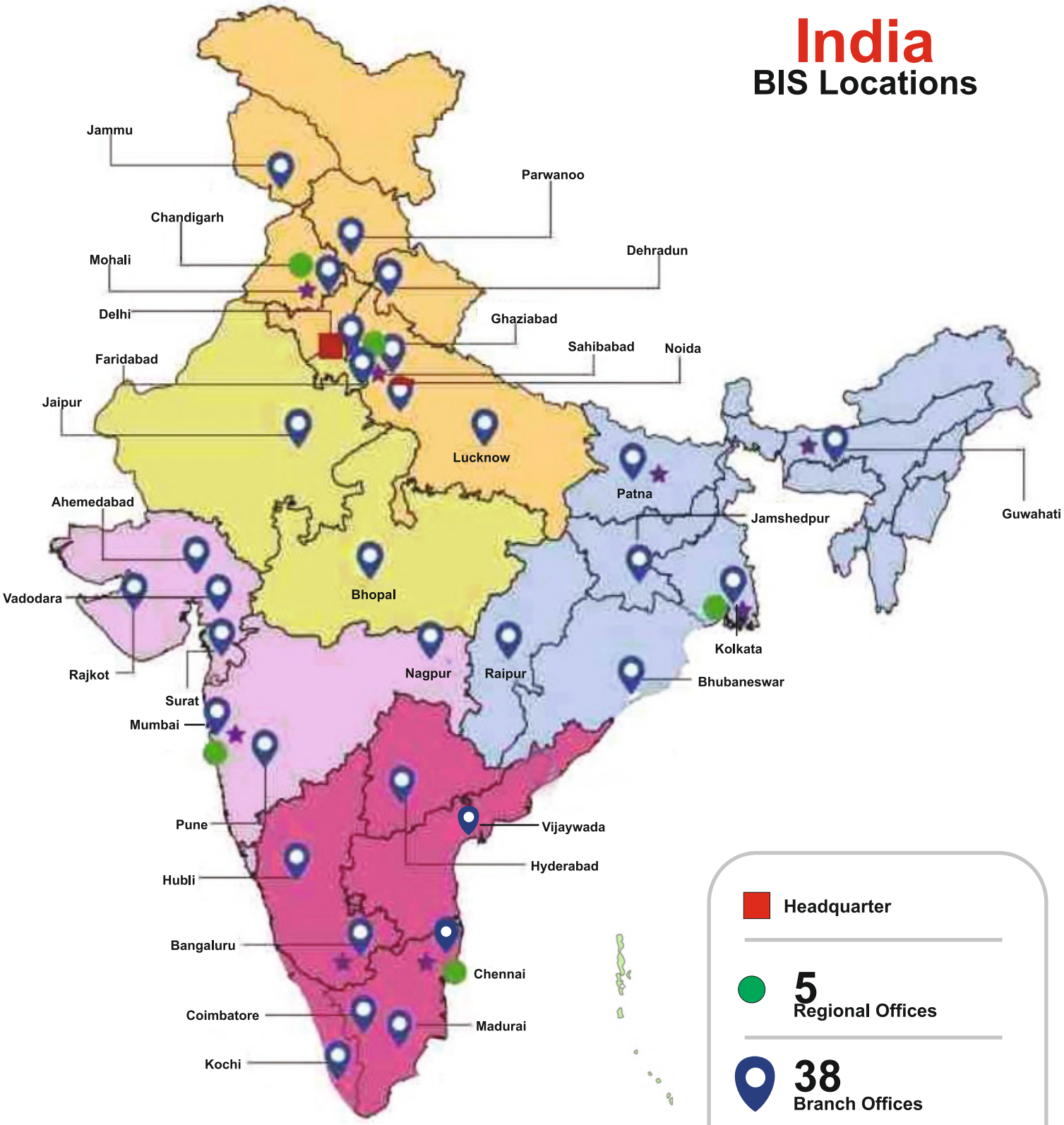
STANDARDIZATION IN THE EMERGING INFORMATION TECHNOLOGY AREAS

BUREAU OF INDIAN STANDARDS
Ministry of Consumer Affairs,
Food and Public Distribution
Government of India

भारतीय मानक ब्यूरो
उपभोक्ता मामले, खाद्य और
सार्वजनिक वितरण मंत्रालय
भारत सरकार

India
BIS Locations



Headquarter

5 Regional Offices

38 Branch Offices

8 Laboratories

— Training Institute (NITS)

सत्यमेव जयते

मानकः पथप्रदर्शकः

Azadi Ka Amrit Mahotsav

ABOUT BIS

Bureau of Indian Standards (BIS), the National Standards Body (NSB) of India was established under the *BIS Act*, 1986 and came into existence on 1 April 1987 assuming the functions of the erstwhile Indian Standards Institution (ISI). The ISI was established on 6 January 1947. *The BIS Act*, 2016 came into force on 12 October 2017 superseding BIS Act 1986. *The BIS Act*, 2016 provides for the establishment of a national standards body for the harmonious development of the activities of standardization, conformity assessment and quality assurance of goods, articles, processes, systems and services and for matters connected therewith or incidental thereto.

BIS through its core activities of standardization and conformity assessment, has been benefiting the national economy by providing safe, reliable and quality goods; minimizing health hazards to consumers; protecting the environment; controlling over proliferation of varieties; promoting exports and imports substitutes, etc. The standardization and conformity assessment schemes of BIS apart from benefitting the consumers and industry also support various public policies especially in areas of product safety, consumer protection, food safety, environment protection, building and infrastructure development, etc.

BIS also represents India in international standards bodies like International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) and participates actively in the international standardization work undertaken by these bodies. BIS presents the national viewpoints on new areas taken up for international standardization and on various draft international standards during the process of development of these standards so that the country's interest is protected and reflected in these standards. This also enables the BIS technical committees to consider adoption of the international standards as Indian Standards, with or without modifications, in order to enable our products and services to integrate with global trade and commerce.

What are Standards?

Standard is a document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.

Importance of Standardization

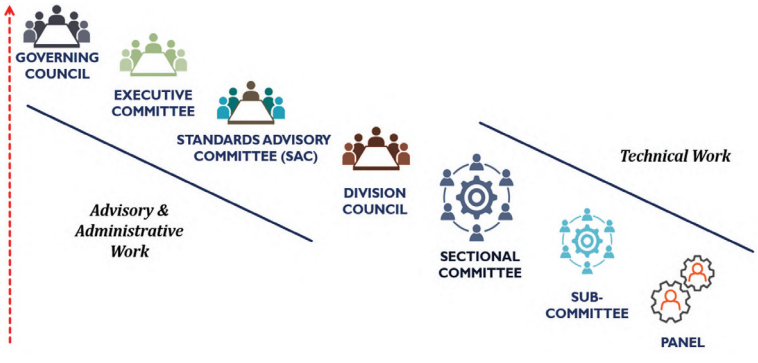
Standardization is the process of developing technical standards through consensus of different parties.This standardization aims to address one or all of compatibility, interchangeability, variety control, safety, environment protection, product protection and fitness for purpose. Standards provide numerable benefits to the technologists, producers, consumers and traders besides defining purpose for each of these entities.

Standards can be formulated at various levels ranging from an individual through National (IS) to International level (ISO). Also, depending on the subject in hand, standards can be made on various aspects such as terminology, specification, sampling, testing, code of good practice, systemes and services.

STANDARDIZATION ACTIVITY OF BIS

Standardization Structure

There are 16 Technical Departments formulating standards in various subject areas. Corresponding to these departments, 16 division councils exist. Each division council has several sectional committees working under it. The standards cover important segments of economy and help the industry in upgrading the quality of their goods and services.

