ISO 9001 : 2008

TEC टी ई सी संचारिका NEWSLETTER

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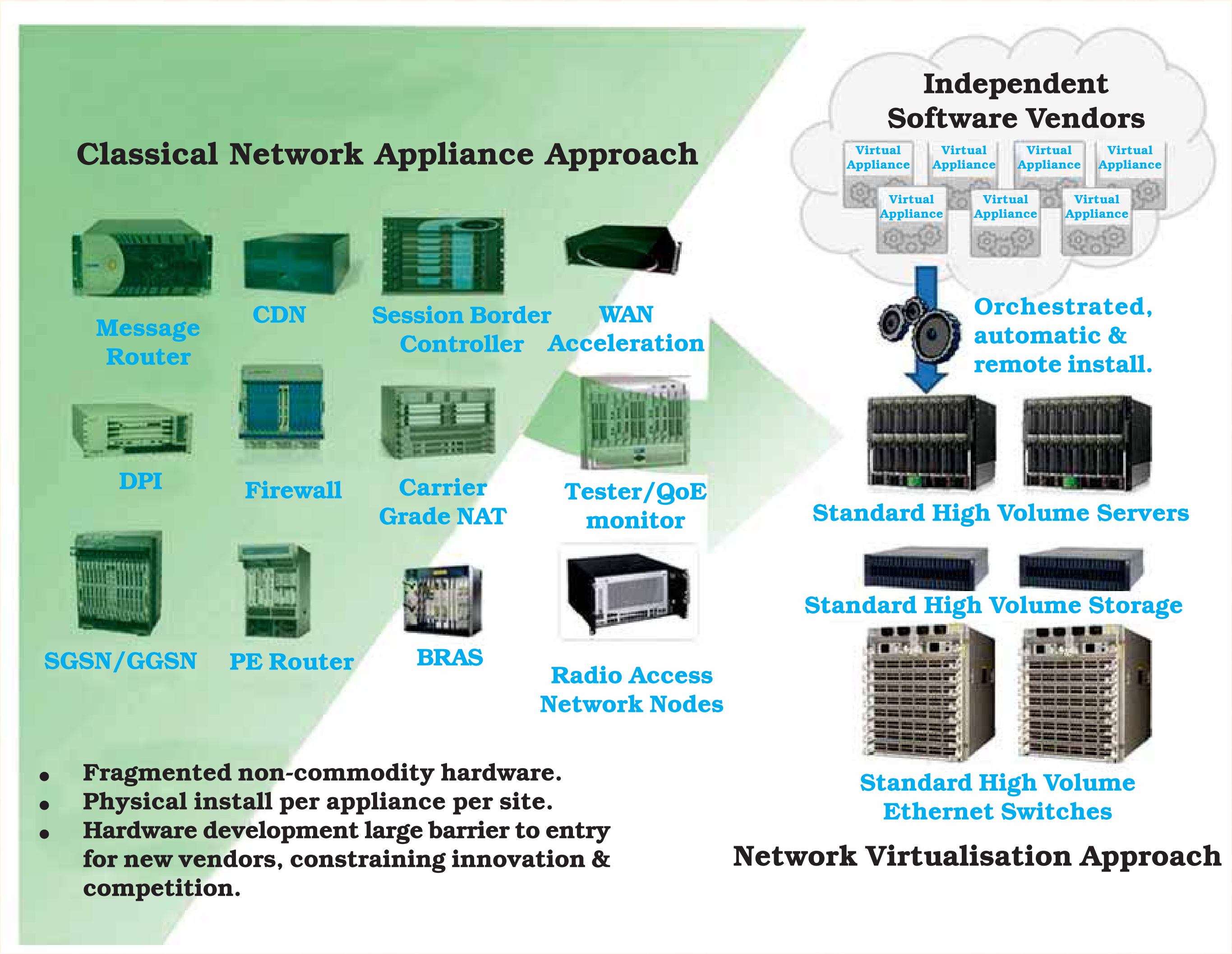
Network Function Virtualisation : Architecture and Core Network Applications



