

Automated Aggregation of Data for Asset Health Analysis

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Introduction: Asset Health Analysis

- ❑ T&D utilities are tasked with maintaining a large fleet of aging assets
 - At AEP, 33% of transformers are over 50 years old
- ❑ Historically asset management was done at a local level, but has transitioned to a central function

Asset health is not a new concept

- We have been inspecting and testing our equipment for years
- This analysis has been used to make maintenance and replacement decisions... expert analysis from local engineers provided reliable but costly asset management



Introduction: Transitioning Data Practices



- ❑ Automatic analysis of data was never a primary concern of data collection techniques!
 - Handwritten notes, inspection log books, file cabinets...
 - Personal computing brought in spreadsheets and databases that often involved digitizing of hand records (double recording!)
 - SCADA systems organized with a system focus (rather than an asset focus)
 - Silos of data systems that cannot communicate



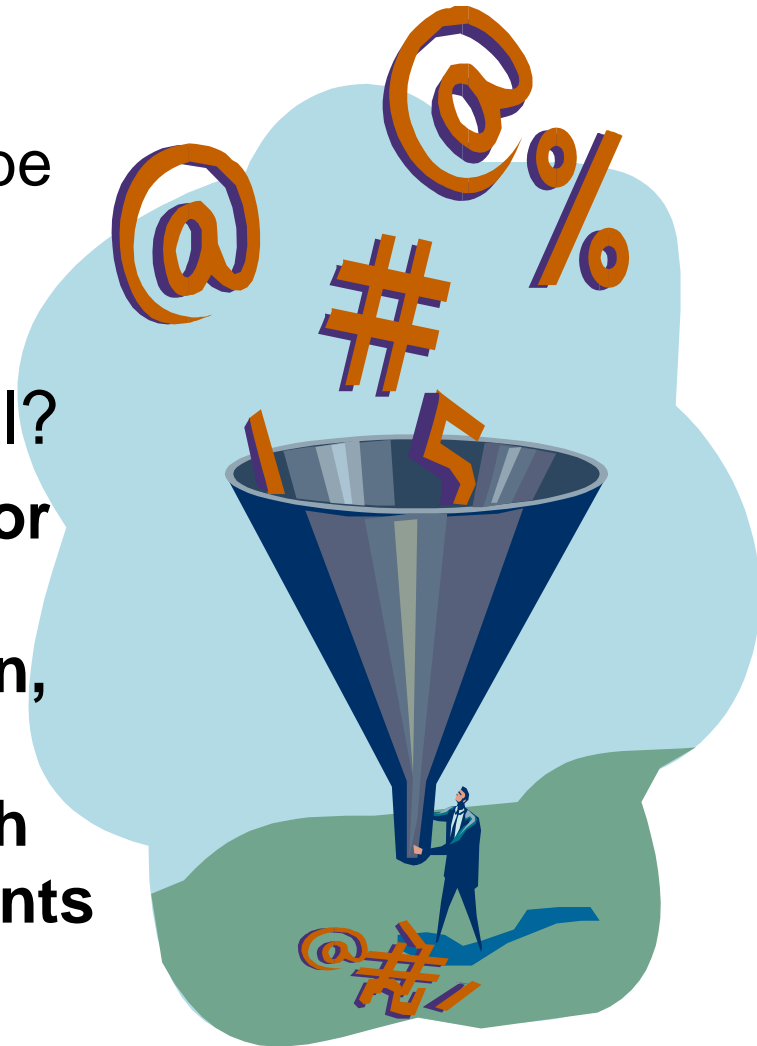
Asset Health Systems

- ❑ Two possible flaws of asset health systems
 - Asset health system that understands its limitations based on an unstructured data set
 - *Limits the effectiveness!*
 - Asset health system that assumes a well structured input data set
 - *Requires human interaction to manipulate source data!*



