

Assignment 1 - Network Programmability (ACCA5029)

by Jaromir Pauer

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Report

Network Programmability

(ACCA5029)

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1. Introduction.

Previously, computer networks largely comprised of hardware and software that were installed on-premises. Businesses usually purchased the hardware and either licensed or purchased the software. Under this model in-house staff exercised a great deal of control over the operation of the networks. Over the past twenty years these traditional networks have experienced great difficulty coping with the exponential growth in internet traffic [1]. This report explores how computer networks have moved towards a greater reliance on software, with a particular focus on cloud computing. It also addresses the cloud's impact on the industry and how technical developments, including the adaption of software defined networking, have affected the role of professionals. Finally, consideration is given to how RESTFUL and JSON, including their interoperability features, have facilitated change.

2. Virtualisation

Virtualisation is a process that uses software to create abstractions over physical hardware [2]. The process of virtualisation has produced many computing advantages, including the creation of networks with increased agility, flexibility, speed and economy [2] and [3]. Virtual machine software has been particularly useful, for example, by making it possible for companies to operate more than one operating system on each server [4]. Software manages the flow between virtual machines so enabling engineers to manage changes to the network without having to reconfigure hardware [5]. As soon as it is possible to connect virtual machines it is practicable to utilise Network Functions Virtualisation, for example, to decouple network functions such as firewalls and encryption from hardware and then move them to virtual servers [6]. The great advantage of software defined networking is that it separates the control and forwarding functions and so provides a centralised view of the entire network so facilitating its management centrally [7]. SDN very usefully connects networks to applications by means of application programming interfaces, which strengthen performance [2]. SDN can also be used to facilitate the management of physical and virtual switches and other network equipment from a centralised controller [7]. In short, virtualisation makes it possible for professionals to rapidly manage large data flows and so avoid the need for companies to invest in additional hardware. In addition to lowering costs, centralised management makes it easier to control and monitor the security of a network [2]. The continuing innovative qualities of SDN should not be overlooked as they will play a critical role in delivering the greater flexibility and programmability of the upcoming 5G network models [8]. It is noteworthy that the advantages of virtualisation are being deployed by users operating very different infrastructures, such as LANs, WANs, or Cloud networks [9] and [10].

3. Defining the cloud.

A good definition of cloud computing is provided by the National Institute of Standards and Technology : “ It is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be readily provisioned and released with minimal management effort or service provider interaction” [11]. Essentially, the cloud has 4 deployment models: private, public, community and hybrid clouds. Aligned to the deployment models are 3 principal service models known as Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS),and Software-as-a-Service. All these models make extensive use of visualisation software [12].

4. Statistical impact of cloud on industry.

The greatest impact of virtualisation has been in the cloud, indeed it has been described as the backbone of the cloud industry [13]. This statement is supported by two sets of statistics. Firstly, it was estimated that by the end of 2020, 67% of infrastructural software, covering operational matters such as firewalls, API gateways and emails, would be based in the cloud [14]. Secondly. it has been calculated that 83% of enterprise software workloads, encompassing business orientated tools, are now cloud based [15] and [16] . It is not surprising therefore that the cloud vendors now offers a wide range of services to meet customer requirements.

5. Practical examples of the impact of the cloud on industry.

5.1 Businesses are attracted by the SaaS model because it saves them having to purchase or licence specific pieces of software and then install, update and upgrade them on countless pieces of hardware equipment [14]. Thanks to the economies of scale, another benefit of SaaS, as compared with software installed on a customer's hardware, is that it is likely to include a good range of customisable features at competitive prices. The downside is that multi tenant models place a limit on the number of customisable options, although it seems that most customers mostly focus on 20% of the available features [17]. Other SaaS packages that business customers purchase include state of the art statistical analysis software, which help shape business strategy by providing customer profiles, including their buying habits and interest in specific products [18] and [19]. Another advantage of cloud software is that IT functions can be controlled centrally. Increasingly, employees working away from the office need access to their company's database, particularly to stored confidential data. Cloud software provides such connectivity via a virtual environment [20]. The combination of cloud infrastructure and software features ensures that these mobile communications can be conducted securely and that any increased workload can be easily scaled [20]. A cloud Enterprise Mobility Management scheme is one way of ensuring that devices owned by employees or by the company are accessed only by authorised personnel. EMM software is also a means of minimising administrative burdens by centrally monitoring whether staff are adhering to a company's BYOD policy. EMM schemes can also be used to update, upgrade and patch these devices [21] and [22].

