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Advancing Applied AMI Analytics for Operational Excellence

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4.18.14

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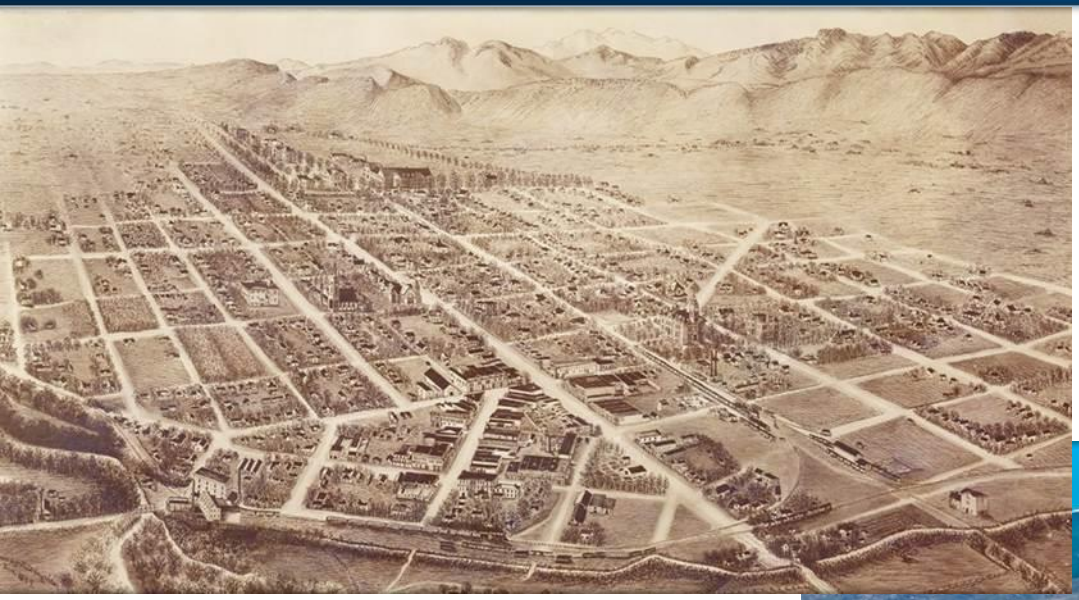
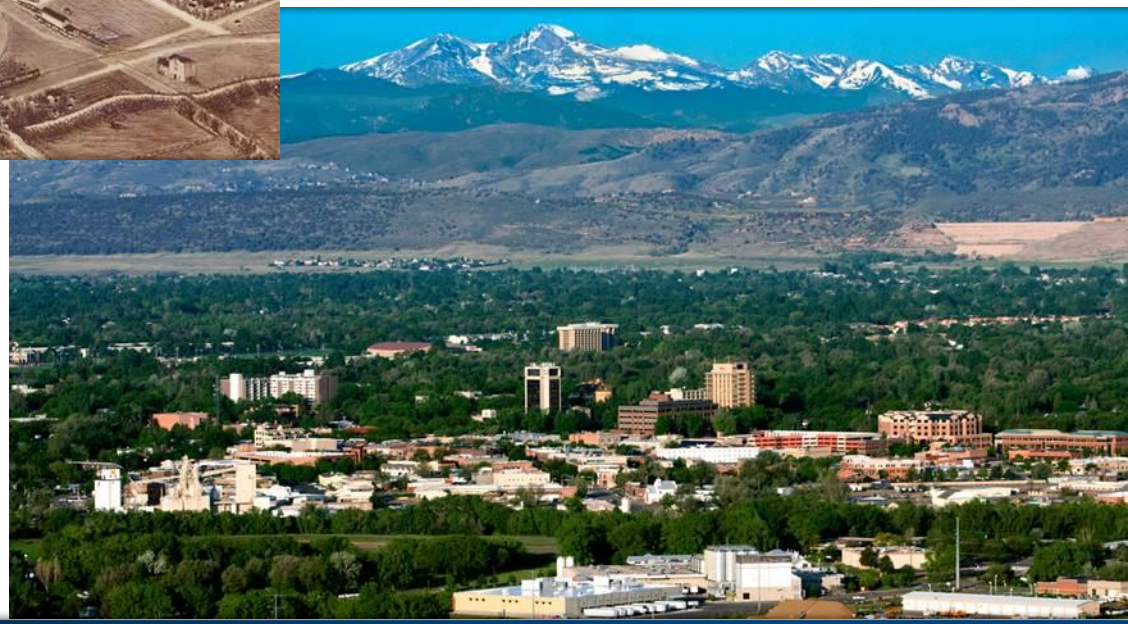
Who We Were & Who We are Now…





Fort Collins Utilities Customers

- Population about 155,400
- Customers:
  - 68,000 electric;
  - 34,000 water;
  - 34,000 wastewater;
  - 42,000 stormwater
- Educated community
- High rental community
- Median Household Income - $53,359
- Persons 18 to 64 years - 71.34%

Who we are

B^3

Bikes,

Beer,

Bands

Fort Collins AMFC Program

- Ft Collins constructed an AMI-focused business case and began planning
- Subsequently applied for & received ARRA DOE Funding
- **Advanced Meter Fort Collins (AMFC) Program Vision:-**
  - *Advanced Meter Fort Collins is a key foundation to transform Fort Collins Utilities' ability to support, inform, inspire and empower our community*
- The Program included implementation of the following:
  - Advanced Metering Infrastructure (AMI)
  - Meter Data Management (MDM)
  - Customer Web Portal (CWP)
  - Demand Response (DR)

Architecture

Ft Collins AMI Analytic History

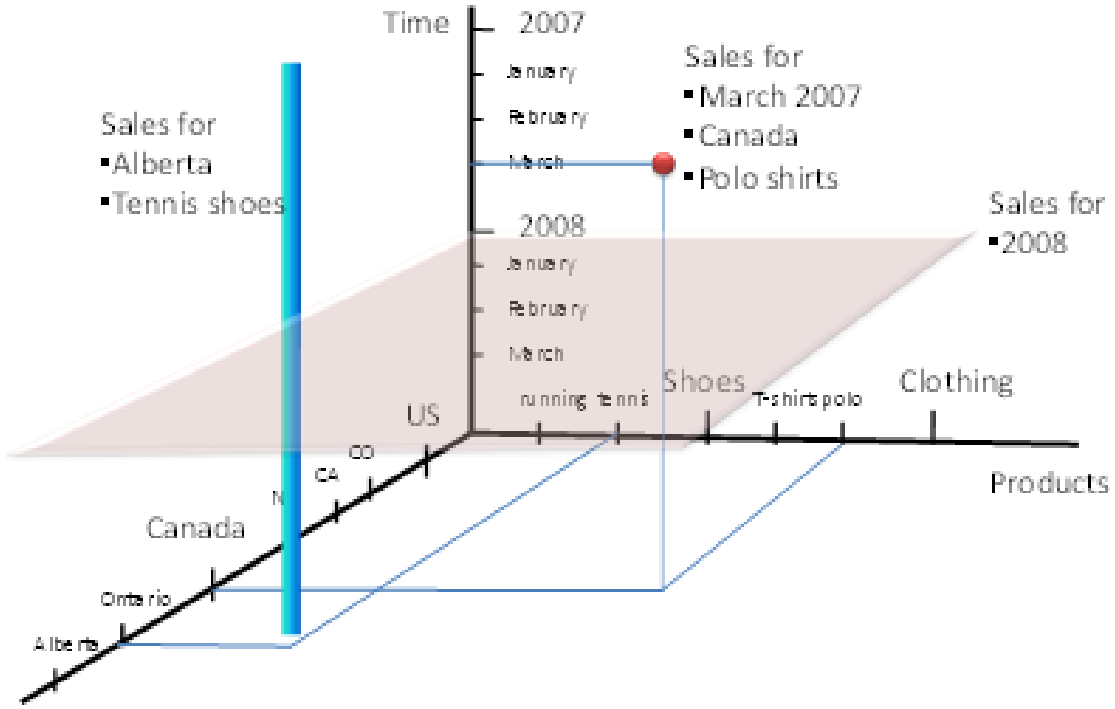
- Fort Collins Utilities made use data analytics to support AMI deployment tracking (Third party tool), including
  - Identification of meters failing that were likely to be an **installation** issue (never have been heard from)
  - Identification of meters failing that were likely to be a **meter failure** (meters that were heard from at least once)
  - Data quality issues from the AMI system
    - Those not “Dealt with” easily in the MDM
  - Basic Meter Events
- After deployment, Fort Collins’ goal was to use analytics to support **operational** needs

Fort Collins Requirements

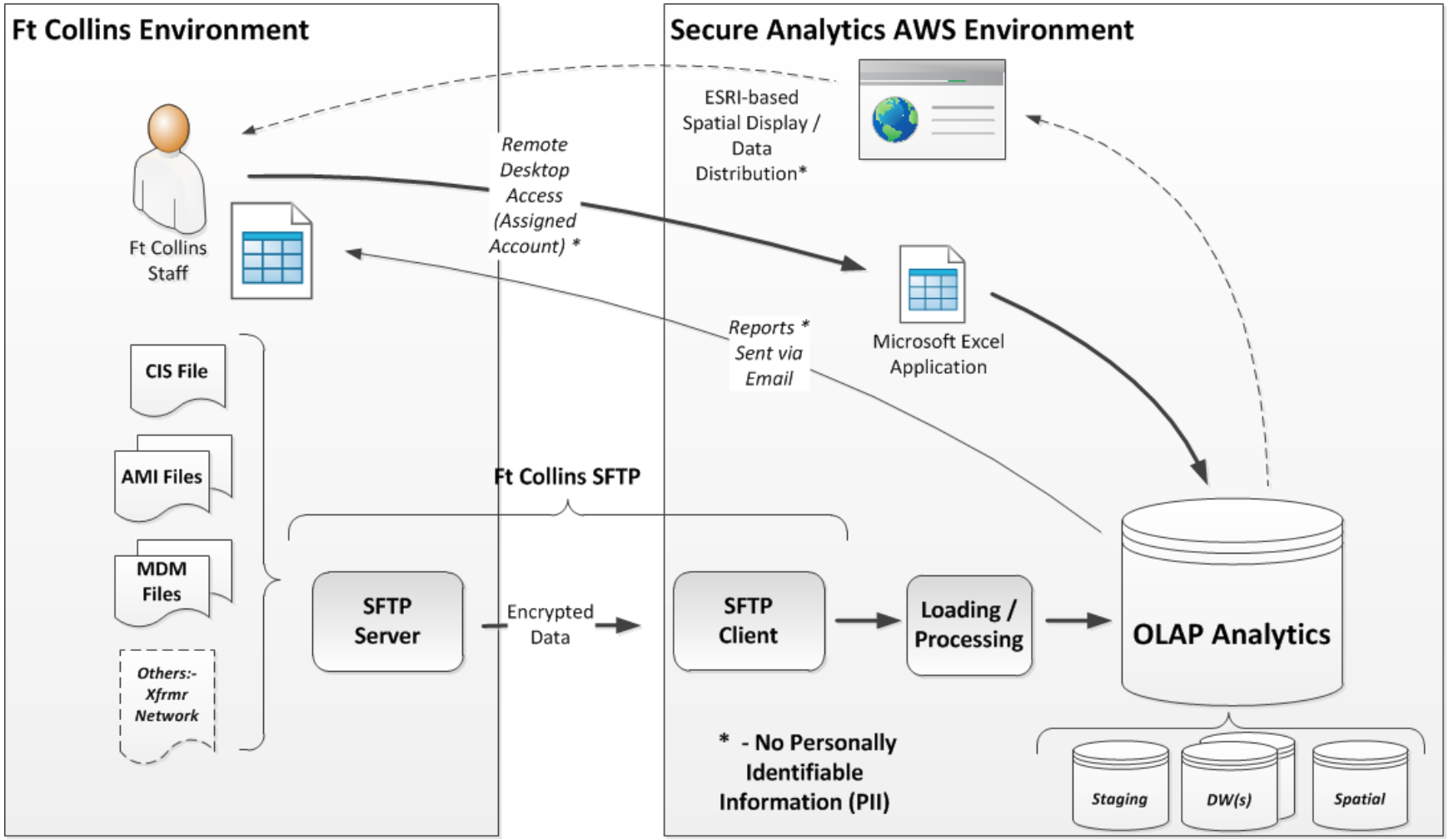
- To accomplish operational needs, needed **flexibility** in analysis of AMI data go beyond meter related operations
- Key Requirements included:-
  - The ability to store and maintain all “Raw” AMI data
    - The ability to update from our MDM
  - The ability to view “Aggregate” Data
    - Max/Min values, Sum, Average Statistics
  - **Flexible analysis:** The ability to have easy access / ad-hoc viewing of data
  - The ability to view data spatially
  - The ability to bring information into daily work flows

