Asset Management of Electrical System

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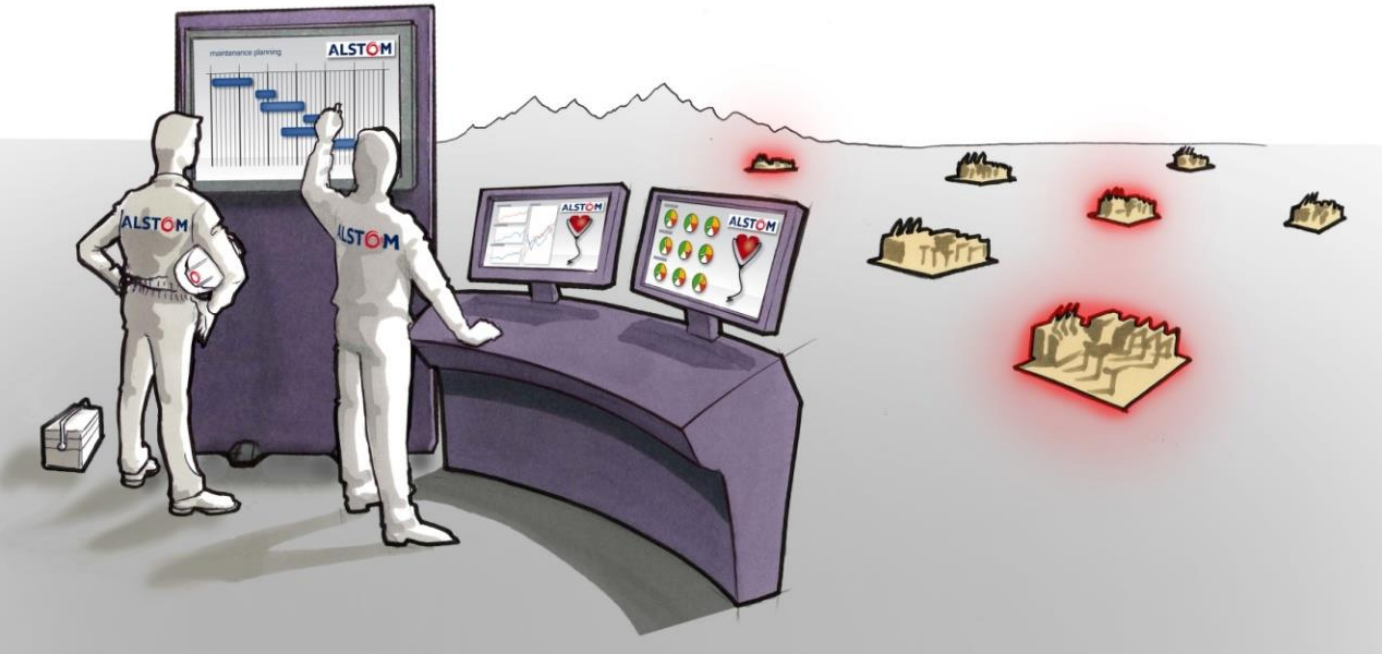

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Managing Electrical Assets: What's at stake?

Asset Health

CAPEX OPEX

Criticality

Asset Management Perspective

- How to develop the best **maintenance** strategy?
- How to develop the best **replacement** strategy?

Operations Perspective

- How to **maximize the use** of the existing assets?
- How to operate with a **risk management** vision?

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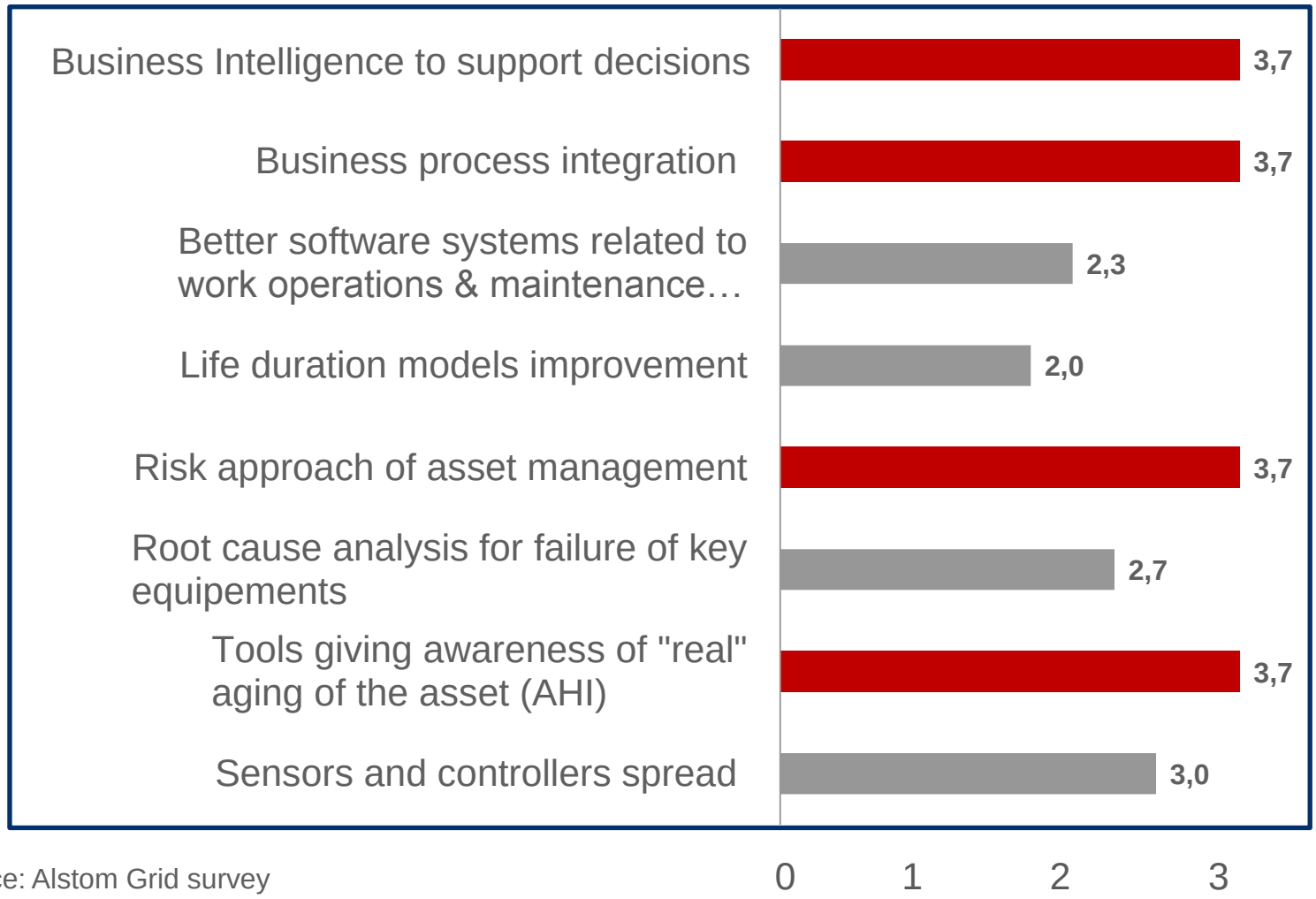
Asset management: Customer needs

