Network Function Virtualization

Internet of Things

Rahul Shandilya

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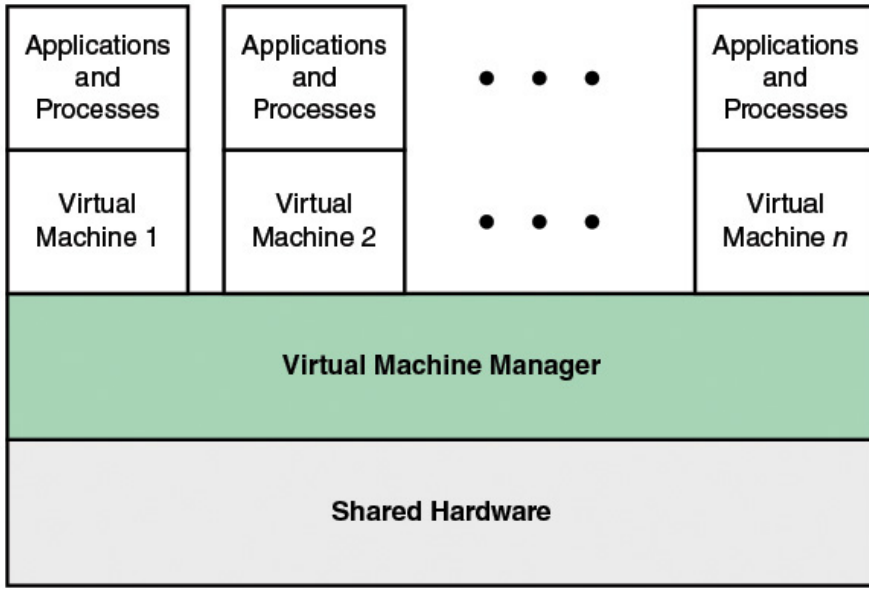
- The solution that enables virtualization is a *virtual machine monitor* (VMM), or commonly known today as a *hypervisor*. This software sits between the hardware and the VMs acting as a resource broker.


Applications and Processes
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Virtual Machine 1
Virtual Machine 2
Virtual Machine n
Virtual Machine Manager
Shared Hardware

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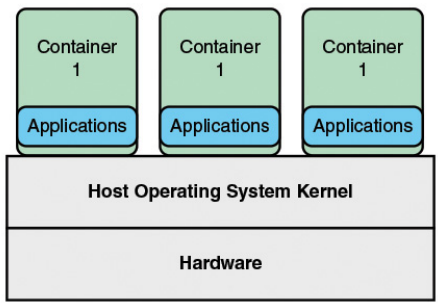

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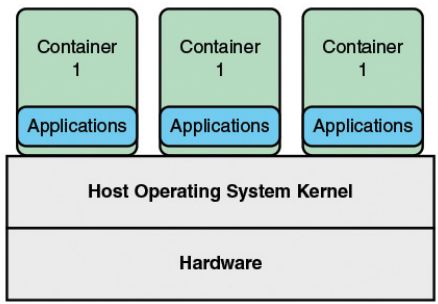

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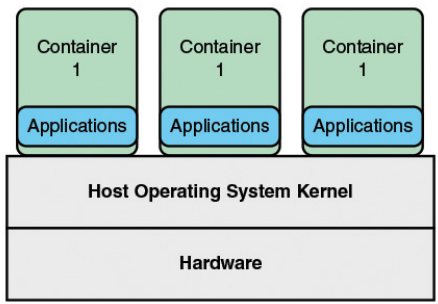

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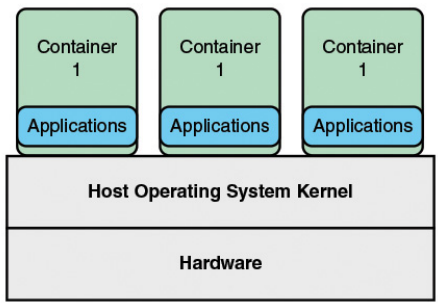
- An OS can have many containers running on top of it, compared to the limited number of hypervisors and guest operating systems that can be supported.



