Conceptualization Model for Cyber Secure National Time Dissemination System

Amutha Arunachalam, K. Seetharaman, and Ashish Agarwal

Abstract "Time" and "timestamp" lead to a term "Time Commerce" in cyberspace. Disseminating accurate time in cyberspace and distribution of timestamp and event identification initiate the need to have Synchronized Indian Standard Time (IST) to guarantee Government of India's Digital India Program. The paper discusses "time" with its unit "second" as one of the quantities defined in Indian Legal Metrology Act 2009. Timestamp defines at least the time and correct date of action as well as identity of the device or person which receives or sends in the provisions of the Indian Information Technology Act 2000. CSIR-National Physical Laboratory (NPL) as National Measurement Institute (NMI) of India develops "Primary Time Scale" with international traceability to Coordinated Universal Time (UTC). The paper conceptualizes the design model for a collaborative national organizational structure within regulatory framework to establish National Time Dissemination System.

Keywords Timestamp · Cyber security · Time synchronization · Time dissemination · Indian standard time

Abbreviations

BIPM	Bureau International des Poids et Mesures
CSIR	Council of Scientific and Industrial Research
CIPM	Certificate in Investment Performance Measurement
CCA	Controller of Certifying Authorities
CA	Certifying Authorities
DST	Day light Savings Time

A. Arunachalam (✉) · A. Agarwal
Time and Frequency Metrology,, National Physical Laboratory, New Delhi, India
e-mail: amutha@csir.res.in

K. Seetharaman
Department of Computer and Information Sciences, Annamalai University, Chidambaram, India

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GPS	Global Positioning System
GMT	Greenwich Mean Time
IST	Indian Standard Time
LM	Legal Metrology
MRA	Mutual Recognition Arrangement
NTCA	National Time Commerce Authority
NMI	National Measurement Institute
NPL	National Physical Laboratory
NZMT	New Zealand unit of time
NABL	National Accreditation Board of Laboratories
NTA	National Time Authority
NTA	National Time Authority
RRSL	Regional Reference Standard Laboratories
RCAI	Root Certifying Authority of India
SI	International System
STT	Synchronised Traceable Time
TSA	Timestamp Authority
	Timestamp Authority Time dissemination service
TSS	Timestamp service
TC	Time Commerce
TDS	Time dissemination service
TTS	Trusted Timestamping
UCOS	Unified Collaborative Organisational Structure
UTC	Coordinated Universal Time

1 Introduction

The government [1] aims to facilitate the Indian Standard Time (IST) service to the entire nation for the benefit of common man and various strategic sectors. For example, "time" with different levels of accuracies is used in our society in various applications ranging from cybersecurity, communication, transportation, weather forecast, operations of electric power grids, accurate positioning of satellites, detecting the location of enemy missiles or targets, satellite-based navigation, disaster detection and management and so on. A common man also uses the precise timing system without knowing it; for example, the cell phones and all broadcasting services rely on it. Accurate timestamping is inherently important for synchronized functioning of the IT security device such as gateway routers, network switches and servers along with the communication channels. Few of the areas which need immediate attention are cybercrimes, weather forecast and disaster management. In case of inaccurate timestamping, any cybercrime becomes difficult to detect and remains untraceable in most of the cases. Thus, it is essential to synchronize all time-reliant devices used in digital communication to Indian Standard Time. This is

extremely important for socioeconomic as well as national security. In this paper, we identify challenges in operational timing infrastructure and coordinated management structure for smooth dissemination of Indian Standard Time (IST) across the country.

2 Indian Legislation for "Time"

2.1 Indian Legal Metrology Act 2009—Regulating "Time"

Consumer Affairs Department's **SI unit** is as part of "Ministry of Consumer Affairs, Food & Public Distribution" [2]. This has been well-grooved as per a different department in Gregorian calendar month 1997 because this needed to possess a different department for relinquishing a positive stimulus to a movement of rising consumer in the nation. This department was commended that are evident in Weights and Measures Standard's Implementation—The Legal Metrology Act, 2009, Training in Legal Metrology, Internal Trade, Consumer Cooperatives, National Test House, Implementation of Consumer Protection Act, 2019 and others.

