MANUFACTURING AND THE CLOUD

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The broad general acceptance of cloud computing means that the market for cloud services is growing rapidly. In this article we take a look at some of the types of cloud services that can add value for manufacturing and processing organisations.

It is predicted that over the next decade, cloud services will be a leading driver of productivity for manufacturers. Cloud services provide the opportunity to eliminate investment in IT capital equipment and the associated software costs and expenditure in in-house expertise through the use of pay-as-you-go solutions. These solutions allow small to mid-sized businesses to leverage applications previously considered prohibitively expensive and designed for use by large organisations.

With its low cost of entry and maintenance, the cloud can help to level the playing field and ensure that enterprise-class systems are no longer out of reach for even the smallest companies, while for larger companies, particularly those with multiple facilities to manage, costs can be reduced dramatically while improving business competitiveness.

So how can cloud computing be of benefit to those in the processing and manufacturing industries? Naturally, one does not expect that real-time process control or automation can be performed using cloud services — latency and security will always be issues here, at least for the foreseeable future. However, there are two main areas of application in which industry can benefit from cloud technology — customer- and partner-facing business services, and non-real time, non-process critical applications such as ERP, EAM and CMMS systems, as well as reporting and analytics.

In the first area, manufacturing businesses can leverage cloud technology in the same way that non-manufacturing businesses can — to provide additional internet-based services to both customers and suppliers; to streamline ordering, procurement, sales and product support; and to provide interactive services for customers — all more efficiently and without having to invest heavily in internal resources for these purposes. As Internet 4.0 and the Internet of Things (IoT) become adopted within manufacturing, the extent to which these services can be leveraged will increase, to enable greater competitiveness and responsiveness to market demands.

There is much information about the possibilities in the area of improved business and market responsiveness enabled by cloud services and the internet. In this article we will focus more on how cloud technology can help with streamlining a manufacturing or processing business at the technical level.

In recent times, as new technologies have emerged, we have often heard the term 'killer app'. In other words, the application for a new technology that will launch it into the mainstream. Many would say that in the application of cloud services in the manufacturing and processing industries, there are two killer apps: the availability of cloud-based asset management and condition monitoring, and cloud-based process analytics and reporting. How 'killer' these applications will be, will depend largely on the size and nature of the individual business.

But first we need to understand what the cloud provides, and how it does it.

Cloud models

There are three basic cloud models:

- **Public cloud:** All services are provided by a cloud service provider over the internet, offering the greatest level of efficiency in shared resources but the least level of control over the data.
- **Private cloud:** The services and infrastructure are privately managed by the end user, providing the greatest level of security and control but not significantly lowering the cost burden.
- **Hybrid cloud:** A mix of public and private cloud in which the organisation chooses which aspects of the business are best served by either service.

For industrial companies, the hybrid cloud model is clearly the best compromise between efficiency and security. The

Collaboration and work task execution	• Condition-based maintenance (CBM) • Workflows and certain types of procedural enforcement • Shared development and collaborative testing • Virtual reality simulation and training environments
Reporting and analytics	• Process analytics, especially for post-production optimisation and root-cause analysis • Remote diagnostics and system health monitoring • Long-term process historians • Manufacturing business intelligence • Process or batch summary reports • Energy management • Mobile summary reports, alerts, and notifications • Dashboards, KPI monitoring, and other web portal-based solutions • Manufacturing Execution System (MES) reports.

Table 1: Typical business needs that can be addressed with cloud-hosted solutions. (Source: "The Cloud for Manufacturing", Invensys and Microsoft, 2014)

Item	On-Premises	SaaS
Licensing	Varies	Included
Maintenance	Varies (typically 15%–20% of licensing costs, annually)	Included (performed automatically)
Support	Varies (typically 22% of licensing costs, annually)	Included
Hardware	Extensive	Included (sized automatically)
Implementation	Varies (additional cost in time)	Included (with rapid provisioning)
IT infrastructure	Extensive	Included (scaled automatically)
Payment	Up front	Typically by user/usage per month

Table 2: Cost comparison between on-premises and SaaS models. (Source: Microsoft and Invensys, 2014)

organisation can choose which applications are suitable for hosting in the cloud, and which are not.

Deployment models

There are three methods of deploying cloud services: infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS).

IaaS

IaaS is the most basic cloud-service model and basically offers computers — physical or (more often) virtual machines — and other resources. Additional resources may include virtual-machine disk image libraries, raw block storage, data storage, firewalls, load balancers, IP addresses and VLANs. IaaS cloud providers supply these resources on-demand from their large pools installed in data centres. For wide-area connectivity, customers can use either the internet or dedicated virtual private networks (VPNs).

With IaaS, cloud users are still responsible for installing operating system images and their application software on the cloud infrastructure. Cloud providers typically bill IaaS services on a utility computing basis, the cost reflecting the amount of resources allocated and consumed. The financial benefit for the customer is in not having to maintain some or all of their computing resources themselves, saving on hardware costs and depreciation, as well as space and energy costs. The customer still needs to maintain the operating systems and software applications and data, including backups, and therefore still requires the technical expertise in-house.

PaaS

In the PaaS model, cloud providers deliver a computing platform, typically including operating system, programming language execution environment, database and web server. Customers can develop and run their software solutions on a cloud platform without the cost and complexity of buying and managing the underlying hardware and software layers. With some PaaS offers the underlying computer and storage resources scale automatically to match application demand so that the cloud user does not have to allocate resources manually.

In an industrial cloud PaaS service, an industrial automation software vendor or ERP, EAM or CMMS vendor may provide the platform (along with the maintenance of that system) to provide the associated service, and it is up to the customer to program and configure it to their needs and manage the collection of the data from the site.

SaaS

In the SaaS model, a service provider deploys, manages and services the entire solution stack. The manufacturer retains ownership of the data, including the right to remove the data at any time. SaaS is sometimes referred to as 'on-demand software' and is usually priced on a pay-per-use basis or using a subscription fee. SaaS applications are different from other applications in their scalability — which can be achieved by cloning tasks onto multiple virtual machines at run-time to meet changing work demand, while load balancers distribute the work over the set of virtual machines.

To accommodate a large number of cloud users, SaaS applications can be multitenant, that is, any machine may serve more than one cloud user organisation. This, however, may raise security concerns for some organisations, so the choice of application (and therefore the criticality of the stored data) is important.

The pricing model for SaaS applications is the most flexible — typically a monthly or yearly flat fee per user — so the cost is scalable and adjustable if users are added or removed at any point.

Comparing deployment costs

Table 2 shows the typical costs of an on-premises model compared to a subscription-based SaaS model. Note that the cloud-hosted SaaS option is significantly less complex and can be easily scaled up or down as needed because there is no commitment period.

Asset management and maintenance

Within large sectors such as oil and gas, elaborate condition monitoring programs have often been run on-site or as 'private cloud' services since such large organisations usually have the budget to run them, along with the associated skilled resources. However, for smaller organisations that may not have the IT infrastructure and support to do the things that they want to do or need to do, the SaaS model may be much more attractive and cost-efficient (Table 2). With the SaaS model, the client pays a subscription fee to use software over the internet or a VPN. All software updates

are included, and users can access the software and configure it to their needs. All other tasks associated with maintaining the software, including data backups and server maintenance, are handled by the provider.

One of the benefits of using the cloud for asset management and condition monitoring is that measurements and analysis can be executed faster and correlated with more data. Rather than implementing such systems at each facility — also an expensive exercise with so much duplication of resources and effort — data can be shared from all the facilities of an organisation in a 'central' cloud application. Aside from much lower cost, the next most important advantage is that a larger statistical data set is available to perform predictive analysis. In other words, for a given technology in use at multiple plants, more data is likely to be available to make statistical reliability predictions more accurate.

Data storage

Of course, the comprehensive collection of condition monitoring and process analytics data will result in a large increase in data storage requirements. Purchasing and maintaining the infrastructure for keeping such data in-house is extremely expensive, as are the resources required to process the data. However, the scalable infrastructure provided by cloud services provides the storage in a much more cost-effective way.

Remote access for specialists

Traditionally, one of the common difficulties faced by smaller organisations with CMMS and EAM systems, or advanced analytics tools, is having the in-house expertise to do something with the data. For example, reliability experts at the facility level often don't have the skills to do the necessary kind of statistical analysis to fully take advantage of the tool. So one of the emerging benefits attributed to the cloud for asset management is the ability to tap into a much wider pool of experts and technicians.

With the cloud, organisations now have the opportunity to utilise an enterprise-wide approach — not treating each facility as an island and not requiring experts at each facility, since the data can be accessed by experts anywhere in the organisation or by third-party consultants and advisors.

Mobility and collaboration

A major factor driving cloud use is the ubiquity of mobile devices, both in and out of the workplace. The ability of mobile devices to securely access business and machine data stored in the cloud is creating greater business agility and knowledge, and has the potential to increase loyalty and productivity at the employee level.

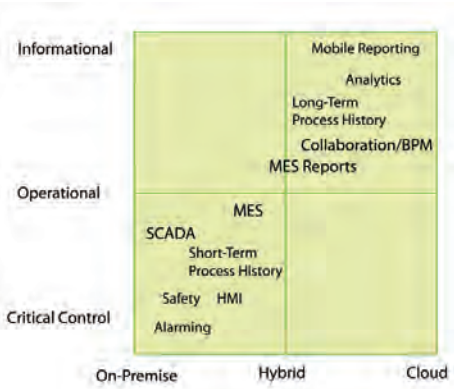

Figure 1: Matrix of possible hosted solutions for industrial applications. (Source: Microsoft and Invensys, 2014)

In asset management and field maintenance mobile data access has become a requirement, making it possible to react quickly to changing events, while it also supports the expectation of younger employees of having connectivity to their data and having a collaborative environment, so they can share information with their colleagues.

With mobile devices and the right back-end systems in the cloud, industrial organisations have the ability to collect and share data from the older workforce, such as work instructions and notes.

The issue of security

For any organisation, anything that is seen to present the possibility that an intruder might get access to operational systems is considered a threat. Data privacy is also of great concern, as is performance. Fourth is data access: what if the cloud service stops working? Can the data be retrieved? The idea of trusting the company's data to some other organisation's service can be a concern.

Cloud-based software lowers the TCO but it can be a different matter to trust your data to an entity that is not a full-time member of your own organisation.

It is important to confirm that the service provider, particularly in a SaaS scenario, can guarantee independence of the networks and non-interference, as well as the security of the connectivity and the data. The systems on-site accessing the cloud service also need to be via a carefully configured encrypted VPN.

Data and application selection

One of the first security considerations when looking at cloud solutions should be an evaluation of how sensitive the data is that would be stored off-site. One thing to consider is that any machine data that is not critical to the physical output of the production process may be a good candidate to be hosted in the cloud. This could potentially include condition-based maintenance data, as well as optimisation, analysis, reporting and alerts or notifications (Table 1).

If the data being collected isn't business proprietary data (not general control system data), such as acoustic or vibration data, it's not as sensitive as process, temperatures, pressures and flows. Process analytical data (such as MES reporting data) that is not considered intellectual property can also be stored and analysed in the cloud without posing a significant security risk.

The cloud may actually be more secure

Unless an organisation is large enough to afford its own IT group with specific security skills, then a cloud service based on a well-known infrastructure such as Amazon AWS or Microsoft Azure (for example) may be far better. Since cybersecurity is a relatively new issue for manufacturing organisations, and many do not have the necessary skills and knowledge in-house, then the question is whether their on-site servers and storage systems in their traditional architectures are more secure than what is available from cloud service providers anyway. Quite often, they're actually less secure, because IT security is not part of the organisation's core competency. Modern vendors of cloud services typically have more secure servers than their clients, since it is one of their range of core competencies.

Summary

Many manufacturers today are competing in a global marketplace in which their aspirations are being eroded by greater competition. Legacy information systems make it difficult to extend the plant's information infrastructure globally and to take advantage of new methodologies and services offered by clever use of the internet.

Applied in the right way, cloud-based infrastructures allow manufacturers to overcome these restrictions and allow them to seek new business opportunities and efficiencies — while at the same time reducing costs and overheads. Now is the time to start thinking about how your organisation can take advantage of the cloud.