ISO 9001:2008
TELECOMMUNICATION ENGINEERING CENTRE

IN THIS ISSUE

1.0 Introduction

1.1 Telecom Service Provider networks are populated with a large and increasing variety of proprietary hardware appliances. To launch a new network service often requires yet another variety and finding the space and power to accommodate these boxes is becoming difficult; compounded by the increasing costs of energy, capital investment challenges and the rarity of skills necessary to design, integrate and operate complex hardware-based appliances (Router, firewall, CDN, PGW, NAT etc.). Moreover, hardware-based appliances rapidly reach end of life, requiring much of the procure design-integrate-deploy cycle to be repeated with little or no revenue benefit.

1.2 Network Function Virtualisation (NFV) addresses these problems by leveraging standard software virtualisation techniques to consolidate many network equipment types into industry standard high volume servers, switches and storage, which could be located in Data centers, Network Nodes and in the end user premises (see figure on cover page). It involves the implementation of network functions in software that can run on a range of industry standard server hardware, and that can be moved to, or instantiated in, various locations in the network as required, without the need for installation of new equipment.

2.0 NFV architectural framework

2.1 The NFV architectural framework focuses on the changes likely to occur in an operator's network due to the NFV process. The NFV architecture has been defined by the ETSI NFV ISG and comprises three principal elements as shown in figure: the NFV Infrastructure (NFVI), Virtualised Network Functions (VNFs) and the NFV Management and Orchestration (MANO) functions.

2.1.1 The NFV Infrastructure (NFVI) consists of physical networking, computing and storage resources that can be geographically distributed and exposed as a common networking/NFV infrastructure. It is the combination of both hardware and software resources which build up the environment in which VNFs are deployed, managed and executed. The NFVI can span across several locations i.e. places where NFVI-PoPs are operated. The network providing connectivity between these locations is regarded to be part of the NFVI.

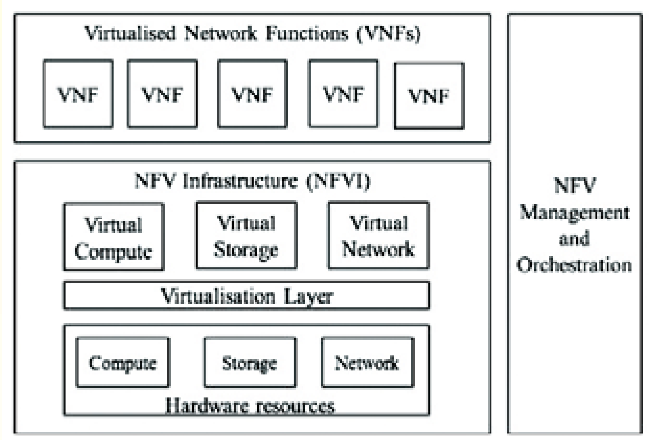


Fig. 1: High Level NFV Framework

2.1.2 Virtualised Network Functions (VNFs) are software implementations or virtualisation of network functions (NFs) that are deployed on virtual resources such as Virtual Machine (VM). Virtualized network functions (VNFs), are responsible for handling specific network functions that run in one or more virtual machines on top of the hardware networking infrastructure, which can include routers, switches, servers, cloud computing systems and more. Individual virtualized network functions can be chained or combined together in a building block-style fashion to deliver full-scale networking communication services.

2.1.3 NFV Management and Orchestration (NFV MANO) functions provide the necessary tools for operating the virtualized infrastructure, managing the life cycle of the VNFs and orchestrating virtual infrastructure and network functions to compose value-added end-to-end network services. NFV MANO focuses on all virtualisation specific management task necessary in the NFV framework.

2.2 Architectural Functional blocks:

2.2.1 Figure 2 shows 3 main functional blocks but the NFV architectural framework also identifies other functional blocks and main reference points between such blocks.

