

ESA/ESOC REAL TIME INFRASTRUCTURE

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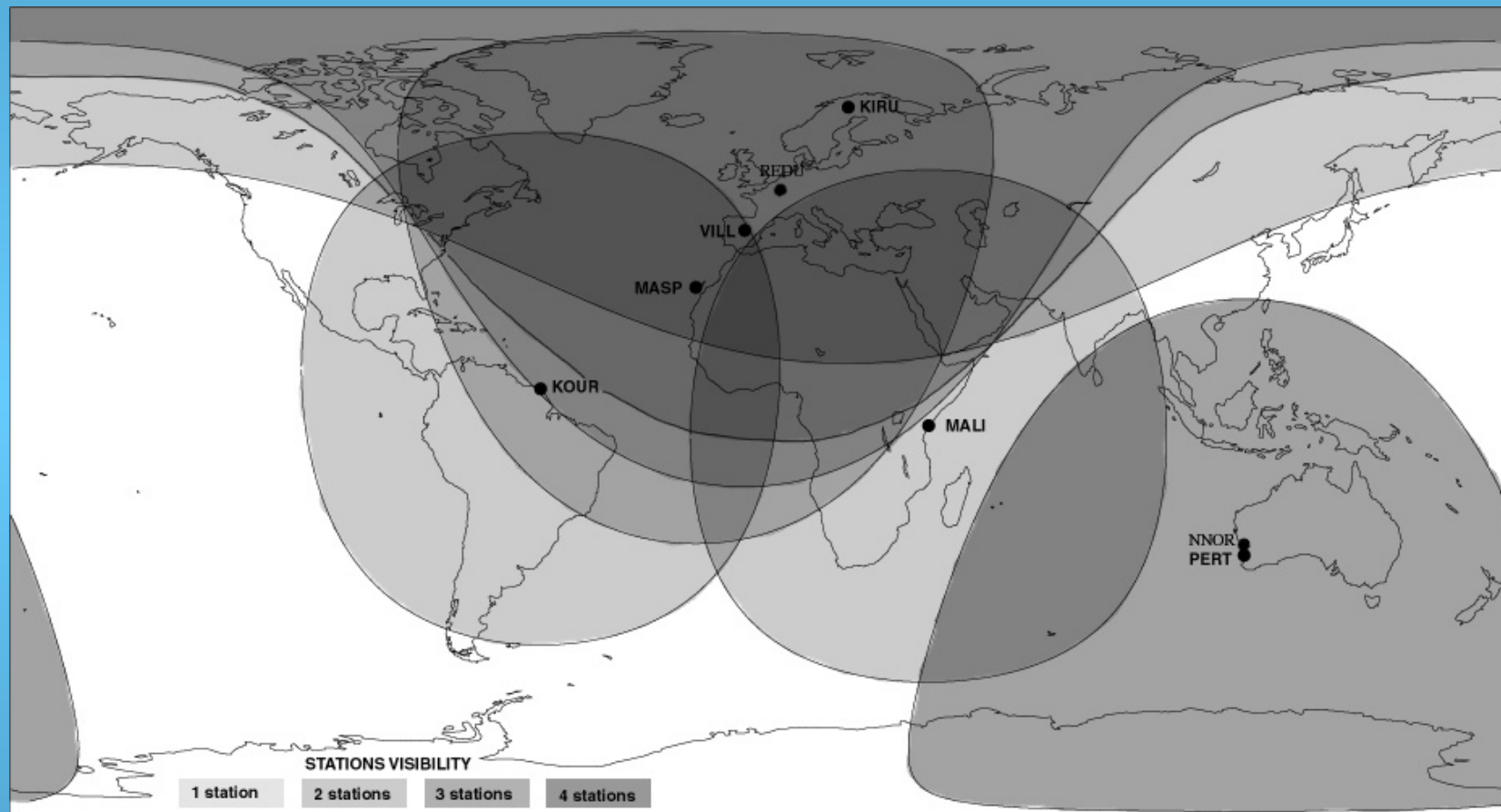
