BAKER HUGHES
a GE company

GE Bently Nevada Portfolio Overview

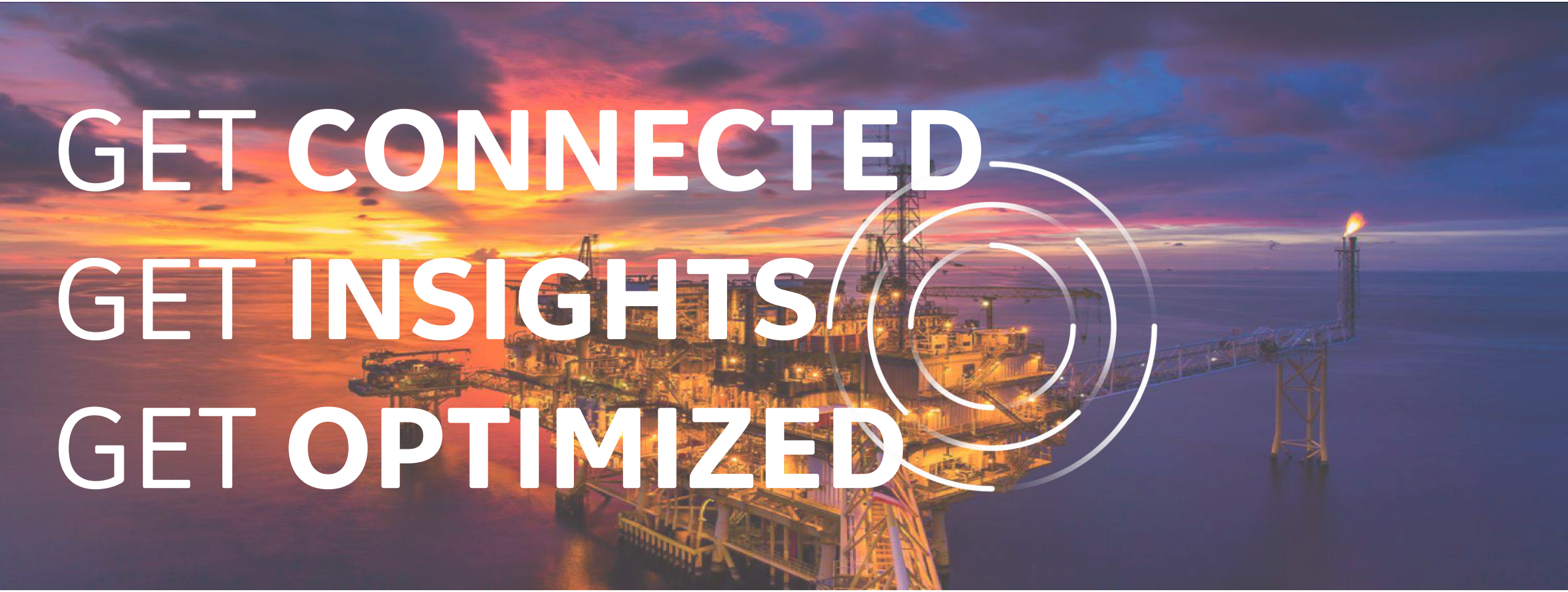
Toronto, ON
March 23, 2018

Bently Nevada Delivers

Confidence for your enterprise to maximize digital potential

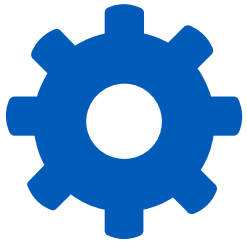
- **50+ Years** — Monitoring experience
- **300+** — Certified Field & Diagnostic Engineers
- **15 K+** — Software licenses & portables in use
- **300 K+** — Protection & condition monitors in service
- **4 M+** — Specialty sensor points installed

Industrial Internet Themes



GE APM

GET CONNECTED



Machine and Equipment Health

Complete, Accurate, & Centralized view of your assets state and health

GET INSIGHTS

Reliability Management

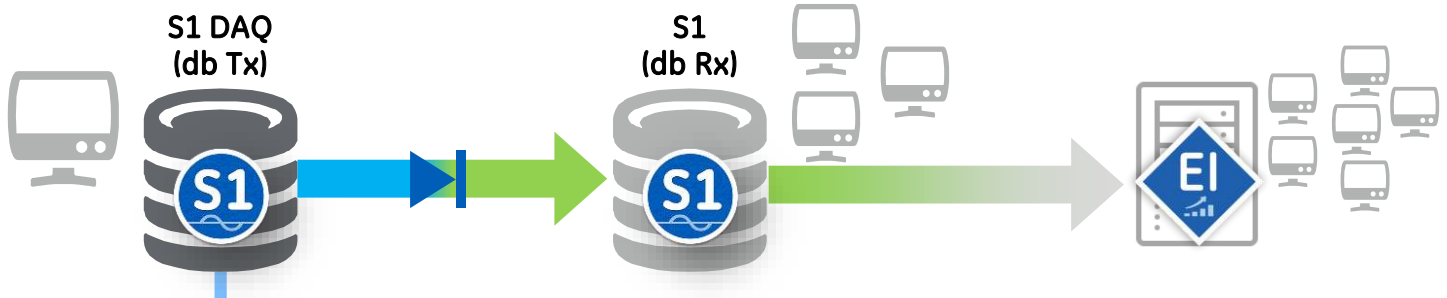
Diagnose assets and predict issues to respond before assets fail

GET OPTIMIZED

Maintenance Optimization

Maintenance strategies that balance reliability, performance, & cost

Bently Nevada



CRITICALITY

Bently Nevada Network

3500

3701 ADAPT

2300/20

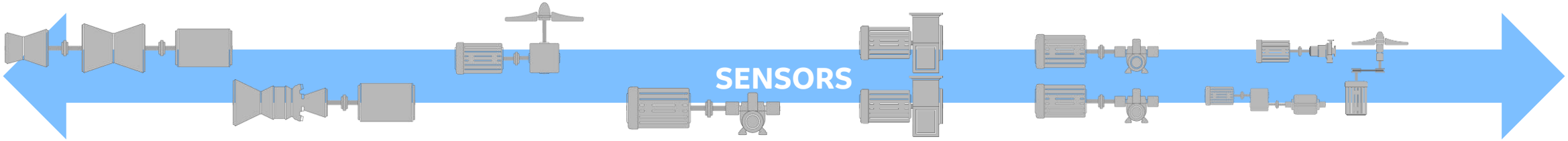
S1 6.x
AS A DEVICE

vbOnline Pro

Ranger Pro

Portables

Process Data



Installation Services

SIE

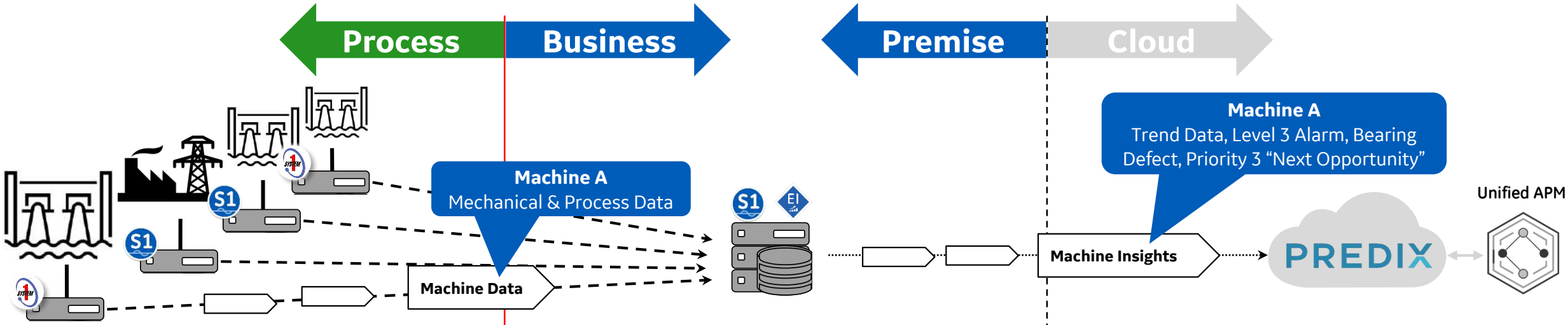
MDS

Technical Training

Product Support

RM&D

Machinery Condition Monitoring from Edge to Cloud



Site Level

- Tactical Machinery Diagnostics
- Device Connectivity

Enterprise Level

- Machinery Fleet Awareness
- Proactive Machinery Condition Monitoring

Bently Unified APM Enablers

- Asset Strategy Optimization
- EAM Integration

Core Machine Connectivity
Live Data Analysis

Detect Machinery Problems
Diagnose Fault Condition & Priority

Propagate Actionable Information
Manage Machinery Fleet

10% of Time

90% of Time

Services

Installation Services

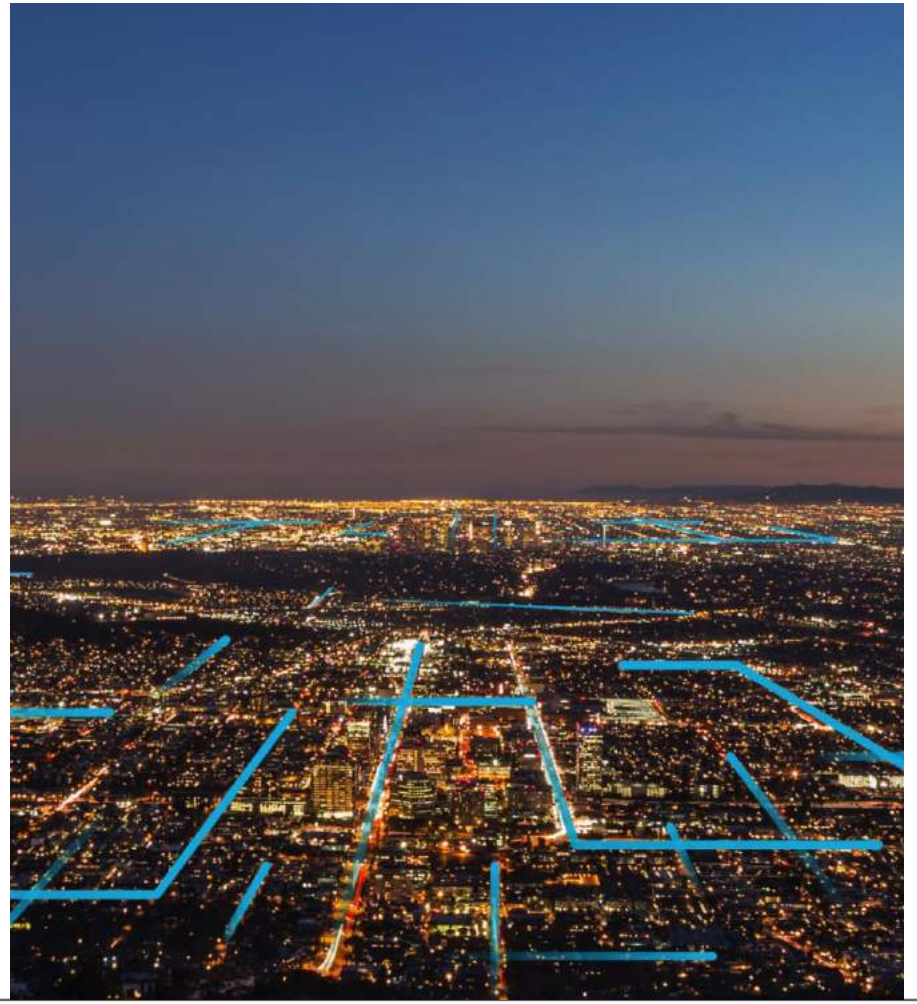
- Project Management
- Design & Specification Development
- Site Supervision / Project Management
- Packaged Systems
- Mechanical & Electrical Designs
- New or Retrofit Applications
- FAT & SAT
- Safe & Timely
- Systems & Instrumentation (S&I) Services

Machinery Diagnostic Services

- Machinery startup/turnaround assistance
- Condition monitoring system optimization
- Field & shop rotor balancing
- Thermal growth studies
- Rotordynamic modeling
- Machinery failure analysis
- Reciprocating machinery diagnostics
- Specification consulting

System Integration Engineering (SIE) Services

- OPC/Modbus Integration
- Network Architecture Review / Design
- Remote Site Connectivity (VPN)
- Cyber Security review for System 1 installations
- Hosting Solutions



Technical Training

- System-specific training
- *3500 Operation & Maintenance*
- *System 1 Fundamentals*
- *Machinery Diagnostics*
- *Recip Compressor CM&D*
- *Portable Vibration*
- *…and more*
- On-Site or in one of our Global Training Facilities

Product Support

- Technical Support (24x7)
- Repair & Calibration
- Product Certification
- Access to product updates &upgrades

Remote Monitoring & Diagnostic Services

- *Offsite Monitoring, Onsite Results*
- Affordable
- Responsive
- Comprehensive Scope
- Root Cause Diagnostics
- Recurring Data Review
- On-Demand Data Review
- System Optimization
- System Support
- Site Support

Transducers

Proximity Transducers

- **Applications**: fluid film (sleeve) bearings (non-contacting), position measurements

- Capable of low frequency response (down to 0 Hz)

- <u>Units</u>:
microns (μm)
or
thousandths of an inch (mil)

Velocity Transducers

- **Applications**: Measuring vibration of machine casing and other structural response characteristics.

- Useful for medium frequencies (~10 Hz to 10,000 Hz).

- Units:
millimeters per second (mm/s)
or
inches per second (ips)

Accelerometer Transducers

- **Applications**: gearboxes, rolling element bearings, etc.

- Capable of high frequency response (up to ~20 kHz).

