

**Synthesis:**

The continuous merging of technology and products are producing radical changes in the way businesses work. These products need an entirely new infrastructure or so called "Technology stack", this new infrastructure needed for the implementation of smart and connected products imply changing and even creating new core business functions as well as changing the organizational structure. Smart and connected products have capabilities that enable businesses and managers to understand fundamentally the process and derive accurate judgement from the data collected from them. The benefits from using this infrastructure are that products are now able to monitor themselves and report on their own condition, the products are also remote controlled meaning they are accessible remotely through numerous remote access options, and they can be better optimized, which naturally spans from being able to monitor and control the product, this results in a better and better product since there is always information pertinent to how the product is performing and thus there is also room for continuous improvement. From this you can derive an array of benefits such as preventing problems before they occur.

These products' new capabilities affect every activity in the value chain, from IT to finance, fundamentally this change is being driven by data, the most valuable contemporary resource for a firm to have, never before has it ever been more accurate and easy to acquire data. Smart connected products allow us to get data basically in real time and this boosts firms' competitiveness. Also, the easy collection and analysis of data allows firms to make better products and get better feedback, thus driving innovation and allowing the possibility of preventing defects. Such availability for data also allows firms' to predict and diagnose events many months, weeks, or days before they happen.

Another very important aspect of firms making smart and connected products is the necessity of rethinking all of the design. It is now cheap and feasible for customers to personalize their product via software menus and other such tools without having to rely on hardware modifications. It is also possible to update and maintain the product remotely via software updates or other such features; in addition there are such things as augmented reality being incorporated to the product that make the product controllable from a distance, which is to say allow for remote control.

Testing smart and connected products is also very accurate, since firms are able to see exactly what and in which conditions ultimately the defect was produced, thus firms are able to correct it as fast as possible. Smart and connected products also allow for less physical components to be needed and used and more personalized software to be employed in the product. Smart and connected products also are easily traceable and thus allows for a practical and conflict free logistical process, but there are even more perks that stem from the usage of smart connected products, aside from the product being traceable for logistical purposes, you can also access location history, temperatures in several locations, exposure to stress and other such variables, this allows in some respect as a form of quality assurance as well as making logistical operations easier.

As the world shifts from wanting products to wanting services, firms adapt their business models to adjust to that shift in preferences. Now the customer demands firms to provide a

continual value stream, the product becomes merely a medium in which the company delivers that value as a service, the product is no longer an end in itself.

But there is a dark side when using and implementing smart and connected products, there is a very big security risk, smart connected products don't have as much processing power to be equipped with typical anti-malware software, thus the chances these products end up in the control of hackers and other criminals is a big one. Since these products span from a simple heart monitor all the way up to aircrafts and cars, hackers conducting malicious deeds can do very real and grave damage if they get control to such devices. Some have implemented so called 'layered' authentication and timed usage sessions built into the product, or giving the user control of when to upload data to the cloud, also regulating what the cloud service can and cannot have stored in its data base, but this is not as robust as to say it's safe.

Manufacturing smart and connected products implies that a firm must change virtually all functions, some functions will be created, and this means there will be a demand for technical and high skilled labor. The firms have to shift from mechanical engineering to software engineering and from selling products to selling services, new positions will open, and new departments will have to work conjointly with each other to achieve the challenge of getting things done. Making this shift means modifying the organizational structure, policies and norms and also means offering new employees better remuneration and perks such as free time and flexibility, this is by all means a process of great complexity.

Another challenge is the fact that the new functions will have to coordinate with the old, this continued coexistence of the new and the old will complicate organizational structures and make them difficult to understand and work with, ultimately this is not a linear process, virtually every traditional function will also need to be restructured, given the dramatic realignment of tasks and roles taking place in the firm.

Naturally, all the software maintenance and execution require a specialized department dedicated just for that, this is called DevOps, it stands for Development Operations and it is a collaborative, cross functional software development and deployment method. The DevOps department is in charge of managing and optimizing the ongoing performance of connected products after they have left the factory.

#### **Problem pertaining to DevOps:**

The problem is basically that the changing market is now demanding products that are smart and connected, this implicitly implies that firms change virtually every aspect of their organizational structure to accommodate the new needs as they pertain to smart and connected products. As the market demands these products firms must change from delivering a product that was considered an end in itself to delivering a service. This implies a shift from mechanical engineering to software engineering and from selling products to selling services, ultimately this end in creating a demand in part of the firm for software maintenance and software development. This proximately ends up in the firm needing a DevOps department. So, the problem in essence is the fact that in order for companies to deliver a service that continually adds value to the user the firm needs an agile and effective team to create and maintain software.

#### **Solution pertaining to the DevOps Method:**

In this respect, the DevOps method organizes, maintains, and ensures continuous improvement of the software in need; the DevOps methodology uses two core methodologies, first there is the Scrum methodology and then there is the CI/CD. Scrum allows the DevOps team to have a consistent and constant delivery of results.

**Scrum:** The DevOps team using the Scrum methodology or framework to fulfill *User Stories* defined by the product owner and supervised by the scrum master, the team is constantly committing to the fulfillment of user stories and due to the nature of Scrum impediments and problems are spotted early on in the process thus this ensuring the most effective development operation. The main reasons to preferring Scrum is basically because it is a very light weight methodology to implement and it works well with teams.

It adapts to the changing priorities because the Product Backlog is able to change and adapt as time progresses. The product backlog contains all the details and prerequisites of the project, it contains what a project will be, it also contains a detailed list of features that more accurately describe the final product as it pertains and adapts to the final users' needs and wants.

It allows for a better and more global perspective and visibility of the project since the Product Backlog serves as a kind of 'outline' for the entire project. The team can explore what are the project's priorities and whether something is more important than another.

It also allows faster time to market compared to other methodologies and thus is the most effective at obtaining feedback. In a business setting feedback is one of the most important things a firm can have, feedback drives innovation and allows for the refining of user stories so that the better fit the necessity of the final user. In this respect Scrum serves a very vital purpose and this is why it is widely used in the DevOps Method.

**Continuous Integration and Continuous deployment (CI/CD):** Continuous Integration and Continuous deployment (CI/CD) on the other hand seeks to deliver with frequency, via automatization of the development phases, updates and maintenance to the user's programs, in the context presented above, CI/CD would be present in all the updates made to the smart and connected products and in all the bug and defects fixes done by the DevOps team.

As a form of back up for the scrum methodology CI/CD consists of continuously submitting work for revision and feedback so that the team can improve it, this creates a cycle of continuous submission of work, revision of work, feedback of work and improvement of work.

As you can see implicitly, we inherit core principles from scrum, lean and kaizen all beautifully merged into CI/CD. As you can see DevOps becomes a very effective methodology which is widely employed to solve the problems of software maintenance and creation in firms.