

RTAP Trainer Systems



An Overview of the Enbridge SCADA Simulator

Overview:



- **What is a Trainer System?**
- **Why do we need Trainers?**
- **System Architecture**
- **Implementation**
 - **HMI**
 - **Scan Task and Model communication**
 - **PTSS (Pipeline Trainer SCADA Simulator)**
 - **RTAP Trainer Database**
- **System Maintenance**
- **Future Direction**

What is a Trainer System?

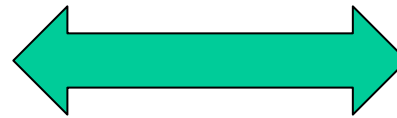


- **Essentially an offline replica of the SCADA System.**
 - Operators can train and expand their knowledge on a simulated system.
 - Behavior and response of the pipeline is controlled by mathematical transient models, based upon operator input.
 - Look and feel of the Trainer system is identical to that of the live production systems.

The Trainer System



Model responds to commands and provides realistic read backs, replacing the live field data.
Live production system, SCADA polls field telemetry



SCADA Operator

Trainer Functions



- **Operator Training**

- Regular refreshing of skills
- Develop experience in an offline environment, avoid learning “on the job”
- Learning new systems

- **Regulatory recommendations**

NTSB/ USA DOT - Pipeline incidents

- “Simulation of abnormal events would better prepare controllers for these rare events”



