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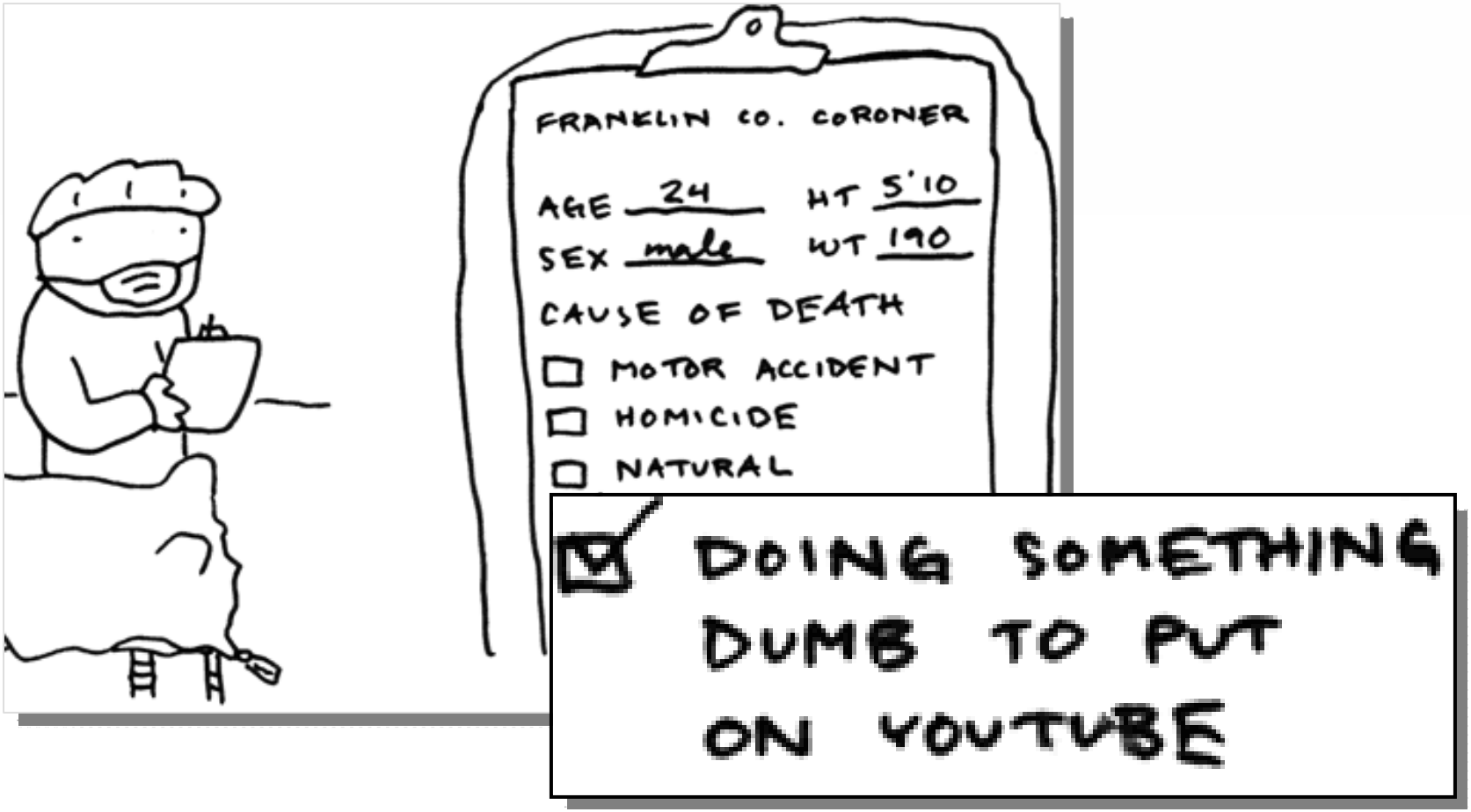
IT for a Sustainable and Secure World

Is Your Geodatabase Ready for Smart Grid?

Ed Blair

Telvent Utility Group

You Can't Have a Smart Grid with Dumb Data, Jeffery R. Meyers



Scope of the Discussion

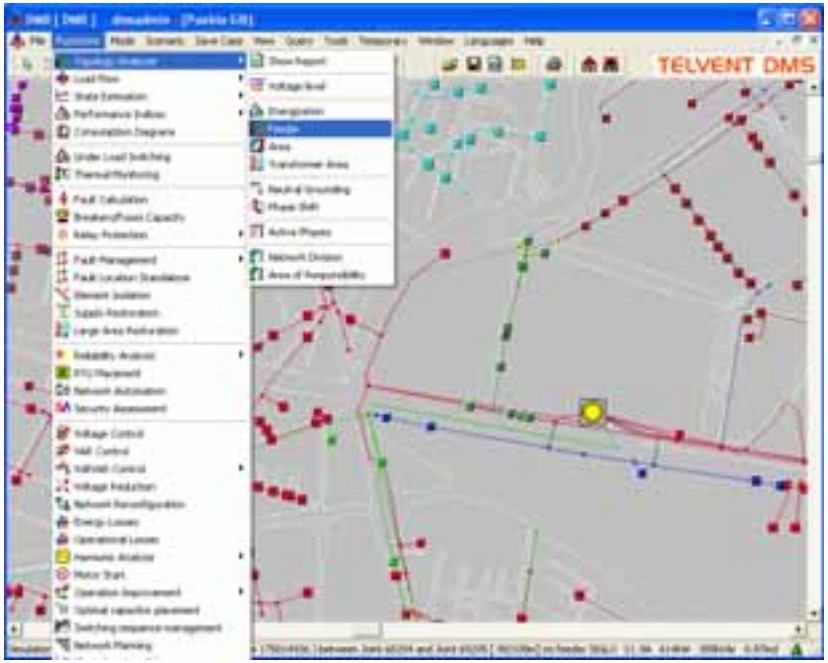
- A “Geodatabase-centric” view of Smart Grid technologies
  - Smart Grid has many moving parts.
  - Smart Grid means many things to many people.
- How your Geodatabase can support SG apps
- Things you may need to consider

Three Key Things

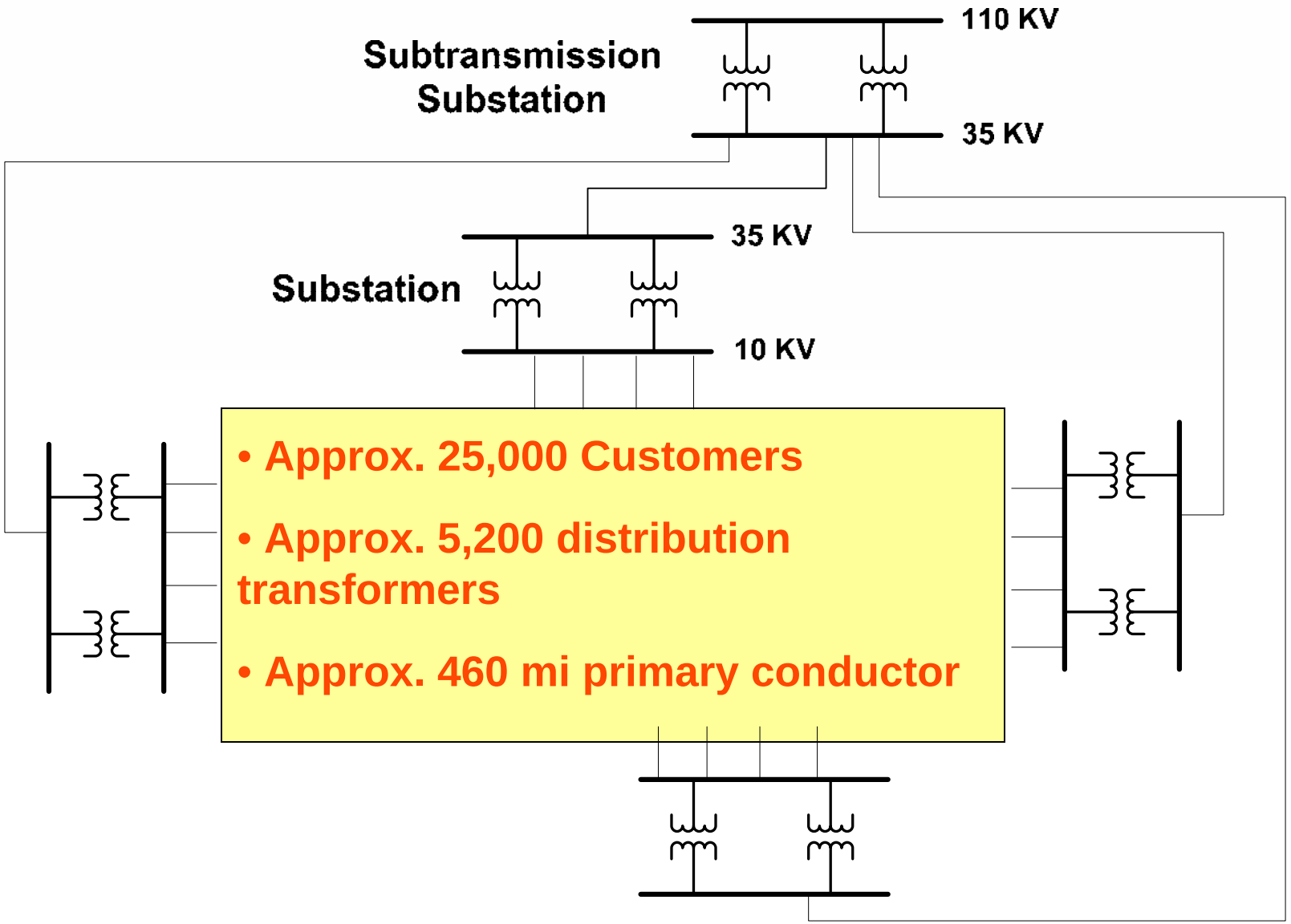
- Your GIS can add more business value by supporting Smart Grid than nearly any other way.
  - DMS in particular
- You may have preparation to do… but it may not be backbreaking.
- ArcGIS has the right tools for this job.

What IS a DMS?

- Suite of real time and study mode applications to support online SCADA operations to:
  - Dynamic network modeling and control
  - Reduce losses and operations costs
  - Improve quality of supply to customers

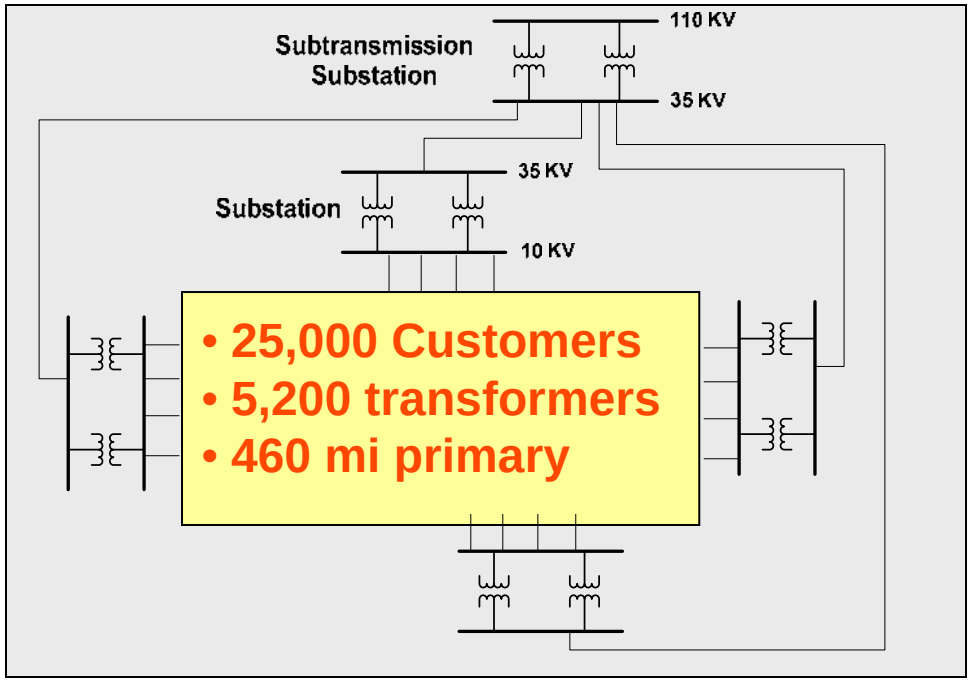


DMS Benefits Example



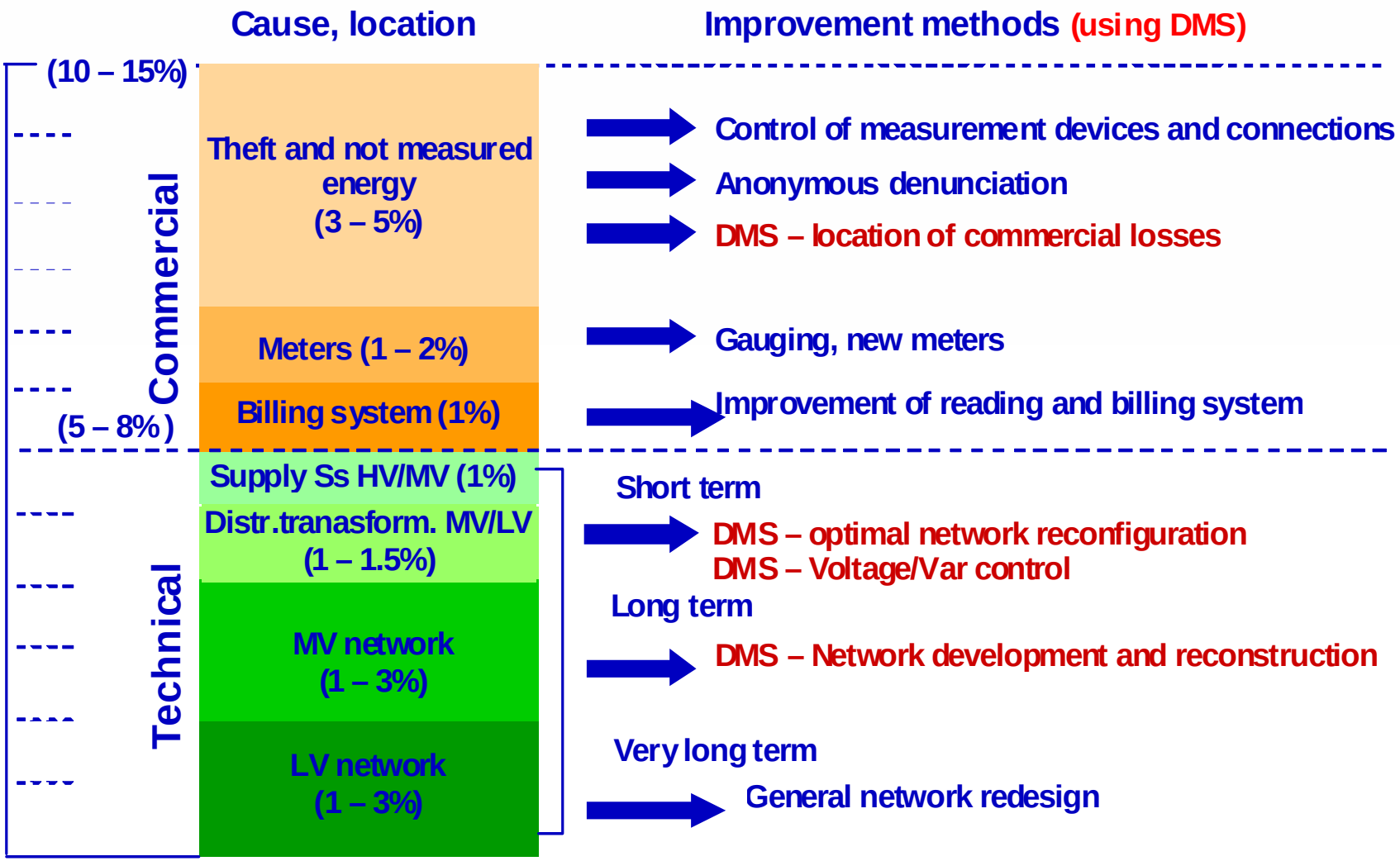
DMS Benefits Example

266,400 MWh	**Annual Electricity Supplied (*)**
$60/MWh	**Per unit supply cost**
$15,984,000	**Total supply cost**
12.5%	**Total losses (btw 10% - 15%)**
$1,998,000	



(*) Based on DOE estimate of 888 KWh usage per residential customer per month

DMS Benefits Example



DMS Benefits Example

Benefit from Reduction of Losses

266,400 MWh	266,400 MWh	Annual Supplied
$60/MWh	$60/MWh	Per unit supply cost
$15,984,000	$15,984,000	Total supply cost
12.5%	11.8%	Total losses
$1,998,000	$1,886,112	$111,888 Saving

Reduction of Technical and Commercial Losses

- Optimal Network Configuration
- Voltage Control
- Var Control (with controllable capacitor banks)
- Reduction of commercial losses (theft)
- Reduction in losses during outage events

0.7%*

* Dr Nenad Katic, Telvent DMS Group

DMS Benefits Example

Overall Benefits

- **Overall savings as a percent of annual energy supply costs**

Application	Savings *
Reduction in Power Losses	0.7%
Reduction in Operational Costs – if utility pays penalties for customer outages	4.5%
Reduction in Network Development	1.0%
Increase from Improved Power Quality	1.0%

* Dr. Nenad Katic, Telvent DMS Group

What does a DMS expect of the network?

