White Paper: Edge to Cloud - Enabling an Industrial Paradigm Shift
by Joseph Campbell, CTO for Industry

INTRODUCTION

Even though industrial automation has been in place for decades, productivity gains have slowed over the past three decades. As the age of a factory in the United States averages around 25 years old and contains equipment typically at least a decade old if not older, companies looking at the investment required to upgrade to a new generation of smart machines is prohibitively expensive. This is especially true in heavy industries, such as Petro-Chemical processing, where hardware such as pumps, valves, and related types of infrastructure can be in service for many decades.

This multi-decade slump in productivity improvement can be attributed to the instrumentation; modernization of this hardware has not been a practical possibility until recently. Long runs of wiring, often through hazardous environments, has been impractical. In addition, the cost and sensitivity of the sensors themselves have been limiting factors. The result of this is that modern industrial processes are limited by an understanding that is locked into decades-old operating paradigms.

However, the advent of Edge to Cloud computing has enabled numerous industrial use cases which offer significant opportunity for improvement not available before. Having an Edge to Cloud framework in place greatly reduces the complexity of interconnected systems, making it easier than ever to collect and analyze data in near real-time scenarios.

An Edge to Cloud framework can also provide for the effective collection of critical information in remote sites where network connectivity is inconsistent or not cost effective. In these cases, data can be gathered and analyzed locally, with only critical information being sent back wirelessly to the cloud for further processing and analytics. The combination of edge to cloud computing and industrial IoT devices will make it easier to optimize industrial processes, improve supply chains, and provide a heightened ability to protect Health, Safety, Security and the Environment (HSSE), creating a “smart” factory for a fraction of the cost.

The aim of this whitepaper is to investigate emerging opportunities and provide a current overview of the agile and growing market where Edge to Cloud solutions drive competitive industrial change. In addition, scenario modeling demonstrates how deployment of this technology can be used to reach the next level of cost saving, safety and competitive advantage in the manufacturing and process control space.

CURRENT MARKET DEVELOPMENTS

Coupling the advancement of LTE into 5G with integrated, high-power industrialized compute abilities – such as that offered by the HPE Edgeline Series –works together to shift the standard paradigm in the Operation Technology [OT] arena. Here we see compact industrial computing converging with evolving wireless communication thanks to the rapid evolution of software-defined radio technology. Previous 3G/4G wireless technologies were inefficient and costly options to move the massive amounts of information created by the current generation of advanced sensors. The evolution of LTE-Advanced to 5G now solves part of this problem. However, we must also deliver the ability to process these vast amounts

of data near the source of creation, distilling huge volumes of common data into unique meta-data, mathematically describing the process and triggering alerts for near real-time action.

