



Analytics Are Just the Tip of the Iceberg—How the PI System Revolutionizes Asset Management

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Key Takeaways

- Better understanding of the Analytics Path
 - How to get where we are going
- Understand how a common infrastructure is being used to evolve our ideas of asset management
 - O&M—short-term
 - CapEx—long-term
- The PI System as the enabling technology



Doble Engineering Company

Global Leader in T&D Engineering Services – founded 1920



Consulting & Assessment Services

Client Services

Asset Risk Management

dobleARMS™

dobleDATABASE™

Transformer
Diagnostics



Circuit Breaker
Diagnostics



Protection
Diagnostics



Rotating
Machinery
Diagnostics



Cable &
Switchgear
Diagnostics

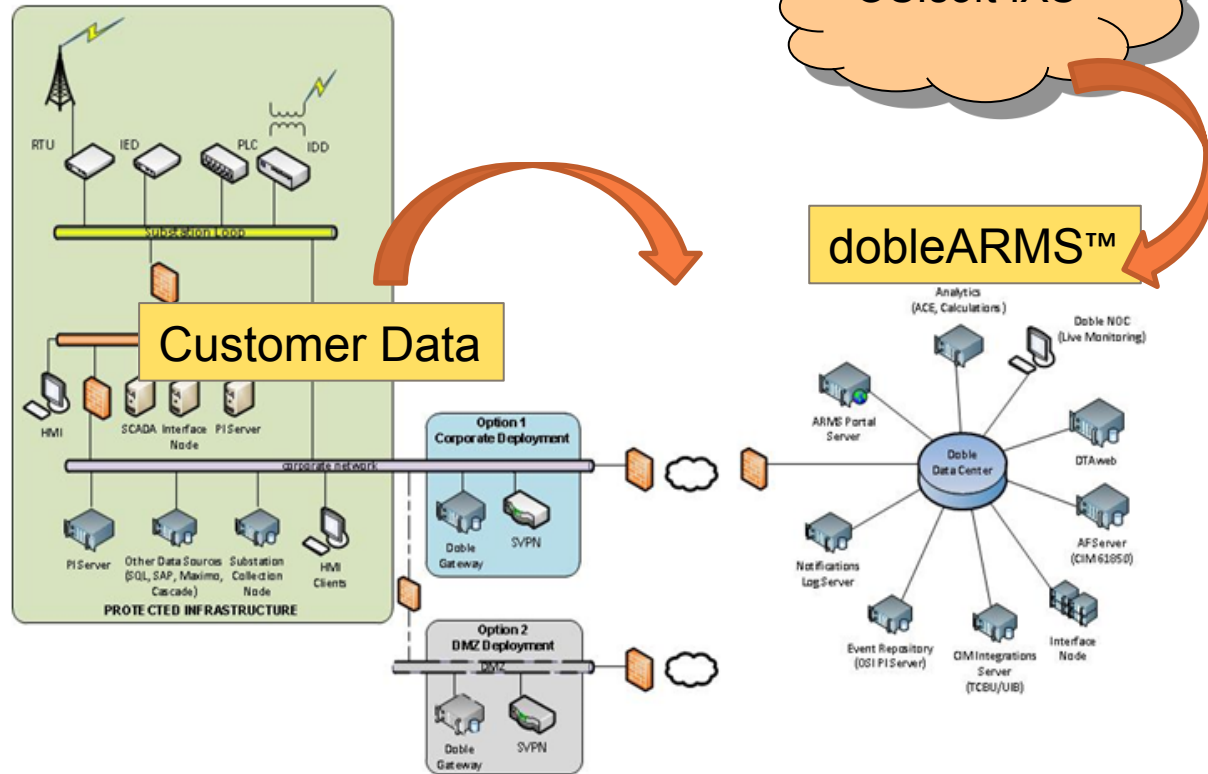


Doble Material
Laboratories



Business Cases

- Doble Engineering
- Consortium Members
 - 3 Companies
- Partnership with S&C Electric
 - Deployed 2
- Other Deployed Sites
- UCSD-PMU
 - Test of OSIsoft's IXS



