White Paper

Aligning Business & Operational Transformation: Enabling the Network to Participate in the API Economy

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Introduction

As the digital services economy – also known as the application programming interface (API) economy – gains momentum, companies in every industry are focusing on joining it. Leading players want to establish digital platforms, the linchpins and marketplaces for API economy value chains, to rival those of the successful webscale players. As key connectors of such value chains, communications service providers (CSPs) have an excellent opportunity to influence the API economy and exploit their insights into its workings, as well as to contribute revenue-generating digital platform services of their own.

Advanced operators, such as AT&T with its Domain 2.0 program, are already engaged in building digital platforms, transforming their IT and network assets into digital services with open APIs that can be composed together in innovative ways and consumed by API economy value-chain partners and customers. They are drawing both inspiration for this exercise from the microservices design pattern being adopted by the IT/cloud industry and support from network functions virtualization (NFV) developments in which virtualized network functions (VNFs) are being re-engineered as sets of microservices.

The business goal of participating in the API economy will require organizational and operational transformation. Digital services need to be immediately manageable across their lifecycles, whether these last for a few seconds or years, and no matter how fast or broadly the service scales. In a digital network platform context, existing operational approaches are unlikely to be sufficiently flexible or real-time enough to cope with this requirement.

Leading CSPs want to introduce a new, microservices-based operational architecture, management organization, processes and systems to manage the network at the same level of abstraction and speed as digital services. The automated, API-enabled composition of a digital network service must be accompanied by the automated, API-enabled composition of its associated management function. And fundamental to this capability is an information (meta) model that describes all the services in the digital network platform and supports composability.

The combination of digital network platform attributes – the quality of its meta-model, microservice-based design, service catalog and business support – promises to enable service agility at a level currently unachievable within a CSP organization. This is the level of agility CSPs need to compete against webscale rivals and participate in the API economy. Many operators will not have AT&T's resources when it comes to building such a digital network platform, and will look for industry help. This means identifying a partner with the right transformation vision and skills, as well as the ability to deliver clear business benefits in terms of new revenues, significant cost reduction and transformed service delivery.

This white paper explains the significance of the emerging API economy and the drivers for CSP participation in it, and describes the need for a digital network service platform as the repository for a CSP's IT and network assets expressed as digital services. It then explores the management implications of the digital network platform and the need for a new operational architecture. Finally, the paper describes the properties of the new operational architecture, including the information (meta) model and service catalog.

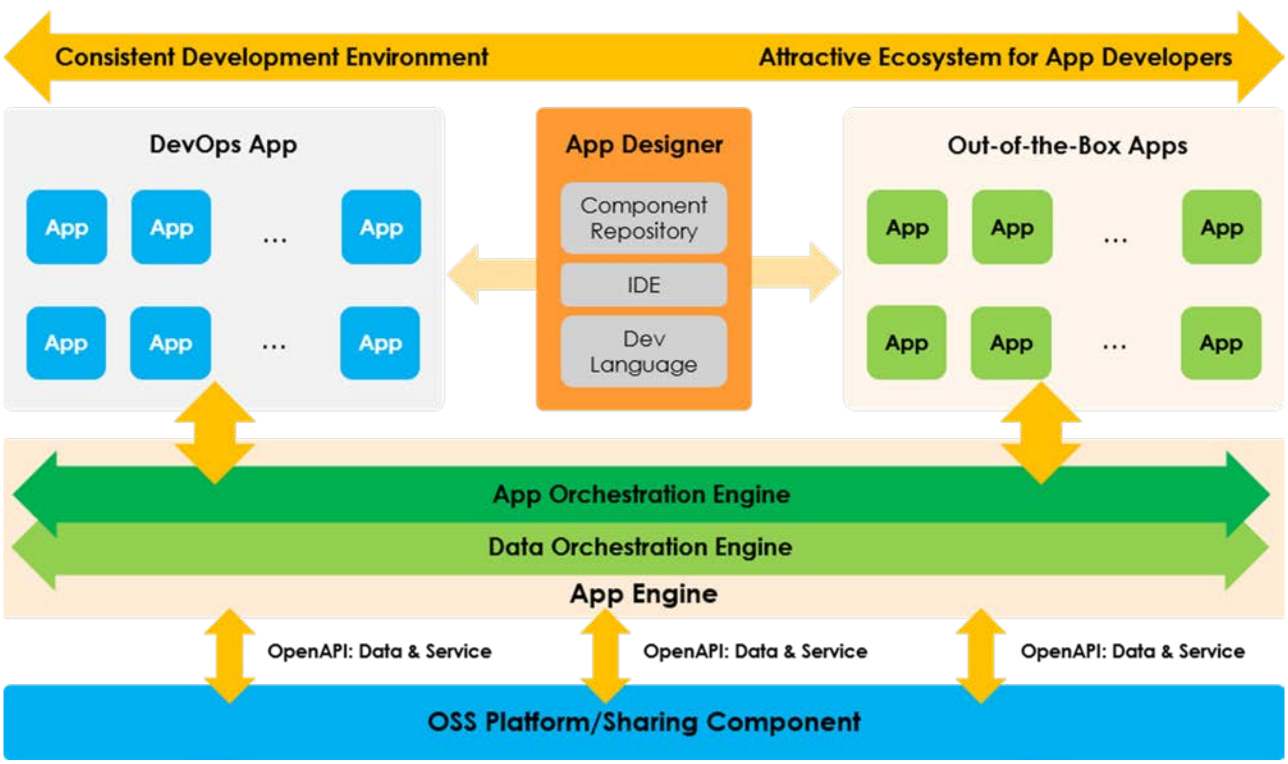
The API Economy: Drivers for CSP Participation