Trainer Functions

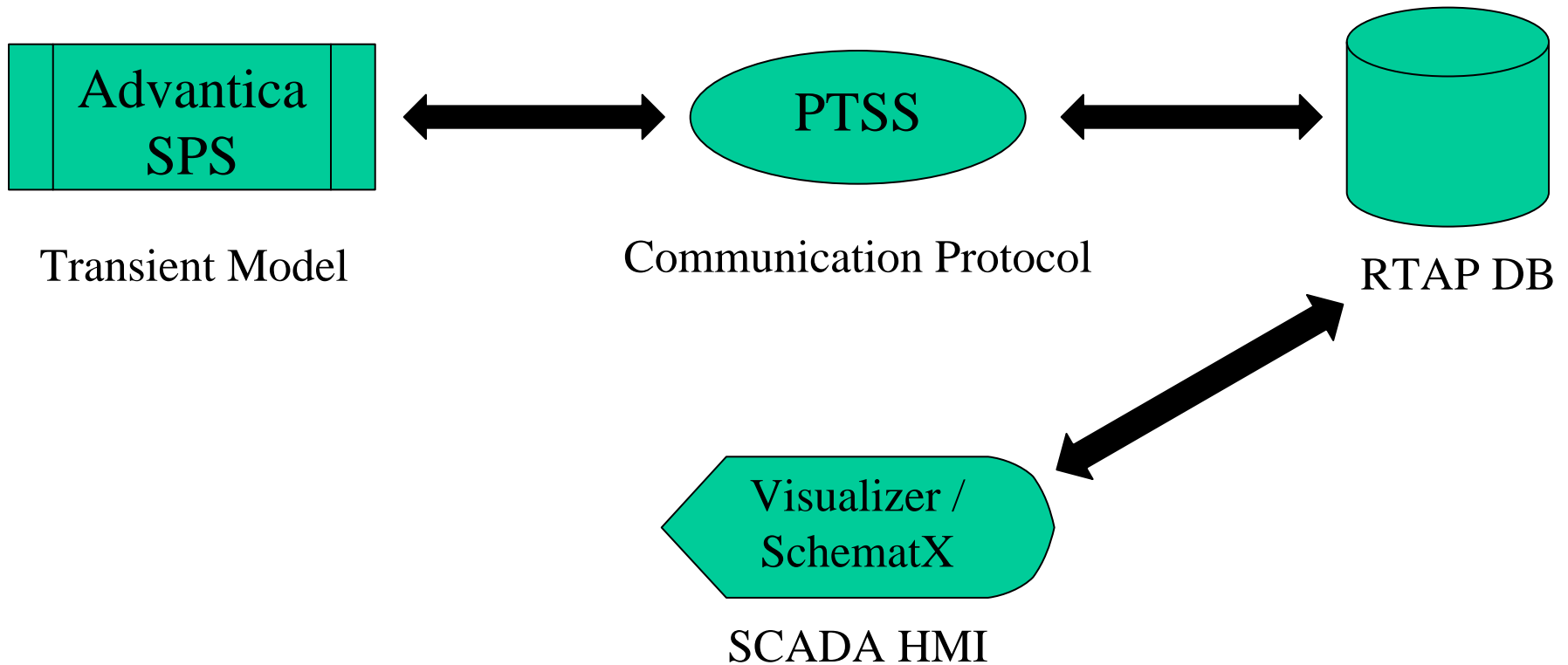


- **Simulations**

- New features and components can be tested before release into production
- Efficiency of new operating procedures can be analyzed.
- Run “mock emergencies”, scenarios of rare abnormal operating conditions.



Trainer Component Layout



SCADA HMI – Operator Console



- **Visualizer HMI for Gas systems, SchematX for Liquid**
- **Identical hardware to production consoles**
 - XV6000, RP3440, etc
- **HMI Display set identical to production**
 - **Additional displays for controlling the model**
 - Start, stop and reset the model



Trainer HMI Screenshot



Gas Trainer control panel

The screenshot shows a software window titled "Trainer Control" with a blue title bar. The interface is divided into several sections:

- Top Left:** The "PROCYS™" logo with the tagline "progressive control systems" below it.
- Top Right:** A digital clock displaying "2008-09-08 15:23:07".
- Center:** A large panel titled "Select Case" in green. It contains a list with "Vector" selected and highlighted in blue.
- Left Side:** A vertical stack of three buttons: "Select Case", "Select Scenario", and "Start Model".
- Bottom Left:** A command prompt window showing the text "pcCmdHandler Set Case\alias>" and "TRVC\vector".
- Right Side:** A panel titled "Current Case and Scenario" containing a list with "vector" and "fix", and a text field labeled "archiveName". Below this is a field containing the IP address "10.220.25.226:0.0".
- Bottom:** A horizontal bar with three buttons: "Confirm Command" (in red text), "Help", and "Close".

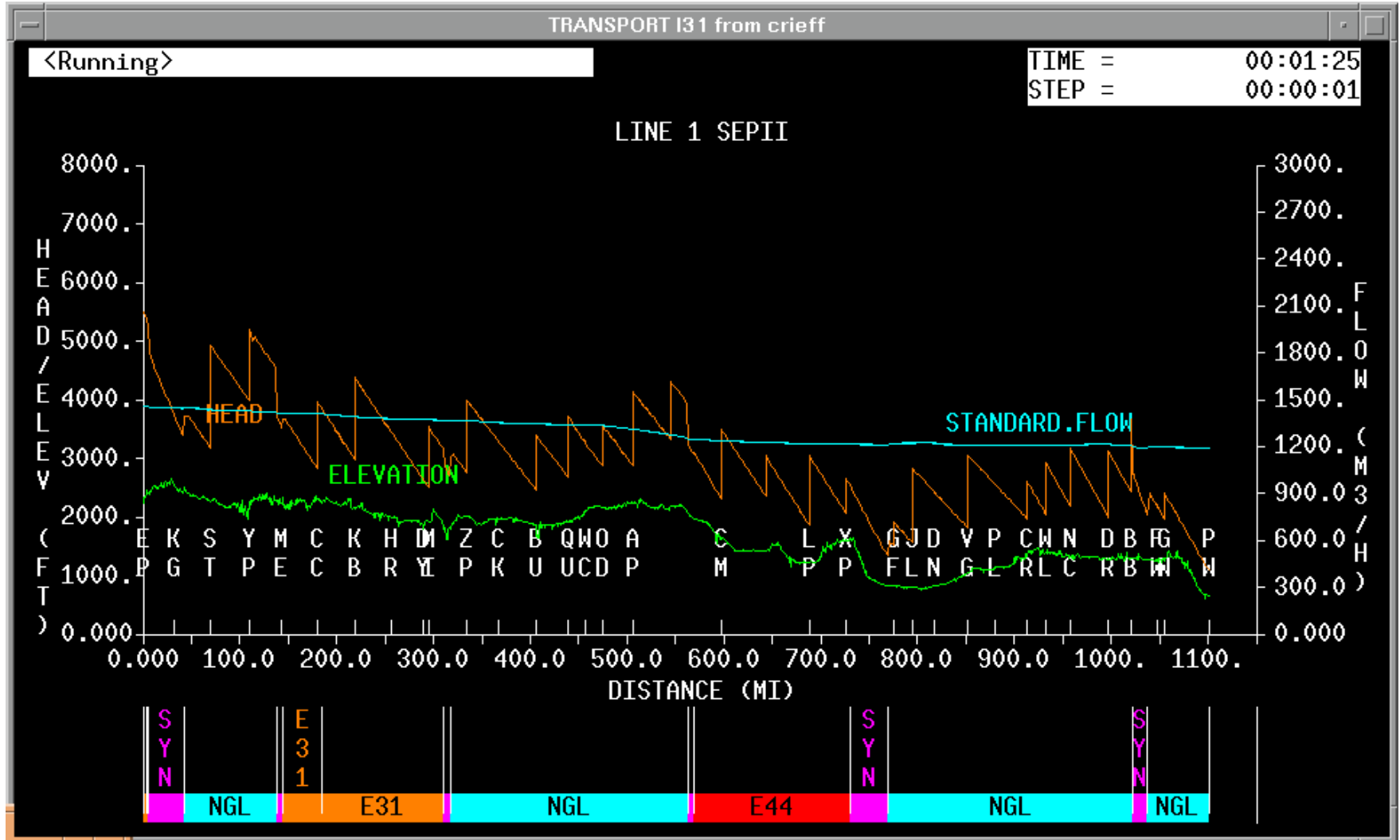
- **RTAP running on HPUX 11i**
- **Version of the Production DB is copied to the Trainer server**
- **Trainer configuration information is contained within the database structure**
- **Scripts are used to convert the production DB into a Trainer DB**
 - **Basic structure is retained**
 - **Majority of modifications pertain to the Scan system config**