Figure 2 shows the detailed NFV architectural framework depicting the functional blocks and reference points in the NFV framework. The various functional blocks are as following:

- Virtualised Network Function (VNF).
- Element Management (EM).
- NFV Infrastructure, including:

- Hardware and virtualised resources, and
- Virtualisation Layer.
- Virtualised Infrastructure Manager(s).
- NFV Orchestrator.
- VNF Manager(s).
- Service, VNF and Infrastructure Description.
- Operations and Business Support Systems (OSS/BSS).

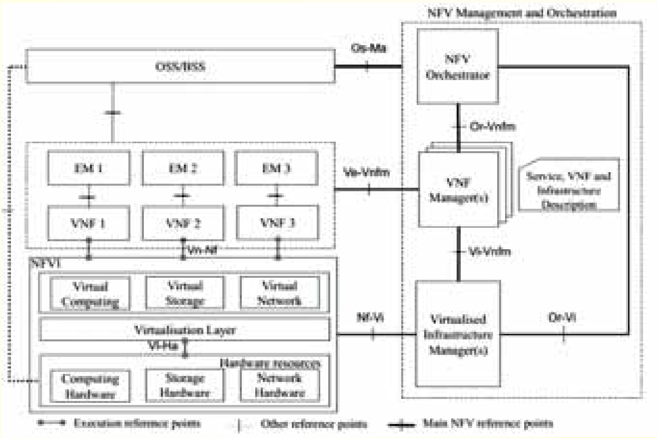


Fig. 2: NFV reference architecture framework

2.2.2 The overview of the functional blocks in the architecture framework are as follows:

2.2.2.1 Virtualized Network Function (VNF): A VNF is a virtualisation of a network function in a legacy non-virtualised network. Examples of NFs are 3GPP™ Evolved Packet Core (EPC) network elements, e.g. Mobility Management Entity (MME), Serving Gateway (SGW), Packet Data Network Gateway (PGW); elements in a home network, e.g. Residential Gateway (RGW); and conventional network functions, e.g. Dynamic Host Configuration Protocol (DHCP) servers, firewalls, etc. A VNF can be composed of multiple internal components. For example, one VNF can be deployed over multiple VMs, where each VM hosts a single component of the VNF. However, in other cases, the whole VNF can be deployed in a single VM as well.

2.2.2.2 Hardware Resources: In NFV, the physical hardware resources include computing, storage and network that provide processing, storage and connectivity to VNFs through the virtualisation layer (e.g. hypervisor). Computing hardware is assumed to be COTS as opposed to purpose-built hardware. Storage resources can be differentiated between shared network attached storage (NAS) and storage that resides on the server itself. Computing and storage resources are commonly pooled. Network resources are comprised of switching functions, e.g. routers, and wired or wireless links. Also, network resources can span different domains. However, NFV differentiates only the following two types of networks:

- **NFVI-PoP network:** the network that interconnects the computing and storage resources contained in an NFVI-PoP. It also includes specific switching and routing devices to allow external connectivity.
- **Transport network:** the network that interconnects NFVI-PoPs, NFVI-PoPs to other networks owned by the same or different network operator, and NFVI-PoPs to other network appliances or terminals not contained within the NFVI-PoPs

2.2.2.3 Virtualisation Layer and Virtualised Resources: The virtualisation layer abstracts the hardware resources and decouples the VNF software from the underlying hardware, thus ensuring a hardware independent lifecycle for the VNFs. In short, the virtualisation layer is responsible for:

- Abstracting and logically partitioning physical resources, commonly as a hardware abstraction layer.
- Enabling the software that implements the VNF to use the underlying virtualised infrastructure.
- Providing virtualised resources to the VNF, so that the latter can be executed.

The architectural view of NFV infrastructure and network function virtualisation is presented in figure 2. The virtualisation layer in the middle ensures VNFs are decoupled from hardware resources and therefore, the software can be deployed on different physical hardware resources. Typically, this type of functionality is provided for computing and storage resources in the form of hypervisors and VMs. A VNF is envisioned to be deployed in one or several VMs.