- Units:

meters per second^2 (m/s^2)
inches per second^2 (in/s^2)
or
Standard Gravity (g)

Air Gap Transducers

- **Applications**: hydroturbine generators
- Air Gap ranges from 7 mm to 40 mm
- 125°C operation
- 1.5 Tesla magnetic field
- Two sizes

  19 mm linear range

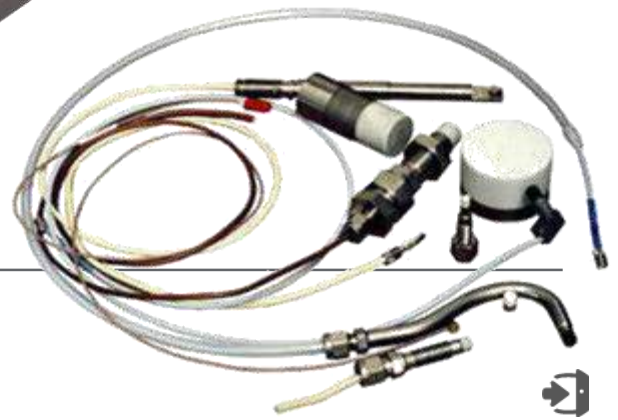
  50 mm linear range

Dynamic Pressure Transducers

- **Applications**: Hydro Turbines, Centrifugal Pumps
- both static and dynamic pressure in fluid machines
- Hydro: Rough Load Zone, vortexing, cavitation in the draft tube & head cover area, pulsations in penstock
- Pumps: monitoring cavitation and other flow instabilities
- Ranges from 0 to 15-5000 psia (0 to 1.03-345 bara)

Other Transducers

- Including:
- Hydro Air Gap
- Dynamic Pressure (recip applications)
- Case Expansion, Valve Position
- Optical
- Custom Applications



Accessories

- Housings
- Conduits
- cable seals
- junction boxes
- mounting brackets and more

Portables

vbSeries

- Lightweight, portable instrument for offline data collection
- Available in 4 different models with varying capabilities & channel counts
- Class 1, Div 2, CSA
- Data to System 1 Evolution

SCOUT200 Series

- 2-Piece Form Factor
- App on Android phone
- Data Acquisition Module
- Light weight, single-handed
- Easy to Use – Data Collector
- Data to System 1 Evolution (Fundamental)

SCOUT200 Series

- SCOUT220-IS : CSA C1D1 & ATEX Zone 1
- COMMTEST220 : not rated
- Currently shipping with BCOM EX-SM14 Android handheld

Remote Comms

System 1 Server

Remote Comms Server

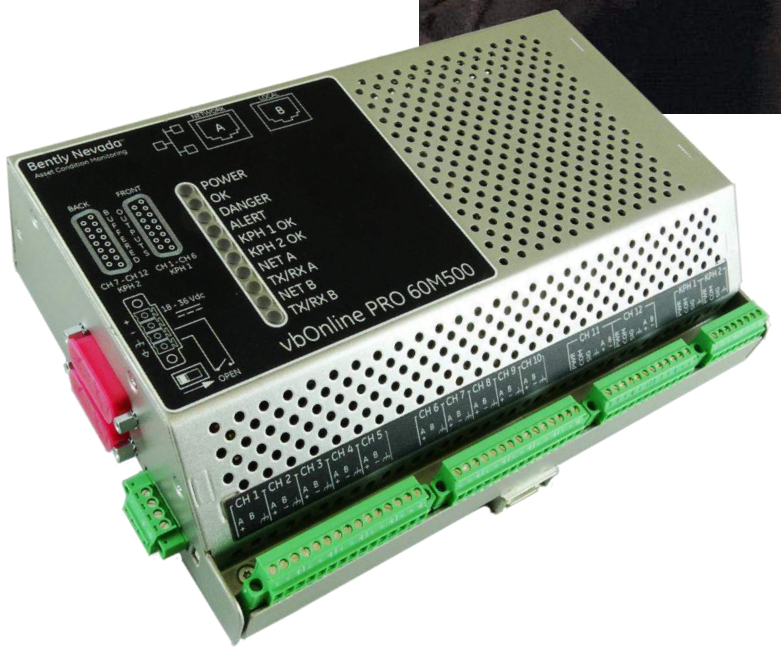
ADRE

- Scalable Architecture
- Self Contained Windows Server
- Up to 5 Clients at one time
- Pre-trigger buffer
- 1 to 120,000 rpm sampling
- Up to four waveforms sampled for each channel
- Power for up to 32 transducers

Monitors – Condition Monitoring

vbOnline PRO

- Scanning system -> economical solution
- 12 input channels & 2 speed
- Detects machinery problems at early stages
- Proven in wind – now for general purpose machinery
- Data to System 1 Evolution
- All data needed for detailed analysis available:
  Spectral, waveform, enveloping, trends, etc.



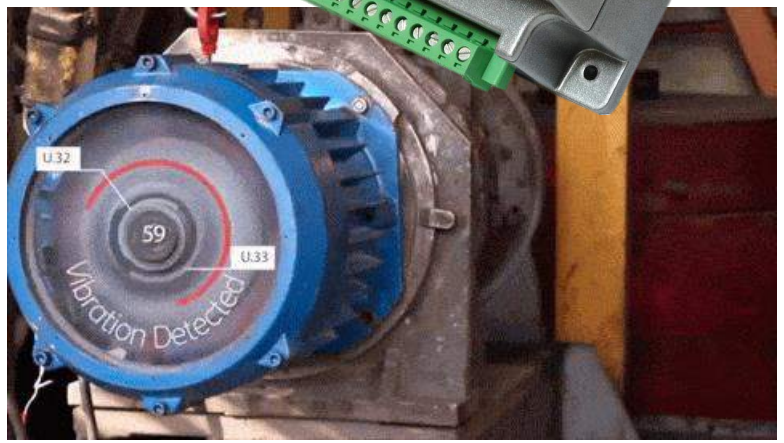
Ranger Pro

- Reduced cabling cost
- Choice of single axis or triaxial vibration plus surface temperature can be measured
- Mesh or Star Topology
- Zone 0 classification
- ISA100 Standard compatible*
- Data to DCS directly (trends only) and/or System 1 Evo (spectral, waveform, enveloping, trends, etc.)

Monitors - Protection

2300/20

- 2300/20 monitor provides vibration monitoring and high vibration level protection.
- Two vibration measurement channels
- Various transducer types (accelerometer, velocity, proximity)
- Speed input channel for time-synchronous measurements
- Relay contact, 4-20 mA, SPA, and Modbus/TCP outputs
- Easily configured utilizing GE's Bently Nevada Monitor Configuration software (BNMC)
- DIN rail & bulkhead (1900/25 footprint) mounting options
- Data to System 1 Evolution

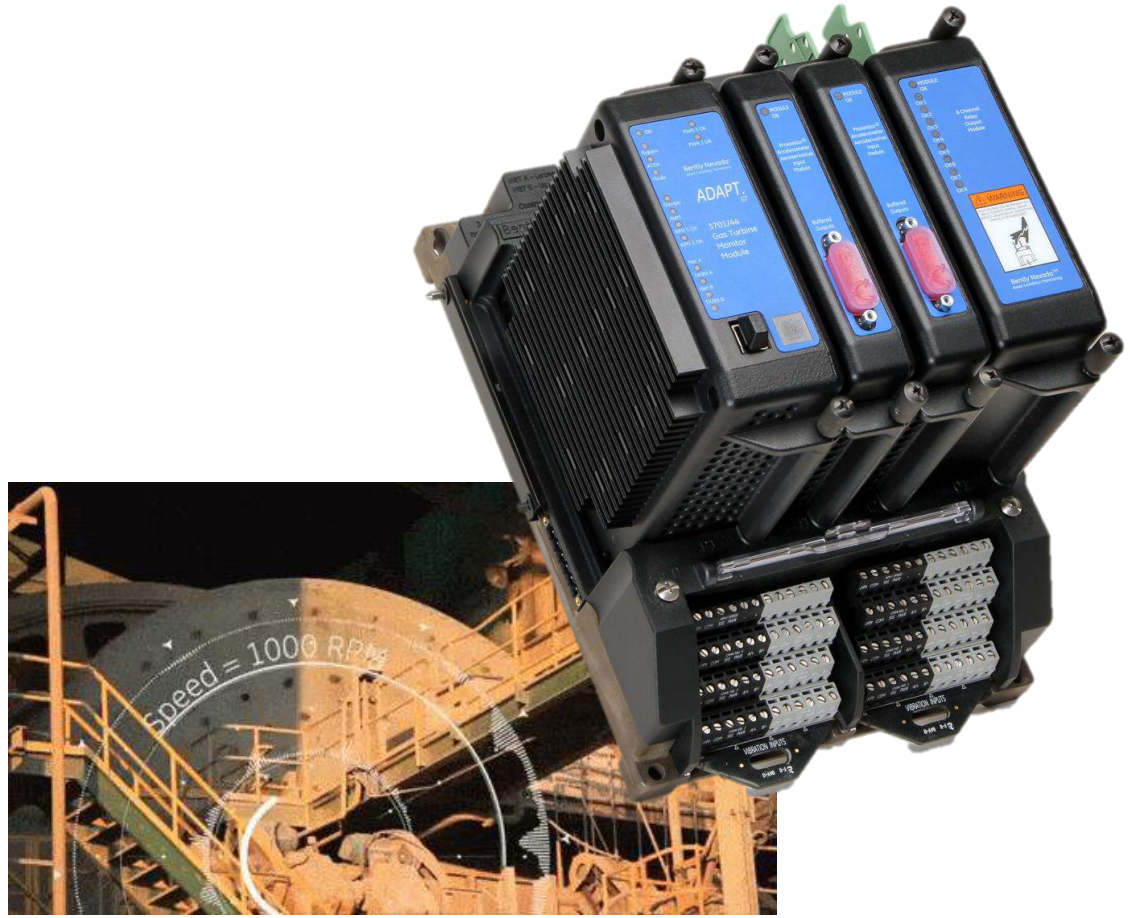


1900/65A

- Local monitoring system, wiring is minimal
- 4 vibration and 4 temperature inputs
- Can be used for protection
- 3 different vibration measurements from a single sensor: Problems seen in low, mid and high frequency range can be detected just by using one sensor
- Modbus, mA and 6 relay outputs
- Buffered output for portable data collector or to scanning online system
- Inexpensive

3701 ADAPT

- *Advanced Distributed Architecture Platform Technology*
- Small, lightweight, skid mountable, rugged monitor
- High and Mid-level criticality
- Vibration
- Thrust
- Keyphasor / Speed
- Data to System 1 Evolution



3701 ADAPT

- 12 vibration, 2 speed, 8 relay channels (graphical editor)
- Modbus TCP/IP & EGD output
- High performance signal processing capability (multiple variables per input, etc)
- Async waveforms:

  Fmax can be set between 10 Hz and 40 kHz in 12 discrete steps. Fmin is always at 0 Hz.

  12.5 to 3200 spectral lines (in 12 discrete steps)

- Sync waveforms:

  Number of samples per revolution can be set from 8 to 4096.

  Number of revolutions per waveform can be set from 1 to 1024.

3701 ADAPT ESD

- TMR stand-alone safety Electronic Shutdown Device
- Over speed protection
- SIL 3 and hazardous ratings
- Graphically configurable trip logic
- Six Speed Inputs

  2 redundant speed inputs per module

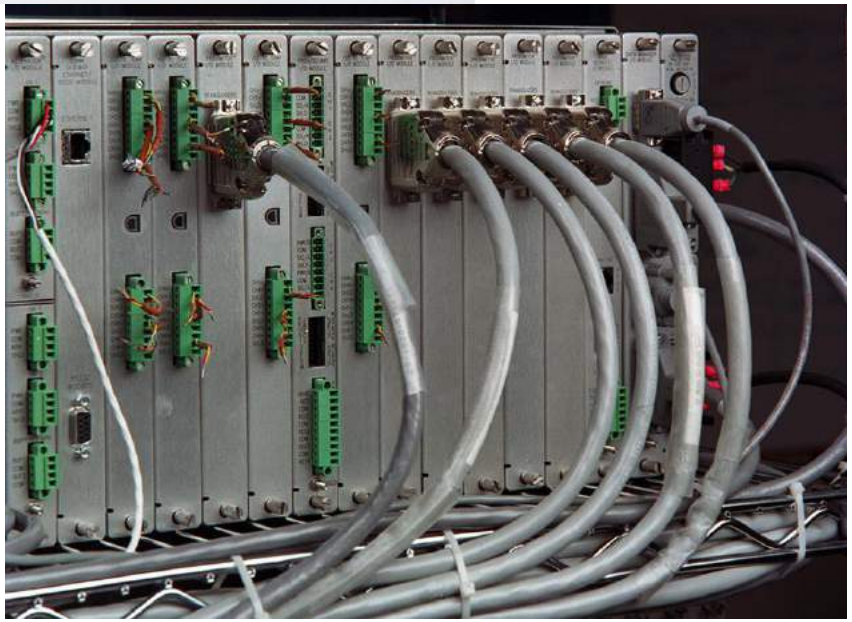
  Magnetic Pickup or Proximity
- 32 Discrete Inputs, 12 Analog Inputs
- 4-20mA Outputs, 12 Relay Outputs
- Supports industry standard communication protocol, Modbus TCP/IP

3500

- High density 19” EIA system rack
- Dual Power Supplies
- Skid or Remote Mounting
- Class I Div 2
- IS Barriers
- Relay Modules
- Modbus Communications
- API 670
- Data to System 1 Classic or Evolution
- Multiple Approvals
  (Hazarous Areas, Functional Safety, Cyber, and Maritime)

3500 - Inputs

- AC/DC power (redundant)
- Keyphasor, speed, tachometer, MEW
- Vibration (proximity, velocity, acceleration)
- Position (thrust, diff exp, valve pos'n, case expansion, etc)
- Air gap
- Temperature (RTD, TC)
- Pressure
- Process Variables (4-20mA, -10 to +10V)
- Recip-specific, Aeroderivative-specific, Hydro-specific



