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Towards DevOps: Practices and Patterns from the Portuguese Startup Scene

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Abstract

The Internet is a constantly evolving space with millions of users and untapped opportunities.

In order for businesses and companies to successfully conduct their operations in the Internet, new organizational patterns and procedures have appeared and evolved. This processes and organization patterns aim to answer the difficulties of handling the volatility and the complexity of this space.

Eventually culminating in the DevOps movement, this changes have been gaining adopters in the industry and showing promising results.

Contrary to what would be expected, based on some of the results and the number of adopters, this new movement has not yet seen substantial investigation or formalization.

This lack of information is often responsible for the failure of new adopters that are forced, along the way, to learn how to overcome the different obstacles and challenges associated with the adoption of DevOps.

To reduce both the chances of failure and time of adoption it is important to empower businesses with enough information about this subject as possible.

By studying the Portuguese Startup Scene and extracting valuable information about solutions and challenges identified while adopting DevOps this thesis intends to do just that.

This gathered information is expected to be compiled in a organized and structured way in order to allow businesses to have a better understanding of both the DevOps movement and the adoption process.

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Abbreviations

ADT	Abstract Data Type
NIST	National Institute of Standards and Technology
SaaS	Software as a Service
PaaS	Platform as a Service
IaaS	Infrastructure as a Service
IoT	Internet of Things

Chapter 1

Introduction

1.1 Context

As the Internet grew and more people joined, an ever increasing number of businesses and opportunities started to emerge.

Initially, businesses that wanted to provide services over the Internet would need to buy servers, hire operations crews and buy real estate to accommodate the previous two. Additionally, businesses were also subjected to large usage fluctuations. This meant that a lot of the time, servers and teams were not being used in an optimal way.

Large upfront costs combined with large maintenance costs and unused resources were obviously not desirable and eventually solutions to this problems started to appear. Eventually named ”cloud computing”, the solution consisted in a new type of business that allowed other businesses to rent computing resources with little to no upfront costs. Cloud computing providers would charge businesses based on the usage as well as allow them to quickly increase or decrease computing resources. This elasticity combined with the elimination of the previously mentioned upfront costs meant that more businesses could be born and that the existing ones could lower their operational costs.

In the midst of this change a new set of opportunities and problems started to arise. This ideas and problems eventually started the denominated DevOps movement. This movement called for the end of organizational boundaries between operations and development departments, integration of the previous two and the automation of repetitive tasks. This way DevOps aimed to reduce software time to market, teams sizes and also increase businesses agility and efficiency.

1.2 Problem

The DevOps movement spans throughout a vast set of areas. This means that successfully understanding DevOps is not easy and can often seem like a never ending task requiring an informed and multidisciplinary approach.

Regarding the current state of the literature on DevOps there is not a lot of investigation done on the subject 2.3.2.

Companies that want do adopt DevOps are, as a result, required to learn the challenges and solutions of adopting DevOps while adopting it. Obviously this is far from being ideal and consequently companies may fail to adopt DevOps or practice it in an efficient way.

1.3 Motivation & Objectives

This work aims to provide companies and teams that want to adopt DevOps with knowledge relative to DevOps and the adoption process. This information should be easy to access and understand and, it should allow companies to have a feeling of the effort needed to adopt DevOps as well as allow them to define a preliminary road map for the adoption.

Lastly with the information provided, companies must be able to solve most of the problems that will appear when adopting DevOps.

1.4 Expected Contributions

Contributions of this work will be:

- A comprehensive description of the current state of the art regarding the DevOps movement.
- Identification of good practices concerning the DevOps adoption.
- Elicitation of common obstacles faced when adopting DevOps.
- Validation of the former two items in a real world scenario.

1.5 Outline

This report was made as preparation for the dissertation.

In it there is a Introduction 1, followed by the state of the art 2 regarding the reach and size of the Internet 2.1, cloud computing 2.2 and DevOps 2.3. Section 3 defines both the problem 3.1, the solution 3.3, and the methodology 3.2. Then, the method for validating the obtained results is described in 4.

Lastly, the Conclusion is presented and the planning for the future work is presented 5.

Chapter 2

State of The Art

2.1 The Internet

The Internet has existed since the 1970s yet, the vast majority of the current users only became familiar with it after 2005 [Guangming(2011)]. Since then, the number of users of the Internet has been increasing and there are currently 3.2 billion people with Internet access representing 43% of the total world population [SANOU(2015)].

Economically, the size of the Internet is not less impressive.In 2010, in Europe, e-commerce represented around 3.5% of all retail. Additionally, in the same study, around 40% of individuals admitted to have made an online purchase the year before [European Commission(2012)].

