Protection & Controls Analytics for a Reliable Grid

Texas A&M Protective Relay Conference – 2016
College Station, TX

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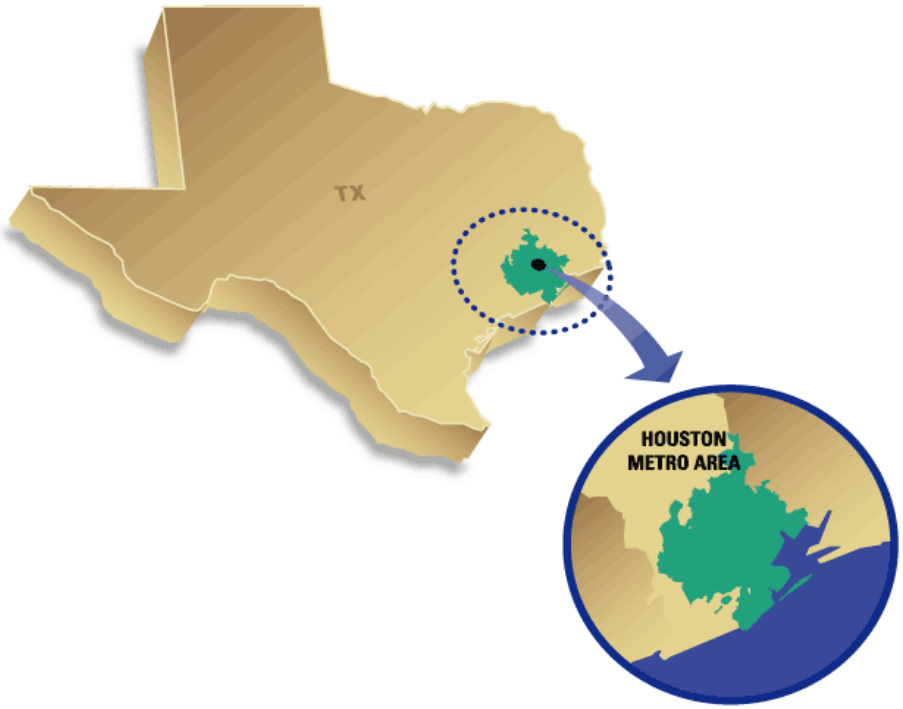
CenterPoint Energy's Overview

- Chartered in 1882
- 5,000 square-mile service area
- 2.2 million metered customers
- 78.6 million megawatt hours delivered yearly for about 60 certified competitive retailers
- Transmission and Distribution System
  - 3,199 miles of transmission lines
  - 49,162 miles of distribution lines
  - 233 substations
  - 14 service centers



Asset Life Cycle Analytics – Value Add

- Provide analytics to support CenterPoint Energy's asset replacement strategies and help mitigate asset failure risk
- Provide scoring methodology comparing condition of assets
- Support asset strategies with actionable intelligence – reduce time for obtaining information
- Use consistent methodology for assimilating disparate data sources and analytics development that supports Subject Matter Experts decision making
- Support Investment Prioritization for projects and programs
- Support knowledge transfer due to retiring workforce

Asset Life Cycle Analytics

- Existing
  - Substation Transformers
  - High Voltage Circuit Breakers
  - Distribution Circuit Breakers
  - URD Cable
  - Contamination Mitigation
  - **Protection & Controls – Transmission**

- 2016 Developments
  - Protection and Controls – Distribution
  - Intelligent Grid Switching Devices (IGSD)
  - Vegetation Management

Protection & Controls
Asset Analytics Life Cycle

Protective Relays
Condition Assessment using Analytics

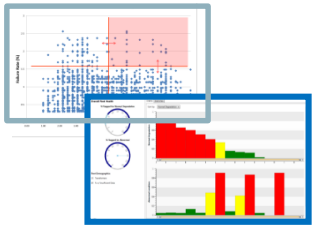
CenterPoint Energy

Assessment Parameters

- Age
- Mean Time Between Failures
- O&M Expense
- Misoperations
- Type & Obsolescence
- Station Impact
- Bus Configuration
- Protection Scheme
- No. of trips

Expert Algorithms

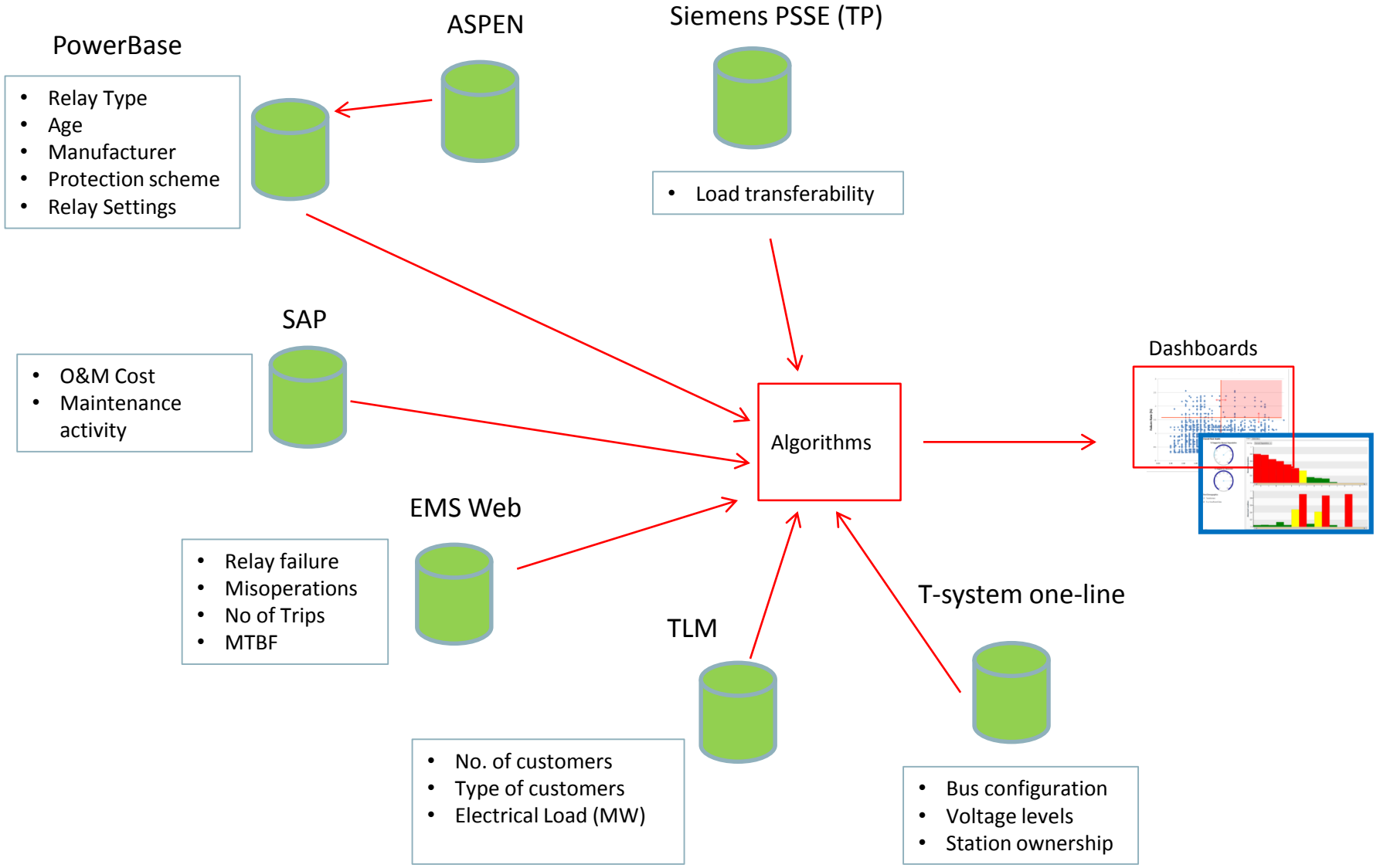
Condition Assessment Dashboards/ Reports



