SOME NATIONAL AND INTERNATIONAL ROUTINES FOR SYSTEM EVALUATION AND FAULT REPORTING

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Summary: A description is given of basic procedures for optimising the availability and quality of data from some automated observing systems.

1. INTRODUCTION

Without specific arrangements for evaluating the performance of observing systems, significant shortfalls in the availability of their data to users, and shortcomings in the quality of data are commonly found. Such arrangements are essential for systems which are administered to some extent by international groups (eg those concerned with drifting buoys and aircraft systems such as ASDAR), because of the number of agencies and links responsible for obtaining compatible measurements and communicating reports in a timely way from the various sources. Effective monitoring procedures also maximise the return of good quality data from nationally operated systems, for example land based automatic weather stations; those procedures already established in the United Kingdom involve assembly, analysis and distribution of information from numerical models, operators, system maintainers, and communications computers.

Observations from radiosondes (and, for example, those from merchant ships) form a special category, since although the systems are nationally controlled, their data are circulated internationally to many users and along various communications paths; there is thus a strong need for some internationally agreed procedures for performance monitoring and evaluation, appropriate remedial actions and feedback. Some components of such procedures already exist, for example the periodic instrument intercomparisons conducted by CIMO.

The purpose of this paper is to depict the characteristics of monitoring schemes already being implemented for two observing systems, one national and one international, and to indicate which characteristics may be basic to a scheme for radiosondes. Firstly however the arrangements basic to any effective scheme are considered in a little more detail.

2. SYSTEMS EVALUATION - BASIC REQUIREMENTS

It is not worthwhile setting up procedures for system evaluation unless remedial action can be taken to rectify or deal with problems which the evaluation identifies. Remedial actions fall into several different categories:

a) Real time investigations by the on-site operators, maintenance or communications authorities as soon as observational reports are missing, become corrupt, or obviously in error.

b) Responses by the same authorities as in a) after a period of continuous monitoring indicates systematic offsets or drifts in measurements, or repeated system or sensor faults.

c) Follow up action by the owners if contractual maintenance or repair has not been carried out.

d) Changes to the design of the system, its communication interface, communication methods or observing practices by developers, manufacturers or operators.

e) Inclusion of appropriate corrections in numerical analysis programmes for systematic differences between measurements from different stations; additionally additions to and deletions from "blacklists" of data to be totally rejected.

Obviously a problem could be tackled by taking any or several of the assorted actions listed above. The results may be rather chaotic; for example as a result of systematic offsets being corrected at source at the same time as data processing centres introduce corrections appropriate to the previous performance of the systems or the performance of a different design. Thus there is a need for expert consideration of all available information on the performance of a system, and then coordination and initiation of appropriate courses of remedial action with the groups identified in a) to

e) above. Any centre(s) undertaking these roles must not only have the capability to continually monitor data, but also to assemble statistics of system performance over periods of weeks or months in order to identify systematic faults, indicate desirable design modifications, etc.
Assessment of performance is based on the following information:

a) data availability and quality from data processing centres

b) data timeliness and message integrity from processing centres or communications hubs.

c) operational and maintenance reports

d) results of field trials and intercomparisons

It can be seen that several of the authorities which act as a source of information on some aspect of system performance are also on the list of those who can take remedial action; however it is not the case that the remedy can or should be based purely on information available at the same source. For example a routine maintenance inspection is often assisted by the results of centralised monitoring in determining where systematic offsets lie. Similarly offsets derived by numerical analyses of operational data should be checked against available field trial results before being used as a basis for corrections in the numerical models.
These inter-relationships demand a cohesive system of transferring relevant information from one authority to another. Additionally the system must encourage feedback of information once remedial action has been taken, for example to allow the data processing centres to distinguish between system performance before and after a design change.
Figure 1 depicts the general characteristics of an effective scheme for systems evaluation; some examples of this scheme are described in following Sections.

