



Introduction



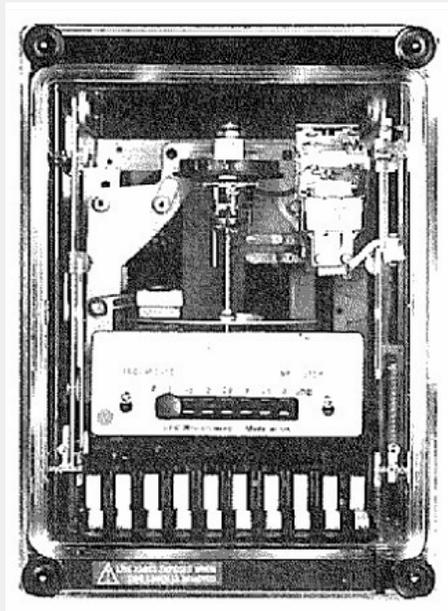
- Background - Historical context and evolution of protection relays and settings management
- Common protection settings management methods
- A 'wish list' for a modern Protection Settings Management System (PSMS)





Background – Where have we come from?

- First relays were electromechanical (mechanical contact driven by action from current through a winding)
- Superseded firstly by static relays (protection functionality controlled by analog electronics)
- Most modern relays are 'numerical'



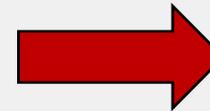
gré

Australia
AP B5
SEAPAC 2009



Current practice - settings management

- Utilities generally manage protection relay settings with a combination system including:
 - Paper based settings sheets
 - Spreadsheets
 - File servers and databases
- These systems have increased in complexity with the relays
- Gradual evolution





Settings management by spreadsheet

Advantages

- It 'just works' (saved by the engineer)
- Spreadsheets ubiquitous
- Powerful 'fast' search features
- Flexibility

Disadvantages

- Non integrated
- Data integrity
- No user rights management
- Lack of auditing
- No common data format
- Large administration overhead
- Challenges for remote access
- Difficulty replicating the 'business lifecycle'





Example – managing data integrity

- A spreadsheet management system records the active relay functionality (definite time over-current) in simple text field.
- Question: How is this information stored in the spreadsheet?
 - O/C, OC(DT), Over-current, Definite time over-current, I>>, 50
- A spreadsheets free text fields mean that users are free to enter any value that makes sense to them
- This leads to data inconsistencies and confusion
- Result – time and money is wasted
- Worst case - A failure to operate puts lives at risk





The solution! – A modern PSMS



- Requirements:
 - Settings repository (independent format)
 - Remote access (web based)
 - Flexible user management and auditing
 - Implementation of the business lifecycle
 - Powerful reporting and search
 - Automatic storage of important documents such as relay manuals, test reports and historical records
 - Links to an advanced analysis tool





Data repository – A common data format

- Storage of the settings in an independent format allows display of the relay settings in a common interface
- Settings changes can be easily tracked and audited

Settings		Actions	
Name	Default	Edit...	Export...
Device type	SEL-551	Change status...	Import...
Status	PowerFactory	Copy...	[Report] Simple settings report...
Description		Delete...	[Report] Settings changes...
Last change	6/06/2008 11:45:00 AM [Administrator]	Compare to another device...	[Report] Settings alternative...
Voltage Level [kV]	0		
GlobalNote			

0	L	P	T	R	Settings documents	Additional documents	Notes	Links	Audit trail
Attribute	Description	Value	Range	Unit	Assigned				
Identifier Labels									
RID	Relay Identifier	DEMO		12 chars	<input checked="" type="checkbox"/>				
TID	Terminal Identifier	HELLO		12 chars	<input checked="" type="checkbox"/>				
Current Transformer Ratios									
CTR	Phase (IA, IB, IC) Current Transformer Ratio	120	1-6000		<input checked="" type="checkbox"/>				
CTRN	Neutral (IN) Current Transformer Ratio	120	1-6000		<input checked="" type="checkbox"/>				
Minimum Trip Duration Timer									
TRIPD	Minimum Trip Duration Time	0	0-6000	seconds	<input checked="" type="checkbox"/>				

Setting	Additional documents	Notes	Links	Audit trail
Changed item				
Changed on [Thursday, 31 July 2008 3:06:26 PM] by [Brad]				
Lifecycle status		Thursday, 31 July 2008 3:06:20 PM		Planning Pending
Changed on [Thursday, 31 July 2008 3:06:45 PM] by [Brad]				
Setting		CS		40 38
Setting		TS		0.13 0.15
Changed on [Thursday, 31 July 2008 3:06:51 PM] by [Brad]				
Lifecycle status		Thursday, 31 July 2008 3:06:49 PM		Pending Issued
Changed on [Thursday, 31 July 2008 3:06:54 PM] by [Brad]				
Lifecycle status		Thursday, 31 July 2008 3:06:52 PM		Issued Applied