Digital Services Rule

The Forbes 2015 list of the top 10 most valuable global brands is dominated by Apple, Microsoft, Google, IBM, Samsung and Facebook, technology companies that provide digital services and/or the devices that access them. The only telecom company in the Forbes Top 20 is AT&T at number 12, just ahead of Amazon in 13th place. Apple, Google and Microsoft also feature in PriceWaterhouseCoopers' 2015 list of companies with the highest market capitalizations, with Apple setting a new record this year. The lesson is clear: Those companies that are leading the digital services revolution are reaping rich financial rewards.

Digital services – software-based services that are delivered, stored and used in electronic format – have been disrupting the global economy for the past two decades. In fact, the leading technology brands are simply not interested in selling discrete digital services; they are selling digital platforms, the basis for an ecosystem that encompasses their own and third-party digital service innovation.

Figure 1: Digital Service Development in the API Economy



Source: Huawei

Digital platforms support the "mashing up" of pieces of software-based function from many different sources, both internal and external, to create a marketplace of new digital services that attract new customers. The technology that enables the integration of digital services are programmatic interfaces, or APIs. Companies with business models that support the exposure of their assets as digital services via APIs are creating new value ecosystems. These are collectively becoming known as the "API economy."

The API economy experience is in tune with the demands of the millennial generation. This emerging and increasingly powerful market segment expects to go to a digital service platform – for example, Airbnb, Netflix, Amazon or a portal for ordering a connected car – and have the platform instantly adapt to their immediate, highly personalized, context-driven need. A digital platform must automatically assemble, in real time, the relevant set of digital services to serve that need. Customers self-select the services they want, and the platform fulfils them instantly, potentially coordinating delivery across multiple ecosystem service partners.

Organizations in every industry sector are focusing on joining the API economy. Identifying business assets that can be exposed programmatically as digital services is now a boardroom concern. The most advanced companies want to follow the Webscale giants and establish the leading digital platforms in their territory or industry. Such digital platforms will be critical to the functioning of the complex and dynamic ecosystems required to support, for example, a connected car or other Internet of Things (IoT) services in a Gigabit City. API economy value chains will involve large numbers of disparate digital service providers being able to quickly and programmatically integrate their digital services into these platforms.

CSPs Target the API Economy

CSPs have an excellent opportunity to influence the API economy because of its extreme dependence on the world's communications networks. Without the network, the ability to access and integrate digital service APIs beyond the bounds of a single computer would not exist.

Ownership of the network gives CSPs unique insight into the workings of the API economy – for example, through their knowledge of traffic flows to and from its digital platforms and the physical context of platform users. CSPs therefore have a critical ability to shape the availability, performance, security and monetization opportunities of digital ecosystems. At the same time, CSPs need to be agile enough to participate in any API value chain as it is dynamically instantiated. This means making their key business assets – networks – available, too, as a set of digital services. Network and IT assets exposed as digital services can be integrated on demand with, and manipulated by, other digital services through APIs, in an automated way.

AT&T's Domain 2.0 initiative has API economy goals. Its Domain 2.0 Vision paper states that Domain 2.0 "is characterized by a rich set of APIs that manage, manipulate and consume services on demand and in near real time." Domain 2.0 seeks to expose AT&T's valuable IT and network assets as a digital platform that AT&T and third parties can use to underpin new API economy ecosystems. Service developers will programmatically bind API-enabled network capabilities into their digital services in innovative ways. Or they can use the platform's APIs to add new network functions that leverage and extend the platform's capabilities, bringing new network services to market faster.

