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Senior Design
Final Presentation

DISTRIBUTION FAULT LOCATION SYSTEM

Presented by

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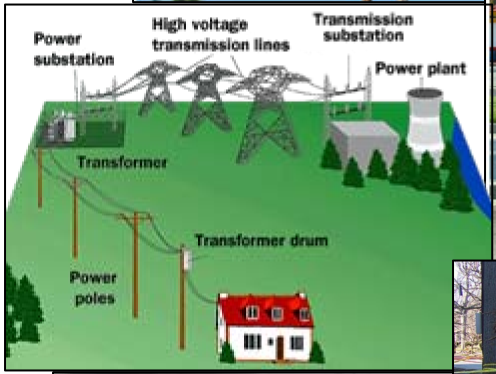
BACKGROUND

- Distribution Network
  - Overhead/ Underground
  - Commercial, industrial, residential
- Smart Grid
- Faults
  - Internal
  - external

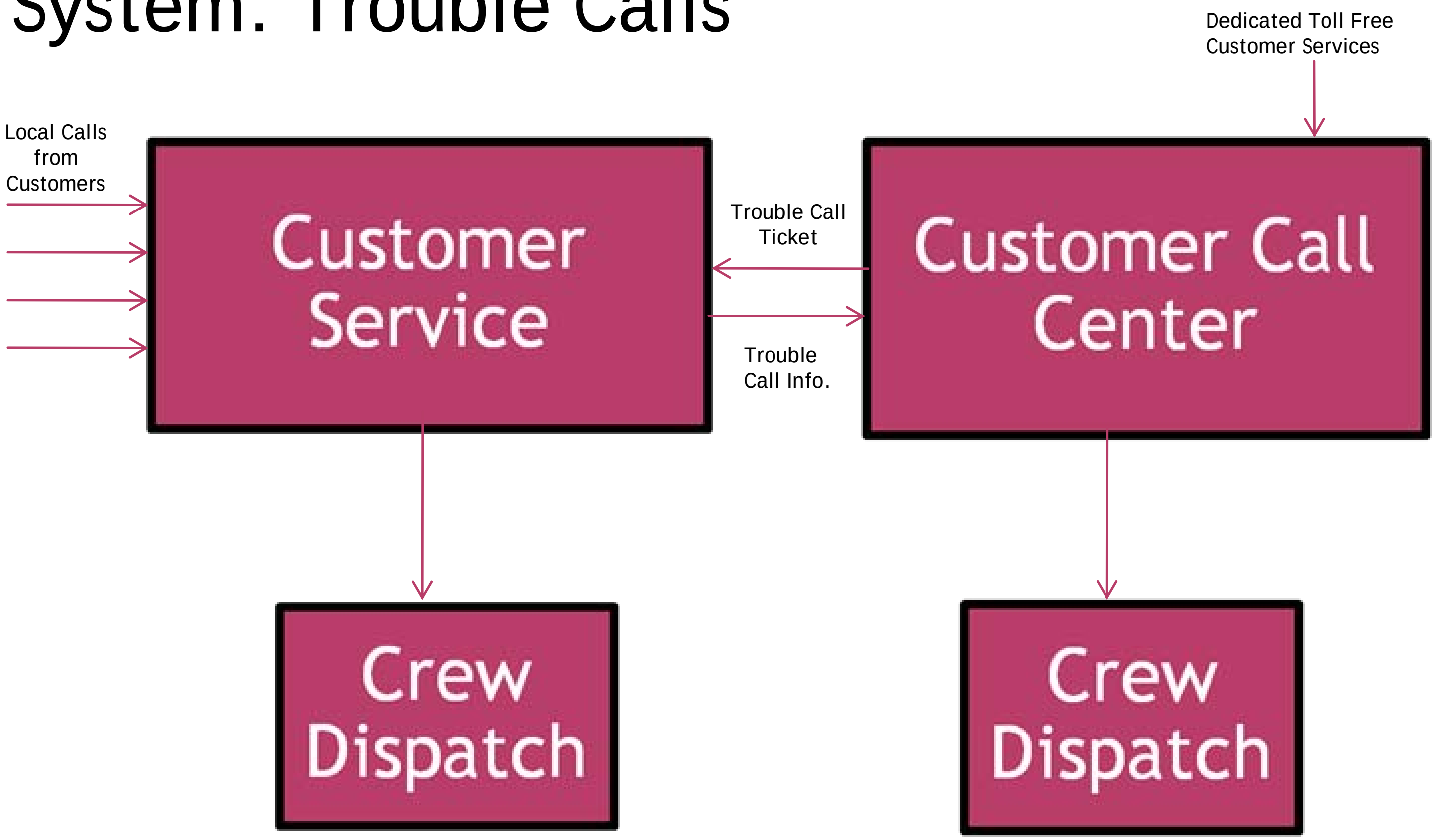


PROBLEM FORMULATION

Integrate an intelligent, reliable, real-time fault location system using technologies compatible for a distribution power system

