STA-RMS
Remote Monitoring System

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Introduction to Remote Monitoring

Remote Monitoring

- What is it
- Why do we do it
- What do we do
Introduction to Remote Monitoring
- What is it?

Remote Monitoring System

Products

Users

Siemens Regional Support

Siemens Product Specialists

Data

Information

STA-RMS
Automated Data Analysis

The Remote Monitoring System collects Data & delivers Information to everyone concerned with the Operation and Support of the Equipment

We provide Regional Support to our Users

Live Troubleshooting

Backed up by Product Technical Specialists

Local Assistance

Specialist Technical Support
Introduction to Remote Monitoring
- Why do we do it?

Customer Benefits

- **Uptime (improving Reliability)**
  - Keep the unit running
  - Get the unit back up and running in the shortest possible time following an unplanned shutdown

- **Availability**
  - Forward plan maintenance interventions
  - Advance knowledge of an unexpected service requirement

- **Business Reporting**
  - Understand how your assets are performing
Introduction to Remote Monitoring
- What do we do?

All Siemens PGI products utilise a common Remote Monitoring System called **STA- RMS** *(Siemens Turbomachinery Applications – Remote Monitoring System)*

The Remote Monitoring System consists of:-
- **Data Collection** – local recording at site of measurements and alarms
  - normally built into the product, or available as a retrofit option
- **Automated Data Transfer** – via the Remote Service Connection
  - This utilises the Siemens Common Remote Service Platform (cRSP)
    - Safe, Secure connection via the Internet or other means
- **Data Storage & Analysis** – building on experience by applying design knowledge
- **Information Delivery** – via advanced Web based interfaces
Remote Monitoring

Benefits
- Reduce maintenance spending
- Reduce unplanned downtime
- Avoid catastrophic failures

Complex Industrial Systems
- Worldwide distributed fleet
- Power, logistics, transportation …
- High availability, reliability required

Communication Network:
Sensor data transmission

Remote Monitoring Center

Advanced Analytics + Expert How Know

Probabilistic Analysis, State Estimation, Predictive Modeling, Fleet Analysis

Early Fault Detection, Alarming
→ better Maintenance Planning

Benefits
- Reduce maintenance spending
- Reduce unplanned downtime
- Avoid catastrophic failures
Introduction to Remote Monitoring
- How does it work?
Introduction to Remote Monitoring

- Additional comments for non standard applications

- general overview of remote monitoring provided.
- more complex Applications
  - non standard application
  - use of alternative fuels
- additional sensors are embedded in any equipment that may deviate from the standard design or capability
- In such applications additional monitoring and analysis may be necessary.
  - more complicated the duty
  - the more the deviation from standard applications
  - requires more extensive investigation and support
- increase in dedicated resource
  - increase charges
    - one-off charge
    - increased monthly premiums (LTSA)
Benefits of Remote Monitoring

Available within selected Siemens Long Term Service Programmes

**Business Reporting**
- Customer configurable data to suit specific business reporting preferences
- Customer peace of mind throughout analysis
- Online web access with secure customer log-in
- Proactive analysis, troubleshooting and resolution of trending events by Siemens engineers

**Increased Uptime**
- Proactive analysis, troubleshooting and resolution of trending events by Siemens engineers
- Analysis of running, warning, trip and failure data
- Rapid and accurate diagnosis and response based on actual operating data for diagnosis
- Helpdesk Support with 24hr contact to troubleshooting engineers

**Failure Management**
- Customer configurable data to suit specific business reporting preferences
- Customer peace of mind throughout analysis
- Online web access with secure customer log-in
- Proactive analysis, troubleshooting and resolution of trending events by Siemens engineers

Proactive analysis, troubleshooting and resolution of trending events by Siemens engineers
Benefits of Remote Monitoring
- Increased Uptime

Access to OEM technical support:
Helpdesk Support with 24hr contact to troubleshooting engineers

Rapid fault diagnosis:
Analysis of running, warning, trip and failure data as recorded by the control system and available to the helpdesk engineers via the remote online connection

Rapid response:
Rapid and accurate response to customer based on availability of actual operating data for diagnosis allowing correct parts and manpower to be despatch to site to rectify the fault.

