

CREATING VIRTUAL CLOUD INFRASTRUCTURES

By Mauro Campanella, FEDERICA project, GARR, Italy

In recent years, telecommunication networks have evolved into global communication infrastructures, comprising not only data transmission circuits and network equipment, but also computing elements and the associated software to control, monitor and manage the services they offer to users. The National Research and Education Networks (NRENs) are excellent examples of this evolution towards hybrid (packet- and circuit-based) modern communication infrastructures.

Virtually clouds

Recently, “virtualization” and “clouds” have become hot topics. Virtualization is considered in FEDERICA as the ability to create a virtual instance of a physical resource, both in terms of computing and network environments. Virtual resources (e.g. virtual circuits, disk partitions, virtual computers)

are usually created by segmenting (or ‘slicing’) a physical resource. Recent advances in virtualization technologies have been enabled by powerful ASICs and CPUs. Using the hardware of a single computer, it is easy to host multiple virtual machines, each with their own operating system. All machines can also be active at the same time, and fair sharing is enhanced by the virtualization-aware hardware.

The key enabler is usually a thin software layer (e.g. XEN, VMware or KVM), which abstracts the physical resources to a standard (virtual) system. Such advances create more degrees of freedom for end users, allowing e.g. migration to a different hardware platform without the need to upgrade or modify their operating system or application.

Virtualization also enables optimal use of physical resources, the ability to collapse services whilst maintaining dedicated (virtual) machines for each service, and new functionalities, such as better resilience, by using live migration capabilities in the case of failures. Virtualization is also applicable to networks, where the routing, switching and control functionalities can be virtualized. More than one Virtual Router can be active in the same node without influencing other processes. Network virtualization technologies like MPLS (Multiprotocol Label Switching) and VLANs are examples of circuit virtualization already common in commercial networks.

In computers and networks, virtualization technologies have enabled new service models in which the physical infrastructure can be quickly organized into virtual infrastructures and user services. These services are easily accessible through the network and can be effortlessly adapted to a wide range of user requirements (different operating systems, numbers of hosts, applications and even network topologies). Such offerings are known as “cloud services” and are based on computing elements. The term “cloud” denotes their ‘virtual’ nature, since they are decoupled from a physical location.

Introducing FEDERICA

The EC project FEDERICA is an example of a large-scale infrastructure in which virtualization is a foundation: it is available in all its elements. The project is similar to other initiatives, such as PlanetLab and OneLab Europe that are also based on system virtualization but it extends the capacities offered to full network control and arbitrary topologies between the virtual nodes.

FEDERICA has the scope to support experiments on the current and future Internet. It “slices” its

substrate according to users' requests, providing "virtual infrastructures" (slices) made up of virtual computing and network resources. Users may fully configure and control the resources in their assigned slice, also performing disruptive experiments. The project also places a particular focus on the reproducible behaviour of each resource: a key issue in a virtual environment. Such polymorphic capabilities of the substrate offer a working example of the role of virtualization in the future Internet, and how "cloud" infrastructures made of virtual computing and network resources can be created on-demand.

IaaS, PaaS, AaaS

Cloud services are usually referred to as services of three types: Infrastructure as a Service (IaaS, e.g. Amazon Amazon EC2); Platform as a Service (PaaS, e.g. Windows Azure); and Application as a Service (AaaS, e.g. Google apps). An infrastructure based on the FEDERICA architecture can offer basic samples of all three by creating an appropriate slice, also in the Wide Area environment. When massive amounts of resources are requested, a large computing centre or a commercial offering may be needed.

These exciting developments and new virtualization capabilities bring associated research and implementation challenges: interoperability between different types of "clouds" in different administrative domains requires new standards. Guaranteed Quality of Service implies an understanding and control of virtual resource behaviour. And finally, avoiding the complexity of the global physical infrastructure can simplify management of the resources required for applications.