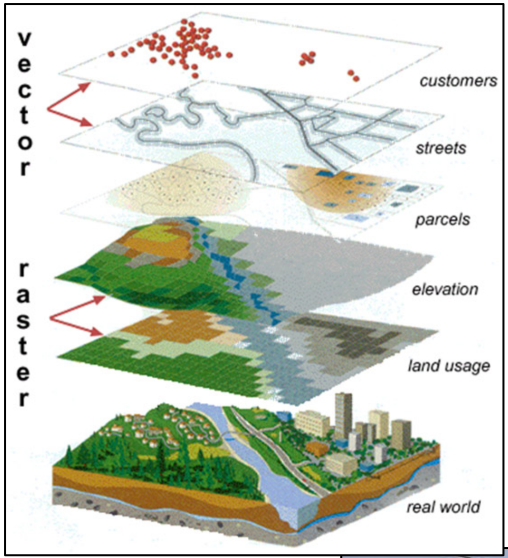
CURRENT STATUS OF ART

System: Trouble Calls



CURRENT STATUS OF ART CONT.

- GIS and mapping systems
  - Visual display of fault locations



- Reactance algorithms
  - Provides fault distances from the substation

- DMS automation
  - Feeder automation

Design Requirements

- Fault location will be accurate with a quarter mile radius
- Fault location is determined within 5 minutes of fault occurring

- Requirements and Standards:
  - IEC61850
    - Standard protocol for SCADA, Control, Protection
  - Communication
    - Full duplex and adhere to TIA-232-F

