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NEW ANALYTIC METHODS FOR DETERMINING NETWORK PERFORMANCE ISSUES AND PREDICTING SERVICE DISRUPTIONS IN CABLE NETWORKS

John Holobinko
Independent Communications Consultant &
(former) VP, Strategy and Business Development
ARRIS

Problem Determination in Cable Networks Is Becoming More Challenging

1. We are increasing network performance demands
   - Higher orders of modulation
2. The network faces new external sources of interference
   - Example: High power LTE interference
3. There are fewer expert RF technicians
   - Retirement has resulted in the loss of critical skills
   - Very few tech schools/colleges are training new technicians for cable systems
     - Online programs to train new technicians in cable/RF skills only recently launched by SCTE

Current Tools And Their Challenges Meeting The Performance Resolution Goals

Current tools are focused on data collection and reporting

- Gather tons of data; but virtually no cross-correlation or interpretation of data

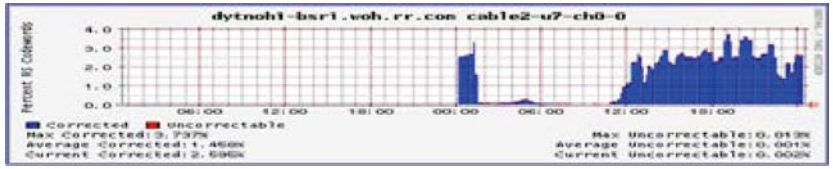
Data interpretation and problem identification is dependent upon highly-skilled personnel

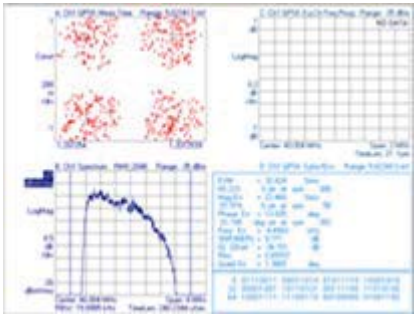
- Requires RF engineers/RF technicians to interpret data
- Relies on expert to “connect the dots” on disparate information

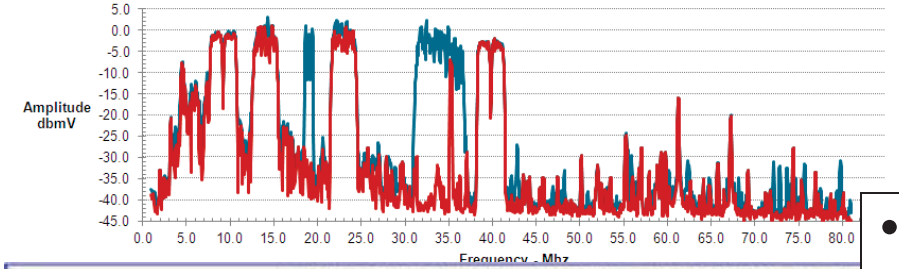
No easy means to correlate data to actual customer addresses and equipment locations

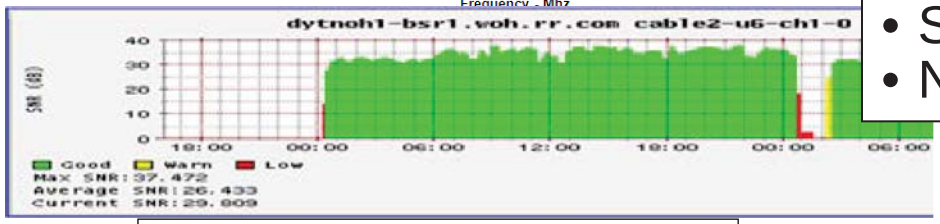
- Data not correlated to network maps nor to customer address databases

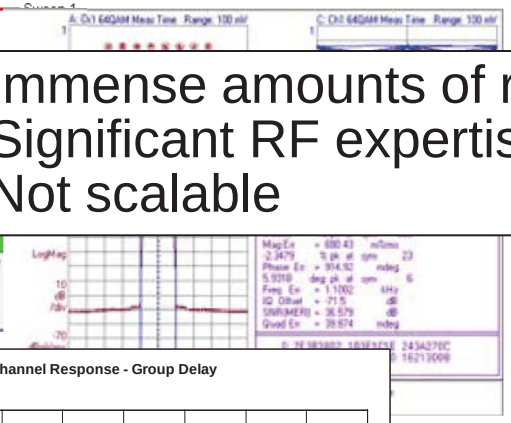
Today's Tools



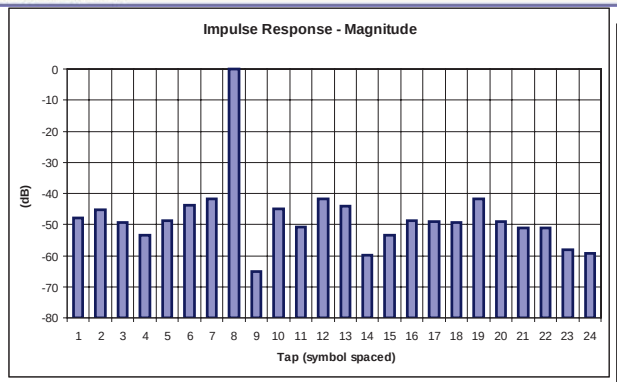


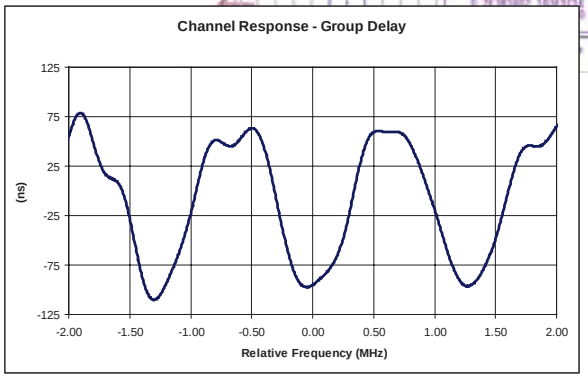






- Immense amounts of raw data
- Significant RF expertise required
- Not scalable





Definitions:

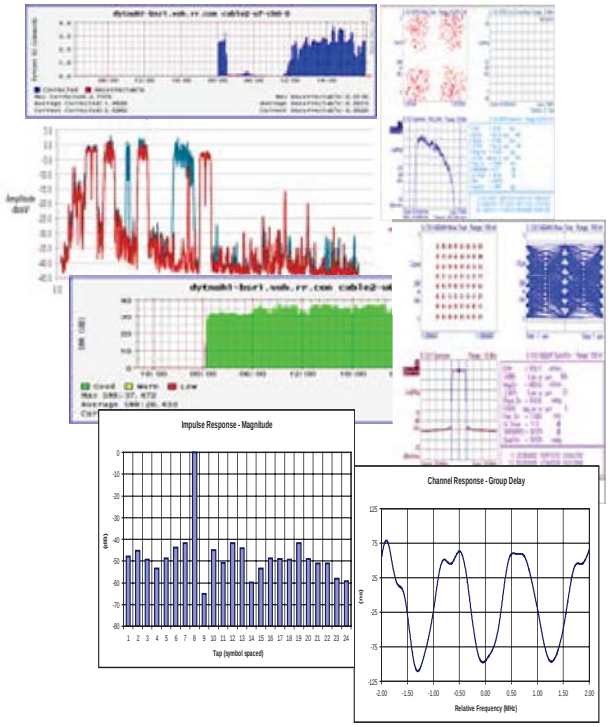
Proactive maintenance: *The concept of finding a potential problem and correcting it before it is service-affecting*

- Contrast to: "Finding an existing problem before a customer reports it"

Analytics: *The method of logical analysis*

- Merriam Webster Dictionary

Goals of a Network Analytics Solution



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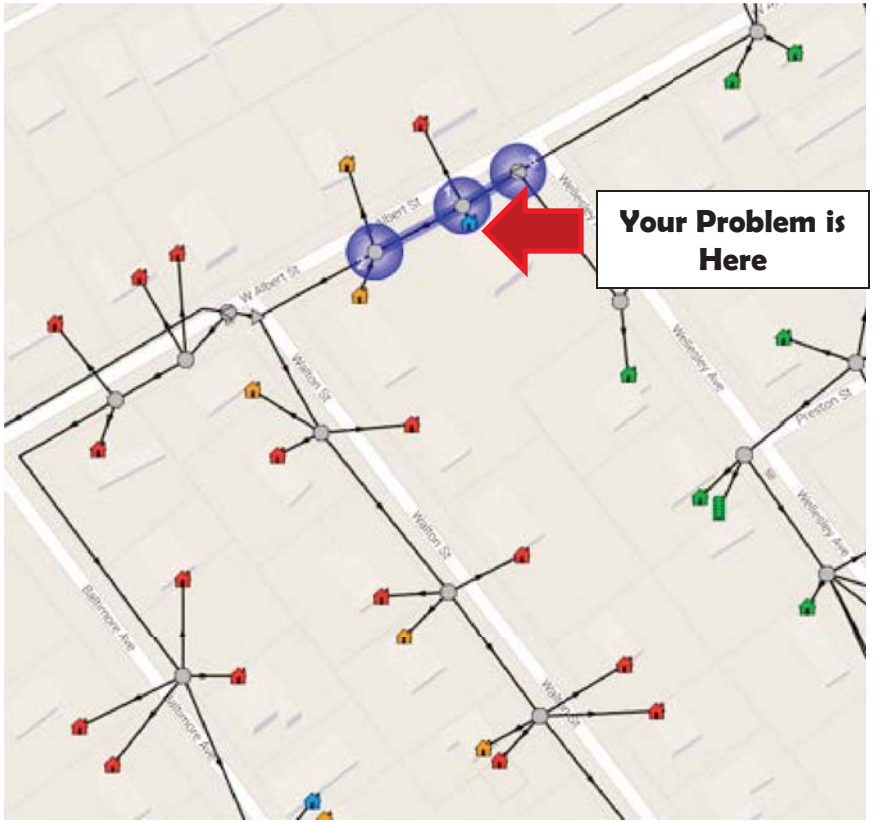
Network Analytics Solution



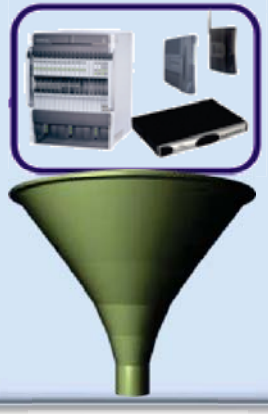
- Root cause analysis
- Pinpoint fault origination
- Intuitive and scalable visualization

Goals For a Network Analytics Solution

1. Selectively view the network with adjustable granularity
   - To individual street and individual customer level including geo coordinates
2. Graphically display via color code, the status of every service area, device and customer
   - Including associated measured data and performance
3. Simple visual means to determine network status and visually map location of all existing and impending problems
4. Identify the location of each fault, in addition to and separate of the customer locations impacted by the fault
   - Provide a ranking of potential fault causes
5. Ability to set variable thresholds on various defects and performance parameters
6. Provide alarm correlation as a means of prioritizing problems and managing the level of alarms
   - Values may be different at initial implementation versus after network performance is stabilized

Example System Functional Characteristics

CMTSs and CPE



1. Collect data

- CMTS and DOCSIS CPE MIBs
- Time & frequency domain RF parameters
- Network topology data

3. Phase 2 Analysis

- Solve a series of equations based on the inter-dependent relationships of the parameters