The use of hypervisors is one of the present typical solutions for the deployment of VNFs. Other solutions to realize VNFs may include software running on top of a non-virtualised server by means of an operating system (OS), e.g. when hypervisor support is not available, or VNFs implemented as an application that can run on virtualised infrastructure or on bare metal.

When virtualisation is used in the network resource domain, network hardware is abstracted by the virtualisation layer to realize virtualised network paths that provide connectivity between VMs of a VNF and/or between different VNF instances. Other possible forms of virtualisation of the transport network include centralizing the control plane of the transport network and separating it from the forwarding plane, and isolating the transport medium, e.g. in optical wavelengths, etc.

2.2.2.4 Element Management (EM): The Element Management performs the typical management functionality for one or several VNFs.

2.2.2.5 Virtualised Infrastructure Manager(s): From NFV's point of view, virtualised infrastructure management comprises the functionalities that are used to control and manage the interaction of a VNF with computing, storage and network resources under its authority, as well as their virtualisation. According to the list of hardware resources specified in the architecture, the Virtualised Infrastructure Manager performs:

- **Resource management**, in charge of the:
  - Inventory of software (e.g. hypervisors), computing, storage and network resources dedicated to NFV infrastructure.
  - Allocation of virtualisation enablers, e.g. VMs onto hypervisors, compute resources, storage, and relevant network connectivity.
  - Management of infrastructure resource and allocation, e.g. increase resources to VMs, improve energy efficiency, and resource reclamation.
- **Operations for:**
  - Visibility into and management of the NFV infrastructure.
  - Root cause analysis of performance issues from the NFV infrastructure perspective.
  - Collection of infrastructure fault information.
  - Collection of information for capacity planning, monitoring, and optimization.

2.2.2.6 NFV Orchestrator: The NFV Orchestrator is in charge of the orchestration and management of NFV infrastructure and software resources, and realizing network services on NFVI.

2.2.2.7 VNF Manager(s): A VNF Manager is responsible for VNF lifecycle management (e.g. instantiation, update, query, scaling, termination). Multiple VNF Managers may be deployed; a VNF Manager may be deployed for each VNF, or a VNF Manager may serve multiple VNFs.

2.2.2.8 Service, VNF and Infrastructure Description: This data-set provides information regarding the VNF deployment template, VNF Forwarding Graph, service-related information, and NFV infrastructure information models.

2.2.2.9 Operations Support Systems and Business Support Systems(OSS/BSS): The OSS/BSS in use case refers to the OSS/BSS of an Operator.

2.2.3 Reference Points

2.2.3.1 Virtualisation Layer - Hardware Resources - (Vl-Ha): This reference point interfaces the virtualisation layer to hardware resources to create an execution environment for VNFs, and collect relevant hardware resource state information for managing the VNFs without being dependent on any hardware platform.

2.2.3.2 VNF - NFV Infrastructure (Vn-Nf): This reference point represents the execution environment provided by the NFVI to the VNF. It does not assume any specific control protocol. It is in the scope of NFV in order to guarantee hardware independent lifecycle, performance and portability requirements of the VNF.

2.2.3.3 NFV Orchestrator - VNF Manager (Or-Vnfm): This reference point is used for:

- Resource related requests, e.g. authorization, validation, reservation, allocation, by the VNF Manager(s).
- Sending configuration information to the VNF manager, so that the VNF can be configured appropriately to function within the VNF Forwarding Graph in the network service.
- Collecting state information of the VNF necessary for network service lifecycle management.

2.2.3.4 Virtualised Infrastructure Manager - VNF Manager (Vi-Vnfm): This reference point is used for:

- Resource allocation requests by the VNF Manager.
- Virtualised hardware resource configuration and state information (e.g. events) exchange.

2.2.3.5 NFV Orchestrator - Virtualised Infrastructure Manager (Or-Vi): This reference point is used for:

- Resource reservation and/or allocation requests by the NFV Orchestrator.
- Virtualised hardware resource configuration and state information (e.g. events) exchange.

