

**SALVA:  
A VOCAL AUTOMATED SYSTEM FOR DETECTING HYDROLOGICAL ALARM SITUATIONS**

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**ABSTRACT**

One of the aims of the Servizio Idrografico e Mareografico Nazionale (SIMN) consists in monitoring the trend of the hydro-meteo conditions interesting Italy. Such a task is performed by means of a measuring net, named “Rete Nazionale di Rilevamento e Sorveglianza”, connected by a telematic geographic network to an information system located in Rome. In order to give the people involved in the monitoring task a suitable set of automated tools; several functionalities have been included in the information system. The most recent one is named SALVA (Sistema di Allarme Vocale Automatico), and consists in an autonomous automated system capable to detect situations of hydrological alarm as well as system faults and to inform the users with a vocal message by using a normal telephonic line. Such functionality allows a generic user to be informed about risk situations requiring only the possession of normal telephonic equipment, or a mobile telephone. The system is also capable to detect whether the user did not receive the message and consequently adopt the adequate procedures, such as, for example, call another user or retry.

**THE SALVA PROJECT**

One of the tasks of the Servizio Idrografico e Mareografico Nazionale (SIMN) is monitoring the trend of the hydro-meteo conditions interesting Italy. Such a task is performed by means of a measuring net, named “Rete Nazionale di Rilevamento e Sorveglianza”, connected to an information system located in Rome. Hydrometric levels of the rivers and amount of precipitation, across a geographic network, arrive at the department server that shares them for further following processes. The SALVA project arises from the demand of having an autonomous automatic system able to report hydrologic alarm and/or network failures, using a normal telephone line to inform the users involved in the monitoring tasks.

The system has been realised taking into account some specifics, such as:

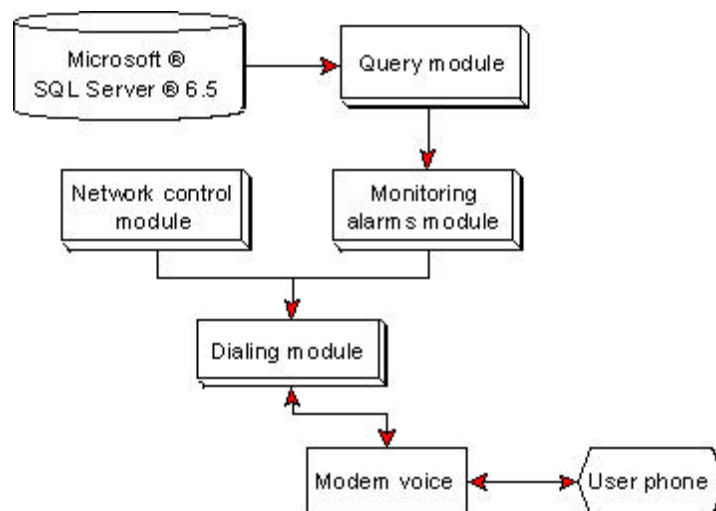
- Simplicity of use: the system must be as much user friendly as possible, allowing the use to all the user category, including those ones devoid of computer science culture;
- Scalable implementation in operation of the present and future necessity; that means expandable management of data and users, possibility of extending the assembly of the

managing reports and using also other output types besides those vocal ones ( fax, other local or remote computers);

- Implementation inexpensiveness: the system must work with a common use equipment: standard personal computers and modem with voice capability, found on the market nowadays at a very small selling price; this kind of solution offers, among other things, also the possibility to duplicate or triple the system to avoid the failures possibility without the great necessary expense for existing custom systems;
- Operation reliability: the system must work 24 hours a day with a minimum maintenance, then it must be carried out with techniques of tested programming and on sufficiently stable operative systems.

Thus SALVA program has been realised, in keeping to the cited specifics, with the following characteristics:

The program, periodically (with a period decided by the system manager) runs a query on the data residents on the server located in the Data Center (RNRS server), stored on of a SQL server by Microsoft; to make this phase as fast as possible I don't follow the classic method of dialogue with the server through the ODBC library or BDE, but I use the (DLL) side client connection library coming directly with SQL server; in this way the program has also another important characteristic, such as that it does not need any installation: in brief it's sufficient to copy in a chosen directory the program itself with its data files, and two further file (one of initialisation and the DLL of connection to the server), and the program is ready for the utilisation; this characteristic is important in the case in which the program has to be installed rapidly by not specialised personnel, for example in case of substitution of a damaged machine.



*SALVA diagram block.*

After acquiring data from server, the program effects a control set and numerical comparison, also interpolating the possible defective data, in order to establish if the received data point out one or more alarm reports, accordingly to the specifics established from the authority provost organisms. In particular the program examines the hydrometric data in comparison with three predetermined levels for each sensor (if they exceed, it goes into an attention, alert or alarm status), and the stored precipitation occurred in the latest 1, 3, 6, 12, 24, 48, 72, 96,

192 hours; according to the particular characteristics of the basin, or to values predetermined from special rules and implemented in the code, the program estimates the potential danger of the event and passes in appropriate status (standard, warning or alarm) in order to predict possible floods or slides, or danger for the public safety.

When the program has finished the research and data processing, it examines the cases that exceed the specifics and effects a further control on the reliability of the datum looking at the functionality of the sensor: in fact in case of fault the received data could cause false alarms, and thus sensing mechanisms and error corrections (based both on the operation of measure instrument and on the characteristics of the catchment basin) have been implemented. This is the most delicate phase of the process and it is in fact the most sensible one to improvement and refinement, because of the variability winger of the hydrologic reports that, according to the basin, are possible to have completely different meanings.

At this stage the program has in memory an information list to communicate and it goes into the dialling phase; in order to effect this operation the program implements a finite state sequential machine (DFA, Deterministic Finite Automaton) that cares of a common voice modem management (at present is in use a Sportster Flash of USR Robotics), effecting all the initialisation operations, connection, sending the proper AT commands and taking over the line status, reading the incoming messages from the modem through the serial port and managing the DTMF signals. In this way the program knows any time the current report, the consignee of the call, the status of modem and serial port.

The following step is the generation of the vocal notice. I thought out different implementation techniques, and finally the choice has been the simplest solution and the most effective too: simple sound file previously sampled (Microsoft ADPCM type, 22 kHz, mono) with the keywords the program has to play; this choice has been made above all for two themes: first, because generally the resulting phrase is comparatively limited, and in any case it's possible to extend it with a small effort; second because, according to the present status, the quality of a recorded spoken phrase is better than a synthesised one, at least with the hardware of commercial type toward which this project is addressed, and besides it allows the best comprehension of the message, as it is possible having noisy telephonic line.

In order to have the certainty that the issued message is actually joined to destination, at the end of the output message the program asks the user to confirm the reception of the message as soon as reproduced, pressing a specific key of the telephone, that has to be of tone type; the relative return of DTMF to the modem will be interpreted as the reply of the user and memorised by the program in special variables and subsequently in a log file that registers all the actions effected, for a possible following check. In this way all the possible situations in which the user has not actually answered are eliminated (answering service, mobile phone off, telephone company announcement etc).

In case of call not successfully (engaged user, absent or lack of confirm), the program searches, in its configuration file, further telephone addresses for the same user and after a few seconds it repeats the procedure, for a number of times that is defined in the initialisation file of the program. Since the program memorises all the parameters of the reported calls, the same user will be not called back again for an already received alarm and confirmed, in order to achieve an optimal efficiency, also in the use of the telephone line. This shows that a software solution like this one is superior to the use of a common telephone dialler that has almost no one capacity of programming according to the demands of the user.

The notice is sent to the users present in a special list, any time modifiable; using the same DTMF system through the telephone keyboard, the program communicates to the user, under his request, the other calls effected for the same alarm report, listing the users and the result of each call; this function is very useful in case the people involved in the monitoring task have to co-ordinate among themselves, giving knowledge to anyone about who has already been informed.

The program effects besides a diagnostic procedure on the regular operation of the Hydrographic Service net, (indeed it effects a simple PING on the various routers and servers listed in the initialisation file) and check if the department SQL servers answer regularly to the incoming queries; otherwise the program automatically switches to a backup SQL server. In case of failures, it provides to effect an analogous telephone notice to the interested users (typically the system manager and the people in charge of the informative system).

Because of simplicity of development, and at the same time thanks to the power of the language, the whole procedure has been developed in Object Pascal, incorporated in the development system Delphi by Borland (now Inprise) for the 32 bit operating system Windows (95, 98 or NT). This language has already been used with very good results for other software products able in monitoring and displaying data in real time (SASI project), and in loading and storing data in various DBMS (SQL Server, Oracle, and Microsoft Access too) used by the personnel (engineers and technicians) of the Hydrographic Service.

Software is structured with a main module that keeps the principal functions of the program (i.e. the communication with the server and the automaton for the calls), and an expandable block that includes the additional functions (i.e. at present the module for the alarm control and that for the overseeing of the network connections); with a comparatively few effort it is possible to extend the program features holding the original stability: for example it has been examined the possibility of making the system able to answer to calls incoming from outside and, through the same DTMF commands, unwind a set of additional operations, that is for example:

- a vocal report on the hydrologic situation, in general terms or on specific request;
- the switch on other data sources;
- sending a fax to a free choice number;
- sending a command to other applications in execution;
- file handling operations, as transfer from and toward the user;
- the message recording of the calling user that will be sent to the other users automatically or by request or even at a specified time.

At present the hardware resources needed for the correct operation of the program are extremely "light": it is sufficient a simple personal computer, with the minimum characteristics requested for the installation of the operating system Windows, 32 bit (then 95, 98 or NT). In effect the working system (24 hours a day) at the Service's Data Processing Center is compound by a simple low cost personal computer, based on an Intel 486 at 66 MHz with 12 Mb of RAM; the disk space taken by the program, included all the sound files with the names of the sensoriums and numbers is only 10 Mbytes, of which 700 Kbytes for the program and the DLL library for the client connection to the server.

In shortly, the development possibilities of the system are very high, since the availability of the source code allows not to be tie up to commercial solutions that are not possible to modify, and, unless of great investments, it will not be possible to upgrade the software fully

in keeping up with the demands that are possible to present later in time. Besides the evolution of the performances more and more growing of the hardware equipment allows to develop scalable software, with the opportunity to implement more functions without decreasing performances in the application. In last, the presence in the Servizio Idrografico of staff with an big knowledge of the hydrologic problems and situations, allows software improvements extremely accurate with reduced times of development, and at the same time with no need of effecting further investments.

Finally it is possible to say that the choice of using internally developed software and using commercial hardware components of low cost allows free distribution of the programs freely, in the field of the various offices of the department, in source form too, in order to allow the utilisation or the modification to suit to the demand of different tasks.

**CO-ORDINATES**

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