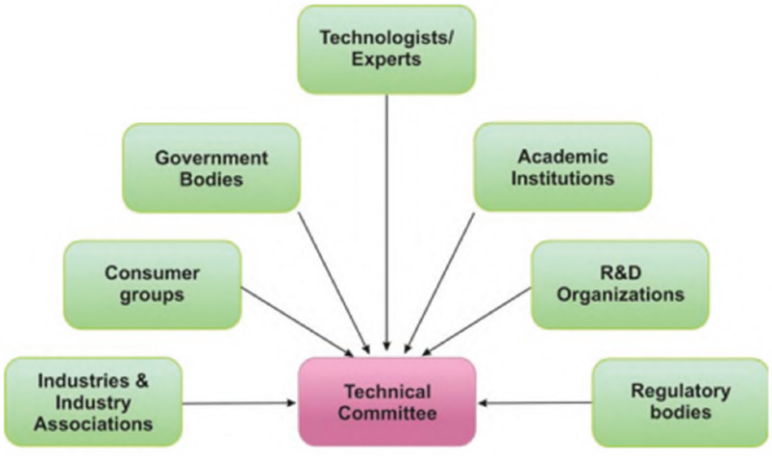


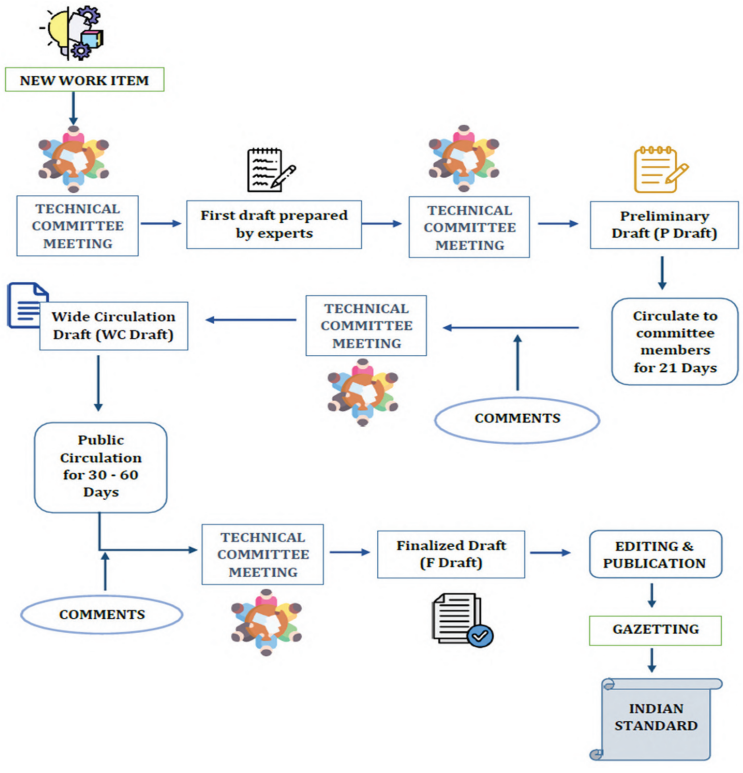
Ayush Division Council (AYDC)	Chemical Division Council (CHDC)	Civil Engineering Division Council (CEDC)	Electro-Technical Division Council (ETDC)
Electronics & Telecommunication Division Council (LITDC)	Food and Agriculture Division Council (FADC)	Mechanical Engineering Division Council (MEDC)	Management and Systems Division Council (MSDC)
Metallurgical Engineering Division Council (MTDC)	Medical Equipment & Hospital Planning Division Council (MHDC)	Petroleum, Coal & Related Products Division Council (PCDC)	Production and General Engineering Division Council (PGDC)
Transport Engineering Division Council (TEDC)	Textile Division Council (TXDC)	Water Resources Division Council (WRDC)	Service Sector Division Council (SSDC)

Standards Formulation Process

The Indian Standards are developed by technical committees that are representative of various stakeholders having interest in the relevant subject of standardization under the scope of such committees through a process of consultation so that views of all are given due consideration and a consensus is evolved in formulating a standard. The stakeholders involved in national standardization can broadly be categorized as industry, consumers/ users, technologists (R&D and scientific institutions, academia, individual subject experts, etc) and government departments/regulators.

The process of standards development of BIS is aligned with accepted international best practices that are based on the core principles of openness, transparency, impartiality and consensus. The process begins with the identification of the standardization needs of the given sector or subject following which the development of the standard is taken up and planned bythe relevant technical committee. Apart from consultation within the technical committees, draft standards are also open for public views/comments.





Standards Development Process Flow

Standardization in the Emerging Information Technology areas

Information Technology (IT) has become an integral part of our lives and has been transforming the way we communicate, work, and interact. As technology continues to evolve at a rapid pace, the establishment and adherence to standards have become crucial in ensuring compatibility, interoperability, Information interchange, life cycle management, data Privacy and security. IT standards serve as the foundation for a reliable and efficient IT infrastructure.

In an increasingly connected world, harmonization with international IT standards is also crucial. BIS actively collaborates with international standards bodies such as the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), specifically Joint Technical Committee (JTC 1) of ISO/IEC dealing with standardization in the area of IT. This collaboration enables Indian standards to align with global best practices, fostering international interoperability, and facilitating trade and exchange of IT goods and services. This also gives us the platform for proposing and preparing new International Standards from India as per our requirements.

In the field of Information Technology, BIS formulates Indian Standards (IS) covering broad range of areas, including:

- Software and Systems Engineering
- Smart Cards and Computer peripherals
- Biometrics
- E-learning
- Cybersecurity, Data Privacy and Data protection
- Data Centres
- Indian Languages Technologies
- Block-Chain and Distributed Ledger Technologies (DLT)
- Internet of Things (IoT)
- Artificial Intelligence
- Smart Infrastructure
- Brain-Computer Interface
- Quantum technologies
- Metaverse

The standards in the above IT areas are prepared by the various technical committees under Electronics & Information Technology Division Council (LITDC) of BIS which includes members from Government, Regulators, Industry, Laboratories, Research & Developments, Consumers and Academia. There are a total of 35 Technical Committees in the Electronics and Information Technology Department of Bureau of Indian Standards. The details of these committees can be viewed at : **https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/dgdashboard/committee_sso/committeeDetails/66**

During the recent past in the last few years BIS's endeavour has been to constantly monitor and identify future emerging technology areas in the field of IT. Several new Committees under LITDC like AI, Metaverse, Quantum, Brain Computer Interfaces, Internet of Things (IoT) and Digital Twins, Smart Infrastructure, Blockchain etc have been constituted.

Details of BIS Technical Committees dealing with emerging technology areas of IT

Technical Committee Number	Technical Committee Name
LITD 14	Software And System Engineering
LITD 15	Data Management System
LITD 16	Identification & Data capture techniques, Cards and Security Devices
LITD 17	Information Systems Security And Privacy
LITD 19	E-Learning
LITD 20	Indian Language Technologies And Products
LITD 22	Geospatial Information
LITD 25	Digital Governance
LITD 27	Internet of Things and & Digital Twin
LITD 28	Smart Infrastructure
LITD 29	Blockchain and Distributed Ledger Technologies
LITD 30	Artificial Intelligence
LITD 31	Cloud Computing, IT & Data Centres
LITD 32	Biometrics
LITD 33	Wearable electronic devices and technologies
LITD 34	Smart Manufacturing
LITD 37	Brain-Computer Interface

The standards in the aforementioned emerging technology areas are developed with an aim to:

- Enable interoperability among products and services from different suppliers
- acilitate global supply chains and enable cooperation among suppliers, providing a foundation for global trade
- Establish expectations and practices that result in higher quality products and services and provide confidence to purchasers
- Provide a common language and set of guidelines that enable seamless integration and interoperability among various systems, applications, and devices.