3 Defining Indian Legal Metrology and Its Roles: "Legal Metrology"

"Legal Metrology" that measured the units of measurement and weighment, techniques of measurement and weighment as well as instruments used for measuring and weighing with relation to the required legal and technical terms which are mandatory that objects for ensuring public guarantee in terms of accuracy and security of measurements as well as weighment [2].

Measurement accuracy and precision have a very important part in our daily life. The economical and clear legal system of scientific disciplines raises high confidence in terms of shoppers, industry, as well as trades which leads to a harmonious setting to conduct a business using the techniques of (a) contributing to country's economy which increases in revenues under different sectors, (b) having a crucial part is decreasing the losses of revenues in railways, petroleum, industries, mines and coal; and (c) reducing wastage and loss in the infrastructure sector.

The social control of legal scientific discipline laws is completed by the state governments by the controller of legal scientific discipline and alternative legal scientific discipline officers according to the act. The 2009 Legal Scientific Discipline Act is enforced to impact from first Gregorian calendar month; In 2011, the preamble of the act is given as: "An act to determine and enforce standards of weights and measures, regulate trade and commerce in weights, measures and alternative commodities that are sold-out or distributed by weights, live or variety and for matters connected therewith or incidental thereto."

The main feature of this act as defined below is each weight unit or must be as per the weights and measures system supported the International System of Units. The base unit under this Legal Metrology Act (i) meter defines the length, (ii) kilogram defines mass, (iii) second is for time, (iv) ampere defines electric current, (v) Kelvin is for physics temperature, (vi) candela defines aglow intensity, and (vii) mole defines the substance quantity.

Legal Metrology Act, 2009 has been added with rules for the effective implementation: (a) The Legal science (Government Approved check Center) Rules, 2013, (b) The Legal science (Government Approved check Center) Rules,2013, (c) The Indian Institute of Legal Metrology Rules, 2011, (d) The Legal Metrology (National Standards) Rules, 2011, (e) The Legal Metrology (General) Rules, 2011, (f) The Legal scientific discipline (Numeration) Rules, 2010, (g) The Legal Metrology (Approval of Models) Rules, 2011, and (h) The Legal Metrology (Packaged Commodities) Rules, 2011.

Regional Reference Standard Laboratories (RRSLs) were formed for setting up the requirement of Legal Metrology for consumers, industries, and state governments, of the country. These measure all of the five RRSLs, located in Guwahati, Faridabad, Bhubaneswar, Bangalore, and Ahmedabad. The RRSLs also offer to form a link among the states weights and measure laboratories and the National Physical Laboratory for making sure the exact measurements and weights in transaction and trade. More of these RRSLs square measures are situated in Varanasi and Nagpur. All these RRSLs of Guwahati, Faridabad, Bhubaneswar, Bangalore, and Ahmedabad are under the accreditation of National Accreditation Board of Laboratories (NABL), where all departments of Legal Metrology Division and subordinate offices are certified already under ISO 9001. RRSLs upgradation, the Bangalore branch will make on part having the best International Laboratories. The national test houses and RRSLs serve as Reference Standards having traceability to National Standards.

These laboratories are accountable to verify the measure for secondary authority standards, weights and measures models testing, sophisticated weighing Calibration, instruments measuring, as well as setting up some consumer awareness program. Indian Institute of Legal scientific discipline, Ranchi [3], is that the National Center for impartation skilled coaching to the Legal scientific discipline provides coaching to Indian and foreign participants of the neighboring/developing countries. They offer all of the facilities of organizing seminars and training. The organization also offers a basic course of training in Legal Metrology field which imparts knowledge pertaining to an Act of Legal Metrology and Rules along with its implementation in the field. Having understood the National Legal Metrology structure, it is essential further to connect its traceability with the International Organization.

3.1 National Metrology Institute (CSIR-NPL) within the Board of Legal Metrology Act 2009 is the Generator of Indian Standard Time (IST)

The responsibilities of CSIR-National Physical Laboratory as a signatory to Certificate in Investment Performance Measurement (**CIPM**) under Mutual Recognition Arrangement (MRA) of BIPM which maintains, develop, as well as disseminate the national standards of measurements required for the national requirement, and also makes sure the international recognized traces of calibration and measurements for instruments used for measuring and offers a base for activities like the conformance testing, trade metrology services, and the calibration services in every sector. The outcome of this is that a higher awareness is required for the discussion, improvement, and comparing the abilities of the countries for establishing, improving, and maintaining the infrastructural practices, along with recognition and compatibility internationally in such regions.