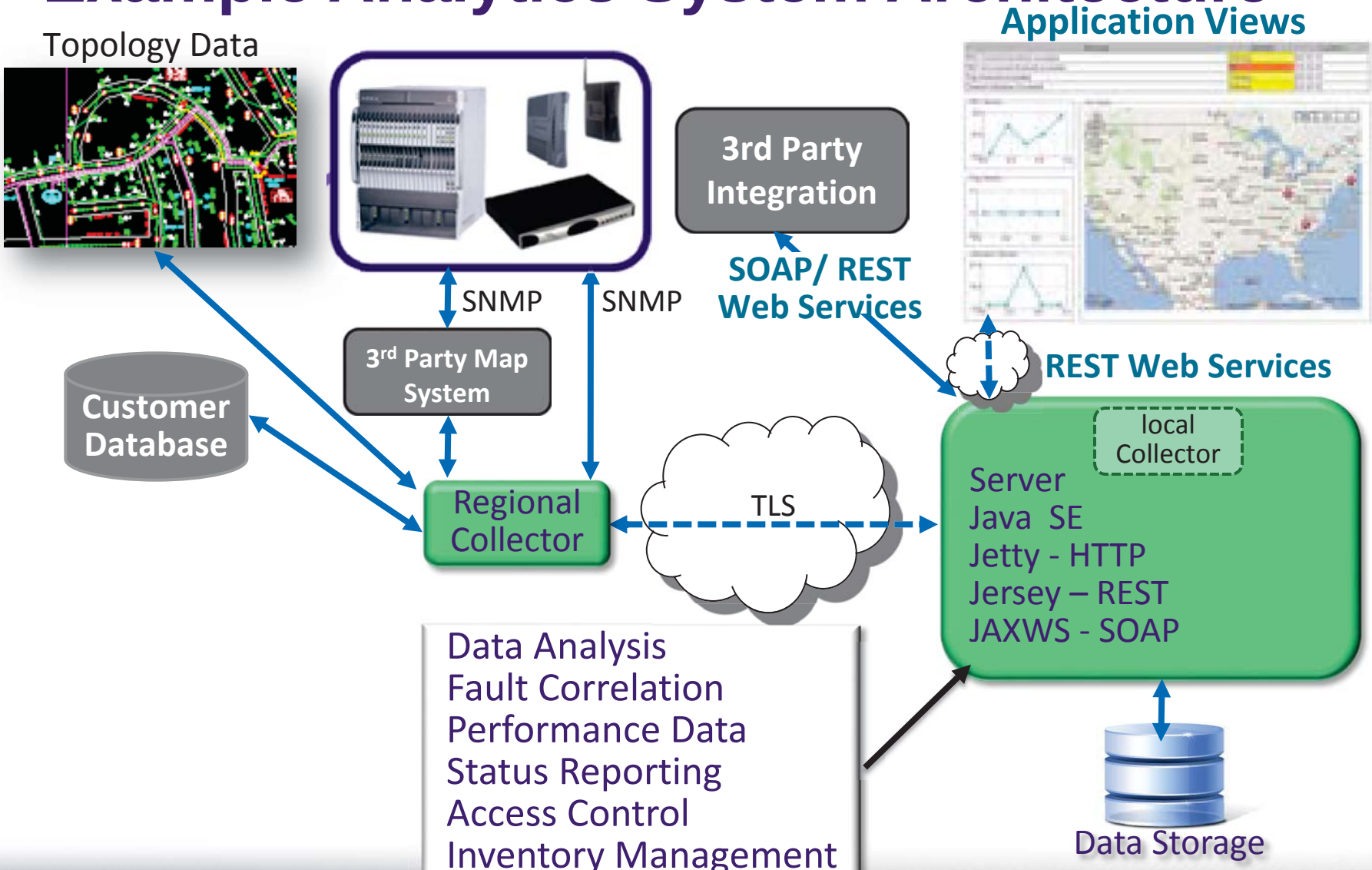
2. Phase 1 Analysis

- Process the received signal & transmit signal data
- Map to network topology

4. Display Results and Detailed Data

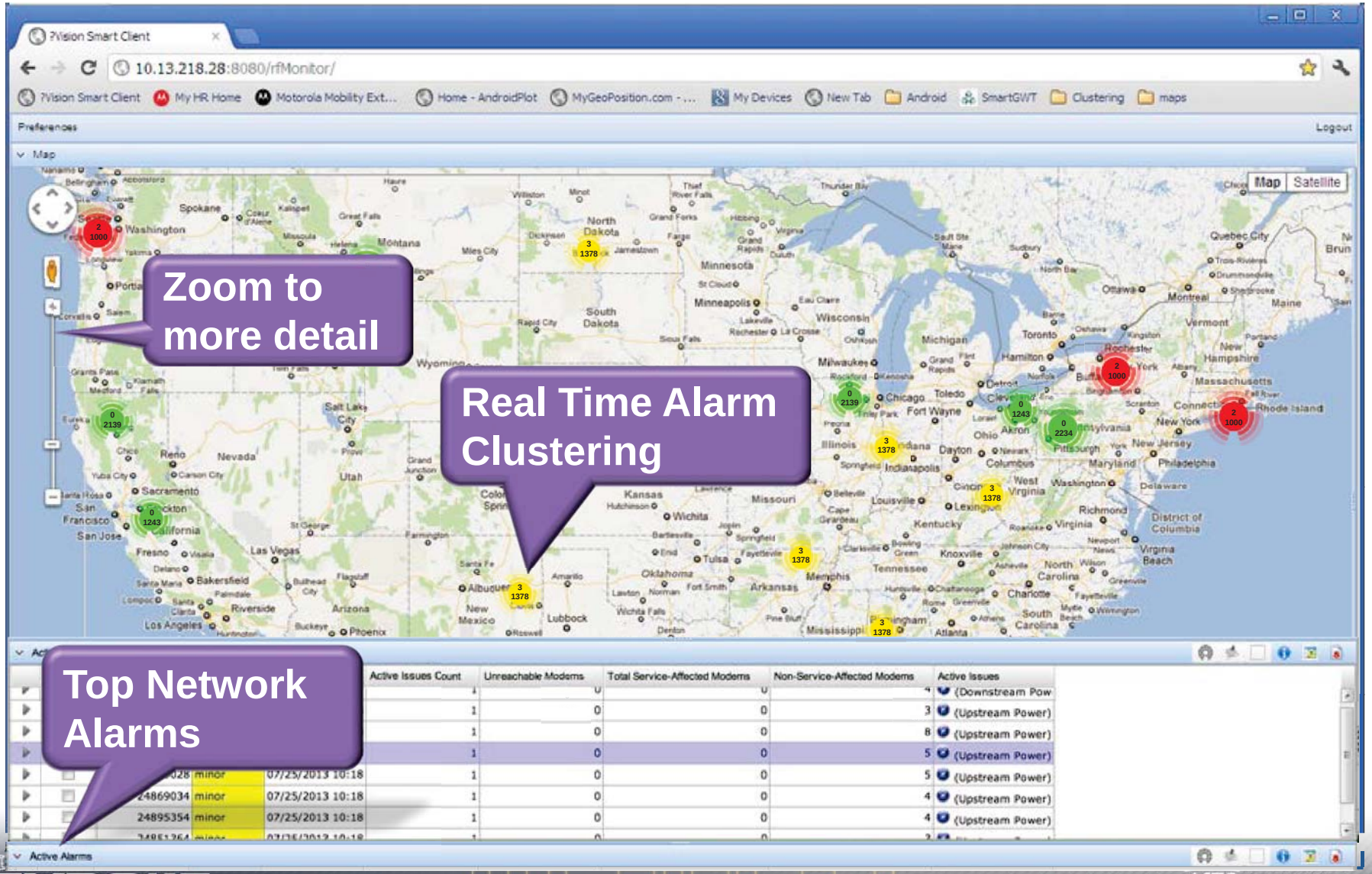
- Map/topology based repair recommendations
- Network wide alarm summary
- Detailed data reports & trouble shooting tools

