PdM Powered by “the Cloud”

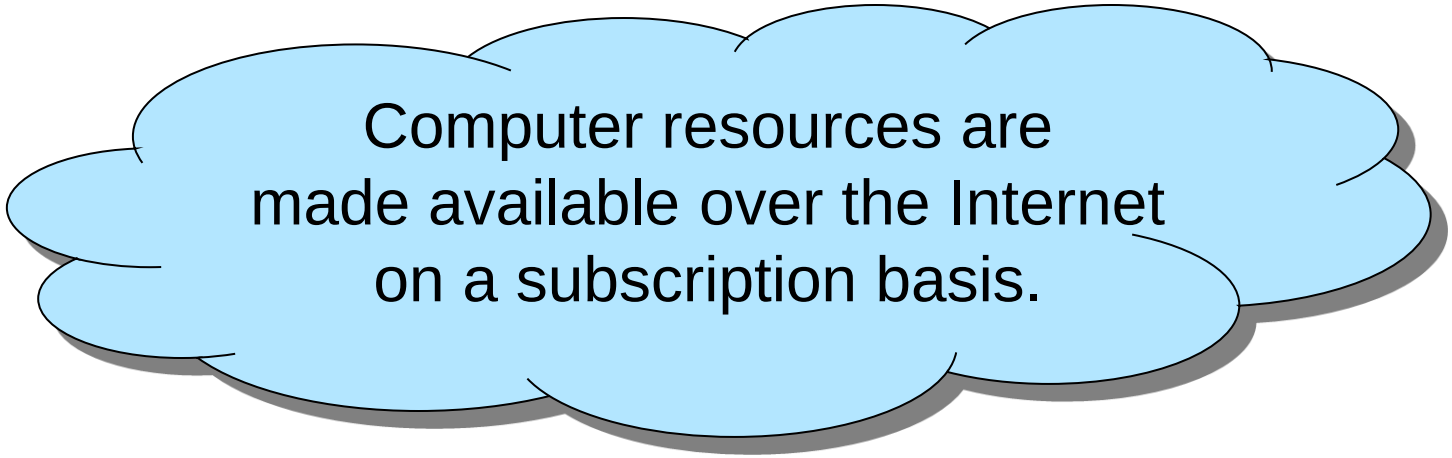
How Cloud Computing Benefits the Predictive Maintenance Industry

Kenneth Piety | September 29, 2010

What is “Cloud Computing?”

“Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.” – NIST definition

Plain English:



Various Configurations

- **Infrastructure as a Service**
  - Vendor: Provides only server infrastructure.
  - User: Provides and maintains operating system hardware and software.
- **Platform as a Service**
  - Vendor: Provides server and operating system.
  - User: Installs and maintains software.
- **Software as a Service**
  - Vendor: Provides all hardware/software for the intended application to the Customer.
  - Offers additional cost savings over the first two options.
- **Expertise as a Service**
  - Vendor: Provides all hardware/software for the intended application and the expert application knowledge (turn-key solution).
  - Offers greatest cost savings and enhanced operational efficiencies.

What is the Cloud Made Of?

A Server Farm (multiple, connected servers) functions as one "super computer."

Benefits include:

- **Instant Scalability --** Power up/down servers as needed with no service interruption.
- **Outage Protection --** Multiple "virtual servers" running simultaneously means that the loss of one or more servers does not impact availability.

