WHITE PAPER

Service Providers
Data Center

5 Steps to a 5G-ready cloud

Launching new 5G services will require the flexibility, scalability and responsiveness found in the Communications Service Provider (CoSP) Cloud. Ready to get started?

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Introduction

To take advantage of 5G, CoSPs must start preparing now. The communications service provider (CoSP) cloud brings the flexibility, scalability and responsiveness associated with the cloud to the entire CoSP value chain, making it easier to develop, launch and provision new services. This paper will help you take your first steps into the CoSP cloud, so you can be better positioned to reap the rewards of 5G readiness.

5G will be a transformative force, offering not only enhanced mobile broadband, but also enabling a huge volume of machine to machine communications, based on its ultra-reliable and low latency network. For communications service providers (CoSPs), it puts them in a strong position to offer new services, including in the Internet of Things (IoT), visual computing, analytics, and enhanced mobility. Augmented reality and autonomous cars are just two of the applications we know of today that will benefit from the high performance and network locality that telcos can offer.

But to take advantage of 5G, CoSPs must start preparing now.

Network architects and engineers will be instrumental in bringing about the business and technology changes required to launch and monetize these services. It won't be viable to spend weeks or months developing services. Nor will the legacy architecture suffice: fixed function network devices cannot adequately scale or adapt to handle the increasingly diverse and data-hungry workloads. The growth in connected devices, higher data rates and subscriber density are already putting unprecedented demand on the communications network. People routinely download or stream films and music on their phones, putting pressure on the network. With the richer bandwidth of 5G, new applications will emerge to take advantage of it, putting further strain on the network.

The CoSP cloud (also known as telco cloud) provides a solution. It extends the virtualization concepts that underpin Network Functions Virtualization (NFV) and Software-Defined Networking (SDN), to the Operations Support Systems and Business Support Systems (OSS/BSS) that are used to sell, provision and manage services throughout the network. The CoSP cloud brings the flexibility, scalability and responsiveness associated with the cloud to the entire CoSP value chain, making it easier to develop, launch and provision new services, and to respond flexibly to the unprecedented demand that 5G is expected to bring.

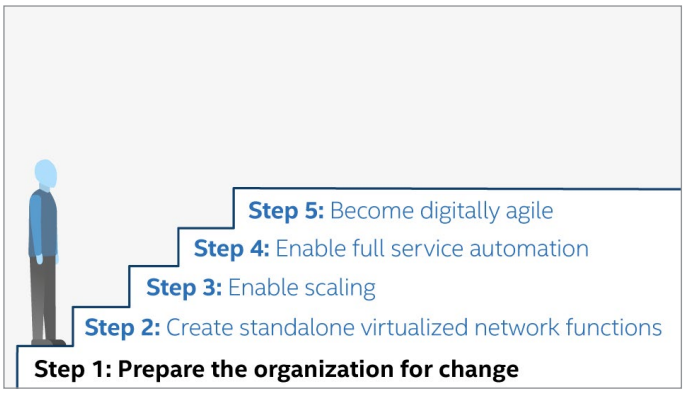
Using a cloud architecture, CoSPs can flexibly provision services where and when they need them. Virtualized network functions can sit in the data center, at the edge (close to the customer) or in-between the data center and the edge,

depending on the use case, workload needs, or customer value. Any upgrade in the network promises to increase the capacity and capability across the network, because resources can be flexibly allocated and reallocated in line with demand. As a result, it's no longer necessary to upgrade every point in the network to meet the expected future peak demand, as it is using traditional proprietary hardware devices.

Intel has created this strategic pattern for entering into the CoSP cloud, to help you to acquire the flexibility to launch new services today, and the agility to benefit from 5G.

Intel® technologies have been central to enabling the transformation from proprietary mainframe and legacy systems to flexible and efficient open architectures, and more recently to cloud. Our technology platforms are increasingly delivering the computing, storage, networking and analytics capabilities for agile networks that support the cloud and 5G. Intel is working with innovative CoSPs, industry standards bodies and open source communities to develop NFV/SDN and 5G technologies that are optimized for maximum performance and flexibility when running on Intel® architecture.

