Technology Digest

Bulletin of telecom technology

Issue 23, July 2015

For limited circulation

Telecom Regulatory Authority of India

Internet of Things

In this issue

While getting out of the office, imagine an app telling you that if you wait for 3 more minutes, you won't get any red lights on the way back. Or the bus that you want to take is late by half an hour and you might as well sit in your office rather than waiting at the bus stop. Can you believe if your refrigerator calls you when you are at the market asking you to buy milk as well, as the kids have spilled it?

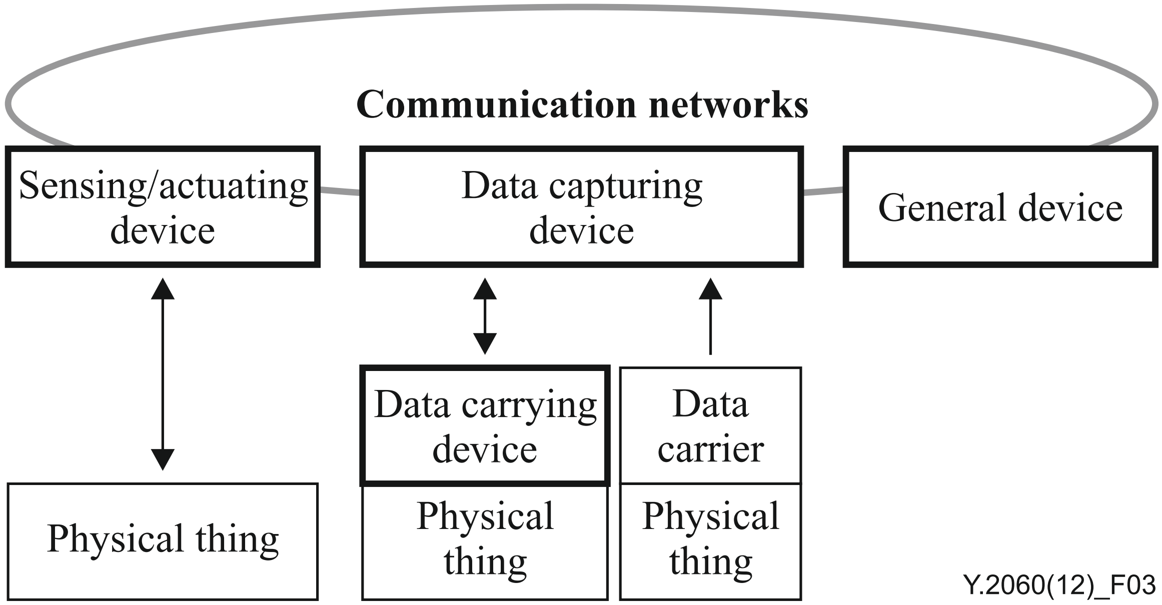
This is all possible right now with the use of the buzz word that has taken the tech world by the storm; 'Internet of Things'. With the use of sensors that can report almost all aspects of the real world and objects can thus sense and communicate with humans, it is now possible to know anything about everything you own (or not) and manage daily activities and work accordingly. Moreover, currently cities account for 50-60% of GHG emissions as well as 75% of the global energy consumption. While cities generously contribute to around 75% of the global GDP, they also generate over 50% of the world's waste. By 2050, 70% of the world's population is estimated to reside in cities. A sustainable life for the future generations would thus depend on making cities smarter and more sustainable. Internet of Things (IoT) leads a sweeping cultural change as a huge number of machines, devices, sensors, actuators, and other objects become interconnected to each other and to higher-level systems.

The Internet of Things (IoT) provides connectivity for anyone at any time and place to anything at any time and place. With the advancement in technology, we are moving towards a society, where everything and everyone will be connected. The IoT is considered as the future evaluation of the Internet that realizes machine-to-machine (M2M) learning. The basic idea of IoT is to allow autonomous and secure connection and exchange of data between real world devices and applications. The IoT links real life and physical activities with the virtual world. The number of Internet connected devices is increasing at the rapid rate. These devices include personal computers, laptops, tablets, smart phones, PDAs and other hand-held embedded devices. Most of the mobile devices embed different sensors and actuators that can sense, perform computation, take intelligent decisions and transmit useful collected information over the Internet. Using a network of such devices with different sensors can give birth to enormous amazing applications and services that can bring significant personal, professional and economic benefits. The IoT consists of objects, sensor devices, communication infrastructure, computational and processing unit that may be placed on cloud, decision making and action invoking system. The objects have certain unique features and are uniquely identifiable and accessible to the Internet. These physical objects are equipped with Radio-Frequency IDentification (RFID) tags or other identification bar-codes that can be sensed by the smart sensor devices. The sensors communicate object specific information over the Internet to the computational and processing unit. A combination of different sensors can be used for the design of smart services. The result of processing is then passed to the decision making and action invoking system that determines an automated action to be invoked.