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The NFV approach moves away from dependence on a variety of hardware platforms to the use of a small number of standardized platform types, with virtualization techniques used to provide the needed network functionality.

NFV Concepts

NFV is a significant departure from traditional approaches to the design, deployment, and management of networking services. NFV decouples network functions, such as Network Address Translation (NAT), firewalling, intrusion detection, Domain Name Service (DNS), and caching, from proprietary hardware appliances so that they can run in software on VMs.

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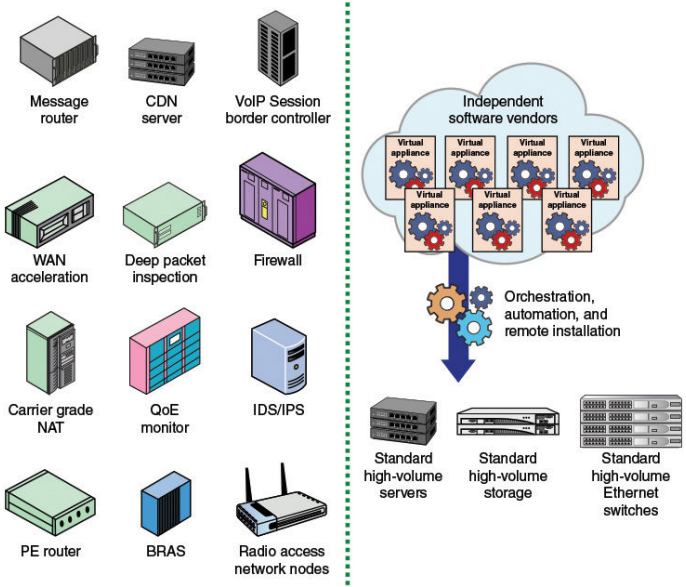
In traditional networks, all devices are deployed on proprietary/closed platforms. All network elements are enclosed boxes, and hardware cannot be shared.With NFV, however, network elements are independent applications that are flexibly deployed on a unified platform comprising standard servers, storage devices, and switches. In this way, software and hardware are decoupled, and capacity for each application is increased or decreased by adding or reducing virtual resources



CDN = content delivery network
WAN = wide area network
NAT = network address translation
QoE = quality of experience
VoIP = voice over Internet Protocol
IDS = intrusion detection system
IPS = intrusion prevention system
PE = provider edge router
BRAS = broadband remote access server

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- **Network Function Virtualization Infrastructure (NFVI):** The totality of all hardware and software components that build up the environment in which virtual network functions (VNFs) are deployed. The NFVI can span across several locations (that is, multiple points of presence [N-PoPs). The network providing connectivity between these locations is considered to be part of the NFVI.

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- **NFVI-Node:** Physical devices deployed and managed as a single entity, providing the NFVI functions required to support the execu- tion environment for VNFs.

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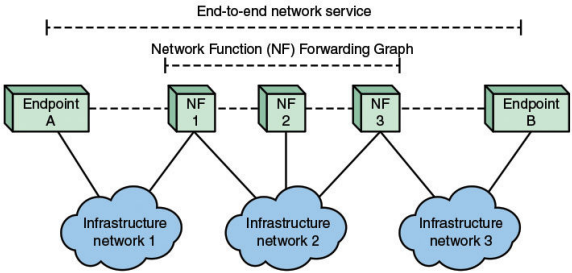
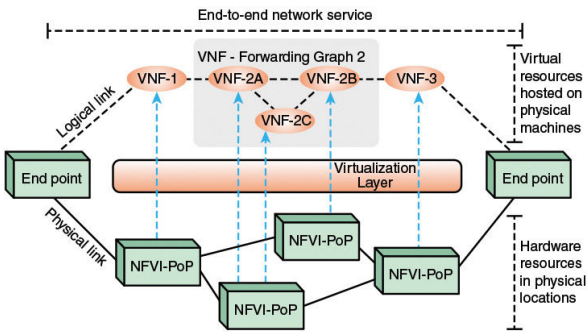
- **VNF Forwarding Path:** Graph of logical links connecting VNF nodes for the pur- pose of describing traffic flow between these network func- tions.