CSIR-National Physical Laboratory (CSIR-NPL) [4] is National Metrology Institute (NMI) of India which also has the mandate for unit's establishment, maintenance along with dissemination of physical dimensions depended on the International Systems (SI units) beneath the Legal Metrology Act 2009.

One of the unit "time" measured in "second" is disseminated to the nation as the *Indian Standard Time* (IST). CSIR-NPL, internationally known as UTC (NPLI) and the *Timekeeper of India,* is the "Primary Reference Clock" that can be traced to the Universal Time Coordination (UTC) as stated by BIPM situated in Sevres, France. As stated by Dennis [5], the development of UTC remains till today with the existing assumption in terms of its characterization, specific realization and applications. The IST (i.e., UTC-NPLI plus 5.30 h) is generated by a bank of cesium clocks, and hydrogen maser has current uncertainty of 20 nanoseconds. The traceability of the "Indian Standard Time" is globally recognized as UTC (NPLI) which contributes to universal coordinated time (UTC).

4 "Timestamp" in Indian Legislation within Indian Information Technology Act, 2000

The 2000 Information Technology Act states regulations which mandated that "Controller of Certifying Authorities (CCA) [6] shall provide Timestamping Service for its subscribers." Establishment of timestamps on any time reference requires a timestamp. This reference can be contracts, certificates, transactions, or documents. Operation of a digital signature could be integrated to the method of timestamping to link it mathematically with the time reference derived from the selected supply of national time for coming up with a stamp [6]. The timestamps then undergo verification for establishing the attestation time needed for the references. The services of timestamping are operated under Certifying Authorities (CAs). Likewise, this

service of timestamping can also be managed under personnel who is trustworthy, to be operated under highly secure surroundings which were subjected to compliance as well as audit.

4.1 Timestamp

This indicates at least the exact time and date on which the action took place along with the identification of the device or the person who received or has sent the time (IT Act). Timestamp defines a signature created digitally for the service of timestamping which details the integrity submitted to a subscriber on exact time and date.

4.2 Timestamping

This service helps in asserting a timestamp using a digital signature denoting a time at which the reference is received from the subscriber. The subscriber then submits the request which is referred to the service of timestamping and acquires a response which is signed digitally with a timestamp. The source of time to implement this is having traceability of NPLI—UTC.

5 Encounters and Cybersecurity Difficulties of Unit "TIME" AND "Timestamp" in Digital Transactions

The Indian Legal Act by making a law to mandatorily accept the Indian Standard Time (IST—UTC (NPLI) as official Legal Time shall facilitate the consumers/industries/organizations and all the "Time Consumers" legal endowment to support the digital economy for end-user protection.

1. The legal provisions handled for **"time"** by Metrology Act and for **timestamp** by Information Technology Act are held by two different ministries; it requires greater amount of understanding and coordination for the purpose of the lawfulness of electronic commerce and protecting intellectual property rights for the benefit of consumers.
2. The complexity of the **"time requirements"** extends to various digital information in the form of electronic storage, electronic transactions, and real-time applications. Such requirements to assure integrity in the electronic form by the use of digital signatures and timestamps serve as electronic evidence in courts. Such evidences can be provided with a help of Nationally Synchronized Legal Time through networks.

3. For "time" as a source, understanding the dissemination chain and calculating the uncertainty is an essential requirement for demonstrating traceability. Each link along with associated uncertainty evaluation requires documentation, and the total uncertainty of timestamp or time output must be determined and recorded.
4. Spoofing: This can be illegitimate act in the mask of a right person. Few prior researchers [7–9] and real-world attacks in GPS spoofing have specified the GPS signal vulnerability and probability of spoofing the receivers in GPS.
5. Alteration: the illegitimate person trying to alter the digital document.
6. Repudiation: denial of contradiction of the fact of having done something in the electronic execution process [10].
7. Nowadays, the eruption in digital economy realizes the creation half of trade transactions electronically creating a new revolution. Technologically, the actual problem is essentially in mastering the protection along with the date and time traceability from the source of energy of theirs to the end user. This is vital to cure cyber-attacks which inhibit with the time message.
8. Secrecy in digital channel, authenticity of interchanging documents, and verification of document are crucial to security of transaction.