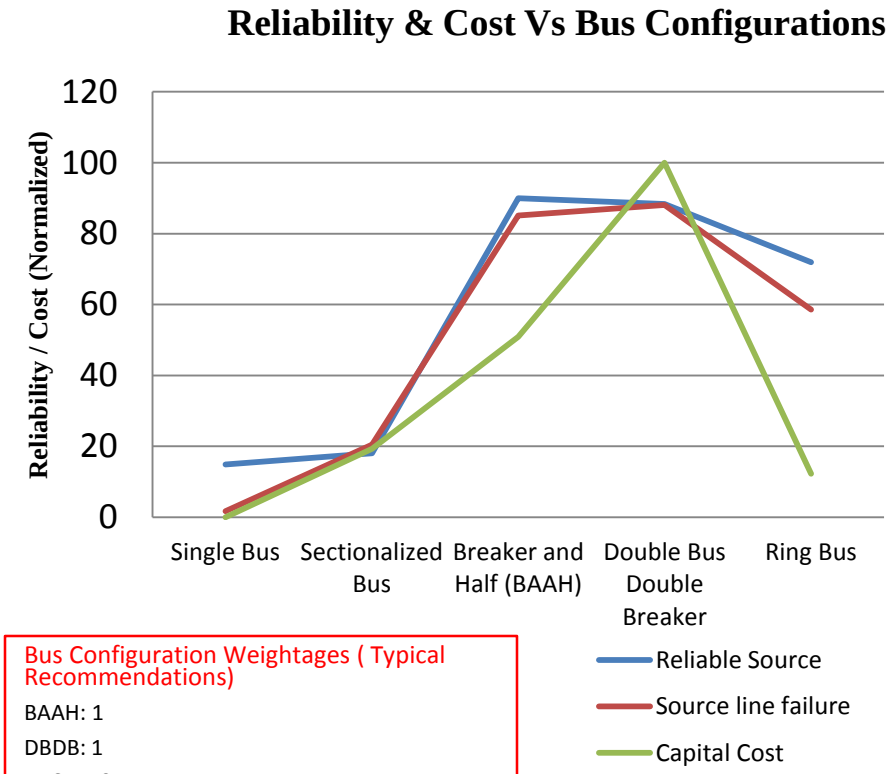
Impact Score = {(X% Station Impact) + (Y% Protection Scheme) + (Z% Bus Configuration)}
Health Score = A% Sum of all Performance Indices + B% Age
Total Score = (C% Impact Score) + (D% Health Score)

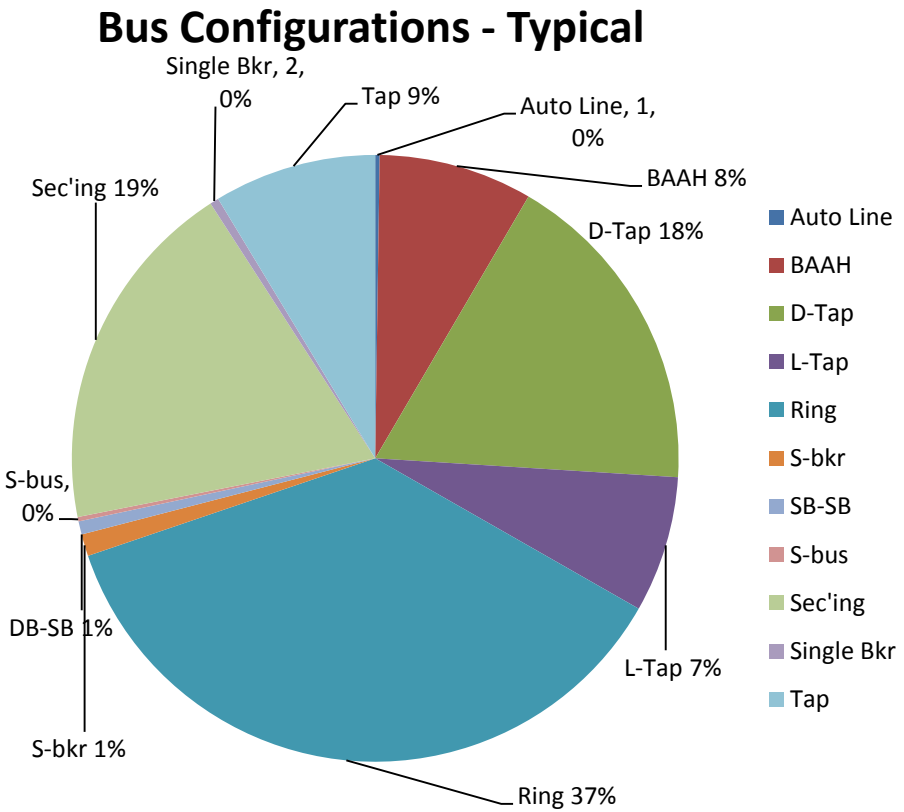
Risk Index = Probability of failure x System Impact