Example Analytics System Architecture



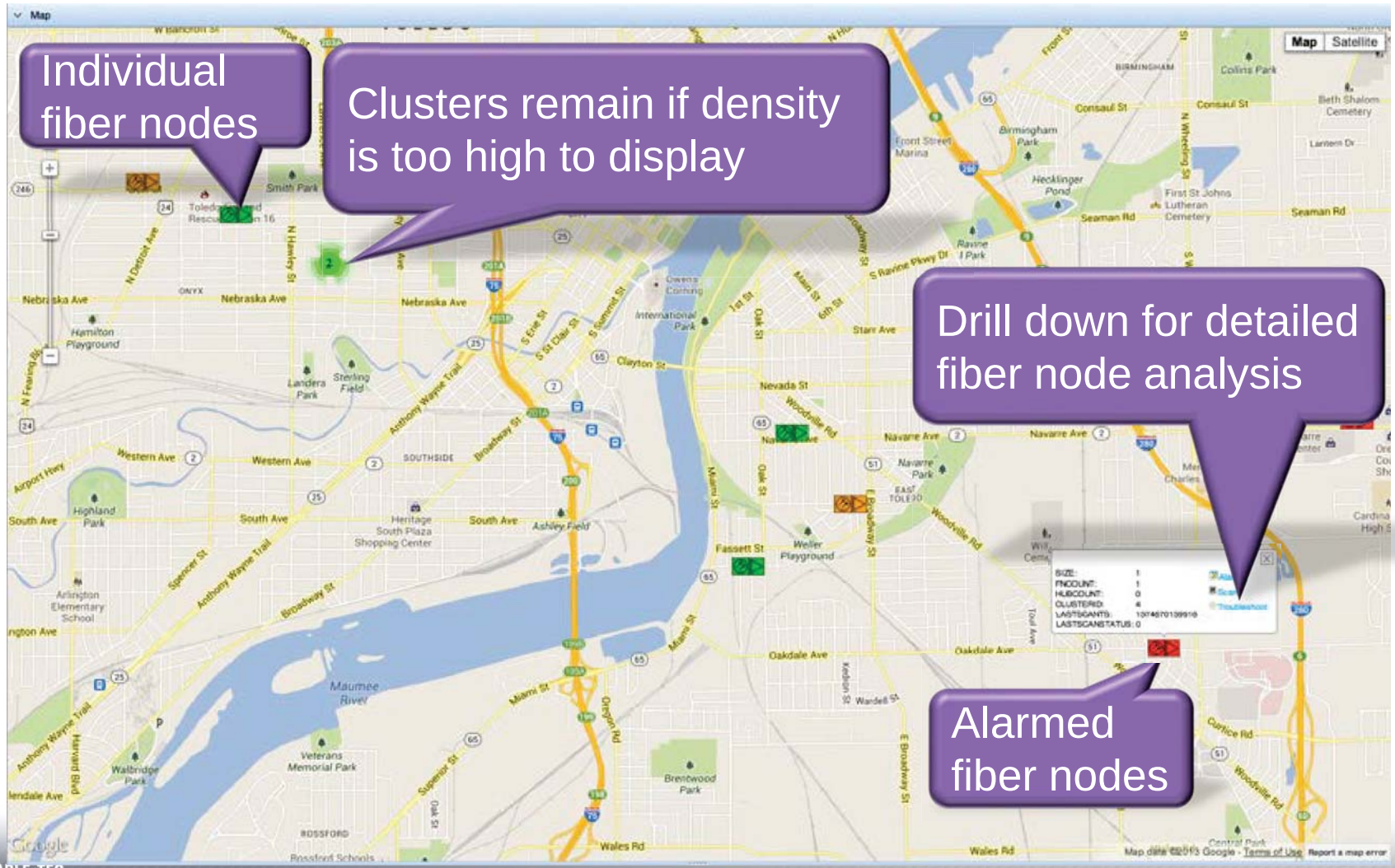
Example Use Case

Provide NOC operators network-wide visibility



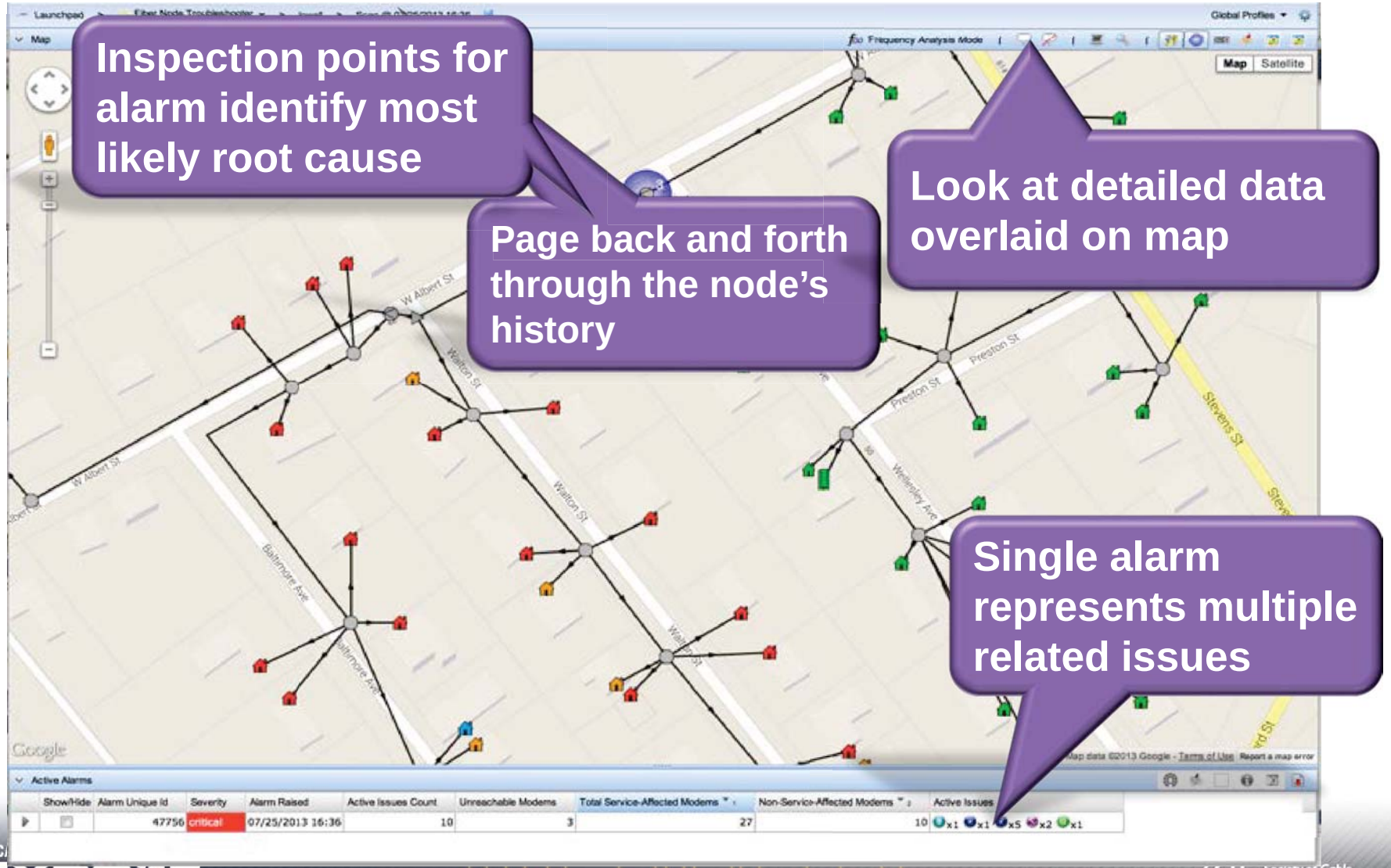