"Accurate network data is crucial to obtain good performances and results very close to reality."

Di Lembo, Petroni, Noce, "Reduction of Power Losses and CO2 Emissions," CIRED, 20th International Conference on Electricity Distribution, Prague, 8-11 June 2009

What does a DMS expect of the network?

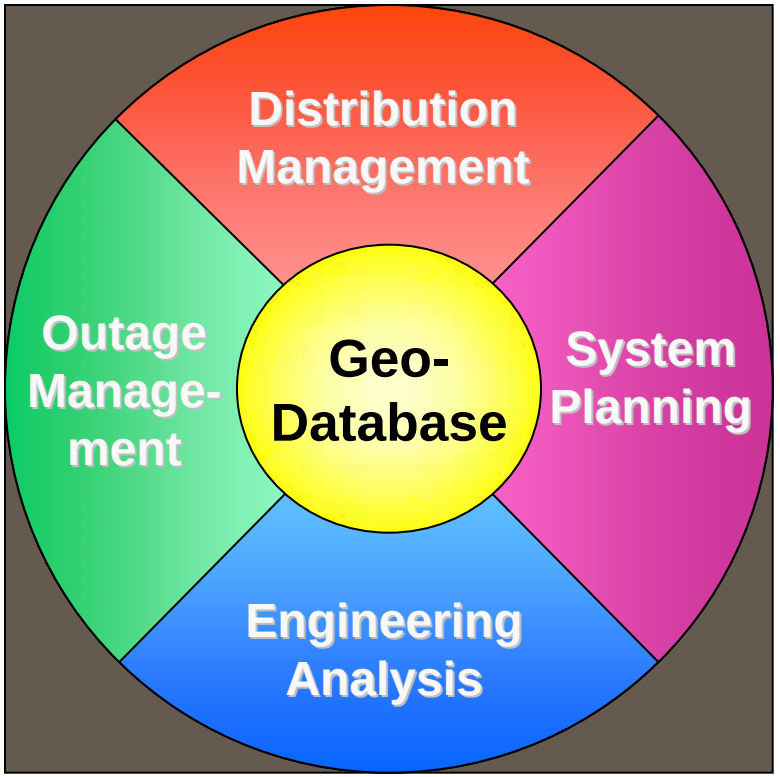
"… to perform network calculations such as 'State Estimation' or 'Load Flow' quickly and precisely many inputs are needed;

- The precise Network Topology
- The electrical characteristics of elements (transformers, conductors, switches,…)
- Basic measures from the field
- Reliable evaluation of customers' load and generation"

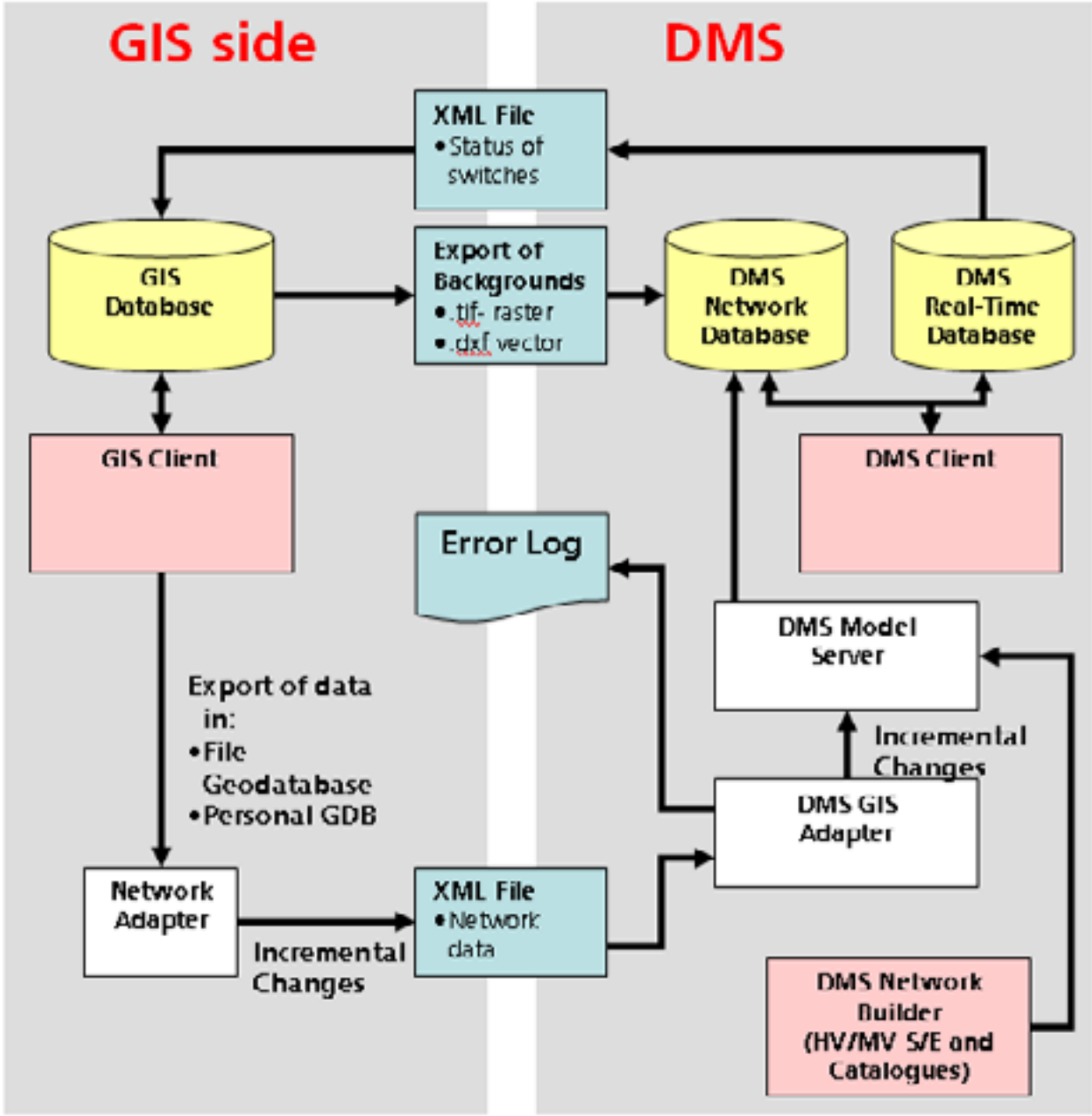
Di Lembo, Petroni, Noce, *op cit*.

Role of the Geodatabase in Smart Grid Solutions

- A “Smart Grid” application may:
  - Operate directly on the Geodatabase
  - Exchange data with the Geodatabase
  - Rely on data maintained in the Geodatabase for an authoritative network representation
    - Conveyed via a standard definition such as Multispeak or CIM



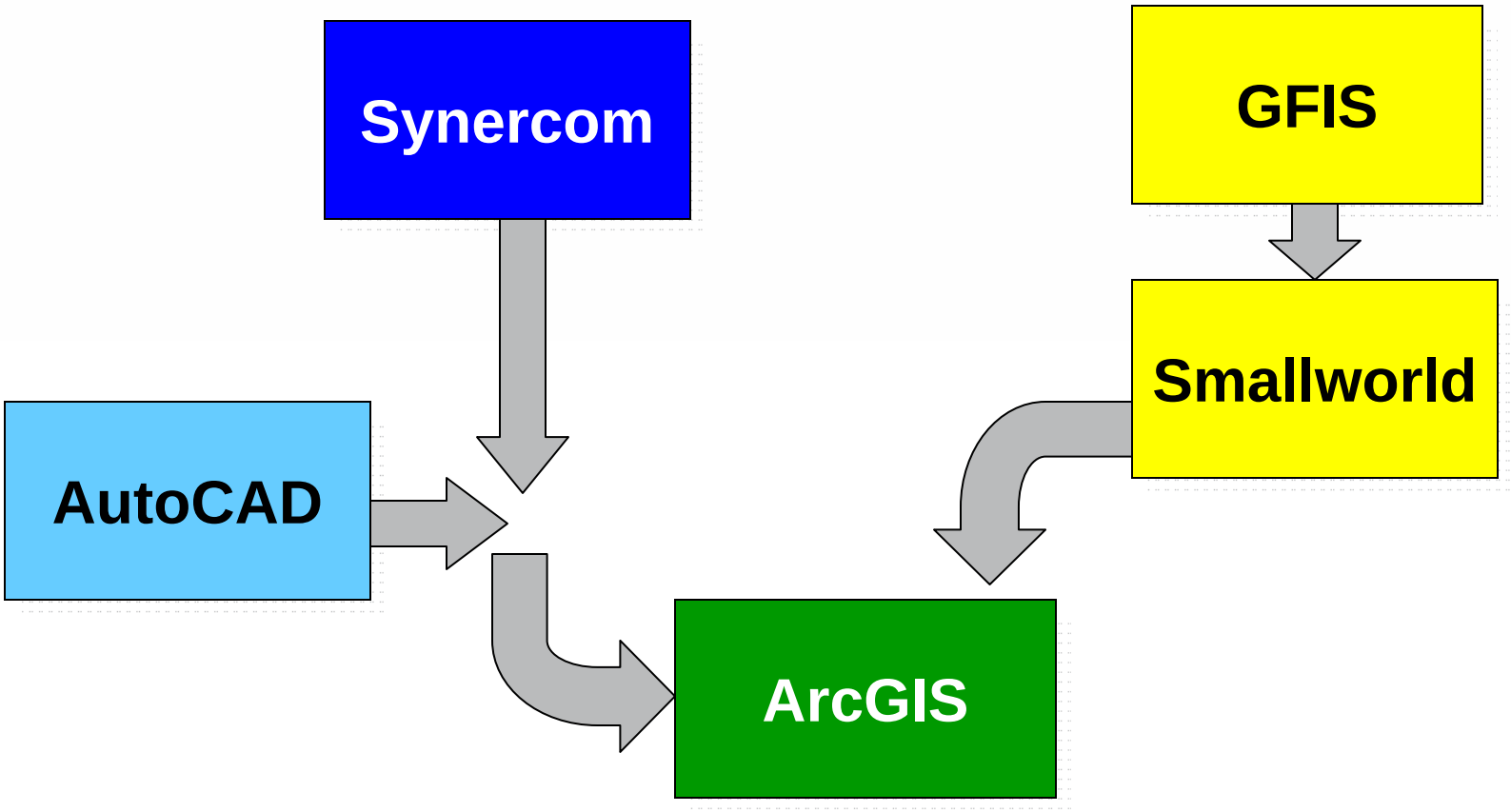
Conceptual GIS-DMS Integration Workflow



Data Management Philosophies

Geodatabase	SG Apps
▪ Source data may be of varying quality ▪ Powerful tools for validation and cleanup	▪ Source data expected to be correct from the start ▪ If not correct, not loaded

Your Geodatabase May Be of a Rich and Diverse Heritage



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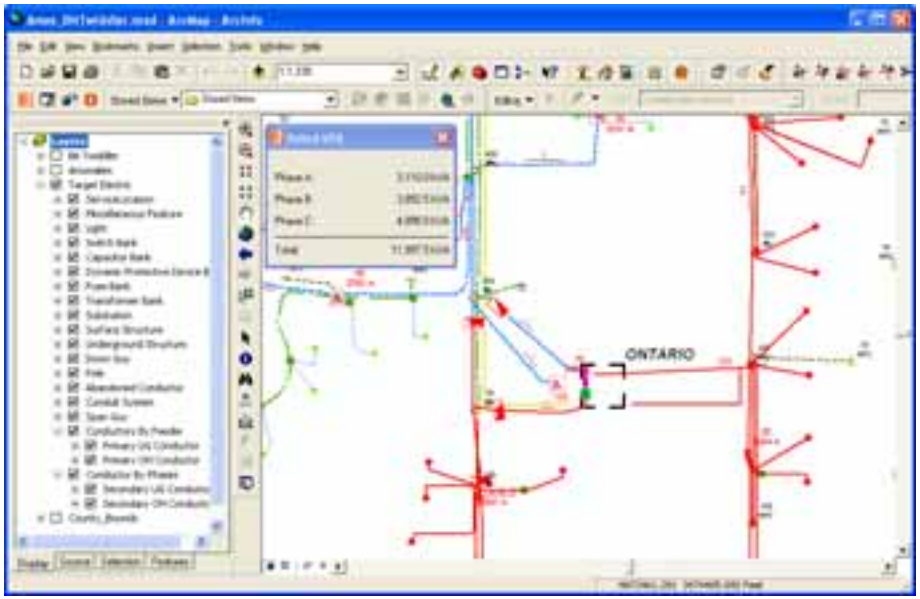
Geodatabase Content

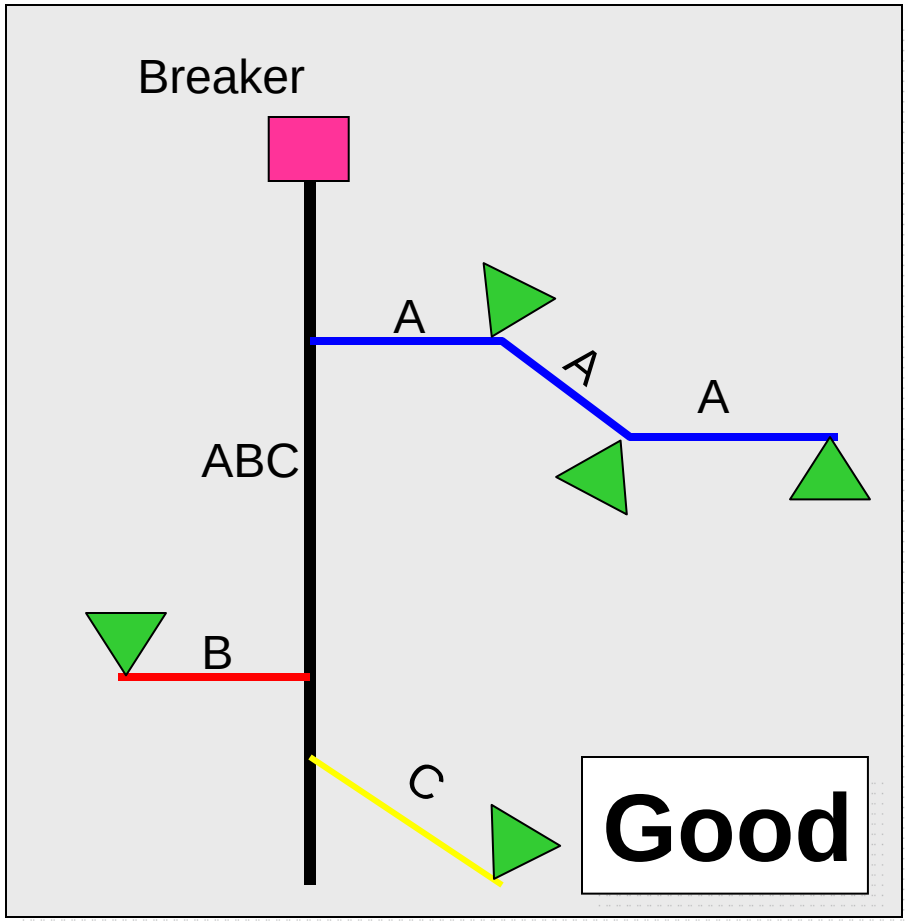
What Does the SG App Expect?

