सत्यमेव जयते
Goverment Of India

दूरसंचार विभाग के लाइसेंस प्राप्त सेवा प्रदाताओं को भारतीय मानक समय के वितरण के लिए राष्ट्रीय योजना

National Plan for Distribution of Indian Standard Time to Licensed Service Providers of Department of Telecom

दूरसंचार अभियांत्रिकी केंद्र

खुर्शीदलाल भवन, जनपथ, नई दिल्ली–११०००१, भारत

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HISTORY SHEET

S. No.	Name of the document and Number	Issue	Remarks
1.	National Plan for Distribution of Indian Standard Time to Licensed Service Providers of Department of Telecom.	01	Issued in XXX 2022
2.			

FOREWORD

Telecommunication Engineering Centre (TEC) is the technical arm of Department of Telecommunications (DOT), Ministry of Communications, Government of India.

Its activities include:

- Framing of TEC Standards for Generic Requirements for a Product/Equipment, Standards for Interface Requirements for a Product/Equipment, Standards for Service Requirements & Standard document of TEC for Telecom Products and Services
- Formulation of Essential Requirements (ERs) under Mandatory Testing and Certification of Telecom Equipment (MTCTE)
- Field evaluation of products and Systems
- Designation of Conformity Assessment Bodies (CABs)/Testing facilities
- Testing & Certification of Telecom products
- Adoption of Standards
- Support to DOT on technical/technology issues

For the purpose of testing, four Regional Telecom Engineering Centres (RTECs) have been established which are located at New Delhi, Bangalore, Mumbai, and Kolkata.

ABSTRACT

As per the licensing conditions, LSPs are obliged to have a traceability facility to uniquely identify the users at any point in time. In order to do so, all network elements of all LSPs in the telecom infrastructure must trace back to a single timing source.

This document is a plan for distributing Indian Standard Time to Licensed Service Providers in the Indian Telecom Network.

Contents

1. Scope

The Department of Telecom issues licenses to telecom service providers for providing various telecom services. Licensed service providers (LSPs) set up their own telecom network to provide telecom services as per the terms and conditions of the license. Licensed service providers (LSP) are obliged to provide facilities to trace all users. Having a standard time reference is critical for the traceability of the users.

Telecom Network is a critical infrastructure of the nation. It is very important that all licensed Service providers use reliable authorized time references for their operation.

National Physical Laboratory provides an authorized source of Time through UTC NPLI. NaVic through PNT service.

Global Navigation Satellite Systems (GNSS) is also another source of time reference through PNT Service. It is widely used as a Time reference by many Telecom Service Providers. The dependence of telecommunications services on Global Navigation Satellite Systems (GNSS) for time reference signals is vulnerable to disruption. The availability of accurate time reference signals from a robust national timing infrastructure is required to complement PNT time reference and mitigate the impact of any disruption to GNSS signals to these critical services.

This plan proposes setting up Time Source Centres (TSC) to develop a robust, geographically distributed time scale infrastructure across India. The aim is to standardise time reference in Licensed Telecom networks to improve security and resilience.

This document details the authorized time reference sources and the required network infrastructure for its distribution to Licensed Service Providers (LSPs) of the Department of Telecom.

2. References

The following Standards are referred to in this document. These standards are subject to revision. It is encouraged to apply the updated version.

i. Precision Time Protocol (PTP) Grandmaster Clock - GR (TEC 49170:2020)
ii. Precision Time Protocol (PTP) Slave Clock - GR (TEC 49070:2012)
iii. Network Timing Protocol Server - GR (TEC 48150:2019)
iv. Time Synchronization in IP Networks - SR (TEC 49004:2019)

3. Abbreviation and Acronyms

AAA	*Authentication Authorization and Accounting*
ATM	*Asynchronous Transfer Mode*
CDR	*Call Detail Record*
CSIR	*Council of Scientific and Industrial Research*
DoT	*Department of Telecommunications*
FDD	*Frequency Division Duplex*
FDMA	*Frequency Division Multiple Access*
FDMA	*Frequency Division Multiple Access*
GGSN	*Gateway GPRS Support Node*
GPRS	*General Packet Radio Service*
GPS	*Global Positioning System*
GSM	*Global Service Mobile*
IETF	*Internet Engineering TAsk Force*
IP	*Internet Protocol*
IRNSS	*Indian Regional Navigation Satellite System*

ISP	*Internet Service Provider*
LSP	*Licensed Service Provider*
LTE	*Long Term Evolution*
MPLS	*Multi-protocol Label Switching*
MSC	*Mobile Switching Centre*
NAT	*Network Address Translation*
NavIC	*Navigation with Indian Constellation*
NPL	*National Physical Laboratory*
NTP	*Network Time Protocol*
PDH	*Plesiochronous Digital Hierarchy*
PDSN	*Packet Data Serving Node*
PON	*Passive Optical Network*
PTN	*Packet Transport Network*
PTP	*Precision Time Protocol*
RFC	*Request for Comments*
SDH	*Synchronous Digital Hierarchy*
SGSN	*Serving GPRS Support Node*

SSU	*Synchronous Supply Unit*
SyncE	*Synchronous Ethernet*
TSP	*Telecom Service Provider*
TDD	*Time Division Duplex*
TDM	*Time Division Multiplexing*
TEC	*Telecommunication Engineering Centre*
UDP	*User Datagram Protocol*
UMTS	*Universal Mobile Telecommunications Service*
UTC	*Coordinated Universal Time*
WAN	*Wide Area Network*
WCDMA	*Wideband Code Division Multiple Access*
3GPP	*3rd Generation Partnership Project*

4. Licensed Service Providers & Significance of Time Reference

Licensed Service Providers

Unified License issued by the Department of Telecom covers the following services:

a. Unified License (All Services)

b. Access Service (Service Area-wise)

c. Internet Service (Category-A with All India jurisdiction)

d. Internet Service (Category-B with jurisdiction in a Service Area)

e. Internet Service (Category-C with jurisdiction in a Secondary Switching Area)

f. National Long Distance (NLD) Service

g. International Long Distance (ILD) Service

h. Global Mobile Personal Communication by Satellite (GMPCS) Service

i. Public Mobile Radio Trunking Service (PMRTS) Service

j. Very Small Aperture Terminal (VSAT) Closed User Group (CUG) Service

k. INSAT MSS-Reporting (MSS-R) Service

l. Resale of International private Leased Circuit (IPLC) Service

The licensed service providers have been given licenses to services as per licensing conditions.

As per the relevant clauses of their license conditions clauses, the licensees have to abide by the following: -

i. Clause 38.2 of the Unified License is reproduced as follows:-

"The licensee is obliged to provide, without any delay, all the tracing facilities to trace nuisance, obnoxious or malicious calls, messages or communications transported through his equipment and network, to the agencies of Government of India as authorised from time to time, when such information is required for investigations or detection of crimes and in the interest of national security. Any damages arising on the account of Licensee's failure in this regard shall be payable by Licensee."

ii. Each licensed service provider(LSP) must maintain a log of all users connected and the service they are using (mail, telnet, http etc.). The LSPs must also log every outward login or telnet through their computers. Type of

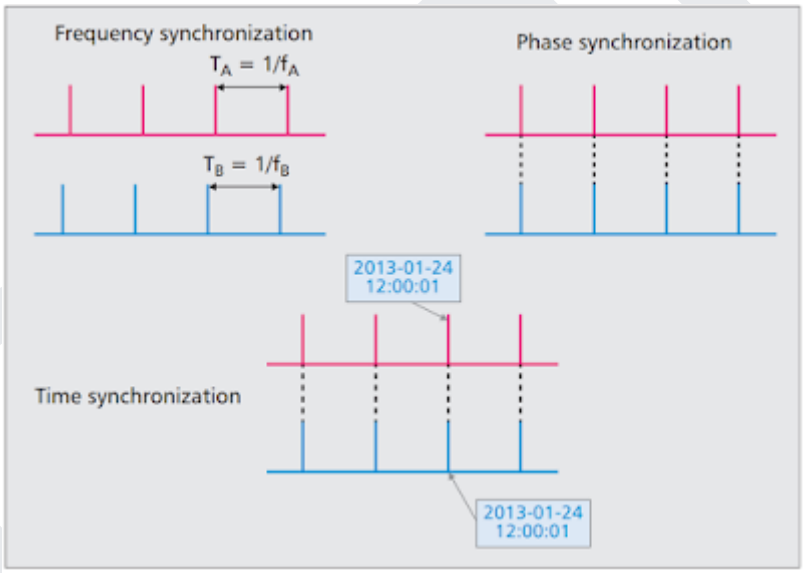
logins, where the identity of the logged-in user is not known, should not be permitted.

In view of the above, it is important for the LSPs to ensure that proper mechanisms are in place to uniquely identify the users at any point in time. This necessitates that all service providers implement a uniform IST time zone time synchronization for traceability of users.

Significance of Time Reference in Telecom Network

Time Reference

Time Reference for synchronization mainly comprises of frequency, phase and time (TOD) reference. The state in which the clock frequencies of different systems match is called frequency synchronization and the state in which the timings between the clocks agree is called phase synchronization. In particular, when the clock timing is synchronized with Coordinated Universal Time (UTC), that state is defined as time synchronization.



