REPORT ITU-R M.2073

Feasibility and practicality of prioritization and real-time pre-emptive access between different networks of mobile-satellite service in the bands 1 525-1 559 MHz and 1 626.5-1 660.5 MHz*

(2005)

1 Introduction and background

At WRC-97 the mobile-satellite service (MSS) allocations in the 1 525.0-1 559.0 MHz and 1 626.5-1 660.5 MHz bands were made generic, and Resolution 218 (WRC-97) was adopted. At WRC-2000, this Resolution was replaced with Resolution 222 (WRC-2000).

Resolution 222 (WRC-2000) *resolves* 2 states:

> "that administrations shall ensure the use of the latest technical advances, which may include prioritization and real-time pre-emptive access between MSS systems, when necessary and where feasible, in order to achieve the most flexible and practical use of the generic allocations;"

Resolution 222 (WRC-2000) also *invites ITU-R*

> "to complete studies to determine the feasibility and practicality of prioritization and real-time pre-emptive access between different networks of mobile-satellite systems as referred to in *resolves* 2 above, while taking into account the latest technical advances in order to maximize spectral efficiency,".

Application of prioritization and intersystem real-time pre-emption is one method by which the spectrum requirements of priority aeronautical mobile-satellite (R) service (AMS(R)S) traffic could be ensured. It was intended to improve spectrum efficiency in the case that distress communication occurs with very low probability by shared use of the same spectrum by other communications with low priority.

A work plan responding to the request of Resolution 222 (WRC-2000) was established in 2001. Several contributions have been submitted to the meetings of Radiocommnication Working Party 8D for the study. The work plan indicates steps for determining feasibility and practicality of prioritization and real-time pre-emptive access between different MSS networks (hereafter indicated as "prioritization and intersystem real-time pre-emption") as below.

- Completion of revision of Recommendation ITU-R M.1089.
- Definition of the terms "immediate availability" and "real-time pre-emptive access".
- Identification of scenarios where real-time pre-emption would be applied.
- Investigation of potential methodologies and mechanisms to accommodate prioritization and call pre-emption processes (e.g. spectrum reserve pool).
- Determination of feasibility and further development of technical and operational factors relating to the interface architecture between MSS systems operating in the frequency band of interest.

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* The studies under this Report have addressed aeronautical mobile-satellite (R) service (AMS(R)S), since the contributions were focused on AMS(R)S.

A revision of Recommendation ITU-R M.1089 was adopted in 2002. This Report addresses the remaining items in the work plan.

It is noted that, in *resolves* 2.3 of Resolution 803 (WRC-03), WRC-03 adopted the following preliminary agenda item for WRC-10:

> "2.3 to consider results of ITU-R studies in accordance with Resolution **222 (WRC-2000)** to ensure spectrum availability and protection for the aeronautical mobile-satellite (R) service, and to take appropriate action on this subject, while retaining the generic allocation for the mobile-satellite service;"

2 Definitions

2.1 Immediate and real-time

Nos. 5.353A, 5.357A and 5.362A of the Radio Regulations (RR) use the term "immediate availability". Resolution 222 (WRC-2000) also addresses the term "real-time pre-emptive access". Some have questioned what "immediate" and "real-time" mean in terms of time (in s, min, etc.) to accomplish the actions intended.

The term "immediate" means a very short period of time (such as a few seconds) as perceived by an individual. An engineer trying to implement this would look at what is possible from a technology point of view and laws of physics. There is also the operational aspect, where an action is not needed in an instant but depends on the operational environment. Therefore, "immediate" could be a range of values.

From a regulatory point of view it may be difficult to define the term "immediate", as it would have different values dependent on the operating environment. The term "immediate" can be defined as a period of time "less than X s", where "X" is to be determined and might vary depending on the operating environment. The value "X" should account for various factors such as propagation delays, computer processing time, authentication, etc.

The term "real-time" also means that spectrum is made available to the requesting system within a specified delay.

2.2 Prioritization and pre-emptive access

The terms of "prioritization" and "pre-emptive access" or "pre-emption" are used in this Report.

In the context of this Report, the term "priority" means that if multiple messages are competing for access to a communications resource, then AMS(R)S messages with priority categories (1-6) will be granted access first and followed by other messages.

The term "prioritization" is the treatment of different message types in order of their established priority.

The terms of "*intersystem* pre-emption" or "*intersystem* pre-emptive access" means accommodating AMS(R)S safety communication messages by transferring spectrum for a limited period of time despite the current usage of the spectrum within a specified delay that is determined via analysis of the operational requirements and characteristics of the MSS networks involved.

