

Overcome the telco dilemma: reduce 5G infrastructure costs with open source

Executive summary

The telecommunication industry has always been at the forefront of technological advancements, with each new generation of mobile networks being faster and more reliable than the previous one. Despite being competitors, telecommunications providers shared a similar set of challenges with the transition from 3G to 4G and now to 5G. As a result, these firms are increasingly turning to collaborative efforts and shared investments in open source. This trend began with the development of network function virtualisation projects within the industry.

This whitepaper provides an overview of the challenges faced by telcos in building and maintaining 5G infrastructure. It discusses how certain open source technologies, including those offered by Canonical, can help reduce infrastructure costs and enable telcos to deliver more innovative services to customers.

Introduction

5G technology has the potential to revolutionise the telecommunications industry, offering high speed and connectivity for a wide range of devices ranging from radio access networks (RAN), user equipment (UE), and core networks. However, its adoption has proved difficult to say the least.

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Challenges faced by telcos in building and maintaining 5G infrastructure

The high costs associated with 5G infrastructure have been a significant blocker for telecom service providers (TSPs), hindering innovation and growth in this area for the data-intensive applications and services we have always dreamed of.

Building and maintaining 5G infrastructure requires significant investment in new hardware and software, as well as the acquisition of a limited and highly regulated frequency spectrum. Additionally, the deployment of more base stations and antennas required for 5G can be challenging in certain areas, such as rural or densely populated regions. Furthermore, the higher frequencies used by 5G can lead to interference from buildings, trees, and other obstacles. According to a McKinsey [report](#), there would be an inevitable increase in the infrastructure cost of 5G to cope with the growing traffic. The prediction is that the total cost of ownership for RAN would increase significantly in the period from 2020 through 2025, compared to the expected 2018 level. For instance, in a scenario that assumes 25 percent annual data growth, TCO would rise by about 60 percent. For 50 percent data growth, it might hit 300 percent.

In summary, telcos face several challenges in building and maintaining 5G infrastructure, including:

1. **High investment costs:** 5G infrastructure requires significant investment in new hardware and software.
2. **Limited spectrum:** The available spectrum for 5G is limited and highly regulated, which can make it difficult for telcos to acquire and use.
3. **Network coverage:** 5G requires more base stations and antennas than previous generations of mobile networks, which can be challenging to deploy in certain areas, such as rural or densely populated regions.
4. **Interference:** 5G operates at higher frequencies than previous generations of mobile networks, which can lead to interference from buildings, trees, and other obstacles.
5. **Security:** 5G networks are vulnerable to cyber attacks, which can compromise the security and privacy of users' data.
6. **Vendor Lock-in:** a telecom operator is heavily dependent on a single vendor for all of its 5G network infrastructure and services, making it difficult for the operator to switch to another vendor without incurring significant costs and disruption to its network.

How open source can help

Open source can help resolve these challenges by lowering costs, increasing innovation, providing greater flexibility, improving security, and enabling better interoperability. Many big operators have used the power of open source to virtualise up to 75 percent of the core network functions. This is paying off in big cost savings.

Open source can deliver the following benefits for telco companies looking to implement 5G:

1. **Lower costs:** Open source software can be developed and shared freely, which can reduce the costs of building and maintaining 5G infrastructure.
2. **Increased innovation:** Open source communities can collaborate and share ideas to develop new technologies and solutions for 5G infrastructure.
3. **Greater flexibility:** Open source can be customised and adapted to meet the specific needs of telcos and their customers.
4. **Improved security:** Open source software can be reviewed and audited by a wide community of developers and experts, which can improve the security and privacy of users' data.
5. **Better interoperability:** Open source software can be designed to be compatible with other systems and technologies, which can improve the interoperability and integration of 5G infrastructure with other networks and devices. Standards are agreed specifications which ensure the interoperability between multiple products.

Considerations for open source adoption in telco

With open source solutions, telecom operators can collaborate with other organisations and developers to create new and improved solutions, which can ultimately benefit the entire industry.

While the benefits are compelling, there are also risks associated with the adoption of open source technologies in the telecom industry. One risk is the potential lack of support for open source solutions. Unlike proprietary solutions, open source software is often developed and maintained by a community of developers rather than a single vendor. This can lead to a lack of support and a lack of accountability when things go wrong.

Another risk associated with open source technologies in the telecom industry is the potential for security vulnerabilities. Because open source software is open to the public, anyone can view and modify the code. While this can lead to improved security through increased scrutiny, it can also lead to security vulnerabilities if developers are not diligent in their coding practices.