OLAP Selected

- Online Analytical Processing (OLAP Model)
  - Generic Example Below



Architecture



Analytics & Operations

Monitoring Deployment: Meter Install Counts by Month

Initial Deployment Area (IDA)

Deployment stops as new Summer Seasonal Rates kick in…

Deployment starts again, and majority of meters are deployed

Negative installation rate helps find clerical error where meters were classified incorrectly

Daily AMI System Performance
Normal Performance Example

Report Information

Metrics for Date:- **9/13/2014**

Date Report Executed:- **9/14/2014 4:31:49 PM**

Field Inventory Information

Total Meters:-	102401	Total AMI Installed:	100317	AMI % Installed	97.96%
Total Electric Goal:-	68367	Total Electric Installed:	68326	Electric % Installed	99.94%
Total Water Goal:	34034	Total Water Installed:	31991	Water % Installed	94%

Electric Meter Performance

Our goal is by the time this report runs, to have the target level of required reads captured by the AMI (one register read and 96 interval reads), for the previous day (**9/13/2014**). In many cases, some reads will take longer to be delivered, and as such the report below includes the results for two days prior (**9/12/2014**) also.

Metrics Date	Meters with at Least One Register Read		Meters with all Interval Reads Expected	
	% Success (Target 98)	Unsuccessful	% Success (Target 95)	Unsuccessful
Data for **9/13/2014** delivered by Today	**99.93%**	50	**98.37%**	1112
Data for **9/12/2014** delivered by Today	**99.93%**	46	**99.87%**	89

Daily AMI System Performance
Low Performance Warning Example

Report Information

Metrics for Date:- **9/9/2014**

Date Report Executed:- **9/10/2014 3:27:18 PM**

Field Inventory Information

Total Meters:-	**102380**	Total AMI Installed:	**100297**	AMI % Installed	**97.97%**
Total Electric Goal:-	68355	Total Electric Installed:	68315	Electric % Installed	99.94%
Total Water Goal:	34025	Total Water Installed:	31982	Water % Installed	94%

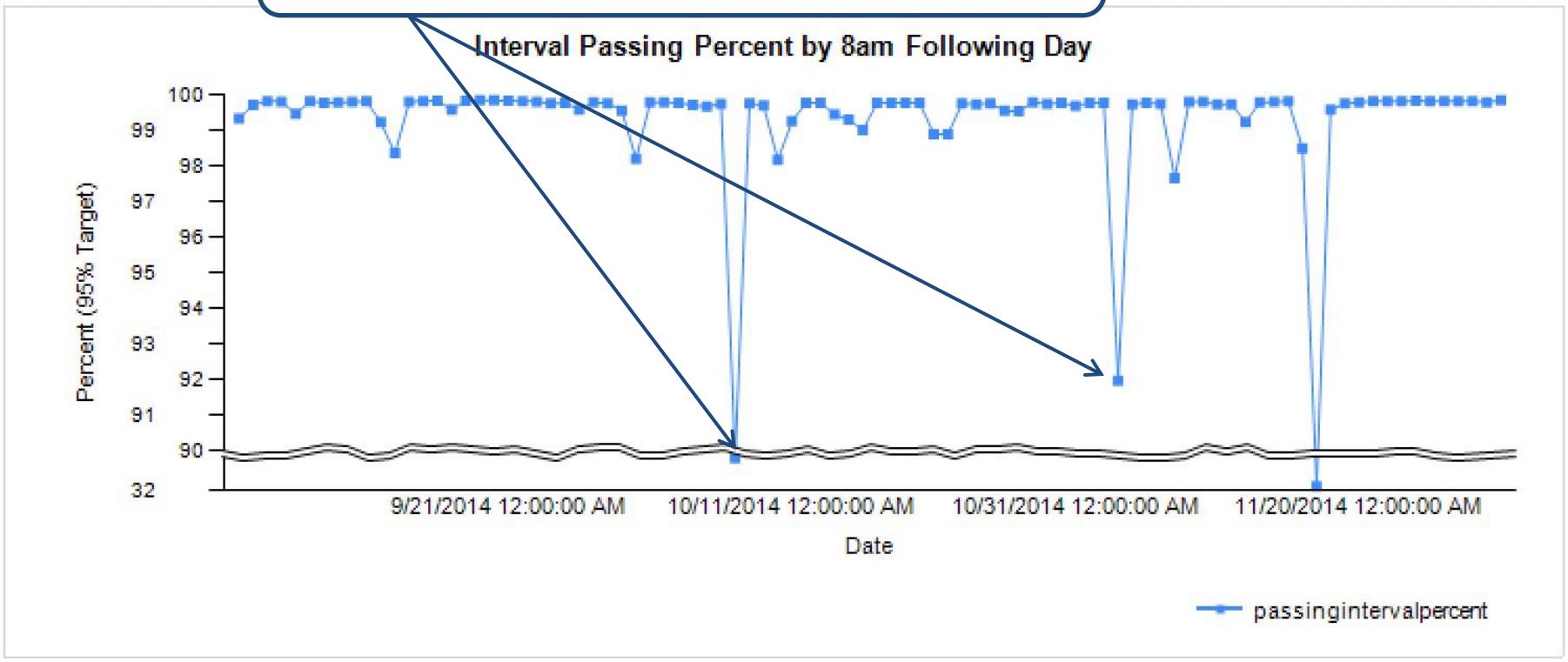
Electric Meter Performance

Our goal is by the time this report runs, to have the target level of required reads captured by the AMI (one register read and 96 interval reads), for the previous day (**9/9/2014**). In many cases, some reads will take longer to be delivered, and as such the report below includes the results for two days prior (**9/8/2014**) also.

Metrics Date	Meters with at Least One Register Read		Meters with all Interval Reads Expected	
	% Success (Target 98)	Unsuccessful	% Success (Target 95)	Unsuccessful
Data for **9/9/2014** delivered by Today	**99.91%**	61	**0.04%**	67976
Data for **9/8/2014** delivered by Today	**99.92%**	52	**99.81%**	132

Adjust and Design reports to reflect operational needs:

Each time interval success drops, AMI operations personnel receive flood of email



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Inspiration…

Weekly AMI System Performance

Report Information

Metrics for Date:- **9/8/2014**

Date Report Executed:- **9/10/2014 11:42:29 PM**

Field Inventory Information

Total Meters:-	102380	Total AMI Installed:	100271	AMI % Installed	97.94%
Total Electric Goal:-	68355	Total Electric Installed:	68315	Electric % Installed	99.94%
Total Water Goal:	34025	Total Water Installed:	31982	Water % Installed	94%

Electric Meter Interval Performance

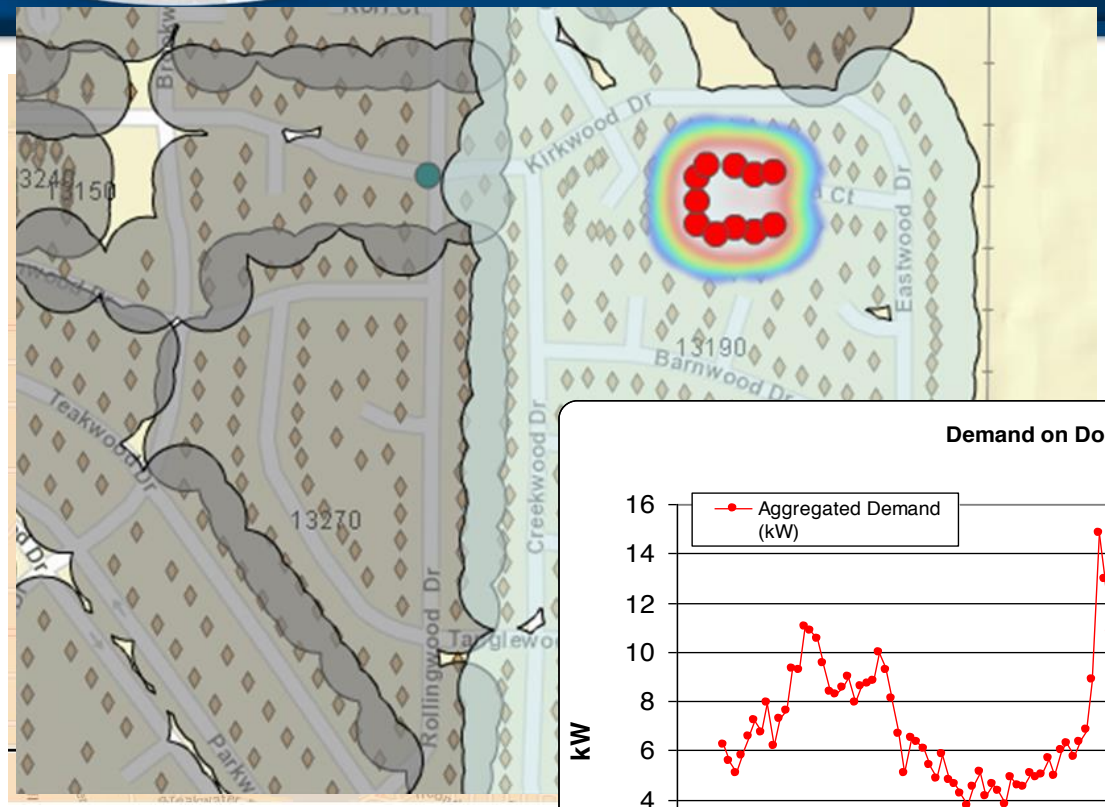
Our goal is to have the target level of required reads captured by the AMI (one register read and 96 interval reads), by the following day. In many cases, some reads will take longer to be delivered, and as such the reports below includes the metric results after two days of loading reads also.