3. NATIONAL SCHEMES

The scheme operated within the United Kingdom for assessment of the performance of land based synoptic automatic weather stations (AWSs) is depicted in Figure 2. In real time the AWS provides (in addition to the actual observations) housekeeping data, whilst regional meteorological offices where the data are polled advise of any faults (eg message corruptions) which

they see; this information is sent to an assessment cell at the Bracknell Headquarters of the Meteorological Office. Times of receipt of reports, and estimates of data quality derived from comparisons of observed and analysed values of a variable, are obtained from centralised data banks. Assessments of data quality are also available from field trials. Finally the assessment centre receives periodic reports on system faults or site problems from the on-site caretaker, inspectors and maintenance engineers who visit the AWS.

As soon as the assessment centre establishes that a problem exists from the available information, the responsible area maintenance centre staff are asked to visit the system to determine the exact nature of the fault and undertake repairs; some repair actions involve liaison with British Telecommunication. Area maintenance centres must report back details of any sensors which are changed or re-calibrated, or other repairs effected, and the dates of such actions. Centralised output of the meteorological quality of the data can then be related to the changes which have been effected. The assessment centre is also responsible for suppressing corrupt data before it reaches the central data banks, and for releasing data once repairs are implemented; this is done by instruction to the regional collecting centre.

Each month the assessment centre produces a bulletin which includes statistical information on the performance of each system. The statistics highlight systematic errors and repeated faults which demand further investigation by maintenance staff. The bulletin also summarises the maintenance undertaken during the month, outstanding maintenance action and communications faults, and shortcomings in caretaker support; such problems are brought to the attention of the Headquarters authorities so that an appropriate technical response can be organised. Bulletins are sent to data users, for example to enable them to make corrections for offsets. Finally the centre produces an annual report aimed at identifying design problems for the system and its communications links. These highlight post design work necessary by the developers, manufacturers or in some cases the communications authority.

The cell consists of two people (who also have other responsibilities), and helps to achieve a 95% return of good data from (at present) 40 systems

mostly in very remote areas.

4. THE PROPOSED SCHEME FOR AUTOMATED AIRCRAFT REPORTS

The scheme proposed for the operational evaluation of the ASDAR (Aircraft to Satellite Data Relay) system is depicted in Figure 3; this scheme satisfies the requirements of the international Operating Consortium of ASDAR Participants (OCAP). A similar international scheme already exists for drifting buoys.

The ASDAR Centre will be responsible for many aspects of assessment and field management of the ASDAR system. Since the system is completely automatic, and will often be displaced thousands of miles from the ASDAR Centre, the Centre will rely very heavily on information on data availability, timeliness and quality from communications hubs and data processing centres before initiating any remedial action. Information will be required from satellite and other communications authorities on transmission outages and other communications problems including interference: ASDAR owners and/or airlines will have to supply reports including planned schedules and movements of carriers, engineering base locations and facilities, engineering base problems, and dates of removal and despatch.

When the information sources indicate that a problem exists the Centre will normally contract the satellite authorities first of all to ensure that communications problems are not the cause of bad or missing data; if they are not, and rapid access to engineering base facilities is not possible, the satellite authority may be asked to suppress data. The airline engineering base will be alerted to determine the location of the fault as soon as possible; problems may lie in the aircrafts own systems (for example its flight data acquisition unit, or the aircraft sensors), within the ASDAR data processors or the satellite transmission unit. If faults are isolated to the ASDAR equipment, it will be returned to the manufacturer/ maintenance authority for repair; technical staff from the Centre will monitor all actions taken by the repairer, and keep the owners or airline informed of progress. Data users will be informed of suspect data or data which cannot be suppressed so that they can take appropriate action. Obviously the engineering bases and satellite authorities must be informed

respectively when systems are ready for reinstallation and data can be released. A feedback of information to the data processing centres is necessary to enable changes of or to an ASDAR system in a specific aircraft to be distinguished in the monitoring statistics.