Next Generation Mobile Networks (NGMN) Alliance 5G use cases are aligned with the API economy. For example, in a 5G network, users and/or services themselves will use network platform APIs to create, dynamically, slices of the network and "chains" of Layer 4-7 functionality tailored to their service requirements.

The past decade has shown that digital platforms – from operating systems to the Web and now the cloud – unlock innovation and create new value. The network as a digital platform will enable new revenue-generating opportunities for CSPs beyond basic connectivity services. There is, therefore, a compelling financial argument for CSPs to re-engineer their networks as a set of digital services that expose their capabilities to others. We are using the term "network" in a generic sense here, as the digital platform could include a wide range of related IT assets, such as billing, identity and cloud. This re-engineering activity will become critical to business survival.

Turning Telco Business Assets Into a Digital Platform

Many CSPs have already attempted to API-enable their networks in order to build Apple/Facebook-style communities around network functionality such as location, charging and voice. Their initiatives have often ended in failure, not just because telcos couldn't capture the imagination of the Web 2.0 developer community, although that has been a factor, but also because the physical network is hard to programmatically enable, and early SOA-based API-enablement technologies were difficult to work with.

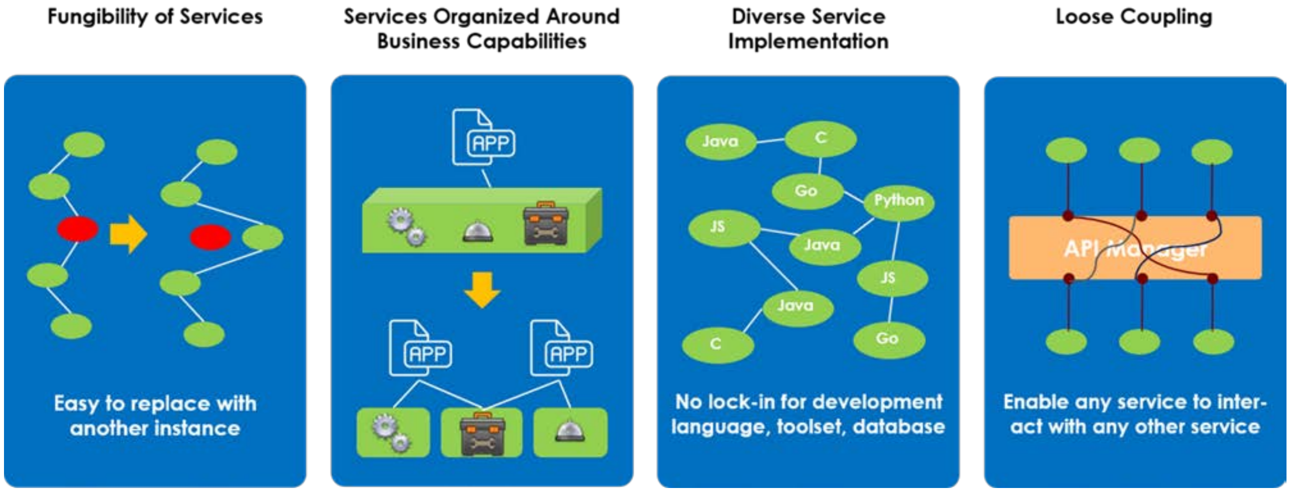
Modern, simple RESTful APIs coupled with software-defined networking (SDN) and NFV are making the network-as-a-digital-platform vision feasible at last. SDN provides programmatic access to connectivity while NFV removes network function dependency on hardware and enables it to run as pure software in the cloud. Network functions that are virtualized in this way effectively become digital services – software-based services that can be delivered, stored and used in electronic format.

Digital services in the API economy are increasingly being developed using a new design pattern known as microservices. Wikipedia defines microservices as: "a software architecture style in which complex applications are composed of small, independent processes communicating with each other using language-agnostic APIs. These services are small, highly decoupled and focus on doing a small task, facilitating a modular approach to system-building."

