

ARPEGE ISIS-4G/IRIS-4G/IRMA-4G Satellite Monitoring System

Retrieval of information from ACeS/ISAT satellite communications system (GMR-2)



A Rohde & Schwarz Company



ARPEGE ISIS-4G/ IRIS-4G/IRMA-4G Satellite Monitoring System

The ARPEGE ISIS-4G/IRIS-4G/IRMA-4G satellite monitoring system enables the passive monitoring and analysis of communications sessions of the ACeS and ISAT satellite communications systems via the air interface.

The GMR-2 satellite monitoring system includes three main system components and the ARPEGE monitoring center:

- | ARPEGE ISIS-4G monitors the telephone activities within the GMR-2 satellite global beam. ARPEGE ISIS-4G is part of the central station
- | ARPEGE IRIS-4G monitors active GMR-2 mobile phone contents within the GMR-2 satellite global beam (C-band-only). Duplex phone contents are available within a range of approx. 1000 kilometers from the monitoring site. ARPEGE IRIS-4G is part of the central station
- | ARPEGE IRMA-4G monitors active GMR-2 mobile phone contents outside the ARPEGE IRIS-4G system's two-way coverage area. ARPEGE IRMA-4G is part of the remote sensor station
- | The ARPEGE monitoring center is usually located near the central station. Operators there analyze the intercepted GMR-2 activities and communications contents

The modular system concept allows information to be captured with and without call contents (traffic channels) monitoring.

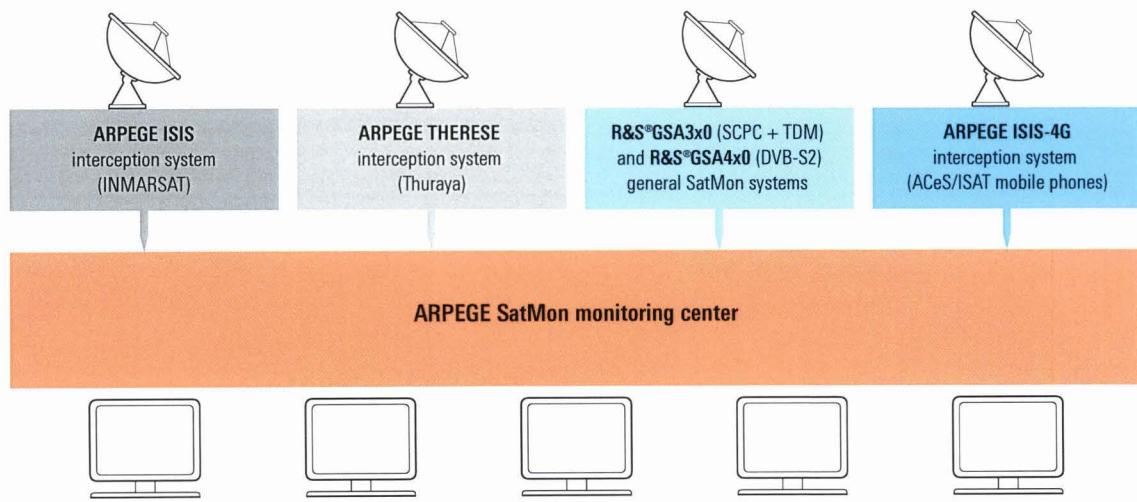
Without call contents monitoring, the system supplies statistical information about the IMSIs of active GMR-2 mobile phones in GMR-2 spot beams. With call contents monitoring, the system provides identifying characteristics of the calling and the called subscribers, as well as intercepted contents, e.g. voice, fax or data. The information thus gained can be processed, analyzed and forwarded to the customer by means of the ARPEGE monitoring center.

The ARPEGE ISIS-4G/IRIS-4G/IRMA-4G satellite monitoring systems are part of the SatMon system family from ARPEGE (see figure below).

Key facts

- | Satellite monitoring system for GMR-2 footprint areas (ACeS over Garuda-1 and ISAT over I-4 INMARSAT satellites)
- | Two-way contents monitoring in areas outside range of central station by means of remote sensors
- | Display of telephone activities in spot beams on electronic map
- | Contents analysis and network analysis by means of ARPEGE monitoring center software
- | Modular, scalable system configuration
- | Sustained system concept: universal hardware platform for implementing various SatMon systems, and comprehensive system health monitoring

Overview of satellite monitoring systems



ARPEGE ISIS-4G/ IRIS-4G/IRMA-4G Satellite Monitoring System

**ARPEGE ISIS-4G – determining GMR-2 activities
and identifying areas of interest**

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**ARPEGE IRIS-4G/ARPEGE IRMA-4G – monitoring
GMR-2 contents**

- Interception of duplex traffic with a central station
- One-way interception of transmissions in remote regions without deploying a remote sensor
- Interception of duplex traffic in remote regions by deploying remote sensors

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**Seamless intelligence by reconstructing intercepted
GMR-2 data**

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Monitoring fax and data communications

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**Convenient, subscriber-oriented analysis with the
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Safe investment due to sustained system concept

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Introduction

GMR based mobile radio systems

GMR is an ETSI standard and stands for "GEO mobile radio interface". Many parts of the GMR standard are derived from the GSM standard.

Three satellite systems run GMR-based radiocommunications systems: Thuraya, ACeS (Asia Cellular Satellite System) and ISAT. Thuraya is based on the GMR-1 standard, which is not discussed in this document. For more information about the Thuraya system, refer to the ARPEGE EDITH/THERESE/MARTHE product brochure. ACeS and ISAT are based on the GMR-2 standard.

ACeS is a company headquartered in Indonesia and operates one satellite (Garuda-1). The coverage area includes Indonesia, Malaysia, Thailand, Vietnam, China, India and parts of Pakistan. In 2006, ACeS entered into a collaboration agreement with INMARSAT, a satellite telecommunications company based in Great Britain. INMARSAT runs the ISAT mobile radio system and operates three 4th generation satellites (I-4 EMEA, I-4 APAC, I-4 Americas), which provide GMR-2 service. Currently, I-4 EMEA and I-4 APAC provide ISAT service in Africa, the Middle East, Asia and Europe.

The GMR-2 system enables voice, fax and data communications. Voice traffic accounts for the largest part of all GMR-2 communications.

GMR-2 mobile phones are only slightly larger than conventional GSM mobile phones. GMR-2 mobile phones operate in dual mode: If a GSM network is available, it is used to set up a call; otherwise, a call is established via a GMR-2 satellite. However, subscribers can force a connection via satellite even if a GSM network is available.

The geosynchronous satellites provide coverage for mobile communications via a large number of spot beams. Communications within a spot beam take place in the L band. Communications between the satellite and the gateway stations take place in the C band in the global beam and can thus be monitored from any location within the GMR-2 satellite's footprint area.

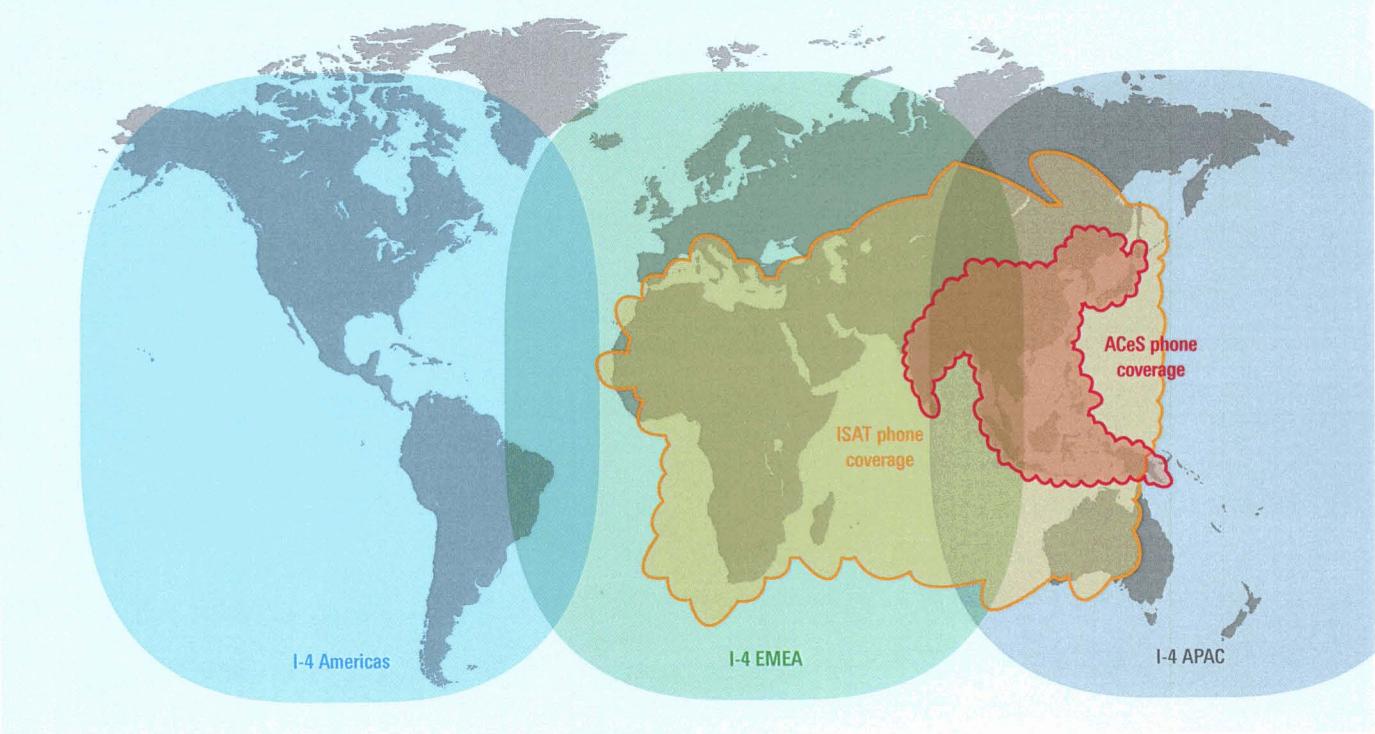
Aspects of radiomonitoring

Similar as in GSM networks, the traffic channels and most signaling channels are encrypted in the GMR-2 system. For contents analysis, captured traffic needs to be decoded first.

