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**Real Time Market  
Zonal Load Filter  
and Intelligent Selection  
of Generation and Tie-line Metering**

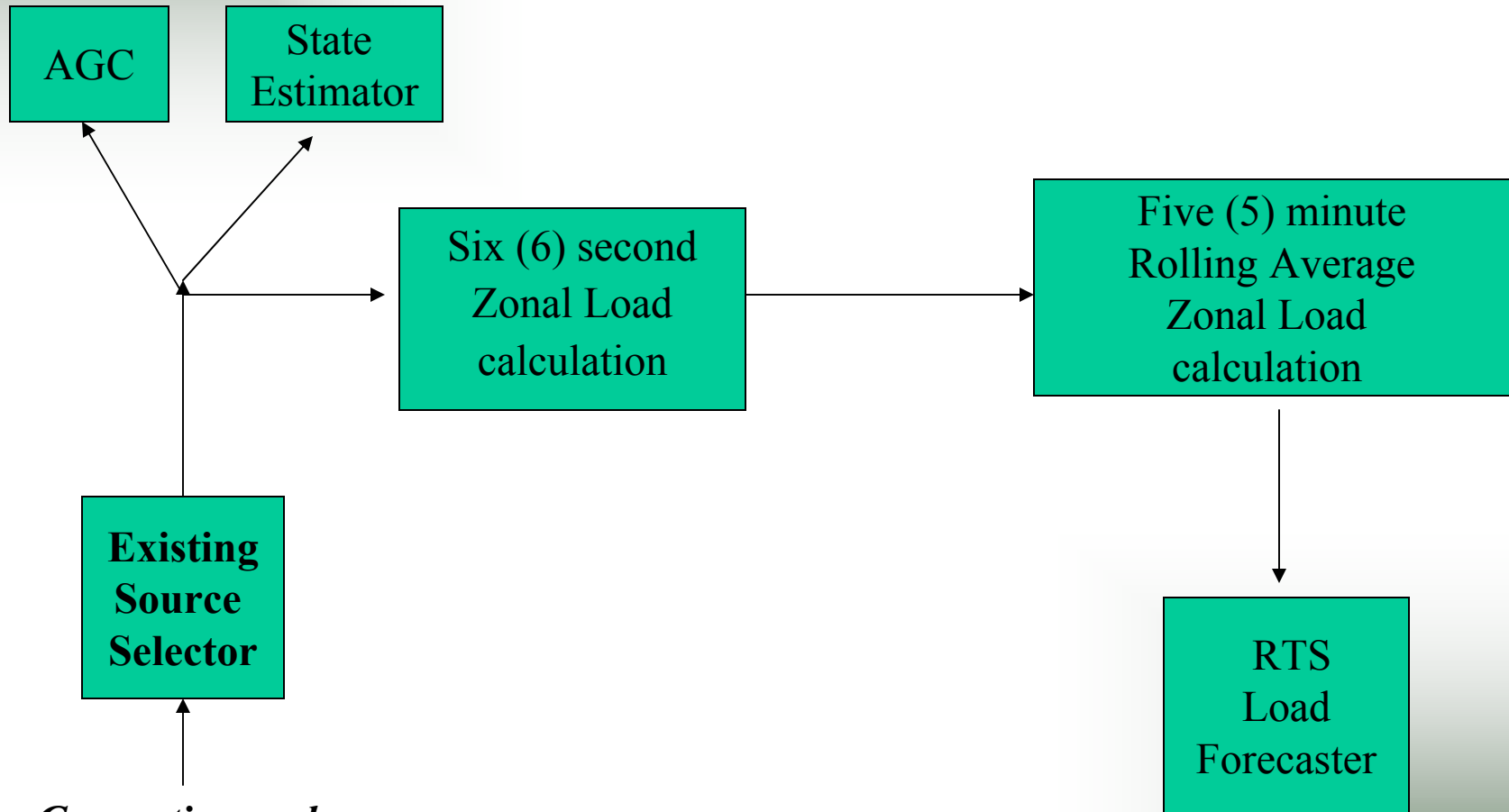
Scheduling & Pricing Meeting  
January 20, 2006

Energy Market Operations

# Outline

- Review of Current Implementation
- Problem Definition / Issues
- Basis of New Approach
- New Approach Implementation
- Zone Load Filter and Monitor
- Generator and Tie-Line Monitor
- Intelligent Source Selection
- Summary

