

# Virtual Network Monitoring: Powered by PI System

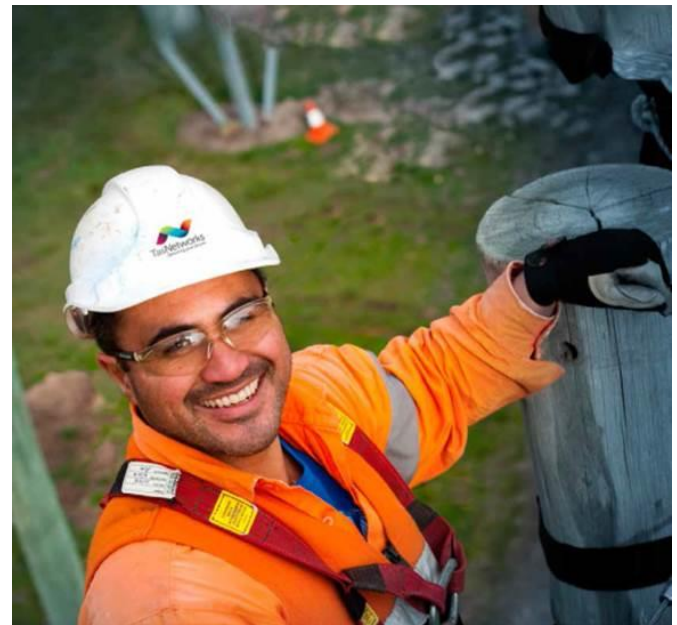
Thanh Nguyen (TasNetworks) and Chris Reid (eTree)



USERS CONFERENCE 2015

# Who is TasNetworks?

- Commenced on 1 July 2014 merging Aurora Distribution and Transend (Transmission)
- State-owned with two shareholder ministers
- Transmission, Distribution and Telecommunications all core business
- \$3bn Regulatory Asset Base
- Over 250k small, 4 major industrial customers.
- Approx. 1,000 staff

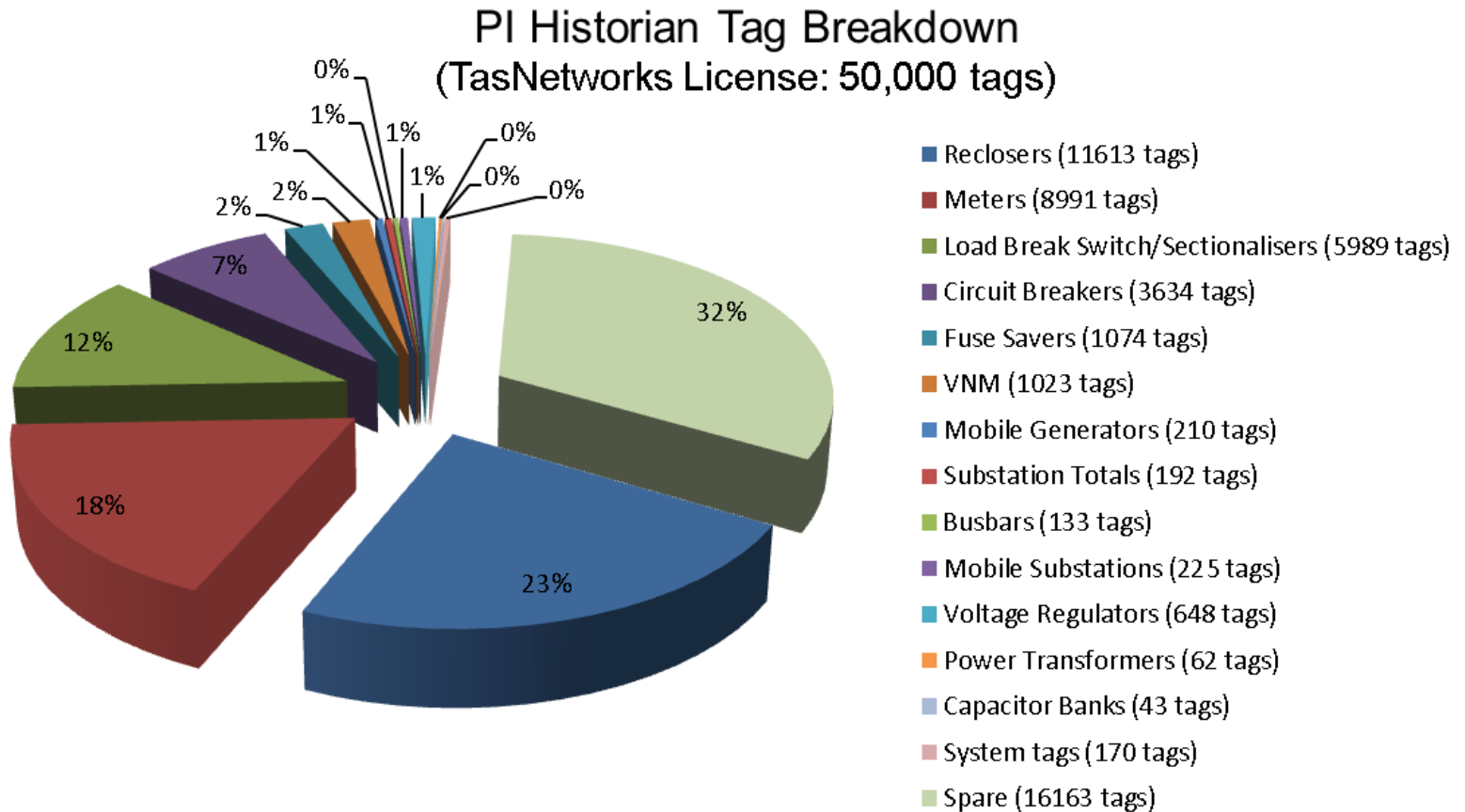


# Tasmania's Smart Network Strategy

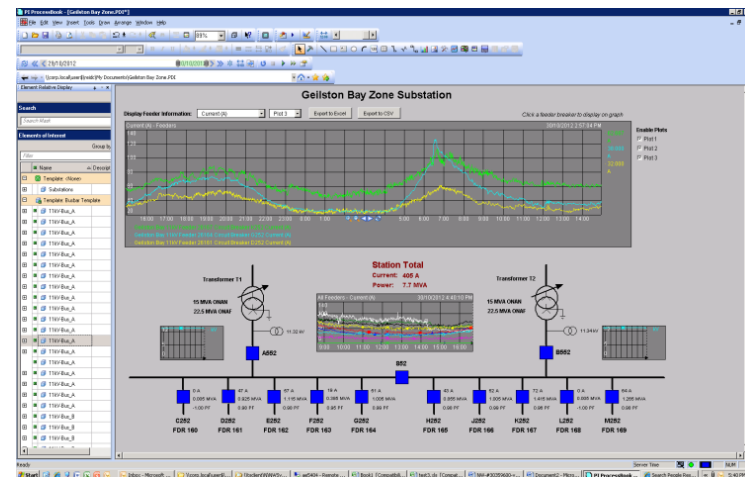
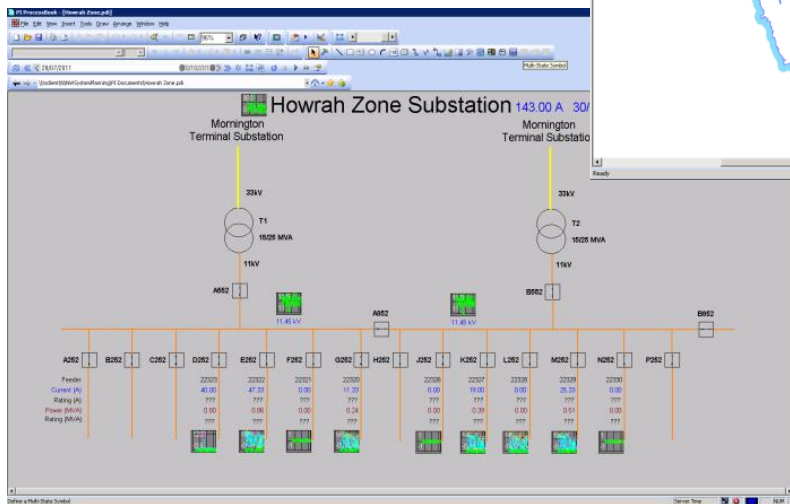
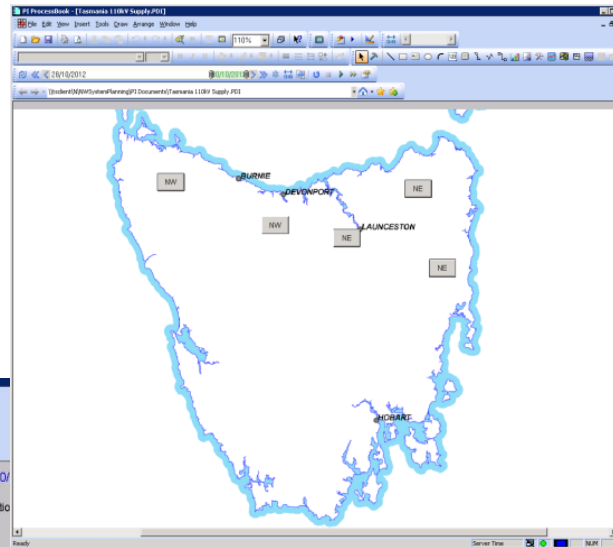
*Modernise the 'poles and wires' electricity network through innovative technologies and systems in order to:*

