L E T T E R S

621.39 (540.53)

AN INTEGRATED APPROACH IN DESIGN, INSTALLATION AND COMMISSIONING OF MIRROR RTH AND GLOBAL INFORMATION SYSTEM CENTER (GISC) AT, PUNE

1. WMO Information System (WIS)/Global Information System Center (GISC) and Mirror of Regional Telecommunication Hub (RTH) is basically a metadata catalogue web service and allows Data communication, synchronization of metadata with other Data Collection or Production Center (DCPC), GISCs or National Centers (NC's) based on protocol OAI-PMH. Such catalogue is quite useful for rapidly integrating real-time and non- real- time data sets for better interpretation of weather systems by the forecaster (Singh *et al.*, 2017).

With a view to make an effective national telecommunication network an attempt has been made to study the integrated approach in design, installation and commissioning of WMO Global Information System Center (GISC) and Mirror RTH (Disaster Recovery Centre) at Pune to act as full online backup of RTH, New Delhi. The heart of the RTH and WIS/GISC is the Automatic Message Switching System (AMSS) for data transmission and Reception globally.

WIS/GISC and Mirror RTH at Pune is one of the 15 designated RTH and three WMCs (World Meteorological Centers) namely Washington, Moscow and Melbourne on the Main Telecommunication Network (MTN) of the GTS. GISC system in India has already been commissioned at IMD, Pune. WIS/GISC maintains 15 point-to-point GTS links with centers at varying speeds and protocols as shown in Fig. 1 Three more circuits New Delhi-Melbourne, Pune-Muscat (Oman) and Pune-Male are operating *via* the internet tunnel.

The international circuits connected with RTH New Delhi and Pune are shown in the Fig. 1.

2. *Function and performance of AMSS system*: The main function of the system is to check, apply firewall and Collect the observational data originating from IMD's national network and associated National Meteorological Centre's (NMC) of neighboring countries and transmitting such data in appropriate form on the MTN, directly or through the designated WMC/AMSS. It relays the data selectively on the circuits of the MTN, as internationally agreed to by the member countries to adopt WMO standards. It ensures the selective distribution of meteorological data and meteorological information products to the IMD's national network and associated National Meteorological Centre's (NMC) of neighboring countries and to the AMSS's not situated on the MTN which they serve. Basic features of the system are given below:

(*i*) Time accuracy - AMSS system time in UTC must be maintained accurate to the nearest millisecond with reference to global time standard (GPS) synchronized across all the computers comprising the AMSS system.

(*ii*) Message throughput - 200 messages per second and above of message length of 15000 octets under peak traffic load.

(*iii*) File throughput - 20 files each of 500000 octets size per second and above under peak traffic load.

(*iv*) Message and File Switching delay (registration time at output queue - registration time at input queue) - Less than 1 second under peak traffic load.

(*v*) CPU usage - Less than 70 percent under peak load.

(*vi*) Memory usage - Less than 60 percent under peak load.

(*vii*) Disk usage - Less than 70 percent for a comprehensive total online operational requirement of 30 days.

(*viii*) Fail-over latency - overall less than 20 seconds at operation level.

(*ix*) Maximum local network traffic - Less than 70 percent of the designed operation limit.

(*x*) Daily throughput - 1 TB designed throughput.

(*xi*) Availability - 99.9% and above.

