

April 20, 2011 Randy Schrieber, Paul Bower ABB

Asset Health Center

Central Asset Management System to Alarm and Recommend
Actions Based Upon Incoming Data

WPO-105-1

Managing the Aging Installed Base

- Very aged infrastructure (average 40+ years)
- Lack of expert knowledge (retirees, non-replacements, etc.)
- Utilities cannot afford to continue time-based maintenance
- Utilities cannot afford to replace aging equipment

- Utilities would like to move to condition-based maintenance to reduce cost and also reduce risk
- Data for asset management is often distributed in various locations and formats
- Monitoring systems are being installed to provide timely data

- Several utilities are pulling data from many places and concentrating it in new data servers, then prompting the questions ...

What do I do with all this data?
and what data should I be gathering?

And, I only want one system for all my assets!

Traditional Scope of ABB Support Services



▪ Transformers

- 70% of large power transformers are ABB legacy
- Risk assessment and life extension
- Advanced diagnostics and testing
- LTC repairs and replacements
- Factory repair and remanufacturing



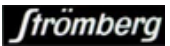
▪ High Voltage Breakers

- Support capability for 60-70% of installed base
- Parts, Refurbishment and Retrofit
- Advanced diagnostics – radiography and SF6 leak detection
- Risk assessment and life extension

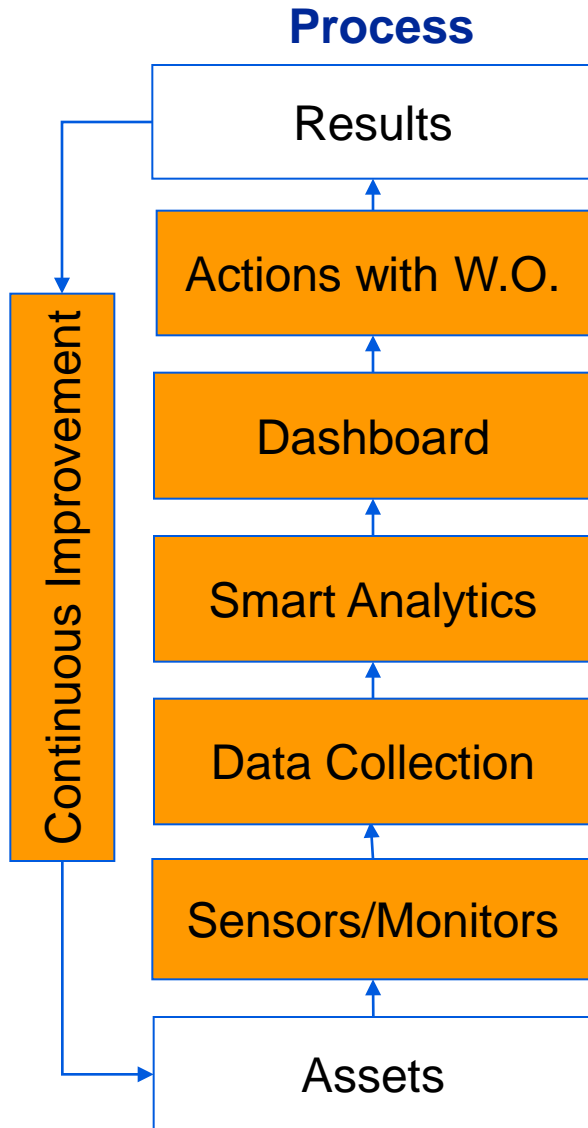


▪ Low- and Medium-Voltage Switchgear

- Over 1 million breakers in service in US
- Parts, Refurbishment, Retrofit, Roll-in Replacement
- Protection & Control assessment and upgrades
- Nuclear & Non-nuclear



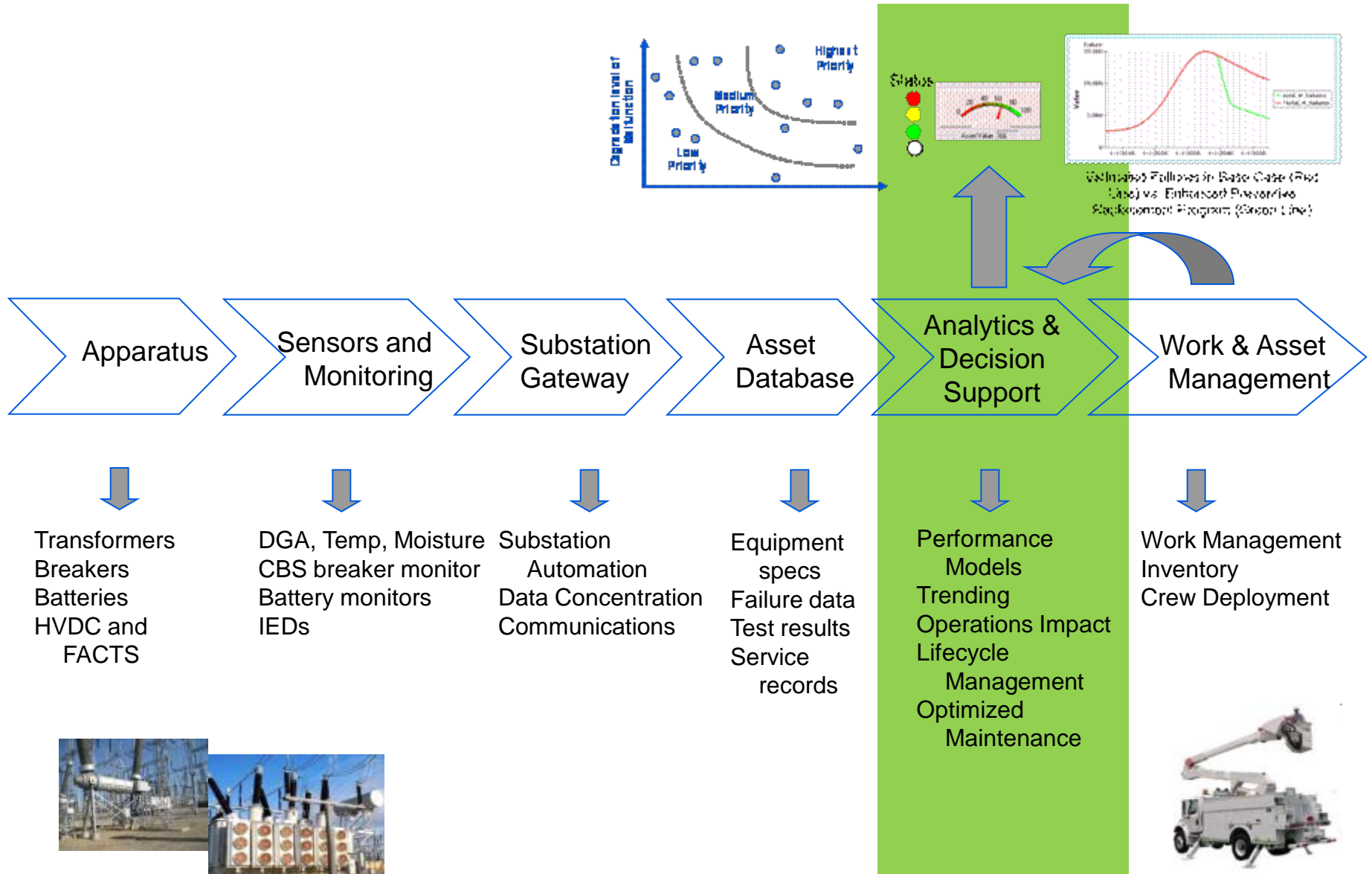
Overall Asset Health Center Vision



Benefits

Business Management	Overview of system operational conditions with drill down capability
Service Levels	Clear and complete set of service performance levels
Decision Making	Business decisions based on data to minimize uncertainty and increase confidence in the direction of the business
Operation Improvement	Improved operational efficiencies by making high priority information available to employees
Life Cycle View	Life cycle cost analysis consistently applied to determine how to best spend funds – right-size O&M and CapEx replacement. Influence specs of new equipment.
Financial Impact	Forecasts of asset performance impact to future revenue requirements
Risk Management	Management of system operational risks with streamlined proactive sensing, analytic and data mining technology.

