

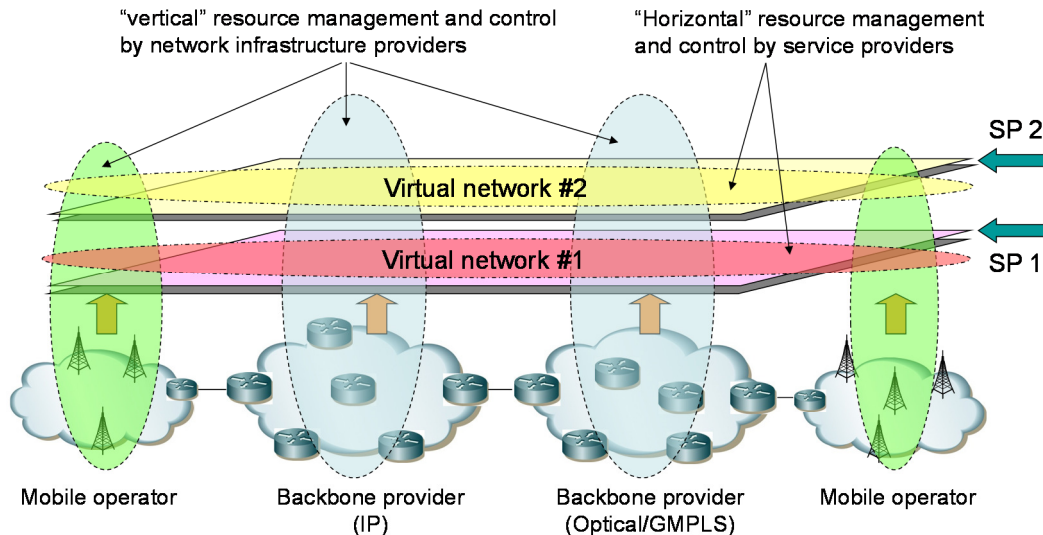
The Internet, which is a global heterogeneous network composed of diverse wireless mobile access, home broadband and core IP/optical networks, is a, perhaps, *the*, critical element in future global ICT strategy. However, the way the current Internet is managed and the way it provides services cannot match the fast changing and more demanding requirements imposed by user-end applications. *Network virtualisation*, coupled with an effective and efficient approach to *manage* virtualised resources is a key solution to the problem.

Therefore, the overall objective of the EVANS project is to *accelerate the transfer and deployment of research knowledge between European countries and China in order to obtain better understanding of network virtualisation for future Internet infrastructure*. In particular, the knowledge transfer, mainly as a result of researcher's mobility, will focus on *the management aspects* of the virtualised network resources across heterogeneous networks and services rather than the virtualisation techniques of physical network resources. The latter has attracted much attention in recent years whereas the former is less concerned in the current research community. As more and more network resources, amongst other computational and storage resources, are virtualised, there arises an imperative issue of how to manage these resources.

On one hand, it is natural and necessary to have an end-to-end virtualised network platform to interconnect all other (shared) virtual resources to offer high flexibility to networked systems and services. On the other hand, after enjoying years of rapid growth, the significant technological progress of the Internet has been slow down. This is largely due to the existence of "tussles" between multiple stakeholders with different and sometimes conflicting goals and policies, which makes the alternations to the current Internet being limited to simple and incremental updates. This status has impeded the introduction and deployment of both new network technologies and new services at the Internet scale. To tackle this problem, network virtualisation paradigms have been proposed as a powerful technology for future Internet architecture thanks to its capabilities in supporting flexibility, diversity support and increased manageability.

There are two types of important stakeholders in the Internet based business market: infrastructure providers (InP) that own and manage the physical network infrastructure, and service providers (SP) that provide end-to-end services to end users without necessarily owning any physical infrastructure. Instead, SPs may "rent" network resources from the underlying InPs according to their specific business and service plans. In virtualised networks, an SP typically creates its own virtual networks by "concatenating" the rented (virtual) resources from multiple InPs in order to offer Internet-wide services. On the other hand, an InP needs to concern how to optimally slice its resources, for instance bandwidth, CPU time, memory etc, to heterogeneous requesting SPs, such that the overall infrastructure resources can be efficiently allocated for maximising its own profits. Therefore, two orthogonal dimensions of management tasks in a virtualised network environment will be tackled in the EVANS Project. Firstly, an InP needs to manage its own physical resources, which involves tasks such as how to describe the physical resources, how to slice them, how to handle incoming resource requests from heterogeneous SPs and allocate virtual resources in a cost-efficient way, etc. This project names this type of management as vertical resource management for easy reference. Another dimension of network management is how an SP manages and controls its virtual network resources which are rented from multiple heterogeneous InPs in order to offer its specific services across the corresponding geographical area. This type of management is called horizontal resource management, in this project.

As far as the types of network platforms are concerned, there are not only fixed IP networks for the core networks that constitute the Internet backbone, but also various broadband wireless network technologies for mobile access in addition to the conventional fixed access. In order to provide an end-to-end service solution to end users, wireless mobile access network technologies have to be considered as an increasing number of users use mobile devices to get access to the Internet.



In summary, as depicted in the figure above, the EVANS project aims to investigate into a network virtualisation environment over a fully heterogeneous network infrastructure and to research on an integrated network management system across different types of network platforms. The project will investigate into two complementary aspects of such an integrated network resource management system: (1) vertical management of virtualised resource for service heterogeneity, which is performed by infrastructure providers, and (2) horizontal management of virtualised resource for network heterogeneity, which is for the interest of service providers.

The Project has successfully finished all its tasks and achieved the planned objectives, including the final evaluation of the system. About 90 joint publications have been generated out of the above research as mainly driven by staff/student exchanges.

Consortium:

Partner name	Short Name	Country
University of Essex	UEssex	UK
Universitat Politècnica de Catalunya	UPC	Spain
Simula Research Laboratory	SRL	Norway
University of Surrey	UniS	UK
Tsinghua University	THU	China
Beijing University of Post & Telecommunications	BUPT	China

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