5.2 Businesses wishing to develop custom built or specialised software applications have increasingly made use of PaaS packages. The great advantage of PaaS is that developers can easily collaborate on a project, even if they are located in different parts of the world [23]. Other advantages of this software service include scaling, access to a wide range of development tools designed to reduce coding tasks, and the availability of expert assistance from the PaaS vendor's development team [24] and [25]. The downside of PaaS is that the performance levels are sometimes affected by the specifications, speed and reliability of the vendor's software and equipment [24].

6. Case studies of the impact of the cloud.

6.1 It is necessary to examine a few case studies to appreciate how the cloud has impacted the industry. Some companies with excellent growth potential had infrastructures that were not fit for purpose. An excellent example of this is Lyft, a highly successful international taxi hailing company, who hired AWS to run a network for them. The AWS package purchased by the Lyft includes IaaS, PaaS, and SaaS specifications, and software, such as Auto Scaling, Amazon Redshift, Amazon Kinesis, and Amazon DynamoDB [26]. Lyft were attracted by the AWS software, but the decision to hire AWS was also influenced by the reality that Lyft did not have the in-house expertise to build a network quickly and by the fact that the cost of engaging AWS only amounted to 5% of Lyft's income [27]. Netflix is another company that chose AWS for its networking expertise and innovative software [28] and [29]. Essentially, AWS takes care of backroom functions, such as computing and storage needs, analytics and video transcoding [28] and [29]. However, Netflix, which has experience of distribution, decided to retain certain network responsibilities by using its own Open Connect service to distribute video content to customers [30]. In sharp contrast to Lyft and Netflix, Uber, a much bigger taxi hailing business, largely relies on its own collocated data centres to service its business, although it does outsource some work to the cloud, for example, the handling of spikes in demand [31] and [27]. The size of Uber and the existence of an expert in-house IT team have enabled the company to build its own network, although it purchases much of its software from others, for example, the Core Location Framework, Google locate APIs, and Mapkit. Uber's strategy was based on the understanding that its predominantly in-house approach is the most cost effective option for them [27]. These case studies illustrate that the structure of the industry is being significantly determined by the hardware, innovative software of the cloud, but it is also being shaped by other factors such as in-house expertise, the resources of a company, and by the comparative cost effectiveness of the various network options available to companies.

6.2 The cloud's impact on the industry is also being influenced by concerns about the difficulty of securing confidential data on the cloud, for example, the risks created by multiple clients sharing servers. In such circumstances, a cyber criminal's unlawful access to one client's data, may jeopardise the data of others on the network [32]. In some circumstances cloud security concerns can, of course, be mitigated by adopting a private cloud model, but this is not an option for a company providing services to the public [33] and [34]. The Financial Conduct Authority's guidance to financial institutions has stopped short of fully endorsing the public cloud, for it merely points out its advantages and risks. The FCA draws attention to the Data Protection Act 2018 and the General Data Protection Regulation, 2018, which state that institutions cannot delegate their responsibilities for data security [35]. As such, the financial institutions operate hybrid networks, for example, HSBC makes use of the public cloud for non sensitive banking functions, but in-house mainframes continue to account for most of the banks processing [36]. A hybrid approach is considered the safest means of securing confidential data and of delivering uninterrupted services. Indeed, the institutions referred to in this report are mostly relying on hybrid models. The implication of this is that many businesses are continuing to rely on their own hardware and software, at least in part. Consequently, the employment of professionals continues to be spread across multiple businesses and is therefore not confined to cloud vendors.

7. How job roles of professionals have evolved to meet the challenges of the cloud.

7.1 Unsurprisingly, the job descriptions of network professionals evolve so that they have the requisite skills to operate existing infrastructures and new technologies. Today there is a continuing need for network engineers and administrators to have a good understanding of network hardware, particularly if their companies are operating hybrid models. However, professionals also need a good knowledge of software technicalities so that they can master, for example, the coding necessary to support SDN and NFV, even if their companies make limited use of the cloud [37]. The reality of modern networking is that many technical tasks performed by professionals are related to the cloud. Cloud vendor companies will, of course, employ engineers to manage, administer and maintain their networks. Nevertheless, network engineers, not working for cloud vendors, have a number of cloud functions to perform. These functions include: selecting the most suitable cloud providers; designing and implementing cloud arrangements that meet their company's requirements; scaling cloud services to correspond with the company's growing business needs, monitoring usage of the cloud, and implementing effective security strategies on cloud networks [38] and [39]. The performance of many of these functions will involve the use of application programming interfaces, which are the links used to integrate workloads into the cloud [40]. Network engineers and administrators will require enhanced programming skills to code these APIs and other programming functions [40]. According to Chakray it is necessary to master data oriented languages for cloud programming, such as Java and Python [41].