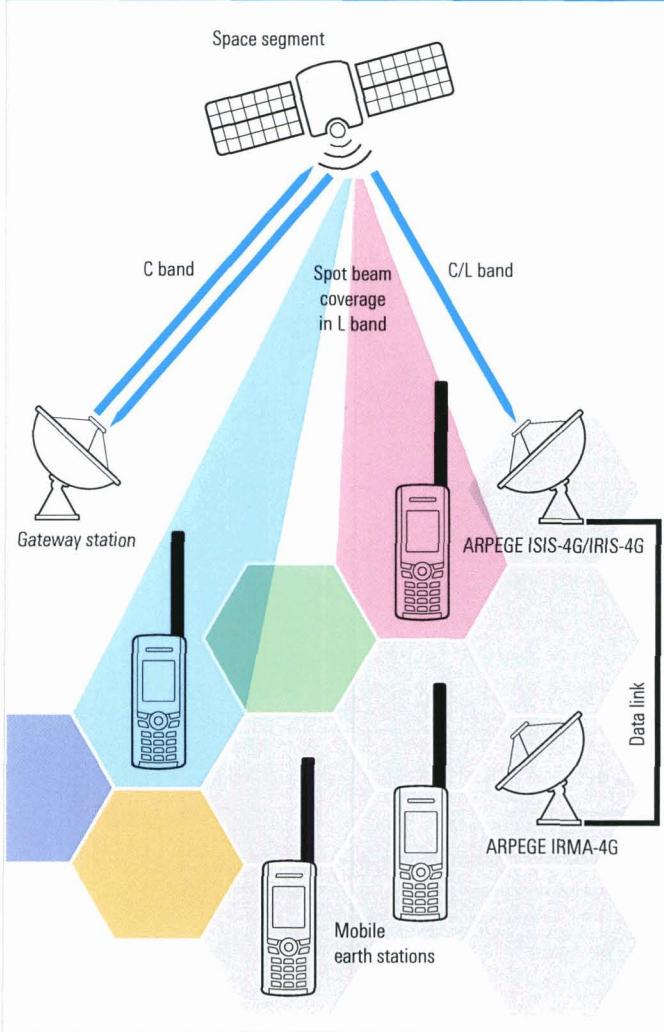
ARPEGE ISIS-4G monitors communications in the C band from any location within the GMR-2 satellite's footprint area.

ARPEGE IRIS-4G and ARPEGE IRMA-4G capture traffic channels (voice, fax, data) and identifying call characteristics.

GMR-2 coverage areas



Communications via GMR-2 satellite



Monitoring range

Similar to the terrestrial GSM, the GMR-2 system uses the same radio frequencies in different spot beams (frequency reuse). As an inherent feature of the GMR-2 system, two-way interception of traffic channels is possible only in a limited number of spot beams around the site of the monitoring system. Two-way interception means the reception and processing of the incoming (forward link) and outgoing (return link) radio signals (each from the perspective of the GMR-2 subscriber). The two-way interception range depends on the areas covered by the spot beams and on the distance between spot beams using the same frequency and timeslots. Outside the two-way interception range, a central station (ARPEGE IRIS-4G) intercepts and processes the return links (outgoing voice, fax and data) for a specific number of spot beam areas. Remote L band sensors (ARPEGE IRMA-4G) intercept the forward link on site, thus expanding the two-way interception range of the monitoring system.

As a basic rule, duplex communications can be intercepted in the spot beam in which the monitoring system is located. Plus, duplex communications can be intercepted in some spot beams adjacent to the center spot beam depending on the allocation of frequencies and timeslots.

The figure on the lower left shows as an example the coverage provided by a Korean-based ARPEGE IRIS-4G system.

Neighboring spot beam clusters can use the same frequencies without interfering with one another. Spot beams that use the same frequency can be successfully intercepted by one monitoring station due to the use of different timeslots. Typically, the spot beams in question differ in signal power. The stronger signal will be intercepted; the weaker signal will be lost.

A preliminary site survey is recommended in order to measure the actual coverage provided by the relevant spot beams (spot beam visibility). This, in turn, will help to determine the monitoring coverage provided by ARPEGE IRIS-4G.

ARPEGE ISIS-4G – determining GMR-2 activities and identifying areas of interest

Principle of operation

Each activity of a mobile phone in the GMR-2 system starts with some bursts that are transmitted over the standalone dedicated control channel (SDCCH). This feature has been adopted from the GSM standard, though the GMR-2 SDCCH burst's structure is different from that of the corresponding GSM burst.

An SDCCH channel is established for each traffic channel in a spot beam for one of the following reasons, for example:

- The subscriber initiates a call (mobile-originated call)
- The subscriber accepts a call (mobile-terminated call)
- For technical reasons (location update, etc.), without any activity on the part of the subscriber

SDCCH bursts are transmitted from the mobile phone to the satellite in the L band. Signal interception takes place in the C band, i.e. in the downlink from the satellite to the gateway station.

It must be taken into account, however, that there is no fixed mapping of the traffic channel of a spot beam in the L band uplink to frequencies in the C band downlink. Instead, frequency mapping may be changed without notice. For the monitoring system, this means that all SDCCH channels of the GMR-2 satellite system have to be intercepted simultaneously, even if the area of interest may be limited.

The required monitoring bandwidth may vary depending on the type of satellite being monitored (ACeS or INMARSAT). ARPEGE ISIS-4G provides full-band activity detection for ACeS monitoring. For GMR-2 activities over INMARSAT satellites, which operate in a wider frequency range, ARPEGE ISIS-4G needs to be expanded to provide full-band activity detection (ARPEGE ISIS-4G + ARPEGE ISIS-4G-X).

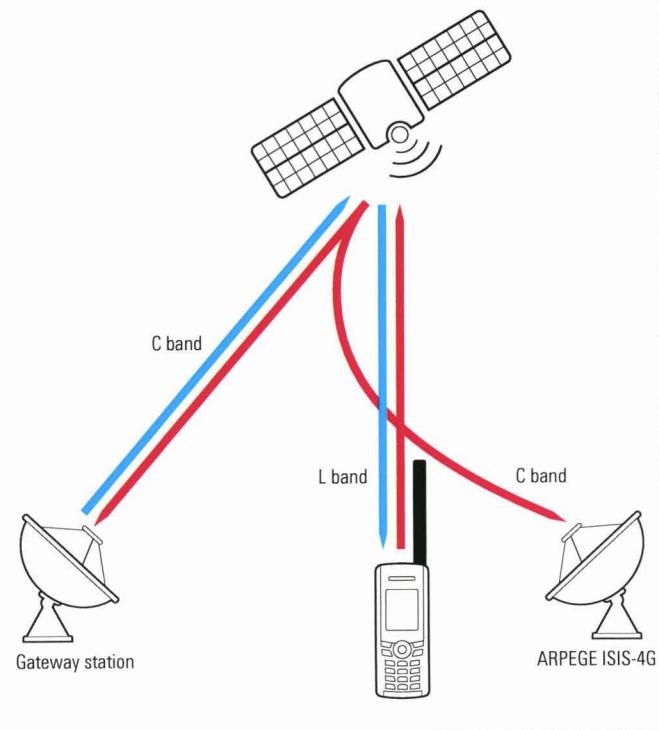
ARPEGE ISIS-4G receives the GMR-2 signal from a tracking parabolic antenna for the C band that converts the signal to the L band. The figure opposite shows the operating principle of the ARPEGE ISIS-4G satellite monitoring system in a simplified manner.

System structure

The ARPEGE ISIS-4G satellite monitoring system contains the following components:

- L band downconversion to the IF
- Wideband digitizing and signal processing unit including SDCCH burst detection
- SDCCH burst analyzers
- Sensor server
- Analysis and statistics workstation

Operating principle of the ARPEGE ISIS-4G satellite monitoring system



Functional description

The global beam of the GMR-2 satellite is received in the C band with a parabolic antenna. The GMR-2 frequency band is downconverted by means of multiple downconverters. The required number of downconverters and corresponding processing units depends on the type of satellite being monitored (ACeS or INMARSAT).

The required antenna size depends on the location of the ARPEGE ISIS-4G monitoring system. Antenna diameters in the order of seven to nine meters are appropriate.

After conversion to the L band, the signals are transmitted to the building that houses the central station of the monitoring system. Long distances of more than 100 m between the antenna and this building can be bridged by using fiber-optic cables.

The described system configuration is dimensioned to monitor signals from one satellite. To monitor several GMR-2 satellites simultaneously, multiple sets of equipment must be used.

The signals are digitized and searched in realtime for SDCCH bursts. Detected bursts are marked and transferred to one of the SDCCH burst analyzers.