In addition to this numbers, new developments in areas like IoT [1] where devices will be able to interact with other devices through the Internet [Suresh et al.(2014)Suresh, Daniel, Parthasarathy e Aswathy] indicate that the already huge size and span of the Internet will only increase in the next years.

2.2 Cloud Computing

If we had to pinpoint the start of the rise of popularity of the term "Cloud" we would probably refer to 2006 when Eric Schmidt, Google's CEO, used it to refer to the business model of providing services across the Internet[Zhang et al.(2010)Zhang, Cheng e Boutaba]. Since then the term was used in different contexts and with different meanings which lead to the lack of a agreed upon definition [Zhang et al.(2010)Zhang, Cheng e Boutaba].

2.2.1 Definition

Several definitions exist that try to capture the concept of cloud computing, in "A break in the cloud" [Vaquero et al.(2008)Vaquero, Rodero-Merino, Caceres e Lindner], for instance, 22 different definitions of cloud are analyzed in an attempt to create a standard definition of "cloud".

[1] Internet of Things

Nevertheless throughout this thesis we will use only one definition, namely, the one provided by NIST [2]. NIST defines cloud computing as:

“Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources... that can be rapidly provisioned and released with minimal management effort or service provider interaction.”.

NIST, in the same article, also defines the essential characteristics of cloud computing to be:

- On-Demmand self-service - Cloud providers must allow their users to, without requiring human interaction, provision computing resources.

- Broad network access - Users must be allowed to access resources through standard mechanism.

- Resource pooling - A multi-tenant model should be used in order to serve multiple users. Resources are allocated dynamically meaning that users do not know were, physically, the allocated resources are [Garrison et al.(2012)Garrison, Kim e Wakefield].

- Rapid elasticity - Resources can be elastically allocated or deallocate. This should be possible to be done automatically [Garrison et al.(2012)Garrison, Kim e Wakefield, Mell e Grance(2011)].

- Measured service - The usage of resources should be measured providing transparency in the provider-client relation.

2.2.2 Delivery methods

In regards to their accessibility,it’s common to identify three or four main categories of clouds [Zhang et al.(2010)Zhang, Cheng e Boutaba, Garrison et al.(2012)Garrison, Kim e Wakefield, Garrison et al.(2012)Garri Khajeh-Hosseini et al.(2012)Khajeh-Hosseini, Greenwood, Smith e Sommerville] :

- Public Clouds - Public clouds are a pool of resources hosted by cloud providers who rent them to the general public. This resources can be accessed over the Internet and are shared among users.

- Private Clouds - Private clouds are usually administered and used by the same organization. Alternatively a third party can also be hired to manage the resources. The main difference between public and private clouds is the usage of the resources. Private clouds resources are only used by one company as opposed to public clouds were resources are shared.

- Hybrid Clouds - Hybrid clouds combine both the private and public concepts. When using an hybrid clouds approach, infrastructure is divided by the two types of clouds meaning that some modules may be hosted in the private space and others on the public one.

[2] National Institute of Standards and Technology of the U.S Department of Commerce

- Virtual Private Cloud - Virtual private clouds are an alternative to private clouds. This type of cloud are essentially a public cloud that *leverages virtual private network (VPN) technology.*.[Zhang et al.(2010)Zhang, Cheng e Boutaba] allowing users to combine characteristics of both public clouds and private clouds.

  Some authors choose not to mention VPCs [Garrison et al.(2012)Garrison, Kim e Wakefield, Garrison et al.(2012)Garrison, Kim e Wakefield, Khajeh-Hosseini et al.(2012)Khajeh-Hosseini, Greenwood while others do [Zhang et al.(2010)Zhang, Cheng e Boutaba]. The reason why some do not mention it is mainly due to the fact that VPCs can be seen as a platform over a public cloud.

2.2.3 Service Levels

In terms of service levels cloud computing can be classified in regards to the provided abstraction. The main categories are the following [Garrison et al.(2012)Garrison, Kim e Wakefield, Zhang et al.(2010)Zhang, Mell e Grance(2011), Sampaio(2011), Vaquero et al.(2008)Vaquero, Rodero-Merino, Caceres e Lindner] :

- SaaS - Software as a Service (SaaS) gives users access to a platform usually through a web client. Without the need to download or install software the user is able to use the provided software instantly and virtually everywhere.

  Applications of this model include messaging software, email services, collaborative platforms, etc.

- PaaS - Platform as a Service (PaaS) allows it's users to quickly deploy applications with little to no configuration. In this type of platform environments are usually pre-setup or configurable. PaaS users should nevertheless expect only to be able to deploy applications or software supported by the provider.

