

Exploiting the Functionalities of Commercial Softwares in Power System Planning Studies

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February 2012

Outline

- 1 Introduction**
- 2 Python**
- 3 Exploiting PSS/E Functionalities**
- 4 Developed Tools for VSAT**
- 5 GE-MARS Automation**
- 6 Summary**

Introduction — Commercial Softwares

PSS/E

- Siemens PTI
- Power flow and dynamic simulation

VSAT

- PowerTech
- Assessment of power system voltage security

MARS

- GE Energy
- Multi-area reliability simulation program

Introduction — Study Process

Prepare Data/Check Data

Monitor and Control Parameters or Indices

Perform Analysis/Simulation

Screen and Output Results

Produce Reports

Introduction — Challenges and Difficulties

The Amount of Data!

System complexity and number of cases to be studied.



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Data:

- Generating units
- Branches
- Transformers
- Load.....



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Monitor and Control:

- Voltage
- DC level
- Reliability indices.....

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Monitor and Control:

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- Reliability indices.....

Results and Reports

Results screening and analysis; Customize results output;
Reports preparation

Introduction — Purpose of This Presentation

Illustrate the automation of the processes

- Data modification and retrieval
 - Parameter monitor and control
 - Results output customization
-
- For softwares such as PSS/E, VSAT and GE-MARS
 - Using **Python**

Python

What is Python?

- A dynamic programming language
- Runs on different operating systems
- Widely used in various applications

Python Official Website

<http://www.python.org/>



Python

Why Python?

- Clear and readable syntax
- Dynamic data types
- Full modularity
- Open Source-Free!

Example

```
print "A small example of Python program:"  
t = [1, 2, 3, 4]          # Assignment statement  
for onenumber in t:       # for statement  
    if onenumber < 2:      # if statement  
        print str(onenumber) + " < 2"  
    if onenumber > 2:      # if statement  
        print onenumber # print statement
```

Exploiting PSS/E Functionalities — PSS/E Automation

Response files-.idv

IPLAN programs-.ipl

Need to be compiled to .irf to be used in PSSE

Python programs-.py

- PTI provides Python starting from PSS/E 30.
- Python is a great improvement to IPLAN.
 - Faster development
 - Flexibility
 - Easy to write and debug
 - Powerful data processing
 - Easy integration with other applications

Exploiting PSS/E Functionalities — PSS/E APIs

Application Program Interface (API) provided by PSSE: psspy, excelpy, dyntool...

PSSPY

- Retrieval of Single Element Data
- Retrieval of Subsystem Data
- Change Power Flow Data
- Power Flow Operations
- Non-Engineering Functions

EXCELPY

Provides functions to interface with Excel.

Exploiting PSS/E Functionalities — Developed Tools for PSS/E

Tools for PSS/E

- MHSum.py
 - Show case info in progress window
 - Produce case summary report for multi cases
- RAWout.py : raw out multi .sav cases in the specified path to .raw files
- MHDCAdj.py: adjust MH DC
- MHACAdj.py: adjust MH AC generation
- adjustV.py: adjust voltage of selected buses

MHSum-Retrieve and Display Data

PSS/E 32 - C:\D\2013-TSR\Redirect\redirect-2015SU0-area700-MDX20DB.sav - [Network data]

File Edit View Program Power Flow Fault GPF Trans Access Dynamics Disturbance Subsystem Mdc I/O Control Tools Window Help

100%

Network Data

669803: Bus NOT FOUND!
669802: Bus Not Found!

Line Tie Summary

MH - SPC 220kV	= 49.9 MW
MH ->SPC 115kV	= -54.5 MW
MH ->ONT	= 0.9 MW
S ->1-2-US	= -97.3 MW
S ->4-Ties West	= 104.4 MW
MWS	= 1034.7 MW
MDEX	= 2082.3 MW

MH DC = 2936.5 MW(Dorsey)

The following is the MVAr data:

Dorsey MVars	[669821, 669822, 669823, 669824, 669825]
Qmax = 1700.0	MVAr
Open = 851.8	MVAr
	Cushion = 848.2 MVAr
Riel MVars	[669826, 669827, 669828, 669829]
Qmax = 0.0	MVAr
Open = 0.0	MVAr
	Cushion = 0.0 MVAr
Grand Rapids MVars	[669774, 669775, 669776, 669777]
Qmax = 165.2	MVAr
Open = -41.8	MVAr
	Cushion = 207.0 MVAr
Ponton MVars	[669820]
Qmax = 150.0	MVAr
Open = -0.2	MVAr
	Cushion = 150.2 MVAr
Birchtree MVars	[669819]
Qmax = 95.0	MVAr
Open = -2.5	MVAr
	Cushion = 97.5 MVAr

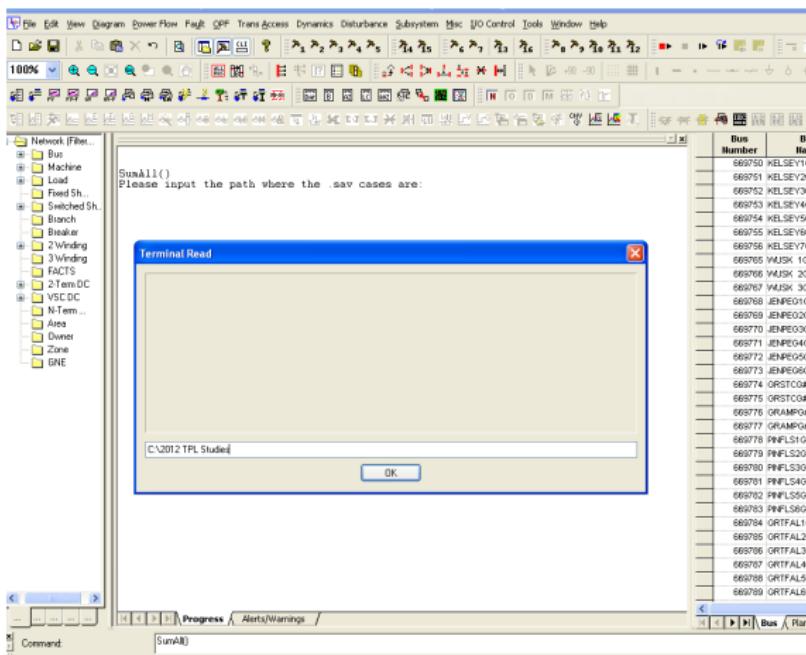
The following is generation data:

Grand Rapids gen = 479.9/479.9 MW	Kelsey gen = 251.0/315.0 MW	Vuskavatin gen = 200.0/222.9 MW
Winnipeg River gen = 591.0/611.9 MW		
Great Falls: 135.0/139.6 MW	Seven Sisters: 165.0/165.4 MW	Pine Falls: 89.0/103.6 MW
Slate Falls: 68.0/68.0 MW	MC Arthur Falls: 56.0/56.5 MW	Pointe Du Bois: 78.0/78.8 MW