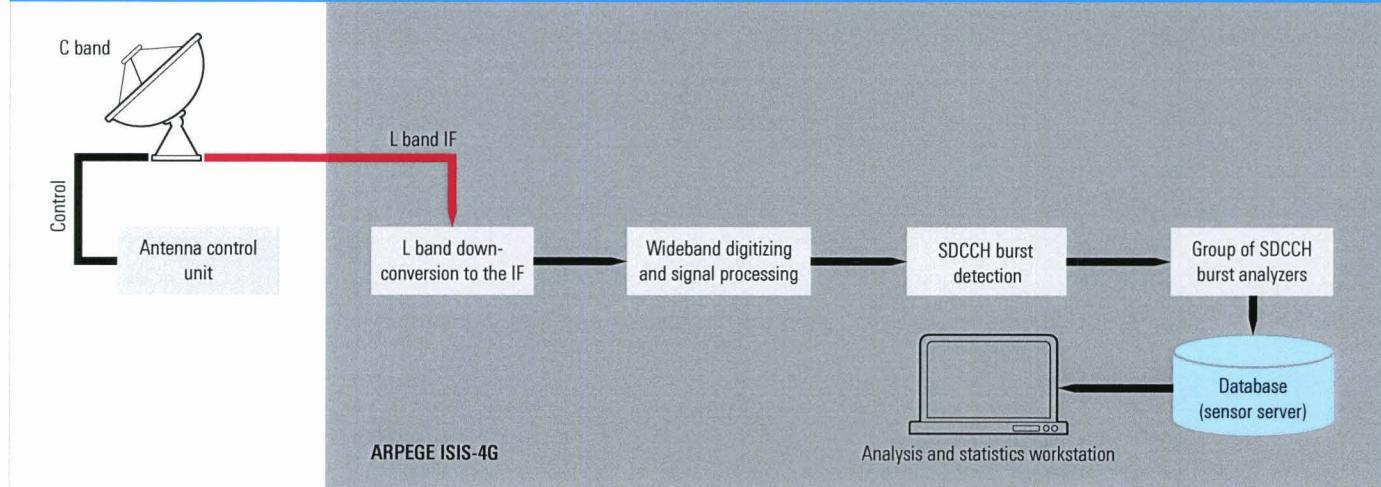
The SDCCH analyzer demodulates and decodes the burst information. The results obtained are stored as data records in a database on the server.

A result data record is generated for each access of a mobile phone to the GMR-2 system. The data record essentially contains the following information:

- Timestamp
- Spot beam ID
- Reason for activity (e.g. mobile-originated call, response to paging, location update)
- Power class of mobile phone
- IMSI of satellite terminal (SIM card)

To visualize and analyze the stored data records, we recommend that you use the ARPEGE monitoring center (see page 15).

Simplified block diagram of the ARPEGE ISIS-4G satellite monitoring system



ARPEGE IRIS-4G/ ARPEGE IRMA-4G – monitoring GMR-2 contents

Interception of duplex traffic with a central station

Principle of operation

ARPEGE IRIS-4G is an expansion of ARPEGE ISIS-4G. Some components of ARPEGE IRIS-4G require data from ARPEGE ISIS-4G. The ARPEGE IRIS-4G modules operate on the following principle: They monitor the downlink transmissions from the satellite in the C band and in the L band. In the L band, the system receives the forward link (from the gateway station to the mobile phone); in the C band, it receives the return link (from the mobile phone to the gateway station).

In the L band, the mapping of frequencies to the spot beam footprints is stable. In the C band, by contrast, the frequency mapping may change. Based on the results obtained with ARPEGE ISIS-4G, the current frequency mapping is automatically determined. The resulting pairs of frequencies are integrated into the processing chain through digital subband selection.

The term “frequency mapping” designates the relationship between the L band uplink frequency and the C band downlink frequency for each channel. The frequency mapping can be changed by the network operator. The wideband concept of ARPEGE ISIS-4G ensures that any changes in frequency mapping will be immediately detected¹⁾.

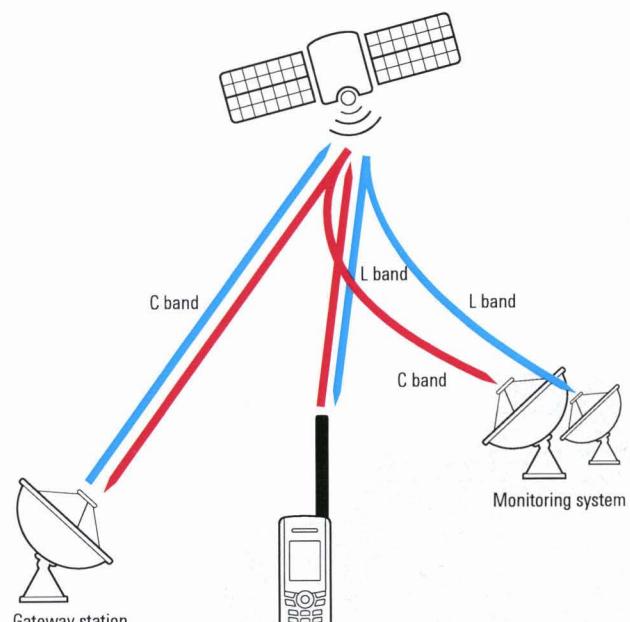
System structure

The figure on the next page (bottom) is a block diagram of an ARPEGE ISIS-4G/ARPEGE IRIS-4G satellite monitoring system. It contains the following components:

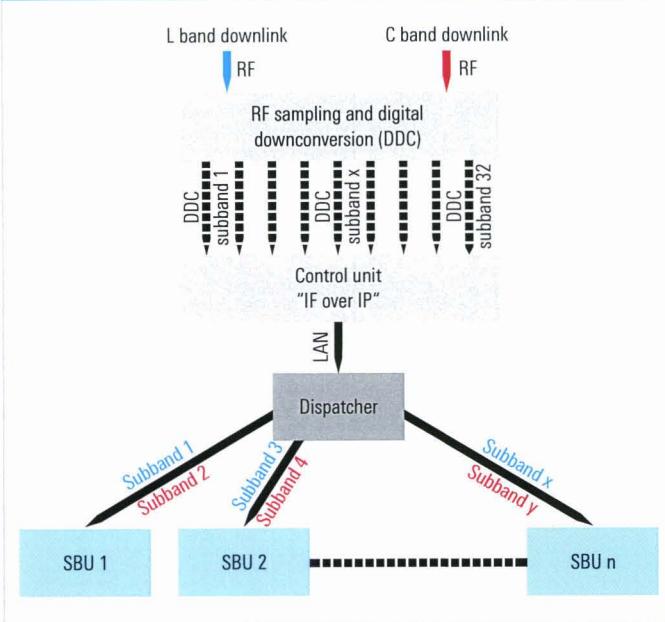
- ARPEGE ISIS-4G monitoring system including a tracking antenna for the C band (e.g. ARPEGE IM-AC)
- Fixed L band antenna (e.g. ARPEGE IM-AL)
- Subband selection unit for C band and L band signals (included in ARPEGE IRIS-4G)
- Scalable number of subband processing units (ARPEGE IRIS-SBU)
- GMR-2 source decoding (included in ARPEGE IRIS-4G)
- ARPEGE monitoring center including session server and analysis workstations

¹⁾ ARPEGE ISIS-4G provides full-band activity detection for ACeS monitoring. For GMR-2 activities over INMARSAT satellites, which operate in a wider frequency range, ARPEGE ISIS-4G needs to be expanded to provide full-band activity detection (ARPEGE ISIS-4G + ARPEGE ISIS-4G-X).