Reliability	Avoid disaster events due to equipment failure Improve quality of service and reduce penalties
Financial	Minimize the asset impact on the balance sheet Minimize the financial risk exposure Optimize total expenditures (CAPEX and OPEX)
Strategic	Collect information to build plans and performance objectives Define maintenance and replacement strategy Justify investment plans to regulators and shareholders
Organizational	Bridge silo'ed organization - as per PAS 55 / ISO 55K standard Capture and grow knowledge Maximize the value of existing data and online monitoring tools

An Asset management survey: Key investment priorities from utilities



Source: Alstom Grid survey

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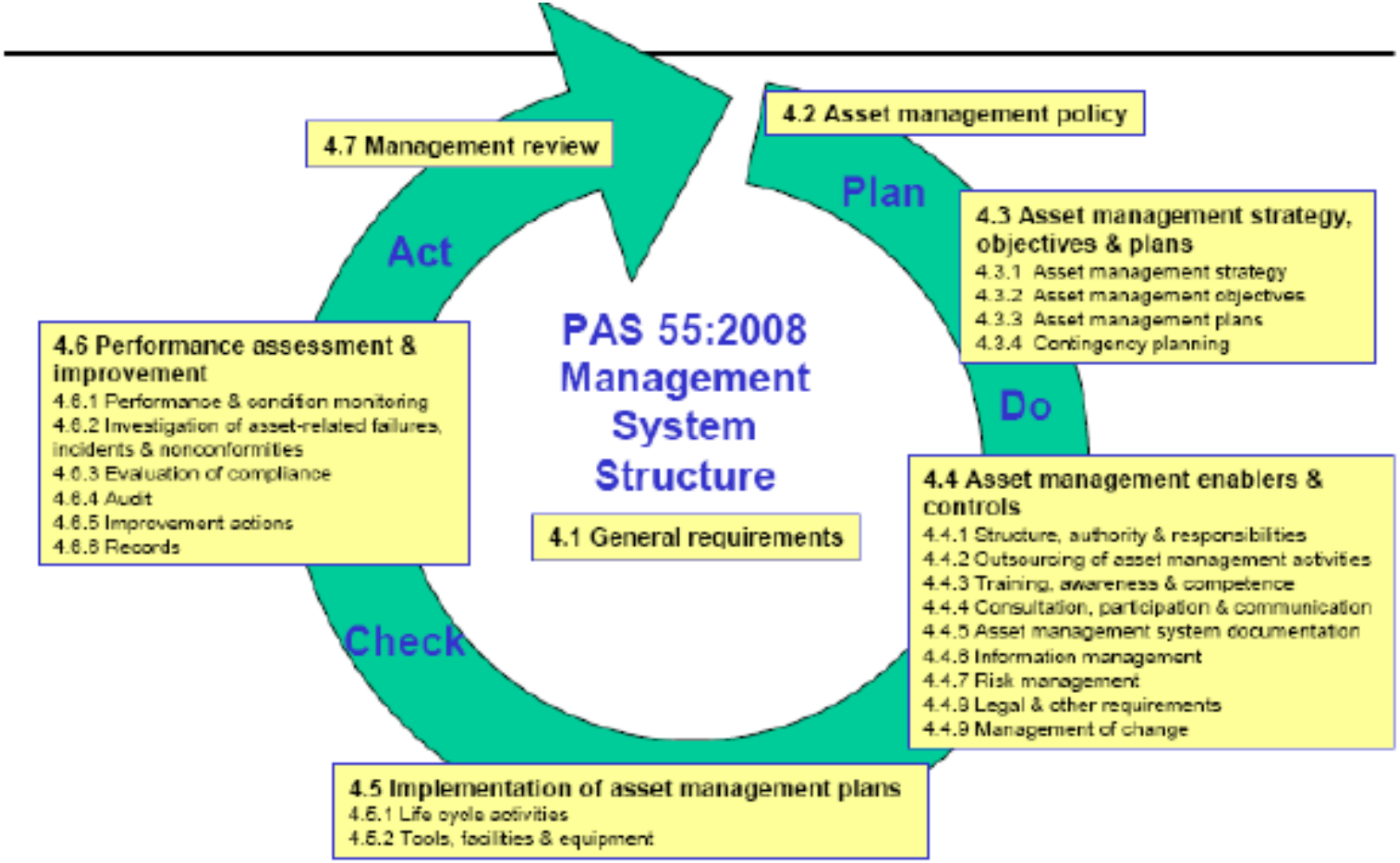
PAS 55 standard for Asset Management
Best practices & Improvement Cycle



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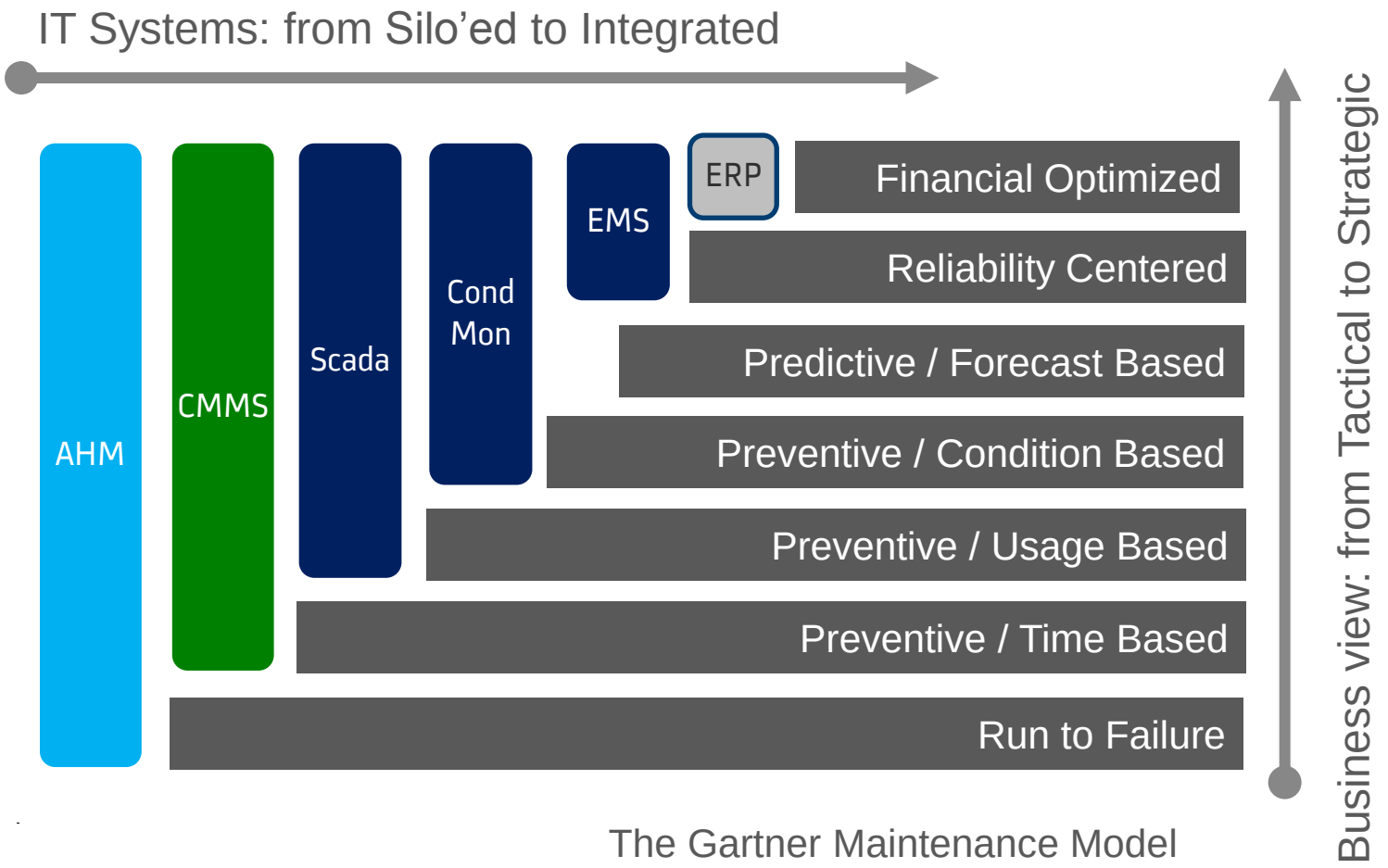
Asset Management:
From Tactical to Strategic



