Smart & Connected: Technologies at Larsen & Toubro

Abhishek Kapoor – July 24, 2019

During the summer of 2019, I had the privilege of participating in a 1-month internship with Larsen & Toubro Technology Services (LTTS) – a global multinational corporation specializing in engineering and information technology services. Throughout my internship, I was able to get an in-depth understanding of various solutions developed by LTTS, who their clients are, and how the services are developed. I also had the privilege of speaking with various product managers and engineers – many of whom are industry-leading experts – and I was therefore able to develop a sound knowledge of various cutting-edge technologies.

This paper serves to document some of the technologies, applications, concepts, and computing paradigms I learned about while working with Larsen & Toubro Technology Services.

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What is Predictive Maintenance?

In today's modern world, industrial machines are used in almost every industry – whether it be for manufacturing goods or for delivering services. Unfortunately, machines – although far more reliable and accurate than humans – are not perfect; machines can break down at any point of time and machine failure is often extremely costly to firms involved in manufacturing of consumer goods. For this problem, a new solution has recently emerged.

Predictive Maintenance is a technique used to predict the future failing point of a machine or component so that measures can be taken to replace the equipment and thus prevent machine failure during critical times. Predictive Maintenance typically involves the crunching of large sets of data in order to derive insightful information from it. An important component of this is the ability to monitor certain parameters of a machine or component.

By utilizing predictive maintenance technologies, clients can expect to reduce machine downtime by systematically predicting when certain machines or components are likely to fail – thus avoiding machine downtime during critical time periods. This allows corporations to gain a competitive advantage in the market and can help them increase profits and minimize losses.

What is Condition Monitoring?

Condition Monitoring refers to the process of closely monitoring a parameter or condition in a machine, equipment, or component in order to detect changes in the parameter which may be

indicative of a developing fault in the system. Condition Monitoring is a crucial part of predictive maintenance.

Closely monitoring certain conditions/parameters often reveals crucial information that may hint at future downtimes. In addition, large sets of data that is collected can also serve as a base upon which to run algorithms in order to derive insightful information regarding future downtimes of machines.

During my internship at LTTS, I was able to interact with the team involved with developing an integrated condition monitoring device. The device is able to monitor acceleration and movement of certain components in the machine. All this data is collected and sent to on-site servers.

Commonly Monitored Machine Parameters

As you may have guessed, certain parameters are monitored more indicative of developing faults – and are therefore chosen to be monitored. The parameters monitored often vary significantly from machine to machine; for certain machines, monitoring certain parameters is more beneficial than for other machines. Condition Monitoring includes the use of technologies including, but not limited to:

- Vibration Measurement and Analysis
- Oil Analysis
- Motor Current and Vibration Analysis
- Thermal and Heat Analysis

Use of Predictive Maintenance Technologies

The Automotive Industry

Throughout the past few years, there has been a major increase in the adoption of predictive maintenance technologies, especially in the automotive industry – primarily for the manufacturing equipment used for producing vehicles. According to some estimates, the predictive maintenance market is expected to grow from 3 billion USD currently (in 2019) to 10.7 billion USD by 2024 – in a period of just 5 years.

This shows the speed at which predictive maintenance is growing – and the speed with which corporations around the world are adopting this technology.

The Volvo Group

MINI CASE STUDY: VOLVO GROUP

Volvo - a prominent carmaker - was experience downtime costs of around $448 to $760 per day per vehicle due to unexpected machine failure. This danger was significantly reduced after Volvo invested in a cloud-based predictive analytics platform from IBM. Volvo was therefore able to get a competitive advantage in the market due to being able to prevent downtime and predicting when key repairs should take place in order to not disrupt the manufacturing and deployment process for its vehicles.

Introduction to Edge Computing

What is Edge Computing?

"With the forecast of over 30 billion IoT-enabled devices being deployed globally by 2020, the amount of data stored in the cloud is hard to imagine. Not to mention the processing power needed to derive any tangible value from it. " – EasternPeak.com

The rapid increase in IoT-enabled devices has led to a wealth of data being generated. In predictive maintenance technologies, machines, equipment, and components are often sensorized and this just furthers the case. With this great quantity of data, data centers can no longer guarantee a fast rate of transfer/processing. Thus arrives the need for something greater.

Edge Computing is a computing paradigm that brings computation and data storage closer to the location where it is needed, in order to decrease response times and save on valuable bandwith.

In basic terms, in Edge Computing, data is processed by the device itself - or by a local computer or server - rather than being sent to a data center or to the cloud for processing.

Implementing edge computing in predictive maintenance technologies can lead to data being processed where it was generated - leading to decreased response times and making the entire process faster.

Edge Computing Terms and Definitions

EDGE DEVICES: These can be any device that produces data. Examples include: sensors, industrial machines

Edge: what the edge is depends on the use case. In a telecommunications field, perhaps the edge is a cell phone or maybe it's a cell tower. In an automotive scenario, the edge of the network could be a car. In manufacturing, it could be a machine on a shop floor. In enterprise IT, it could be a laptop.

Edge Gateway: A gateway is the buffer between where edge computing processing is done, and the broader fog network. The gateway is the window into the larger environment, beyond the edge of the network.

Fat Client: Software that can do some data processing in edge devices. This is opposed to a thin client. Thin clients would merely transfer data.