7.2 More specifically, companies must ask whether they want to use the cloud provider's standard IaaS model, or a variant that enables them to build a cloud database of their choice, at least within the limits set by the IaaS specifications [42]. To operate this model requires professionals with a high level of coding expertise [42], which is also the case if a company does business with multi-cloud providers who operate different programmes [40]. Professionals working on the cloud also need good communication skills, team working abilities, and an awareness of business priorities so that they can assist colleagues on technical matters and work with managers and developers to create software packages that will best meet the interests of a business [43] and [42]. Attaining a computer science degree and the appropriate professional certificates are means of demonstrating that an individual is a suitably qualified cloud professional. At an entry level, the Cisco CCNA Cloud Certificate is a useful qualification [44].

8. How RESTful Web Services have been used to facilitate changes in computing.

8.1 RESTful is an independent language architecture providing interoperability between systems that use its coding interface. The RESTful architecture ensures that the customer's code remains separate and independent of the provider's code. Consequently, the customer's code can be changed without affecting the functioning of the provider's applications or services. Similarly, the provider's code can be changed without affecting the customer's operations [45]. RESTful APIs are designed to facilitate usage by multiple users which is highly beneficial to vendors. RESTful also enables users to quickly mobilise their data across multiple platforms, which is advantageous if they are seeking the most competitive services from cloud network vendors [46]. The separating of customer and provider interfaces and the stateless nature of RESTful means that it improves performance through enhanced reliability, scalability and speeds [47]. Separation also means that the customer's and the provider's interfaces can evolve independently [45]. Another advantage of RESTful is that it can be used to track usage of an application or service and therefore supply management with useful and highly profitable data [46]. It's notable that RESTful's interoperable features include an agnostic format, meaning it can be used in conjunction with XML, HTML, pure text, custom models, or JSON [48]. The interoperability of RESTful is taken full advantage of when it is coupled with the JSON interchange format, which is also described as interoperable because every programming language is capable of parsing JSON [49]. JSON's speedy performance, resulting from a low character count, easy reading and parsing, also make it a good match for RESTful [50].

8.2 RESTful APIs can be relied upon as they use HTTP and Transport Layer Security encryption to secure the transfer of data [51]. Additionally, RESTful APIs combine the use of HTTP and JSON to avoid the need to store or repackage data, which makes RESTful faster than SOAP APIs [51]. As stated the implementation of RESTful APIs require a customer and provider, but this does not mean that RESTful APIs are all Web-APIs [52]. Some APIs are productively used internally by a provider to link microservices and their containers. Basically, each microservice can expose an API, which other microservices can use to request data. The overall result is improved performance from the scaling achieved through the use of microservices and containers [52].

9. Conclusion.

Software has made it possible for computer networks to cope with today's huge demand for data. Software also forms the foundation of the cloud industry, which facilitates networking across the internet, including the provision of new services such as video streaming. Software, such as SDN, has saved cloud and other companies the expense of investing in additional servers and other hardware equipment. Statistics indicate that companies are making increasing use of the cloud, although whether it makes sense for a business to fully rely on it will depend on a number of factors, such as cost and quality of service, in particular it's security standards. A combination of in-house and Hybrid cloud arrangements seem to be the most popular networking structure at the moment so professionals continue to be employed by a wide spectrum of companies. What is clear is that professionals certainly need good coding skills to manage their companies' interfaces with the cloud.

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Assignment 1 - Network Programmability (ACCA5029)

GRADEMARK REPORT

FINAL GRADE

74/100

GENERAL COMMENTS

Instructor

Engagement with Literature Skills (40): 26

Knowledge and Understanding Skills (30): 25

Cognitive and Intellectual Skills (20): 16

Transferable Skills for Life and Professional Practice (10): 7

A very detailed and generally well-written report, with work of a high standard. Well done, Jaromir.

You have a phenomenal number of sources - however, these are mostly of poor academic quality, presumably mostly derived from a search engine. You can improve your mark significantly, particularly in research-heavy assignments, by trying to rely predominantly on fewer, higher quality (peer reviewed) sources.

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