Metrics % for Electric Interval Reads (Target 95%) for the Past Week							
Metric Day	9/2/2014	9/3/2014	9/4/2014	9/5/2014	9/6/2014	9/7/2014	9/8/2014
Results by next day	99.35%	99.72%	99.83%	99.81%	99.47%	99.83%	99.78%
Results after two days	99.41%	99.76%	99.85%	99.85%	99.49%	99.85%	99.81%

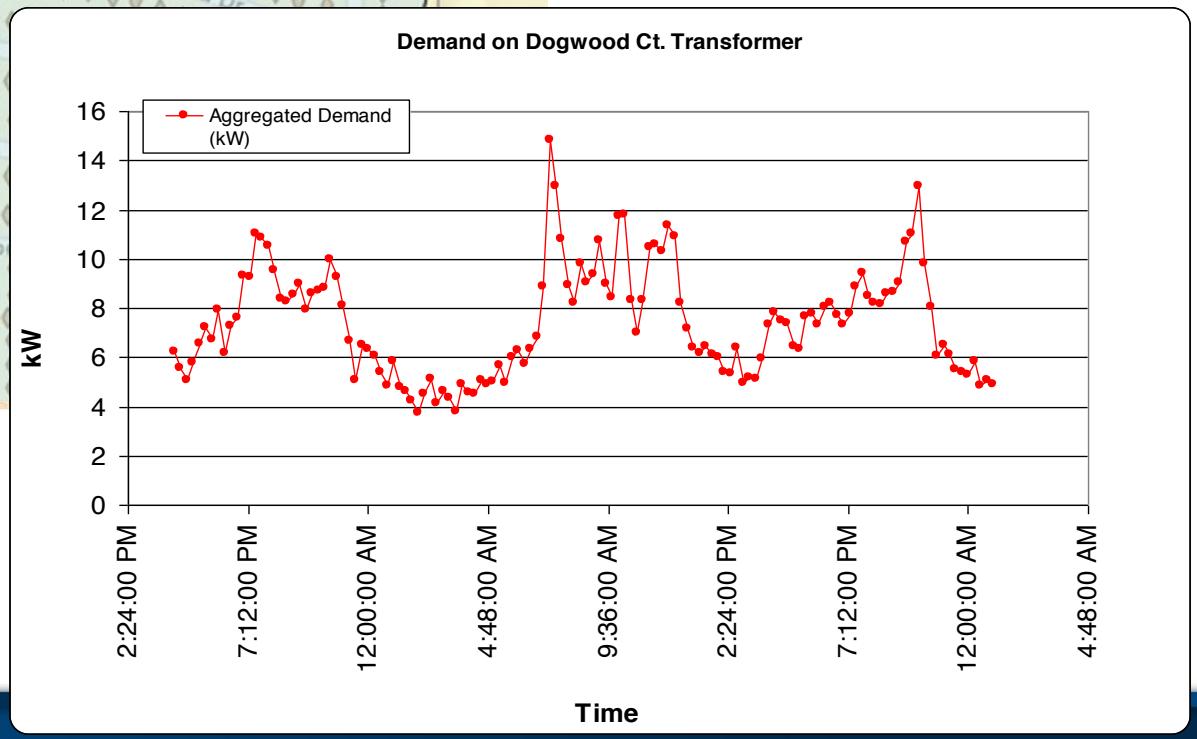
Metrics % for Electric Register Reads (Target 98%) for the Past Week							
Metric Day	9/2/2014	9/3/2014	9/4/2014	9/5/2014	9/6/2014	9/7/2014	9/8/2014
Results by next day	99.94%	99.95%	99.95%	99.93%	99.94%	99.93%	99.92%
Results after two days	99.94%	99.95%	99.95%	99.93%	99.94%	99.93%	99.92%

% of Total Electric Interval reads Expected versus Electric Interval Reads Delivered for the Week	99.68%	% of Total Electric Register Reads delivered versus Electric Register Reads expected for the Week	99.86%

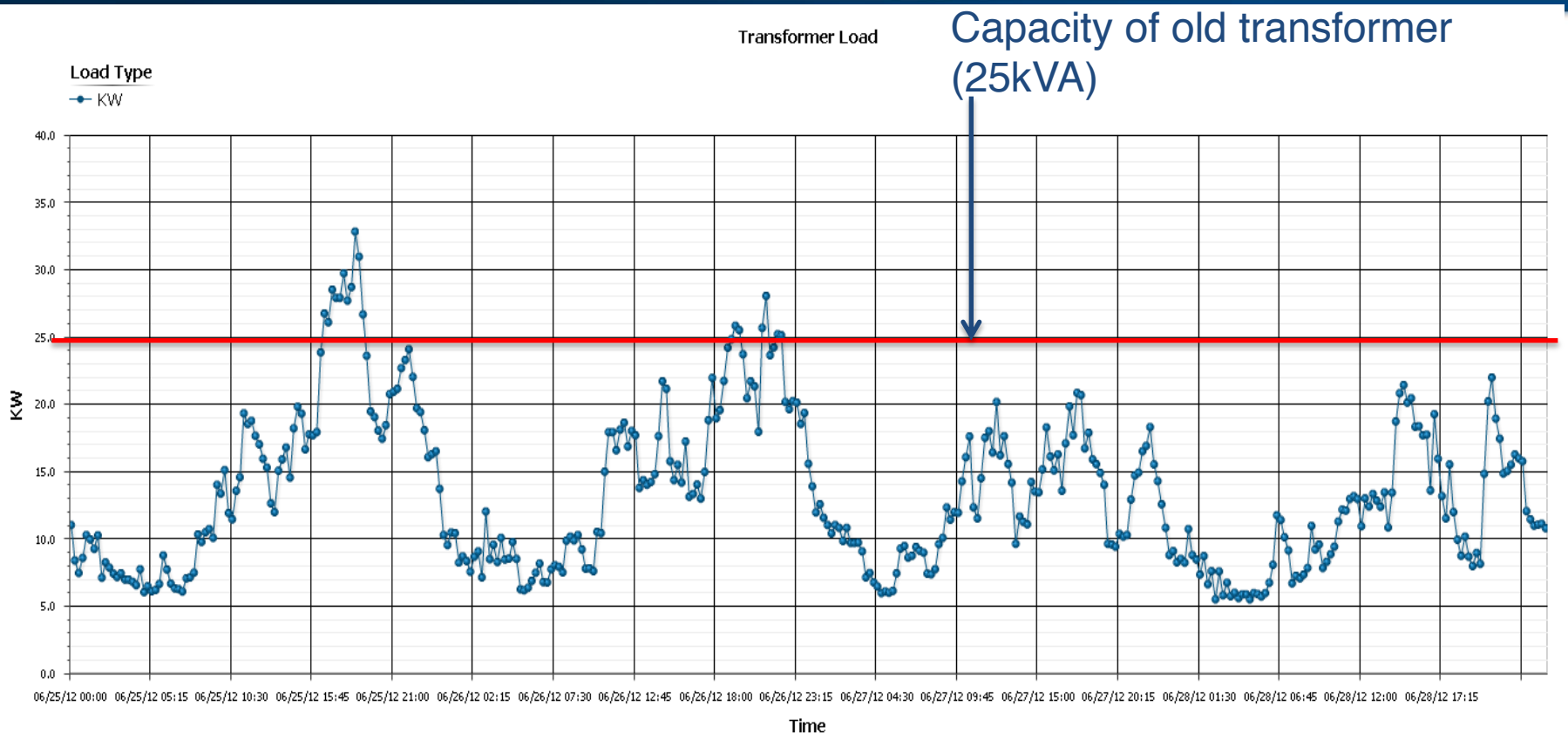
Transformer Overload Early Warning: April 2012



To get actionable results from meter alarms, we have tied the data from them by location and timestamp

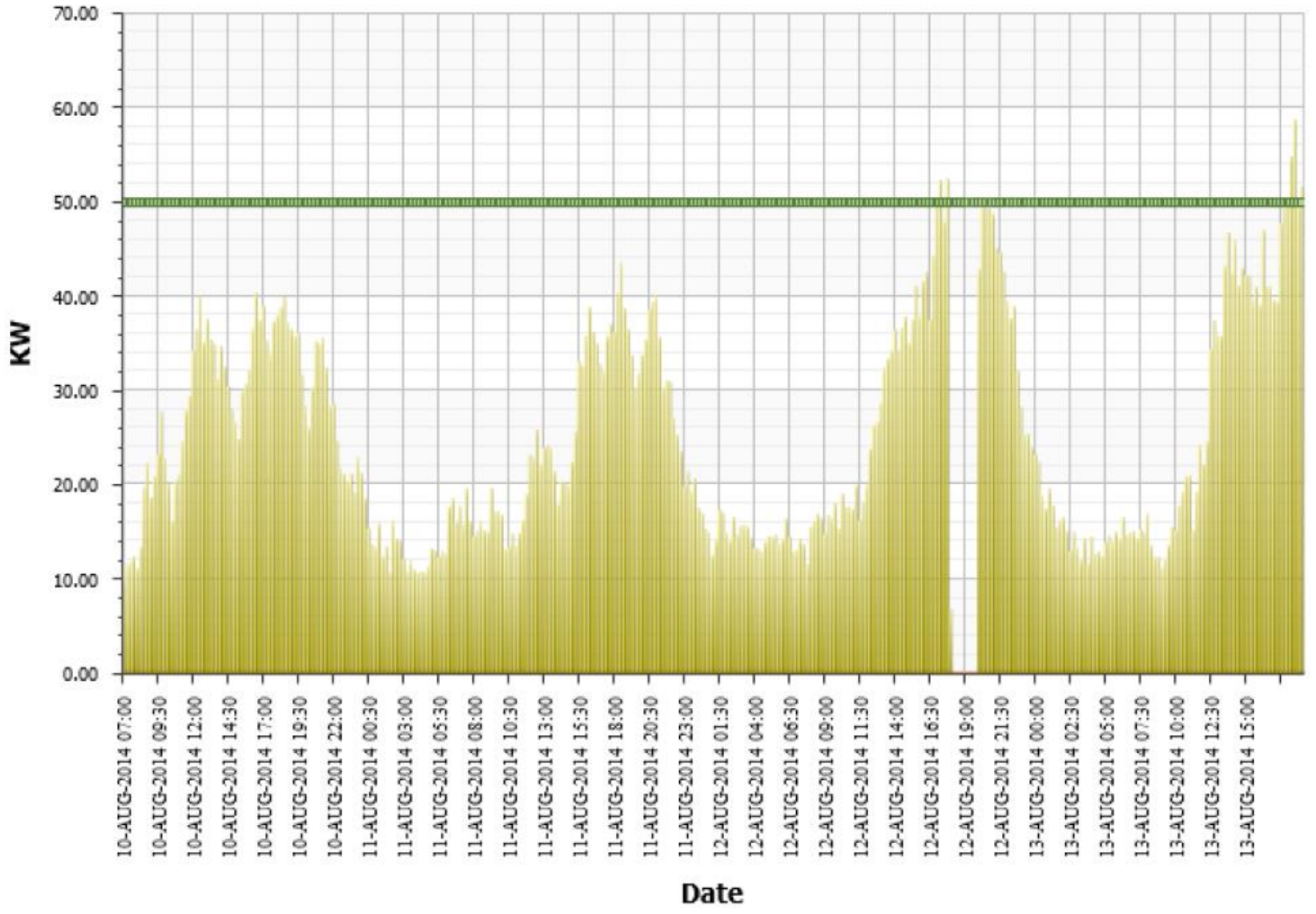


Transformer Overload Confirmation: June 2012 Review of Transformer Load



Inspiration…

Example of Excessive Loading (Transformer Overload Caught in Action)