The highlights of the standardization work in each of these areas mentioned above is given in the following pages:

ARTIFICIAL INTELLIGENCE

BIS Committee: LITD 30 Artificial Intelligence

International Committee: ISO/IEC JTC 1/SC 42 Artificial intelligence

Artificial Intelligence (AI) is a fast-evolving family of technologies that can be designed to operate with varying levels of autonomy. The promise of digital transformation coupled with the continued and rapid innovation in AI has also changed the dynamic of how AI systems are being deployed. Traditionally, AI had been focused on large-scale problems that were either too hard/complex to solve with traditional compute methods or were in specialized emerging areas. This is no longer the case. AI is one of the key enablers of the digital transformation driven by a demand for services and more intelligent analytics. Examples include:

- AI expert systems are helping healthcare professionals make better decisions for patients with proper trustworthiness measures designed into the system,
- AI deployment in the industrial manufacturing sector where it is driving higher efficiencies by allowing robots to work alongside human workers with the proper safety measures designed into the system,
- AI deployment in the financial ecosystem where it is enabling applications that range from asset management that takes into account factors such as the clients risk to fraud detection that reduces false-positives
- Emerging applications are numerous and diverse e.g. consumer, retail, digital assistants, expert systems such as smart grid, marketing intelligence tools, enterprise etc.

The AI ecosystem continues to be ripe for standardization. International standards and specifications play an important role for the secure and reliable functioning of AI applications. They form the basis for trust in their technical systems and processes and foster their reliability and implementation.

At the National level, NITI Aayog has published discussion paper like National Strategy for Artificial Intelligence – #AIFORALL and approach documents on Part 1 'Principles for Responsible AI' and Part 2 'Operationalizing Principles For Responsible AI'.

LITD 30 identifies the areas for AI standardization based on National priorities in line with the NITI Aayog National Strategy for AI and pursues these at International level.

AIM of AI Standardization:

- Common concepts and terminology
- Enabling meaningful and Intelligent insights from large amount of data sets
- Defining Characteristics of Quality of Data
- To tackle Governance issues
- To ensure Trustworthiness : security, privacy, ethical and societal consideration aspects

BIS has published following Indian standards in the field of AI : on Vocabulary of Big data, Reference architecture, use cases, overview of Trustworthiness, robustness of neural of networks have been published by Bureau of Indian standards:

1. IS/ISO/IEC 20546:2019 Information technology — Big data — Overview and vocabulary

2. IS/ISO/IEC 20547-3:2020 Information technology — Big data reference architecture — Part 3: Reference architecture

3. IS/ISO/IEC TR 24028:2020 Information technology — Artificial intelligence — Overview of trustworthiness in artificial intelligence

4. IS/ISO/IEC TR 20547-1:2020 Information technology — Big data reference architecture — Part 1: Framework and application process

5. IS/ISO/IEC TR 24029-1:2021 Artificial Intelligence (AI) — Assessment of the robustness of neural networks — Part 1: Overview

6. IS/ISO/IEC TR 24030:2021 Information technology — Artificial intelligence (AI) — Use cases

7. IS/ISO/IEC/TR 24368 : 2022 Information Technology Artificial Intelligence Overview of Ethical and Societal Concerns

8. IS/ISO/IEC/TR 24372 : 2021 Information technology Artificial intelligence AI Overview of computational approaches for AI systems

9. IS/ISO/IEC 38507 : 2022 Information technology Governance of IT Governance implications of the use of artificial intelligence by organizations

10. IS/ISO/IEC 24668:2022 Process management framework for big data analytics

There are many standards under development at national and international level as well which are related to Data Quality, trustworthiness, vocabulary, Bias, Testing of AI systems etc. Some of the important one are:

- Artificial intelligence Guidance on risk management
- Artificial intelligence Assessment of machine learning classification performance
- Information technology Artificial intelligence Data life cycle framework
- AI Assessment of the robustness of neural networks Part 2: Methodology for the use of formal method
- Software engineering Systems and software Quality Requirements and Evaluation SQuaRE Quality model for AI systems
- Data quality for analytics and ML
- AI system life cycle processes
- Artificial intelligence — Reference architecture of knowledge engineering
- Transparency taxonomy of AI systems
- Environmental sustainability aspects of AI systems
- AI system impact assessment
- Artificial intelligence — Management system

BIS Committee experts are leading the development of a number of standards at International level. Some of these are listed below:

1. **Guidelines for AI applications:** This standard intends to develop guidelines for identifying the context, opportunities, and processes for developing and applying AI Applications. The proposed guidelines will provide a macro level view of an AI Application and a common framework to stakeholders to answer the question: "What is an AI Application?"

2. **Verification and validation Analysis of AI systems:** This document describes approaches for verification and validation of AI systems against their stated requirements and specifications.

3. **Overview of differentiated benchmarking of AI system quality characteristics:** This document provides an overview of conceptual frameworks for graded benchmarking of AI system quality characteristics. The aim is to examine the feasibility of using differentiated benchmarking of quality characteristics based on the complexity and context of use of an AI system

4. **Guidance for Generative AI Applications:** This document provides guidance to identify value contribution and value realization for each stakeholder when developing or using a generative AI application. This document also provide guidance for governance mechanism to manage use of an existing generative AI application as a service

WEARABLE ELECTRONIC DEVICES & TECHNOLOGIES

BIS Committee: LITD 33 Wearable electronic devices and technologies

International Committee: IEC TC 124 Wearable electronic devices and technologies

The wearable electronic devices and technologies are materials, devices, and systems that provide information as well as entertainment, both of which are directly and indirectly related with convenience, health care and well-being.

Major current and upcoming wearable devices are categorized as accessories, electronic textiles, patchable devices, implantable devices. While wearable electronic devices and technologies are different in their types and shapes, they share common characteristics that they always stay on and collect data with the aim to improve how users interact and benefit from their environments.

