



Distance to Fault

The PI System and ESRI Geospatial system supporting
real time operational decision making

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Agenda

- Who we are
- Business problem
- Solution
- Technical overview
- Live demo
- Conclusion and next steps

Dimension Software

- Specialist **PI Systems Integrator** providing advanced solutions including:
 - PI System - end to end
 - Design and project management
 - Software development (web, mobile, desktop, reports)
 - Analytical engines
 - Customised training and support



Transpower New Zealand

- Owner and operator of the National Grid
- State owned enterprise
- 12,000 km of transmission lines
- 180 substations
- Implemented the PI System in 2006
- OSIsoft Enterprise Agreement customer
- Approximately 400,000 PI tags



Distance to Fault history

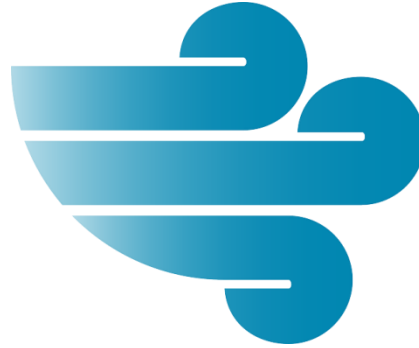
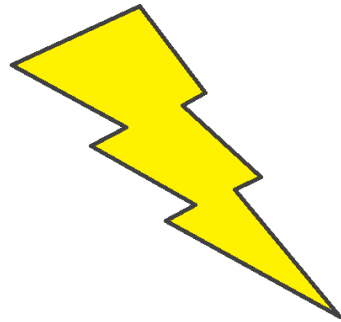
- Nomograms
- Re-evaluate operational decisions
- Public place data with nomograms
- Distance to Fault

Nomograms

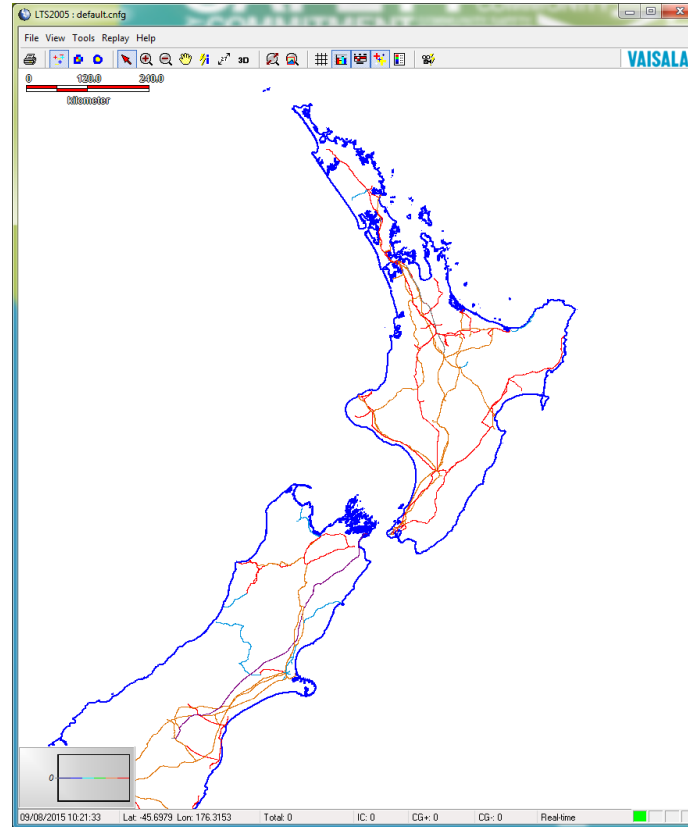
A	B	C	D	E	F	G	H	I	J	
Imported ACI Data	Fault Location ADD-ISL:				Data Buffer Cells		0			
Rows in Buffer	60				Sorted Data Cells		0		Site Column	
Number of Columns	16	Circuit Column		12	Row Difference		0			
Automatic Branch Data	Circuit Name		ADD-ISL-2							
Total Branch Length (km)	8.580					Relay +ve Seq Imp Setting (Ω)?	Extract Stations			
Number of Towers		DATE YYYYMMDD	20070801		Branch Start:	ADD	2.106	ADD		
Total Branch +ve Seq Imp (Ω)	2.106	82.16° Ω					ISL		Line Reactance X (Ω) :	
Relay Fault % Reading?	0.00%				Branch Finish:	ISL	2.106	2	2.0863	
COB_IDENT	DESCRIPTION	COB_IDENT	DESCRIPTION	CIRCUIT_TYPE	CONDUCTOR_TYPE	BUNDLE_COUNT	POS_SEQ_IMPEDANC	SPAN_LENGTH	POS_SEQ_REACTANCE	POS
ADD-ISL-2	Addington Islingt MMS: 10245230		ADD-ISL-A-ADD-0000A-Conductor-ADD-ISL-2	SING	ZEB		2	0.0092	37.63	0.0091
ADD-ISL-2	Addington Islingt MMS: 10193210		ADD-ISL-A-0001-0002-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.021	85.51	0.0208
ADD-ISL-2	Addington Islingt MMS: 10193213		ADD-ISL-A-0002-0003-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.042	171.29	0.0416