Transformer & Meter Voltage Alarms

Transformer/Meter Voltage Alarms

Alarms for Date:- **9/13/2014**

Date Report Executed:- **9/14/2014 4:31:49 PM**

Transformers with Voltage Alarms

This report lists the transformer with a total of more than one AMI Meter Voltage alarm reported in the last 24 hours. The alarms include the follwoing - 'No Voltage Detected with Disconnect Closed', 'Voltage Monitoring Max Event', 'Voltage Monitoring Maximum Voltage Threshold', 'Voltage Monitoring Min Event', 'Voltage Monitoring Minimum Voltage Threshold', 'Voltage Monitoring Voltage Returned to Normal

Switch Point	Transformer ID	MeterID	Address	Count of Voltage Alarms
54620	**T10063**	14582788	831 CAMBRIDGE DR	2
72074	**T10145**	15932821	4026 S TIMBERLINE RD UNIT 100A	4
34827	**T12246**	16399880	2451 S TIMBERLINE RD UNIT 2/201	3
64230	**T2846**	14586641	1232 TEAKWOOD DR	6
64131	**T9664**	15928708	1132 PARKWOOD DR	8
64131	**T9664**	15928704	1184 TEAKWOOD DR	10
64131	**T9664**	15928701	1124 PARKWOOD DR	12

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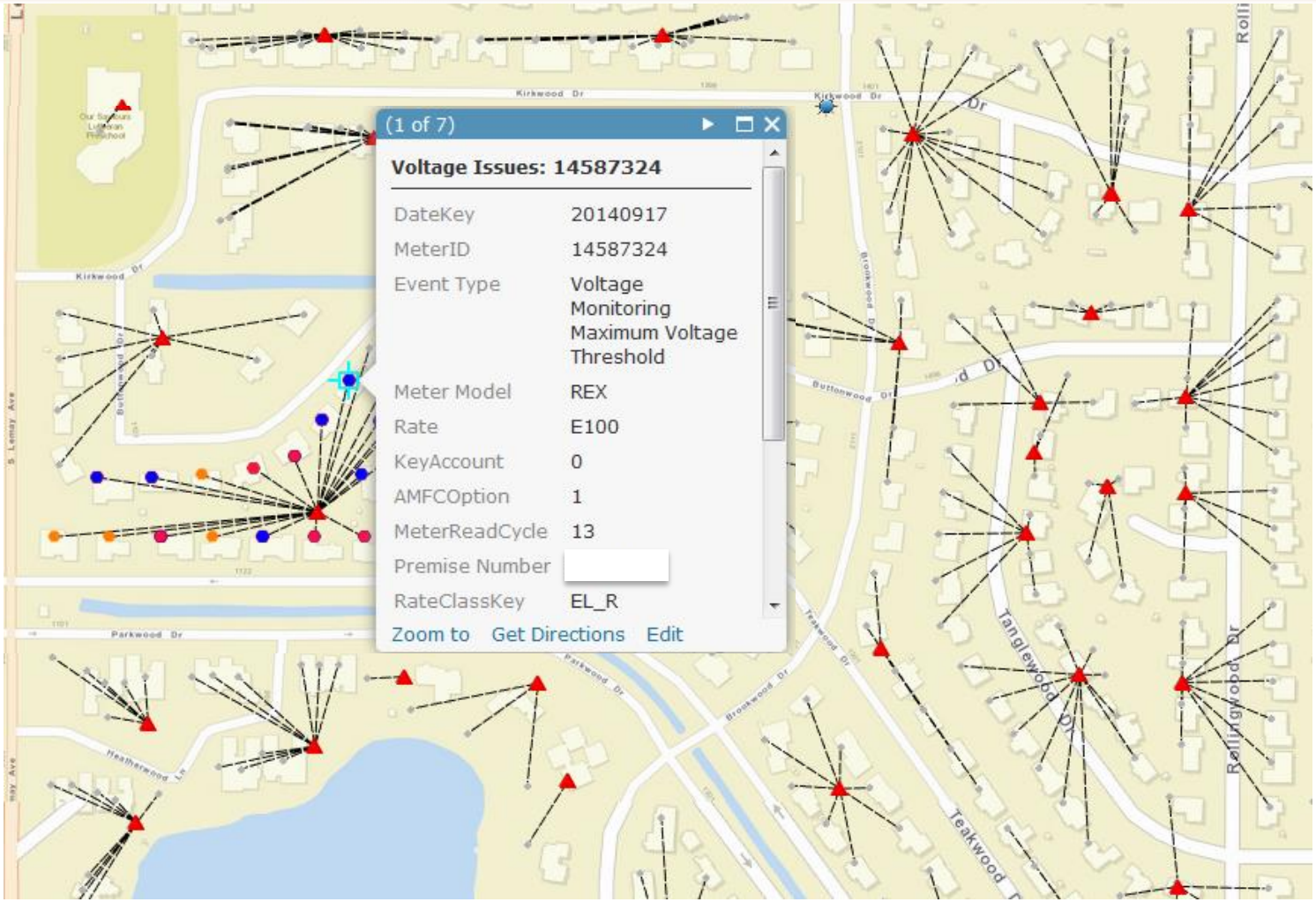
Transformer & Meter Voltage Alarms



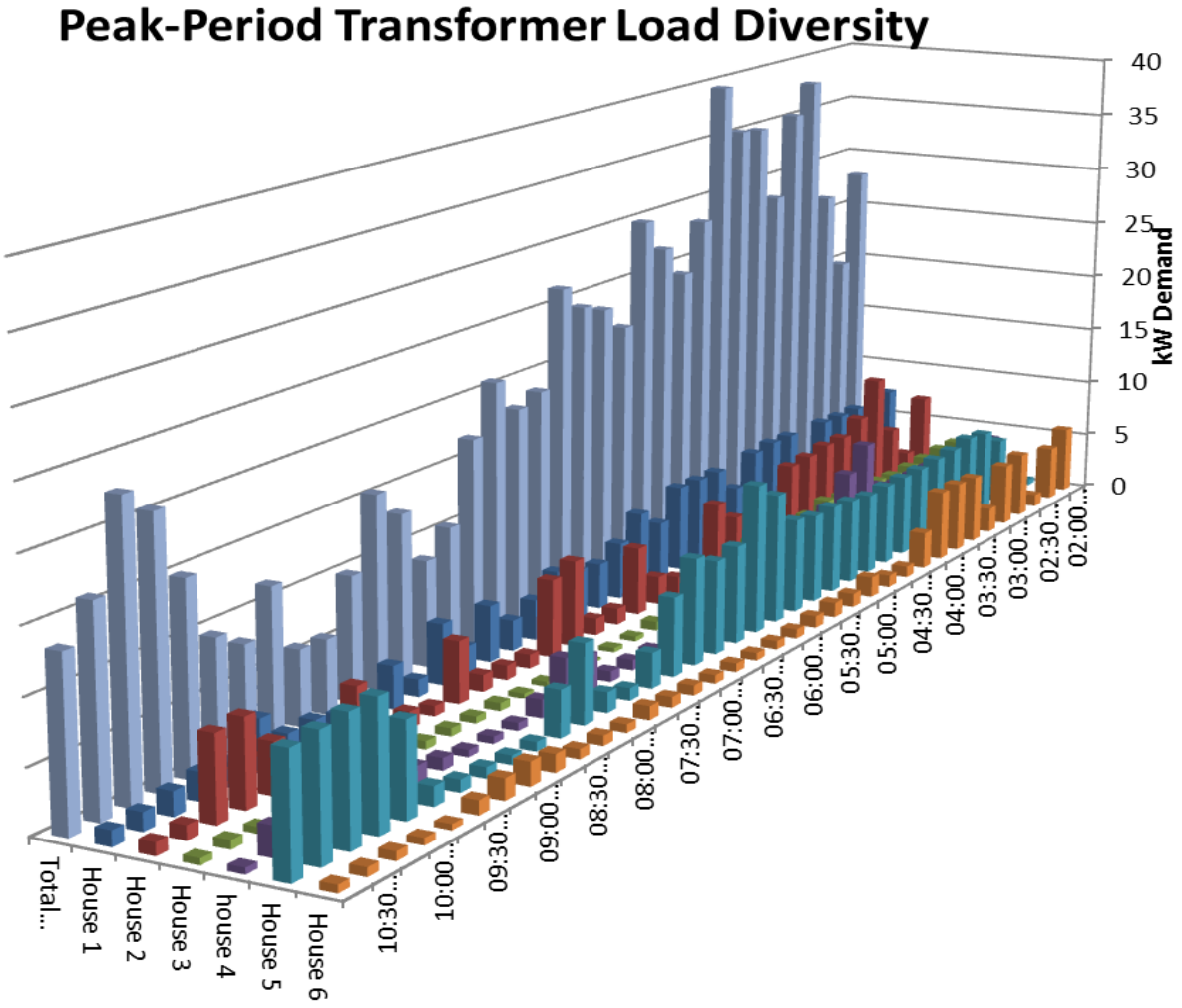
Transformer & Meter Voltage Alarms

Map application indicates which transformers have had voltage alarms for at least 3 of the last 5 days from the attached meters.