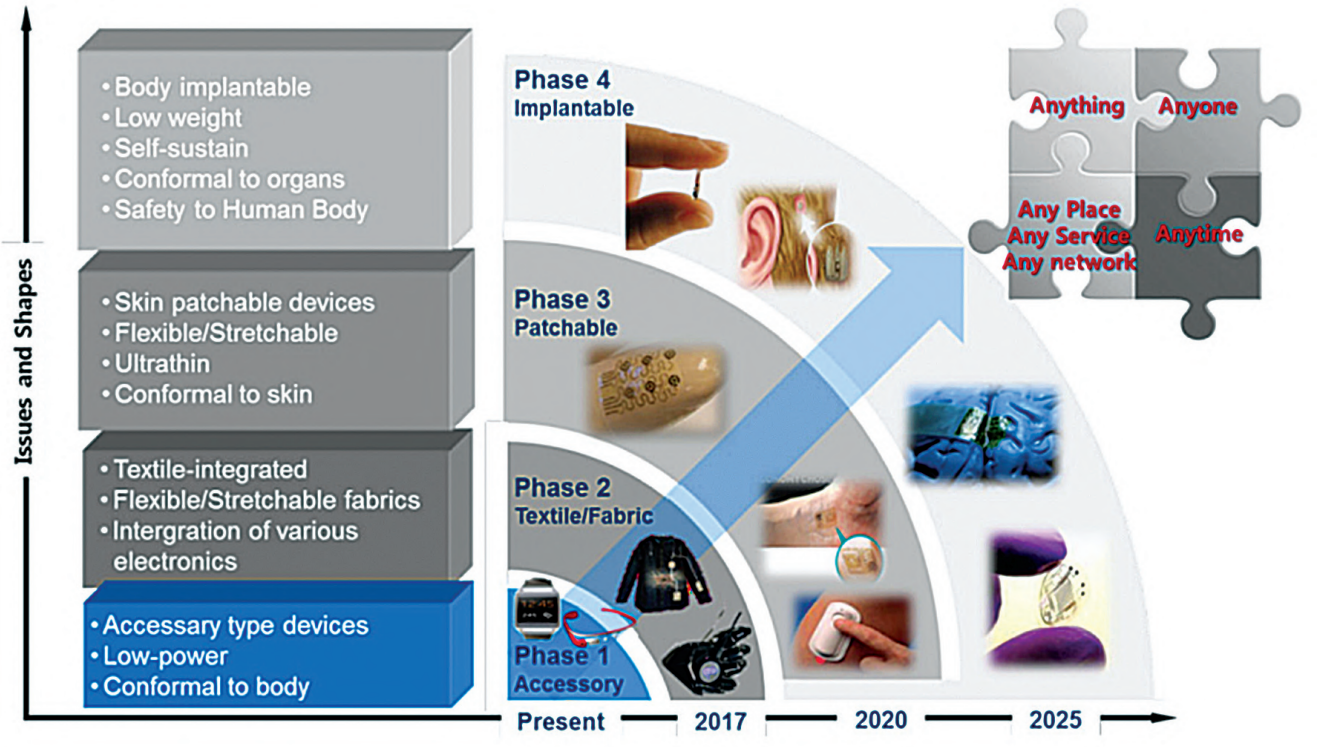
Wearable electronic devices and technologies are rapidly expanding on a global basis with new emerging markets and applications. Wearable electronic devices and technologies will be used in emerging applications sectors using various technologies that will include semiconductors, displays, sensors, textiles, IoT, etc.

The Bureau of Indian Standards (BIS) recognizes the significance of the standardization work in the field of 'Wearable Electronic Devices and Technologies' and is actively contributing to its development.

BIS Committee experts are involved in the development of a number of standards at National and International level. Some of these are listed below:

- Performance of stress measurements in wearables
- Performance Measurement of Fitness Wearables - Sleep Measurements
- Performance Measurement of Fitness Wearables - Step Counting
- Performance measurement method of wearables - Accuracy of Heart Rate Determination
- Test methods of surface electromyography sensors for wearable applications

- Test method for assessing washing durability of e-textile products
- Test method for measuring surface temperature of wrist-worn wearable electronic devices while in contact with human skin



BIS Technical Committee experts have proposed and are leading the development of standards at International level:

1. Performance of fabric-based piezoelectric Nanogenerator:

This draft International Standard, being led by India, specifies a method of evaluating energy harvesting performance of fabric-based piezoelectric nanogenerator for wearable electronic devices used for energy storage and self-powered electronic applications

2. Performance of fabric-based triboelectric Nanogenerator:

Textile-based triboelectric generators are found to be an alternative and promising proposal for converting human motion into electricity. This draft International Standard, being led by India, specifies terms and configuration for fabric-based triboelectric generators, and measurement methods to determine and characterize the power generation performance of textile generators under different modes.

3. Mobile Wearable Device Data Security:

Many wearables don't come with built-in security, which makes them vulnerable to being compromised. From an enterprise IT standpoint, this is particularly worrisome because of the connectivity wearables maintain with smartphones, cloud apps, and potentially corporate networks, which could serve as a launch point for an attack . There are serious issues with data in transit when it's being synced and with data being stored on the manufacturer's or service provider's cloud servers. Some third-party apps neglect basic security standards and send or store information that's not encrypted . There is a lack of insight and policy

to cater for issues related to wearable devices, which often run their own operating system and applications, and provide OS/firmware updates accordingly. As wearable devices become more common, they'll also become bigger targets for hackers . Issues of Device Authenticity, Confidentiality, Data Integrity, Availability, and User Authentication / Authorization exist in Body Area Networks. To address these issues, India is leading the formulation of an International Standard on 'Mobile Wearable Device Data Security'.

INTERNET OF THINGS & DIGITAL TWIN

BIS Committee: LITD 27 Internet of Things and & Digital Twin

International Committee: ISO/IEC JTC 1/SC 41 Internet of things and digital twin

The Internet of Things (IoT) has rapidly emerged as a transformative force in the realm of technology, promising to revolutionize industries, enhance efficiency, and improve the quality of life. IoT refers to the interconnection of everyday objects and devices through the Internet, allowing them to collect, exchange, and act upon data autonomously. This technology has the potential to create a smarter and more connected world. However, to fully unlock its potential, it is essential to establish robust and comprehensive IoT standards.

Following Indian standards on IoT reference architecture, use cases & interoperability have been published by Bureau of Indian standards:

1. IS 18004 (Part 1): 2021 IoT System Reference Architecture

This Indian Standard describes the Internet of Things (IoT) Reference Architecture, that comprises IoT Concept Model, IoT Reference Models (Domain based IoT reference model, Entity based IoT reference model) and IoT Deployment Views. The Standard is useful for anyone involved in the design, development, deployment, and implementation or certification of an IoT device, network or application ecosystem.

2. IS/ISO/IEC TR 22417: 2017 IoT Use Cases

This document identifies 25 IoT scenarios and use cases based on real-world applications and requirements. An objective of this document is to assist in the identification of potential areas for standardization in the IoT environment to ensure ease of operation and interoperability.

3. IS/ISO/IEC 30118 series (18 parts) Information technology- OCF Specifications

This series was developed for smart home focused Internet of Things (IoT) devices, such as appliances, door locks, security cameras, sensors, and actuators; these to be modelled and securely controlled, locally and remotely, over an IP network. In addition, security concerns for IoT deployments in commercial environments.

JTC 1/SC 41 adheres to this scope with the help of its five Working Groups which are responsible for standardization in the following subareas of IoT & DT:

- IoT Architecture
- IoT Interoperability
- IoT Applications
- Digital twin
- Maritime, underwater IoT and digital twin applications

Some of the important published standards are listed below:

1. ISO/IEC 20924:2021 IoT Vocabulary
2. ISO/IEC 21823 series: Interoperability for IoT systems
3. ISO/IEC 29182 series: Sensor Network Reference Architecture (SNRA)
4. ISO/IEC 30140 series: Underwater acoustic sensor network (UWASN)
5. ISO/IEC 30161 series: Data exchange platform for IoT services
6. ISO/IEC 30162:2022 Compatibility requirements and model for devices within Industrial IoT systems
7. ISO/IEC 30165:2021 Real-time IoT framework
8. ISO/IEC 30169:2022 IoT applications for electronic label system (ELS)
9. ISO/IEC 30179:2023 Overview and general requirements of IoT system for ecological environment monitoring

Some of the important standards under development are listed below:

1. Underwater network management system (U-NMS) interworking
2. IoT for Stress Management, Good health & Well-being
3. IoT – Functional architecture for resource ID interoperability
4. Data exchange platform for IoT services – Part 2: Transport interoperability between nodal points
5. Autonomous IoT object identification in connected home – Requirements and framework
6. Functional requirements to determine the status of self-quarantine through IoT data interfaces
7. IoT - Data format, value and coding
8. IoT- Behavioural and policy interoperability
9. Addressing interoperability between IPv6-based network and UWASN
10. Addressing interoperability between heterogeneous underwater acoustic sensor networks (UWASNs) based on underwater delay and disruption tolerant network (U-DTN)

METAVERSE

BIS Panel: LITDC/Panel 8 Metaverse

International Group: ISO/IEC SEG 15 Metaverse

The concept of the Metaverse has captured the imagination of technologists, creators, and the general public alike. It envisions a vast, interconnected virtual world where users can work, socialize, learn, and play. The Metaverse, often described as the successor to the internet, will encompass virtual and augmented reality environments, interactive 3D spaces, digital economies, and immersive experiences.

