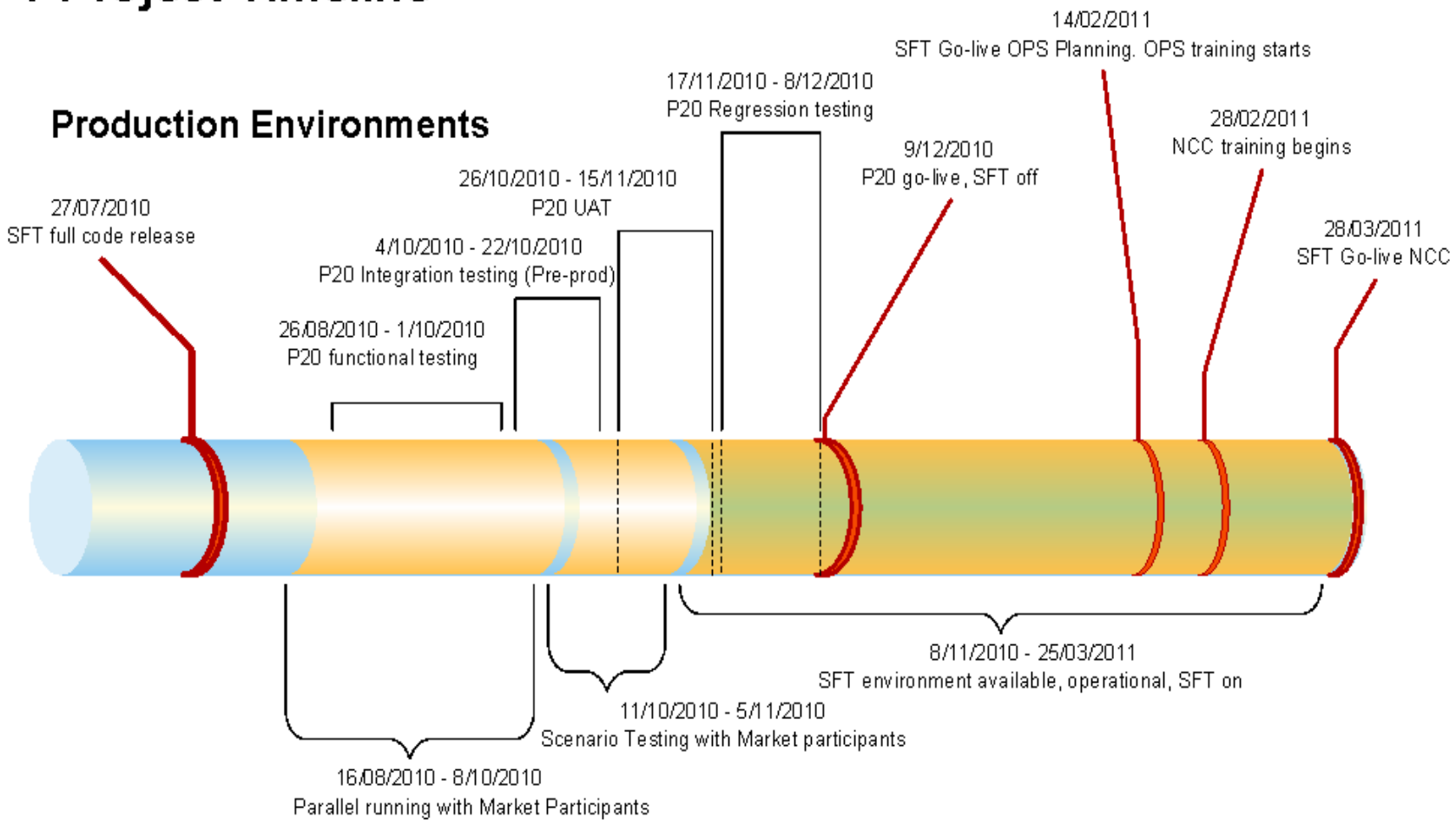
SFT Implementation

Debrief Presentation

SYSTEM OPERATOR

SFT Project Timeline



SFT Test Environment

Workshop Content

- SFT Application
- Test Outcomes
- Operational Management
- Parallel Operations Results
- Scenario Testing Results
- Issues Register
- Discussion

SFT Application

- International Use
- SFT was created for the initial PJM Financial Transmission Right auction in 1999
- SFT is now used for both FTR auctions and grid security management:
  - PJM
  - Midwest ISO
  - ISO-NE
  - SPP

Test Outcomes -Testing Stages

- Software validation – Passed July 2007
- Functional testing – Passed June 2009
- Boundary Analysis testing – Passed with recommendations March 2010
  - SPD – SFT Iteration & convergence
- Internal testing – Due December 2010
  - Performance testing
  - Constraint validation / accuracy
  - SAD – Stand Alone Dispatch
  - Market system operator interface – displays / events / alarms
  - Publication of results
  - Business processes
  - Exceptions / scenarios
  - Daylight savings
  - Functional testing
  - User acceptance testing
  - Regression testing
- Customer Parallel Operations – Completed October 2010
- Customer Scenario Tests – Completed November 2010

Test Outcomes - Business Process

- Issues Identified
  - System Operator SFT support was limited
  - Schedules take longer to run with SFT on
  - The affect of reactive profiles on SFT constraints was unknown
- Changes
  - Focus will shift from identifying where we want / need constraints to where we don't
  - Constraints related to outages will no longer be overrides, outage time changes will require running a SFT schedule
  - Correct MDB contingency modelling will be necessary
- Unchanged
  - Stability constraints will still be manually applied
  - Constraints will still be adjusted in real time
  - Discretion will still be required