Transformer Voltage Alarms

Review of historical voltage alarms suggested voltage drop due to loose connections

Transformer Loading Analysis

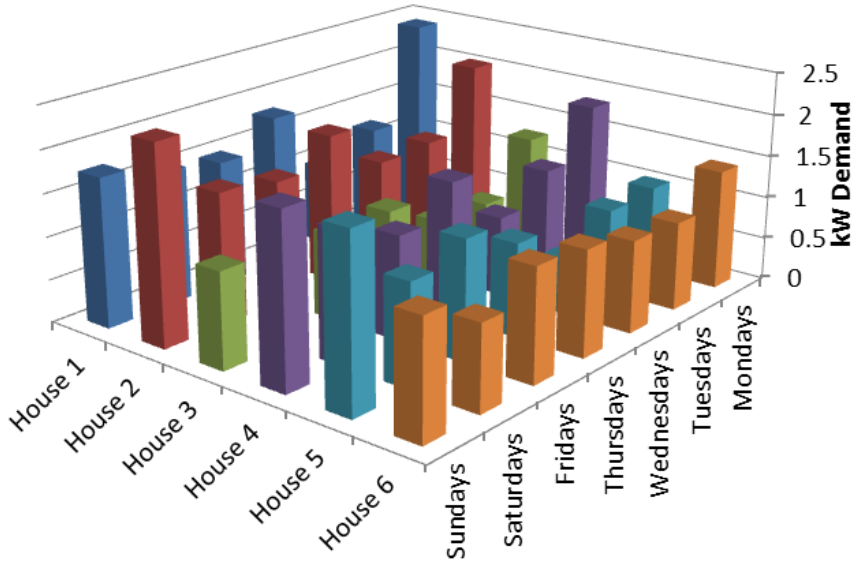


Review of Transformer:

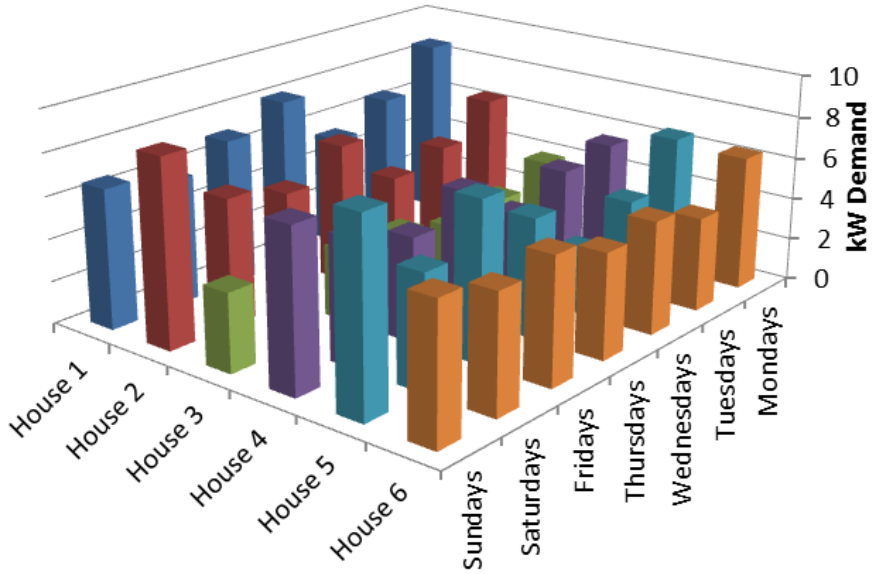
- Randomly Selected 50kVA unit
- Review of sum of 2014 maximum intervals is 49.86kVA for 20 July 2014
- Pull all intervals for July 20 and look for load diversity to see if there is a concern
- Note the coincident peak on this transformer is only about 39kVA, so it is within its rating