Transmission Protection & Controls Asset Analytics Schema



Transmission Bus Configurations

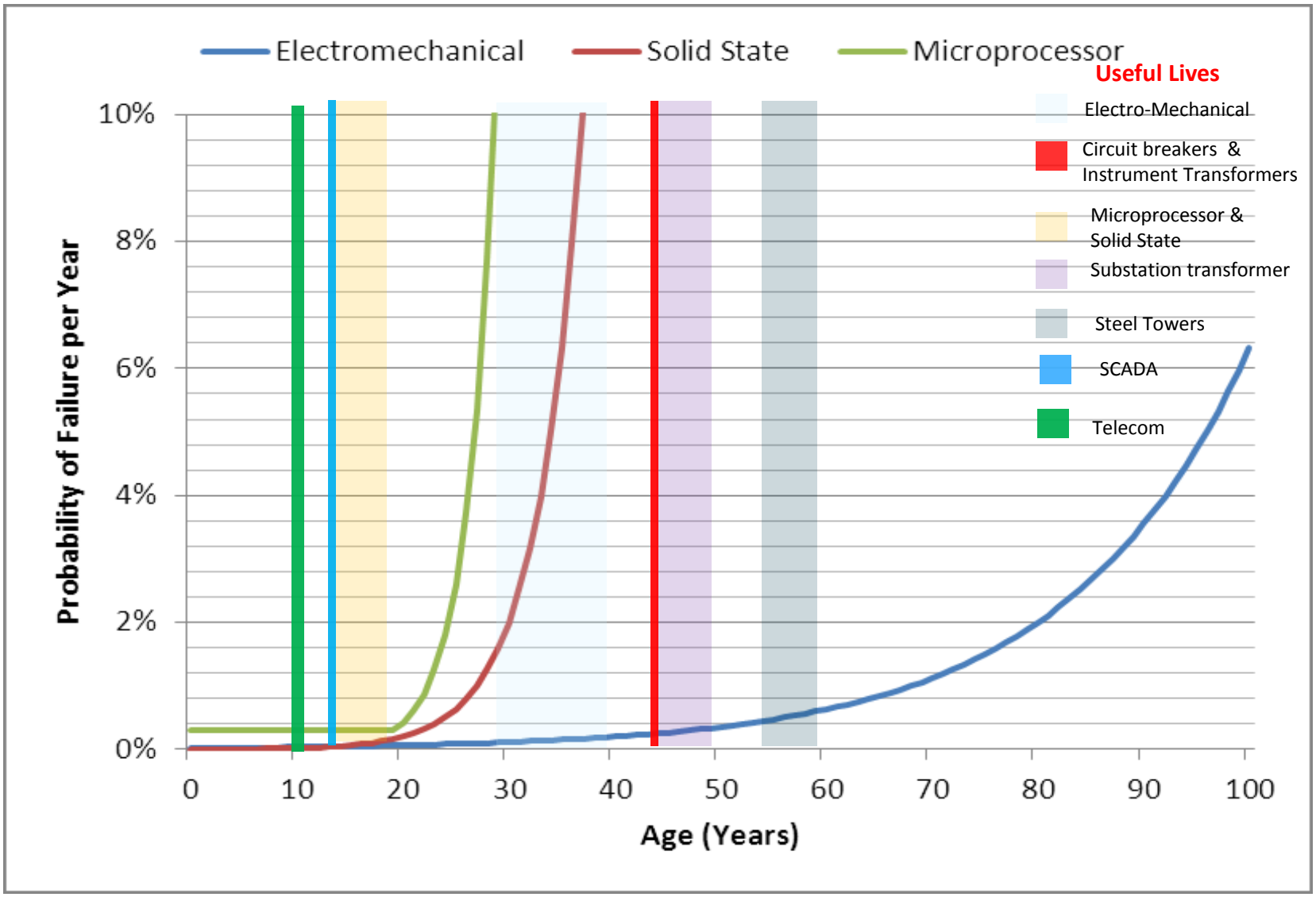




Bus Configuration Weightages (Typical Recommendations)

BAAH: 1
DBDB: 1
DBSB: 10
DBSB + DBDB: 5
Ring: 1 (includes BAAH operated as Ring)
SBSB: 6
L-Taps: 9 (One or more taps from same line)
D-Tap: 10 (Double Taps from Two lines)
Tap: 9 (identical to a L-Tap)
Sectionalizing: 5
Auto-terminated: 5
SB:9 (single breaker)
S-Bus:4

Probability of Failure Vs Age (Industry Recommended)



Relay Failure Curves

- **Electro-mechanical Relays:**

$$\lambda_{EM} = 0.0002 * e^{0.05756463t}$$

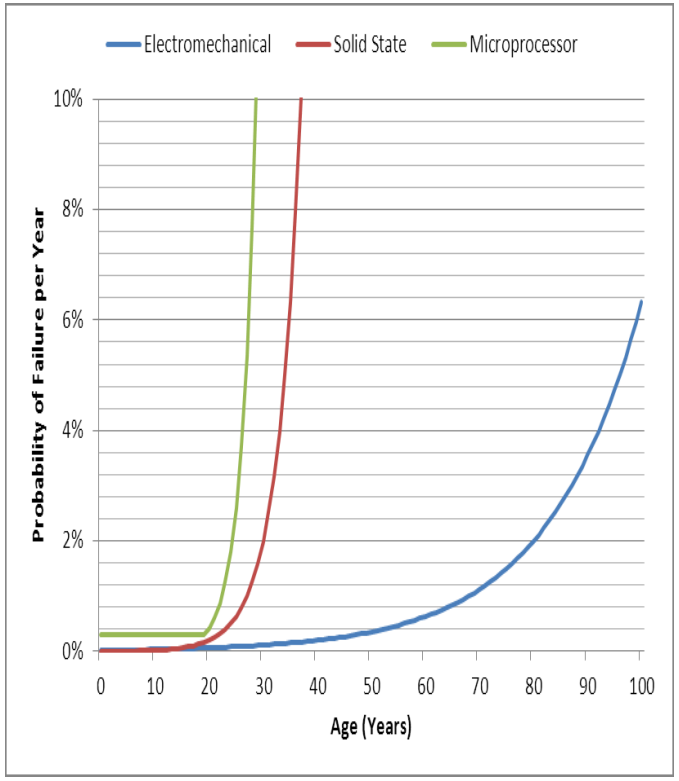
- **Solid State Relays:**

$$\lambda_{SS} = 0.00002 * e^{0.2262t}$$

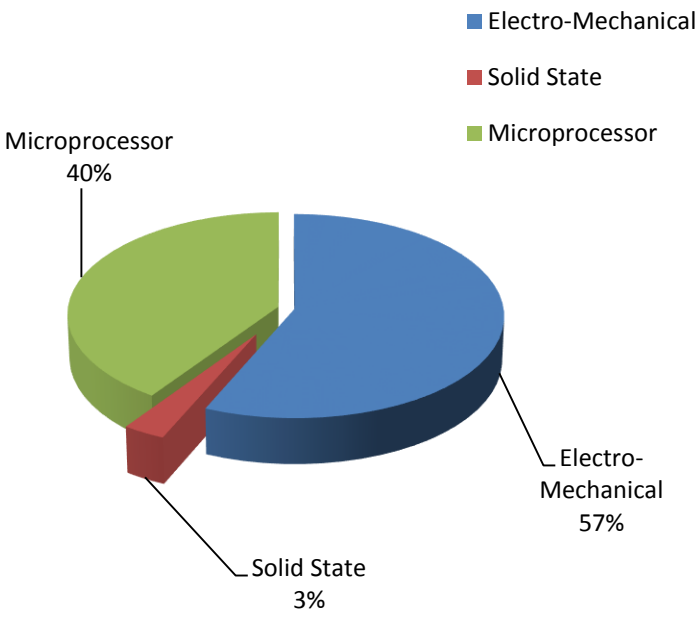
- **Micro-processor Relays:**

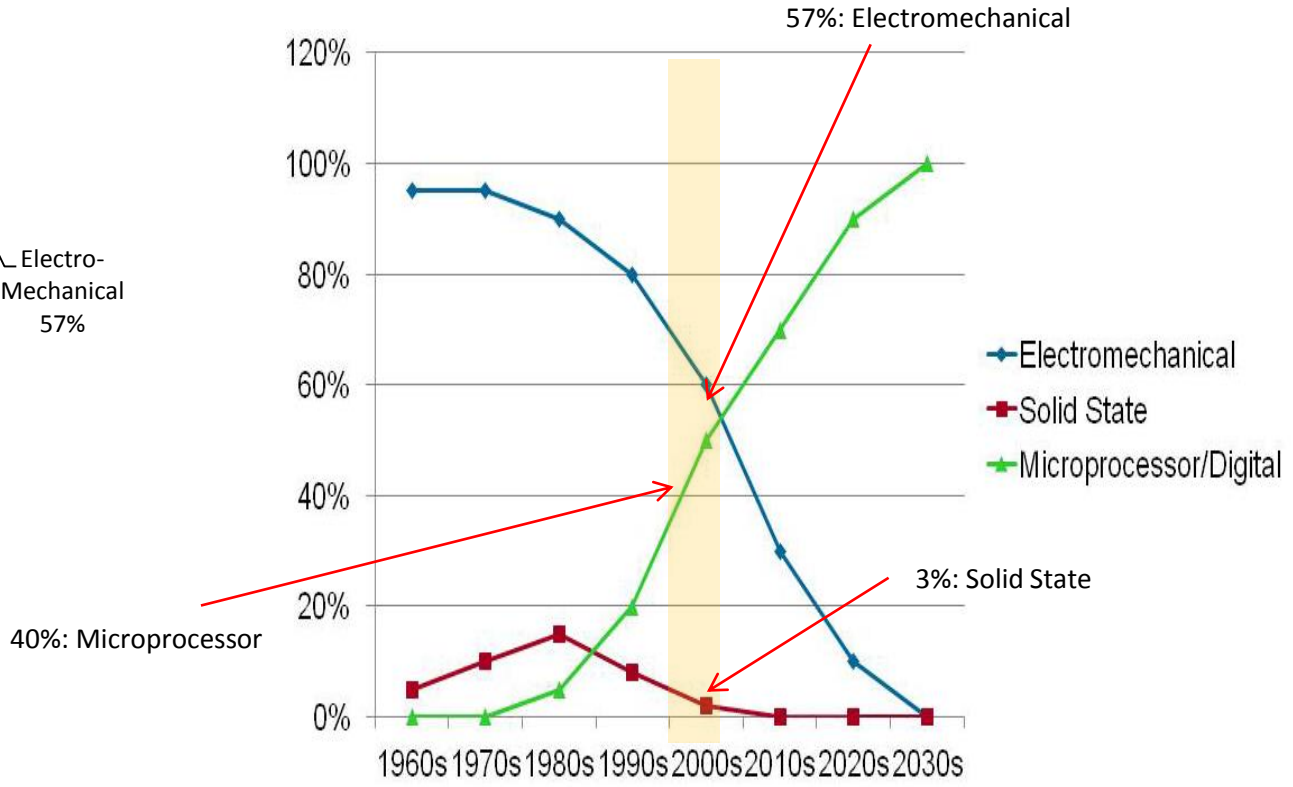
$$\lambda_{MP} = 0.0034; 0 < t \leq 18$$