Progress Alerts/Warnings

Command

SumAll()-Customize and Export Data



SumAll()-Customize and Export Data

Case Summary20120507.xlsx - Microsoft Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Summary Created On : Mon May 07 15:07:16 2012																
2																	
3	Tie Line Flow (MW)																
4	Case Name	MH-NUS	MH+SPC 298MV	MH+SPC 115MV	MH+SPC Net	MH+ONT	RHTT (\$)	S. Out (UR)	EMMNS	E-W Ties West	PW	MWS	North Dakota				
5	NR0-COLL1-FINAL-R1-20125UO	217.87	56.25	-54.89	1.37	-0.40	165.33	-38.19	190.41	-218.53	67.53	686.37	601.59				
6	NR0-COLL1-FINAL-R1-20125UO	149.74	57.43	-54.88	2.37	-1.97	189.13	-38.38	190.49	-247.22	96.37	544.59	630.00				
7	NR0-COLL1-FINAL-R1-20125WN	-696.80	55.82	-43.71	11.91	0.48	-185.23	-35.35	101.34	-251.13	6.52	-35.44	131.88				
8	NR0-COLL1-FINAL-R1-20135UO	217.99	31.51	-54.46	-2.95	0.00	165.00	-38.38	190.85	-42.06	70.58	772.81	872.37				
9	NR0-COLL1-FINAL-R1-20135UO	149.61	53.84	-54.82	-1.18	0.20	180.44	-1.83	150.44	-14.12	67.34	544.59	607.83				
10	NR0-COLL1-FINAL-R1-20135WN	701.88	42.99	-42.00	0.25	0.00	184.53	-38.38	190.49	-46.01	2.84	188.00	186.39				
11	NR0-COLL1-FINAL-R1-20225UO	218.04	49.74	-54.47	-4.73	0.00	165.50	-38.38	190.12	-73.17	66.58	683.93	565.45				
12	NR0-COLL1-FINAL-R1-20225UO	1308.13	56.86	-54.53	2.33	0.40	165.49	-1.04	190.33	-140.91	61.98	310.43	458.96				
13	NR0-COLL1-FINAL-R1-20225WN	-706.33	36.87	-42.82	-5.85	0.05	-164.50	-5.74	-0.93	-66.58	-1.32	31.75	70.06				
14																	
15	Power (MW)																
16	Case Name	MHDC (MH) Kelsey	Weekend	Emergency	Grandparent Subsidy	Branch	Peakload	Overflows	Masterfamily	Secondary	Standoffs	Pointbreaks	Stress	Strength	Windspeed		
17	NR0-COLL1-FINAL-R1-20125UO	203.00	210.00	200.00	479.80	0.00	0.00	85.20	135.00	30.00	165.00	68.00	70.50	19.80	27.00	591.00	
18	NR0-COLL1-FINAL-R1-20125UO	310.00	210.00	200.00	479.80	0.00	0.00	89.00	135.00	56.00	165.00	68.00	70.50	19.80	27.00	591.00	
19	NR0-COLL1-FINAL-R1-20125WN	207.00	210.00	200.00	479.80	0.00	0.00	89.00	135.00	56.00	165.00	68.00	70.50	34.85	48.30	591.00	
20	NR0-COLL1-FINAL-R1-20135UO	300.00	210.00	200.00	165.50	0.00	0.00	89.00	135.00	56.00	165.00	68.00	70.50	19.80	26.31	591.00	
21	NR0-COLL1-FINAL-R1-20135UO	250.00	210.00	200.00	479.80	0.00	0.00	89.00	135.00	56.00	165.00	68.00	70.50	18.40	26.31	605.50	
22	NR0-COLL1-FINAL-R1-20135WN	243.00	210.00	200.00	339.13	479.80	0.00	89.00	135.00	56.00	165.00	68.00	70.50	18.40	26.31	605.50	
23	NR0-COLL1-FINAL-R1-20225UO	300.00	210.00	200.00	385.00	479.80	0.00	89.00	29.80	135.20	56.50	165.40	68.00	70.50	47.77	65.92	591.50
24	NR0-COLL1-FINAL-R1-20225UO	305.00	210.00	200.00	387.55	479.80	0.00	0.00	103.50	135.80	56.50	165.40	68.00	70.50	24.70	54.08	613.50
25	NR0-COLL1-FINAL-R1-20225WN	265.00	210.00	200.00	194.81	479.80	0.00	0.00	85.80	135.20	56.50	165.40	68.00	70.50	42.42	59.13	591.50
26																	
27	Allstar	Customer	QGen	Grandparent	Subsidy	Branch	Peakload	Overflows	Masterfamily	Secondary	Standoffs	Pointbreaks	Stress	Strength	Windspeed		
28	Case Name	Delivery	Grandparent	Parents	Reserves	Delivery	Grandparent	Reserves	Parents	Reserves							
29	NR0-COLL1-FINAL-R1-20125UO	876.96	210.52	151.81	95.00	824.04	14.08	-1.81	0.00								
30	NR0-COLL1-FINAL-R1-20125UO	601.15	214.75	152.37	95.00	1098.85	11.85	-2.37	0.00								
31	NR0-COLL1-FINAL-R1-20125WN	1488.71	221.38	155.08	95.43	211.29	-55.90	-5.08	-0.43								
32	NR0-COLL1-FINAL-R1-20135UO	764.89	209.83	150.00	97.48	211.11	-43.00	-0.95	-2.49								
33	NR0-COLL1-FINAL-R1-20135WN	1259.96	210.24	146.89	96.94	406.80	0.00	0.00	0.00								
34	NR0-COLL1-FINAL-R1-20135WN	1827.26	210.03	150.00	95.18	127.28	-24.82	-0.89	-1.19								
35	NR0-COLL1-FINAL-R1-20225UO	1944.57	188.83	150.00	94.99	-244.57	-23.63	-0.08	0.01								
36	NR0-COLL1-FINAL-R1-20225UO	1856.78	199.61	150.74	95.00	-150.70	-24.41	-0.38	0.00								
37	NR0-COLL1-FINAL-R1-20225WN	1696.39	204.51	151.89	95.16	1.61	-58.31	-1.89	-0.16								
38																	