3. *Integration and configuration of mirror Regional Telecommunication Hub (RTH) at Pune*: The Mirror Regional Telecommunication Hub (RTH) installed and commissioned at Pune, is of latest state of the art technology information exchange system conforming to the standards of Global Information System
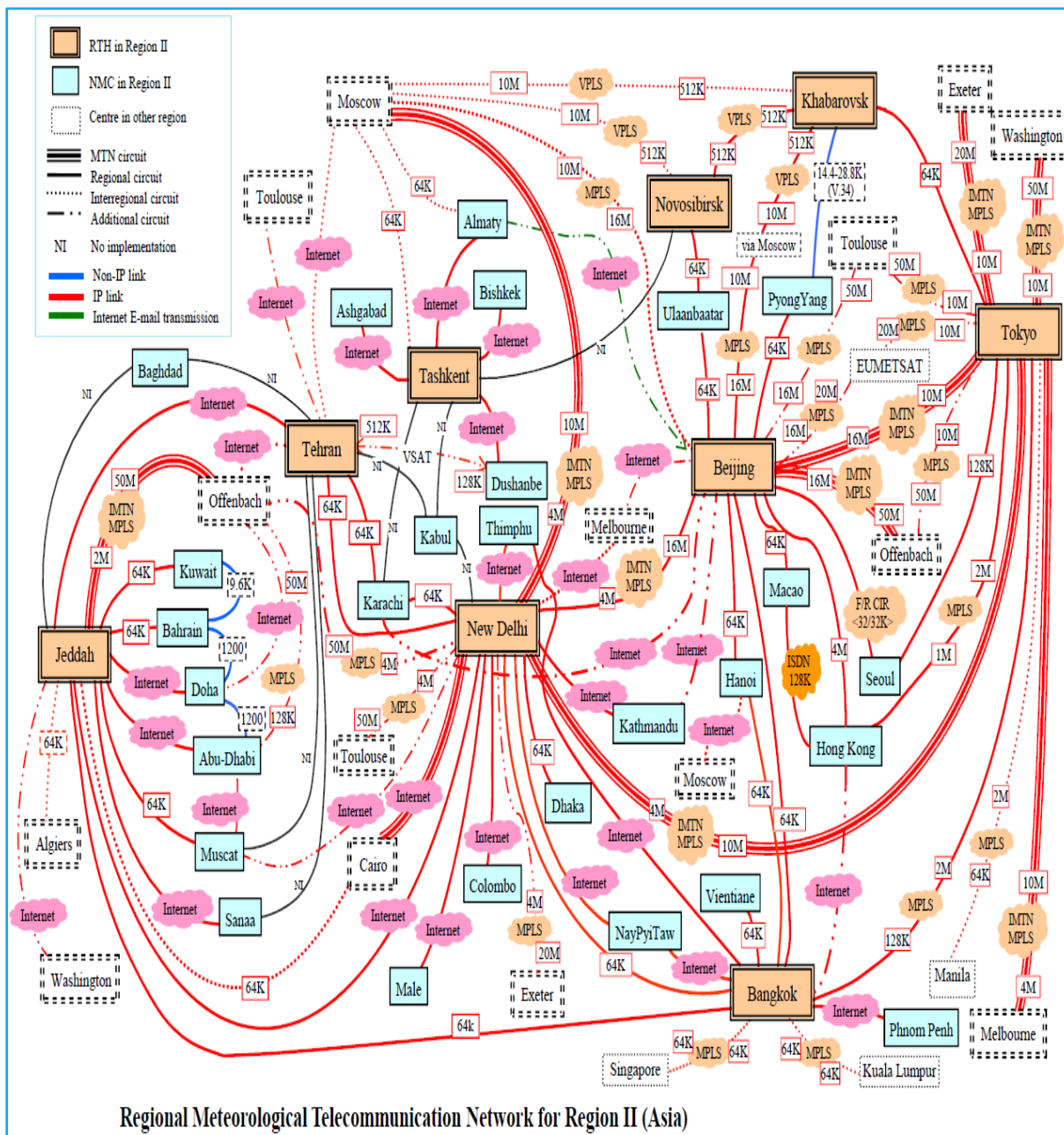
Fig. 1. International circuits connected with RTH, New Delhi and RTH, Pune

Centre (GISC) for Regional Telecommunication Hub (RTH) under the framework of WMO Information System (WIS) at par with the latest recommendations of Commission for Basic Systems (CBS Ext.; 2010, CBS - 13; 2005) and latest amendments.

The system at Pune works in parallel operation with system at New Delhi with load sharing of both systems at New Delhi and Pune with the present configurations. For this purpose Server, storage, networking equipments,

operator workstations, UPS, database, firewall, AMSS application software conforming to WMO standard has been developed *via* above specified functions for improvement in services and internet applications. Hardware and software appliances in redundant configuration are installed, integrated, commissioned and put into operation round-the-clock.

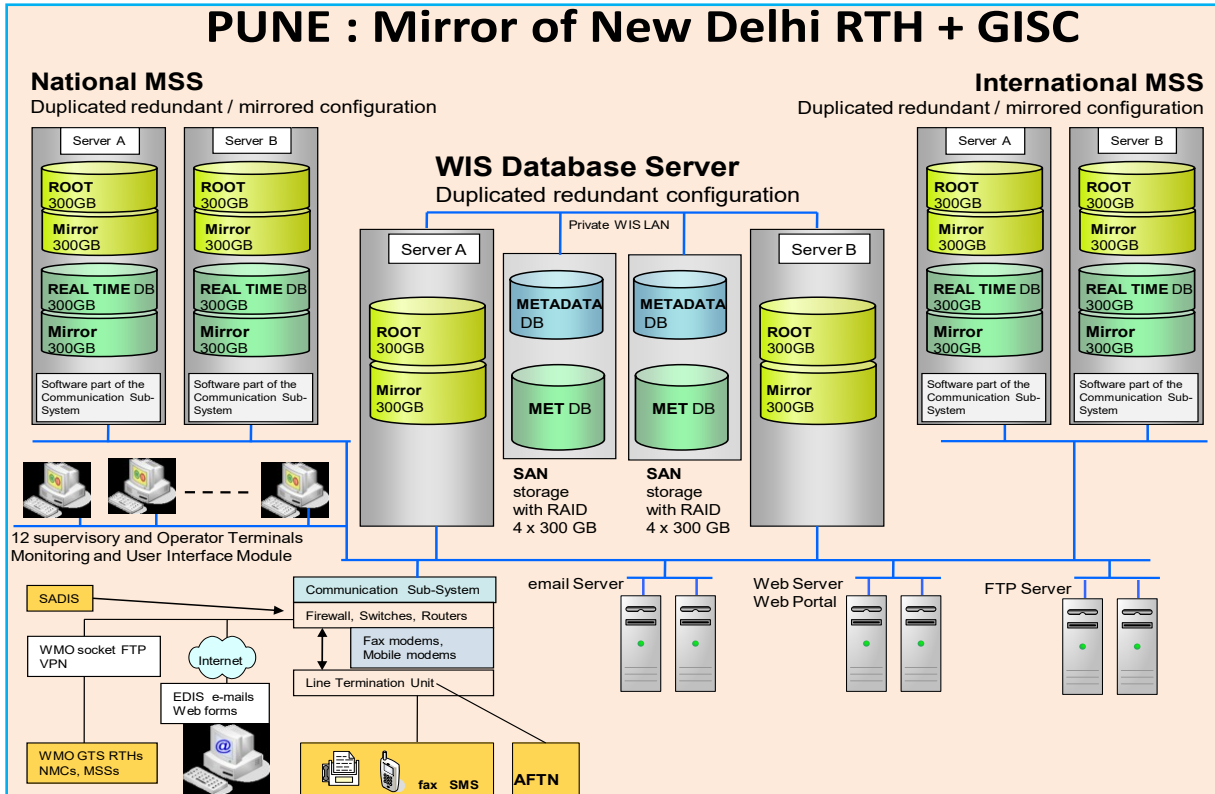The hardware configuration shown in Fig. 2 is designed in such a way that there are two Automatic