Key features of microservices include:

- **The "fungibility" of services:** Each microservice instance is easy to replace with another instance, supporting high availability when run in a cloud environment. If one microservice fails, the entire application doesn't stop working.
- **Services organized around business capabilities, not technologies:** Web applications are typically built today with a three-layer technology architecture – graphical user interface (GUI), server-based business logic and database – by siloed functional teams. This leads to siloed business logic across applications, making composition difficult. Services developed by cross-functional teams around a business area are likely to have more clearly defined boundaries, which aids composition.
- **Diverse service implementation, using the programming tools of user choice:** Developers are not locked into a particular development language, toolset, database or even development style, although microservices are closely associated with agile, continuous delivery-based development.
- **Services are discrete and loosely coupled in a symmetrical architecture, enabling any service to interact with any other service:** There are no hierarchical dependencies between microservices. This feature supports many-to-many communications between services in a producer-consumer model, where producers and consumers of services don't have to know about each other in advance.

Figure 2: Benefits of Microservices



Source: Huawei

Much of the digital network platform could also be built in this way. Already, at the vanguard of NFV, many VNFs are being re-engineered as sets of microservices. VNFs therefore begin to look similar to cloud native IT applications, which are also being developed as independently deployable, pluggable and fault-tolerant microservices instead of large, monolithic applications. This starts to blur the boundaries between the digital network platform and types of IT digital platform, making cross-platform service compositions easier to achieve.

Although microservices are typically built as small, discrete capabilities, this new architectural approach is also being used to encapsulate legacy applications. Through the use of simple APIs, some organizations are encapsulating large, monolithic applications, complex VNFs and even entire network domains as microservices. One CSP recently told Heavy Reading that it is investigating ways of wrapping its MPLS network as a microservice. In this context, there is a growing consensus that a microservices approach is service-oriented architecture (SOA) "done right."

Taking the Digital Network Platform Into the Cloud

The native execution environment for digital services – whether of the IT or network variety – is the cloud. The cloud itself is a digital platform. It is nothing more than an abstraction of physical IT infrastructure and its exposure as a set of software-based services. Infrastructure level services can be thought of as microservices, since they can be programmatically and automatically linked together – in other words, orchestrated – through APIs, to deliver customized IT environments to application-level digital services. Virtualizing the network by modeling its functionality as sets of microservices completes the trio of technologies – compute, storage, network – needed to build a cloud platform. CSPs can use the services that comprise the cloud to extend their network-as-a-platform offer as well as leverage them to provide appropriate execution environments for VNFs.

Managing Telco Assets as a Digital Platform

The Need for Telco Management Transformation

As CSP partners reposition themselves for the API economy and their customers increasingly demand an API economy experience, CSPs are embarking on their own business transformations. Their goal is to transform their business assets, and specifically their networks, into digital platforms able to participate in the new business realities of the API economy, as AT&T Domain 2.0 shows. But this will require CSPs simultaneously to transform their asset management stacks.

Digital services and their constituent components need to be managed. Each service needs to be designed, deployed, configured, monitored for availability and performance, remediated, secured and metered until its end of life. The components that manage the lifecycle of a digital service – whether that takes a few seconds or years – can themselves be modeled as microservices.

In the IT world, API economy leaders are pioneering the concept of "DevOps" in order to streamline and automate the management of digital services. DevOps, microservices and the cloud platform are intrinsically linked. The DevOps approach requires service developers to take more responsibility for the management aspects of their digital services and for operations staff to pre-define those management aspects so it is easy for developers to integrate them. If management capabilities are defined as microservices accessible through APIs, integration can be fast and automated.

The adoption of DevOps and cloud platforms means that digital service providers are beginning to be able, very rapidly, to deliver and manage the application software for a connected car, for example, or a new healthcare monitoring service. But it can currently take months to fulfill connectivity, firewall and other communications services such applications need to run across the cloud. An end user ordering an enterprise cloud service or remote desktop solution wants it delivered just in time, but it can take weeks to set up the associated VPN(s).