CaseSummary20120507.xlsx

DC Adjustment Program

76 MH DC Adjustment for PSSE32...

DC Before Adjustment		DC After Adjustment	
There are in total 4 dc lines and 2 Bipoles in MH system:			
MRD_05_RD-DC	667036		
MRD_06_RD-DC	667037		
MRD_07_HY-DY	667035		
MRD_08_HY-DY	667035		
The total DC loading is 2938.9 MW			
Bi Pole1:	1378.3 MW		
Bi Pole2:	1560.5 MW		
Current Northern Collector System Generation : 3098.0 of 3612.5 MW			
Plant	MW	# Units DN	
LimeStone	1174.0	10 of 10	
LongSpruce	897.1	10 of 10	
Kettle	1026.9	12 of 12	
Keeyask	0.0	0 of 0	
Conawapa	0.0	0 of 0	
AC filters and plant voltage control need to be adjusted as required!			
Maximum MH DC = 3350.0 MW			
Please input target DC or change in the DC and the steps in which the adjustment will be performed!			
Current DC (MW)	2938.9	Target DC (MW)	
Adjust DC By (MW)		Steps	
Adjust DC			
Please input target MH-US transfer or change in the transfer and the steps in which the adjustment will be performed!			
Current MH-US (MW)	2174.5	Target MH-US (MW)	2000
Adjust MH-US By (MW)		Steps	3
Adjust MH-US			
Load Case:		Open	Save

DC Adjustment Program

76 MH DC Adjustment for PSSE32...

DC Before Adjustment			DC Alter Adjustment		
There are in total 4 dc lines and 2 Bipoles in MH system:					
MRD_05_RD-DC	657036	MRD_05_RD-DC	657036		
MRD_06_RD-DC	657037	MRD_06_RD-DC	657037		
MRD_07_HY-DY	657035	MRD_07_HY-DY	657035		
MRD_08_HY-DY	657035	MRD_08_HY-DY	657035		
The total DC loading is 2938.9 MW					
Bi Pole1:	1378.3 Mw	Bi Pole1:	1294.4 Mw		
Bi Pole2:	1560.5 Mw	Bi Pole2:	1465.6 Mw		
Current Northern Collector System Generation : 3098.0 of 3612.5 MW					
Plant	MW	# Units ON	Plant	MW	# Units ON
LimeStone	1174.0	10 of 10	LimeStone	1092.3	9 of 10
LongSpruce	897.1	10 of 10	LongSpruce	834.6	9 of 10
Kettle	1026.9	12 of 12	Kettle	973.2	11 of 12
Keeyask	0.0	0 of 0	Keeyask	0.0	0 of 0
Conawapa	0.0	0 of 0	Conawapa	0.0	0 of 0
AC filters and plant voltage control need to be adjusted as required!					
Maximum MH DC = 3350.0 MW					
AC filters and plant voltage control need to be adjusted as required!					
Maximum MH DC = 3350.0 MW					
Please input target DC or change in the DC and the steps in which the adjustment will be performed:					
Current DC (MW)	2760.0	Target DC (MW)		Adjust DC By (MW)	
Steps		Adjust DC			
Please input target MH-US transfer or change in the transfer and the steps in which the adjustment will be performed:					
Current MH-US (MW)	2000.4	Target MH-US (MW)		Adjust MH-US By (MW)	
Steps	3	Adjust MH-US			
Load Case:		Open		Save	