End-to-End Solution to Drive Asset Performance



End-to-End Solution to Drive Asset Performance

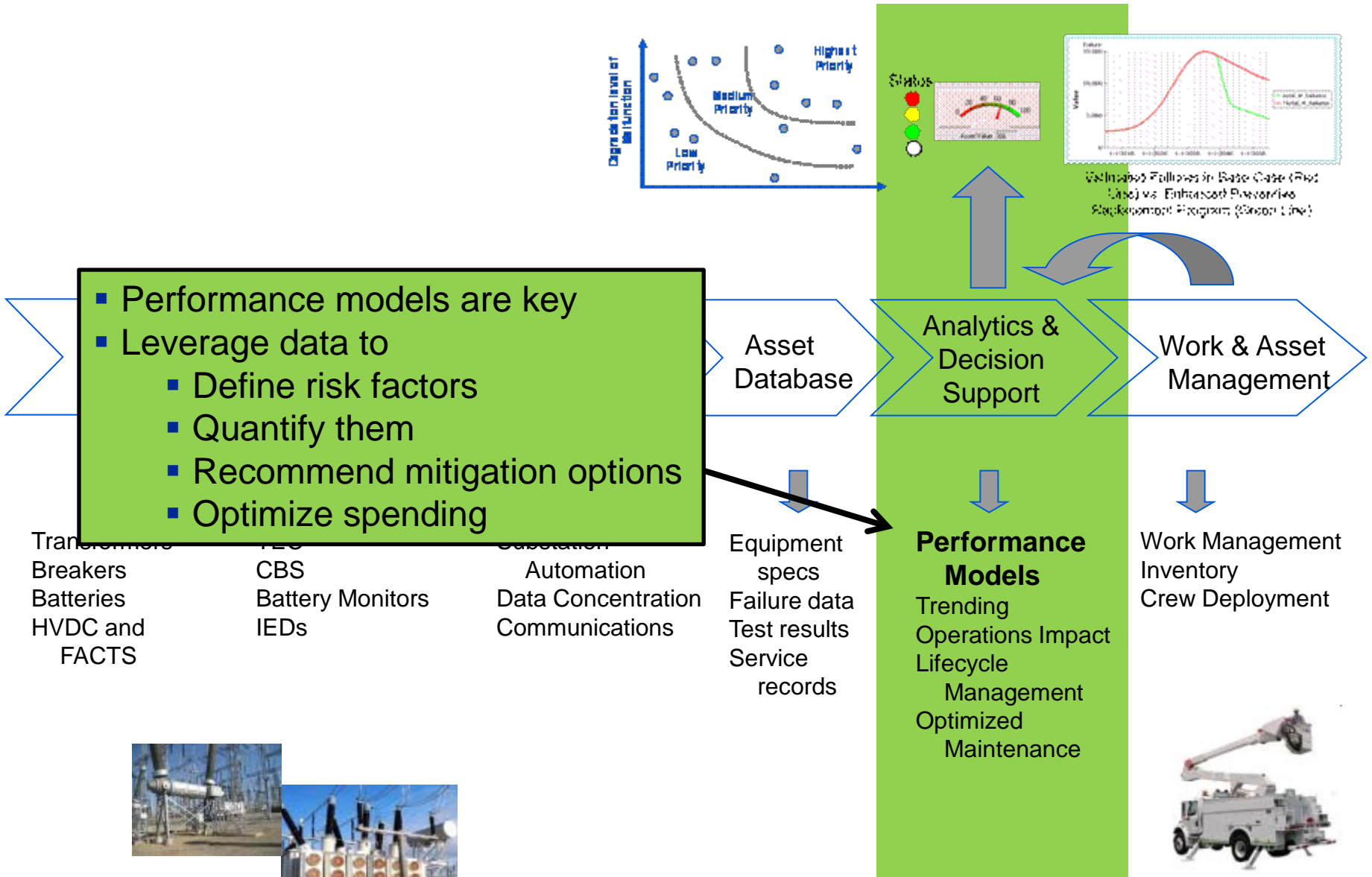
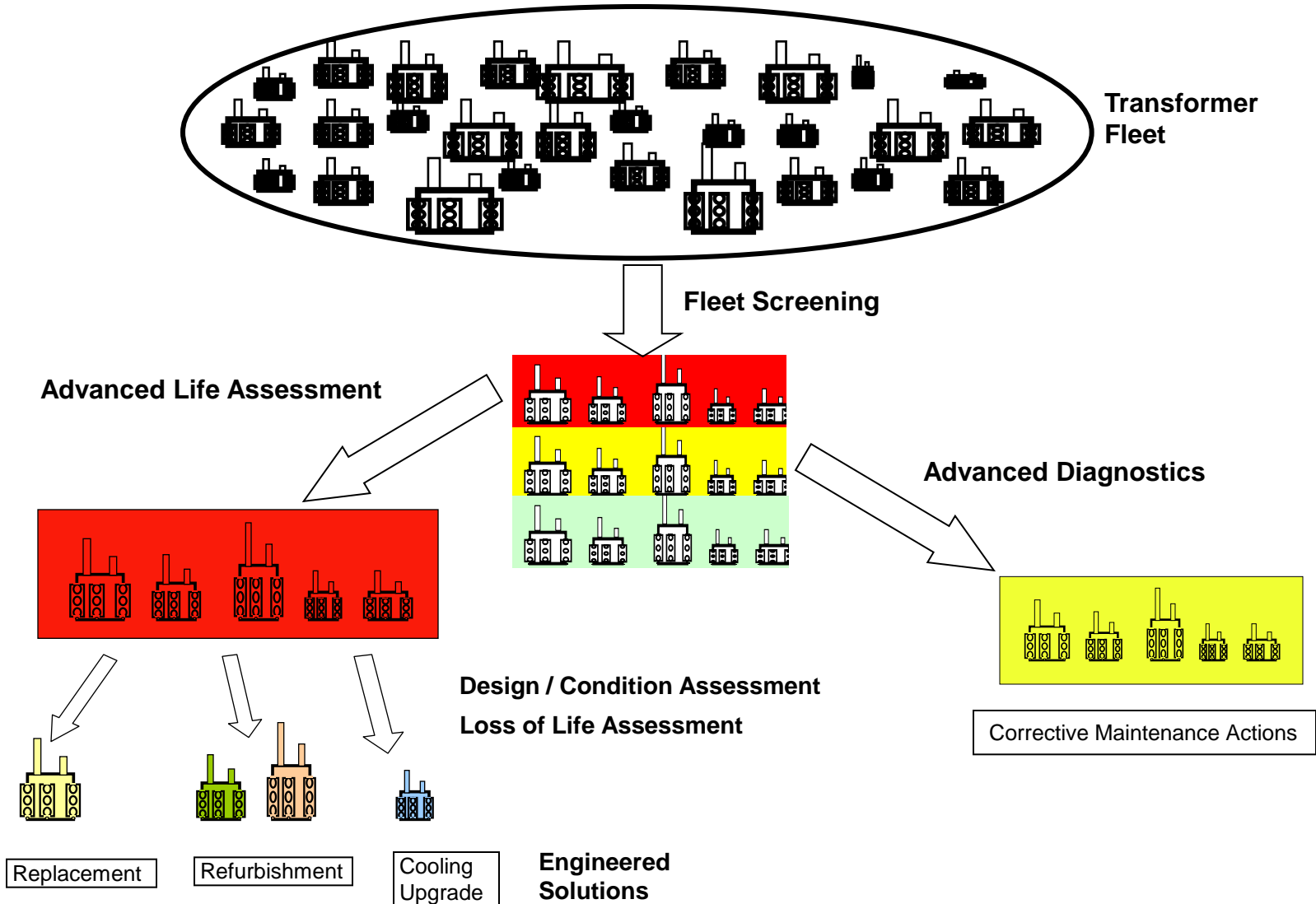