Fig. 2. Hardware configuration of Mirror RTH and WIS/GISC New Delhi

Message Switching Systems (AMSS) - one for handling national circuits and one for handling international circuits. This system has specific meteorological message switching system based on WMO/ICAO/CCITT and ISO specifications and standards. The basic message switch has been designed as a store and forward system and designed primarily for high efficiency control of telecommunication Networks.

The system shown in Fig. 2 is configured in such a way that it is dedicated to self-contained two node high availability linux servers connected to high capacity Raid level 1 and 5 disk storage on two separate I/O channels. Each node has one root disk which is mirrored in one package for which it is the primary node. Resources have been allocated to each node so that each node may adopt the package from the other node. Each package has one logical volume group assigned to it and the logical volumes in that volume group are mirrored. This arrangement eliminates single points of failure and makes either the logical volume or its mirror available in the event of failure of one of the buses. Both national and international systems are secured from the national as well as international WAN and internet through firewalls running under hot standby configuration as shown in Fig. 3.

In the national AMSS system as shown in Figs. (2&3) Mobile, WAN, VSAT and Internet network has been connected to the Server through firewall. The WAN has been connected through Router-1 and Router-2. These two Routers are in hot standby mode by Hot Standby Router Protocol (HSRP). Two nodes of the system operate in redundant mode. Systems have external four-port intelligent storage RAID box for connecting to each node having two controllers. This network has been connected with others LAN through Firewalls. These two Firewalls have been connected through fail over port. Whole Internet users' network is terminated at Multi-port Firewall-1 and Firewall-2 and then connects to Internet through Internet Router which is also in hot stand-by mode by HSRP.