3500 - Outputs

- System 1
- Modbus
- 4-20mA (recorder outputs)
- Relays
- Local Display
- Buffered Outputs

Software

The Evolution of System 1

2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2012 | 2014 | 2016 | 2018 | 2020

v1.0: Portable
v2.0: TDXNet
v3.0: TDI

v4.0: Trendmaster
v5.0: Hydro, DS
v6.0: Recips

v6.5: Platform Stability
v6.52: Wireless
v6.85: Enhancements

v6.87: Enhancements
v6.88: Enhancements
v6.89: EI Integration

Standard Support through 2020

17+ Development Driven by Users

User Research
CM + Portable

Primary Investment

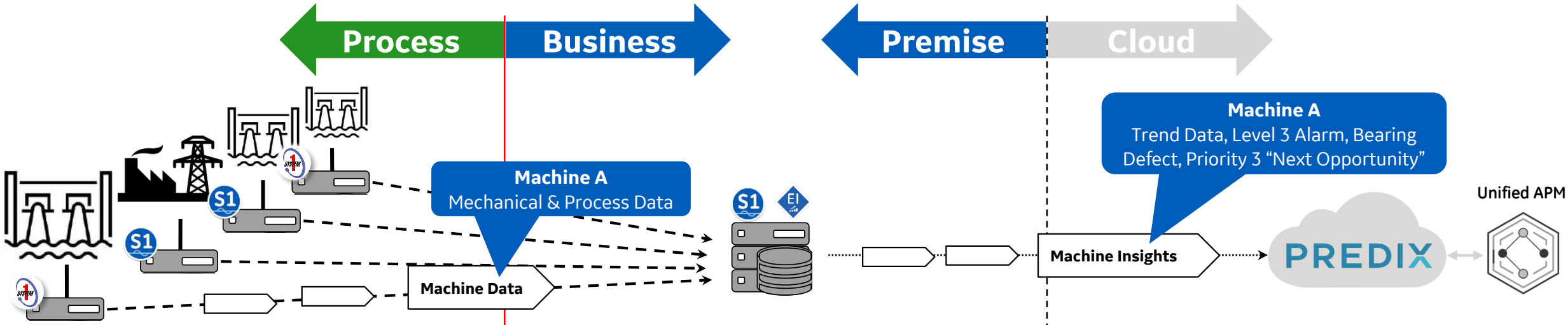
User Research
CM + Turbo

v15.1: Limited Portable
v15.2: Limited Turbo
v16.1: Limited Scanning
v16.2: Turbo + Scanning

User Research
CM + Recip

v17.1: CM + Replication
v17.2: Recip + Migration
v18.1: CM + 6.x Replace
v18+: Enhancements

Machinery Condition Monitoring from Edge to Cloud



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- Device Connectivity

Enterprise Level

- Machinery Fleet Awareness
- Proactive Machinery Condition Monitoring

Bently Unified APM Enablers

- Asset Strategy Optimization
- EAM Integration

Core Machine Connectivity
Live Data Analysis

Detect Machinery Problems
Diagnose Fault Condition & Priority

Propagate Actionable Information
Manage Machinery Fleet

10% of Time

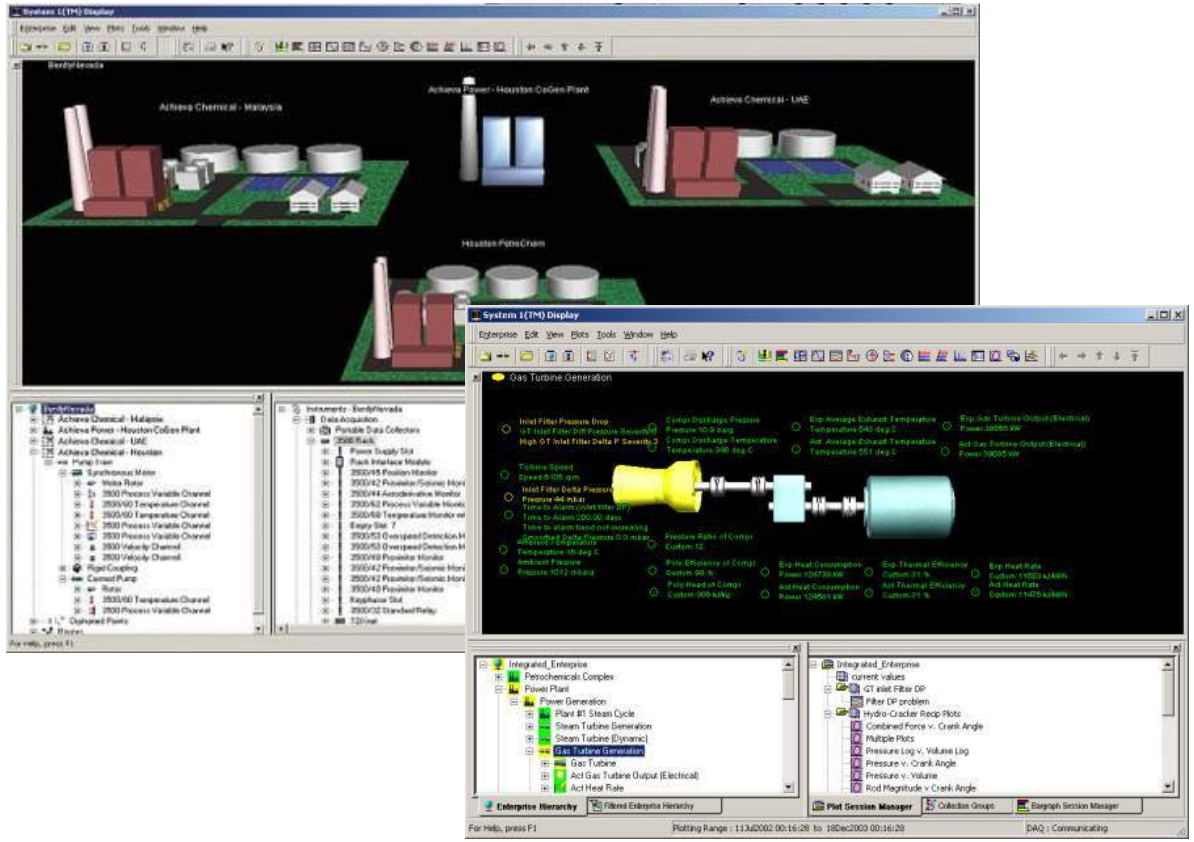
90% of Time

System 1 Classic (v6.x)

BENTLY NEVADA*
Machinery Condition Monitoring

System 1 6.x

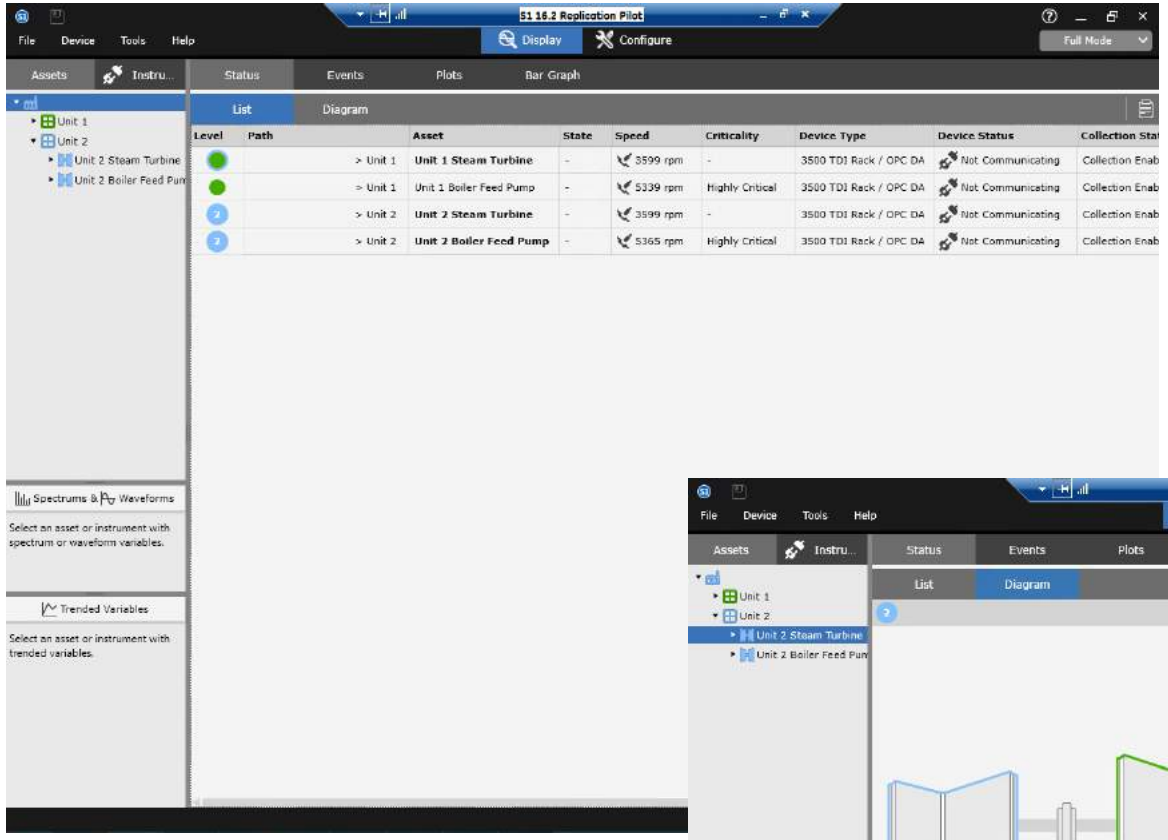
- Microsoft® client /server technology stack including Microsoft SQL.
- Provides the core functionality of configuration, data storage, and user presentation.
- Collects data from the Bently Nevada condition monitoring systems
- Allows for flexible scaling