In summary, the Internet of Things will:

1. Connect both inanimate and living things
2. Use sensors for data collection
3. Identify, track and communicate with objects over IP network

The following figure according to the ITU recommendations (ITU-T Y.2060) shows the different types of devices and the relationship between devices and physical things in an IoT environment.



Main attributes

The six main attributes that make "things" a part of the Internet of Things, or IoT:

Sensors: IoT devices and systems include sensors that track and measure activity in the world. One example is open-and-close sensors that detect whether or not a drawer, window, or door in your home is open or closed.

Connectivity: Internet connectivity is either contained in the item itself, or a connected hub, smartphone, or base station. If it's the latter, then the base station will likely be collecting data from an array of sensor-laden objects, and relaying data to the cloud and back.

Processors: Just like any computing device, IoT devices will contain some computing power "under the hood," if only to be able to parse incoming data and transmit it.

These characteristics all apply to today's smartphones, of course, but many IoT devices will also need to be equipped with several special features to be truly useful. These will differentiate IoT devices, particularly remote ones, from today's smartphones.

Energy-efficiency: Many devices in the IoT may be difficult, costly, or dangerous to access for charging or battery replacement. One may even think of the Mars Curiosity Rover as an example of such a device. Therefore, they may need to be able to operate for a year or more unattended using a conservative amount of energy or be able to wake up only periodically to relay data.

Cost-effectiveness: Objects that contain sensors may need to be distributed broadly to be useful, as in the case of sensors in food products in supermarkets that would indicate if an item has spoiled. These would need to be relatively inexpensive to purchase and deploy.

Quality and reliability: Some IoT devices will need to operate in harsh environments outdoors and for extended periods of time.

Security: IoT devices may need to relay sensitive or regulated information such as health-related data, so data security will be critical.

Fundamental characteristics of IoT

According to ITU, the following are some fundamental characteristics of IoT:

Interconnectivity: With regard to the IoT, anything can be interconnected with the global information and communication infrastructure.

Things-related services: The IoT is capable of providing thing-related services within the constraints of things, such as privacy protection and semantic consistency between physical things and their associated virtual things.

Heterogeneity: The devices in the IoT are heterogeneous as based on different hardware platforms and networks. They can interact with other devices or service platforms through different networks.

Dynamic changes: The state of devices change dynamically, e.g., sleeping and waking up, connected and/or disconnected as well as the context of devices including location and speed. Moreover, the number of devices can change dynamically.

Enormous scale: The number of devices that need to be managed and that communicate with each other will be at least an order of magnitude larger than the devices connected to the current Internet. The ratio of communication triggered by devices as compared to communication triggered by humans will noticeably shift towards device-triggered communication. Even more critical will be the management of the data generated and their interpretation for application purposes. This relates to semantics of data, as well as efficient data handling.

Other high-level requirements include:

- Identification-based connectivity
- Interoperability
- Autonomic networking ((including self-management, self-configuring, self-healing, self-optimizing and self-protecting techniques and/or mechanisms))
- Autonomic services provisioning:
- Location-based capabilities:
- Security
- Privacy protection
- High quality and highly secure human body related services
- Plug and play capability and,
- Manageability

IoT Reference Model

IoT reference model is described in the ITU Recommendation ITU-T Y.2060. It is composed of four layers as well as management capabilities and security capabilities which are associated with the four layers. These layers are application layer, service support & application support layer, network layer, device layer. Since machine to machine (M2M) technologies are a key enabler of the Internet of Things (IoT), at present discussions are going on to include the M2M service layer in the reference model. "ITU-T M2M service layer" – includes a set of generic and specific functions for the support of a variety of applications enabled by the M2M technologies. These functions include management functions and security functions as well as service support and application support functions. Figure below shows the ITU-T M2M service layer and its position in the IoT reference model [ITU-T Y.2060].