In the International AMSS system as shown in Figs. (2&3) there are Two International AMSS Servers. These Servers are in redundant mode. Server unit should have four-port external intelligent storage RAID box connecting to each node having two controllers. International circuits are connecting to AMSS New Delhi through two-port V.35 modem in redundant mode and Firewall with fail over facility through 10 Mbps VPN, NX64 kbps and MPLS VPN link. For security reasons entire network that is national AMSS, International AMSS, LAN and DMZ network is communicating through Firewalls.
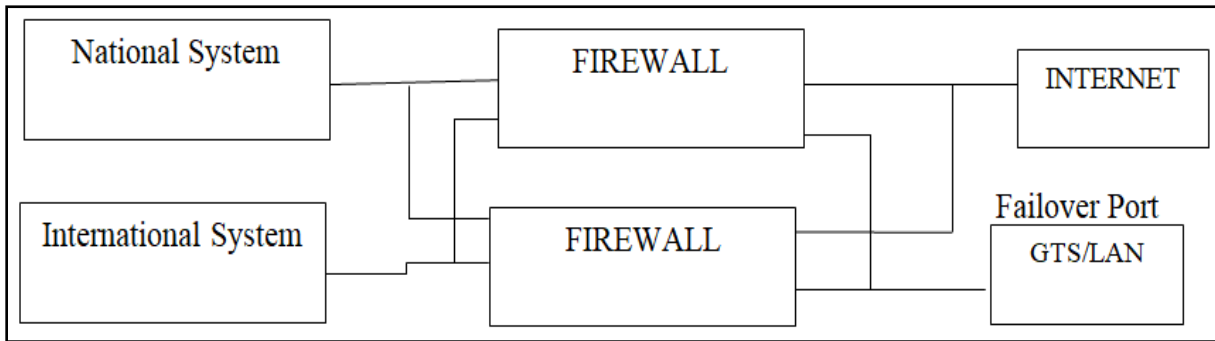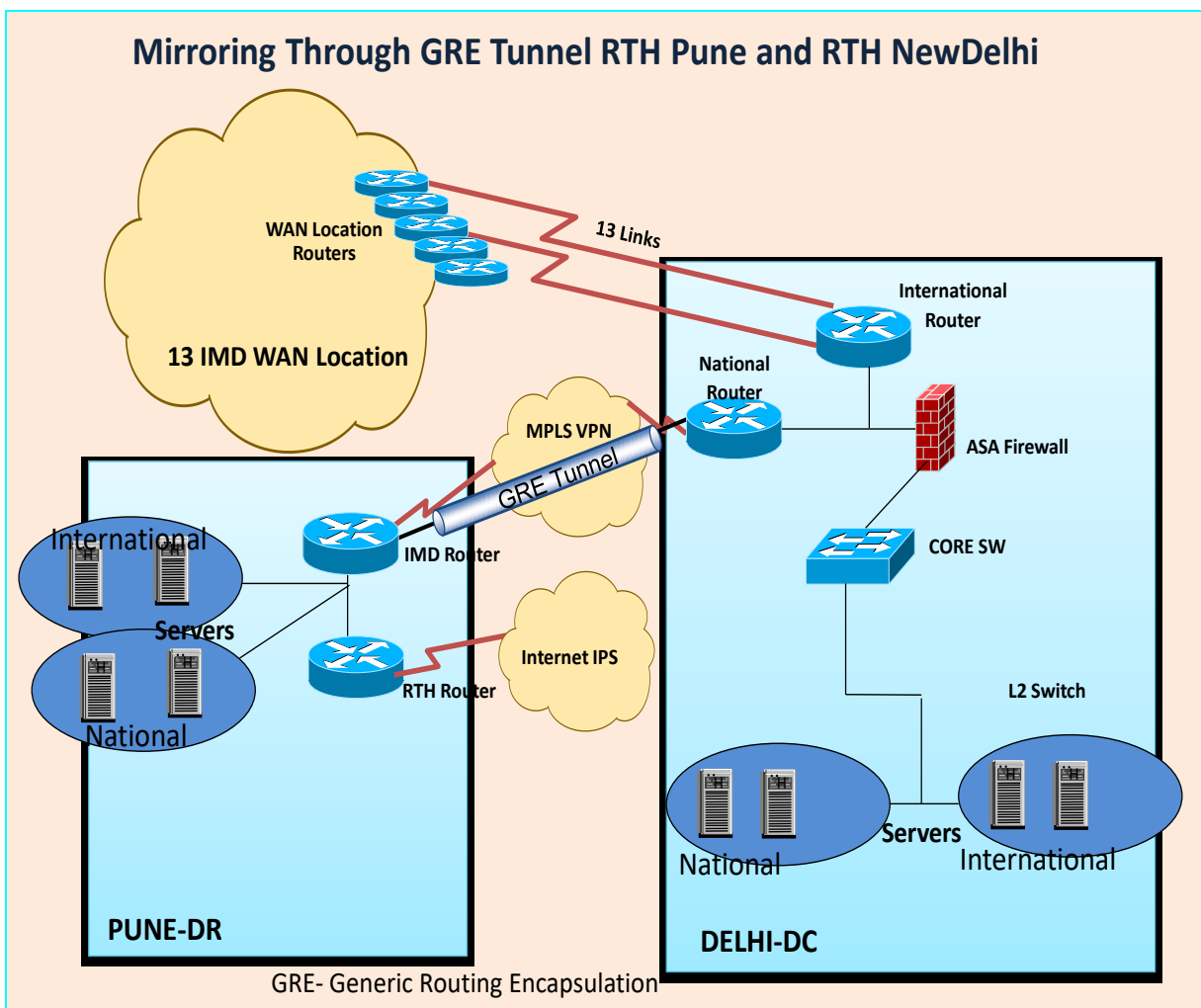
Fig. 3. Network interconnect diagram

Fig. 4. Mirroring through GRE Tunnel RTH, Pune and RTH, New Delhi

The integrated commissioned system shown in Fig. 2 provides the conversion of messages received under Traditional Alphanumeric Codes (TAC) to WMO Table Driven Code Forms (BUFR and CREX) in real time, switching and monitoring of the bulletins including binary products (GRIB), imagery and graphics in real- time. It provides automatic point to multi-point data cast through satellite, mobile and telephone networks of the time-critical observational data (earth quake, tide gauge etc.) and advisories/warnings to reach directly up to the
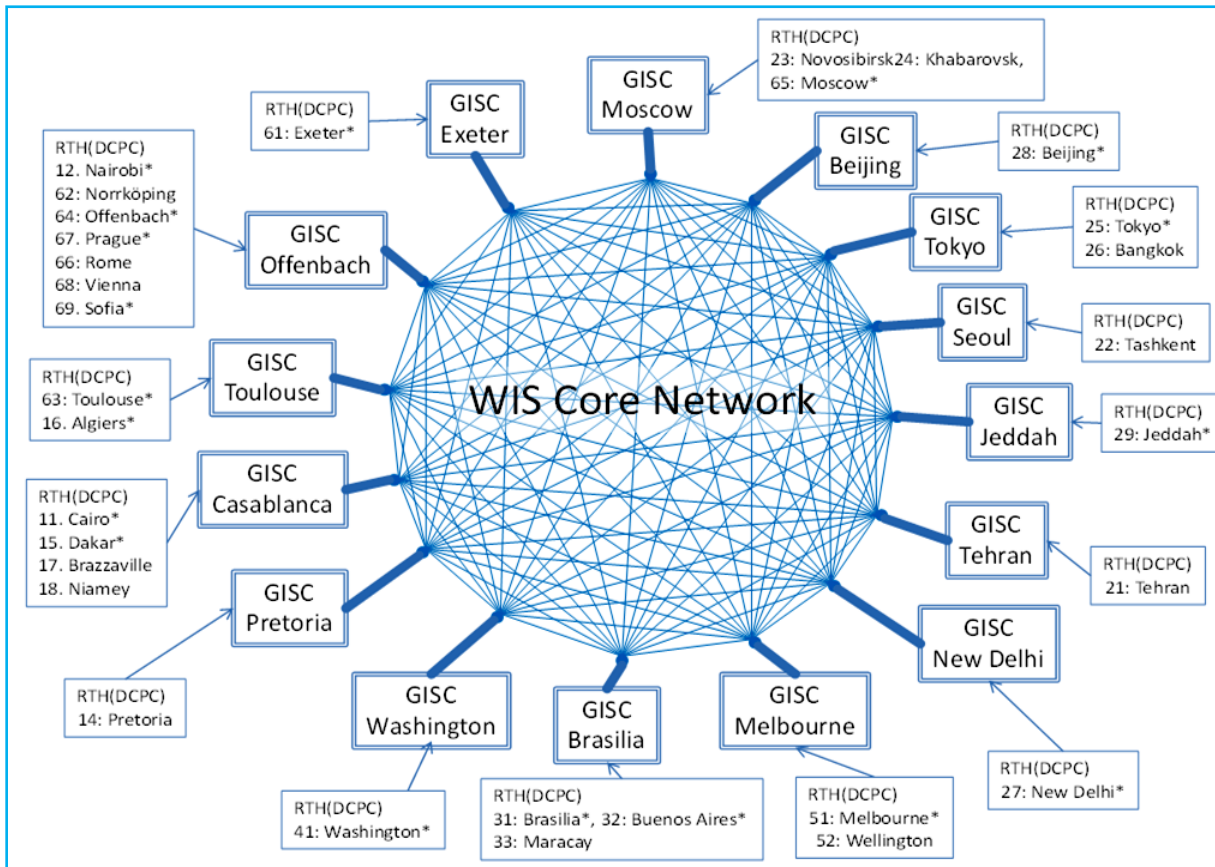
Fig. 5. Operational GISCs (15) with associated RTH on WIS core network