Analytics & “Big Data”— the new “Holy Grail”

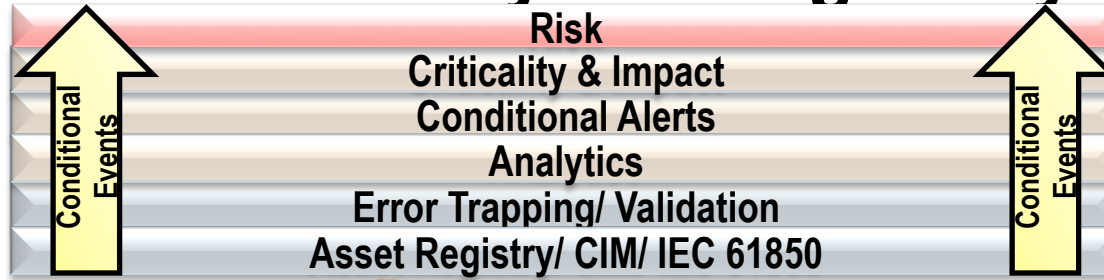
- No contest: data volumes are increasing
- Need a way to intelligently filter through the data
- Analytics will help with this process
- Asset Analytics are VERY different than VEE/metering Analytics



Data Sources Currently Feeding Analytics

1:1

1:N



1. Offline Diagnostics



Insulation Analyzer



Sweep Frequency



Partial Discharge

dobleDATABASE™



Bushing



DGA



Moisture in Oil



Continuous Monitoring

2. Online Diagnostics

SCADA/
Relay/
Gateway

3. Real-time

IEDs, RTUs, Transducers

5. Maintenance

**Inspection

Oil Sample

4. Lab

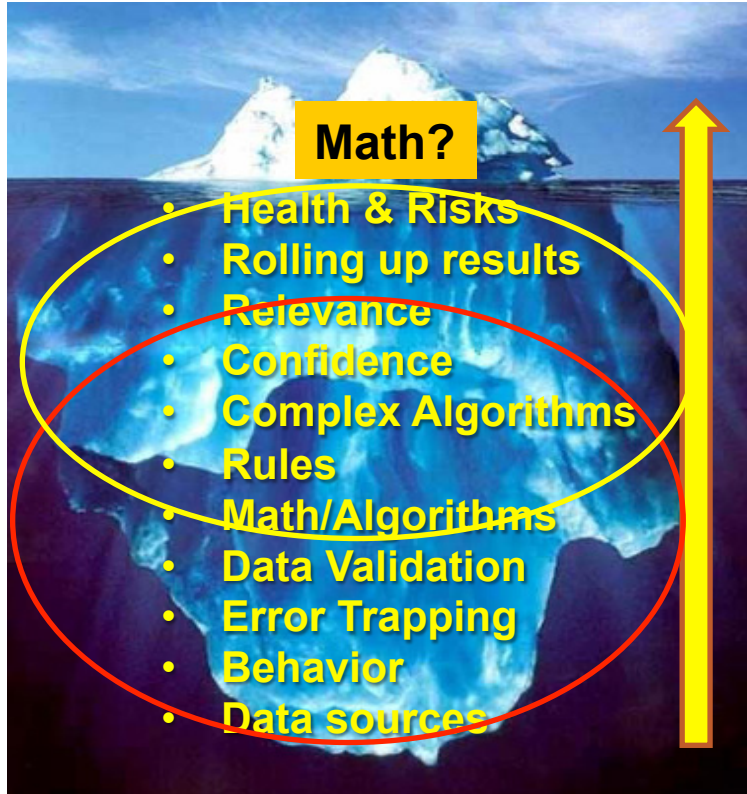
Is it Analytics or really Math?