Test Outcomes - Business Process

Observed Benefits

- Generators will be able to offer closer to binding constraint limits with reduced margins of error due to the constraints all being created based on the most up to date offers, topology and load forecasts
- SFT generated constraints highlighted steady state security issues that had not been previously considered in steady state. Early indication of where constraints will be applied reduces the need to apply new manual constraints at short notice (with inherent risk), use discretion (limiting generators ability to manage fuel) or change existing constraints by large amounts
- The speed and accuracy of the constraints generated by SFT and the ability to quickly check the impact on security of outages will allow outages to occur that previously would not have been considered due to complexity in planning; this will have the downstream affect of delaying the need for transmission investment
- Significantly less constraints applied to schedules to check / validate

Test Outcomes - Issues

- At times constraints could be generated with extremely high and / or low sensitivity
- Reserves were removed from convergence criteria
- Needed the ability to define branches that should not be protected
- Manually deactivated constraints were recreated
- Needed code change for modelling SPS where conditional monitoring used
- SFT results were not readily available in the MOI
- Needed the ability to define number of iterations by case type
- Manual adjustments to RHS were overwritten by subsequent solves
- Constraints are not created for unsolved / partially solved contingencies or when SFT fails
- There was no way of turning SFT off
- A schedule has to be run / triggered when system conditions change
- SFT fail originally failed entire case
- Constraints protecting transformers were calculated using post event voltage
- Constraints were not always calculated using flows at sending end of branches

SFT
Operational Management

Planning Time

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Contents

- Process Changes
- Improvements on Manual Constraint Process
- WDS & SDS constraints

Process Changes – Planning Time

Current Manual Constraints Process

- Manual Powerflow analysis done to identify constraints
- Multiple studies must be done to try to predict all likely scenarios
- Constraints manually built in Asset Capability Information database (ACI)
- Current process involves pair checking and can involve several man hours to produce a single constraint.
- If there is a change in system conditions constraints must be built at the last minute putting pressure on planners and creating risk of error.
- Constraints Process requires large time resource

Process Changes – Planning Time

SFT Constraints Process

- Performs a power flow analysis based on schedule inputs
- Creates constraints for the **forecasted** scenario for every trading period
- Only creates constraints which are near binding in the forecast
- When the schedule is rerun any changes in topology, offers, load forecast and voltage profile are accounted for and all constraints are revised, new constraints are created and applied.
- The majority of work required to Filter SFT constraints will be done in the CSM base model and will not need to be revised unless there is a new generator commissioning.

Advantages of SFT in Planning Time

- SFT will require less resource than Manual Constraint Process
- Majority of work will be done in the base model:
  - Workload on Security Assessment team is reduced
  - Need to revise constraints is reduced (less rework)
  - Reduce 0 - 6 weeks workload
- SFT will identify constraints which may not have been picked by the manual process

What will change - WDS & SDS

- Currently constraints published to Schedules when >= 85% Binding
- SFT constraints published to Schedules when >= 85% Binding
- Manual Outage constraints only published once outage approved
- SFT only accounts for outages once approved
- SFT automates the manual constraint building process, SFT constraints that are published to COMIT will be the same as constraints that would have been published using the manual constraints process.

SFT
Operational Management

Realtime

SYSTEM OPERATOR

Realtime - Processes

Processes remain largely unchanged

- Scheduling (near real time)
  - WDS: Binding constraints will be assessed for validity
  - SDS: All constraints will be checked for validity and accuracy. Security results analysed and compared to SFT results
  - SDPQ: Binding constraints checked for validity and accuracy. Security results checked and compared to SFT results
- Real Time
  - RTD: Binding constraints checked for validity and accuracy.
  - RTCA (real time contingency analysis) results checked and compared to SFT results. RHS adjusted if necessary

Real Time - Changes

Tool functionality

- Ability to turn SFT off
- Ability to edit / copy SFT constraints (effectively become manual / locked constraints)
- Ability to prevent SFT creating a constraint to protect a branch
- Ability to prevent SFT creating a constraint to protect a branch for a defined contingency
- A new two trading period schedule
- Ability to create a manual case with SFT / NBT / number of iteration selections
- New display with SFT results

Increased awareness of effects of modelling in the Market System, in particular correct contingency definition application

Pricing

- Process to resolve infeasibilities or HSWPS unchanged
- Test results:
  - Final pricing resolves
  - Final Pricing picks up the correct SFT generated constraints
  - Displays show the correct SFT constraints
  - SFT constraints can be over-ridden for final pricing
  - Output files from final pricing contain correct SFT constraints

Parallel Operations Results

Observations

- There were no unnecessary SFT constraints generated in scheduling time due to planned outages (where an exclude SFT constraint outage override would have been applied).
- All constraints generated by SFT and applied to RTD were valid.
- There was no RHS adjustments required in real time, whenever a constraint was binding the associated violation was active or near violating.
- At times, constraints were not generated where offers did not reflect intended generation. In some cases a security violation occurred in real time, though the manually applied constraint would not be binding in this situation either.

