UPD, CE_OPER, CONN_INFO, DEFINITION, DE_TYPE, DIRECT, DIRECT_ATTR, EVENT, EXPR_ORDER, FIELD_NAMES, FIRST_CHILD, GROUPS, GROUP_NAMES, LRL, NEXT_SIBLING, PARENT, PTS_IN_CLASS, PT_CLASS, RESIDENCE, SYM_ABS, SYM_ALIAS, SYM_REL, USAGE

Database (cont.)

rtdb_read
rtdb_set
rtdb_write
rtdb_unit_write

Historian

rtdh_close
rtdh_config *item*
AUTOREARM, COPY_ABS_POINT, COPY_REL_POINT, DELETE_TABLE_POINT, RECORD_DATA, TABLE_NAME, TABLE_RESIDENCE, TABLE_SIZE
rtdh_control *item*
ARM_TABLE, AUTOARM_DISABLE, AUTOARM_ENABLE, CLEAR_TABLE, DATAWRAP_DISABLE, DATAWRAP_ENABLE, DISABLE_TABLE, DISARM_TABLE, ENABLE_TABLE, ONESHOT_TABLE
rtdh_open
rtdh_query *item*
AUTOARM, AUTOREAM, DATAWRAP, OUTPUT_TRIGGER, RECORD_DATA, TABLE_CONN_PLIN, TABLE_LIST, TABLE_LIST_CNT, TABLE_NAME, TABLE_RESIDENCE, TABLE_SIZE, TABLE_STATE
rtdh_read
rtdh_set

Event Manager

rtem_attach_event
rtem_change_event
rtem_detach_event

Environment System

rtenv_bind_msg_handler
rtenv_break_dispatch
rtenv_dispatch_msg
rtenv_get_env_dir
rtenv_get_error
rtenv_get_my_name
rtenv_ get_option *item*
    DEBUG, PRECISION, READ_BUFFER, READ_WRITE_STAT
rtenv_get_proc_name
rtenv_get_proc_num
rtenv_get_unix_pid
rtenv_log_error
rtenv_msg_recv
rtenv_msg_send
rtenv_print_error
rtenv_query_msg_handler
rtenv_sched_process
rtenv_set_my_name
rtenv_set_option *item*
    DEBUG, PRECISION, READ_BUFFER, READ_WRITE_STAT

Plot System

rtpd_control *item*

CLOSE_VIEW, CONFIGURE_PLOT, COPY_PLOT, COPY_PLOT_UNDER, DELETE_PLOT, HOUR_GLASS_OFF, HOUR_GLASS_ON, ICONIFY, ICONIFY_VIEW, OPEN_VIEW, OPEN_VIEW_AT, PRINT_PLOT, PRINT_PLOT_TO, REFRESH, SET_LIST_BY_PARENT, SET_LIST_BY_SIBLING, SWITCH_VIEW, UNICONIFY, UNICONIFY_VIEW

rtdp_query *item*

GET_CONTEXT, GET_VIEW_STATUS

Scan System

rtss_close

rtss_control *item*

COLD_RTS_DEVICE, COMM_PORT_MODE, DISABLE_SS, DISABLE_CP, DISABLE_SD_SI, DISABLE_SD_SI_PT, DISABLE_SD_SO, DISABLE_SD_SO_PT, ENABLE_SS, ENABLE_CP, ENABLE_SD_SI, ENABLE_SD_SI_PT, ENABLE_SD_SO, DENABLE_SD_SO_PT, FORCE_POLL, FORCE_POLL_TYPE, FORCE_PRBX, FORCE_PRBX_TYPE, POLL_PERIOD, POLL_TYPE, PRBX_PERIOD, PRBX_TYPE, SET_TIME, SNAP, SNAP_WITH_VERIFY, WARM_RST_DEVICE

rtss_open

rtss_query *item*

SYSTEM_STATE, TASK_STATE

rtss_read

rtss_set

rtss_write

SCL Initialization

scl_init

Time Keeper System

rttk_cancel_timer

rttk_delay

rttk_start_timer

Watchdog

rtwd_cancel_monitor

rtwdcontrol_server

rtwd_report_condition

rtwd_start_monitor

Appendix B

SVM Extensions

Schematic View Manager

- svm_bind
- svm_control item
  - POLL
  - REFRESH
  - RUN
  - STOP
- svm_config_menu
- svm_config_menu_item
- svm_config_sch
- svm_config_sym
- svm_control
- svm_create_menu
- svm_create_sch
- svm_destroy_sch
- svm_message
- svm_query
- svm_query_sch
- svm_query_sym
- svm_set