WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR INSTRUMENT AND METHODS OF OBSERVATION

OPAG-UPPER AIR

CIMO EXPERT TEAM ON UPGRADING THE GLOBAL RADIOSONDE NETWORK
First Session

Geneva, Switzerland, 3-7 November 2003

Distr.: RESTRICTED

CIMO/OPAG-UPPER-AIR/
/ET UGRN-1/Doc.3.7.5

(16.X.2003)

ITEM: 3.7

Original: ENGLISH ONLY

INTRODUCTION OF NEW “UNIVERSAL” UPPER-AIR SYSTEMS

(Submitted by the Secretariat)

Summary and purpose of document

This document contains available information on new “universal” upper-air systems and a present experience with their use as well as a potential role of WMO/CIMO in their wider introduction.

Action proposed

The meeting is invited to examine the available information on new “universal” upper-air systems, update it and develop a strategy on how to best deal with the issue of their introduction into the global upper-air network.

Introduction of new "universal" upper-air systems (discussion document)

1. Background

1.1 Since the beginning of 2003, discussions were being made at various user and donor levels on introducing more widely the so-called "universal" upper-air systems that can use GPS and non-GPS sondes. As this may have both positive and negative impacts on the global radiosonde network, it is necessary that the Expert Team on Upgrading the Global Radiosonde Network (ET on UGRN) develop a strategy on how to best deal with this issue.

1.2 This document contains information that was neither discussed at any official CIMO level nor was commented by any relevant CIMO expert. For this reason, the attached information is presented only to facilitate the discussion on this issue at the meeting of ET on UGRN. The information may be far from complete as it was neither comprehensively provided by users of "universal" upper-air systems nor by relevant manufacturers.

2. What is "an universal" upper-air system?

2.1 "An universal" upper-air system should be able to use different navigation and tracking systems and should provide an interface to wide range of radiosondes. Such a system could use both GPS and non-GPS radiosondes. It may use combination of different navigation and tracking systems, such as Radiotheodolite (RDF) systems and Global positioning system (GPS) or GPS and Hyperbolic navigation systems (LORAN-C). Through the radiosonde data converter, the system may be used with various radiosonde types and should allow for a real-time tracking and data processing of radiosondes operating on both 403 MHz and the 1680 MHz band. It should be an open and modular system.

3. Potential benefits of using "universal" upper-air system

3.1 "An universal" system provides opportunity, when appropriate and feasible, to limit the use of expensive GPS radiosonde to a necessary minimum and use much cheaper non-GPS radiosondes. In the medium-term it would lead to a reduction of the operational cost of upper air sounding networks.

3.2 "An universal" system also provides backup in case of failure or in case of low or bad reception or interference in certain bands. For example, in case of failure of radiotheodolite antenna the system may use the 403 MHz GPS sondes taking an advantage of the solid state UHF and GPS antennas with no moving parts. Similarly, in case of high interference in GPS the non-GPS sondes may be used.

4. Practical experience with "universal" upper-air systems

4.1 There is very little experience in using "universal" upper-air systems, however some configurations are already in use or are commercially available.

4.2 Indian Meteorological Service installed 10 InterMet IMS 1500 radiotheodolite systems that are able to track Indian (MK4), InterMet (IMS 1680 MHz GPS and IMS 1680 MHz RDF), Sippican (MK2, MK2A and B-2) and Vaisala RS-80 radiosondes if they supply a decoder with their sonde. Meteorological Service purchased decoders for Indian MK4 and Sippican MK2, however, with the new IMS 1500 systems, they are initially using only Indian sondes. No report from Indian Meteorological Service concerning the experience with new systems is available at present.

4.3 Six Caribbean countries use InterMet IMS 1500C (version for warm climate), however only with Sippican B-2 sondes. These systems have performed quite well in the tropical region and have been more than adequate for wind determination where the winds are generally light to moderate throughout the year and radiosonde flight distances are significantly less than 200 km.

4.4 Norwegian army is using InterMet IMS 1600 system that combines 1680 MHz radiotheodolite wind finding and 403 MHz GPS wind finding with omnidirectional antenna. With this system the Sippican MK2 sonde for 1680 MHz RDF and Modem sonde for 403 MHz GPS are used. Again no detailed information is available.

4.5 The predecessor of IMS 1500 is being used in Cape Verde, Abu Dhabi.

4.6 Under the Radiosonde Replacement Programme in US NWS new ground system was designed by InterMet - IMS 2000. This system has bigger antenna than IMS 1500 and can track sondes to a bigger slant distance (250 km). IMS 2000 will work in 1680 MHz GPS and RDF or in 1680 MHz and 403 MHz dual mode. IMS 2000 will be used with Sippican and InterMet sondes and it is about to be deployed.

4.7 VAISALA Radiotheodolite RT 20 equipped with MARWIN MW12 sounding processor is used in number of mostly European countries and mostly for military purposes. MW12 permits the redundant use of NAVAID technique, such as VLF-NAVAID, LORAN-C and GPS), New version RT20A connects directly to latest DigiCora III sounding system.