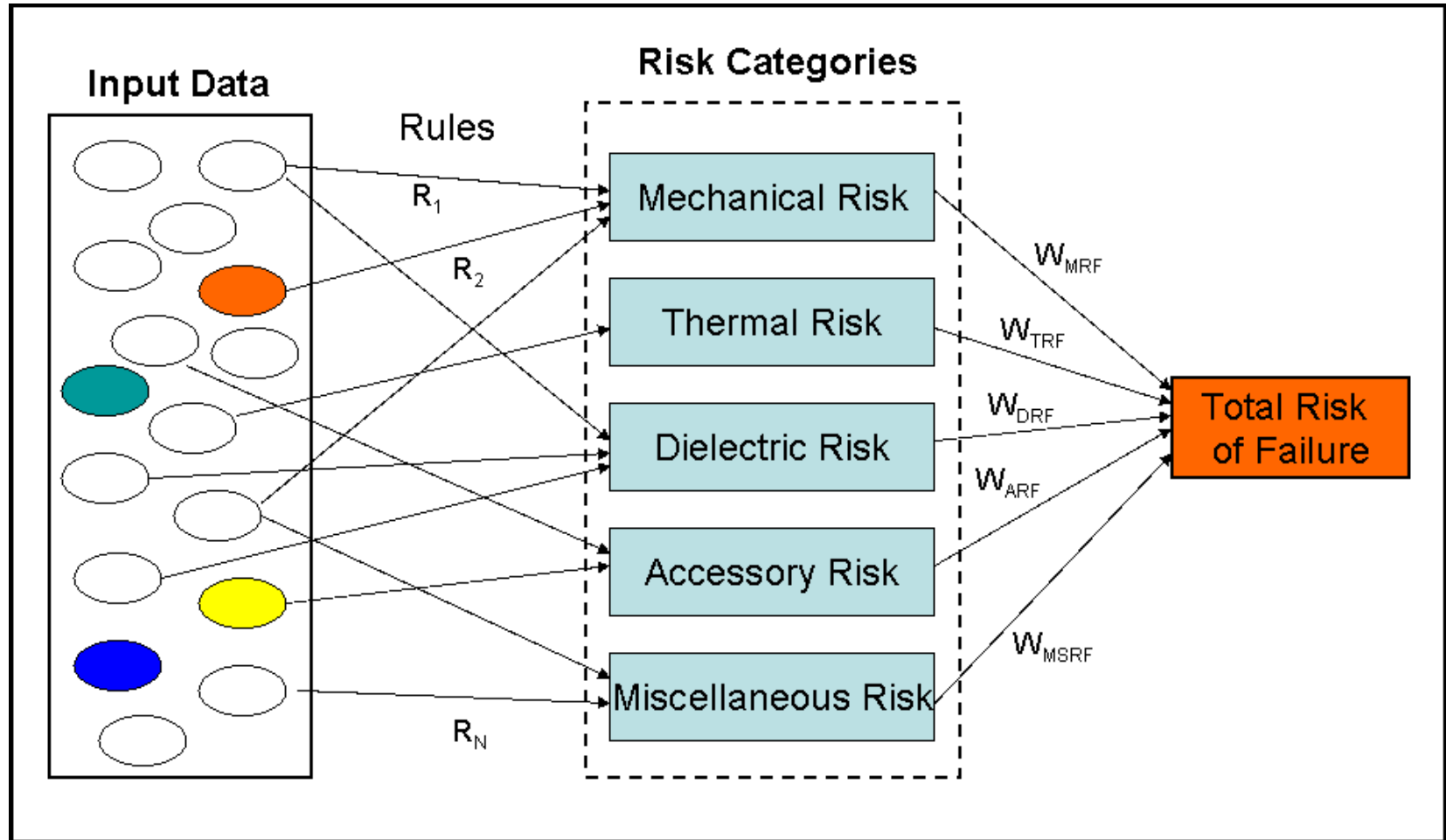
ABB MTMProgram

Well Established Fleet Risk Assessment – Patented Process



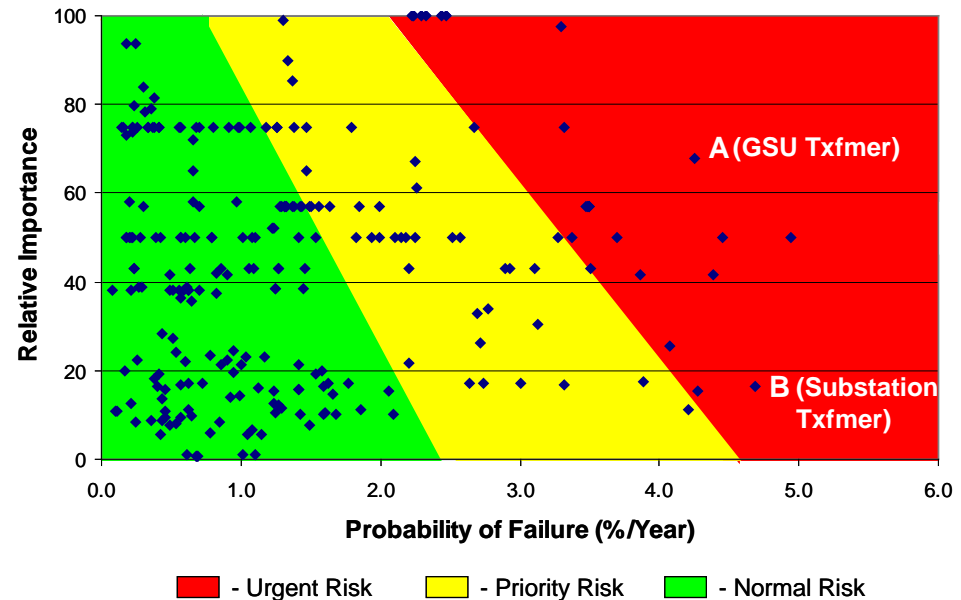
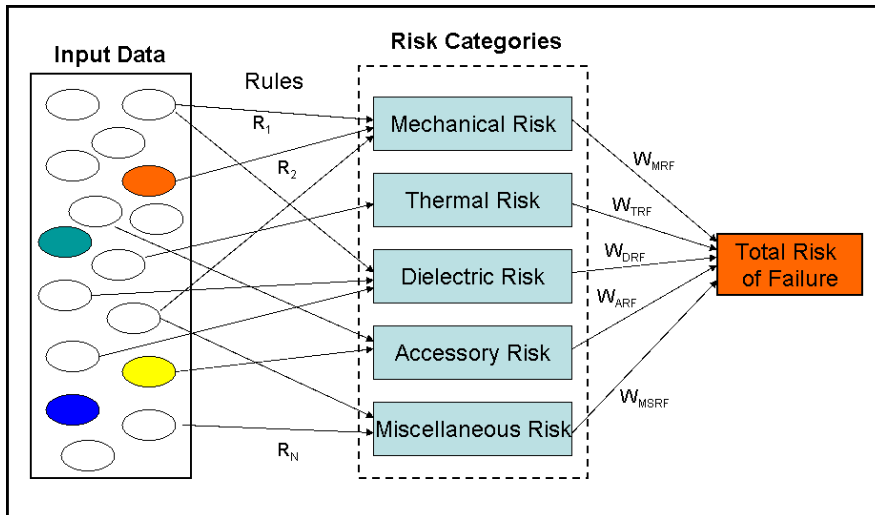
Transformer Fleet Assessment – Process Flow Map

Includes Risk Factors Specific to Individual Designs



Transformer Fleet Assessment – Process Flow Map

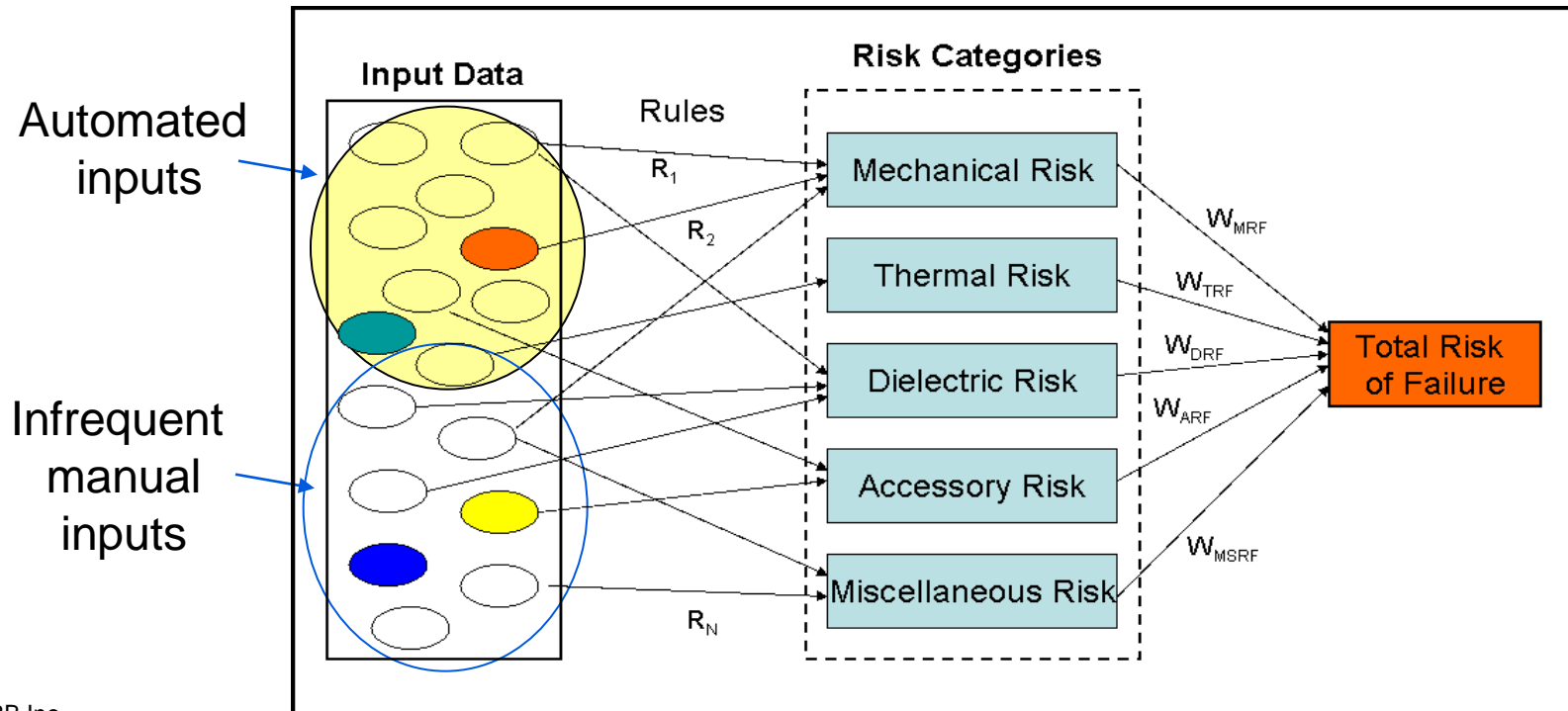
- One-time data gathering process
- Utilizes ABB Risk of Failure algorithms developed using ABB legacy design knowledge and field experience
- Uses the unit criticality as defined by the utility to prioritize the work required to reduce risk