As the Metaverse evolves from science fiction into a tangible promising digital frontier which has the potential to reshape industries, communication, and human experiences, a robust framework of standards to ensure interoperability, security, privacy and ethical considerations becomes paramount. Standardization efforts, both in India and globally, are instrumental in guiding the responsible development of this transformative technology.

Considering the above listed factors, BIS formulated a dedicated Panel on "Metaverse" in April 2023 to investigate the needs for standardization in the area of Metaverse, considering current research, technology and standardization activities, and trends & recommend an initial roadmap for standardization activities in the area of Metaverse. It also acts as the National Mirror Panel of ISO/IEC SEG 15 "Metaverse".

BIS is currently working on the following key areas of Metaverse Standardization:

- **Content Creation and Accessibility**: Standards for content creation tools and accessibility features ensure that the Metaverse remains inclusive, enabling creators and users of all abilities to participate.
- **Digital Identity Standards**: To enhance security and user trust, there is a need for standards for digital identities within the Metaverse, enabling secure and verifiable user profiles.
- **Ethical Frameworks**: Develop ethical guidelines to address concerns related to digital rights, inclusivity, and the responsible use of the Metaverse.
- **Interoperability**: The Metaverse will comprise numerous platforms, applications, and technologies. Standardization will enable seamless interaction between different Metaverse components, allowing users to transition between virtual environments effortlessly.
- **Security and Privacy**: Defining security and privacy standards to protect users and their data within the Metaverse will include guidelines for encryption, authentication, and data handling practices.

Provided below is a list of some important international standards related to Metaverse:

- ISO/IEC 18038:2020 Sensor representation in mixed and augmented reality
- ISO/IEC 23488:2022 Object/environmental representation for image-based rendering in virtual/mixed and augmented reality (VR/MAR)
- ISO/IEC TS 23884:2021 Material property and parameter representation for model-based haptic simulation of objects in virtual, mixed and augmented reality (VR/MAR)
- ISO/IEC 18039:2019 Mixed and augmented reality (MAR) reference model
- ISO/IEC 18040:2019 Live actor and entity representation in mixed and augmented reality (MAR)
- ISO/IEC 18520:2019 Benchmarking of vision-based spatial registration and tracking methods for mixed and augmented reality (MAR)
- ISO/IEC TR 23844:2023 Immersive content and technology
- IEC 63145-10:2023 Eyewear display - Part 10: Specifications
- IEC TR 63344:2021 Conceptual model of standardization for haptic multimedia systems
- ISO/IEC 19774-1:2019 Humanoid animation (HAnim) architecture
- ISO/IEC 19774-2:2019 Humanoid animation (HAnim) motion data animation

BIS experts are also involved in the development of a number of standards at the International level. Some of these are listed below:

- Information modelling for VR/AR/MR based education and training systems*
- Augmented and Virtual Reality safety — Guidance on safe immersion, set up and usage*
- Coded representation of immersive media*
- Human Information Data Model for 3D Virtual Smart Cities*
- Constructs for visual positioning systems in mixed and augmented reality (MAR)*

Challenges:

The Metaverse is still in its nascent stages, and the challenges of standardization are significant. Rapid technological advancements, evolving user expectations, and the need for cross-industry collaboration pose ongoing challenges.

QUANTUM COMPUTING

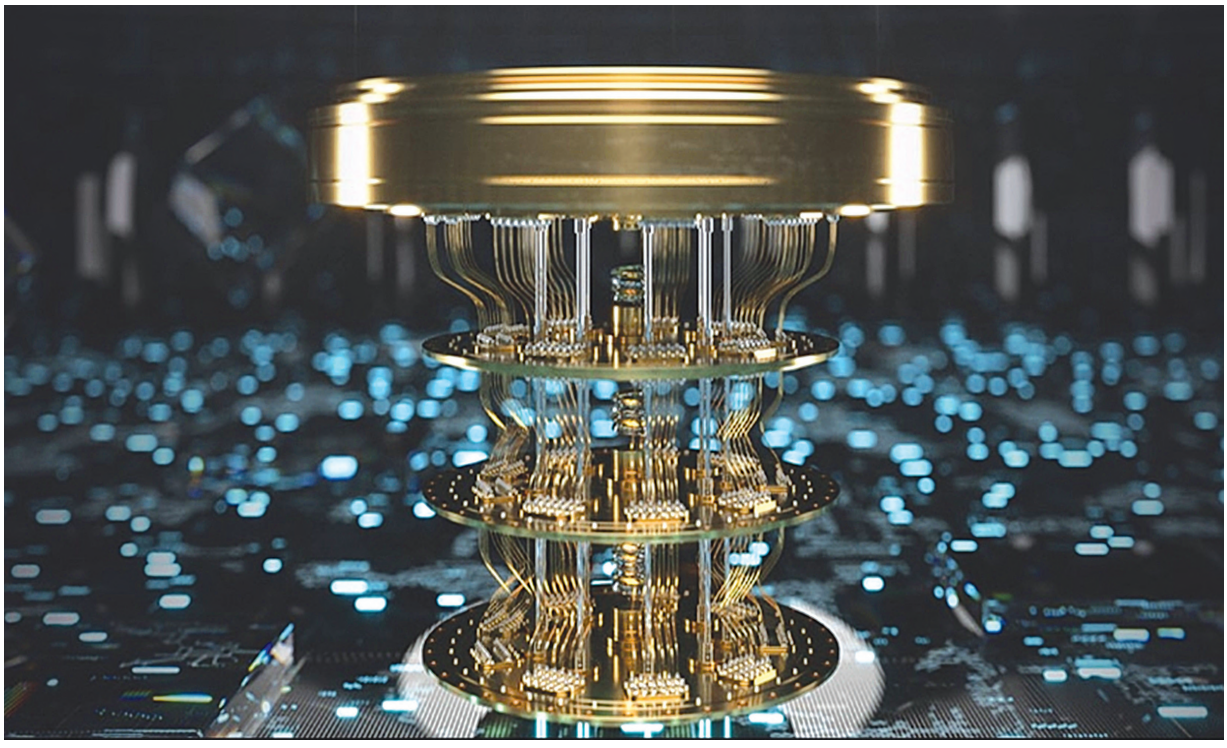
BIS Panel: LITDC/Panel 5 Quantum computing

International Group: ISO/IEC SEG 14 Quantum technologies and ISO/IEC JTC 1/WG 14 Quantum Information Technology

Quantum technology is an umbrella term that encompasses a variety of emerging technologies and applications based on the principles of quantum mechanics, a branch of physics that describes the behavior of matter and energy at the smallest scales, such as atoms and subatomic particles. Quantum technology leverages the unique properties of quantum systems to create novel tools and solutions that can have a profound impact on fields ranging from computing and communication to sensing and cryptography.