Parallel Operations Results

All RTD SFT Constraints

ARI_HAM1.1__ARI_HAM2.1__$ARIHAM2__HAM__LN	ARI_KIN1.1__ARI_KIN2.1__ARIKIN2$__ARI__LN	KAW_MAT2.1__KAW_MAT1.1__:S__KAW_MAT1__MAT__LN
ARI_HAM1.1__ARI_HAM2.1__:S__$ARIHAM2__HAM__LN	ARI_KIN2.1__ARI_KIN1.1__$ARIKIN1__ARI__LN	KAW_MAT2.1__KAW_MAT1.1__KAW_MAT1__MAT__LN
ARI_HAM1.1__HAT_WKM1.1__$HAMWKM1__HAM__LN	ATI_OHK.1__WKM_PPI_WRK.1__WKM_WRK__OHK__LN	KAW_OHK.1__WKM_PPI_WRK.1__:S__WKM_WRK__KAW__LN
ARI_HAM1.1__HAT_WKM1.1__HAMWKM1!__HAM__LN	COB_STK2.2__COB_UTK1.1__COB_UTK1__COB__LN	KIN_TRK1.1__HAT_WKM1.1__$HAMWKM1__KIN__LN
ARI_HAM1.1__HAT_WKM1.1__HAMWKM1$__HAM__LN	COB_STK2.2__MPI_UTK.1__MPI_UTK__COB__LN	KIN_TRK1.1__HAT_WKM1.1__HAMWKM1!__KIN__LN
ARI_HAM2.1__ARI_HAM1.1__$ARIHAM1__HAM__LN	HAM_KPO1.2__HIN_KPO.1__HIN_KPO__KPO__LN	KIN_TRK1.1__HAT_WKM1.1__HAMWKM1$__KIN__LN
ARI_HAM2.1__ARI_HAM1.1__:S__$ARIHAM1__HAM__LN	HAT_WKM1.1__HAT_WKM2.1__$OHWWKM1__WKM__LN	KIN_TRK1.1__KIN_TRK2.2__KIN_TRK2__KIN__LN
ARI_HAM2.1__HAT_WKM1.1__$HAMWKM1__HAM__LN	HAT_WKM1.1__HAT_WKM2.1__OHWWKM1!__WKM__LN	KIN_TRK1.2__HAT_WKM1.1__$HAMWKM1__TRK__LN
ARI_HAM2.1__HAT_WKM1.1__HAMWKM1!__HAM__LN	HAT_WKM1.1__HAT_WKM2.1__OHWWKM1$__WKM__LN	KIN_TRK1.2__HAT_WKM1.1__HAMWKM1!__TRK__LN
ARI_HAM2.1__HAT_WKM1.1__HAMWKM1$__HAM__LN	INV_NMA.1__NMA_TWI1.1__:S__NMA_TWI1__INV__LN	KIN_TRK1.2__HAT_WKM1.1__HAMWKM1$__TRK__LN
ARI_KIN1.1__ARI_KIN2.1__$ARIKIN2__ARI__LN	INV_NMA.1__NMA_TWI2.1__:S__NMA_TWI2__INV__LN	KIN_TRK1.2__KIN_TRK2.2__KIN_TRK2__TRK__LN
ARI_KIN1.1__ARI_KIN2.1__:S__$ARIKIN2__ARI__LN	KAW__T13__110KV__EDG_OWH.1__EDG_OWH__XF	ROX__T10__110KV__BAL_GOR.1__BAL_GOR__XF
ARI_KIN1.1__ARI_KIN2.1__:S__ARIKIN2!__ARI__LN	KAW__T13__220KV__EDG_OWH.1__EDG_OWH__XF	ROX__T10__110KV__GOR_ROX.1__GOR_ROX__XF
ARI_KIN1.1__ARI_KIN2.1__:S__ARIKIN2$__ARI__LN	KAW_MAT1.1__KAW_MAT2.1__:S__KAW_MAT2__MAT__LN	ROX__T10__110KV__HWB_ROX1.1__HWB_ROX1__XF
ARI_KIN1.1__ARI_KIN2.1__ARIKIN2!__ARI__LN	KAW_MAT1.1__KAW_MAT2.1__KAW_MAT2__MAT__LN	ROX__T10__110KV__HWB_ROX2.1__HWB_ROX2__XF

Parallel Operations Results

All RTD SFT Binding Constraints

ARI_HAM1.1__ARI_HAM2.1__$ARIHAM2__HAM__LN	HAT_WKM1.1__HAT_WKM2.1__$OHWWKM1__WKM__LN	ROX__T10__110KV__GOR_ROX.1__GOR_ROX__XF
ARI_HAM1.1__ARI_HAM2.1__$ARIHAM2__HAM__LN	HAT_WKM1.1__HAT_WKM2.1__OHWWKM1!__WKM__LN	ROX__T10__110KV__GOR_ROX.1__GOR_ROX__XF
HAM_KPO1.2__HIN_KPO.1__HIN_KPO__KPO__LN	HAT_WKM1.1__HAT_WKM2.1__OHWWKM1$__WKM__LN	ROX__T10__110KV__GOR_ROX.1__GOR_ROX__XF
HAM_KPO1.2__HIN_KPO.1__HIN_KPO__KPO__LN	KAW_MAT1.1__KAW_MAT2.1__KAW_MAT2__MAT__LN	ROX__T10__110KV__GOR_ROX.1__GOR_ROX__XF
HAM_KPO1.2__HIN_KPO.1__HIN_KPO__KPO__LN	KAW_MAT2.1__KAW_MAT1.1__KAW_MAT1__MAT__LN	ROX__T10__110KV__GOR_ROX.1__GOR_ROX__XF
HAM_KPO1.2__HIN_KPO.1__HIN_KPO__KPO__LN	KAW_OHK.1__WKM_PPI_WRK.1__:S__WKM_WRK__KAW__LN	ROX__T10__110KV__GOR_ROX.1__GOR_ROX__XF
HAM_KPO1.2__HIN_KPO.1__HIN_KPO__KPO__LN	KIN_TRK1.2__HAT_WKM1.1__$HAMWKM1__TRK__LN	
HAM_KPO1.2__HIN_KPO.1__HIN_KPO__KPO__LN	KIN_TRK1.2__KIN_TRK2.2__KIN_TRK2__TRK__LN	