AC Adjustment Program

74 MH AC Adjustment...

AC Before Adjustment			AC After Adjustment	
PLANT	Mw's Pout/Pmax	# Units ON/AI		
Kelsey	251.00/315.00	7/7		
Waskesiu	200.00/222.90	3/3		
Jenpeg	116.50/139.80	5/6		
Grand Rapids	479.89/479.90	4/4		
Selkirk	0.00/0.02.00	0/2		
Brandon	0.00/0.00.00	0/3		
Pine Falls	89.00/103.60	6/6		
Great Falls	135.00/139.60	6/6		
MacArthur Falls	56.00/56.50	8/8		
Seven Sisters	165.00/165.40	6/6		
Slave Falls	68.00/68.00	8/8		
Ponte du Bois	78.00/78.80	16/16		
St Leon	19.07/99.00	1/1		
St Joseph	26.31/138.00	1/1		
Winnipeg River	591.00/611.90	50/50		
All AC Stations	1683.15/2525.00	71/77		

Note: Please make sure the plant and bus names in MHdata being correctly input!

Select a Plant	Units in the Plant
Kelsey	1 : [669768, 1]
Waskesiu	2 : [669763, 2]
Jenpeg	3 : [669770, 3]
Grand Rapids	4 : [669771, 4]
Selkirk	5 : [669772, 5]
Brandon	6 : [669773, 6]
Pine Falls	
Great Falls	
MacArthur Falls	
Seven Sisters	
Slave Falls	
Ponte du Bois	
St Leon	
St Joseph	
Winnipeg River	
All AC Stations	

Selected Plant: Jenpeg PGen [MW]: 116.50 Max [MW]: 139.80

Adjust To [MW]: Adjust By [MW]: Steps:

Machines can be used as Syncs at this station. Available Syncs: None ON Syncs #:

Developed Tools for VSAT

VSAT Tool

Extract data from VSAT contingency study results and customize the output in excel files:

- Thermal violation
- Voltage violation
- Voltage collapse
- Var violation

Contingency Converter

Convert contingency files from VSAT format to PSS/E format.

VSAT Tool

test-ovl-sum.xls [Compatibility Mode] - Microsoft Excel

	A	B	C	D	E	F	G	H	I	J
1										
2	2017SO-IFR0-SPUS-MHSP-GR480-									
3	Contingency	Facility	Overload %							
4			1	2	3					
5	MH-C R7B/C2B-BF	MR11	1417	1377	1337					
6	SPC-B P2C TRIP	672511,672588,1, BPLNTAP6	100.4	x	x					
7	SPC-C P2C & PR907T	672511,672588,1, BPLNTAP6	111.6	112.9	114.3					
8	MH-B FC56	RC57	111.6	112.9	114.3					
9	MH-B I2F	I2F	x	x	103.1					
10	MH-B I2F	I1F	x	x	146					
11	MH-B RC57	FC56	x	x	108.8					
12	MH-B CLIF BK2	FC56	x	x	108.7					
13	MH-B CLIF BK1	RC57	x	x	109.2					
14	SPC-B I1F TRIP	I2F	x	x	144.8					
15	SPC-B P2C TRIP	672507,672524,1, REGINA 6	138	x	x	100.8				
16	SPC-B P2C TRIP	672511,672524,1, BPLNTAP6	138	x	x	100.9				
17	SPC-C P2C & PR907T	672507,672524,1, REGINA 6	138	x	x	100.8				
18	SPC-C P2C & PR907T	672511,672524,1, BPLNTAP6	138	x	x	100.9				
19										
20	2017SO-IFR0-SPUS-SPMH-GR480-									
21	Contingency	Facility	Overload %							
22			1	2	3					
23	MH-B A3ROCK	C28R	1417	1377	1337					
24	MH-C A3ROCK/BK3-BF	C28R	104.3	106.4	107.7					
25	MH-C A3ROCK/D16R/BK1-BF	C28R	104.3	106.4	107.7					
26	MH-C R7B/C2B-BF	A3R	104.6	106.5	108					
27	SPC-C PRPQ & A1P	P2C	104	104.4	104.8					
28	SPC-C P2P & A1P	P2C	104	104.4	104.8					
29	MH-B FC56	RC57	x	x	109.4					
30	MH-B I2F	I2F	x	x	145.3					
31	MH-B I2F	I1F	x	x	145.3					
32	MH-B RC57	FC56	x	x	109.6					
33	MH-B CLIF BK2	FC56	x	x	109.6					
34	MH-B CLIF BK1	RC57	x	x	108.5					
35	MH-C A4D/054?	C28R	x	x	100.1					
36	SPC-B I1F TRIP	I2F	x	x	144.8					
37										
38	2017SO-IFR0-USSP-MHSP-GR480-									
39	Contingency	Facility	Overload %							
40			1	2	3					
41	SPC-B P2C TRIP	R1S	1417	1377	1337					
42	SPC-C PRPQ & A1P	R1S	101.8	101.5	101.1					
43			105.8	105.2	104.6					