- Results may not be that informative
- False positives
- Example: Abnormal TAP activity
 - # Tap changes over 30 days > 9K
 - Is it true? Telemetry errors?
 - Digital value stored as an analog?
 - Are there comms errors?
- How relevant is the result?
 - Fixable or likelihood of failure?
 - What is the confidence in data source?
 - Is the algorithm broad or specific?



- **Woman:** I'm not a witch! I'm not a witch!
- **Valdimir:** ehh... but you are dressed like one.

The Analytics Path



- Complex, multilayered process
- The PI System makes our job easier!
- Similar data sources allow us to correlate results
 - DGA—online vs. oil sample
 - Tap—Inspection vs. SCADA
- Rules for how we handle bad data
 - Fix the data, eliminate source, or let run with analytic management of alerts?
 - Establish policies
- Analytics need to differentiate between issue and long-term health

Tuning the Data: Establishing Expected Ranges & Behavior—the PI System is Key!



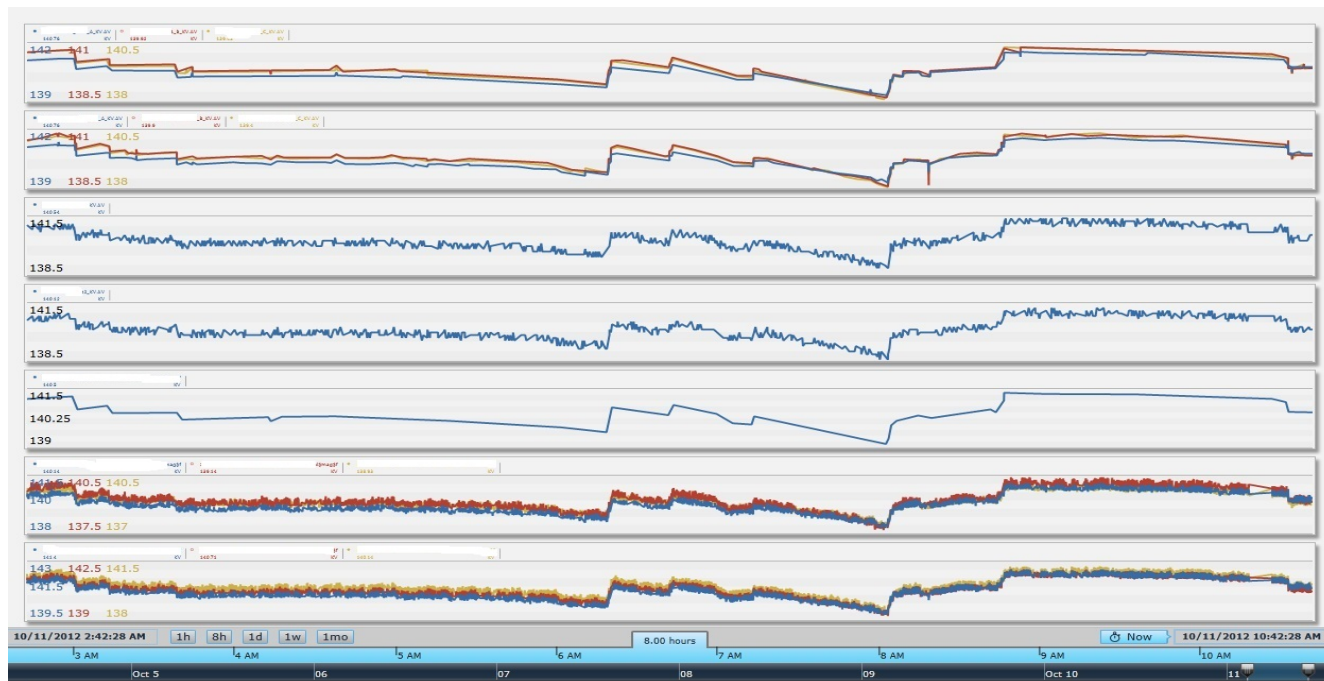
- Timestamps (**need common)
- Update Rates (.5 sec. to 5 yrs.)
- Expected Range (0-span)
- Exception (when data changes)
- Compression (when stored)
- Engineering units (W or MW)
- Scaling (x10)
- Type-digital, integer, float