NFV Example



(a) Graph representation of an end-to-end network service



(b) Example of an end-to-end network service with VNFs and nested forwarding graphs

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- **Distributed architecture**: A VNF may be made up of one or more VNF components (VNFC), each of which implements a subset of the VNF's functionality. Each VNFC may be deployed in one or multiple instances. These instances may be deployed on separate, distributed hosts to provide scalability and redundancy.

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- **NFV infrastructure (NFVI)**: The NFVI performs a virtualization function on the three main categories of devices in the network service environment: computer devices, storage devices, and network devices.
- **NFV management and orchestration**: Encompasses the orchestration and lifecycle management of physical/software resources that support the infrastructure virtualization, and the lifecycle management of VNFs. NFV management and orchestration focuses on all virtualization-specific management tasks necessary in the NFV framework.

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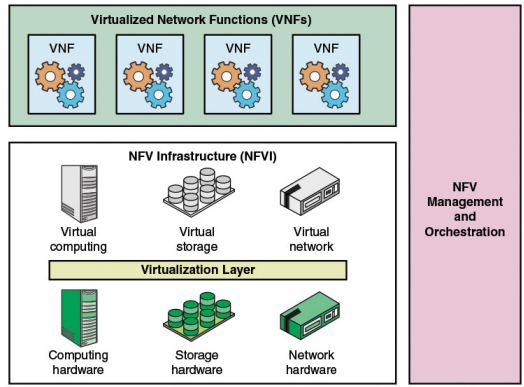

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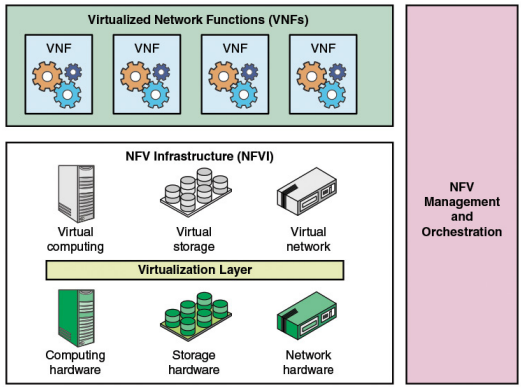

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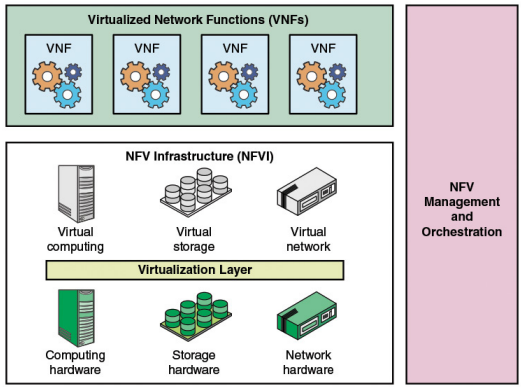