Example Use Case

Zoom in for more detail



Example Use Case

Empower technicians and field engineers



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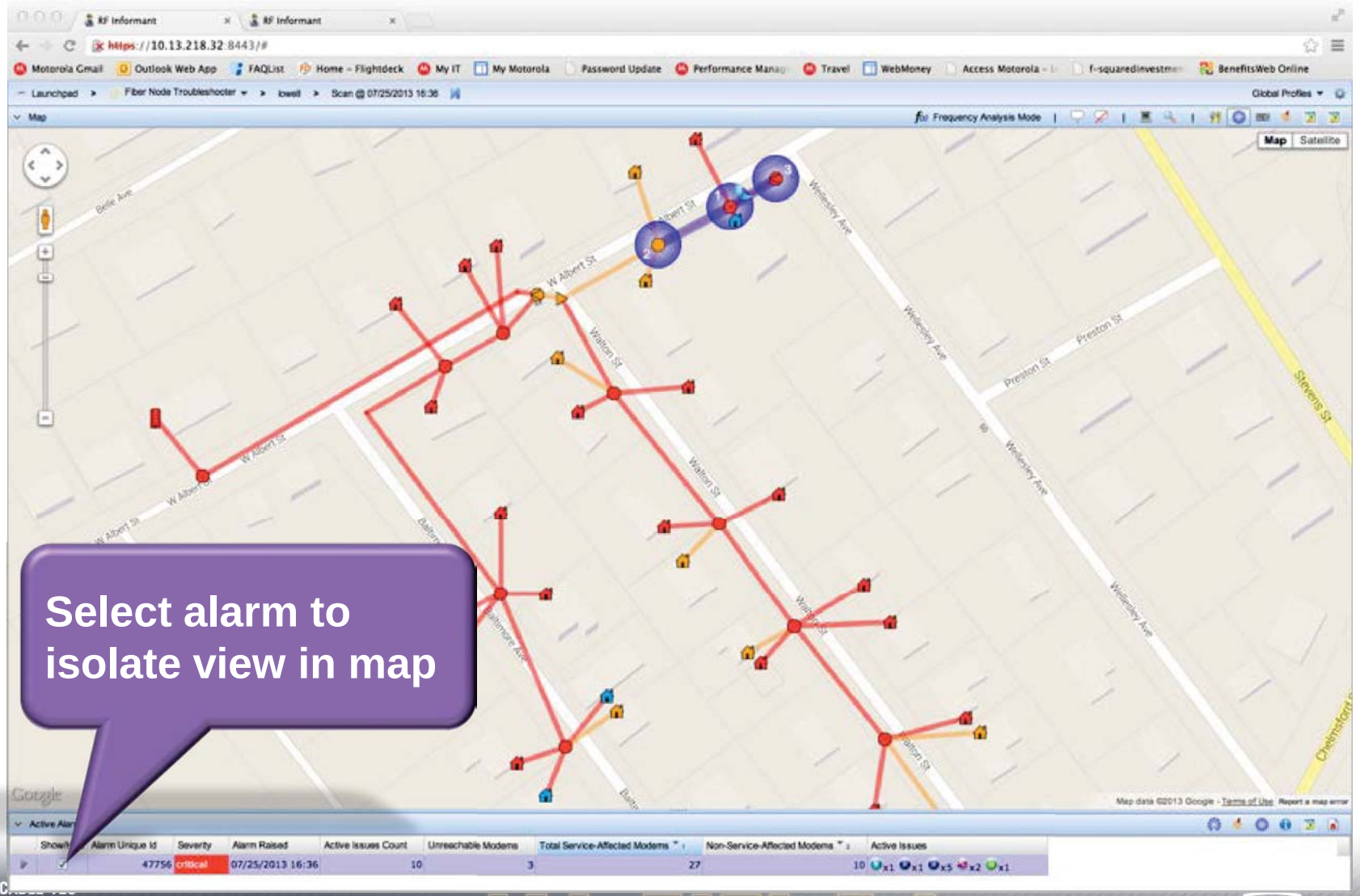