# Current Implementation



*Generation and Tie-Line Sources*

# Count of Zonal Load Sources

Zone	Generators	Inter-Zonal Ties	External Zones Ties	Count
A --- West	25	10	8	43
B --- Genesee	13	18	0	31
C --- Central	39	25	4	68
D --- North	11	7	4	22
E --- Mohawk Val	28	32	0	60
F --- Capital	30	15	4	49
G --- Hudson Val	26	20	15	61
H --- Millwood	4	15	0	19
I --- Dunwoodie	1	16	0	17
J --- NYC	50	10	3	63
K --- Long Island	72	4	2	78
<b>Total</b>	<b>299</b>	<b>172</b>	<b>40</b>	<b>425</b>

# Problem Definition / Issues (I)

- **Incorrect telemetry corrupts Zonal Load Calculations used by Real Time Market Applications (RTS Load Forecaster) and impacts EMS Functions (AGC, State Estimator)**
- **Large number of telemetry sources are used and at any given time some data may be incorrect**
- **Multiple real reasons are responsible - Transient bad metering, ICCP metering non-simultaneity (time skew), incorrect or stale manually maintained data values, meter calibration work, etc.**
- **Errors may last from a few six (6) second scans to potentially longer and depends exclusively on operator actions to identify and resolve**

# Problem Definition / Issues (II)

- **Conventional Energy Management System (EMS) telemetry processing is not sufficient**
  - *Data smoothing (1<sup>st</sup> Degree Filter) – not useful as in most instances this simply results in a delay of the telemetry error*
  - *Reasonability Checks - not effective as in most instances telemetry data is reasonable but incorrect*
  - *Existing source switching –not a reliable indicator of most telemetry errors since it is based only on telemetry failure status*
- **By the time a telemetry error is identified and corrected, the rolling average Zonal Load determination for RTS Load Forecaster has been impacted and Real-Time Market operation is often affected**
- **While the load averaging process reduces the impact of short duration telemetry errors - it does not address the real telemetry problem**

# Basis of New Approach

- **Step (i.e. Sudden, Fast) changes in Generation or Tie-line source data can be the result of either correct or incorrect telemetry.**
- **Step (i.e. Sudden, Fast) changes in Zonal Load values are nearly exclusively the result of incorrect telemetry \*.**
- **Zonal Load changes from one six second scan to the next are the result of random metering noise and not the result of actual load changes.**
- **Zonal Load changes from one six second scan to the next normally have a zero average and a standard deviation (STD) that is quasi-independent of day-type and quasi-constant over a 24 hour period. Zonal Load changes greater than a multiple (k) of the STD indicates an outlier condition resulting from a generation or tie-line telemetry error.**
- **Generation or Tie-line source data problems can be identified timely and automatically corrected via two basic approaches:**
  - (a) *State Estimation or SE-like techniques based on redundancy***
  - (b) *Simultaneous source data changes and Zonal Load changes outside  $k \cdot \text{STD}$***
- **Slow Zonal Load corruption is often the result of stale Generation or Tie-line source data**

\* One "Normal" Exception (Alcoa smelter load in Zone D); "Exceptional" Case: Load Shedding