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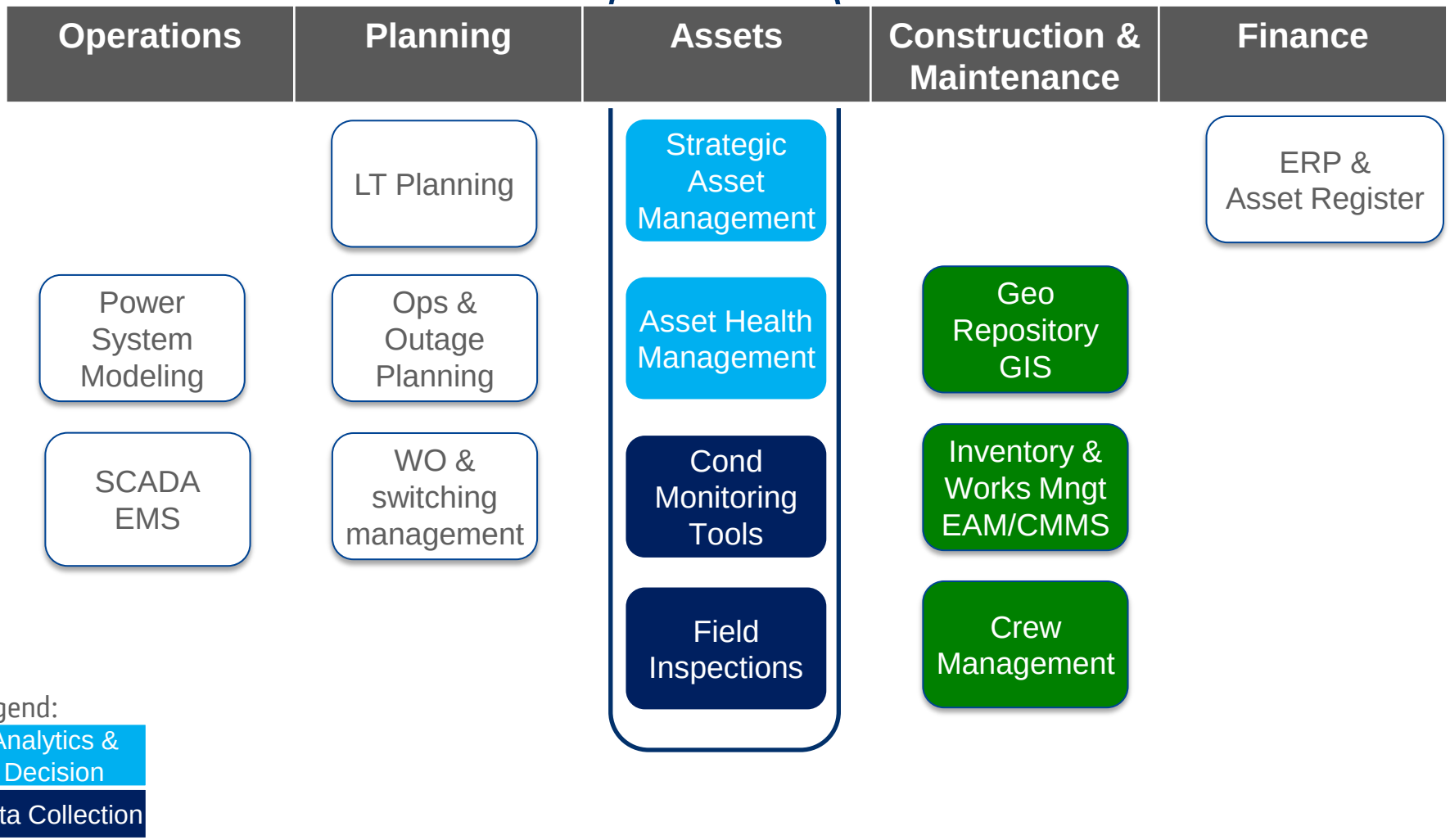
Electrical Asset Management
Functional Utility map