Operating principle of the ARPEGE IRIS-4G satellite monitoring system



Subband selection

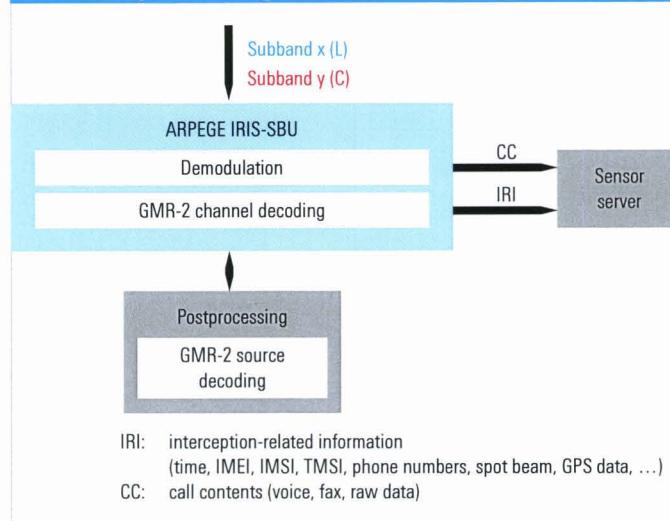


Functional description

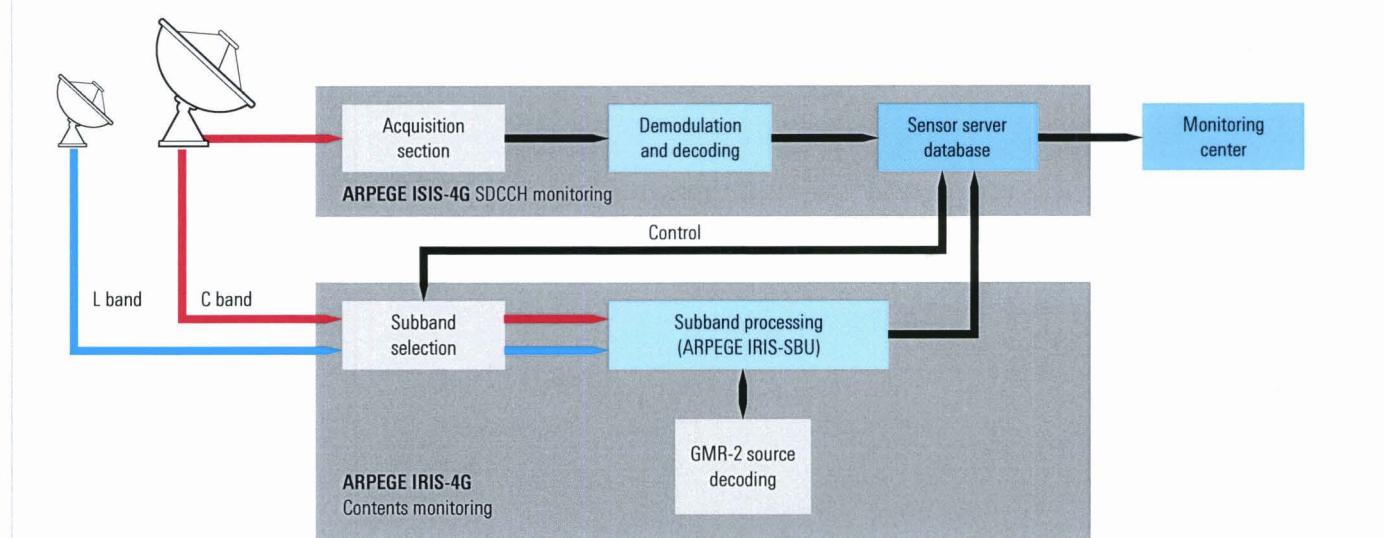
A GMR-2 subband consists of one carrier with a bandwidth of 200 kHz for the forward link (L band downlink) and four carriers of 50 kHz for the return link (C band downlink). The subbands assigned to a spot beam are digitally downconverted (DDC) and dispatched in pairs for the return link and the forward link to a subband unit (SBU) via a local area network (LAN). Each SBU can process up to four subbands per spot beam (for detailed information about subband units, refer to the specifications at the end of this product brochure).

After A/D conversion and demodulation, the relevant protocol layers are decoded and analyzed. Results are stored on the server. Depending on the selected operating mode, the system intercepts and stores all calls or only those related to specific targets (subscribers). Target/subscriber management is performed by means of the target database of the ARPEGE monitoring center.

Subband processing



Block diagram of the ARPEGE ISIS-4G/ARPEGE IRIS-4G satellite monitoring system



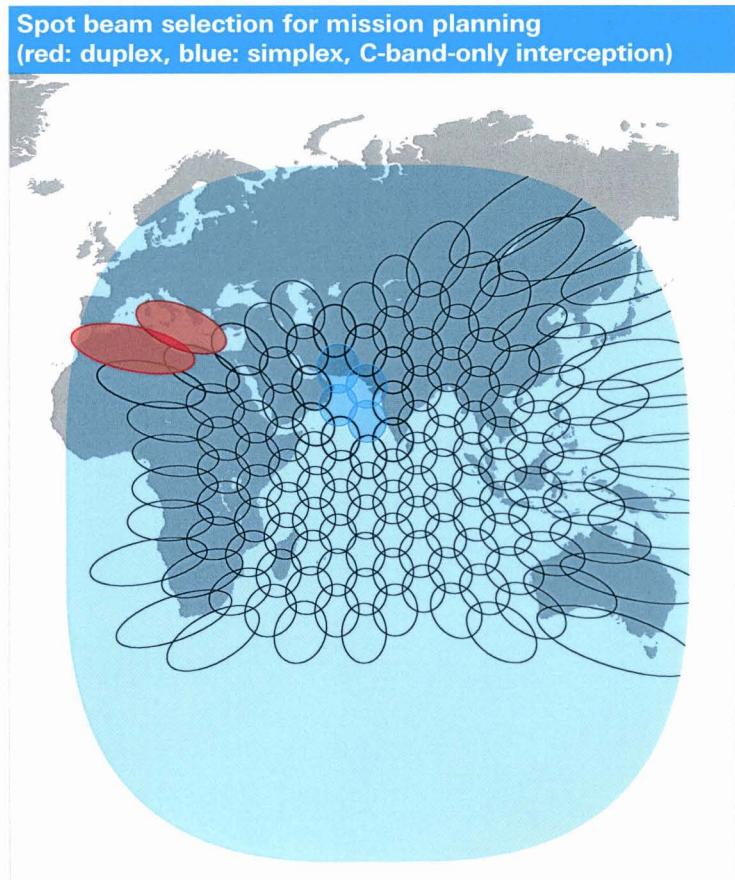
One-way interception of transmissions in remote regions without deploying a remote sensor

Principle of operation

The ARPEGE IRIS-CON C-band-only option intercepts one-way channel contents in remote areas without the use of a remote sensor. It extracts the contents from the C band signal, allowing the return link contents of any spot beam to be analyzed. It is thus possible to collect mission-relevant information immediately, i.e. without – or before – installing a semi-mobile or fixed L band sensor in the target area.

The system operator assigns C-band-only processing resources (SBUs) to spot beams of interest. Subband units in C-band-only mode make it possible to intercept contents and to locate GMR-2 subscribers with spot beam accuracy. Missions to be performed as part of new operations can, therefore, be promptly accomplished.

The figure below illustrates mission planning for ARPEGE IRIS-4G (including ARPEGE IRIS-CON). The red spot beam footprints are located near the central station, and the associated subbands are processed by subband units in two-way mode. The blue spot beam footprints are located in remote regions, and the associated subbands are processed by further subband units at the central station in C-band-only mode.



Interception of duplex traffic in remote regions by deploying remote sensors

Principle of operation

The remote satellite monitoring system intercepts down-link transmissions from the satellite in the C band at the central station (ARPEGE IRIS-4G with ARPEGE IRIS-SBU(s)). In the L band, downlink transmissions are received at one or more remote locations (ARPEGE IRMA-4G with ARPEGE IRMA-SBU(s)) that are not covered by the central station.

The operating principle of remote monitoring differs from that of central monitoring in only one aspect: The SBU subsystems for traffic channel and signaling channel interception and processing are located at different sites for the C band and the L band. The remote sensor station (ARPEGE IRMA-4G) is connected to the central station (ARPEGE IRIS-4G) via a wide area network (WAN), and is remote-controlled from the central station.

System structure

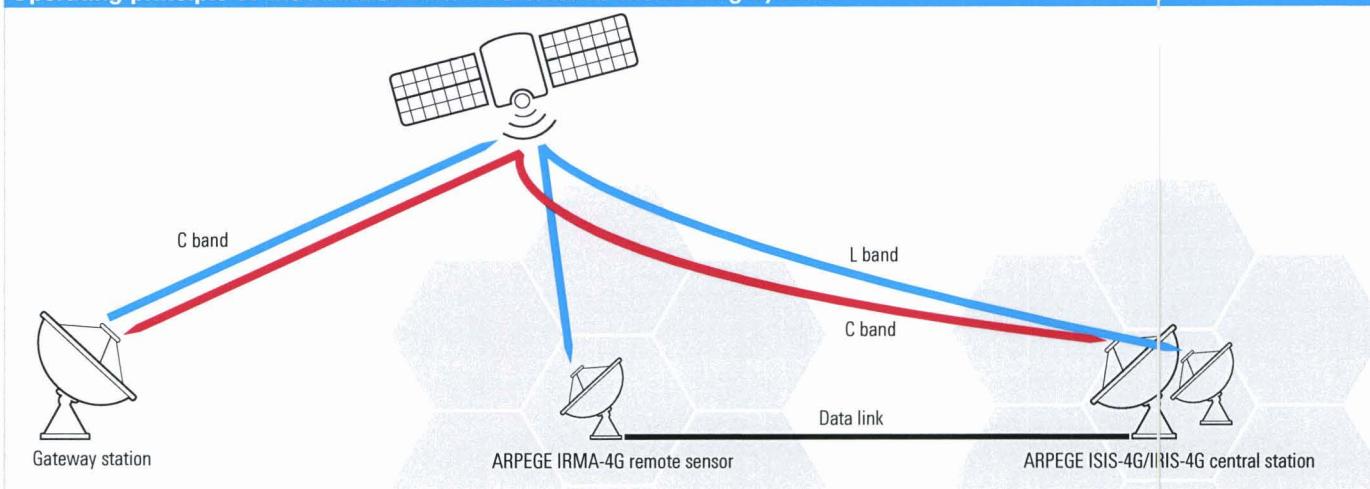
The figure below shows an ARPEGE ISIS-4G/ARPEGE IRIS-4G central station that intercepts GMR-2 duplex contents by means of an ARPEGE IRMA-4G remote sensor.

For two-way interception of voice channels, the hardware for traffic channel and signaling channel processing must be distributed symmetrically at the central station and the remote site. In other words, there must be an equal number of subband processing units (ARPEGE IRIS-SBU/ARPEGE IRMA-SBU) provided at the central station and at the remote site. This is necessary to ensure that an equal pool of resources is available to capture the forward and the return link of a voice connection.