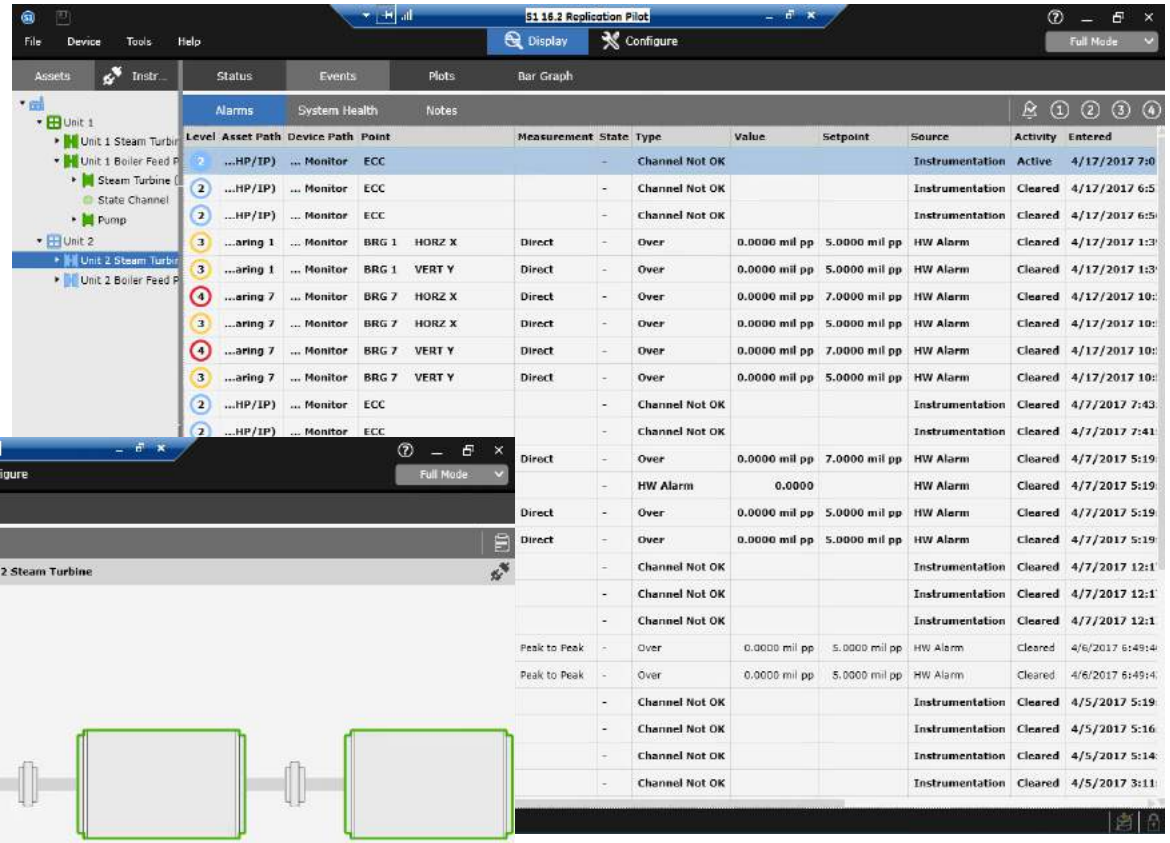


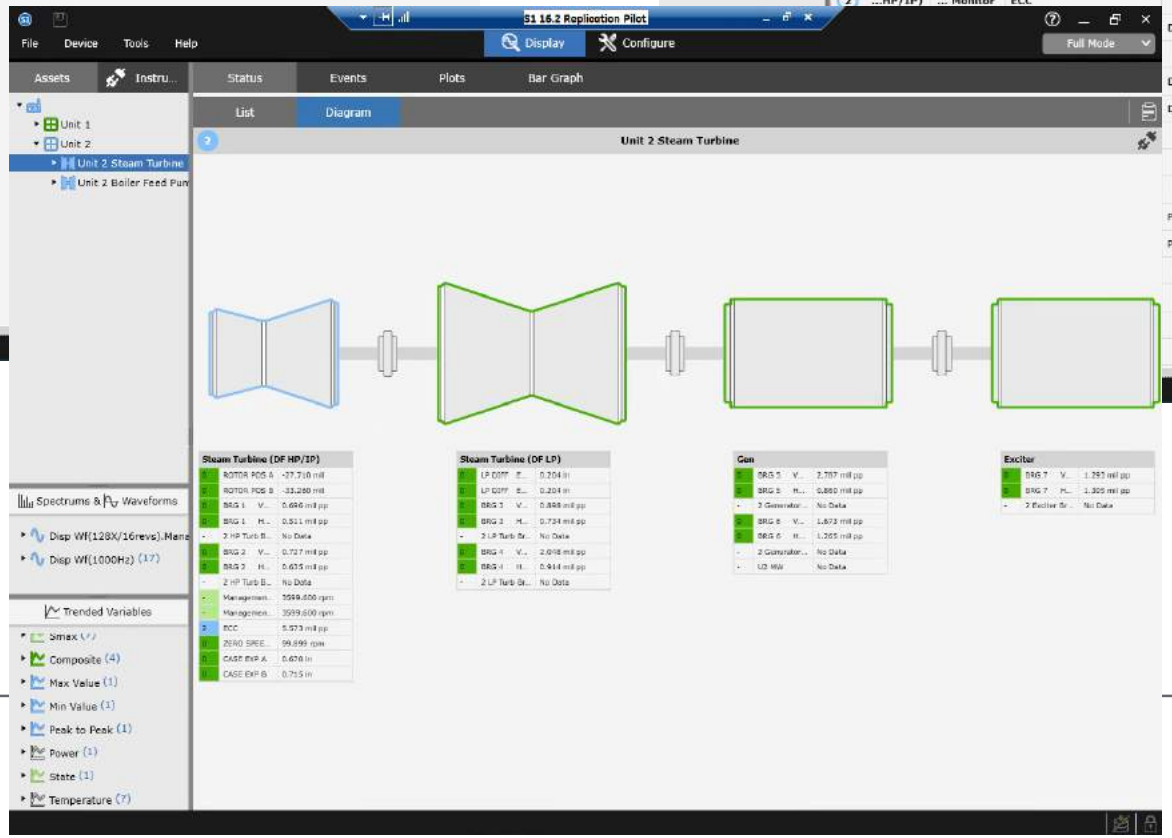
System 1 Evolution (v17.2+)

BENTLY NEVADA*
Machinery Condition Monitoring

System 1 Overview

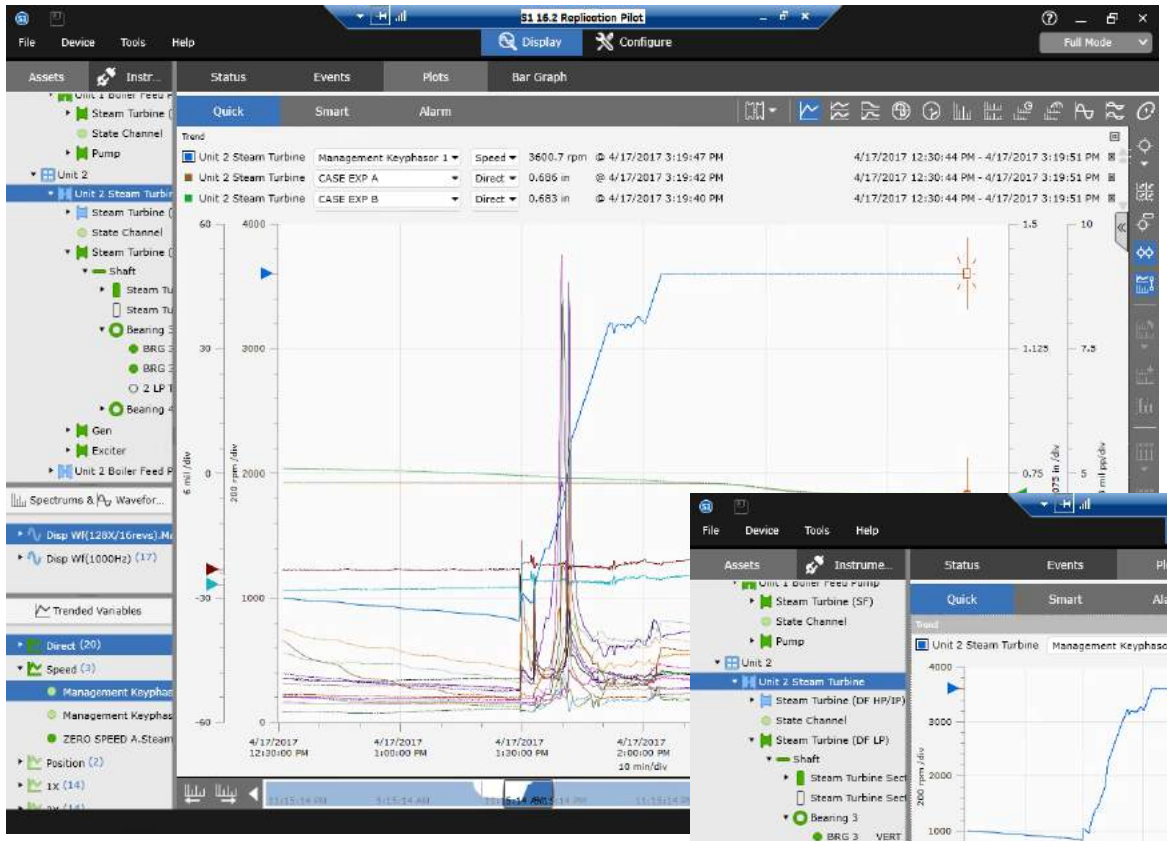


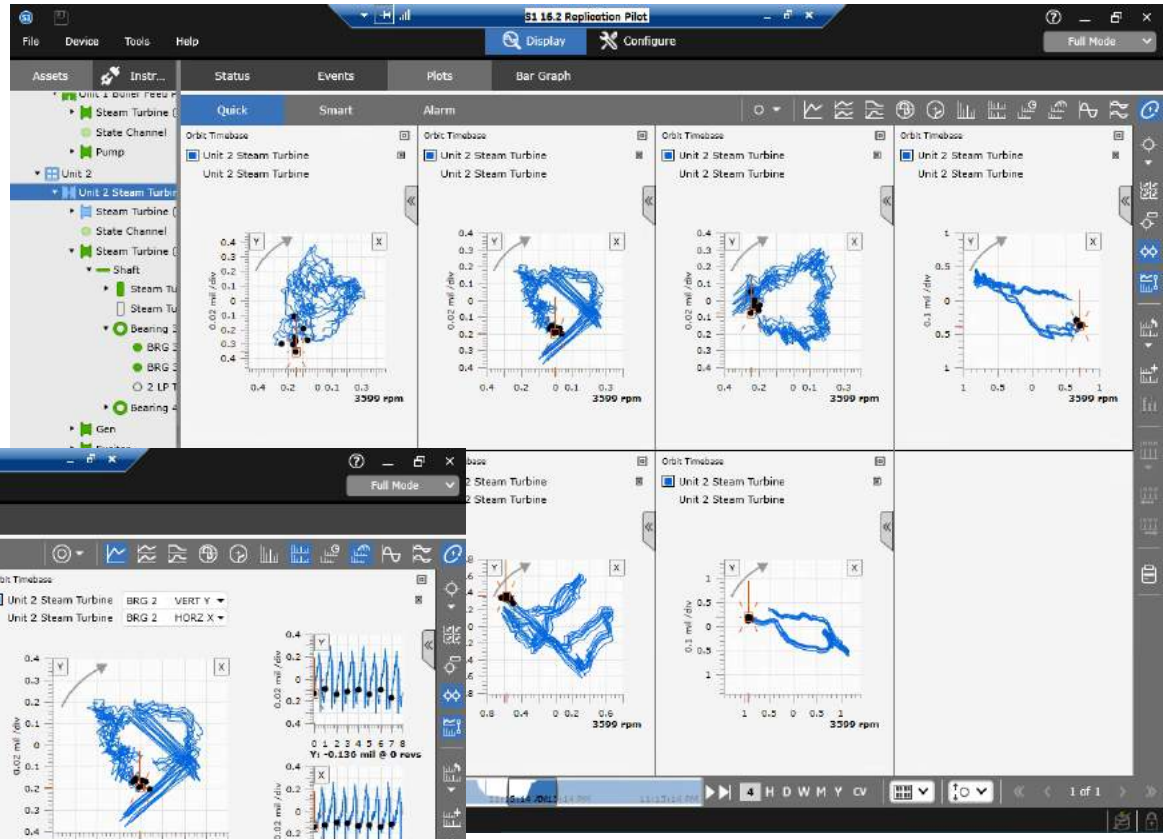


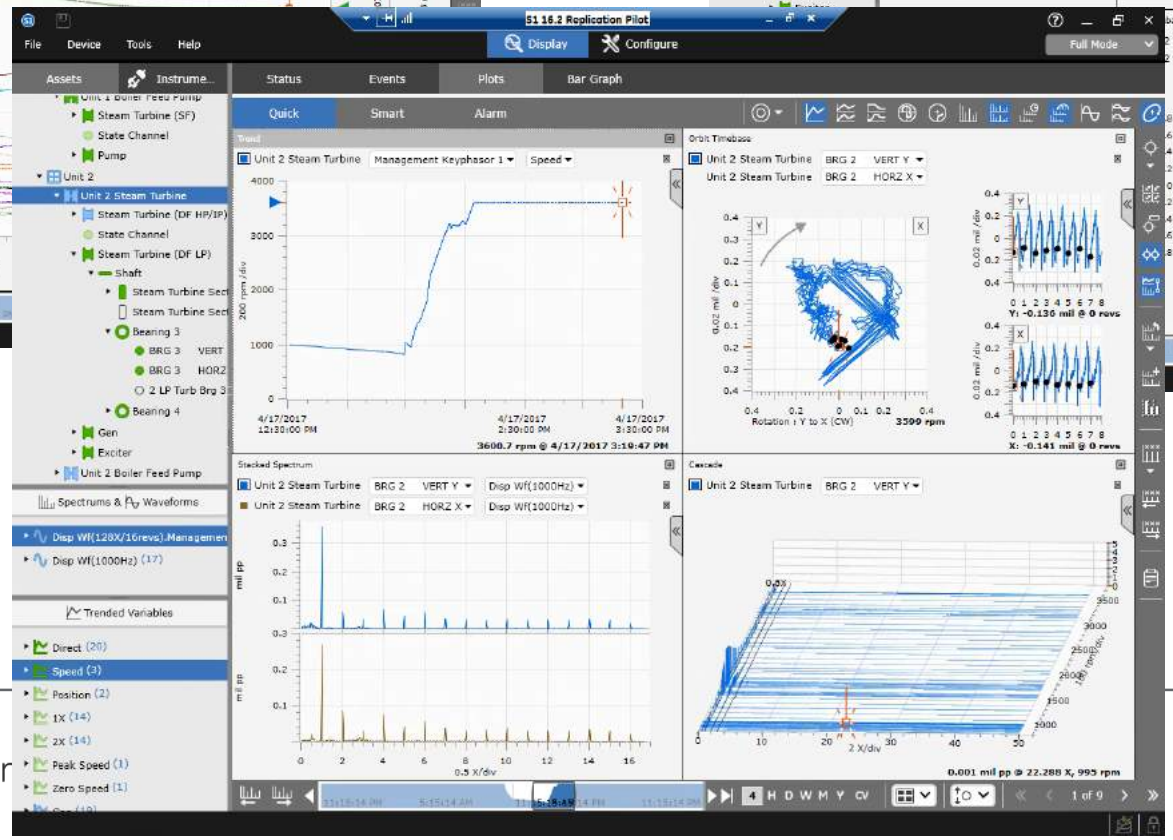


BENTLY NEVADA*
Machinery Condition Monitoring

System 1 Overview







Commitment to Install Base (>$$10MM user driven annual investment)

Customers by Industry

Industry	System 1
Oil & Gas	43%
Petrochemical	15%
Power Gen / Utilities	32%
Renewables (wind/hydro)	4%
Metals & Mining	2%

Business profile

Customers	1,635
Licensed Sites	1,934

Benefits of upgrading from 6.x to 16+

- ✓ Ability to reduce number of CM applications supported now that S1 provides true plantwide capabilities
- ✓ Ability to reduce training overhead by standardizing on one CM application
- ✓ Improved condition monitoring productivity because application has been designed to facilitate the process
- ✓ Reduce ongoing training overhead because of consistent interaction pattern & contemporary interface
- ✓ Improved user productivity through simplified access to the application on the business network
- ✓ Reduced IT server overhead through increased device support for each S1 server (Up to 30 TDIs)
- ✓ Reduced implementation time through domain expert driven configuration wizards
- ✓ Reduced database management overhead (determinant data storage) with improved machinery management

BENTLY NEVADA*
Machinery Condition Monitoring

Install base can upgrade with Active M&S Agreement!