- IaaS - Infrastructure as a Service (IaaS) represents the lowest abstraction made available by cloud providers. In this model the user is able to configure and access a machine directly without constraints. This machine, usually a virtual server managed by the provider, can be configured and maintained by the user.

  This model is used when applications are complex and therefore need complex configurations.

2.2.4 Benefits

The main advantages of cloud computing for it's users can be summarized as following:

- Monetary Efficiency - Cloud providers allow users to keep their resources to the needed minimum. By allowing users to quickly and easily increase/decrease the allocated resources amount and billing clients only for the resources used, cloud providers are good way to save money and spend only the needed amount [Garrison et al.(2012)Garrison, Kim e Wakefield, Mell e Grance(2011)].

- Scalability - usually through a public API of some kind most cloud providers allow for the quick increase or reduction of resources [Mell e Grance(2011)]. This enables businesses to quickly go from zero to millions of users with minimum overhead. Additionally because processes related with the management and configuration of cloud servers can be automated it is usually possible to manage large systems with small teams [Loukides(2012)].

- Maintainability - Cloud Providers are responsible for the maintenance of all the hardware and infrastructure aspects. Cloud computing users therefore do not need to worry about updating the hardware or maintaining the physical infrastructure. This enables users to focus their resources in improving their product rather than improving the structure that supports it [Garrison et al.(2012)Garrison, Kim e Wakefield].

2.2.5 Challenges

The main challenges related with cloud computing are related with security aspects [Zhang et al.(2010)Zhang, Cheng e Bo
Given the remote accessibility nature of cloud computing resources, there is always fear that unwanted entities/parties may gain access to both the resources and the information that they hold. Some solutions to this problem include virtual private clouds or private clouds.

2.3 DevOps

In “What is DevOps” [Loukides(2012)], Mike Loukides recalls a time when operations and development weren’t separated and the same person that developed would also operate the equipment.

In the time between then and the present a great deal of things changed. Personal computers appeared, the internet grew to become a global network and two separate roles emerged in the software development life cycle: Developers and Operations. Developers, would rise as the creators of the software and operations, as the maintainers and managers of both the software and the infrastructure that supported it after it was developed.

As maintainers of the software and infrastructure, operations would have ,as their goal, keeping both hardware and software working. This meant deploying new instances of software every time usage increased, adding or fixing servers and, when needed, upgrading the software and infrastructure. Manually done, in the beginning, and eventually automated with the help of scripts, this tasks would prove to be too hard and complex to be done efficiently and reliably.

New solutions to handle this problem had to be found and taking advantage of cloud computing and virtualized servers a shift from hardware owned resources to hosted resources begun.

In the cloud, resources are virtualized and operations are no longer responsible for maintaining the hardware. Tools that allowed the configuration of virtualized resources in the form of code would soon appeared.

It became clear, as a result of the advances of cloud, that, the traditional role of operations no longer applied. As there was no hardware to manage and infrastructure could now be managed by code, the operational role had lost most of it’s significance. The responsibilities that remain were, therefore, integrated in the development team. This team would now work closely with ex-operations to ensure the reliability of the produced software.

2.3.1 Benefits

In [Elliot(2015)], a number of claims is made in regards to the possible benefits of adopting DevOps. These benefits are:

- DevOps projects are believed to accelerate in 15%-20% the ability to delivery of capabilities to the client
- Adopting DevOps allows business to practice Continuous Delivery

2.3.2 Challenges

DevOps is powerful in the sense that it allows companies to better react to different kind of scenarios and environments. Nevertheless the adoption of DevOps is not easy and a lot of companies struggle to achieve it.

Making the matters worst study or information relative to DevOps is scarce [Saugatuck Technology(2014)] and, the existent information, is usually spread throughout several sources.

Recently, in a survey made by [Saugatuck Technology(2014)] where around 300 development and IT companies were surveyed, it was asked what were the main issues identified when adopting DevOps. Some of the highlighted aspects emphasized were:

- Overcoming cultural habits inside the organization.
- Lack of experience or understanding of DevOps practices.
- Lack of buy-in from leadership.

In another study, [Debois(2008)] where three attempts to implement ideas similar to the ones defended by DevOps the same aspects related to cultural aspects as well as the lack of information are mentioned.

Both studies emphasize that adopting DevOps is far from being easy and that more work must be made in order to allow future DevOps adopters to fully understand the consequences,problems and solutions associated with DevOps.

2.4 The Portuguese startup scene

Motivated by a recent investment in innovation and entrepreneurship, Portugal startups have been growing their position in the global startup scene [Coleman(2015)].