ADD-ISL-2	Addington Islingt MMS: 10193216		ADD-ISL-A-0003-0004-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0403	164.08	0.0399
ADD-ISL-2	Addington Islingt MMS: 10193219		ADD-ISL-A-0004-0005-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0261	106.34	0.0259
ADD-ISL-2	Addington Islingt MMS: 10193222		ADD-ISL-A-0005-0006-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0359	146.27	0.0356
ADD-ISL-2	Addington Islingt MMS: 10193397		ADD-ISL-A-0006-0007-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0448	182.35	0.0443
ADD-ISL-2	Addington Islingt MMS: 10193399		ADD-ISL-A-0007-0008-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0424	172.56	0.042
ADD-ISL-2	Addington Islingt MMS: 10193401		ADD-ISL-A-0008-0009-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.041	167.21	0.0407
ADD-ISL-2	Addington Islingt MMS: 10193403		ADD-ISL-A-0009-0010-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0307	125.25	0.0305
ADD-ISL-2	Addington Islingt MMS: 10193405		ADD-ISL-A-0010-0011-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0346	141.07	0.0343
ADD-ISL-2	Addington Islingt MMS: 10193407		ADD-ISL-A-0011-0012-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0361	147.15	0.0358
ADD-ISL-2	Addington Islingt MMS: 10193409		ADD-ISL-A-0012-0013-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0389	158.3	0.0385
ADD-ISL-2	Addington Islingt MMS: 10193411		ADD-ISL-A-0013-0014-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0551	224.59	0.0546
ADD-ISL-2	Addington Islingt MMS: 10193413		ADD-ISL-A-0014-0015-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0462	188.19	0.0458
ADD-ISL-2	Addington Islingt MMS: 10193415		ADD-ISL-A-0015-0016-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0457	186.08	0.0452
ADD-ISL-2	Addington Islingt MMS: 10193417		ADD-ISL-A-0016-0017-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0442	179.88	0.0437
ADD-ISL-2	Addington Islingt MMS: 10193419		ADD-ISL-A-0017-0018-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0482	196.19	0.0477
ADD-ISL-2	Addington Islingt MMS: 10193421		ADD-ISL-A-0018-0019-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.0178	72.61	0.0177
ADD-ISL-2	Addington Islingt MMS: 10193423		ADD-ISL-A-0019-0020-Conductor-ADD-ISL-2	DOUB	ZEB		2	0.04	163.13	0.0397