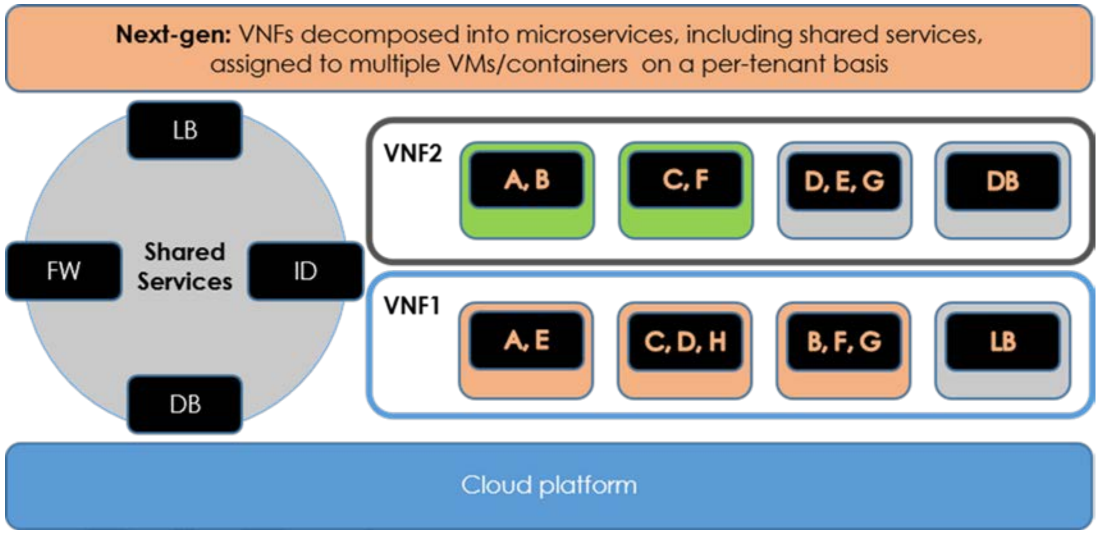
This is because today, the network is managed as separate layers and domains, each populated with physical boxes. Poor levels of abstraction and a proliferation of management silos that require complex, hard-coded integration puts severe constraints on how fast new network elements can be integrated and new customer-facing communications services delivered. This is the cause of the speed gap between digital services in the API economy and network-based services.

Addressing the IT-Network Speed Gap

CSPs urgently need to address this management gap as a core business transformation activity. For example, in order to manage the network as a digital platform in an agile and automated way, they will need to invest in a platform-level abstraction of the network, end-to-end across layers and domains. It will not be enough simply to adopt NFV and SDN in certain parts of the network.

However, platform-level abstraction is easier to achieve when network functionality is virtualized and running on the cloud. As we have pointed out, VNFs can be architected as microservices which are supported by horizontal and virtualized sets of infrastructure microservices – compute, storage and connectivity – that are decoupled from physical hardware. Microservice-based functionality lends itself to being represented in an abstract way and these abstractions can be assembled to create an end-to-end model of the network which can be managed, quickly and flexibly, at a logical level.

Figure 3: Rearchitecting VNFs Using Microservices



Source: Heavy Reading

In the virtualized network, network management is no longer about managing physical boxes. Hardware is managed separately and, in a cloud paradigm, is dispensable and can fail without affecting the operation of microservices-based applications/VNFs. So network management is increasingly about managing the network as software, in software, where it is easier to program and automate change.

But since CSP organizations reflect the way their networks are managed and operated, so changes to network management will require organizational and culture change. CSPs will need to introduce a new operational architecture, management organization, processes and systems in order to manage the network in software, at the same level of abstraction as digital services. This is because managing the network as a software-based digital platform running on the cloud will require CSPs to adopt IT software management paradigms, including DevOps and an extreme automation approach. These will need to replace the slow processes and static systems that have grown up around the manual management of physical boxes.