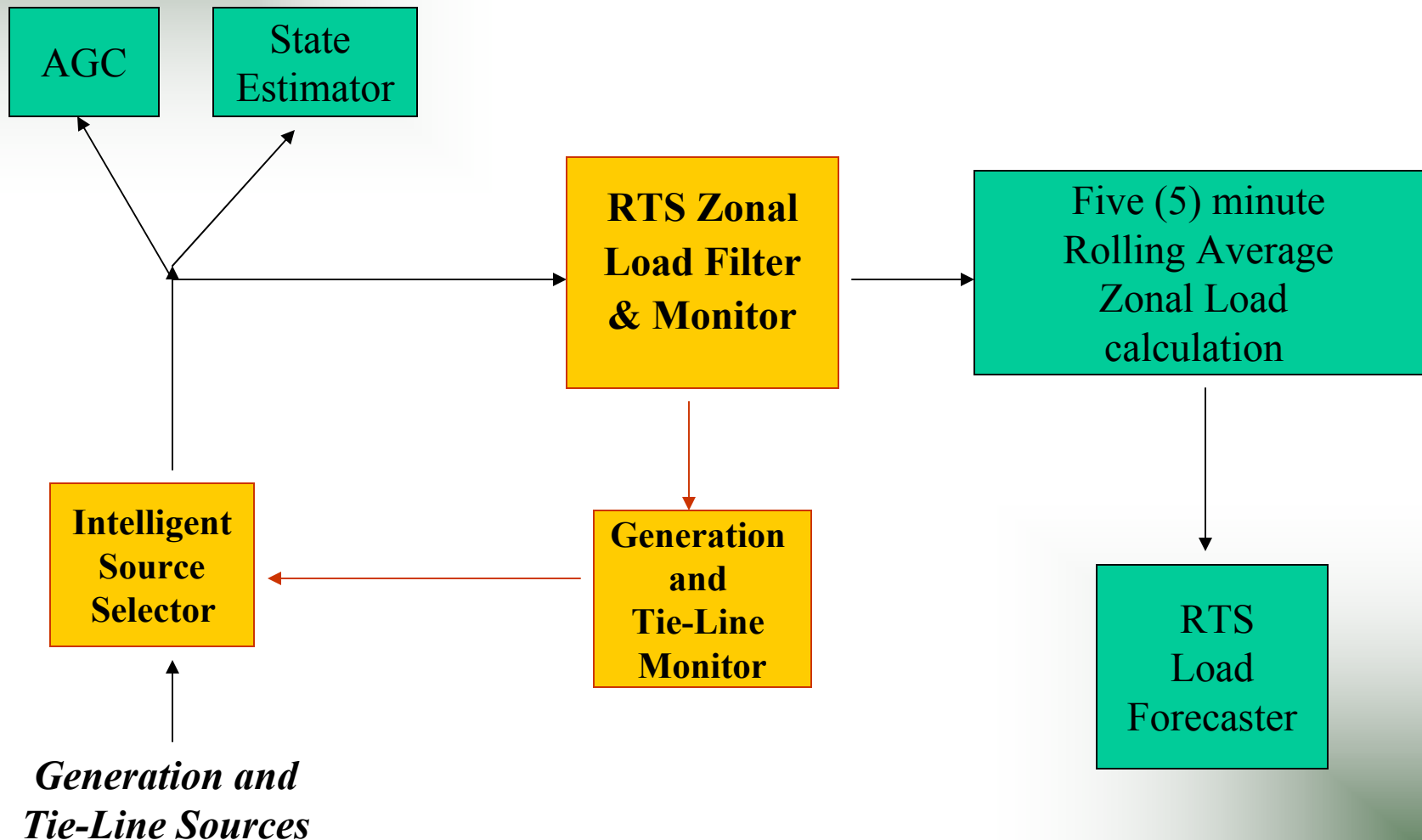
# Standard Deviation of Zonal Load Changes

	A	B	C	D	E	F	G	H	I	J	K
16-Jan-06 00:00:00	10.9	4.6	6.7	5.7	7.4	12.1	14.2	12.6	11.3	10.0	7.2
16-Jan-06 01:00:00	11.5	4.9	7.2	6.7	7.0	13.7	13.0	8.2	5.5	10.4	4.5
16-Jan-06 02:00:00	9.8	4.7	6.4	8.3	6.1	13.5	12.1	7.5	5.5	9.8	4.0
16-Jan-06 03:00:00	10.3	4.7	7.5	8.2	7.9	12.6	13.3	8.9	5.9	10.8	5.4
16-Jan-06 04:00:00	10.1	5.1	7.1	5.9	7.7	12.2	12.1	7.4	5.1	9.8	4.5
16-Jan-06 05:00:00	10.7	5.5	8.2	6.1	8.2	16.3	12.7	8.9	6.2	12.7	5.8
16-Jan-06 06:00:00	10.2	4.7	7.3	6.5	7.4	15.1	12.2	8.1	5.5	11.0	5.6
16-Jan-06 17:00:00	9.9	5.0	7.4	6.1	6.3	12.4	13.4	9.0	6.9	12.5	5.6
16-Jan-06 18:00:00	10.9	4.4	7.1	6.0	6.8	12.0	14.2	8.2	6.0	11.2	6.1
16-Jan-06 19:00:00	8.8	4.5	6.6	5.2	6.7	13.4	13.4	7.6	5.6	10.8	5.6
16-Jan-06 20:00:00	12.0	4.9	6.7	6.3	6.8	12.1	12.9	8.6	5.5	10.9	4.8
16-Jan-06 21:00:00	10.5	4.3	6.5	6.3	6.7	11.0	12.1	7.9	6.0	9.8	4.8
16-Jan-06 22:00:00	13.9	4.6	9.5	6.5	8.3	10.0	15.2	8.7	8.1	12.4	5.9
16-Jan-06 23:00:00	10.9	4.9	6.6	7.1	7.4	12.6	13.4	8.1	5.6	10.8	4.4
Average STD	10.5	4.5	6.8	6.9	6.9	12.6	13.3	8.4	6.3	11.3	5.4
<b>3*SIGMA</b>	<b>31.6</b>	<b>13.6</b>	<b>20.4</b>	<b>20.6</b>	<b>20.7</b>	<b>37.8</b>	<b>39.9</b>	<b>25.3</b>	<b>18.9</b>	<b>33.9</b>	<b>16.2</b>