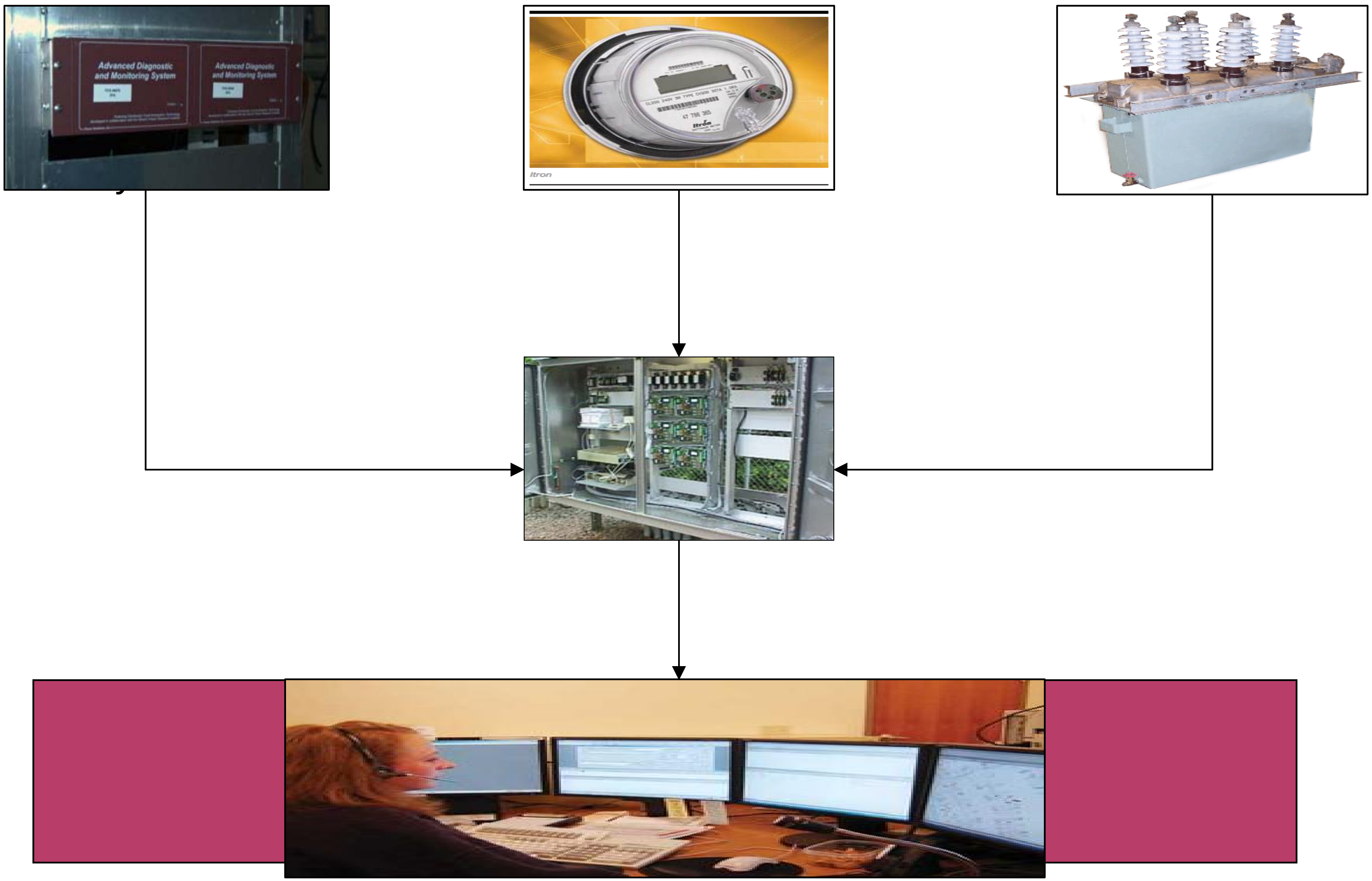
ALTERNATE SOLUTIONS

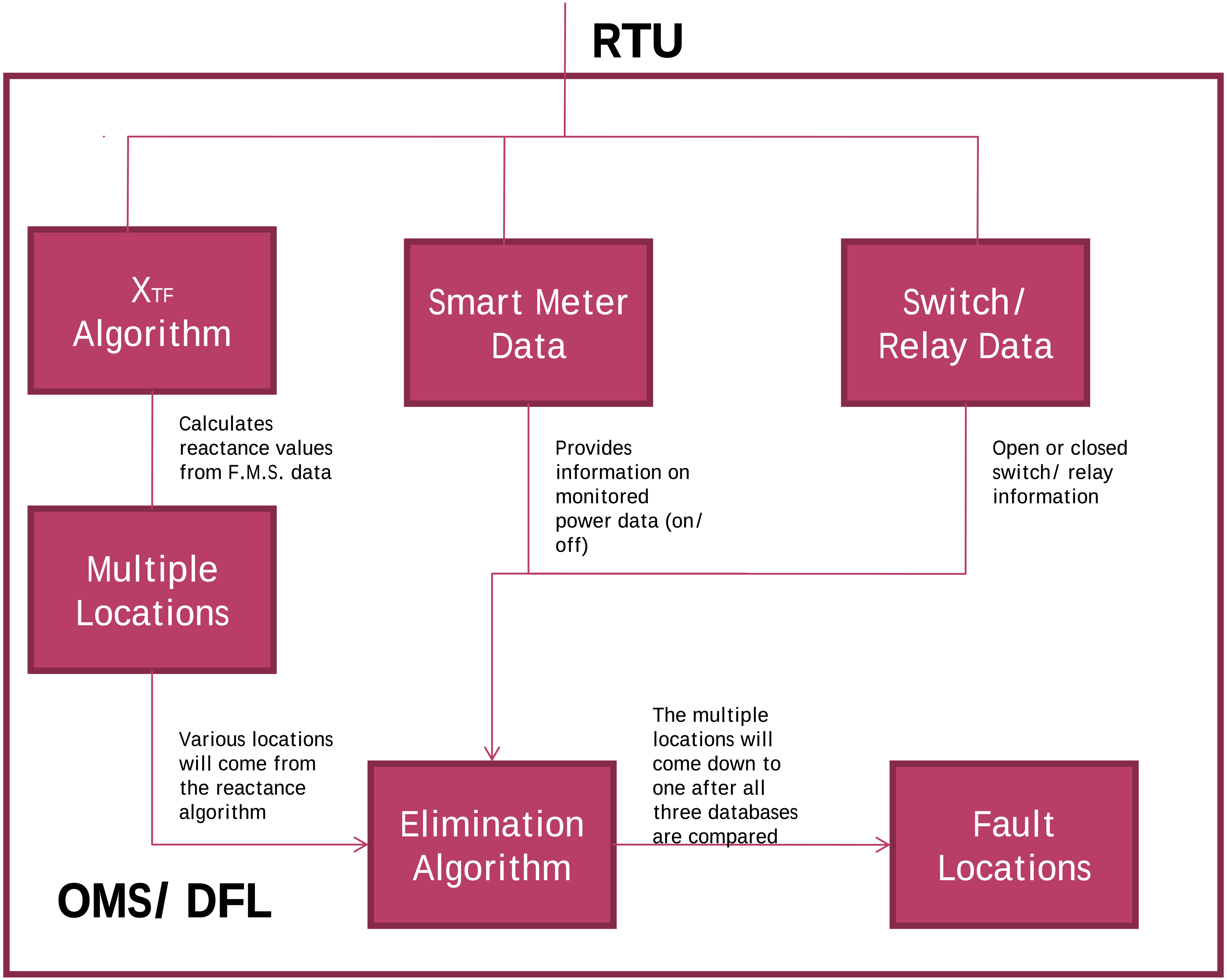
- *An alternative to the DFL system:*
- **Trouble Calls and Smart Meters:**
  - This alternative requires no use of fault locating devices on the distribution network
  - Relies solely on GIS, an efficient trouble call management system and an easily accessible Smart Meter data base
  - Does not give diagnostic insight into the distribution power systems