Potential to avoid manpower call out through Remote Online Support ‘write access’ parameter changes to customer control system
Benefits of Remote Monitoring
- Failure Management

**Early failure detection:**
Proactive analysis, troubleshooting and resolution of trending events by Siemens engineers

*Applicable to SGT100-400 units only*
Benefits of Remote Monitoring
- Business Reporting

KPI’s
Basic operational KPI data for RMS LTSA’s
Customer configurable operational KPI and detailed key system data to suit specific business reporting preferences for Support, Preventive and Corrective LTSA’s

Easy Access with High Security
Monthly reports sent via email to designated person
Online web access with secure customer Log-in for Support, Preventive and Corrective LTSA’s

OEM Expert Analysis
Customer peace of mind through analysis & feedback by Siemens engineers for Preventive and Corrective LTSA’s (optional for Support LTSA)
STA-RMS Technical - Overview

PGI Units at customer site

GT
ST
CP
Other

Data Transmission
Secure Transmission

Common Central Database

Data Analysis & Delivery

Data Collection on site
Short Term Data Storage

Information To User

Level 1
Level 2
Level 3
Level 4
Level 5

Expert Centres

GT
ST
CP

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Energy Sector
STA-RMS Common Central Database

- The hub of STA-RMS is a database which holds historic information
  - This consists of raw data collected from the equipment at site and also the results of analysis performed on the raw data (e.g. Diagnostic Alarms)

- The database is structured to ensure that users of the RMS can access the data they need, provided that they are properly authorised to do so

- The database allows
  - Managers to observe product performance (key performance indicators)
  - Product Lead Centre (helpdesk) staff to examine recent incidents and provide support
  - Product Designers to statistically analyse product performance
STA-RMS automatically analyses data to extract new information

- Some analysis is generic (such as trend monitoring and prediction)
- Some analysis is specific to the product – bringing to bear our business knowledge

Data is delivered to authorised users via the Intranet (/Internet)

STA-RMS has an advanced document based Web Interface which allows the user to conveniently build views of the information which he needs, or to access standard reports and historic data
Questions

What does the customer want …

…. can vary from simple logging of data in order to support unit, through simple algorithms to mine data and trend key operating parameters onto supplying trend data to areas where intense analysis is required.

Question:
The more complex the requirements the more parameters need to be monitored and more sensors included leading to increased chance of device failure and unit downtime follows, although there is nothing wrong with unit. How is the balance between unit uptime and increased surveillance seen and managed by end users?
Remote Monitoring System
- types of Data Analysis

The raw data is analysed in many different ways to extract useful information

- Including
  - Downtime / Operation Analysis
  - Event Sequence Analysis
  - Pareto Analysis of events and alarms
  - Key Performance Indicators
  - Predictive Trending

- Analysis is distributed and takes place automatically
  - Generating new information and updating the RMS database

Summary Reports are automatically generated

- Showing results of Analysis and Trends
  - Engineering Review
  - Web Publication
Remote Monitoring System
- Downtime / Operation Analysis

STA-RMS analyses the events reported by the equipment and identifies ISO period hours categories associated with the state of the equipment.

In simplified terms:-

- **Available Hours**
  - When the unit was in service
  - When the unit was available for service use

- **Unavailable Hours**
  - When the unit was down due to a Forced Outage (unscheduled)
  - When the unit was down for a Planned Outage (scheduled)

In reality, the analysis is more comprehensive than the illustration above and classifies the period hours into a large number of categories.
Event Sequence Analysis provides the user with an overview of the events which have taken place on the machine.