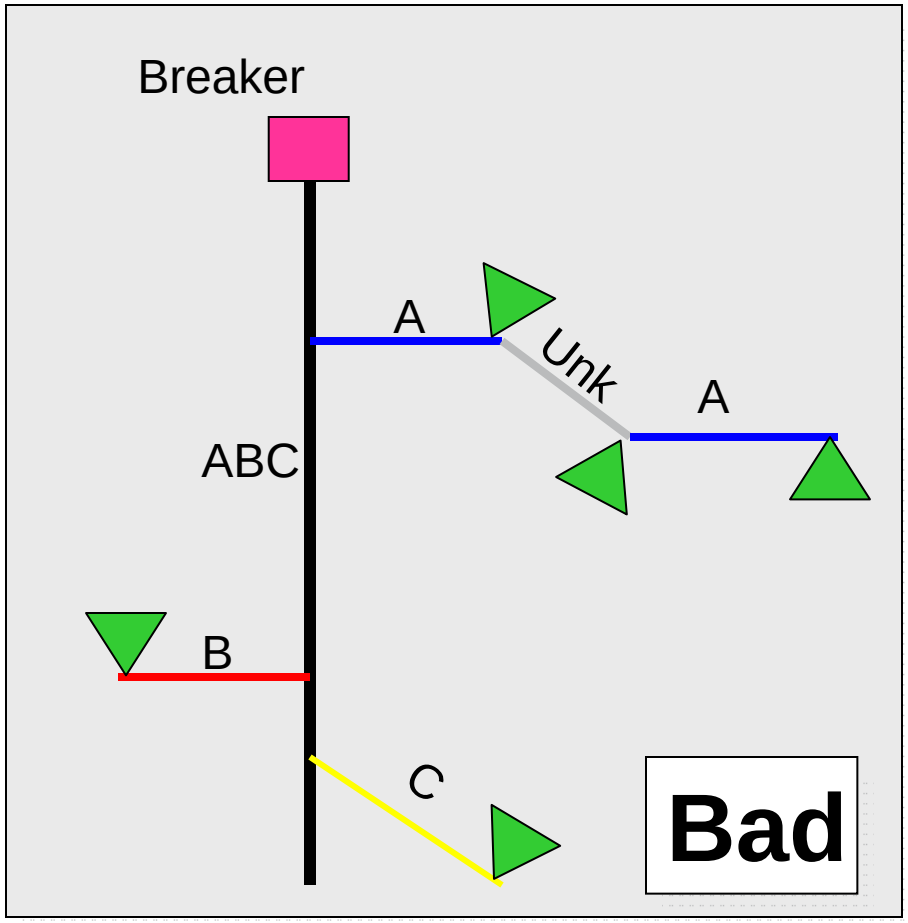
Importance of the Geometric Network

- There must be a geometric network and with connectivity that's an accurate representation.
  - You can get business value from a Geodatabase without a complete or accurate network.
  - You can't get value from supporting Smart Grid apps without one.



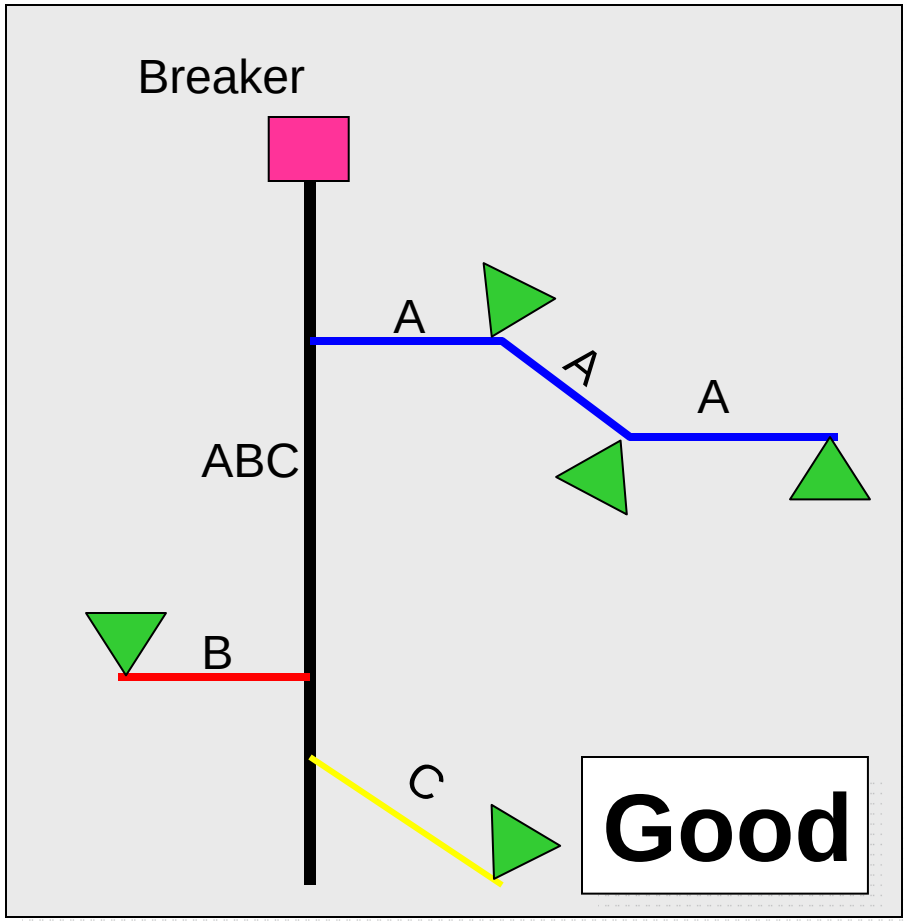
Phasing

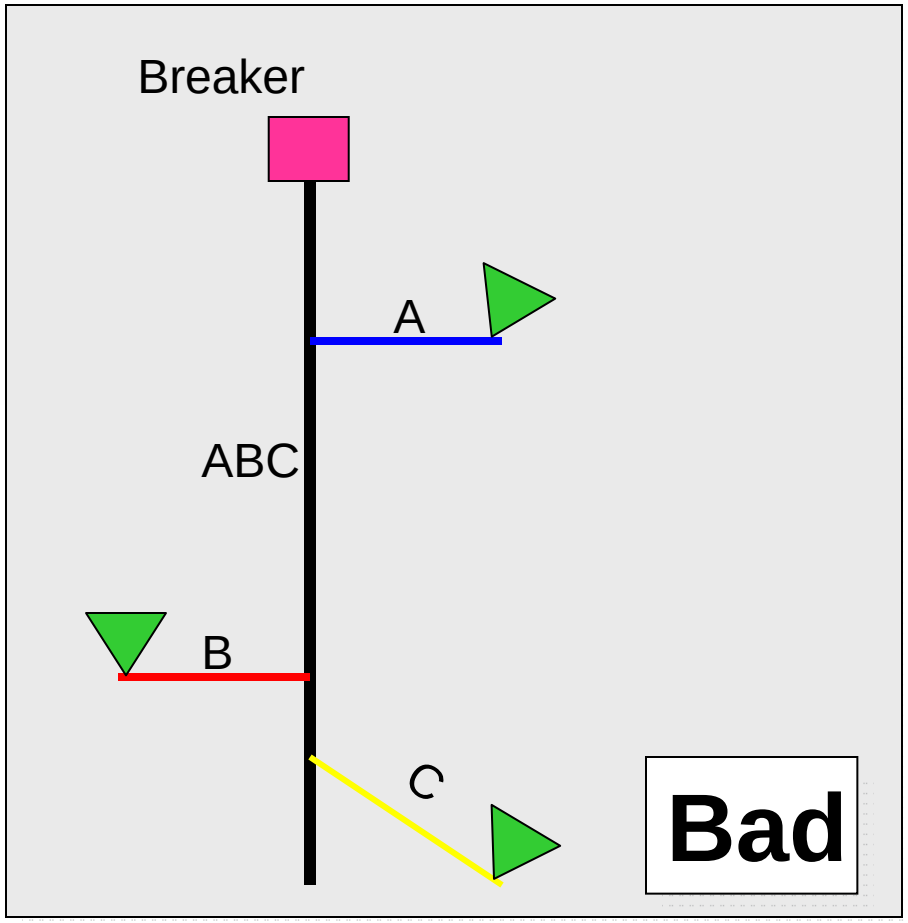




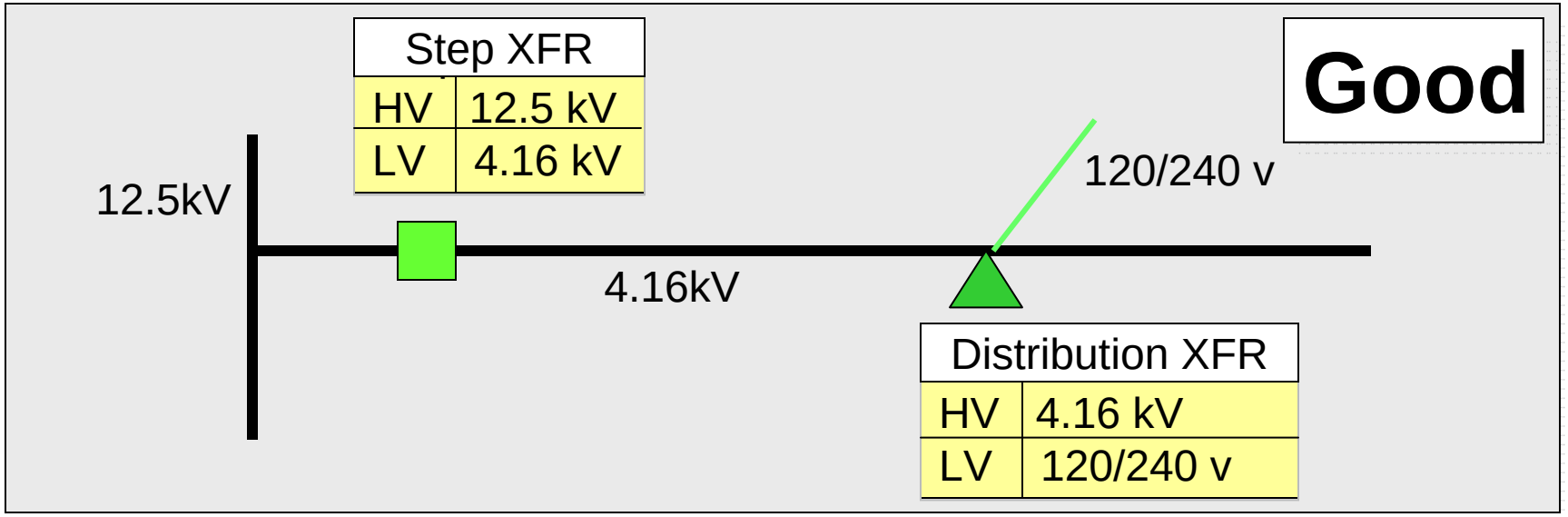
Conductor record phases in sync with the feature phase