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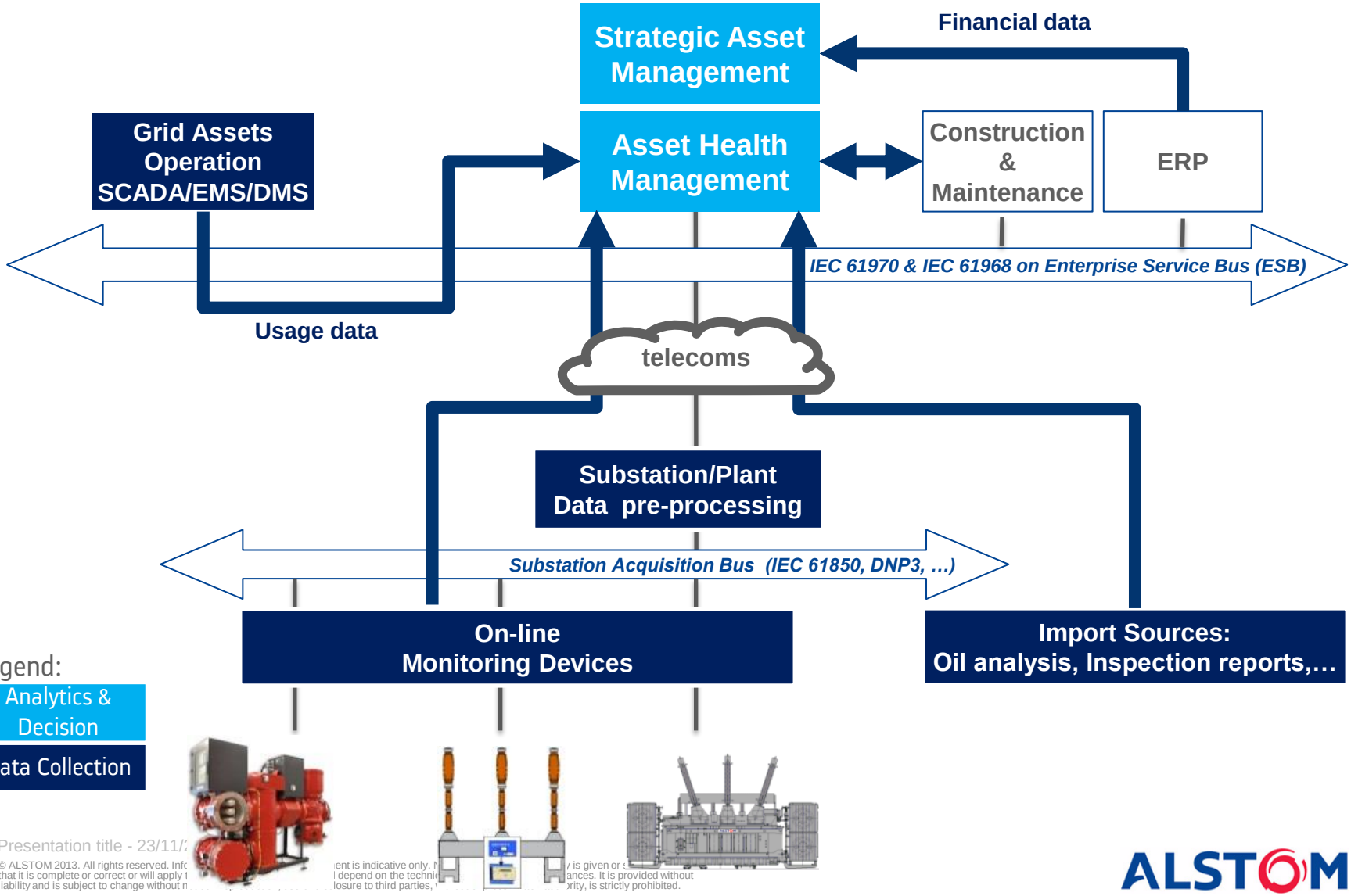
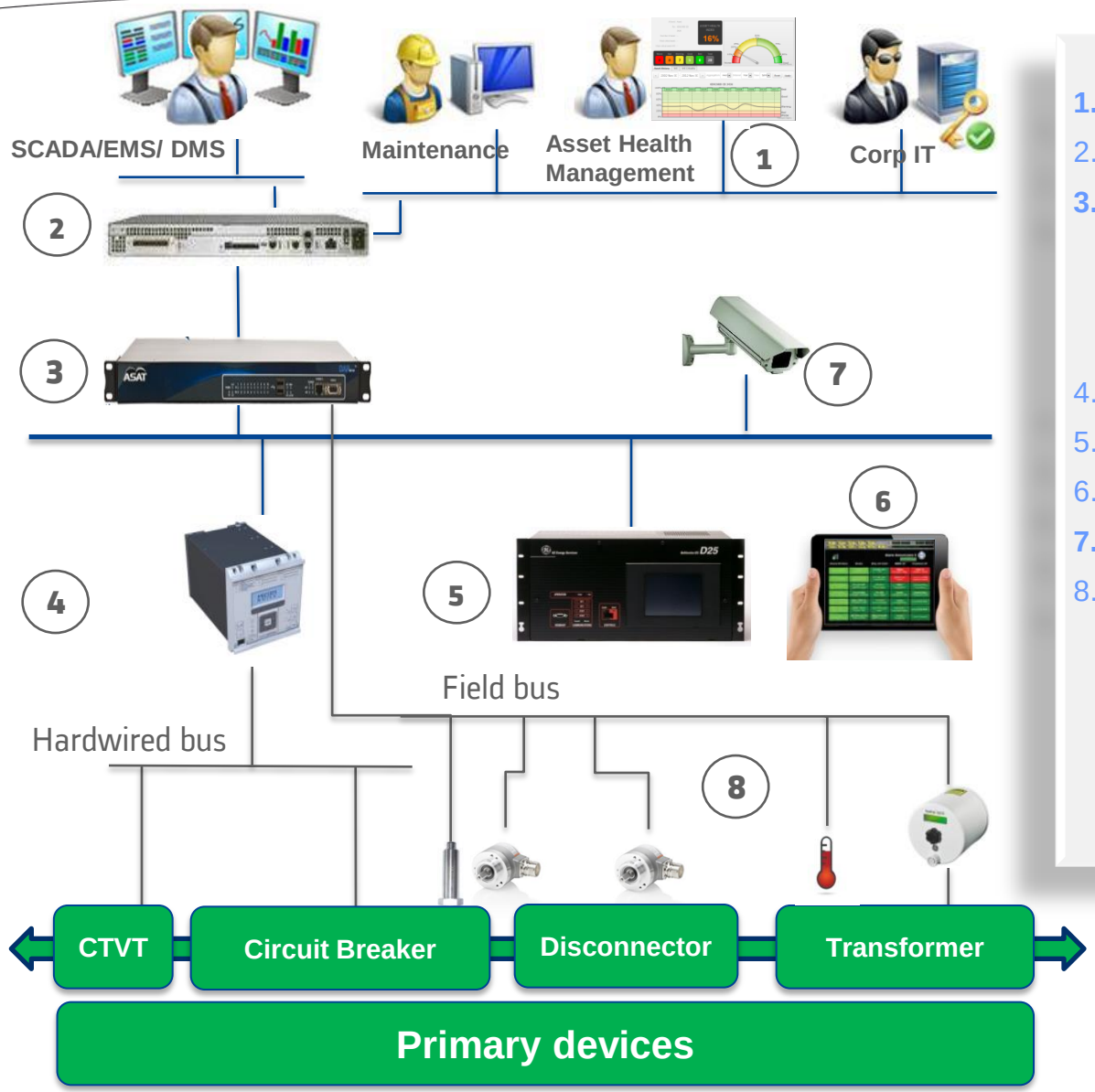
From data collection to Enterprise IT



Communication in legacy substations: Connecting Condition sensors with ASAT's DAP server