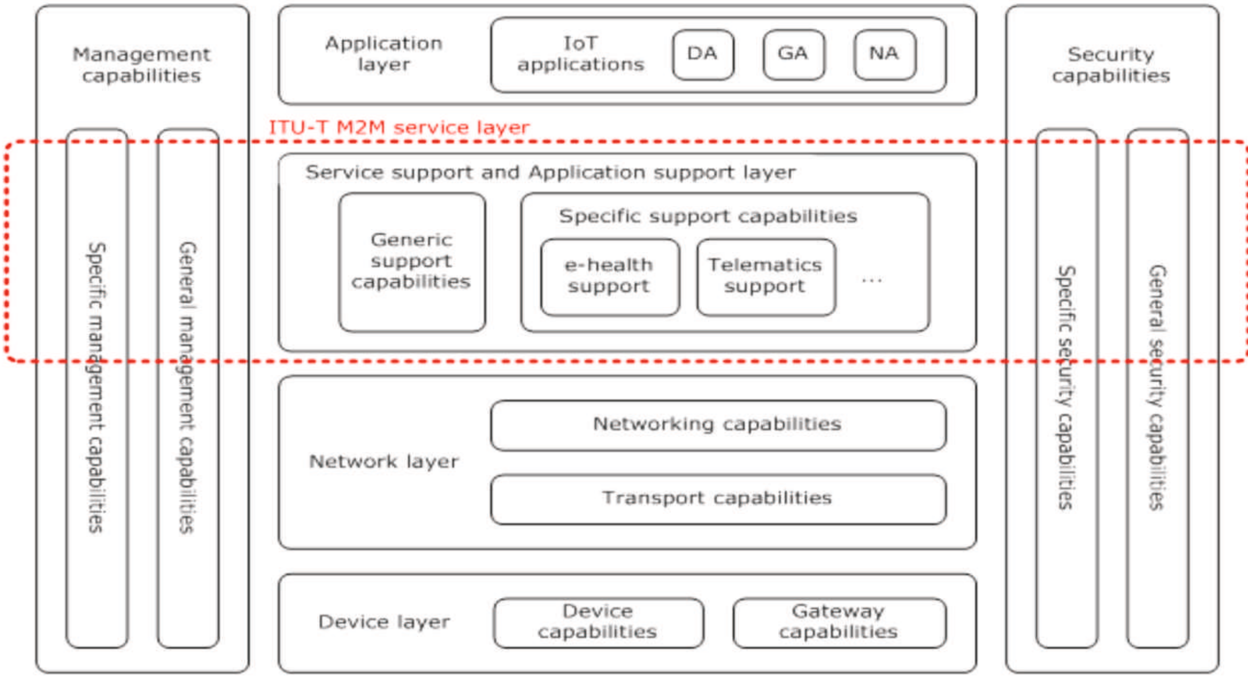


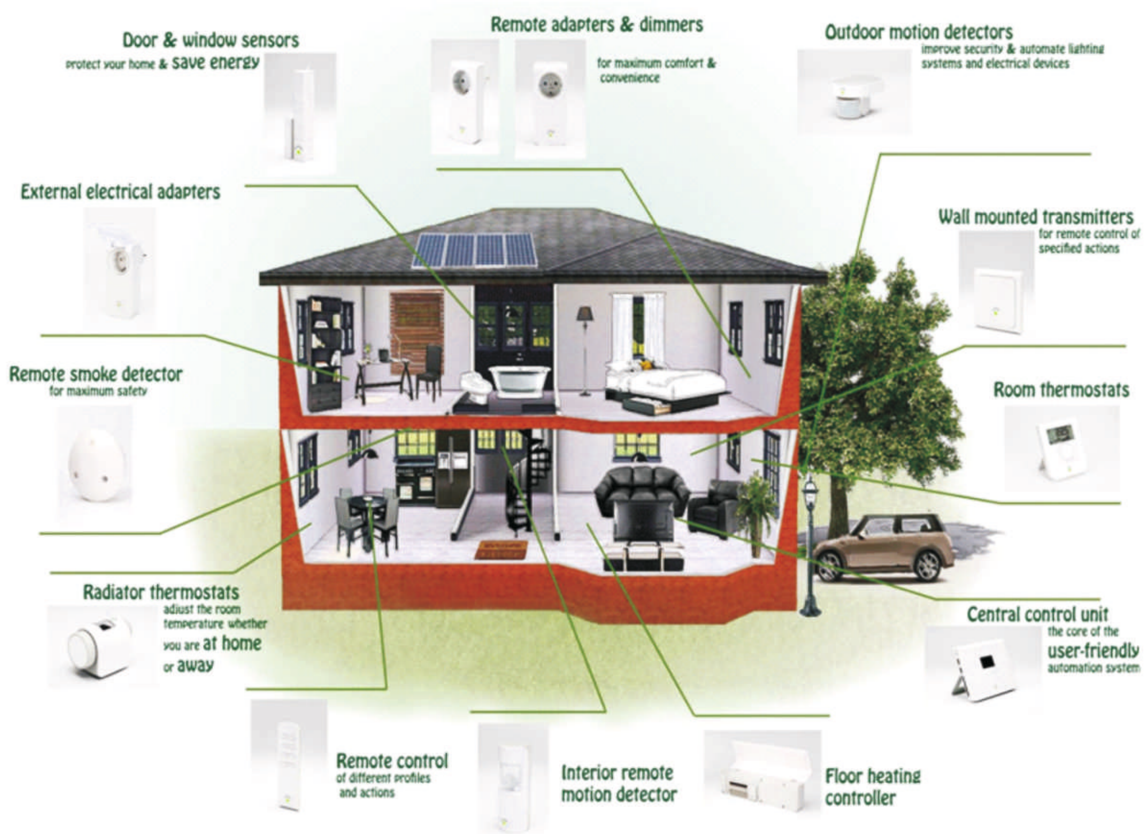
Fig.: The ITU-T M2M service layer in the IoT reference model

Application of IOT:

There is no end to the use of imagination in how IoT can empower and enable people. Right from automating everyday mundane things like switching on and off lights and finding lost keys to regulating city transport and monitoring health of people, IoT has numerous advantages. The potentialities offered by the IoT make it possible to develop numerous applications based on it, of which only a few applications are currently deployed. In future, there will be intelligent applications for smarter homes and offices, smarter transportation systems, smarter hospitals, smarter enterprises and factories. Some of the important examples of applications of IoT are as below.

Independent Living - IoT applications and services will have an important impact on independent living by providing support for an aging population by detecting the activities of daily living using wearable and ambient sensors, monitoring social interactions using wearable and ambient sensors, monitoring chronic disease using wearable vital signs sensors and in body sensors. With emergence of pattern detection and machine learning algorithms, it would be possible to watch various parameters related to a patient's environment and necessary care for the patient can be extended. Things can learn regular routines and raise alerts or send out notifications in anomaly situations.

Home Automation- It means security systems with no keys, self monitored heating, ventilation and air conditioning, centralized control of lighting, changing the ambiance "scenes" for different events, sophisticated systems maintaining an inventory of products, recording their usage through bar codes, or an RFID tag, and preparing shopping lists or even automatically ordering replacements. This is probably the first and most celebrated use case of Internet of Things.