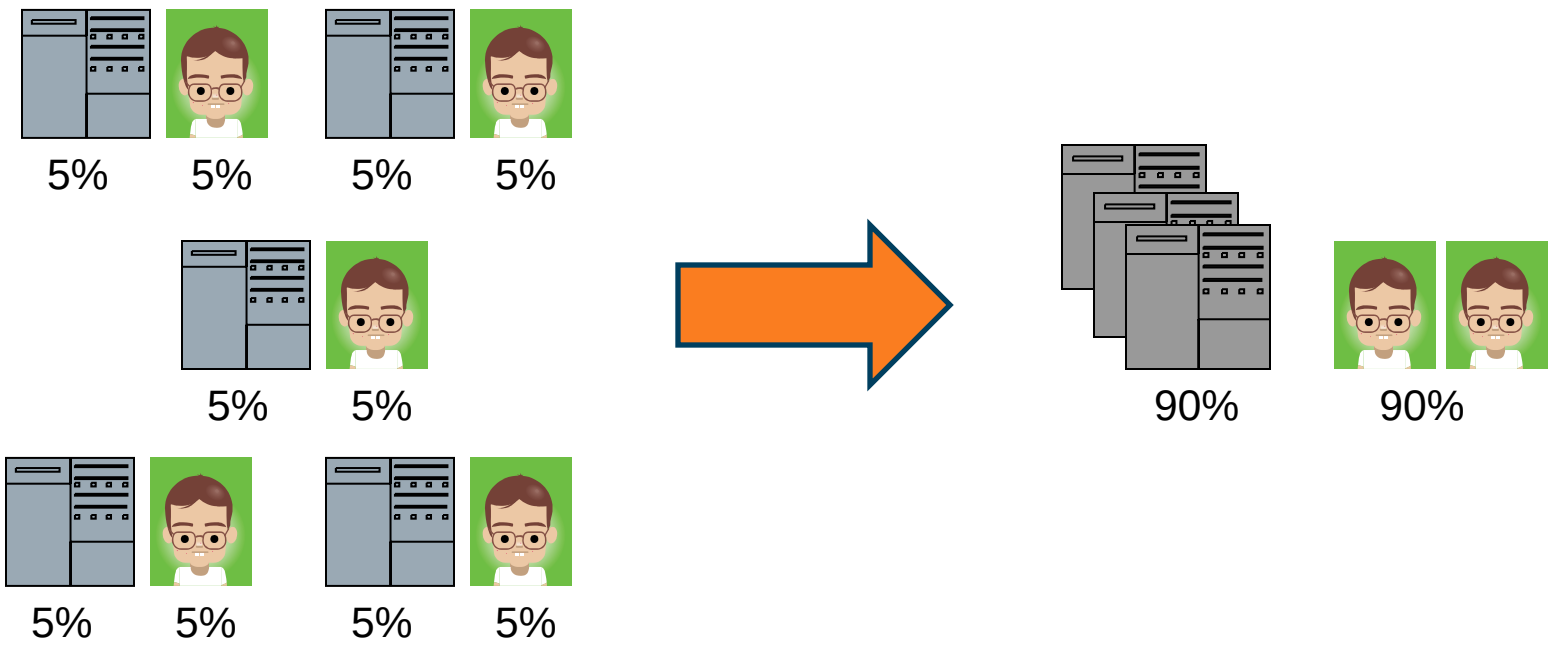
Advantages of Cloud Computing

- **Reduced Implementation Costs**
- **Reduced Operating Costs**
- **Increased Productivity**
- **Easy Access**
- **Predictable Maintenance Costs & Performance**

Advantages: Reduced Operating Costs

Savings range from 40% to 95%.

Resource consolidation yields better utilization.



Advantages: Increased Productivity

Increased availability boosts user productivity.

- Maintenance and upgrades with zero downtime.
- Redundant systems with automatic failover.
- Power and data backup systems.

Advantages: Easy Access

Internet provides anywhere, anytime access.

- Data and applications are hosted and just a login away.
- Access from mobile devices.
- Especially advantageous when traveling.

Advantages: Predictable Costs & Performance

You pay set service fee; vendor burdened with maintaining performance per service agreement.

- Hard drive failures
- Bug fixes & security patches
- Restoring corrupt data
- Power outages
- KPI’s

Notable Examples

Cloud Computing is one of the few computing innovations to start in the consumer market and then migrate to commercial enterprise systems.