Transient Model



- **Advantica Stoner Pipeline Simulator (SPS) software**
 - Transient flow simulation of Gas or Liquid pipelines
- **Simulates all major equipment and controls**
 - Peng-Robinson, CNGA, AGA-8 equations of state
- **Pipeline behavior modeled through thermodynamic and hydraulic modules**

Model Screenshot



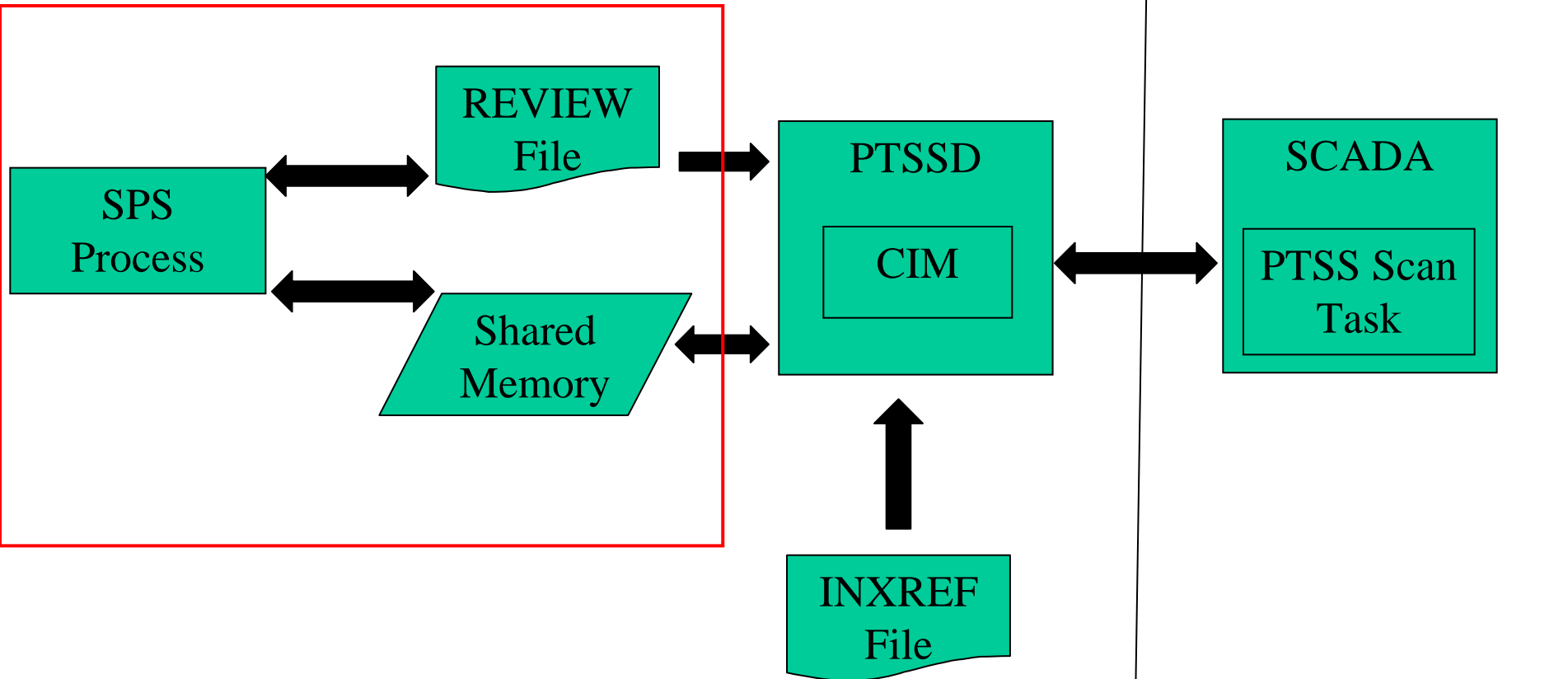
- **SPS displays allow certain model values to be updated.**
 - **Trainer coordinators introduce events to training sessions**
 - **Build scenarios to be saved and replayed**
 - **Simulations can be modified to run under different combinations of line states**