We understand "time" as the serious substructure of information society. The danger management with appropriate cybersecurity methods in digital transactions needs to be determined through time and synchronizing clocks of multiple computers working in collaboration.

6 Conceptualization Model for Cyber Secure National Time Dissemination System

The authors propose the new term "Time Commerce" for a collaborative effort that needs to be tailored under **"National Time Commerce Authority"** to remove the operational limitations and legislative augmentations to suit the growing needs in digital economy [1]. National Timing infrastructure requires to be built within international standards that have safety, health hazard free, environment, and consumer friendly.

The immediate concerns for enabling the digital economy is to have governance by National Level *Collaborative Organizational Structure* as authors designed the model proposed in Fig. 1 for national timing requirements with Legislation, Technical Regulation, Standardization, Accreditation, Training, Testing and Certification and Infrastructure Creation to cater the entire population. In this paper, we conceptualize plan to design, operate and maintain the accurate National Level Timing Infrastructure involving national metrology institute, regional metrology laboratories and designated Institutes to industrialize and disseminate time with high level of security and traceability across the country. This shall help to fulfill the ultimate goal of serving the digital economy with complete confidence.

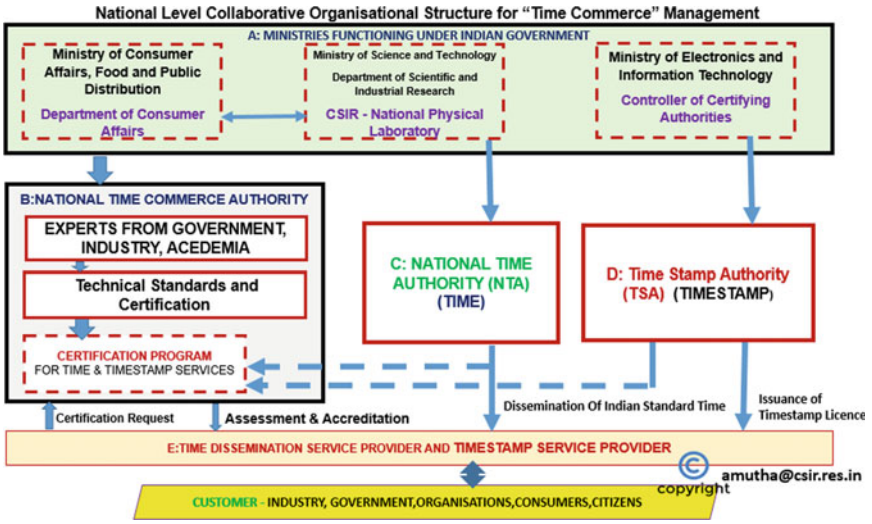

Fig. 1 Conceptualization model for cyber secure national time dissemination system. *Note* In the figure, Representation of **a** Ministries functioning under Indian Government, **b** National Time Commerce Authority, **c** National Time Authority (NTA), **d** Timestamp Authority (TSA), **e** Time dissemination service (TDS) and Timestamp service (TSS)

We propose this model for establishment of a National Time Commerce Authority that enables to build a National Level Timing Infrastructure supported by legislation, standardization, metrology, accreditation and conformity assessment. The authority will help the competiveness in *Indian Time Industry* to be competitive and at par with International Market. Here, we identify and elaborate features and areas of responsibility for building the Timing Infrastructure at national level. It is evident that variety of areas required at national level is functioning under different department necessities and greater harmonization with fixed responsibilities for a qualitative outcome in compliance to the international and regional agreements.

A. Ministries functioning under Indian Government

Are within the structure as shown in Fig. 1a and have specific business allocation roles under different departments in Indian Government and their legislation responsibilities. In context to this, Table 1 specifics the roles and legislation of the ministries that are currently engaged in the "Time Commerce" activities. And these organizations form three pillars of the Indian Legislation Authorities to disseminate the Indian Standard Time with all administrative, operational, and financial provisions at national level.