What caused the outage?

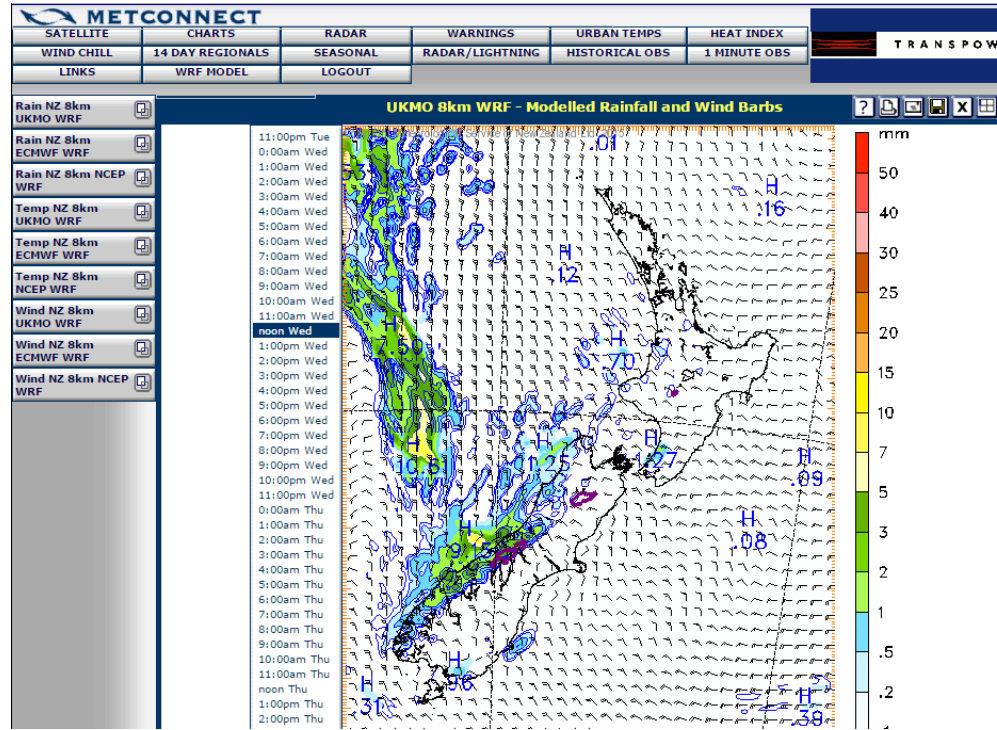
- Lightning
- Wind
- Snow



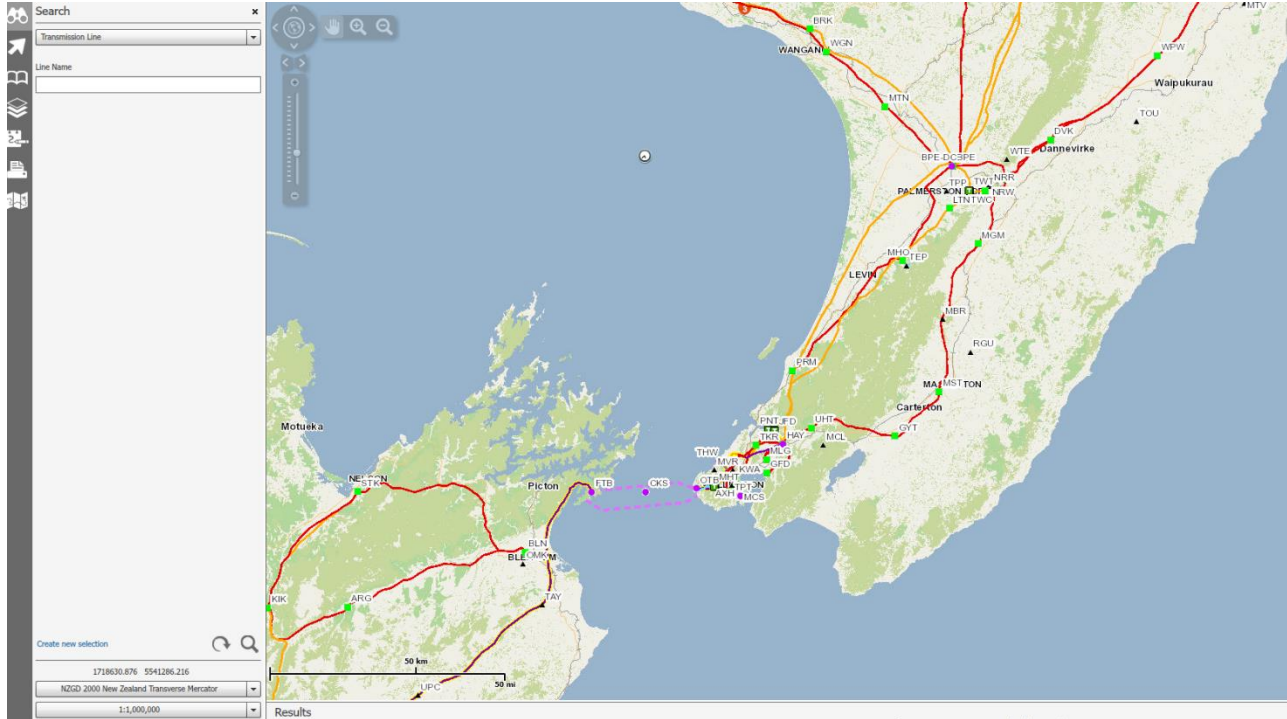
Lightning monitoring system



Weather monitoring system



Spatial system



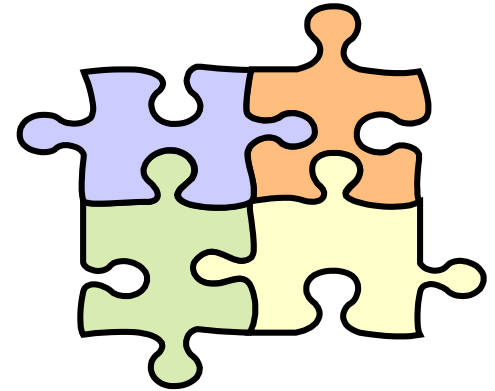
The problem

- Multiple systems required to make operational decisions
 - Distance to Fault
 - Lightning Data
 - Weather Data
 - Spatial Asset Data
- Standalone systems were not ideal