Core S1 Use Cases

Enabled by

S1 Product Pillars

Condition Monitoring

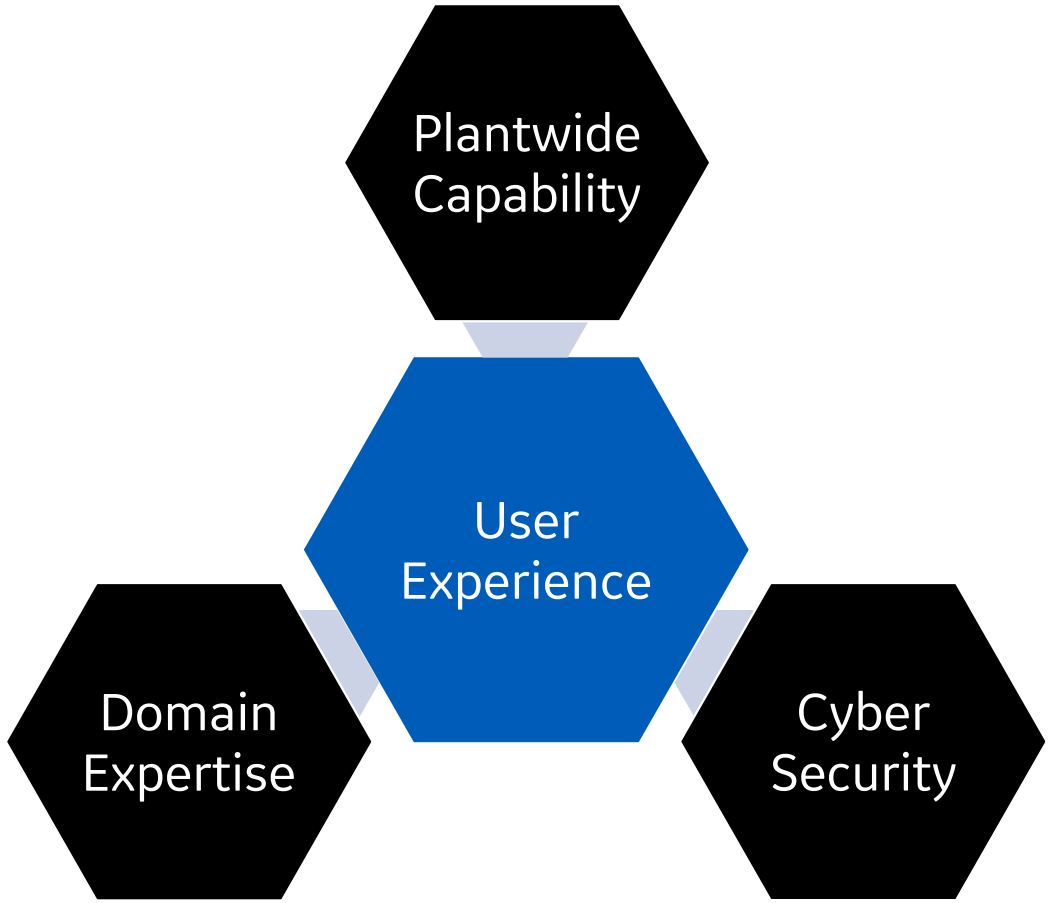
Identify changes in machinery health & understand risk

Post Trip Analysis

React intelligently to surprises

Machinery Management

Closely monitor new, overhauled, and damaged equipment



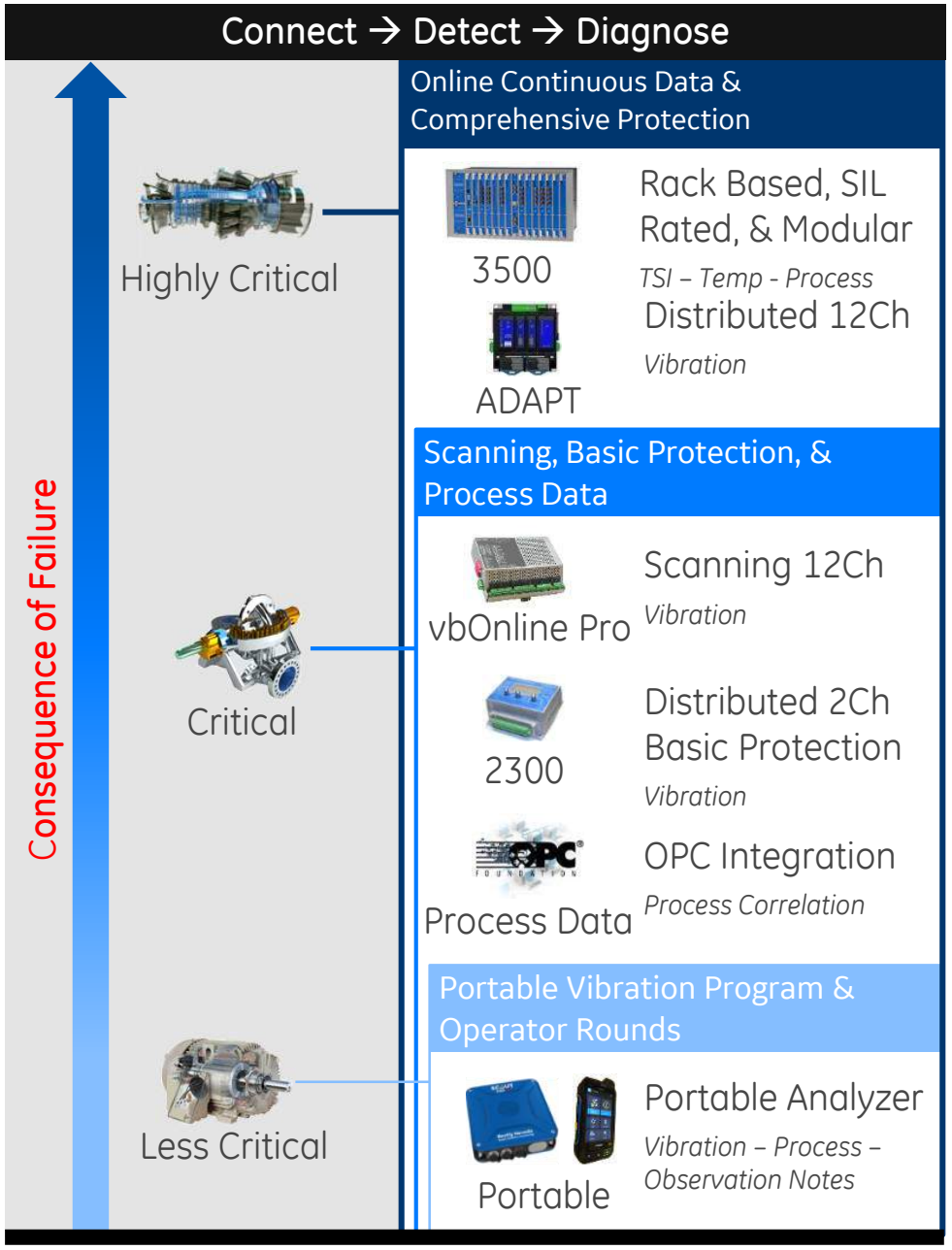
Plantwide Capabilities – A dedication to condition monitoring for all rotating & reciprocating equipment

Core benefits over 6.x

- ✓ Reduce CM vendors now that S1 truly provides plant coverage
- ✓ Reduce training overhead by standardizing on one CM application
- ✓ Reduce IT overhead by supporting a single condition monitoring system

Core 17+ Capabilities

- Connectivity to the latest plant-wide focused CM devices
- Condition monitoring reporting (Fault & Priority Reviews)
- Comprehensive anti-friction bearing diagnostics
  - Spectral tools (Auto-Harmonics, micro cursors, etc.)
  - Flexible spectral bands (recalculate, re-alarm)
- Offline data management
  - Move data when collected on wrong machine
  - Delete bad data
  - Observation note integration
- Comprehensive equipment template management



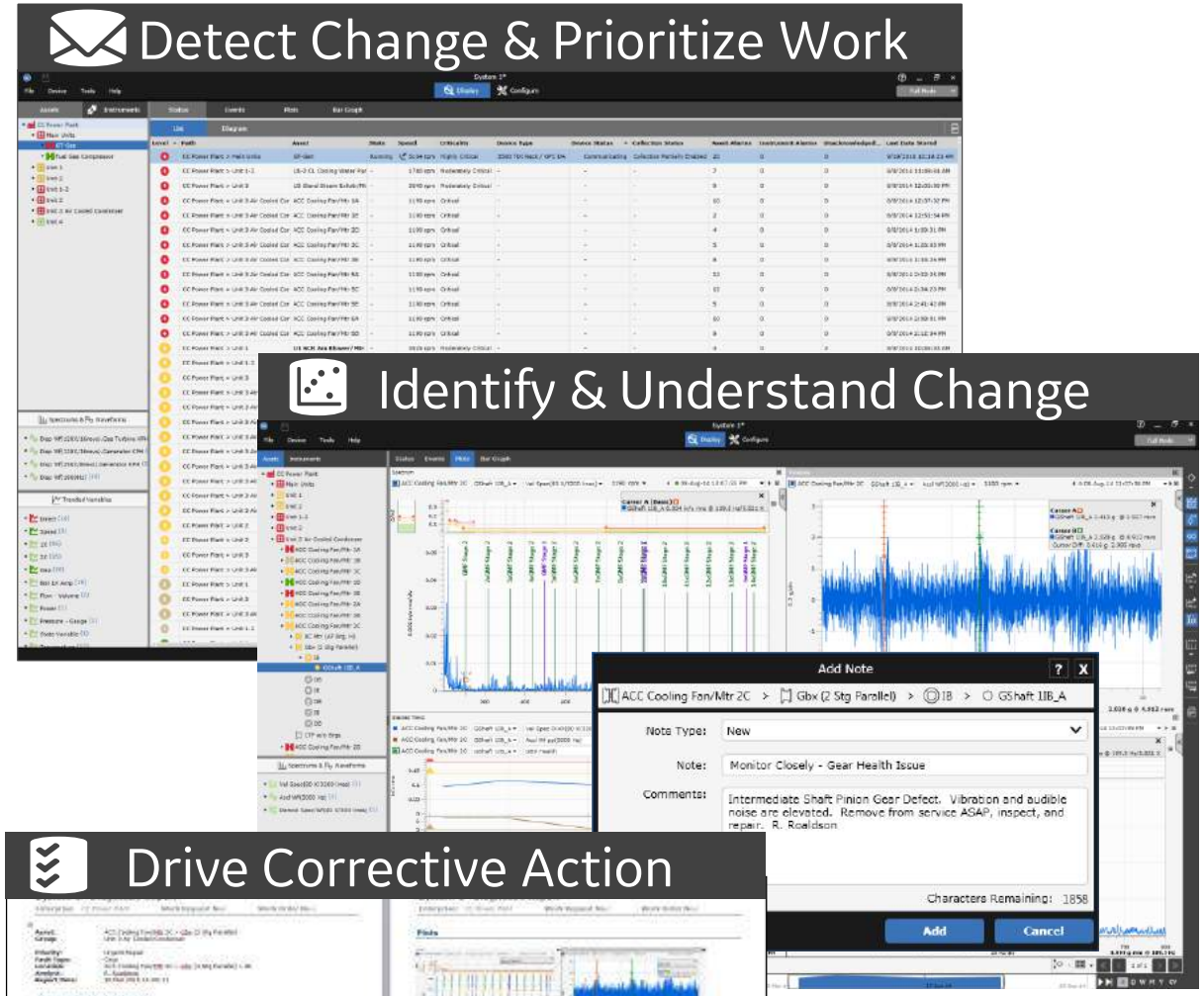
User Experience – A dedication to condition monitoring workflow, not simply a collection of capabilities

Core Benefits Over 6.x

- ✓ Improved condition monitoring productivity because application is designed to support the process
- ✓ Reduced training overhead because of consistent interaction pattern & contemporary interface
- ✓ Commitment to ongoing user engagement ensures that future releases improve user experience & productivity

Core 17+ Capabilities

- Condition monitoring report workflow
  - Summary list view drives work prioritization
  - Equipment reviews drive consistent fault condition & priority reporting
  - Easy export of database information to Excel for KPI tracking
  - Quick diagnostic report for driving corrective action
- Best-in-Class trend analysis (including multi-unit)
- Designed for internationalization



Cyber Security – A commitment to moving data not people securely

Core Benefits Over 6.x

- ✓ Improved user productivity through simplified access to the application on the business network
- ✓ Reduced IT server overhead through increased device support for each S1 server
- ✓ Enhanced data security

Core 17+ Capabilities

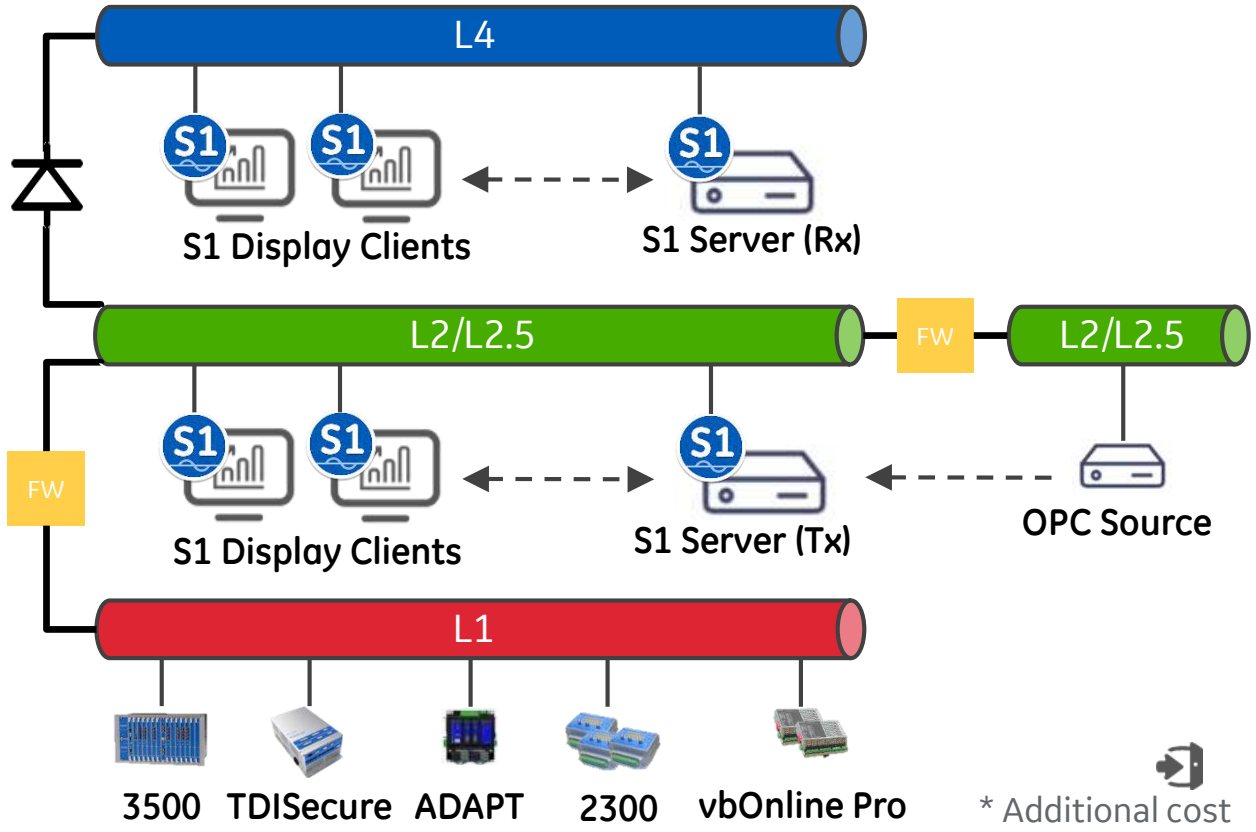
- Database Replication*
  - Perform 80% of CM from the business network
  - One way transfer through diode or firewall
- Client to server communication
  - Only 2 TCP/IP ports required (6.x=DCOM)
- Enhanced Device Connectivity
  - Connect up to 30 TDIs into one S1 server (6.x=12)
- OPC UA
  - Latest standard removes DCOM & supports enhanced data type transfer (trend, waveform, alarm, etc.)