Step 1: Prepare the organization for change



The business must adopt the same lean and agile practices that have enabled over-the-top (OTT) service providers to innovate and win markets quickly. CoSPs will need to acquire some domain expertise that was previously held by their supply chain, and skill up in DevOps, agile software development, and lean software development.

We often hear talk of legacy architecture, with the term implying that it's become a burden or a liability. We rarely hear talk of a legacy organization structure, but that too will prove to be restrictive when attempting to launch new cloud-based services, both in today's network and in the 5G network. It's not enough to change the network: the business too must be cloudified. It must adopt the same lean and agile practices that have enabled over-the-top (OTT) service providers to innovate and win markets quickly.

This change will be difficult. The legacy network architecture was defined by custom solutions with limited capabilities, around which organizational silos were able to grow around specific skills and competencies. There was little need for many teams to communicate with each other. To create the CoSP cloud will require much more cross-functional work, as previously discrete workloads will now work much more closely together and in many cases will share the underlying hardware and software infrastructure.

The organization will also need to acquire the knowledge to develop and deploy new network applications, if it is to meet the promise of discovering and delivering truly innovative new services. In the past, service providers have not needed the same degree of knowledge in-house. They have been able to rely on outsourced partners for much of their service deployment. Close cooperation with the ecosystem continues to matter, but it will no longer be enough. For a service provider to reap the rewards from enhanced technical flexibility, there needs to be much greater organizational agility, and that starts with having knowledge in-house.

There are two key areas where communications service providers will need to skill up. They will need to acquire some domain expertise that was previously held by their supply chain. Intel can offer support with this, including training to get more from cloud-ready solutions. Intel® Network Builders University offers comprehensive online training programs for enhancing organizations' network functions virtualization (NFV) and software defined networking (SDN) expertise. Courses range from high level overviews to deep technical dives on point solutions. Many vendors can also offer support.

Organizational change and training take time, and will require much learning "on the job" as the CoSP cloud evolves. The need for organizational change must be identified at the outset, though, to avoid project failure, and it must be supported with strong leadership to make it happen.

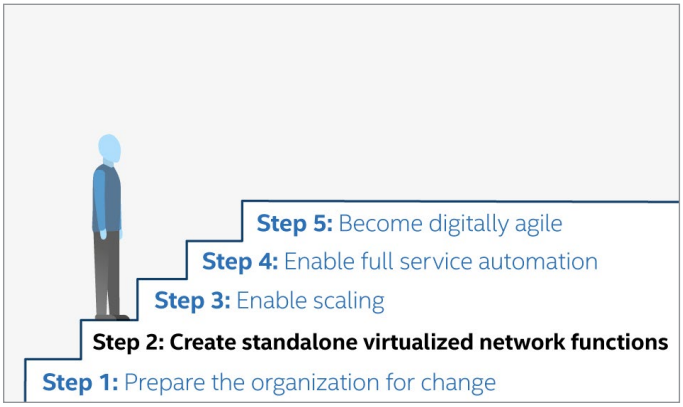
Beyond technical skills

Service providers will also need to acquire broad software development and deployment skills in areas including:

- **DevOps**, enabling continuous improvement of services and the fluid roll-out of new capabilities thanks to close cooperation between developers and the operations team;
- **Agile software development**, with frequent delivery and deployment of working software, rather than a mammoth development project followed by a "big bang" launch; and
- **Lean software development**, with its focus on eliminating waste, reducing uncertainty through late decisions, rapid delivery and systems thinking (looking at the interactions between software systems).

Organizations may adopt these methodologies, or others, to varying degrees, but the key message is that most CoSPs will need to radically change the way they deliver large projects, and acquire the skills in-house to deliver new cloud-based services faster and perhaps in smaller increments.

Step 2: Create standalone virtualized network functions (VNFs)



Which VNF to choose for the first one? Popular starting points include virtual customer premises equipment (vCPE), the integrated messaging service (IMS), and the evolved packet core (EPC).

As you enter into the CoSP cloud in preparation for 5G, the first question is where to begin the transformation. For launching new services, a “greenfield" approach could be used, which means starting with a new cloud-based infrastructure. This frees the organization from a dependence on its legacy systems. As a result, it can be a relatively uncomplicated place to start, although it also means the organization cannot benefit from its existing investment. On the upside, that investment is not at risk, either. With a greenfield development, CoSPs are working in the same way their over-the-top competitors do, as cloud natives. Customers or traffic can be routed to the new services, with the legacy architecture running other services in parallel. Over time, the legacy architecture can be transitioned out as business conditions warrant.

CoSPs can also look at modernizing their existing infrastructure with virtualization. The advantage of this approach is that they can gradually transform the existing network, beginning with services that are relatively easy to swap out. Other “legacy” upstream and downstream components can remain in place, so the transformation can be completed function by function. This approach enables a more gradual transition, and gives the organization time and opportunity to develop its expertise.

These approaches are not mutually exclusive: it's possible to use greenfield for some services, while also updating the existing infrastructure.

In this paper, we assume that you intend to ultimately virtualize the existing network. In that case, your journey begins with a single standalone virtualized network function (VNF).

The aim of Step 2 is to have a virtualized function, from a single vendor, in a production environment. The minimum requirement is a standardized hardware platform, and common software components such as a virtual switch (vSwitch), Type 2 hypervisor, and a host OS that delivers the performance required.

The question then is: Which network function should be the first to be virtualized?

A popular starting point is virtual customer premises equipment (vCPE). CPE is one of the least vulnerable places in the network to start. If there is a problem, any outage is confined to a single customer and the integrity of the network as a whole is not at risk. This makes it a relatively safe test bed for the organization’s ability to deploy VNFs, and a relatively safe place to make mistakes and learn from them. That said, customer service and the integrity of the customer’s network remain paramount. By partnering with enterprise customers on early deployments, service providers can minimize the risk of outage, win their understanding when things go wrong, and build alliances that will help to develop innovative services together in the future. vCPE can be the foundation for personalization services, including separate content filters for different devices, and end-to-end security management services.

The CPE often needs to be refreshed, which presents a natural opportunity to move it into the cloud, and virtualizing it will make future updates easier and seamless for customers. The virtual device provides scalability to meet growing bandwidth demands, driven by greater video consumption and an increasing number of smart consumer and IoT devices. It also lowers costs if the service provider is able to update a device without physically replacing it, or visiting it. The shift to a virtualized function is invisible to customers, who will receive the same, consistently high, level of service.

Instead of deploying physical firewalls or routers, vCPE enables the operator to use virtualized network functions, under the control of a software-defined WAN (SDWAN).

The integrated messaging service (IMS) is also a popular candidate for the first VNF, as a function that is relatively easy to virtualize.

Leaders in virtualization have gone on to show that even the evolved packet core (EPC) can be virtualized. AT&T, for example, launched virtual EPC in Europe in 2015 to facilitate global IoT traffic and connected cars, and has been using virtual EPC in the US for even longer[1]. Affirmed Networks has more than 50 carrier deployments for its virtual EPC solution[2]. The leading vendors of EPC software have already developed the next generation of solutions, so there are experienced partners to work with.

To begin with, the VNFs are isolated from each other. Typically, each virtualized service (such as vCPE or vEPC) will reside on its own infrastructure, to ensure it has the resources it needs.

Already at this stage of developing the CoSP cloud, it's possible to enhance the service experience of end customers. The ability to deploy VNFs quickly can cut the service delivery time, and improve the CoSP's competitiveness and attractiveness to prospective customers.

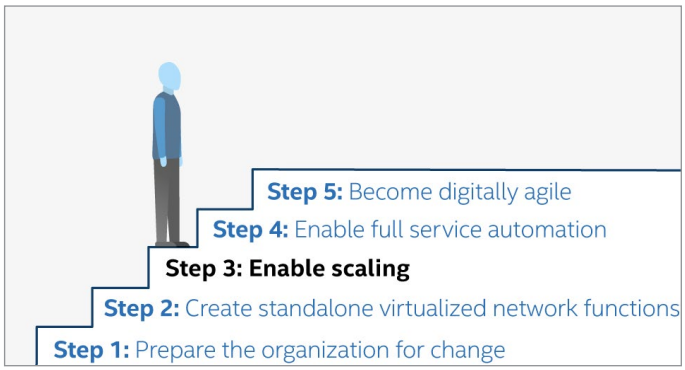
To find tools and resources to help you launch your first VNF, see:

- Intel® Network Builders Solutions Library: offers reference architectures, white papers, and solutions briefs to help build and enhance your network infrastructure, at any level of deployment.

Help!

It's difficult (and unnecessary) to achieve this transformation by yourself. Ask yourself: who can help? Vendors can demonstrate what works and will often be able to help you benchmark your progress against the industry as a whole, as they see it. Additionally, customers may be able to support you by partnering on test deployments.

Step 3: Enable scaling



Network traffic and control traffic are highly parallelizable workloads. To meet the demand, VNFs can be automatically created, destroyed and augmented with additional capacity where required. To deliver more sophisticated virtual functions, VNFs from multiple vendors can be automatically combined.

The reason the CoSP cloud is such a powerful platform for network services, including 5G, is its agility and scalability. Having deployed standalone VNFs, the next step is to enable real-time network reconfiguration, so that VNFs can be provisioned in response to demand.

VNF vendors use VNF descriptors with a common information model to articulate the resources the VNFs require and their SLAs. A common information model is also used for the capabilities and characteristics of the underlying infrastructure. Standardizing the way the VNF requirements and resources are described means it's possible to use vendor-neutral orchestration to place workloads where they will run better, matching VNF requirements to the infrastructure characteristics. The common information models help the virtual functions to interoperate with the traditional tools CoSPs use to manage their networks. This is an essential requirement for an effective CoSP cloud.

Network traffic and control traffic are highly parallelizable workloads, and platform telemetry can be used to sense oversubscription of shared resources to enable load balancing. The orchestration and management layers can allocate additional resources where they are needed, when they are needed. Auto-scaling decisions are based on network traffic and key performance indicators (KPIs). To meet the demand, VNFs are automatically created, destroyed and augmented with additional capacity where required. To deliver more sophisticated virtual functions, VNFs from multiple vendors can be automatically combined. The physical infrastructure serving the VNFs must be sufficient to meet the needs of the VNFs as they change.

The total network capacity can be increased by adding more general purpose hardware and VNF software licenses.

The dynamic way that resources are allocated and re-allocated can have significant implications for billing, so one of the key tasks in this part of the process is to link the virtual network to the billing functions in the BSS/OSS infrastructure.

When auto-scaling is implemented, analytics are not only being used to review the past but also to better predict the future. It becomes possible to plan capacity and right size the network and the data center, in line with business requirements.

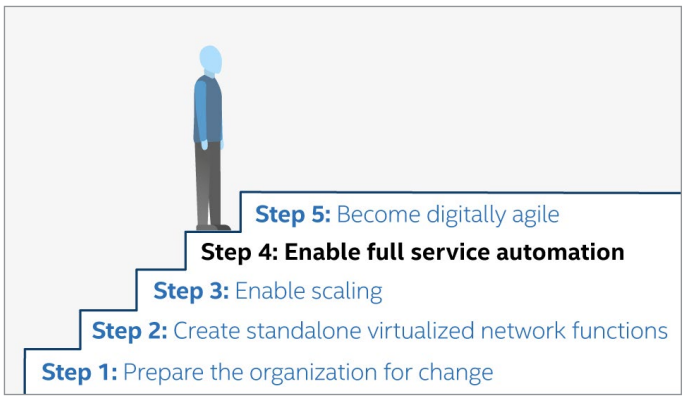
Tuning the infrastructure

At this stage of developing the CoSP cloud, service providers are able to monitor the VNF and the underlying hardware and software infrastructure (the NFV infrastructure, or NFVI) independently, so that they can both be fine-tuned for optimal performance. Virtualizing network functions adds a performance overhead, which can affect throughput, latency and jitter (consistency of throughput). The traditional CoSP method of performance optimization has been to accelerate the hardware and software at each point in the network, and this also applies here. The Data Plane Development Kit (DPDK) can be used to optimize the performance of packet processing software on general purpose hardware. It's also possible to further accelerate the workloads by adding hardware-assisted cryptography or compression, using Intel® QuickAssist Technology.

Find out more:

- Intel® QuickAssist Technology
- Data Plane Development Kit (DPDK)
- Webinar - Telco Cloud: Exploring the Tools and Technologies Powering the Ecosystem

Step 4: Enable full service automation



Enable the network to automatically take action to meet KPIs, in response to real-time performance metrics and service requests. Now that the network is able to provision and correct itself, it is a powerful platform for rapidly launching applications.

Being able to scale services is essential for service assurance, but to achieve the agility required for launching new services, CoSPs need to introduce full service automation. This enables applications to request services from the network, which can automatically adjust to meet their requirements, chaining together multiple VNFs as required. As an extension of this, customer self-service can be enabled, streamlining the provision of highly personalized services, cutting the cost of sale, and increasing customer satisfaction.

Solutions can be delivered in minutes or hours, rather than weeks or months, bringing the service provider within the faster timescales often achieved by OTT operators and cloud service providers. The enhanced scalability and flexibility as well as localized deployments ensure that the network remains resilient and performant at times of heightened demand, potentially differentiating the service provider from traditional communications and cloud service provider competition.

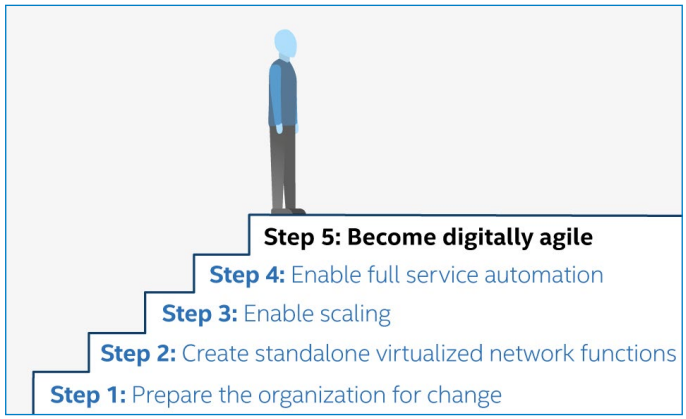
With an end-to-end view of the network, and the capability to program the entire network using well-known interfaces, resources can be optimally allocated and used, minimizing any waste without compromising on the customer experience.

In some cases, service fulfillment may require specific physical infrastructure to be provisioned (such as providing customer premises equipment for a new customer). In that case, the service orchestrator will need to connect to the service fulfillment tools to initiate that part of the set-up. To allow this, the virtualized network infrastructure should be seamlessly integrated with the OSS and BSS.

A prerequisite for achieving full service automation is to introduce an end-to-end network view which includes the backhaul. This enables applications and network services to take advantage of the entire network. This view can be achieved by using a federated model, in which an NFV orchestrator-of-orchestrators coordinates between the previously isolated domain orchestrators. Similarly, the SDN controller-of-controllers would have visibility of all the SDN controllers managing domains.

Now that the network is able to provision and correct itself, it is a powerful platform for rapidly launching applications.

Step 5: Become digitally agile



When the CoSP cloud is mature, service providers can innovate at cloud speed. The range of services that can be created is broad, spanning connection, performance, data management, and digital.

Achieving service assurance

New services will have the same needs for service assurance that existing services do, but service assurance is more challenging when using virtualized functions. With traditional architecture, you have a dedicated and integrated technology stack for a particular function. Using virtualized functions, the applications are decoupled from the underlying hardware, which is dynamically allocated and in which shared resources may be contested. Service assurance components must transform into common open standard components and interfaces, and integrate with traditional and next generation management systems. FCAPS (fault, configuration, accounting, performance, security) is considered as the foundation for SLAs, but meeting customer expectations in these areas will require a deep insight into the performance of the underlying technology platforms. Intel® Infrastructure Management Technologies enable you to monitor, manage and control the resources that support your data and services. You can identify, for example, memory corruption events or cache utilization rates and respond accordingly.

New service innovation

The range of services that can be created is broad, spanning:

- Connection: Services such as vCPE and NaaS that are related to optimizing connectivity and network services. An example of NaaS would be managing a virtual private mobile network for emergency services, fully isolated from the main network, to replace the expensive dedicated networks they now operate for themselves.
- Performance: Services such as optimized CDN and Software as a Service (SaaS) optimization, where the performance and delivery of content and apps is improved. This can draw on the service provider's key strength of having low latency across the network, and local presence across a wide geographic area.
- Data management: Services such as Internet of Things (IoT) sensor gateways and control nodes, and enterprise augmented reality. The opportunity here is to not only collect data, but also to analyze it and react to it with service modifications in real time. Further, only a communications service provider can likely provide end-to-end data sovereignty guarantees, which will be required for sensitive applications or highly regulated markets.
- Digital: This draws on the capabilities of the CoSP cloud to enable new classes of services, such as smart home, connected car, and dedicated industry solutions.

Source: STL Partners, HPE

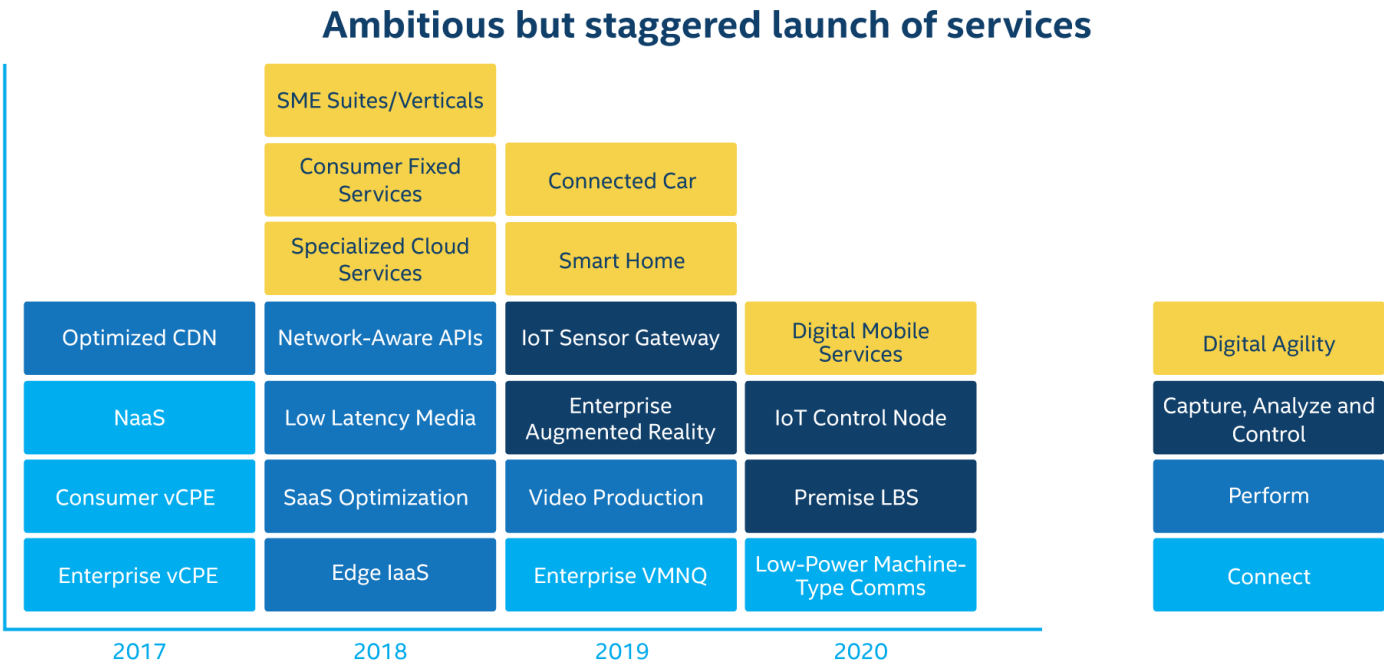


Figure 1. STL Partners has drawn up a four-year plan for launching 21 services, which it describes as "intentionally ambitious". Source: STL Partners, HPE

Throughout the evolution of the CoSP cloud, it's possible to launch value-added services on top of the low level network services. For example, a content delivery network (CDN) can be built that combines encoding, decoding and rights management services in the network. Services based on the vCPE can be launched as soon as the network capability is available, and Network as a Service (NaaS) can be launched on top of SDN infrastructure when it is available.

However, it is only when the CoSP cloud is mature that service providers are truly empowered to innovate at cloud speed, and to be digitally agile.

Figure 1 shows a timeline that STL Partners has used in modeling industry revenues over the next four years. Its rapid pace of deployment partly reflects the way that some services would typically be launched together, and the increased pace of innovation that CoSP cloud enables. Nevertheless, STL has described it as intentionally ambitious, and an illustration of the art of the possible. For more information on it, see the free webinar Profiting from NFV: Telco Cloud Revenue and Services Opportunities.

In the past, CoSP services have been developed over a period of months or years and at great cost. Failure was expensive and the organization was structured to avoid such risks. With the CoSP cloud, experimentation is not only affordable, but highly desirable. It's the only way to innovate. In such scenarios, if a project fails, its resources can be reallocated within the network, so the capital expenditure risk is