Quantum computing is an aspect of quantum technology and is a cutting-edge field of science and technology that promises to revolutionize the way we solve complex problems. Unlike classical computers, which use bits as the fundamental unit of information, quantum computers use quantum bits or qubits, opening up new possibilities for solving problems that were once considered unsolvable. The projected global market for quantum computing alone is estimated to be in the billions of dollars by 2030. Assumptions made, the technology included and the

range of revenues projected vary greatly but rapid growth to high and sustained revenues are widely agreed.



Need for standardization in Quantum technologies:

Quantum technology (QT; quantum computing and closely related technology) is the second generation of technologies to exploit quantum effects, manipulating the quantum states of individual particles (eg photons or atoms). It promises revolutionary advances for some sectors of industry and society, with rapid financial growth.

For example, quantum sensing has applications in a wide variety of fields, including distributed, high-precision time, magnetic-field sensors, inertial sensors, and distributed quantum computing; quantum communications, in principle, will be invulnerable to eavesdropping.

Various industrial sectors have also started to apply quantum technologies, such as in aviation and space, energy and oil, finance and insurance, logistics and distribution, health and medical care, chemical and materials. Although hardware products currently dominate quantum developments, software and service products are steadily on the rise.

Whilst standards for some aspects of quantum technologies are already under development, there is a pressing need to begin standardization at the global level, for example in: quantum computing (device characterization, hardware and software benchmarking), quantum simulation (validation of results, common languages), quantum sources (characterization of single photon/electron sources), quantum detectors (calibration and characterization of single-photon avalanche photodiodes), quantum communications (characterization of quantum random number generators, specifications for quantum key distribution products and systems).

Considering the vision of the Government of India laid out in the **National Quantum Mission**, BIS has set up a panel LITDC/Panel 5 on Quantum Computing.

Significant areas where the activity of standardization related to this field is taken up are as below:

- Potential areas of quantum hardware listed below identified where standards can be developed to help the stakeholders.

- Cold atoms
- Ion trap
- Superconducting qubits
- Quantum simulators
- Photonic qubits

- Create a benchmark against classical computers, factors like energy, memory. Need to come up with a set of problems that can be used as a benchmark against classical computers.
- Develop terminology on different aspects of quantum information technology including the aspects below to create a common understanding among a diverse set of stakeholders:
  - Superconducting qubits,
  - photonic qubits
  - ion traps and cold atoms
  - cryptography (quantum crypto, post-quantum crypto)
- Conduct a survey to get to know the technologies being used in the area of quantum information technologies (QIT).

Additionally, the following projects have been taken up for development by ISO/IEC JTC 1/WG 14

1. Quantum computing — Terminology and vocabulary
2. Introduction to quantum computing
3. General requirements for quantum resource simulation platform
4. Quantum machine learning datasets

SMART INFRASTRUCTURE

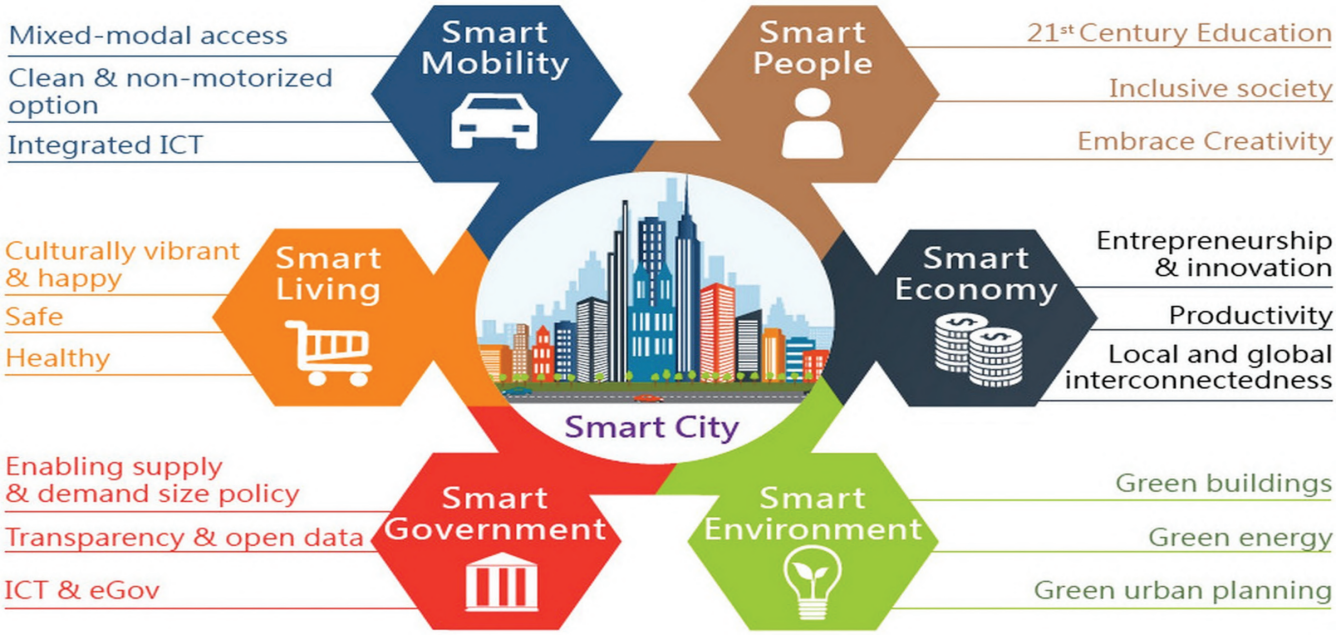
BIS Committee: LITD 28 Smart Infrastructure

International Committee: IEC SyC SyC Smart Cities

The Government of India started its smart cities mission to develop 100 Smart Cities with an objective to provide a decent quality of life to its citizens using smart solutions. The mission focuses on harnessing technology, especially technology that leads to Smart outcomes and the creation of cities that are properly connected, adaptive, efficient, and resilient.

BIS has embraced the vision of Smart Cities and has embarked on an ambitious journey to develop a comprehensive set of standards for Smart cities, covering all aspects of the Information & Communication Technologies (ICT), pertaining to Smart Cities. These include an overall master document, ICT Reference architecture, & a host of standards to cover, Data and associated technologies, Geographical Information Systems (GIS), Internet of Things (IoT) technologies, Communication protocols, E-governance Systems and Data models and Taxonomy standards for all the relevant domains of Smart Cities.

BIS, has published standards on ICT Reference Architecture, Unified Data Exchange, IoT System, Municipal Governance Reference Architecture etc. These standards are not static entities, however shall continually evolve as per the learnings from actual practice and evolving needs.



Sustainable resource management lies at the core of smart cities. Standards play a vital role in ensuring the optimal utilization of resources, such as energy, water, and transportation. Through the adoption of standards, smart cities can deploy advanced metering systems, real-time monitoring, and intelligent infrastructure, facilitating the efficient distribution and consumption of resources. For example, standardized protocols for smart grid technology enable the integration of renewable energy sources, demand-response mechanisms, and energy storage systems, leading to reduced energy waste and enhanced grid stability.

The proliferation of data in smart cities poses significant challenges in terms of security and privacy. Standards provide a robust foundation for addressing these concerns. By implementing standardized security measures, encryption protocols, and data privacy regulations, smart cities can safeguard sensitive information and build trust among citizens and stakeholders. These standards help prevent unauthorized access, data breaches, and cyber-attacks, ensuring that personal data and critical infrastructure remain secure.