Consumer Market

Commercial Market

PdM in the Cloud (SaaS/EaaS)

Predictive maintenance applications stand to gain more from cloud computing than most other business system…

- PdM applications are generally isolated on laptops and desktops (almost entirely left behind from the client-server boom of the 90's).
- Migrating PdM to the cloud yields benefits of Cloud Computing + Client-Server benefits.
- PdM programs gain greater access to diagnostic expertise and can optimize the use of available expertise.

Benefits Specific to PdM Industry

- **Centralization** – PdM data centrally stored for access by multiple users.
- **Collaboration** – Multiple analysts can collaborate, thus increasing diagnostic accuracy.
- **Integration** – PdM is accessible to other business systems which opens the door to data exchange between systems
- **Transparency** – The more people who see PdM information, the more valuable it will become.
- **Communication** – Can send email alerts, text messages, and automated phone calls.
- **Participation** – Others can gather data, contribute knowledge, and record observations.
- **Optimization** – The right people can perform each function at the lowest cost.

PdM in the Cloud – Why Now?

- Industry is favorably disposed toward outsourcing services that are not central to their business.
- Barriers to movement of data and information have been overcome.
- Analysis and diagnosis is the most technically challenging activity in a vibration PDM program and highly labor intensive whether monitoring with portable or online systems.
- Retention of analysts presents a challenge and typically it takes 2 years to train a new analyst.
- The ROI for any PDM program is directly related to accurate and timely equipment health assessments.

A Growing Concept in PdM

- **Cloud-based PdM has been quietly growing for more than seven years.**
- **Today, more than 50 companies (many Fortune 500) rely on cloud-based PdM services.**

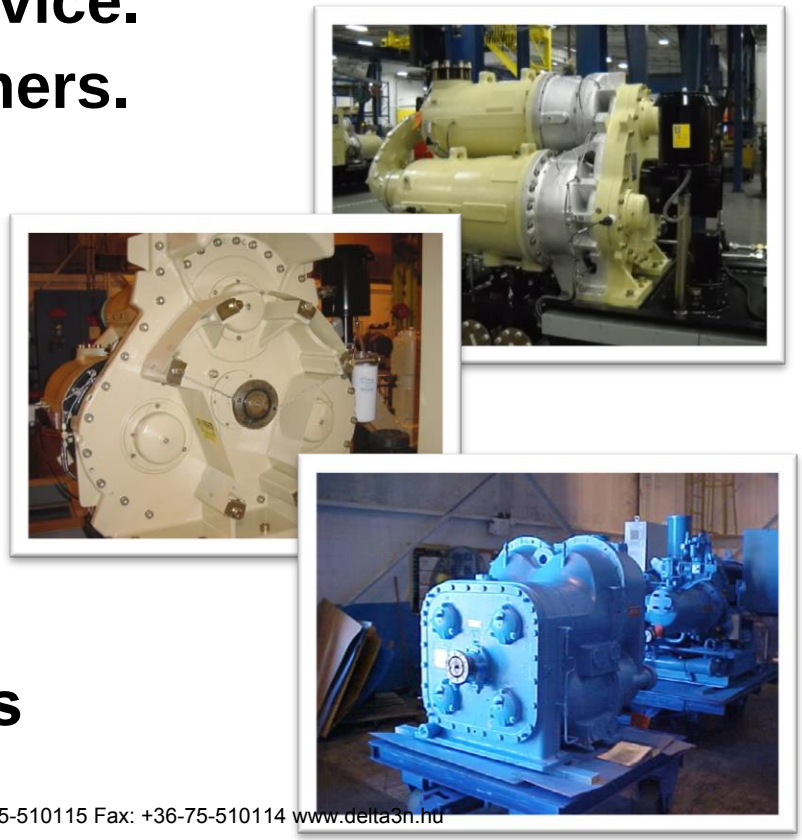
Companies Using Cloud-Based PdM

Air Liquide

- **World's largest industrial gases company.**
- **Cloud-computing service contract for 104 plants.**
- **Access to all data and reports**
  - **Online monitoring of high-speed compressors**
  - **Route-based vibration data**
  - **Oil analysis**
  - **Infra-red surveys**
- **Compliance tracking**
  - **Timely data collection**
- **Risk**
  - **Risk-adjusted problem severity**