A study from 2015 [Startup Europe Partnership(2015)] in which the Portuguese startup scene was analyzed, revealed that there were already 40 technology scaleups [3] operating in Portugal at

[3] Scaleups are companies that raised more than $1M funding (since foundation) and had at least one funding event in the last five-year period

the time. The same study stated that this startups were able to raise a large portion of the received investment from international investors indicating, therefore, that the reach and scale of this startups was broader than just the national arena. Additionally, it is also indicated in the study that Porto and Lisbon are the main centers of innovation, encompassing 70% of the total of existing scaleups. In addition to the scaleups identified other smaller scale startups exist. Some of this startups are currently being incubated in incubators around the country. UPTEC [4] and Startup Lisboa, both business incubators, have currently more than 300 companies [Uptec(), Startup Lisboa()] under their wing.

[4] Science and Technology Park of University of Porto

Chapter 3

Towards DevOps

3.1 Problem

Current investigation on DevOps and the associated processes is manifestly insufficient. This fact, exposed in 2.3.2 often makes it difficult for companies to understand a priori what adopting DevOps really takes and means. Frequently resulting in the complete failure or wrong application of DevOps practices and principles this problem is can be responsible for the ultimate demise of some of this companies.

In order to approach this problem, an attempt will be made, in this work, to answer the following questions:

- What is DevOps ?
- Where to start when adopting DevOps?
- What are the common problems faced when practicing/adopting DevOps?
- How can we solve the problems related with DevOps adoption and practice?

3.2 Methodology

Both the companies and the individuals that have been involved in the adoption of DevOps are the best sources regarding the subject. Even though most of the knowledge they hold is not formalized, it represents a tested set of solutions to identified problems.

In order to collect this knowledge individuals and companies must be given a way to share their experiences and knowledge.

This collection of data will initially be made through online surveys. These will serve the purpose of selecting companies in which to focus.

When chosen, provided that they authorize it, companies will be asked to in a detailed way :

- Why did they felt that adopting DevOps was necessary.

- What initial concerns did they have when adopting DevOps.
- What were the obstacles that they have to overcome and how they they overcome them.
- What technologies do they use.

The gathered data from all companies will then be analyzed, compiled and formalized in the form of patterns.

3.3 Solution Perspective

Collecting data from different companies will provide us with useful information on how to successfully adopt DevOps and what are the common pitfalls and traps, however, if not treated, this information can feel clumsy and disconnected. That is why, in addition to the collected data, common problems and solutions will be represented as patterns.

3.3.1 Why patterns?

In the software development world there are several examples of different domains that were studied and where patterns were identified. Architecture, software development and Scrum are just some examples of that.

Patterns are by definition recurring and, in that sense, identifying them means identifying situations that will frequently happen. This allows us to prevent common pitfalls and be prepared with solutions in case we can not prevent them.

When identified, patterns allow us to have a common language while referring to domains of knowledge. Instead of having to constantly describe a situation or solution one can simply refer the pattern and, provided that there is a common knowledge of the pattern, communication can be greatly simplified.

Additionally patterns are also useful when reasoning about a subject. They allow us to abstract away the complexity of a situation and better visualize the overall solution as a set of pattern instead of an agglomerate of situations.

Lastly, although they are tied to a context, patterns are within that context generic, meaning that they are not tied to a specific moment in time or space. This makes them even more useful as they can be reused.

3.3.2 Granularity

In it's lowest level, granularity for the solutions presented could go as far as to specify what tools to use and how to configure and set them up. This would nonetheless be counterproductive as different companies have different requirements and different requirements require different tools. Consequently, the final solution will try to be tool agnostic and only present the situation and the types of solutions available with the hope to help the broader audience it can reach.

3.3.3 Domains

As DevOps spreads throughout different areas of knowledge both the cultural and technological aspects need to be considered.

In the cultural side, information about aspects like how to redistribute operations teams or how to improve communication between peers will ,as well as other problems, be gathered and discussed. This will hopefully allow companies and their members to better accept the adoption of DevOps.

In the technological side, ways to improve the infrastructure elasticity among others will also be addressed.

Chapter 4

Validation

Validating the collected data and the subsequently identified patterns cannot be made in a formal way.

The only course of action available is therefore to measure the effects that applying the gathered information has in a real world situation. In order to do so, measurements must be made before and after the application.

4.1 Ventureoak

VentureOak is a startup currently operating at UPTEC, Porto that started its activity in 2014.

Having more than 20 employees, Ventureoak focus is on developing software products for other companies and in offering consultancy solutions both in the product idealization and developing phases.

At Ventureoak projects have usually a short duration - 3 to 6 months - and they usually target the web market.