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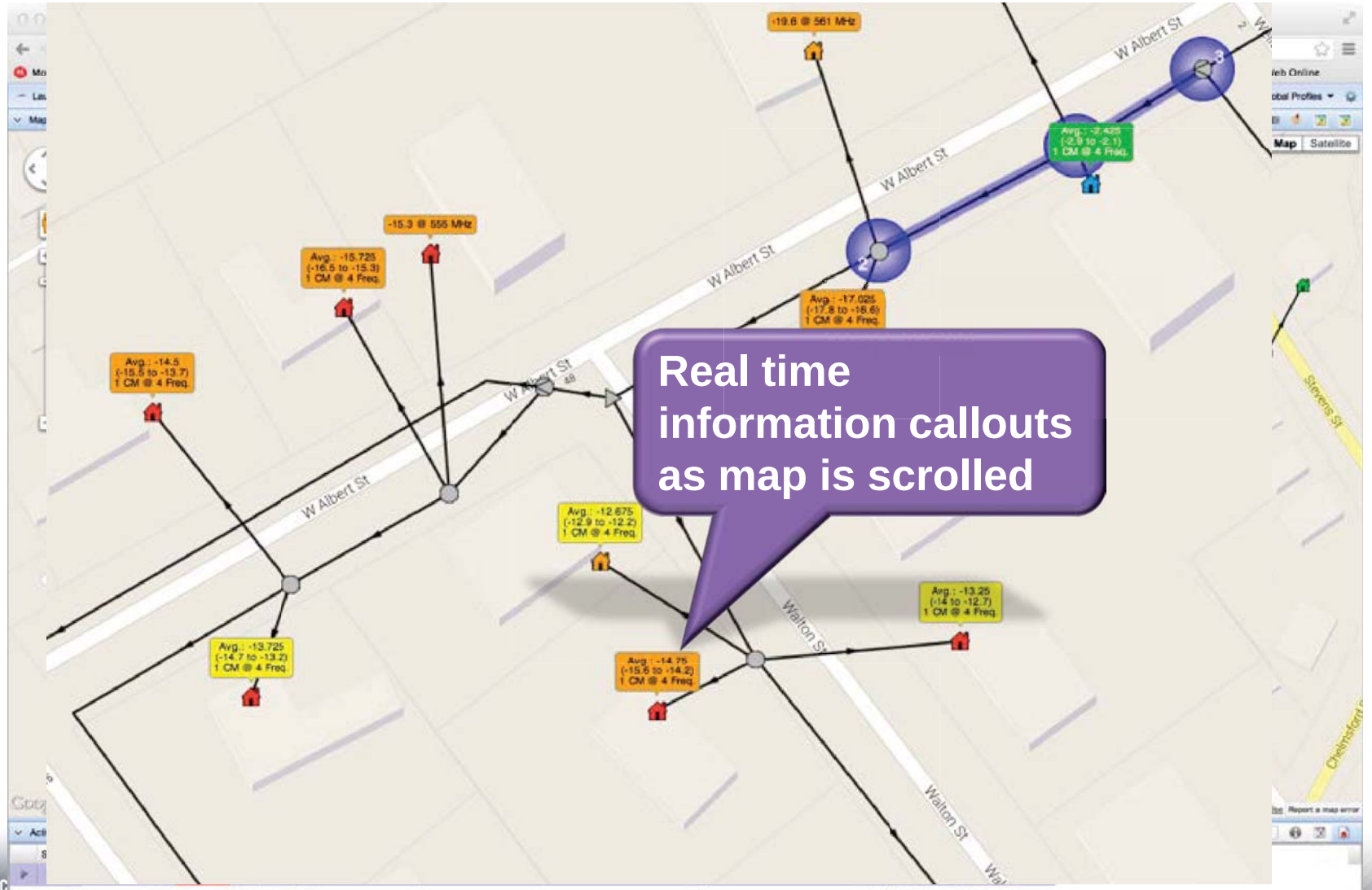