- Event Sequence Analysis reduces thousands of detailed alarms to an overview of the key events during a period – a précis of the operation of the selected item(s) of equipment.

Sequence of Events → Event Sequence Analysis → State Analysis
Remote Monitoring System
- Pareto Analysis

Pareto Analysis allows a user to examine a sequence of events in a different way:
- Which events occur most frequently
- Which events cause most downtime for the equipment
Remote Monitoring System
- Key Performance Indicators

KPI Analysis allows a user to view a range of high level Key Performance Indicators
- derived through analysis of the observed operation of the equipment
Remote Monitoring System
- Predictive Trending

Performed automatically on selected data measurements
- Analyses historic trends
- Projects forward
- Raises alerts on RMS users

New Measurements → Predictive Trend Analysis → Historic Measurements
Remote Monitoring System
- Data Delivery

STA-RMS delivers information to authorised users via the Web

- Users can obtain data on demand
  - building documents which contain any mix of data required

- Users can subscribe to automatically generated and delivered reports
Remote Monitoring Case Studies

case studies from our experience with Remote Monitoring....
Remote Monitoring Case Study #1
- Detection of worn Journal Bearing

Predictive trender output 17 November

Indicates that Vibration trips are likely within 14 days

- Notifications raised in Siemens SAP system
- E-mails sent to Customer Support Manager and Technical Help Desk
Remote Monitoring Case Study #1
- Our Response

20 Nov
- Engineer visits site and determines worst vibration during reduced load operation.

30 Nov
- Second site visit to undertake vibration survey. Vibration trip levels raised and monitored remotely to ensure safe operation

13 Dec
- Scheduled maintenance period. Bearing changed out as examination determined that there was wear on the reverse side of the journal pads

Post Service
- Operation now satisfactory and downtime due to vibration trips alleviated

Benefit to User
- Early detection and remote monitoring allowed the unit to run through to the next planned service point, avoiding unplanned downtime and loss of production
Remote Monitoring Case Study #2
- Detection of worn Starter Clutch

The following extracts were taken from a User’s internal monthly report

‘The (Remote Monitoring System) fitted to GT1 and GT2 earlier this year has trended abnormal gearbox vibration levels on both GTs. These vibration levels were increasing and (the system) predicted that these levels would be sufficient to have resulted in unplanned outages later this year…. ‘Analysis of the data and on-site investigation of the turbines has pin pointed the fault to the bearings on the triple-s clutch

‘The triple-s clutch is fitted between the starter and main generator gearbox and is used when spinning the turbine up from rest. Remedial action has been taken and the clutch on GT1 will be replaced in parallel with the current compressor turbine work. The clutch on GT2 will be replaced during the planned service outage due next period

‘This has resulted in avoiding an estimated two weeks of unplanned turbine outage…. 
An Oil & Gas offshore operator was concerned about his process availability and conducted a joint engineering review to understand the causes of process downtime

- Using RMS data it was seen that
  - typically 7% of downtime was caused by interactions between the process infrastructure and the Gas Turbines
    - E.g. Instrument Air, Fuel Supply, Electrical Power
  - Certain Gas Turbine systems were sensitive to process transients

- After using the RMS to understand the root causes, engineering upgrades were put into place
  - Following upgrade Gas Turbine Availability was seen to increase by more than 6% and trips reduced by a factor of 5
Future Trends

Future Activities

or

Where does RMS go from here?
Data Analysis & Modeling Framework

Applications
- Sensor data
- Image features
- Text
- Health records
- ...

Algorithms
- Bayesian Networks
- Neural Networks
- Support Vector Machine
- ...