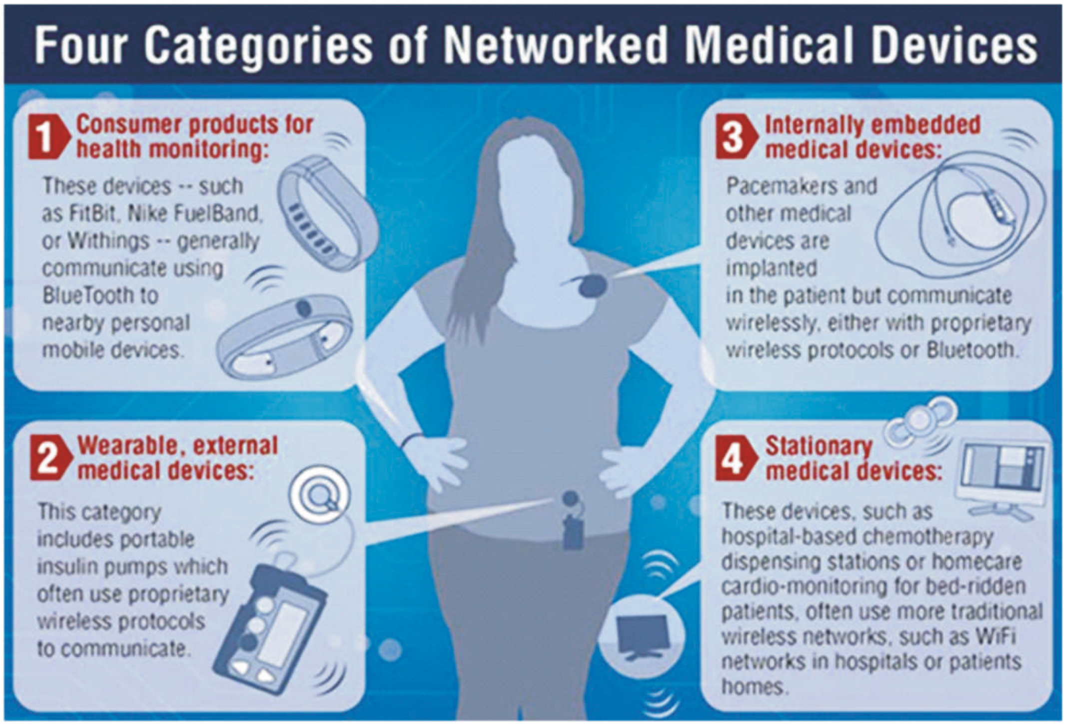


Smart water systems and meters - The cities of Doha, Sao Paulo, and Beijing have reduced leaks by 40 to 50% by putting sensors on pumps and other water infrastructure. Smart meters are being used for preventing electricity pilferage and balancing grid loads.

Public transportation/smart cities - London iBus system is a good example. It works with information from over 8,000 buses that are fitted with GPS capabilities alongside various other sensors which relay data about the vehicle's location and current progress so bus stop signposts can display details of a bus's impending arrival. It can also include toll-taking operations, congestion penalties, and smart parking-space management. For e.g. If we detect that a road is blocked using those sensors and if we are connected to the GPS of our car and it will suggest the routes avoiding blocked roads, this would really improve traffic congestion.

Telecommunications Industry - IoT will create the possibility of merging of diverse telecommunication technologies and create new services. An illustrative example is the use of GSM, NFC (Near Field Communication), low power Bluetooth, WLAN, multi-hop networks, GPS and sensor networks together with SIM-card technology. In these types of applications the reader (i.e., tag) is a part of the mobile phone, and different applications share the SIM-card.NFC enables communications among objects in a simple and secure way just by having them close to each other. The mobile phone can therefore be used as a NFC reader and transmit the read data to a central server. When used in a mobile phone, the SIM-card plays an important role as storage for the NFC data and authentication credentials (like ticket numbers, credit card accounts, ID information etc).

Healthcare - Hospitalized patients whose physiological status requires close attention can be constantly monitored using IoT-driven, non invasive monitoring using sensors. Remote patient monitoring is also a possibility by securely capturing patient health data from a variety of sensors, apply complex algorithms to analyze the data and then share it through wireless connectivity with medical professionals who can make appropriate health recommendations.



Environment Monitoring - Utilization of wireless identifiable devices and other IoT technologies in green applications and environmental conservation are one of the most promising market segments in the future. There will be an increased usage of wireless identifiable devices in environmentally friendly programs worldwide.