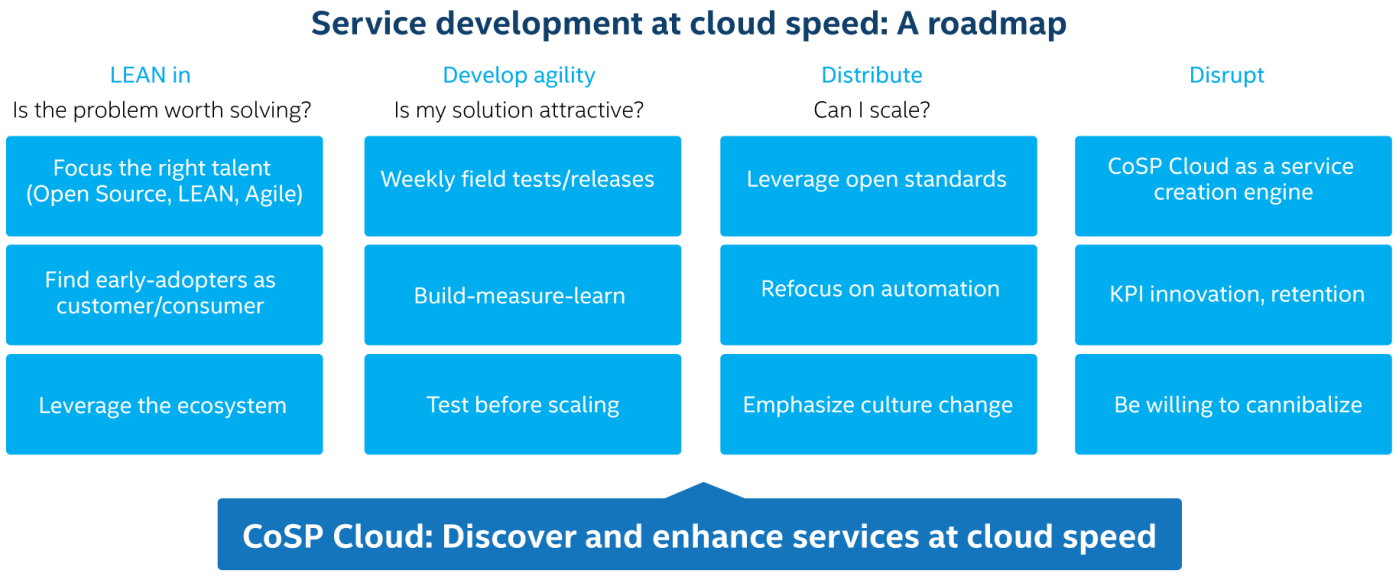


Figure 2: Using the road map can help to reduce the risk in deploying new CoSP services

relatively low, and the rapid deployment times mean that it's possible to get technical and market feedback fast.

Over the course of developing the CoSP cloud, the organization will have acquired many new skills in agile and lean software development. Those skills will prove valuable as the organization prepares to deliver new commercial services based on the new network capabilities.

It's been said that many start-ups don't fail because they run out of money: they fail because they run out of customers. It's important, then, to ensure that there is differentiation in the service and demand from the customer before investing too heavily in it. Figure 2 provides a roadmap for successfully deploying new CoSP cloud applications. The starting point is to validate that the problem is worth solving, working with customers and suppliers as appropriate to get an outside perspective and co-develop solutions. Customers who are on their cloud journey but want to retain their existing SLAs and guarantees are perfect candidates. Intel® Network Builders provides an ecosystem of NFV and SDN suppliers who can work with you to develop your solutions, together with Intel or alone.

The next step is to validate whether the solution is attractive using a highly iterative approach of testing, measuring and refining the solution over a number of weeks. Now you should know that there's a gap in the market (the problem is worth solving) and a market in the gap (your solution is attractive to the market). You can then proceed to scaling the solution, using open standards to accelerate deployment and protect the investment, and finally disrupting the market with the service launch.

For more information, see:

- **Webinar - Profiting from NFV:** Telco Cloud Revenue and Services Opportunities
- **Webinar - Telco Cloud:** Driving Service Transformation in the Telecommunications Industry

Summary

The CoSP cloud gives communications service providers a way to optimize for business transformation today and to be prepared to deliver on the potential of 5G, transforming their inflexible legacy networks into an architecture fit for tomorrow. It will enable them to handle the extreme demands of 5G, and empower them to quickly create and deliver innovative services. It will combine the cloud infrastructures that have proven successful for OTT service and cloud service providers, with the CoSP's unique strengths in low latency, locality, and end-to-end network control.

This paper has outlined the key steps in the journey, and the milestones in organizational and technical evolution that will be required (see table below). While it may not fully apply to every organization, it outlines the key issues and can help CoSPs to plot their own course, benchmark their success, and identify any potential pitfalls.

Checklist

Step	Milestone
1 ☐	• Begin organizational change. Adopt DevOps, agile and lean practices. • Get senior management commitment.
2 ☐	• Decide whether to virtualize existing services or start with NFV for new services. • Successfully deploy a virtualized function in a production environment.
3 ☐	• Add standard descriptors for VNFs and resources. • Enable automatic scaling of VNFs in line with demand.
4 ☐	• Achieve complete view of the network, using an orchestrator of orchestrators. • Enable the network to automatically take action to meet KPIs and deliver services.
5 ☐	• Rapidly launch a new service based on the virtualized network capabilities.

[1] http://www.fiercewireless.com/tech/at-t-launches-virtualized-packet-core-europe

[2] http://www.rcrwireless.com/20170305/evolved-packet-core-epc/20170305evolved-packet-core-epcvirtualized-epc-5g-internet-of-things-tag17