Several projects are developed concurrently at Ventureoak by teams of 2 to 6 elements. This teams are self organizing and are usually made up of only developers.

Operations at Ventureoak are done by one of the employees. This member of the company accumulates most of the operations responsibilities and these are usually done manually.

4.2 Methodology

During the month of May, in order to validate the gathered information, one of the projects that will being developed at that time will be chosen. In this project an attempt to partial or fully automate the work flow will me made.

During this attempt a set of indicators will be extracted periodically - once each week. This indicators will be of two types:

- Objective Indicators - Indicators in this category are for instance the deployment frequency or time and will be gathered by direct observation.

- Subjective Indicators - Subjective indicators will be gathered by asking - in the form of questionnaires - teams members and management what is their impression about the current changes. They will also be asked to quantify how much better/worse they think they are in a different set of indicators.

At the end of each week, questionnaires will be made and based on them a plan of action will be written that will aim to solve possible dissatisfactions felt by both team and management and improve direct measurement indicators.

Additionally teams will be allowed to give suggestions about what they think should change or in what direction to go. These opinions will also be considered when creating the action plan.

4.3 Indicators & Acceptance Criteria

Having a wide area of application and focusing its attention in several areas and domains, measuring the success of adopting DevOps can be difficult. In this work the evaluation of the success factor will be divided into two main categories having each a set of criteria for acceptance:

- Objective indicators
  - Deployment Frequency - Deploying an application is the process by which software can be made available to the customer. By increasing the deployment frequency teams can more frequently transmit value to the customer.
  - Deployment Time - Deployment time is of great importance as it enables companies to quickly respond to change.
  - Set Up Time - Being able to quickly set up new environments is crucial in order for teams to bring new developers in quickly and effectively.
  - Infrastructure Elasticity - Being able to quickly and in an automated way increase or decrease the infrastructure size can mean the difference between success and failure.
- Subjective indicators
  - Team cohesion & communication - Teams should be able to communicate and feel as if they are one. This enables them to better react to change.
  - Team satisfaction - Team satisfaction is essential as it promotes more motivated professionals and better results.
  - Managerial satisfaction - The satisfaction of the managerial team is of great importance as it usually reflects the current state of the business.

For the previous indicators the following acceptance and rejection criteria will be used:

Table 4.1: Objective Indicators

Indicator	Acceptance	Rejection
Deployment Frequency	Increase	Decrease
Set Up Time	Decrease	Increase
Deployment Time	Decrease	Increase
Infrastructure Elasticity	Increase	Decrease

Table 4.2: Subjective Indicators

Indicator	Acceptance	Rejection
Team satisfaction	Increase	Decrease
Team cohesion & communication	Increase	Decrease
Managerial Satisfaction	Increase	Decrease

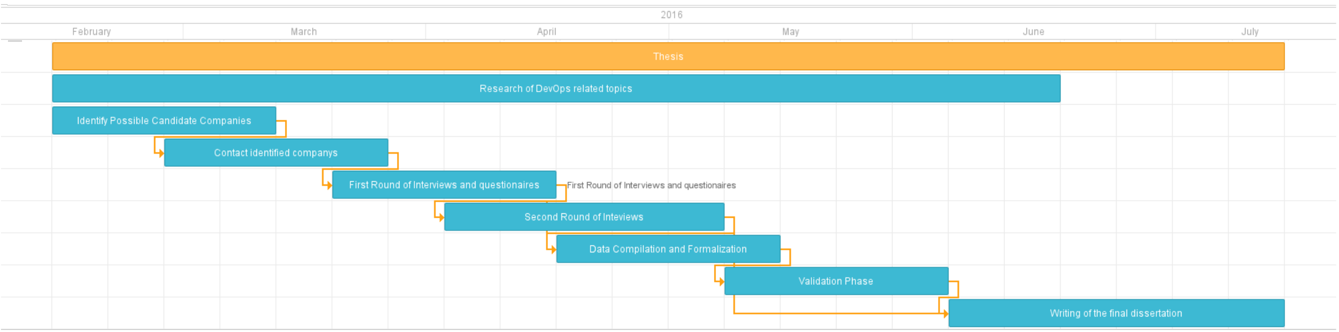
Chapter 5

Conclusion

As a result of the vastness of areas that the DevOps movement touches, there is a feeling that more research work has to be done in regards to understanding technologies and practices related to DevOps before advancing to the next phase.

Nevertheless the current work allows us to be confident in a good final result. Additionally the lack of information regarding the current state of DevOps and its practices is a good motivator in the sense that studying DevOps seems to be both useful and innovative.

Figure 5.1: Thesis Planning



Conclusion

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