

Web application system for Internet dissemination of the forecasting products

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Abstract. The paper presents the new way to create and access, in real time, some of the meteorological products directed to the general public – forecasts, diagnoses and warnings – mainly via Romanian media. Comparisons are made between the old ways of transmitting and receiving these products and the new procedure, based on the use of worldwide computers network and the AJAX model of programming web applications.

Keywords: meteorology, media, Internet, AJAX

1. INTRODUCTION

Information from any Internet site can be accessed through “web pages” – a means through which anyone having access to a server host and a text editor can display information in various modes – either HTML (Hypertext Markup Language) – formatted pages, with visual aspect enriched with CSS (Cascading Style Sheet), or structured by XML (EXtensible Markup Language) templates and XSL (EXtensible Style Language) schemes. During the last decade, programming languages have been developed for the content of such pages, the status of the JavaScript, VBScript, ASP, PHP and Perl languages raising remarkably. Web pages design has received a boost and became easier after launching the Macromedia/Adobe program packages supplying possibilities to create interactive pages and animations.

In the last 5–7 years these modes of designing websites were added “web applications”, which are complex software products able to combine

all programming languages suited for processing and disseminating information into an entity that ensures a website's functioning and aspect.

A web application can thus modify a section of one page by using JavaScript and DHTML (Dynamic HTML) and display, in another section, information from a database through code sequences written in C++.

Until the spring of 2006, most of the meteorological products (forecasts, diagnoses), created at the National Weather Forecasting Centre in Romania and dedicated to customers in the media were elaborated and transmitted to them through so-called classical or traditional means: creation via complex text editing programs and transmission by fax, electronic mail or even by phone.

This was the reason why those products reached the clients according to their order on waiting queues only.

As the set of needed products multiplied and the customers diversified together with their demands, it has become obvious that products needed to be disseminated more rapidly and in a simpler way. Such demands are being met through appealing to the Internet as an optimum environment for disseminate information simultaneously toward a large number of locations, with the possibility to access those data at destination in real time.

Starting in April 2006, economic circumstances and the evolution of various means of communication made it possible for meteorological products to be gradually delivered to most of the beneficiaries in Romanian media via the particular web application presented in this paper.

The web application is hosted on a server of the National Meteorological Administration (NMA) and is used by all our customers in the media. The application has been fully designed (programming, pages design and maintenance) by the author of this paper, and the server is managed by the Management Group of NMA's Information Network, along with the author.

This software system's objective is to meet the needs of implementing an operational, secure, fast and efficient method for conveying meteorological products to the general public, through users in the media and also to meet the need to render in a flexible way these products.

From the general products that the forecasters create and the system manages, each customer sees those products only that are dedicated to them and automatically created by the web application, depending on their demands. Personalized products thus constructed are made available to the users of the web application, in order to be accessed from any computer connected to the Internet. The web application is ensuring access to information as soon as it is introduced into the system.

The web application, together with the satellite software applications, automates procedures that would be dramatically time consuming, should they be performed manually by human operators. Moreover, the economic resources (used by both suppliers and users of meteorological products)

necessary to convey information to direct customers have been drastically reduced, due to the use of this efficient system.

As of 2011, the system supports the real-time dissemination process of the medium-, short- and very short-range forecasts, along with severe weather warnings at national level, nowcasting warnings and customised messages for the numerous clients of the National Weather Forecasting Centre (NWFC) and the Regional Meteorological Centres in Romania (RMCs).

The start page can be found at:

<http://anm.meteoromania.ro/meteoinfo>

To access the rest of the web application beyond this page, authentication is necessary with username and access password. Each user is to provide such a pair of authentication data in order to be able to access the products delivered via the application.

Each Regional Meteorological Centre has its own set of pages, which it uses to manage and distribute information; the system's architecture is, however, unitary for the entire ensemble of NWFC and RMCs.

2. WEB APPLICATION ARCHITECTURE

The web application is made visible on the Internet through the Microsoft Internet Information Services web server (*fig. 1*), placed in the "demilitarized zone" (*DMZ*) of a computer network, which implicitly makes it highly secure.

The operating system the server runs is Microsoft Windows 2003 but the application can also run on lower versions.

The web application code was written in the C# programming language, which is a modern, high level language, related and resembling to C++ and Java through its syntax, being an *Object-Oriented Language*. Parts of the applications are written in JavaScript, and most of the information (texts and connections to image-files) are stored in files, in HTML format. JavaScript sequences allow for users controlling the content of pages they see by using resources of their own computer, without straining the server.