| | compdevpercent | excdevpercent | span | zero |
|------------|----------------|---------------|------|------|
| 17_B_KV.AV | 0.1 | 1 | 155 | -5 |
| 11_A_KV.AV | 0.1 | 1 | 155 | -5 |

No sense going any further if these are not well understood!

Deviations were tied to filtering on relay

- Station to Station with PT in between
- Same filter on back-end, different filters on the front-end
- We can resolve during the tuning phase



Temperature Scenario—Easy & Tricky

- Three temperature monitors (bad (blue), went bad (yellow) & good (red))
- Identification of faulty sensor (blue & yellow trend) is straightforward
- Business must decide how we handle the alert- built into analytic rules

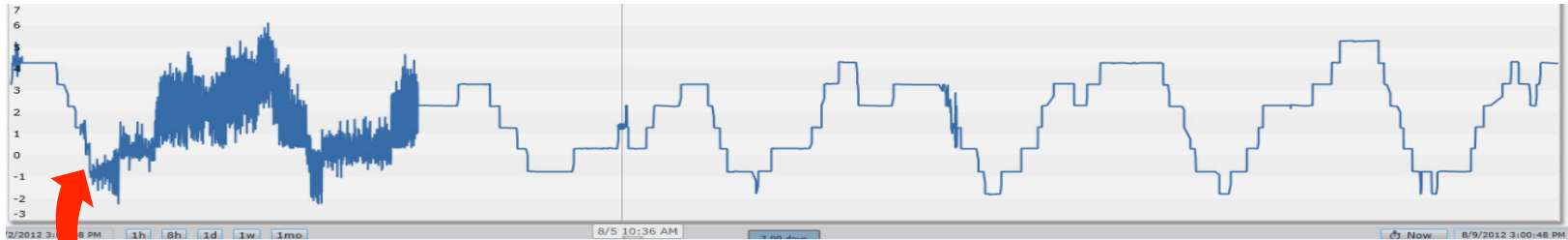
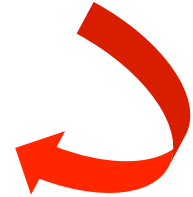
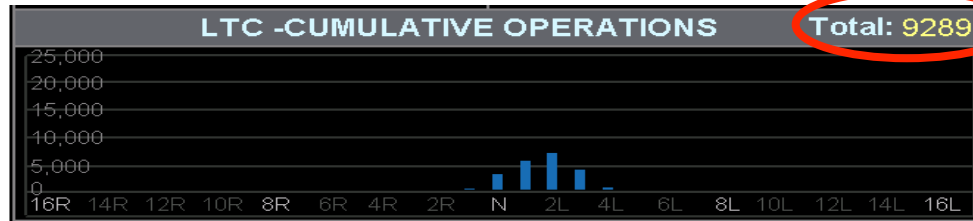


Advanced Analytic: Overly active OLTC:

1. SCADA

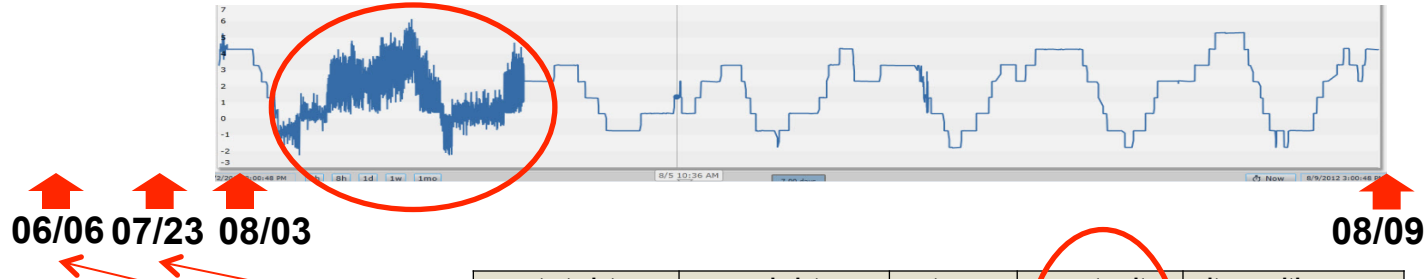


Analytic Results



A look at the actual data

Correlation of SCADA Data Using Maintenance Records



2. Compare results with inspection data

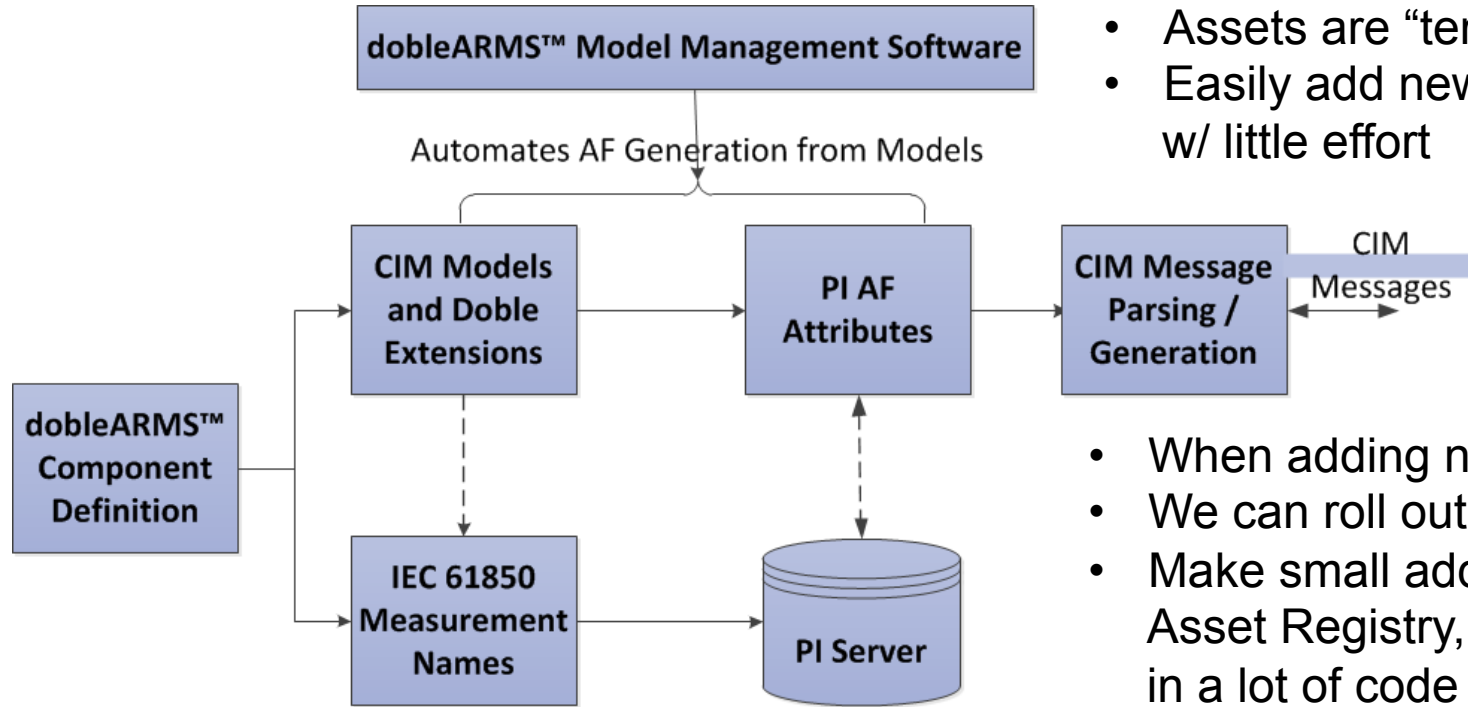
| start_date | end_date | type | counter_ltc | ltc_position_max |
|-----------------|-----------------|--------|-------------|------------------|
| 7/23/2012 9:07 | 7/23/2012 9:43 | Patrol | 50105 | 6R |
| 6/6/2012 8:46 | 6/6/2012 9:14 | Patrol | 49284 | 4R |
| 4/23/2012 11:39 | 4/23/2012 12:07 | Patrol | 48547 | 7R |
| 2/29/2012 8:22 | 2/29/2012 8:47 | Patrol | 47761 | 4R |
| 1/11/2012 8:34 | 1/11/2012 9:07 | Patrol | 47219 | 3R |
| 11/4/2011 9:09 | 11/4/2011 9:57 | Patrol | 46522 | 4R |