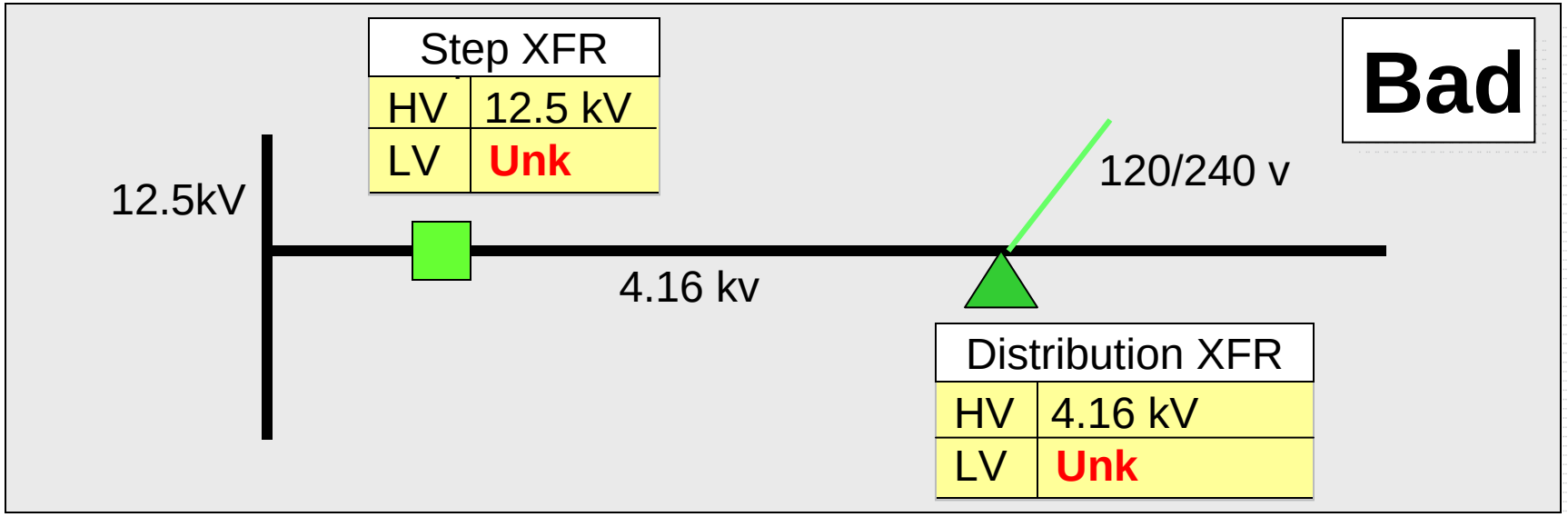
Phasing





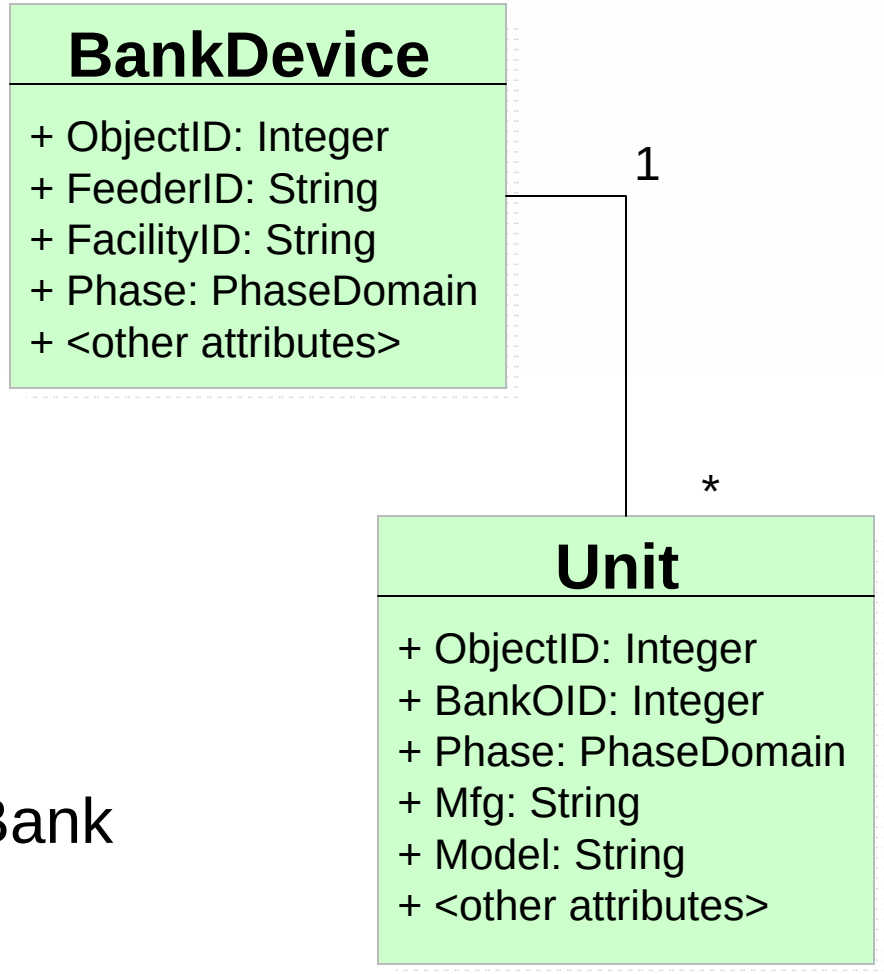
Voltage Consistency





Equipment Catalog

GIS Model



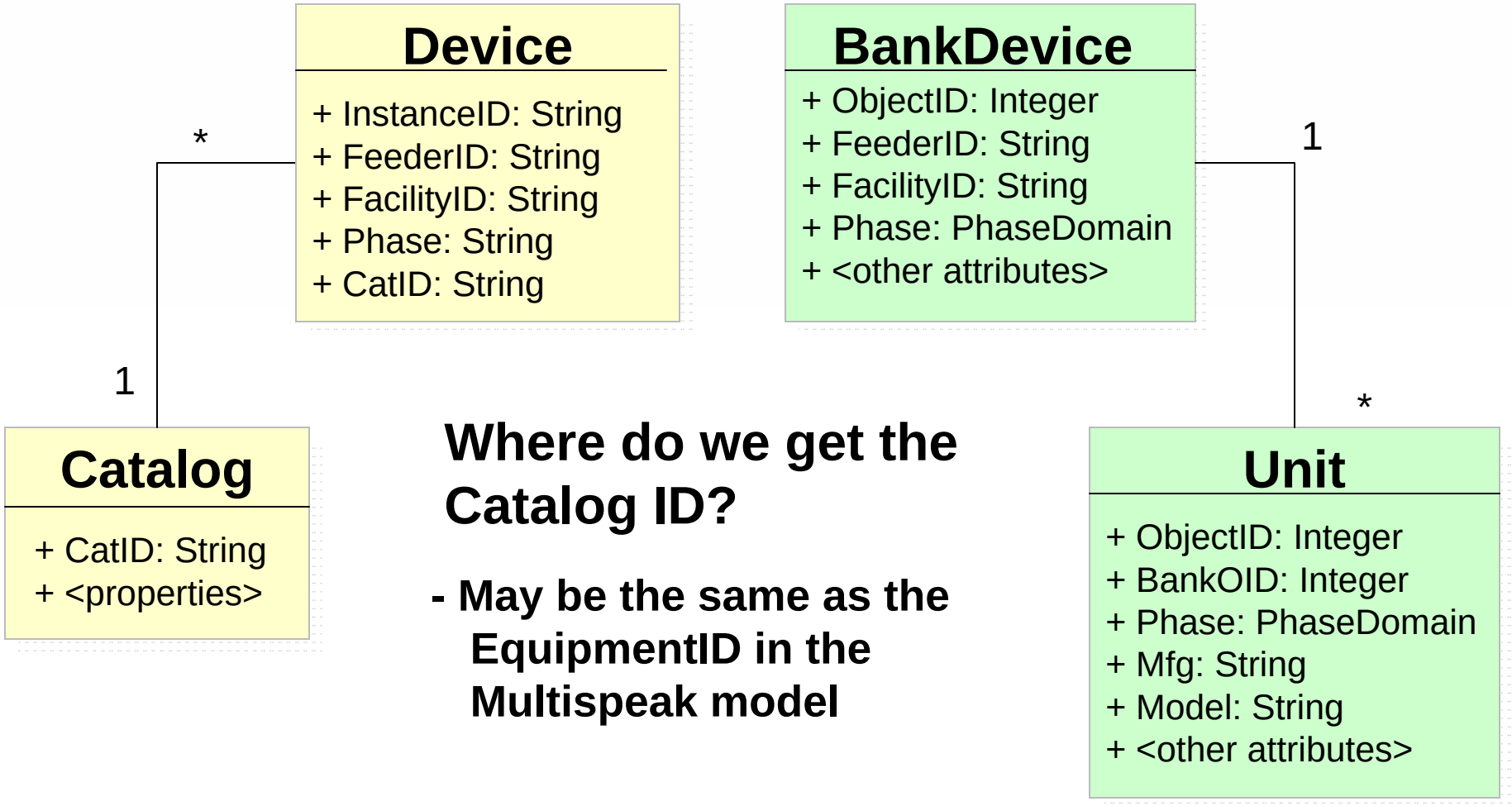
Examples:

- TransformerBank
- FuseBank
- SwitchBank
- CapacitorBank
- DynamicProtectiveDeviceBank

Equipment Catalog

DMS Model

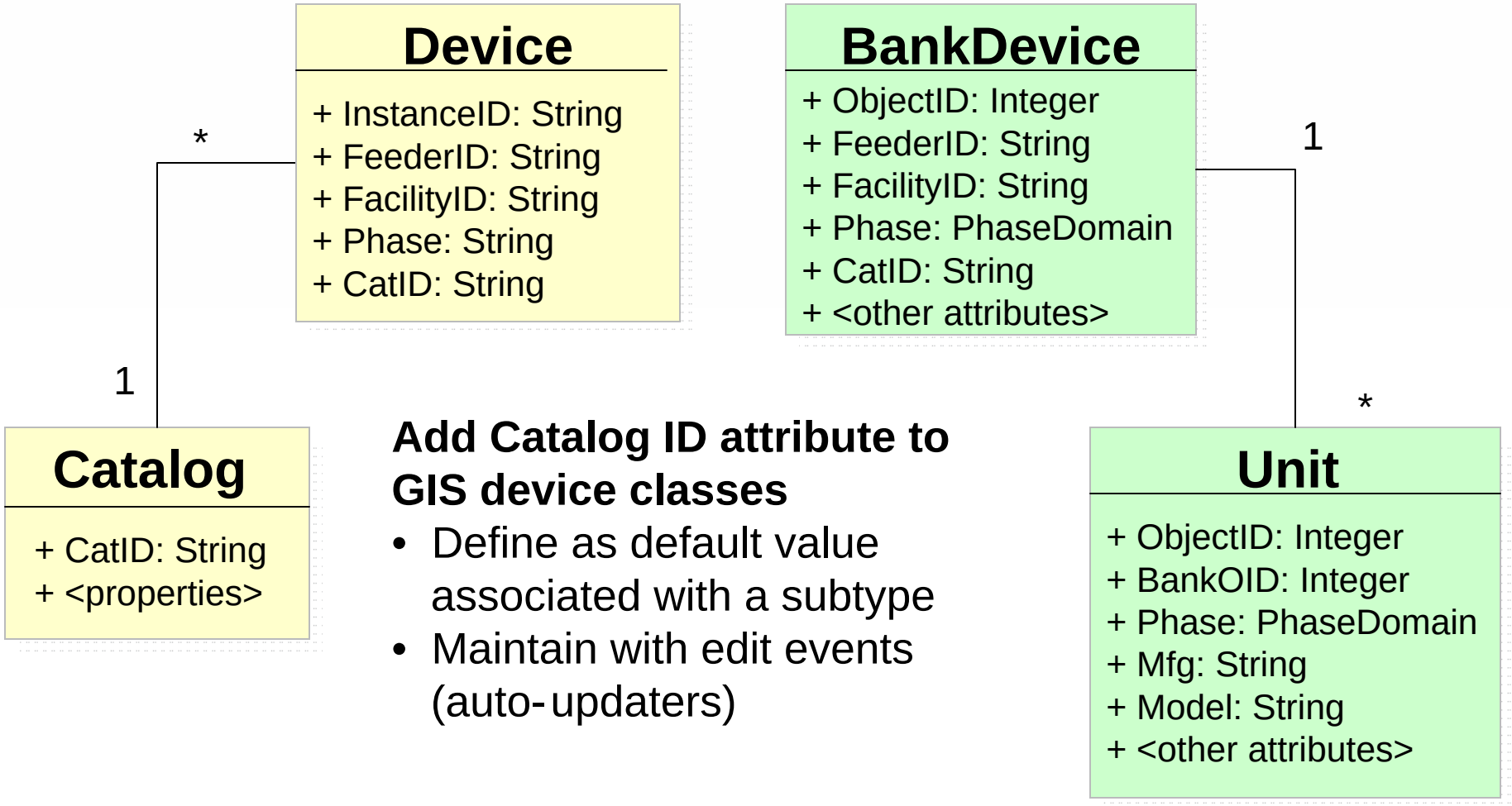
GIS Model



Catalog ID – Option 1

DMS Model

GIS Model



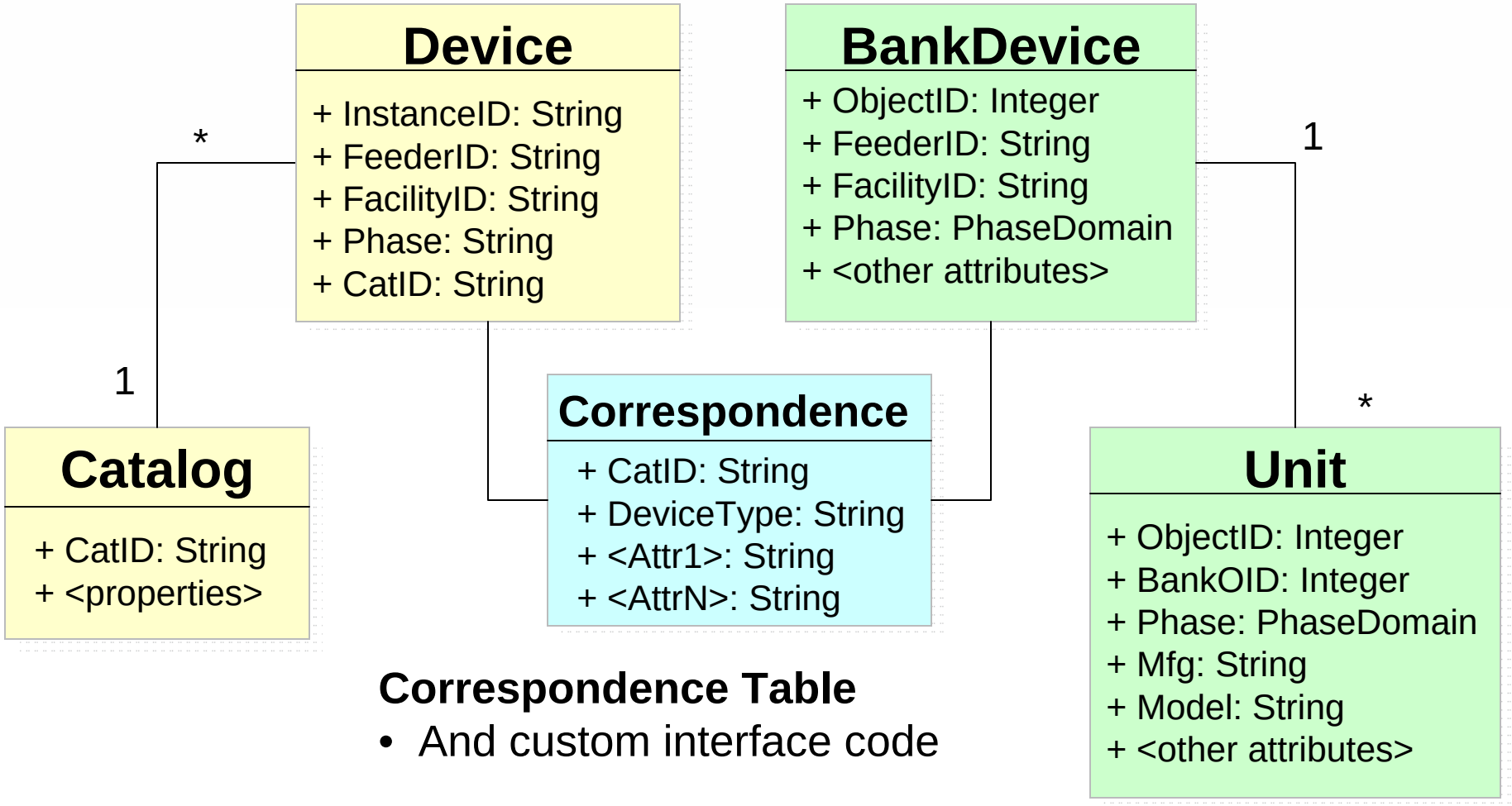
Add Catalog ID attribute to GIS device classes

- Define as default value associated with a subtype
- Maintain with edit events (auto-updaters)