2.2.3.6 NFVI - Virtualised Infrastructure Manager (Nf-Vi): This reference point is used for:

- Specific assignment of virtualised resources in response to resource allocation requests.
- Forwarding of virtualised resources state information.
- Hardware resource configuration and state information (e.g. events) exchange.

2.2.3.7 OSS/BSS - NFV Management and Orchestration (Os-Ma): This reference point is used for:

- Requests for network service lifecycle management.
- Requests for VNF lifecycle management.
- Forwarding of NFV related state information.
- Policy management exchanges.
- Data analytics exchanges.
- Forwarding of NFV related accounting and usage records.
- NFVI capacity and inventory information exchanges.

2.2.3.8 VNF/EM - VNF Manager (Ve-Vnfm): This reference point is used for:

- Requests for VNF lifecycle management.
- Exchanging configuration information.
- Exchanging state information necessary for network service lifecycle management.

3.0 Use Case

The NFV ISG member companies identify and describe a first set of service models and high level use cases which represent, important service models and initial fields of application for NFV. The different use cases are Virtualisation of Enterprise CPE, Virtualisation of Mobile Core Network, Virtualisation of Mobile base station, Virtualisation of Home CPE and Virtualisation of Fixed Access Network. Details of these use cases are available on the TEC website (*http://tec.gov.in/pdf/Studypaper/Study%20Paper%20on%20Network%20Function%20Virtualisation%20final.pdf*).

4.0 Key benefits of NFV

4.1 Reduced equipment costs and reduced power consumption through consolidating equipment and exploiting the economies of scale of the IT industry.

4.2 Increased speed of Time to Market by minimizing the typical network operator cycle of innovation. Economies of scale required to cover investments in hardware-based functionalities are no longer applicable for software-based development, making feasible other modes of feature evolution. Network Functions Virtualisation should enable network operators to significantly reduce the maturation cycle.

4.3 Availability of network appliance multi-version and multi-tenancy, which allows use of a single platform for different applications, users and tenants. This allows network operators to share resources across services and across different customer bases.

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

4.5 Enables a wide variety of eco-systems and encourages openness. It opens the virtual appliance market to pure software entrants, small players and academia, encouraging more innovation to bring new services and new revenue streams quickly at much lower risk.

5.0 Conclusion

Network Functions Virtualisation is likely to deliver many benefits for network operators and their partners and customers while offering the opportunity to create new types of eco-systems which may encourage and support rapid innovation with reduced cost and reduced risk. To reap these benefits, the technical challenges need to be addressed by the industry. To arrive at possible solutions to these technical challenges, the IT and Telecom Network industries may have to combine their complementary expertise and resources in a joint collaborative effort to reach broad agreement on standardised approaches and common architectures which may address these technical challenges, and provide tested and interoperable solutions for delivery of end to end virtualised services with economies of scale. NFV need to be part of the broader transformation effort and may require service providers to make significant changes and progressive efforts.

Activities at NTIPRIT (Feb.-Mar., 2017)

1. Conduction of ITEC course for foreign participants

NTIPRIT, Ghaziabad conducted a 3-week long course on “Public Safety Communication Systems including Role of Telecom in Disaster Management” from 6th to 24th March, 2017 for foreign participants under India Technical and Economic Cooperation (ITEC) programme of Ministry of External Affairs, Govt. of India. In this course, 18 participants from 12 different counties namely Turkmenistan, Vietnam, Uzbekistan, Kenya, Sudan, Tanzania, Tunisia, Uganda, Tajikistan, Malaysia, Palestine and Seychelles participated.

Sh. D. P. De, Sr. DDG (TEC/NTIPRIT), NTIPRIT faculty members and trainees of ITEC course during inaugural session

Sh. R. K. Misra, Member (S) delivered the valedictory address to mark the conclusion of the course and awarded letters of participation & group photos to the participants. Shri H. K. Sharma, Director, Ministry of External Affairs was also present.