2.3 Other definitions

Taking into account above and discussions in § 3.2, the following definitions are also used for the purpose of this Report:

immediate availability: assignment by the network of required channels for safety communication within a specified period;

capacity yielding: action of providing required spectrum for AMS(R)S communications by releasing spectrums for non-safety communications in other MSS networks.

3 Identification of scenarios where real-time pre-emptive access would be applied

3.1 Characteristics and requirements of AMS(R)S communications

Requirements of AMS(R)S communications and safety communications are well defined by the International Civil Aviation Organization (ICAO) and ITU publications as follows;

Annex 10 to the Convention on ICAO

Volume III, Part I, Chapter 4: Aeronautical mobile-satellite service

ITU Constitution

Article 40: Priority of Telecommunications Concerning Safety of Life

Radio Regulations

RR No. 4.10: Protection of safety services

RR No. 5.357A and Resolution 222 (WRC-2000): Priority and protection of AMS(R)S communications

ITU-R Recommendations

Recommendation ITU-R M.1037 – Bit error performance objectives for aeronautical mobile-satellite (R) service (AMS(R)S) radio link.

Recommendation ITU-R M.1089 – Technical considerations for the coordination of mobile-satellite systems supporting the aeronautical mobile-satellite (R) service (AMS(R)S) in the bands 1545 to 1555 MHz and 1646.5 to 1656.5 MHz.

Recommendation ITU-R M.1180 – Availability of communication circuits in the aeronautical mobile-satellite (R) services (AMS(R)S).

Recommendation ITU-R M.1233 – Technical considerations for sharing satellite network resources between the mobile-satellite service (MSS) (other than the aeronautical mobile-satellite (R) service (AMS(R)S)) and AMS(R)S.

Recommendation ITU-R M.1234 – Permissible level of interference in a digital channel of a geostationary satellite network in the aeronautical mobile-satellite (R) service (AMS(R)S) in the bands 1 545 to 1 555 MHz and 1 646.5 to 1 656.5 MHz and its associated feeder links caused by other networks of this service and the fixed-satellite service.

It is noted that some requirements relating to communication delay time, which would significantly affect the applicability of prioritization and intersystem real-time pre-emption, have not clearly been defined yet. However, acceptable call set-up delay time for the air traffic control communications is generally considered as about 500 ms.

Other characteristics and requirements of AMS(R)S communications are summarized in Annex 1.

3.2 Conditions in which pre-emptive access would be applied

3.2.1 Characteristics of aeronautical traffic

For identifying scenarios where prioritization and intersystem real-time pre-emption would be required, it may be useful to estimate characteristics of peak instantaneous aircraft count (PIAC) using satellite communications as shown in Annex 2.

These characteristics, and historical data on AMS(R)S traffic, show that the AMS(R)S traffic and spectrum requirements display predictable diurnal variations and slow long-term growth.

It is noted that prioritization and intersystem real-time pre-emption would be beneficial only in situations where there are occasional requirements for large amounts of additional AMS(R)S spectrum. Moderately varying AMS(R)S spectrum requirements can be satisfied through the coordination process.

There is no evidence that AMS(R)S traffic exhibits the highly specialized kind of traffic demand, which would be conducive to pre-emption.

3.2.2 Conditions of MSS networks to apply real-time pre-emptive access

Real-time pre-emptive access would require the following conditions.

1 Application of capacity yielding is to be agreed among administrations concerned in the frequency coordination.

2 Following conditions are to be agreed among MSS operators concerned:
- frequency range for yielding and unit of yielding;
- category and priority of the communication concerned;
- order of application of capacity yielding among MSS networks.

3 A sufficient capacity of data link is to be implemented among network control centres (NCCs) of each MSS network.

4 Process of capacity yielding is to be defined and agreed.

3.2.3 Satellite network capacity design

The ability of an AMS(R)S network to meet quality objectives is dependent on the capacity of the network relative to the traffic loads offered to it. If insufficient capacity is available, access delays will increase. Capacity transfers from lower priority traffic may need to be invoked to satisfy delay requirements for AMS(R)S, substantially increasing delays for low-priority communications.

Three resources that determine network capacity are satellite radio channels, ground earth station (GES) channel units, and terrestrial interconnection ports. A well-designed AMS(R)S network will most likely be provisioned in these three areas to accommodate traffic peaks with a very high probability. Under these conditions, the amount of coordinated spectrum available will determine the capacity available to the AMS(R)S system and hence the ability of the system to meet traffic demand.