$$\lambda_{MP} = 0.000008 * e^{0.3202t} \text{ ; t > 19}$$

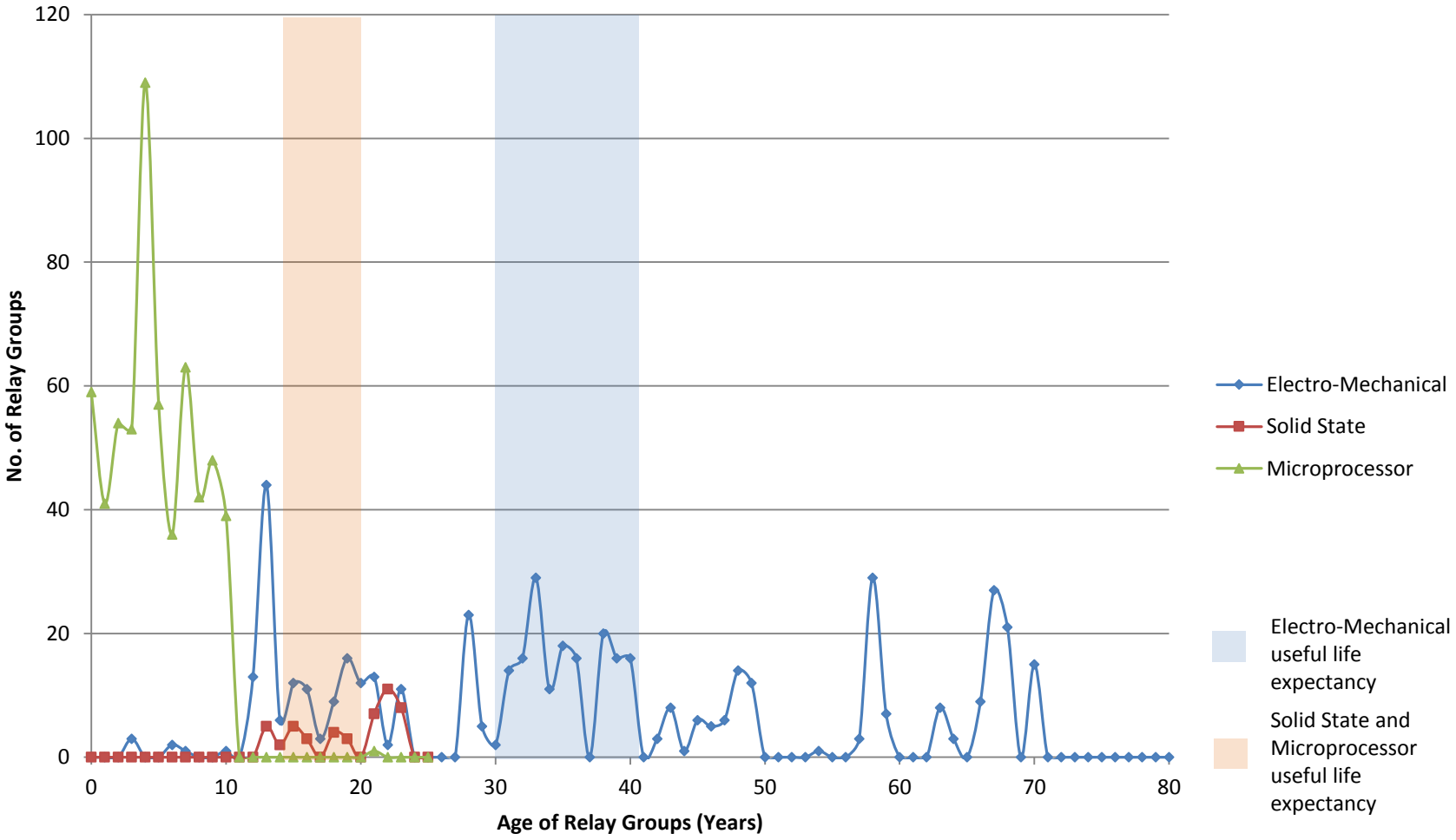


T&D Relay Mix - Typical

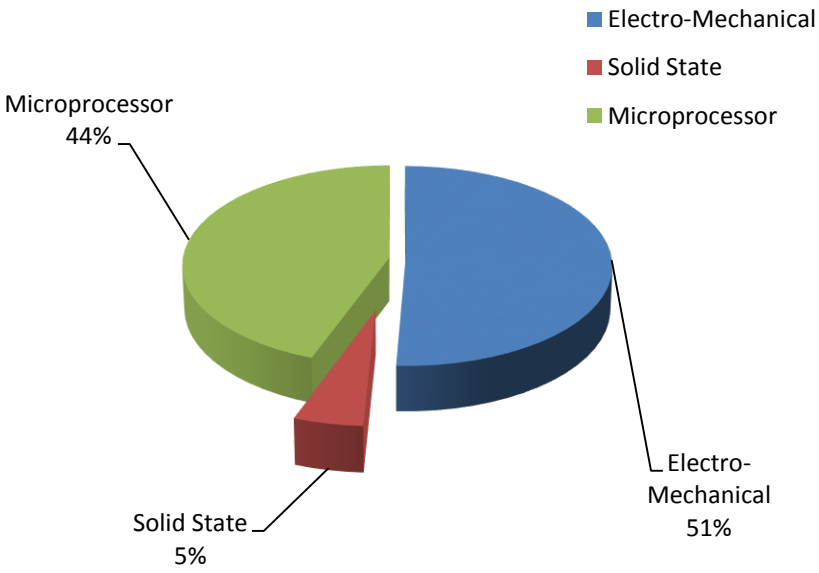


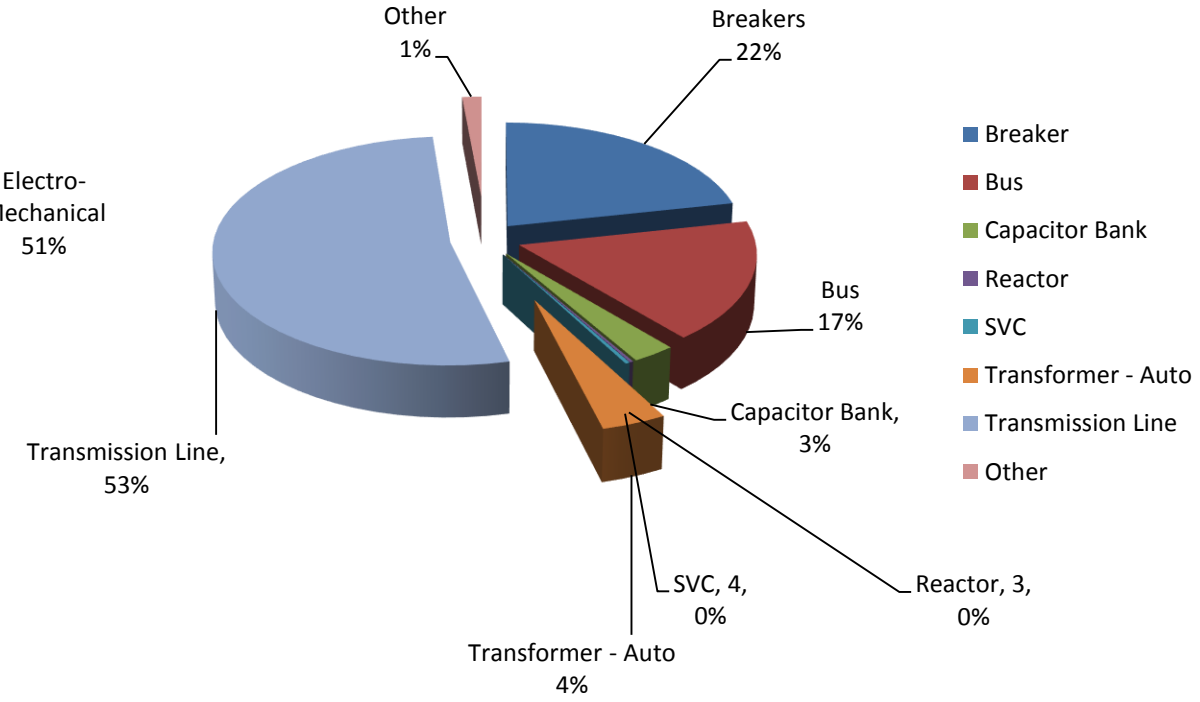


Transmission Relay Groups - Age & Type
Typical