This ensemble is part of the *AJAX (Asynchronous JavaScript and XML)* model.

When a functional feature supplied on a page is called (e.g. pressing the button for displaying the forecast for cities), the server executes only the sequence of code responsible for that particular feature. In addition, *AJAX* methodology allows for an extreme efficiency of the procedure of displaying the page to the user, as the server transmits back to the client those parts of the page only that have been modified on request. All the unmodified elements, however, keep on being displayed and the page does not lose its integrity.

The pages' aspect is controlled through the use of "styles" for some of

the elements therein – the colour of the background and of scroll bars, of links to other pages, size and alignment of paragraphs, and so on. These styles can be modified at any time, even between two displays of a page, without the need to change the code that ensures that page’s functionality.

Thus, the functionality of each page is separated from its design, with the AJAX model supplying additional dynamics.

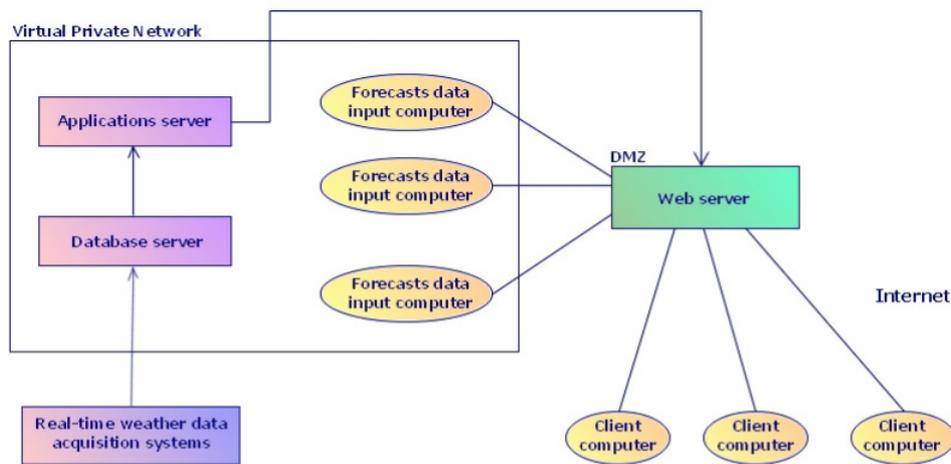


Figure 1. Hardware architecture of the system

3. PARADIGM SHIFT AND BENEFITS BROUGHT BY THE WEB APPLICATION

The major paradigm shift that this system has brought to the way information of meteorological specific is distributed to a large number of users is the possibility to access the products in real time, i.e. immediately after their creation and simultaneous dissemination. This means that immediately after a certain piece of information is recorded and modified, it becomes available to all those entitled to access it.

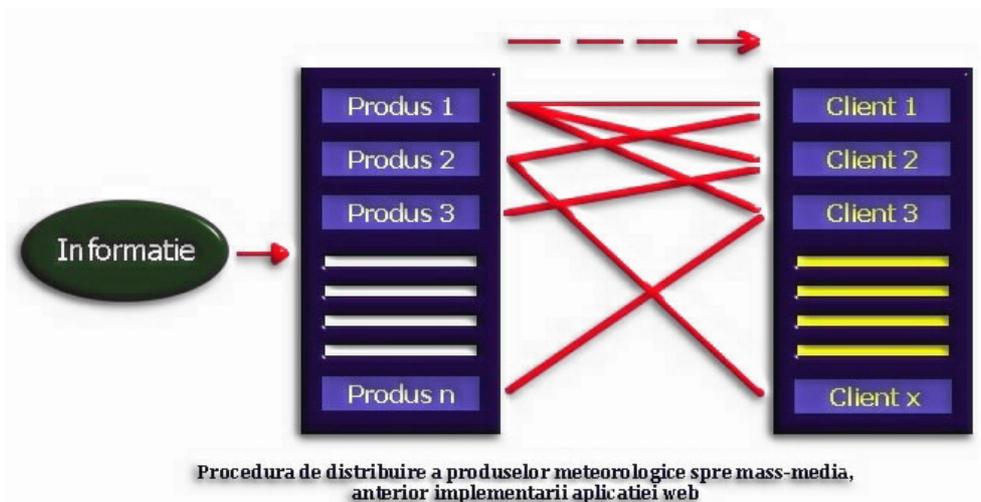


Figure 2. The procedure of delivering meteorological products to the media, prior to the implementation of the web application.. (DE TRADUS IN ENGLEZA)