Significance of Time in various Telecom services

Many services — like IPTV, VoIP, wireless content downloads and multi-player gaming — involve real-time delivery of multimedia. Not only do these services require more accurate time than networks previously needed to provide, they but they also need time delivered in more places and more often. Real-time services with high QoS expectations require real-time monitoring and measurements at many points in the network — not just at a few as in the past

— right to the customer premise and end-user device. Moreover, these services typically employ multiple systems to complete service requests, leading to an explosion in the number of systems that need NTP services.

Many other packet-based services — in addition to IPTV and VoIP — also require accurate, secure, reliable, and network-wide NTP. Both gaming and video conferencing, for example, require that the endpoints be tightly synchronized to enable a satisfactory user experience. But beyond NTP's services impact, NTP also has an impact on network operations itself.

- NTP for Network Operation
- Performance monitoring and measurements
- Network fault diagnostics and recovery
- Billing and CDR generation

5. Time Source Centers

5.1. Indian Standard Time Sources:

CSIR-NPL is responsible for the maintenance and dissemination of Indian Standard Time and for keeping it traceable to the Coordinated Universal Time (UTC) provided by the International Bureau of Weights and Measures (BIPM) located in Sevres, France.

CSIR-NPL has a "Primary Timescale" generating UTC (NPLI) which is the realization of UTC at NPLI. The IST (i.e. UTC (NPLI) plus 5:30 hours), which is generated using a bank of caesium clocks and hydrogen masers, has current systematic uncertainty of ±2.8 nano-seconds with respect to UTC.

CSIR-NPL provides Indian Standard Time to users via different techniques using terrestrial and satellite links.

IST is also disseminated by NAVIC using PNT services. It is operated by the Government of India.

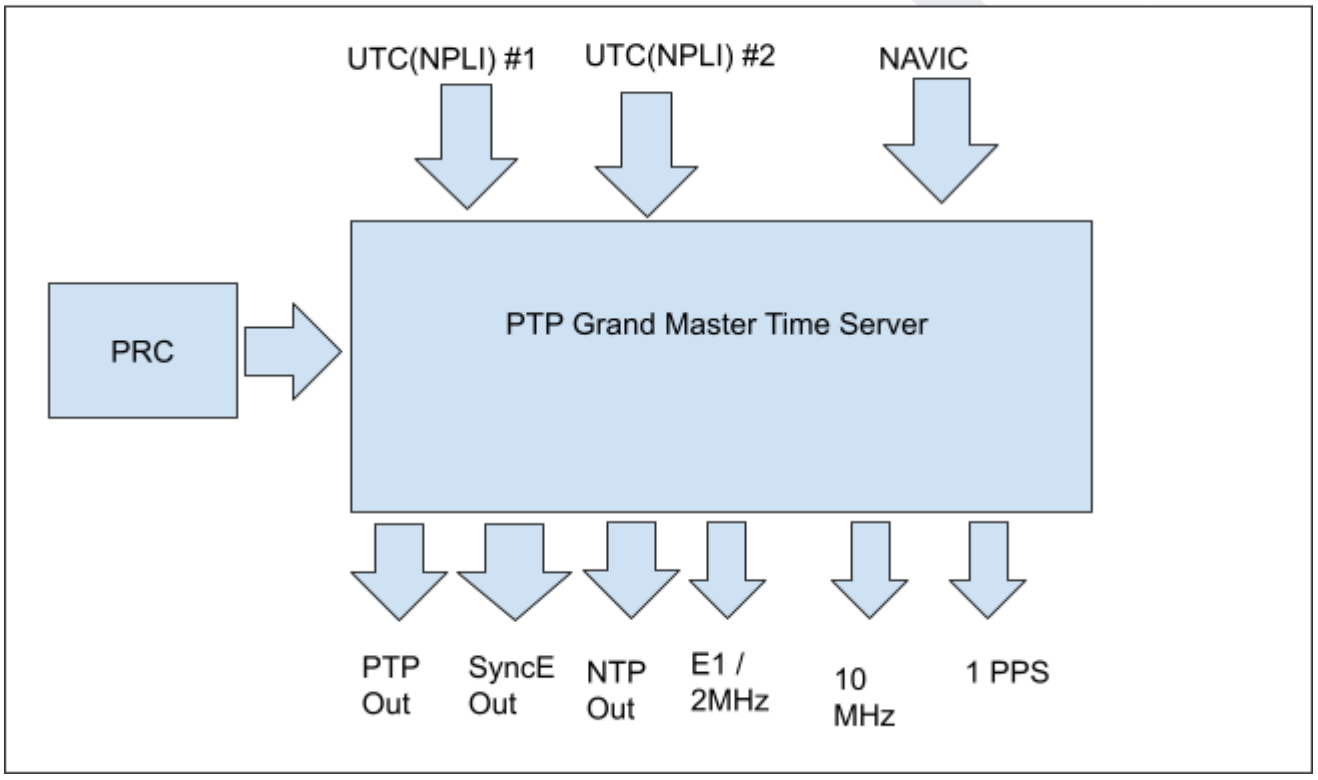
5.2. Setting up of Time Source Centres

Time Source Centres are to be set up. It will use UTC(NPLI) as an input reference and provide the Time reference signal on various protocols and interfaces. It will be spread over the territorial geography of India as per the deployment plan. These TSCs would be maintained by the respective LSA of the Department of Telecom.

i. Time Source Centres would host PTP GM Clock as per - GR (TEC 49170:2020)

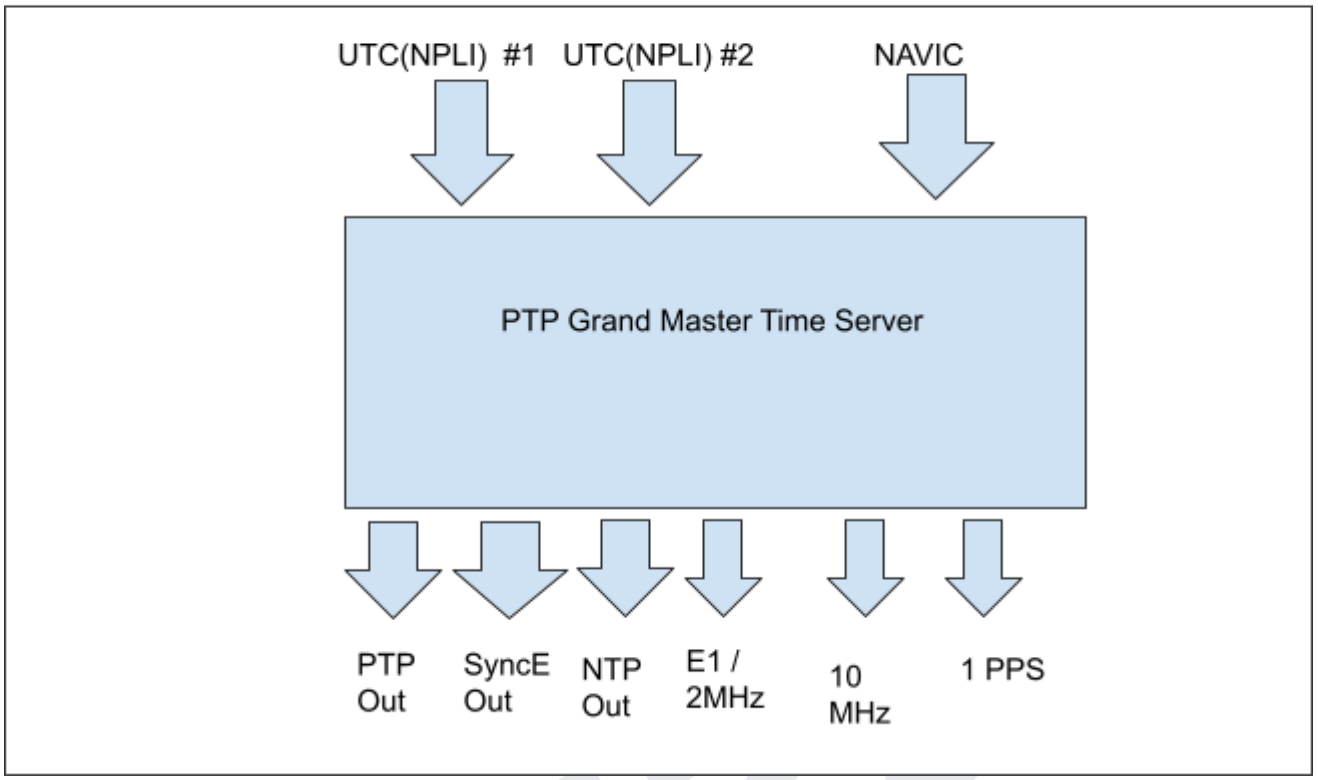
ii. TSC would generally have two input time references UTC(NPLI) directly from two distinct CSIR-NPL sites and from NAVIC through the IRNSS constellation. For that, there would be Support for the L5 band antenna in the IRNSS constellation. PTP will compare the quality of input references and select the best one as per the approved plan.

Time Source Centre Type A



iii. TSC Type A would have an additional input source of PRC as per the GR (TEC 49170:2020) in comparison to Type B TSC. PRC will provide the hold over mechanism in case input references fail or become unavailable or spurious.