Transmission Protection System - Typical

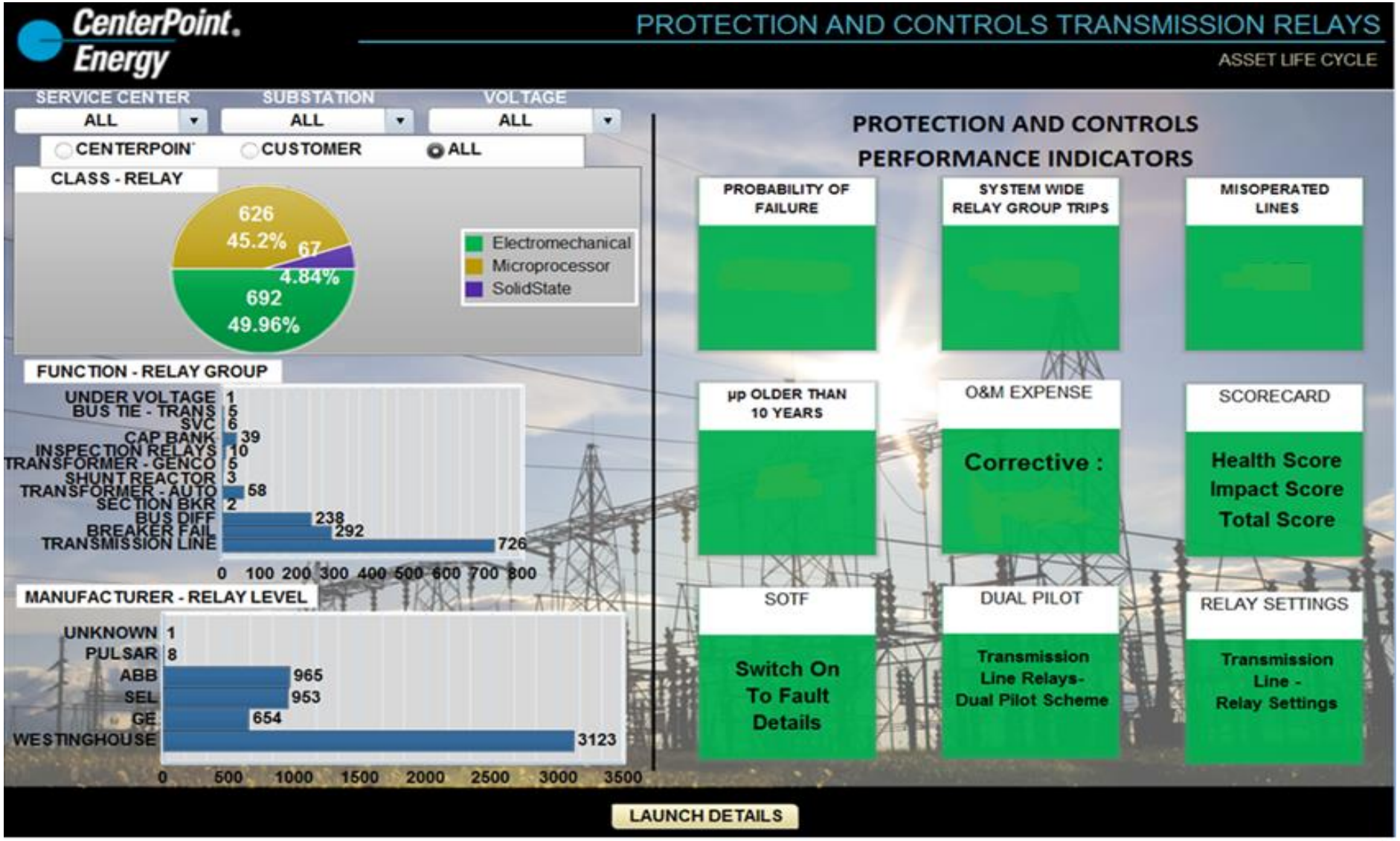




Protection Schemes Weightages - Recommended

AC under-voltage: 1
Breaker Trip/failure: 10
Bus protection: 10
Line protection: 5
Overcurrent: 1
Transformer Protection: 6
Capacitor Bank: 4
Reactor: 4