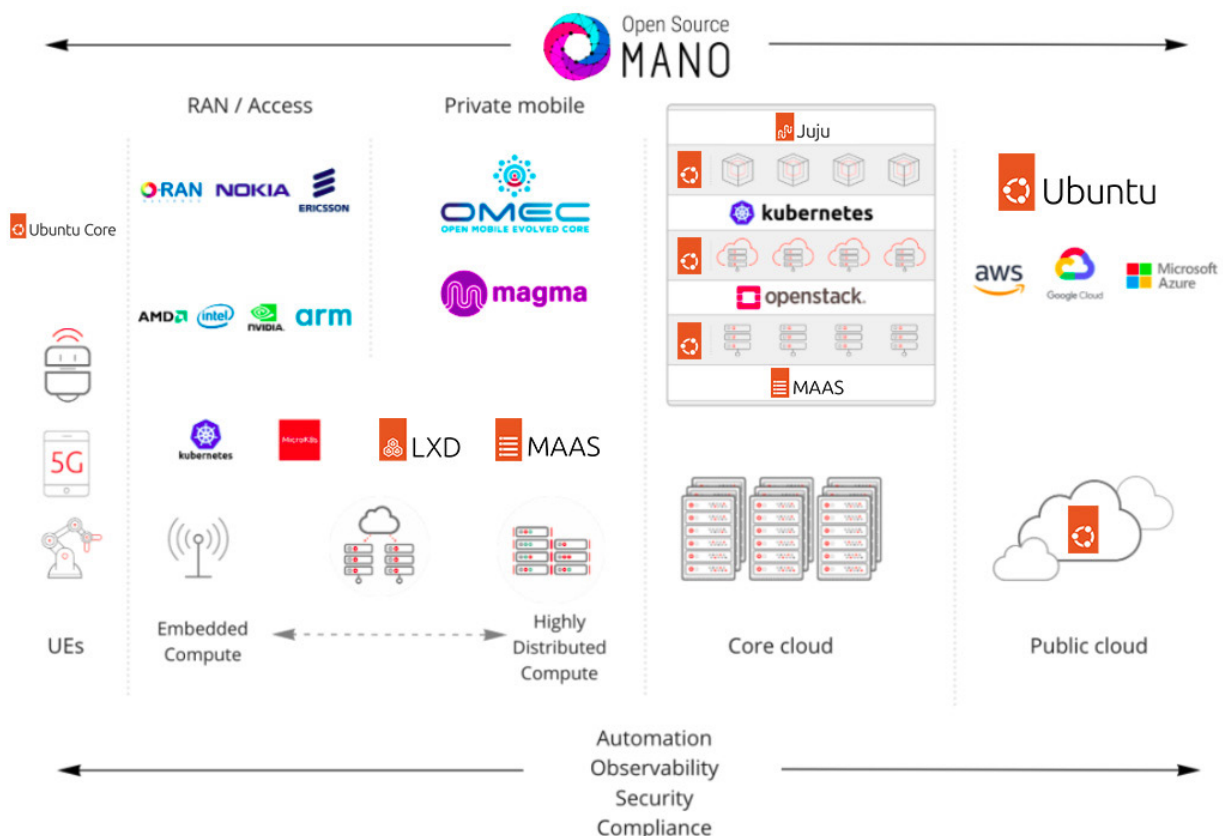
There are some specific considerations related to software provenance for open source in the telecom sector.

1. **Provenance:** All software should be obtained from a secure and reputable source - well-known open source communities or supported repositories.
2. **Licensing:** Open source software can come with different licensing requirements, and it is important to ensure compliance with these licences. Telecom companies must ensure that they understand the terms of the licences and that they are in compliance with them.
3. **Backporting:** In some cases, backporting may be necessary to make the software work with older systems. It is important to ensure that the backported software is still secure and compliant with licensing requirements.
4. **Ongoing maintenance:** Open source software requires ongoing maintenance and support to ensure that it remains secure and compatible with other systems. Telecom companies must consider the cost and availability of maintenance and support for the open source software they use.

Open source across the compute continuum

The Canonical journey to open source starts with Ubuntu and covers every part of the telco stack, from UE (user equipment) to the public cloud. Ubuntu is available in traditional server and desktop versions, as well as cloud-specific versions designed for use in Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP).

We also continually innovate with strategic ecosystem partners such as Intel, Nvidia, Arm, Dell, HPE, Public Clouds and many others to help our partners use open source across their products and solutions.



Canonical's offerings adhere to the following core principles for any open source offering:

Pure upstream	• Use the power of the community to bring value and avoid lock-in. • Consistent quick releases after upstream. • Contributions are upstreamed and not residing in separate branches.
Meet demanding telco requirements	• Performance - Low latency and real-time kernels, EPA support. • Longevity - 10 year maintenance on all ubuntu LTS releases. • Deployment flexibility - common open source tooling across multi-clouds. • Efficiency - systems management with automation to reduce complexity.
Secure	• Trusted source for open source to customers and partners. • Supported - CVE patching on the Ubuntu Main repository and 23,000+ open source software packages in the Ubuntu Universe repository for up to 10 years. • Ensure product and solution compliance to Government regulations in the US, EU and Asia (e.g. FIPS, NCSC TSR compliance, CIS hardening, etc).
Commercially supported	• Effective support models that bring "peace of mind" to production environments from the infrastructure up to and including the applications. • SLA-based phone and ticketing support. • Managed Services options for Infrastructure (OpenStack, Kubernetes, Ceph) and selective Applications.
Cost effective	• A single Ubuntu OS from development to production environments; no replatforming required from community to enterprise. • "Mutual success" commercial model with simple per node pricing (physical or virtual), enabling deploying larger, higher configuration nodes.