- Minimise the electricity network costs*
- Meet the changing customer needs*
- Improve business efficiency*

# PI Tags for devices on the Network

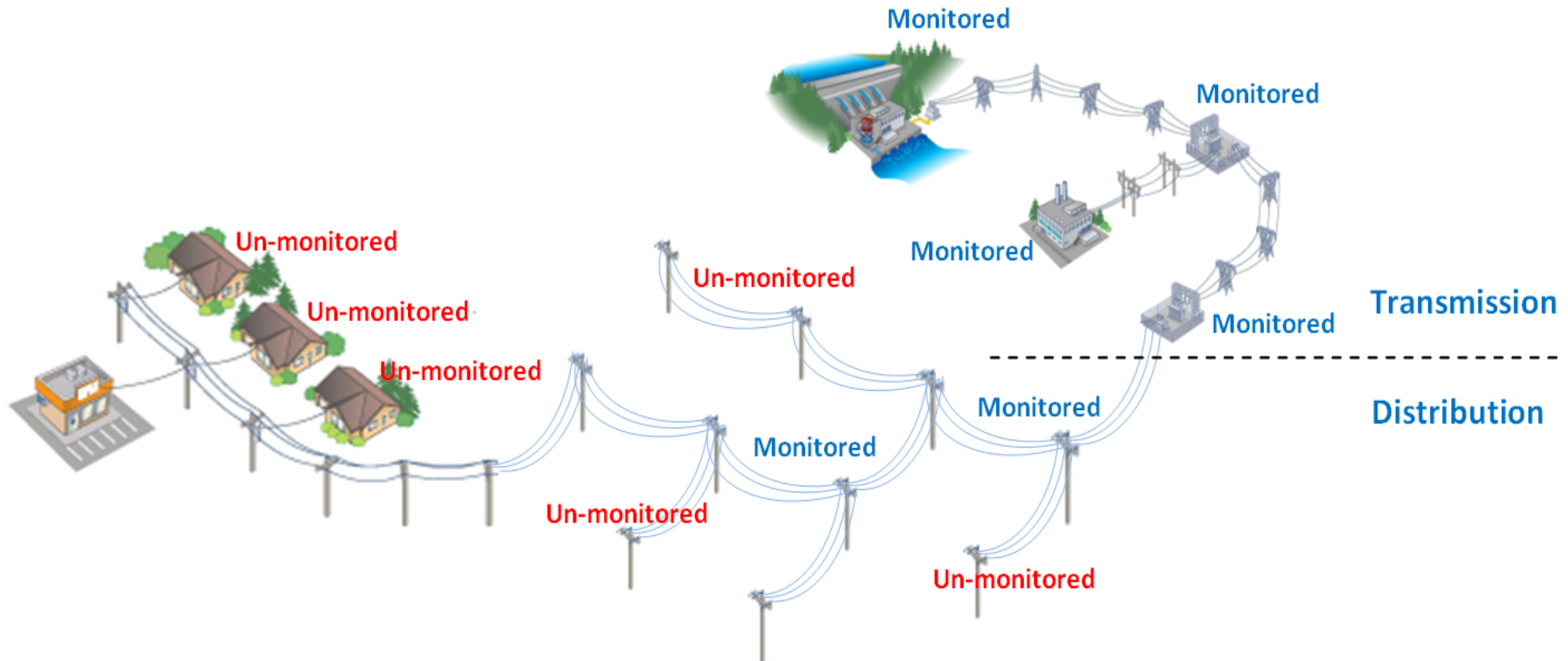


# Example user developed tools



# Virtual Network Monitoring

# “If you can’t measure it, you can’t manage it”





## **Conservative Network Design & Decisions**

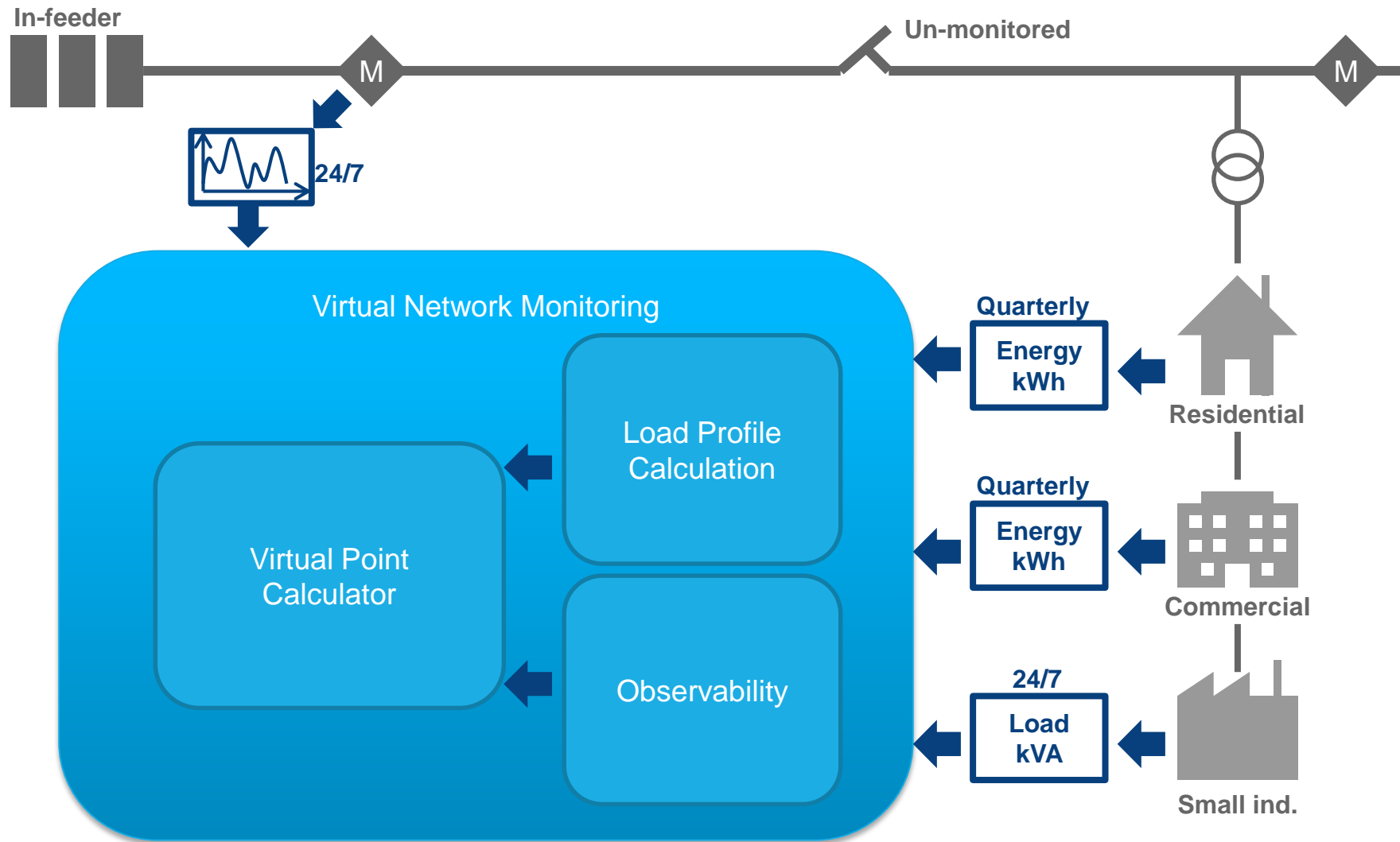