Smart city standards also promote citizen engagement and inclusivity by establishing guidelines for user interfaces, accessibility features, and open data policies. By adopting standardized interfaces, smart city applications and services become more user-friendly and accessible to individuals of diverse backgrounds and abilities. Open data standards enable the transparent sharing of information, empowering citizens to actively participate in decision-making processes, identify areas for improvement, and contribute to the development of their communities.

The Government of India's Smart Cities Mission, launched in 2015, aims to transform 100 cities across the country into smart cities by integrating technology, governance, and citizen participation. These cities are designed to be more efficient, connected, and liveable, offering a range of smart solutions across various sectors.

LITD 28, Smart Infrastructure Sectional Committee of BIS has published a number of standards for ensuring a harmonized, secure, and sustainable digital infrastructure across the smart cities that will facilitate the implementation of various Smart City projects in an efficient, cost-effective and secure manner.

The series of standards would be applicable across any geographical region that can encompass Smart Village to Smart Cities to the entire nation.

One of the important standards published is IS 18000 Unified Digital Infrastructure – ICT Reference Architecture. The standard defines the reference architecture and models for information and communication technologies needed to realize a Unified Digital Infrastructure in Smart Cities without mandating any specific components. The ICT Reference Architecture defined in this standard comprises the Functional reference Model, Technology reference models, and Information reference models. The description of the ICT Reference Architecture in this standard starts with capturing the stakeholder expectations. These stakeholder expectations naturally lead to a set of functionalities that are needed to meet the expectations and these functionalities constitute the Functional Reference Model. The technology reference model and information reference model that are needed to realize the functionalities are derived from the functional reference model.

IS 18003 Unified Data Exchange Part 1 Architecture-This Indian Standard describes the architecture for the data exchange, interfaces of data exchange components and the use cases that are enabled in the ecosystem. It also describes the responsibilities of various stakeholders, their interactions with other stakeholders in the system, and the consequences of those interactions. This Standard also describes a high-level architecture of the three main components of the data exchange services: Catalogue service; Authorization service; and Resource access service. Security and privacy are incorporated by design in this architecture. This architecture should simplify the life of the data custodians as well as the application developers.

IS 18010 (Part 1) for Unified Digital Infrastructure - Unified Last Mile Communication Protocols Stack Part 1 Reference Architecture. This Indian Standard defines the Unified Last Miles Communication Protocol Stack – Reference Architecture for communication devices deployed in the digital infrastructure. The reference architecture describes how different communication technologies can be harmonized to coexist at lower layers of the communication stack, while keeping unified upper layers running over different communication technologies. Part 5 Section 1 of this standard describes the Physical Layer and MAC layer specification based on IEEE 802.15.4 using Sub-Giga Hz spectrum 865 – 867MHz.

The establishment of smart cities standards is instrumental in shaping sustainable, connected urban environments. These standards enable interoperability, optimize resource management, enhance data security and privacy, promote citizen engagement, and facilitate scalability. As cities around the world embark on their smart city journeys, it is imperative that they prioritize the development and adoption of comprehensive standards. By doing so, cities can harness the full potential of technology, fostering a brighter future for their citizens and paving the way towards a more sustainable and inclusive world.

BLOCKCHAIN AND DISTRIBUTED LEDGER TECHNOLOGY (DLT)

BIS Committee: LITD 29 Blockchain and distributed ledger technologies

International Committee: ISO TC 307 Blockchain and distributed ledger technologies

Blockchain and Distributed Ledger Technology (DLT) are related concepts that have gained significant attention and use in recent years, primarily in the context of cryptocurrencies like Bitcoin and Ethereum. However, their applications extend beyond cryptocurrencies to various industries.

The aim of blockchain standardization is to establish a set of commonly accepted protocols, specifications, and best practices for the development and implementation of blockchain technology.

The current standards published by LITD 29 are given below:

1. IS/ISO/TS 23258:2021 Blockchain and distributed ledger technologies Taxonomy and Ontology
2. IS/ISO 23257:2022 Blockchain and distributed ledger technologies - Reference Architecture
3. IS/ISO/TR 23249:2022 Blockchain and distributed ledger technologies — Overview of existing DLT systems for identity management
4. IS/ ISO/TS 23635 : 2022 Blockchain and distributed ledger technologies Guidelines for governance
5. IS/ISO/TR 3242:2022 Blockchain and distributed ledger technologies — Use cases
6. IS/ISO 22739 : 2020 Blockchain and distributed ledger technologies Vocabulary
7. IS/ISO/TR 23244 : 2020 Blockchain and distributed ledger technologies Privacy and personally identifiable information protection considerations

Standardization in the context of blockchain has several important objectives:

1. **Interoperability**: Blockchain standards ensure that different blockchain platforms and applications can seamlessly communicate and interact with each other. This is crucial for creating a unified and interconnected blockchain ecosystem.
2. **Consistency and Reliability**: Standards help maintain a high level of consistency and reliability in blockchain systems, reducing the risk of errors, vulnerabilities, and inconsistencies in how data is stored and transactions are executed.
3. **Security**: By setting security standards and best practices, the blockchain industry can mitigate risks associated with cyberattacks, fraud, and data breaches. Standardized security measures help protect users and their assets.
4. **Scalability**: Standards can facilitate the scalability of blockchain networks, allowing them to handle a larger number of transactions and participants without compromising performance.
5. **Regulatory Compliance**: As blockchain technology becomes more widely adopted, governments and regulatory bodies are increasingly interested in its use. Blockchain standards can help organizations adhere to legal and regulatory requirements.
6. **Adoption and Innovation**: Standardization can promote broader adoption of blockchain technology by providing a stable foundation for developers and businesses to build upon. This, in turn, can spur innovation

and the development of new applications and use cases.

7. **Simplified Development**: Developers benefit from established standards because they provide clear guidelines and reusable components, reducing the complexity and time required to create blockchain solutions.

8. **Cost Reduction**: Standardization can lead to cost savings in the development, maintenance, and integration of blockchain systems, as it streamlines processes and reduces the need for custom solutions.

9. **User Trust**: When users know that a blockchain system adheres to recognized standards, they are more likely to trust it, leading to increased confidence in the technology and its applications.

10. **Long-term Viability**: Blockchain standards help ensure the long-term viability and sustainability of blockchain networks by promoting a structured and well-defined approach to technology development.

There are many standards under development which are related to NFTs, Smart Contracts, Interoperability, Models etc. Some of the important one are:

1. Data flow model for blockchain and DLT use cases

2. Representing Physical Assets using Non-Fungible Tokens

3. Interoperability Framework

4. Overview of smart contract security good practice and issues

BRAIN COMPUTER INTERFACE (BCI)

BIS Committee: LITD 37 Brain Computer Interface

International Committee: SO/IEC JTC 1/SC 43 Brain-computer Interfaces

Until recently, the dream of being able to control one's environment through thoughts had been in the realm of science fiction. However, the advance of technology has brought a new reality: Today, humans can use the electrical signals from brain activity to interact with, influence, or change their environments.

A Brain Computer Interface (BCI) is a computer-based system that acquires brain signals, analyzes them, and translates them into commands that are relayed to an output device to carry out a desired action. Thus, BCIs do not use the brain's normal output pathways of peripheral nerves and muscles.

Brain computer interface technology represents a rapidly growing field of research with applications ranging right from Medical and Health domain to Smart Environment, Learning and Education, Training, Industrial Controls, Gaming, Communications and so on and so forth. Though some of these might be in the 'Prototype' or 'Proof of Concept' stage, many have reached the 'Operation' stage and are actively being used.