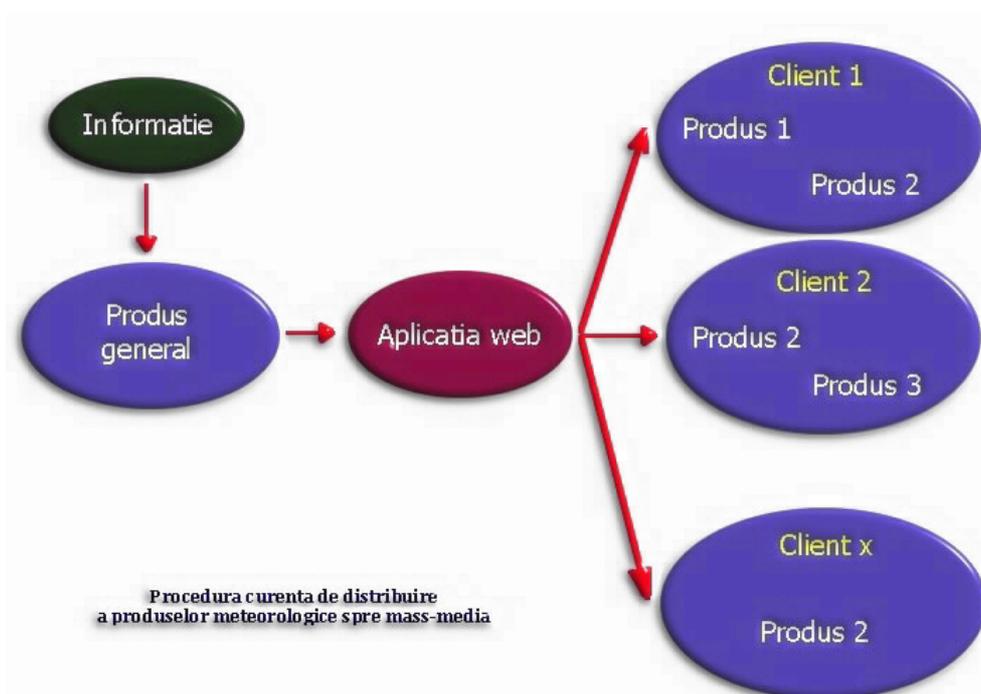


Figure 3. The current procedure of delivering meteorological products to the media, after the implementation of the web application.

The latency of the time necessary to access the information is just a few seconds – between the client calling the server and the server’s response, i.e. the actual display of the products on web pages.

The result is that meteorological forecasts and severe weather warnings reach simultaneously all the beneficiaries that have subscribed to

the system. However, the moment the information is effectively reaching the customers depends on the moment they request it. Worth of mentioning is that, in regards to severe weather warnings, a satellite application has been created that is displaying information without an express demand.

There is no need any longer to manually structure the products necessary to each client, as the web application takes out of a general product, that contains the entire batch of information that was supplied by meteorologists, only the sequences of interest to the client (*figs. 2 and 3*).

Each piece of information is recorded only once and may be updated at any time, and the finite products are being created automatically by the web application from the initial data.

Data processed by the web application may be accessed based on each user's rights. Thus, meteorologists have unrestricted access to information, meaning that they can create, change and display all of the products, whereas each client may only visualise those data for which he has expressed a preference within the contracts they have with the National Meteorological Administration.

Other significant benefits are listed below:

- reducing costs of telephone calls, through a decrease of the number of such calls for transmitting information through facsimile;
- absence of significant demands for software and hardware for the server that hosts the application, since only simple-structured files are being managed, something that can be done safely on any computer newer than 10 years;
- any forecast, irrespective of its format (text or graphics) can be created and modified by its creators at any time, and the result becomes available to the users immediately after the creation or update.

4. METEOROLOGICAL INFORMATION CONVEYED BY THIS SYSTEM

The approach to distributing meteorological products is novel, in the way that it is no longer necessary to create documents containing particular forecast products for each client.

Forecast-dedicated files store the whole forecast, structured over time intervals that cover the whole interval – these intervals are following the current protocol of elaborating the short- and medium-range forecasts, respectively.