PTSS Process Diagram



Model Software

SCADA Software



PTSS Components

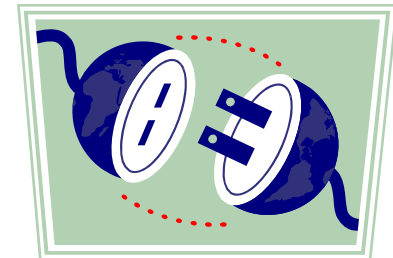


- **SCADA scan task**
 - generates PTSS poll and command messages, which are sent back via the PTSS interface server to the model
 - Handles the response to all sent messages
- **PTSS interface server (PTSSD)**
 - PTSSD runs as a daemon process, located on the same server as the SPS model
 - Formats and transfers data between Scan Task and Model

PTSS Scan Task Communication



- **The SCADA scan task is configured with the hostname and service name of the PTSSD process**
- **Inter-process communication between scan task and PTSSD is handled using socket streams over TCP/IP**



PTSS Configuration



- **Config file parameters provide the following:**
 - **Path to SPS executables and libraries**
 - **PTSS working directory where temporary model files are stored**
 - **Scenario file name, which contains a list of scenarios**
 - **Saved model files which can be loaded, starting the model in a specific state**

PTSSD Model Communication



- **PTSS uses an SPS API function to pass messages between the simulation and the SCADA scan task**
 - **CIM (communication interface module)**
 - **CIM accesses model data via a REVIEW file and shared memory structures, where the model stores it's running data.**
 - **CIM recognizes appropriate messages and executes the corresponding model directive**