SOLUTION CRITERIA

		System			
		Alternative		Solution	
Selection Criteria	**Weight**	**Rating**	**Weighted Score**	**Rating**	**Weighted Score**
Ease of Implementation	45	3	1.35	4	1.8
Reliability	25	2	0.5	3	0.75
Maintenance	15	4	0.6	4	0.6
Cost	15	3	0.45	3	0.45
Total Score			2.9		3.6
Rank			2		1

SOLUTION APPROACH




RTU
X_{TF} Algorithm
Smart Meter Data
Switch/ Relay Data
Calculates reactance values from F.M.S. data
Provides information on monitored power data (on/ off)
Open or closed switch/ relay information
Multiple Locations
Various locations will come from the reactance algorithm
Elimination Algorithm
The multiple locations will come down to one after all three databases are compared
Fault Locations
OMS/ DFL

TECHNICAL APPROACH

DFL Algorithm rules:

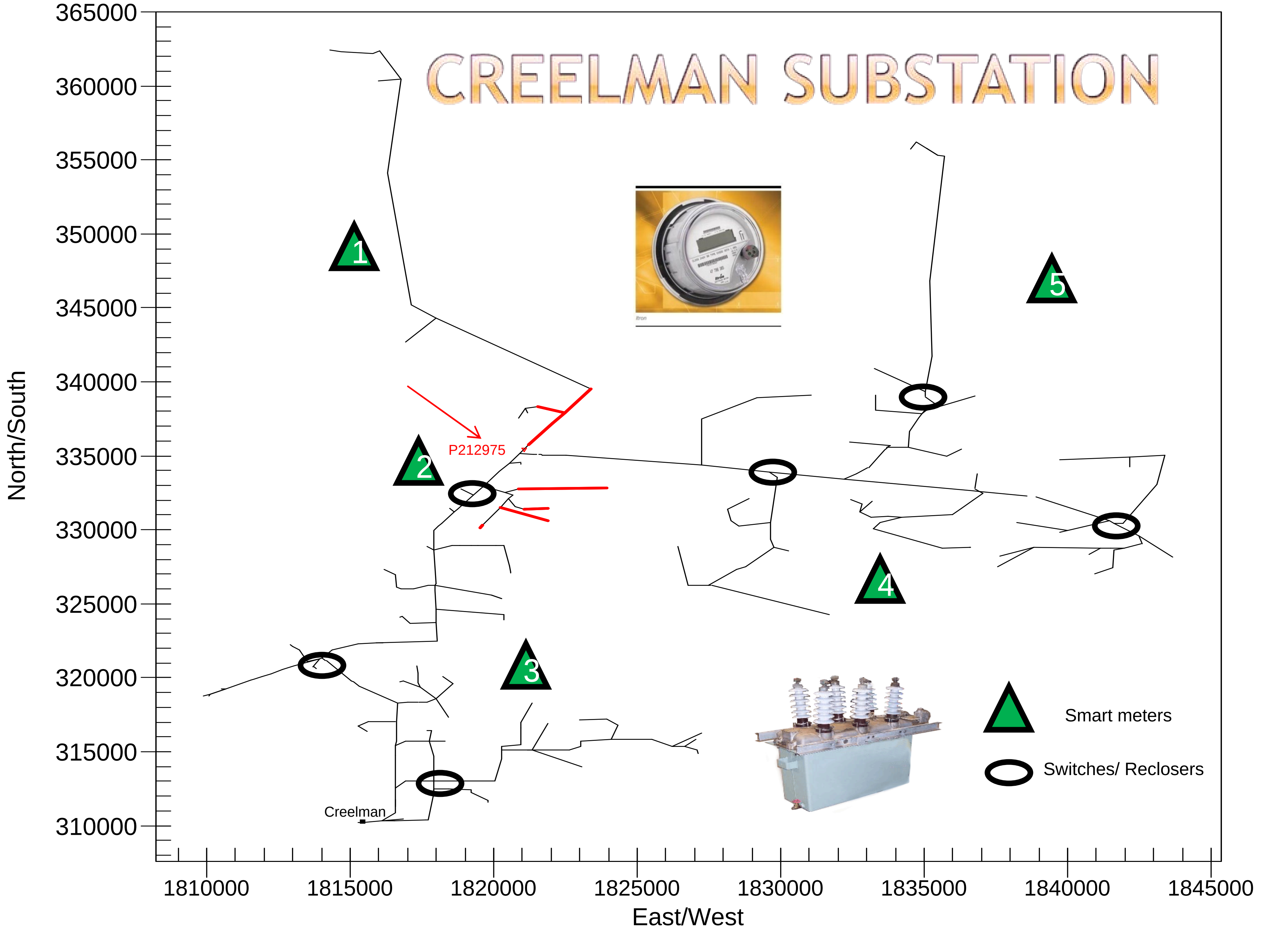
- **Feeder Monitoring System**
  - Reads pre-fault and fault voltage and current data
    - Calculates magnitude & angle
- **Runs through EPRI Reactance to Fault Algorithm**

$$X_{TF} = k\frac{|V_a|}{|I_r|}\sin(\theta_{V_a} - \theta_{I_r})$$

- **Compares calculated value to short circuit analysis data**
- **Gets multiple fault locations**
- **Substation RTU information is taken**
  - Smart meter (On/Off)
  - Switch/ re-closer information
- **Runs through elimination algorithm**
- **Fault Location is displayed**
  - By pole to pole