## **Limited Situational Awareness**

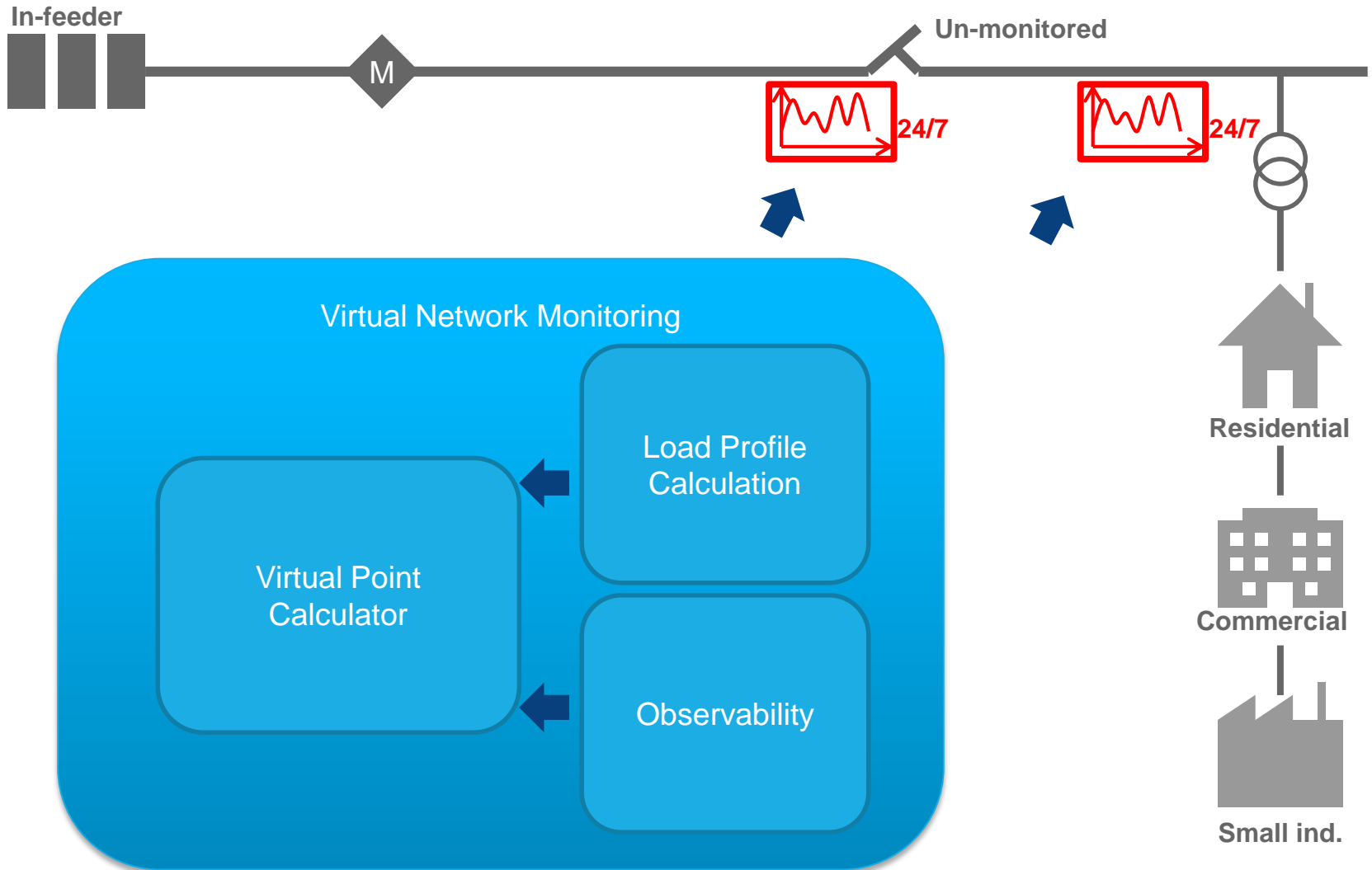




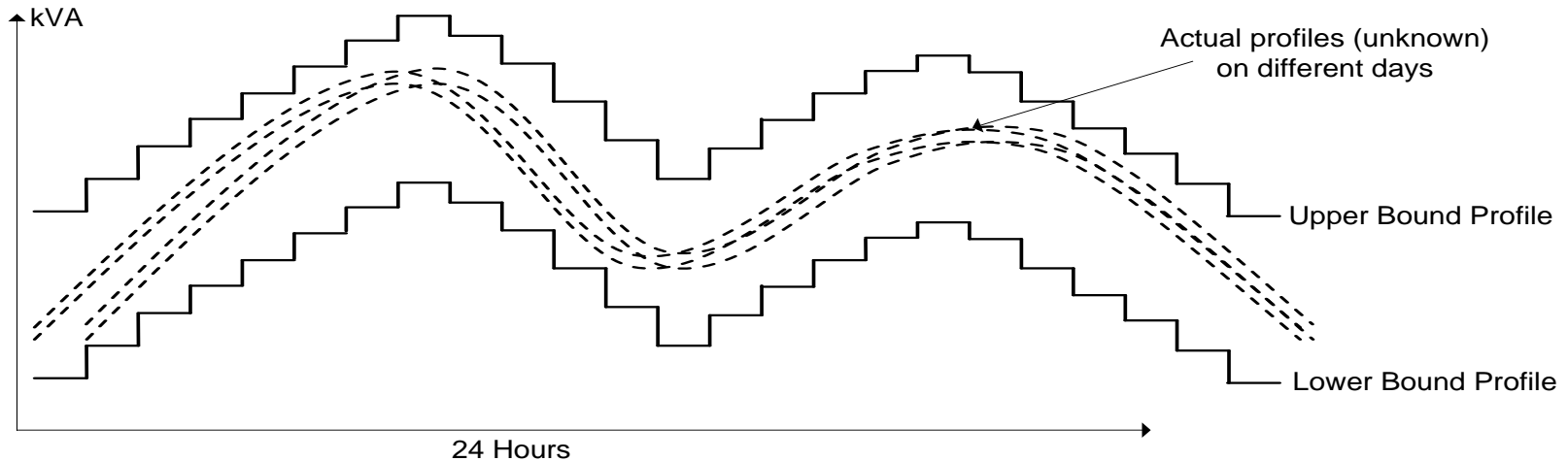
# What is Virtual Network Monitoring?



# What is Virtual Network Monitoring?



# Load Profile Calculator



## Data Input

- Quarterly energy readings
- Customer usage patterns

## Key Principle

- Aggregate profile from a **large** number of customers has **narrow** bounds,
- and vice versa

