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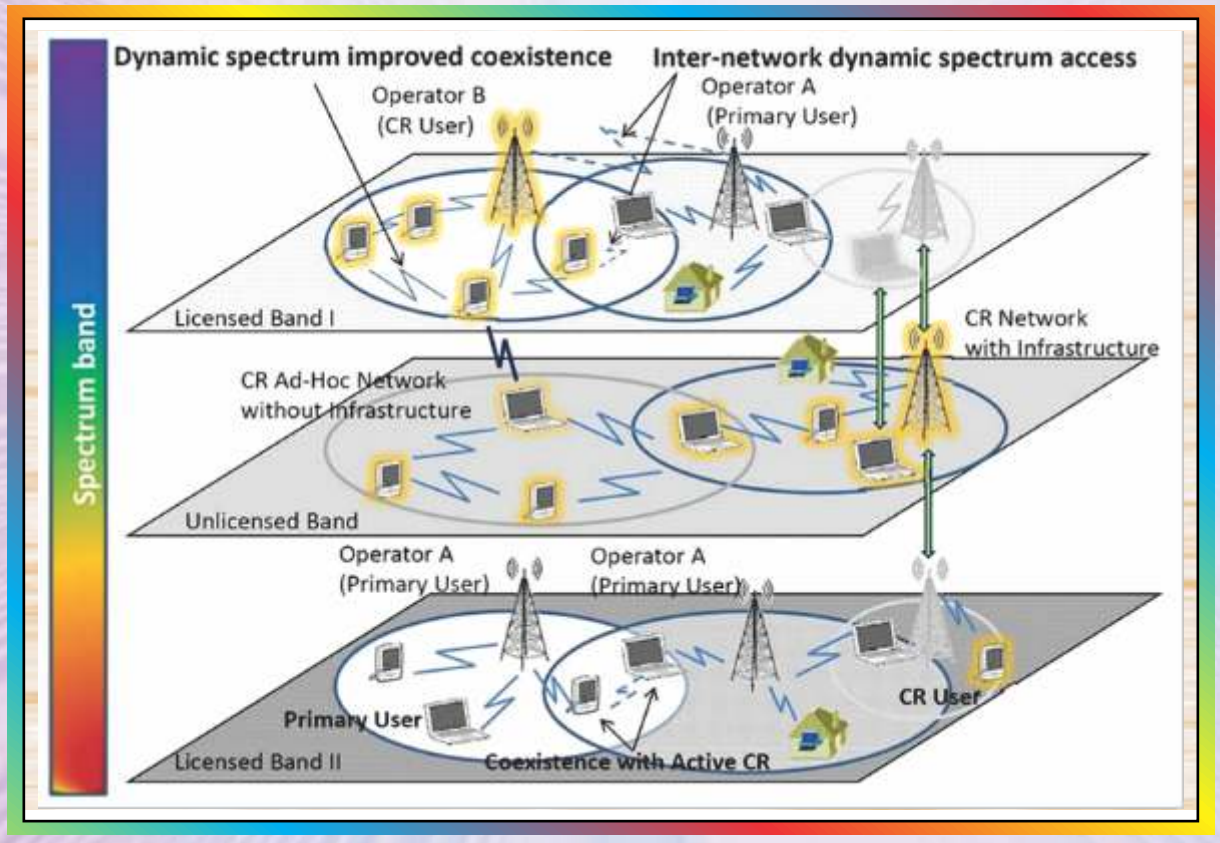
TEC

टी ई सी संचारिका

NEWSLETTER

VOL. 17 OCTOBER 2013 ISSUE 3

COGNITIVE RADIO TECHNOLOGY



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TELECOMMUNICATION ENGINEERING CENTRE

IN THIS ISSUE

1.0 Introduction:

Communication networks are vital components of any modern society. They are used extensively in numerous applications, including financial transactions, social interactions, education, national security, and commerce. In particular, both wired and wireless devices are capable of performing a plethora of advanced functions that support a range of services, such as voice telephony, web browsing, streaming multimedia, and data transfer. With the rapid evolution of microelectronics, wireless transceivers are becoming more versatile, powerful, and portable. This has enabled the development of *software-defined* radio (SDR) technology, where the radio transceivers perform the baseband processing entirely in software: modulation/demodulation, error correction coding, and compression. An SDR platform that can rapidly reconfigure operating parameters based on changing requirements and conditions and through a process of cognition is known as cognitive radio. Cognitive radio clearly goes hand in hand with SDR; together, they can achieve functionality considered impossible only a decade ago.