4.1. Forecasts

Clients are supplied with medium-range forecasts (anticipation of up to 7 days) for the entire national territory, for the capital city, for the

mountain and seacoast area, for the county capital cities, for European capital cities and for the continental European area.

4.1.1. The forecast, in text and graphic form, for localities in Romania, Europe and other countries, created on the current day;

4.1.2. The forecast, in graphic form, for localities in Romania and in Europe, created on the previous day.

These forecasts provide the temperature values expected for each night and day and the weather phenomenon representative to each interval. The forecast may also contain the snow layer depth, the sea water temperature and the wind direction for each location.

4.2. Severe weather warning messages on short-, very short- and medium-range

Warnings covering longer intervals for the entire territory of Romania or larger regions of it (so-called “general warnings”), which are also accessible on the National Meteorological Administration’s official site, are distributed through the web application, which displays the information both in text and graphic format (the maps highlight the areas that are forecast to be affected) and at the same time offers the users supplementary Internet (URL) addresses where they can get more information on the events.

Since these warnings are of national importance, the corresponding messages can be accessed by all beneficiaries – no matter what forecast products they have chosen on a contract basis.

4.3. Nowcasting warning messages, of imminent severe weather

Forecasts covering intervals of up to 3 hours can be issued by the *nowcasting* forecasters or by them in cooperation with those forecasters that create short and medium-range forecasts. Further, the interested customers (mainly, local media in the affected areas) can access and disseminate to the public and the authorities messages referring to the phenomena that are to occur in the next several tens of minutes – something that could certainly not have happened if a queue for the fax was to be used, with 5 -10 clients in the waiting.

Such messages can be elaborated by each Regional Meteorological Centre and can be then accessed by its clients and those of the National Weather Forecasting Centre in Bucharest.

4.4. Current weather in Romania

Information about current weather in cities and other locations where weather stations are operational are being extracted from a database, displayed on pages dedicated to each Regional Meteorological Centre, and

this information is updated every 10 minutes. The procedure of "rephrasing" raw information offered by weather stations is also automated – a console software application extracts the values of the meteorological parameters, creates the map of weather in Romania and transfers periodically the information in a directory placed on the server; then, the information is being further displayed on the corresponding pages that request it.

4.5. "Customised" forecasts and messages.

"Special" or "customised" forecasts can be created too, for instance forecasts covering non-conventional intervals (i.e. 12 hours during day or night time, or 24 hours), as well as announcements dedicated to a customer only.

5. STORAGE OF INFORMATION TRANSPORTED THROUGH THE SYSTEM

XLM files may contain text made of Unicode characters, that is text structured by an efficient and minimal scheme, allowing for the storage of varied information in dedicated fields. This structure allows for the use of small size files as minimal, easy to edit, databases.

Using this type of files is an efficient and justified way when it comes to information of relatively small sizes (e.g. less than 10 MB), and texts containing weather forecast do meet this condition indeed. It is, for instance, not recommended to store images (in binary format) in XML files, because one single image may occupy millions of bytes, therefore one can store it more efficiently into a "real" database (Microsoft SQL Server, Oracle, MySQL etc.). However, the representation in text form of the content of binary files (images, Microsoft Office and Adobe documents, ZIP archives etc.) can be very well stored and accessed by resorting to XML files.

For all the above-mentioned reasons, the web application does not use any database managed by a dedicated database server, in order to store meteorological products. Aiming to reduce the risk of errors caused by the absence or scarcity of software and hardware resources demanded by such a server system, and because the effective amount of daily transported information (measured in bytes) is small, we preferred the use of a set of XML files, automatically prepared daily to be filled with information.

Unlike the forecast products, the information about current weather is stored in files persisting from day to day that are overwritten as soon as new information is extracted from the weather observations database. The information is extracted from a database managed by a Microsoft SQL Server system, where observations from the weather stations in Romania are

centralized, then the files are filled with those data and are subsequently transferred via File Transfer Protocol (FTP) on the web application server (fig. 4).

Creating, recording and updating the products is done by forecasters accessing the web page's application through the HTTP protocol, which is a method to transfer information in the Internet that any modern browser is able to perform.