3.2.4 Factors affecting the design of an AMS(R)S resource management process

Resource sharing among different MSS networks would require some scheme to manage capacity transfer among networks – an intersystem resource management process. This intersystem resource management process would have to be defined such that its implementation would result in fair and equitable pre-emption practices by the different MSS operators serving AMS(R)S and other users while maintaining the required high level of availability for their priority services.

To be effective and fair, an intersystem resource management process must include the effects of a number of factors. The following list gives an indication of what would be required:

1 Some MSS systems include both AMS(R)S and non-AMS(R)S components.

2 An AMS(R)S system must have the ability to quickly bring additional channels on-line so that spectrum transferred may be used.

3 An AMS(R)S system will generally have high-priority (1-6) and low-priority traffic. An AMS(R)S system shall not request capacity from the intersystem resource management system unless all of its low-priority channels, including any non-AMS(R)S channels, have been reallocated to channels with priorities 1-6.

4 The resource management schemes need to take account of the fact that MSS operators are planning satellite designs with a large number of spot beams. The high frequency reuse factor and small regions served by spot beams will provide additional flexibility to meet the AMS(R)S needs in a responsive timely manner.

5 MSS systems that are designed to use small-spot beams have high frequency reuse factors and may achieve high efficiency. An AMS(R)S system with large beams that requests spectrum from a system with small beams may cause spectrum in a large number of spot beams to be excluded, reducing the overall spectrum use efficiency of the band.

6 An AMS(R)S system must only request pre-emption when a real traffic requirement exists and all intrasystem resources are occupied with traffic of equal or higher priority, so as not to unnecessarily deprive other systems of capacity.

7 The definition of "real-time" is important. The important criterion is that an AMS(R)S system obtains its required spectrum when it needs it. If that criterion is met, real-time may be fractions of a second in some circumstances, and perhaps minutes in others, while still ensuring aeronautical safety. The process of evaluating the feasibility of an intersystem resource management system should include a determination of the minimum practical time in which transfer can occur, taking into account the design of the different MSS systems.

8 The system that is asked to transfer spectrum is likely to have internal frequency planning constraints that would determine what spectrum segments are most suitable (or least detrimental) to transfer. Therefore, the request from the AMS(R)S system would be for an amount of spectrum, and the response would necessarily include an identification of the frequency ranges being transferred. The AMS(R)S system would need the agility to rapidly incorporate those new blocks, without knowledge in advance of which specific frequencies they would obtain.

9 Spectrum should be returned as soon as it is no longer needed by the AMS(R)S system. A mutually agreeable and fair procedure must be developed to determine when spectrum can be returned, again serving safety needs while not unnecessarily depriving other systems.

10 AMS(R)S systems operate in areas where there are multiple systems with overlapping coverage areas. Some procedure would need to be mutually agreed such that all operators needs are treated fairly in determining which systems would give up spectrum in any particular pre-emption event. In many cases, more than one system would need to be pre-empted to make spectrum available to an AMS(R)S system.

11 The impact of spectrum transfers of hundreds of kilohertz would be far different from spectrum transfers of a few tens of kilohertz, and the management process will be affected as well.

12 All operators would need to mutually agree on the algorithms used by AMS(R)S operators to determine when and how much additional spectrum is required.

13 Managing such transfers would require the network control centres of all MSS systems to be interconnected to each other. Operators would have access to information as to the state of each other's system. Information transferred would need to be sufficient to enable the resource management process while not revealing an unacceptable amount of proprietary information.

14 The consequences of a failure in the intersystem resource management system could be very serious, possibly leading to loss of life. The liability of each MSS system involved in the intersystem pre-emption concept would need to be carefully considered.

Intersystem resource management requires the solution to a large number of technical interface problems, and multilateral agreement on a large number of policy, legal and management issues. There are many practical issues that, at least for the time being, make intersystem pre-emption an unworkable concept.

3.3 Possible scenarios for intersystem pre-emptive access

The section presents some provisional requirements on MSS networks related to intersystem pre-emption. It is emphasized that the requirements listed below would need further development to enable implementation. It is also expected that there will be additional requirements to the ones listed below.

Annex 3 shows an example of the general concept and structure of MSS networks for capacity yielding by prioritization and intersystem real-time pre-emption that was discussed during the course of the studies. It is emphasized that this structure is not complete or definitive.