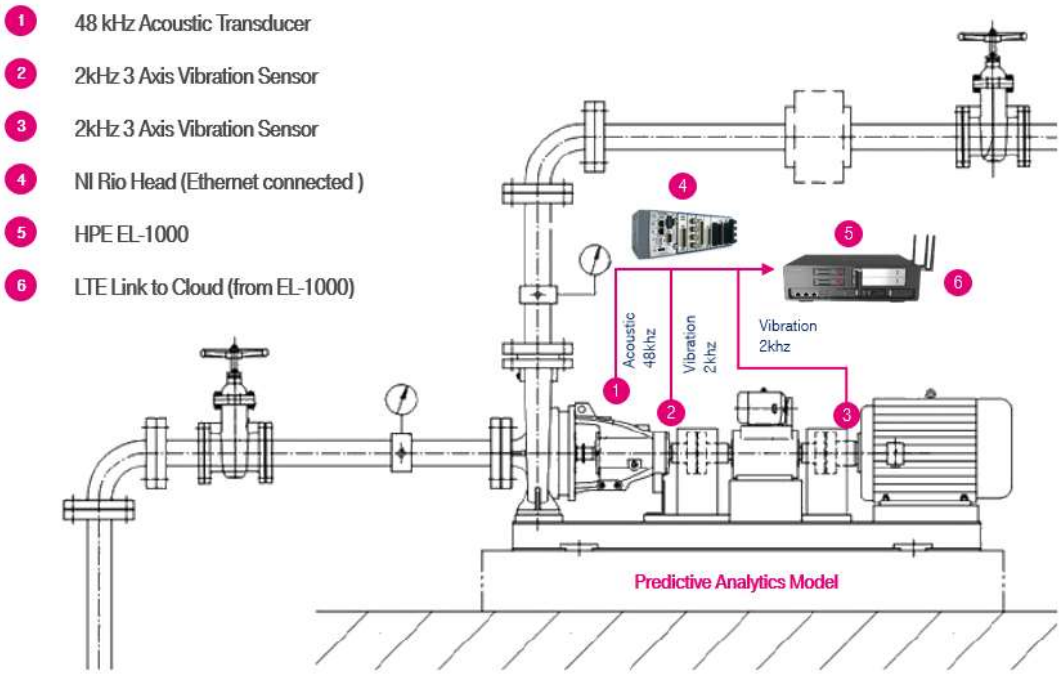
These changes are opening doors to new forms of data acquisition (i.e. high frequency, multi-axial vibration; streaming video) along with the ability to pre-process the information into anomaly focused meta-data or even trigger events which can then be transferred wirelessly with low latency to a public cloud for action and analysis. Here, an Edge to Cloud system can be deployed as a "green-field" solution or can be easily integrated with an existing industrial bus structure (e.g. Fieldbus, HART, ICAN, etc.) or deployed with a completely new sensor technology.

This ability to manage large amounts of data with low latency has in turn driven the growth and deployment of the next generation of sensors, which are lower cost yet deliver the ability to capture high-frequency data critical for advanced analytics and projections. As low resolution data streams mask or omit valuable time based anomalies, the capture and analysis of high-frequency data is a must to achieve sufficiently advanced forward looking analytics.

EDGE TO CLOUD TOPOLOGY

The core of the emerging wireless and compute convergence strategy rests in a turnkey, field-ready industrialized compute solution with a software configurable LTE radio as a part of the unit's native network topology offering a highly efficient, low latency Edge solution.

Note: *The following simple topology is for example purposes only. This configuration can accommodate far more sensors then illustrated here.*



In this example topology, we have deployed two triaxial vibration and temperature sensors to the pump bearing assembly and the motor/clutch bearing assembly, each producing 2kHz of data. A 48kHz acoustic sensor has been attached to the pump housing itself. These sensor are connected by standard local bus to a National Instruments eRio head as a bus aggregator. In turn, the eRio is connected to the HPE EL-1000, which is locally running process control and analytics software with the ability to support up to 16 cores as well as offer GPU support.

Utilizing this compute power locally offers the ability to tease out deep analytic detail from the sensor data as well as correlate the interdependencies of the process to reduce or even eliminate false positives. In our example, pre-failure vibration in the motor bearings could be transferred as a false positive to the pump bearing; cavitation in the pump could also mask developing anomalies. With locally-based, high-performance computing power comes the ability to unravel the process itself and identify the correct component for proactive maintenance.

COMPETIVITE ADVANTAGE

Beyond the forward-looking proactive maintenance aspect of Edge to Cloud solutions, there is also the value proposition of competitive advantage. For the purpose of example, we will continue to focus on a common pump assembly due to its rather simplistic yet ubiquitous application. Pumps, particularly in the Petro-Chemical and Refining industrial sectors, tend to last "forever". (From personal experience, we have instrumented pumps which operated for over 50 years!) While seeming rather basic in concept, pumps are critical components in the process space. By utilizing Edge to Cloud technology, pumps can offer a low-cost competitive advantage use case overlooked by many.

