Programmability and end-to-end automation for Telecommunication Operators (TELCOs)

Paul Gunning
BT Applied Research, Adastral Park, Suffolk IP5 3RE, UK
paul.gunning@bt.com

Abstract: Networking equipment with OpenAPIs admit automation of end-to-end services that span optical and packet domains. Adoption will be considered and proportionate to match *business logic* that lubricates and couples several architectural domains in a TELCO; and constrained by scarcity of programmers adept at effecting the necessary automation.
OCIS codes: 060.4253, 060.4259, 060.6718, 060.6719

1. Introduction

Privatized telecommunications operators (TELCOs) prosper by providing competitive products and services that meet customer needs in a timely and cost-effective fashion. But in recent times the reduction of margin on revenues: reflecting the long-term trend of *modest increases* of the average revenue per user (ARPU) being insufficient to offset the more *pronounced increases* in operational (OpEx) and capital (CapEx) expenditures is of concern. Attention is now focused on how the *business logic* that has developed over many decades and which represents substantial value for a TELCO can admit greater opportunities for automation. It is the business logic that provides the lubricant that couples the products and services customers seek, through a constellation of business support systems (BSS), to the series of actions that effect changes to the management, control and forwarding plane elements of the electronic packet-switching; optical carrier-switching; and transponding devices administered by the TELCO. The latter is the preserve of the operational support systems (OSS). So, at face value, it's really quite simple: set-up the service; get the cash in the bank; and delight both shareholders and customers alike. If only it were that simple. TELCOs need to develop, activate and maintain products and services, both old and new, to ensure that the customer is completely satisfied and not tempted to look elsewhere to fulfil her needs. But they do so whilst evolving their platform architecture judiciously.

2. Webscale Programmability and Automation

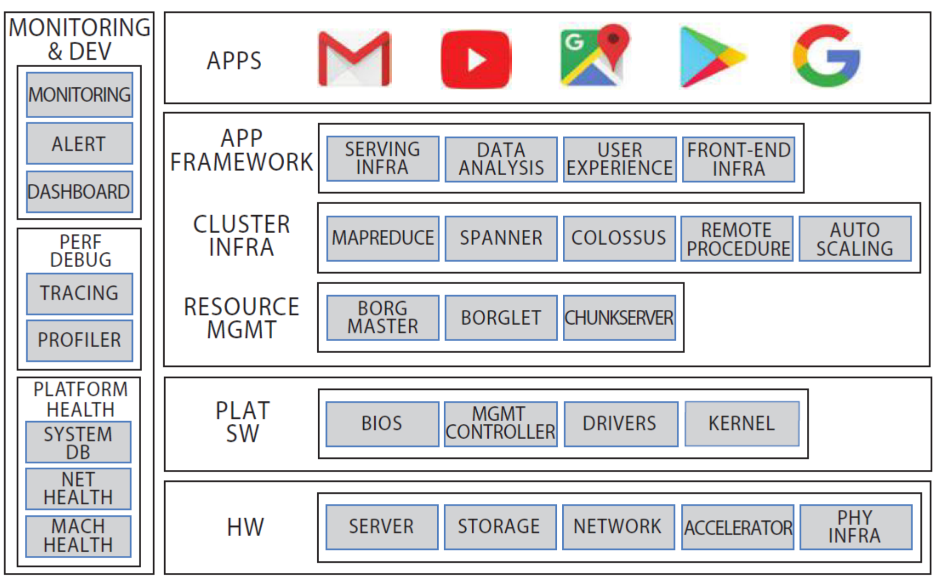

Figure 1: Software Stack Architecture of a Google Warehouse Scale Datacentre [1]

Much emphasis, in recent times, has been placed on the introduction of 'white-box' (or 'bare-metal') electronic packet- and optical circuit-switching network hardware to support the forwarding of information that supports revenue-generating products and services. This introduction admitted the 'disaggregation' of the forwarding plane of a device, whether real or virtual, from its control and management software. Open application programming interfaces (APIs) using protocols like gRPC, RESTconf or Netconf then support the programmability of functional hardware resources e.g. temperature sensors, fans, packet ASICs, wavelength selective switches (WSS) etc. These resources are usefully described by YANG data models that can read-from/write-to the registers of the components contained within every individual hardware device. Service models can also be described with YANG and so developed to orchestrate end-to-end services across an extended, distributed collection of inhomogeneous devices.