3. Quality bit—no telemetry error; no alarm.

- Period of maintenance--start & end
- Compare number of operations = 716
- Compare Average daily operations = 10.5

PI AF Central to the dobleARMS™ Asset Registry

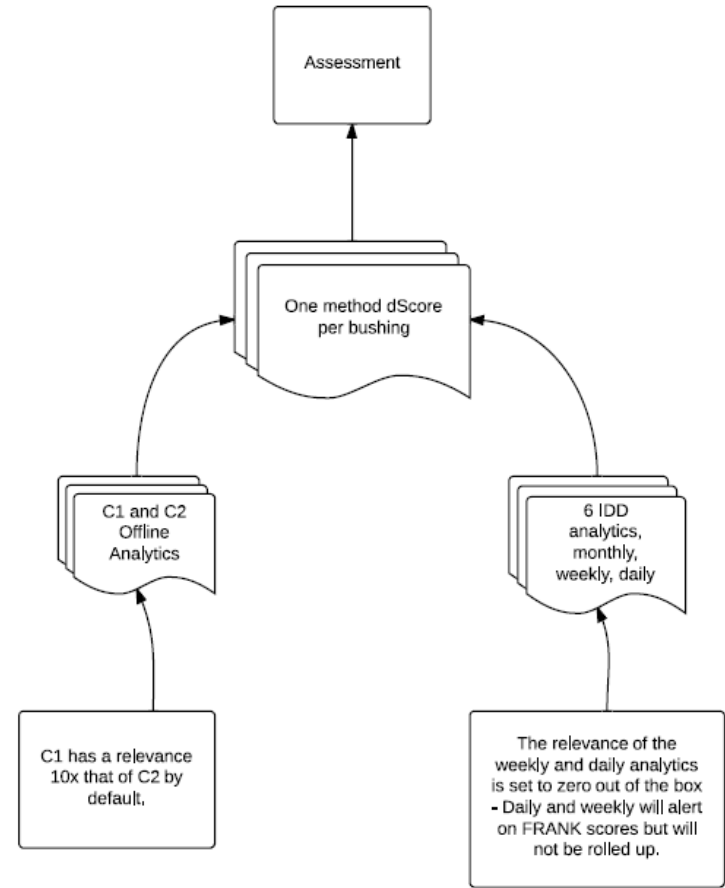
- Unified framework for all of data
- Assets are “templated”
- Easily add new sources w/ little effort



- When adding new source
- We can roll out quickly
- Make small additions to the Asset Registry, rather than in a lot of code