Time Source Centre Type B



iv. These Time Centres would provide necessary interfaces to LSP to take reference timing information for their network as per the GR (TEC 49170:2020)

v. Time Source Centres would augment interface and capacity as per the requirement.

vi. LSP would set up a transmission medium upto the Time Source Centre for fetching timing information as per the technical specifications prescribed by the Time source Centre.

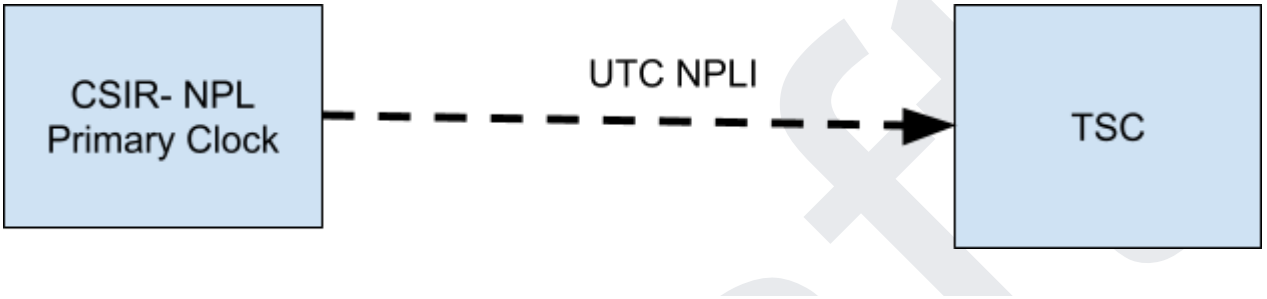
vii. Small ISPs may draw the time reference from the nearby NTP source of other LSP to maintain uniformity of Time reference, as per the mandate of DoT.

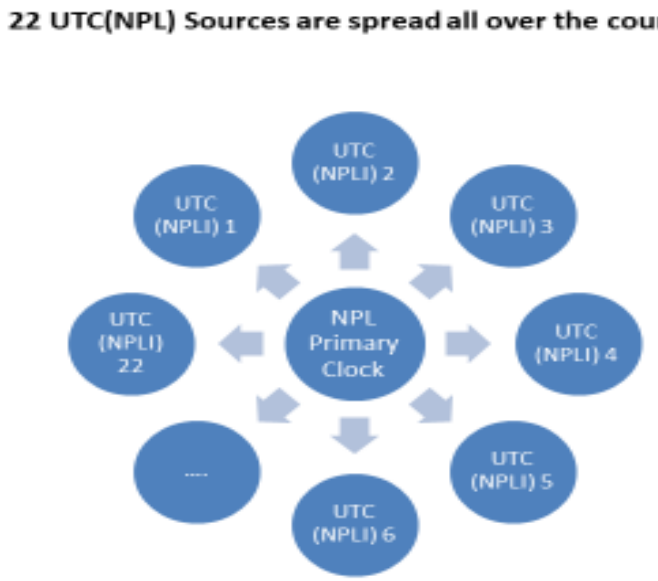
viii. The tentative List of Equipment at each Time Source Centre is below, this would be duly updated after the Trial Phase. :

Sl. No.	Equipment Type	Qty	Remarks
1	PRC	1	For Backup source to PTP GM
2	PTP GM/NTP Server	2	For PTP/NTP/SYNC-E/ E1 Fanout
3	Switch	1	For NTP/PTP interface connectivity

4	Firewall	1	For security purpose when implementing NTP over Internet
5	Gateway Router	1	For connecting to the internet

5.3. Dissemination of Time Reference UTC (NPLI) to TSC

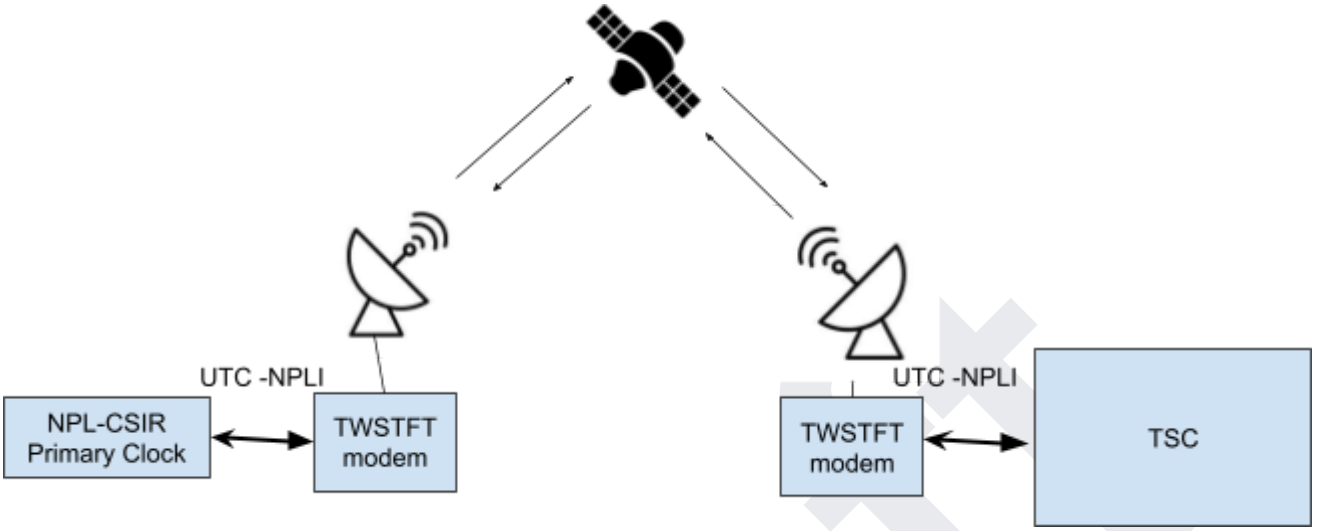




1. Two-way Satellite Time and Frequency Transfer (TWSTFT):

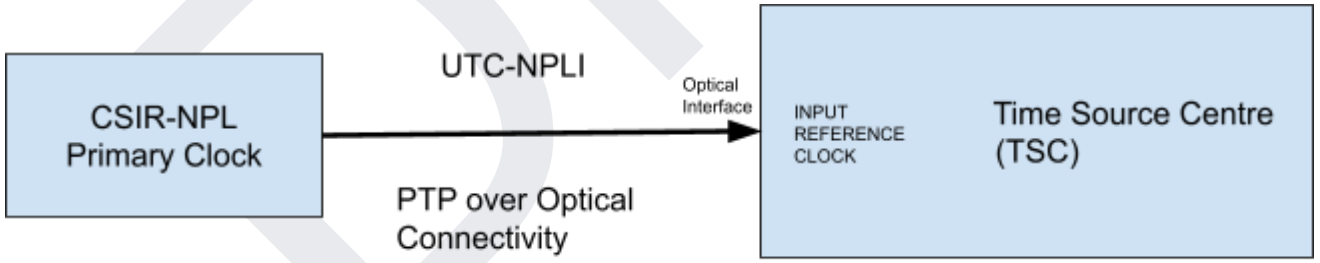
The TWSTFT technique utilizes a telecommunications geostationary satellite to compare clocks located in two different positions, i.e., at receiving and emitting

stations. Two-way observations are scheduled between pairs of laboratories so that their clocks are simultaneously compared at both ends of the baseline using the satellite's transponder.



2. Carrying UTC-NPLI through Optical Connectivity:

a. Scenario: CISR-NPL Primary Clock Site and TSC are co-located

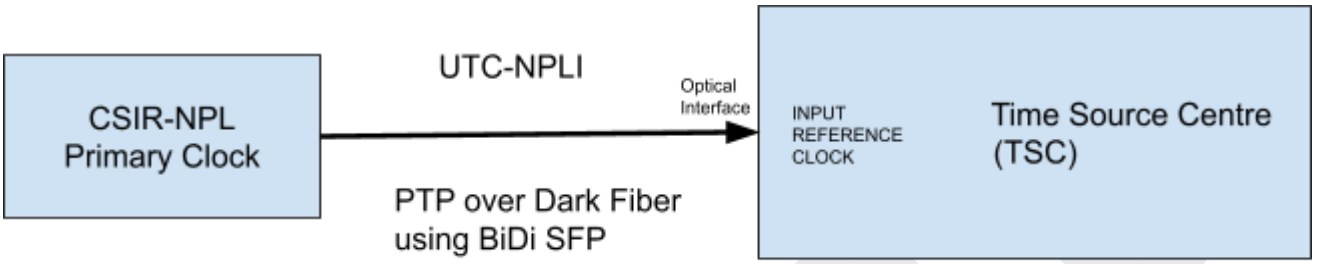


In case of CISR-NPL Primary Clock Site and TSC are collocated then the input reference to Time Source Centre will be provided by optical connectivity at optical interface. PTP will be provisioned between this optical connection. 1G optical/Electrical interface is required at the PTP GM for input reference from CSIR-NPL