community level. It provides automatic update and management of all metadata (WMO No. 9 A, B, C and D) as per the operational guidelines specified under WMO Manual on Data Management (DM) including WMO SMM (Special MTN Monitoring) and AGM (Annual General Monitoring) and routing directory. It has web based Discover, Archive and Retrieval (DAR) and dissemination features as per GISC Tokyo, DWD, CMA etc. in a fully automatic mode as per WMO GISC requirements to designated centers and research institutions in India and abroad in addition to the other GISC centres. It is a system with a very high level of availability (99.9 percent and above) and is very reliable in operation. Fig. 4 shows the Mirroring of RTH, New Delhi and RTH, Pune through GRE Tunnel. Generic Routing Encapsulation (GRE) is a mechanism for encapsulating any network layer protocol over any other network layer protocol. GRE is widely used in VPNs as the mechanism for transporting IP packets between private IP networks across public networks with globally routed IP addresses. The advantage of GRE over other tunneling protocols is that it can encapsulate broadcast, multicast traffic (multicast streaming or routing protocols) or other non-IP protocols. GRE packets can be protected by using Internet Protocol Security (IPSec) ensuring confidentiality and integrity of the tunneled traffic. GRE allows hosts in one private IP network to communicate with hosts in another private IP network by providing a tunnel between two routers across the Internet. The GRE connection endpoints are terminated *via* a Virtual Tunnel Interface (VTI) configured in each device.

4.   *Implementation of GISC system in IMD Pune under WIS programme*: The GISC system implemented at IMD, Pune is as per WMO directives. The Currently operational GISCs are Beijing, Exeter, Jeddah, Melbourne, Moscow, Offenbach, Seoul, Tokyo, Toulouse, Tehran, Washington, Brasilia, Pretoria, Casablanca and New Delhi.

However, brief details about WIS, its implementation in IMD along with its salient features/facilities have been discussed in a paper (Singh *et al.*, 2017).

Fig. 6. Common dashboard for monitoring of all the 15 GISCs

WIS is Build on Global Telecommunication system (GTS) Network for highly reliable delivery of time-critical data and products and its base core communication network. WIS consists of three types of centers namely GISC, DCPC, NC and a communications network (GTS) consisting of managed, regional and internet networks. GISC is a major part of WMO information system (WIS) http://wis.imd.gov.in.

There are 358 data centres in WIS plus 15 GISCs. 224 of these data centres are NCs, 134 DCPCs. More centres are joining or planning to join and be a contributor in WIS. As WIS evolves, we will see more centres communicating directly with their GISC, enabling faster distribution & collection of data. The WIS core network of present GISCs centers connectivity is shown in the Fig. 5.

Fig. 7. Network status of GISCs for 1-2 October, 2018 at 0000UTC

GISC New Delhi (Response time)