Transformer or Breaker Risk Assessment

Risk Monitoring with Remote Monitoring and Consolidated Data

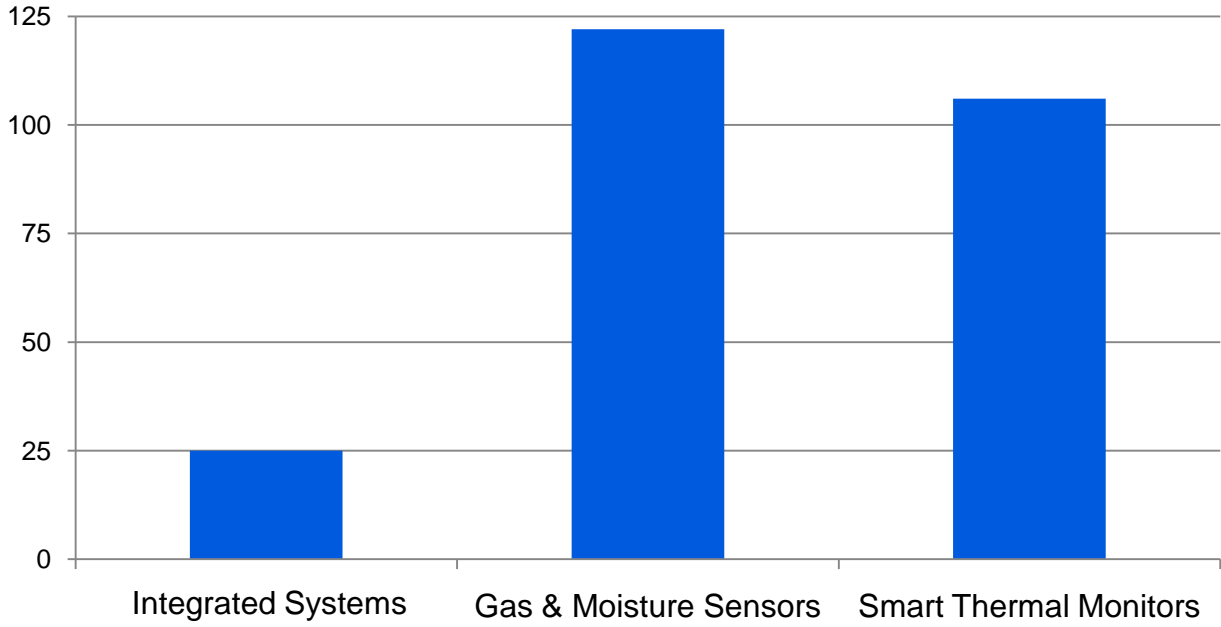
- Remote monitoring can continuously update many factors in the risk assessment to provide a near-real time alert for critical risks as they develop
- Defer routine inspections and PM but still stay ahead of risks that can cause an unexpected outage



Mix of Sensor Usage

Units Shipped with ABB Transformers

Gas & Moisture sensors and Thermal Monitors are the predominant sensors installed on new power transformers



Sensor Price Range

System / Sensor	Price Range (\$)
Integrated monitor	12 K – 60 K
Gas in Oil	5 K – 50 K
Moisture in Oil	1.5 K – 3 K
Thermal Monitor	5 K – 15 K
Bushing Monitor	3 K – 15 K

Individual Asset Assessment

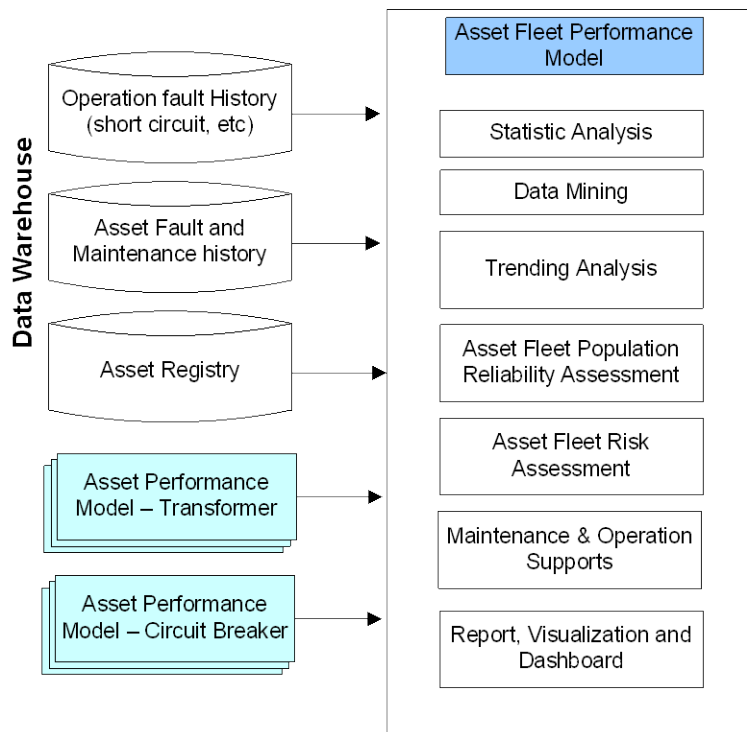
- Define contributing risks
- Quantification of Risk Factors
- Recommendation of mitigation actions and urgency
- Auto-notification of responsible parties
 - Everyone knows all we know
- Generation of draft work order for review
- Data mining capability to allow searches for similar issues and/or similar units in the fleet



Fleet Assessment

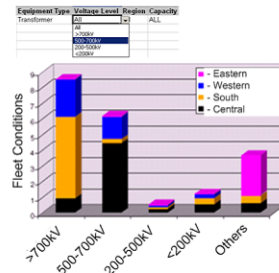
- Optimize spending across an asset fleet to address the highest risks first
- Quantify the unaddressed risks at selected spending levels
- Optimize the capital replacement program to evaluate the tradeoffs with continued maintenance expense and/or unaddressed risk
- Compliance reporting