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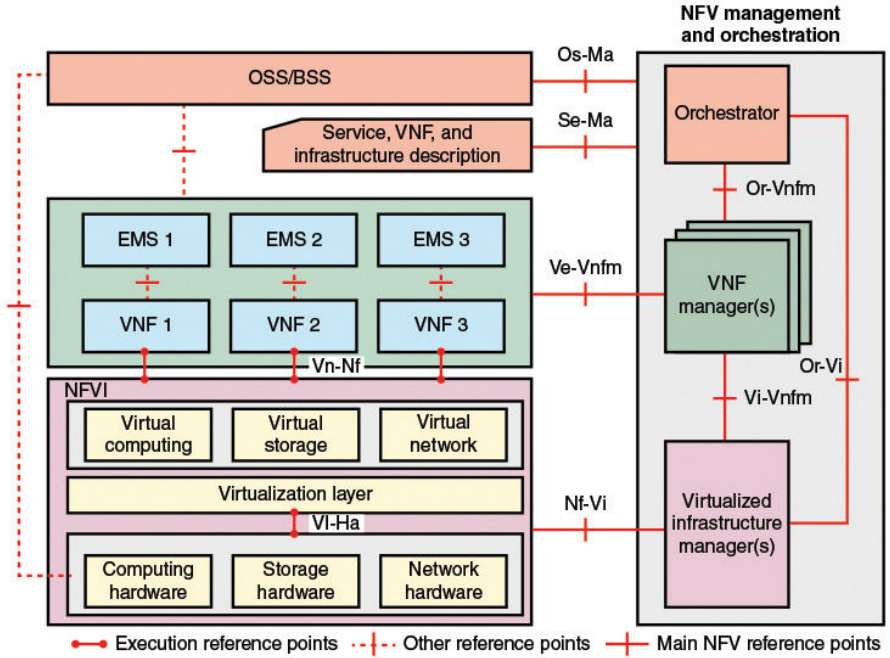
- **OSS/BSS**: Operational and business support systems implemented by the VNF service provider.


NFV management and orchestration
OSS/BSS
Os-Ma
Service, VNF, and infrastructure description
Se-Ma
Orchestrator
Or-Vnfm
EMS 1
EMS 2
EMS 3
VNF 1
VNF 2
VNF 3
Ve-Vnfm
VNF manager(s)
Vn-Nf
Or-Vi
Vi-Vnfm
NFVI
Virtual computing
Virtual storage
Virtual network
Virtualization layer
Vl-Ha
Nf-Vi
Virtualized infrastructure manager(s)
Computing hardware
Storage hardware
Network hardware
Execution reference points
Other reference points
Main NFV reference points

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- **NFV orchestrator**: Responsible for installing and configuring new network services (NS) and virtual network function (VNF) packages, NS lifecycle management, global resource management, and validation and authorization of NFVI resource requests.
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Reference Points

Architecture defines a number of reference points that constitute interfaces between functional blocks.

- **Vi-Ha**: Marks interfaces to the physical hardware. A well-defined interface specification will facilitate for operators sharing physical resources for different purposes, reassigning resources for different purposes, evolving software and hardware independently, and obtaining software and hardware component from different vendors.

- **Vn-Nf**: These interfaces are APIs used by VNFs to execute on the virtual infrastructure. Application developers, whether migrating existing network functions or developing new VNFs, require a consistent interface the provides functionality and the ability to specify performance, reliability, and scalability requirements.

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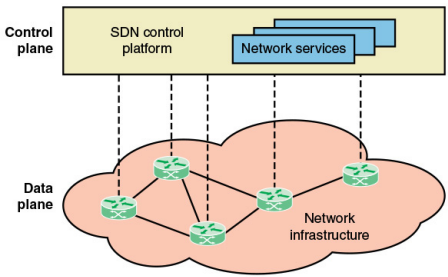
- Targeted service introduction based on geography or customer sets is possible. Services can be rapidly scaled up/down as required.

SDN and NFV Differences and Similarities

SDN



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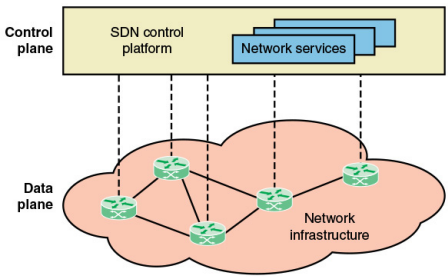

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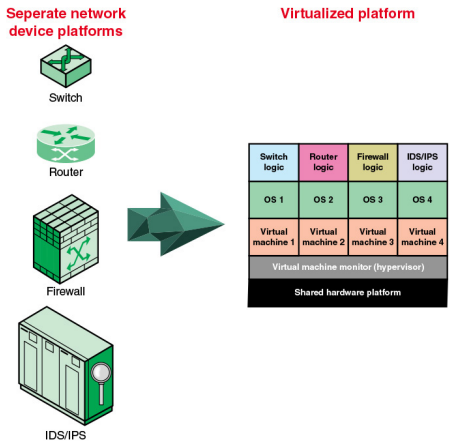

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- SDN abstracts physical networking resources –switches, routers and so on – and moves decision making to a virtual network control plane. In this approach, the control plane decides where to send traffic, while the hardware continues to direct and handle the traffic. NFV aims to virtualize all physical network resources beneath a hypervisor, which allows the network to grow without the addition of more devices.

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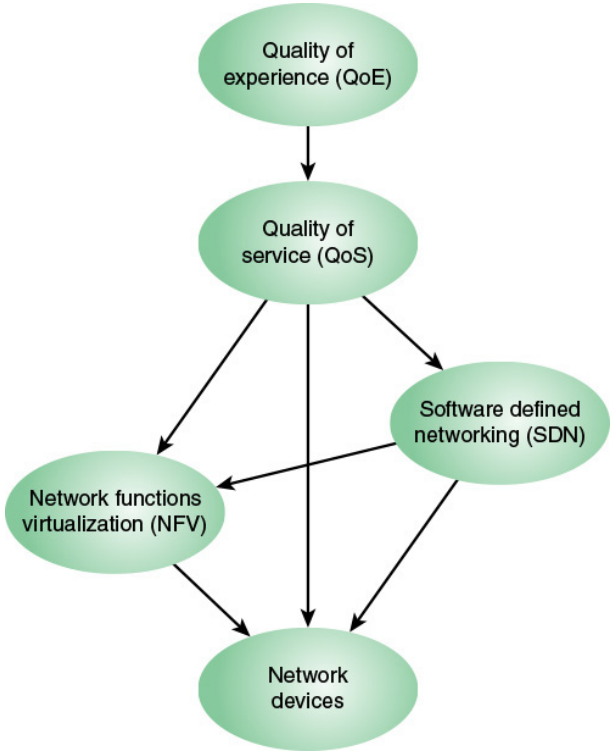
- When SDN executes on an NFV infrastructure, SDN forwards data packets from one network device to another. At the same time, SDN's networking control functions for routing, policy definition and applications run in a virtual machine somewhere on the network. Thus, NFV provides basic networking functions, while SDN controls and orchestrates them for specific uses. SDN further allows configuration and behavior to be programmatically defined and modified.


Quality of experience (QoE)
Quality of service (QoS)
Software defined networking (SDN)
Network functions virtualization (NFV)
Network devices

SDN and NFV

The concern of a network service provider is about the set of network devices (such as routers) and the control and management of the functions they perform (such as packet forwarding). Both SDF and NFV can be used seperately to provide this but SDN and NFV are not mutually exclusive. If both SDN and NFV are implemented for a network, the following relationships hold:

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- Without SDN, NFV requires much more manual intervention, especially when resources beyond the scope of NFVI are part of the environment.

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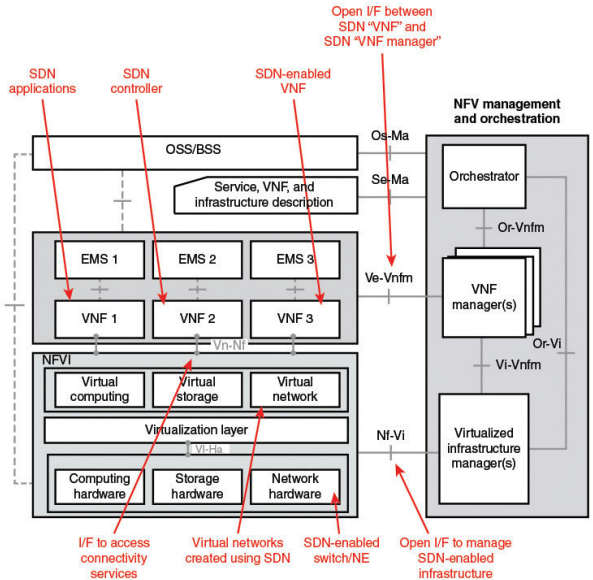
- The SDN controller can be run as a VNF, possibly as part of a service chain including other VNFs. For example, applications and services originally developed to run on the SDN controller could also be implemented as separate VNFs.