With the addition of a low-cost, high-frequency acoustic sensor, it is possible to capture the detailed interaction of the fluid with the pump itself. Through the use of rather simple mathematical models, we can understand how the particular fluid is reacting inside the pump cavity and impellers, e.g. Is there cavitation within the pump due to fluid shear, or negative resonance due to the impellers? With more advanced mathematical models it is also possible to understand the performance aspect of the impeller assembly, e.g. What is the efficiency of the pump across a various range of effluents (especially important for toll processing)?

Along with the growth in analytic and predictive models, declassified defense technology originating from submarine acoustic research is rapidly adding new value to the tolling and process control space. Edge to Cloud platforms are driving this acceleration, allowing the localized decomposition of high-frequency data coupled with GPU-based power to apply advanced mathematical models and create previously undiscovered business value through large step process improvements.

CONNECTING THE EDGE TO THE CLOUD

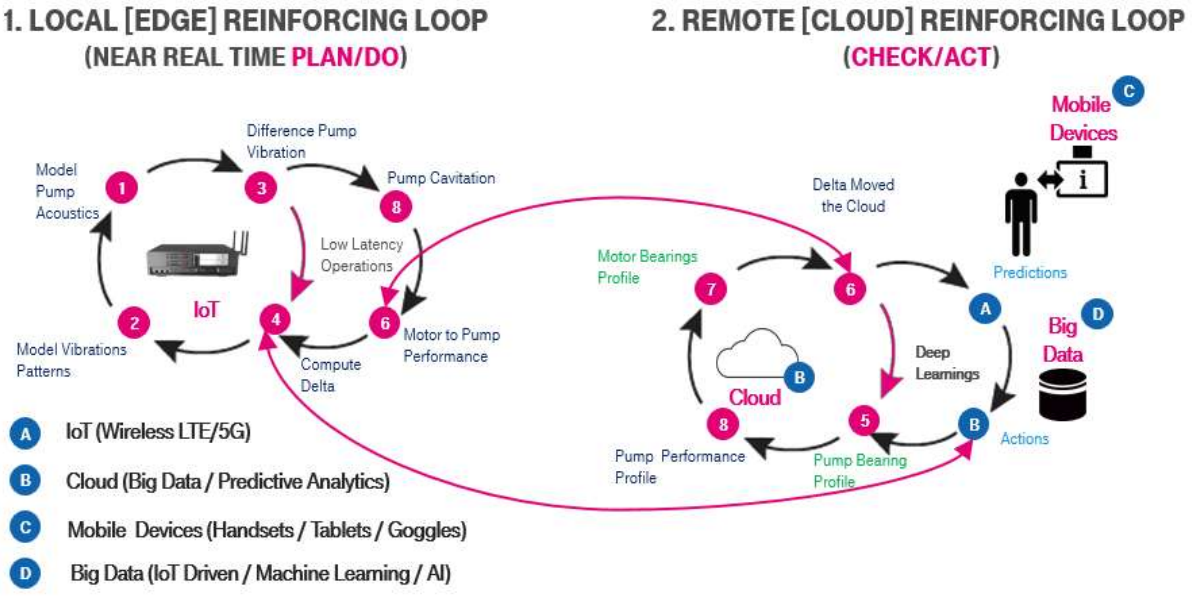
In our pump example, the HPE EL-1000 gateway is not located in a datacenter or even a data room; it is co-located with the pump assembly itself in the field. As the industry's first "Converged Edge System", the Edgeline is leading the shift away from the data center and even the cloud to the industrial edge, integrating precision data capture and control systems all in one converged box. These rugged and compact systems are designed to thrive in harsh Edge environments and can handle extremes of shock, vibration and temperature. They were purpose-built to accelerate IoT insights and control actions in real-

time through advanced wireless connectivity. T-Systems, with its deep wireless heritage, employs LTE-Advanced technology utilizing 5G wireless transmission to move large amounts of data securely.

This wireless model removes the need for costly and time-consuming site-wide wiring projects. A lengthy "hard-wired" solution is also less future-proof as new sensor technology is released. In our pump example a local bus was used; however the integrated radio abilities of the TSi solution make it possible to deploy a completely wireless version of the same topology utilizing various wireless bus structures for an inbound data-stream, while the outbound stream is facilitated via an LTE connection.