Ingersoll Rand

- **Global condition monitoring partnership.**
- **Vendor provides hardware, software, and diagnostic service.**
- **Private labeled for IR customers.**
- **Standardized reporting, one ‘look and feel.’**
- **IR can scale field services business without costly in-house expertise.**
- **No need for in-house server/IT support.**
- **24x7 response from vendor’s Diagnostic Center.**



Case Study 1 – Method Comparison

<u>Situation:</u> Alarm on second stage bearing of a high-speed compressor. Customer suspects bearing or impeller issue.

Traditional PdM

- Analyst travels to plant (8 hours away).
- Gathers data, analyzes, and creates a report.
- If he is uncertain, he must use his best judgment to make the call.
- Return travel (8 more hours).

PdM using "the Cloud"

- Customer trained to gather vibration data as part of routine work.
- Data uploaded to cloud-based PdM system
- Analyst sees a problem, but being a little uncertain of the cause, asks another analyst with lots of compressor experience to take a look.
- Analysis and recommendation performed remotely.

Case Study 1 – Efficiency Comparison

Traditional PdM

- **Time Consuming** – Two days travel for a single machine test.
- **Slow Response** – Several hours/days pass before any data is gathered.
- **Single Opinion** – Analysts work “in a bubble.”

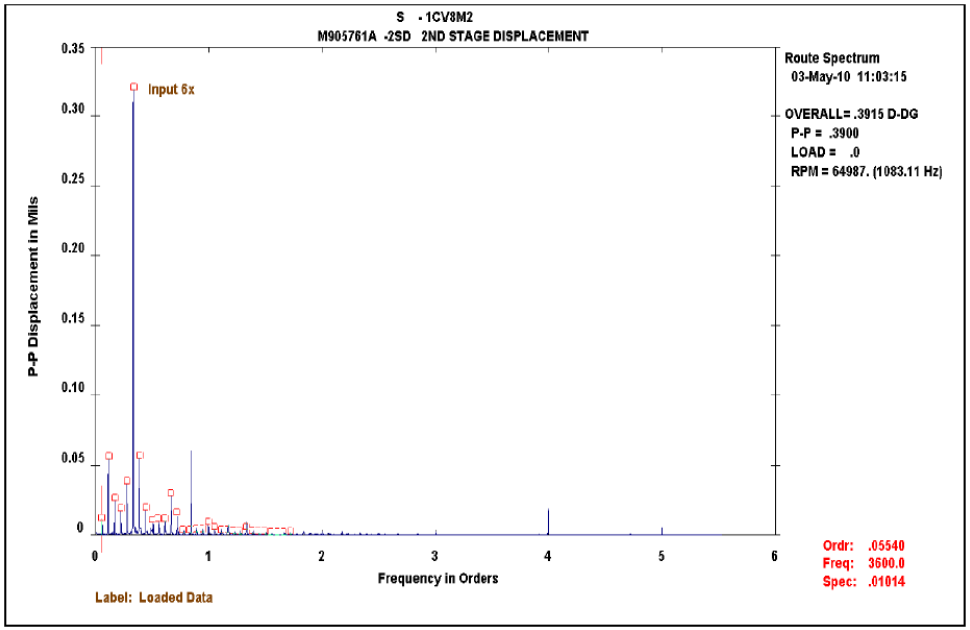
PdM using “the Cloud”

- **Time Saving** – No travel for analyst (which reduces cost to customer).
- **Fast Response** – Preliminary results within one hour of data collection. Final report issued same day.
- **Better Accuracy** – Easy collaboration means more accurate diagnostics at a lower cost.