Reports produced from an analysis of information over several weeks or months will, as in other cases, play a part in highlighting systematic differences, repetitive faults, and design errors. Such reports will thus be generated for those authorities able to react to such problems, but also to the OCAP so that the effectiveness of remedial procedures, and any contractual arrangements governing them, can be examined.

It is expected that $1\frac{1}{2}$ man years per year of effort will be used to run the centre, comprising one year of scientific effort and $\frac{1}{2}$ year of technical support.

5. CONCLUSIONS AND APPLICATIONS TO RADIOSONDE OPERATIONS

Given specific arrangements for obtaining information, and the prior discussion with and agreement of various authorities able to take remedial action, assessment centres have proved very effective in minimising observing system "down-time" and maximising the supply of high quality data. The importance of different types of performance information, and of different remedial actions, varies from one observing and communications system to another. Any scheme for radiosonde systems should recognise several factors, including

a) the need for manufacturers to inform the meteorological community of changes to their system software and hardware, and for assessments to be made of the effect of those changes on reported values.

b) the need for countries to inform data users of changes of or to the radiosonde systems they are using, and of changes to any manual data reduction procedures.

c) the importance of information from both the observational processing data bases, and from field trials in identifying, for example, systematic differences.

d) the value of time series data especially as an indicator of performance at isolated stations.

e) the importance of information identified in c) and d) above for a variety of purposes, including the adequate correction of values used in numerical analysis and the redesign of software and hardware at source to provide data of acceptable accuracy and reproducibility.

and f) the need to involve the potential 'remedial authorities' in the specification of the assessments which are required.

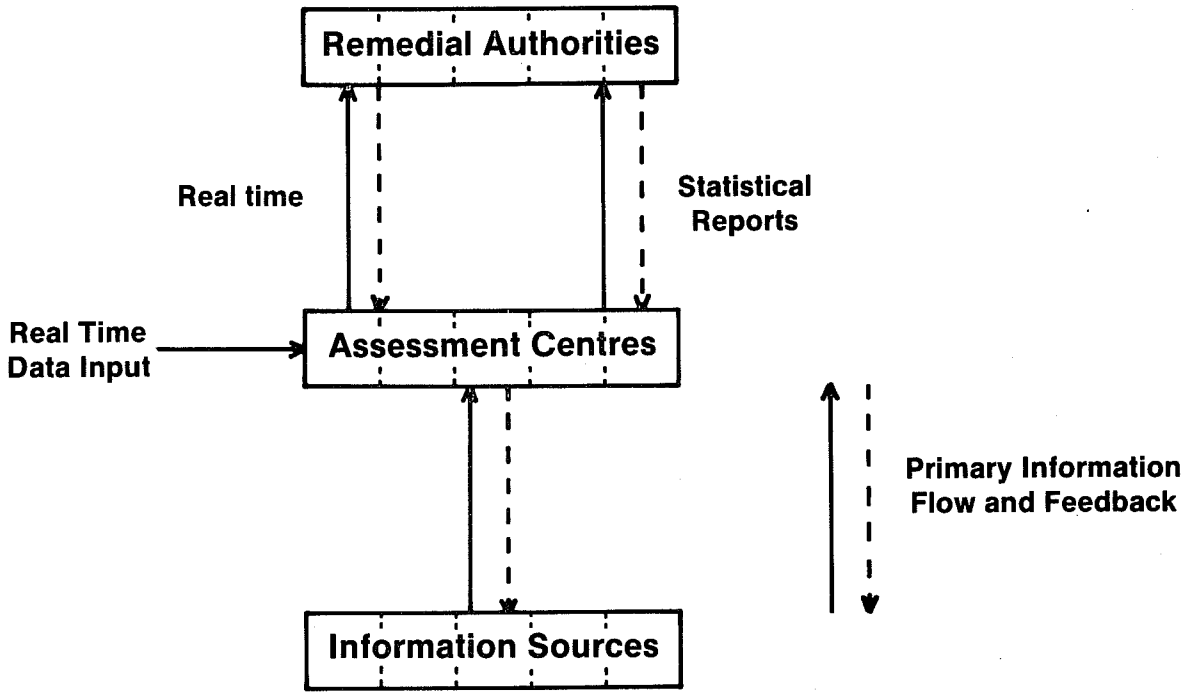

Fig. 1 General characteristics of evaluation scheme.