Transformer Loading Analysis

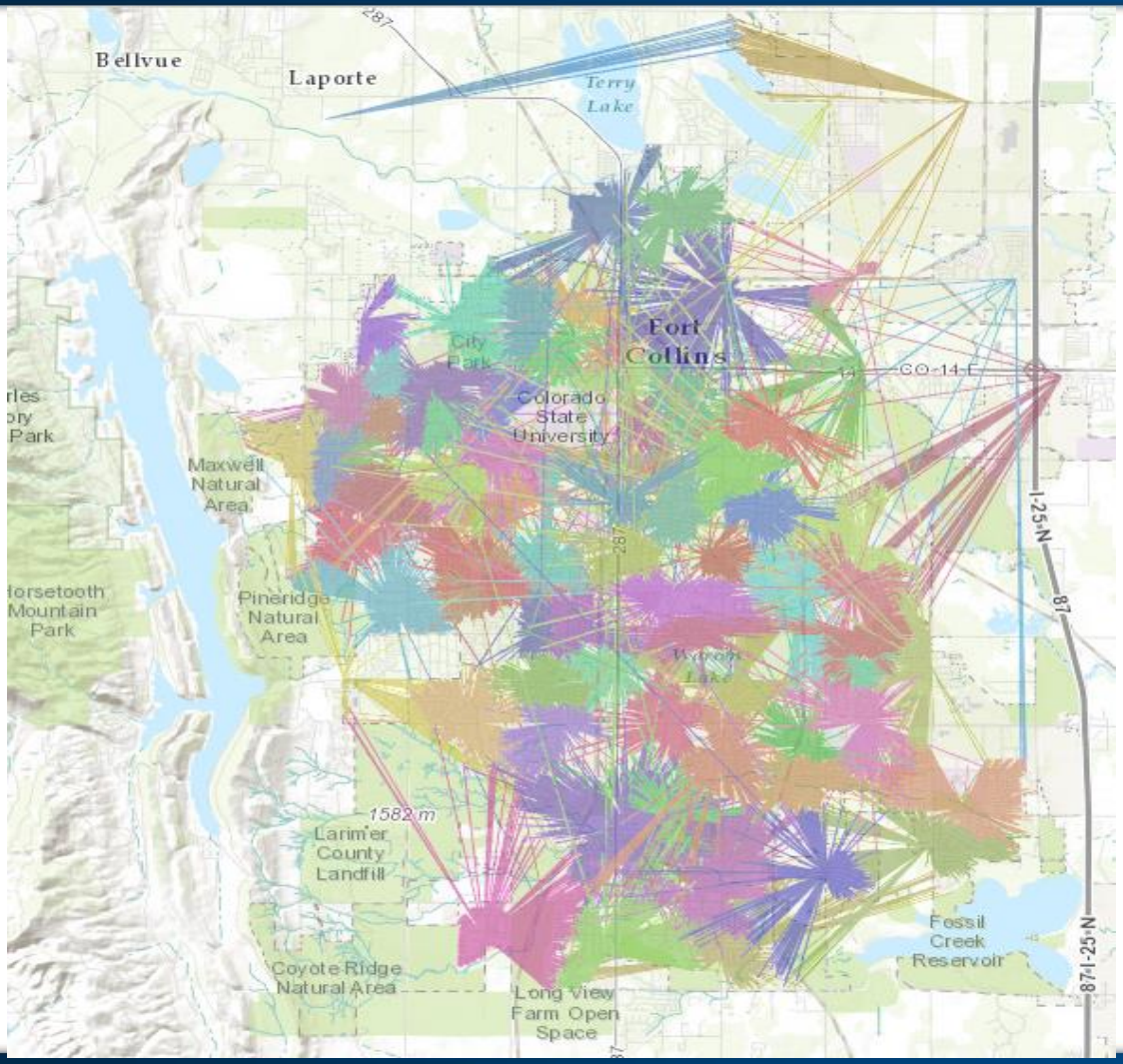
Average Transformer Weekday demand



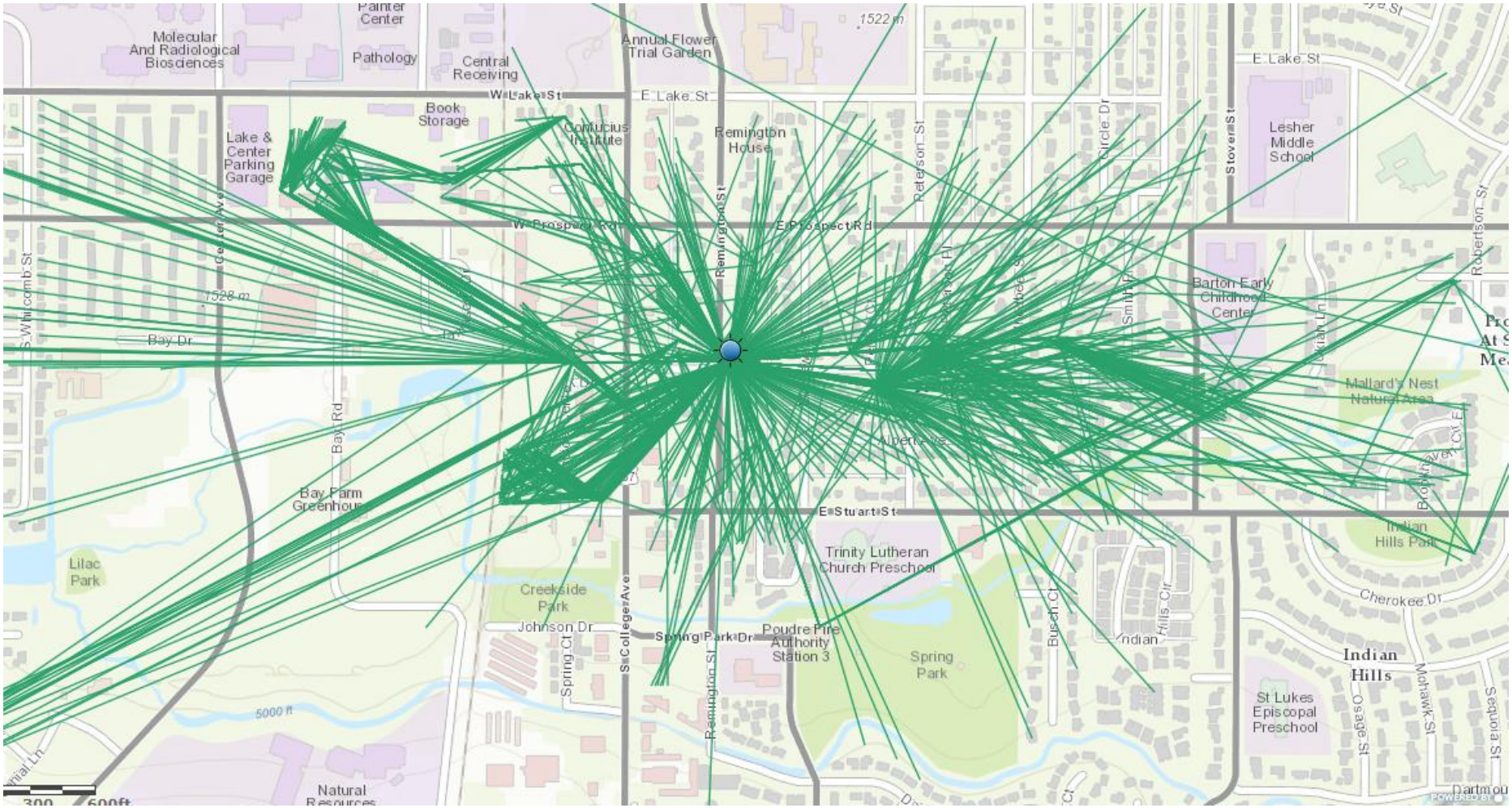
Maximum Transformer Weekday Demand



Graphical Communication Path Overview



Gatekeeper-to-Meter Communication Path



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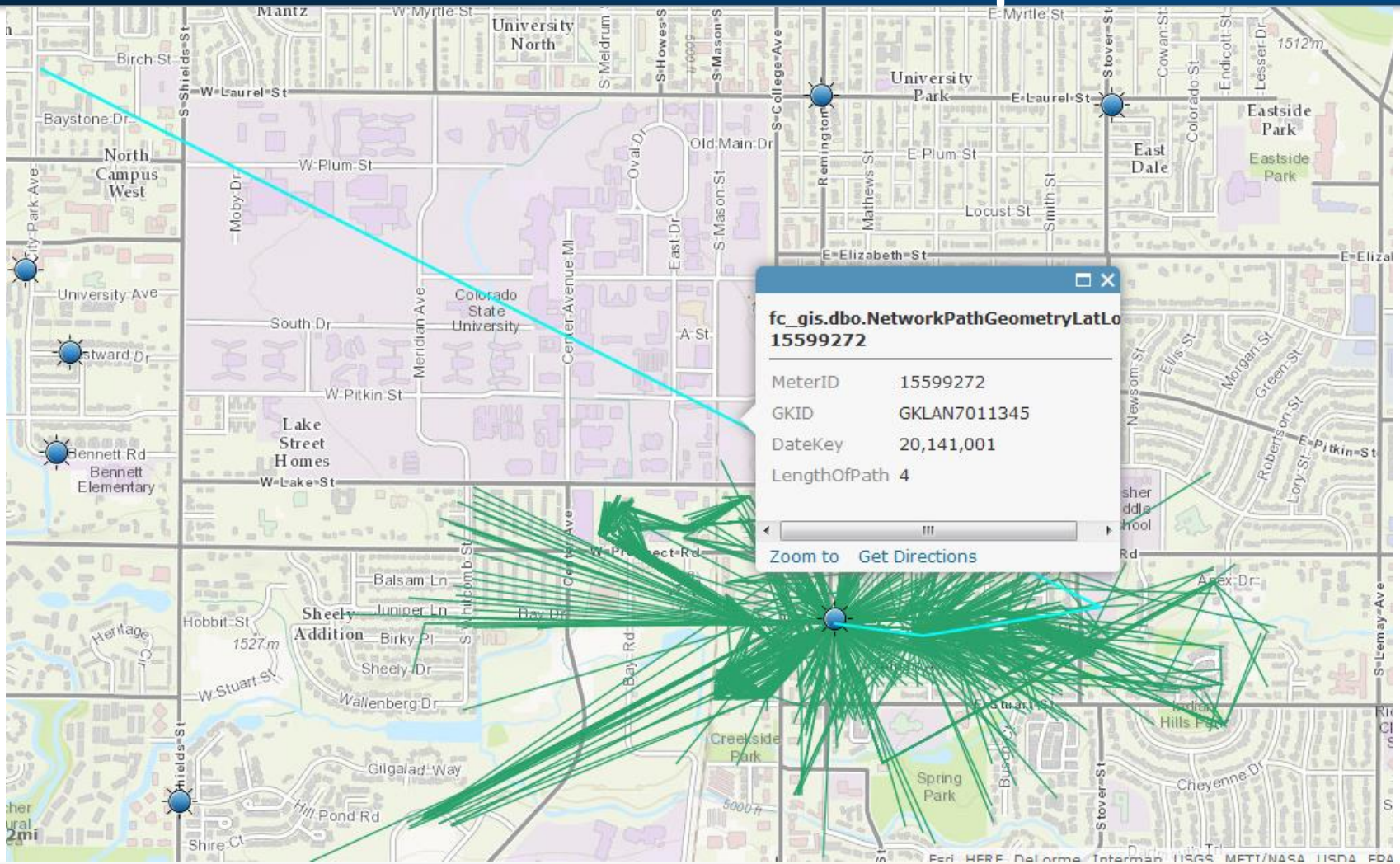
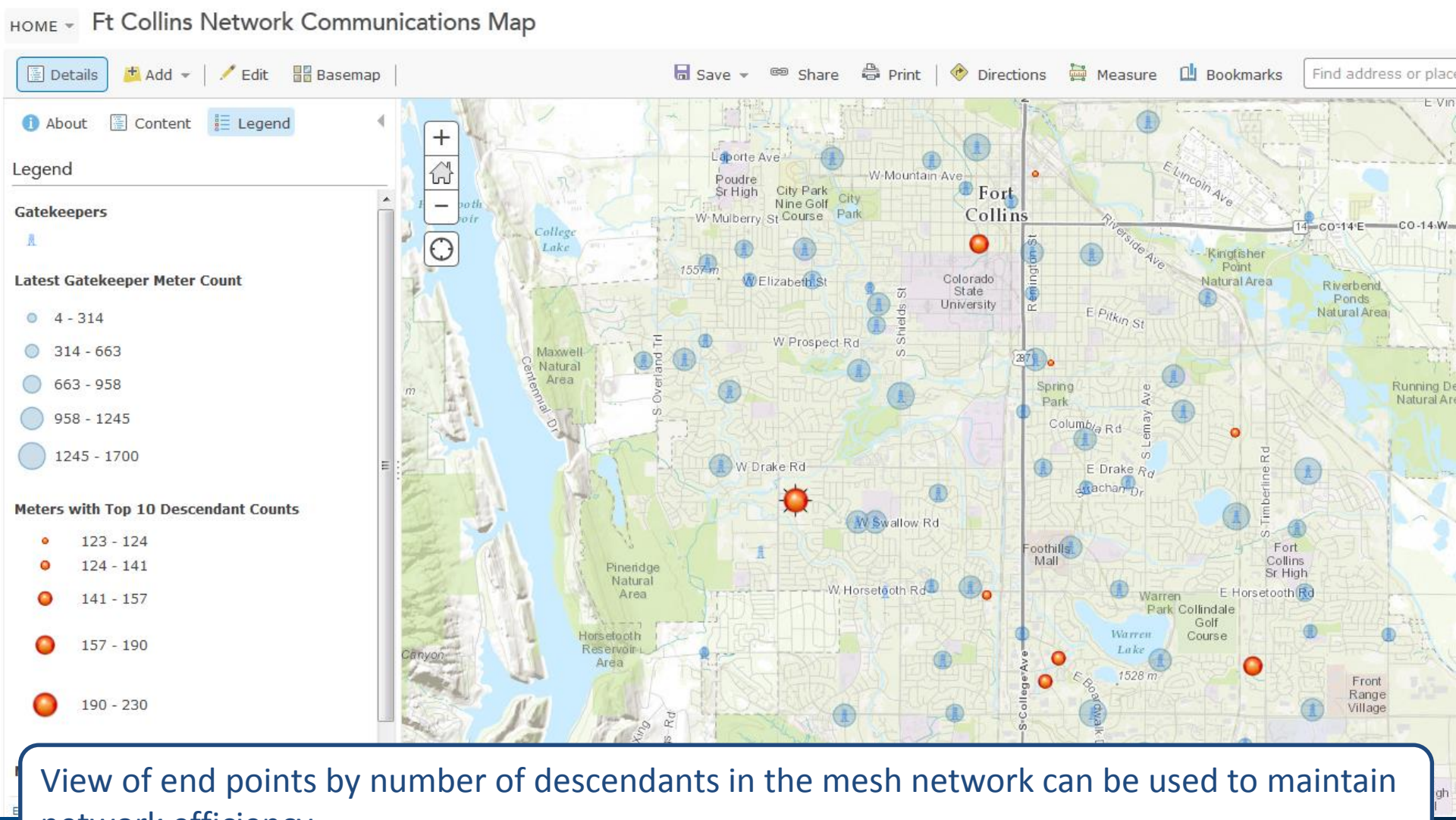
Graphical View Can Help Data Cleanup