# Observability

Observability Index

Correlated Standard Deviation of Load

Load Mean

$$OI = 1 - \frac{2\sigma}{\mu}$$

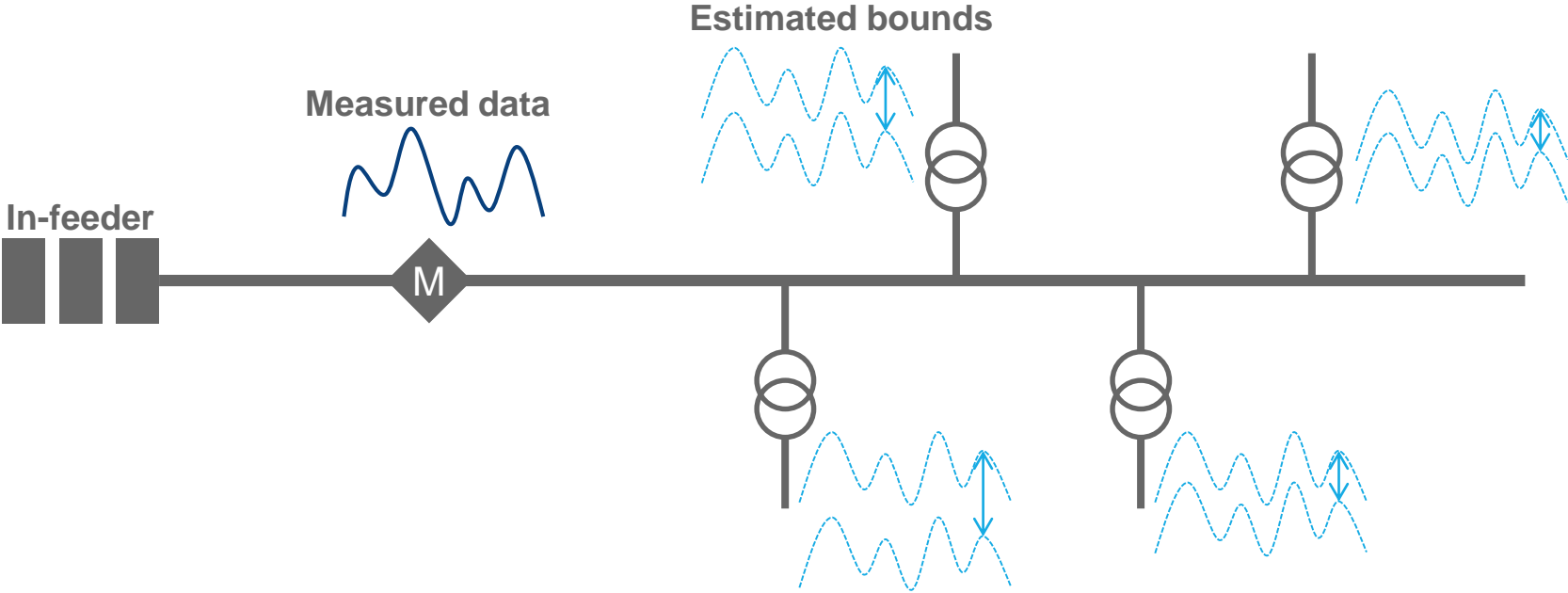
## Data Input

- Load bound profiles
- The configuration of network monitoring zones

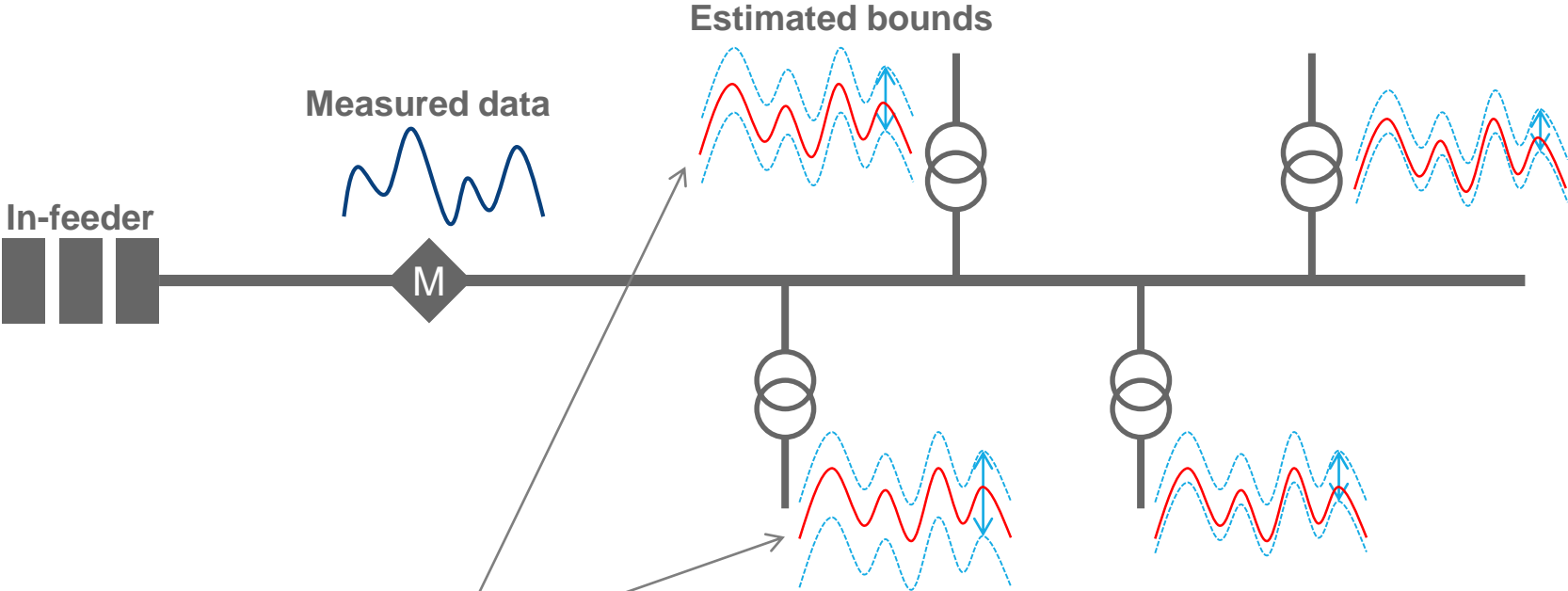
## Key Principles

- Loads within **tighter** monitoring zones are **more** observable
- **Narrow** load bounds implies **high** observability