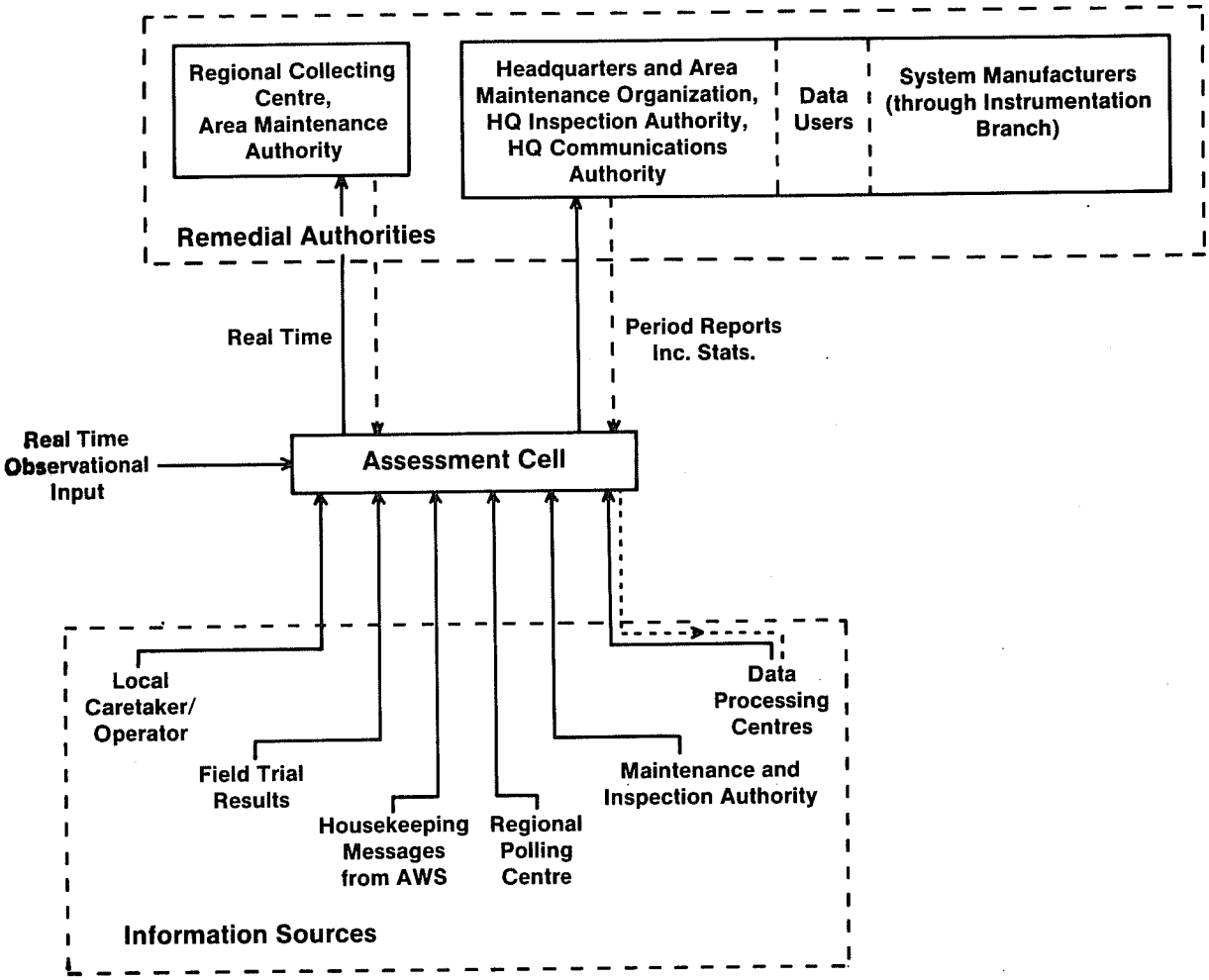

Fig. 2 United Kingdom system for evaluating SAWS performance and follow-up remedial actions.