The webscale companies (Facebook, Amazon, Microsoft, Google, Apple et al.) have been to the forefront of encouraging and exploiting this disruption to the business models of the existing, vertically-integrated aggregated equipment vendors; and they have put a huge emphasis on the automation of the many disaggregated resources that have been exposed. In this they are aided by relatively homogenous, highly-optimised, infrastructure domains within huge 'warehouse-scale' datacentres.[1] Their application of modern methodologies that conflate software development with hardware operations (DevOps) and harness automation tools has been transformational. Webscale companies can also attract and, most critically, retain the talent to program, activate and maintain the compute, storage and networking resources that is consumed by their customer-facing applications (Figure 1). Some of this programming resource can be deployed to create software in-house that is bespoke to specific tasks critical to their operational model. This both reduces their reliance on commercial, third-party software components with an attendant reduction of operational expenditure (OpEx.). It also has the ancillary benefit of developing only those features which are required for their specific operational needs.

3. TELCO Programmability and Automation

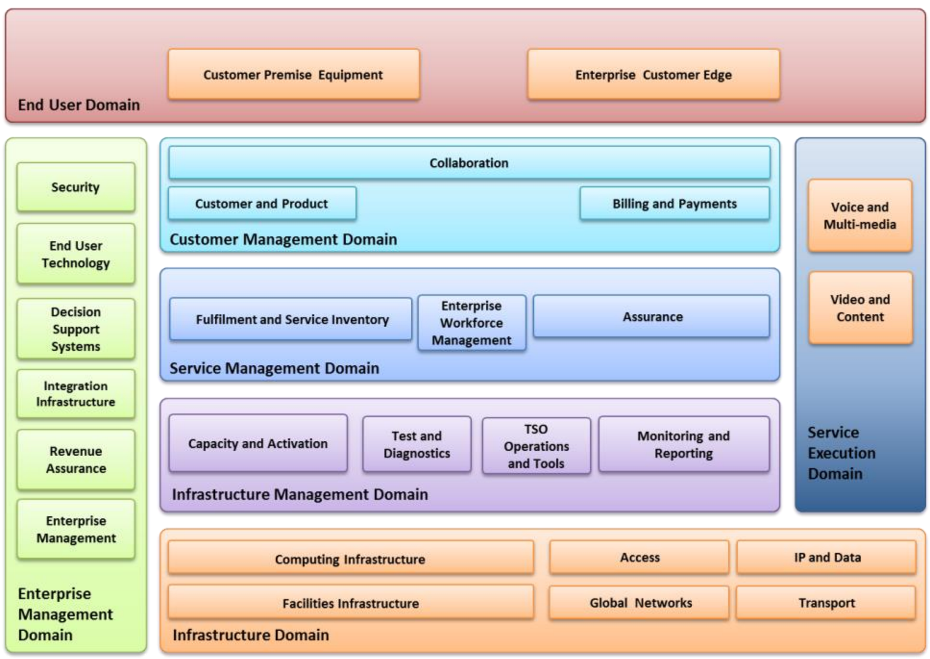

Figure 2: Platform architecture of a modern TELCO.