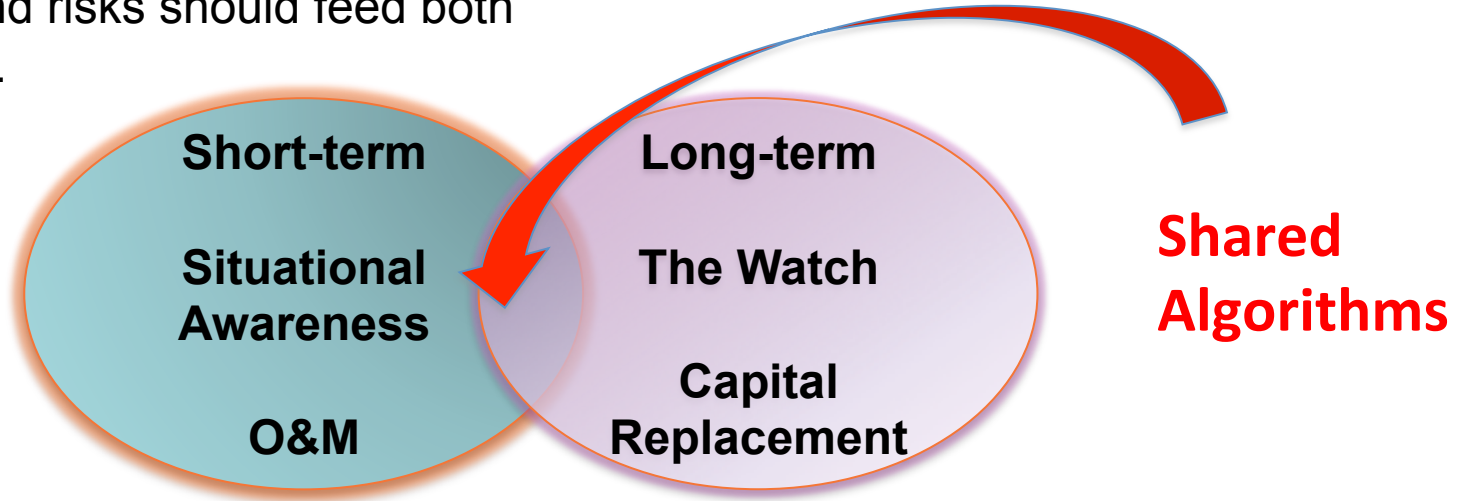
PI AF & Links to Analytics

- Structure allows us to (quickly) add new analytics
- Data director—Feeds data to the rules engine
- Ensures that the calls to the rules engine always look the same regardless of apparatus



Building Toward One Version of the Truth

Overall asset health scores & evaluation of asset fitness and risks should feed both CapEx and O&M.



- Multiple data sources
 - Real-time, online diagnostic, offline diagnostic, lab, & inspection
- One common Asset Registry
- Common set of Analytics