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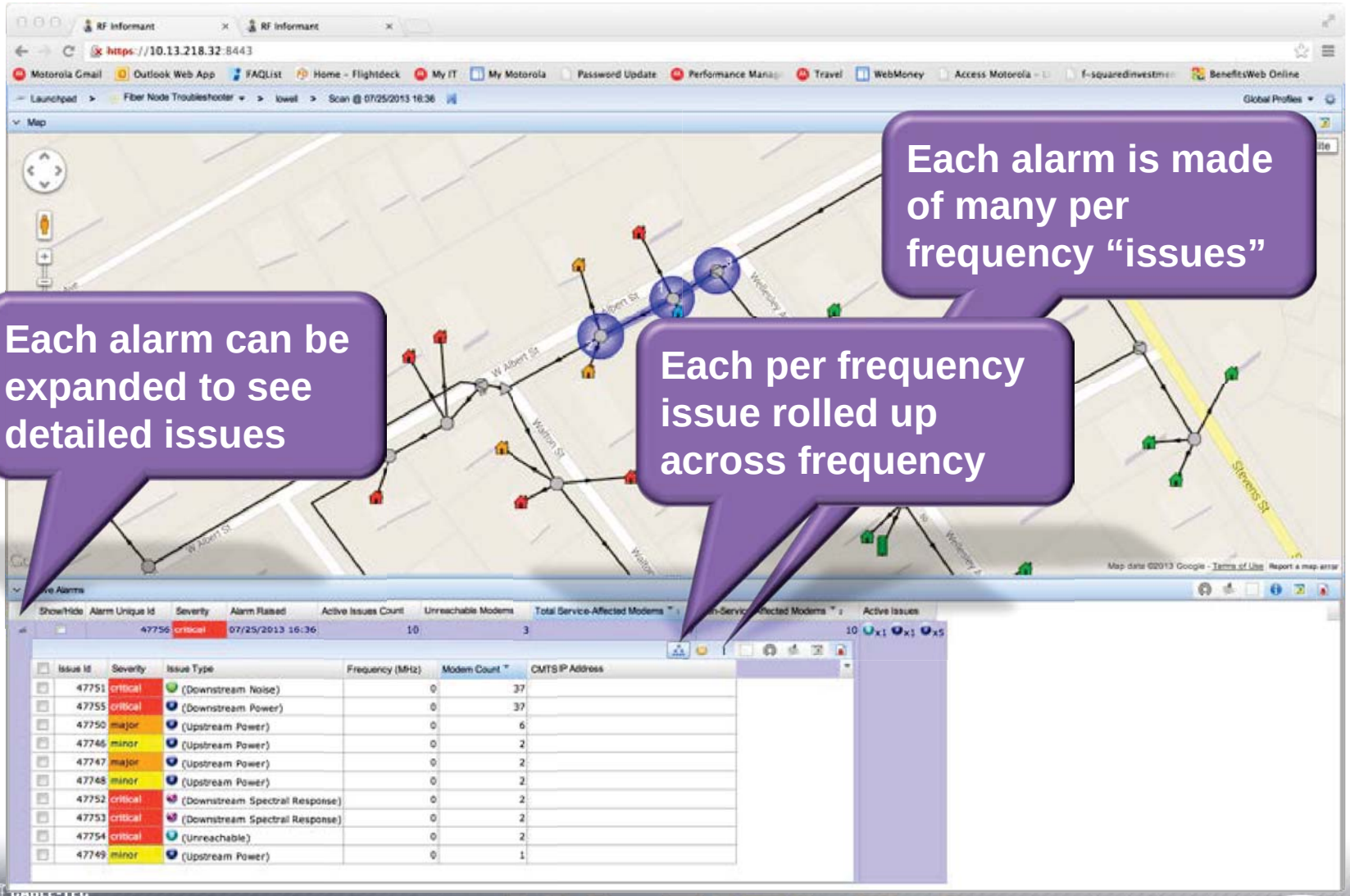
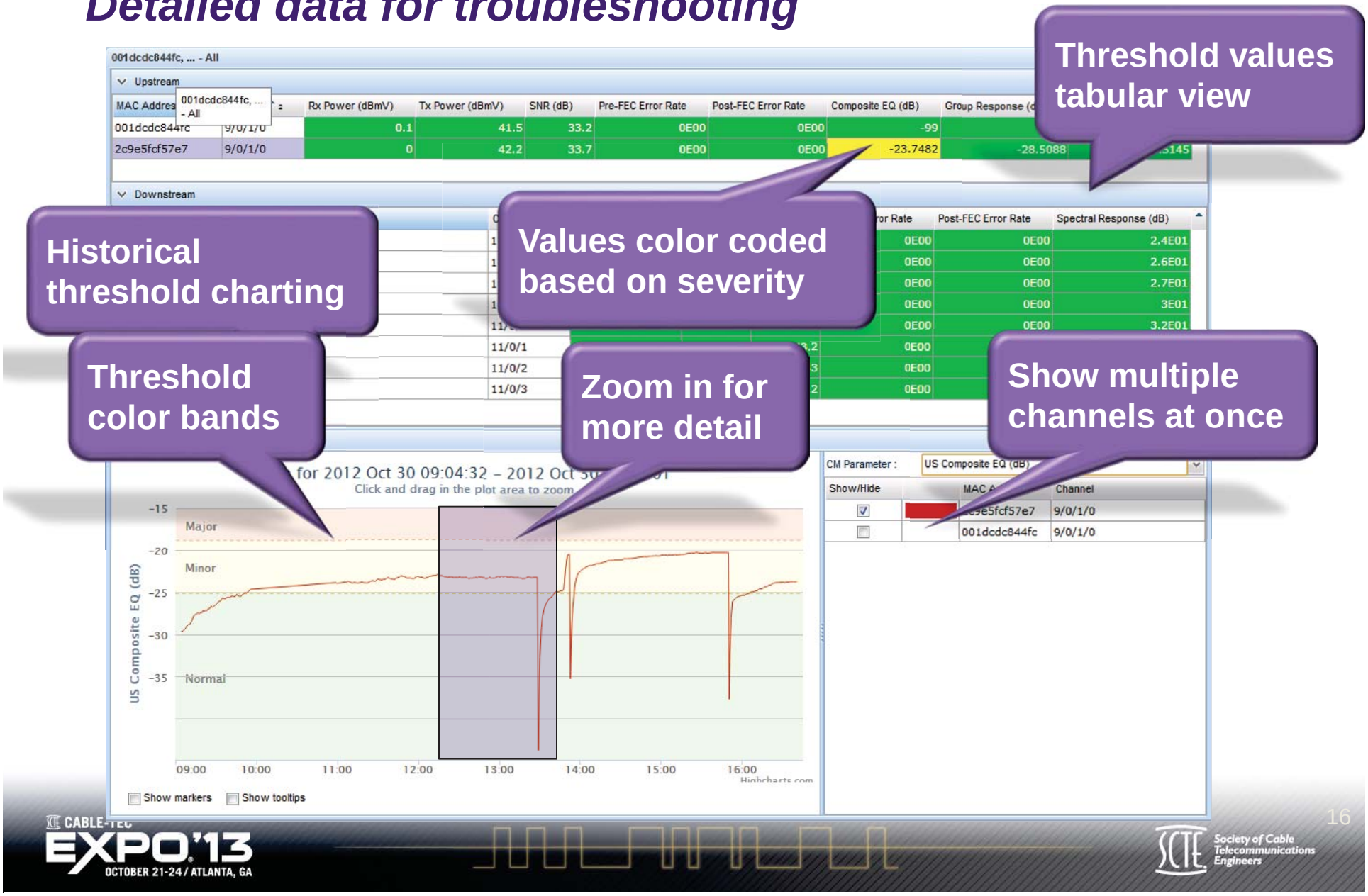