Date	No	Centre	Moscow Portal	Moscow OAIPMH	Moscow SRU	New Delhi Portal	New Delhi OAIPMH	New Delhi SRU	Offenbach Portal	Offenbach OAIPMH	Offenbach SRU	Pretoria Portal	Pretoria OAIPMH	Pretoria SRU	Seoul Portal	Seoul OAIPMH	Seoul SRU	Tehran Portal	Tehran OAIPMH	Tehran SRU	Tokyo Portal	Tokyo OAIPMH	Tokyo SRU	Toulouse Portal	Toulouse OAIPMH	Toulouse SRU	Washington Portal	Washington OAIPMH	Washington SRU
	1	GISC Beijing	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	NoRes	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	2	GISC Brasilia	ok	ok	ok	ok	--	ok	ok	ok	ok	ok	ok	--	ok	ok	NoRes	ok	--	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	3	GISC Casablanca	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	--	ok	ok	ok	ok	ok	NoRes	ok	NoRes	ok	ok	ok	ok	ok	ok	ok
	4	GISC Exter	ok	NoRes	NoRes	ok	ok	ok	ok	ok	ok	ok	ok	--	ok	ok	ok	ok	NoRes	NoRes	NoRes	NoRes	NoRes	ok	ok	ok	ok	ok	ok
	5	GISC Jeddah																											
	6	GISC Melbourne	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	--	NoRes	NoRes	NoRes	ok	NoRes	ok	ok	ok	NoRes	ok	ok	ok	ok	ok	ok
	7	GISC Moscow				ok	ok	ok	ok	ok	ok	ok	ok	--	ok	ok	ok	ok	NoRes	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
10/1/2018	8	GISC New Delhi																											
	9	GISC Offenbach	ok	NoRes	ok	ok	ok	ok				ok	ok	ok	ok	ok	ok	ok	NoRes	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	10	GISC Pretoria																											
	11	GISC Seoul	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok				ok	NoRes	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	12	GISC Tehran																											
	13	GISC Tokyo	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	NoRes	ok	ok	ok	ok	NoRes	NoRes				ok	ok	ok	ok	ok	ok
	14	GISC Toulouse	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	--	ok	ok	ok	ok	NoRes	ok	ok	ok	ok				ok	ok	ok
	15	GISC Washington																											

GISC New Delhi (Response time)

Date	No	Centre	Moscow Portal	Moscow OAIPMH	Moscow SRU	New Delhi Portal	New Delhi OAIPMH	New Delhi SRU	Offenbach Portal	Offenbach OAIPMH	Offenbach SRU	Pretoria Portal	Pretoria OAIPMH	Pretoria SRU	Seoul Portal	Seoul OAIPMH	Seoul SRU	Tehran Portal	Tehran OAIPMH	Tehran SRU	Tokyo Portal	Tokyo OAIPMH	Tokyo SRU	Toulouse Portal	Toulouse OAIPMH	Toulouse SRU	Washington Portal	Washington OAIPMH	Washington SRU
	1	GISC Beijing	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	NoRes	NoRes	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	2	GISC Brasilia	ok	ok	ok	ok	--	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	--	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	3	GISC Casablanca	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	--	ok	ok	ok	ok	ok	ok	ok	ok	NoRes	ok	ok	ok	ok	ok	ok
	4	GISC Exter	ok	NoRes	NoRes	ok	ok	ok	ok	ok	ok	ok	ok	--	ok	ok	ok	ok	NoRes	ok	NoRes	NoRes	NoRes	ok	ok	ok	ok	ok	ok
	5	GISC Jeddah																											
	6	GISC Melbourne	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	--	NoRes	NoRes	NoRes	ok	ok	ok	ok	ok	NoRes	ok	ok	ok	ok	ok	ok
	7	GISC Moscow				ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
10/2/2018	8	GISC New Delhi																											
	9	GISC Offenbach	ok	NoRes	ok	ok	ok	ok				ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	10	GISC Pretoria																											
	11	GISC Seoul	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok				ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	12	GISC Tehran																											
	13	GISC Tokyo	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	NoRes	NoRes				ok	ok	ok	ok	ok	ok
	14	GISC Toulouse	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	--	ok	ok	ok	ok	ok	ok	ok	ok	ok				ok	ok	ok

Each WIS centers, *i.e.*, GISC, is associated with a principal GISC that serves as the centre's main entry point for distributing and receiving WIS data and Metadata by appropriate telecommunication systems, including the GTS. Association between a centre and a GISC is established by bilateral agreement. The WIS database contains a list of WIS centers and associated principal and back-up GISCs. This list is updated when members notify the Secretariat of associations between centres and GISCs.

The state of the art design, developed and installed GISC at Pune is also acting as disaster recovery centre for the installed DCPC for other centers. The main responsibilities of WIS are to act as a GISC and DCPC are:

(*i*)   Routine collection and dissemination service for time-critical and operation-critical data and products: This service is based on real-time "push" mechanism including multicast and broadcast; it is being implemented through dedicated telecommunication means and providing a guaranteed quality of service.

(*ii*)   Data Discovery, Access and Retrieval service: This service is based on request/reply "pull" mechanism with relevant data management functions; it is being implemented through the Internet.

(*iii*) Timely delivery service for data and products: This service is based on delayed mode "push" mechanism; it is being implemented through a combination of dedicated telecommunication means and of public data-communication networks, especially the Internet.