# Virtual Point Calculator



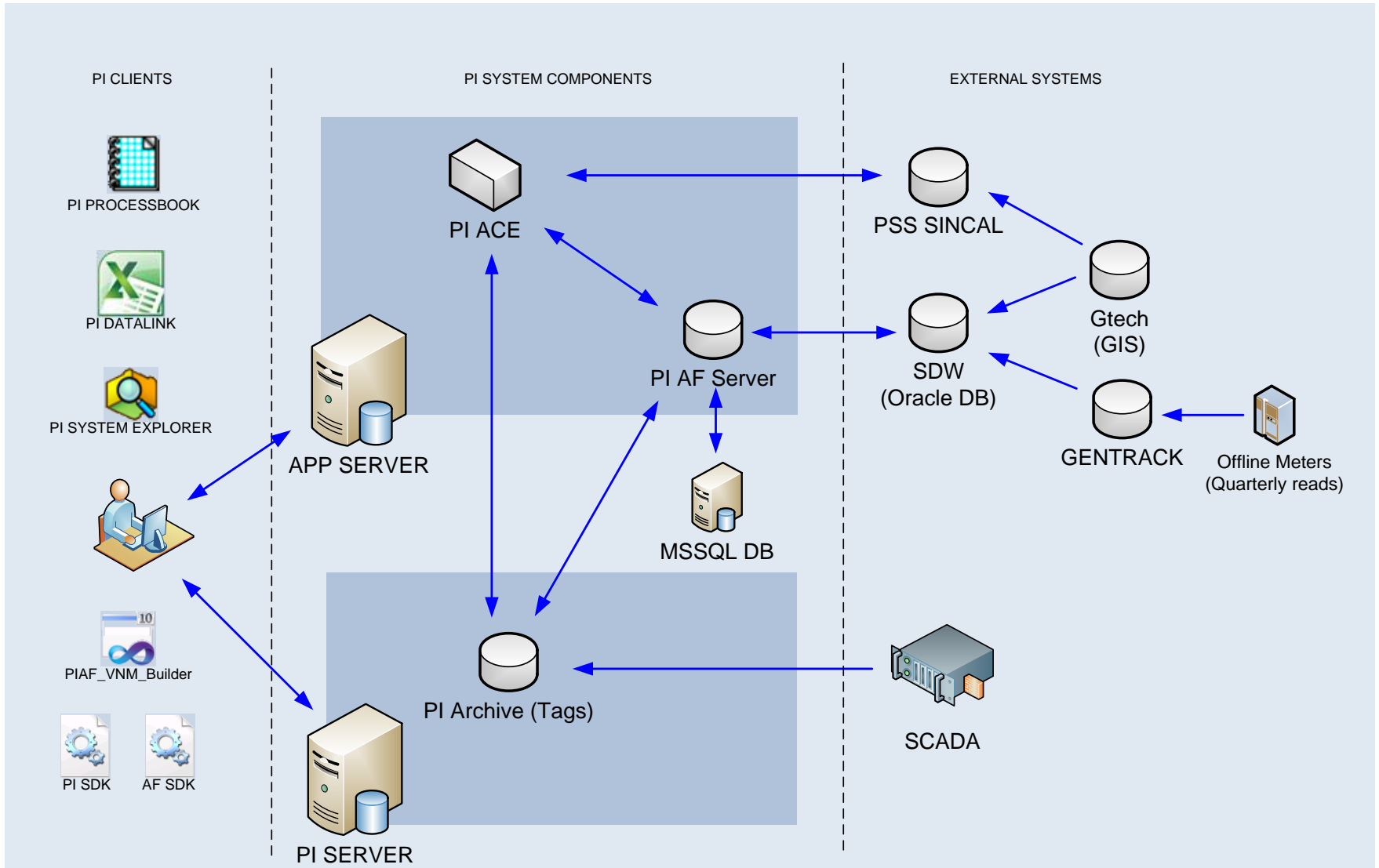
# Virtual Point Calculator



- Best guesses:**
- Collectively suit the measured data
  - Make load flow converge

# VNM Solution Implementation

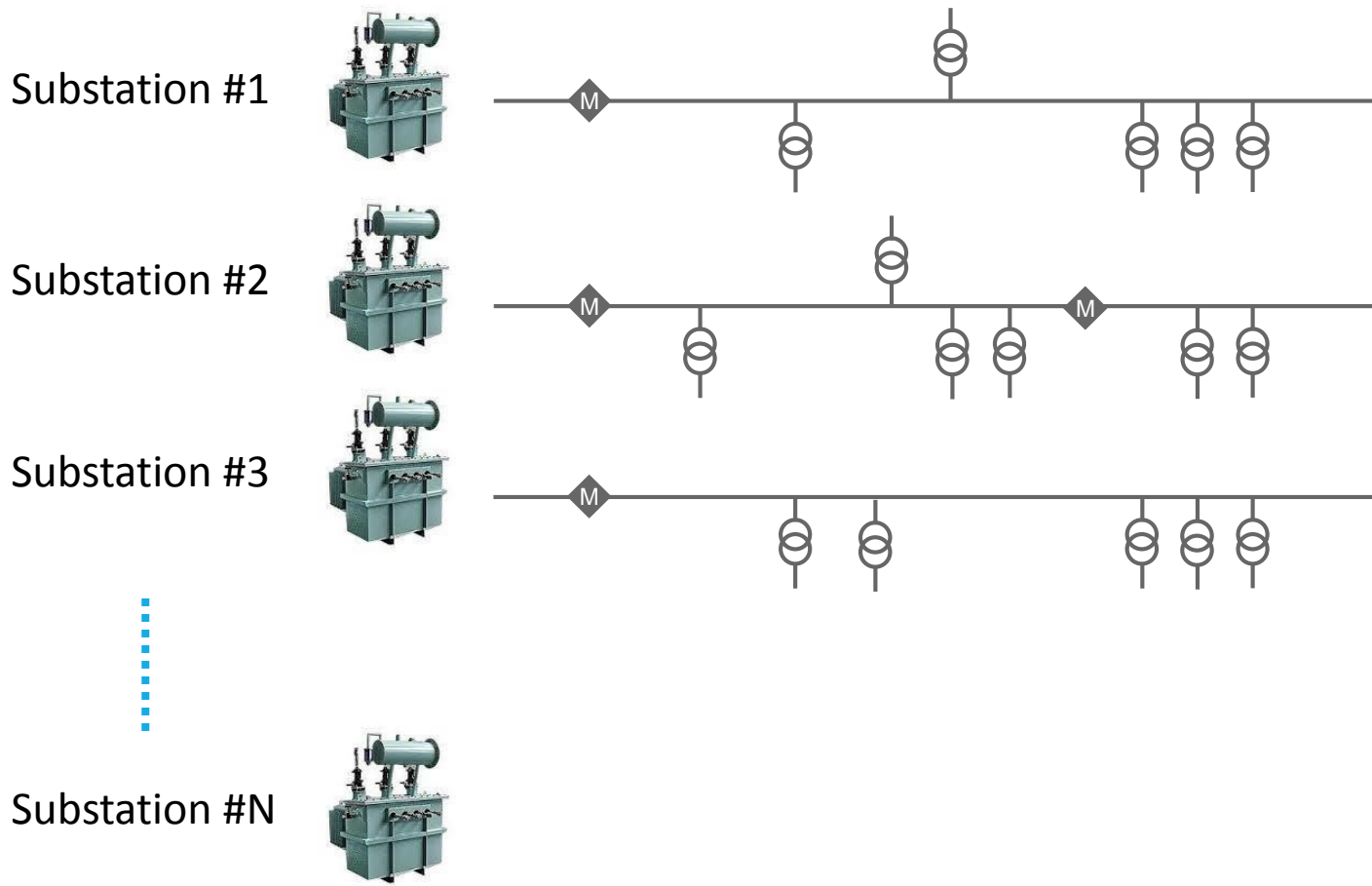
# High Level System Architecture



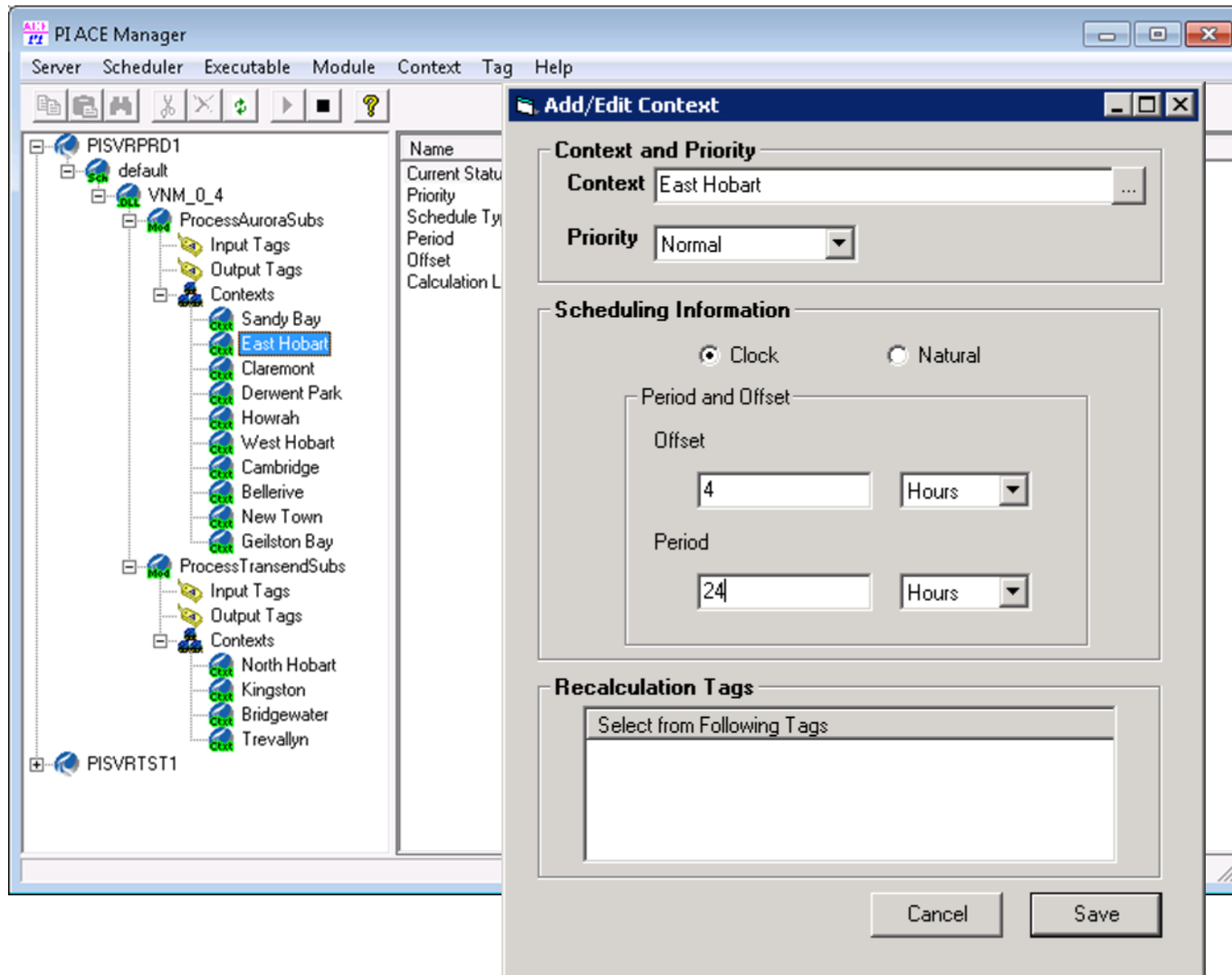


# PI ACE class

- Develop generic VNM calculation for a substation, apply to many (contexts)