Asset Fleet Performance Model

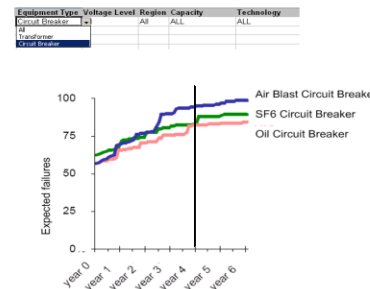


Sample Outputs

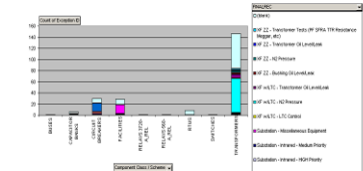
Fleet Condition



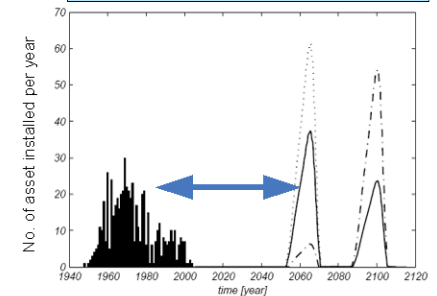
Fleet Performance Trending



Root Cause Identification



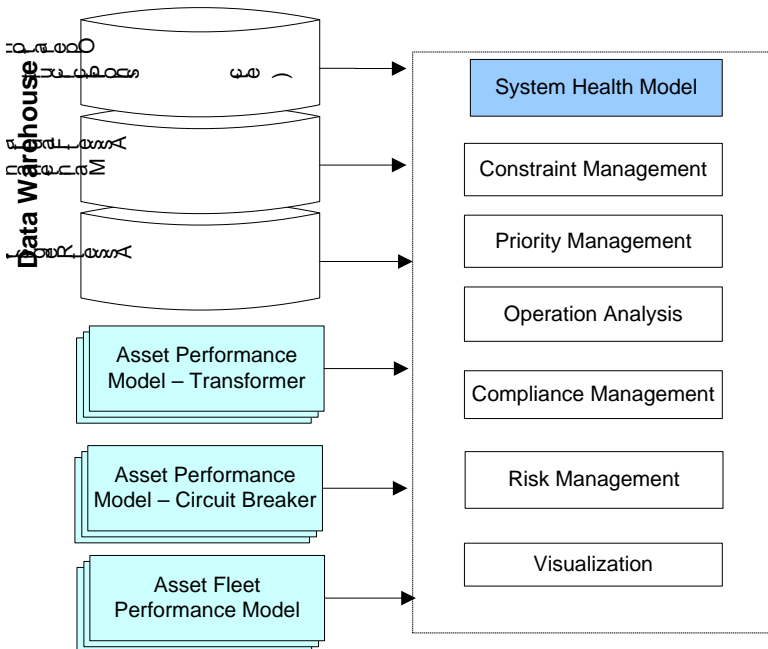
Fleet Replacement Planning



System-Wide Assessment

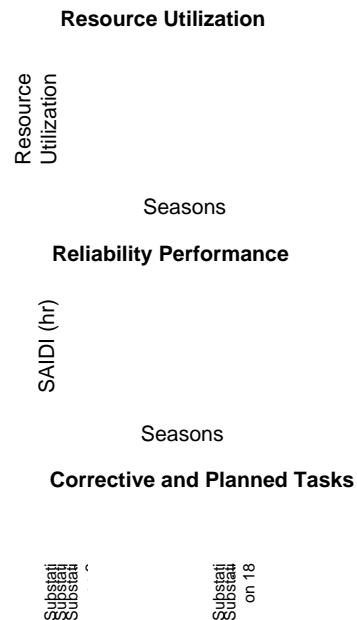
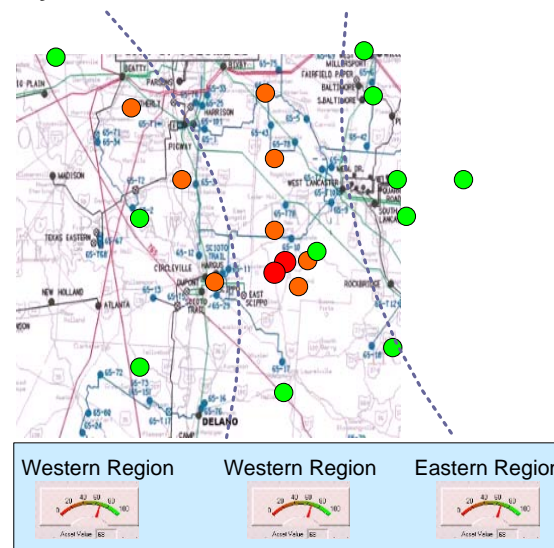
- Define risk by region or substation
- Optimize O&M and CapEx replacement spend across assets for a balanced risk mitigation plan
 - Transformers
 - HV Breakers
 - Station batteries, ...

System Health Model



Sample Outputs

System Health Status



Integrating the Data, Algorithms, Reporting, ERP

- ABB acquired Ventyx in 2010
 - Leading business solutions provider offering software, data and advisory services
- Ventyx acquired Insert Key Solutions in Dec 2010
 - Reliability focused process improvement at nuclear and thermal plants
- Ventyx acquired Obvient Strategies in Jan 2011
 - Obvient's FocalPoint Platform provides data integration and visualization capabilities

Asset Health Center – Solution Architecture

Ad Hoc Query, Reporting & Analysis



Activity Monitoring & Trending



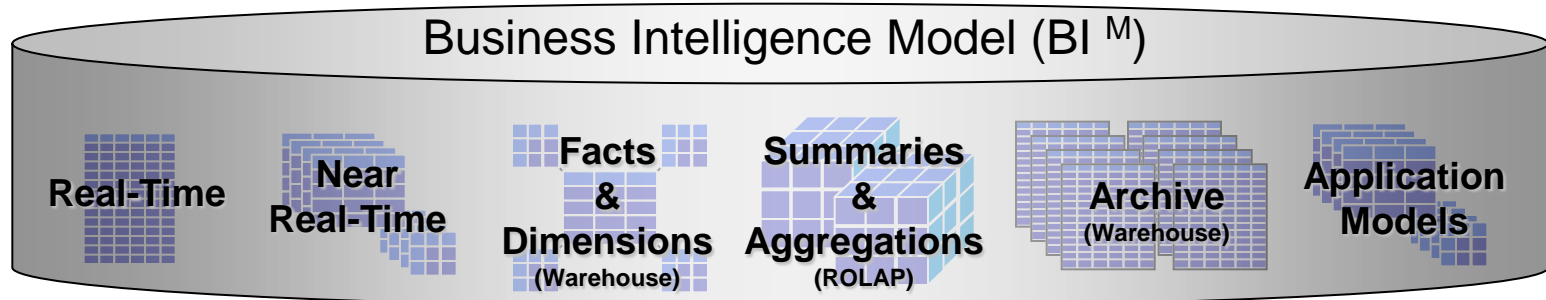
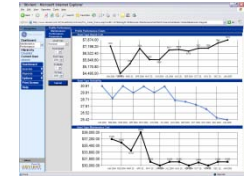
Digital Dashboards



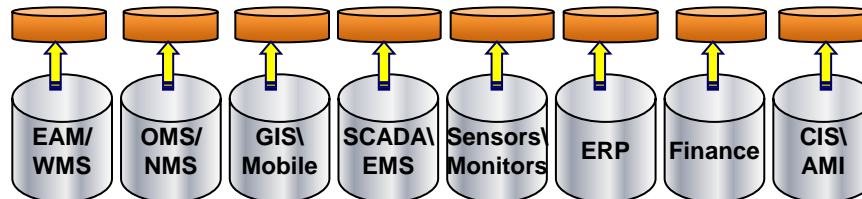
External Communications & Notifications



BI Applications
Asset Mgmt.,
Cap Project Mgt., etc.