2.0 Definition of Cognitive Radio

As per ITU-R recommendations,

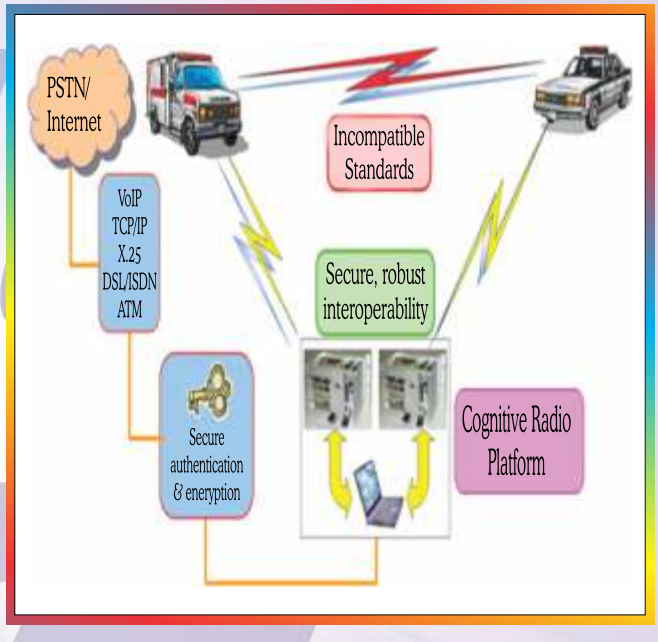
"*Cognitive radio system (CRS):* A radio system employing technology that allows the system to obtain knowledge of its operational and geographical environment, established policies and its internal state; to dynamically and autonomously adjust its operational parameters and protocols according to its obtained knowledge in order to achieve predefined objectives; and to learn from the results obtained."

3.0 Key Benefits of Cognitive Radio Technology

Following are the key benefits of the cognitive radio technology:

3.1 *Interoperability*

The use of multiple (potentially incompatible) communication standards within a specific sector could seriously impact the effectiveness of coordinated operations.

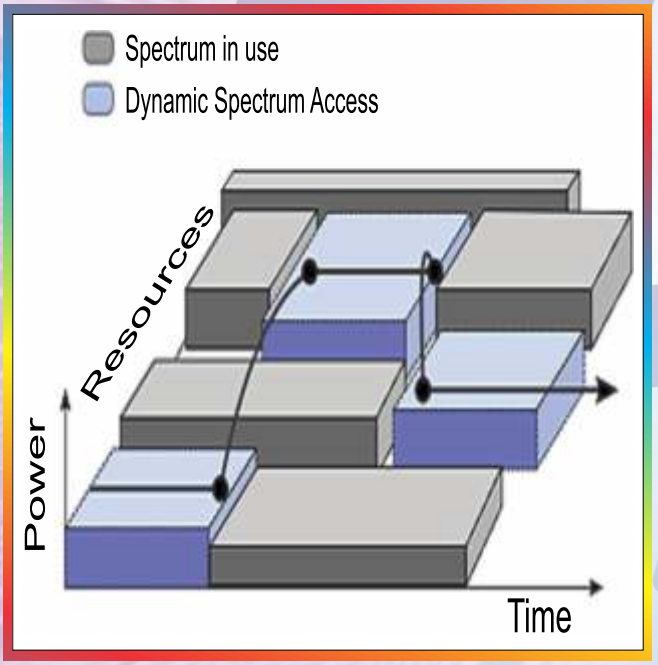


Due to its ability to rapidly assume any available radio configuration, CR platforms can reconfigure themselves to a legacy communications standard in order to communicate with any communication system deployed in the field or facilitate communications between two non-CR platforms employing different standards. Furthermore, with its onboard artificial intelligence, CR can automatically distinguish between different communication standards in the absence of any centralized control.

3.2 *Dynamic Spectrum Access*

Measurement studies have shown that much of the licensed spectrum is relatively unused

across time and frequency. Nevertheless, current regulatory requirements prohibit unlicensed transmissions in these bands, constraining them instead to several heavily populated, interference-prone frequency bands. To provide the necessary bandwidth required by current and future wireless services and applications, the concept of unlicensed users "borrowing" spectrum from spectrum licensees has been introduced. This approach to spectral usage is known as dynamic spectrum access. With recent developments in CR technology, it is now possible for these systems to simultaneously respect the rights of incumbent license holders while providing additional flexibility and access to spectrum.