The remote satellite monitoring system contains the following components:

- Fixed L band antenna at remote site (ARPEGE IM-AL)
- Subband selection unit for C band signals at central station (included in ARPEGE IRIS-4G)
- Subband selection unit for L band signals at site of remote sensor (included in ARPEGE IRMA-4G)
- Scalable number of subband processing units for the L band and the C band (ARPEGE IRIS-SBU/ARPEGE IRMA-SBU)

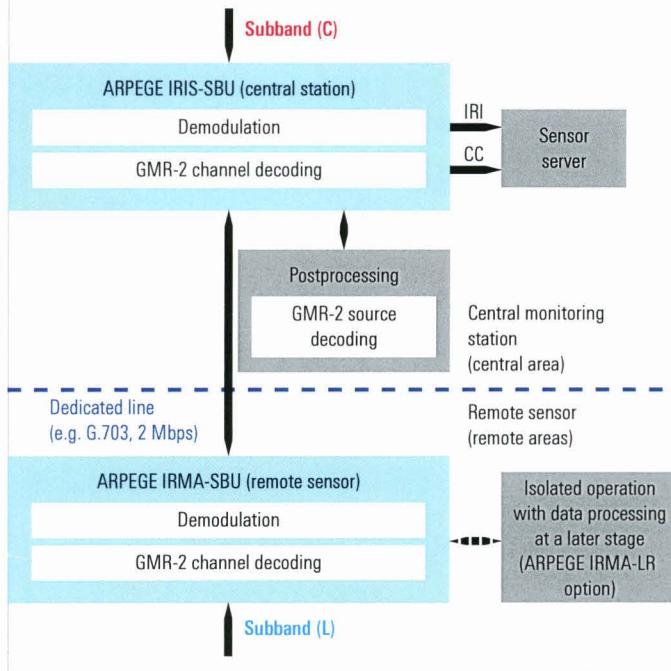
Operating principle of the ARPEGE IRMA-4G satellite monitoring system



Functional description

Subbands assigned to each other in the L band and in the C band are received at different sites. They are digitally downconverted (DDC), and each subband is dispatched via a LAN to an SBU at the respective site. The traffic channels and signaling channels are then processed in the same manner as in the ARPEGE IRIS-4G system. Each SBU can process up to four subbands (for detailed information about subband units, refer to the specifications at the end of this product brochure).

Subband processing with ARPEGE IRMA-4G



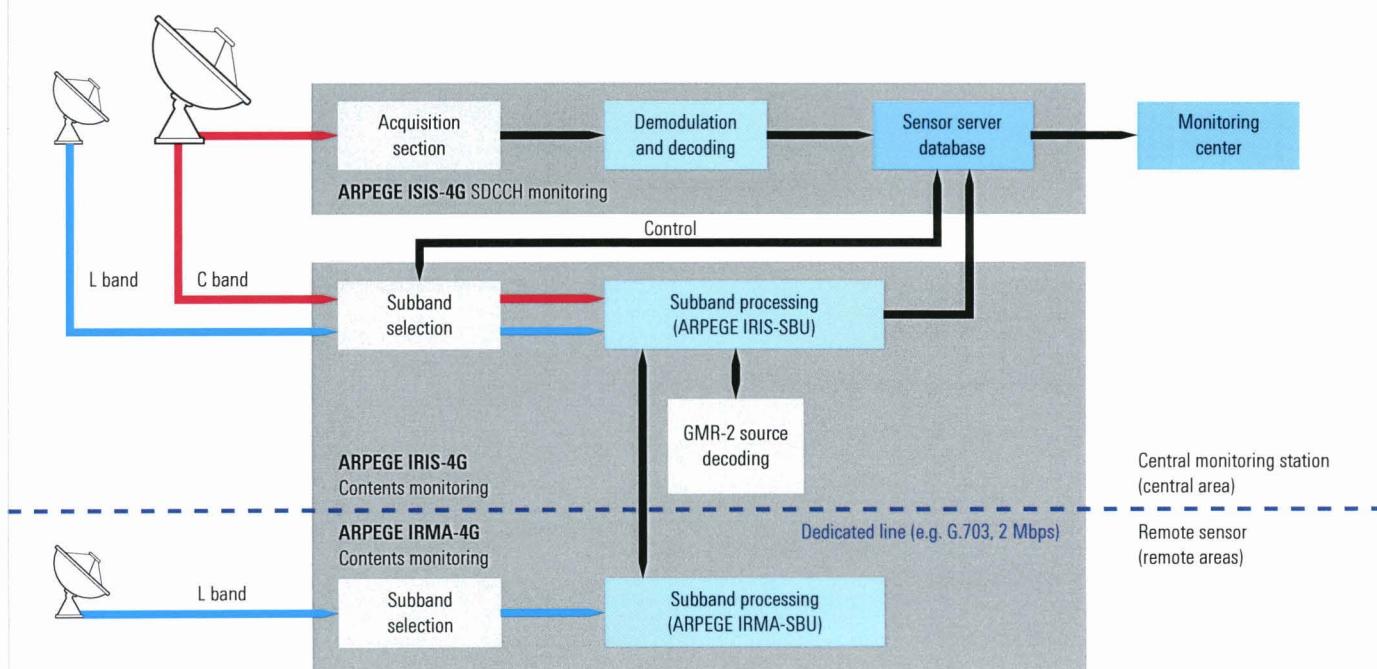
The SBUs at the central station and at the remote site are connected to one another via a WAN. This connection is used to transport encrypted and plain contents from the remote sensor to the central station. Plus, the WAN is used for configuring and controlling the remote sensor.

It is also possible to install a workstation for contents analysis at the sensor site (analysis workstation not included in ARPEGE IRMA-4G).

The monitoring system is capable of handling failures in the data transmission between the central station (ARPEGE IRIS-4G) and the remote sensor station (ARPEGE IRMA-4G). If interruptions occur, the subband units involved automatically switch to isolated operation and store the intercepted data. When the link is re-established later, the stored intercepted data is processed offline.

ARPEGE IRMA-4G supports downtimes of up to five minutes. The ARPEGE IRMA-LR option allows longer downtimes to be covered.

ARPEGE ISIS-4G/ARPEGE IRIS-4G system with an ARPEGE IRMA-4G remote sensor



Seamless intelligence by reconstructing intercepted GMR-2 data

ARPEGE IRMA-4G supports downtimes in the data transmission between ARPEGE IRIS-4G and ARPEGE IRMA-4G of up to five minutes. Longer downtimes place greater demands on memory capacity and offline processing. The ARPEGE IRMA-LR link recovery and replay option provides the customer with seamless intelligence. Even though the dedicated line between the central station and the remote sensor station in the target area may be down for several hours, the GMR-2 data intercepted during isolated operation can be reconstructed at a later time.

ARPEGE also provides custom-tailored, project-specific hybrid solutions. If the broadband dedicated line goes down, the system switches to isolated operation and can automatically establish a narrowband backup link (e.g. via VSAT or mobile radio). The resource management function transmits interception-related information (IRI) and selected call contents (CC) via the narrowband backup link. Despite the limited WAN connection, the customer can largely continue to gain intelligence about mission-relevant GMR-2 subscribers. For further information and to select the best solution, please contact our Sales department.

Monitoring fax and data communications

Fax and circuit-switched data communications account for only a small portion of all GMR-2 traffic. Subscribers need a special data cable and a PC in order to send fax or e-mail messages via a GMR-2 mobile phone.

Demodulation and channel decoding

Fax and data information is transmitted via logical traffic channels at higher data rates. The call setup procedure for fax and data transmissions is in the beginning identical to that used for voice links. At the end of the call setup procedure – i.e. after authentication – a reallocation to traffic channels with a higher transmission rate takes place. Compared with logical voice channels, the decoding of fax and data channels requires twice or three times the amount of resources.

Source decoding

Intercepted fax data is converted to a readable picture format (source decoding). For data links, intercepted binary data is analyzed by means of a data decoder and represented in a suitable format.

The optional ARPEGE IRIS-DAF data and fax expansion includes all components necessary to intercept fax and data traffic, i.e.:

- | Channel decoder software for SBUs
- | Data decoder for decoding data traffic
- | GMR-2 fax source decoder

Convenient, subscriber-oriented analysis with the ARPEGE monitoring center

GMR-2 activity analysis software

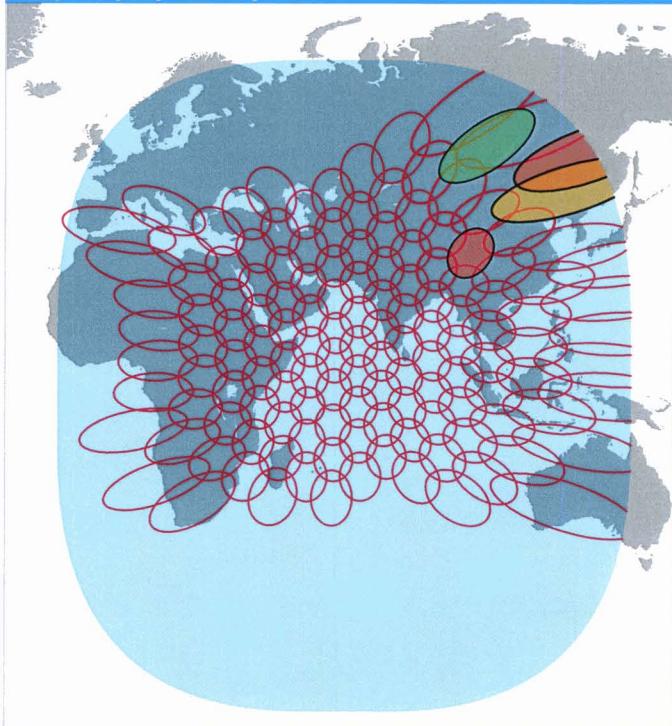
The data stored in the database is subjected to extensive analysis using the system-specific software. Analysis can be carried out according to spot-beam-specific or time criteria, and can also be correlated with information gained from other sources. Operators can use predefined filters or generate database queries of their own using a convenient input mask. Results are displayed in a table and/or graphically on a digital spot beam map. A number of tools are available to help operators configure and operate the system in line with their specific requirements, thus optimizing work efficiency. The various events displayed on the map are assigned different colors and symbols, which can be configured by the operator.

The operator can define alarm criteria, e.g.:

- Calls from a specific area (GMR-2 spot beam)
- Specific IMSI activity

The map display can be filtered according to a variety of criteria. The operator can choose between a global display and the display of an operator-defined region. Zoom functions are also available. Additional information can be called up for each region on the map by selecting the specific spotbeam.