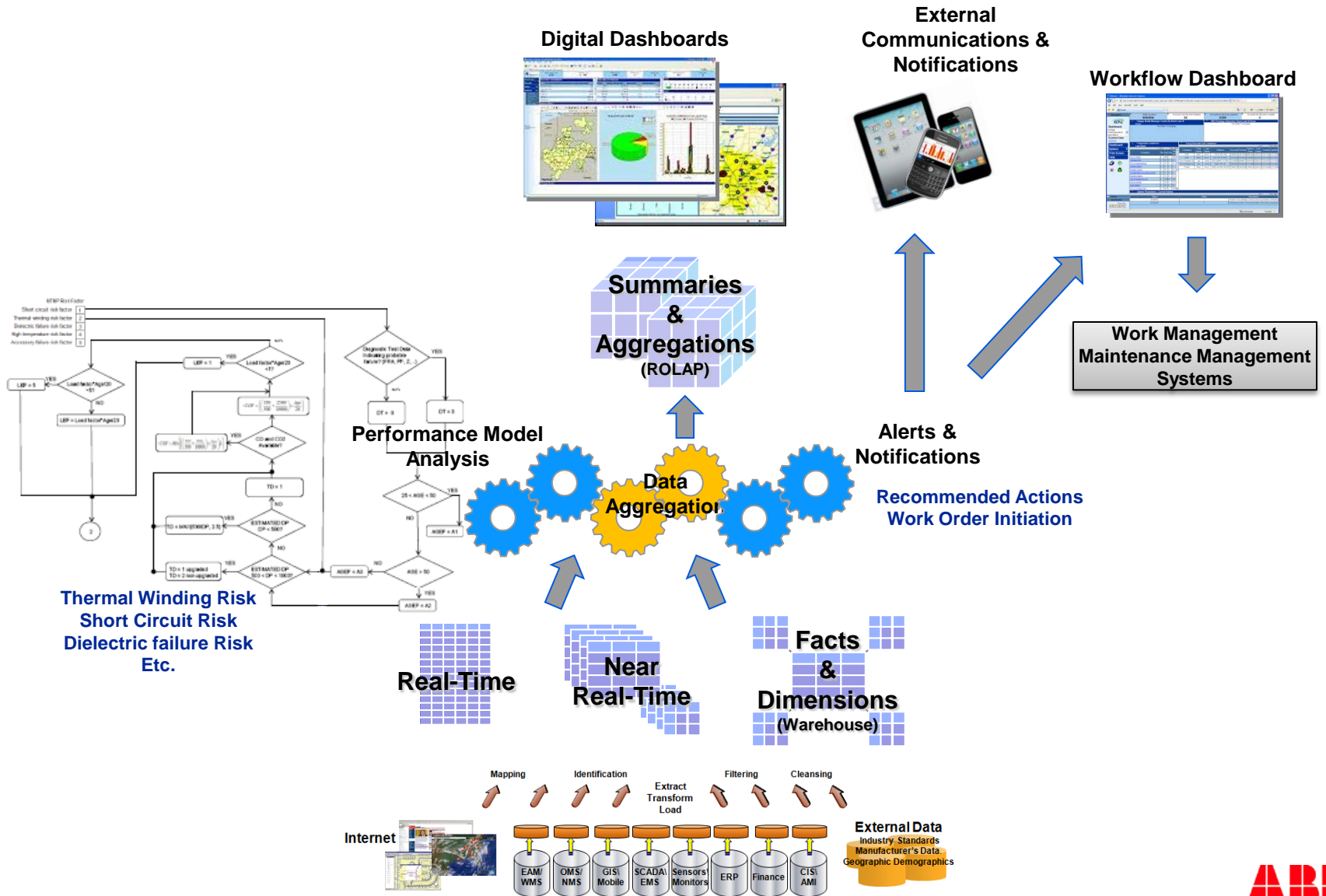


Internet

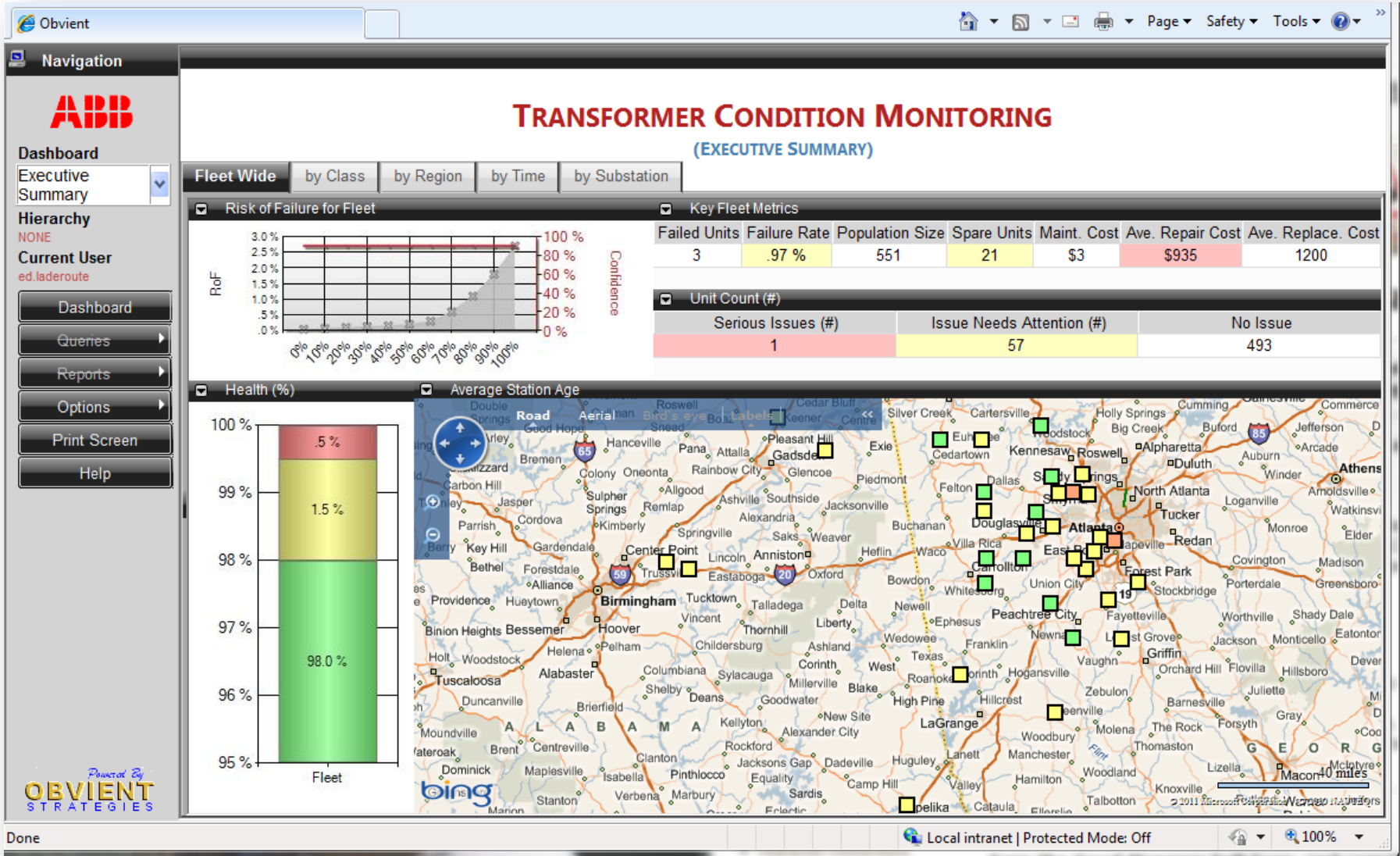


External Data
Industry Standards
Manufacturer's Data.
Geographic Demographics

Asset Health Center – Information Flow and Analysis



Asset Health Center – Transformer Fleet



Asset Health Center – Transformer Fleet by Class

Obvient
Page Safety Tools

Navigation

ABB

Dashboard

Executive Summary

Hierarchy

Current User: ed.laderoute

Dashboard

Queries

Reports

Options

Print Screen

Help

TRANSFORMER CONDITION MONITORING

(EXECUTIVE SUMMARY)

Fleet Wide **by Class** by Region by Time by Substation

	Failed Units (# - last 12 months)	Failure Rate (%)	Population Size (# of units)	Available Spare Units (#)	Maintenance Cost (k\$/unit)	Average Cost to Repair (k\$)	Average Cost to Replace (k\$)
< 69 kV	2	.07 %	5	21	\$0	\$1	7
69 kV - 230 kV	1	.04 %	5	2	\$7	\$1	6
> 230 kV	0	.01 %	1	1	\$9	\$2	3

Health (%)

Unit Count (#)

	Serious Issues (#)	Issue Needs Attention (#)	No Issue
< 69 kV	1	32	341
69 kV - 230 kV	0	7	135
> 230 kV	0	2	27

Average Station Age

Done
Local intranet | Protected Mode: Off
100%



Asset Health Center – Transformer Fleet by Class

Obvient FocalPoint Composite WebPart - Windows Internet Explorer

Asset Details

Asset Detail [731412]

Asset Id: **731412** Health Index: **57.98 %** Utility: **Energy South**
 Asset Type: **Auto Transformer** Health Score: **207 of 357** Operating Area: **AUR**
 Manufacturer: **General Electric** Station: **TSS - 167 - Senoia**
 Model Number: **N/A** Circuit / Utility Designation: **TR 94 B PHASE**
 Serial Number: **K547387**
 Manufacture Date: **Jul 01, 1974** Annual Maintenance Cost:
 Age: **35** Replacement Cost:

Attributes | Health Index | CM Activity | Loading | Assessments

Asset Attributes [731412]

LTC Manufacturer:	
LTC Model:	
LTC Date of Manufacture:	
LTC Annual Maint Cost:	
LTC Replacement Cost:	
Max MVA:	333 MVA
Mid MVA:	
Min MVA:	
Primary Voltage Rating:	765 kV
Secondary Voltage Rating:	345 kV
Tertiary Voltage Rating:	33 kV
Nominal MVA:	333 MVA

Map: Shows a geographic view of the area around Senoia, GA, with a 40-mile scale bar.

Summary Table:

Average Cost to Replace (k\$)
7
6
3

No Issue Summary:

341
135
27

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Asset Health Center – Transformer Fleet by Class

Obvient
Page Safety Tools

Navigation

ABB

Dashboard

Executive Summary

Hierarchy

NONE

Current User

ed.laderoute

Dashboard

Queries

Reports

Options

Print Screen

Help

Obvient FocalPoint Composite WebPart - Windows Internet Explorer

Asset Details

Asset Detail [731412]

Asset Id: 731412	Health Index: 57.98 %	Utility: Energy South
Asset Type: Auto Transformer	Health Score: 207 of 357	Operating Area: AUR
Manufacturer: General Electric		Station: TSS - 167 - Senoia
Model Number: N/A		Circuit / Utility Designation: TR 94 B PHASE
Serial Number: K547387		Annual Maintenance Cost: <input type="text"/>
Manufacture Date: Jul 01, 1974		Replacement Cost: <input type="text"/>
Age: 35		

Attributes | Health Index | CM Activity | **Loading** | Assessments

Load Peaks [731412]

Health Index

Monthly Chart

Monthly Chart (N)

7
6
3

341
135
27

Local intranet | Protected Mode: Off



Asset Health Center – Asset Class Scorecard

Obvient - Windows Internet Explorer

http://winxptemplate2/DEV606ORA/common/frm_mode_frame.aspx?_WI=1011&_HT=666&m

Navigation Click Arrow to Show Query

Health Index Scorecard | Health Index Chart | Health Score Chart | Health Index Trend | Loading | Asset Age

