

# Virtualized environments, from connectivity to services

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Virtualization technologies have revolutionized the way services and networks are conceived and designed by cutting down the cost and reducing complexities of infrastructural configurations for service platforms or network elements. These technologies are becoming more and more adopted in various domains in the field of telecommunications, from radio access networks to the Internet of Things.

Despite some clear differences in the way these technologies are being implemented in various domains, a common framework may abstract the way these technologies operate. In particular, virtualized environments usually involve three well-defined layers:

- A *Physical layer* containing the physical resources (e.g., computation, storage, and captor or actuator)
- A *Virtualization layer* managing virtual elements (e.g., Virtualized Network Functions, Virtual Machines, and Virtual Objects) that relies on the physical resources for their instantiation
- A *Service layer* including the services that orchestrate or chain these virtual elements to build end-to-end solutions, answering to user requirements and delivering a measurable value-proposal to services' users.

This common framework is illustrated in Fig. 1 below.

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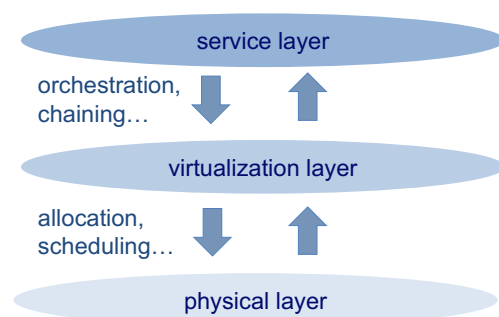
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Regardless of the application domain in which virtualization technologies are being introduced to, each of the previously mentioned layers raises some common challenges. In the physical layer, the main research topics concern with the scaling, energy consumption, system performance, or reliability issues. In the virtualization layer, modeling of loosely coupled virtual elements, semantics analysis, and self-management are among the most challenging issues. Concerning the service layer, research is investigating on-demand service composition to answer users' needs or expectations—and the way these needs may be detected or expressed is among the key challenging issues (e.g., through intent-based mechanisms or relying on AI-powered data insights).

Of course, these layers are not independent but interrelated. The main issue between the service and virtualization layers will be about composing, orchestrating, or chaining various virtual elements to provide value-added services, while ensuring that these virtual elements remain autonomous and loosely coupled. Whereas the main issue between the virtualization and physical layers will be allocating and scheduling physical resources to execute a virtual element, while ensuring a continuous monitoring to detect and circumvent potential physical failures.



**Fig. 1** Virtualized environments design pattern

The purpose of this special issue is to illustrate some of these challenging issues raised by virtualized environments within three specific domains:

- Connectivity, especially in the scope of 5G
- Cloud computing and web services
- Internet of Things (IoT)

This issue includes five enhanced versions of the best papers selected from the 19th international conference on Innovations in Clouds, Internet and Networks (ICIN 2016), completed by one additional paper accepted through a dedicated call for papers. A brief description of the selected articles is provided below.

The first paper, entitled “Cloud RAN Challenges and Solutions” and authored by Rajeev Agrawal, Anand Bedekar, Troels Kolding, and Vishnu Ram, addresses the key technical challenges for the virtualization of the radio access network (RAN) and proposes solutions to assure real-time scalability and performances in relationship with the adjacent network elements or hosting environments.

The second paper, entitled “Penalty Migration as a Performance Signaling Method in Energy-Efficient Clouds” and authored by Marat Zhanikeev, is focused on optimizing the mapping between the virtualization and physical layers for energy-aware Cloud Computing by proposing a new method for allocating and reallocating virtual machines on active physical machines.

The third paper, entitled “Consensus-Based Resource Allocation Among Objects in the Internet of Things” and authored by Virginia Pilloni and Luigi Atzori, develops the vision of virtual objects for virtualizing the physical objects of the Internet of Things and proposes a distributed algorithm to allocate the necessary resources from the physical layer (i.e., real-world objects).

The fourth paper, entitled “Subjective Perception Scoring” and authored by Jörg Niemöller and Nina Washington, is focused on the service layer, especially for connectivity services. It proposes a new method to measure and predict user’s satisfaction, relying on data analytics correlated with psychological factors, that also enable to assign a subjective scoring to network assets.

The fifth paper, entitled “XMPP-based Network Management infrastructure for agile IoT application deployment and configuration” and authored by Enrico Ferrera et al., is addressing the issue of service composition and management for the Internet of Things. It proposes a comprehensive architecture for building and operating IoT services based on virtual elements.

The last paper, entitled “Cross-Domain Identity and Discovery Framework for Web Calling Services” and authored by Ibrahim Tariq Javed et al., develops the vision of distributed virtual computing elements named “hyperties” and details how this vision contributes to solve the issue of identity management for web communication services.

We would like to express our special thanks to Prof. Guy Pujolle, the Editor-in-Chief of *Annals of Telecommunications*, for his great support and efforts throughout the whole publication process of this special issue. We are also grateful to all the authors for submitting and improving their papers, as well as to the reviewers for their professional and timely work that was a great help for the authors to enhance their papers. Our sincere thanks go to Nicolas Puech and to the editorial staff especially Ms. Alexia Kappellmann and Ms. Véronique Charlet, and to the Springer Journal Editorial Office for their continuous support to publish this special issue, as well as to Ms. Dina Hussein for her precious help.