Although *intrasystem*, interservice prioritization and pre-emption functions are already implemented in some MSS systems, it seems to be difficult to apply such functions to all different networks operating in the relevant bands with various complicated conditions.

For example, the scenario would require that the operation of all MSS networks, intended to access the relevant bands sharing with AMS(R)S networks, be subject to certain requirements as follows:

– all networks using the same frequency pool shall be interconnected between ground earth stations concerned by a real-time high-speed data link;
– high absolute frequency stability shall be required for satellite stations as well as earth stations among all networks concerned;
– all MSS carriers intending to operate in the bands for AMS(R)S must either be compatible with the AMS(R)S system(s) or capable of releasing spectrum on a real-time basis;
– the terminals need to be frequency agile (the duplex spacing may be fixed at 101.5 MHz);
– the transmit and receive function need to be under constant control;
– the control protocols need to be implemented to permit pre-emption in a timely manner.

4 Investigation of potential methodologies and mechanisms

4.1 Spectrum reserve pool

Only one basic concept has been introduced as a means of implementing prioritization and inter-system real time pre-emption, that of having a pool of frequencies in reserve that can be used by AMS(R)S when there is peak demand so that the MSS user does not have to be pre-empted. This concept allows AMS(R)S access to more spectrum when needed without interruption of MSS services. Prioritization and intersystem real-time pre-emption would only be used in cases where there was a significant rise in demand for AMS(R)S in a short period of time, reducing the "spectrum reserve pool" to less than a minimum size or exceeding its resources. Furthermore, the

AMS(R)S system would maintain a pool of additional resources in order to serve immediately any priority level traffic of the higher-priority services.

However, the concept of a spectrum reserve pool is essentially nothing more than an additional allocation of spectrum to the AMS(R)S system to provide a buffer against unexpected large temporary additional spectrum requirements. The idea of spectrum reserve pools therefore introduces unwanted inefficiencies in the use of the L-band spectrum.

4.2 Call set-up delay

As discussed in § 2.1, frequency transfer between MSS networks shall be completed within acceptable call set-up delay time, e.g. 0.5 s.

Due to the relatively long delay time for exchanging information through satellite link and interconnection link among GESs, and the processing time in the GES concerned, the overall delay time from initiating a priority call to receiving the information at the destination could be far longer than required for safety communications. It would therefore be difficult to justify the mechanism of prioritization and intersystem real-time pre-emption for transferring spectrum required for safety services from non-safety services even if the MSS frequency is occupied.

4.3 Unit of frequency transfer

The unit of the frequency bandwidth to be transferred is currently considered as 5, 7.5, 10 and 17.5 kHz depending on type of carrier for the AMS(R)S communications.

Frequency transfer between MSS networks would usually be for both uplink and downlink together with the same bandwidth in each direction. All MSS systems, implementing prioritization and intersystem real-time pre-emption, would need to be capable of frequency transfer of the specified frequency bandwidth requested by the AMS(R)S network in a common frequency range for both networks.

Currently, channel bandwidths for general MSS are different to those for AMS(R)S and such frequency transfer could require the MSS network to yield more spectrum than is requested. This would significantly reduce spectrum efficiency.

4.4 Intersystem data link and protocols for frequency transfer

All MSS systems intended to implement prioritization and intersystem real-time pre-emption, would need to provide reliable and high-speed data links among all other MSS networks through their respective NCC with standardized protocols. Availability and data transmission delay would need to satisfy the requirements of all the AMS(R)S networks.

4.5 Standardization

As discussed in § 3.2, there are many items to be standardized if all MSS networks concerned implement prioritization and intersystem real-time pre-emption.

Since AMS(R)S networks are operating globally, all MSS networks operating in the frequency bands of interest would need to participate in the scheme and satisfy all conditions defined above. The definition of the scheme would need to involve international and regional organizations, ITU, ICAO, IEC and others, as well as the MSS operators and their administrations.

It usually needs a long time to complete such standards, and strong initiative and broad consensus are required to develop such standards.

4.6 Current developments

Some mobile-satellite networks, such as Inmarsat and those operating in North America, provide *intrasystem* pre-emptive access functions. However, no prioritization and intersystem real-time pre-emption functions are provided and no such plan or no such method is proposed.

Moreover, there are no other MSS networks providing or planning intersystem pre-emptive access functions in their networks.

It is concluded that currently there is no MSS network to support prioritization and intersystem real-time pre-emption, and none planned for the near future.