P&C Analytics - Dashboard

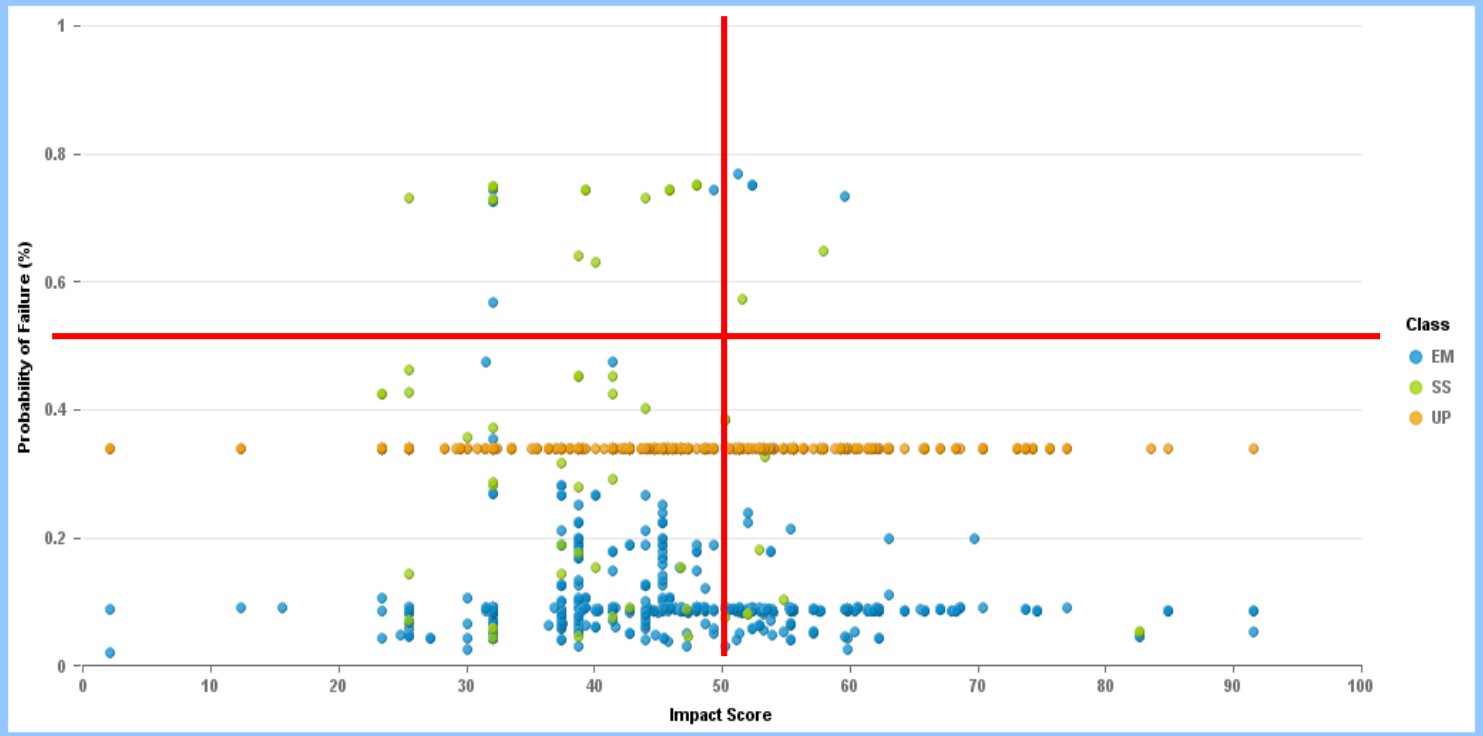


P&C Analytics – Heat Map

CenterPoint Energy

P&C Analytics - Transmission Relays - Heat Map - Most Population

1/19/16 8:45 AM



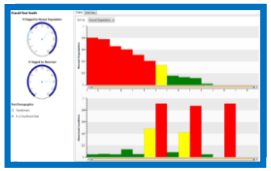
Detailed Report

Analytics Application – CNP Journey

- T-Breakers
- D- Breakers

Stage 1

Asset Condition Assessment using Analytics



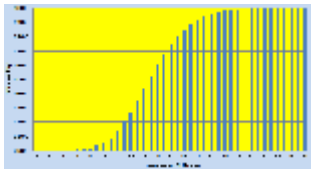
Analytics

Collaboration with EPRI[1]

Stage 2

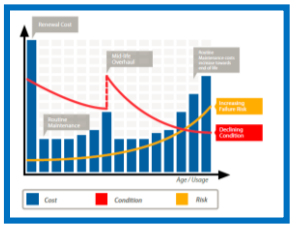
- Auto Transformers
- Power Transformers
- T-Protective Relays