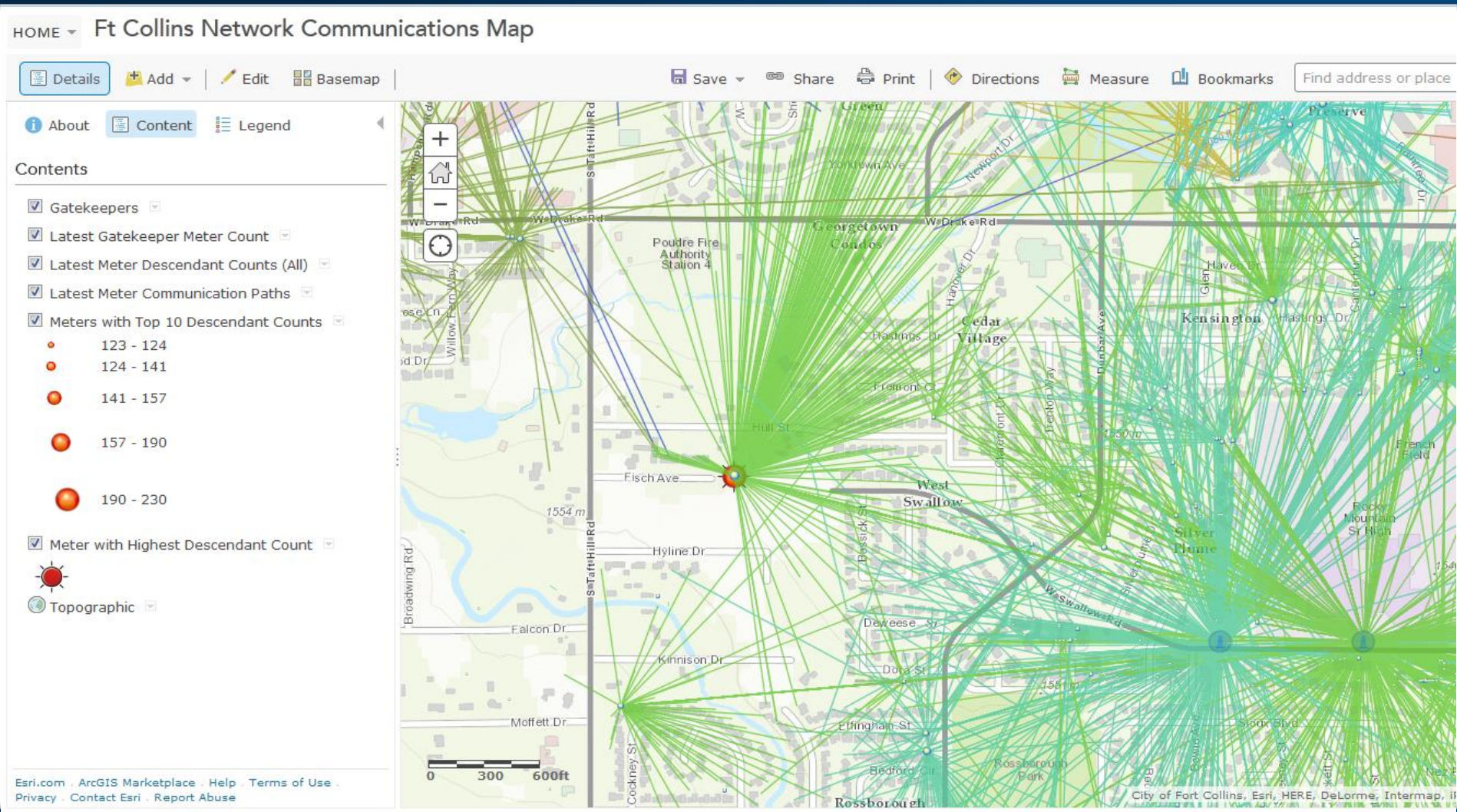


Network Management

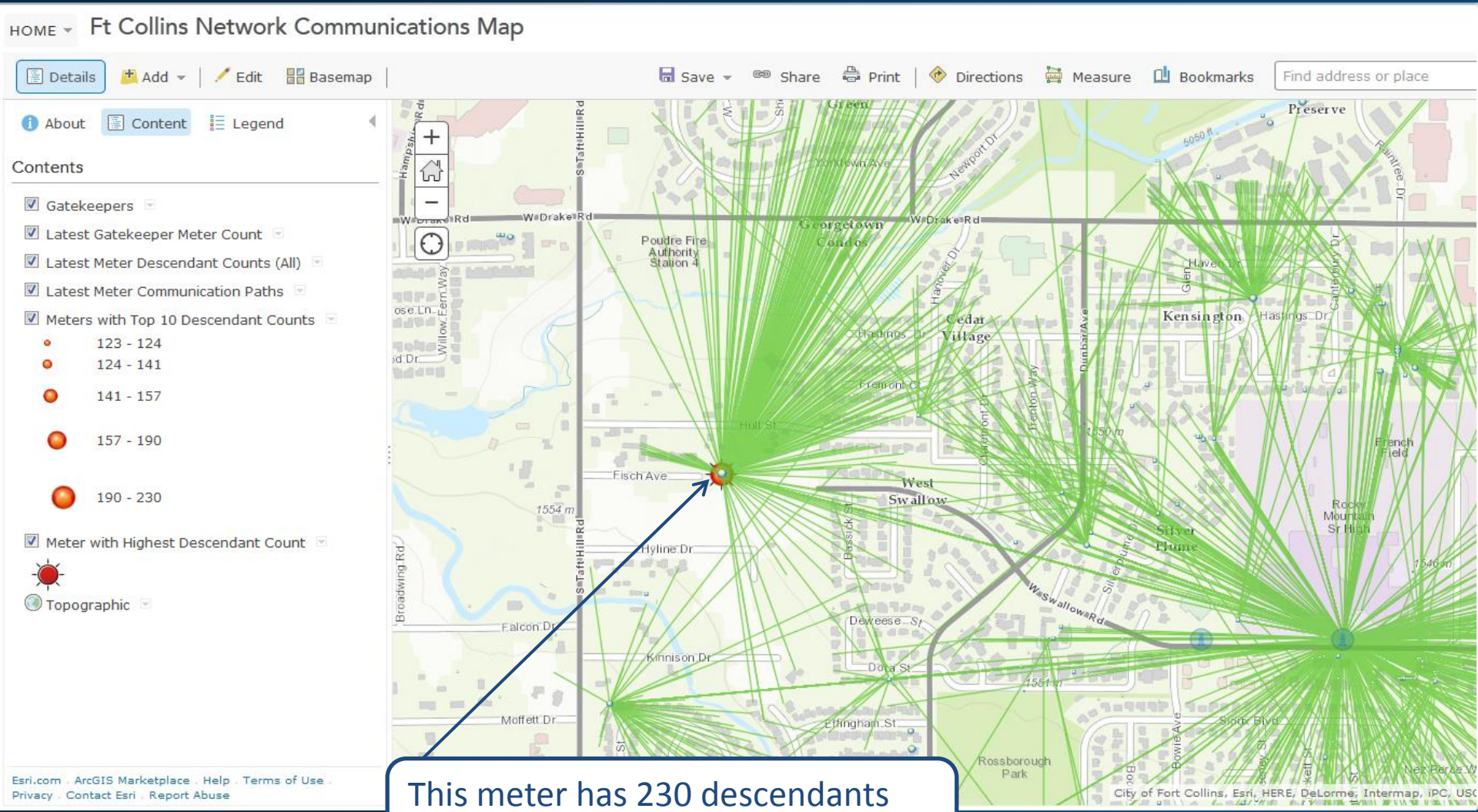


View of end points by number of descendants in the mesh network can be used to maintain network efficiency.

Meter with High Descendent Count

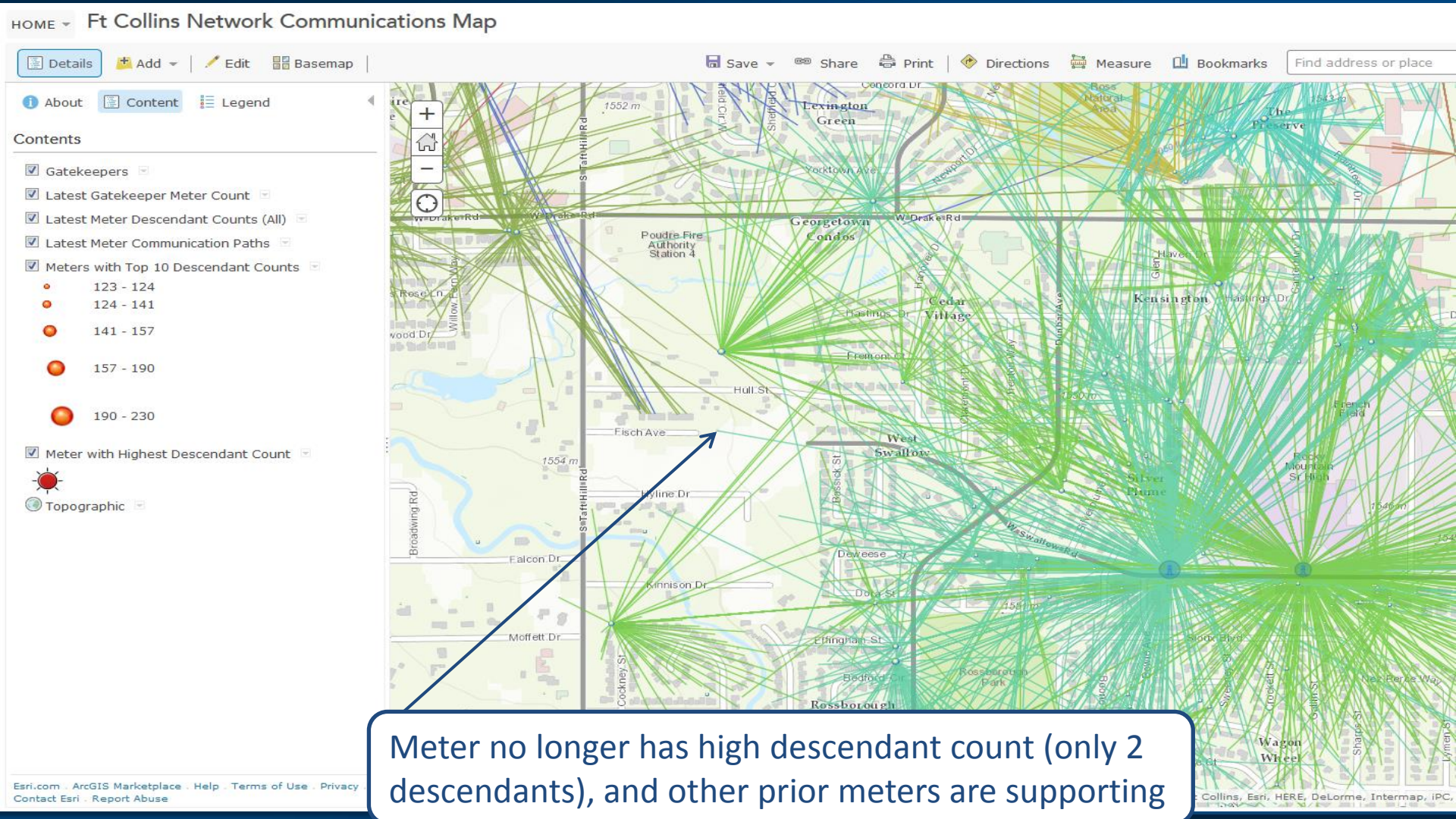


Isolate Communications for Single GK



This meter has 230 descendants prior to leaf-level mesh rebuild.