1. **Asset Health Management System**
2. Enterprise Gateway
3. **DAPserver multi-function Gateway** :
   - Substation Gateway
   - Authentication & Security
   - client/server HMI
   - **Pre-processing of Condition data**
4. Legacy protections relays
5. Legacy RTU (eg: GE D20 series)
6. Mobile substation HMI (iPad, smartphone)
7. **Thermal imaging IR** camera
8. Condition sensors:
   - **SF6** sensor
   - **travel curve** sensor for CB & switchgears
   - **current** transformers for motors
   - **temperature** sensors
   - **DGA** for transformers…

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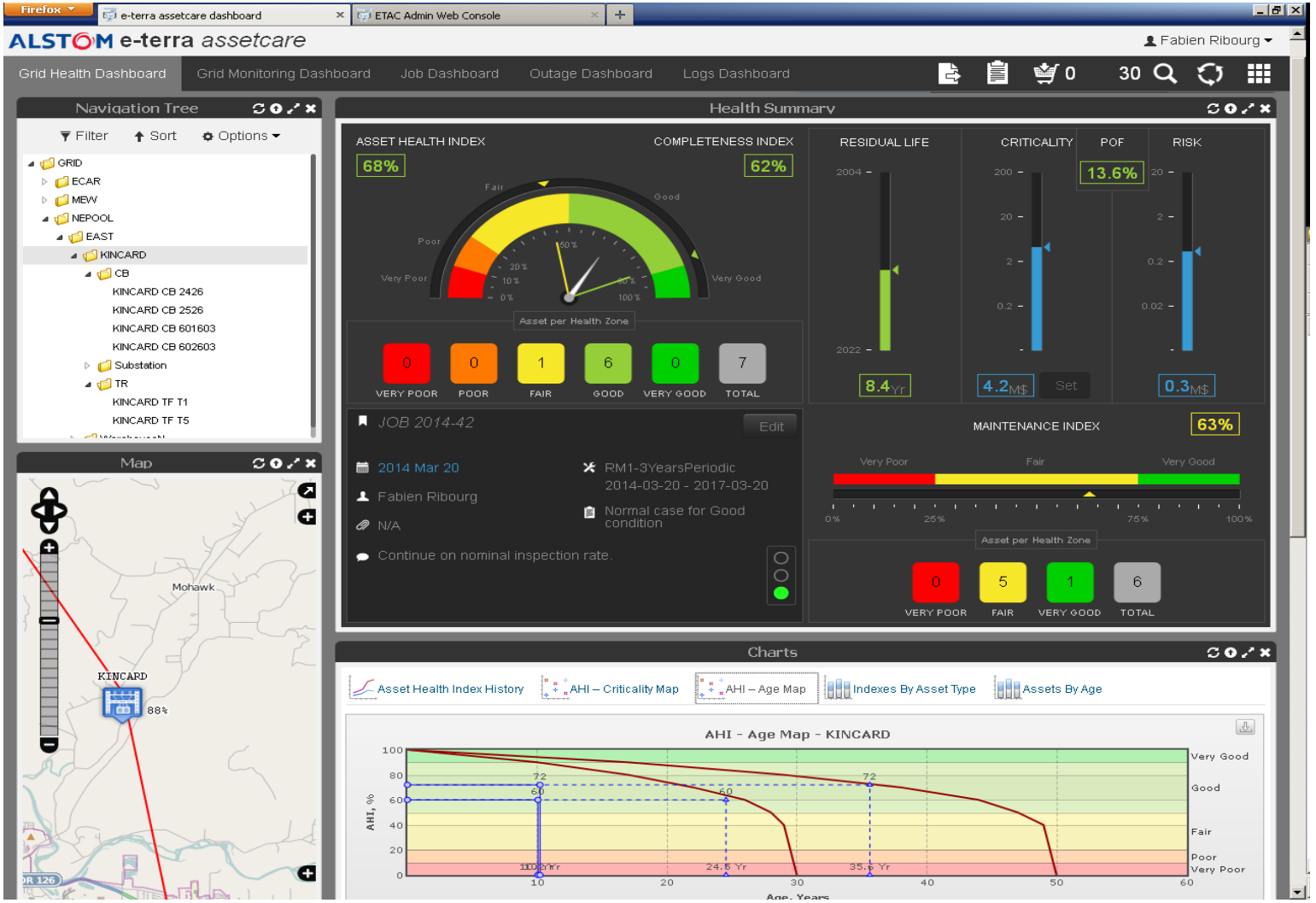
e-terra*assetcare:* the decision support tool

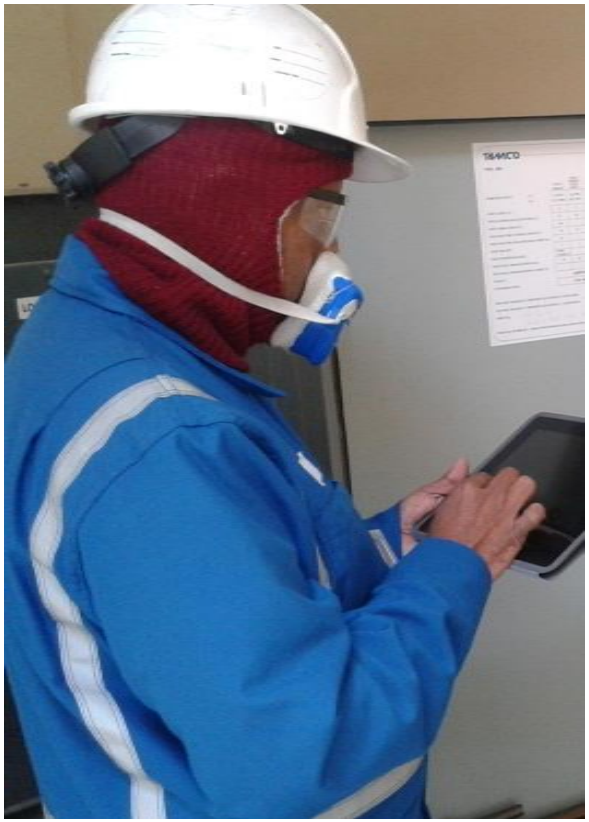
Analytics for Maintenance and Replacement decisions



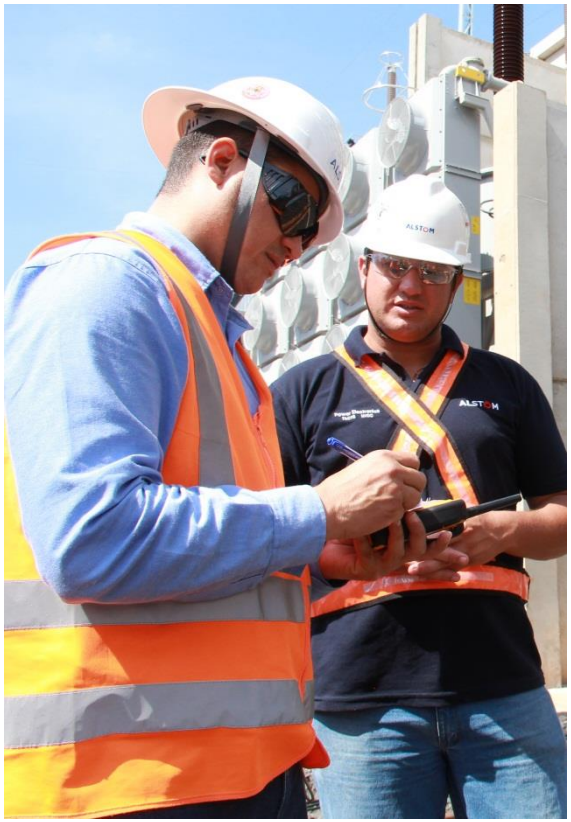
Tailor-made Solutions Applicable to all Segments