CLOUD INTEGRATION WITH EDGE

While the processing of local data takes place at the Edge, the power of an Edge to Cloud solution is to leverage a public, private or even hybrid cloud to act a mass aggregator and perform deeper, longer term analytic study of the aggregated data. For example, a company may operate 10 plants, and each plant may have a hundred similar pumps, resulting in a portfolio of 1,000 pumps in operation. In the past, the idea of managing a portfolio of so many operating assets was simply inconceivable. Yet today, with Edge to Cloud technology, this is now a possibility – and a highly competitive possibility at that.



In the example above we can apply the Deming Model (Plan/Do/Check/Act) to develop a "many to one" relationship, where site-based pump information is collected and processed locally, and anomalies (a meta subset of the data as a whole) are then transferred wirelessly to the cloud via LTE (4G or 5G) to be processed further. In the cloud, we can both identify deeper patterns from aggregated data, as well as seek to develop improved performance models such as Proportional Integral Derivative (PID) controls.

However, the benefits of this model are not purely technical. Aggregated data can serve to support business negotiations related to performance metrics (i.e. claimed to actual) when procuring new assets. It can also be used to develop better models for part stocking, logistics and support contracts. Furthermore, a streaming information flow from the field may precipitate completely new business

models. For example, pay-per-use service models, where detailed performance aspects of individual assets can be rolled into service level agreements, allow for the conversation of CapEx to OpEx, offering the financial advantage of capital conservation.

SECURITY

Collecting and transmitting industrial manufacturing data from an ever-increasing number of connected devices requires a better approach to processing and analysis. Bringing these functions closer to data source, as in the T-Systems Edge to Cloud solution, enables execution within the Edge of the facility itself rather than depending solely on central locations. The basic idea is to optimize data transmission time as much as possible. While increased vulnerability to hackers may be an unwanted side effect of distributing activity across a wider range of endpoints, the Edge to Cloud solution provides a clear advantage here.

Loopholes in device security – supported by transport means, such as LoRa and NB-IoT – can offer hackers access to a data stream or possibly even the core of a network. This is of particular concern when some devices have been rushed to market before thorough testing has been performed, or when companies race to adopt the technology without a complete understanding of the security risks involved.

In the T-Systems Edge to Cloud solution, sensor data is held locally on either a wired or localized short range wireless bus, reducing the foot print of the threat vector. Because of the associated local compute, it is also possible to offer increased security schemes such as digital twinning, encryption and other security technologies typically found in applied compute scenarios. The Edge to cloud solution offers an effective multi-application compute platform.

OUTLOOK

While we are still in the early evolution of the Edge to Cloud model, the pace has quickened toward a tipping point of Revolutionary change. For many years, companies have been intently focused on the goal of cost cutting. The emergence of 5G technologies coupled with advancements in data analytics are providing a new path for business differentiation. This pairing is leading a paradigm shift in the industrial manufacturing segment: from a cost focus to competitive advantage.

Over the past two decades the brown-field stalwarts have become threatened and been defeated – not by cost saving, but by competitive advantage. Tesla is now more valuable than Ford and Chrysler put together. Airbnb threatens and in some cases has defeated many long-term hospitality brands. Apple, Google and Microsoft have all crossed the Trillion dollar mark in value. Not one of these brands' achievements have been the result of cost cutting; they have relentlessly sought an innovative advantage over their competition.

By leveraging our extensive wireless heritage and deep industrial computing origins, T-Systems is powering higher performance. Our Edge to Cloud solution breaks new competitive ground for brown-field business to compete with green-field market entrants, to shift the traditionally slow evolution of manufacturing paradigms, all while fostering a sense of security – both functionally and as a business.

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... has worked at T-Systems International since 2008 as a lead innovator in the industrial and process space . This experience is also complimented by additional two decades of involvement leading IT focused Industrial transformation on a global stage.