# PI ACE contexts



# PI Asset Framework (AF)

each ACE context uses a corresponding AF structure

The screenshot displays the PI System Explorer interface. On the left, a tree view shows the hierarchy of elements, including 'Virtual Network Monitoring', 'Substations', and 'Monitoring Zones'. The 'T121008' element is selected under 'Distribution Transformers'. The main pane shows the 'General' tab for this element, displaying a table of attributes and their values.

Name	Value
Apparent Power	58.9238 kVA
Corrected Load Lower Bound	Single Array
Corrected Load Profile Mean	Single Array
Corrected Load Profile Standard Deviation	Single Array
Corrected Load Upper Bound	Single Array
Correlation Coefficient Array	Single Array
Customer Count	81
Customer Count Commercial	17
Customer Count Industrial	1
Customer Count Residential	63
Feeder	12037
G3E_FID	5291703
Last ACE Update	8/09/2015 6:01:10.813 AM
Locality	Sandy Bay
Location	David Ave Sandy Bay
LP_Com_Mean	Single Array
LP_Com_SD	Single Array
LP_Ind_Mean	Single Array
LP_Ind_SD	Single Array
LP_Res_Mean	Single Array
LP_Res_SD	Single Array
Number of Phases	3
Observability Index	Single Array
Observability Index Mean	80.97999 %

On the right side of the interface, a configuration panel for the 'Apparent Power' attribute is visible. It includes fields for Name, Description, Configuration Item, Categories, Default UOM (kVA), Value Type (Single), Value (58.9238 kVA), and Data Reference (PI Point). A 'Settings...' button is also present.

At the bottom of the window, the following text is displayed: T121008 Modified:8/09/2015 6:00:48 AM. Version: 1/01/1970 12:00:00 AM, Revision 231

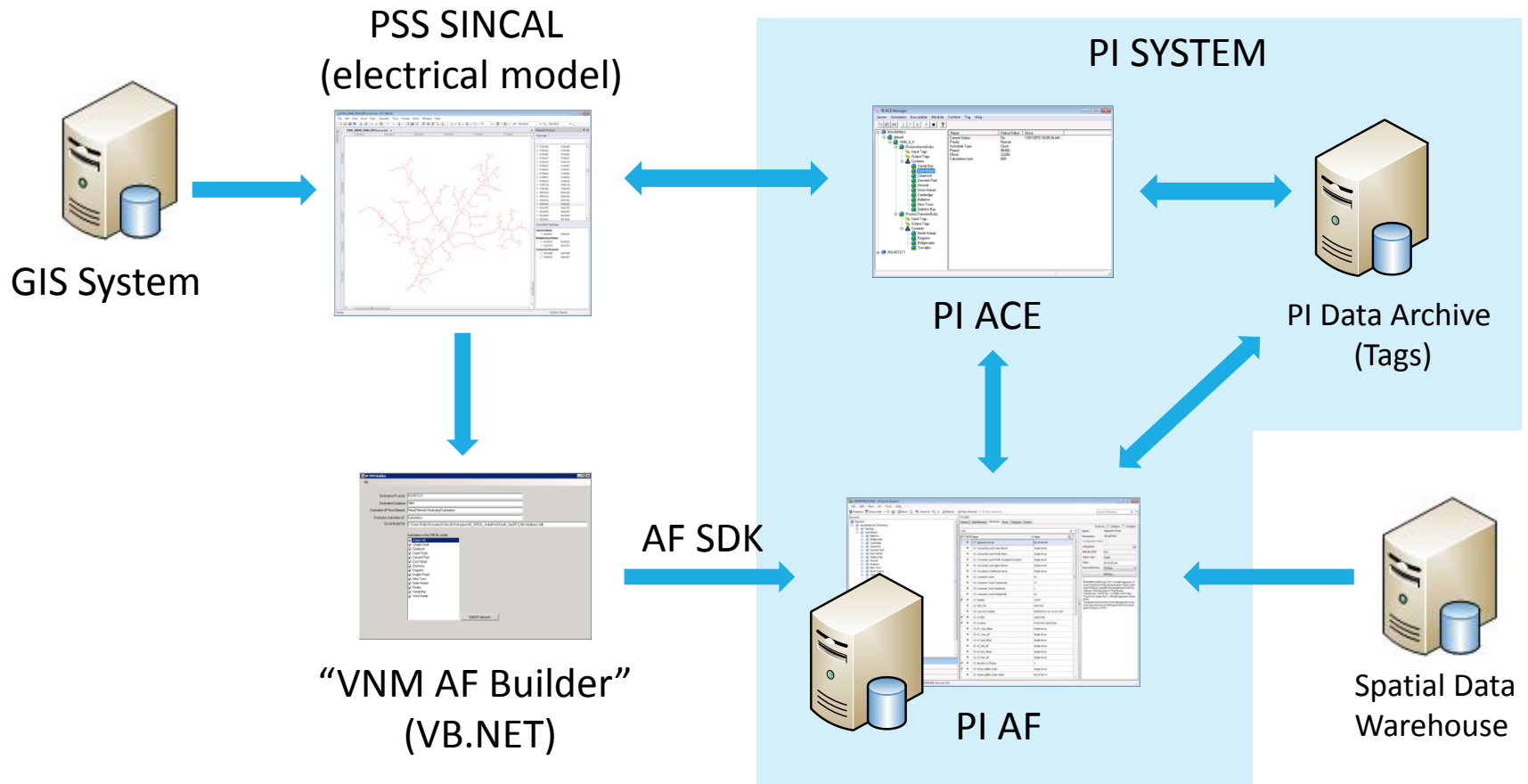
# AF Tables link to Spatial Data Warehouse

The screenshot shows the PI System Explorer interface. The left-hand pane displays a tree view of the library structure, with 'Distribution Transformers' selected under the 'Tables' folder. The main window displays a table of data for 'Distribution Transformers'. The table has the following columns: ASSET\_TYPE, G3E\_FID, PLATE\_ID, RATING, TRAN\_TYPE, VOLTAGE, FEEDER\_NO, FEEDER\_STATION, FEEDER\_CLASS, MONITORIN, LOCATION\_DESC, LOCALITY, and PC. The data rows show various transformer assets with their respective attributes.