Risk Identification



Projected failures

Investment Optimization

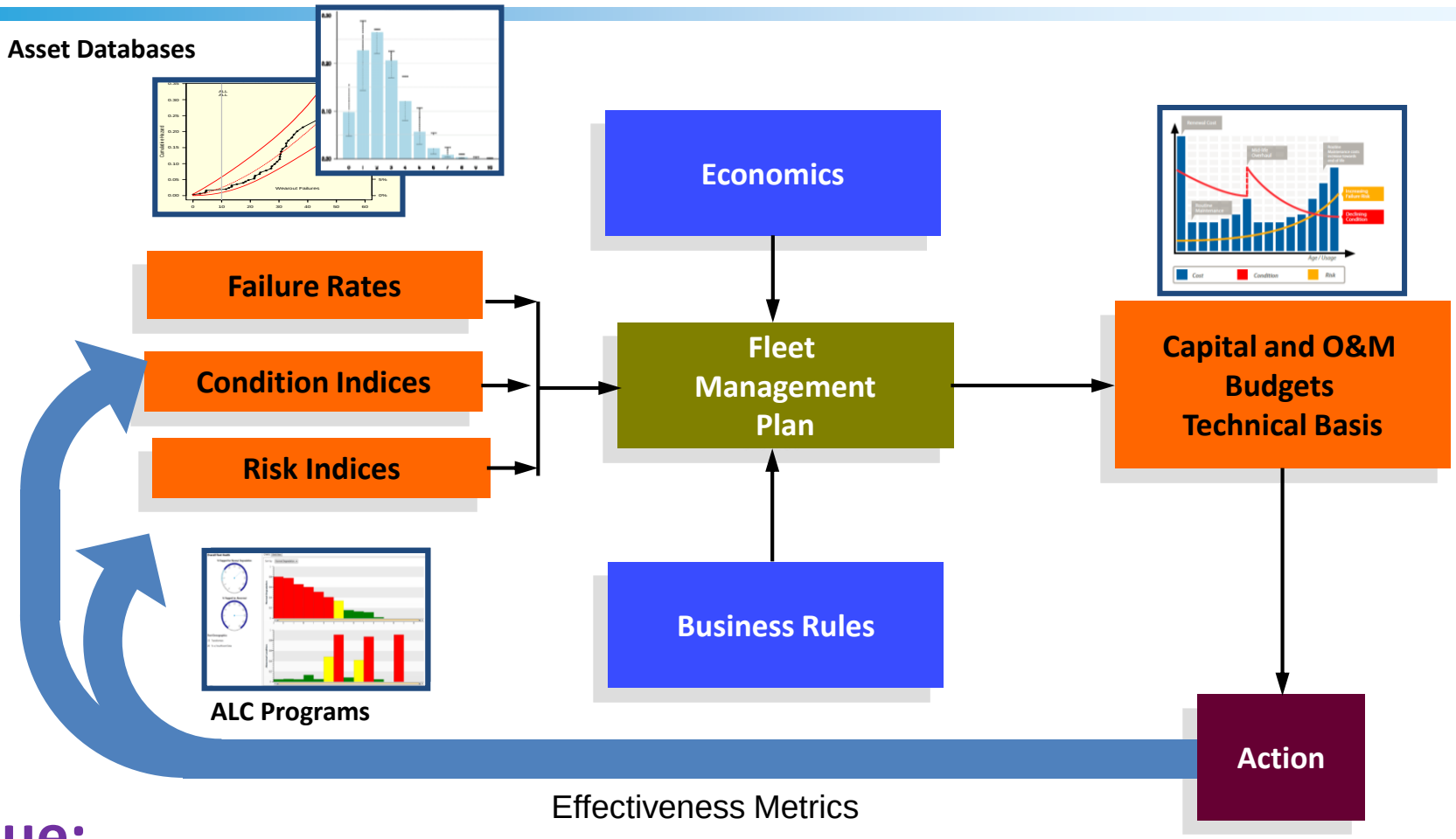


Stage 3

Risk Vs Budget Comparison

1. Substation Transformers condition assessment, PTX and through-fault analytics

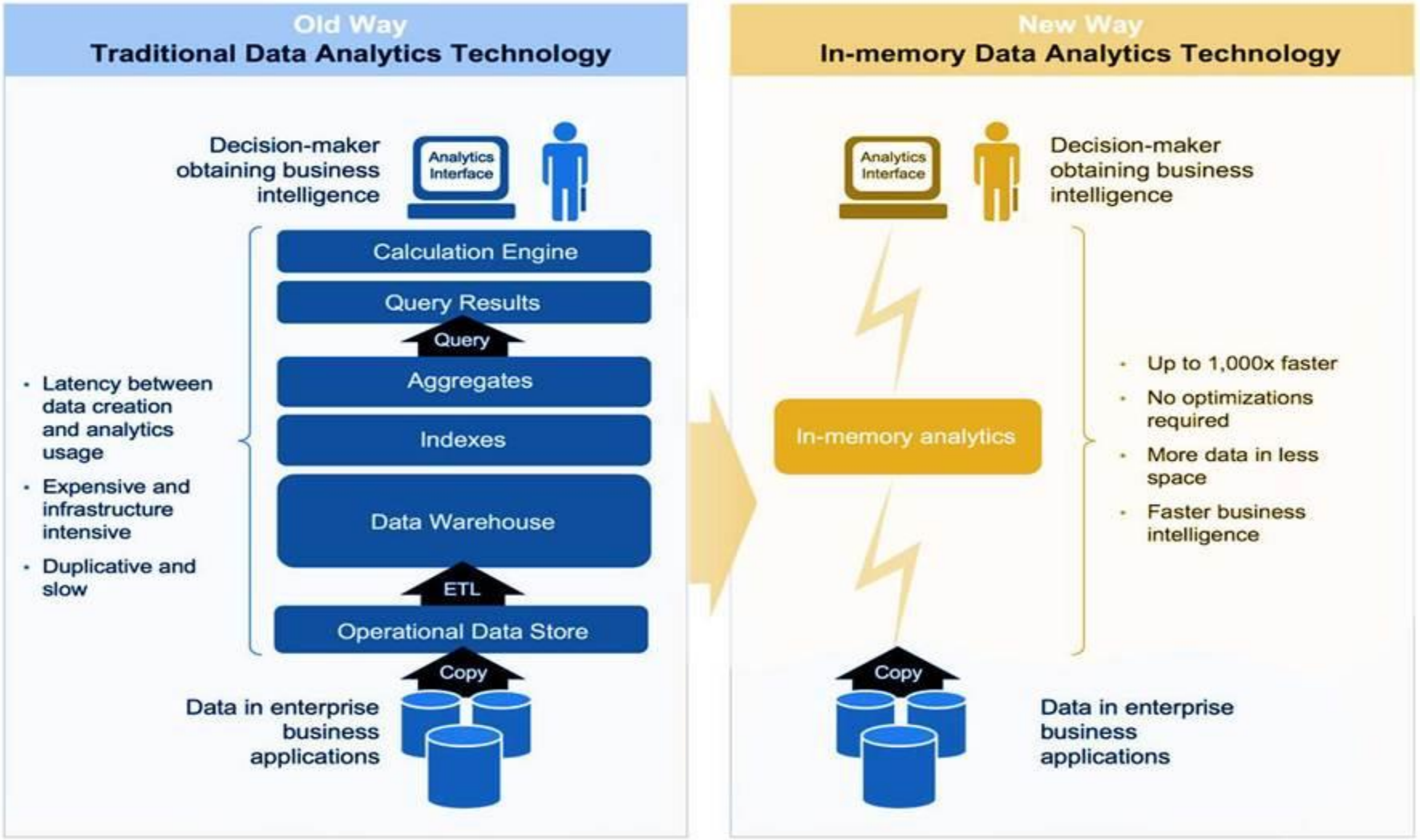
Analytics Applications – Business Decisions
Collaboration with EPRI - Ongoing



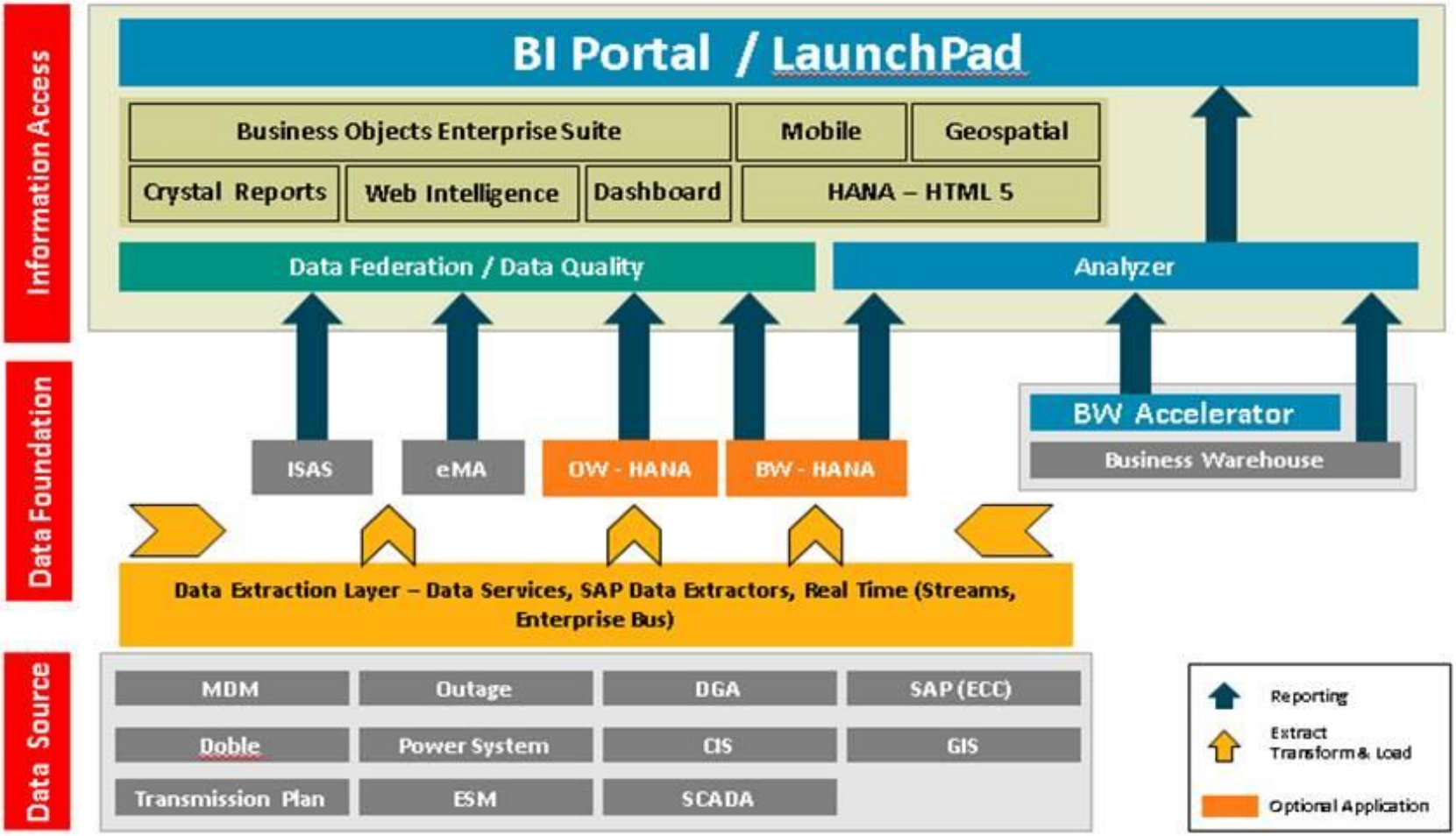
Value:

- Technical basis for Capital and O&M budgets with measured risk
- Metrics to assess decision effectiveness