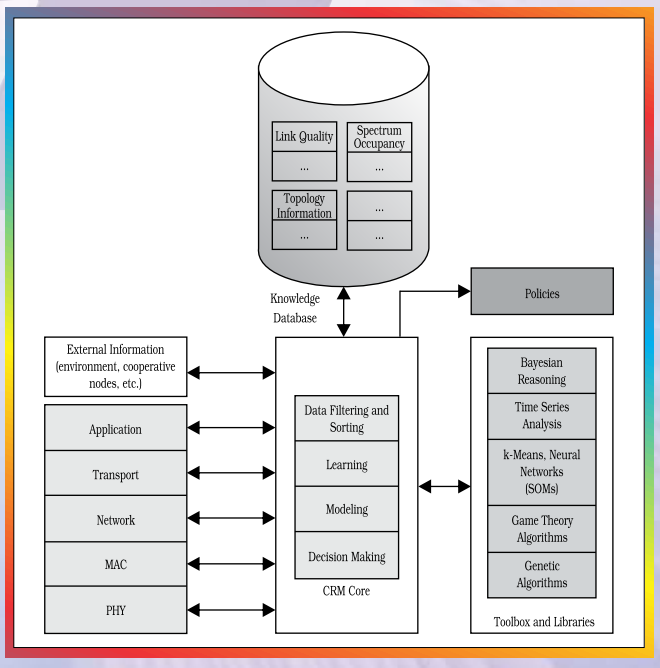
To achieve higher spectral efficiency, multiple access techniques can be employed such that multiple secondary users can transmit data within the same frequency range. Several techniques have been proposed to achieve multiple secondary user access, including those based on code division multiple access (CDMA), spatial multiplexing, and orthogonal frequency division multiplexing (OFDM). With respect to OFDM-based techniques, the spectrum pooling concept can be effectively employed, where data are transmitted across unoccupied portions of frequency using a subset of active subcarriers.

3.3 *Spectrum Pooling*

The importance of the CRS technology employed by the operators is to improve spectrum utilization and traffic load distribution. An operator today must manage a heterogenic radio environment due to its multiple services, different network architectures, various multiple access techniques and multiple frequency bands. Intra-operator spectrum pooling enabled by a CRS is becoming essential in order to balance the load of the different networks that represent different technologies and different generations. Spectrum pooling also can increase the utilization of the scarce resources available.

4.0 Cognitive Radio Architecture

Here we describe the cognitive resource manager (CRM)–based architecture, which can be seen as example architecture for Cognitive Radio Networks (CRNs).



Introducing the key components of the architecture, we have,

- A *CRM-core module* that acts like an operating system. It is responsible for interoperability between different toolbox processes that perform modeling, optimization, and interactions.
- *Toolboxes*, which are processes or libraries provided for optimization purposes. This modular architecture decision leaves it open for implementation purposes to decide which particular methods are actually implemented and executed in the entities of the cognitive radio networks.
- *Standardized interfaces* are required to ensure that different modules and protocol entities can exchange data both in a networked fashion and inside cognitive radios.
- Databases or *repositories* that contain policy information and models. Although access to these repositories could be provided through independent modules, it is architecturally better to show them as standalone components due to their highly specialized and central role.

5.0 Enabling Technologies for Cognitive Radio

Chief enabling technologies for the Cognitive Radio Systems are:-

5.1 Geolocation/Database

In this approach, cognitive devices measure their location and consult a "geo-location" database to determine which frequencies they can use at their location (location which they have indicated to the database). Parameters such as location accuracy and frequency of database enquiry are important. The devices are not allowed to transmit until they have successfully determined from the database which channels, if any, are available in their location. There are several ways to implement the geo-location. Fixed CRS devices such as access points can be professionally installed and their location then programmed into the device. Personal computers and other portable devices can use geo-location technologies such as GPS chips. Also triangulation using radio towers or any other location determination method, provided those methods provide sufficient accuracy to determine the location of devices at a given point and time are used. Once the device determines its location, or it is determined by the access point acting as a master device, it can be communicated to the database to determine the frequencies available for use in its area.