Transmission Fleet

Distribution Fleet



Generation Fleet



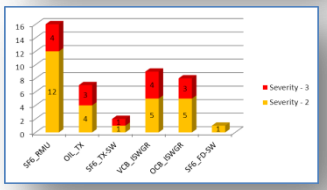
Qatar Case study

Business objectives: Priorities for condition based maintenance and repair

- Assess in live state the condition of 150,000 distribution assets (12 asset types)
- Identify equipment that need corrective action
- Maintenance and replacement decisions via a consistent methodology from a central system

Outputs

- Consistent Analytics for all Assets
- Recommendations for action based on Condition & Risk

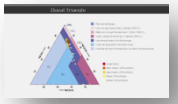


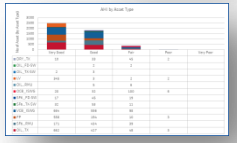
- Periodic reports for fleet assessment

Methodology Steps

1. Asset Health Models
2. Tablet-based Data Collection:

3. Analytics and reports





4. Criticality analysis
   $$$$ €€€€
5. Risk-based Analysis & Decision process from Alstom's **e-terra***assetcare*

Business Outcome:

Information / Optimized decisions / Avoided failures

via a unique combination of:

- ✓ Field inspection skills
- ✓ Electrical expertise
- ✓ Advanced analytics and IT

Sr No.	SS No	Substation Name	SS Type	YOM	SR NO	MFG	Replacement Date
1	488	NEW SALATA 3	ID	2006	813628	Voltamp	09-02-2014
2	488	NEW SALATA 3	ID	2003	3280	Federal	09-02-2014
3	3065	N.D.-16	OD	1994	135388	South Wales	19-03-2014
4	10778	NEW WAKRAH SOUTH	ID	2006	8813919	Voltamp	12-01-2014
5	4427	Baharna HSQ South-3	ID	2007	8814323	Voltamp	20-03-2014
6	4008	Najeea West-11	OD	2004	15183	Federal	18-02-2014
7	1981	Najeea Sports Club	ID	2007	8813706	Voltamp	19-03-2014
8	3639	Fariq Blouch No-09	OD	2008	8816195	Voltamp	12-02-2014
9	3000	Doha Motor Showroom	OD	2006	18047/11	Emirates	20-03-2014
10	1034	Ghanim Garden 2	ID	1996	1895708	Emirates	26-01-2014
11	1049	Fahad Bin Abdullah	ID	2006	1701018619	Emirates	21-01-2014
12	1051	Montaza School-1	OD	2007	8814080	Voltamp	19-01-2014
13	3954	FERIQ BALOUCH 10	OD	2007	8814925	Voltamp	12-02-2014
14	2987	TRADE GALLERY	ID	1993	122884-56	Babcock	18-03-2014
15	20	SH FB Jassem -B	ID	NA	8813058	Voltamp	02-02-2014
16	16413	IH COMPLEX-4 S/S-4	ID	2000	1852304	Emirates	30-03-2014
17	2809	BANI HAJIR - 18	ID	2009	8817203	Voltamp	23-03-2014

Asset Health Management & Analytics

with **e-terra***assetcare*

Jean-Louis COULLON
Asset Management Activity Director

Asset Health Management
Summary of Objectives

- Consistent assessment of Assets health
- Identification of Assets needing action
- Identification of the remedial works that:
  - Optimize costs, risk & return
  - Achieve the business objectives of the Utility
  - Are aligned with the strategy of the Utility

Asset Health Management
Functional Steps

1. Model Assets
2. Collect data
3. Build Information
4. Monitor & Analyse
5. Support Decisions
6. Report

Customer Value

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e-terra*assetcare*
Product Summary

- Core functionality
  - Data Collection services
  - Flexible Calculation engine for Asset Analytics (AHI, MI, …)
  - Business Intelligence layer & Alerts detection
  - Contents Management System (documents, inspection files, reports, ..)
  - Support for Operator Decisions
- Integration in Utility Operation IT
  - SOA interfaces (EMS, EAM/CMMS, …)
  - CIM based interface to EAM/CMMS (IEC 61968)
  - N-tiers architecture for scalability
  - Thin UI client (HTML5) for company-wide access
- Deployment:
  - Standalone or integrated (eg: to ALSTOM Grid EMS **e-terra***platform)*

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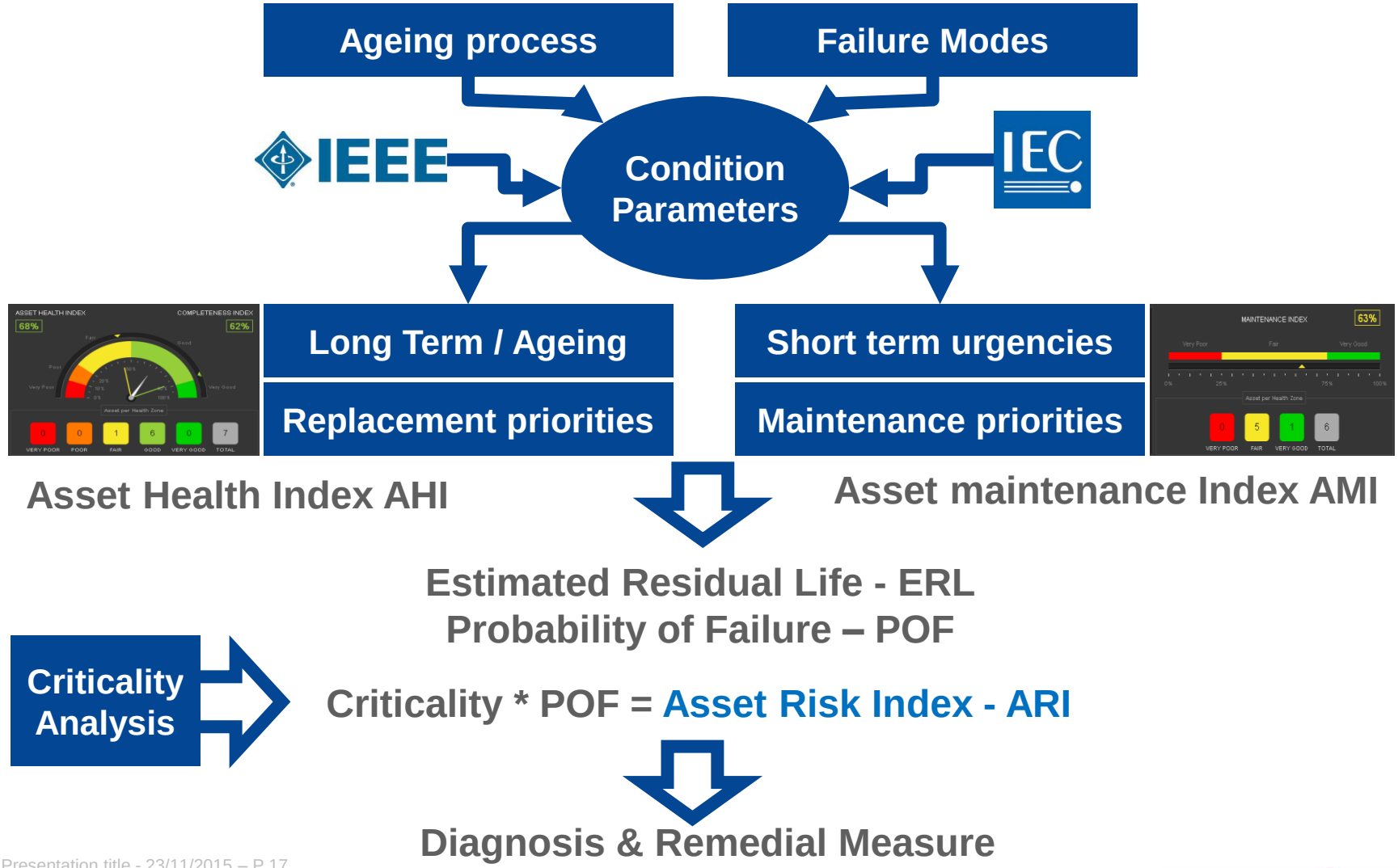
Health Management Analytics
e-terra*assetcare* methodology