Canonical's open source technology primitives provide a unified approach, with Ubuntu for each network area. This enables partners to meet any current or future use-cases –from OpenRAN to next generation Core (5G and beyond) and AI at the edge.

Let's explore how open source is transforming the stack in specific areas.

Open source for RAN

The telecom industry is trying to achieve greater network interoperability with OpenRAN. With a virtualisation approach, operators can deploy RAN infrastructure more quickly and with fewer physical components, which can lower capital expenditure costs. The ability to use off-the-shelf hardware also reduces ongoing maintenance and support costs. This could lead to improved service for customers. One such example is single-tenant multi-vendor OpenRAN. It is a new approach to radio access network (RAN) technology that is gaining traction in the telecommunications industry. Single-tenant multi-vendor OpenRAN allows operators to use components from different vendors, creating a more open and interoperable RAN solution, unlike traditional RANs, where telco operators typically rely on a single vendor for all of their equipment, including base stations, radio units, and software.

Ubuntu for RAN infrastructure

[OpenRAN](#) is the most open and mobile-network-operator-friendly way of setting up the radio access network. It requires low latency and high throughput and is built based on custom L1/L2 implementations or using specialised platforms like [Intel FlexRAN](#) or NVIDIA Aerial which have both selected Ubuntu LTS for their SDKs. Canonical provides support for OpenRAN through [Ubuntu Pro](#), a comprehensive subscription for open source software security and compliance.

Benefits of Ubuntu Pro

1. **Security:** Ubuntu Pro comes with enhanced security features supported for 10 years, such as AppArmor and Kernel Livepatch, which help protect against vulnerabilities and exploits. This can be particularly important for telecom operators, who need to ensure that their networks are secure and free from cyber threats.
2. **Performance:** Ubuntu Pro is optimised for performance, with features such as low-latency kernel options and an optimised network stack. The performance gains can be seen in a demo where Intel and Canonical worked together to autoscale the DU (Distributed unit) component of the RAN by leveraging the real-time kernel and AI capabilities.
3. **Scalability:** Ubuntu Pro is designed for scalability, with support for containerisation and orchestration tools like Docker and Kubernetes. This can help telecom operators build and manage large-scale infrastructure for their networks.

Specifically for OpenRAN, Canonical caters to the following infrastructure requirements:

- Deployment of containers without any performance or security compromise.
- Support for various accelerators, such as FPGA, SmartNICs, GPUs.
- Single OS support for normal, low-latency and real-time kernel options.
- Management of thousands of sites in a fully automated fashion.
- API-driven re-building of a site which has completely different configurations.

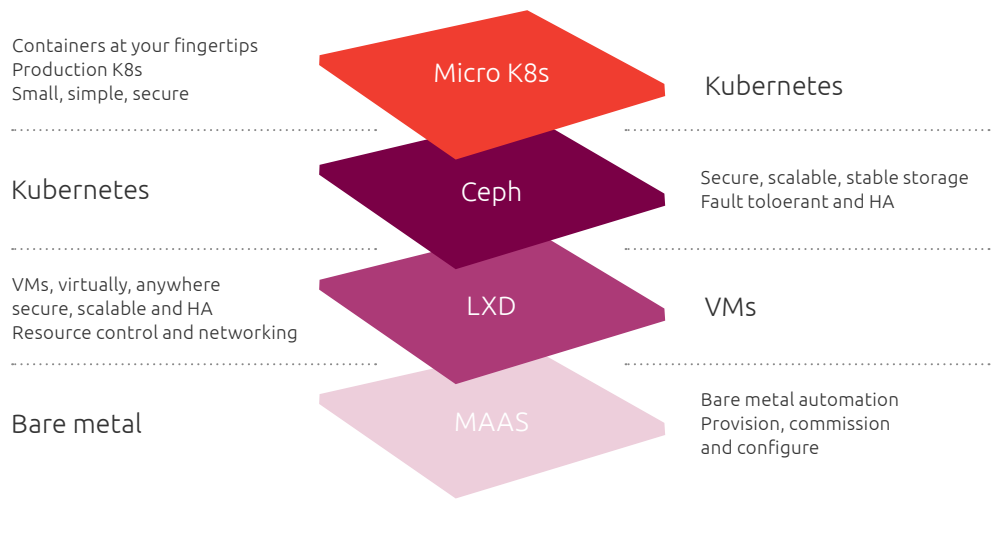
One of the best ways to satisfy these requirements is by using Micro clouds on Ubuntu, as it offers high performance with low computing capabilities at the edge.

Micro clouds

Micro clouds reproduce the APIs and primitives of the big clouds at the scale of the edge. A micro cloud strategy helps build an ecosystem of many interconnected systems over a complex network. Micro clouds are typically targeted to easily deploy and lifecycle manage distributed micro clouds - bare metal compute clusters of between 3-100. They use COTS servers to meet not only initial use-case requirements but also be able to easily cope with future use-cases, without having to retool or redeploy.

Micro clouds typically consist of multiple layers. Using open source-based infrastructure gives you the freedom of choice and the ability to craft your architecture to exactly match the requirements. Depending on the particular site purpose, there might be different combinations used from the following products according to the latency requirements.