Automatic Aggregation of Data

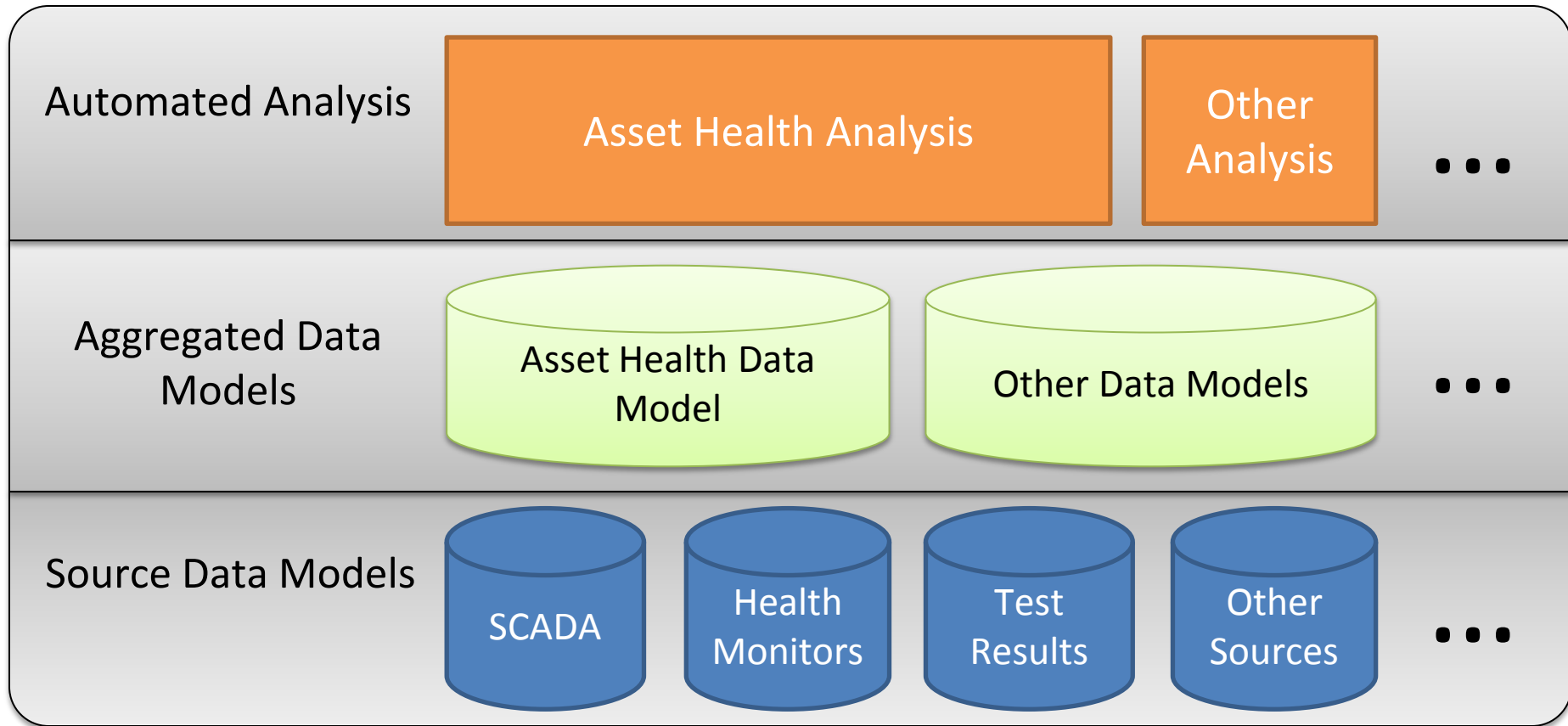
- What is the goal?
 - Asset health analysis that can be performed with minimal human interaction in the process
- How can we achieve our goal?
 - **We must consider the need for automatic data aggregation when designing the collection, storage, organization, attributes, and history of each source database and datapoints that may be used for asset health analysis**



Automated Aggregation of Data



❑ What does it look like?