A Future Mode of Telco Operations

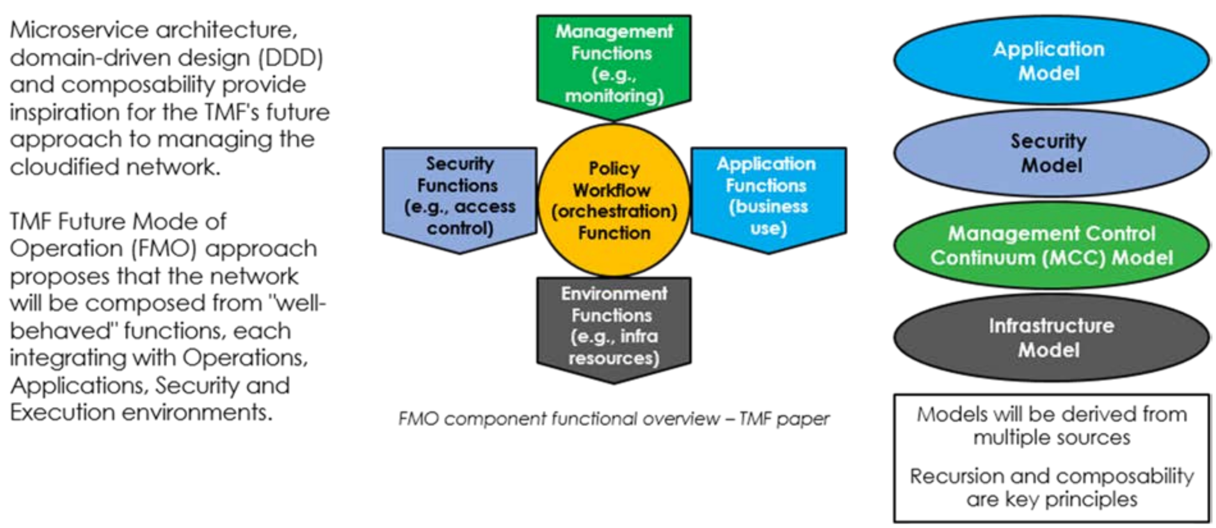
The Future Operations Vision

CSPs want to become agile businesses, able to participate in on-demand, context-driven API economy value chains and to bring new services to market faster. The network as a digital platform will enable them to design and deploy customer-facing digital services by "mashing up" network and IT service components that run in the platform with each other, and potentially with services exposed by third-party platforms. Mashups – and the microservices they are composed of – rely on orchestrating API-API communication at runtime, not the writing of integration code. Composing new services from existing components is faster than writing them from scratch and supports API economy goals of personalization and near instant value chain participation.

But if new combinations of communications services are composed, deployed and torn down dynamically, they need to be manageable from the moment of creation. Service lifecycle management can't be an add-on after the fact: If a CSP is offering a newly-composed service to an API economy chain in near real time, there can be no delay while the CSP integrates it with the required management systems. Components of the service must each arrive ready to be managed. The automated, API-enabled composition of a service needs to be accompanied by the automated, API-enabled composition of its associated management function.

Next-generation management of both virtualized networks and the services that run across them needs a new management vision. The TM Forum is beginning to describe a "future mode of operation" in which network-related digital services, right down to individual components within VNFs, have management interfaces (APIs) that are automatically invoked when service components are assembled into customer-facing digital services (see **Figure 4**).

Figure 4: TMF Future Mode of Operation



Source: Heavy Reading

The network as a digital platform will therefore need an accompanying management platform. In this vision, the management platform will adopt a microservices architectural approach. In a management context, microservices represent self-contained units of management functionality that can be orchestrated, on demand, to fulfil a specific business process or control flow. As functional components are assembled and orchestrated into digital services, so the management platform will assemble and orchestrate their associated management microservices.

Some of these management microservices will be developed natively for the digital network platform. However, given the flexibility of the microservices design pattern, preexisting components that are already being managed in their own way will have their management stacks encapsulated as microservices. At an abstract, API level, all microservices look the same, so it doesn't matter how they are implemented under the covers.

Such composability of service management capabilities in parallel with service function composability is extremely powerful. It means the instant they are launched, digital services are automatically plugged into the means of configuring, monitoring, metering and remediating them without further effort on the part of operations – the DevOps vision. The SLA of a digital service is created automatically as an amalgam of the SLAs of its constituent components (microservices). The same goes for its configuration or cost.

Microservices & Metamodels

Microservices need to be discovered and their function understood before they can be assembled into digital services. They also need to be parameterized with service-specific data to enable them to be orchestrated and managed in an appropriate way at runtime. A microservices-based architecture needs:

- A **service catalog** that supports the discovery of all the platform components that can be composed into network-related digital services, as well as their related management components. The catalog maintains the **specification** of each functional or management service component – i.e., **what** it does – and its **behavior**, in particular **who** can influence that behavior, **when**, **where** (at what time/location), **why** and **how** (using what methods).
- A **metamodel**, an abstract model of the universe of microservices that exists in the digital network platform. The metamodel is a common language that enables all microservices to be handled in the same way, however differently they have been implemented behind their APIs – for example, with different data models and programming tools. In other words, the metamodel normalizes the different domain models used by different microservices. In a network context, such domain models might include TOSCA, YANG, MEF and ITU-T models. The metamodel interworks and synchronizes with the service catalog model, becoming the central point for all the metadata used to parameterize customer-specific instances of services and service compositions at runtime.

Because information in the metamodel is manipulated at an abstract level, as metadata, services can be composed without reference to their physical implementation. CSPs can decide how to implement digital services – that is, where, physically, the various components of the digital service will execute – at runtime. Implementation choices will be defined, in metadata, as policies that can be attached to the service and passed to an infrastructure management layer. This layer will use APIs to program physical or virtual infrastructure resources, in accordance with the policies, to deploy the service and instantiate their management. The metamodel description of a digital service will be parameterized with management data – for example, configuration data or KPIs for monitoring purposes – at runtime and different instances of a service can have different management parameters.