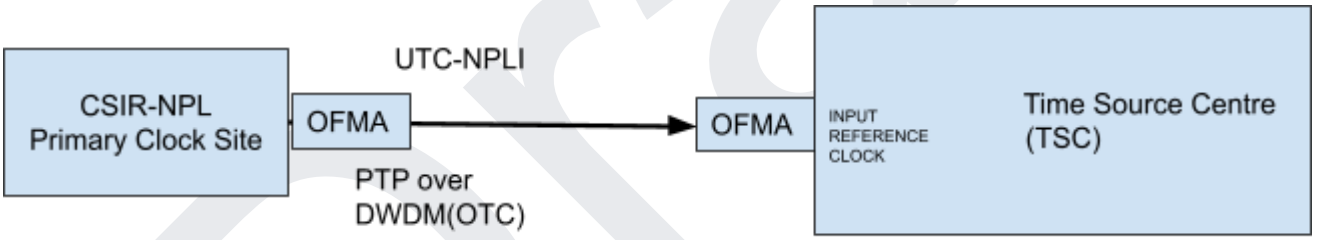
b. Scenario: CISR-NPL Primary Clock Site and TSC are not co-located

In case of NPL and TSC are not collocated but are available within the same LSA. The connectivity between them can be established using one of the below options:

i. Bi-Di SFP over single fibre (Dark Fibre)

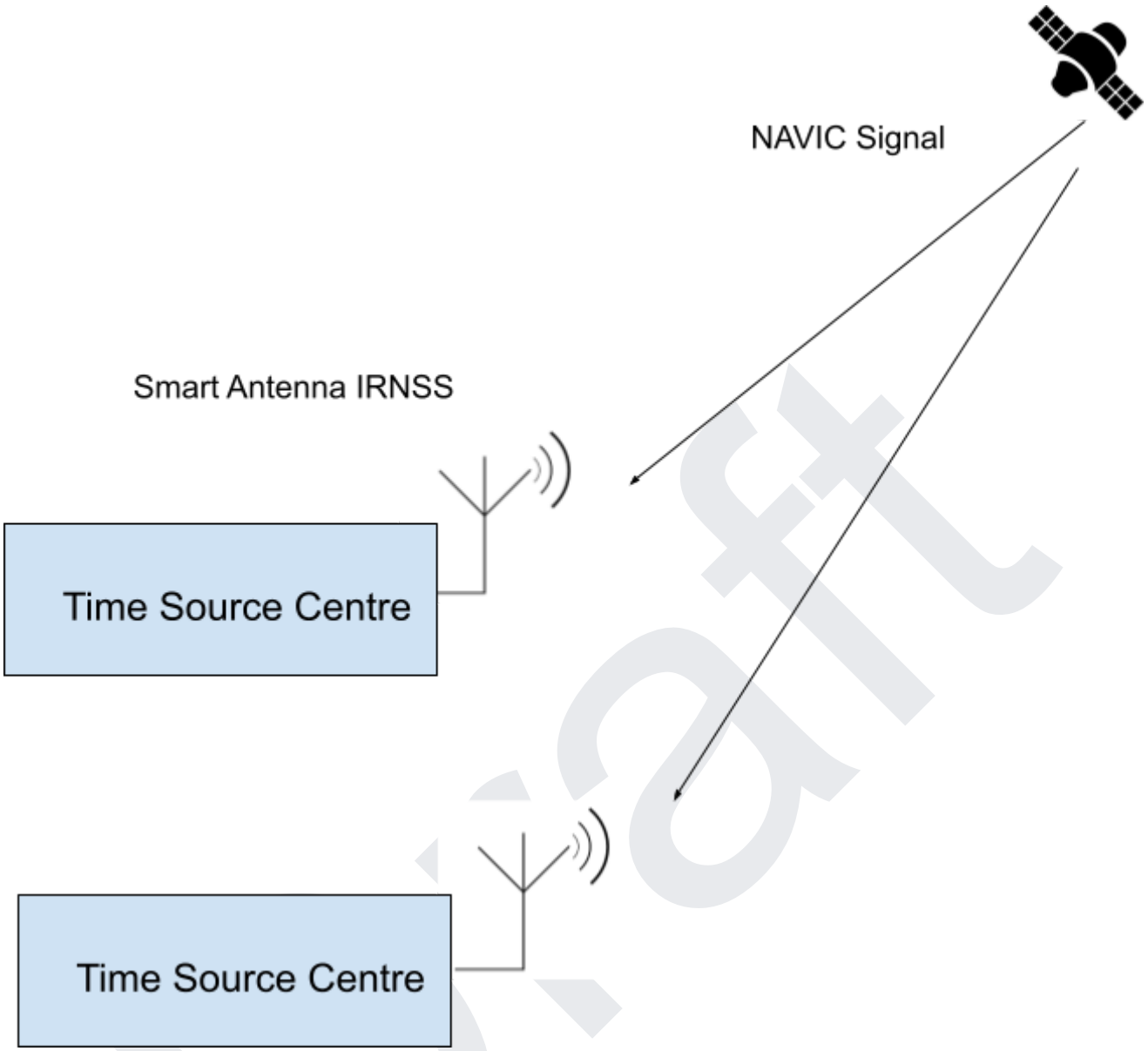


ii. Using OTC over DWDM

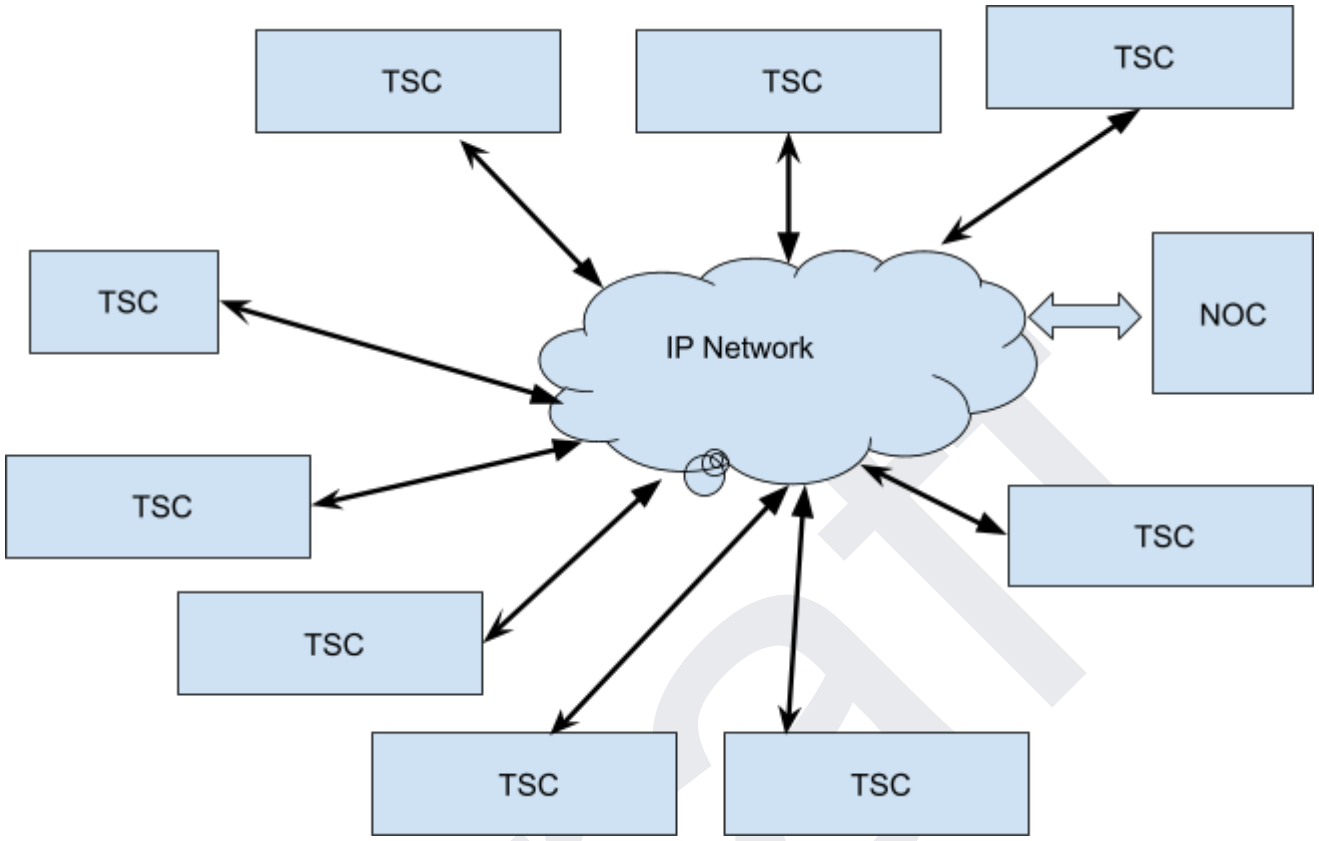


3. Using Global Navigational Satellite System (NAVIC)

UTC-NPLI time reference is embedded in a GNSS signal which is emitted by a satellite and received by a smart antenna at Time Source Centre. This service is provided by ISRO.


NAVIC Signal
Smart Antenna IRNSS
Time Source Centre
Time Source Centre

5.4. Management of TSCs



i) Network Operations Centre (NOC) will be set up in Delhi.
ii) NOC will monitor the health of TSC and also have the capability to manage the provision of access to a time reference.
iii) NOC would keep a log of access provided for different LSP. It would produce customized reports as per the requirement.