Data Sources

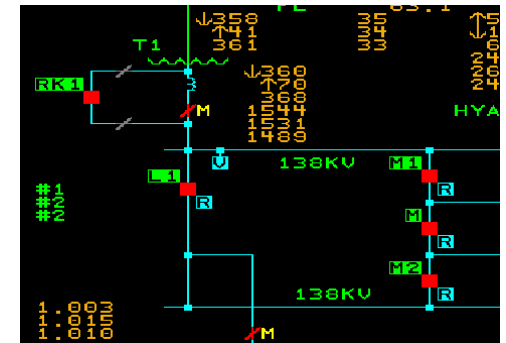


| Source / Type | Description | Updates |
|--|--|-------------|
| Nameplate | Typical nameplate data includes manufacturer, year of manufacture, voltage levels, power ratings, model number, serial number, etc. | Static |
| Manufacturer Specifications | Manufacturer specifications include suggested maintenance steps and intervals. Also included here is specific performance information such as contact travel speeds for breakers or factory bushing power factor for transformers. | Static |
| Operator Specifications | Operator specifications include utility maintenance steps and intervals (compliance based or otherwise). This data set also includes things like acceptable limits for measurements such as DGA levels. | Static |
| Accounting Data | Accounting data includes initial cost, cost of ongoing maintenance, depreciation timeline, availability of spare parts, cost of failure, etc. | Periodic |
| Status and Network Topology | This data describes if the unit is in service or spare, where it is connected in the network, and tracks the history of changes. | Periodic |
| Test Results | Results from equipment tests such as insulation tests, oil quality, breaker timing, etc. | Periodic |
| Inspection Results | Results from visual inspections that cannot otherwise be automated. | Periodic |
| SCADA | Real time data used by operations such as loading, voltage levels, breaker status, etc. | Continuous |
| Health Monitors | Health monitors measure data in real time specific to asset health. Most monitors replicate or imitate traditional equipment testing or metering and also provide on-board intelligence. | Continuous |
| Relay Event Files | Event files can be triggered to capture information about faults or other abnormal events. | Event Based |
| Trouble and Failure Information | Data recorded about corrective maintenance or equipment failure. Failures can be subsystem failures or complete asset failure. | Event Based |

Challenges: Inadequate Source Data Models

- ❑ Inadequate data
 - Model does not contain correct fields
 - Poor population
 - Data requires interpretation or data mining (free form text fields)
- ❑ Discrepancies in asset identification between sources
 - “Bkr-A” vs. “CB-A”
- ❑ Identification by position vs. asset
 - “138kv Line Breaker” vs. “Breaker1234”
- ❑ Undefined data model
 - Non-standard fault files

| Station: | MALISZEWSKI 765 KV | | Equipment | | |
|---|--------------------|------------------|-----------------|-----------|-----|
| Equip: | XF #1 | PH 2 | | | |
| S/N: | 96493 | | | | |
| Status: | In Service | kV: 765/138/13.8 | | | |
| <input type="button" value="Add"/> <input type="button" value="Edit"/> <input type="button" value="Export"/> <input type="button" value="Print"/> | | | Schedules are i | | |
| MAINT TYPE | Last Test | Norm Sch | Cur Sch | Date Due | Sch |
| COOLER CLN | 4/28/2005 | 12 | 12 | 4/28/2006 | TIM |
| DGAEQ | 9/6/2012 | 6 | 6 | 3/6/2013 | TIM |
| OILEQ | 9/6/2012 | 48 | 48 | 9/6/2016 | TIM |
| MINOR | 9/21/2012 | 48 | 48 | 9/21/2016 | TIM |
| TCGEQ | 1/1/1900 | 0 | 0 | | |
| MAJOR | 1/1/1900 | 0 | 0 | | |



❑ Common Information Model

- IEC 61970-301: abstract model of major elements in an electric utility system that are part of the operations of the utility
- IEC 61968-11: extends the model to additional aspects of the power system, including the distribution system, asset tracking, work scheduling, and customer billing
- IEC 62325-301: models data exchanged between participants in electricity markets