Hourly Standard Deviations for Zone Load Changes Calculated from 600 samples.



# New Approach Implementation



# RTS Zonal Load Filter and Monitor

- **Detects Zonal Load step changes and conceptually “freezes” the incorrect telemetry value to its prior good value (last scan value)**
- **Handles multiple telemetry source errors, either occurring in same or subsequent scans**
- **Provides intelligent alarming for affected Zone(s)**
- **Eliminates short duration errors due to transient telemetry steps or delayed source data with no operator intervention**
- **Provides a timeframe for longer duration errors to either self-correct, to allow the Intelligent Source Switching to correct the error, or, as a last resort, to allow the System Operator to correct the error.**

# Zone Load Monitor Display

WS500 1 PPD2RTS1 Console: 76 Server: ppd2rts1 Priority 8 User: Iradu [ZONELOAD SCADA MODE Picture 4]

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View SCADA Generation Control Network Analysis SCUC Day Ahead RTC RTC - AMP RTD DTS Alarm Lists First page Last page Page up Page down 12/21/2005 15:22:54

OUS Add Component OUS Add Open Breaker OUS Add Close Breaker OUS Modify OUS Copy OUS Delete OUS View OUS Store

## ZONE LOAD MONITOR

ZONE	GEN	TIE	LOAD RAW	LOAD	LOAD 1 MIN	CHG	3 * SIGMA	TIME	BIAS	STATUS	STALE #	
											GEN	TIE
A_WEST	3628 M	- 1481	2146 M	2146 M	2152 M	9	40	0.0	0	NORMAL	0	0
B_GENS	696	611	1308	1308	1307	1	20	0.0	0	NORMAL	0	4
C_CENT	3679 M	- 1424	2255 M	2255 M	2257 M	2	34	0.0	0	NORMAL	1	2
D_NRTH	1072 M	- 85 M	987 M	893 M	888 M	99	27	0.9	94	ALARM	1	1
E_MHKV	285 T	653 M	938 M	1028 M	1032 M	95	24	0.9	- 90	ALARM	0	1
F_CAPT	716 M	785	1500 M	1500 M	1499 M	0	40	0.0	0	NORMAL	0	0
G_HUDV	1489 M	- 244	1245 M	1245 M	1244 M	3	50	0.0	0	NORMAL	2	4
H_MILW	2118	- 1782	336	336	336	1	30	0.0	0	NORMAL	0	0
I_DUNW	2	776	778	778	786	8	28	0.0	0	NORMAL	0	0
J_NYC	3575 M	3043	6619 M	6619 M	6617 M	1	42	0.0	0	NORMAL	1	0
K_LISL	1792 M	939	2731 M	2731 M	2724 M	8	20	0.0	0	NORMAL	0	0