B. Describing the National Time Commerce Authority

Digital trade that uses **"time"** and **"timestamp"** information will improve the safety and reliability of the electronic information such as various electronic data, documents, and information, and we term it as **"Time Commerce"** in this paper**.** To

Table 1 Roles of ministries in Indian Legislation that are currently involved in the "Time Commerce" activities

Ministry and Department under Indian Government	Business allocation	Legislation responsibilities
Ministry of Consumer Affairs, Food and Public Distribution [11] Department of Consumer Affairs [2]	Underneath the Ministry of Consumer Affairs, the Department of Consumer Affairs is actually among the two departments, i.e., Food and Public Distribution. In June 1997, this was established as a distinct department as it had been regarded as required to escalate a distinct department to make a nascent fillip to the customer action in the nation	Execution of Consumer Protection Act, 1986 Execution of Bureau of Indian Standards Act, 2016 Execution of Weights and Measures Standards—The Legal Metrology Act, 2009
Ministry of Science and Technology (9) Department of Scientific and Industrial Research [12] Council of Scientific and Industrial Research [13] CSIR—National Physical Laboratory- [4]	DSIR features a mandate to hold out the tasks associated with indigenous know-how promotion, advancement, transfer, and utilization CSIR is actually the National R&D business providing scientific manufacturing exploration for India's economic welfare as well as economic growth. It is a country-wide community of 80 area and forty laboratory facilities covering applied and fundamental R&D in most aspects of science as well as technologies barring atomic investigation, nurturing and establishing S&T human resource for the nation through additional mural assistance and encouraging scientific skill through awards, fellowships, etc. National Physical Laboratory is actually the National Metrology Institute of India along with a Premier Research Laboratory under the area of Physical Sciences	National Physical Laboratory has the duty of sighted the products of actual physical dimensions depending on the System International (SI devices) underneath the secondary legislations of weights and Measures Act 1956 (rereleased in 1988 **underneath the 1976 Act and 2009)**

(continued)

Table 1 (continued)

Ministry and Department under Indian Government	Business allocation	Legislation responsibilities
Ministry of Electronics and Information Technology [14] Controller of Certifying Authorities [6]	In order to market e-Governance for empowering people, advertising the sustainable and inclusive progress of the Electronics, IT and ITeS industries, improving India's function in Internet Governance, following a multipronged strategy which has improvement of human resources, promoting Innovation and R&D, improving effectiveness through digital solutions and making sure a safe cyber space To trust development in Electronic Transactions	**Information Technology Act 2000** Notification under IT(Amendment) Act, 2008, IT (Amendment) Act 2008 IT Act 2000 Rules for the Information Technology Act 2000 Report of the Expert Committee on Amendments to IT Act 2000 Under Section 18(b) of the IT Act, the Controller of Certifying Authorities (CCA) has proven the Root Certifying Authority (RCAI) of India to digitally sign the public keys of Certifying Authorities (CA) of the nation

build a safe and secure digital society, it is necessary to establish **"National Timing Commerce Authority"** to deliver trustworthy time shown in Fig. 1b.

Functions Identified for the Functioning of National Time Commerce Authority

1. Build, operate, and maintain National Time Infrastructure.
2. Creation of National Time Service Models
3. Identifying Technology Trends for "Time Industry."
4. National Guidelines for Time (operations, administration, training, audit, certifications, etc.)
5. National level Identification of all issues relating to "Time Commerce"

Time dissemination and timestamp services are required for "accurate time and reliable time" in the system of electronic commerce, electronic application, etc. As CPSs interrelate with their environs, synchronized necessities and significance are of essential nature, since there are time limits to be conversant with structure reactions [15]. The authority shall help to develop significant public infrastructure for cutting-edge information and communication networked society. We foresee digital threats in the form of "fraud" and the "Information system failures" that use the characteristics of electronica data with more CPSs interconnecting to the surrounding network, and the threat to impairment that caused deliberately is greater than ever. Consequently, as stated by Schneider [16] there is a demand to synchronize safety and reliability engineering such that the difficult risk of harm as a result of either faulty or spiteful intention is sufficiently addressed. Hence, we propose a system that shall "certify the originality of electronic data," "precisely hold transaction time," and "deliver

to the third party." To achieve this, we need to setup suitable administrative and technology operational organizational structure having experts from government, industry, and academia. The NTCA shall have compliance to international standards and world trade agreements. Under this authority, operational and auditing skills for the timing services are to be built with testing and training capabilities in the form of accreditation program specific to the time dissemination and timestamp services. The program shall need to be nationally and internationally recognized by accredited organizations. Figure 1b identifies the proposed National Time Commerce Authority with the given workflow.