5 Summary and conclusions

Although some mobile-satellite networks currently provide *intrasystem* pre-emptive access functions, there are no actual MSS systems providing prioritization and intersystem real-time pre-emption functions, and despite several years of study there are no methods yet developed.

The study has identified a number of significant technical, operational and economic issues that would have to be overcome to make prioritization and intersystem real-time pre-emption a reality.

It is summarized that prioritization and intersystem real-time pre-emption would not necessarily increase the efficiency of spectrum use compared to the current situation, but it would certainly complicate substantially the coordination process and network structure. Furthermore, it may not satisfy the operational and commercial requirements of AMS(R)S communications.

The study has concluded that prioritization and intersystem real-time pre-emption is not practical and, without significant advance in technology, is unlikely to be feasible for technical, operational and economical reasons.

Annex 1

Characteristics and requirements of AMS(R)S communications

1 Characteristics of AMS(R)S communications

According to ICAO definitions (Annex 10, Volume III, Chapter 3), AMSS communications consist of the following:

a) ATSC (air traffic service communication):

Communication related to air traffic services including air traffic control, aeronautical and meteorological information, position reporting and service related to safety and regularity of flight.

b) AOC (aeronautical operational control):

Communication required for the exercise of authority over the initiation, continuation, diversion or termination of flight for safety, regularity and efficiency reasons.

c) AAC (aeronautical administrative communication).

d) APC (aeronautical passenger communication).

As a safety service, AMS(R)S communications include ATSC and AOC above.

2 Types of AMS(R)S communications and organization of flight information region

There are two kinds of AMS(R)S communications: data and voice. It is necessary to handle them separately because their natures are different.

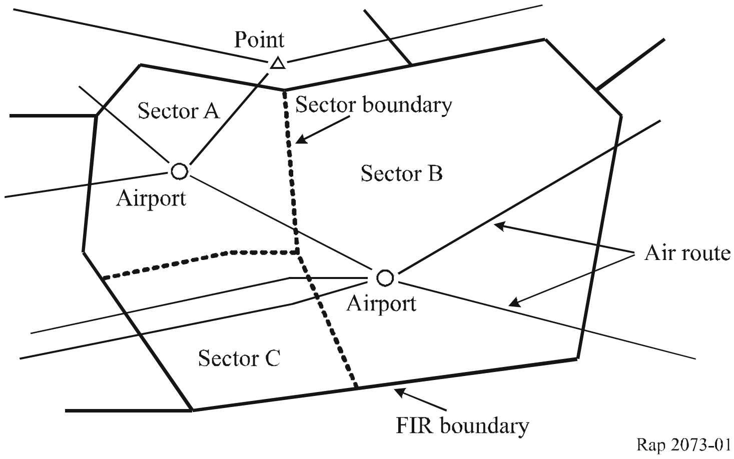
Data communication is mainly used for routine communications such as air traffic control and aeronautical operational control. There are two different natures of channel requirements, such as indispensable channels to be assigned to each beam for communication control, channels to be assigned to each airspace for air traffic control and flight information service, and other AOC communication channels proportional to the number of operating aircraft.

As for voice communication, it is mainly used for transmission of non-routine information that data communication would have some difficulties with. Accordingly it is necessary to reserve at least one channel per designated operational coverage area (sector) in the flight information region (FIR) for the need of unexpected communication such as in the case of sudden meteorological deterioration, situations causing a risk to the aircraft and revision of flight plan. For AOC communications, their traffic will be proportional to the number of operating aircraft as usual, except in non-routine situations.

Figure 1 illustrates the concept of the FIR divided into sectors.

FIGURE 1

Concept of the FIR and sectors



3 Required performance of AMS(R)S communications

3.1 Requirements of AMS(R)S communications

International civil aviation, through ICAO's, established the need for message priority capabilities, which are reflected in ICAO's Standards and Recommended Practices (SARPs), and are consistent with RR Article 44. Annex 10 of the ICAO Convention, Volume 1, Part II, Chapter 5, § 5.1.8 defines a consistent set of aeronautical safety communications message types. A message priority capability is required in an aeronautical safety communications system to ensure that higher priority, time critical, messages can be sent while delaying lower priority, less time critical, messages.

The message priority capability gives a system the means to ensure that higher priority safety messages can be transmitted in a timely manner and before non-safety messages. In addition, since some safety messages are more critical in nature than others, the message priority structure extends to rating the relative priority of safety messages, such as that defined by RR Article 44, which defines the priority of AMS(R)S message types (priorities 1-6).