Sh. R. K. Misra, Member (S) delivering valedictory address to the ITEC course participants

Sh. R. K. Misra, Member (S) awarding letter of participation and group photo to a participant

A cultural programme involving foreign trainees and faculty members of NTIPRIT was conducted during the course at ALTTC campus. The trainees as well as faculty members participated in the cultural programme with great enthusiasm and displayed their talent in singing, music, dance etc. to enthrall the audience.

NTIPRIT officers & their family members enjoying the cultural talent showcased by a foreign trainee during the event

Cultural presentation by foreign trainees, Dance by Ms. Vidushi d/o Sh. Vineet Verma, Director, NTIPRIT

2. Induction Training of the following batches of Officer Trainees of ITS/BWS and JTO probationers was conducted during the period:

   i. ITS-2015 batch (32 officers)
   ii. BWS-2015 batch (1 officer)
   iii. ITS-2014 batch (17 officers)
   iv. ITS-2013 batch (4 officers)
   v. JTO-2015 Batch (24 officers)
   vi. P&T BWS-2010 & 2013 Batch (8 officers)

Various training programs like orientation programme, technical modules and Field attachment of ITS/BWS and JTO batches were conducted during this period as per respective training calendar.

3. A new batch of 32 Officer Trainees from ITS-2015 batch and one Officer Trainee from P&T BWS (Civil)-2015 batch joined NTIPRIT on 27.03.2017 for two years long induction training. A one week long Orientation programme was conducted for ITS/BWS-2015 batch from 27th to 31st March, 2017.

   The Officer Trainees called upon Sh. D. P. De, Sr. DDG (TEC/NTIPRIT) at TEC, New Delhi on 30.03.2017. Sr. DDG (TEC/NTIPRIT), in his address to OTs, asked them to take the induction training seriously and utilise this opportunity to learn.

(Presentation of flower bouquet to Sh. D. P. De, Sr. DDG (TEC/NTIPRIT) by Officer Trainees of ITS-2015 batch during interaction meeting at TEC, New Delhi on 30.03.2017)

4. 16 Officer Trainees of ITS-2014 batch were deputed to North East for a study visit from 30.01.2017 to 03.02.2017 to study the status of telecom facilities in some of urban as well as rural areas of North Eastern states and give suggestions for improvement of telecom facilities in the region.

हिंदी कार्यशाला

दूरसंचार अभियांत्रिकी केंद्र में दिनांक 16.03.2017 को एक हिंदी कार्यशाला का आयोजन किया गया। इस कार्यशाला में कुल 26 अधिकारियों/कर्मचारियों ने भाग लिया। इस कार्यशाला के अतिथि वक्ता श्री नगेन्द्र सिंह, तकनीकी निदेशक (राजभाषा विभाग) द्वारा यूनिकोड इन्स्टाल करने, गूगल–ट्रांसलेसन, गूगल वॉइस टाइपिंग, मोबाइल फोन पर गूगल वॉइस टाइपिंग, क्रोम ब्राउजर का प्रयोग करके हिंदी/अंग्रेजी में डिक्टेशन देने और गूगल डॉक्स पर कार्य करने के बारे में विस्तार से बताया गया।

हिंदी कार्यशाला के दौरान उपस्थित अधिकारी एवं कर्मचारी गण

Approvals from Feb. to March 2017

S.No.	Name of the Manufacturer/Trader & Name of Product & Model No.
A	**Aspect Contact Center Software Pvt Ltd.**
1	TMS-00
B	**Sunren Technical Solutions Pvt. Ltd.**
2	G3 Fax Machine/Card, PROXPRESS M4080FX
3	G3 Fax Machine/Card, XPRESS C480FW
4	G3 Fax Machine/Card, PROXPRESS M4070 FR
5	G3 Fax Machine/Card, PROXPRESS M4070 FX
6	G3 Fax Machine/Card, SNPRC-1602-02
7	G3 Fax Machine/Card, PROXPRESS M4580FX
8	G3 Fax Machine/Card, SNPRC-1602-01
9	G3 Fax Machine/Card, VCVRA-1502-01
10	G3 Fax Machine/Card, BOISB-0703-00
11	G3 Fax Machine/Card, BOISB-1500-00
C	**Elcom Innovation Pvt. Ltd.**
12	PABX for Network Connectivity, IP@Core
D	**Team Engineering Advance Technologies India Pvt Ltd**
13	High speed line driver, TEAM LINK 3002 SHDSL E1
14	High speed line driver, TEAM LINK 3002 SHDSL V.35
E	**Coral Telecom Ltd.**
15	PABX for Network Connectivity, IRIS IVDX
F	**Cisco systems India Pvt Ltd.**
16	Router, CISCO 4431
17	Router, CISCO 4351
18	Router, CISCO 4331
19	Router, CISCO 4321
G	**Hewlett Packard Enterprise India Pvt. Ltd.**
20	Router, BJANGA-BB0006