❑ CIM Users Group – Asset Health

Data Collection Practices: Equipment Inspections and Testing



1. Inspection data cannot be handwritten
2. The equipment should be barcoded
3. Measurement data must have data validation at the source
4. Subjective inspection data must be collected in a way that can be automatically assessed
5. Equipment testing software and hardware should ideally deliver results directly to utility's maintenance database

Data Collection Practices: Event Based Data – Relay Event Files



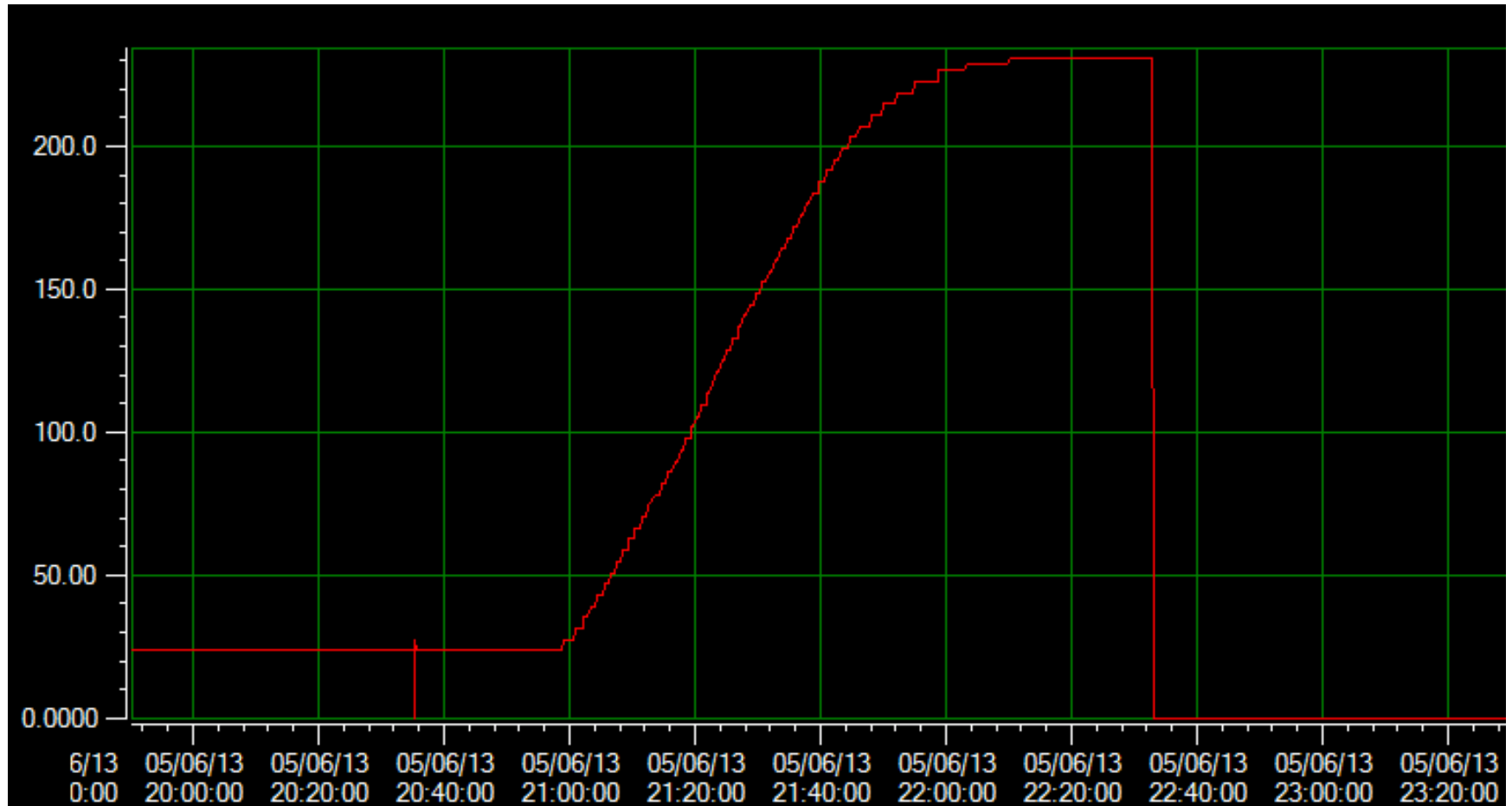
1. The file must use a pre-defined standard format
2. The filename must link the file to an asset in the CIM
3. The association with the asset must be understood from the CIM