Asset Health Management with **e-terra***assetcare*
Asset Health Index AHI and Health Zones

- **Purpose of AHI:**
  - **Assess horizon for replacement (long term)**
- 5 normalized zones ABCDE are the most common
- Used to align Condition Parameters together

AHI	Health Zone	Expected Lifetime	Requirements
85-100	Very Good	> 15 Years	Normal Maintenance
70-85	Good	> 10 Years	Normal Maintenance
50-70	Fair	< 10 Years	Increase diagnostic testing, remedial work / replacement needed depending on criticality
30-50	Poor	< 3 Years	Plan for replacement or rebuild, considering criticality / consequence of failure
0-30	Very Poor	End of Life	Immediately replacement or rebuild

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Asset Health Management
Condition Parameters: Multiple data sources

- Examples:
  - File Import (eg: Oil analysis files, site Inspection files)
  - On-line Condition Monitoring tools
  - Manual entries
  - EMS online/historical measurements (eg: LTC operations)
  - Calculated (eg: age)

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Asset Health Management with **e-terra***assetcare* Maintenance Index AMI & severity zones

- **Purpose of AMI:**
  - **Define domains and urgency for action (short term)**
- Ex of Normalized zones ABCD

AMI	Severity	timeframe	Requirements
40-100	Normal	3 years	Normal Inspection period
40-15	Non-Urgent	< 1 year	Action needed – when convenient
15-5	Urgent	< 3 months	Urgent Action to be planned
0-5	Critical	< 3 weeks	Immediate Action

- AMI allows for implementing Time-based, Usage-based or Condition-based models

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Summary of Analytics

	Index	Name	Purpose
1	AHI	Asset Health Index	What is the health in a replacement/end of life perspective ?
2	AMI	Maintenance Index	Where is the severity & urgency for action ?
3	CPLI	Completeness Index	Do we have all required data ?
4	ERL	Estimated Residual Life	How many years are left ?
5	POF	Probability of Failure	Of a major failure
6	ACI	Criticality Index	What is the $/€/… impact in case of failure ?
7	ARI	Risk Index	My exposure in $/€/… = ACI*POF
8	RM	Remedial Measure	What should I do ?

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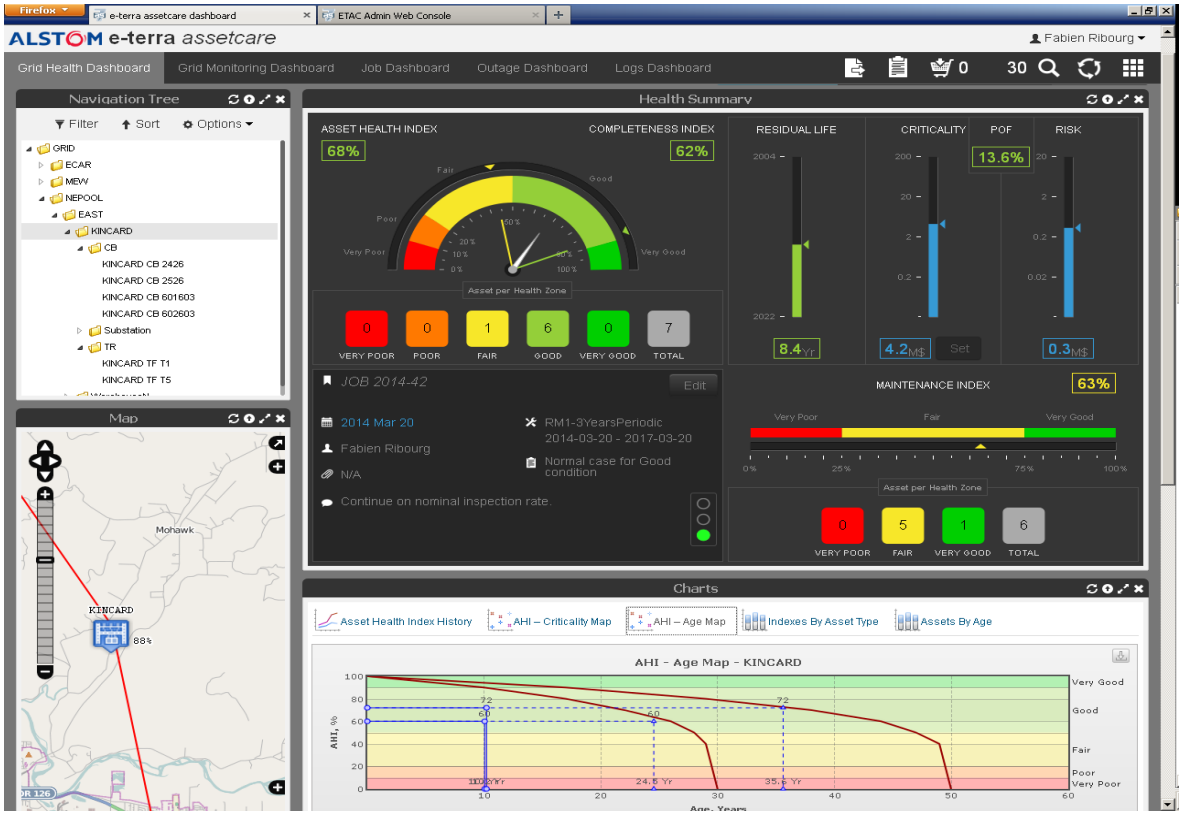
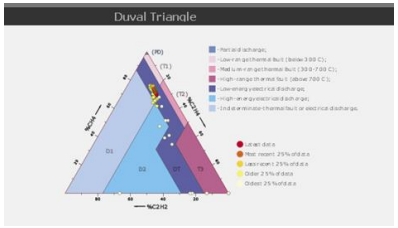
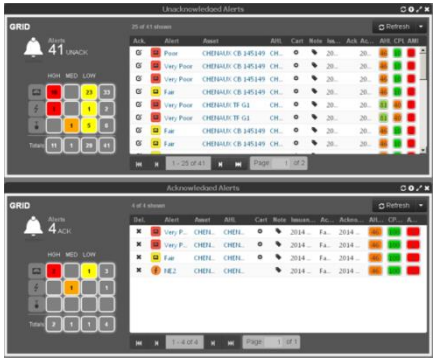
Taking Actions:
Available Workflows in **e-terra***assetcare*