Mobile Edge Computing: This may refer to the buildout of edge computing systems in telecommunications systems and can have a massive impact on today's technology, particularly with 5G scenarios.

What is IoT and IIOT?

The Internet of Things is fundamentally a fairly basic concept - it refers to the idea of extending internet connectivity to devices beyond just laptops and smartphones. IoT is a model where everything - yes, everything - is connected to the internet, including refrigerators, sensors, and practically any electronic device. All these "things" have the ability to send and receive information over the internet.

When combined with predictive maintenance, IoT has some incredibly useful applications. Sensorization of machines, equipment, or components refers to the addition of sensors - whether it be light sensors, temperature sensors, or vibration sensors - to machines. When these devices are IoT-enabled devices, there is potentially no limit to the amount of useful data that can be gathered, processed, and quickly sent over the internet.

Similarly, IIOT refers to interconnected sensors, instruments, and other devices networked together with computers' industrial applications

Other corporations involved with Predictive Maintenance Technologies

Throughout my internship at Larsen & Toubro, I gained an understanding of the MCare product. But various other corporations are also involved with the development & deployment of predictive maintenance technologies. Examples of such corporations include, but are not limited to:

- C3 IoT - Enterprise AI
- Uptake - Industrial AI and IoT
- Sight Machine - AI Platform for Manufacturing Analytics
- Falkonry - Predictive Operations & Operational Machine Learning

What is a software platform? Platform vs Solution

Platform and Solution are terms we hear thrown around a lot in the computer software industry. But what exactly do they mean? and what is the precise difference between the two?

Simply put, a platform is a group of technologies that are together used as a base upon which software applications and products can be built. Developing a software requires various resources, which are provided to the developer via the platform.

Think about a platform in a train station. At any point in time, various different trains may arrive at the same platform. The platform provides the infrastructure for the train to arrive there and for passengers to board the train - thus acting as an intermediary between the train and the passengers. Similarly, a software platform provides resources and acts as an intermediary between a user and an

application. Several different software products and applications can be developed upon a single platform.

An example of a platform is Microsoft Azure. Azure is a cloud platform that allows software developers to remotely gain access to computing resources - such as storage, CPU processing power, and servers - on a pay-per-use model. A software developer can utilize this platform to develop a variety of different applications or solutions.

L&T's Homegrown UBIQWeise Platform

Throughout my internship with Larsen & Toubro, I had the chance to speak personally with Mr. Anurag Wats – product manager for UBIQWeise, a cloud-based IoT platform used and developed internally by LTTS. UBIQWeise

For the past several years, UBIQWeise has served as the platform on which various innovative solutions have been developed. As an intern, I was given exclusive rights to several documentation, presentations, and human resources that allowed me to understand some of the important solutions that have been powered by the UBIQWeise platform.

Why UBIQWeise? The benefits of using UBIQWeise is numerous – and I shall cover some of these advantages that I learned after speaking with UBIQWeise's product manager – Mr. Wats.

- **Cloud Agnostic:** Deployable on any public or private cloud

- Connect devices **without any device agent**
- **Scalable & Modular:** Add devices, protocols, or new cloud platforms
- Easily customizable & light weight

Other Innovative Solutions Developed at Larsen & Toubro

As a large multinational corporation, LTTS is involved with a variety of innovative solutions that have acted as a catalyst and spurred other innovations in the technology services industry. During my internship, I had the privilege of speaking to product managers and reading documentation that allowed me to learn more about some of these innovative solutions.

One such solution that immediately caught my attention was RAPM – Remote Asset Performance Management. RAPM is a software application designed to manage & track fixed and mobile assets. In order to learn more about this technology, I had a brief conversation with Mr. Ashok Kumar – an industry-leading engineering manager at LTTS with decades of experience designing and developing various products.

“Larsen & Toubro has a construction business”, he said, “ and most of the vehicles and capital – such as cranes, tractors, and other heavy vehicles – are leased from third parties. We pay those third parties to use their vehicles for our construction sites across the country” - he explained.

With Mr. Kumar's explanation, it became clear why a solution like RAPM would be necessary for LTTS. As a student from a technical background, however, I wanted to learn more about how the internal structure works – and the high-level design of the solution.

"You see, we have gateways that sends GPS locations along with a set of crucial data info to the cloud. Most of this information is already available from the car – via its built-in sensors. Things like fuel level are already easily available. But for some other information, we added our sensors", clarified Mr. Kumar.

RAPM is a solution that in reality offers various benefits – primarily avoiding theft, improving asset availability, increasing productivity, improving operational efficiency, and offering predictive maintenance for the assets. It is quite crucial in optimizing productivity for Larsen & Toubro's construction business - one of the largest in the world.

Conclusion

RAPM, MCare, and many other similar solutions are just a fraction of the wealth of innovative projects that LTTS has worked on. As a major industry-leading firm with a revenue of over USD 700 million and a workforce of over 15,000, LTTS has developed innovative engineering and technology solutions that has drastically affected thousands of people and has shown the extent to which technology can impact human life for a better tomorrow.

As an intern, I had the absolute privilege of interacting with various product managers, engineers, and software developers in order to learn about such projects at LTTS. With the completion of this short internship, I have now gained a better understanding of various emerging technologies, and

I plan to use this knowledge soon as I graduate with my Computer Science degree, and enter the workforce.