Data Collection Practices: Real Time Data – Equipment Health Monitors



1. The amount of on-site data analysis should be limited
2. IEC61850 is the preferred communication method
3. The use of the data should determine the collection frequency of the aggregating system

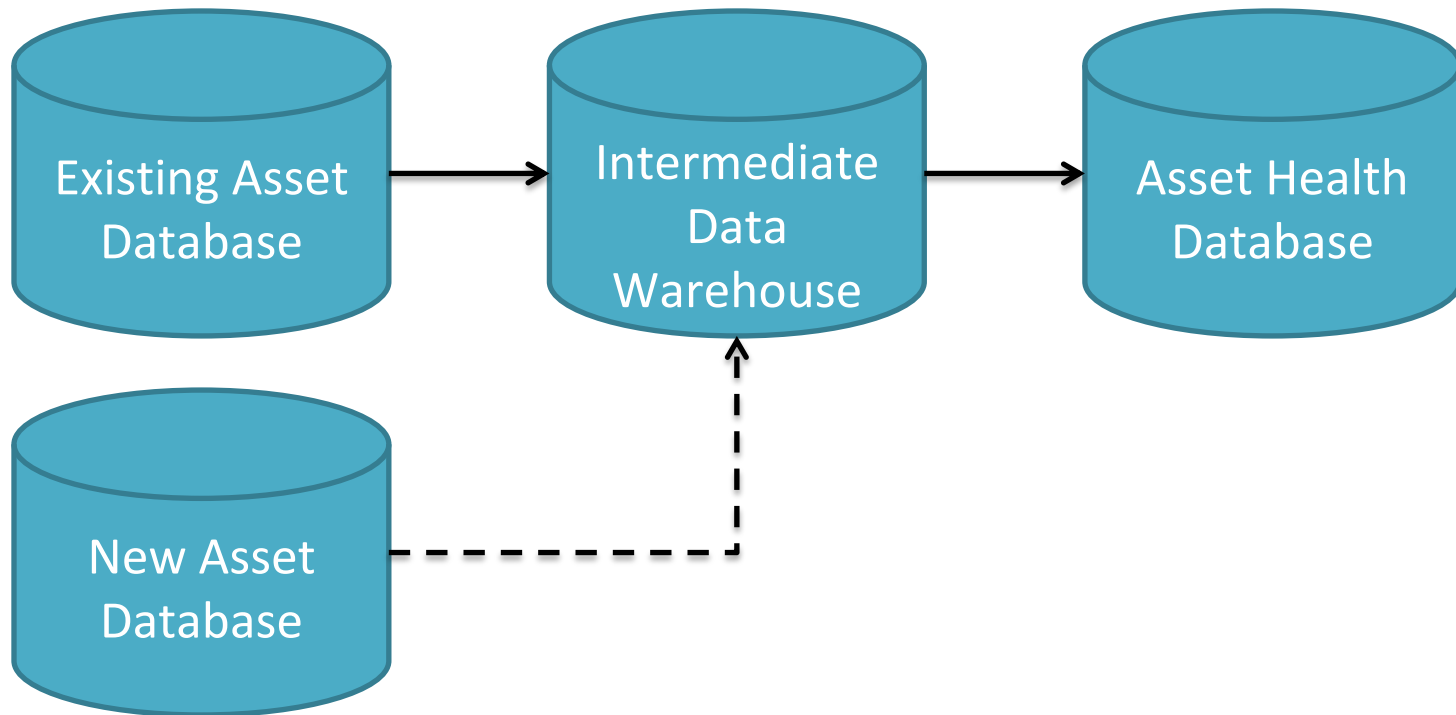
Dissolved H2 PPM rise over 3 hour period