P8 f_x

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Section - I	Fault - Location	Phase - Cc	Dist - kFt	Phase - Cc	Nominal -	Symmetri	Symmetri	Symmetri	Symmetri	Symmetri	Cumulativ	Cumulative Impedance (Ohms) - X1	Cumulativ	Cumulativ
2	Feeder 02	---	---	0	XYZN	12	173	8518	10792	11264	12461	0.05	0.55	0.02	1.33
3	0236_0236	236 TO P516420	3-636_AL_	0.17	XYZN	12	173	8073	10409	10841	12019	0.05	0.57	0.03	1.42
4	02361_023	P516420 TO P810501	3-394_AL_	0.21	XYZN	12	173	7975	10318	10742	11914	0.05	0.58	0.03	1.44
5	02362_023	P810501 TO Z610015	3-394_AL_	0.25	XYZN	12	173	7873	10223	10640	11805	0.05	0.58	0.04	1.47
6	02363_023	Z610015 TO P415601	3-394_AL_	0.42	XYZN	12	173	7472	9844	10228	11367	0.06	0.61	0.06	1.56
7	02364_023	P415601 TO Z212795	3-394_AL_	0.64	XYZN	12	173	7025	9406	9756	10862	0.07	0.63	0.08	1.68
8	02365_023	Z212795 TO P115864	3-394_AL_	0.83	XYZN	12	173	6676	9055	9380	10456	0.08	0.66	0.1	1.79
9	02366_023	P115864 TO P169126	3-#2_AL_E	0.92	X ZN	12	173	6486	8812	9125	---	0.11	0.67	0.13	1.84
10	02366_023	P115864 TO Z416579	3-394_AL_	1.27	XYZN	12	173	5976	8320	8596	9607	0.11	0.71	0.14	2.03
11	02367_023	Z416579 TO P212812	3-394_AL_	1.5	XYZN	12	173	5665	7980	8237	9215	0.12	0.74	0.17	2.16
12	02368_023	P212812 TO P516425	3-394_AL_	1.71	XYZN	12	172	5413	7699	7939	8890	0.13	0.77	0.19	2.28
13	02369_023	P516425 TO P516426	3-394_AL_	1.93	XYZN	12	172	5171	7423	7649	8572	0.14	0.8	0.21	2.4
14	023610_02	P516426	3-394_AL_	2.11	XYZN	12	172	4982	7203	7418	8318	0.15	0.82	0.23	2.5
15	023611_02	P516426 TO P516427	3-394_AL_	2.59	XYZN	12	172	4552	6693	6883	7728	0.17	0.88	0.28	2.76
16	023612_02	P516427 TO P516428	3-394_AL_	2.99	XYZN	12	172	4239	6309	6482	7285	0.19	0.93	0.33	2.99
17	023613_02	P516428 TO P810505	3-394_AL_	3.21	XYZN	12	172	4090	6122	6288	7070	0.21	0.96	0.35	3.11
18	023614_02	P810505 TO P516429	3-394_AL_	3.41	XYZN	12	172	3958	5957	6115	6878	0.22	0.98	0.37	3.22
19	023615_02	P516429 TO P516430	3-394_AL_	3.88	XYZN	12	172	3687	5608	5753	6476	0.24	1.04	0.42	3.48
20	023616_02	P516430 TO P516431	3-394_AL_	4.26	XYZN	12	172	3490	5350	5485	6177	0.26	1.09	0.46	3.69
21	023617_02	P516431 TO P516432	3-394_AL_	4.63	XYZN	12	171	3320	5124	5251	5916	0.28	1.14	0.5	3.9
22	023618_02	P516432 TO P610676	3-394_AL_	4.77	XYZN	12	171	3257	5040	5163	5819	0.29	1.16	0.51	3.98
23	023619_02	P610676 TO 236-29	3-394_AL_	4.9	XYZN	12	171	3204	4968	5089	5736	0.29	1.17	0.53	4.05
24	0236601_(	P169126 TO P169125	3-#2_AL_E	1.25	X ZN	12	172	5879	7995	8275	---	0.2	0.72	0.24	2.03
25	0236602_(	P169125 TO P194228	3-#2_AL_E	1.59	X ZN	12	172	5356	7256	7509	---	0.29	0.78	0.34	2.22
26	FU 023617	P516431	Device Co	4.27	ZN	12	172	3490	---	---	---	0.26	1.09	0.46	3.69
27	FU 023619	P610676	Device Co	4.78	XY N	12	171	3257	5040	5163	---	0.29	1.16	0.51	3.98
28	SW 02362(	236-29	Device Co	4.91	XYZN	12	171	3204	4967	5089	5736	0.29	1.17	0.53	4.05
29	023617A_(	P516431 TO D128223	1C#2SAPE	4.71	ZN	12	171	3319	---	---	---	0.45	1.15	0.65	3.76
30	023619A_(	P610676 TO P610677	3-#2A5005	4.87	XY N	12	171	3211	4958	5080	---	0.31	1.17	0.54	4.03
31	023620A_(	236-29 TO P713175	3-394_AL_	5.07	XYZN	12	171	3140	4881	4999	5636	0.3	1.19	0.54	4.14
32	023621_02	P713175 TO P516433	3-394_AL_	5.34	XYZN	12	171	3036	4740	4853	5473	0.31	1.23	0.57	4.29



EPRI/Electrotek

PQView®

PROJECT DETERMINATES

Challenges	Lessons Learned

Challenges

- Calculating Reactance Values
- Integrating our 3 databases with the use of our program
- Making up our own data
- Understanding Key formulas

Lessons Learned

- Teamwork
- Leadership/ Project Management
- Problem Solving
- Time Management

FUTURE WORK

- Continue testing of our DFL system on different circuits and actual faults
- Try to apply system to distribution fault anticipation
- Apply several reactance algorithms to our system so determine if they provide fewer fault locations on the map

CONCLUSION

- We attempted to create an efficient distribution fault location system that can be implemented by utility companies across the country
- With the use of the technologies and this system we have designed, a “Smart” distribution fault location system will be obtainable
- This system will be beneficial for utility companies and their customers.

THANK YOU

Dr. Kim

Dr. Chouikha

Tom Bialek

Senior Design Group

Our Senior Design Peers