4.8 VAISALA also claims that it has a commercially available new DigiCora system equipped with both 1680 MHz RDF and 403 MHz GPS wind finding capability. No information is available on its possible use.

5. Risks

5.1 **Suitability of radiotheodolite RDF technique.** The US NWS performed a study to determine the suitability of a RDF for its Radiosonde Replacement System Program. It was concluded that for the entire network ranging from Arctic regions through mid-latitudes and into the subtropical as well as tropical regions the RDF technology would not be suitable. However, for Arctic regions, tropical regions, and to some extent subtropical regions, RDF radiosonde systems could provide good wind coverage. (Tropical areas have a very low probability of RDF antenna low elevation angle winds and would function quite well with RDF systems. In the subtropical latitudes, elevation angles could be a limiting factor on the use of RDF radiosonde systems.)

5.2 **Higher investment cost of “universal” systems.** The cost of “an universal” system (100-150k $) is much higher than the one of 403 MHz GPS system (30-40k $). Higher initial investment may deter some users from purchasing such a system.

5.3 **Availability of Decoders** for different sondes from different manufacturers. “An universal system” would only work with different kind of sondes if manufacturers were willing to supply their decoders to their competitors.

5.4 **Charges for the frequencies** used by meteorological ground equipment may significantly increase in the future with the negative cost implication on a dual system operation that uses more than one frequency.

5.5 **Sustainability due to extra maintenance and training.** The operational performance of new generation radiotheodolites have significantly increased, however their operation requires regular maintenance, (rare) repairs and better trained staff than sole

403 MHz GPS system, which has no moving parts and tracking of radiosonde is fully automatic. Lack of trained staff and maintenance support may be a limiting factor in some developing countries.

5.6 **Limited functional tests of “universal” systems.** Functional test are available only for individual modules and for individual sondes but not for the system as a whole. Functional test should be done by manufacturer or users and the results should provide information on how a system meets its specified performance, maintenance and MTBF requirements. It should also provide information on the variability that can be expected in the network of like systems, information on functional reproducibility and the comparability of measurements of different sensors and systems. “An universal” system would be a very complex system with a higher risk of failure of individual parts of the whole module chain or incompatibility of individual modules that may (inevitably) come from different manufacturers, such as signal processors and ground check systems for different sondes of different manufacturers.

5.7 **Limited field tests and experience with “universal” systems.** There is limited experience with above-mentioned systems and there is hardly any experience with their “universal” use.

5.8 **Questionable data homogeneity.** Premature (wide) use of “universal” systems may cause inhomogeneity in data series.

6. Proposed WMO/CIMO role and steps in a development and implementation of “universal” upper-air systems

6.1 Taking into account that WMO should promote introduction of new measuring systems/sensors that may lead to a reduction of the operational costs of observing networks as well as the need to monitor a development of any new systems/sensors and their implication on the global observing network, it is proposed that the work programme of CIMO ET on UGRN would also cover this issue with the aim to develop a strategy including main actions needed to be done to amplify the positive and limit the negative impacts of new “universal” upper-air systems on the global radiosonde network.

6.2 Due to the lack of proven information on new “universal” upper-air systems and their use in practice, it is proposed that ET on UGRN should monitor the development of “universal” upper-air systems and should suggest ways on how to collect comprehensive information on the present use of “universal” upper-air systems as well as on their technical specifications.

6.3 The ET on UGRN is invited to consider the following temporary measures:

(a) Functional tests to be conducted by willing NMSs over a period of about 6 to 12 months (e.g., January 2004 to October 2004) with a support from WMO/CIMO ETs. UK Met Office and Meteorological Service of NZ have already showed their willingness.

(b) Field test to be conducted in one or two developing countries in a harsh environment. Dar Es Salaam, Tanzania, where a good level of local support is expected with good communication and accessibility, would be a good site for the field test. This installation in a tropical environment would be under the performance monitoring of a developed NMS (UK Met Office) to review the quality of observations of a system over a period of about 6 to 12 months (e.g., January to October 2004). In addition, a local manager would provide assessment on operational performance of the system over the same period.

(c) Analysis of functional and field tests with a reasonable response time for remedial action from respective manufacturer(s) would be finalized by the end of 2004.

(d) Based on the analysis of functional and field tests (and experience gained by US NWS during their radiosonde Replacement Programme), WMO may proceed with the preparations for the intercomparisons of available “universal” systems that would be essential for the establishment of compatible datasets. Intercomparison may take place in February 2005 together with the intercomparison of GPS radiosondes in Mauritius. However, it should be kept in mind that Intercomparisons should be performed only with the well proven observing technology and techniques that are unlikely to be (significantly) changed in the next 4 to 5 years period.

(e) Results of the intercomparisons would be available in mid 2005.

(f) It may not be feasible to encourage the wider use of new “universal” upper-air systems before the common strategy is developed based on the above steps.