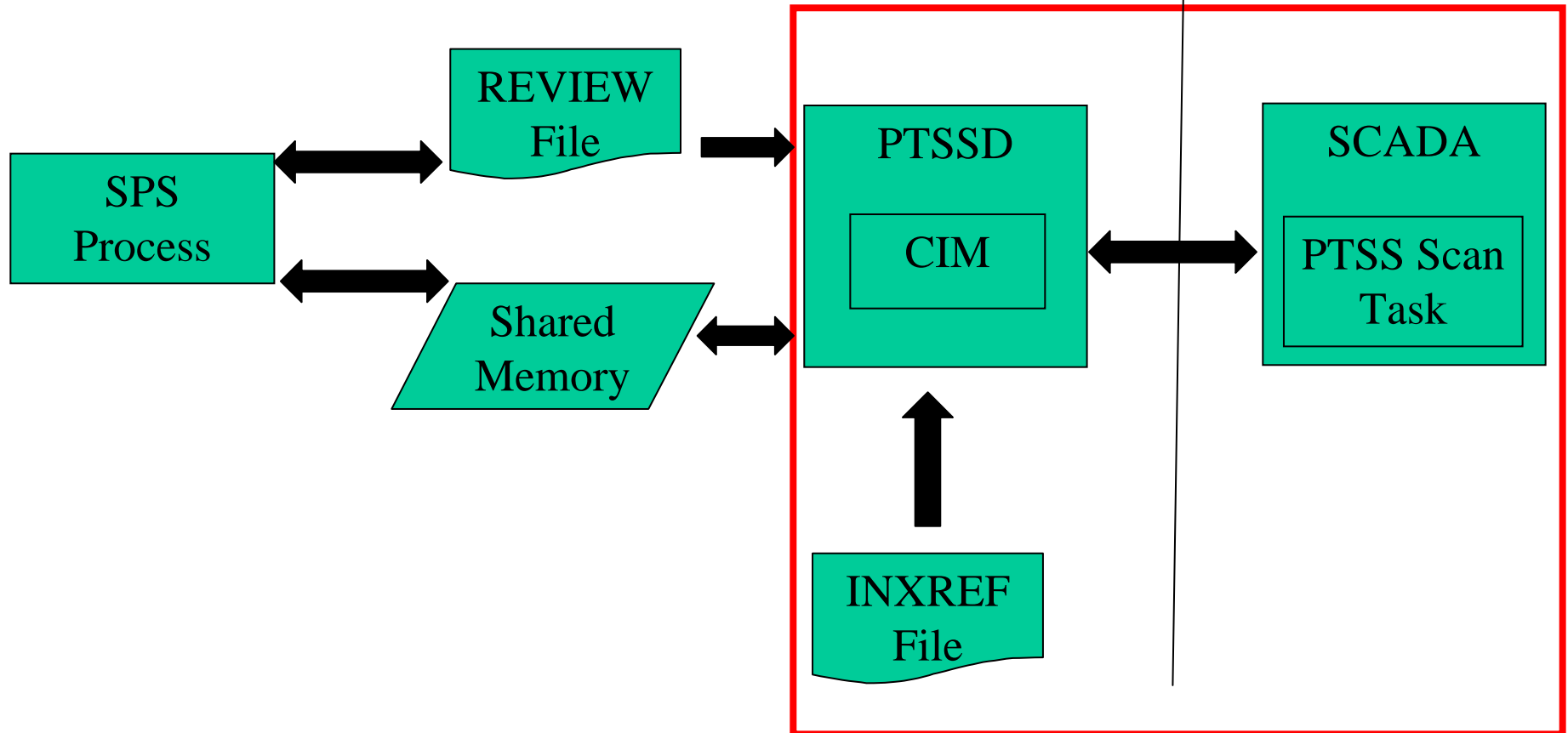
- **Point mapping reference between the Simulator and SCADA system**
- **ASCII file format, is read by CIM**
 - INXREF file is used by CIM to recognize valid messages
 - Describes all valid commands and messages
 - Poll request, Open Valve, Scan Station, Stop Simulation, etc
 - Lists any directives or actions to be taken by the model
 - Stop Model command received triggers a HALT command inside the Model