GE-MARS Automation — Tools for GE-MARS

Tools

- GE-MARS Run Tool
- GE-MARS Data Modifying Tool

Functions

- Modify data in the input data file
- Control input and output files
- Control specified reliability index
- Display reliability indices

GE-MARS Run Tool

GE-MARS - Run Tool

Working Path: C:\GE-MARS

MIF: mars-new.in05 Select Load: mars.in02 Select

Shape: shape.in17 Select Replications: 100 Add Case

Output Files: mars-new Study Year: 2020

Area: MISO Peak Load (MW): Cap Adj(MW):

Run Different Cases: MIF, Load, Shape, Study Year, Cap Adj, Peak Load:

Out Names: Create

mars-new.in05, mars-in02, shape.in17, 2017, ,
mars-new.in05, mars-in02, shape.in17, 2018, ,
mars-new.in05, mars-in02, shape.in17, 2019, ,
mars-new.in05, mars-in02, shape.in17, 2020, ,
mars-new-2017
mars-new-2018
mars-new-2019
mars-new-2020

Results Display Options:

Interested Area: MHEB >> MHEB MISO

Index: LOLE (days/year) >> LOLE (days/year) LOLE (hours/year) LOEE (MWh/year)

Calculated Indices:

Adjust Parameters to Meet the Index Requirements:

Area or Pool Name: MISO Interconnected

Target Index: Value: Tolerance:
LOLE (days/year) 0.1 0.01

Adjust Parameter: Min Value: Max Value:
Cap Adj (MW) 0 1000

Sort Cases Min and Max Range: 1500 Add an Area to Adjust

Max Number of Trials: 0

Number of Replications During Trials: 2

Number of Replications for the Last Trial: 20

Write Log Log File Name: mars-new

Simulation Time

From: To: Show Results Run Exit

GE-MARS Data Modifying Tool

■ GE-MARS - Data Modifying Tool

Working Path: MIF: New File Name:

Add Unit Data

Unit General Data:

Unit Name: <input type="text" value="GASUNT"/>	Area Name: <input type="text" value="MHEB"/>	# of Units: <input type="text"/>	# of Units in Plant: <input type="text" value="="/>
Installation Date: <input type="text" value="01JAN2017"/>	Retirement Date: <input type="text" value="01JAN2099"/>	Unit Type: <input type="text" value="TH"/>	Unit Summary Type: <input type="text" value="CT-GAS"/>

Unit Capacity and States

Unit Size (MW): <input type="text" value="209"/>	Number of States: <input type="text" value="2"/>	Transition Rates:												
<table border="1"><thead><tr><th>States</th><th>Capacity %</th><th>State1</th><th>State2</th></tr></thead><tbody><tr><td>State1</td><td>100.00</td><td>0</td><td></td></tr><tr><td>State2</td><td>0.00</td><td></td><td>0</td></tr></tbody></table>			States	Capacity %	State1	State2	State1	100.00	0		State2	0.00		0
States	Capacity %	State1	State2											
State1	100.00	0												
State2	0.00		0											

Remove Areas:

Summary

Automation Using Python (For PSS/E, VSAT, GE-MARS)

- Retrieve Data
- Modify Data
- Control Parameters
- Export Data

Benefits

- Improve Efficiency and Save Time.
- Reduce Chances of Errors.
- More Fun

Questions?

Thanks!!!