A Canonical micro cloud stack consists of the following building blocks.

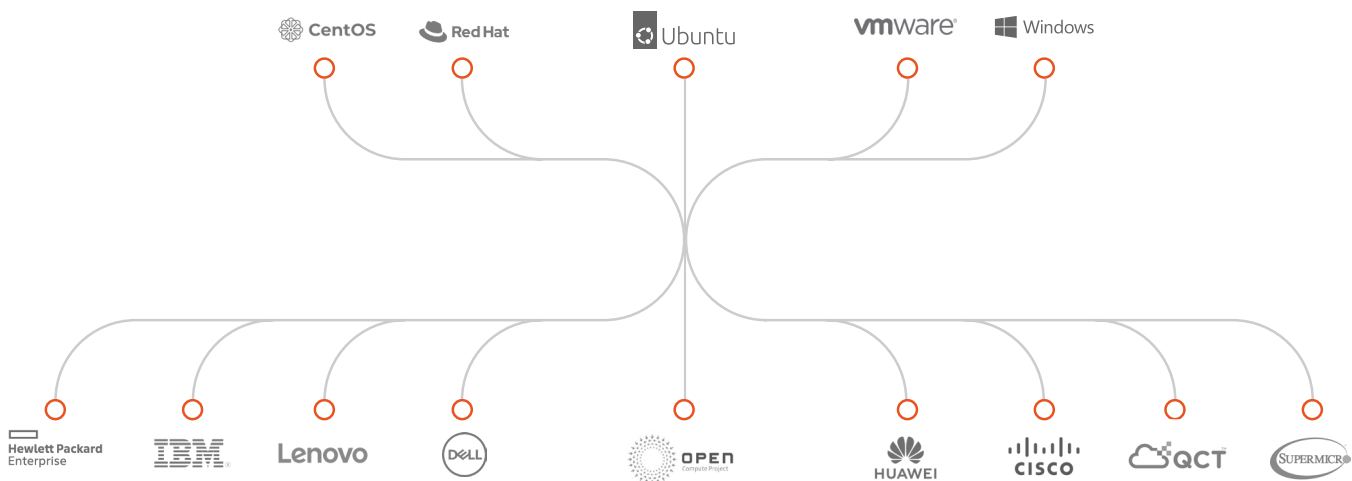


Canonical Microcloud Stack

1. [MicroK8s](#) is a low-ops, minimal production Kubernetes, for devs, cloud, clusters, workstations, edge and IoT. It's highly opinionated and provides:
 - a. Full Kubernetes in a single package
 - b. Pure upstream - no vendor-specific APIs
 - c. Edge, IoT and appliance compatibility
 - d. Zero-ops user experience, minimal intervention
 - e. Highly available configuration
 - f. Single-node and multi-node cluster support
 - g. Opinionated distribution with sensible defaults
 - h. Automatic updates and security patching
2. [Ceph](#): Canonical's software-defined storage solutions include all-open source components with highly automated operations and support to drive down the cost of ownership.

3. [LXD](#) is a next generation system container and virtual machine manager. It offers a unified user experience around full Linux systems running inside containers or virtual machines. It is image based with pre-made images available for a wide number of Linux distributions and is built around a very powerful, yet pretty simple, REST API.
4. MAAS: [Metal As A Service](#) turns your bare metal into an elastic, cloud-like resource. It is a tool designed for fast server provisioning. MAAS features include:
 - a. Bare metal cloud with on-demand servers
 - b. Remote edge cluster operations
 - c. Infrastructure monitoring and discovery
 - d. Ansible, Chef, Puppet, SALT, Juju integration
 - e. Super fast install from scratch
 - f. Custom images with pre-installed apps
 - g. REST API for provisioning
 - h. Disk and network configuration including machine cloning
 - i. Role-based access control (RBAC)
 - j. Hardware testing and commissioning

MAAS supports a wide range of operating systems installation on various types of bare metal.



MAAS: A single tool for multiple operating systems and bare metal

Open source for core - private clouds

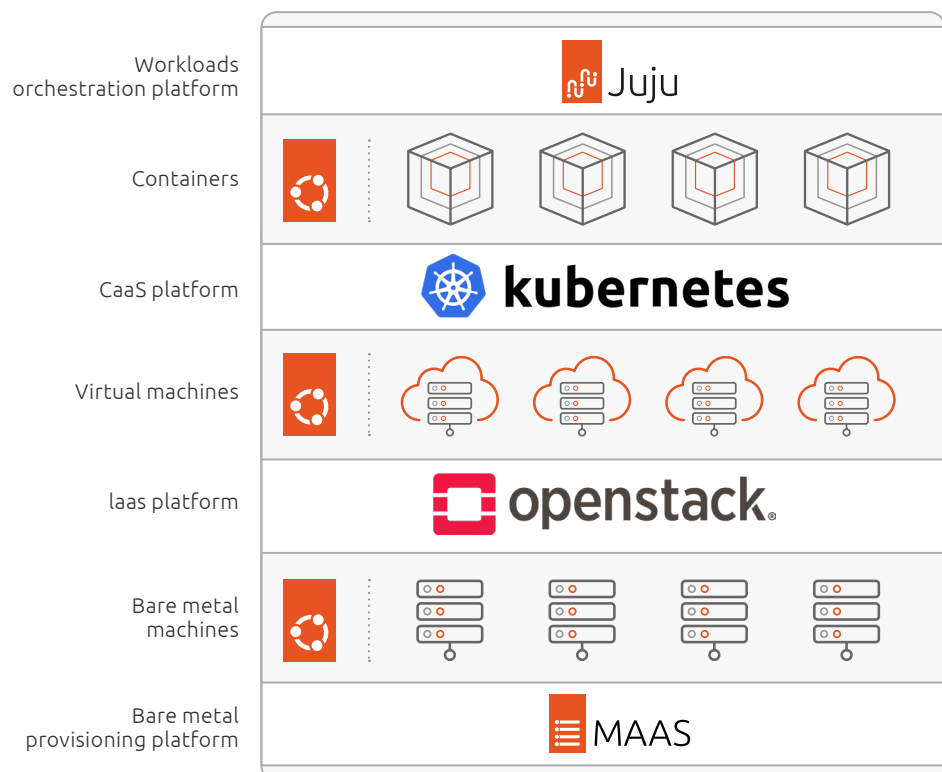
Canonical has enabled telecom operators to build and manage their 5G infrastructure more easily and effectively on each part of the telecom network, from user equipment to RAN and network core. The open source ecosystem is all about choice and the freedom to use tools you like as per your business needs. The core part of 5G networks uses private clouds for various reasons.

First, to handle an enormous amount of data traffic, the core network needs to be highly reliable and secure to ensure flawless data communication. Private clouds offer a higher level of security and control than public clouds, which makes them a better fit for hosting the critical infrastructure that forms the core of the 5G network.

In addition, private clouds can be customised to meet the specific needs of the 5G network, such as providing low-latency connectivity or supporting virtualized network functions. This level of customisation is not always possible with public clouds.

Canonical's stack for private clouds

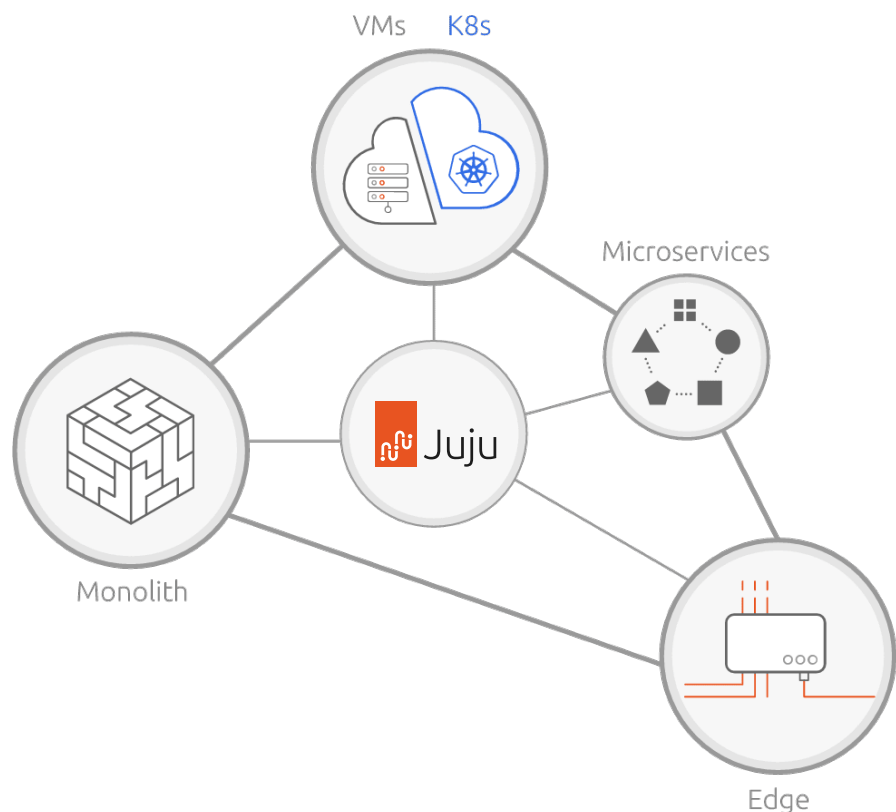
Among the many ways to build such infrastructure, the most popular with Canonical's partners has been a stack that combines MAAS, OpenStack, Kubernetes and Juju, Canonical's workloads orchestration platform.



Canonical stack for private clouds

1. **Juju:** Juju is an open source application modelling tool that is used to deploy and manage applications in a cloud environment. It has been used by many telecom operators to deploy and manage their 5G infrastructure components, such as network functions virtualization (NFV) components. Juju uses [Charmed Operators](#), or 'Charms', to deploy cloud infrastructure and applications and manage operations from Day 0 through Day 2. A Juju Charm is a structured bundle of YAML configuration files and scripts that enables Juju to deploy and manage the software component as a service.