Assets with Worst Health Index

Asset ID	Asset Age	Age Score	CM Score	Health Score	Max Score	Health Index	Station	Manufacturer	Serial Number	VE Map	Google Map
731412	35	6	78	207	357	57.98 %	TSS - 167 - Senoia	General Electric	K547387	↕	↕
72876	36	6	83	224	357	62.75 %	TSS - 112 - Helena	Westinghouse	7001989	↕	↕
731411	33	6	83	235	357	65.83 %	TSS - 167 - Senoia	Westinghouse	7002528	↕	↕
72875	36	6	81	238	357	66.67 %	TSS - 112 - Helena	Westinghouse	7001990	↕	↕
731426	29	6	63	266	357	74.51 %	TSS - 86 - Ellenwood	Westinghouse	7002702	↕	↕
731440	20	6	55	267	357	74.79 %	TSS - 115 - Braselton	Cooper Power Systems	C0717751	↕	↕
731439	14	8	75	269	357	75.35 %	TSS - 103 - Odum	Smit	220214	↕	↕
731437	20	6	74	270	357	75.63 %	TSS - 51 - Peachtree	General Electric	D590849 XAM3009	↕	↕
1475408	34	6	86	271	357	75.91 %	STA - 13 - Douglas	Westinghouse	7002230	↕	↕
72880	39	6	82	273	357	76.47 %	TSS - 112 - Helena	Westinghouse	7001564	↕	↕
731409	36	6	79	275	357	77.03 %	TSS - 144 - Woodstock	Westinghouse	7002227	↕	↕
72881	36	6	81	276	357	77.31 %	STA - 23 - Dearing	Westinghouse	7002033	↕	↕
731410	36	6	70	276	357	77.31 %	TSS - 144 - Woodstock	Westinghouse	7002226	↕	↕
731413	35	6	82	276	357	77.31 %	TSS - 167 - Senoia	General Electric	K547388	↕	↕
731438	20	6	62	277	357	77.59 %	TSS - 103 - Odum	ABB	AEM21934	↕	↕
731408	33	6	86	278	357	77.87 %	TSS - 167 - Senoia	Westinghouse	7002527	↕	↕
1475432	20	6	68	279	357	78.15 %	TSS - 138 - Tennille	Cooper Power Systems	C0717752	↕	↕
1475431	40	4	62	280	357	78.43 %	TSS - 138 - Tennille	General Electric	D596508	↕	↕
72874	36	6	82	280	357	78.43 %	STA - 23 - Dearing	Westinghouse	7002032	↕	↕
731424	35	6	80	280	357	78.43 %	TSS - 179 - Cedartown	Westinghouse	7002298	↕	↕
1475423	40	4	60	281	357	78.71 %	TSS - 88 - Thomas	ASEA	6201218	↕	↕
1475422	17	8	86	282	357	78.99 %	TSS - 88 - Thomas	ABB	AEM31031	↕	↕
1475409	34	6	75	283	357	79.27 %	STA - 13 - Douglas	General Electric	K547058	↕	↕
731423	39	6	80	286	357	80.11 %	TSS - 167 - Senoia	Westinghouse	7001563	↕	↕
72879	39	6	82	288	357	80.67 %	TSS - 112 - Helena	Westinghouse	7001562	↕	↕

Dashboard

AMSHIHealth Index Results

Current User paul.bower

Dashboard

Options

Dashboards

Executive Summa...

Emergency Respo...

Current Outages

Work Backlog

Work Commitments

Work Performance

Work Volume

Inbox

Powered By OBVIENT STRATEGIES

Asset Health Center – Asset Class Loading Scorecard

Obvient - Windows Internet Explorer

http://winxptemplate2/DEV606ORA/common/frm_mode_frame.aspx?_WI=1011&_HT=666&m

File Edit View Favorites Tools Help

Obvient

Navigation

Health Index Scorecard | Health Index Chart | Health Score Chart | Health Index Trend | **Loading** | Asset Age

OBVIENT focalPOINT SOLUTIONS

Dashboard
AMSH\Health Index Results

Current User
paul.bower

Dashboard

Options

Dashboards

Executive Summa...

Emergency Respo...

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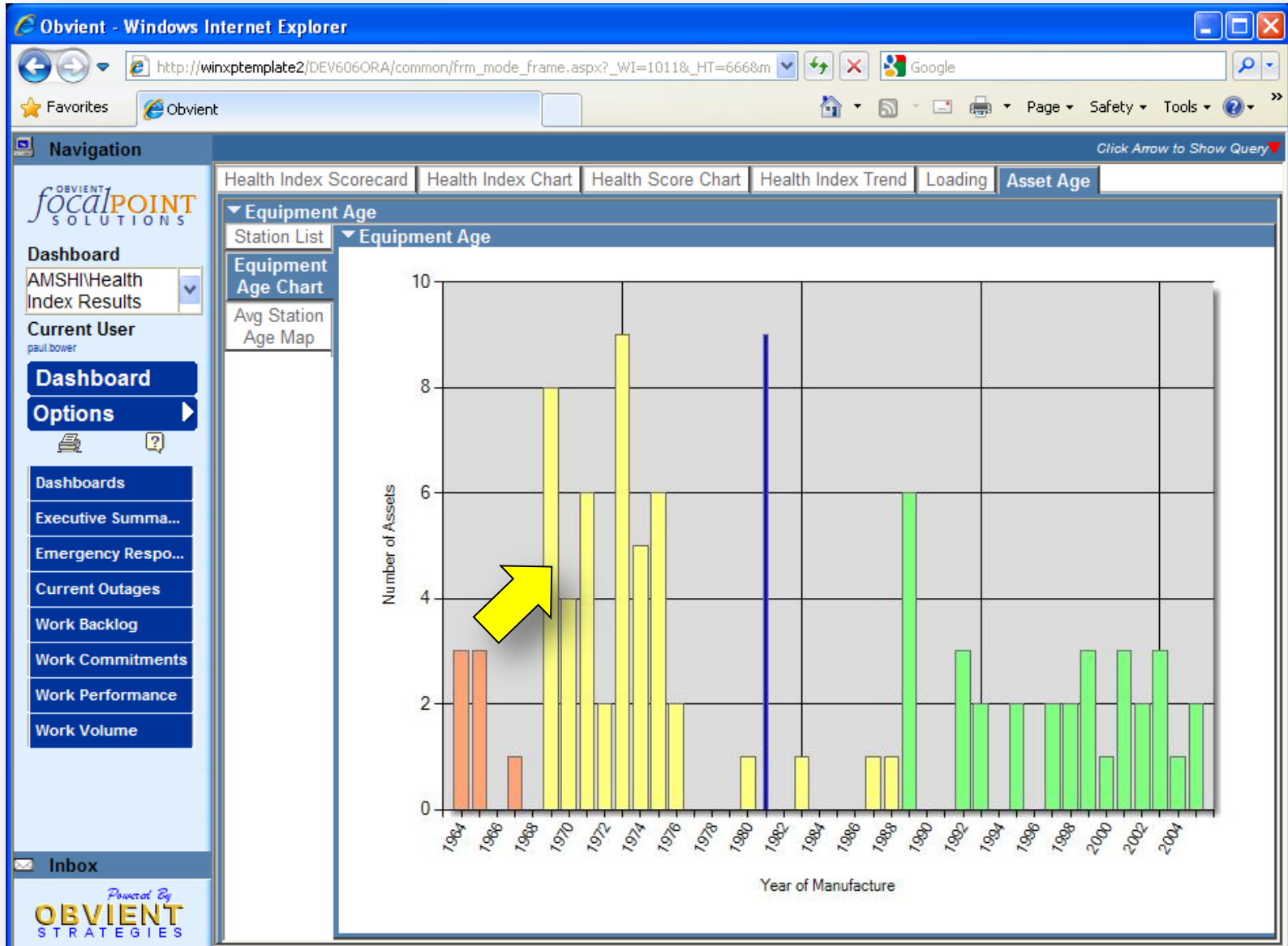
Powered By OBVIENT STRATEGIES

Click Arrow to Show Query

(EXL PeakLoad T Title)

Asset Id	Zero Readings	Good Readings	Number of A, B, C, D Ratings	Number of A, B, C Ratings	Number of A, B Ratings	Number of A Ratings	Load Health Index	Number of Overheating Peaks	Modified Load Health Index	Modified Load Health Index (Eq)
731413	7	52	3	3	3	3	0.2308	27	0	0
731412	7	52	3	3	3	3	0.2308	27	0	0
731414	7	52	3	3	3	3	0.2308	27	0	0
731423	7	52	4	3	3	3	0.25	27	0	0
731408	7	52	4	3	3	3	0.25	27	0	0
731411	7	52	4	3	3	3	0.25	27	0	0
72874	0	59	13	2	1	0	0.2712	26	0	0
72882	0	59	13	2	1	0	0.2712	26	0	0
72881	0	59	13	2	1	0	0.2712	26	0	0
2722759	50	10	8	2	0	0	1	0	1	1
72875	6	51	34	19	5	4	1.2157	4	1	1
72876	6	51	34	19	5	4	1.2157	4	1	1
72877	6	51	34	19	5	4	1.2157	4	1	1
1475409	0	59	51	28	5	0	1.4237	0	1	1
72878	10	47	34	22	7	4	1.4255	1	1	1
72879	10	47	34	22	7	4	1.4255	1	1	1
72880	10	47	34	22	7	4	1.4255	1	1	1
1475408	0	59	54	33	5	0	1.5593	0	2	2
1475415	9	51	50	28	2	2	1.6078	0	2	2
1475429	0	60	50	32	15	3	1.6667	0	2	2
731409	10	50	49	31	9	0	1.78	0	2	2