5.2 Spectrum Sensing

With spectrum sensing, devices try to detect the presence of protected services in each of the potentially available channels. Spectrum sensing essentially involves conducting a measurement within a candidate channel, to determine whether any protected service is present. When a channel is determined to be vacant, sensing might be applied to adjacent channels to determine what constraints there might be on transmission power, if any. A significant advantage of spectrum sensing (stand alone) would be that it does not rely on any existing local infrastructure, such as connection to a database or a beacon. This could be important in remote and rural areas. However, if sensing thresholds are to be set very low in order to protect existing services, this will result in increasing device cost and complexity as well as a reduced number of available channels.

Currently different spectrum sensing methods are considered for CRSs. These methods include energy detection, matched filtering, cyclostationary feature detection and waveform based detection etc. The choice of a particular sensing method can be made depending on sensing requirements, available resource such as power, computational resource and application/signal to be sensed.

5.3 Combined Spectrum sensing and Geolocation/Database

It is possible to use sensing in parallel with access to database. If this combined approach were to be adopted then the following process may apply;

- Identification of device location (information to be provided by the device to the centralized database).
- Identification of the usable frequencies and EIRP (information to be provided by the database to the device).
- Cross-check of availability of usable frequencies (spectrum sensing carried out by the device).
- Enable transmission (the device is transmitting). Transmission should be allowed only upon confirmation by the geolocation database and by sensing.

5.4 *Beacons*

Beacons are signals which can be used to indicate that particular channels are either in use by protected services or vacant. The use of beacons can ease the performance requirements on devices that use spectrum sensing, by increasing the likelihood of detection at higher threshold values.

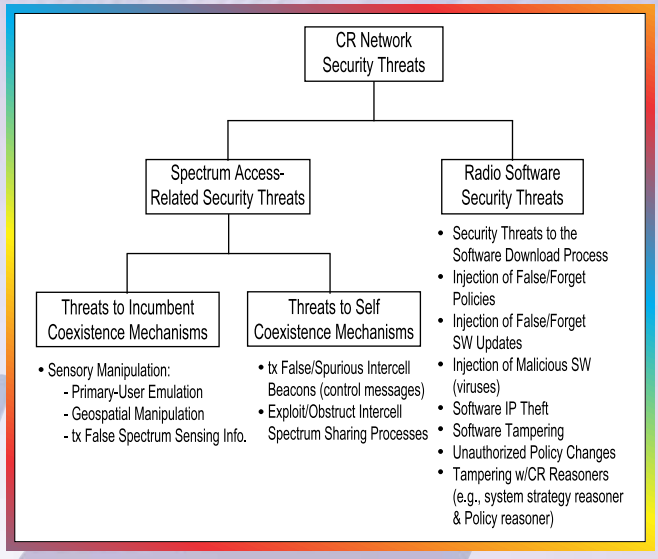
Enable beacon: If the beacon is detected, the considered channel can be used.

Disable beacon: If the beacon is detected, the considered channel is occupied and cannot be used by cognitive device.

Beacon as pilot channel: Identifies locally used TV channels, i.e. local database.

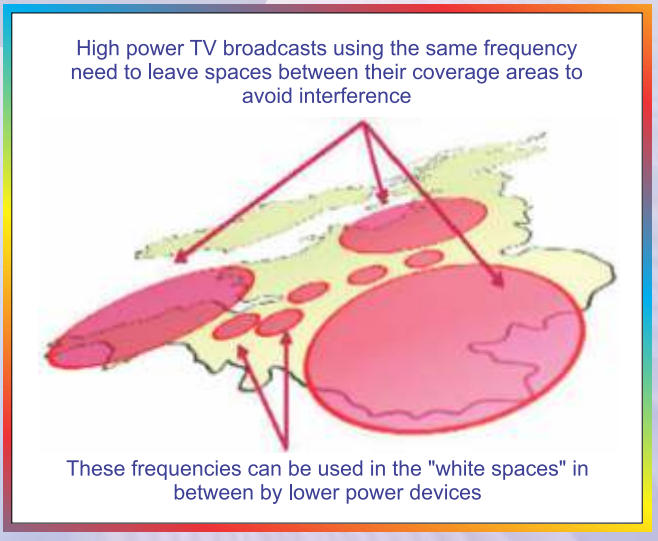
6.0 Cognitive Radio Network Security Considerations

The successful deployment of CR networks and the realization of their benefits depend on the placement of essential security mechanisms in sufficiently robust form to resist misuse of the systems. The figure below depicts some of the security considerations of cognitive radio technology.