Catalog ID – Option 2

DMS Model

GIS Model

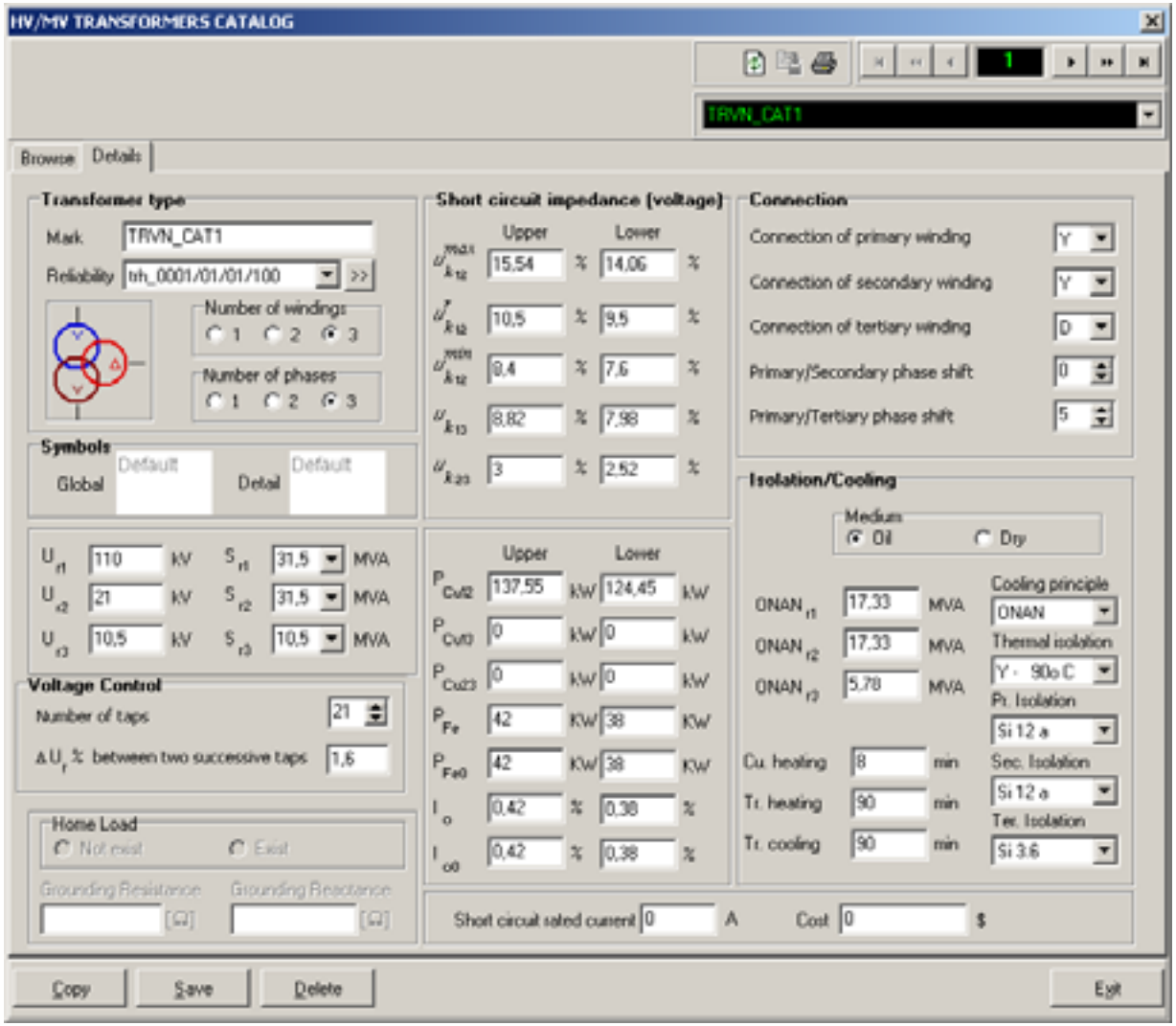


Correspondence Table

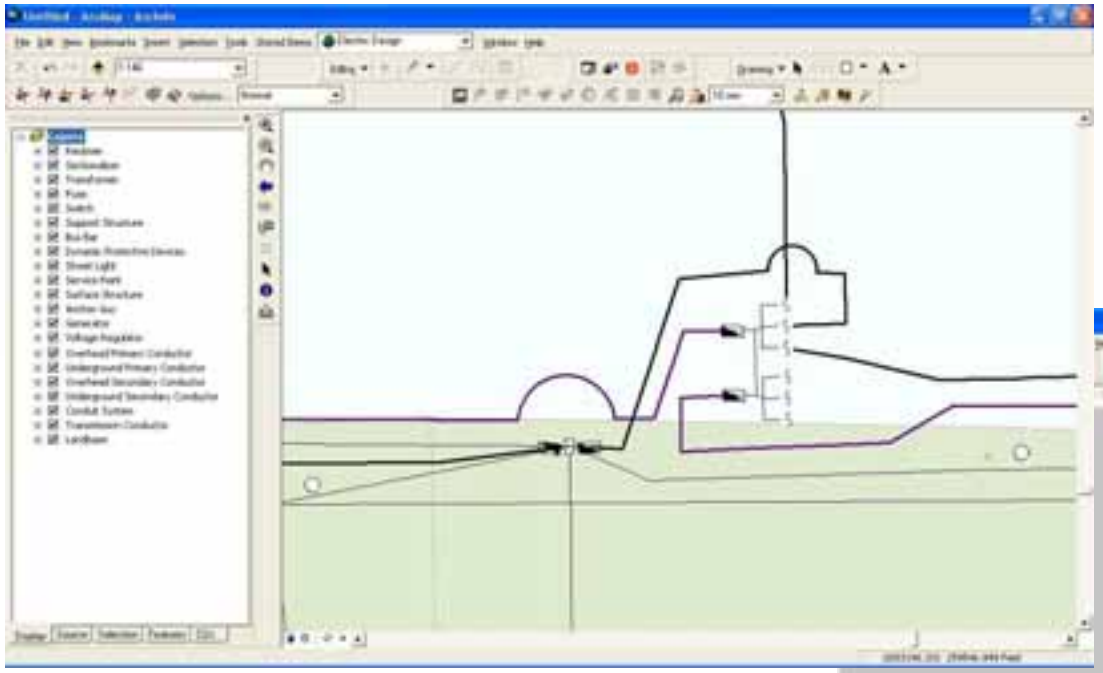
- And custom interface code

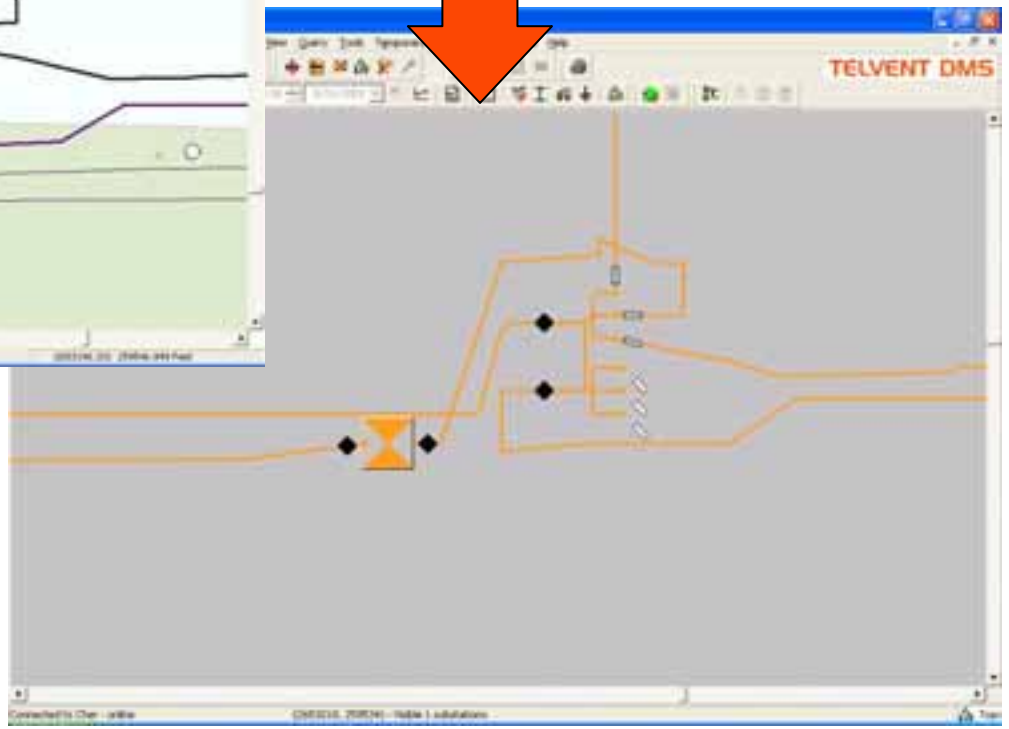
Transformer Catalog Entry Example

Catalog Entry Definition for Overhead Transformer

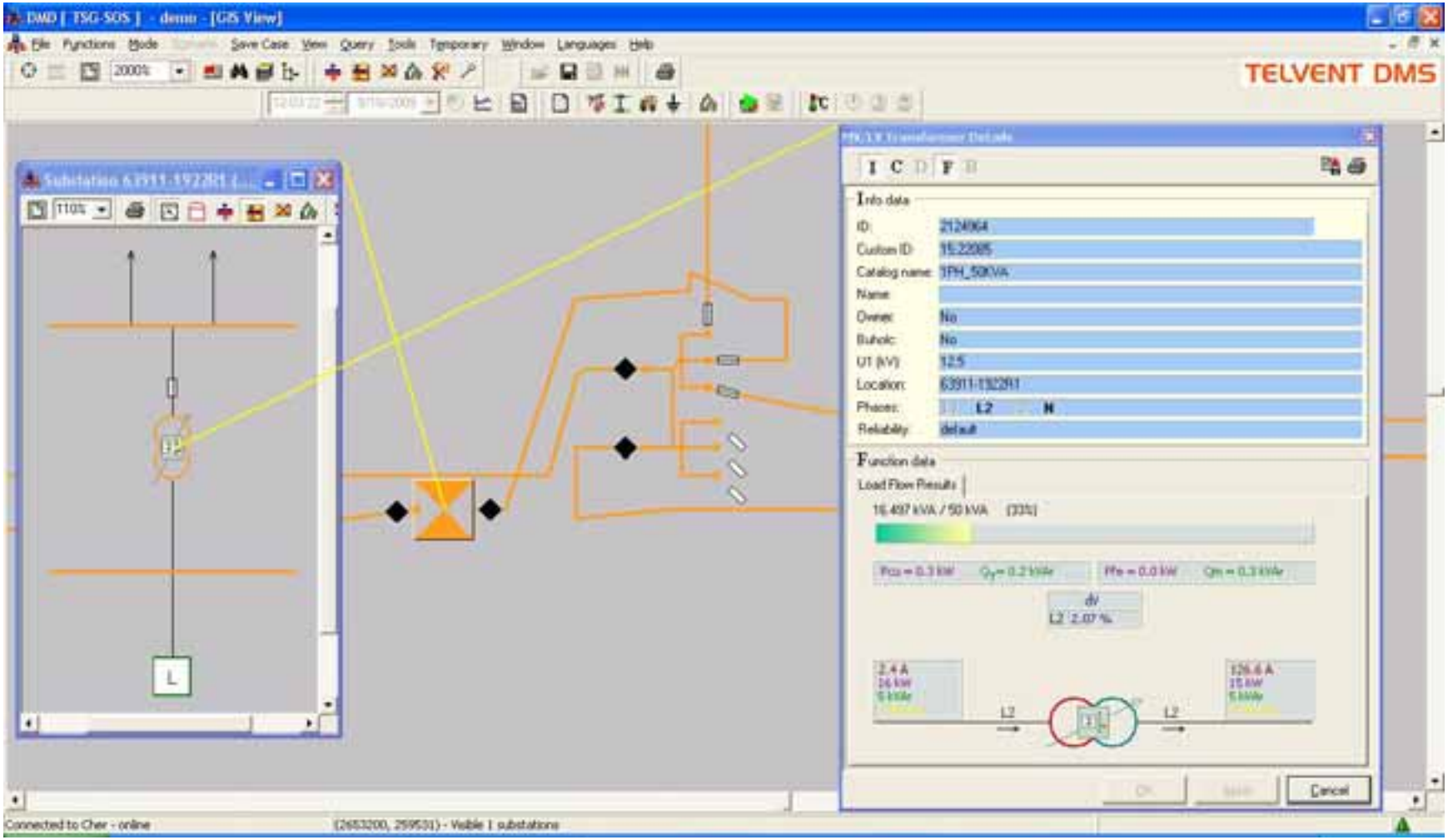


GIS/DMS Representations



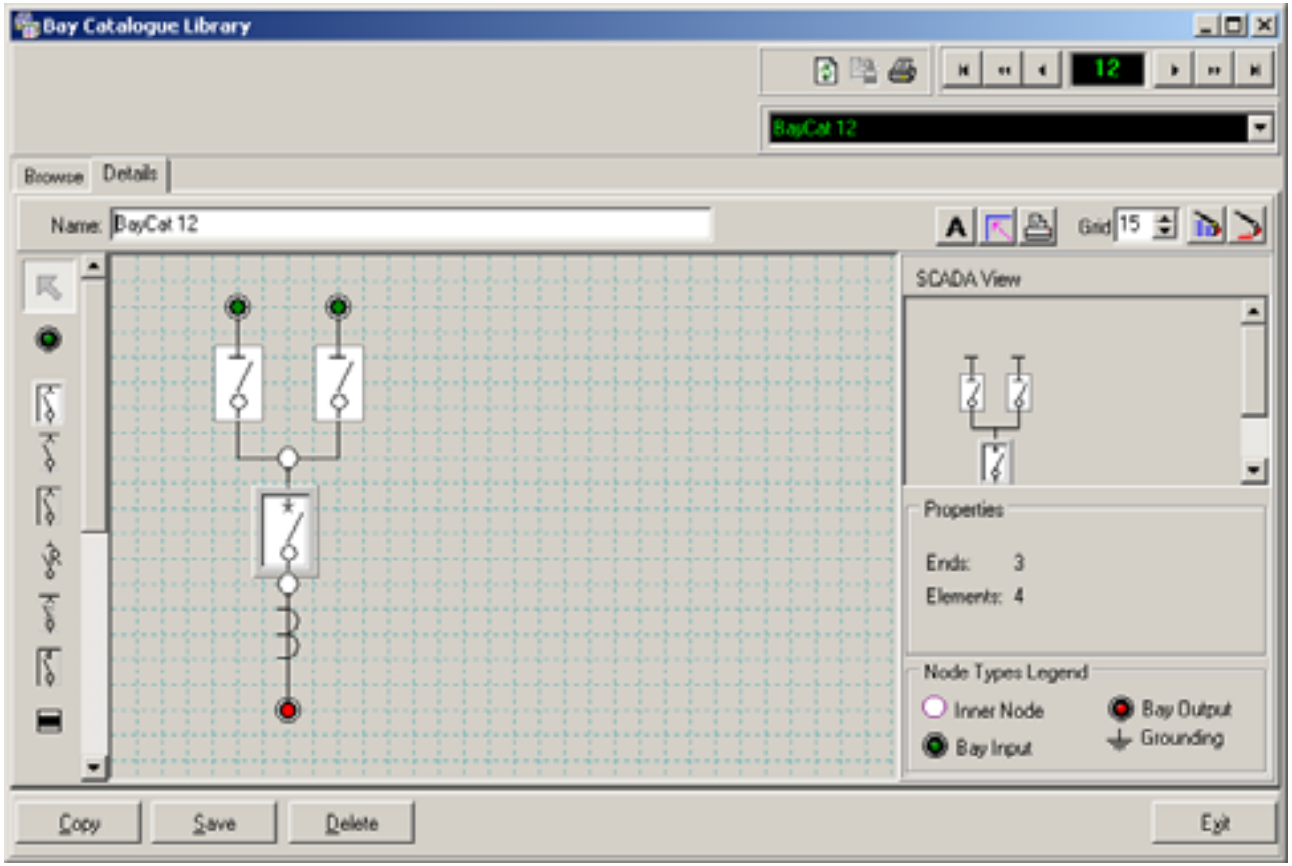


With Detail from Catalog



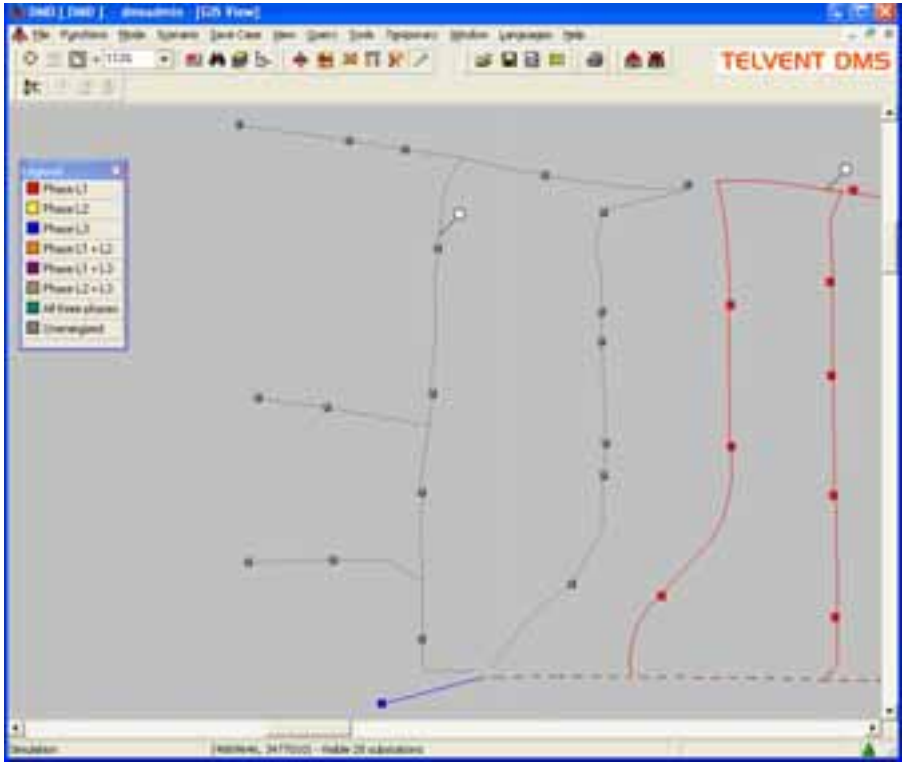
Padmount Transformer Definition

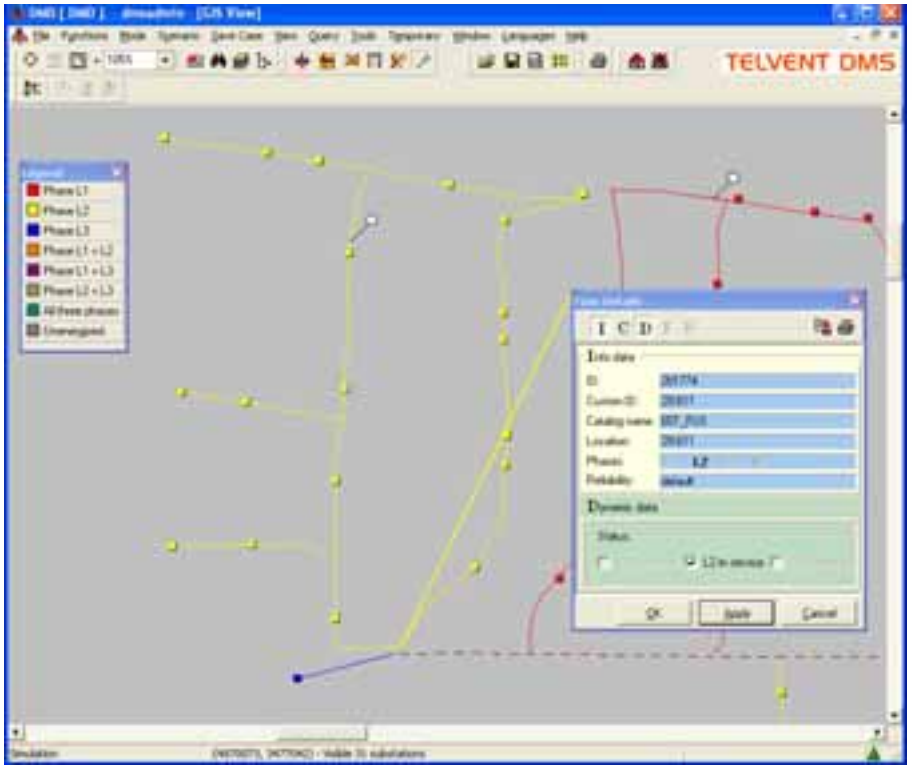
Catalog Entry Definition for Padmount Equipment