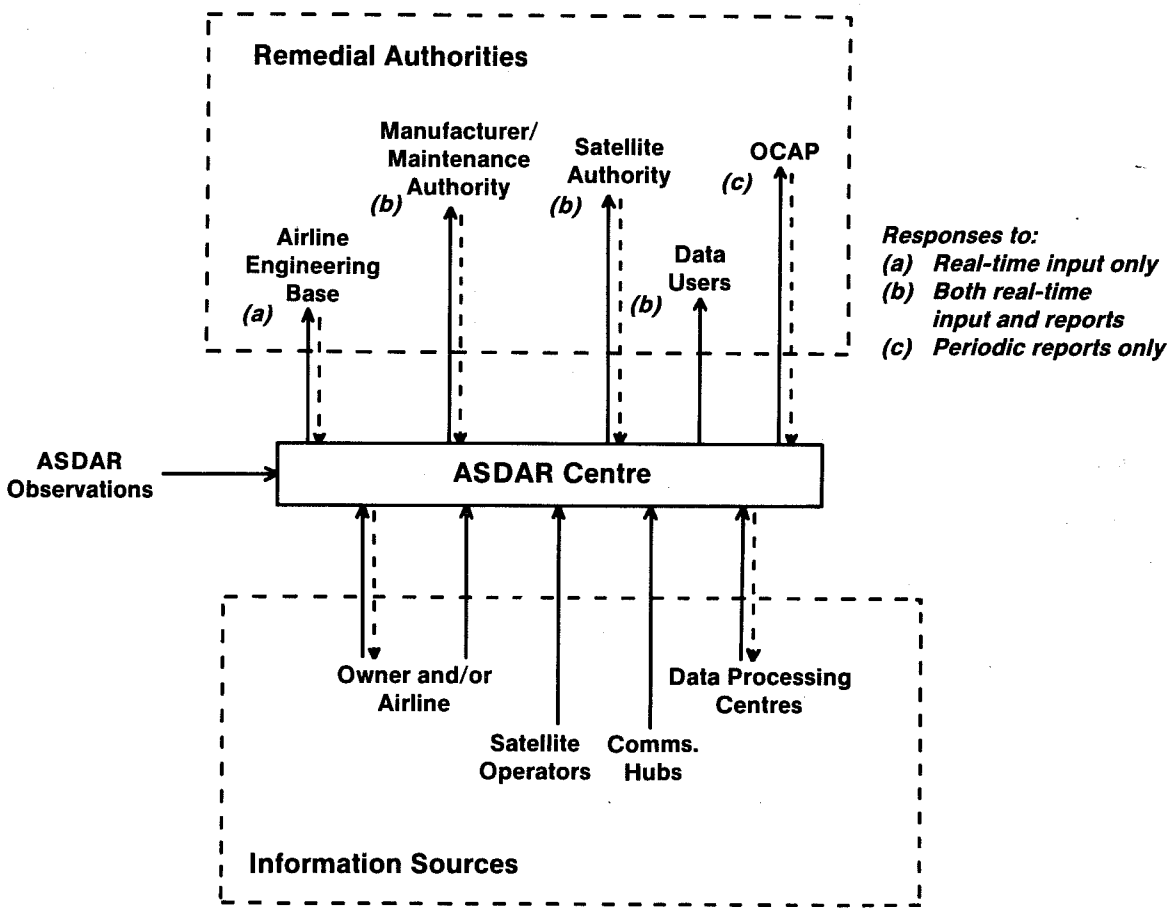

Fig. 3 Proposed functions — ASDAR centre.