Asset Health Center – Asset Class Age Distribution



Asset Health Center – Asset Class Age Distribution

The screenshot shows a web browser window displaying an application interface. The main content area shows a table titled "Asset List by Manufacture Year [AutoTransformer - 1969]". The table has the following data:

Asset Number	Age	Manufactured	Station Name	Manufacturer	Model Number	Circuit
1475404	40	January, 1969	TSS - 46 - Fairburn	General Electric	N/A	TR 81
731436	40	January, 1969	TSS - 51 - Peachtree City	General Electric	N/A	TR 84
1475431	40	January, 1969	TSS - 138 - Tennille	General Electric	N/A	TR 82
1475419	40	January, 1969	TSS - 155 - Rock Spring	General Electric	N/A	TR 84
1475416	40	January, 1969	TSS - 156 - Dahlonega	General Electric	N/A	TR 81
1475434	40	January, 1969	TSS - 172 - Holly Springs	General Electric	N/A	TR 81
731427	40	June, 1969	TSS - 76 - Chatsworth	ASEA	N/A	TR 82
1475423	40	June, 1969	TSS - 88 - Thomaston	ASEA	N/A	TR 84

The interface includes a navigation sidebar on the left with sections for "Dashboard" (AMSHIHealth Index Results), "Current User" (paul.bower), and "Options" (Dashboards, Executive Summa..., Emergency Respo..., Current Outages, Work Backlog, Work Commitments, Work Performance, Work Volume). The bottom of the page shows a status bar with "Done", "Local intranet", and "100%" zoom.

Asset Health Center – Parameters & Equations

The screenshot displays the Obvient software interface, which is used for configuring parameters and equations for asset health monitoring. The interface is divided into several sections:

- Navigation Panel (Left):** Contains a sidebar with the Obvient logo, a dashboard menu, and a list of dashboards including 'AMSHIHealth', 'Index Parameters', 'Current User', 'Dashboard', 'Options', 'Dashboards', 'Executive Summa...', 'Emergency Respo...', 'Current Outages', 'Work Backlog', 'Work Commitments', 'Work Performance', and 'Work Volume'.
- Parameters Section (Top):** Shows a list of parameters under 'Factors & Weights'. The parameters are categorized by 'Asset Type / Measure / Range' and include:
 - AirMagenticBreaker / AIR HYDRO PRESS (CM):**

Asset Type / Measure / Range	Factor	Weight	Score
No CMs	4	1	4
AIR HYDRO PRESS (CM) is > 0 and <= 1	4		4
AIR HYDRO PRESS (CM) is > 1 and <= 2	3		3
AIR HYDRO PRESS (CM) is > 2 and <= 5			
AIR HYDRO PRESS (CM) is > 5 and <= 70			
AIR HYDRO PRESS (CM) is > 70			
 - AirMagenticBreaker / AIR LEAK (CM):**
 - No CMs
 - AIR LEAK (CM) is > 0 and <= 1
 - AIR LEAK (CM) is > 1 and <= 2
 - AIR LEAK (CM) is > 2 and <= 5
 - AIR LEAK (CM) is > 5 and <= 70
 - AIR LEAK (CM) is > 70
 - AirMagenticBreaker / ALARM REPAIR (CM):**
 - No CMs
 - ALARM REPAIR (CM) is > 0 and <= 1
 - ALARM REPAIR (CM) is > 1 and <= 2
 - ALARM REPAIR (CM) is > 2 and <= 5
 - ALARM REPAIR (CM) is > 5 and <= 70
 - ALARM REPAIR (CM) is > 70
 - AirMagenticBreaker / ARC EX COMP (CM):**
 - No CMs
 - ARC EX COMP (CM) is > 0 and <= 1
 - ARC EX COMP (CM) is > 1 and <= 2
- OSIS - Obvient Strategies (Right):** Shows a detailed view of an equation named 'SendEmailWithAttachment'. The description is 'Send an email with an attachment'. The diagram illustrates the logic flow:
 - Inputs:** 'mail.obvj' (mail.obvient.com), 'null', and 'robert.henry' (robert.henry@obvient.com).
 - Operations:** 'Array' operations to combine email details, 'Object' operations to create a 'System.Net.Mail.MailMessage', and 'Execute' operations to send the message.
 - Logic:** A 'Getter' operation retrieves attachments from a 'System.Net.Mail.AttachmentCollection' and checks if the email body contains the word 'much'.
 - Output:** The final result is a 'System.Net.Mail.AttachmentCollection' containing the attachment 'd:\obvient\FortYargo-sitemap.pdf'.

Asset Health Center – Functional Expansion

Performance Model Closed-Loop - Measure Algorithms

Inputs: Inspection Data, Loading Data, Nameplate Data, History of Work
Design Information, Actions to Take, Performance Model

Outputs: Individual Asset Health Status, System Health Status, Alarm Notification
Individual Asset Health Trends, System Health Trends
Action(s) to Take
Generated Work Orders – Inspection, PM, CM

Performance Model Analysis - Measure Algorithms

Inputs: Inspection Data, Loading Data, Nameplate Data, History of Work
Design Information, Actions to Take, Performance Model

Outputs: Individual Asset Health Status, System Health Status, Alarm Notification
Individual Asset Health Trends, System Health Trends
Action(s) to Take

Discreet Measure over time Asset Health – Factors, Weights & Trending

Inputs: Inspection Data, Loading Data, Nameplate Data, History of Work

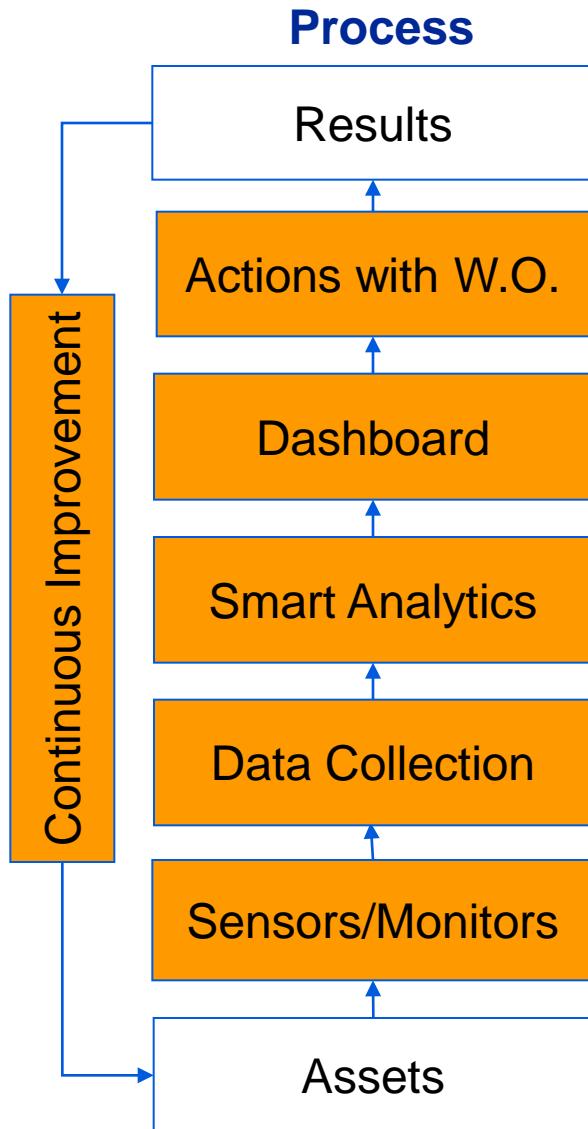
Outputs: Individual Asset Health Status, System Health Status, Alarm Notification
Individual Asset Health Trends, System Health Trends

Discreet Measure Analysis – Factors & Weights

Inputs: Inspection Data, Loading Data, Nameplate Data, History of Work

Outputs: Individual Asset Health Status, System Health Status, Alarm Notification

Overall Asset Health Center Vision



Benefits

Business Management	Overview of system operational conditions with drill down capability
Service Levels	Clear and complete set of service performance levels
Decision Making	Business decisions based on data to minimize uncertainty and increase confidence in the direction of the business
Operation Improvement	Improved operational efficiencies by making high priority information available to employees
Life Cycle View	Life cycle cost analysis consistently applied to determine how to best spend funds – right-size O&M and CapEx replacement. Influence specs of new equipment.
Financial Impact	Forecasts of asset performance impact to future revenue requirements
Risk Management	Management of system operational risks with streamlined proactive sensing, analytic and data mining technology.

Asset Health Center

- We believe that the convergence of domain expertise and system integration can be a great step forward in quantifying risk and optimizing spending plans
- Early identification of incipient failures can avoid unexpected and costly outages
- We are working closely with utilities to define their requirements for the system
- Product risk algorithms are already well developed, and more are in process
- Ventyx's Obvient FocalPoint software platform is already applied at many utilities, and seems well suited for visualization and as a dashboard
- Target for pilot application late 2010

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