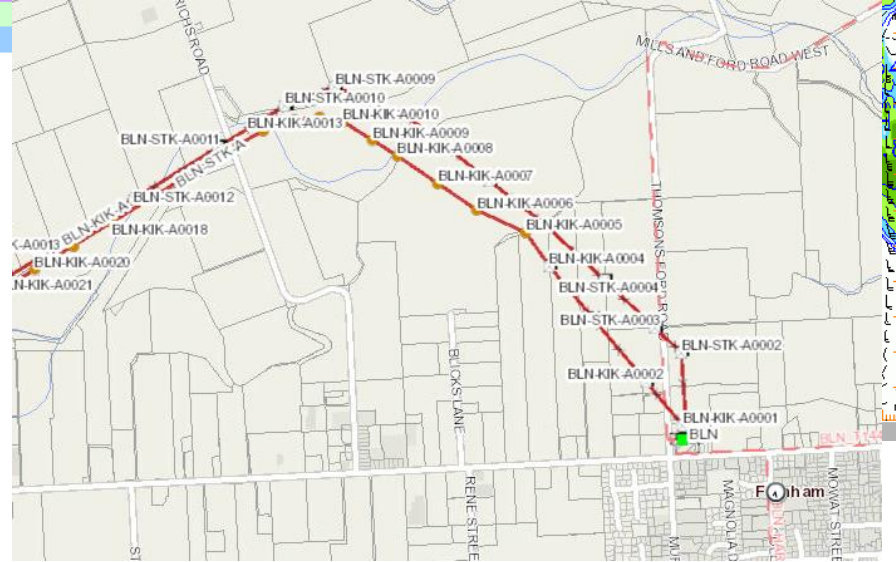
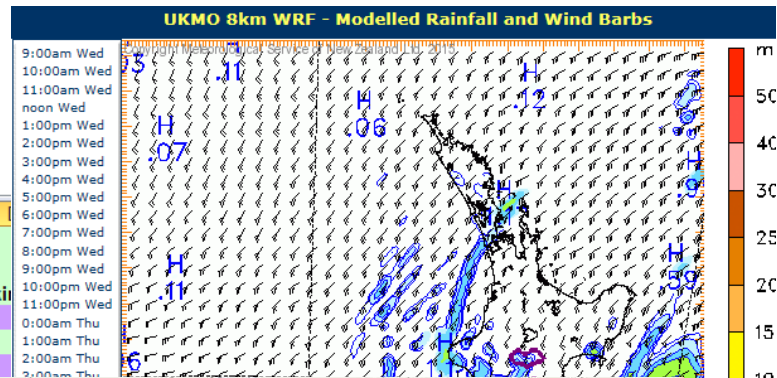
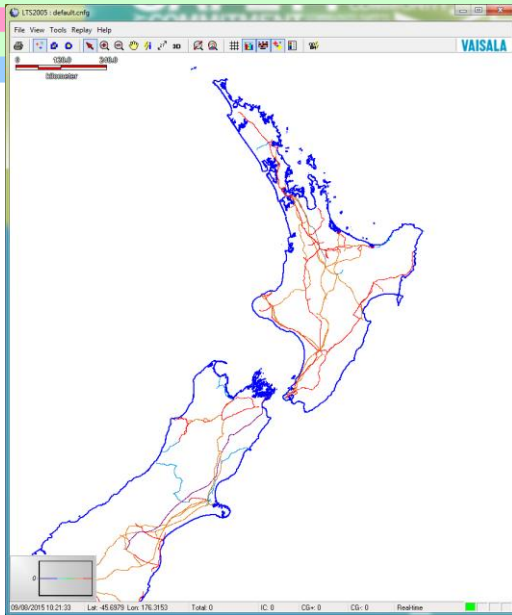
Spatial Distance to Fault

- One place to look to see the whole picture
- Ability to see where the fault may be instantly
- One system tailored for one purpose
- Less chance of user error

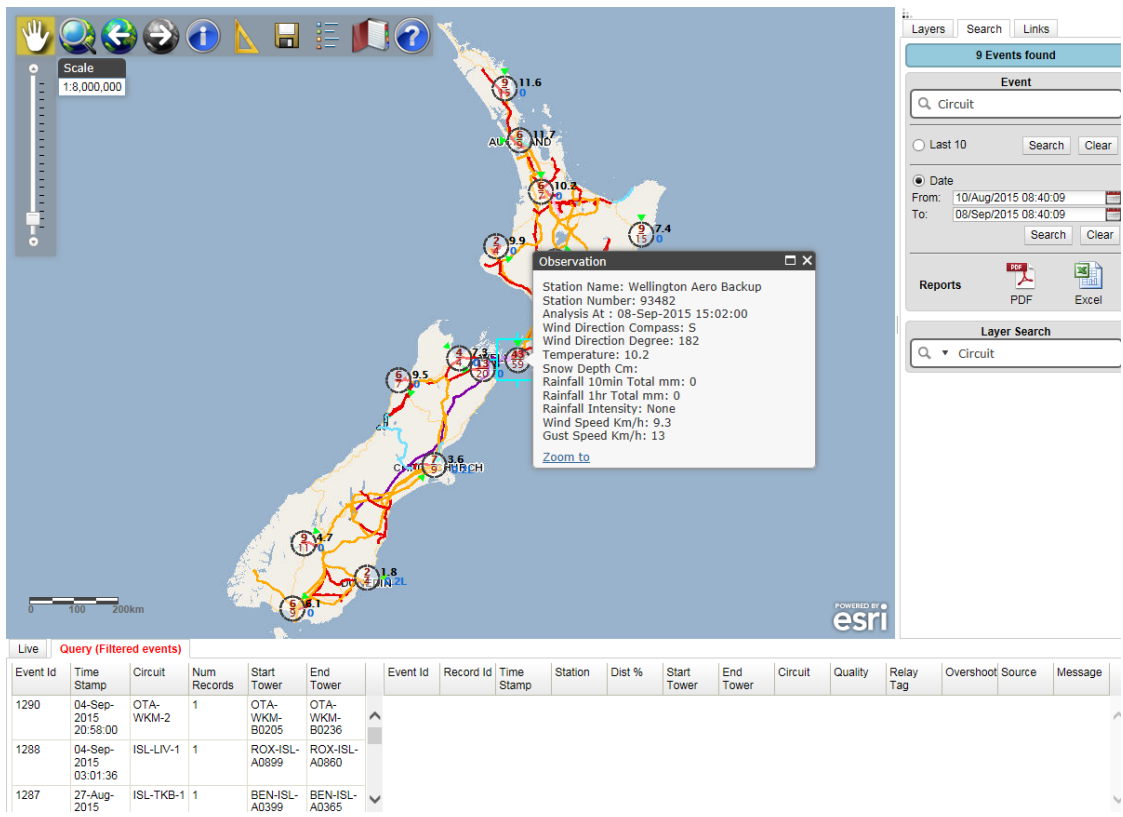


Before...