All RTD Production Binding Constraints

ARI_HAM_1_and_2_ARI_RUNBACK_ENABLED_W_P_1A	HAM_KPO_2_W_O_1	INV_MAN_2_W_O_1
ARI_HAM_1_and_2_ARI_RUNBACK_ENABLED_W_P_1A	HWB_ROX_2_W_O_z	INV_MAN_2_W_O_1
ARI_HAM_1_and_2_ARI_RUNBACK_ENABLED_W_P_1A	HWB_ROX_2_W_O_z	INV_MAN_2_W_O_1
HAM_KPO_2_W_O_1	HWB_ROX_2_W_O_z	KIN_TRK_1_W_P_2A
HAM_KPO_2_W_O_1	HWB_ROX_2_W_O_z	ROX_T10_P_1_temp
HAM_KPO_2_W_O_1	INV_MAN_2_W_O_1	ROX_T10_P_1_temp
HAM_KPO_2_W_O_1	INV_MAN_2_W_O_1	ROX_T10_P_1_temp
HAM_KPO_2_W_O_1	INV_MAN_2_W_O_1	

Scenario Testing Results

Notes

To carry out the scenario testing the inputs from the actual final pricing case for the day were used:

- Outages, MV90 metering data for area loads, bids / offers.
- Load forecast data from an actual SDPQ that spanned the study time was applied.
- The case was run with SFT off.
- Permanent and outage manual constraints were invalidated and the case ran with SFT on.

Observations

For all of the scenarios, some being extreme, SFT always solved.

- No SFT constraints were generated that would not be required, though for Scenario 7 while the results with SFT on have been published, this was only to demonstrate that SFT continued to AC solve and create valid constraints even during this extreme situation.
- In reality for that event where constraints could never be satisfied (N-8) SFT would be turned off, at least until it was identified where security could be restored. Monitoring (SFT creating constraints) would then be turned off where security could not be restored and SFT would be turned back on.

Scenario 1: Reduced transmission capacity between Waitaki and Southland

Due to outages, similar to CYD CML TWZ outage TP 12-23 on 19 August 2009

Example of binding constraint and prices

SFT On

TP	Constraint	Limit	Price	Constraint Build
13	NSY_ROX.1__CYD_TWZ2.1__:S__CYD_TWZ2__ROX__LN	267.67	8.93	-.948 * CYD_TWZ2.1 + -1 * NSY_ROX.1

TP		13
Energy Price	ROX2201	0.02
	TWZ2201	9.03

SFT Off

TP	Constraint	Limit	Price	Constraint Build
13	CYD_TWZ_1_W_O_1_z	267	8.72	-1 * NSY_ROX.1 + -.99 * CYD_TWZ2.1 <=

TP		13
Energy Price	ROX2201	0.02
	TWZ2201	9.04

Observations

Scheduled prices are indicative of those that occurred in final pricing.
The management of security violations in these situations remains unchanged; the RHS of the constraint will be amended in real time if / as needed.

Scenario 2: Multiple generation unit tripping

Similar to 23 September 2009

SFT On

No violations were present as a result of the loss of generation / shortfall.
No SFT Constraints were generated.

SFT Off

No binding constraints.

Observations

There was no impact during the shortfall of generation event whether SFT was on or off. With no scheduled security issues there were no SFT constraints generated. As expected there was no change in prices.

Scenario 3: Shortage of generation capacity in the North Island

North Island Reserves set to zero
Similar to 5 October

SFT On
No binding SFT constraints.
All SFT generated constraints:

KAW_MAT1.1__KAW_MAT2.1__KAW_MAT2__MAT__LN
KAW__T13__110KV__EDG_OWH.1__EDG_OWH__XF
KAW__T13__220KV__EDG_OWH.1__EDG_OWH__XF
KAW_MAT2.1__KAW_MAT1.1__KAW_MAT1__MAT__LN
MST_UHT1.2__MST_UHT2.2__:S__MST_UHT2__UHT__LN
MST_UHT1.2__MST_UHT2.2__MST_UHT2__UHT__LN
MST_UHT2.2__MST_UHT1.2__:S__MST_UHT1__UHT__LN
MST_UHT2.2__MST_UHT1.2__MST_UHT1__UHT__LN

SFT Off
No binding constraints.

Observations

Again, there was no impact during this shortfall of generation event whether SFT was on or off. There were no binding constraints so as expected there was no change in prices.

Scenario 4: Shortage of generation capacity in the North Island

North Island reserves set to zero
Similar to 14 October 2009

SFT On

No binding SFT constraints.
All SFT generated constraints:

KIN_TRK1.2__HAM_WKM.1__HAM_WKM__TRK__LN
KIN_TRK1.2__KIN_TRK2.2__KIN_TRK2__TRK__LN
WGN_WVY1.1__HWA_SFD1.1__:S__HWA_SFD1__WGN__LN
WGN_WVY1.1__HWA_SFD1.1__HWA_SFD1__WGN__LN

TP	Constraint	Limit	% Binding	Constraint Build
35	KIN_TRK1.2__HAM_WKM.1__HAM_WKM__TRK__LN	66.67	92.4	-.075 * HAM_WKM.1 + -1.042 * KIN_TRK1.2
35	KIN_TRK1.2__KIN_TRK2.2__KIN_TRK2__TRK__LN	66.76	87.2	-.512 * KIN_TRK2.2 + -1.042 * KIN_TRK1.2
36	KIN_TRK1.2__HAM_WKM.1__HAM_WKM__TRK__LN	66.51	89.8	-.075 * HAM_WKM.1 + -1.04 * KIN_TRK1.2

TP		**35**	**36**	**37**	**38**	**39**	**40**	**41**
Energy Price	**HAY2201**	**871.07**	**1044.69**	**49.76**	**41.12**	**24.94**	**47.69**	**52.95**

SFT Off

Binding constraints.

TP	Constraint	Limit	Price	Constraint Build
35	ARI_HAM_W_P_1A	62	285.6	1.04 * ARI_HAM1.1 + -.07 * HAM_WKM.1 <=
39	COB_MOT_2_W_O	26	16.73	-1.016 * STK_UTK1.2 + -1 * MPI_UTK.1 <=
40	COB_MOT_2_W_O	26	35.97	-1.016 * STK_UTK1.2 + -1 * MPI_UTK.1 <=
41	COB_MOT_2_W_O	26	41.18	-1.016 * STK_UTK1.2 + -1 * MPI_UTK.1 <=

TP		**35**	**36**	**37**	**38**	**39**	**40**	**41**
Energy Price	**HAY2201**	**861.22**	**1044.69**	**49.76**	**41.12**	**25.03**	**47.77**	**53**

Observations

The manually applied constraint that bound in SFT Off was not created to protect what was the worst violation on the day, post event load on KIN TRK 1 for a HAM WKM contingency. SFT created a constraint to manage this event, but was not scheduling it to bind. The overall North Island price in this shortfall of generation event would be unchanged by SFT.

Scenario 5: HVDC Pole 2 outage

Ascertain what happens when the North Island and South Island markets are separated
Similar to TP 16-18 on 12 November 2009 when the average price separation was $870.00

SFT On

No binding SFT constraints.
All SFT generated constraints:

COB_STK2.2__COB_UTK1.1__COBUTK1*__COB__LN
EDG_OWH.1__EDG_KAW3.1__EDG_KAW3__EDG__LN
NSY_ROX.1__CYD_TWZ1.1__CYD_TWZ1__ROX__LN
NSY_ROX.1__CYD_TWZ2.1__CYD_TWZ2__ROX__LN
ROX__T10__110KV__GOR_ROX.1__GOR_ROX__XF

TP		15	16	17	18	19
Energy Price	BEN2201	145.07	140.42	145.43	145.43	145.1
	HAY2201	1000.04	1054.14	1004.37	985.3	452.39

SFT Off

No binding constraints.

TP		15	16	17	18	19
Energy Price	BEN2201	145.07	140.42	145.43	145.43	145.1
	HAY2201	1000.04	1054.14	1004.37	985.3	452.39

Observations

There were no binding constraints so as expected there was no change in prices.

Scenario 6: NSY ROX line is in constraint

With no outages occurring to test how this constraint behaves with SFT

SFT On

All SFT generated constraints:

NSY_ROX.1__CYD_TWZ1.1__CYD_TWZ1__ROX__LN
LIV_NSY.1__CYD_TWZ1.1__CYD_TWZ1__NSY__LN
LIV_NSY.1__CYD_TWZ2.1__CYD_TWZ2__NSY__LN
NSY_ROX.1__CYD_TWZ2.1__CYD_TWZ2__ROX__LN

Binding SFT constraints:

TP	Constraint	Limit	Price	Constraint Build
25	NSY_ROX.1__CYD_TWZ2.1__CYD_TWZ2__ROX__LN	275.13	35.66	-.352 * CYD_TWZ2.1 + -1.307 * NSY_ROX.1
26	NSY_ROX.1__CYD_TWZ2.1__CYD_TWZ2__ROX__LN	275.32	34.37	-.352 * CYD_TWZ2.1 + -1.308 * NSY_ROX.1

TP		23	24	25	26
Energy Price	ROX2201	28.56	28.53	10.11	10
	TWZ2201	30.04	30.01	29.71	28.92

SFT Off

Binding constraints:

TP	Constraint	Limit	Price	Constraint Build
25	NSY_ROX_1_S_P_z	270	35.47	-.34 * CYD_TWZ1.1 + -1.33 * NSY_ROX.1 <=
26	NSY_ROX_1_S_P_z	270	37.25	-.34 * CYD_TWZ1.1 + -1.33 * NSY_ROX.1 <=

TP		23	24	25	26
Energy Price	ROX2201	28.56	28.53	10.11	8.44
	TWZ2201	30.04	30.01	29.7	28.91

Scenario 7: Major transmission trippings causing loss of power to Auckland

TP 31 25 January 2010

SFT On

All SFT generated constraints:

ARI_HAM1.1__ARI_HAM2.1__ARIHAM2$__HAM__LN	KIN_TRK1.1__KIN_TRK2.1__KIN_TRK2__KIN__LN
ARI_HAM1.1__HAM_WKM.1__:S__HAMWKM1$__HAM__LN	KIN_TRK1.2__HAM_WKM.1__HAMWKM1$__TRK__LN
ARI_HAM1.1__HAM_WKM.1__HAMWKM1$__HAM__LN	KIN_TRK1.2__KIN_TRK2.1__KIN_TRK2__TRK__LN
ARI_HAM2.1__ARI_HAM1.1__ARIHAM1$__HAM__LN	OTA_WKM1.1__HLY_OHW2.1__HLY_OHW2__WKM__LN
ARI_HAM2.1__HAM_WKM.1__:S__HAMWKM1$__HAM__LN	OTA_WKM1.1__HLY_SFD.1__HLY_SFD__WKM__LN
ARI_HAM2.1__HAM_WKM.1__HAMWKM1$__HAM__LN	OTA_WKM1.1__HLY_TWH1.1__HLY_TWH1__WKM__LN
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ARI_KIN1.1__ARI_KIN2.1__ARI_KIN2__ARI__LN	OTA_WKM1.1__OTA_WKM2.1__OTA_WKM2__WKM__LN
ARI_KIN2.1__ARI_KIN1.1__:S__ARI_KIN1__ARI__LN	OTA_WKM1.1__SFD_TMN1.1__SFD_TMN1__WKM__LN
ARI_KIN2.1__ARI_KIN1.1__ARI_KIN1__ARI__LN	OTA_WKM1.1__TMN_TWH1.1__TMN_TWH1__WKM__LN
BOB_HAM1.1__BOB_HAM2.1__BOB_HAM2__HAM__LN	OTA_WKM2.1__HLY_OHW2.1__HLY_OHW2__WKM__LN
BOB_HAM2.1__BOB_HAM1.1__BOB_HAM1__HAM__LN	OTA_WKM2.1__HLY_SFD.1__HLY_SFD__WKM__LN
BOB_OTA1.2__BOB_OTA2.2__BOB_OTA2__OTA__LN	OTA_WKM2.1__HLY_TWH1.1__HLY_TWH1__WKM__LN
COB_STK2.2__COB_UTK1.1__COBUTK1*__COB__LN	OTA_WKM2.1__OTA_WKM1.1__:S__OTA_WKM1__WKM__LN
HLY_OHW2.1__HLY_OTA2.1__:S__HLY_OTA2__HLY__LN	OTA_WKM2.1__OTA_WKM1.1__OTA_WKM1__WKM__LN
HLY_OHW2.1__HLY_OTA2.1__HLY_OTA2__HLY__LN	OTA_WKM2.1__SFD_TMN1.1__SFD_TMN1__WKM__LN
KIN_TRK1.1__HAM_WKM.1__HAMWKM1$__KIN__LN	OTA_WKM2.1__TMN_TWH1.1__TMN_TWH1__WKM__LN

SFT On

All SFT binding constraints:

TP	Constraint	Limit	Price	Constraint Build
29	ARI_HAM1.1__HAM_WKM.1__HAMWKM1$__HAM__LN	45.62	0	-.093 * HAM_WKM.1 + 1.032 * ARI_HAM1.1
29	ARI_HAM2.1__HAM_WKM.1__HAMWKM1$__HAM__LN	45.62	2555.58	-.093 * HAM_WKM.1 + 1.032 * ARI_HAM2.1
29	KIN_TRK1.2__HAM_WKM.1__HAMWKM1$__TRK__LN	54.22	1731.86	-.11 * HAM_WKM.1 + -1.035 * KIN_TRK1.2
30	ARI_HAM1.1__HAM_WKM.1__HAMWKM1$__HAM__LN	45.78	1141.4	-.094 * HAM_WKM.1 + 1.032 * ARI_HAM1.1
30	ARI_HAM2.1__HAM_WKM.1__HAMWKM1$__HAM__LN	45.78	0	-.094 * HAM_WKM.1 + 1.032 * ARI_HAM2.1
30	KIN_TRK1.2__HAM_WKM.1__HAMWKM1$__TRK__LN	54.29	684.04	-.11 * HAM_WKM.1 + -1.035 * KIN_TRK1.2
31	ARI_HAM1.1__HAM_WKM.1__HAMWKM1$__HAM__LN	45.59	0	-.094 * HAM_WKM.1 + 1.032 * ARI_HAM1.1
31	ARI_HAM2.1__HAM_WKM.1__HAMWKM1$__HAM__LN	45.59	3320.78	-.094 * HAM_WKM.1 + 1.032 * ARI_HAM2.1
31	KIN_TRK1.2__HAM_WKM.1__HAMWKM1$__TRK__LN	54.13	2250.3	-.11 * HAM_WKM.1 + -1.035 * KIN_TRK1.2
32	ARI_KIN1.1__ARI_KIN2.1__ARI_KIN2__ARI__LN	60.32	33025.16	.912 * ARI_KIN2.1 + 1.062 * ARI_KIN1.1
32	OTA_WKM1.1__OTA_WKM2.1__OTA_WKM2__WKM__LN	397.41	596120	-.649 * OTA_WKM2.1 + -1.317 * OTA_WKM1.1
33	ARI_KIN1.1__ARI_KIN2.1__ARI_KIN2__ARI__LN	57.91	32748.83	.916 * ARI_KIN2.1 + 1.056 * ARI_KIN1.1
33	OTA_WKM1.1__OTA_WKM2.1__OTA_WKM2__WKM__LN	393.81	559910	-.65 * OTA_WKM2.1 + -1.288 * OTA_WKM1.1
34	ARI_KIN1.1__ARI_KIN2.1__ARI_KIN2__ARI__LN	58.18	32921.81	.906 * ARI_KIN2.1 + 1.056 * ARI_KIN1.1
34	OTA_WKM1.1__OTA_WKM2.1__OTA_WKM2__WKM__LN	394.2	560680	-.646 * OTA_WKM2.1 + -1.29 * OTA_WKM1.1
35	ARI_KIN1.1__ARI_KIN2.1__ARI_KIN2__ARI__LN	58.78	32822.95	.915 * ARI_KIN2.1 + 1.057 * ARI_KIN1.1
35	OTA_WKM1.1__OTA_WKM2.1__OTA_WKM2__WKM__LN	393.68	561080	-.647 * OTA_WKM2.1 + -1.287 * OTA_WKM1.1
36	ARI_KIN1.1__ARI_KIN2.1__ARI_KIN2__ARI__LN	58.77	33280.16	.926 * ARI_KIN2.1 + 1.057 * ARI_KIN1.1
36	OTA_WKM1.1__OTA_WKM2.1__OTA_WKM2__WKM__LN	393.81	560190	-.645 * OTA_WKM2.1 + -1.288 * OTA_WKM1.1

SFT Off

Binding constraints:

TP	Constraint	Limit	Price	Constraint Build
31	OHW_WKM_1_S_O_1A	54	745.95	-1.04 * KIN_TRK1.2 + -.11 * HAM_WKM.1 <=

Observations

The only outage constraint that was applied and bound on the day was subsequently ended, no further outage constraints were applied for the tripped equipment, if they had the result would have been similar to SFT.
While the results with SFT on have been shown here, this is only to demonstrate that SFT continued to AC solve and create valid constraints even during this extreme situation. In reality for this event where constraints could never be satisfied (N-8) SFT would be turned off. At least until it was identified where security could be restored. Monitoring (SFT creating constraints) would then be turned off where security could not be restored and SFT would be turned back on.

Scenario 8: South Island West Coast split

Ascertain how SFT manages the associated constraints

Similar to TP 23-26 on 1 February 2010 when the West Coast split caused high Upper South Island prices

SFT On

All SFT generated constraints:

EDN_INV.1__GOR_ROX.1__GOR_ROX__INV__LN
ROX__T10__220KV__EDN_INV.1__EDN_INV__XF

Binding SFT constraints:

TP	Constraint	Limit	Price	Constraint Build
26	ROX__T10__220KV__EDN_INV.1__EDN_INV__XF	50.87	2.03	-1.087 * EDN_INV.1 + 1 * ROX_T10.T10

SFT Off

No binding constraints.

Observations

There were no additional constraints generated due to the trippings.

The tripped equipment was never offered out by the Grid Owner so was not modelled out of service. SFT depends on equipment being modelled out of the market.

DOB T1, T2 and T12 tripped but was made available for service ten minutes later. This would be typical in a wide spread event, only the equipment that could not be returned to service would be offered out and subsequently modelled.

With no binding constraints in either schedule affecting the upper South Island prices are similar whether SFT is on or off.

Scenario 9: Spring washer pricing at OTA

Similar to TP 16-21 on 2 February

SFT On

All SFT generated constraints:

COB_STK2.2__COB_UTK1.1__COBUTK1*__COB__LN	COL_HOR3.1__COL_HOR2.1__COL_HOR2__COL__LN
ARI_HAM1.1__ARI_HAM2.1__ARI_HAM2__HAM__LN	KIN_TRK1.1__HAM_WKM.1__HAM_WKM__KIN__LN
ARI_HAM2.1__ARI_HAM1.1__ARI_HAM1__HAM__LN	KIN_TRK1.2__HAM_WKM.1__HAM_WKM__TRK__LN
ARI_HAM2.1__HAM_WKM.1__HAM_WKM__HAM__LN	KIN_TRK1.2__KIN_TRK2.2__KIN_TRK2__TRK__LN
COL_HOR2.1__COL_HOR3.1__COL_HOR3__COL__LN	SFD__T10__220KV__CST_NPL2.1__CST_NPL2__XF

No binding SFT constraints.

TP	Constraint	Limit	% Binding	Constraint Build
17	ARI_HAM1.1__ARI_HAM2.1__ARI_HAM2__HAM__LN	50.73	91.5	.475 * ARI_HAM2.1 + 1.04 * ARI_HAM1.1
17	ARI_HAM2.1__ARI_HAM1.1__ARI_HAM1__HAM__LN	50.73	91.5	.475 * ARI_HAM1.1 + 1.04 * ARI_HAM2.1
18	ARI_HAM1.1__ARI_HAM2.1__ARI_HAM2__HAM__LN	50.72	93	.474 * ARI_HAM2.1 + 1.041 * ARI_HAM1.1
18	ARI_HAM2.1__ARI_HAM1.1__ARI_HAM1__HAM__LN	50.72	93	.474 * ARI_HAM1.1 + 1.041 * ARI_HAM2.1
19	ARI_HAM1.1__ARI_HAM2.1__ARI_HAM2__HAM__LN	50.76	92.7	.476 * ARI_HAM2.1 + 1.041 * ARI_HAM1.1
19	ARI_HAM2.1__ARI_HAM1.1__ARI_HAM1__HAM__LN	50.76	92.7	.476 * ARI_HAM1.1 + 1.041 * ARI_HAM2.1