Since there may only be a single data link circuit connecting an aircraft (for example) to the ground system, the message priority capability may extend to delaying the transmission of a portion of a lower priority message (which, for example, may be lengthy) to allow a higher priority message to be transmitted. For example, as defined by the ICAO AMSS SARPs, AMSS messages are "broken down" into "signal units" by the system. This capability allows the system to continue to send signal unit portions of a message as long as there are no higher priority messages to send. If a higher priority message appears, the transmission of signal units of a lower priority message are delayed until all the signal units of the higher priority message are sent. The system delivers the total message to the application layer after all the signal units are received.

3.2 Transmission quality and reliability (availability)

The most important issue for aeronautical safety communications is that communication channels shall be surely established when required.

It is observed that characteristics of general telecommunication channels other than AMS(R)S, such as public telephone or entertainment broadband data transmission, are primarily concerned with transmission quality such as frequency response and distortion.

For the reliable communication for ATSC related services, AMS(R)S requires, for both data and voice communications, higher channel availability, integrity and continuity of service compared to that for general communication channels and higher response of channel access such as within a few seconds' delay even in the busy hour.

3.3 Service area and beams

From an operational and economical point of view, it is generally desired that normal traffic in a wide area will be handled by the global beam, and high traffic in congested airspace be handled by spot beams.

Annex 2

Estimation of peak instantaneous aircraft count (PIAC)

For identifying scenarios where real-time pre-emption would be required, it may be useful to estimate characteristics of PIAC using satellite communications.

1 Conditions of estimation

To estimate PIAC, it is necessary to identify the following, *inter alia*:

– applicable airspace: North Pacific, South East Asia, etc.;

– season or time-slot: both in the busiest hour and off-peak hour, etc.;

– category of aircraft operation: scheduled, non-scheduled, etc.;

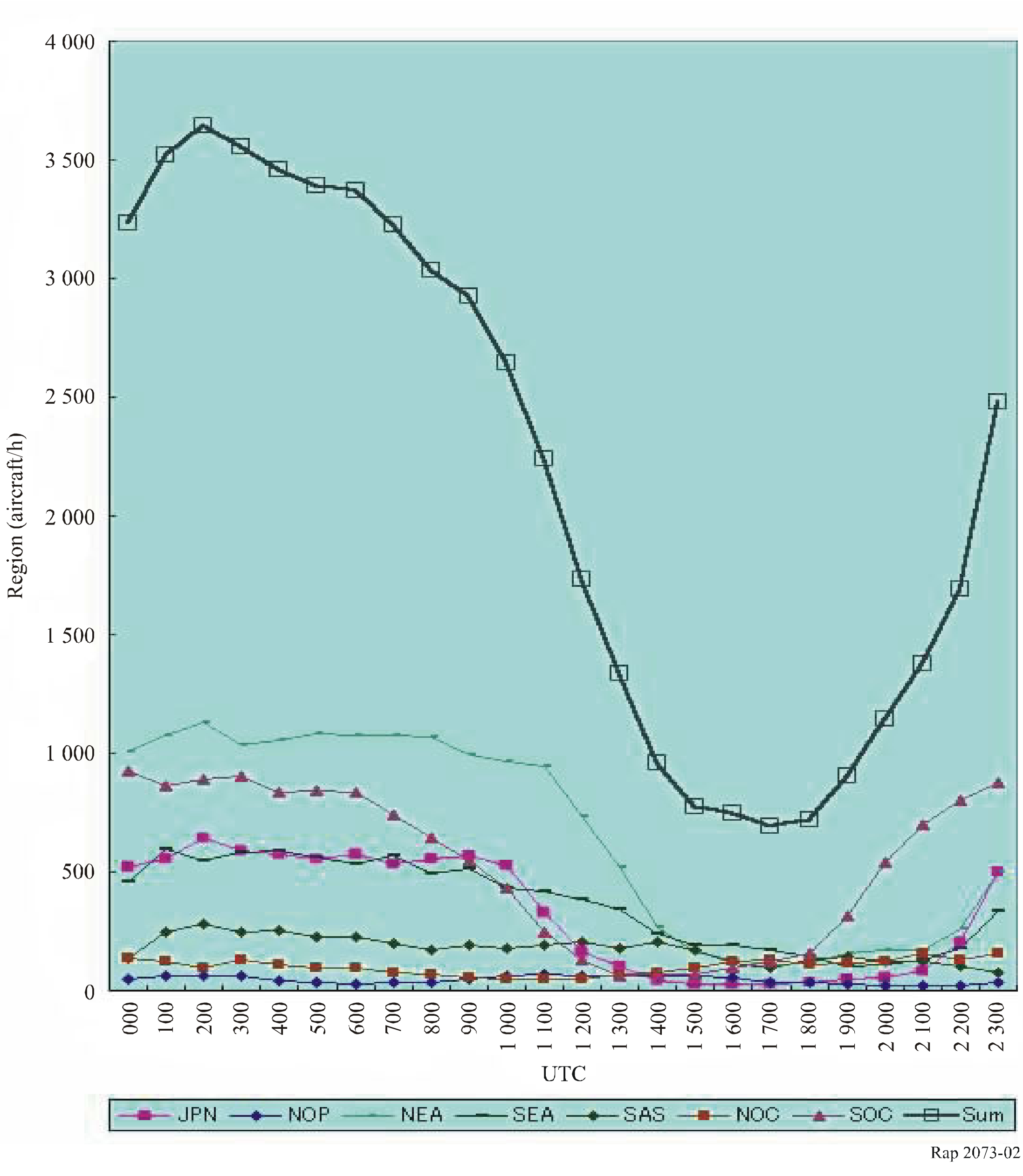
– types of avionics.