C. Role of National Time Authority (NTA) shown in Fig. 1c

The term NTA is drawn from the International Standard ISO/IEC 18014, where the role of NTA is defined as "to generate, maintain, and distribute national standard time." NTA further distributes Time to Time Authority (TAs) which is a trusted Third party for providing time for further dissemination.

D. Role of Timestamp Authority (TSA) shown in Fig. 1d

The term Timestamp Authority is drawn from the International Standard ISO/IEC 18014, and TSA is defined "to produce and issue timestamp token for data submitted from the customer." Further, TSA is also a performer for verification of timestamp token. The TSA is also a confidential third party as designated by the Controller of Certifying Authority.

E. Role of Service Providers for Time and Timestamp shown in Fig. 1e

Time dissemination service (TDS) is a distribution of reliable time information as a service by designated institutes / service operators to the National Critical Infrastructures and other organizations that require highly accurate and reliable time and to citizen-centric services.

Timestamp service (TSS) proves the time when transactions and procedures on the Internet/leased, etc., were performed and the date and time when electronic transaction/ electronic documents existed. TSS also specify whether the particular transaction/object document has been tampered with, but also prove that it has certainly existed at a definite point in the past and the same time can verify that it has not been changed.

7 Classification of Official Methods for Time and Timestamp Certification

In Figure 2 below, we identify the measurable parameters of "time" and "timestamp." This detailing shall help the ***National Time Commerce Authority*** for the ***certification*** process of the ***time and timestamp service providers***. Specifically, focusing on the identified terms with integrity will establish quality of services at national level.

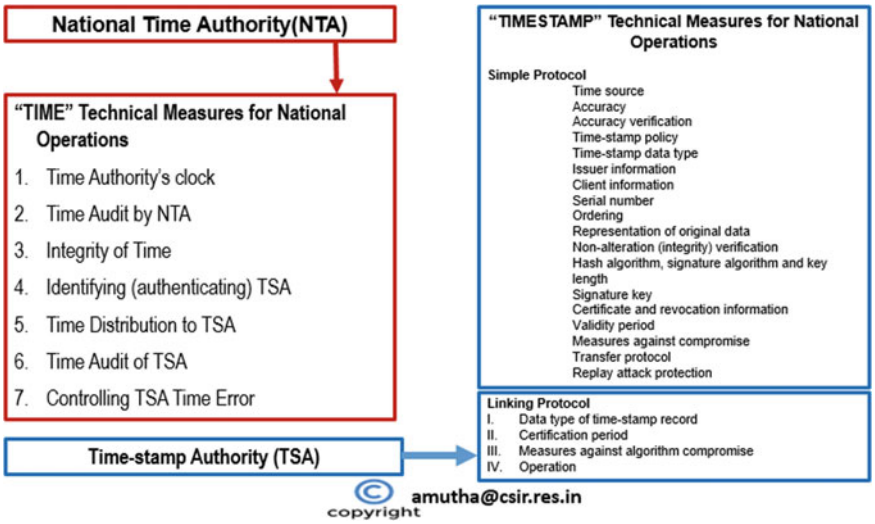

Fig. 2 Cataloguing technical measures for time and timestamp certification

Accreditation system under the National Time Commerce Authority will help to maintain fairness with the experts from government, industry, and academia for certification with the facility of the associated designated ministries.

The authors are working on this for more refinement. This is the primary study for the Ph.D. doctoral work of the first author. We intend to present in this conference the conceptualized model for establishment of National Time Commerce Authority which can be taken for consideration within the current legislation. The inter-ministerial coordination requirements are being addressed in setting up the national authority. The services for time and timestamp with trusted certification program will assure the trust to customers. In the future work, we propose to build the time infrastructure with Cyber Secure Architecture for National Distribution of Time as per international standards for quality and cybersecurity.

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