Supervisory Systems FAST/TOOLS™

SCADA Cloud Computing

Information on Cloud Computing with SCADA systems
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Introduction

Virtualization and Cloud Computing are becoming common terms. Global leaders in Information Technology (IT) advertise with their new solutions of Virtualization and Cloud Computing.
Is Cloud Computing similar to Virtualization? Are these solutions a proven-technology or a hype? Can a virtualized environment handle real-time data? What are the benefits of these solutions? And more over, what are the challenges of these solutions? This white paper will provide insights in these matters and how to phase in with existing and new systems.

CONTENTS

Cloud Computing vs. Virtualization

Virtualization is the abstraction of hardware through software, separating the Operating System (OS) from its hardware, where Cloud Computing separates the applications from the platform on which they run. It is necessary to make clear that these solutions are not the same. Virtualization is a component within Cloud Computing; Cloud Computing embraces a much greater concept than Virtualization.

A brief explanation about Cloud Computing

The National Institute of Standards and Technology (NIST) of the U.S. Department of Commerce defines Cloud Computing as:
"Cloud computing is a model for enabling ubiquitous, 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. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models."

Basically this definition describes that you can allocated performance, resources, storage, applications, platforms outside your devices on a remote location. But still being able to use this as if all these quantities are installed and running on your own device (e.g. PC, laptop, smartphone).
With cloud computing a device shifts from being a framed platform of certain capabilities to being the interfaces to the unlimited activities a user wants to deploy.

Cloud computing is a result of evolutions in the IT environment. Cloud computing derived from the demand to outsource servers and virtualization of these devices outside the premises.
The initial concept of Cloud computing delivers an on-demand Computing environment. The simplest and most common form of these on-demand environments are web applications, such as Google Docs.

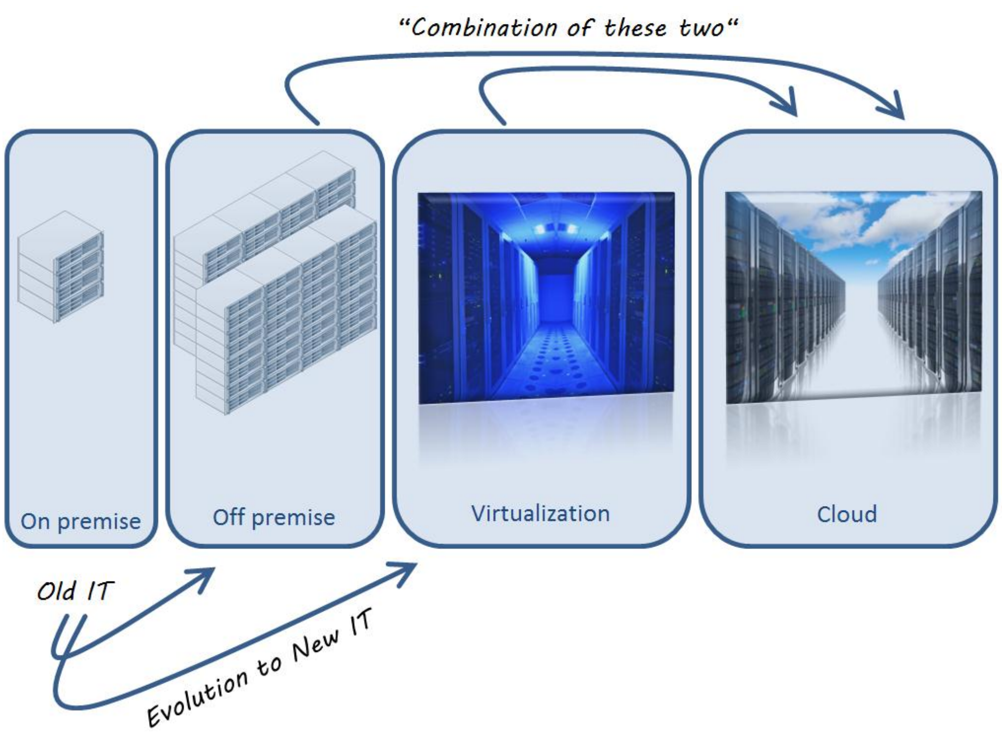

Figure 1: Evolution into the Cloud

The cloud environment is categorized in to 3 service models:

- Software as a Service → SaaS
  Delivering an application with its data to the end-user over the web
  Common use: CRM, Sales application, Relational databases
- Platform as a Service → PaaS
  A combination of Services and Application development tools. Enabling efficient and agile deployment
  Common use: development of business model application
- Infrastructure as a Service → IaaS
  Combination between of hardware and software 'providing' cloud services.
  Common use: outsourcing computing infrastructure to an on-demand cloud service

The hierarchy of these 3 models is best visualized via the stacked diagram below.

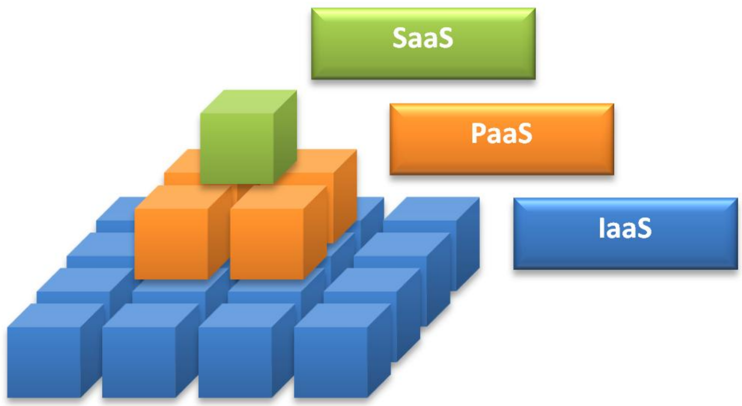

Figure 2: Cloud Stacked Diagram

As you go from top to bottom in the stack, the target user differ from "End-user" target customers in SaaS to "IT-Operator" target customers in IaaS. The flexibility of its purpose devaluates in the same direction while the level of abstraction is inversely proportional to the flexibility.

For industry solutions this means that requirements as: availability, scalability, interoperability prescribe what type of service model is applicable.
As an example: what if Pipeline Management wants to move into the cloud? What kind of service models would be applicable?
With these kinds of extensive process management applications there are a number of features that all require their own philosophy to align the choice of service models. These features can range from real-time data in the cloud up to document control in the cloud.
Pipelines cover lengths as large as tenths of thousands of kilometers. Many devices along the pipeline hold their own manuals, such as installation-, troubleshoot manuals. To equip every field engineer with a device that holds all the documents is inconvenient.
Besides the storage space and application capabilities a device requires to display all the different document, document revision management is also becomes very difficult to handle.
For this kind of challenges SaaS, Software as a Service, can be the right solution. The corporation can centrally manage the documents, making this a more efficient and reliable way of working. Furthermore, documents come in multiple file formats that in turn require multiple software applications. With SaaS this can also be managed centralized, enabling a uniform method of document distribution and availability while being able to maintain transparency in device use.

For each of these models the NIST defined four deployment models with which the level of governance can be differentiated proportional to the level of the exclusivity of infrastructure control.

- Private cloud
  The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers.
- Community cloud
  The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns.
- Public cloud
  The cloud infrastructure is provisioned for open use by the general public.
- Hybrid cloud
  The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

When we combine the service models with the deployment models this result in the following overview.

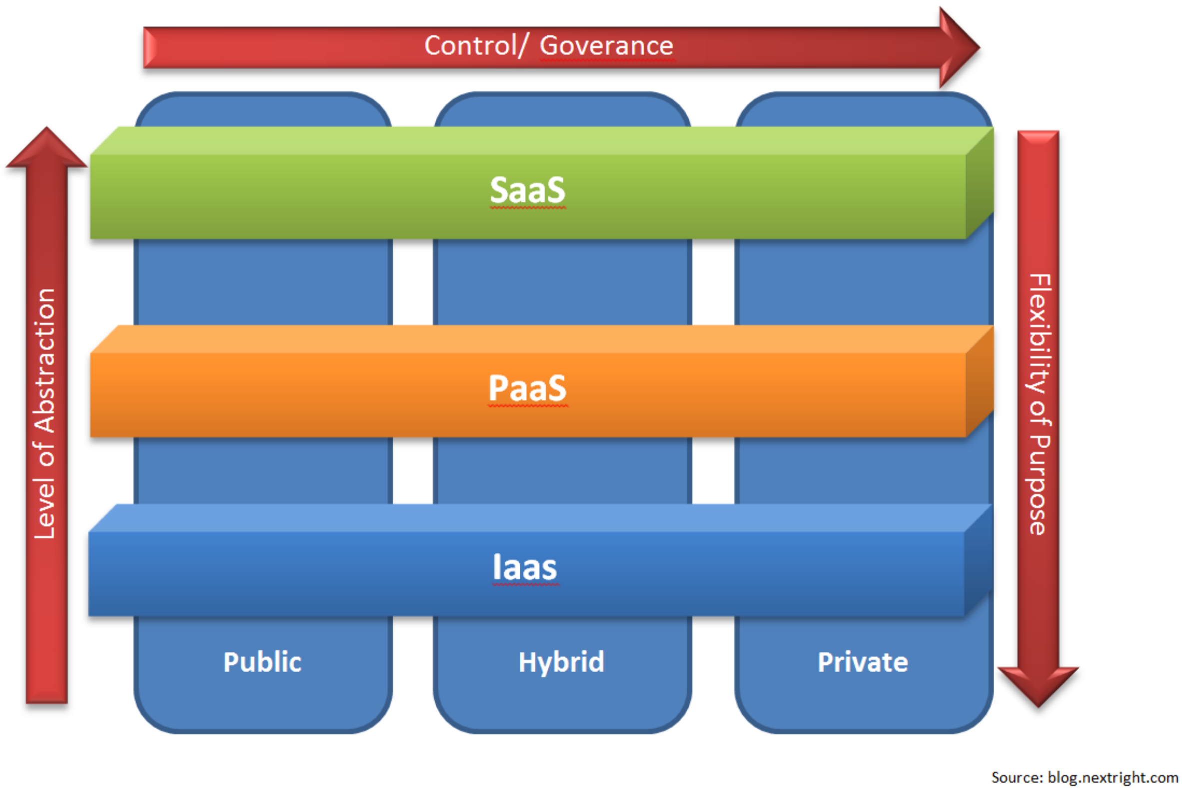

Figure 3: service/deployment model

Benefits of Cloud Computing

The most obvious benefit of cloud computing is the scalability. A sudden increase of computing load can occur often in a SCADA system. Therefore the industry is accustomed to unduly equipped systems in order to handle such an event. This sudden increase of computing load is referred as a "cloud burst" in the definitions of cloud computing.
A benefit that could be a challenge in the same time is internal control. By choosing certain cloud infrastructure models, is it manageable to maintaining internal control while achieving SCADA in the cloud, however the level of control is always less than keeping all hardware in house.
Perhaps one of the most appealing benefits would be lower costs when the infrastructure is outsourced into the cloud. And with that taking the advantage of the environment of the cloud provider such as: processing power, storage capacity, security measures, maintenance service, etc.
Furthermore, cloud computing further enhances the technical functionality and usability of mobile devices. The interest in, and the adoption of, these new generation smart devices is rising significantly. Preparing the infrastructure by integration of SCADA in the cloud would therefore be an important step into future SCADA systems.

Challenges of Cloud Computing

As discussed in the benefits paragraph, a challenge of cloud computing can be internal control. This challenge can be overcome by selecting the most suitable solutions to the specific case. Further details on SCADA in the cloud systems and how to maintain internal control will be discussed in the paragraph "Cloud Computing and the SCADA environment".
The most obvious challenge of cloud computing would be the security. When data is transported over the web the necessity of security becomes even more desirable. Existing SCADA system are often secured with firewalls, VPN tunnels and data encryption between the client user and the SCADA item database, in which the SCADA system acts as a server. In this case the SCADA server awaits requests from its client user, as shown in figure 4.

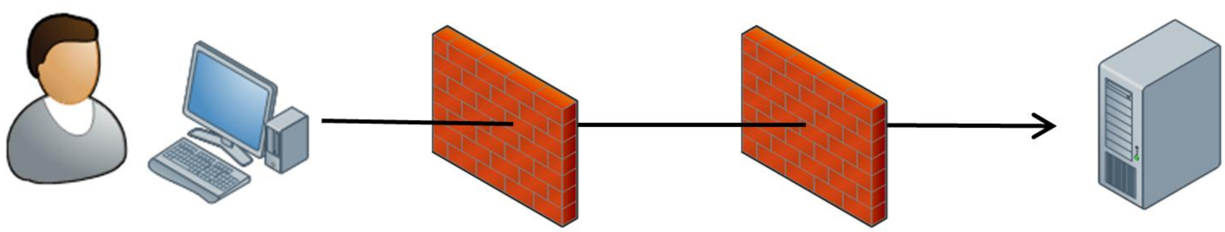

Figure 4: Current Client/Server model

Security is a trending topic within industrial automation and therewith SCADA. Today`s security-conscious climate demands that the modern systems be able to prevent system compromises in order to provide safe and reliable services to its stakeholders. More information on SCADA Cyber Security can be found in the Global SCADA Center document: "SCADA Cyber Security, Information on Securing the SCADA system".

Cloud Computing and the SCADA environment

The most applicable concept for the SCADA environment to leverage its functionality by integrating Cloud Computing is presumable by use of the Hybrid Cloud. Combining the principles of private and public clouds will provide the requirement of remote access while maintaining internal control of system critical control and data. Figure 4 displays the suggested concept.

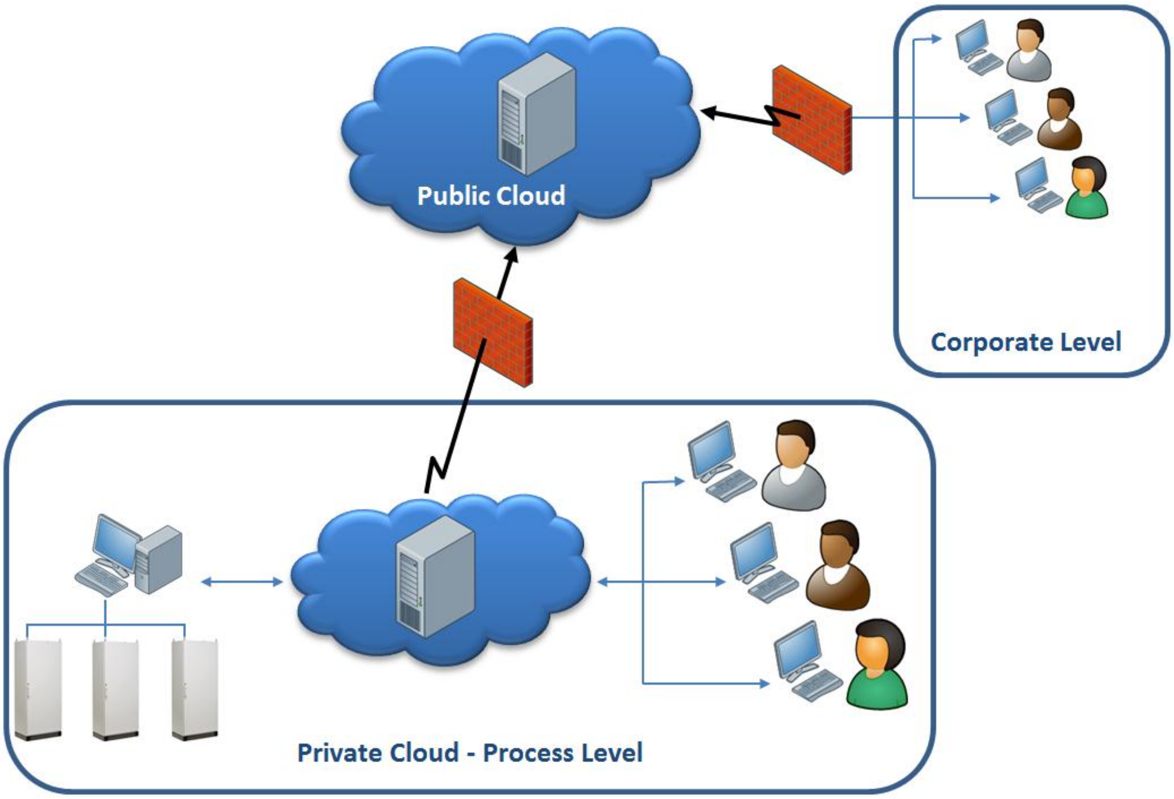

Figure 4: Hybrid Cloud

This proposed concept delivers the beneficial features of both cloud computing deployment models. The private cloud handles all core and process critical data, similar to the current SCADA infrastructure. The SCADA server will be active in the private cloud which will be on premises to ensure internal control and security. Another benefit of placing the private cloud in-house is that the real-time data can still be transferred a LAN speed, mitigating additional latency's.

The public cloud transfers any required data to any user besides those whom execute the actual process control. Via the public cloud partial data is shared with its users, mitigating the performance load on the Private Cloud side. Beneficial aspects of the public cloud are the scalability and relative low costs. Moreover, by choosing for a hybrid cloud solution, the cloud infrastructure can be gradually phased in. After phasing in the private cloud the organization can get accustom to the usability. Once the organization feels comfortable the second phase would be creating the SCADA functionality in the public cloud.

To mitigate processing power and bandwidth usage it is advisable to retrieve value changes by using publish/subscribe (pub/sub) functionality instead of polling data. Pub/sub is based on pushing new values when a value change has occurred. This method of data collection reduces network and processor load on server in the cloud. Even more, when pushing the data the firewalls should remain closed, ensuring the security of the system. Another security measure is solely enabling reading rights for the public cloud users. While maintaining full read and write rights for the user on control level. Thereby further mitigating any unwanted control from unwilling users or outsiders.

Cloud Computing and FAST/TOOLS

SCADA in the cloud would be a logical next step in the evolution of automation technology. Adopting new technology requires an adjustment in the philosophy how we consider applicable systems. When achieving SCADA in the cloud it is necessary to change our mind set to allow real-time data in the cloud. As described a SCADA system should arrange data delivery through pub/sub, since data polling gives a heavy data load. FAST/TOOLS system complies with this philosophy, since the application architecture of data delivery is event based. Moreover, FAST/TOOLS pushes data to its client in an effective manner, by merging similar queries and thereby mitigating transportation of data packages. To clarify, let's assume 100 clients are in connection with the item database. Let say that 25 users are call up the same display at a certain moment. The Web-HMI server mergers these 25 requests into one single request to the item database, as reaction one value is delivered as a response to the Web-HMI server. The Web-HMI server in its turn distributes the data to all the 25 clients, therewith achieving a low performance and network load. To further mitigate performance and network load a data-centric infrastructure can contribute to keep any latencies minimal as possible. In addition to this benefit FAST/TOOLS uses a centralized license structure, which gives the benefit of no revision management on the client side, no software installation required on client side and no license distribution. This so called "zero deployment" means that client applications can be run from any web-browser and the users always get the most recent version of an application. Applications and process information can be rapidly deployed and is easily maintained centrally on the server.

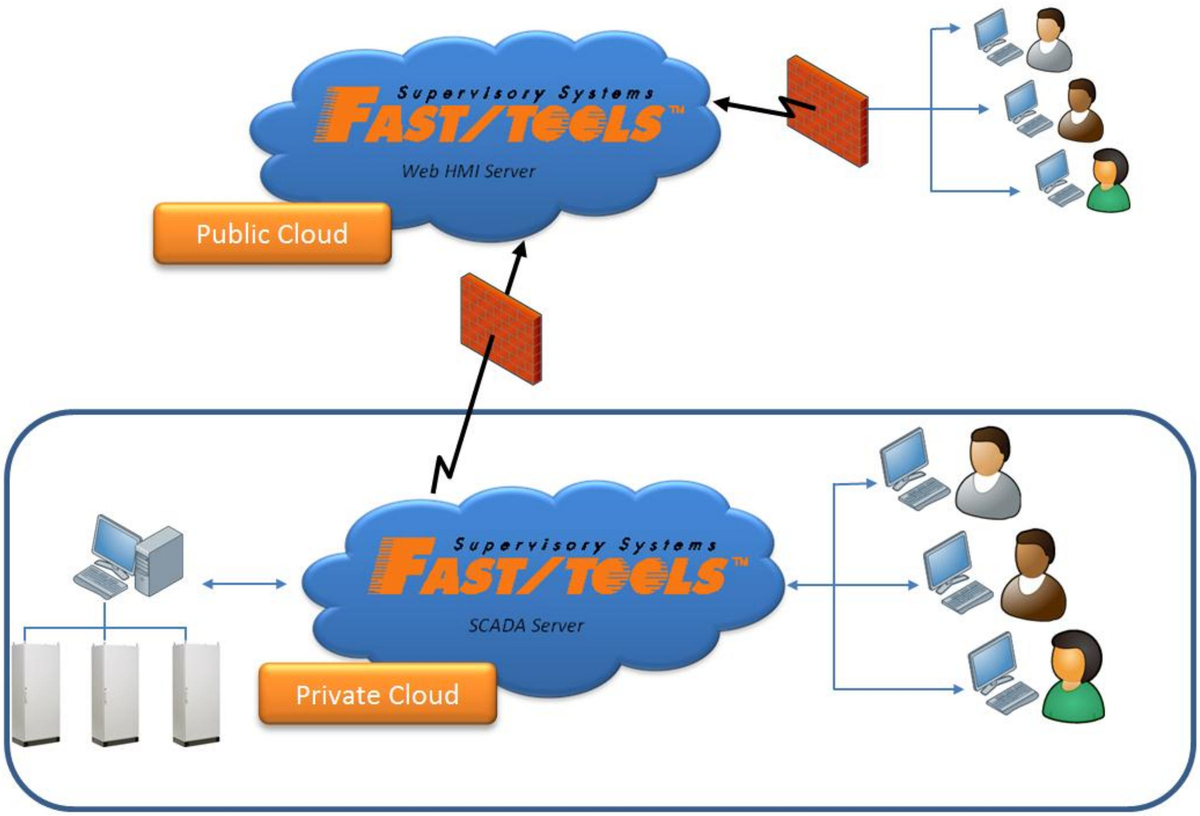

Figure 4: FAST/TOOLS Hybrid Cloud

The communication between the private cloud and the public cloud should be in its rawest form, to comply with a data-centric infrastructure. The communication between the external client and the public cloud can be converted to the required formats such as, SQL, HTML, XML, etc. FAST/TOOLS uses its internal low bandwidth bus language for communication between the private and public cloud. This ensures the data-centric infrastructure between the data source and the cloud, after which the data may be converted in the any other format, e.g. HTML5. In this was FAST/TOOLS enables information delivery in a secure, fast and dynamic manner to any user at any place in the world over the cloud.

Please be advised that this document solely provides a global overview on Cloud Computing. The most suitable solution must be determined on a per case basis. Yokogawa Global SCADA Center can be contact to give advice on these matters.