A microservices and metamodel/metadata approach underpins the agility and innovation CSPs need to participate in the API economy. This approach gives CSPs huge flexibility when it comes to creating and deploying digital services in response to specific market needs. A CSP's metamodel, providing as it does an abstract representation of all the service and management capabilities present in the CSP's organization as assets for "mashup," will be a key source of competitive differentiation. Creating an appropriate metamodel to support this management vision is therefore a critical aspect of a CSP's business transformation.

What Should the Metamodel Look Like?

It is hard to build metamodels, and especially models that support composability. The history of network management is littered with the corpses of "standard" management models based on a conventional enterprise architecture approach. Such monolithic management models try to describe the detail of all services and their management function, but fail on a number of counts – for example, in the breadth of their ability to model the network across layers and domains, in their level of abstraction away from the physical network and in their ability to model behavioral as well as syntactical relationships between the components they model.

Yet to provide the network as a digital platform, CSPs need a metamodel that can address all three shortcomings. It should provide a platform-level view across network layers, and physical and virtual as well as core, edge, fixed and mobile access domains. It needs to model the behavior of management components as well as their function and it needs to provide the right levels of abstraction and automation to support the dynamic composability of modeled components.

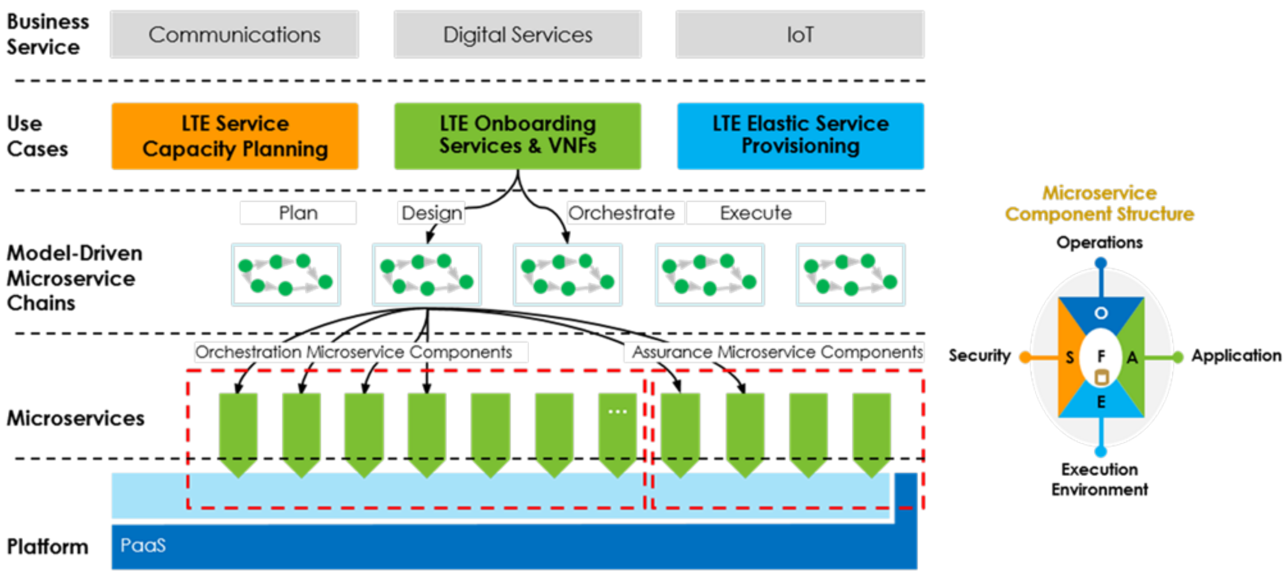
The advent of microservices provides an opportunity to create a different kind of metamodel – one that takes advantage of architectural loose coupling and simple APIs to allow components to use different data models for flexibility, while still providing a central reference point for all metadata in the digital network platform. This requires a tricky balancing act between being detailed enough to provide visibility into domain-specific service functionality and behavior so that the model can control behavior at a fine-grained level and being able to delegate that responsibility to microservices where appropriate.

The metamodel also needs to be able to federate domains, for example, TOSCA and YANG in support of composable, hybrid network services that span physical and virtual network infrastructure. A microservices-inspired metamodel will not require hard-coded integration between domain models, which in the past, have created complex, hierarchical and inflexible dependencies between them. The APIs for these domains will expose their function and behavior to the metamodel but it will allow them the autonomy to execute on that functionality internally in their own way.