Case Study 1 – Outcome

Benefit from cloud computing:

- Analyst was able to respond quickly because he did not have to travel on-site to collect data.
- Two analyst collaborated, resulting in a more accurate diagnosis. (Problem was found to be the oil pump, not the second stage impeller.)
- Customer avoided costly, unnecessary repair on Stage 2 impeller and focused attention on the problematic oil pump.
- Service charges were minimal.



Case Study 2 – Method Comparison

<u>Situation:</u> Routine vibration data collected by technician triggers severe alert on critical pump. Assigned analyst is on vacation.

Traditional PdM

- Technician waits for analyst to return from vacation or brings in another analyst on a call-out.
- If another analyst is called out, he does not have access to historical data or the analysis software used at the plant. (It is on the vacationing analyst's laptop.)

PdM using "the Cloud"

- All data, including historical, is centralized and many analysts have access to it.
- Backup analyst assigned for vacationing analyst is able to review data and provide recommendation remotely.

Case Study 2 – Efficiency Comparison

Traditional PdM

- **Sole Responsibility** – Success and failure of the program are driven by a single person.
- **Location Constraints** – Alarm response is hindered by the physical location of the analyst and/or his equipment.

PdM using "the Cloud"

- **Team Effort** – Having many involved makes program stronger and more valuable.
- **24x7 Coverage** – Having a backup analyst assigned means issues are investigate in a timely manner.

Case Study 2 – Outcome

Benefit from cloud computing:

- Technician was able to reach a backup analyst to review the data.
- The backup analyst, despite being at a weekend barbecue, was able to log in and quickly determine that it was a false alarm.
- The technician no longer needed to worry about the health of the machine; the analyst was able to enjoy the rest of his afternoon.

Case Study 3 – Situation

Situation:

- Steel mill had just rebuilt a large, critical cooling pump using a new vendor.
- Newly rebuilt pump was put back into service.
- Upon startup, vibration was unacceptably high.

- Pump was equipped with a temporary cloud-based, automated, online monitoring system (“Roamer”).

Case Study 3 – Method Comparison

Traditional PdM

- Data collected manually only.
- Collection interval typically monthly.

PdM using “the Cloud”

- Critical machines are outfitted with an online, automated system.
- Important machines may be temporarily monitored during periods of significant interest.
- Data is automatically gathered and analyzed rapidly.
- Collection interval can be adjusted as needed (as often as every few minutes).

Case Study 3 – Efficiency Comparison

Traditional PdM

- **Missed Data** – Initial, high vibration data went unnoticed.
- **Difficulty Pinpointing Root Cause** – Routine data not enough to pinpoint cause/effect.
- **Unexpected Failure** – Pump may fail unexpectedly before next schedule vibration reading.
- **Repeat Problem** – Not knowing why the pump failed means it may happen again.

PdM using "the Cloud"

- **Immediate Detection** – High vibration detected immediately.
- **Automated Notification** – Email alerts sent to stakeholders.
- **Quick Response** – Remote analysis begins soon after receipt of data.
- **Root Cause Pinpointed** – Plethora of quality data provides enough information to identify the root cause.

Case Study 3 – Outcome

Benefit from cloud computing:

- Pump was immediately inspected and many mistakes in the rebuild were found (loose bearing fits and wear rings were not secured).
- Root-cause quickly known.
- Vendor refunded the cost of the rebuild.
- Future pump overhauls performed by a different vendor.

There is a silver lining to the PdM Cloud

- **Improved Efficiency**
- **Lower Cost**
- **Increased Quality**
- **Increased Capability**
- **Sustainable Results**
- **Proven Successes**

Tomorrow's PdM Forecast

Cloudy with 100% chance of increased operational efficiency!

Thank You!

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