- Alerts Management
  - Condition Alerts (from Index calculator)
  - Network Alerts (from EMS)
  - Job Alerts (events from workflows)
  - Actions: ACK, DELETE, CREATE JOB
- Actions (preventive, corrective, replacement, …)
  - Internal actions: Jobs
  - Internal+external actions: Jobs + Work Order
  - Can be attached to a List of Assets
- Outage Approval
  - Basic OK/NOK

e-terra*assetcare* Asset Health Dashboard: Analytics for Maintenance and Replacement decisions







Grid Operation and Assets Management: Integrated for System Reliability & Value

From Tactical to Strategic

Manage operational risks

Optimal Powerflow & Clearing Engines

Look Ahead security & planning

Contingency Analysis N-1

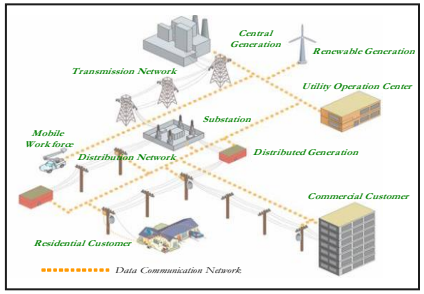
Grid Security Assessment

Operational/Usage Data (I, V, protections, …)

System Criticality Assessment

Probability of Failure

Usage Data



Prioritize Interventions

Optimal Asset Plan

Prediction Models

Asset Health Dashboard

Condition Assessment

Condition Data (open/close times, SF6 pressures, PD events, …)

Maintenance Plan
Asset replacement Plan
CAPEX/OPEX optimisation

Estimated Residual Life
Probability of Failure
Risk Analysis

Health Index / Ageing
Maintenance Index / Actions

Real Time data
History data
Maintenance data

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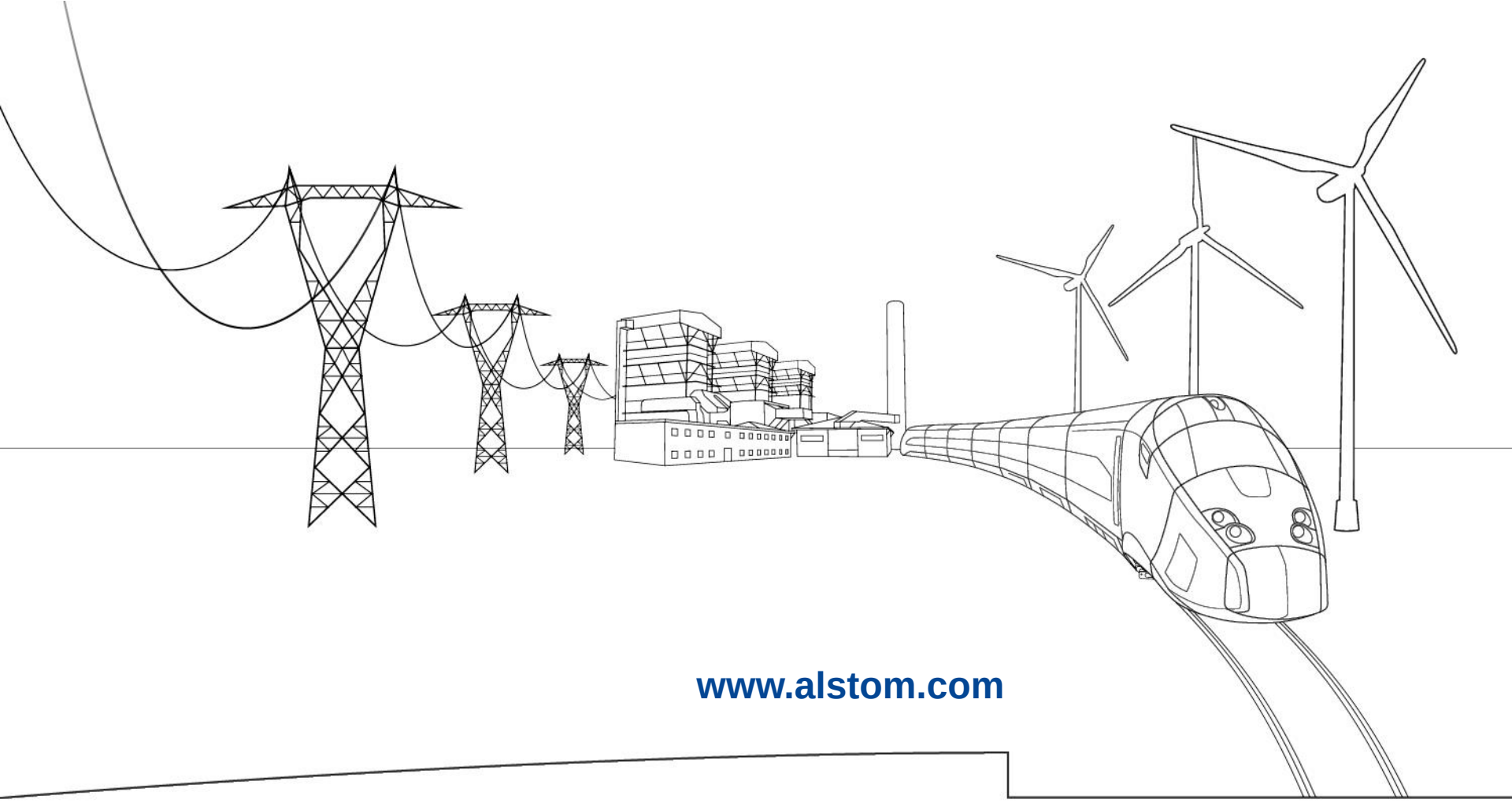

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