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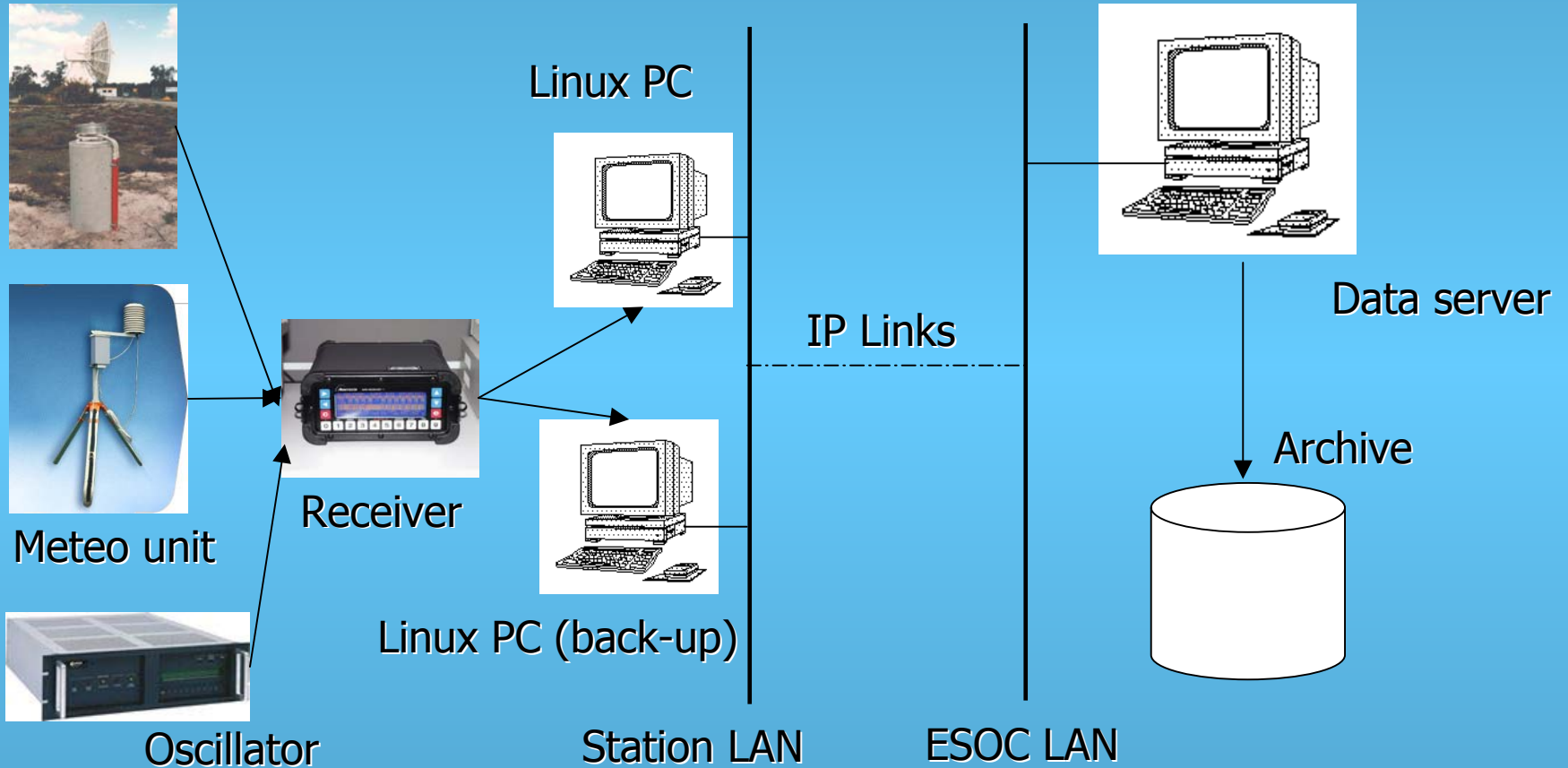
Introduction