1.

6. Distribution of Time Reference Signal from TSC to LSP

a. Distribution of Time Reference Signal Using PTP protocol

iv) LSP shall set up Precision Time Protocol (PTP) Border Clock as per the GR (TEC 49170:2020). It will take the input clock reference from Time Source Centre.
v) LSP shall set up Precision Time Protocol (PTP) Slave Clock as per GR (TEC 49070:2012) for receiving time reference signal from TSC to its Network.
vi) LSP may set up no. of BC/TC/Slaves as per the requirement of the network

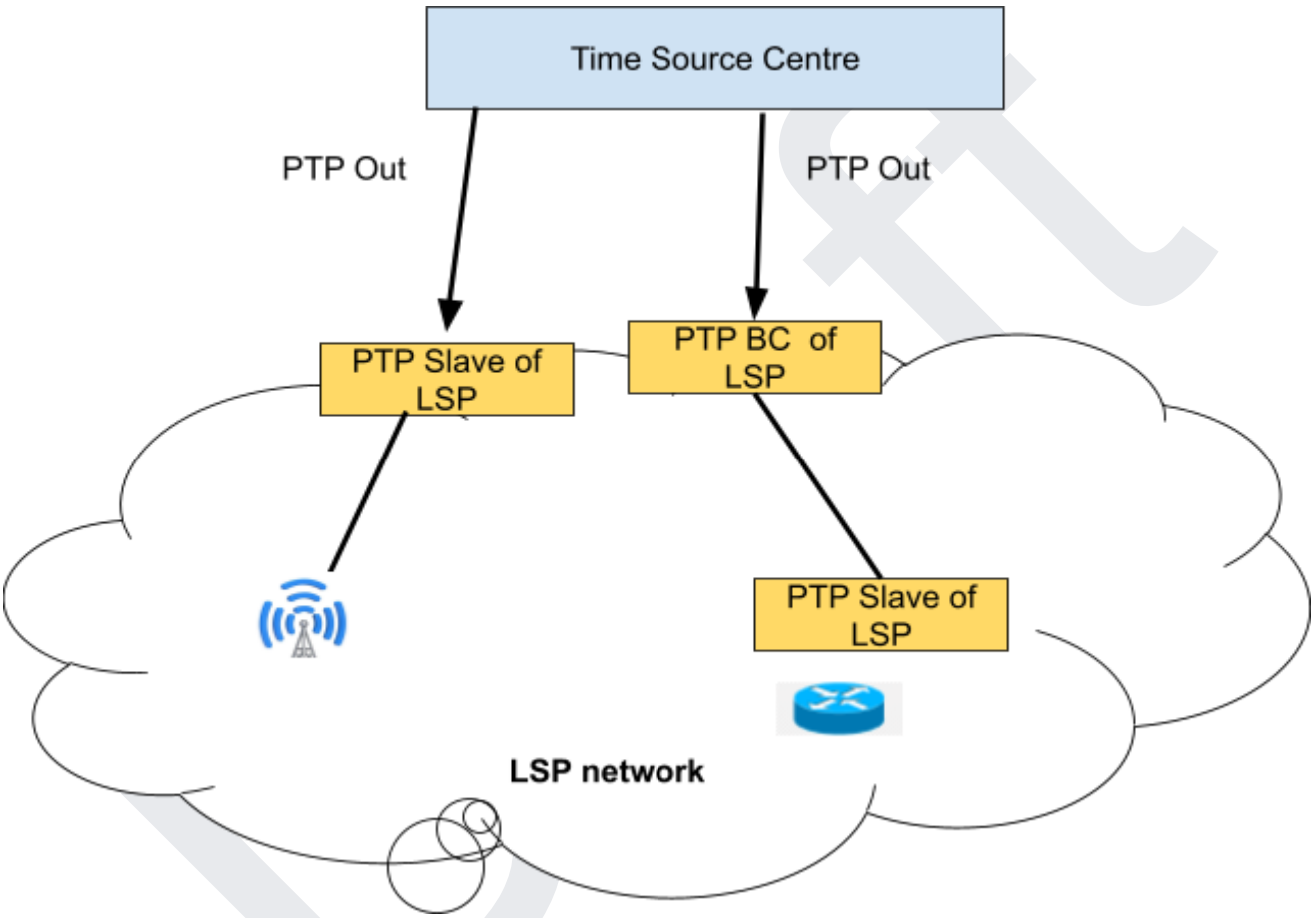
and applications.

vii) LSP may set up PTP link till the Packet gateway to synchronize their control plane.

viii) LSP shall be responsible for the transmission of Time Reference Signal n from Time Source Centre to Border Clock Server and then to PTP Slaves.

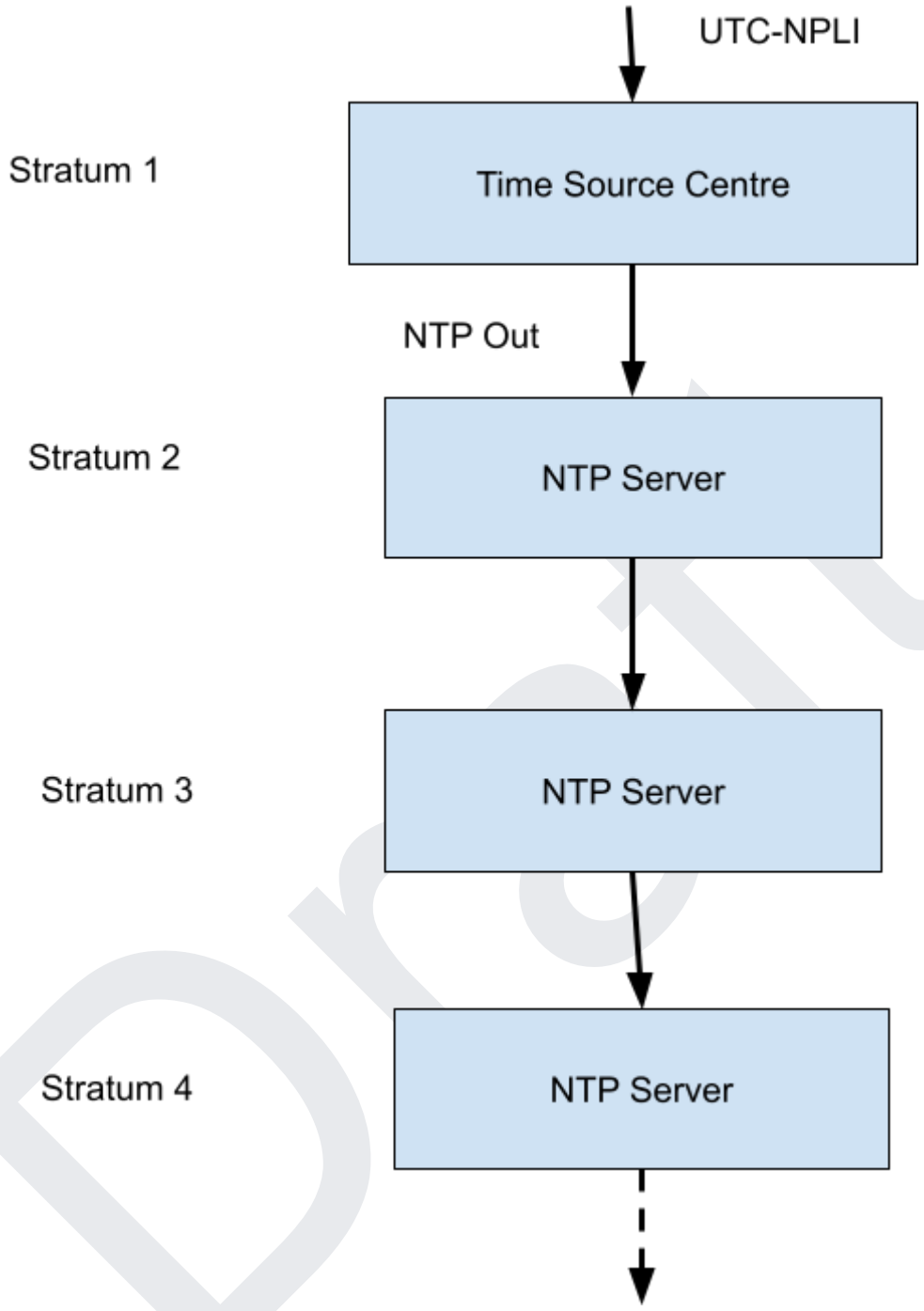
ix) LSP shall synchronize all network elements of their network only with the time reference signal from TSC

x) All Timing servers must be within the national boundary of India.