Example Use Case

Detailed data for troubleshooting



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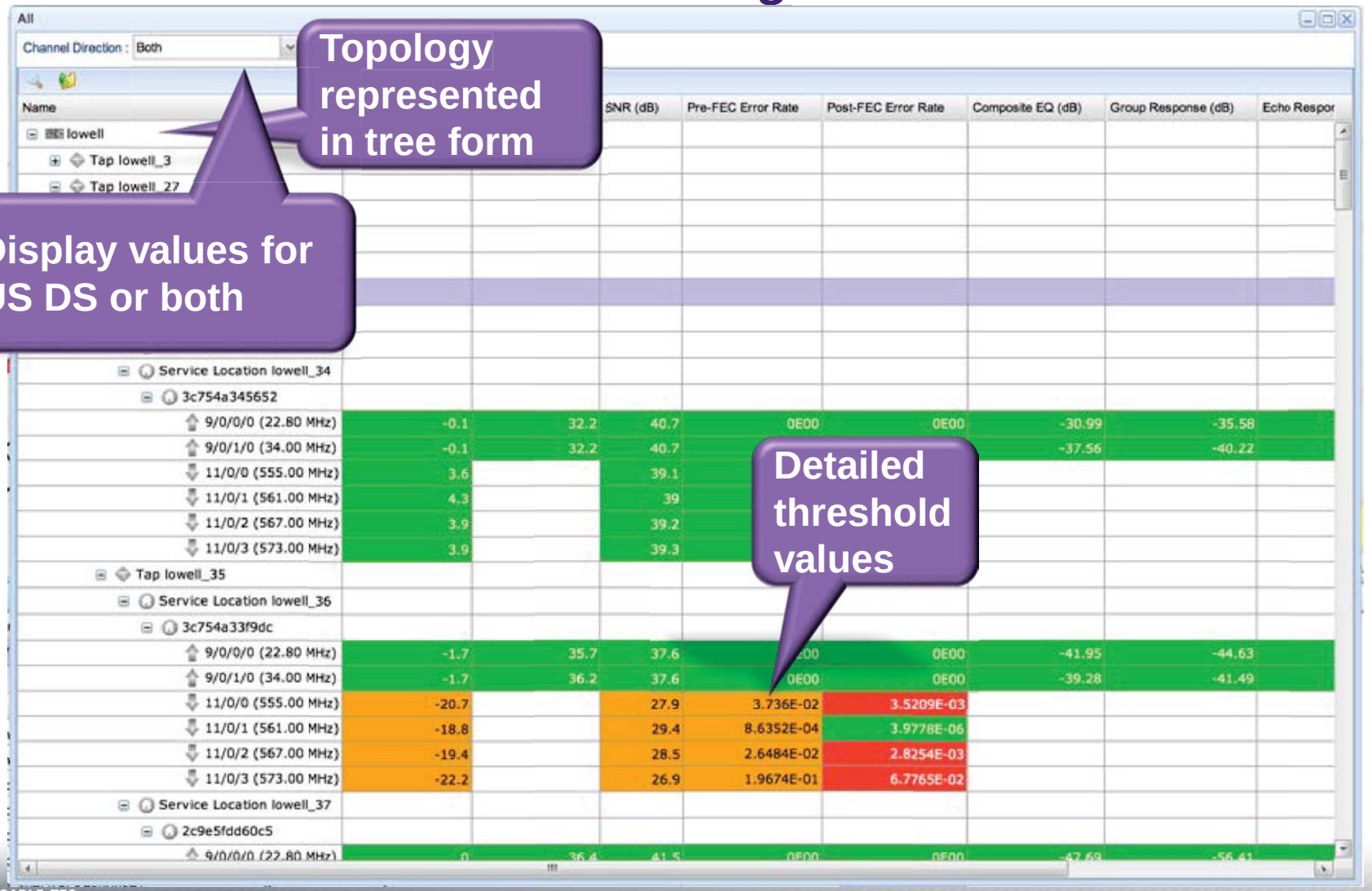

Buckeye Cable Case Study

Analytics system operation in a live cable system

- Initially across 11 problematic serving areas
- Later, 12th RFoG serving area also added
- Over 3000 customers

Diverse equipment from multiple manufacturers

- Two CMTS's, each from a different manufacturer
- Multiple data modem and STB types

Data integration from third party mapping and data collection systems

- Easy import of network topology and customer locations

Re-examination of existing trouble tickets w/ NTFs

- Existing tools reporting system as "OK"

Examples of Problems Detected/Resolved

1. Customer complaints of poor data speeds
   - Other tools showed excellent CNR, RF levels, flatness, “no problem”
   - Analytics solution detected poor FEC in return path and traced problem to group delay on highest DOCSIS channel
     - Channel moved away from filter skirt – Problem Resolved
2. Downstream FEC issue on a number of customers in one area
   - Customer receive RF levels reported within acceptable range
   - Analytics solution pointed to RF amplifier as suspected problem source, even though RF levels were OK
     - Suspect RF Amp module replaced – Problem resolved

Examples of Problems Detected/Resolved

3. Complaints of poor data speeds in some MDUs
   - Analytics solution detected signal levels at high end of design range, pointing to leg on optical node serving MDUs
     - Leg swept, RF level lowered – Problem Resolved
4. Downstream throughput problem for one premium data customer
   - Two of eight bonded channels showed poor DS FEC
   - Some neighbors also complaining of problems
   - Previously modem changed; drop cable visually examined but no trouble found
   - iAnalytics solution pointed to drop cable as problem source
     - Drop cable carefully reexamined. Hand made, unshielded splice found behind strain relief. Proper splice made.
     - Problem Resolved

Quantifying Solution Benefits

Initial reduction in truck rolls probably not a valid measure

- Tested system will identify previously undiscovered problems requiring proactive remediation

Measures relative to truck rolls

- Measure average # of truck rolls to resolve problem
- Measure MTTR and time per truck roll

Measures relative to economic impact

- Reduction in cable modems, STBs unnecessarily replaced
- Reduction in drop cables unnecessarily replaced
- Measure customer satisfaction and customer data penetration trends – possible new marketing programs
- Determine if periodic system sweeps can be eliminated

Conclusions

Maintaining cable network performance is becoming more challenging

- Higher performance demands; more forms of interference

Existing tools provide massive amounts of data; but typically lack correlation to specific network problem

- Too much data to digest, even for RF experts

Analytics can simplify network maintenance

- Correlation of data to network and customer locations
- Conclusions as to most likely causes
- Enablement of truly Proactive Maintenance
- Performance of the tested system has been demonstrated in a demanding real network environment

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John Holobinko
email: jholobinko@comcast.net
David Bowler
email: david.bowler@arrisi.com