A microservices-inspired model is also an opportunity to model network functionality differently than in the past, where model abstractions have been based on a physical view of the network rather than on its functional capabilities. A future model needs only have a single abstract construct, "network element," for example. Metadata can then be applied to be used to identify an instance of that construct as an element at Layer 1, 2 or 3. Abstract capabilities such as capacity, time and layer validation can also be included in the model. Instances of the construct, "layer validation" can be created by composing together all the microservices contributing to a topology that needs to be validated. Constructs fulfilled by particular algorithms in one set of circumstances can be replaced by other algorithms at a later date, without affecting the microservices the algorithms act on, since there are no in-built dependencies between algorithms and the components they need to do their work.

Microservices architectures are inherently extensible so the metamodel can be built bottom-up, from use cases, rather than designed *a priori* top-down as part of a paper-based enterprise architecture modelling process. Each business capability – or microservice – modeled for a specific use case can be defined with reusability in mind, and microservices developed for one use case can be harvested for others as the metamodel builds.

Figure 5: Microservice Chaining for New Agility



Source: Huawei

A Business Context for the Metamodel

The service catalog and accompanying metamodel offer critical support for service composition and management in the digital network platform, enabling CSPs to participate in new API economy opportunities in agile and innovative ways. The layer of abstraction they provide on top of the network, leveraging the new virtualization technologies, SDN and NFV, enables services to be deployed flexibly and programmatically at runtime, closing the speed gap that currently exists between IT and network services. The service catalog and metamodel support service compositions that are "management-ready" from both a business and operational perspective.

However, CSPs can't adopt service catalogs and metamodels out of the box. A CSP's metamodel – and indeed its digital network platform – needs to be a reflection of its business goals, service environment and network. The metamodel is a key link between the business and the network, potentially mapping to a business-oriented model at an even higher level of abstraction, modeling business concepts such as customers, orders, partners and product offers. The network services offered by the digital network platform may be one component of more extensive CSP product offers, such as IoT solutions or software as a service, for example.

The business metamodel is at the apex of these layered abstractions. At the bottom layer of abstraction are the domain models closest to the network, with the digital network platform metamodel sitting above them and stitching them together. The business metamodel in turn stitches the digital network platform into the fabric of the business, enabling business decisions to ripple down, through the metamodel and into the network, driving business agility.

Domain models such as YANG and TOSCA typically do not tie their respective network and IT domains directly to business concepts, hence the argument for intermediate layers of abstraction. At the same time, while the TM Forum Shared Information/ Data Model (SID) is a good starting point for the business metamodel, since it is commonly used across the operator community and is a key tool for business and operational transformation, it does not have the right abstractions to model the end-to-end network domain and particularly virtualized network domains.

The SID will continue to have a role to play in the new management vision at the business level. Over time, it may be extended to include digital network platform metamodel concepts too. Vendors creating new metamodels will need to be mindful of SID developments and how any new capabilities and/or extensions they initiate, so that CSPs can exploit API economy opportunities faster, will eventually need to be retrofitted into an industry-standard model.

Conclusion

Joining the API economy is a prime goal for advanced CSPs. But building the new digital services platform based on IT and network assets to reach it is a major undertaking. The composability at the heart of the digital network platform will require a new approach to telco operations at every level, from network and IT infrastructure management to the business, customer-facing management domain. This transformation starts with understanding the business case for API economy participation, as exemplified by the current crop of successful digital service providers.

The future vision for telco operations will require a significant amount of modeling activity. A CSP's business and network environment will need to be re-architected and/or encapsulated as microservices, and a new service catalog created for the digital network platform. The catalog needs to contain a CSP's IT and network assets for mashup and consumption, and their accompanying management microservices.

It is unlikely that such a catalog can be created all at once, using a top-down, big bang approach. Instead, it should be built incrementally, as operators gain experience from specific use cases, but always with an end-to-end, horizontal architectural vision in mind. To maximize innovation potential, CSPs can't afford to silo the microservices they develop: No one can tell when and to whom a service might be useful in the future.

Managing the network as an end-to-end digital network platform will also require many organizational, process and, eventually, system changes. This transformation needs to be planned for and executed in sensible stages.

This transformation will require CSPs to work with a partner with the right mix of capabilities for the successful realization of an API economy vision. These include business consulting, architecture and process design, culture change management, DevOps education and training and model building and integration services. Although business change and agility are key goals, they cannot be achieved without operational transformation. CSPs embarking on the organizational equivalent of heart surgery would be well advised to select a partner that can keep their business not only alive but thriving through the change – and one that can deliver quantifiable financial benefits, in terms of new revenues, significant cost reduction and transformed service delivery, to justify the upheaval.

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