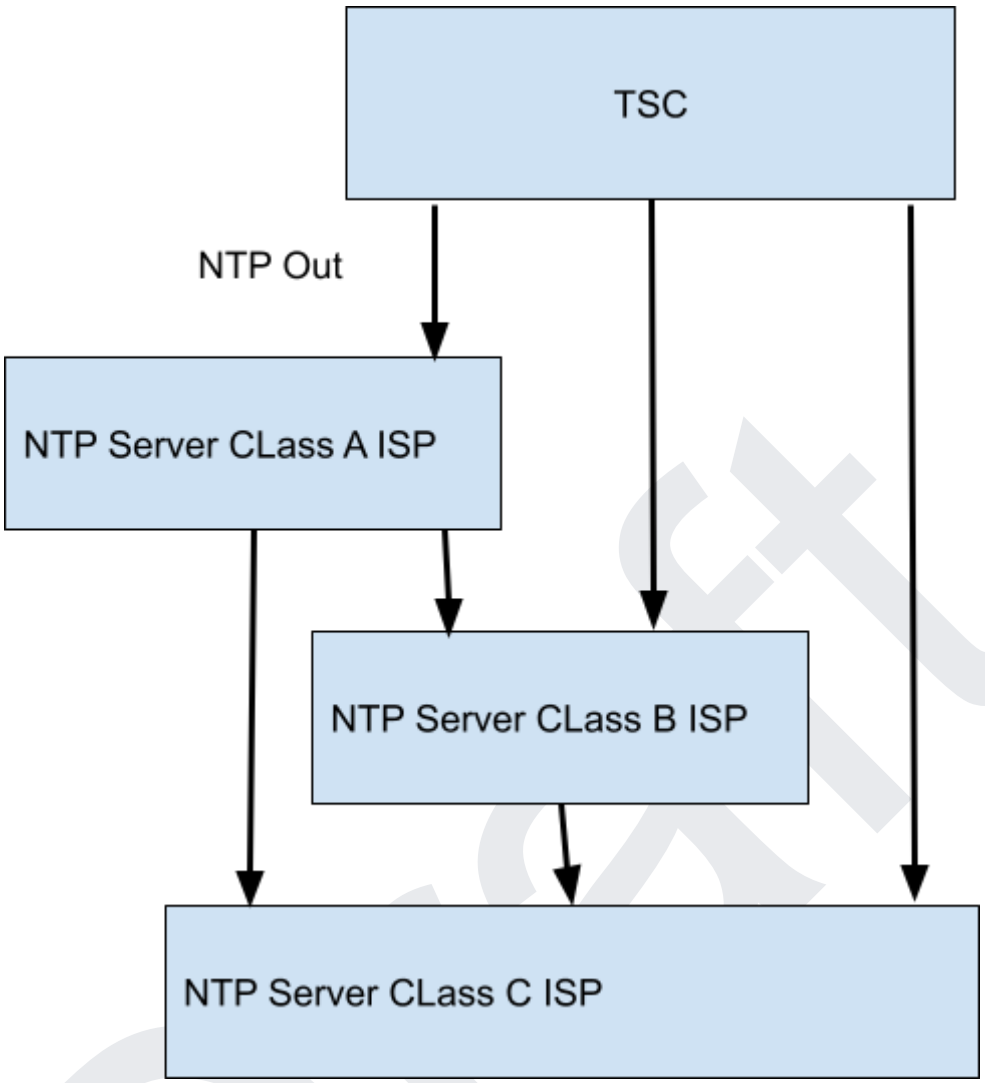


b. Distribution of Time Reference Signal Using NTP protocol

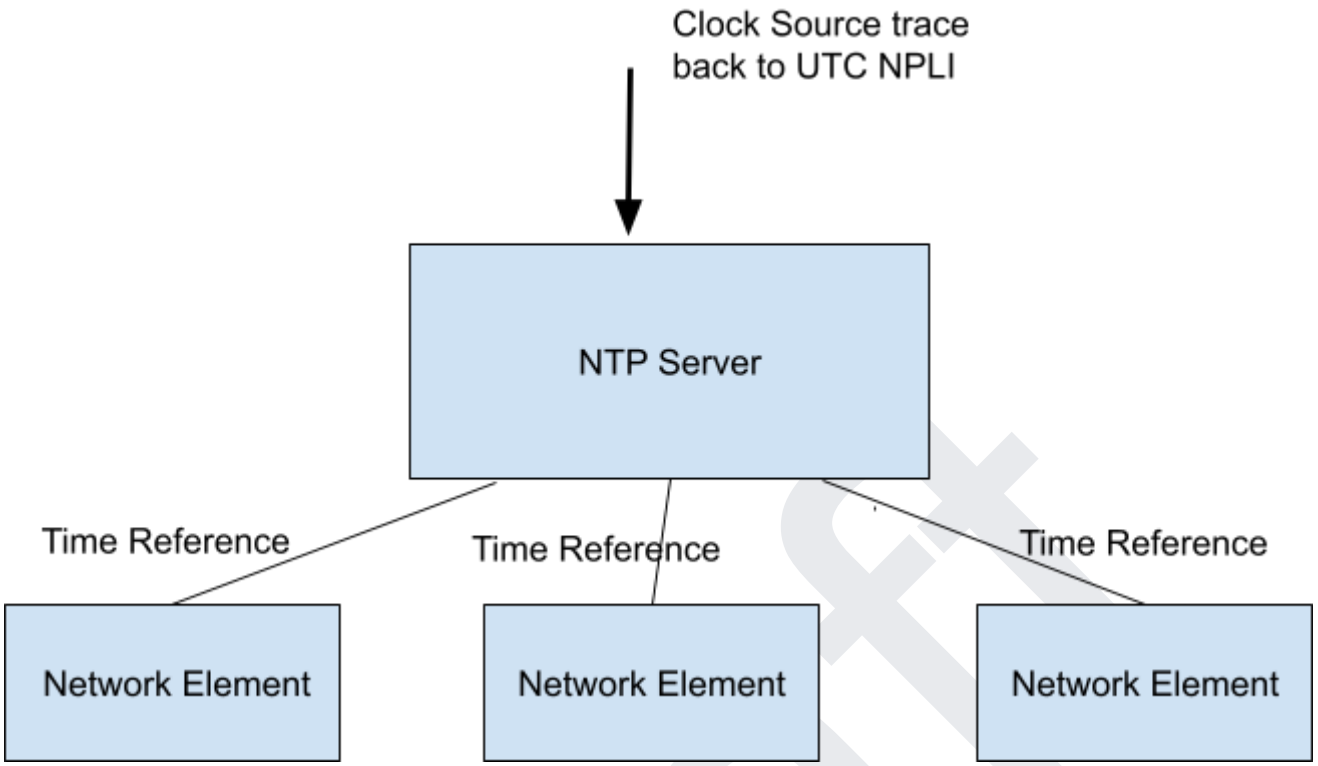
i. NTP out of TSC would be Stratum 1. LSP may set up NTP Server Stratum 2 as per GR (TEC 48150:2019) and take NTP Out from TSC as input time reference signal. Similarly, LSP may set up NTP Stratum 3 GR (TEC 48150:2019) and take a clock reference from NTP Stratum 2 which is in sync with NTP-Out of TSC. So on so for.



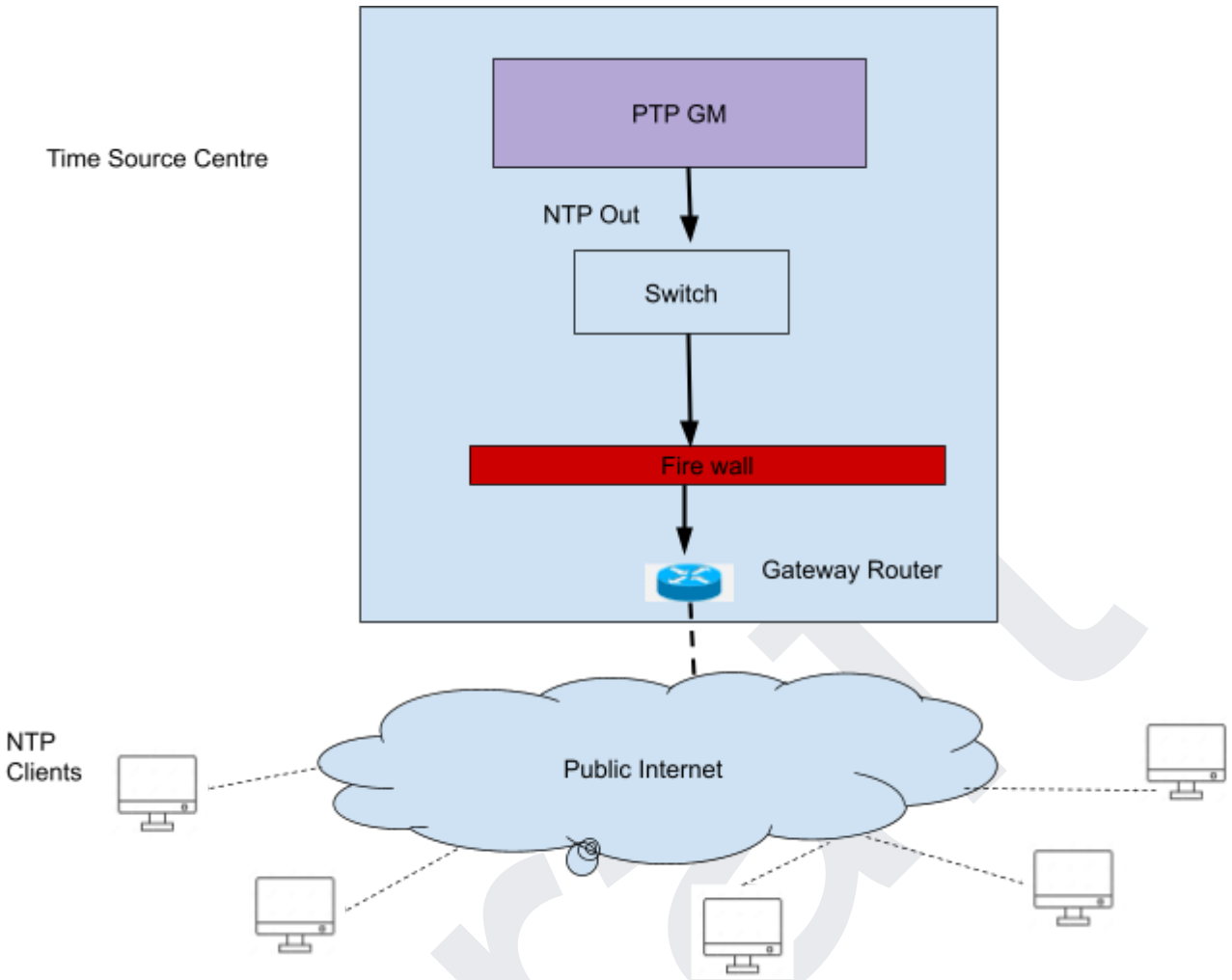
ii. LSP shall synchronize all network elements of their network with the closest NTP servers.
iii. ISP will connect to the types of NTP servers depending on their requirements.