Mapping of SDN Components with NFV Architecture



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- it's difficult to manage incredible number of connected devices generating an impressive amount of data as a whole, without having elasticity and flexibility inherently defined in the network. If the networks are not prepared, the flood of IoT where a lot of traffic are generated could leave the network paralysed.

Advantages of using SDN/NFV for IoT

Solving Interoperability in the Internet of Things

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- SDN approach can be used to address this issue which allows applications to operate with devices with minimal or no configuration.

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- SDN can also provide a dynamic, intelligent, selflearning layered model of security that provides access rules to ensure authorization for people who are allowed to change the configuration of devices.

Management

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- With multiple controllers, this can be used to offload computational tasks which brings benefits in terms of administration. Each domain has its SDN controller which controls all traffic in its domain. When one SDN controller fails, another SDN controller can take control to avoid network failures.

Application Specific Requirements

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- SDN is able to strengthen network controlling ability and also perform dynamic adaptation of control logic by the devices in real-time.
- SDN and its extension to the Wireless Sensors and Actuators Domain will give the possibility to support application specific requirements with control logic that jointly act at the network and processing level enhancing the QoS/QoE of the entire system.

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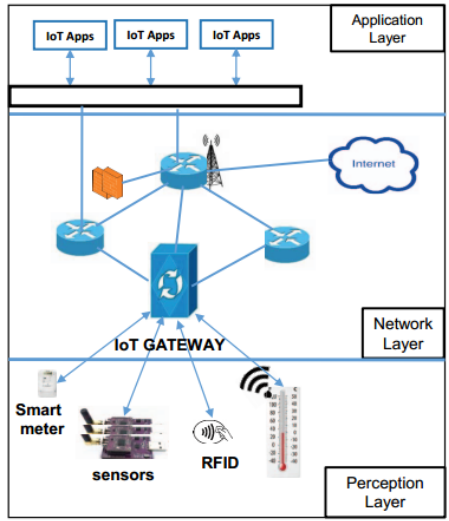
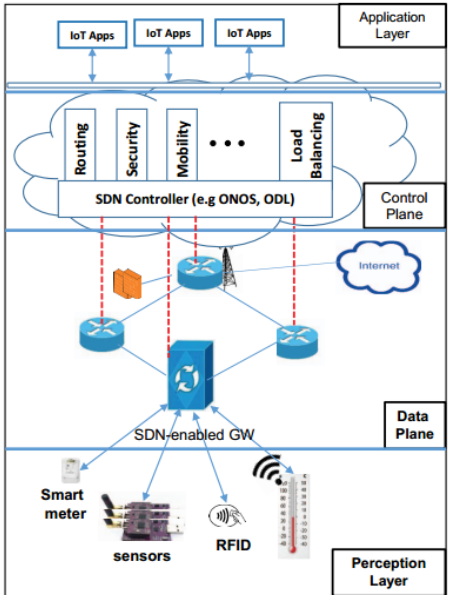
- SDN & NFV will help service providers to enhance their service delivery infrastructure which is very important in the contribution to the IoT.
- This addresses the issues of network ossification by utilizing the network resources in a better way and transiting to software-centric programmable networks due to the rapid evolution and dynamicity of IoT applications.

A Simple IoT Netowrk



IOT with SDN


IoT Apps
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Application Layer
Routing
Security
Mobility
Load Balancing
SDN Controller (e.g ONOS, ODL)
Control Plane
Internet
SDN-enabled GW
Data Plane
Smart meter
sensors
RFID
Perception Layer

IOT with SDN and NFV