AUTO TURN-OFF = 600 MIN

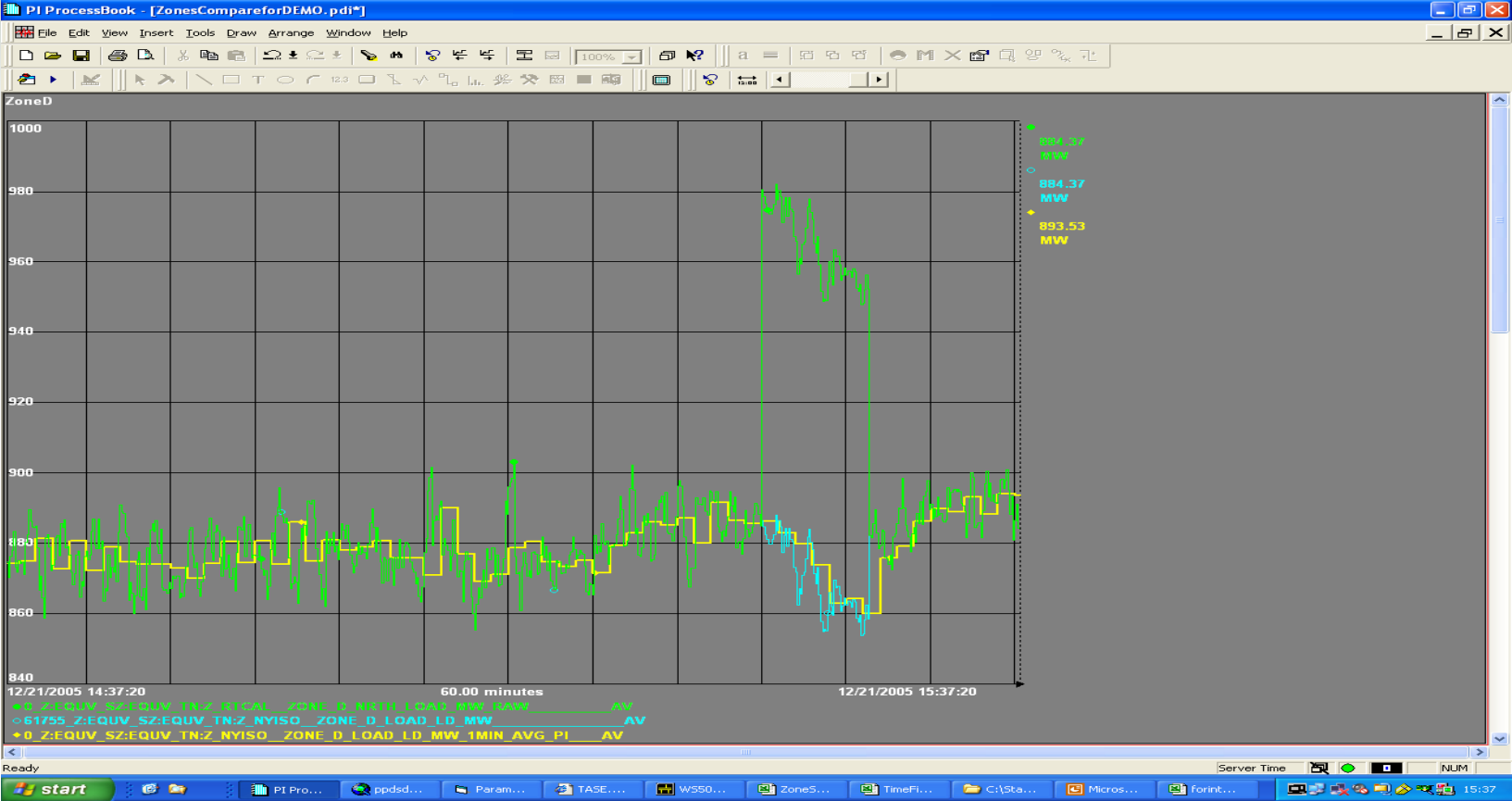
ZONELOAD  
REV.11.29.05  
D.B. 187

MWMON DFK2 DFK3 DFK4 DFK5 DFK6 DFK7 DFK8 DFK9 DFK10

Slide 11 of 27 green\_plain Zoom Level 01 Selected : 0 NUM Active database

start PI Pro... ppsd... Param... TASE... WS50... Zone5... TimeFi... C:\Sta... Micros... forint... 15:22

# Zonal Load Filtering Example



# Generation and Tie-Line Monitor

- **Detects stale generation and/or tie-line telemetry value(s)**
- **Detects step changes in generation and/or tie-line telemetry values correlated with Zonal Load changes and identifies the affected telemetry component**
- **Provides intelligent alarming for affected stale or step change telemetry value(s) and the affected telemetry component**
- **Applies to all telemetry components of Zonal Load**
- **Sets a stale criteria different for tie-lines and generators**