iv. If the telecom services are retailed to other entities then LSP will ensure that the time reference of all network elements of the outsourced network would be traced back to UTC-NPLI.

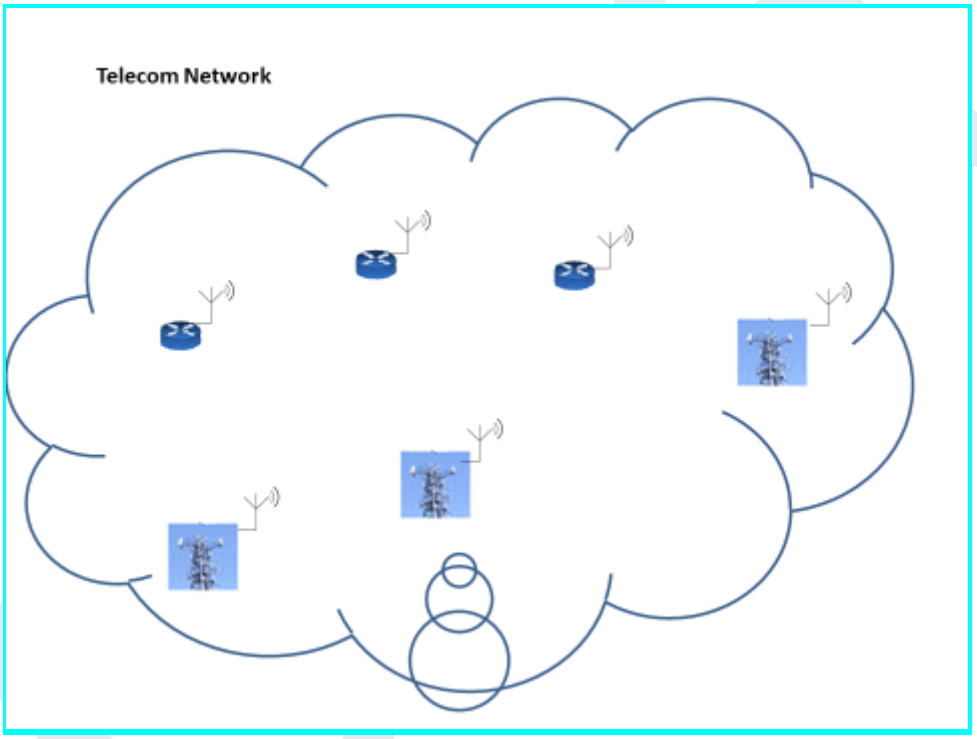


v. Users (NTP Clients) can also access Standard NTP output time reference signal through the public Internet.


Time Source Centre
PTP GM
NTP Out
Switch
Fire wall
Gateway Router
NTP
Clients
Public Internet

c. Accessing Indian Standard Time Reference Signal through GNSS

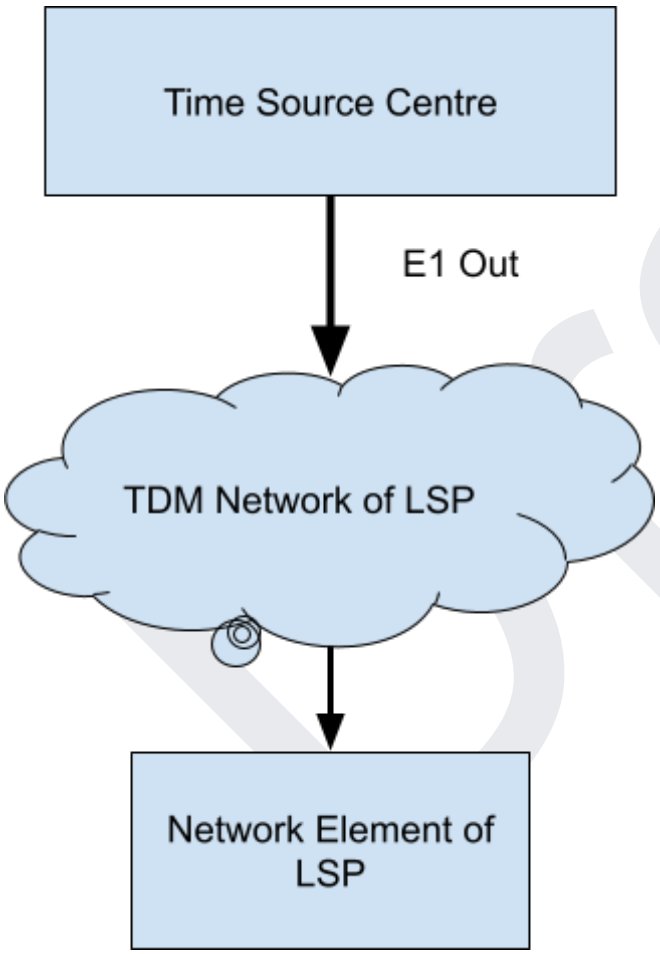
LSP may use Smart Antenna to receive Timing Information from NAVIC at as many places as it may require. However, they need to have a mechanism to verify that timing information is correctly synced with the Navic. If timing information could not be synched due to a technical fault, then an alternate source must be provided within the stipulated time.



d. Using E1 interface

E1 Synchronization can be distributed to remote TSP or any other customer location by connecting E1 from TSC device to the local SDH mux using PDH tributary interface. This tributary interface can be used for synchronizing the local oscillator of SDH mux. Further the STM traffic from the local SDH mux carry forward to the remote SDH Mux. Finally, at the remote location SDH mux can be used to fanout E1 synchronization to the remote device.

In case if the SDH muxes are synchronized through another clock source then the E1 from TSC will be directly mapped to the PDH E1 tributary of local SDH mux and terminate to the remote SDH mux. Further, the E1 clock can be fanout from PDH tributary of remote SDH Mux.



7. Deployment Plan

A. General Guidelines:

i. Licensed Service providers shall not use public Timing Sources. They shall only use UTC-NPLI time reference which is provided by CSIR-NPL the official timekeeper of the Nation.

ii. UTC-NPLI time reference is available at Time Source Centres established by the Department of Telecom. Time reference signal shall provide frequency, phase and TOD synchronization requirements for the LSP.

iii. Time reference Signal in TSC is available on PTP, NTP, SyncE and E1 2 MHz interfaces as per GR (TEC 49170:2020). UTC-NPLI may also be received through GNSS through NAVIC provided by ISRO. The priorities shall be set in the TSC for the selection of the input reference clock. PTP GM at TSC has suitable built-in algorithms to check the accuracy of the incoming clock and in case of any deviations beyond 1pps, it automatically switches over to the next priority clock.

iv. LSP has to set up their own network to receive the Time reference signals from TSC.

v. Time reference clock of all network elements of LSP must trace back to UTC-NPLI.

vi. LSP would establish physical links with TSC as described in the chapter above.

vii. In case LSP uses PTP out time reference signal from TSC, either the LSP may set PTP slave to use TSC as the PTP Grandmaster or the LSP may configure its PTP Grandmaster as a Boundary clock having input reference clock from PTP out of TSC.

viii. NTP out of TSC is Stratum 1. Class A ISP shall set up NTP Server as per TEC GR (TEC 48150:2019) as Stratum 2. Time reference signal can further be redistributed into its own network elements as well as to Class B ISP. Another NTP Server (i.e Stratum 3) may be set up having input time reference from Stratum 2. All NTP servers of LSP must tace back its clock reference to UTC-NPLI.

ix. LSP shall seek to minimize the network delay by bringing the stratum-2 time references as close to the network elements as possible.

x. The Physical connectivity over the GE optical interface at TSC to the LSP Router provides the SyncE clock to the LSP network with accuracy as per G.8261 and G.8262 standards. This method is similar to clock synchronization in SDH networks.

xi. The LSP or its customers shall configure their Servers and computers to access NTP out Time reference signal from TSC through public internet using URL.