The platform architecture of a typical TELCO, like BT, is outlined above in Figure 2 and is comprised of several domains. Two of these - the *Infrastructure Domain* and the *Infrastructure Management domain* - would normally be considered the natural preserve of the OFC conference. Since they represent the specification and deployment; operation and maintenance of inhomogeneous physical hardware, of many types and varied provenance. Moreover the *infrastructure domain* is distributed across towns, cities and countries. And not usefully concentrated within one of several mega-facilities. Residential customers and enterprise customers, the latter both large and small businesses, typically connect to the TELCO with anything from relatively simple customer premises equipment (CPE) to more complex customer edge equipment. This hardware provides the physical demarcation between the customer and the TELCO. It may also host applications that provide the product / service demarcation too. Collectively these form the *End-User Domain*. The nature of hardware is changing. In recent times innovations like network function virtualization (NFV) applications hosted on 'generic' compute hardware where the customer can select one or several network functions from a self-service catalogue. These could include virtualized firewalls, web accelerators etc. We then enter the realm of the *Customer Management Domain* where 'collaboration' represents the mode of interaction. The word 'omnichannel' has been recently coined to describe the many methods of engagement via a self-service web portal, mobile application or interactive voice response (IVR) systems. But there always remains a possibility of speaking to a real person to address more nuanced requests. The most critical part of this domain is billing and payments. Preferably a single 'bill' is issued to the customer. The *Service Management Domain* is where end-to-end products and services are formed, activated and maintained. This domain is central to the operation of a TELCO since it engages northbound towards end users (including collating appropriate usage metrics to produce that all important bill.) But it also reaches down southbound towards the two *infrastructure domains* from which products and service are assembled from. The *service execution domain* maintains a watchful eye on the quality of the services that are being consumed by customers. This leaves the *enterprise management domain* which is charged with keeping the TELCO operating this includes human resources as well as research and development. The pool of external programming talent to effect automation within a TELCO is limited, valuable and highly-mobile. This means that HR departments are now actively seeking-out and developing this talent from within [2].

4. Discussion

There are three key processes or 'journeys' that would are ripe for transformation with increased automation that reduces the cycle time for

1. Concept to market (C2M) this is how timely an idea, whether developed internally or at the behest of a customer, can be converted into a marketable product and offered to customers within the existing product portfolio;
2. Lead-to-cash (L2C) this is the time elapsed between when a customer places an order for a product or service from the portfolio to the moment revenue is credited to the TELCOs bank account;
3. Trouble-to-Resolve (T2R) this is how quickly faults can be identified and corrected. Ideally repairs would be corrected proactively before service level agreements (SLAs) are breached; but it also encompasses reactive repair.

These processes are all ripe for automation. The most notable progress currently towards greater open automation is centered on the *infrastructure domain* where bare-metal and whitebox hardware 'appliances' have been issued with open specifications by Facebook and several TELCOs via the open compute project (OCP) [3] and the telecom infrastructure project (TIP) [4]. But there are initiatives underway across the *infrastructure management domain* too. Here the work of the open networking foundation (ONF) in promoting reference design and exemplar platforms has been valuable [5]; also the work of the Linux Foundation through its open networking automation platform (ONAP) [6] is critical to the widespread adoption of open automation being strongly influenced to address the needs and requirement of TELCOs across the globe.

5. Conclusions

The roles that TELCO, system vendors and system integrators will play in increasing the automation of business logic is still in a state of chassis [7]. Most interestingly the constraint to its increased adoption is probably less about open APIs and programmability, and more about the dearth of skilled programmers to exploit the opportunity.

6. Acknowledgements

Milind Bhagwat, Andrew Lord, Stefano Fogli and many other colleagues within BT are thanked for very useful discussions; also exposure to the thoughts and ideas of the many participants within the Horizon 2020 METRO-HAUL consortium has been invaluable. This work was supported by the European Commission for the H2020-ICT-2016-2 METRO-HAUL project (G.A. 761727). also exposure to the thoughts and ideas of the many participants within the Horizon 2020 METRO-HAUL consortium has been invaluable.

[1] L. A. Barroso, U. Hölzle & P. Ranganathan: "The Datacenter as a Computer: Designing Warehouse-Scale Machines, Third Edition", Morgan & Claypool, Synthesis Lectures on Computer Architecture, October 2018, 189 pages, (https://doi.org/10.2200/S00874ED3V01Y201809CAC046)

[2] J. Donovan & C. Benko: "AT&T's Talent Overhaul", Harvard Business Review, Oct. 2016. Available: https://hbr.org/2016/10/atts-talent-overhaul

[3] https://www.opencompute.org/

[4] https://telecominfraproject.com/

[5] https://www.opennetworking.org/

[6] https://www.onap.org/

[7] E. Riccardi, P. Gunning, Ó. González de Dios, M. Quagliotti, V. López, and Andrew Lord: "An Operator view on the Introduction of White Boxes into Optical Networks," Journal of Lightwave Technology, Vol. 36, Issue 15, pp. 3062-3072, (2018) https://doi.org/10.1109/JLT.2018.2815266