Descendant Meter Count Maintenance

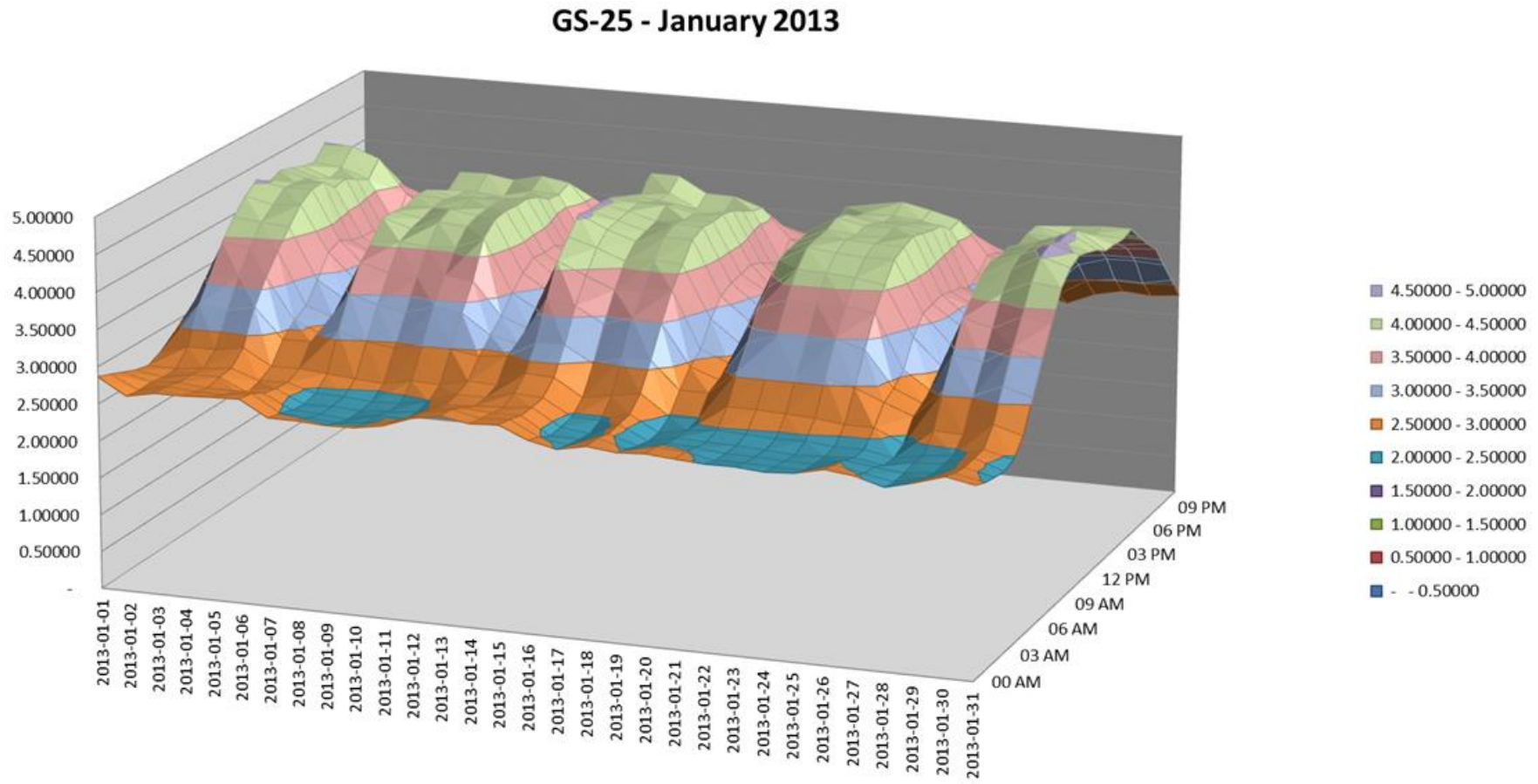


Meter no longer has high descendant count (only 2 descendants), and other prior meters are supporting communications.

Data Becomes Information for Study…

- Make use of our detailed data set to develop flexible rates

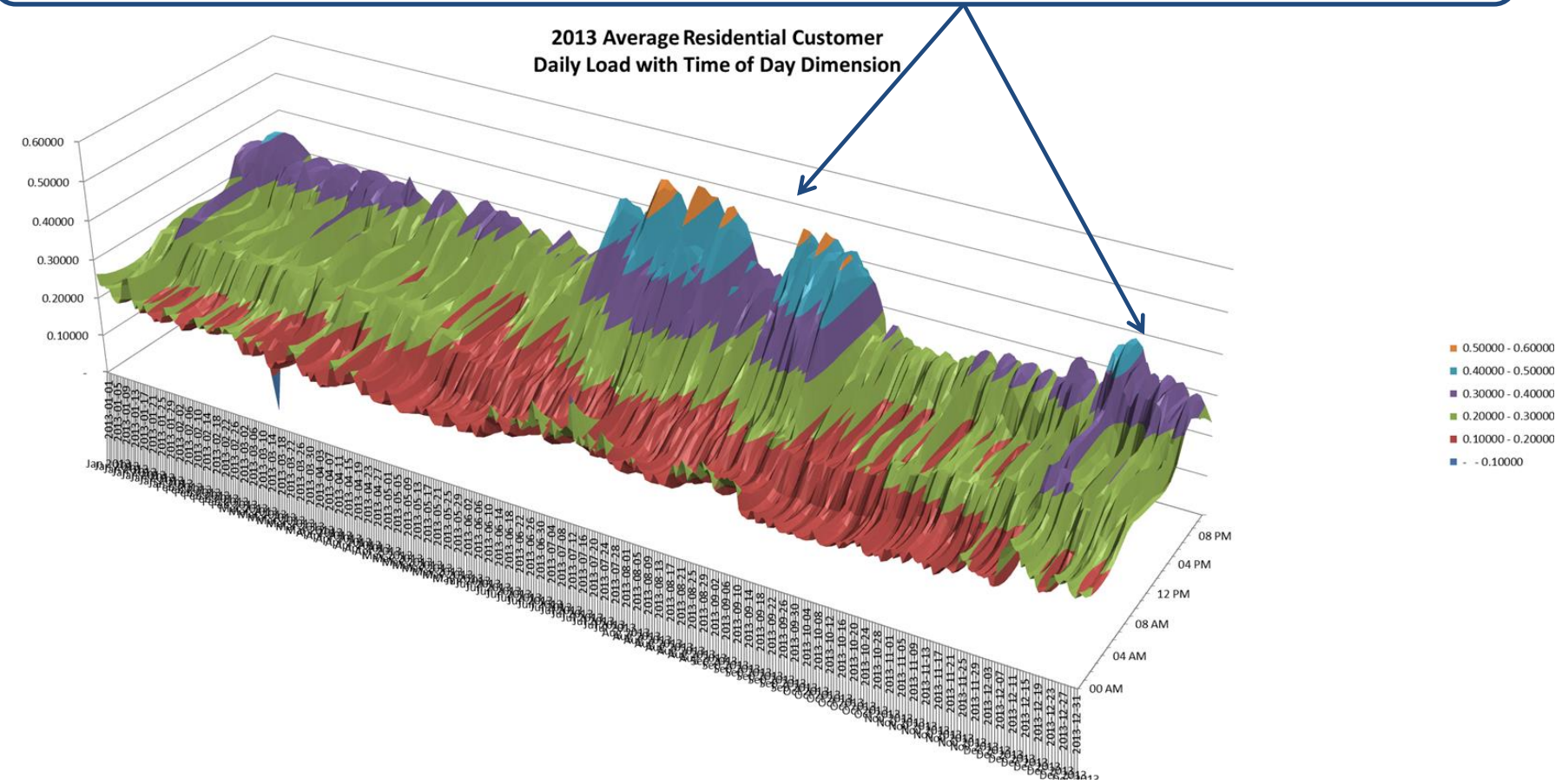
Small Commercial Monthly Load Profile



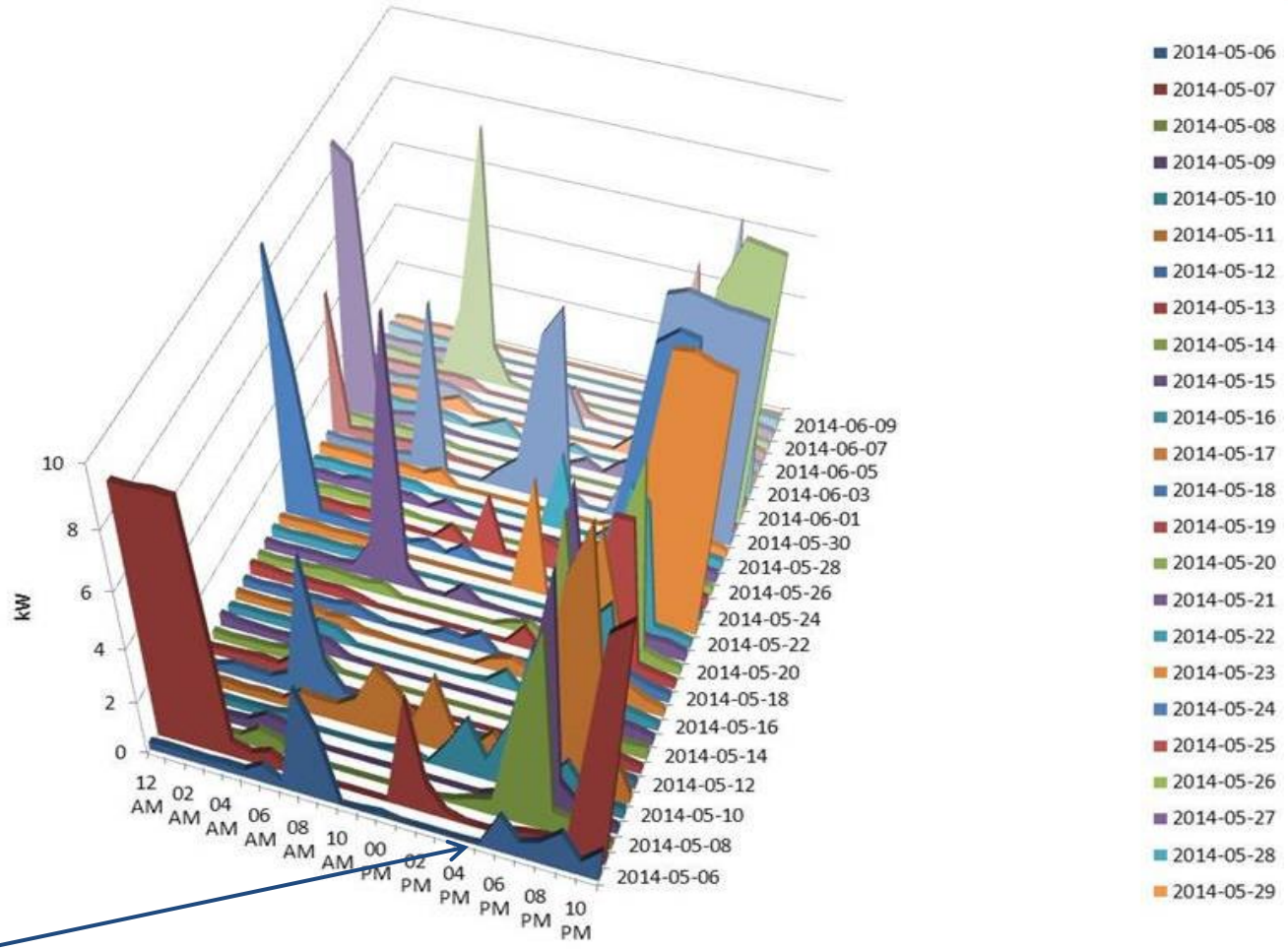
Note that, in general, these customers have a uniform consumption pattern for weekdays versus weekends.

Residential Customer Daily Load

Note that, in general, residential customers have higher consumption for during summer months with a smaller increase in winter.



Data View- Vehicle Charging



With detailed load profile data, it is possible to tell that charging consistently occurs during system peak hours (4 - 6PM in Summer months, 7 – 9PM in winter months)

Next Steps

- Build reports to detect transformer loading concerns
  - Start with transformers near overload
  - Move on to transformers that are loaded significantly under their ratings
- Survey system voltages for voltage optimization opportunities
- Verify load flow models
- Virtual metering to support customer-sponsored parallel generation projects
- Add more demand response capabilities
- Investigate Prepaid metering

Etc.

Etc.

Etc.

Etc.

THANK YOU!

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