- Real time flow developed during 2003
- Motivation:
 - real time data streams
 - reduced latency of currently demanded near real time 15 minutes files
- Based on ESA Ground Stations infrastructure and recent development of IP comms in the last years
- On going integration in IGS Real Time Network

ESA/ESOC Real Time Network coverage (20 degree minimum elevation)



ESA/ESOC station layout



ESA/ESOC stations status

	KIRU	KOUR	MALI	MAS1	NNOR	PERT	VILL	REDU
Receiver	microZ	Z-XII	Z-XII	Z-XII	Z-XII	microZ	Z-XII	microZ
On-site back-up equipmnt	Turborogue ACT	iCGRS + antenna	microZ + antenna	Turborogue ACT + antenna	microZ + antenna			
Computer	2 units	2 units	2 units	2 units	2 units	2 units	2 units	1 unit
Oscillator	Cs	Cs	Rb	Cs	H-Maser	Cs	Cs	Cs
Comms	Internet	Intranet (Office LAN)	Internet (VSAT to Rome) bandwidth limitations	Internet	Intranet (Opsnet)	Intranet (Opsnet)	Intranet (Office LAN)	Intranet (Office LAN)
Real time status	1 Hz to ESOC and IGS	1 Hz to ESOC	1 Hz to ESOC and IGS	1 Hz to ESOC and IGS	1 Hz to ESOC	1 Hz to ESOC	1 Hz to ESOC	1 Hz to ESOC

Receivers

- Homogeneous Ashtech network (Z-XII, microZ or iCGRS).
- On-site back-up units in nearly all the stations
- External atomic (Cs) oscillators. H-maser at NNOR. Rb at MALI.

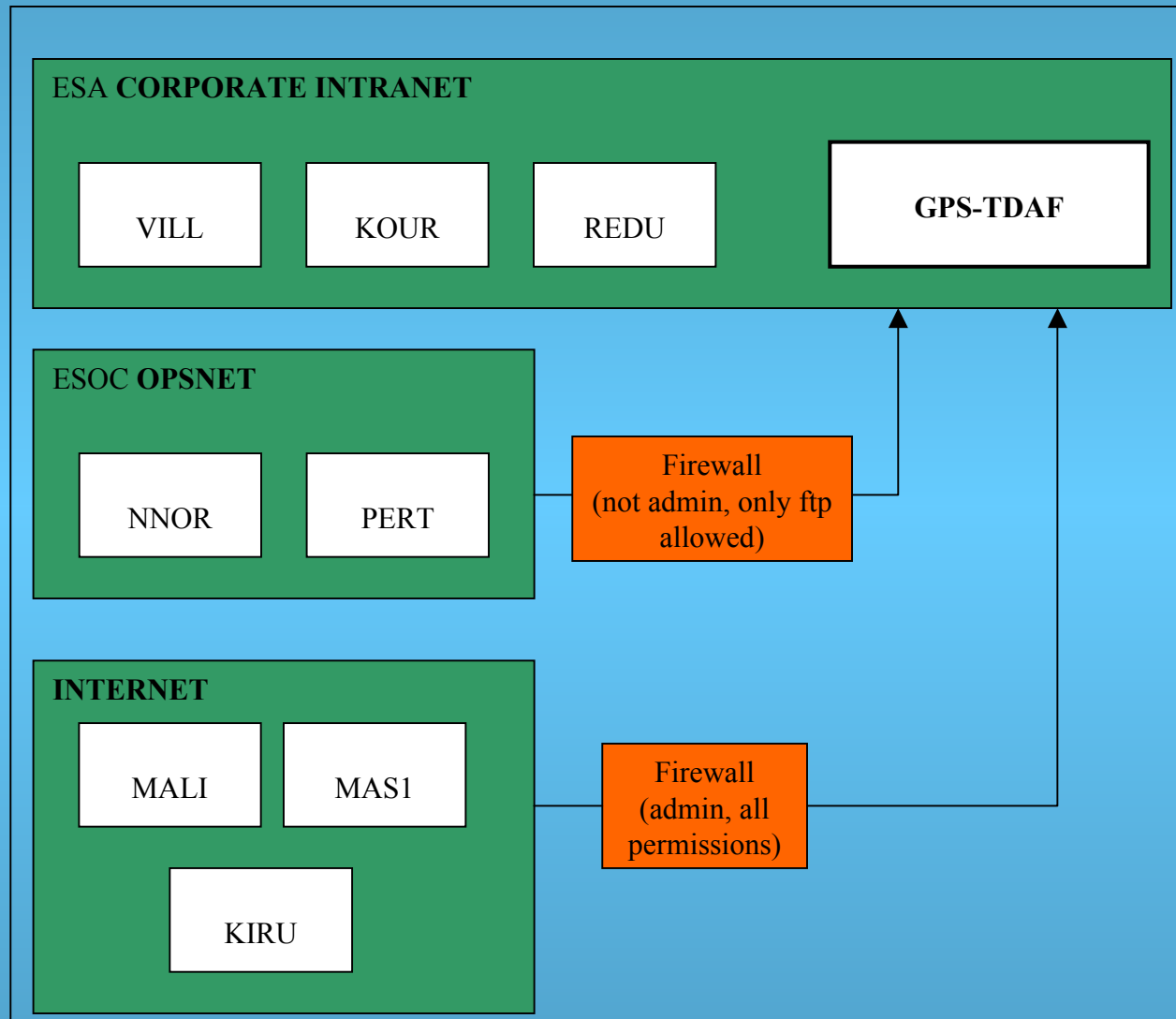
Remote station computers

- At every station:
 - One Linux computer. Good for streaming.
 - One Windows computer with Unix emulator. To support the software of the manufacturer. Being replaced by second Linux computers.
- Both with same functionality regarding data transmission, being warm back-ups from each other.
- Both connected to the same station LAN and to one serial port of the receiver.

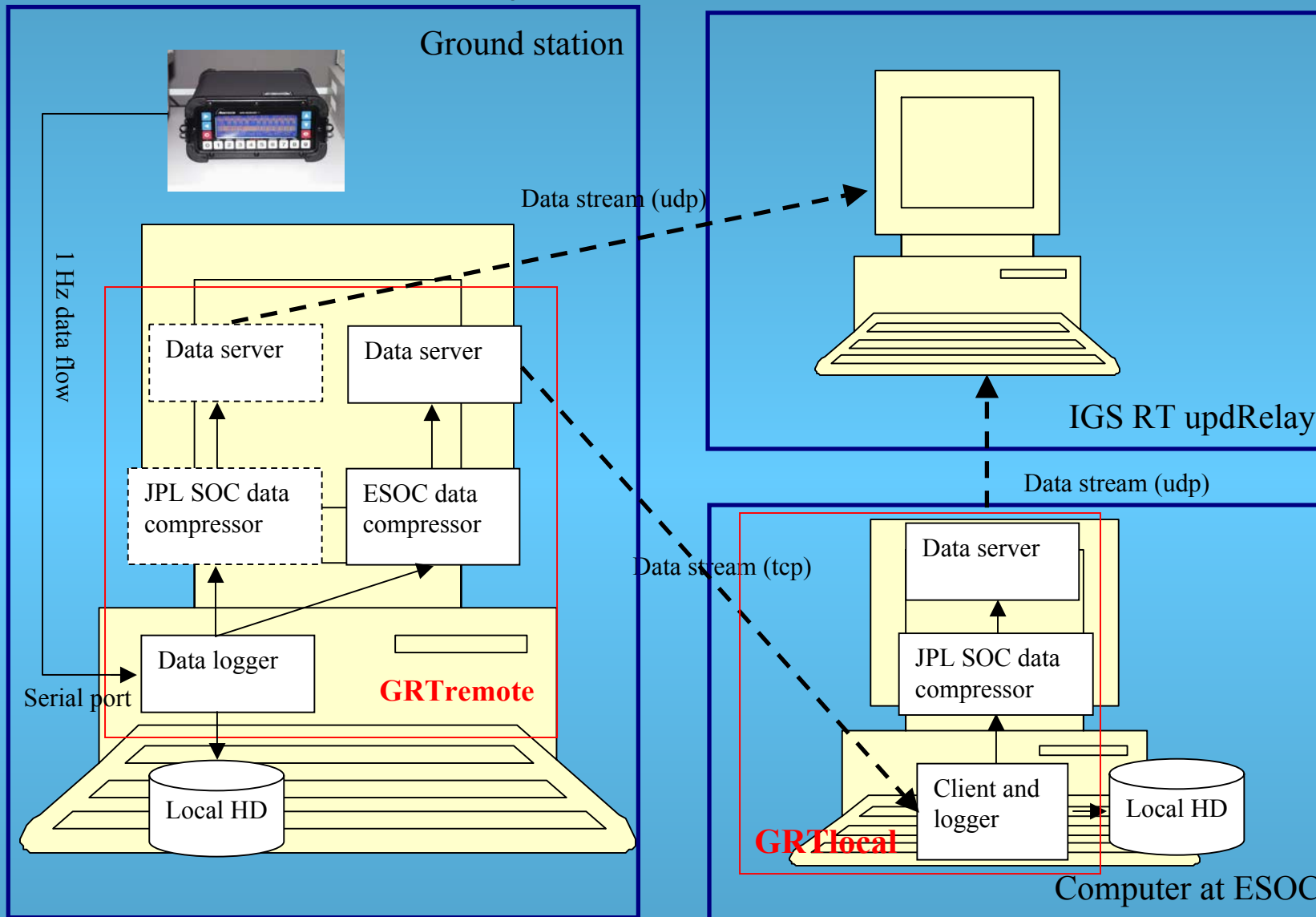
Communications

- Migration to IP communications completed:
 - ESA Intranets
 - OPSNET
 - Corporate office LAN
 - Internet
 - Permanent
 - Dial-up (not for data streaming)
- Modems available at most of the stations.

ESA/ESOC Network configuration



Real time system architecture



Real time data transmission software

- Developed at ESOC for receivers supporting NMEA
- Made up of:
 - GRTremote for remote stations.
 - Data reading from the receiver serial port.
 - Compression.
 - Sending to the network sockets and to the local disk.
 - GRTlocal at ESOC.
 - Data reception from the network.
 - Uncompression.
 - Splitting into files in the local disk.
 - IGS plug-in routines provided by NRC (IGS RT WG) for data dissemination to IGS real time project.

GRT main features (I)

- Coded in ANSI C
- Supports the standard NMEA format
- Multiplatform support:
 - PC
 - Sun
- Multi-Operating System support:
 - Windows (gcc Unix emulation)
 - Linux (gcc)
 - Solaris (cc)

GRT main features (II) - Compression

- Developed due to the lack of a standard in 2003.
- Data compression based on **removal of empty fields, not used information** and **n-th differentiation**
- After compression the data stream is around 30% of the original. A typical stream of a single receiver is reduced from 10 kbps to **3 Kbps**.
- IGS (JPL SOC) real time format will be used in the future if it is adopted as IGS standard.

ESOC real time format (for MPC NMEA)

Type	Size original (bytes)	Content	Existing in compressed format	Size compressed (bytes)
char	11	Header = \$PASHR, MPC	YES	2
Unsigned short	2	Sequence tag	YES (*)	
Unsigned char	1	Number of remaining for current epoch	NO	
Unsigned char	1	PRN	YES	1
Unsigned char	1	elevation	NO	
Unsigned char	1	azimuth	NO	
	1	Channel id	NO	
C/A code data block (29 bytes)				
Unsigned char	1	Warning flag	YES	1
Unsigned char	1	Quality of the pos measurement	NO	
char	1	Set to 5 for backwards compatibility	NO	
Unsigned char	1	SNR	YES	1
Unsigned char	1	Spare	NO	
double	8	Phase in cycles	YES	2
double	8	Raw range in seconds	YES	2
long	4	Doppler (10-4 Hz)	YES	2
long	4	Smooth correction	NO	
	(29)	P code on L1		8
	(29)	P code on L2		8
Unsigned char	1	checksum	YES (**)	
Unsigned char	-	Compression sequence counter for each measurement	YES	9
Total bytes	106			36

GRT main features (III)-Network

- **Data buffering using tcp** in case of communications link interruption. Amount of buffered data is configurable. In case of long link downtimes the retransmission of data is based on RINEX Hatanaka compressed files **via ftp** (more effective compression and it does not affect the RT stream).
- **Client and server interchangeable** at local or remote site for better Firewall handling and usage of public servers.
- If the server is at the remote station **several clients** can be served. The **data are stored at the remote stations** for the case that transmission in files is needed.

GRT main features (IV)-Network

- Current prototype is based on **TCP**.
Emphasis in getting 100% of 1 Hz data. It is adequate for the reliable IP lines to the ESA stations.
- **UDP** being tested in Malindi (bandwidth restrictions)
- Receiver smoothed or not smoothed data can be transmitted by the remote station.

Real time performance

- Real time data availability (1 Hz)

DOY 057/2004

	kiru	kour	mali	mas1	nnor	pert	vill	redu
% data	100%	97%	96% (temporary bandwidth limitations)	95%	100%	100%	98%	97%

Data distribution to IGS

- The real time data are collected at ESOC where they are:
 - Decompressed
 - Quality checked
 - Reformatted to RINEX
 - Hatanaka-compressed
 - Archived in files
 - Disseminated to IGS
- All kinds of IGS data files are supported:
 - Real time (currently kiru, mali, mas1)
 - 15 min 1 Hz files (all stations)
 - Hourly 30 seconds files (all stations)
 - Daily 30 seconds files (all stations)

Plans for the future

- Integration of KOU1 (Topcon GPS + GLONASS) in the real time network. Currently daily 30 seconds.
- Improved handling of retransmissions.
- Extended cooperation with IGS. To facilitate data exchange use of standard:
 - format
 - compression algorithm
 - applications