Expectations about States

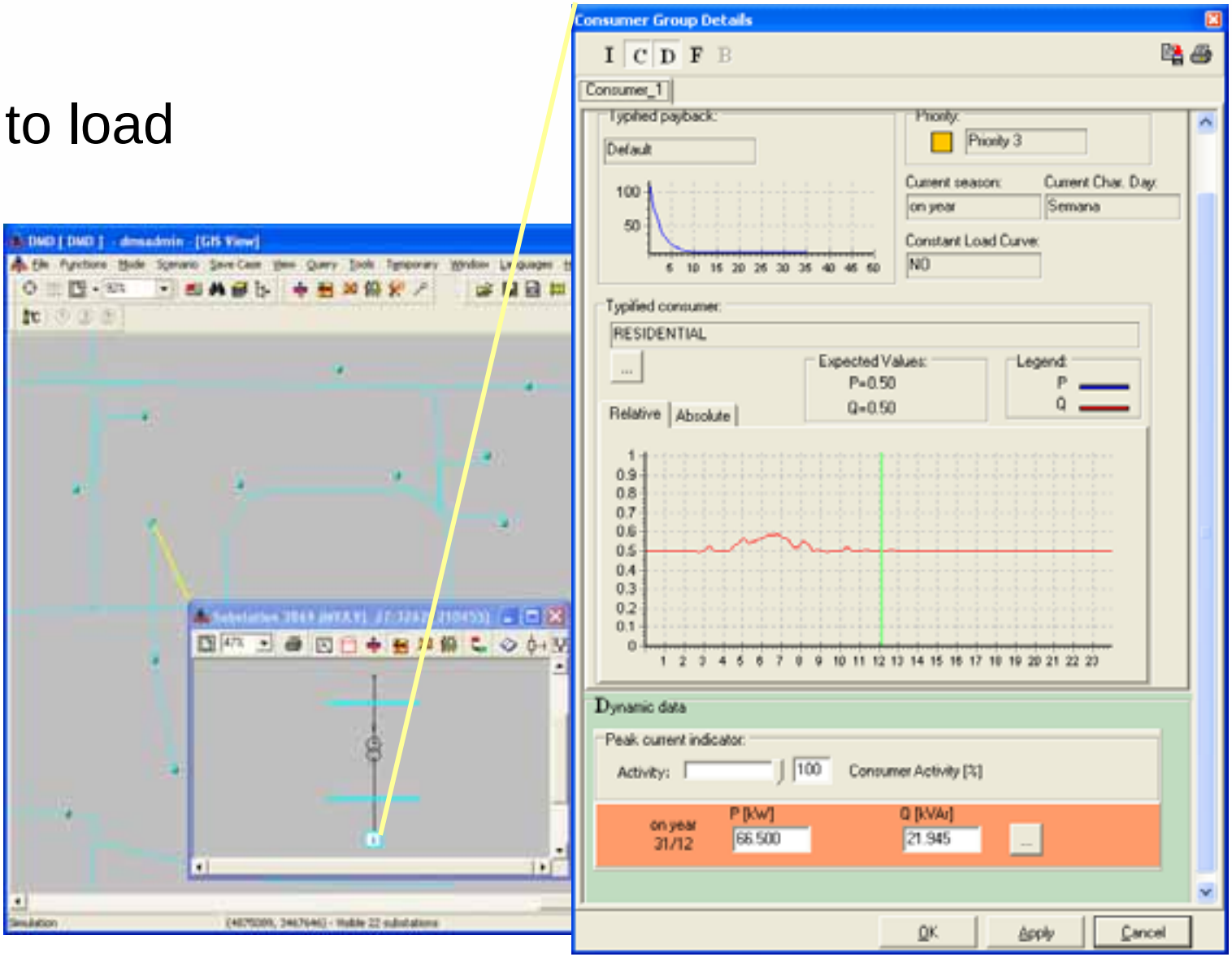
- Likely that your DMS wants to know about “soon to be constructed/energized”





Customer Loads

- Linkage to load data



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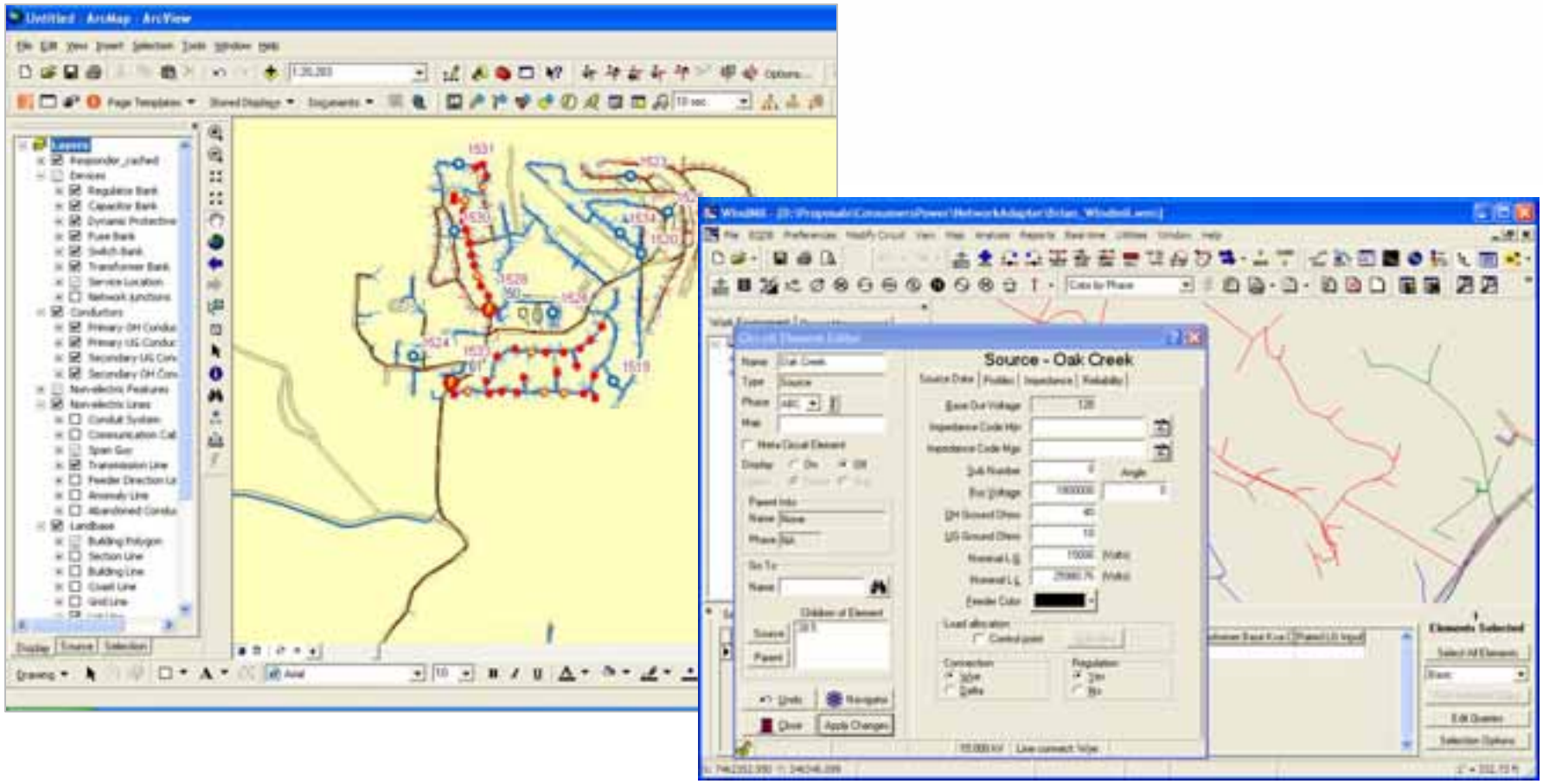
Geodatabase Quality

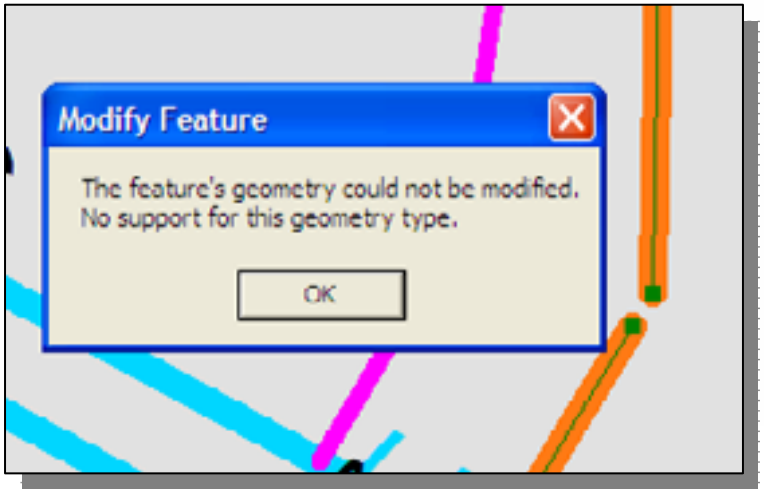
Increased Importance of Quality

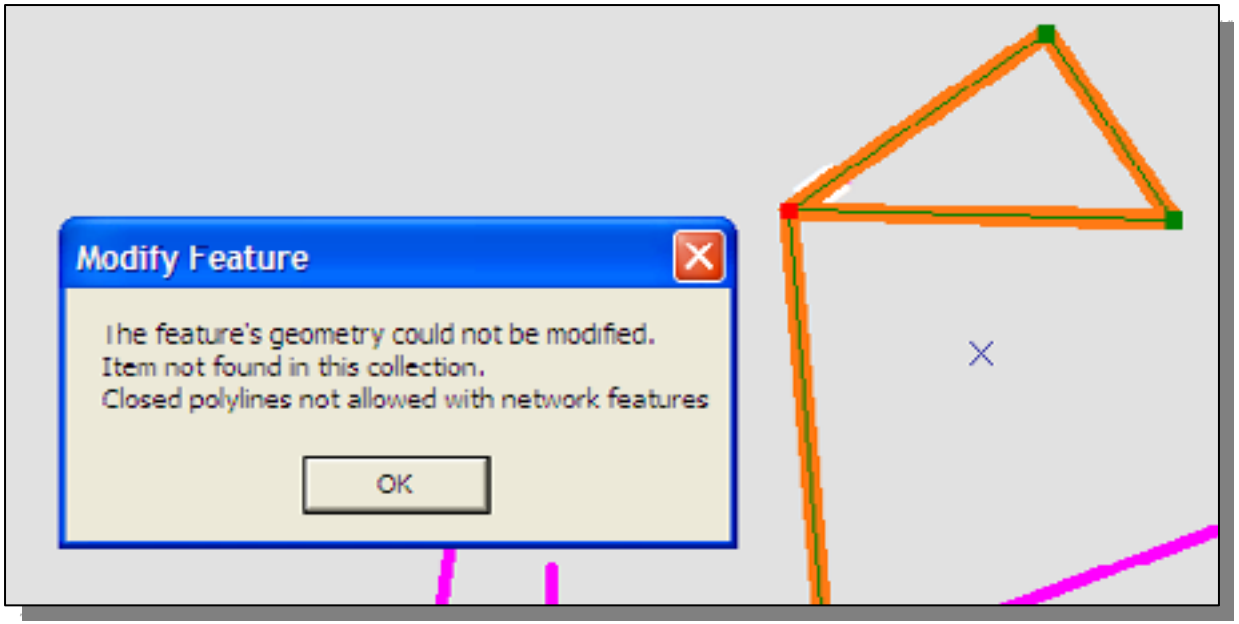
- SG applications assume data from the GIS is both complete and correct.



Types of Errors

- Invalid feature geometries
  - Multi-part geometries
  - Closed polylines
  - Self-intersecting polylines



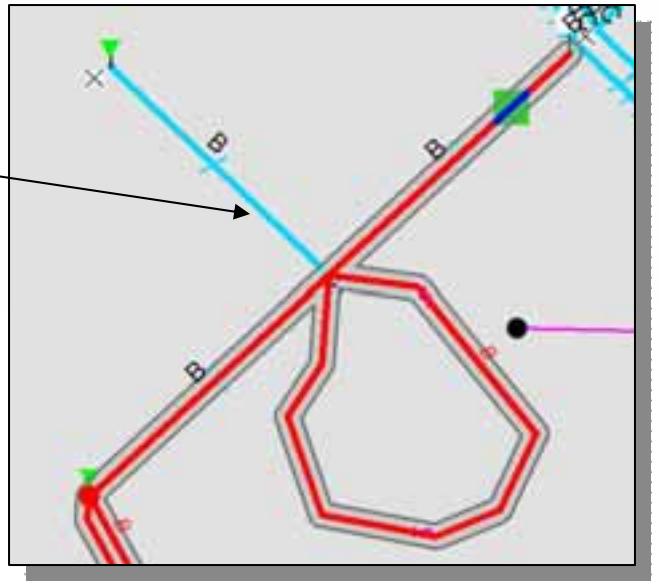


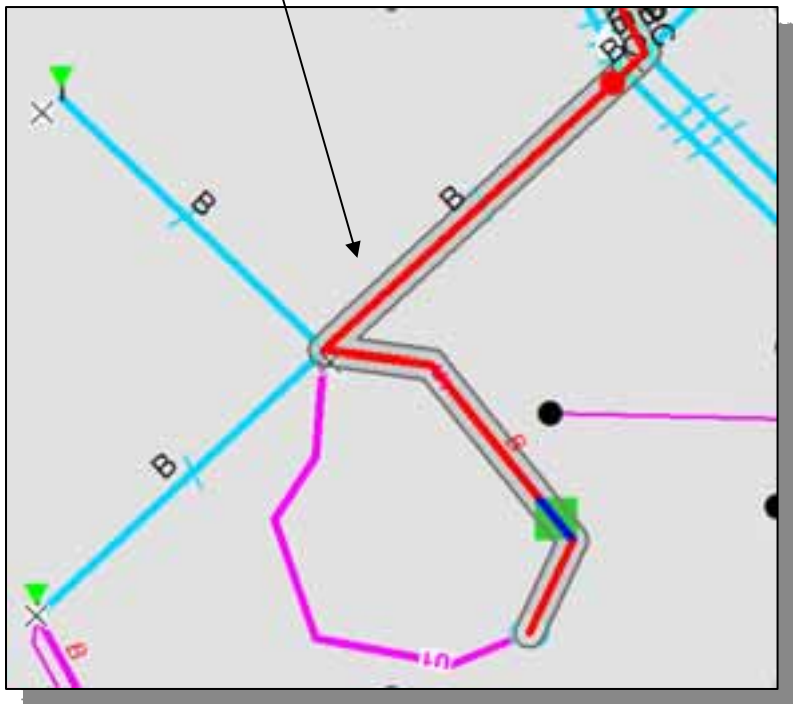
Types of Errors

- Network Connectivity Errors
  - Missing Network Element IDs
  - Network features with multiple Element IDs
  - Element ID that references a feature no longer in the geometric network
  - Inconsistent connectivity

Types of Errors

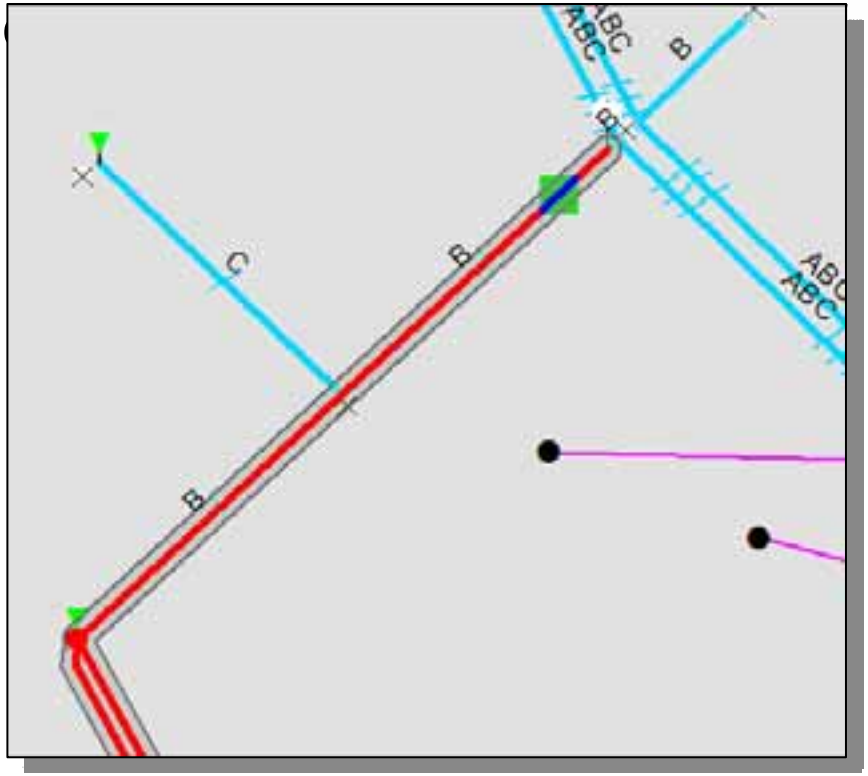
- Invalid Network Configurations
  - Islands
  - Loops
  - Multi-feeds