S1 Server (Rx) – Replicated Database

- Supports 80-90% of daily CM & post trip analysis use cases
- Mirrors the Tx System, containing a sub-set of data
- Support for all online data sources– Portables to be supported in future

S1 Server (Tx) – Transmitting Database

- Conduit to move data to Business Network (L4)
- Contains the configuration definition and direct connection to devices
- Supports CM, Post Trip Analysis, & Real-time Machinery Management



* Additional cost

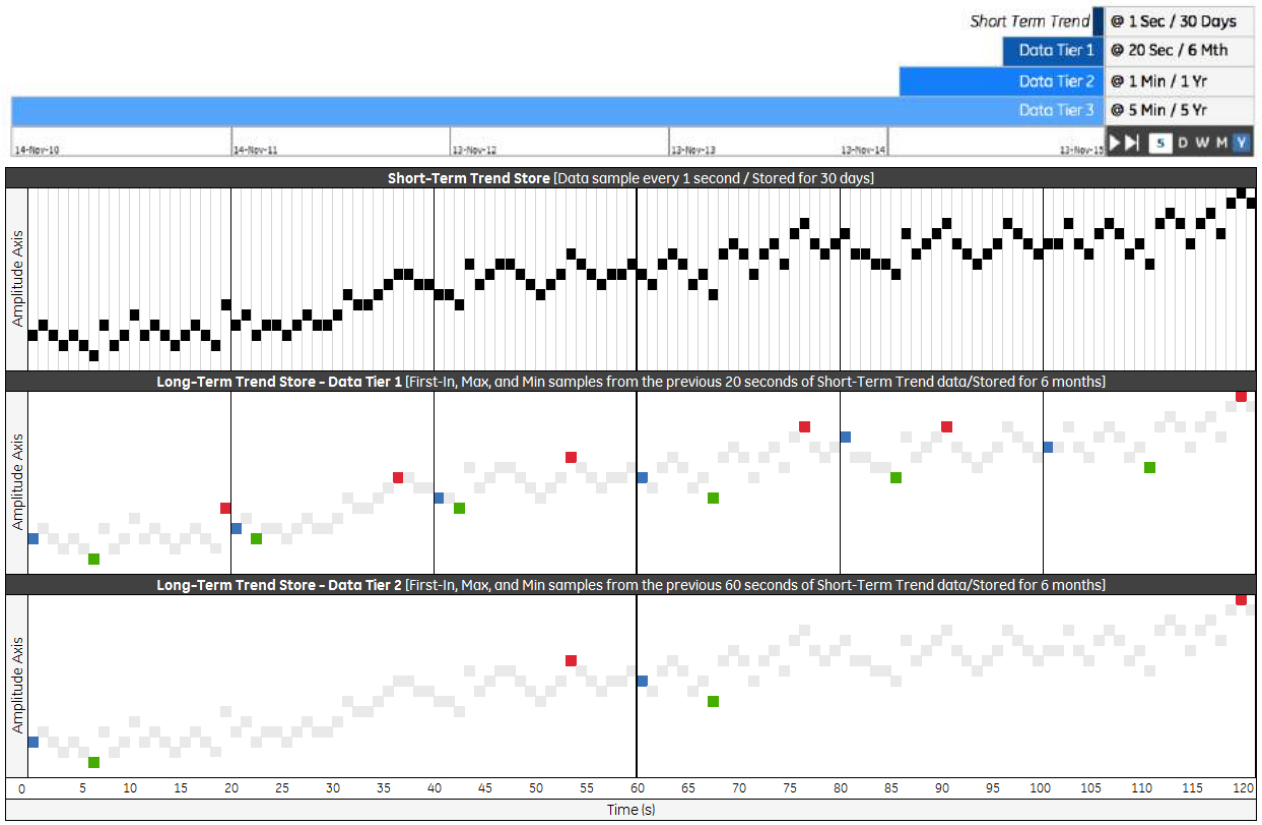
Domain Expertise – Delivering expertise through the platform

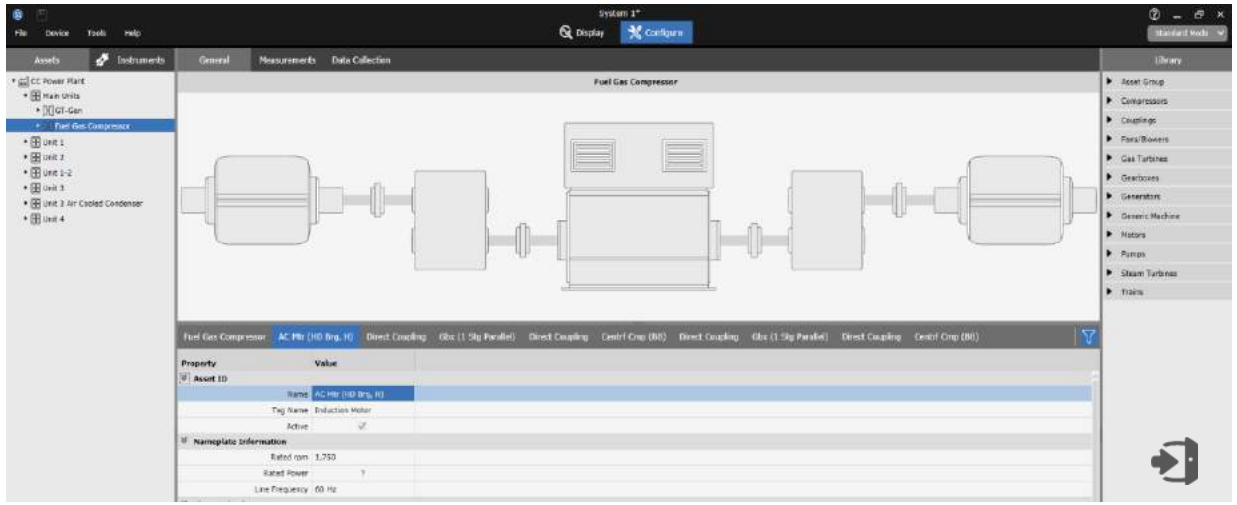
Core Benefits Over 6.x

- ✓ Reduced implementation time through domain expert driven configuration wizards
- ✓ Improved configuration consistency across S1 fleet drives user productivity
- ✓ Reduced database management overhead (determinant data storage) with improved machinery management

Core 17+ Capabilities

- Configuration Wizards
  - Embedded wizards for plantwide (Technical Associates & ISO 10816
  - Bently defined turbo machinery wizard
- State based storage & alarming
  - All equipment
- Improved Machinery Management
  - Store 10-90 days of unfiltered 1-second data
- Simplified DB management
  - No complex change filtering management, simple determinant data storage configuration

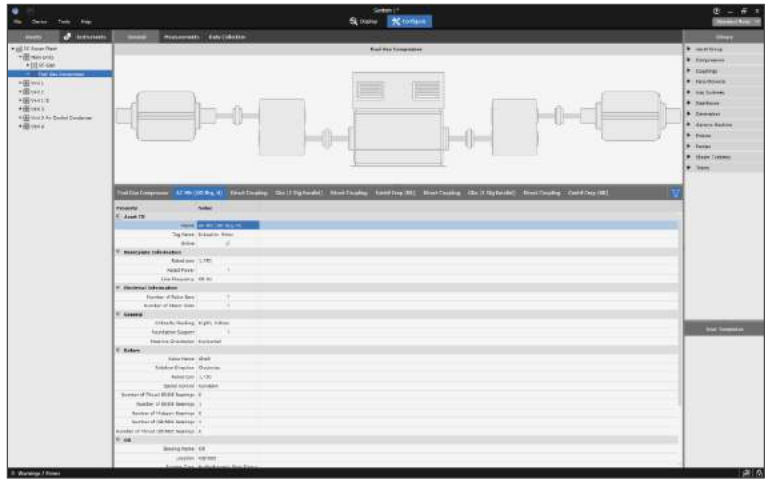




Condition Monitoring, Predictive Analytics, & Diagnostics

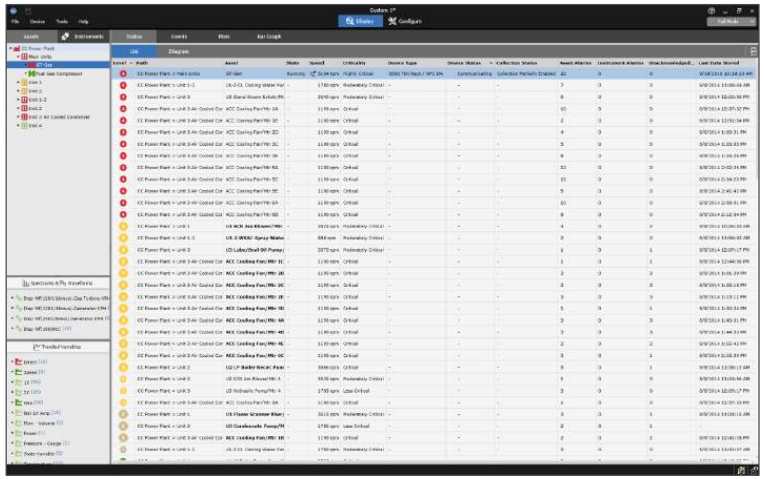
S1 Get Insights

1. Establish CM Program



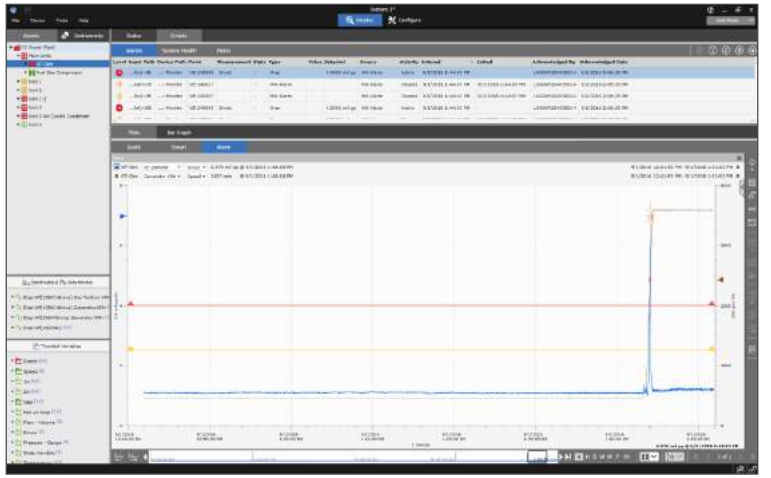
Understand equipment and the impact of failure

2. Get Notified



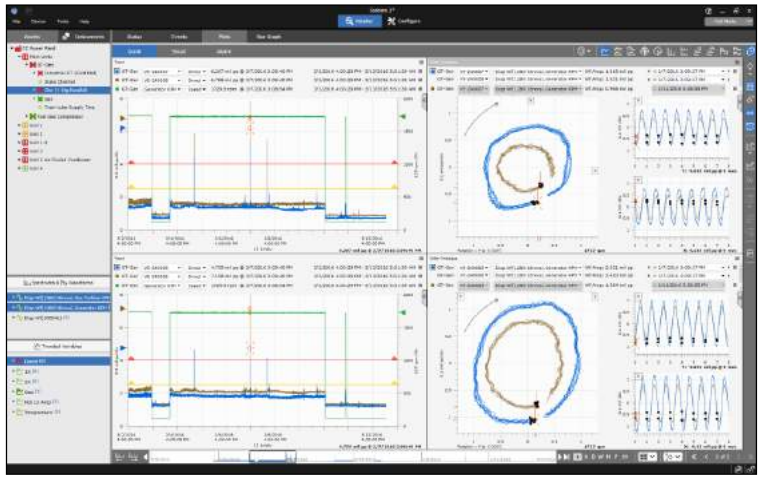
Focus your efforts where change has been detected

3. Identify Change



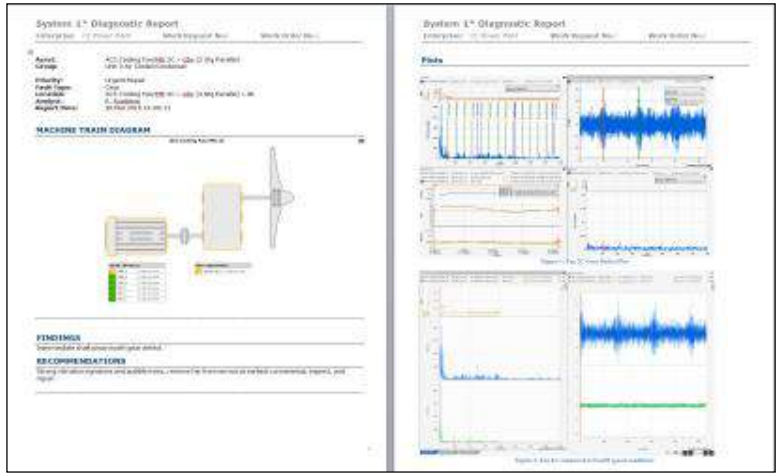
Solve simple issues quickly, dive deeper as needed

4. Understand Change



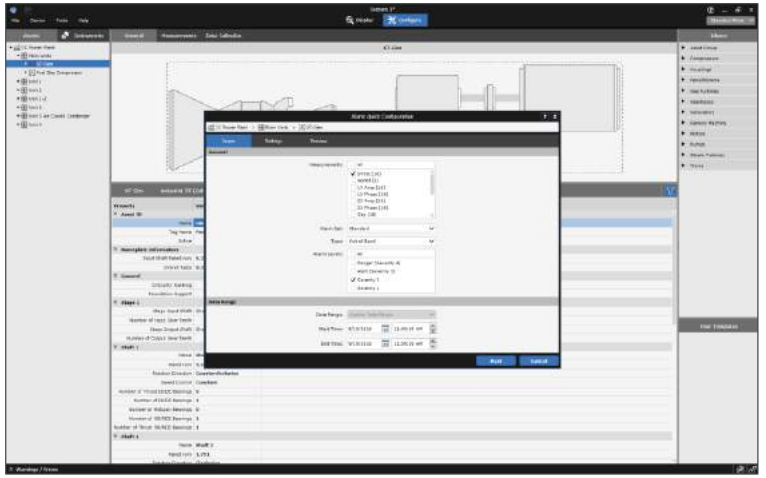
Get to Root Cause with the Complete Data Set

5. Drive Corrective Action



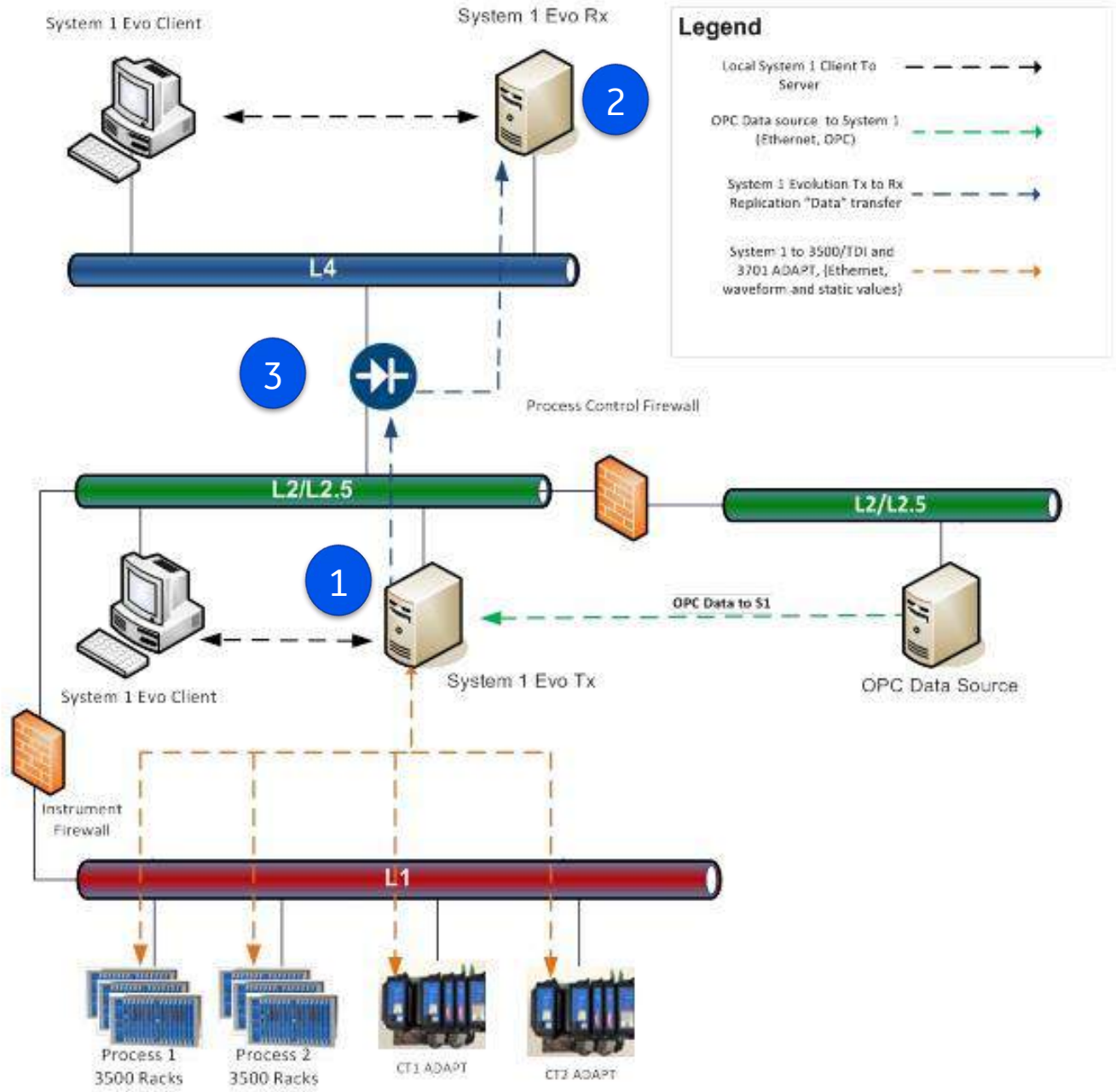
People + Process + Technology

6. Improve CM Program



Build knowledge into your systems & processes

System 1 Replication - Basic Reference Architecture



1 **System 1 Evo Tx "Transmitting Enterprise"**

- Contains the Configuration Definition
- Provides direct connection to devices
- Highest Density of data
- Live data access / viewing
- Conduit to move data to Business Network
- Using a File method to securely move data to the Rx Enterprise

2 **System 1 Evo Rx "Replicated Enterprise"**

- Mirrors the Tx System
- Will contain a sub-set of the Tx data
- Used to serve 80-90% of CM daily tasks
- Will support CM data sources such as OPC, VBOnlinePro and SCOUT *{Future}*

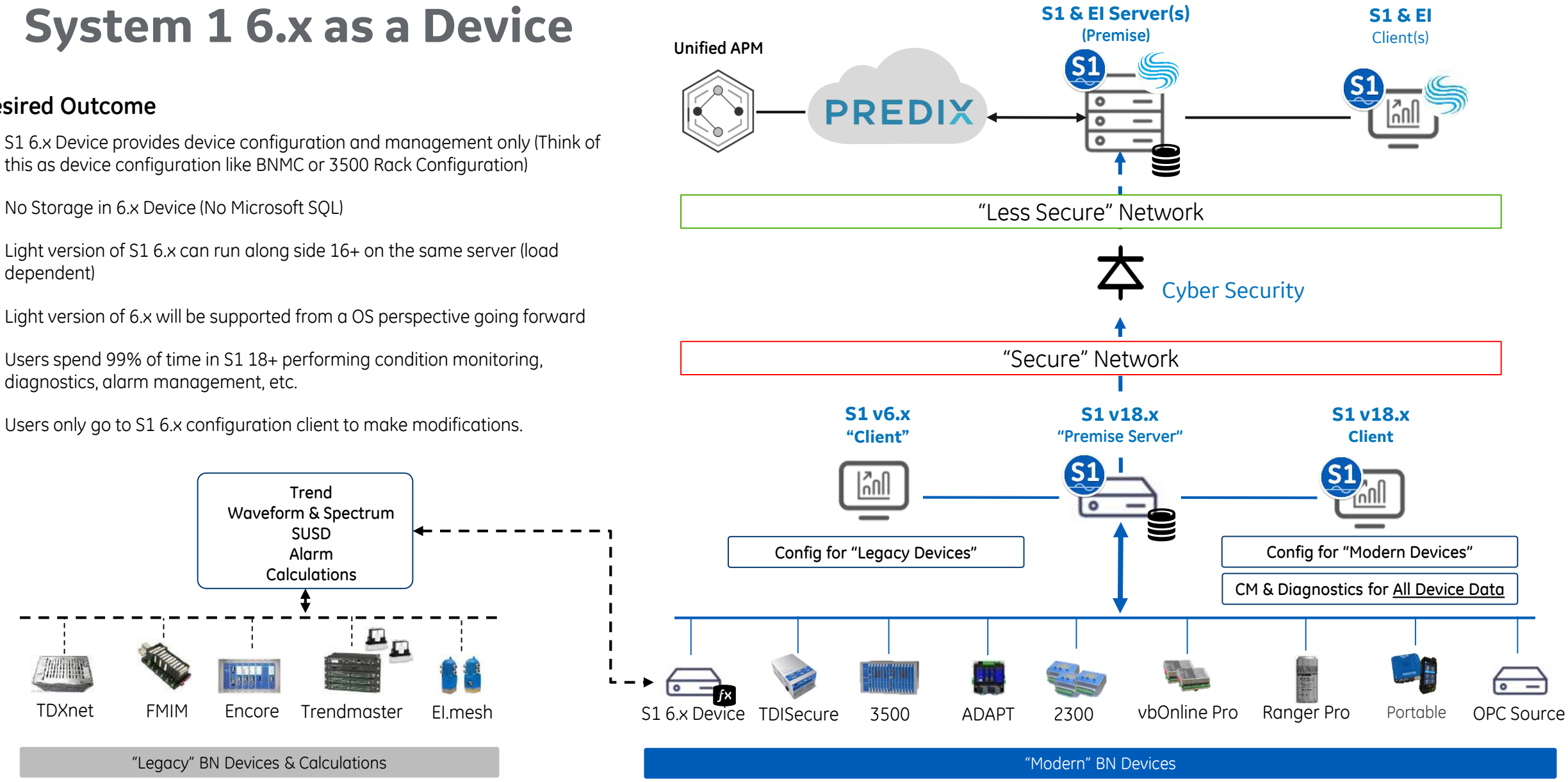
3 **IT Control Instruments**

- Support for Data Diodes
  - Owl
  - Waterfall
  - *Others (Future)*
- Support for Firewall with unidirectional rules

System 1 6.x as a Device

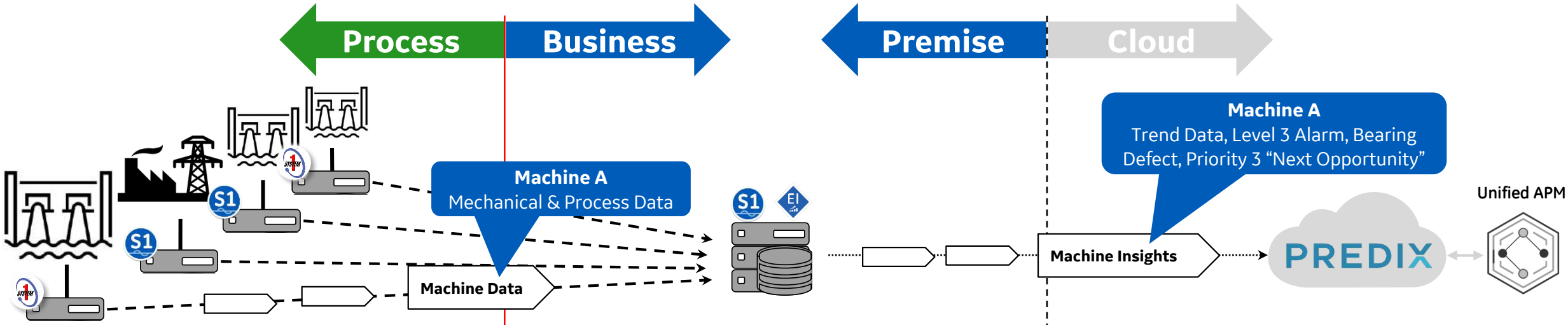
Desired Outcome

1. S1 6.x Device provides device configuration and management only (Think of this as device configuration like BNMC or 3500 Rack Configuration)
2. No Storage in 6.x Device (No Microsoft SQL)
3. Light version of S1 6.x can run along side 16+ on the same server (load dependent)
4. Light version of 6.x will be supported from a OS perspective going forward
5. Users spend 99% of time in S1 18+ performing condition monitoring, diagnostics, alarm management, etc.
6. Users only go to S1 6.x configuration client to make modifications.



Enterprise Impact

Machinery Condition Monitoring from Edge to Cloud



Site Level

- Tactical Machinery Diagnostics
- Device Connectivity

Enterprise Level

- Machinery Fleet Awareness
- Proactive Machinery Condition Monitoring

Bently Unified APM Enablers

- Asset Strategy Optimization
- EAM Integration

Core Machine Connectivity
Live Data Analysis

Detect Machinery Problems
Diagnose Fault Condition & Priority

Propagate Actionable Information
Manage Machinery Fleet

10% of Time

90% of Time

Enterprise Impact: Providing a seamless data journey

PREDIX

SYSTEM 1

DATA ACQUISITION
MACHINE ANALYTICS
MACHINE INSIGHTS
MACHINE DIAGNOSTICS

ENTERPRISE IMPACT

SOURCE AGGREGATION
DOMAIN ANALYTICS
FLEET PRIORITIES
DOMAIN VISUALIZATION

APM

ASSET STRATEGY
STRATEGY PERFORMANCE
FAILURE ELIMINATION
MECH INTEGRITY
RISK INSPECTION
BENCHMARKING

DIAGNOSES


SCOUT


Wireless


ADAPT

PRIORITIES


vbOnline Pro


2300


TDISecure

STRATEGIES


Encore

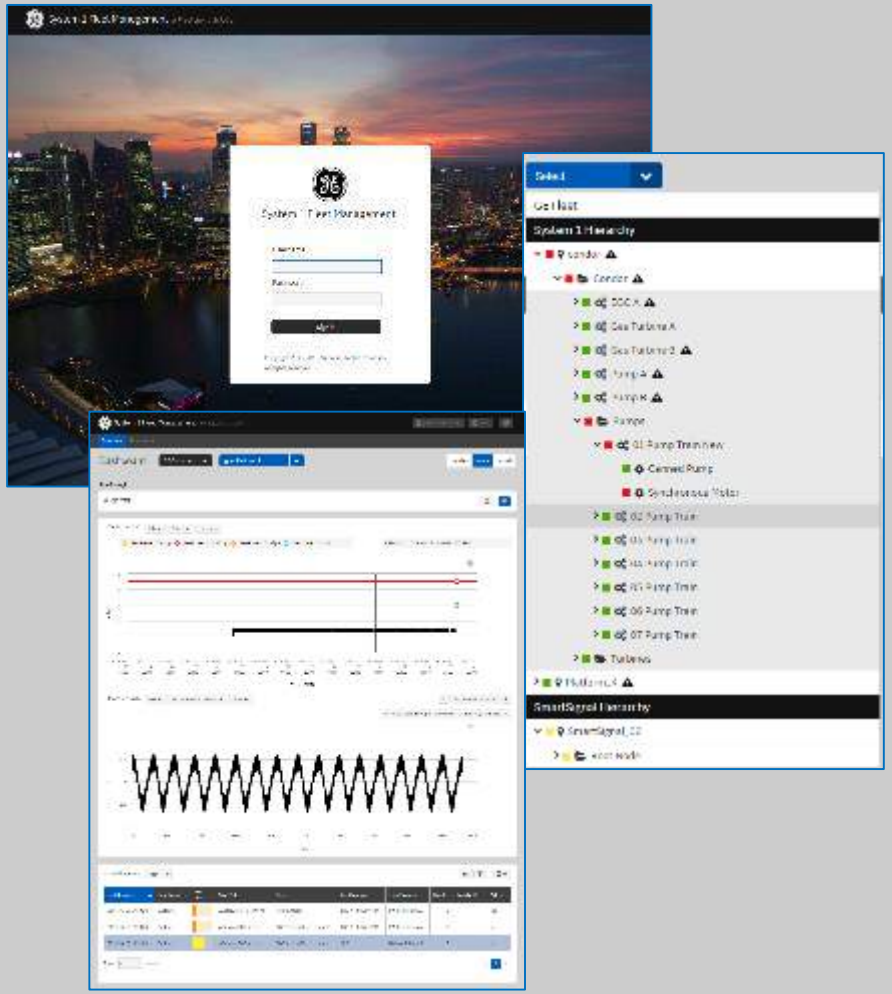

3500

Integrated and Collaborative

Connecting Key Data Sources

- Simple interaction with complex data
- Collects & aggregates
- Integrates high-speed m-sec machinery & sec-min process data
- Navigates between overview, alarms, analysis, and custom views

Fleet Wide



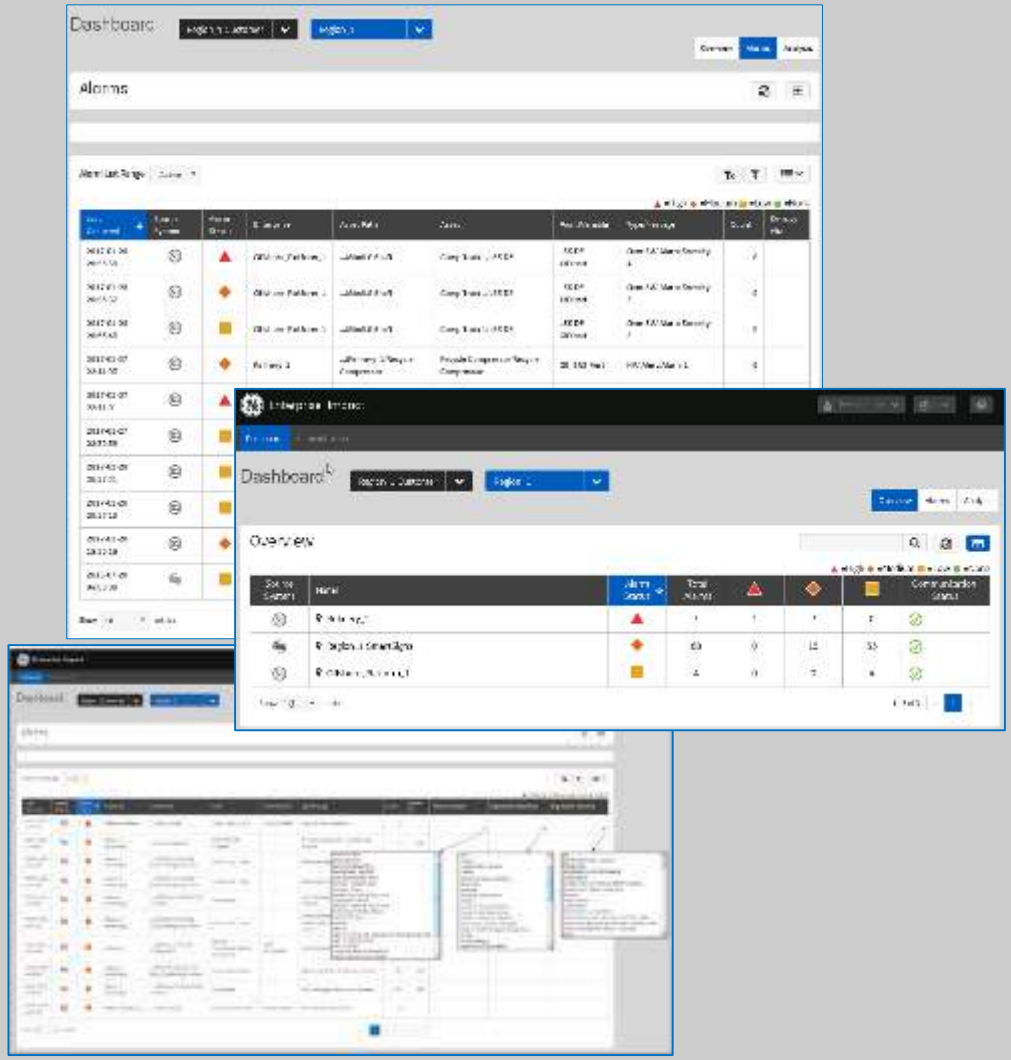
BENTLY NEVADA*
Machinery Condition Monitoring

Integrated and Collaborative

Easy Condition Prioritization

- Efficiently prioritizes problems your enterprise
- Broad range of potential failure modes & assets
- Filters alarms, events, and apparent causes for faster action
- Aligns condition monitoring to asset strategies

Fleet Wide



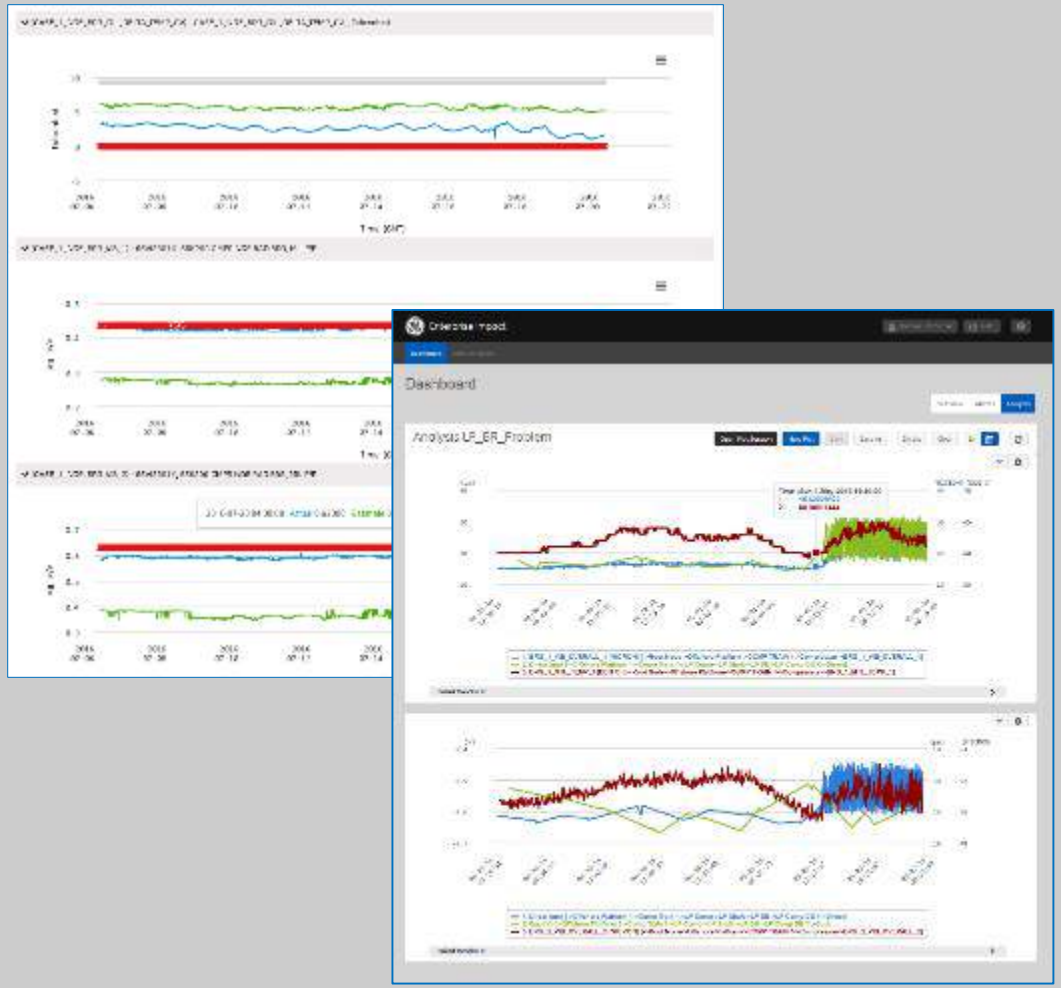
BENTLY NEVADA*
Machinery Condition Monitoring

Integrated and Collaborative

Powerful Comparative Analysis

- Multi-stage analytics with tailored KPIs
- Easy interaction with native System 1* and SmartSignal* linkages
- More effective, targeted use of diagnostics
- Context informed predictive models
- High-speed machine data combined with SmartSignal* technology
- Calculation, derivation, and extraction capability
- Enriches thermodynamic and machinery evaluations

Fleet Wide



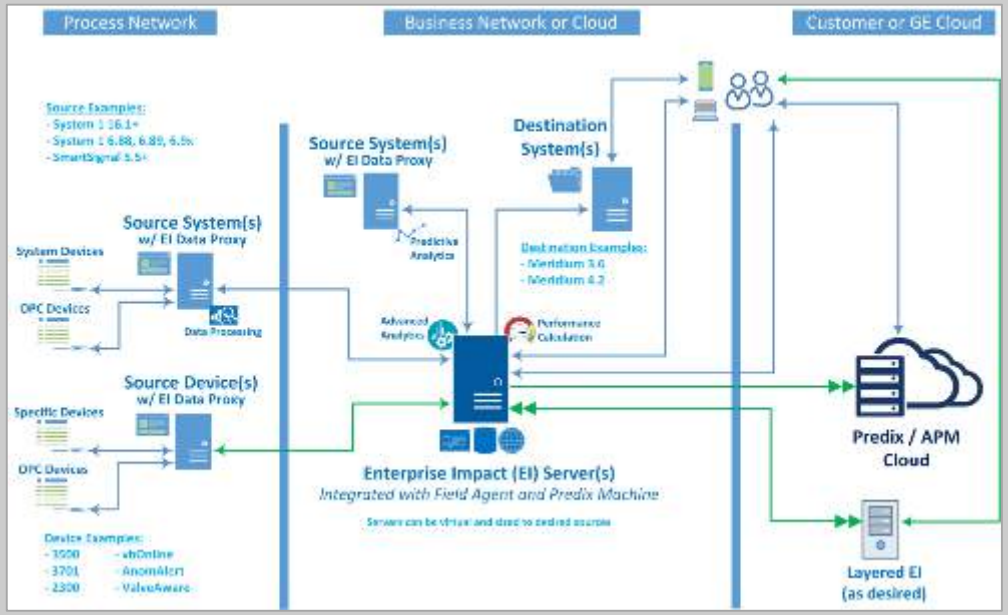
Integrated and Collaborative

Flexible and Secure Architecture

- Legacy installs can be Predix* enabled
- Embraces Cloud Connect, Predix* Machine, Field Agent
- Easily configures to run on Customer Network, the GE Cloud, or both
- Addresses IT concerns with AMQPS protocols and read-only proxy connections
- Facilitates remote services for topical oversight and quick response
- User Preferences adapt to best suit different roles and organizations
- One single Web accessible server with Mobile Apps

BENTLY NEVADA*
Machinery Condition Monitoring

Fleet Wide



EI Generic Architecture