5.   *Hardware configuration for WIS/GISC System*: The hardware configuration shown in Fig. 2 is designed in such a way that the WIS servers fulfil the WMO WIS specifications, *i.e.*, handling metadata

https://www.wis-jma.go.jp/wcd/v1/top.html — Referring to WCD(from json file)
Checking availability of GISCs by manual access in case of no json file provided — Json file not provided

Date	No	Centre	GISC Status Check (Up or Down)								
			Distribution System	Portal	Catalogue Sync	SRU	Network Usage	Metadata records	Data & Products in 24h Cache	Size of Data & Products in 24h Cache	Unique Data & Products Missing Metadata in 24h Cach
10/1/2018	7	GISC Moscow	up	up	up	up	up	99,347	167,364	13,323,344,547	1,569
	8	GISC New Delhi									
	9	GISC Offenbach	up	up	up	up	up	98,848	681,128	26,432,980,286	8,055
	10	GISC Pretoria									
	11	GISC Seoul	up	up	up	up	up	100,623	313,878	3,403,266,905	6,559
	12	GISC Tehran									
	13	GISC Tokyo	Unknown	up	up	up	up	99,288	214,129	null	3,002
	14	GISC Toulouse	up	up	up	up	up	98,180	156,704	7,488,438,310	3,302
	15	GISC Washington									
			GISC Status Check (Up or Down)								
Date	No	Centre	Distribution System	Portal	Catalogue Sync	SRU	Network Usage	Metadata records	Data & Products in 24h Cache	Size of Data & Products in 24h Cache	Unique Data & Products Missing Metadata in 24h Cach
10/2/2018	1	GISC Beijing	up	up	up	up	up	97,699	1,498,611	43,937,244,914	4,378
	2	GISC Brasilia	up	up	up	up	DOWN	98,514	188,308	4,071,379,152	3,731
	3	GISC Casablanca	up	up	up	up	up	98,372	83,989	560,440,111	704
	4	GISC Exter	up	up	up	up	DOWN	95,959	624,450	10,581,266,810	2,302
	5	GISC Jeddah									
	6	GISC Melbourne	up	up	up	up	up	98,566	430,262	8,531,880,054	12,570
	7	GISC Moscow	up	up	up	up	up	99,446	565,660	13,428,206,726	1,552
	8	GISC New Delhi									
	9	GISC Offenbach	up	up	up	up	up	99,344	1,028,248	27,395,736,258	8,301
	10	GISC Pretoria									
	11	GISC Seoul	up	up	up	up	up	104,477	507,333	3,287,358,673	6,552
	12	GISC Tehran									
	13	GISC Tokyo	Unknown	up	up	up	up	99,368	442,292	null	3,036
	14	GISC Toulouse	up	up	up	up	up	98,682	158,181	7,500,268,348	14
	15	GISC Washington									

Fig. 8. Availability status of GISCs for 1-2 October, 2018 at 0000 UTC

http://oai.dwd.de/oaimonitorgui/#complete

Checking metadata synchronizaiton among GISCs and the number of metadata

Date	No	Centre	GISC Beijing MD No.	GISC Brasilia MD No.	GISC Casablanca MD No.	GISC Exter MD No.	GISC Jeddah MD No.	GISC Melbourne MD No.	GISC Moscow MD No.	GISC New Delhi MD No.	GISC Offenbach MD No.	GISC Pretoria MD No.	GISC Seoul MD No.	GISC Tehran MD No.	GISC Tokyo MD No.	GISC Toulouse MD No.	GISC Washington MD No.	Total
10/1/2018	4	GISC Exter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	GISC Jeddah	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	GISC Melbourne	1,200	558	0	17,244	266	1,113	3,432	0	42,506	0	536	68	24,417	4,106	0	95,446
	7	GISC Moscow	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	0
	8	GISC New Delhi	3	6	0	14,449	2	1	8	222	143	67	161	49	4	1,632	0	16,747
	9	GISC Offenbach	1,616	664	0	17,244	244	1,113	3,432	0	42,975	0	536	68	24,469	3,826	0	96,187
	10	GISC Pretoria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	GISC Seoul	1,616	664	27	17,244	298	1,113	3,432	138	42,975	304	536	68	24,469	3,872	0	96,756
	12	GISC Tehran	6,454	670	0	2,400	0	1,113	3,432	0	36,369	0	536	68	24,469	3,826	0	79,337
	13	GISC Tokyo	1,616	664	ERROR	17,244	268	1,113	3,432	ERROR	42,975	ERROR	536	68	24,469	3,826	ERROR	96,211
	14	GISC Toulouse	1,616	0	0	17,244	246	1,113	3,432	0	42,975	0	536	68	24,469	3,826	0	95,525
	15	GISC Washington	0	558	0	16,330	0	1,113	3,433	0	42,928	0	536	0	24,429	3,826	7,721	100,874
		Centre	GISC Beijing MD No.	GISC Brasilia MD No.	GISC Casablanca MD No.	GISC Exter MD No.	GISC Jeddah MD No.	GISC Melbourne MD No.	GISC Moscow MD No.	GISC New Delhi MD No.	GISC Offenbach MD No.	GISC Pretoria MD No.	GISC Seoul MD No.	GISC Tehran MD No.	GISC Tokyo MD No.	GISC Toulouse MD No.	GISC Washington MD No.	Total
10/2/2018	1	GISC Beijing	1,616	665	0	17,244	0	1,113	3,432	0	42,422	0	536	68	24,467	3,044	0	94,607
	2	GISC Brasilia	1,621	664	0	17,244	0	1,113	3,432	0	42,911	0	536	68	24,469	4,635	0	96,693
	3	GISC Casablanca	1,616	0	27	17,244	0	1,113	3,432	35	42,975	0	536	0	24,469	3,730	0	95,177
	4	GISC Exter	1,627	558	0	17,244	240	1,113	3,429	0	42,915	0	536	68	24,429	3,796	0	95,955
	5	GISC Jeddah	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	GISC Melbourne	1,200	558	0	17,244	266	1,113	3,432	0	42,506	0	536	68	24,417	4,106	0	95,446
	7	GISC Moscow	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	0
	8	GISC New Delhi	3	6	0	14,449	2	1	8	222	143	67	161	49	4	1,632	0	16,747
	9	GISC Offenbach	1,616	664	0	17,244	244	1,113	3,432	0	42,976	0	536	68	24,469	3,826	0	96,188
	10	GISC Pretoria	0	595	0	17,584	0	1,112	3,471	0	45,483	67	0	68	24,431	0	0	92,821
	11	GISC Seoul	1,616	664	27	17,244	298	1,113	3,432	138	42,975	304	536	68	24,469	3,872	0	96,756
	12	GISC Tehran	6,454	670	0	2,400	0	1,113	3,432	0	36,370	0	536	68	24,469	3,826	0	79,338
	13	GISC Tokyo	1,616	664	ERROR	17,244	268	1,113	3,432	ERROR	42,976	ERROR	536	68	24,469	3,826	ERROR	96,212
	14	GISC Toulouse	1,616	0	0	17,244	246	1,113	3,432	0	42,976	0	536	68	24,469	3,826	0	95,526
	15	GISC Washington	0	558	0	16,330	0	1,113	3,433	0	42,928	0	536	0	24,429	3,826	7,721	100,874