Types of Errors

- Invalid Feature Attributes
  - Fields set by Auto-Updaters (that may not fire)…
    - … as on operations that d
      Connect and Disconnect
    - FeederInfo and
      ElectricTraceWeight
  - Plain old attribute errors
    - Phase inconsistency
    - Voltage inconsistency



Types of Errors

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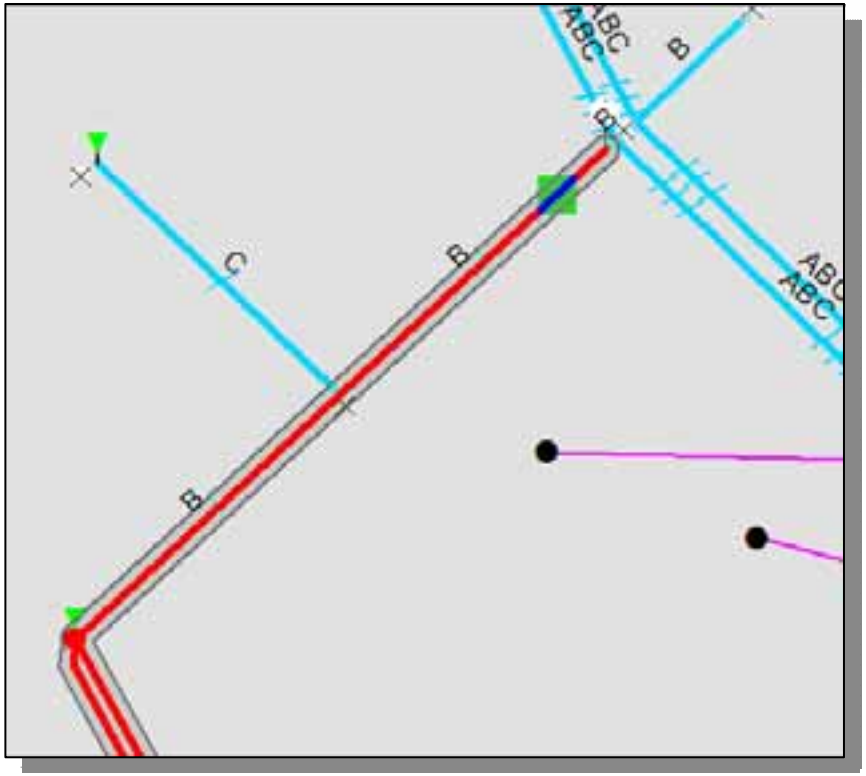
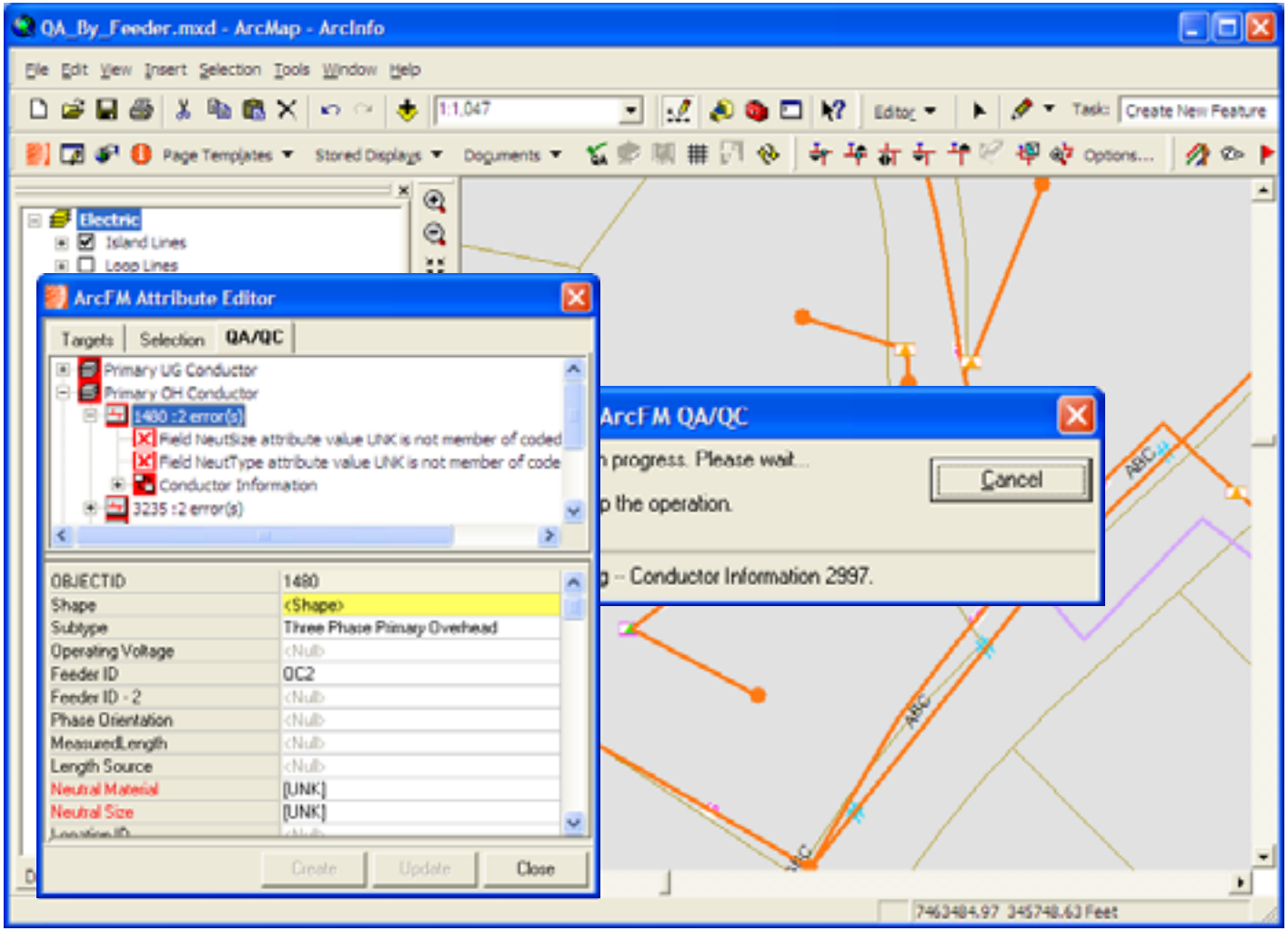


Quality Methods

- All of us employ some manner of quality procedures (right?).
  - Striving to provide the best quality – within reason
  - And when we find quality errors we generally correct them

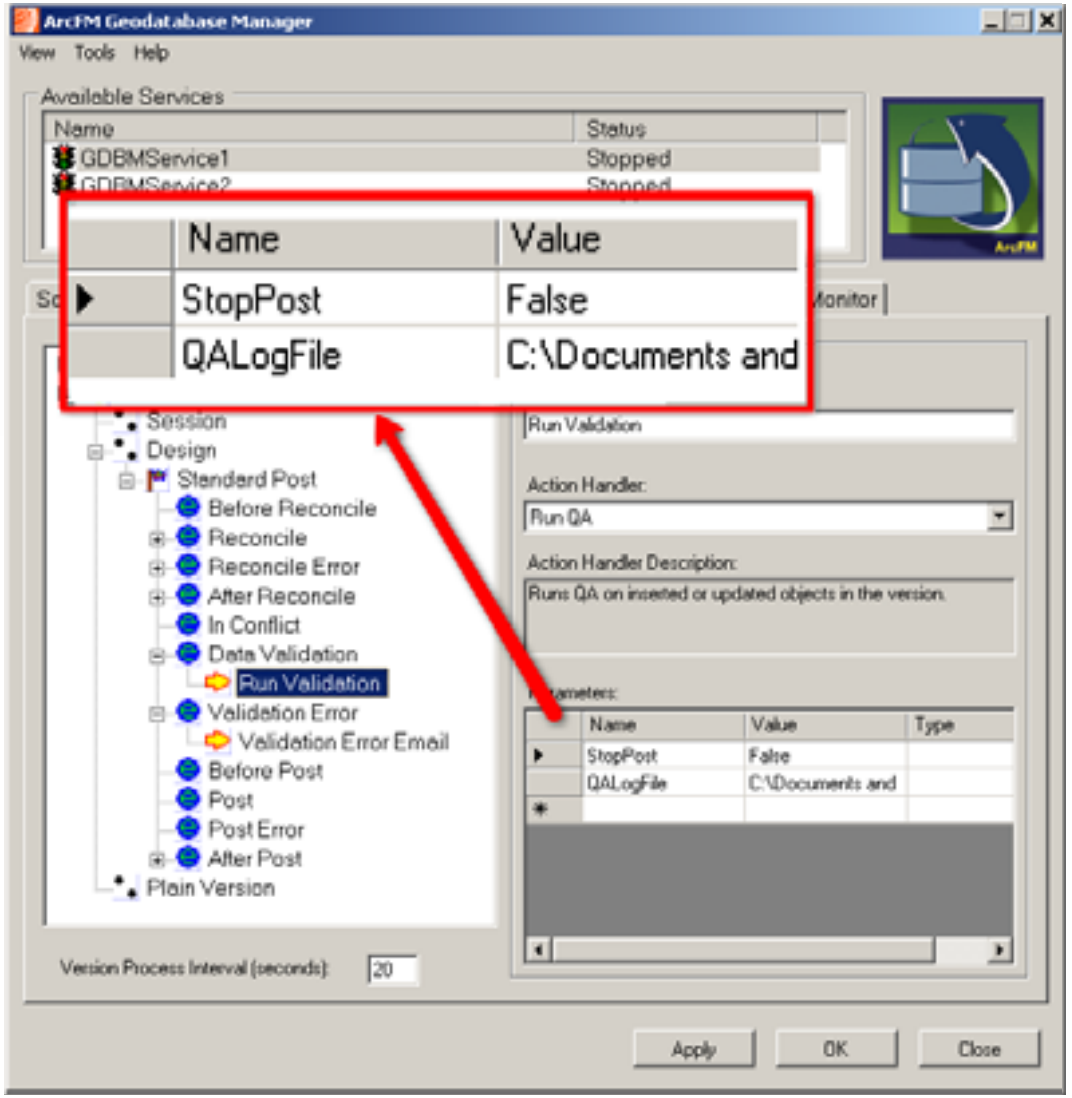
QA Rules

- Create selection set
- Run QA
- Evaluate results



QA with a Geodatabase Manager

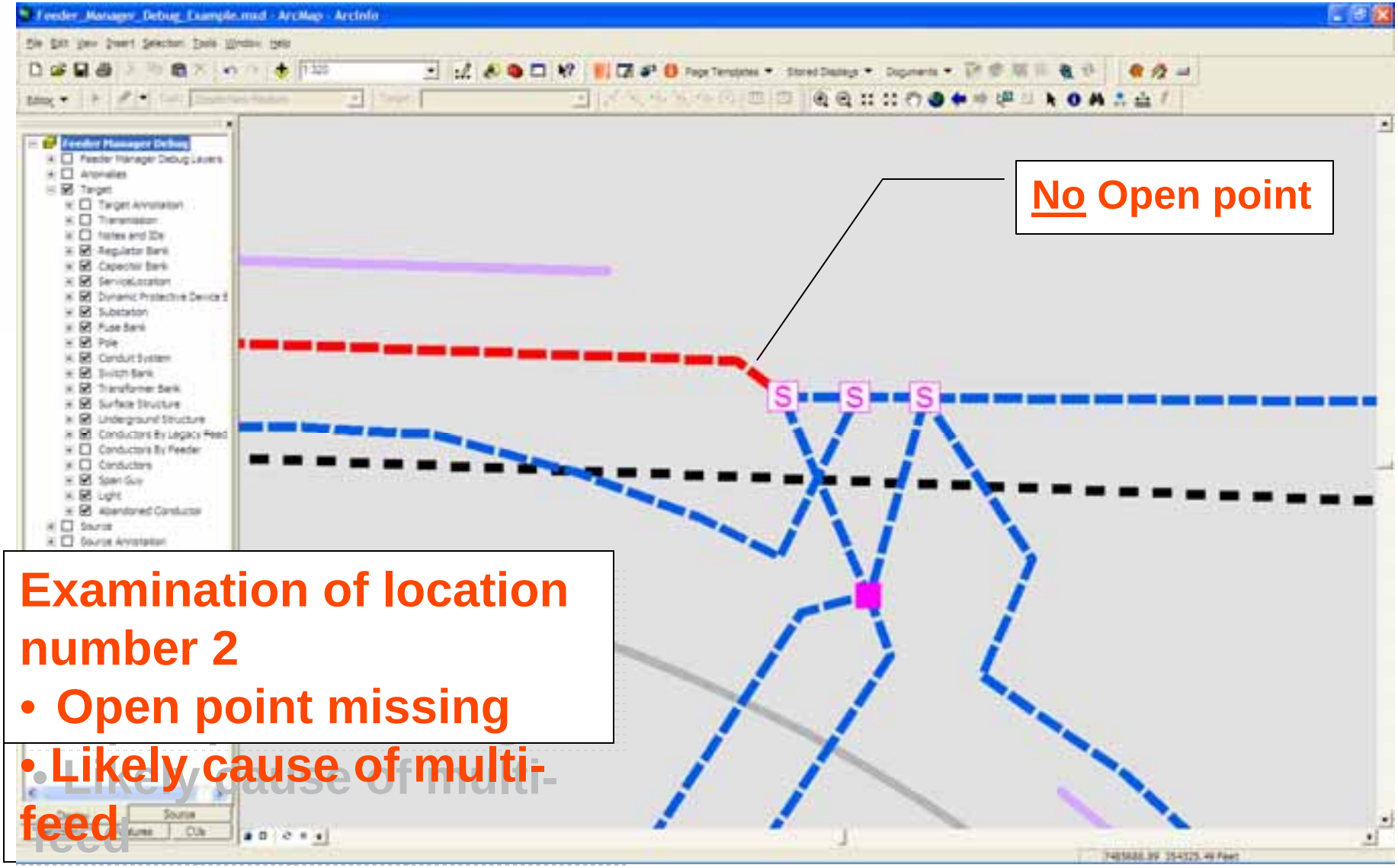
- QA can also be invoked as an “action” within an application such as a Geodatabase Manager.



Quality Methods
Bit Twiddler's Toolbox

- Layers that interpret the FeederInfo field
- Identifies features that Feeder Manager considers anomalous
  - Islands
  - Multi-feeds
  - Loops

Feeder Manager Debug Layers (Bit Twiddler's Toolbox)



Examination of location number 2

- **Open point missing**
- **Likely cause of multi-feed**

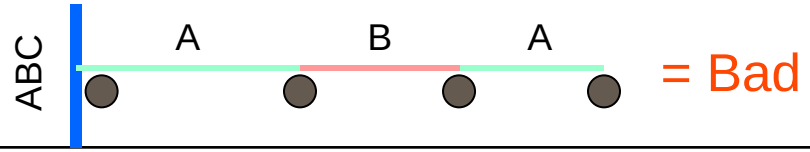
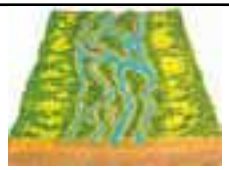
Current Typical Quality Methods Pros and Cons

- Pros
  - Effective in evaluating issues with edited features
    - Data quality should get no worse than start of production use.
- Cons
  - No overall view of database quality
  - No way to differentiate quality types
    - E.g., distinguishing invalid asset rules from network connectivity rules
  - No way to measure database-wide quality change over time

Measures of Quality

- Features with errors of significance per purpose
  - Distribution Management
  - Advanced Metering
  - Engineering Network Analysis
  - Outage Management
  - Staking
  - System Planning

Use Case
Evaluating Data for Smart Grid Application

Feature Geometry	Is it valid?
Phase Designation	Is it in the Phase Domain?
Connectivity	Island, Loop, Multi-feed
Phase Consistency	Is the feature connected to features of the same phase?  = Bad
Bank-Unit Phase Consistency	Does unit phase match bank phase?
Voltage Consistency	Especially at transformers
Braided Phases	Phases split then re-join 

What now?