Map display (example)



Activities during last hour

More than 50 calls
Between 11 and 50 calls
Between 1 and 10 calls

Activity monitoring – list of results (example)

Spot beam	Date/time	Type of activity	IMSI	RF power
105	21/10/2008 09:05:10	Location update	5151110100	Class 3
105	21/10/2008 09:03:27	Mobile-originated call	5151110100	Class 3
105	21/10/2008 09:00:11	Location update	5151110100	Class 4
105	21/10/2008 08:50:55	Mobile-originated call	5151110100	Class 3
105	21/10/2008 08:48:13	Response to paging	5151110100	Class 3
105	21/10/2008 08:40:03	Location update	5151110100	Class 2
105	21/10/2008 08:27:47	Response to paging	5151110100	Class 2
105	21/10/2008 08:10:10	Mobile-originated call	5151110100	Class 3

Operational concept for contents analysis

The supervisor defines the spot beams that are to be further processed. The spot beams are selected from an electronic map that displays the spot beam footprints. Mission-relevant GMR-2 session contents are stored on the session server, which is part of the ARPEGE monitoring center. The monitoring center software offers tools and functions supporting the following operations for strategic contents analysis:

- Tasking
- Processing
- Analysis
- Reporting

Operators administrate the object data of subscribers of interest in the target database as required for the mission to be performed. To identify new subscribers, all calls can be stored in the session database in the open-channel mode. The database application allows calls to be filtered, e.g. according to specific areas, area codes, telephone numbers, identities (IMEI, IMSI) and other GMR-2-specific parameters. Any combination of filter criteria can be used. The session database automatically assigns sessions to specific operators, who are defined in the target database. The operators assess the recorded information and, if appropriate, generate reports, or log calls in the subscriber history lists in the target database. Evaluators can display the spot beams in which GMR-2 subscribers are active on an electronic map.

Components of contents analysis subsystem

Contents analysis is performed by means of the following components:

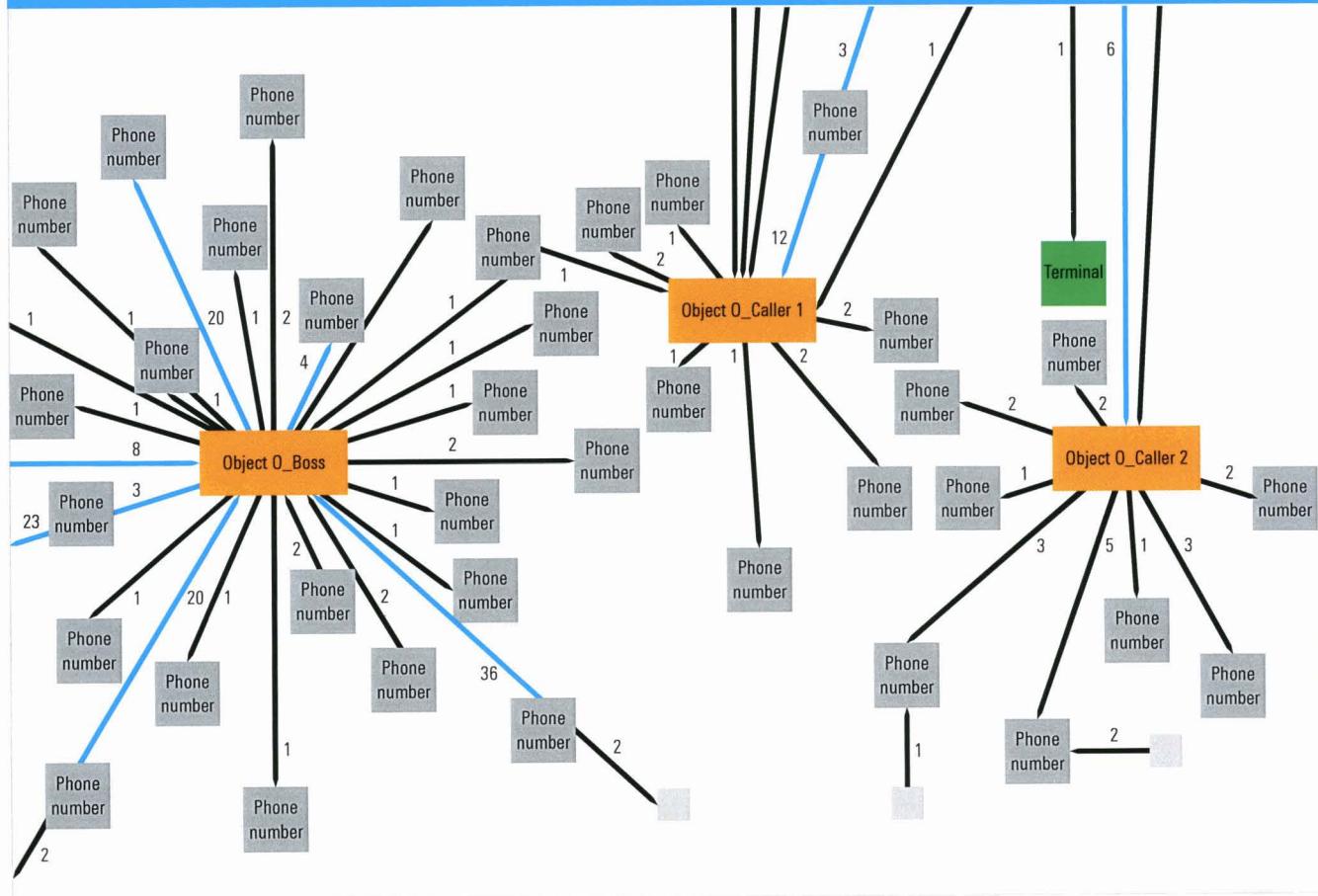
- Session server with mass memory and ARPEGE monitoring center (redundant session server system optionally available on request)
- Workstations for GMR-2 mobile activity analysis (one workstation included in ARPEGE ISIS-4G)
- Workstations for GMR-2 contents analysis

The workstations for contents analysis are suitable for users operating at different hierarchical levels and handling different tasks. Access rights and security levels can be individually defined and administrated by means of the integrated user management. The number of workstations can be scaled to customer's requirements.

Network analysis

The ARPEGE monitoring center software includes analysis tools that support evaluators in determining relationships between subscribers that are difficult to recognize in the result lists produced by a database query. The identification of communications between subscribers is based on phone numbers and on GMR-2-specific identities, see figure "Network analyzer viewer (example)".

Network analyzer viewer (example)



Safe investment due to sustained system concept

The rapid advances in satellite communications and the relatively short life cycles of satellite services require economic and future-ready interception concepts also in the area of satellite intelligence (SatInt). Satellite operators implement new services by means of firmware updates of their satellites (space segment). Plus, new services converge to yield uniform procedures and standards (spot beam technology, FDMA, TDMA, DAMA).

The principles for monitoring and intercepting the various types of GMR-based systems are nearly identical. The ARPEGE ISIS-4G/IRIS-4G/IRMA-4G GMR-2 satellite monitoring systems therefore use a universal hardware platform. An existing GMR-2 monitoring system can be expanded to include a Thuraya (GMR-1) monitoring system by adding nearly the same hardware components as used in the existing system. Comprehensive SNMP-based system management and health monitoring supplement cross-system servicing and monitoring of the system software and hardware.

System overview

The ARPEGE ISIS-4G/IRIS-4G/IRMA-4G satellite monitoring system includes the following components:

- ARPEGE ISIS-4G ACeS/ISAT activity monitoring system
- ARPEGE IRIS-4G ACeS/ISAT contents monitoring system (requires ARPEGE ISIS-4G)
- ARPEGE IRMA-4G remote ACeS/ISAT contents monitoring sensor
- ARPEGE IRIS-SBU/ARPEGE IRMA-SBU ACeS/ISAT subband unit (suitable for use with ARPEGE IRIS-4G and ARPEGE IRMA-4G)
- ARPEGE IRIS-CON ACeS/ISAT C-band-only option (for one-way interception of traffic in remote spot beams without a remote sensor)
- ARPEGE IRIS-DAF ACeS/ISAT data and fax option
- ARPEGE IRMA-LR ACeS/ISAT link recovery and replay option
- ARPEGE IM-AC C band antenna system
- ARPEGE IM-AL L band antenna system

ARPEGE ISIS-4G and ARPEGE ISIS-4G-X

The required monitoring bandwidth may vary depending on the type of satellite being monitored (ACeS or INMARSAT). ARPEGE ISIS-4G provides full-band activity detection for ACeS monitoring. For GMR-2 activities over INMARSAT satellites, which operate in a wider frequency range, ARPEGE ISIS-4G needs to be expanded to provide full-band activity detection (ARPEGE ISIS-4G + ARPEGE ISIS-4G-X).

	ISIS-4G	ISIS-4G + ISIS-4G-X
C band/L band frequency mapping for ACeS	•	•
C band/L band frequency mapping for INMARSAT	•	•
Full-band activity monitoring for ACeS	•	•
Full-band activity monitoring for INMARSAT	–	•

ISIS-4G/ISIS-4G + ISIS-4G-X

Feature	Working principle
Activity monitoring	Interception of SDCCH contents of a satellite footprint by means of wideband concept
Determination of uplink/downlink frequency mapping	0 s to 5 s (the actual time needed is a stochastic value)

Information provided by ARPEGE ISIS-4G:

- Timestamp
- Spot beam ID
- Reason for activating the mobile phone (e.g. mobile-originated call, response to paging, location update)
- IMSI of satellite terminal (SIM card)

ARPEGE IRIS-4G/ARPEGE IRMA-4G

Information additionally provided by ARPEGE IRIS-4G/ARPEGE IRMA-4G (as compared to ARPEGE ISIS-4G):

- | Called telephone number (mobile-originated call)
- | Caller's telephone number (mobile-terminated call)
- | Identifying characteristics, e.g. IMEI of mobile phone, IMSI of SIM card
- | Recorded call contents, e.g. voice, fax or data

The RF frontend of ARPEGE IRIS-4G has the type designation ARPEGE IRIS-CL and supports the processing of up to 32 subbands of the GMR-2 system by means of digital downconversion (DDC). ARPEGE IRIS-CL has 24 unused slots for ARPEGE IRIS-SBU subband units. The configuration depends on requirements (two-way interception or one-way interception).