Implementation at AEP: New maintenance tracking database



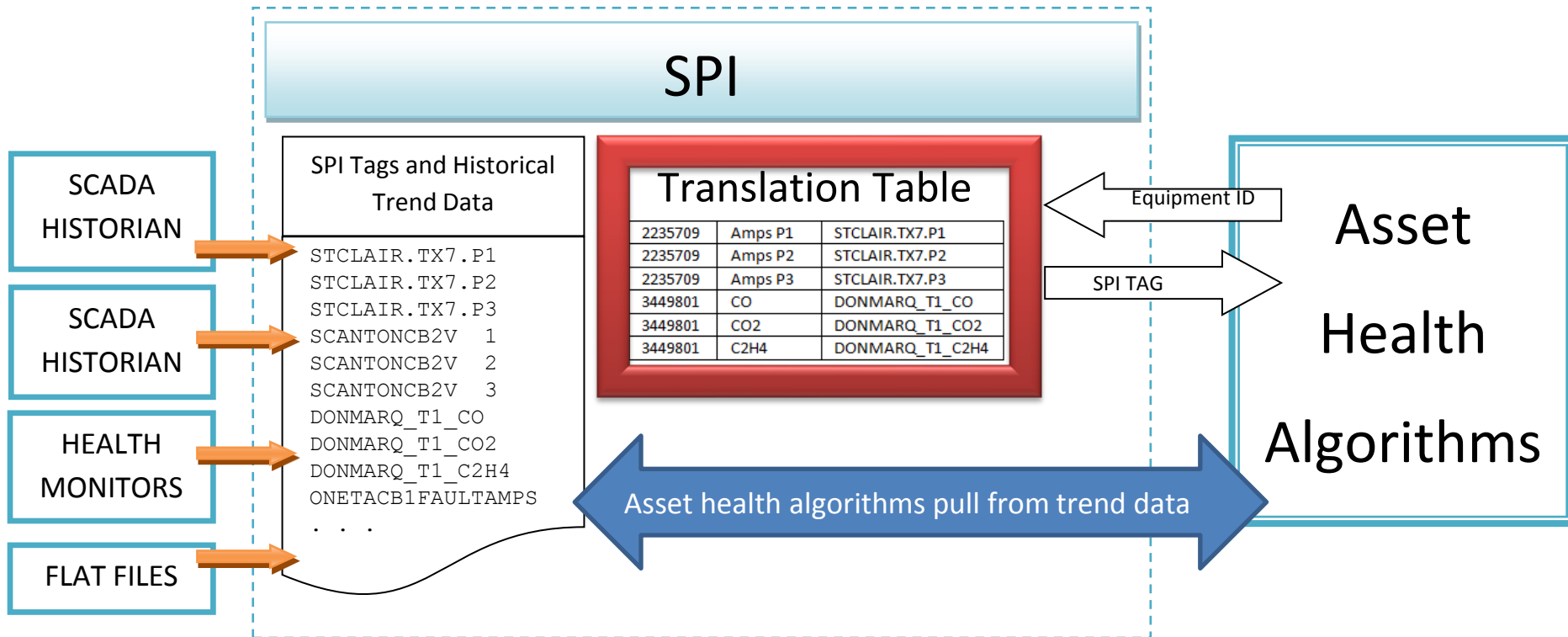
- ❑ Parallel implementation of new asset health system and new asset maintenance tracking system
 - Pro: Perfect time to upgrade the data model from existing equipment database
 - Con: Difficulty in multiple mappings and temporary warehouse