A (Modest) Proposal

- Acknowledge that anomalies exist in every database
- Store anomalies as features
  - Non-Networked
  - Non-Versioned
- Apply a routine process that re-creates anomalies on a regular basis (daily or weekly)
  - Can we put a number on that?

Why Store Anomalies as Features?

- … rather than discovering them at strategic points in time
  - Allows numerical accounting
  - Allows association with convenient units of measure
    - Like Feeder
    - Or like Region

Quality as an Ongoing Process

- You probably have issues.
- You’re not going to solve them in a day.
- There needs to be a way to monitor Geodatabase quality.
- And manage it over time.

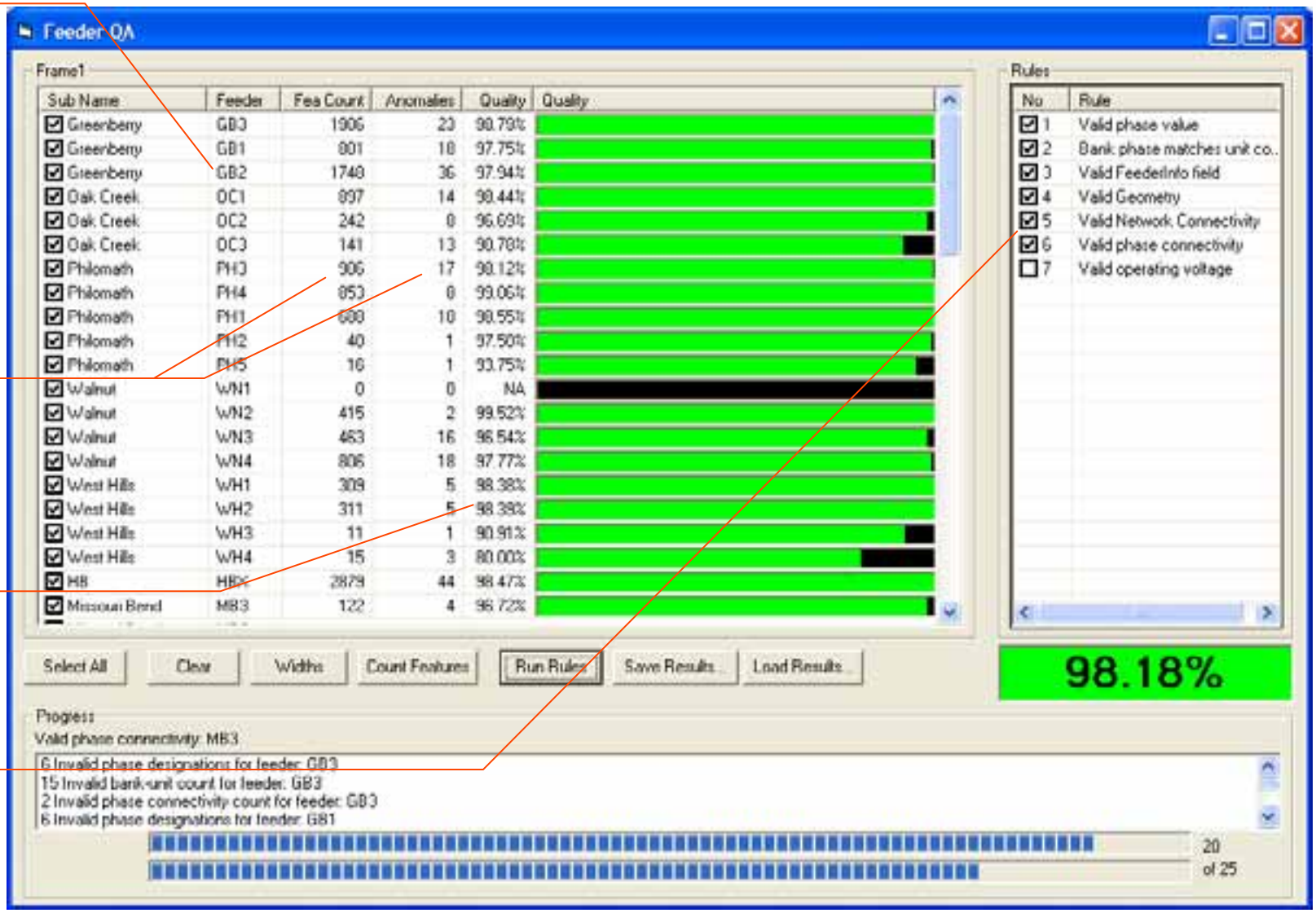
Concept Tool

Feeder

Feature/ Anomaly Counts

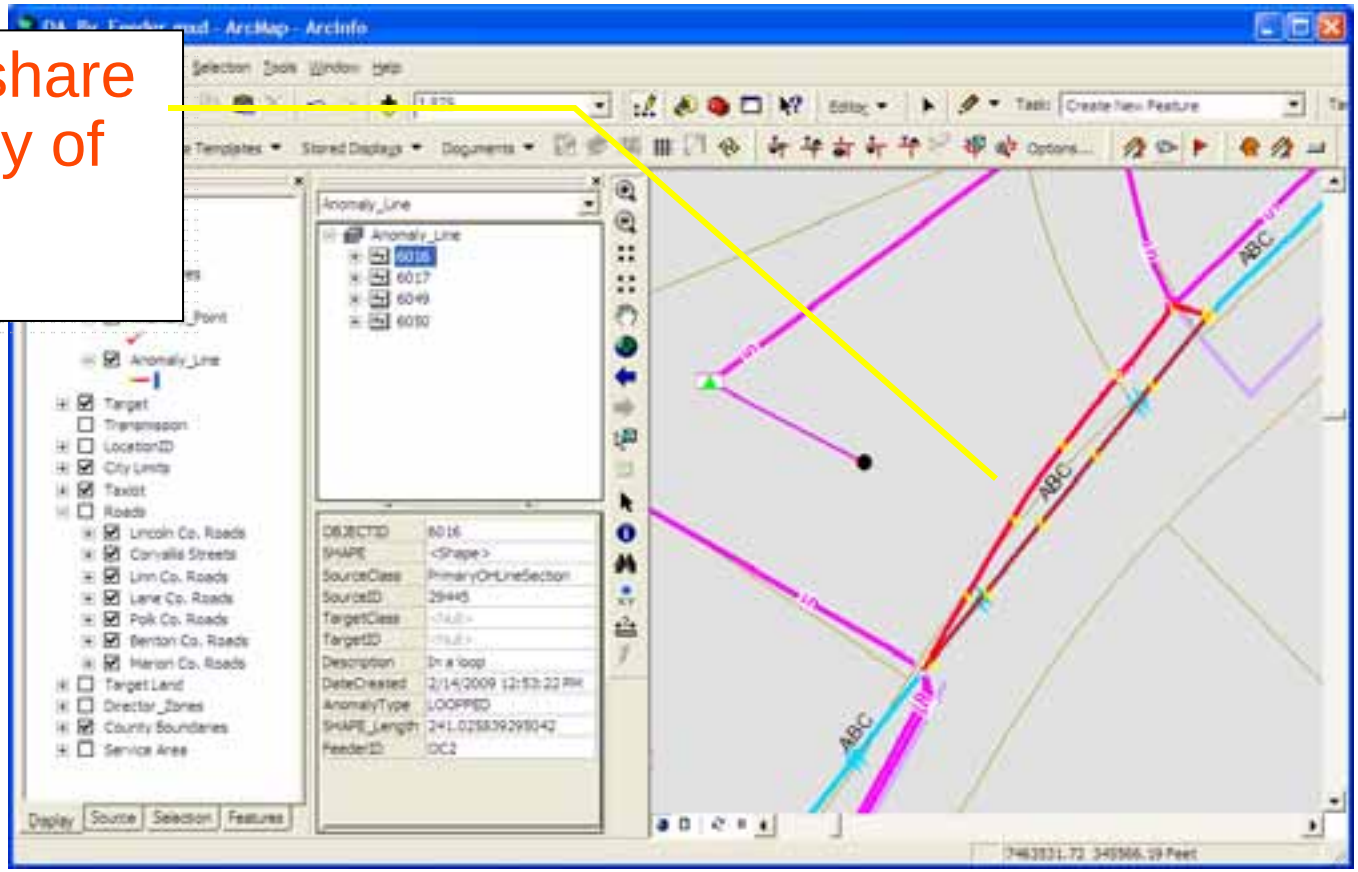
Quality Measure

Rules

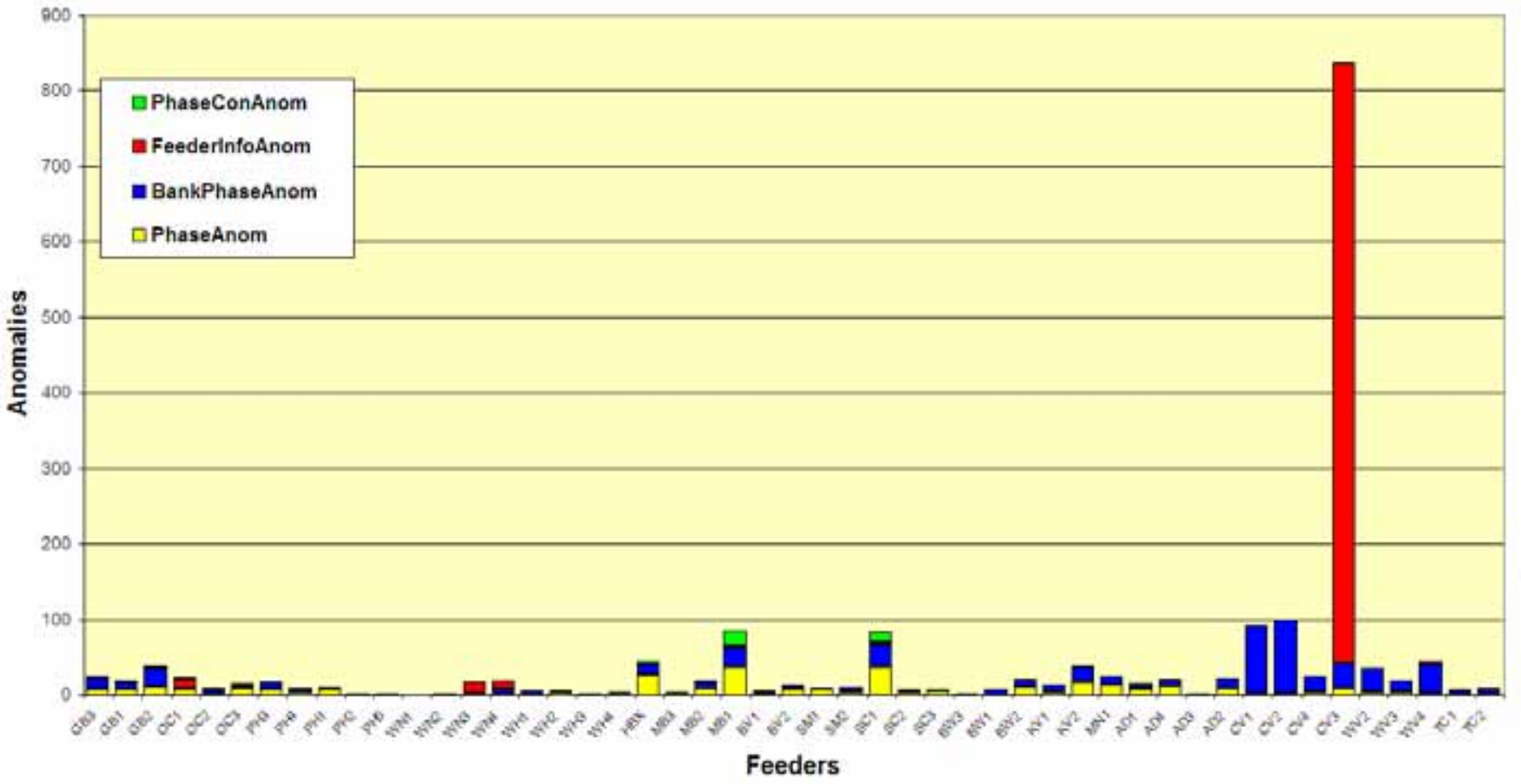


Inspecting Anomaly Features

Anomalies share the geometry of feature they describe.

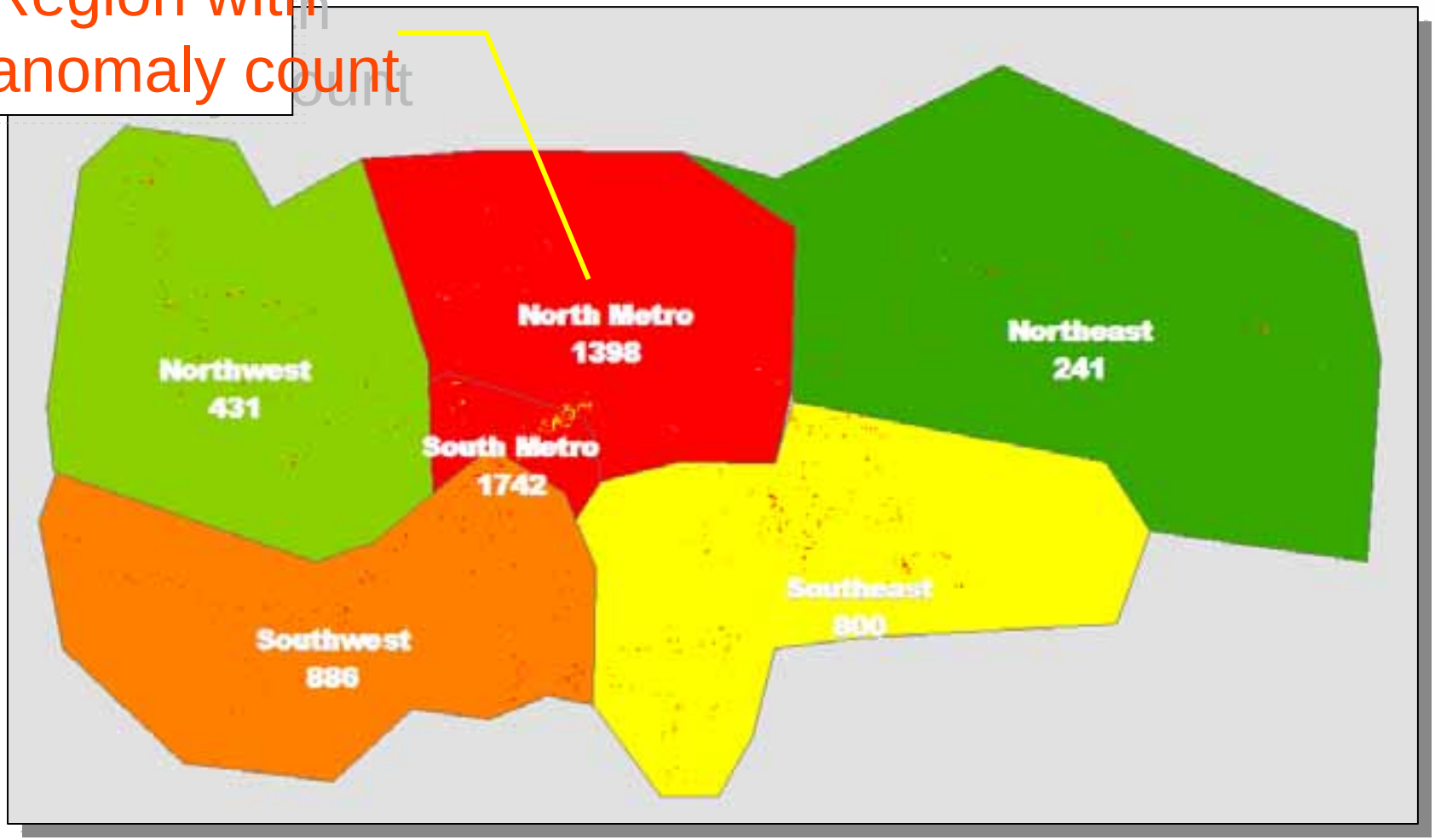


Overall View of Quality



Summarized by Region

Region with anomaly count



Remember

- Your GIS can add great business value by supporting Smart Grid.
- You may have preparation.
- ArcGIS has the right tools for this job.

Next

- Make an assessment
  - Representative pilot or the full Geodatabase
- Define steps to get out of the hole
- Define processes for staying out of the hole

TELVENT

IT for a Sustainable and Secure World

Thank You!