# Tie Line MW Monitor Display

WS500 1 PPD2RTS1 Console: 76 Server: ppd2rts1 Priority 8 User: Iradu - [TIEMOND SCADA MODE Picture 4]

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EMS Help Display Mode Operator setti

View SCADA Generation Control Network Analysis SCUC Day Ahead RTC RTC - AMP RTD DTS Alarm Lists First page Last page Page up Page down 12/21/2005 15:22:11

OUS Add Component OUS Add Open Breaker OUS Add Close Breaker OUS Modify OUS Copy OUS Delete OUS View OUS Store

TIE MONITOR - ZONE D NORTH

M	EQUIPMENT	IN USE	SRC	PRIMARY	ALTERNATE	SE	OPP END	DBND	STATUS	TIME
	HQ									
X	MASSENA - CHATELAIN 7040	- 134	PRIMRY	- 134 M	- 96		100	0	STALE	???.?
	NE									
X	PLATTSBURGH - GRAND ISL 20	130	PRIMRY	131	132			0	NORMAL	0.0
	OH									
X	MOSES - ST. LAWRENCE L33P	17	PRIMRY	17	12		- 12	0	NORMAL	0.0
X	MOSES - ST. LAWRENCE L34P	9	PRIMRY	9	4		- 6	0	NORMAL	0.0
	E MOHAWK VALLEY									
X	MASSENA - MARCY MSUI	0	PRIMRY	0 M	97		- 93	0	SUSPCT	0.0
X	MOSES - ADIRONDACK 1	32	PRIMRY	32	36		- 36	0	NORMAL	0.3
X	MOSES - ADIRONDACK 2	34	PRIMRY	34	37		- 36	0	NORMAL	0.3
X	ALCOA - N. OGDENSBURG 13	20	PRIMRY	20	20		- 14	0	NORMAL	0.2
X	DENNISON - NORFOLK 4	1	PRIMRY	1	0			0	NORMAL	0.0
X	DENNISON - SANDSTONE 5	3	PRIMRY	3	3			0	NORMAL	0.1
X	PARISHVILLE - COLTON 3	24	PRIMRY	24	24			0	NORMAL	0.2

TIE STALE OVER 2 MIN

ZONE LOADS TIE ZONE C TIE ZONE E GEN ZONE D DFK10

x: -615744, y: -560738 Zoom Level 01 Selected : 0 NUM Active database

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start PI Pro... ppsd... Param... TASE... WS50... Zone5... TimeFi... C:\Sta... Micros... forint... 15:22

# Intelligent Source Selector (End-State Operation)

- **Will automatically select an alternate generation or tie-line telemetry source based on errors identified either 1) by source redundancy or 2) by correlating Zonal Load step changes with current source step changes**
- **Will provide intelligent alarming for telemetry source switch changes**
- **Will apply to all telemetry components of Zonal Load**

# Intelligent Source Selector (End-State Operation)

<b>Generator/ Tie-Line Component Type</b>	<b>Alarm for Stale and Step</b>		<b>Automatic Source Change Methodology</b>	<b>Automatic Source Change Source switches to</b>	<b>Example</b>
2plus1	YES		Redundancy	Other source at same location	tie line with two sources at same end and one at opposite end
2plus0	YES		Simultaneous Zonal Load change	Other source at same location	tie line with two sources at same end
1plus1	YES		Simultaneous Zonal Load change	Opposite end source	tie line metered at both ends
1plus0	YES		Simultaneous Zonal Load change	Prior Good Value	tie line metered at one end



# Summary

- **The Zonal Load Filter eliminates short duration errors with no operator intervention and provides a timeframe without corruption for longer duration errors to either self-correct, to allow the Intelligent Source Switching to correct the error, or, as a last resort, to allow the System Operator to correct the error.**
- **The Generator and Tie-Line Line Monitor identifies stale and incorrect step changes in generation and/or tie-line telemetry values and identifies the affected telemetry component**
- **The Intelligent Source Selector will automatically select an alternate generation or tie-line telemetry source based on errors identified either 1) by source redundancy or 2) by correlating zonal load step changes with current source step changes**
- **These three functions comprising this new approach will act in a complementary and coordinated manner to minimize the impact of telemetry errors on the ISO Real-Time Market functions as well as improve other ISO Energy Management System functions.**