PTSS Process Diagram



Trainer Software

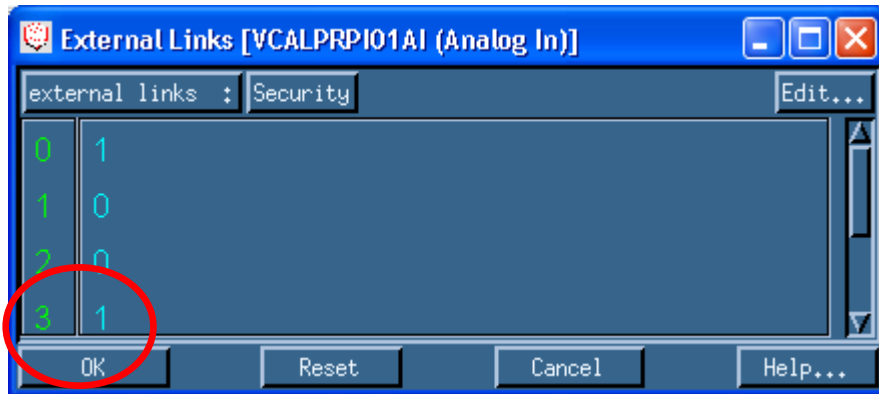
SCADA Software



RTAP Trainer Database

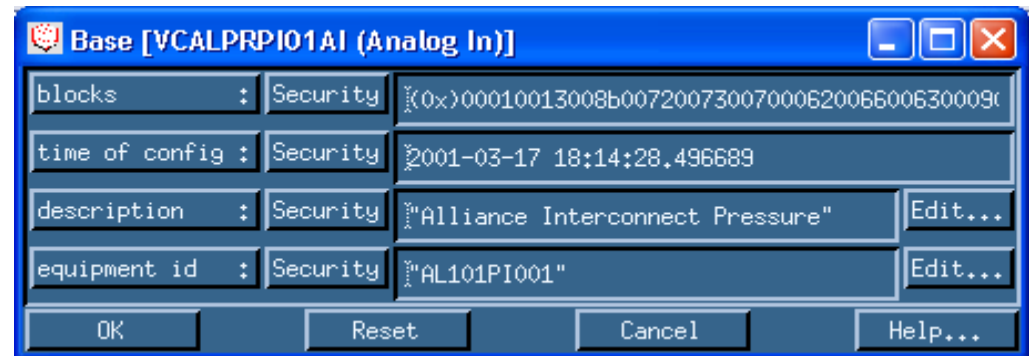


- Database contains configuration for generating the INXREF files



A flag is set in an External Links vector for each point to be linked to SPS

Equipment ID attribute contains the point name to be used in SPS



Generating the INXREF Files



- Perl scripts are used to generate the INXREF files

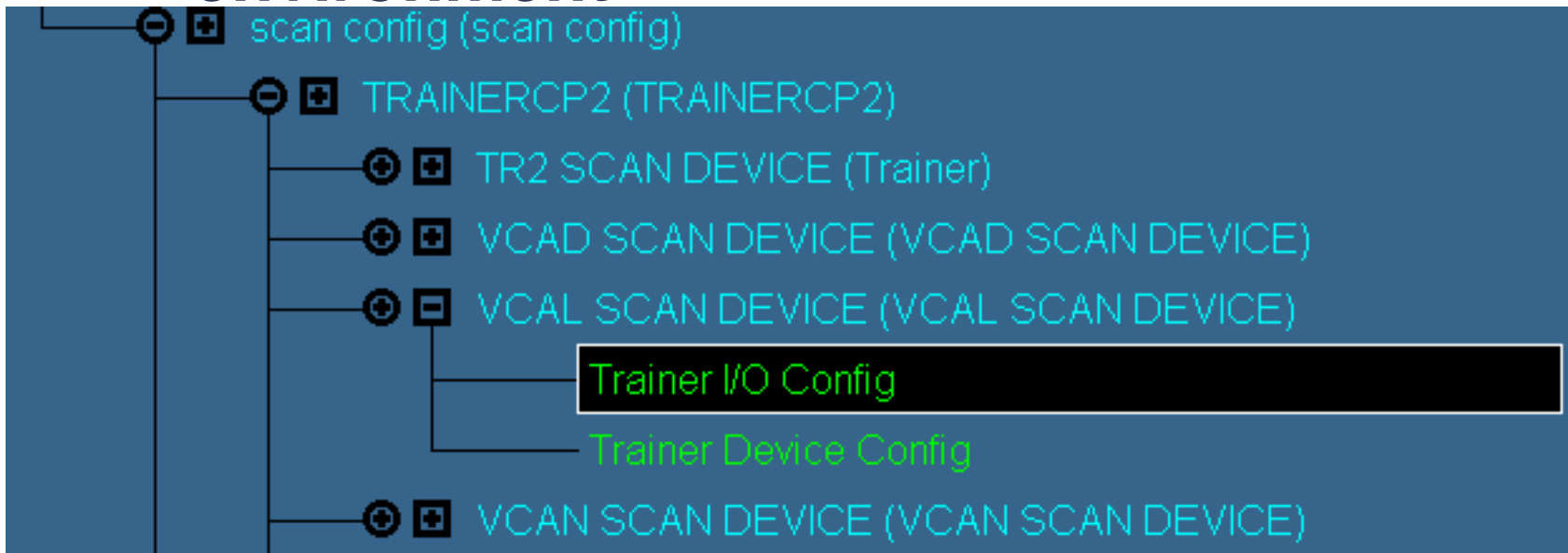
```
UBYTE
  0Ax,
  4,          /* Data Type
  1;          /* Data Subtype
UMINT2
  0,          /* Start Index
  16;        /* End Index
LIEREAL
  VCAL_AL101FLOWZIO03, /* VCALCNFCCO03AI.raw value : 004|001|000000
  VCAL_AL101PIO01,    /* VCALPRPIO1AI.raw value : 004|001|000001
```