SFT Off

Binding constraints:

TP	Constraint	Limit	Price	Constraint Build
17	ARI_HAM_1_and_2_ARI_RUNBACK_DISABLED_S_P_1	45	3.42	1.05 * ARI_HAM2.1 + .48 * ARI_HAM1.1 <=
18	ARI_HAM_1_and_2_ARI_RUNBACK_DISABLED_S_P_1	45	50.84	1.05 * ARI_HAM2.1 + .48 * ARI_HAM1.1 <=
19	ARI_HAM_1_and_2_ARI_RUNBACK_DISABLED_S_P_1	45	50.89	1.05 * ARI_HAM2.1 + .48 * ARI_HAM1.1 <=

Observations

SFT constraints while generated did not bind as there was no scheduled security violation, though the constraints were generated. The constraint that bound with SFT off was not to protect the worst security issue which was for post event load on KIN TRK 2 in the event of HAM WKM contingency.

Scenario 10: Spring washer pricing at TRK

Similar to TP 26-29 on 3 February 2010

SFT On

All SFT generated constraints:

BOB_HAM1.1__BOB_HAM2.1__BOB_HAM2__HAM__LN	COL_HOR3.1__COL_HOR2.1__COL_HOR2__COL__LN
BOB_HAM1.1__OHW_OTA1.1__OHW_OTA1__HAM__LN	KIN_TRK1.1__HAM_WKM.1__HAM_WKM__KIN__LN
BOB_HAM1.1__OHW_OTA2.1__OHW_OTA2__HAM__LN	KIN_TRK1.1__KIN_TRK2.2__KIN_TRK2__KIN__LN
BOB_HAM2.1__BOB_HAM1.1__BOB_HAM1__HAM__LN	KIN_TRK1.2__HAM_WKM.1__HAM_WKM__TRK__LN
BOB_HAM2.1__OHW_OTA1.1__OHW_OTA1__HAM__LN	KIN_TRK1.2__KIN_TRK2.2__KIN_TRK2__TRK__LN
BOB_HAM2.1__OHW_OTA2.1__OHW_OTA2__HAM__LN	KIN_TRK1.2__OHW_WKM1.1__OHW_WKM1__TRK__LN
COB_STK2.2__COB_UTK1.1__COB_UTK1__COB__LN	KIN_TRK1.2__OTA_WKM1.1__OTA_WKM1__TRK__LN
COB_STK2.2__MPI_UTK.1__MPI_UTK__COB__LN	KIN_TRK1.2__OTA_WKM2.1__OTA_WKM2__TRK__LN
COL_HOR2.1__COL_HOR3.1__COL_HOR3__COL__LN	

No binding SFT constraints.

TP	Constraint	Limit	Price	Constraint Build
27	KIN_TRK1.2__KIN_TRK2.2__KIN_TRK2__TRK__LN	54.35	1119.77	-.537 * KIN_TRK2.2 + -1.047 * KIN_TRK1.2
28	KIN_TRK1.2__KIN_TRK2.2__KIN_TRK2__TRK__LN	54.18	1107.74	-.538 * KIN_TRK2.2 + -1.047 * KIN_TRK1.2

TP		26	27	28	29
Energy Price	ARI1101	71.68	441.33	433.39	84.7
	HAY2201	68.72	104.9	100.61	80.97
	KIN1101	72.37	633.75	623.75	85.51
	OTA2201	78.21	161.78	156.46	92.4
	TRK2201	70.69	19.16	15.58	83.52

SFT Off

Binding constraints:

TP	Constraint	Limit	Price	Constraint Build
28	KIN_TRK_1_S_P_1A	57	353.88	-.07 * HAM_WKM.1 + -1.04 * KIN_TRK1.2 <=

TP		26	27	28	29
Energy Price	ARI1101	71.68	93.04	164.38	84.7
	HAY2201	68.72	88.65	84.63	80.97
	KIN1101	72.37	95.43	205.33	85.51
	OTA2201	78.21	100.92	110.4	92.4
	TRK2201	70.69	91.63	66.63	83.52

Observations

On the day the manually applied constraint was relaxed from 54MW to 57MW and discretion was used to manage security. SFT will not change this process, if binding constraint(s) are causing undesirable effects the constraint may be relaxed, though the constraints are valid. Once the SFT constraint was relaxed resulting prices would have been similar.

Discussion - Issues Raised

AC/DC solve and temperature attribute for SFT constraints will not be available in the SWS schedule

The information is available from the schedule that carried out the SFT solve (SDS)

At times the constraint formula for SWS constraints is replaced by an exclamation mark

SWS is a combination of PDS and SDS, when the constraint no longer exists in the SDS there is no build information available for the SWS

Will SFT manage constraints where a special protection scheme is installed

SFT uses the same contingency modelling as real time, where modelling is not accurate, SFT will be prevented from creating constraints

Concerns have been raised that there will no longer be a list of outage constraints

Given that SFT creates constraints using the same methodology as manually created constraints, those applied due to outages can be expected to be the same as those that were applied historically. SFT will always create constraints based on the offered topology

The order of the branches (contingent / protected) formula in WITS is the reverse order of the constraint name (protected / contingent / contingency)

The SFT constraint name should be used to identify the protected / contingent branch. At present between tools there is no formula branch order consistency (random / alphabetical / manual)