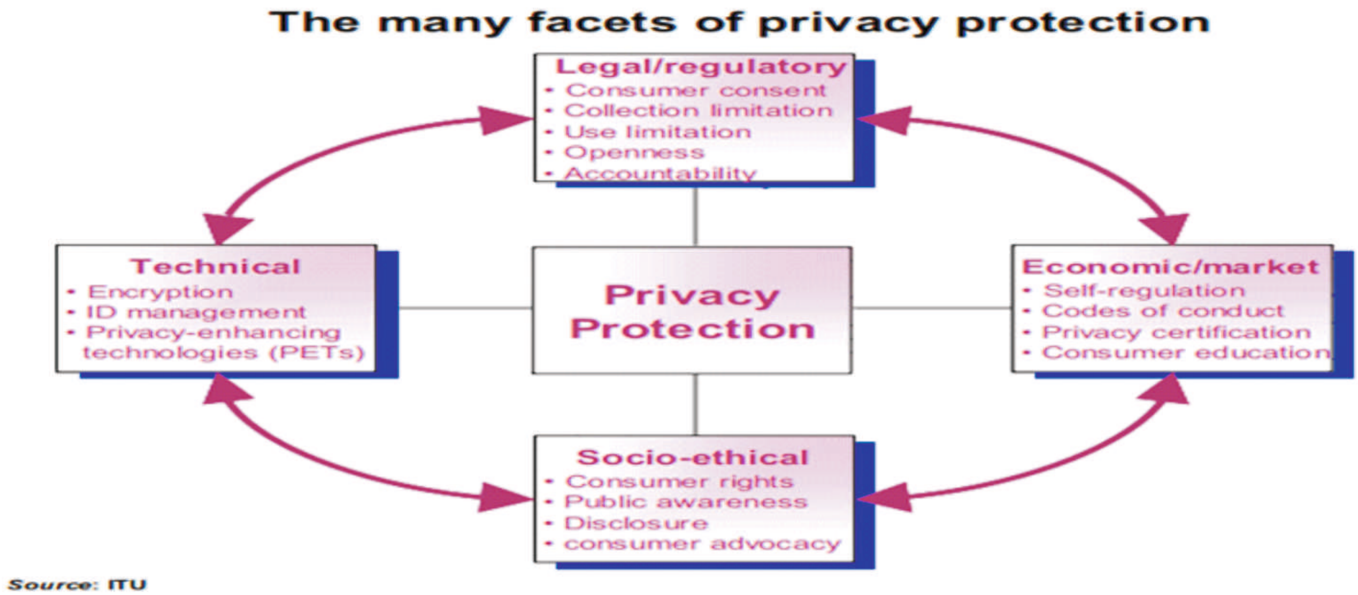
Challenges:

With everything over the network, including making decisions, stakes are quite high in the Internet of Things as compared to the Internet. A robust system will also require high capacity networks that can sustain this magnitude of data transmission. Here are a few challenges that emerge:

Effective data transmission: Data transmission becomes more and more important when the volume of data transmission increases by leaps and bounds by the rapid advent of the small and potent processors. Data management will also become a challenge and this will require rapid developments in the advanced data analytic and the big data arena.

Spectrum Requirement: Many IoT devices will communicate wirelessly, making the availability of spectrum - the raw material that underpins wireless services - an important factor. Even though much of the IoT's short to medium-term spectrum demands are met with current frameworks, there is a need to monitor the IoT's spectrum needs to identify when additional spectrum may be needed.

Data Security and Protection: The increase in data in centrally located servers also calls for increased security measures to safeguard and protect the data. This data will be the asset of lot of companies and thus will be highly confidential. Many new small start-ups will surface that specializes in data security and secure data transmission means leading to employment opportunities for millions.



Storage capabilities: With the colossal increase in the volume of incoming data, innovations and inventions will become the need of the hour. Corporations will look for more compact, reliable and energy efficient storage system. Memory management will also become a significant aspect for analyzing storage capabilities. Further, developers and investors will look for high processing capacity systems. The computing system has to process resource demanding tasks like queuing, searching, controlling data traffic.

Failure Response System: With the dawn of automation, the world will also witness the dawn of failure response systems. Corporations and organizations will invest on mitigation measures and various alarm and emergency systems to monitor the functioning of Internet of Things and to minimize losses for system and process failures.

Increase in e-waste: Since the discarded electronics components within IoT-enabled objects are a significant source of e waste, providers of IoT equipment must increasingly take account of dangers arising from the use of hazardous material in the production of devices. Products should be designed and manufactured to reduce their lifecycle environmental impact. Environmental concerns should also be an integral component of smart manufacturing, which has a symbiotic relationship with the Internet of Things.

Sources :
http://www.telecomcircle.com/2014/05/what-is-internet-of-things/
http://www.econais.com/how-to-easily-put-m2m-iot-devices-online-wifi-module/
http://www.asyouwishelectric.com/home-automation-electrician.htm
http://spectrum.ieee.org/telecom/security/how-to-build-a-safer-internet-of-things
http://www.itu.int/osg/spu/publications/internetofthings/InternetofThings_summary.pdf

Published by: Telecom Regulatory Authority of India
Editorial responsibility: TD Division
Contributions, comments and suggestions: tdra@trai.gov.in