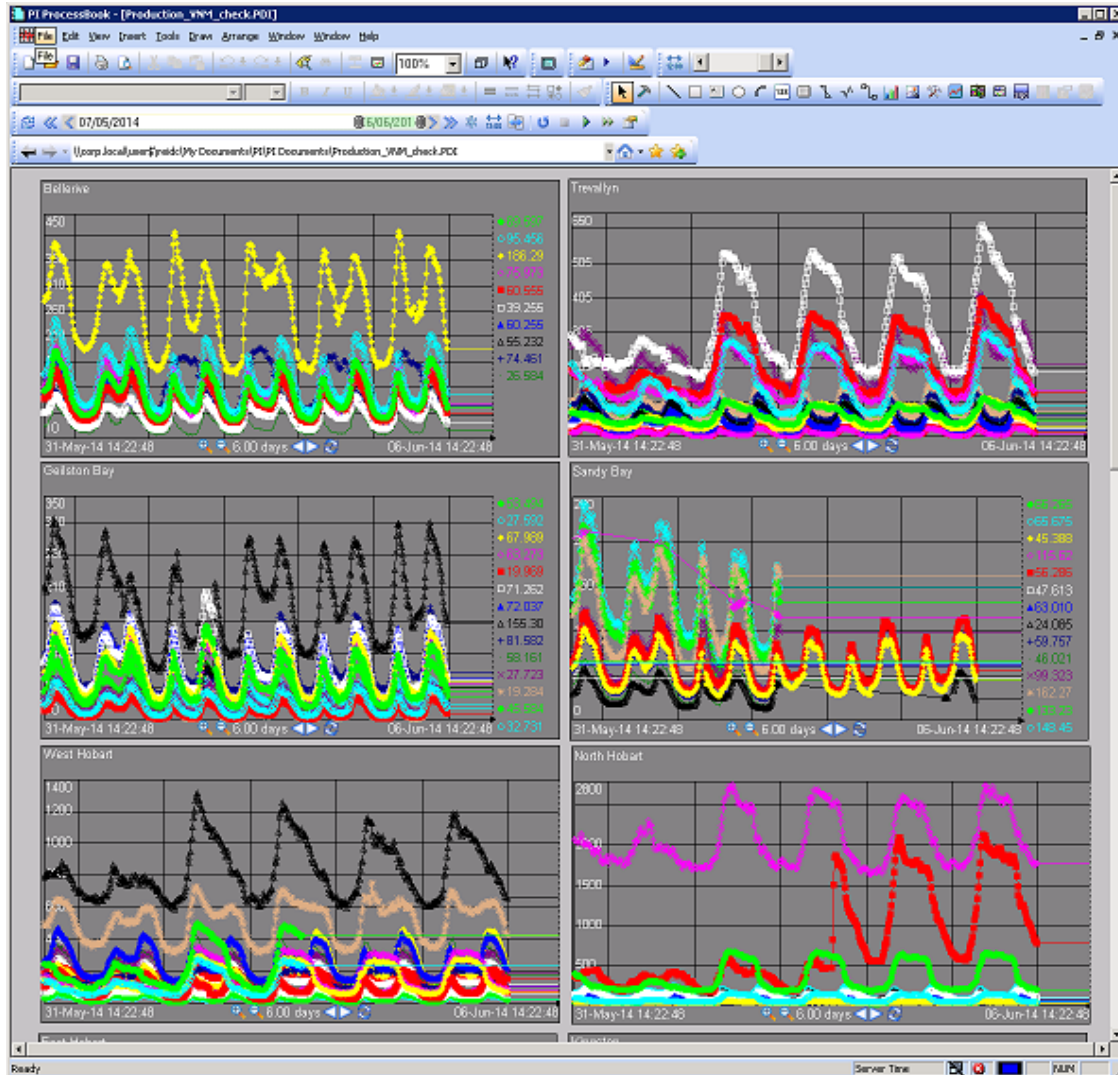
ASSET_TYPE	G3E_FID	PLATE_ID	RATING	TRAN_TYPE	VOLTAGE	FEEDER_NO	FEEDER_STATION	FEEDER_CLASS	MONITORIN	LOCATION_DESC	LOCALITY	PC
HV_LOAD_...	6053912	T740097	100	100kVA_Tran	22kV	56004	Avoca	Terminal	3979844	Macquarie Rd Campbell Town_Greenhill Pump	Campbell Town	721
HV_LOAD_...	6046489	T670827	200	200kVA_Tran	22kV	91012	Burnie	Terminal	3980623	Murchison Highway Yolla_Henrietta	Yolla	732
HV_LOAD_...	6049588	T760239	10	10kVA_Tran_1	22kV	55001	Derby	Terminal	3963365	Ringarooma Road Ringarooma_A.J.Haas	Ringarooma	726
HV_LOAD_...	6050357	T880434	200	200kVA_Tran	22kV	43507	Triabunna	Terminal	3971644	Julia Street Swansea	Swansea	715
HV_LOAD_...	6050769	T880459	25	25kVA_Tran_1	22kV	43507	Triabunna	Terminal	3971677	Pontypool Road Pontypool_alt High Street	Pontypool	715
HV_LOAD_...	6051299	T830381	200	200kVA_Tran	22kV	91008	Burnie	Terminal	3981774	West Street Upper Burnie_Burnie	Upper Burnie	732
HV_LOAD_...	6051407	T680563	200	200kVA_Tran	22kV	93003	Smithton	Terminal	3917365	Trowutta Road Smithton_alt Scotchtown Rd	Smithton	733
HV_LOAD_...	6052625	T272290	750	750kVA_Sub	11kV	22331	Howrah	Zone	3918292	Oceana Drive Tranmere	Howrah	701
HV_LOAD_...	6053694	T770518	50	50kVA_Tran	22kV	49411	Wayatinah	Generation	3807056	Wayatinah Road Wayatinah_Workshop	Wayatinah	714
HV_LOAD_...	5989712	T640132	100	100kVA_Tran	22kV	91002	Burnie	Terminal	3982328	Masters Road South Riana	South Riana	731
HV_LOAD_...	5990486	T900157	15	15kVA_Tran_1	11kV	34251	Kingston	Terminal	3879076	Bruny Island Main Road North Bruny	North Bruny	715
HV_LOAD_...	5988553	T510703	15	15kVA_Tran_1	11kV	35011	New Norfolk Zone	Zone	3961528	Mountain Place Molesworth	Molesworth	714
HV_LOAD_...	5988562	T152940	750	750kVA_Sub	11kV	20536	Chapel Street	Terminal	3955672	Bowden St Glenorchy	Glenorchy	701
HV_LOAD_...	5988768	T640344	25	25kVA_Tran	22kV	91002	Burnie	Terminal	3982328	Fieldings Road South Riana	South Riana	731
HV_LOAD_...	5989427	T630948	15	15kVA_Tran_1	22kV	82004	Ulverstone	Terminal	3916152	Purtons Road North Motton_Purton & Son	North Motton	731
HV_LOAD_...	5982526	T550352	25	25kVA_Tran	22kV	51002	Palmerston	Terminal	3975559	Oaks Road Bracknell_Besanuale	Bracknell	730
HV_LOAD_...	5983159	T630262	25	25kVA_Tran_1	22kV	82004	Ulverstone	Terminal	3916277	South Nietta Rd Nietta_in Woodhouses Rd	Nietta	731
HV_LOAD_...	5983270	T640046	100	100kVA_Tran	22kV	91011	Burnie	Terminal	3972680	Albert Road Heybridge_Cuprona	Heybridge	731
HV_LOAD_...	5983889	T730505	25	25kVA_Tran_1	22kV	41516	Sorell	Terminal	3983115	Woodsdale Back Rd, Woodsdale	Woodsdale	712
HV_LOAD_...	5984352	T700230	25	25kVA_Tran_1	22kV	85008	Railton	Terminal	3986059	Sherwood (to Great Bnd Pumps) Rd Latrobe	Latrobe	730
HV_LOAD_...	5984369	T340650	750	750kVA_Sub	22kV	66109	St Leonards	Terminal	3929068	St Leonards Rd St Leonards	St Leonards	725