It is a misconception that BCIs are mind-reading devices. Brain-computer interfaces do not read minds in the sense of extracting information from unsuspecting or unwilling users but enable users to act on the world by using brain signals rather than muscles. The user and the BCI work together. The user, often after a period of training, generates brain signals that encode intention, and the BCI, also after training, decodes the signals and translates them into commands to an output device that accomplishes the user's intention.

The main aim and benefits of Standardization in this area are:

1. Improved Safety by implementing standardized safety protocols such as IEC 60601-2-26

2. Improved Interoperability via standards for BCI system reference framework and data structures, which will enable different BCI devices to work together seamlessly.

3. Common concepts and terminology (Vocabulary)

4. By establishing minimum requirements for system design and performance, standardized protocols can ensure that BCI systems are more accessible to a broader range of users, including those with disabilities. For example, the IEC 60601-2-27 standard for the safety and performance requirements of implantable neurostimulators.

There are a number of Indian experts who are actively participating in the development of International Standards including the Convenor positions in both the Working Groups established under this technical committee. BIS Committee experts are also leading the development of a number of standards at International level. Some of these are listed below:

1. Brain-computer Interface — Vocabulary

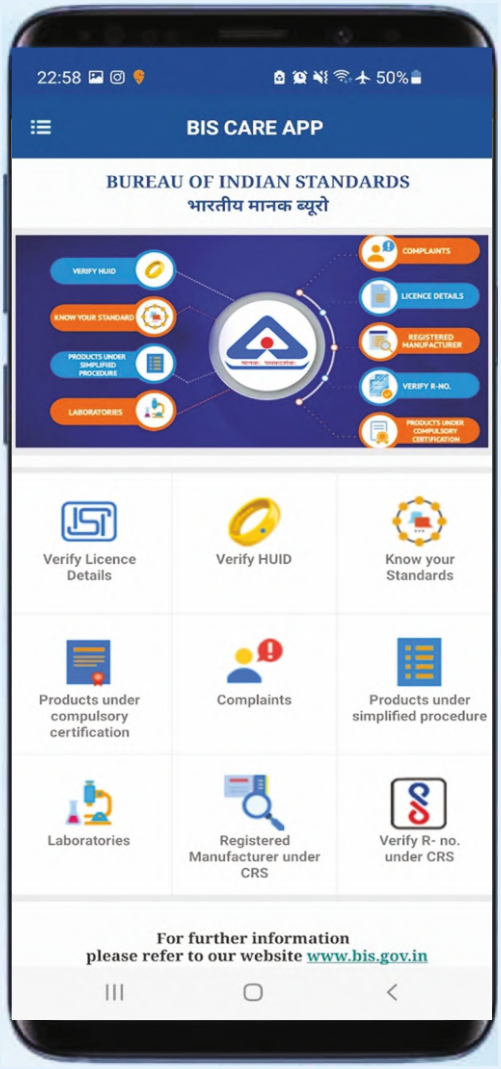
   - This document specifies the terms and definitions commonly used in the field of Brain-computer Interface (BCI), including basic concepts and classifications of BCI, hardware, experiment setups and protocols used in BCI, related neuroscience concepts of BCI (e.g., coding and decoding, feedback and stimulation), and its applications etc. This document is applicable to the understanding of Brain-computer Interface concepts and the exchange of information.

2. Brain Computer Interfaces - Use Cases

   - This document provides a collection of representative use cases of brain-computer interface (BCI) applications in a variety of domains, e.g., medical and health, industrial controls, smart environment, etc. This document is also helpful for BCI industries and products that provide support for communications among interested parties/stakeholders and will be applicable to all types of organizations (e.g., commercial enterprises, government agencies, not-for-profit organizations)

3. Brain-computer Interfaces - Reference architecture

4. BCI data format for NonInvasive brain information collection



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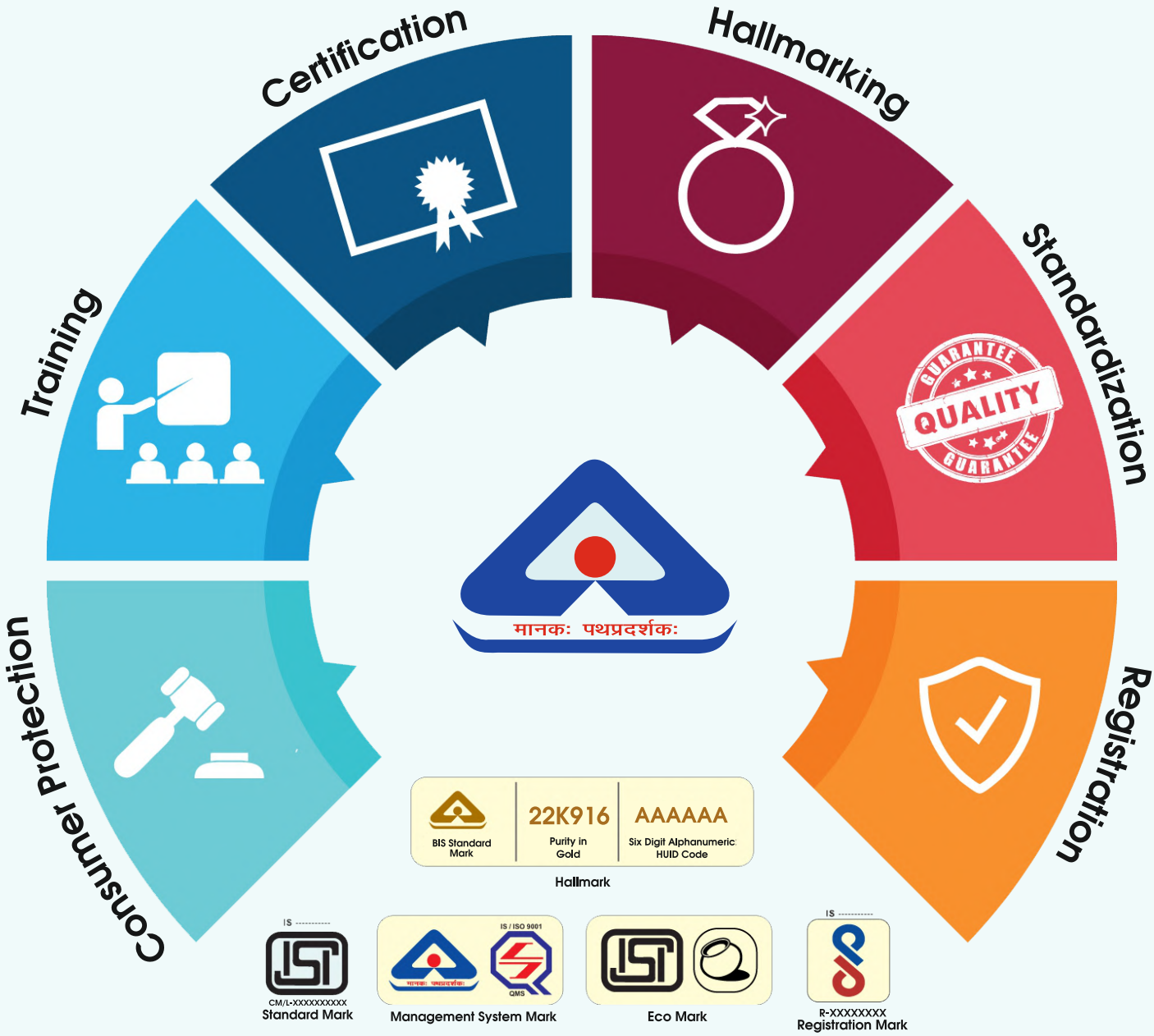

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