- Once defined in the INXREF, the point will receive updates from the model via the scan task

RTAP PTSS Scan Task



- Replaces existing scan tasks in the environment



- Typically one scan task process with one scan device for each station in the system.
- DB Structure created using Perl scripts

Scan Input / Output



- **Scan input and output tables are generated at the same time as the INXREF**
 - Analog points with the external links flag are added to the scan input table
 - Commands are added to the scan output table
 - Perl scripts used again to create the scan links

	elements	RTAP DE type	deadband type	deadband	link address	reserved1	data type	data subtype	index
20	1	2	0		[VCALVLIV02.raw value closed]	0	1	1	19
21	1	2	0		[VCALVLIV02.raw val travl close]	0	1	1	20
22	8	2	0		[VCALCNFCCO03AI.raw value]	0	4	1	0
23	8	2	0		[VCALPRPI01AI.raw value]	0	4	1	1
24	8	2	0		[VCALPRPI04AI.raw value]	0	4	1	2
25	8	2	0		[VCALSTDYFBPVAI.raw value]	0	4	1	3

Scan Input and INXREF



Elements	RTAP DE type	deadband type	deadband	link address	reserved1	data type	data subtype	index
20	1	2	0	[VCALVLIV02.raw value closed]	0	1	1	19
21	1	2	0	[VCALVLIV02.raw val travl close]	0	1	1	20
22	8	2	0	[VCALCNFCCO03AI.raw value]	0	4	1	0
23	8	2	0	[VCALPRPI01AI.raw value]	0	4	1	1
24	8	2	0	[VCALPRPI04AI.raw value]	0	4	1	2
25	8	2	0	[VCALSTDYFBPVAI.raw value]	0	4	1	3

INXREF

```
UBYTE
  0Ax,
  4,
  1;
UMINT2
  0,
  16;
LIEREAL
  VCAL_AL101FLOWZIO03,
  VCAL_AL101PIO01,
```

```
/* Data Type
/* Data Subtype
/* Start Index
/* End Index
/* VCALCNFCCO03AI.raw value : 004|001|000000
/* VCALPRPI01AI.raw value : 004|001|000001
```

Maintenance – Addition of a transmitter



- **New points must be added to the model.**
 - Equipment ID will be provided to the modeling staff
- **Set the external link flag**
- **Execute the scripts to rebuild the INXREF files and create the scan link**
- **Restart PTSS (RTAP scan task and PTSSD)**
- **Commissioning**



Maintenance - Challenges



- **Ever changing systems involve continually keeping the Trainer System up to date.**
 - **Simulations must retain a certain level of resolution**
 - **The training system must provide a realistic view of what is actively being used on the live system**
- **Any work to the trainer system requires coordination between Model and SCADA modifications.**

Portable Trainer



- Allows a trainer system to be setup at any location
- Used for Simulations and training directly in the control center
- Can be moved among external training locations

Portable Trainer In Use!



Simulations and the live systems can be compared side by side



Training can occur inside the Control Centre

Looking Forward



- **Reduce the time required to convert to a trainer database**
 - Reduce the amount of modifications required
- **Modular Implementation**
 - Provide phased trainer solutions
- **Trainer event playback**
 - Take events recorded from the productions system and replay them on the trainer
 - Load production data in the trainer system



Questions



Questions?