The Server URL, as well as the IP address, shall be published for use by the LSP and their clients.

xii. Maintenance of TSC/NOC/associated network would be outsourced either to OEM or to a consortium led by OEM.

xiii. TEC would update GR on Precision Time Protocol (PTP) Grandmaster Clock - (TEC 49170:2020), Precision Time Protocol (PTP) Slave Clock - (TEC 49070:2012) and Network Timing Protocol Server - (TEC 48150:2019) periodically.

xiv. Department of Telecom shall notify LSP regarding the availability of TSC at various locations and modalities to access time reference signals from TSC separately.

B. Security and Reliability Guidelines

i. TSC should be fully redundant to avoid any single point of failure.

ii. Two PTP GM at each TSC have been proposed for the redundancy.

iii. TSC is planned to have two input time references (one primary and another secondary) from CSIR-NPL apart from one GNSS time reference through a satellite link.

iv. Equipment should have hot swappable dual power supply units.

v. For the stable and error-free operation of the PRC, it is recommended to keep the unit in a quiet place with the following conditions.

   a. Temperature should be relatively stable
   b. No powerful electrical engine around
   c. DC power supply stable and relatively noiseless
   d. No powerful vibrations source

vi. Vulnerability of GNSS and Need for Terrestrial based Time Distribution

GNSS has been widely used in communication infrastructures to provide precise time. The wide use of GNSS comes with many threats, including jamming, spoofing and interference from other sources operating in the adjacent band to the GNSS band. GNSS Jamming is a deliberate attempt to disrupt NAVIC services.

GPS spoofing is another attack on the system, where a valid GNSS signal is transmitted with altered position and time of day content. If the counterfeit signal strength is stronger than the actual valid GPS signal, the receiver could decode the wrong time and location information.

The time-distribution system should have reliability, availability, robustness, and security, including cybersecurity and malicious attacks on GNSS. The best way to avoid **such attacks is to use terrestrial based time distribution.**

As the criticality of precise time-based applications increases, so do the requirements for time-distribution system reliability.

It is recommended that LSPs also have terrestrial based time distribution in addition to NAVIC time reference signal.

vii. All Timing servers of LSP must be within the national boundary of India.

viii. Energy requirements of TSC must be available 24x7 with an adequate alternate power source and backup.

ix. Physical security of TSC must be ensured as deemed fit for critical infrastructure.

x. LSPs must document and maintain their synchronization procedures for Clocks. They must keep a log of the times when they synchronize their Clocks and the results of the synchronization process. This log should include notice of any time a Clock drifts more than the applicable tolerance specified. Such a log must be kept for a period of five years.

C. Trial Phase and Proof of Concept:

i. Time Source Centres Type A would be established in Delhi and Lucknow, Time Source Centres Type B would be established in Meerut, Chandigarh and Jaipur.

ii. Department of Telecom will make arrangements with CSIR-NPL to receive UTC-NPLI input references at Time Source Centres.

iii. Department of Telecom will have an arrangement with ISRO to high-quality time reference signal through GNSS NAVIC services.

iv. Before mandating LSP to switch to NAVIC time reference, the availability of GNSS smart antenna in the compatible frequency band for NAVIC has to be looked into.

v. Each TSC would have input UTC-NPLI time reference from two different sites of CSIR NPL for redundancy.

vi. The trial phase would assess whether TSC and NAVIC would be able to deliver the time reference to control as well as data plan of LSPs with desired quality.

vii. Learnings of the Trial phase would be incorporated to devise the next phase of implementation.

D. First phase of Implementation:

i. After a successful trial and Proof of Concept, TSC Type A would be established in Bhubneshwar, Bangalore and Pune.

ii. Type B TSC would be rolled out at the following places:

SNo.	Name of LSA	Place of TSC	States Covered
1	Andhra Pradesh	Hyderabad	Andhra Pradesh and Telangana
2	Assam	Guwahati	All NE States
3	Bihar	Patna	Bihar and Chhatisgarh
4	Gujarat	Ahmedabad	Gujarat, Daman & Diu, Nagara
5	Haryana	Ambala	Haryana
6	Himachal Pradesh	Shimla	Himachal Pradesh
7	Jammu & Kashmir	Jammu	J&K and Laddakh
8	Karnataka	Bangalore	Karnataka
9	Kerala	Ernakulam	Kerala
10	Madhya Pradesh	Bhopal	Madhya Pradesh and
11	Maharashtra	Nagpur	Maharashtra and Goa
12	Odisha	Bhuvneshwar	Odisha
13	Punjab	Chandigarh	Punjab and Chandigarh

14	TamilNadu	Chennai	Tamilnadu
15	UP(East)	Lucknow	UP(East)
16	West Bengal	Kolkata	West Bengal

iii. NOC to manage TSC would set up at Delhi.

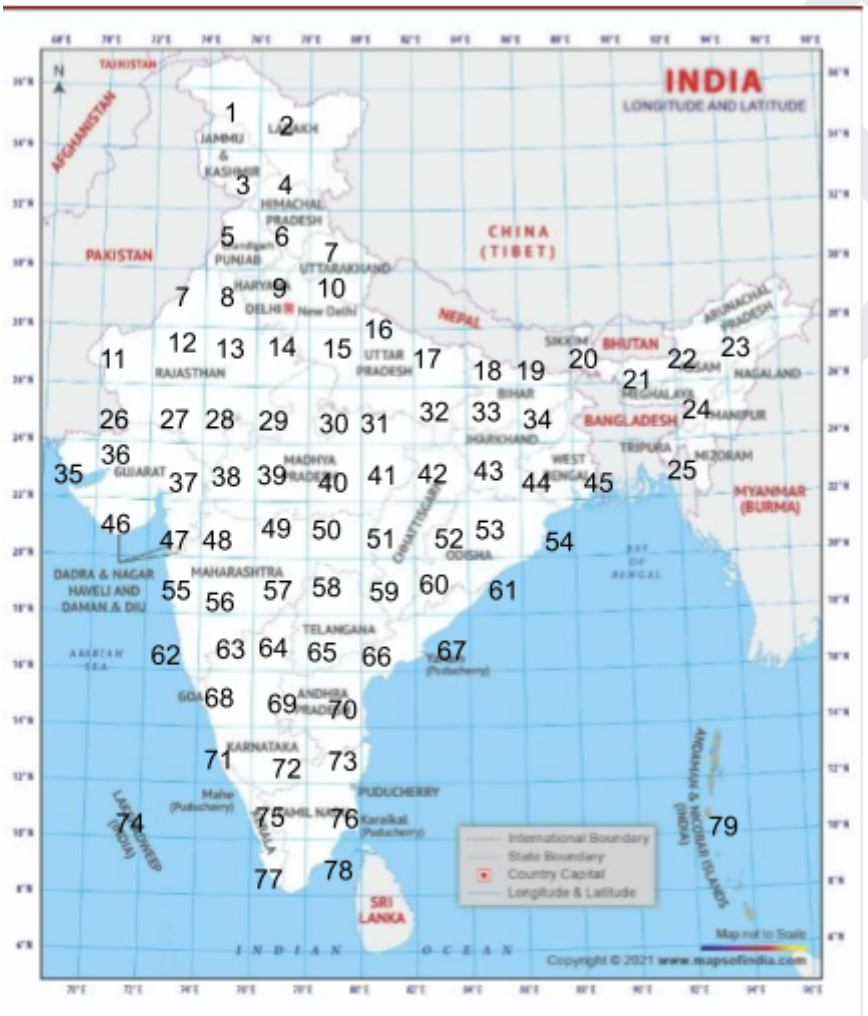
E. Final Phase of Implementation:

i. After successful and efficient implementation of the First Phase, the network of TSC may be spread further lower so as to have a TSC at every 200 km.

ii. LSP can receive UTC-NPLI through GNSS. It largely serves the purpose of LSPs. As the Telecom network is critical infrastructure, it may not be left with a single time reference source as GNSS may be prone to spoofing and hacking. In order to provide a time reference signal through terrestrial means, TSC has to be established at such granularity to provide a quality time reference signal at the bottom of the network.

iii. So it is envisaged to have TSC at all places on the grid in the map below.

iv. So TSC may be established at around 80 locations including what is already set up at the previous implementation phases.



F. Constitution of Implementation and Operating Committee:

i. An Implementation Committee shall be constituted under the Chairmanship of an officer of the rank of DDG for supervising the trial phase and implementation phase.

ii. Thereafter, special cell may be created under DG (Telecom) to operate and maintain TSC and manage the provisioning of LSP for accessing Time Reference signal at TSC. Secretariat with adequate staff would be created for office record keeping and supervision.

iii. Department of Telecom may create a Special Purpose Vehicle (SPV) for professionally managing Time Reference Signal Distribution activities with a guaranteed Service Level Agreement (SLA) to LSPs. After the final phase of implementation, time reference signals may be provided to LSP within 200 Km of its network elements. At this stage, revenue generation from LSP may be explored as LSP would not require to invest in time synchronization network for their network operation.

iv. Operating Committee would frame the rules for certification and audit of the compliance by LSP.

v. Operating committee may ask licensees to provide the status of Synchronization at any time.

vi. LSPs shall share the report in the format specified by the Operating Committee periodically.

vii. Each licensee must report to the Operating Committee any abnormality regarding Clock health.