Important Activities of TEC during FEB. 17 to MAR. 17

New GRs/IRs issued:

- GR on WLAN Controller,
- GR on SPV based Hybrid Power supply for Wi-Fi Terminal & Similar telecom terminals
- GR on Wavelength Division Multiplexing Passive Optical Network
- GR on Riser Optical Fibre Cable (For Indoor Application)
- GR on Integrated Broadband System for delivery of digital services in rural areas
- IR on embedded sim (e-SIM)

Revised GRs/IRs issued:

- GR on Wi-Fi Hot Spot
- GR on Point to Multi Point Multi Frequency Broadband System for frequency bands of 10.5 & 26 GHz
- GR on SMPS Power Plant
- GR on Installation accessories and Fixtures for self-supporting Metal Free Aerial (ADSS) Optical Fibre Cables (Type-I, Type-II & Type-III)
- GR on MPLS-TP based carrier Ethernet switch for aggregation and access network applications
- GR on ADSS Optical Fibre Cable for laying along power line alignment, GR on IVRS
- GR on VoIP Traffic Generator and Protocol Performance Analyser
- GR on FTTH/FTTB/FTTC BB access using GPON
- GR on SPV Power supply for Telecom Equipment
- IR on Ethernet to E1 Converter
- IR on High Speed Line Driver

Study / White Paper issued:

- Network Life Cycle Service Orchestration
- Network Function Virtualisation: Architecture and core network applications
- Unmanned Airborne Vehicle
- G.hn
- Li-Fi & its Applications
- Voice over LTE
- ZigBee
- Satellite Earth stations on vessels and on aircrafts
- Physical Security of Telecom system· Global trend of cyber security, Heterogeneous Network
- Impact of SDN defined networking tool in energy efficiency measurement of a telecom system
- Patent management analysis
- Telephony Application Server
- M2M/IoT in Automotive Sector
- Enabling Technologies for Smart cities
- Security of Wireless Sensor Network
- Evolution of Smart Cities & way ahead
- Security in Cloud computing, CCS7 Security
- Copyright Laws & Legal Consequence of copyright infringement

ISO : 9001-2008

Certifications issued by TEC

Type Approval (TA)

Interface Approval (IA)

Certificate of Approval (CoA)

Visit

www.tec.gov.in

Regional TEC Contact :

Eastern Region	:	033-23570008
Western Region	:	022-26610900
Northern Region	:	011-23329464
Southern Region	:	080-26642900

Other Activities

- Testing of Cisco Router completed in NGN lab in TEC
- Certificate of CAB for M/s BNNSPEAG was issued

Representation of TEC in Training/Seminar/ Meetings

- Technical Presentation on '5G technologies' by M/s Ericsson in DoT
- GCF Workshop on 'Device Certificate for the Indian wireless Industry' in march 2017 in New Delhi
- Training on 'social conflicts analysis and resolution approaches' in DoPT, New Delhi

Approvals issued by TEC during the period from Feb. 2017 to Mar. 2017

Interface Approvals..**20**
Type Approvals **00**
Service Approval..**00**

टी ई सी संचारिका	:	दूरसंचार अभियांत्रिकी केन्द्र
अप्रैल 2017	:	खुर्शीद लाल भवन
भाग 21	:	जनपथ
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