	A	B	C
1	Fault Location Calculator		
2	Likely Fault Location:		
3	Distance to Fault Percentages (as a percentage)		
4	Distance to Fault Percentage 1 (%) ADD End:	50.000%	0027 0030
5			
6	Distance	70%	0044 0042
7			
8			
9			



After



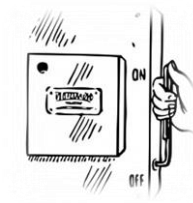
Electricity industry concepts

- **Towers** - aka pylons
- **Span** - the line length between 2 towers
- **Circuit** - electrical connection between 2 substations
- **Protection relay** - trips a circuit breaker when a fault is detected



DTF concepts at a glance

- Protection relay's send the distance percentage to a fault
- Fault **detection** is based on
 - A distance percentage received in PI
 - Circuit breaker OPEN state in PI
- Tower patrol range **calculation** is based on detailed circuit impedance data from an Oracle database

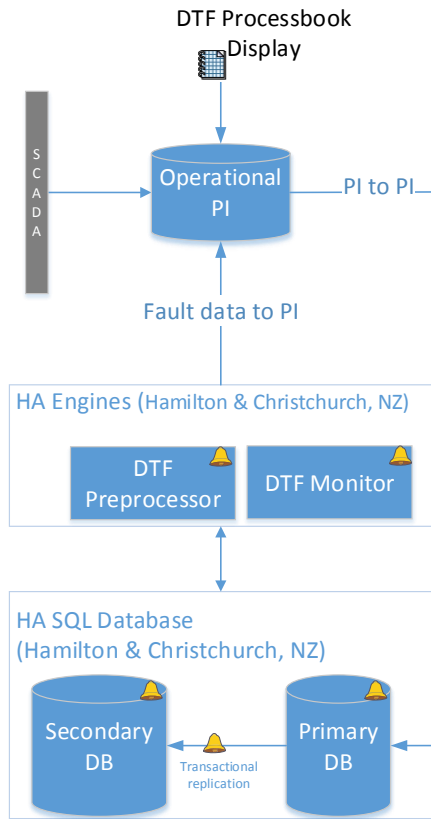


Technical requirements

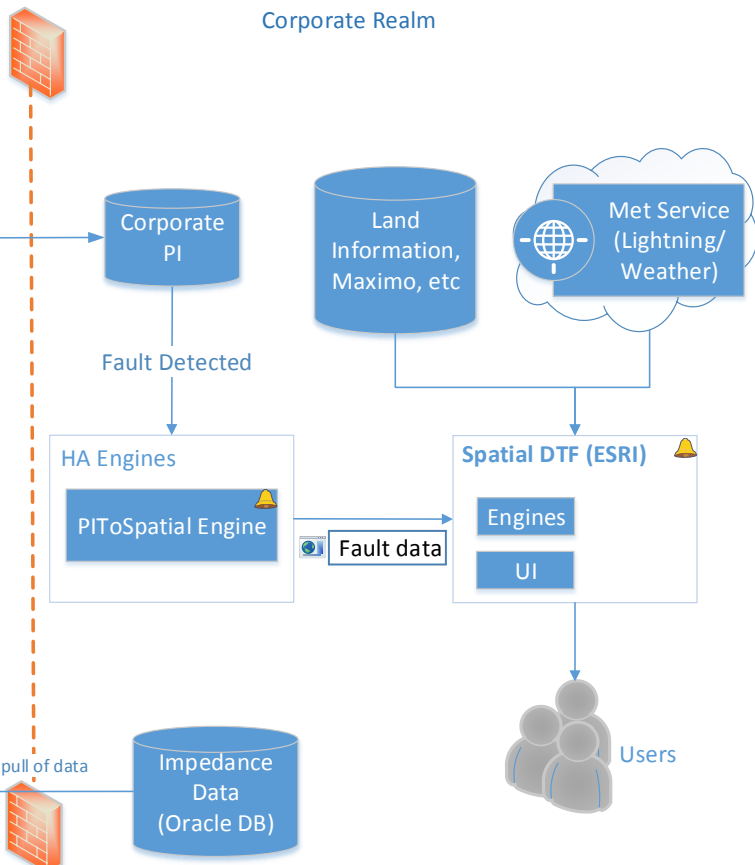
- Real time
- Fully automated
- 24/7 availability
- Advanced calculations to answer the question 'Where do I dispatch people to patrol, when a fault happens?'
- Geographical display of faults with lightning data, weather data, land and asset type information

Architecture

Operational Realm



Corporate Realm

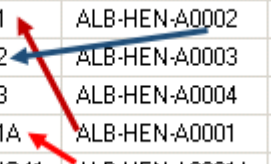


- Fully HA
- Operational
- Corporate
- ESRI

Impedance data

- **DTF Preprocessor engine** orders impedance data according to how towers are physically connected