7.0 Cognitive Radio Technology in TV White Spaces

In USA, UK and other major countries the approach that is being followed in deploying the cognitive radio systems revolves mainly around the TV White Space spectrum utilization. '*White Space*' *is a label indicating a part of the spectrum, which is available for a radio communication application (service, system) at a given time in a given geographical area on a non-interfering / non-protected basis with regard to other services with a higher priority on a national basis.*



The approach dictates the digitization of the TV network. This transition to digital domain of the TV network facilitates the availing of *digital dividend*. The digital dividend refers to the spectrum which is released in the process of digital television transition. When television broadcasters switch from analog platforms to digital platforms, part of the electromagnetic spectrum that has been used for broadcasting will be freed up because digital television has lesser spectrum requirement than analog television. The final step is to deploy the cognitive radio devices in the TV White Spaces using any of the techniques discussed earlier.

References :

1. Cognitive Radio Communications and Networks Principles and Practice by Alexander M. Wyglinski, Maziar Nekovee, Y. Thomas Hou.
2. Cognitive Radio Technology by Bruce Fette
3. ITU-R Report SM.2152: Definitions of Software Defined Radio (SDR) and Cognitive Radio System (CRS).
4. ECC Report on Technical and operational requirements for the possible operation of cognitive radio systemsin the 'white spaces' of the frequency band 470-790 MHz
5. Federal Communications Commission Report on Unlicensed Operation in the TV Broadcast Bands Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band.
6. Mitola, "Cognitive Radio for Flexible Mobile Multimedia Communications", IEEE Mobile Multimedia Conference, 1999, pp3-10
7. Mitola, "Future of Signal Processing - Cognitive Radio", Keynote, IEEE ICASSP, May 1999
8. Mitola, Maguire, "Cognitive Radio: Making SW Radios More Personal", IEEE Personal Communications, August 1999, pp13-18

हिंदी पखवाड़ा

दूरसंचार अभियांत्रिकी केंद्र, नई दिल्ली में दिनांक 14 सितंबर से 28 सितंबर तक हिन्दी पखवाड़े का सफलता एवं उत्साह पूर्वक आयोजन किया गया। पखवाड़े का शुभारंभ वरिष्ठ उप महानिदेशक श्री ए के मित्तल द्वारा दीप प्रज्वल्लित कर किया गया एवं उन्होंने सभी उपस्थित अधिकारियों एवं कर्मचारियों को हिन्दी के प्रचार एवं प्रसार हेतु अधिक से अधिक योगदान करने के लिए प्रेरित किया। इस अवसर पर श्री मित्तल द्वारा माननीय गृह मंत्री श्री सुशील कुमार शिंदे का संदेश पढ़कर सुनाया गया।

श्री ए.के. मित्तल, वरिष्ठ उप महानिदेशक द्वारा हिन्दी पखवाड़े का शुभारंभ

पखवाड़े के शुभारंभ समारोह में उपस्थित अधिकारी एवं कर्मचारीगण

टीईसी में प्रतियोगिता में भाग लेते प्रतियोगी

एनटीआईपीआरआईटी गाजियाबाद में हिन्दी प्रतियोगिता की झलकी

पखवाड़े में राजभाषा हिन्दी से संबंधित विभिन्न विषयों पर कुल 9 प्रतियोगिताओं का आयोजन किया गया। जिसमें प्रतिभागियों ने बढ़चढ़ कर हिस्सा लिया।

समारोह का समापन श्री अरुण गोलस, उप महानिदेशक की अध्यक्षता में सम्पन्न हुआ जिसमें सभी विजेताओं को पुरस्कार राशि एवं प्रमाण पत्र दिये गये।

इस पखवाड़े के दौरान दिनांक 26.09.13 को एक हिन्दी कार्यशालाा का भी आयोजन किया गया जिसमें हिन्दी राजभाषा विभाग से वरिष्ठ तकनीकी निदेशक श्री केवल कृष्ण ने हिन्दी विषय पर उपस्थित अधिकारियों को काफी रोचक जानकारियाँ उपलब्ध कराई। हाल ही में टी ई सी में पदस्थापित वरिष्ठ अधिकारियों द्वारा भी इस कार्यशाला को काफी सराहा गया।