See also section "System configuration – example".

The RF frontend of ARPEGE IRMA-4G has the type designation ARPEGE IRMA-L and supports the processing of up to 32 subbands of the GMR-2 system by means of digital downconversion.

ARPEGE IRMA-L has 12 unused slots for ARPEGE IRMA-SBU subband units. The use of more than 24 (12) SBUs in ARPEGE IRIS-4G (ARPEGE IRMA-4G) is possible. The number of digitally downconvertable (DDC) subbands per frontend is scalable (expandable). Please contact our Sales department.

ARPEGE IRIS-4G/ARPEGE IRMA-4G supports downtimes of the WAN between the central station and the remote sensor station of up to five minutes. Longer interruptions are covered by the ARPEGE IRMA-LR option.

ARPEGE IRIS-SBU/ARPEGE IRMA-SBU GMR-2 subband unit

Supports GMR-2 subband processing:

- | Two-way interception in standard mode (requires two DDCs per SBU)
- | One-way interception in remote mode (requires one DDC per SBU)

Processes all logical subband channels (SCH, BCCH, AGCH, SDCCH, SACCH).

Channel capacity is typically 32 voice channels, or up to 40 voice channels in the case of multiple subbands within a GMR-2 spot beam. The monitoring of GMR-2 hot spots is supported. Please contact our Sales department.

ARPEGE IRIS-SBU/ARPEGE IRMA-SBU

Feature	Value
Spot beams per SBU (standard or remote mode)	1
Subband processing capacity per SBU	up to 4 subbands per spot beam
Sessions/channels per subband	up to 40 (32 typical)

ARPEGE IRIS-CON GMR-2 C-band-only

Enables any ARPEGE IRIS-SBU subband unit to be operated in C-band-only mode. This mode allows one-way interception of communications in remote regions without the use of a remote sensor. ARPEGE IRIS-CON adds a third operating mode to each subband unit (ARPEGE IRIS-SBU) contained in the monitoring system. All subband units support the following modes of operation:

- | Two-way interception in standard mode (requires two DDCs per ARPEGE IRIS-SBU)
- | One-way interception in remote mode (requires one DDC per ARPEGE IRIS-SBU/ARPEGE IRMA-SBU)
- | One-way interception in C-band-only mode (requires one DDC per ARPEGE IRIS-SBU)

ARPEGE IRIS-DAF GMR-2 data and fax

Monitoring of circuit-switched GMR-2 data and fax services. Conversion of call contents to a readable format. ARPEGE IRIS-DAF includes a fax source decoder and a data source decoder.

ARPEGE IRMA-LR GMR-2 link recovery and replay

If the data link fails, the first five minutes are covered by the system's basic configuration (ARPEGE IRIS-4G/ ARPEGE IRMA-4G). ARPEGE IRMA-LR supports extended downtimes of the WAN between the central station and the remote sensor starting at the sixth minute. ARPEGE IRMA-LR enables the second processing step for GMR-2 data intercepted by ARPEGE IRIS-4G and ARPEGE IRMA-4G during isolated operation. If the dedicated line between the central station and the remote sensor goes down for several hours, the data intercepted during this time can be reconstructed at a later time. For further information about ARPEGE IRMA-LR, refer to section "Requirements on data link to remote sensor".

ARPEGE also offers project-specific hybrid solutions for use with narrowband links. For more information, refer to "Seamless intelligence by reconstructing intercepted GMR-2 data".

ARPEGE IM-AC C band antenna system/

ARPEGE IM-AL L band antenna system

The size and configuration of the antenna systems vary depending on the position of the monitoring system within the GMR-2 coverage zone. The C band receiving antenna typically has a diameter of approx. 7 m. The L band antenna typically consists of a flat panel with an edge length of approx. 60 cm. Antenna systems are supplied project-specifically. Existing C band receiving antennas can be taken into consideration if necessary.

ARPEGE IRMA-T retrofit kit for transport of remote sensor

Remote sensors are typically used in a stationary scenario. For operation in semi-mobile applications, the ARPEGE IRMA-T retrofit kit is available to simplify transport of the remote sensor. ARPEGE IRMA-T includes carrier cases and cables adapted to ARPEGE IRMA-4G.

System configuration – example

The system discussed in this example consists of one central station and two remote sensor stations. The figure on the next page illustrates the configuration and components of the ARPEGE ISIS-4G/IRIS-4G/IRMA-4G example system. The figure below shows the geographic perspective. The dashed line represents the border of an example country.

Components of central station

The central station for C band and L band monitoring discussed here consists of the following components:

- | ARPEGE ISIS-4G GMR-2 activity monitoring system including one workstation
- | ARPEGE IRIS-CL GMR-2 contents monitoring system core for traffic channel monitoring
- | 9 x ARPEGE IRIS-SBU GMR-2 subband unit
- | ARPEGE IRIS-CON GMR-2 C-band-only option
- | ARPEGE IM-AC C band antenna system
- | ARPEGE IM-AL L band antenna system
- | ARPEGE monitoring center

Components of remote sensor A

Remote sensor A for L band monitoring is based on ARPEGE IRMA-4G and consists of the following components:

- | ARPEGE IRMA-L remote GMR-2 contents monitoring sensor core for traffic channel monitoring
- | 4 x ARPEGE IRMA-SBU GMR-2 subband unit
- | ARPEGE IM-AL L band antenna system
- | ARPEGE IRMA-LR link recovery and replay option
- | ARPEGE IRMA-T retrofit kit for transport of remote sensor

Components of remote sensor B

Remote sensor B for L band monitoring is based on ARPEGE MARTINE-4G and consists of the following components:

- | ARPEGE MARTINE-4G transportable GMR-2 sensor
- | ARPEGE MARTINE-F retrofit kit for transportable GMR-2 sensor

The subband unit included in ARPEGE MARTINE-4G is connected to the stationary GMR-2 monitoring system. In conjunction with the ARPEGE MARTINE-F retrofit kit, the transportable GMR-2 sensor operates in remote mode. ARPEGE MARTINE-F has free slots which can be installed with additional SBUs (ARPEGE IRMA-SBU).

The system supervisor can dynamically allocate the SBUs to the mission-relevant spot beams.

Factors determining system configuration

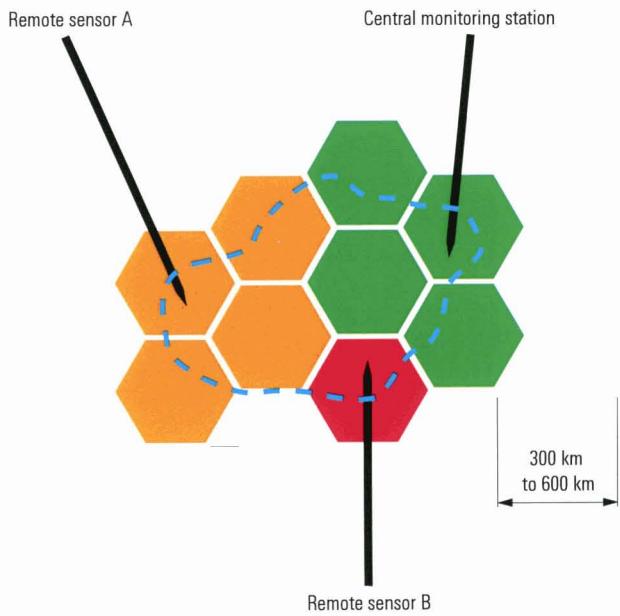
The number of active GMR-2 mobile phones varies from region to region. The number of GMR-2 activities within a region can change as a result of external influences (e.g. natural disasters, major events, unrest). The focus on missions and areas of interest for operations will change accordingly.

In the example configuration discussed here, a total of nine ARPEGE IRIS-SBUs are provided at the central station. The ARPEGE IRIS-SBUs support three modes of operation:

- | Two-way interception in standard mode (requires two DDC channels per SBU)
- | One-way interception in remote mode in conjunction with a remote sensor (requires one DDC channel per SBU plus one common DDC pilot channel)
- | One-way interception in C-band-only mode (requires one DDC channel per SBU plus one common DDC pilot channel)

The RF frontend of ARPEGE IRIS-4G supports the processing of up to 32 DDC subbands. Each DDC subband has (typically) 32 voice channels. Up to 16 ARPEGE IRIS-SBUs can therefore be operated in two-way interception mode in conjunction with an RF frontend. This yields a channel

Geographic perspective – example country

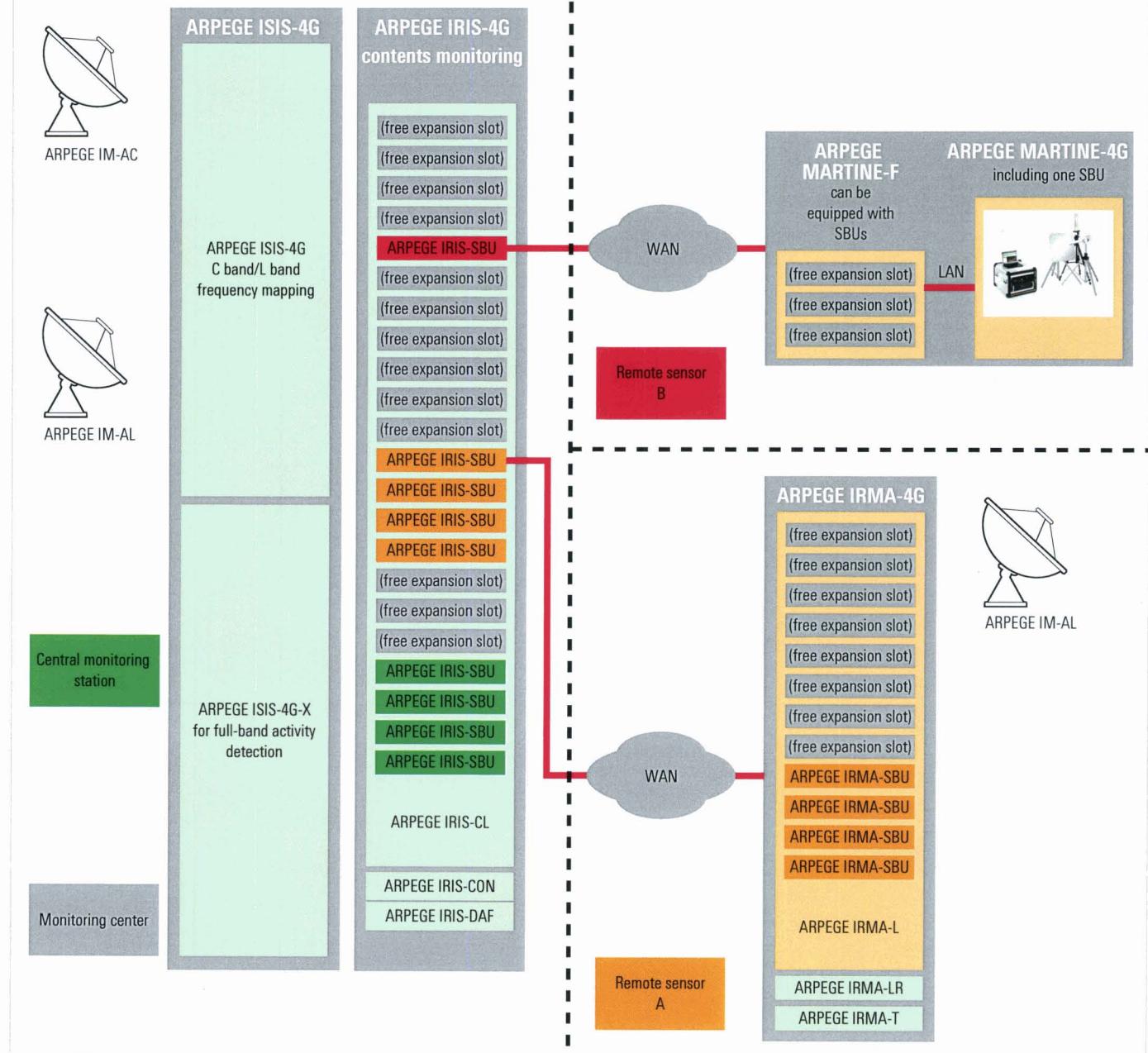


capacity of 512 duplex voice channels. In the example configuration discussed here, the channel capacity is 288 duplex voice channels for local coverage (9×32). Alternatively, all nine ARPEGE IRIS-SBUs of the central station can be operated in one-way interception mode, yielding a channel capacity of typically 288 simplex voice channels. The ARPEGE IRMA-SBUs of the two remote sensor stations A and B process the local L band down-links. In conjunction with the ARPEGE IRIS-SBUs of the central station being operated in remote mode, this results in a total of typically 288 duplex voice channels (two remote sensors plus the central station).

Depending on the area of interest and the missions to be performed, channel capacity can be distributed in different ways between the central station and the remote sensors.

For further questions regarding the scaling of the channel capacity of the GMR-2 (ACeS/ISAT) monitoring system and the required number of remote sensors, please contact our Sales department.

Configuration and components of ARPEGE ISIS-4G/IRIS-4G/IRMA-4G example system



Specifications in brief

The ARPEGE ISIS-4G/IRIS-4G/IRMA-4G GMR-2 satellite monitoring system has been designed for handling the frequency ranges and procedures used in the GMR-2 system.

Specifications in brief

Receiving system

Frequency range, C band

Receiving antenna

Intermediate frequency

Bandwidth

Frequency range, L band

Receiving antenna

Intermediate frequency

Bandwidth

Signal processing

ARPEGE ISIS-4G/ARPEGE ISIS-4G + ARPEGE ISIS-4G-X

Activity monitoring

Determination of uplink/downlink frequency mapping

Information provided by ARPEGE ISIS-4G

ARPEGE IRIS-4G/ARPEGE IRMA-4G

Information additionally provided by ARPEGE IRIS-4G/ARPEGE IRMA-4G (as compared to ARPEGE ISIS-4G)

ARPEGE IRIS-SBU/ARPEGE IRMA-SBU

Spot beams per SBU (standard or remote mode)

Subband processing capacity per SBU

Sessions/channels per subband

3600 MHz to 3800 MHz

7.3 m to 9 m parabolic antenna (ARPEGE IM-AC), righthand and lefthand circular polarization

140 MHz

2 × 40 MHz (ARPEGE ISIS-4G)

4 × 40 MHz (ARPEGE ISIS-4G + ARPEGE ISIS-4G-X)

1525 MHz to 1559 MHz

(ARPEGE IM-AL) receiving antenna, circular polarization

140 MHz

34 MHz

scalable number of processing units in a system

interception of SDCCH contents of a satellite footprint by means of wideband concept

0 s to 5 s (the actual time needed is a stochastic value)

| timestamp

| spot beam ID

| reason for activating the mobile phone (e.g. mobile-originated call, response to paging, location update)

| IMSI of satellite terminal (SIM card)

| called telephone number (mobile-originated call)

| caller's telephone number (mobile-terminated call)

| identifying characteristics, e.g. IMEI of mobile phone, IMSI of SIM card

| recorded call contents, e.g. voice, circuit-switched data or fax

1

up to 4 subbands within one spot beam

up to 40 (32 typical)

Requirements on data link to remote sensor

In general, a permanent data link is required between the remote L band sensor and the central station. The required data rate for transmissions between the central station and the remote sensor depends on the following factors:

- | GMR-2 traffic density at site of remote sensor
- | Number of SBUs at site of remote sensor
- | Type (VPN or proprietary) and extent of encryption; this determines the data overhead

Remote sensors can be connected to the central station via a dedicated symmetrical or asymmetrical line with an ensured data rate of 2 Mbit/s or higher. A data rate of 2 Mbit/s permits the simultaneous processing of 120 channels (at permanent full capacity). In the uplink, the sensor sends L band raw data to the central station. A G.703 frame relay or an ISDN 2SM unframed link should be used as a data link. Other types of data links are available on request (e.g. VSAT). The round trip time should be shorter than one second.

Ordering information

Designation	Type	Order No.
ACeS/ISAT Activity Monitoring System	ARPEGE ISIS-4G	on request
ACeS/ISAT Activity Monitoring Expansion	ARPEGE ISIS-4G-X	on request
ACeS/ISAT Contents Monitoring System Core	ARPEGE IRIS-CL	on request
Remote ACeS/ISAT Contents Monitoring Sensor Core	ARPEGE ISIS-L	on request
ACeS/ISAT Subband Unit	ARPEGE IRIS-SBU	on request
ACeS/ISAT Subband Unit	ARPEGE IRMA-SBU	on request
ACeS/ISAT C-Band-Only Option	ARPEGE IRIS-CON	on request
ACeS/ISAT Data and Fax Option	ARPEGE IRIS-DAF	on request
ACeS/ISAT Link Recovery and Replay Option	ARPEGE IRMA-LR	on request
Retrofit Kit for Transport of Remote Sensor	ARPEGE IRMA-T	on request
C Band Antenna System	ARPEGE IM-AC	on request
L Band Antenna System	ARPEGE IM-AL	on request

The system components are not sold as single products. Additional system components, licenses and services are required depending on the system and its configuration. For information about configuration and licensing, please contact our Sales department.

ARPEGE will help you determine the optimum solution for your requirements.

You will find us at

contact@arpege-sas.com

Types of intercepted information

ISAT CDR duplex mode								
Type of event	Networks	Called No.	Calling No.	IMSI	IMEI	TMSI ⁴⁾	Location ⁴⁾	
Mobile-originated call ¹⁾	ISAT to other	•		•	•			
Mobile-terminated call ¹⁾	Other to ISAT			•	•			
Mobile-to-mobile ¹⁾	ISAT	• ²⁾	• ²⁾	• ²⁾	• ²⁾			
Location update ³⁾	Power on			•	•			
IMSI detach ⁴⁾	Power off							
SMS outgoing/incoming ⁴⁾	ISAT to other							

¹⁾ Voice calls only.

²⁾ If both ISAT mobile phones are within monitoring range.

³⁾ Only during initial registration in a spot beam.

⁴⁾ Not existing in ISAT networks.

ISAT CDR C-band-only mode								
Type of event	Networks	Called No.	Calling No.	IMSI	IMEI	TMSI ⁴⁾	Location ⁴⁾	
Mobile-originated call ¹⁾	ISAT to other	•		•	•			
Mobile-terminated call ¹⁾	Other to ISAT			•	•			
Mobile-to-mobile ¹⁾	ISAT	• ²⁾		• ²⁾	• ²⁾			
Location update ³⁾	Power on			•	•			
IMSI detach ⁴⁾	Power off							
SMS outgoing/incoming ⁴⁾	ISAT to other							

¹⁾ Half-duplex voice calls (one-way interception) only.

²⁾ If both ISAT mobile phones are within monitoring range.

³⁾ Only during initial registration in a spot beam.

⁴⁾ Not existing in ISAT networks.

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