AF elements get attributes from these tables

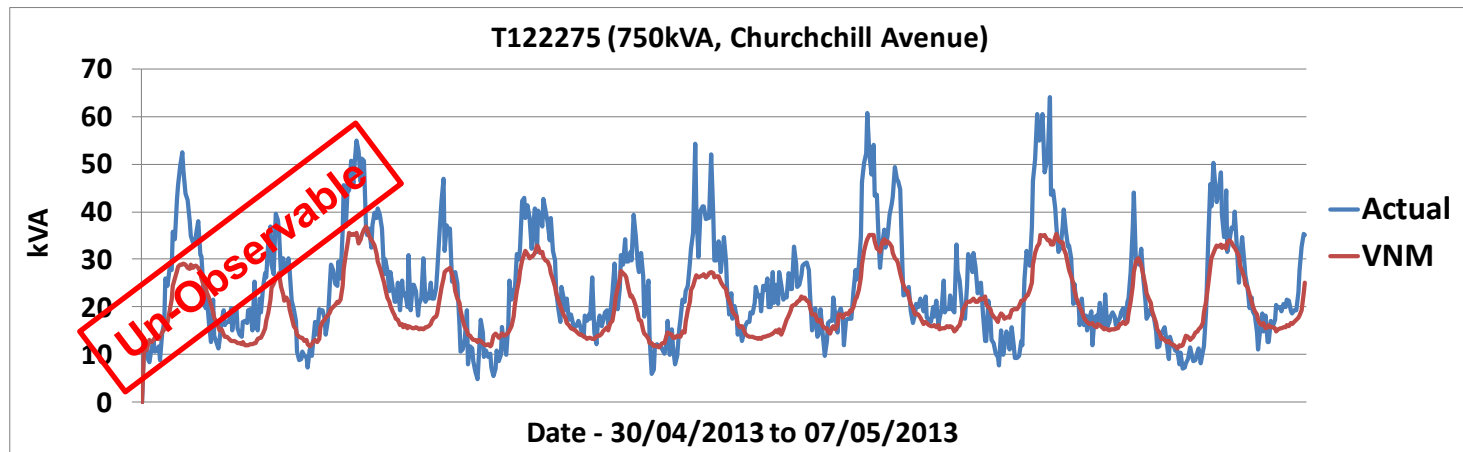
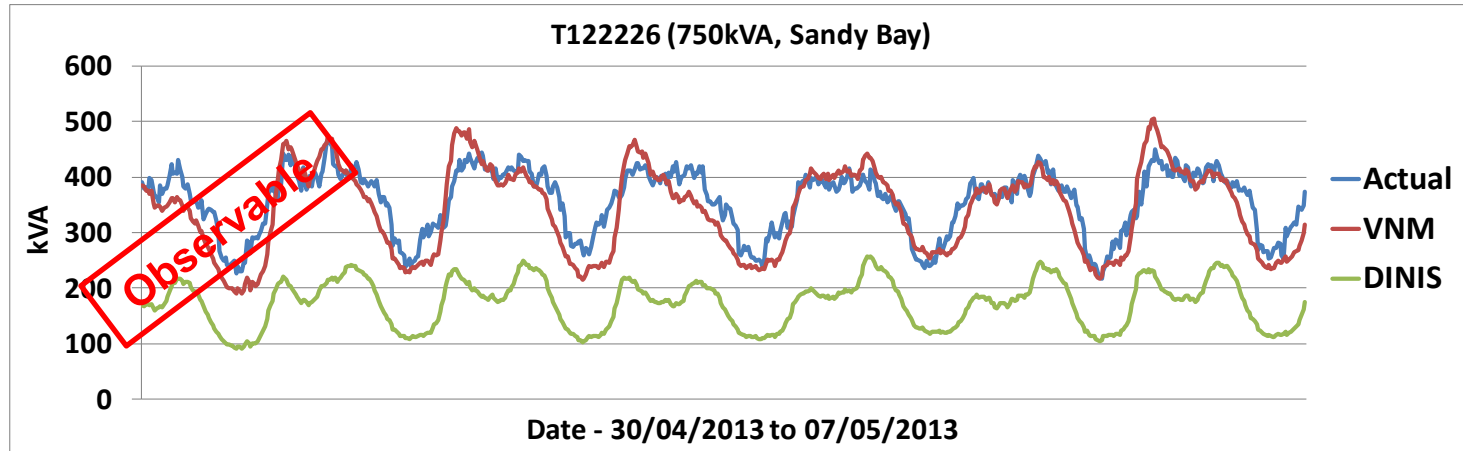
# AF Structure (re)built using AFSDK to keep up with Network changes



# Results: “Virtual” transformer load (kVA) in PI Tags

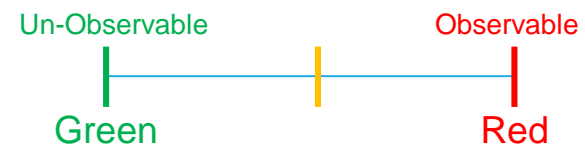
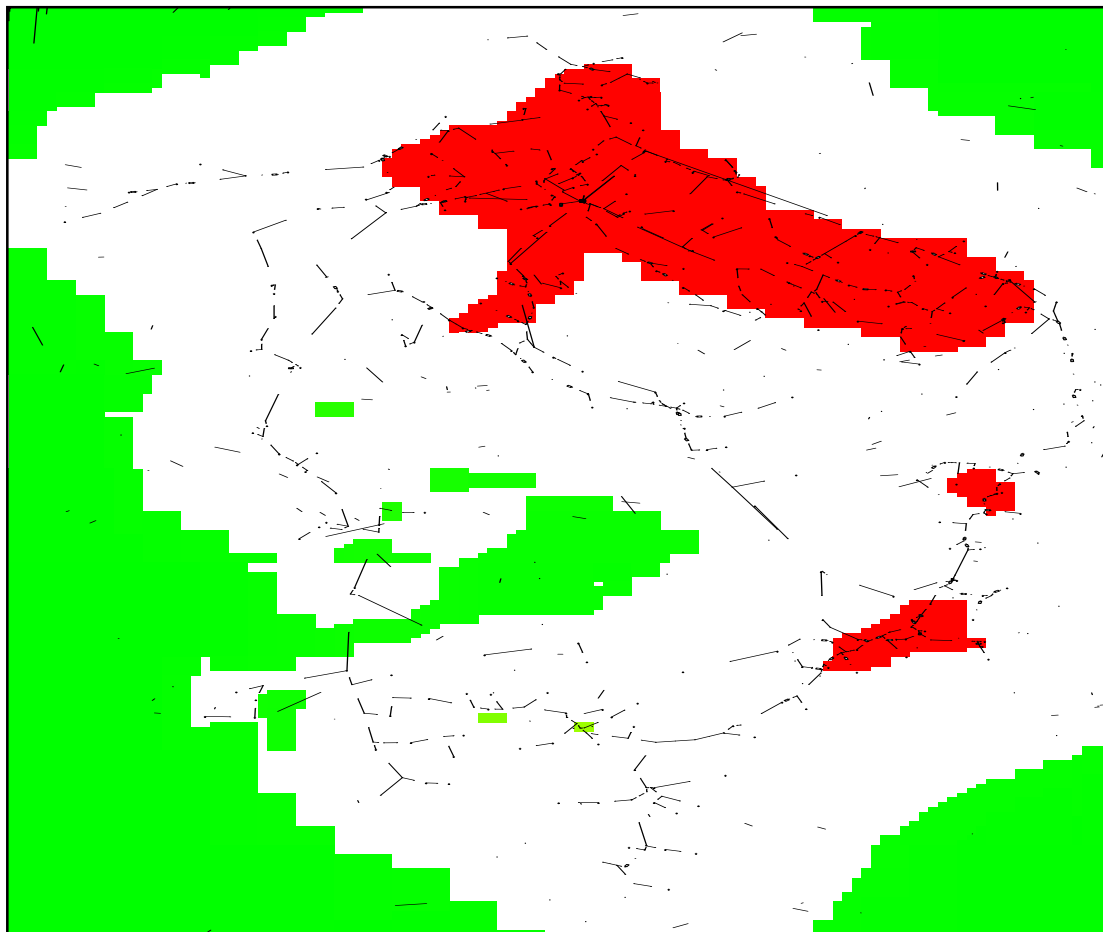


# Results



# Observability Heat Map

—Sandy Bay





# Project highlights

- Significant tangible benefits to community
  - Reduced electricity price
  - Improved power supply reliability and quality
  - Mitigated health and safety risks
    - Through the reduced need for field monitoring activities
- Optimal application of PI System functionality/features
  - Successfully implemented a theoretical model
  - PI System able to link the data silos (GIS/SDW/SINCAL etc)

# Key concepts

- PI System tag naming convention eg

*tag name:* SCADA.CB.BEZ-G252-27171.Power

*descriptor:* Bellerive 11kV Feeder 27171 Circuit Breaker G252 Power (MW)

- Use of AF templates for PI System tag creation, tag attributes etc.
- Integration of PI AF with other data repositories
- Alignment of PI System tag creation with commissioning process

# Questions,...

Contact

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감사합니다

谢谢

Danke

Merci

Gracias

**Thank You**

ありがとう

Спасибо

Obrigado