हिन्दी पखवाड़े का समापन समारोह

Contributions by TEC in ITU

1. Proposed modifications to working document towards a preliminary draft new Report ITU-R M.[IMT.BROAD.PPDR] - The use of International Mobile Telecommunications (IMT) for Broadband Public Protection and Disaster Relief (PPDR) applications
2. Proposal for development of a new Report on national spectrum requirements for implementation of IMT during 2 015-2 025 in support of Agenda item 1.1
3. Input to studies towards WRC-15 Agenda item 1.1 - Suitable frequency ranges for IMT for deployment of mobile broadband
4. Proposal on coexistence with cognitive radio systems
5. Studies on WRC-15 Agenda item 1.1
6. Input to studies towards WRC-15 Agenda item 1.1 - Estimated requirement of IMT spectrum for mobile broadband deployments
7. Incorporation of remote testing using NGN testbed as a valid method of testing in NGN.
8. Successful e-initiative for rural people in remote North Eastern part of India – "Active community participation for sustainability"
9. Proposed modifications to working document towards a preliminary draft new Recommendation ITU-R M.[IMT.OOBE MS]
10. Proposed modifications to the working document towards a PDNR on coexistence in adjacent spectrum blocks in the 2300-2400 MHz band in TDD mode
11. Proposed material for working document towards a Handbook on global trends in IMT

Approvals from JULY 13 to SEP 13

S.No	Company/Product
1.	M/s Sunren Technical Solutions Pvt. Ltd.,
1.1	V.90 MODEM ,Model:CONEXANT RD02-D400
1.2	G - 3 FAX Machine, PROXPRESS M3870FD
2	Viswambara Software Systems Private Limited
2.1	OTN XFP Tunable,OTN XFP4CG (Tunable)
2.2	OTN XFP Fixed,OTN XFP4CG (Fixed)
3	M/s Renishaw Metrology Systems P.Ltd
3.1	Wireless Ballbar,QC20-W
4	M/s Huawei Telecommunications India Co. Pvt. Ltd.,
4.1	Switching Node with Network-Network Interface at 2048 Kbits,MSOFTX 3000 with UMG 8900
5	M/s TEJAS NETWORKS LTD,Bangalore
5.1	STM -1 TM/ADM,TJ 1420
5.2	STM -4 TM/ADM,TJ 1420
5.3	STM -1 TM/ADM,TJ 1400
5.4	STM -4 TM/ADM,TJ 1400
5.5	STM -1 TM/ADM,TJ 100ME
5.6	STM -1 TM/ADM,TJ 1420
5.7	STM -4 TM/ADM,TJ 1420
5.8	STM -1 TM/ADM,TJ 1400
5.9	STM -4 TM/ADM,TJ 1400
5.10	STM -4 TM/ADM,TJ 100ME

Important Activities of TEC during July 13 to Sep 13

GR / IR Amended :

- Mobile Radio Trunking Communication Equipment
- Mobile Radio Trunking Subscriber Unit

DCC conducted :

- GR on Cordless Telephone
- IR on Radio Modems in ISM Band
- GR on L Band IDR Equipment
- GR on 23 GHz High Performance antenna
- MPLS - TP for Metro Network
- MPLS – TP for Access Network
- Optical Power Meter
- Stabilized Light source
- Optical Loss Test Set
- Composite Optical Test Instrument
- Network Network Interface for IP

Other activies :

- NWG meeting for ITU-T Study Groups 5,11,12,15,17 held in TEC in SEP 2013
- Testing of Optical coupler & switch tray of M/s C-DOT
- Meetings of committee on Validation of EMF Web Portal

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Certifications issued by TEC

Type Approval (TA)

Interface Approval (IA)

Certificate of Approval (CoA)

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

Activities at NTIPRIT

a) Courses For ADEsT 2010 batch

- Course on Regulation & Dispute Settlement
- Course on Vigilance & Disciplinary Proceedings

b) Courses For ADEsT 2011 batch

- Course on Cyber Security & LIM Systems
- Course on Mobile Communications
- Course on Structure of Networks & Interconnections

Approvals issued by TEC during the period from July 2013 to Sep 2013

Interface Approvals.....13

Type Approvals 0

Certificate of Approvals.....03

टी ई सी संचारिका : दूरसंचार इंजीनियरी केन्द्र
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भाग 17 : जनपथ
अंक 3 : नई दिल्ली-110001

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