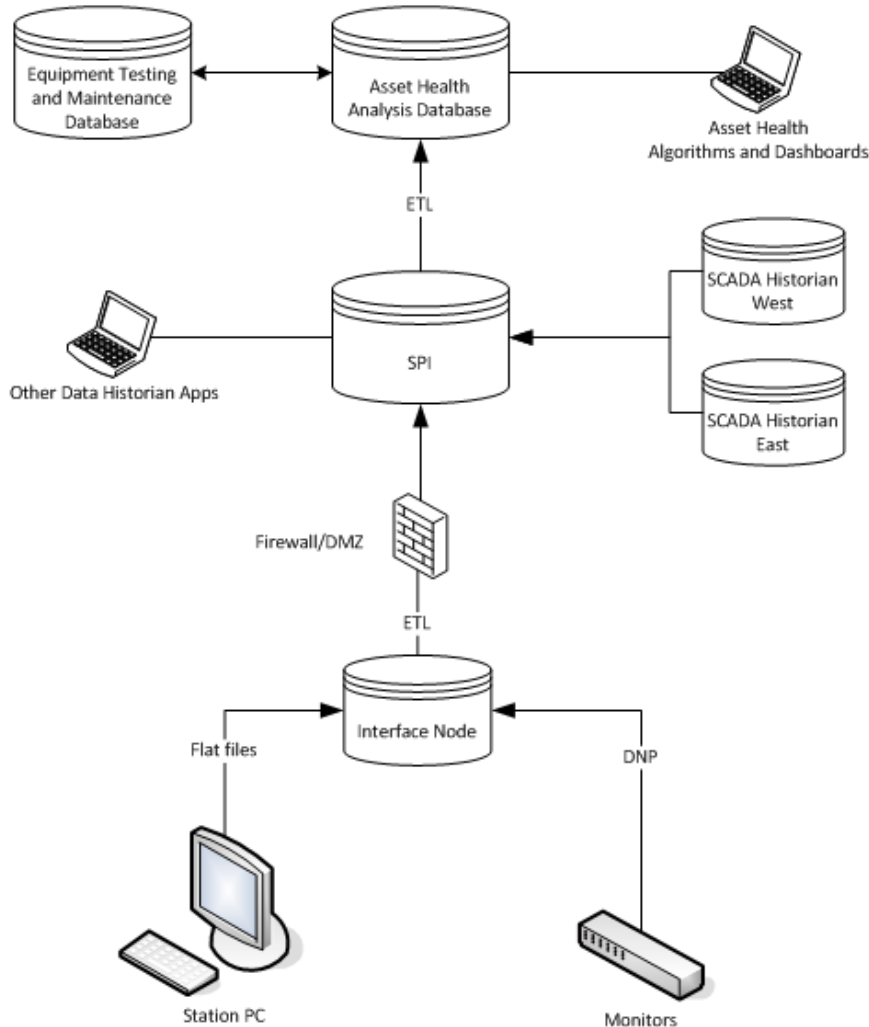
Implementation at AEP: Linking Data Sources



- Creation of “SPI” system to link real time data with equipment database



Implementation at AEP: Connecting Data Sources

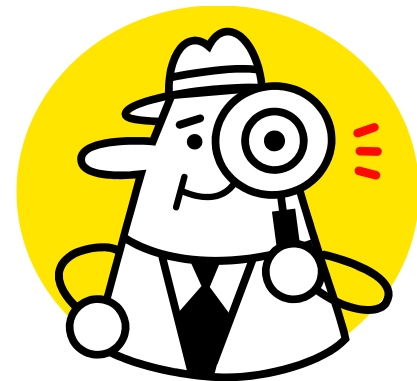


- ❑ Central data historian can directly poll health monitors via DNP
- ❑ Relay fault files collected via station computer, parsed and process and fed into data historian
- ❑ Connection to existing SCADA historians centralizes needed data and simplifies connection to operations databases
- ❑ Allows multiple uses beyond existing asset health system

Implementation at AEP: Smarter Equipment Inspections



- Still in development...
- Allows the system to collect baseline data to capture historical equipment health
- Allows the user to input subjective equipment assessment in objective manner (dropdowns replace free form text)
- Short term: web interface
- Long term: mobile application



Questions?