	Circuit	Span From Tower	Span To Tower	Impedance	Physical Order
1	ALB.HEN.1	ALB-HEN-A0001	ALB-HEN-A0002	0.1827	
2	ALB.HEN.1	ALB-HEN-A0002	ALB-HEN-A0003	0.1692	
3	ALB.HEN.1	ALB-HEN-A0003	ALB-HEN-A0004	0.0988	
4	ALB.HEN.1	ALB-HEN-A0001A	ALB-HEN-A0001	0.0438	
5	ALB.HEN.1	ALB-HEN-AHENG41	ALB-HEN-A0001A	0.0138	



	Circuit	Span From Tower	Span To Tower	Impedance	Physical Order
1	ALB.HEN.1	ALB-HEN-AHENG41	ALB-HEN-A0001A	0.0138	1
2	ALB.HEN.1	ALB-HEN-A0001A	ALB-HEN-A0001	0.0438	2
3	ALB.HEN.1	ALB-HEN-A0001	ALB-HEN-A0002	0.1827	3
4	ALB.HEN.1	ALB-HEN-A0002	ALB-HEN-A0003	0.1692	4
5	ALB.HEN.1	ALB-HEN-A0003	ALB-HEN-A0004	0.0988	5

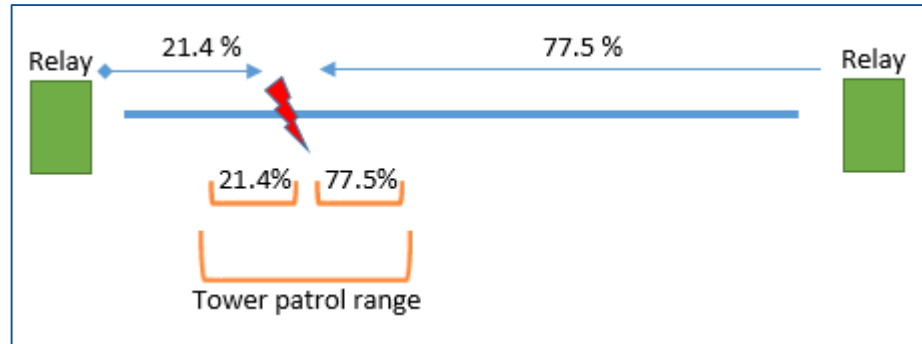
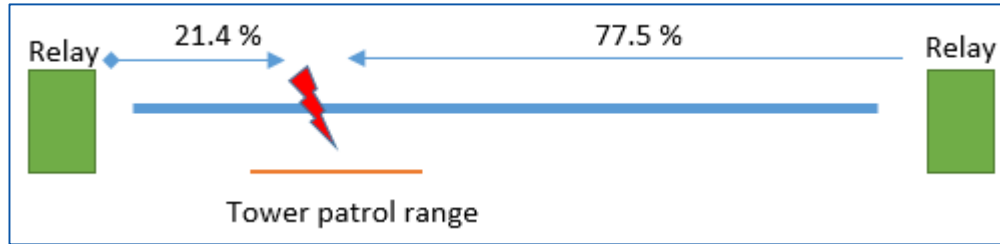
Fault detection and calculations

- DTF Monitor engine
 - Detects faults
 - Calculates **tower patrol ranges** on a circuit
 - Tower patrol ranges to PI as **Events** and **Records**



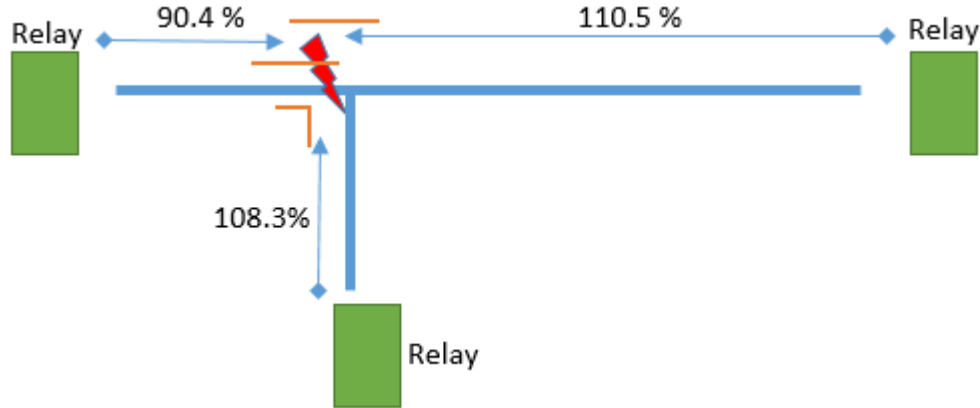
Advanced calculations

- 2 terminal circuit



Advanced calculations cont...