Data Analysis & Modeling Pipeline
- Preprocessing
- Feature Selection
- Classification
- Validation

Machine Monitoring
Biomedical Applications
Text Mining

- NCBP2
- MHC2 beta
- W52
- RNASE6
- GCN5L2
- LAMC1
- CTSH
- H1F2
- TNFRSF7
- PTPRK
- SSA2
- DEFA1
- NOT56L
- EIF3S9
- CDKN1A
- APOC1
- GYS1
- S100A9
- STIP1
- ABL1
- SDF1
- IFRD2
- DPYSL2
- …
Finding Structures in Data Bases: Bayesian Network Learning Tool

Challenges in Data Mining:

- High dimensional feature vector (10K to 200K features)
- Small sample size (less than 100 to several hundred cases)
- Imbalanced training samples

Algorithm:

Bayesian Network is constructed by very efficient dependency analysis; Feature selection retrieves a compact model that can deal with high dimensional data.

Automatic Model Selection: Robust framework for analyzing data with small sample sizes – using cross validation and ROC curve to retrieve a model with optimal generalization performance

Software Features:

- Support domain knowledge input
- Supervised/Unsupervised Learning
- Inference based on incomplete datasets
- Support multiple database and spreadsheet formats

Applications

- Feature Extraction
- Visualization
- Classification (i.e Fault Diagnosis, Root Cause Analysis)
Multivariate Sensor Data Analysis for Anomaly Detection

**Training:** Based on historical data the joint sensor distribution of normal operating range is determined (orange area)

**Monitoring:** For each new data point decide whether it is within (no fault) or outside normal operating range (fault)

**Example:** two sensors
Component Based Architecture for Online Monitoring and Diagnosis

GUI \ Visualization
- Events\Alarms
- Training\Testing
- Sensors\Residuals
- Web Client

Algorithms
- Rulebase\Fuzzy
- Prognosis
- State Estimation
- Computed Sensors
- Filters – time
- Dependency analy.
- Physical Models

Data Management Layer

Data Gateway
- Data base
- Files: Csv etc
- OPC
- Events, Tickets
Summary

Today there are many different approaches to machinery monitoring – from simple visual approach to more complex data gathering and application of developed algorithms.

These have many different uses, from ensuring defined performance is delivered, through to ensure the uptime of the unit is maximised.

The more complex the requirement the more complex the monitoring of the engine. This usually means increased instrumentation and the potential for this to fail, not the machine it is watching! *Who watches the Watcher!!*

For the future there is much attention to intelligent systems able to predict events which may result in enforced downtime, along with understanding the direction of linking devices to the control system (FieldBus?).

A complex subject that shows the need for better awareness and understanding between OEM and customer.
Questions

Already touched on degree of complexity, but in addition:

What are the main drivers to include remote monitoring systems? Is there a need to ensure uptime is maximised or is there a drive to reduced manning, or even unmanned operation? .. Or… is it something else?

Increased surveillance comes at a price. Is this something an end-user requires?

Does the audience allow direct access to their machines by the OEM to download data? Is there any current, or future, changes which may make this harder to achieve, such as the use of FieldBus and ProfiBus to multilink devices back to a mani control system?
Our Values – for a global business

- **Responsible**: Committed to ethical and responsible actions
- **Excellent**: Achieving high performance and excellent results
- **Innovative**: Being innovative to create sustainable value

**Highest performance meets highest ethical standards**
## Compliance is the top priority

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<tr>
<th>Prevent…</th>
<th>Detect…</th>
<th>Act…</th>
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<td>… through clear rules, training programs, communication and clear responsibilities</td>
<td>… compliance violations through audits, reviews and monitoring</td>
<td>… with rigorous and appropriate measures in cases of compliance violations</td>
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- Uniform, seamless and mutually complementary legal, compliance and audit processes worldwide
- Compliance must be part of our company culture and firmly anchored in all business processes
- Unlimited commitment to integrity and responsible action

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**A business based on the highest ethical principles – at all times and everywhere in the world**
"I have made the topic of compliance one of my top priorities.

There will be no compromises here: Illegal and improper behavior will not be tolerated under any circumstances."

(Peter Löscher, President and CEO of Siemens AG)
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