In the context of Core Network Infrastructure, Juju provides a high level of automation at scale and is successfully used by many Tier 1 network operators and adopted by ETSI as part of ETSI Open Source MANO (OSM).



Juju : Operator lifecycle manager

2. **Charmed Kubernetes:** It is an open source container orchestration solution that is used to automate the deployment, scaling, and management of containerised applications. It offers model-driven, declarative cluster operations and features such as role-based access control, secure networking, and encryption. Charmed Kubernetes gives you perfect portability of workloads across all infrastructures, from the core network to the public cloud. With a strong focus on CNF and AI/ML, Ubuntu is the platform of choice for K8s in telco. Key features of Charmed Kubernetes from a CNF perspective include:
 - a. Support for third-party components and services
 - b. GPU acceleration
 - c. Pluggable CNI, CSI, CRI & observability stack
 - d. Support DPDK, CPU pinning, SR-IOV
 - e. High available configuration
 - f. Single-subscription enterprise support

Canonical has been working to improve the integration between OpenStack and Kubernetes, making it easier to deploy and manage containerised applications on private clouds. This work is helping to make private cloud infrastructure more accessible to organisations for critical applications like the core of the 5G network. Charmed Kubernetes and Charmed OpenStack both have a large community of developers working to improve and extend their functionality. This can help telecom operators stay up-to-date with the latest best practices and innovations in private cloud infrastructure.

3. **Charmed OpenStack:** Canonical Charmed OpenStack is an OpenStack distribution engineered for the best price-performance by putting full automation around its deployments and exposed deployment operations. It is a popular open source cloud computing platform that is used by many telecom operators to build and manage their infrastructure. Key features of Charmed Openstack from a VNF perspective include
 - a. Model-driven deployments and operations
 - b. 24/7 support for latest releases and upgrade paths
 - c. IaC approach and CI/CD integration possibilities
 - d. EPA capabilities like (SR-IOV, DPDK, CPU pinning, NUMA topology, Hugepages, GPU and PCI passthrough, OVS hardware acceleration)
4. **MAAS:** As we discussed earlier in this paper, Metal-as-a-Service (MAAS) is another open source technology that is used to provision and manage physical servers in a data centre. It has been used by many telecom operators to manage their 5G infrastructure, including their edge servers.

Canonical also offers open source technologies for telco operators that are looking to benefit from the scalability of the public cloud.

Public clouds

The telecom industry is leveraging public cloud services to optimise their operations, reduce costs, and improve customer experiences. Public clouds offer the telecom industry the ability to quickly and easily provision computing resources on-demand and at scale, without having to invest in expensive infrastructure. Ubuntu is known for its reliability, security, and versatility, making it a popular choice for telecom companies that require a stable and secure operating system to run their applications in the cloud.

Canonical provides several tools and services for deploying and managing applications on Ubuntu in public clouds including Juju, MAAS, OpenStack, Kubernetes. These tools and services help simplify and automate the Ubuntu-based public cloud environments, and provide users with the support and expertise needed.

1. Users can choose the version of Ubuntu that best suits their needs and environment, including Ubuntu Desktop or Server, and Ubuntu for public clouds. The detailed offerings in terms of security and managed services are given in the following series of blogs: Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP)
2. Ubuntu is known for its strong security features, including regular security updates and patches. This helps ensure that Ubuntu-based public cloud environments remain protected against threats.

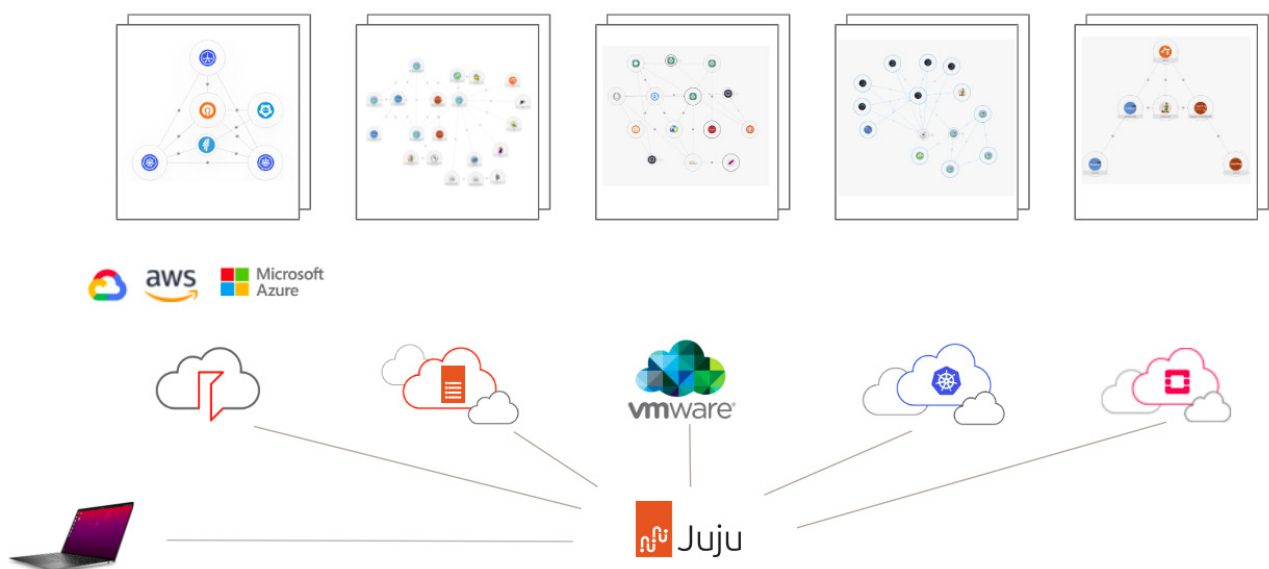
3. Ubuntu is available under a permissive open source licence, which means that it can be used, modified, and distributed freely. This can help reduce the overall costs associated with licensing.
4. Ubuntu benefits from a large and active open source community, which provides a wealth of knowledge, support, and resources for users of Ubuntu in public clouds. This community-driven approach helps ensure that Ubuntu remains relevant and up-to-date in the fast-paced world of public cloud computing.

Hybrid clouds

Despite the appeal of the public cloud's scalability and other benefits, telco network operators are not expected to move their entire compute pool to the public cloud. A hybrid cloud architecture combines the usage of a private cloud and one or more public cloud services with a workload orchestration engine between the platforms. It may provide maximum OpEx efficiency when executed in the right way. Hybrid clouds are ideal for workloads with diverse requirements. In the telco context, this could be a way to address seasonality and traffic spikes.

Open source solutions for hybrid clouds

For the management challenges of hybrid environments, Juju plays the part, as there is no one size fits all cloud architecture. Juju or JAAS (Juju as a Service) automation provides a consistent approach that natively supports all major hyper scalers API's and is a de-facto standard tool for micro clouds in edge use cases. As a result, for Charmed Kubernetes and Charmed OpenStack, you don't need separate code or configuration to migrate a workload from one environment to another. Moreover, you can scale a workload running locally to burst some Kubernetes pods to the cloud and instantly increase your service capacity.



Juju for hybrid multi-clouds

Orchestration at the top

The service orchestration at the top of a Telecom network is essential for managing the complexity of modern networks and ensuring that network functions are effectively delivered. It involves automating the processes of network service design, creation, activation, and assurance across multiple clouds. The challenges that service orchestration is solving include:

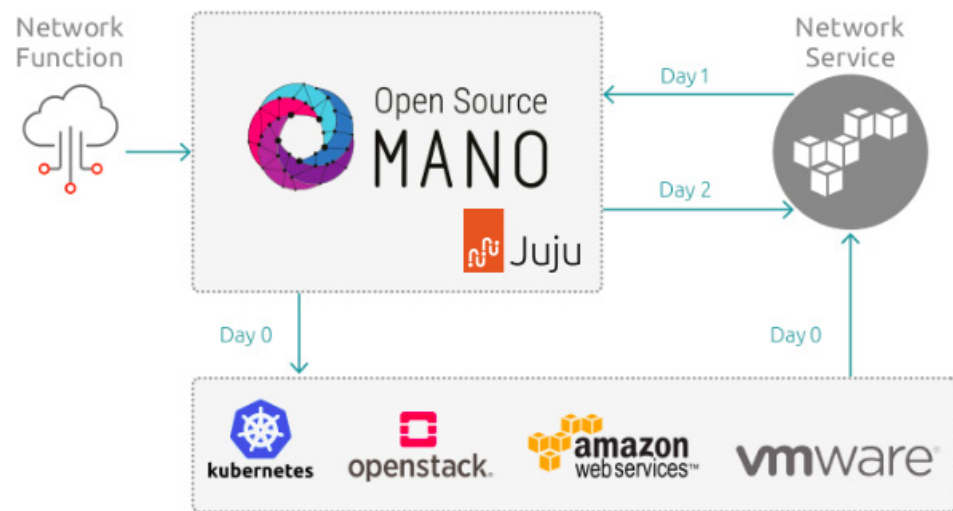
Network complexity	Service orchestration provides a unified view of the complex network, allowing service providers to manage and automate services across multiple domains.
Automated onboarding	Onboarding of network services by providing an open and standardised API for integrating with various network elements.
Service assurance	Service orchestration provides end-to-end visibility and control over services, allowing service providers to identify and resolve issues quickly.
Lifecycle Management	Manages the service deployment and an end to end lifecycle. It enables Day 0 to Day 2 operations like deployment, scaling, monitoring and termination.
Service Monitoring	It displays real-time service performance and usage data. It enables the monitoring of service health and performance, and facilitates the detection and resolution of issues proactively.

Canonical's Charmed Open Source MANO

Charmed Open Source MANO (OSM) is an open source ETSI based MANO solution delivered by Canonical that provides service orchestration capabilities for Telecom networks. It is responsible for the Management and Orchestration (MANO) of Network Functions and provides a framework for deploying and managing NFV components in a 5G infrastructure. Some of the key capabilities of Charmed OSM include:

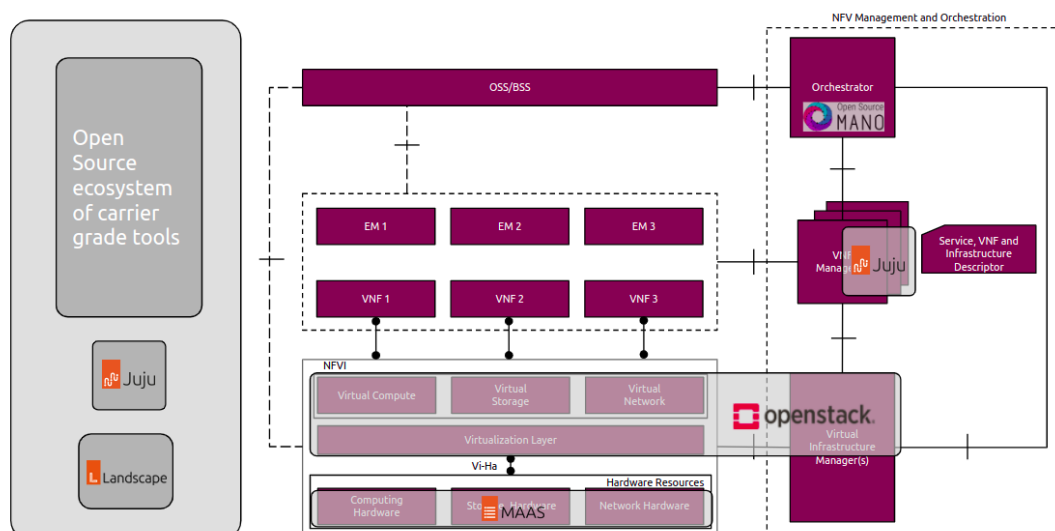
1. Automated deployment and management of virtualized and cloud-native network functions.
2. Support for a wide range of network functions, including both commercial and open source solutions.
3. Integration with cloud management platforms, such as private clouds OpenStack and Kubernetes and Public clouds like AWS, and GCP.
4. Customisable and modular architecture, allowing Telcos to modify according to their needs.
5. Support for multi-tenancy and RBAC, allowing Telcos to manage multiple customers or user groups within a single OSM deployment.

6. Juju in OSM provides the features of installing, maintaining, upgrading, and integrating applications across Kubernetes clusters, containers, virtual machines, and bare metal machines, on public or private clouds.
7. Facilitate greater adoption with Day 0, Day 1 and Day 2 operations of network functions
8. Enterprise support for deployment, management and [onboarding of network services](#).



Open Source MANO - Network functions onboarding tool for multi clouds

9. ETSI-based project and ensuring interoperability with other NFV components by following the standards. The following is the mapping of the Canonical portfolio with ETSI-defined architecture.



ETSI mapping to Canonical's open source products

Service orchestration tools like Charmed OSM are essential in automating the onboarding of network services in telecom networks. Charmed OSM is helping Telcos reduce costs by providing a flexible, automated, and cost-effective solution for managing hybrid network functions.

Wrapping up

In conclusion, building and maintaining 5G infrastructure poses significant challenges for telcos, but open source can provide innovative solutions to these challenges. Canonical's deployment tools, and ongoing support and maintenance services play an important role in mitigating risk and ensuring the performance and reliability of products.

The future of telecom infrastructure is likely to be heavily focused on virtualisation, automation, and software-defined networking (SDN). This will involve the use of cloud-native technologies, such as Kubernetes and OpenStack, to enable more flexible and scalable telecom networks.

Canonical and open source can help in improving the costs of telecom infrastructure in several ways:

1. **Reduced licensing costs:** open source software, such as Ubuntu, OpenStack, and Kubernetes, is typically available under permissive licences that allow for free distribution and modification. This can help reduce the costs associated with licensing proprietary software.
2. **Increased automation:** open source tools like Juju and MAAS can help automate the deployment and management of telecom infrastructure, reducing the need for manual intervention and the associated costs.
3. **Improved efficiency:** by using cloud-native technologies, telecom operators can achieve higher levels of resource utilisation and efficiency, reducing the overall cost of infrastructure.
4. **Vendor flexibility:** open source technologies provide greater flexibility in vendor selection, allowing telecom operators to choose the best solutions for their specific needs and budget.
5. **Community support:** Canonical works closely with open source communities to provide a wealth of knowledge and support, allowing telecom operators to benefit from the expertise of a broad network of developers and users.

Overall, the use of open source software and cloud-native technologies can help reduce the costs of telecom infrastructure, especially with increased demand for 5G. Canonical and other open source companies are at the forefront of this movement, providing the tools, services, and expertise needed to build and manage cost-effective and efficient telecom infrastructure. By working closely with ecosystem players and offering a range of services and solutions, Canonical drives innovation by facilitating the reliable way to access a reliable set of trusted open source packages and capabilities.

[Reach out](#) to us if you are interested in any of the open source and supported solutions mentioned in this whitepaper

Further reading

<https://ubuntu.com/telco>

<https://ubuntu.com/engage/telecom-ai-guide>

<https://charmed-osm.com/>

<https://ubuntu.com/engage/telco-network-functions-whitepaper>

https://ubuntu.com/engage/osm_in_openran

[Contact](#) us to learn more.