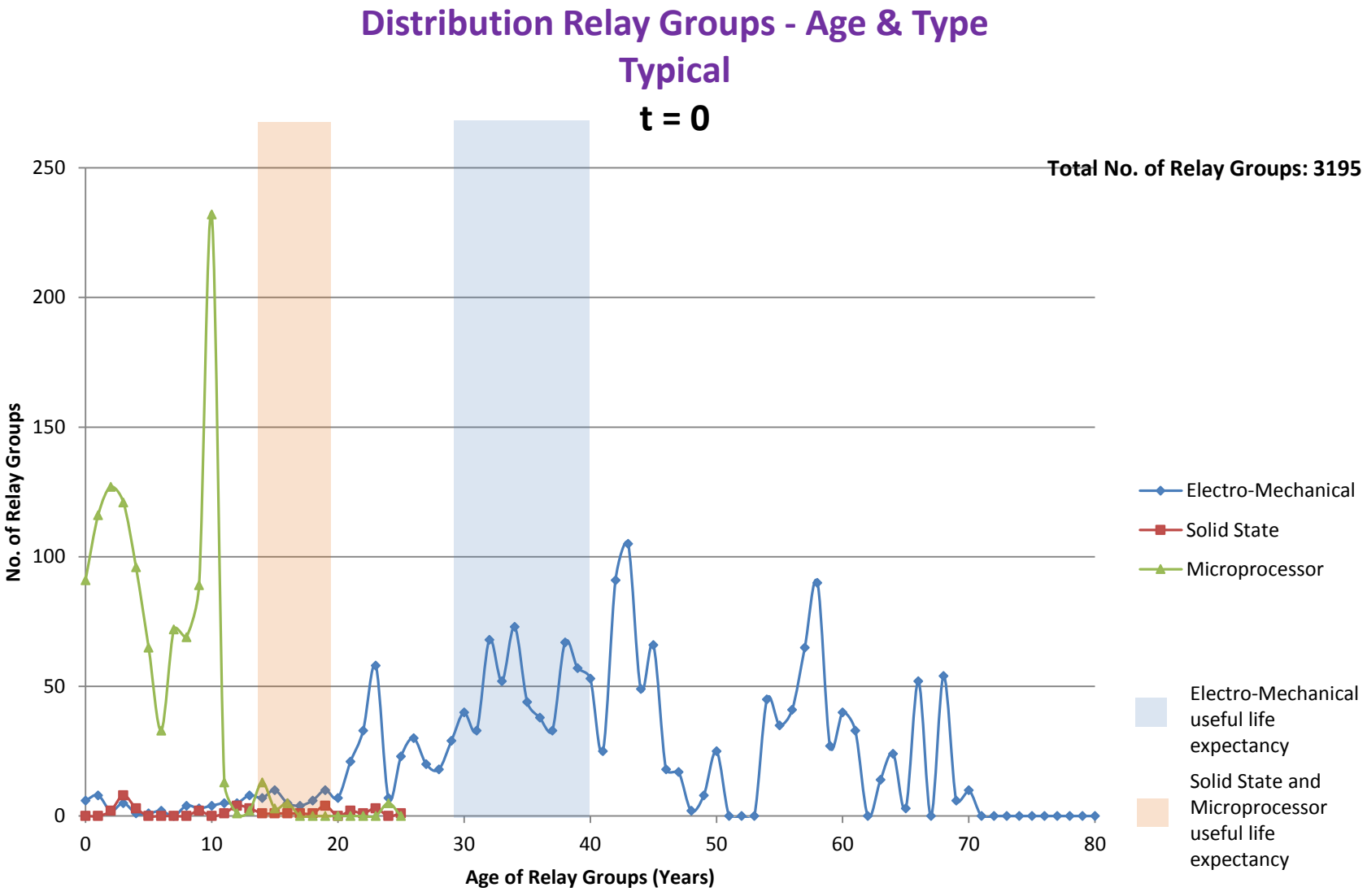
IT Architecture – Old Way Vs New Way



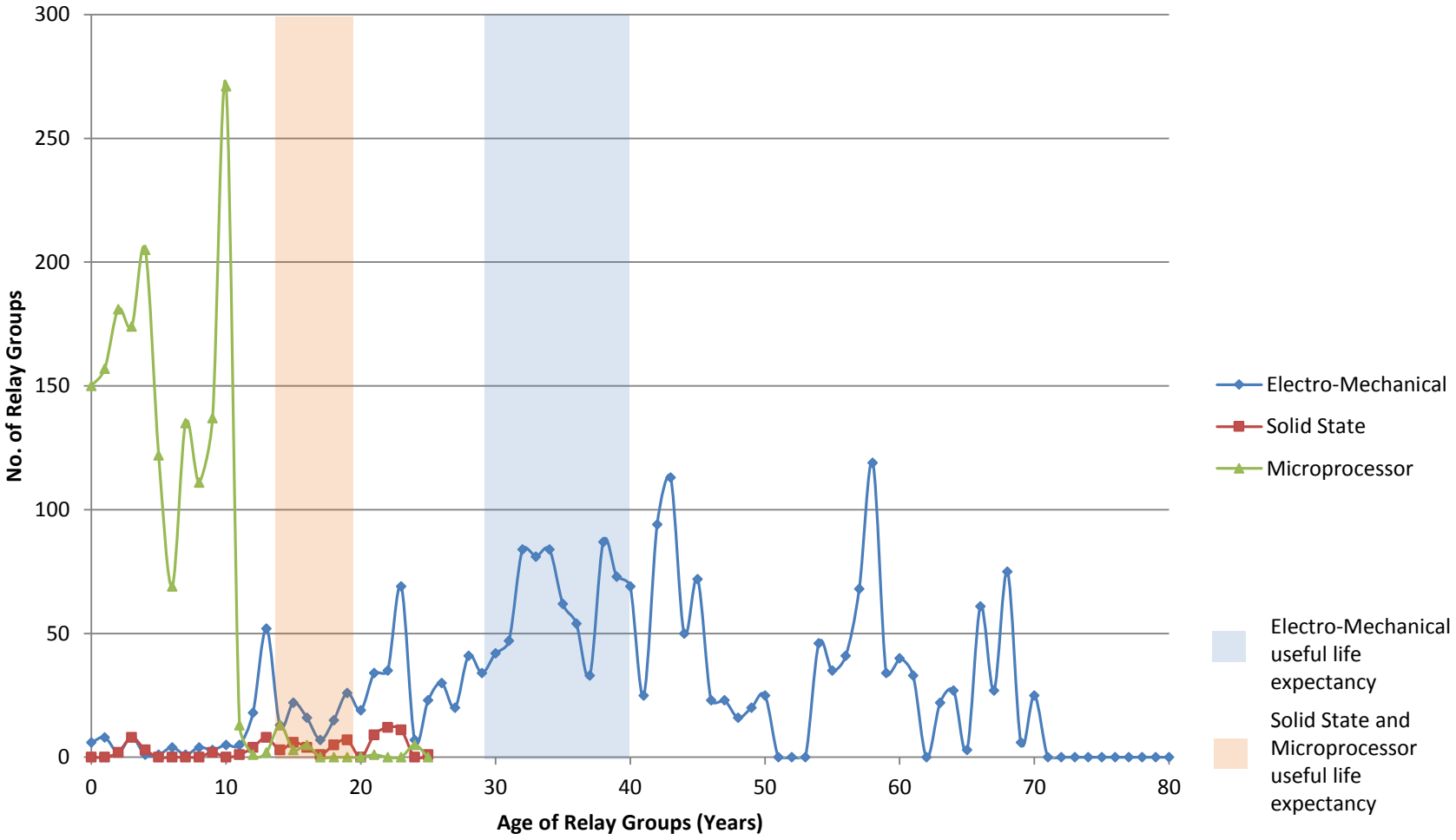
IT Architecture – New Way



Appendix


Distribution Relay Groups - Age & Type
Typical
t = 0
Total No. of Relay Groups: 3195
No. of Relay Groups
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
Age of Relay Groups (Years)
Electro-Mechanical
Solid State
Microprocessor
Electro-Mechanical useful life expectancy
Solid State and Microprocessor useful life expectancy

Transmission & Distribution Relay Groups - Age & Type Typical



Distribution Protection System - Typical