- 3 Terminal circuit



DTF Events and Records

- **Records** represent each individual distance percentage sent by a protection relay

Time Stamp	Station	Dist %	Start Tower	End Tower	Circuit
12-Mar-2015 15:04:29	HLY	98.29994965	SFD-TMN-A0032	SFD-TMN-A0001B	HLY-SFD-1
12-Mar-2015 15:04:33	HLY	105.75000763	SFD-TMN-A0023	SFD-TMN-A0001B	HLY-SFD-1

- Multiple records are grouped as the same **Event** if they are on the same circuit and within 2 minutes of each other

Time Stamp	Circuit	Num Records ▲	Start Tower	End Tower
12-Mar-2015 15:04:29	HLY-SFD-1	2	SFD-TMN-A0032	SFD-TMN-A0001B

Fault information to ESRI

- **PIToSpatial engine** composes the records and events as JSON messages
- Delivers the JSON message to a REST endpoint in ESRI

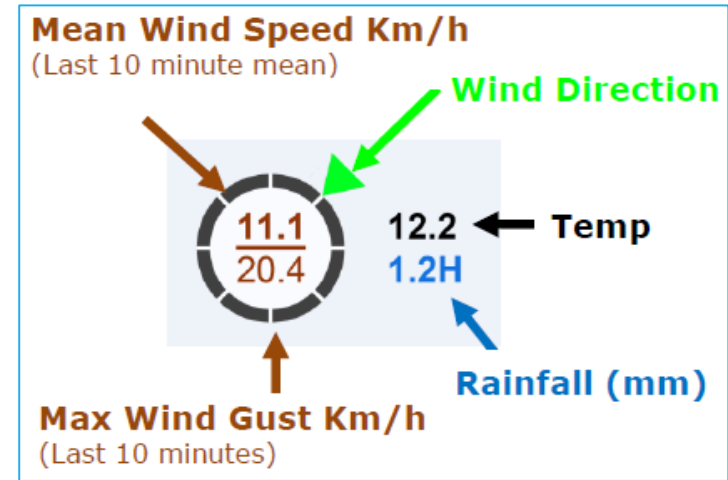
```
{ "DTFEvent": {  
  "Fields": {  
    "Timestamp": "2015-09-04T03:01:36",  
    "Circuit": "ISL-LIV-1",  
    "ID": 1288,  
    "StartTower": "ROX-ISL-A0899",  
    "EndTower": "ROX-ISL-A0860",  
    "NumRecords": 1  
  }  
},  
  "DTFRecord": {  
    "Fields": {  
      "Timestamp": "2015-09-04T03:01:36",  
      "ID": 1991,  
      "EventID": 1288,  
      "StartTower": "ROX-ISL-A0899",  
      "EndTower": "ROX-ISL-A0860",  
      "Overshoot": "No",  
      "Source": "P-2",  
      "Message": "",  
      "Quality": "Good",  
      "Station": "ISL",  
      "RelayTag": "472_2",  
      "DistPerc": 31.4999504089355,  
      "Circuit": "ISL-LIV-1"  
    }  
  }  
}
```


The ESRI platform

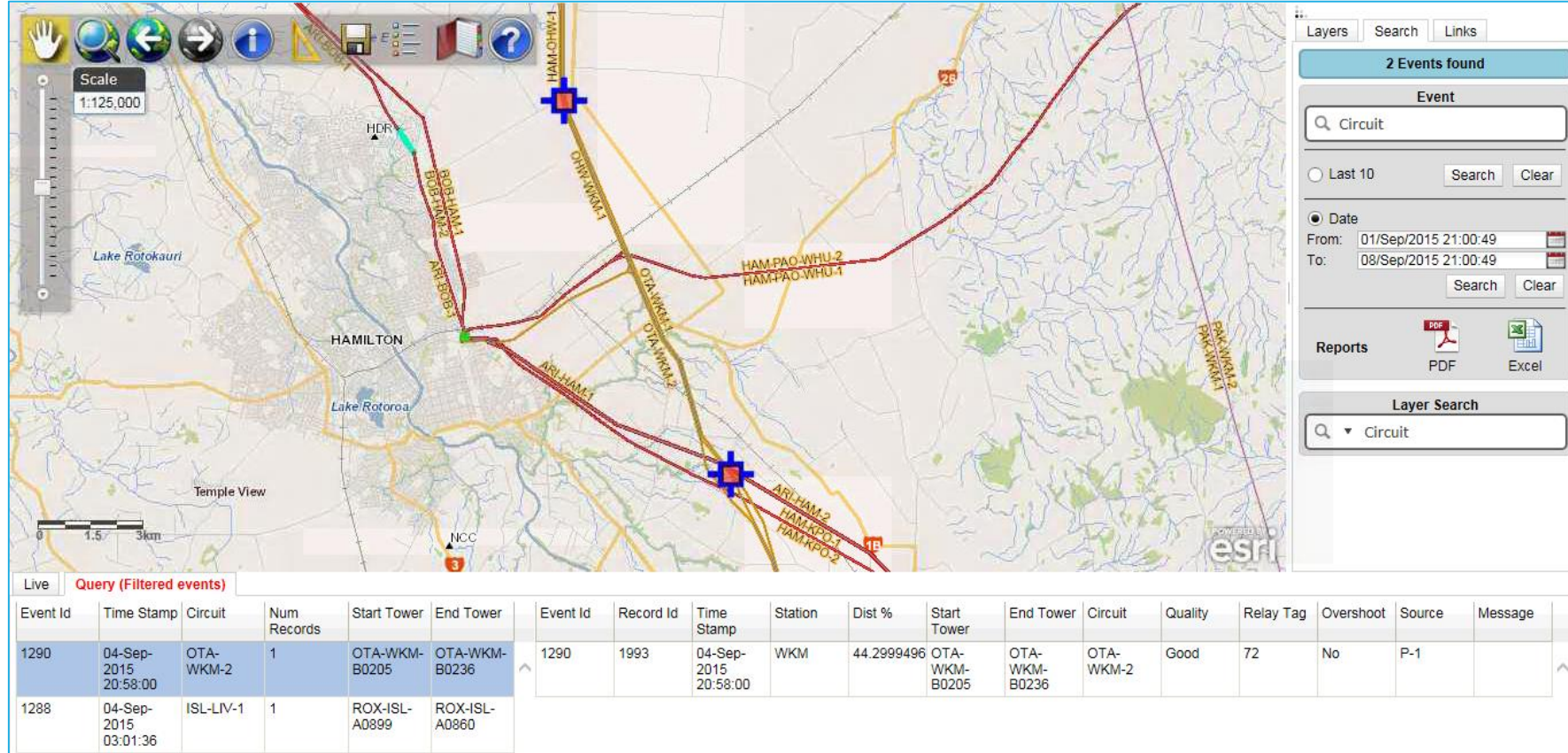
- **Geographically enhances** the records and events
- Associates **lightning** and **weather** data to the faults
- **Displays faults in real-time** with ability to view historical faults