A Common Infrastructure Allows Improved Asset Prioritization for O&M vs CapEx

O&M—Situational

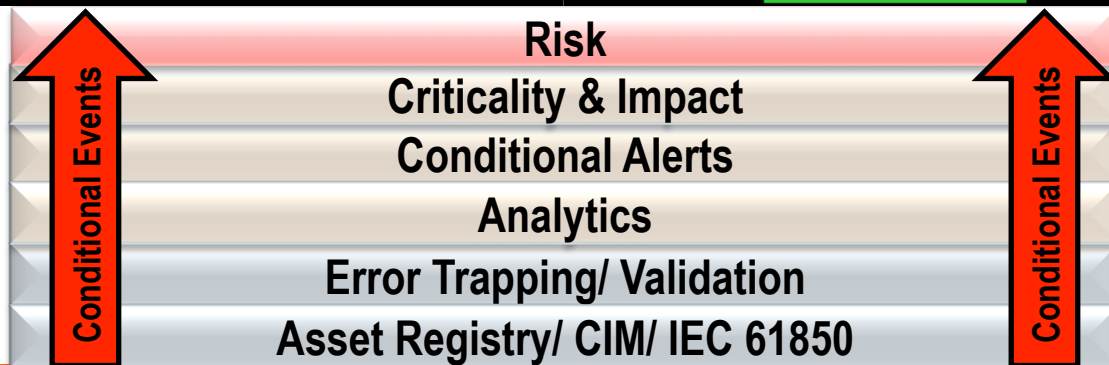
Alerts

| Equipment | dScoreE | RiskE | ConfE | Component | CompAlert | dScoreC | dScoreC |
|-----------|---------|-------|-------|-----------|------------------|---------|----------|
| T1 | 174 | 25 | B | Bushing | Capacitance ARMS | 100 | 3/17/201 |
| T2 | 167 | 20 | A | LTC | LTC stuck | 100 | 3/21/201 |
| T1 | 164 | 15 | A | Bushing | HiHiPowerFactor | 100 | 3/17/201 |
| T1 | 139 | 15 | C | Capacity | >95% | 30 | 3/17/201 |
| CB2 | 114 | 15 | A | DCSystem | LoVoltage | 100 | 3/17/201 |
| T2 | 94 | 19 | A | DGA | Gas Level H | 10 | 3/17/201 |
| T2 | 89 | 8 | A | Oil | Temp Hi | 3 | 3/17/201 |
| CB1 | 89 | 4 | D | PF | ExpertRating | 10 | 3/17/201 |

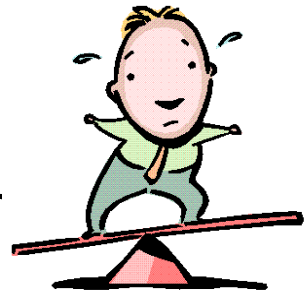
CapEx—Watch List

Risk -Watch List

| Equipment | dScoreE | riskE | confE | PercCapacity | RevImpact |
|-----------|---------|-------|-------|--------------|-----------|
| T1 | 174 | 25 | B | 31.90 | 2,114,783 |
| T2 | 94 | 19 | A | 32.86 | 2,118,384 |
| CB1 | 15 | 3 | D | 89.90 | 429,482 |
| CB251 | 15 | 3 | C | 82.88 | 428,397 |
| CB2512 | 15 | 3 | A | 80.39 | 421,545 |
| CB2534 | 15 | 3 | D | 95.31 | 364,159 |
| CB12 | 6 | 3 | D | 91.43 | 433,432 |
| CB252 | 6 | 3 | A | 80.23 | 421,087 |
| CB253 | 6 | 3 | A | 85.37 | 347,029 |
| CB254 | 6 | 3 | C | 80.73 | 339,035 |



What Everyone Wants



- Greater asset awareness for improved O&M spend
- Making the right decisions in CapEx
 - Need a targeted approach
 - & the ability to balance between O&M and CapEx based on priorities
 - Must reduce O&M, or keep it steady while increasing customer base, or do you have some flex?
 - Must defer CapEx or spend where it makes sense?
 - Be able to quickly adapt methods in a changing business climate.
 - The PI System gives us the kind of flexibility we need

Summary—Evolving Asset Management

- The PI System provides an out-of-the box, scalable, & secure infrastructure for Doble to work with various stakeholders
- Shared data and algorithms gives us one version of the truth
 - Improved metrics around asset Health & Risks
- Correlate short-term conditions with long-term strategies for improved O&M and CAPEX spend
 - Offering efficient execution strategy
- Flexibility to combine views and manipulate data sources for:
 - *Improved asset prioritization*
 - *Targeted approach to asset management*
- Results in greater transparency across the enterprise for multiple stakeholders
- Allows us to achieve things never been done before

Summary—Analytics Path

- Leverage the innate tools within the PI system
- Front-end error-trapping and validation are essential
- Correlation Analytics will improve Confidence
- Bad data = Alerts
 - Provides a good test that analytics are working
 - Correct configuration, comms issues or data errors
 - Analytic infrastructure offers the same opportunity to prioritize, sort and address data issues

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THANK

YOU

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