User management and remote access

- Remote access is a fundamental requirement of the modern workplace
- Solution - web based software and offline modes
- A modern system must have configurable user rights
- Configurable user access, read only, write etc

The screenshot shows the 'Administration > Users and user groups' page in StationWare. On the left, a tree view shows the hierarchy: Administrators, Approvers, Designers (expanded), Everyone, and Maint_WR. Under 'Designers', users listed include Brad, Aragorn, Bilbo, Frodo, Gimli, and MRP. A 'Submit' button is at the bottom of the tree.

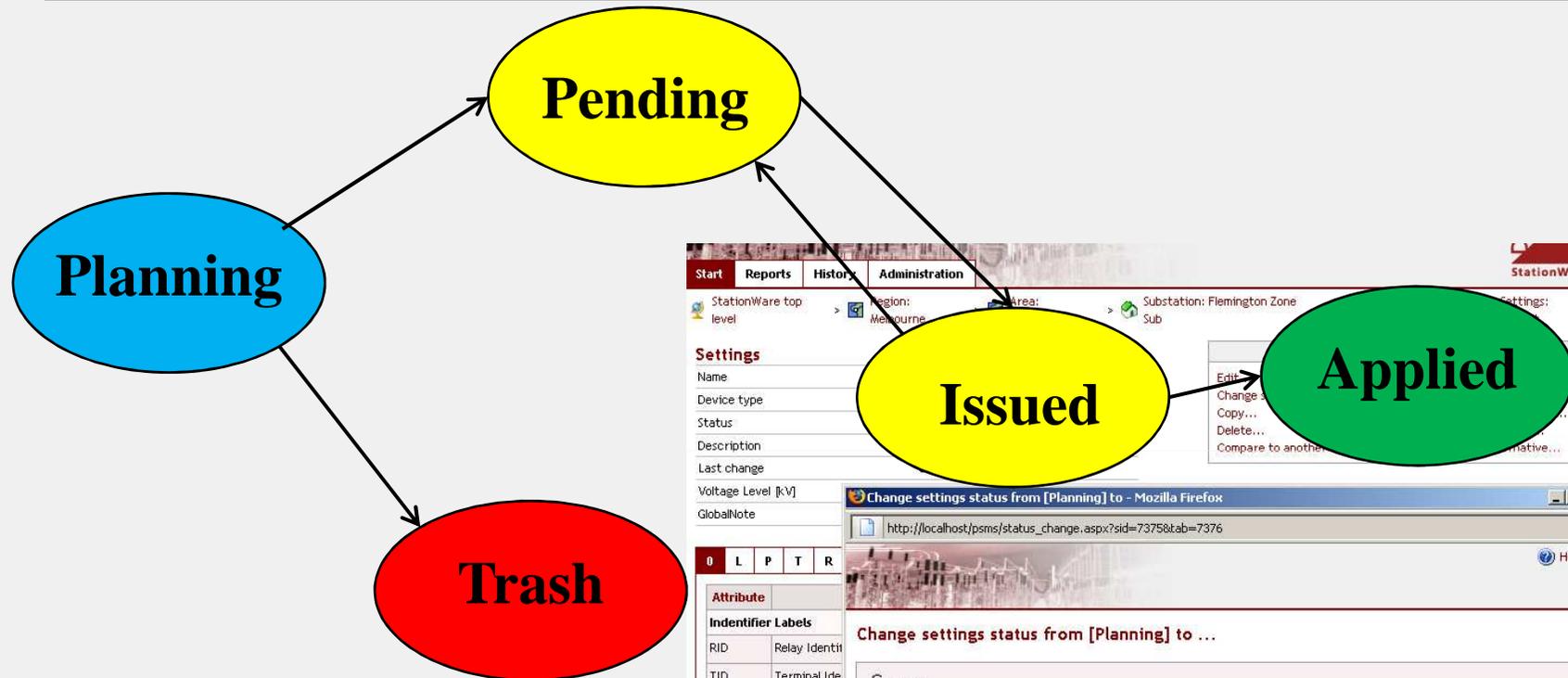
On the right, the 'Group: Designers' details are shown. The 'Rights' tab is active, displaying a table of permissions:

Name	Description	Read	Write	None	Effective
PSMS_DEVICE	Devices	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	Write
PSMS_DOCUMENT	Documents	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	Write
PSMS_GROUP	Settings groups and values	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	Write
PSMS_LINK	Links	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	Write
PSMS_LOCATION	Locations	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	Write
PSMS_OFFLINE	Offline transfer authorization	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	None
PSMS_SETTINGSSTATUS	Settings status	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	Write
S_ALL	Administrative super user right	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	None

Below the table is a 'Submit' button. An 'Actions' panel on the right contains: 'Create user or group...', 'Create user or group as member...', and 'Delete...'. The bottom right corner of the interface shows 'Version: 3.3.A (10/07/2008)'.



Implementation of the business lifecycle



StationWare top level > Region: Melbourne > Area: > Substation: Flemington Zone > Sub: > Settings:

Settings

Name
Device type
Status
Description
Last change
Voltage Level [kV]
GlobalNote

Change settings status from [Planning] to - Mozilla Firefox

http://localhost/psms/status_change.aspx?sid=7375&tab=7376

Change settings status from [Planning] to ...

Pending
 Applied and Accepted
 PowerFactory

Status change date: 31/07/2008 3:42:28 PM

Reason

Change

Done

Attribute	
Identifier Labels	
RID	Relay Identif
TID	Terminal Ide
Current Transformer R	
CTR	Phase (IA, IE
CTRN	Neutral (IN)
Minimum Trip Duration	
TDURD	Minimum Trip
Phase Instantaneous O	
50P1P	Pickup
50P2P	Pickup
50P3P	Pickup
50P4P	Pickup
50P5P	Pickup
50P6P	Pickup
Single-Phase Instantaneous Overcurrent Elements 50A, 50B, 50C	
50ABCP	Pickup
	OFF 0,1-80,0:OFF=1000000 A

Reporting and searching

- A move to an integrated PSMS should not sacrifice existing search capabilities of spreadsheets
- A flexible reporting and searching environment is required

Name	Description
Simple location list	Creates a list of all locations. You can optionally specify an base location
Simple settings report	Reports all the settings parameters belonging to this settings record
Settings alternative	Shows the settings parameters in alternative manner (ideal for long-textual contents)
Settings changes	A comparison between the current parameter values and those being applied
Simple device report	Shows the devices and lists the settings records related
Device details alternative	Alternatively lists the details of a certain device
Advanced Search	Provides a report closely like the advanced search
Flexible report	Report based on user defined script text
Devices on a certain level	Devices on a certain level
Overall status report	A table showing the overall status of the objects such as devices and locations
Historic search	Lists the items according to the timestamp specified
Audit trail report	Lists audit trail entries within a certain location and time span
Devices in use	Lists devices according to a device type
Templates in use	Lists templates according to a template type
Device type usage count	Shows the usage count of a certain device type
Device type usage grouped by location type	Shows all instances of a given device type. The result is grouped by a location type.
Usage of templates	Shows the usage count of a template types
Settings maintenance information	Lists the actions done on the settings records of a device
Changes within a location	Lists the changes done on objects within a location
Lifecycle changes	Shows the lifecycle changes within a location according a specified time period
Settings and lifecycle	Shows settings according to a lifecycle phase
Settings by additional attributes	Lists settings by a certain additional attribute value
New entries	Shows entries that got inserted during a time span specified
Changed entries	Shows entries that got changed during a time span specified
Additional documents	Shows the additional documents added to objects
Locks list	Shows locked objects
All users with their group relation	Shows the users, their properties and group relation
Temporary file clean report	Deletes temporary files (that got created due to import, export and reporting)

Data repository

- Manuals, test reports and settings calculation documents should be easily accessible and stored in the PSMS

Start Reports History Administration

StationWare top level > Region: Melbourne >

Device [Relay]

Name: 351

Description:

Type: SEL-351

Manufacturer: SEL

Last change: 6/06/2008 12:11:3

Manual: [351.pdf](#) (1.00 MB)

Voltage Level [kV]: 0

GlobalNote:

Overall Status: Settings missing

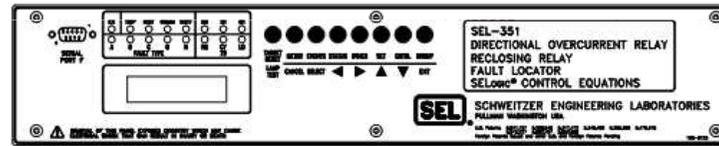
Next Test Due: 1/01/0001 12:00:

Test Frequency [Months]:

ANSI Device Function Number: 50/51/67/79

Settings	Compare	Additional documents	Not
Name		Description	
Default			6/06/2008 1

SEL SEL-351 Distribution and Transmission Relay



Directional Overcurrent Relay, Reclosing Relay, Fault Locator

Data Sheet

- Voltage or load-encroachment control of the four phase time-overcurrent elements for load security.
- Six levels of phase, neg.-seq., neutral, and residual overcurrent elements for coordinated protection.
- Phase and ground directional elements for sensitive, yet secure fault detection:
 - Phase directional element includes memory for directional stability.
 - Patented Best Choice Ground Directional™ Logic selects the optimum element for system conditions.
- Communication tripping scheme logic for rapid fault clearing.
- Programmable four-shot recloser with synch-check matches your reclosing practice.
- Phase and sequence under- and overvoltage elements increase control scheme flexibility.
- Six steps of accurate frequency elements for multilevel under- and overfrequency trip and control.
- Event and sequence-of-event reports simplify fault and system disturbance analysis.
- Breaker monitor, which uses breaker manufacturer's published data for maintenance scheduling.
- Optional high-current interrupting contacts increase reliability by eliminating auxiliary relays.
- Substation battery voltage level feature monitors and reports dc voltage levels.

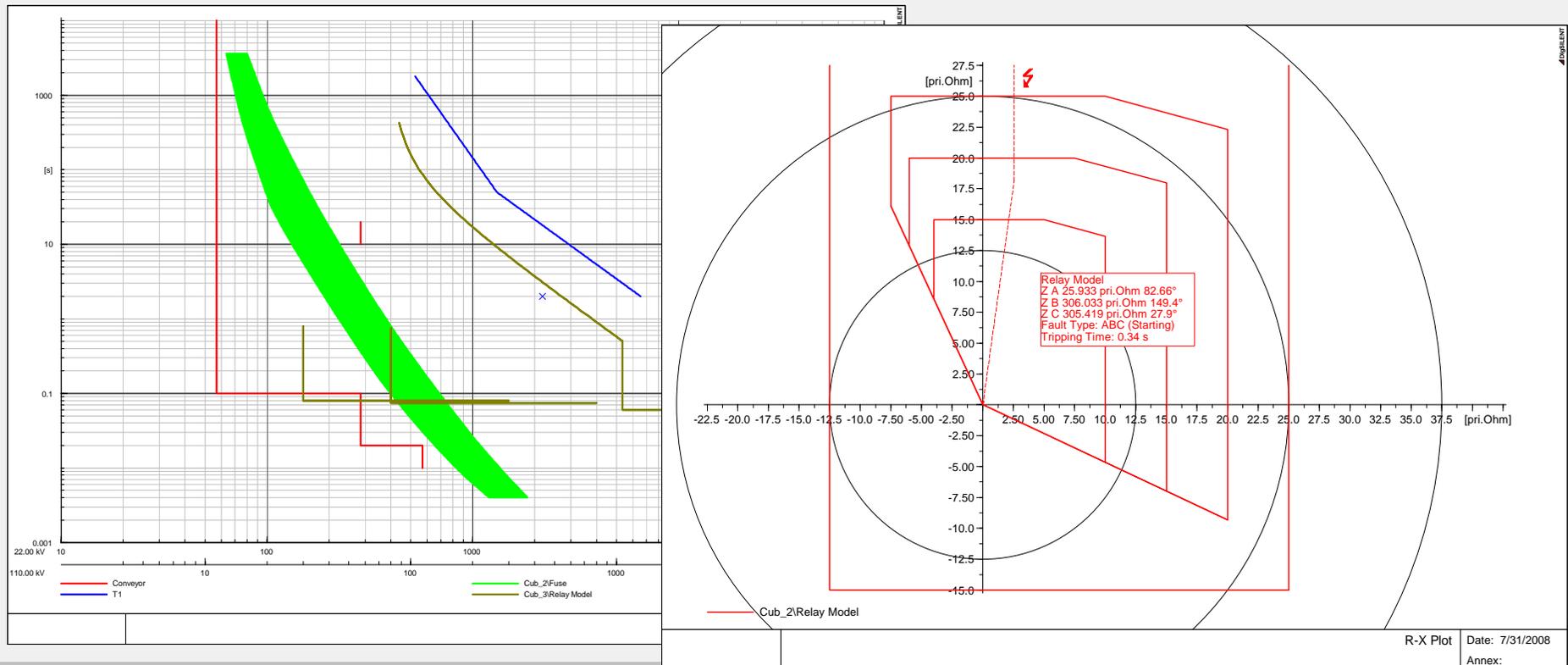


Australia
AP B5
SEAPAC 2009



Linking to the analysis tool

- Automatic linking to a power system analysis tool allows for easy settings design
- Protection settings verification is only a click away





Conclusion

- The increasing complexity of numerical protection relays is leading to great difficulty for protection settings management
- Poor settings management risks lives
- A modern PSMS allows for integration of existing spreadsheets, paper trails and file systems into a single database
- Such a tool will save a utility time, money and reduce the risk of protection mis-operation