2 Target year's PIAC

Generally, the number of operating aircraft widely varies and needs to be investigated on an hourly, daily and seasonal basis. Peak value in the busiest hour in the year shall be obtained, or estimated by taking into account the growth rate for the year. The reference PIAC for the scheduled flight in some specific (reference) year may be obtained by investigating an airlines timetable database for the year, such as official airlines guide (OAG). An example of daily PIAC variation in Asia and the Pacific area is shown in Fig. 2.

FIGURE 2

Example of PIAC (Asia and Pacific zone)



JPN: Japan
NOP: Northern Pacific
NEA: North East Asia
SEA: South East Asia
SAS: South Asia
NOC: North Oceania
SOC: South Oceania
Sum: Summation

The basic PIAC for scheduled flights of the target year, which is *N* years later than the reference year, may be obtained from the reference PIAC by applying a growth factor obtained by statistical data or yearly growth rate based on the economical growth.

The PIAC of non-scheduled flights may be estimated by applying the ratio of scheduled and non-scheduled flights. The PIAC of general aviation (GA) may be estimated by applying the ratio of scheduled and GA flights based on the statistical data of GA flight hours.

The target year's PIAC is then obtained by summing up the above PIACs, for scheduled flights, for non-scheduled flights and for general aviation.

3 PIAC using satellite communications

The PIAC using satellite communications in the specified airspace may be obtained as the product of target year's PIAC and the ratio of aircraft using satellite communication.

It is considered that communication traffic is nearly proportional to the number of the operating aircraft.

Annex 3

Example structure of MSS networks concerning real-time pre-emptive access

A possible example of the general concept and structure of MSS networks for capacity yielding by prioritization and intersystem real-time pre-emption is shown in Fig. 3.

For the purpose of capacity yielding, all MSS networks intended to operate in the frequency bands for common use with AMS(R)S networks would comply with following conditions:

1 Transmission from the satellite and all mobile earth stations (MESs) is to be controlled by the respective NCC through GES.

2 Range of frequency yielding, conditions of yielding, protocols for process of capacity yielding are to be standardized.

3 Unit of frequency range (i.e. channel) for capacity yielding for AMS(R)S is to be predetermined.

4 All NCCs and their respective GESs are to be connected by reliable, and high-speed data link.

5 Information of frequency usage in common spectrum pool is to be continuously transmitted to the AMS(R)S network through respective NCC.

An example of procedures for capacity yielding is shown as follows:

Step 1: Upon request for additional spectrum for AMS(R)S call, AMS(R)S NCC will search unused channel in common spectrum pool by monitoring information from all MSS NCC concerned.

Step 2a: If an unused channel is found, this channel will be assigned to the call and AMS(R)S NCC sends inhibit signal for this channel to all MSS NCC concerned.

Step 2b: If an unused channel is not found, then the AMS(R)S NCC selects appropriate channel (randomly or by predetermined order) and sends inhibit signal for this channel to all MSS NCCs concerned.

Step 3: The MSS NCC receives the inhibit signal and determines if any MES using the affected channel is in the interference zone. If so it:

– sends shut down signal to respective MES;

– confirms that the spectrum is not in use;

– sends acceptance signal to AMS(R)S NCC.

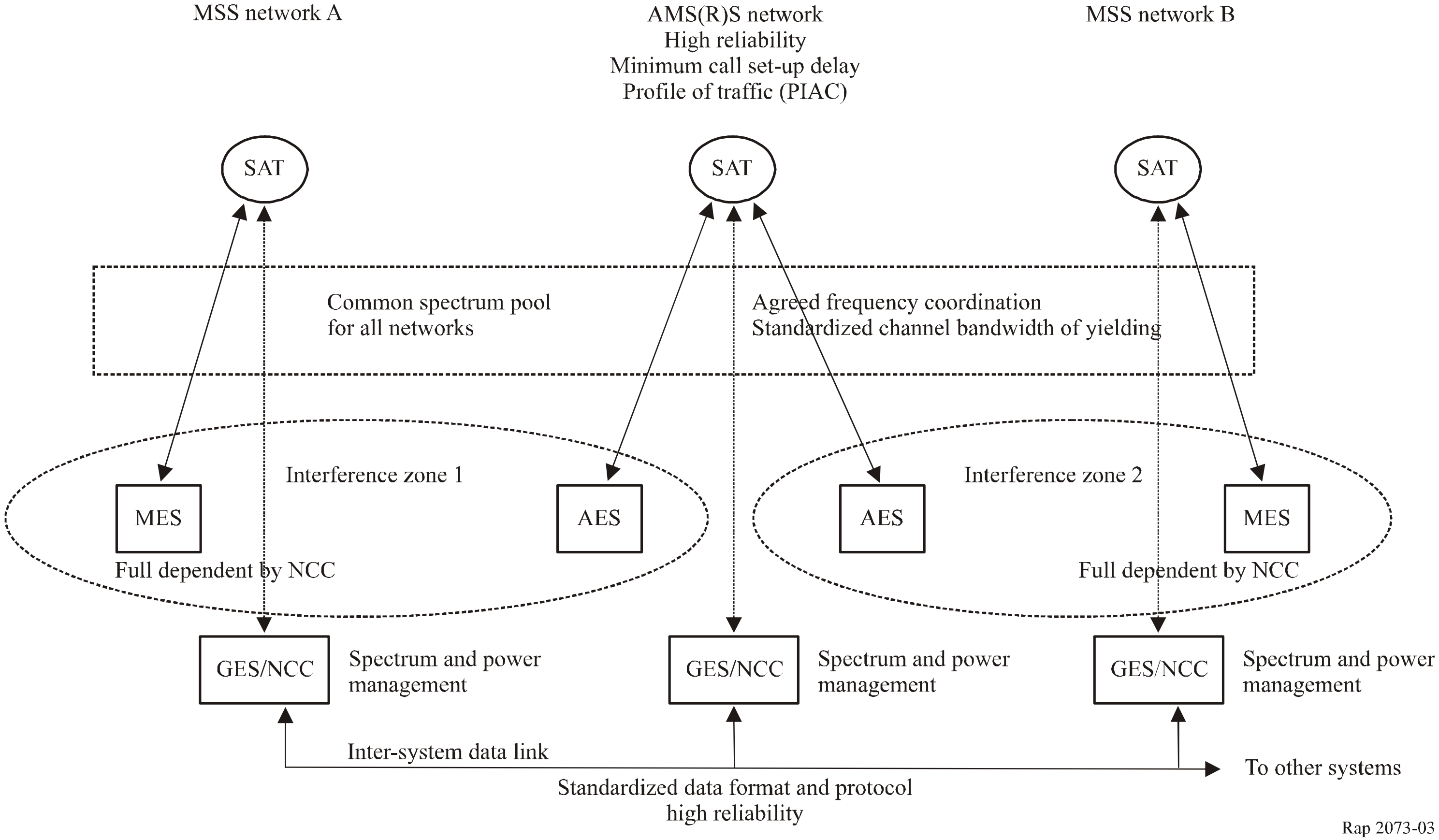
Step 4: After the AMS(R)S network receives acceptance signal from the MSS NCC, the AMS(R)S NCC initiates the spectrum assignment process to the call.

Step 5: If no acceptance process is received, the AMS(R)S NCC needs to repeat Step 2b but may not be successful.

Step 6: After completion of the AMS(R)S call, the AMS(R)S NCC sends spectrum release signal to all MSS networks concerned.

FIGURE 3

General concept and structure of MSS networks for spectrum yielding



AES: aeronautical earth station