The ESRI platform cont ...

- Different layers of information
 - Live and historic faults
 - Lightning
 - Weather observations
 - Land information
 - Imagery or maps
 - Maximo data to show different assets types on the map



Live demo



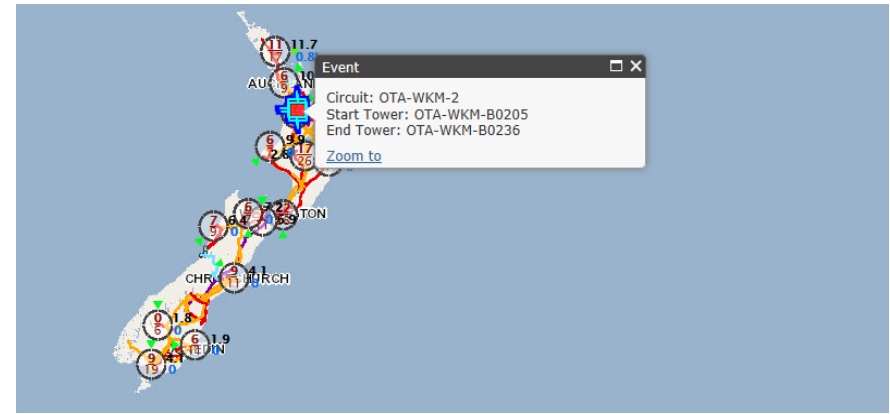
Challenges

- Clean data was our biggest challenge by far
- Calculations were another challenge as rules were not well defined in the previous manual systems

Where to next?

- Fire data
- Strike cast
- Tracking response vehicles
- Implementing the ESRI spatial platform in a HA configuration for 24/7 availability
- More accurate relays have been tested and will be rolled out

Summary



BUSINESS CHALLENGES

- A. Reliance on manual processes
- B. Analyzing multiple systems to the full picture
- C. Keeping data up to date

SOLUTION

- A. Automate the manual processes
- B. Integrate all relevant data into one platform

RESULTS AND BENEFITS

- Fast and accurate decision making
- Lower chance of user error
- Less training required
- Favourite tool in the operations desk

Contact Information

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Questions

Please wait for the
microphone before asking
your questions



State your
name & company

Please don't forget to...

Complete the Survey
for this session



The **Power of Data**

DECISION READY IN REAL-TIME

Evaluation Form (Seminar Location - Date)

Name: _____ Company: _____

Email: _____

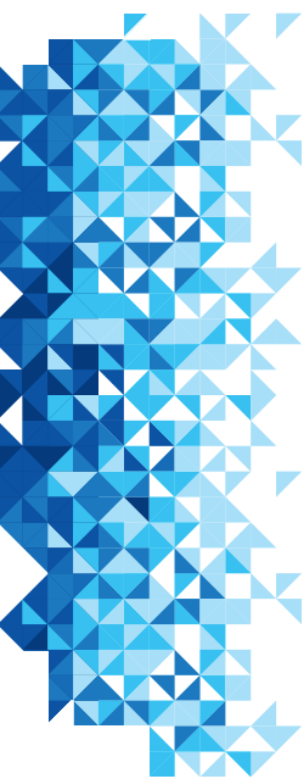
Quality and content of the presentations

Poor Good Excellent N/A

Welcome	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The Journey To Real-Time Operational Intelligence	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The Power of Connection	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tank Level Management System	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Using the PI System to Aid in Troubleshooting Operational Aspects of Oil and Gas Well Drilling and Completion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unleash your Infrastructure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Information on the Spot	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wrap-up/Seminar Conclusion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Quality and organization of the seminar

Choice of date	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time allowed for lunch/breaks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Choice of presentations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Break and time allowed for the presentation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



감사합니다

谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado