Cloud Control

Control in the cloud: trends in cloud computing and their impact on the world of industrial control

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Every two years the Tel Aviv Fairgrounds hosts the Israchem exhibition for the process industry in Israel. Thousands attend to find out about the latest technologies from the major companies in Israel and worldwide. I was recently invited to lecture at the 2013 exhibition, at a professional session on Future Trends in Instrumentation & Process Control, organized by the International Society of Automation (ISA). For the lecture, I chose the topic of "Control in the Cloud: Cloud Computing Technologies and the World of Industrial Control" after conference organizer Arik Barkai of Teva Pharmaceuticals urged me to select a novel topic that had not yet received the attention it deserved.

And so, in the weeks leading up to the conference, I found myself delving deeper and deeper into the fascinating literature and articles on the web about a growing trend among enterprises and institutions to relocate their computing resources outside the organization and enter into service agreements with some of the biggest providers of computing resources in the world.

I began to wonder whether the world of production control and production continuity, which we are specializes in, could benefit from the advantages that cloud computing services have to offer.

I came across huge quantities of literature describing a whole myriad of benefits that numerous enterprises had gained by placing their data centers in the professional hands of strangers, outside their organizations. Cloud computing companies, by delivering computing services to numerous enterprises on a vast scale, are able to invest in and allocate technological resources to their customers' computer systems of a magnitude that no individual enterprise could on its own. Today, enterprises that take advantage of cloud computing services generally enjoy higher levels of uptime, redundancy, information security, and quality than they did in the past. Cloud service providers are obliged to maintain high standards of service in order to ensure their continued prosperity. They are assessed by their standards, and it is by their standards that they differentiate themselves from one another.

Another advantage is the Pay As You Go business model that many enterprises prefer, a fixed monthly installment tailored to the actual computing needs of the enterprise: payment is based on the quantities of computing resources actually consumed, which can be adjusted at any time according to the enterprise's changing needs.

So how did cloud computing come about?

Well, there was no revolutionary technological innovation, no new patent, and no ingenuity not ever seen before. The trend to move servers out of the enterprise to an external provider was made possible by incremental improvements in communications infrastructures and by declining network traffic costs over the past two decades.
The above graph shows the average market rate paid by the American consumer per megabit per second from 1998 to the present day. The trend is clear. Thanks to falling prices and growing bandwidth, the location barrier was eliminated. And as a result, various providers have invested heavily in establishing and developing cloud computing infrastructures in recent times.

Several business models for engaging cloud computing providers exist, the most widespread of which enable enterprises to buy service packages ranging from basic infrastructures, to operating systems, databases and even a whole application provided as a service.

The above figure illustrates the differences between the basic business models for cloud computing systems that exist. In the left column, all the computing and software services are provided by the enterprise itself; in the rightmost column, SaaS (Software as a Service), all the elements of the solution are furnished by the service provider. Enterprises currently tend to use the models in the middle— IaaS (Infrastructure as a Service) — a basic model in which only the hardware is provided as...
a service: the servers, storage, network services and virtualization systems. Another wider model PaaS (Platform as a Service) provides the entire platform; not only the infrastructure services, but also the operating systems, databases, and the supplementary software services that the application requires. Under this model, all that is required of the enterprise is to take care of the application and the data for it; all the other computing infrastructures are furnished by the cloud provider.

The Players

It is not every day that one encounters a player that has garnered 90% of the market share in United States. Amazon is the biggest provider of cloud computing services in the world; analysts expect it to end 2013 with a turnover of $3.8 billion in this area alone, with growth projections to $8.8 billion in 2015. Last month Microsoft announced a competing service, Windows Azure, which aims to eat at Amazon's market share. Amazon's cloud computing services, AWS, offer a user-friendly interface; computing infrastructures can be set up at the press of a button, with starting costs of just few dollars a day for a Windows 2012 Server. Amazon's S3 storage services guarantee 99.99% uptime, with a 1GB storage cost of just 5 to 10 cents a month (depending on the amount of usage). The services are provided in a simple and straightforward manner via a user-friendly interface; setting up an array of new servers is a simple task that does not require IT experts, and customers can also define more advanced services such as DRP, CLUSTER and VPN, etc. Gartner, the leading research and advisory company on IT issues, published an article in March 2013 stating that the traditional service model will disappear by 2015: the software, infrastructure and platform will all be provided as a service.

Control in the cloud

In the light of the huge momentum in implementing computing systems in the cloud, the question arises: how are these trends expected to impact automation and control, the areas we specialize in?

Control and automation systems are responsible for controlling machinery and production line processes. The basic requirements of control systems are maximum uptime, reliability, quality and speed in order to make optimal use of the enterprise's production resources, while at the same time preserving operating security and the confidentiality of sensitive information liable to exist in those systems. For more than three decades such controls have been implemented by means of dedicated Programmable Logic Controllers (PLCs), which provide an excellent solution to the unique requirements of enterprises in the control business and are geared to work in noisy industrial surroundings. What differentiates and sets control systems apart from computer embedded systems is the issue of reliability. No enterprise is going to want to rely on a server or PC computer if the operating system and the software are less stable and their uptime inferior to that of PLCs. Stopping a production facility can have huge financial costs, which is why dedicated hardware systems were developed and the operating logic of the production systems implemented on them.

Though control engineers instinctively reject outright the possibility of a meeting point between cloud computing and the world of traditional control, I questioned whether these two tracks will indeed remain separate, never to converge.

I would like to present different a line of thinking in this post. Cloud computing providers are assessed by the uptime of their systems, and they invest extensively in the security of the computing infrastructure; they have far greater financial strength to make these investments than any individual enterprise does on its own, and as a result, their computing systems are becoming ever more stable and more secure too, not less so. Transmission lines are expanding all the time and the communications providers are constantly improving the uptime of their communication lines. Hence, the forces that drove enterprises to seek dedicated hardware solutions - PLCs- are effectively the same forces driving cloud computing providers to improve their systems and to offer higher levels of service and survivability. In my estimation, therefore, implementation of control systems based on a controller in the cloud will become viable in the not-too-distant future.
PLC As a Service

For many years now, the leading makers of controls, such as Rockwell Automation, have enabled installation of their control system on a computer or a server, with all the same programming tools and functions that can be implemented by means of their standard hardware-based controller. The computer-based programmable controller, SoftLogix, never came into its own despite the fact that its use the powerful RSLogix 5000 programming software, the same tool used to develop software for the hardware-based Logix series of controllers. Contel has never supplied a solution to a customer that uses this ‘soft’ controller. Once again, this is due to the lower reliability of computer systems compared to the high uptime of the traditional PLC. If, at a future time, cloud computing providers install SoftLogix on computing and communications infrastructures that feature greater reliability and greater uptime, we will be able to look at the option of using a controller in the cloud.

Historian as a Service

While a controller in the cloud sounds like a distant vision, the control system can be expected to migrate to the cloud in stages. First to go up will be the monitoring components, which have no real impact on the production resources of the enterprise. Thus, for example, the data collection systems - Plant Historians - are the first systems that can be expected to migrate to the cloud. A study published by American institute ARC entitled the Plant Historian as a Cloud Application is the first significant publication to examine and recommend that the major global makers of industrial controls adopt a strategy in this direction. The 26-page study, published in November 2012, reviewed steps already taken by manufacturers towards solutions in this direction.

HMI as A Service

Several control systems and Human-Machine Interfaces (HMIs) based on cloud computing are already in evidence today. Israeli company RealiteQ, for example, provides monitoring services for control systems by means of an application installed in the cloud. While the scan speed of PLCs constitutes a barrier to their entry to the cloud, the software – the HMI - providing humans with the operating interfaces to the control and production systems do not require the rapid response times of the actual controllers themselves, and are therefore likely to join the cloud before the controllers do.
Control as a Service

A conventional manufacturing system is composed of a variety of devices installed in the field (motors, sensors, control valves, pumps, etc.). The devices are wired up to PLCs by means of electrical signals (I/Os) and by means of communications networks specific to the production floor. With growing use of Ethernet-based industrial communications networks, such as the Ethernet Industrial Protocol (Ethernet IP), the assumption is that the technical barriers will be eliminated in the not-too-distant future, and that all the device arrays will be controllable via IP communication, wireless or landline, interfacing with the control system. Taking the long view, the need for control cabinets, IO cabinets, and wiring of control points from the devices to the control system will be done away with. Also in the long term, possibly two decades down the road, all the devices will be installed at the production site, each equipped with its own individual IP address. The control system in the cloud will identify every device, and all that will be left for us to do as control engineers will be to write the operating logic.

My lecture at the Israchem Exhibition, in the Future Trends in Instrumentation & Process Control session had a mixed reception. Most of the participants I spoke to expressed an interest in the subject, but in the same breath said, when it comes to traditional control, these processes will take many years, if they happen at all. Contel has set up a new cloud-based test lab using the computing services of Amazon Ireland. A SoftLogix controller-- the 'soft' controller from Rockwell Automation was installed on a virtual server there and linked up to remote IO units in the Point IO Series installed at our HQ offices in Israel. We are currently examining the performance of the controller in Ireland vis-à-vis the IO units in the company's in Tel-Aviv area. The aim of the lab is to test the controller scan speed as a function of the communications infrastructures, and to create a feasibility coefficient, as shown below:

![Graph](image.png)

Scan speed of a controller in the cloud as a function of communications infrastructure bandwidth.