Checking metadata synchronizaiton among GISCs and the number of metadata

Fig. 9. Metadata status of GISCs for 1-2 October, 2018 0000 UTC

creation, harvesting, storing data and interactions with WIS users etc. To ensure high availability, it has been made of TWO identical mirrored servers, backing up each other. This system is configured for redundant dual server in hot standby mode of operation. The message database system decode and store the data in data pool as well as metadata in the metadata pool and provide data discovery and web delivery on the front-end. Within each component, the system takeover process will be immediate. No reboot or re-initialization will be necessary. After a server change, users should find the same message transmission queues, correction queue, service message queue, alarms queue. In case of one server being stopped, for example for maintenance, its restart is fully automatic, *i.e.*, once the operating system boot is ordered, this server is back to operational status as passive within a few minutes and without any human intervention. It is the replica of the live system by updating its message database and entire system applications.

The application software for GISC Pune system is MESSIR-WIS which is a metadata catalogue web service, giving access to meteorological metadata and allowing the download of the related data and products. MESSIR-WIS allows the synchronization of the metadata with other DCPC, GISC or NC centers, based on the OAI-PMH protocol. It also allows creating and editing the metadata provided by it. The main page of MESSIR-WIS shown in Fig. 9 is obtained by entering the URL of the web service: *http://wis.imd.gov.in/MessirWIS/srv/en/main.home*.

6. *WIS real time GISC monitoring by GISC Pune center from 1-15 October, 2018*: The GISC Pune center has taken over the GISC watch responsibility from GISC Brasilia for the period 1-15 October, 2018 and handed over the GISC watch responsibility to GISC Washington for the period 16-31 October, 2018 as per WIS roaster duty schedule. WIS roaster duty has been prepared for all the 15 operational GISC for GISC watch operation responsibility throughout the year for duration of 15 days for each GISC center with proper handover and takeover intimation to next GISC center for continued smooth functioning of GISC watch operation.

The GISC Pune has monitored the operation in real-time for Global data exchange by all 15 operational GISC namely GISCs (Beijing, Exeter, Jeddah, Melbourne, Moscow, Offenbach, Seoul, Tokyo, Toulouse, Tehran, Washington, Brasilia, Pretoria, Casablanca and New Delhi).

During this GISC WATCH the following parameters were checked, *i.e.*, web portal, area of Responsibility performance, metadata, harvesting and sharing of meteorological GTS data and products etc. The online monitoring at 0000, 0300, 0600, 0900, 1200, 1500, 1800, 2100 UTC has been observed during the period 1-15 October, 2018 by GISC Pune center. All the GISCs were informed by raising tickets for improving the performance whenever required by GISC New Delhi through URL http://www.inmet.gov.br/giscticket/login_page.php. The real-time status of data updating time, distribution system, web portal, SRU search engine, Network usage on WIS core network, metadata records, data and products including their size in bytes in 24 hours cache of all the 15 GISCs has been observed and can be seen on the common dashboard as shown in Fig. 6. The common dashboard for all the 15 GISCs can be seen in real-time under URL https://www.wis-jma.go.jp/wcd/v1/top.html. Figs. 7-9 show one example of real-time data records for one observation 0000 UTC for 1-2 October, 2018.

7. *Conclusions*: In compliance of WMO mandate, India Meteorological Department (IMD) had installed, integrated and commissioned its Mirror RTH and Primary GISC at Pune. It is acting as full online backup of New Delhi system. The System is state of the art technology with high reliability up to 99.9 percent up time. IMD fulfils the required mandate and international role of India by installing Global Information system Center (GISC) at Pune. It provides the users to achieve quick and reliable exchange of large volume of meteorological data and product online, real- time as well as offline (Archives). This integrated system is tuned with available international system in order to achieve faster and quicker dissemination of meteorological products globally and it is compatible with WIS telecommunication requirements for meteorological data exchange in South Asian region and adjoining countries.

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WIS website under the URL: https://www.wis-jma.go.jp/wcd/v1/top.html.

WMO website: http://www.public.wmo.int.

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