An example of XML file containing a forecast is that for the seaside:

```
<?xml version="1.0" encoding="utf-8"?>
<litoral>
<apa Temperatura="23"></apa>
<zi1 Prognoza="Vremea in prima zi, la mare"></zi1>
<zi2 Prognoza="Vremea a doua zi, la mare"></zi2>
<zi3 Prognoza="Vremea a treia zi, pe litoral"></zi3>
<zi4 Prognoza="La mare, a patra zi"></zi4>
<weekend Prognoza="Vremea la mare, sambata și duminica"></weekend>
</litoral>
```

The structure of a properly formatted XML file is arborescent, as illustrated in the example below:

```
?xml:element or parent node
<litoral>: <?xml> child-node or element of
<apa>, <zi1>, <zi2> etc.: elements or child nodes of <litoral>
Temperatura, Prognoza: attributes of elements <apa>, <zi1>, <zi2>
respectively etc.
"23", "Vremea in prima zi, la mare" etc.: attribute values
```

When the information to be disseminated is recorded, the values of the corresponding XML attributes are actually set. To achieve this, in the web application there are used code sequences that query for, and modify elements in the file, which is a process similar to querying a database.

For instance, on the page where the forecast for the seaside is prepared, there are six text boxes for editing the forecast – one for the sea water temperature and five for the forecast over the next four days and for the last two days of the week. Editing the text in those cases and saving the changes lead to the modifying of values of the corresponding attributes ("Temperatura" and "Prognoza", respectively).

The forecast for each day is stored and updated in files dedicated to the forecast for Romania and Bucharest, for the mountain and seaside area and also for Europe, and in files dedicated to the forecast for cities of interest to customers (county capital cities, resorts in the mountain area and at the seaside, European capital cities and other localities).

Forecasts in text format for the whole national territory or Romania, mountain region, the seaside area, and also for Bucharest and Europe are created on dedicated pages.

The forecast for cities is also created in graphic format, on a dedicated page, where the meteorologist is selecting the icons for the representative phenomena in the intervals of interest, for each locality, and specifying the values of night-time/daytime temperature, snow layer depth, sea temperature (where such is the case) and the wind direction.

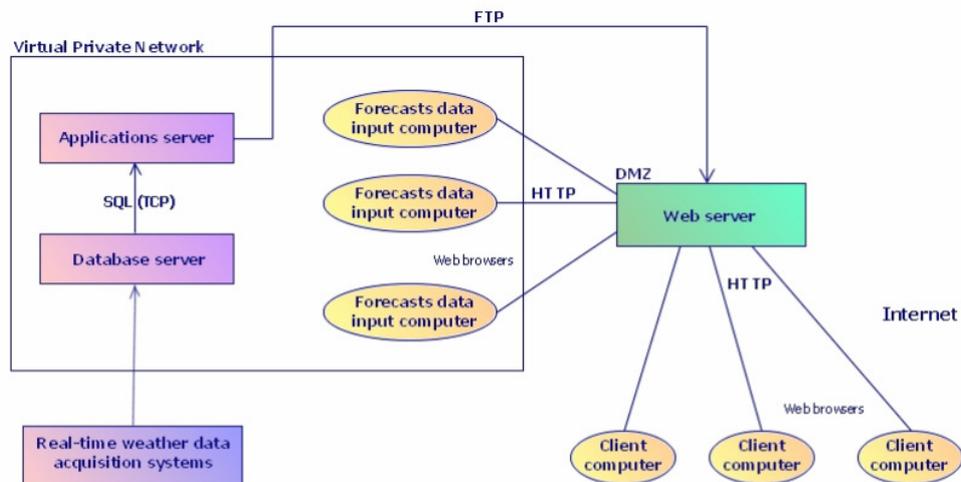


Figure 4. Information flux within the system.

6. WEB APPLICATION SECURITY

All pages benefit from the implementation of features that is ensuring security of the displayed information.

Meteorologists may thus access all pages – those where meteorological products are created and edited and those where products are displayed, while other users are being allowed access to the latter only.

Moreover, all pages are secured against being displayed by unauthenticated users. To access the information, the user must authenticate through the name-password pair; otherwise, the page will not display anything.

7. INFORMATION PRESENTATION MODE

The web application displays the meteorological information in the following formats: text modified with HTML codes for obtaining diacritics and various text styles; unformatted text; tables; icons; maps.

The web application interface is structured for the Regional Meteorological Centres exactly as the one for the National Weather Forecasting Centre in Bucharest – both for those who create the information, and for those who are requiring it.

Each client has access to pages displaying:

- forecasts created on the current day, in text format, for Romania (or for a certain region, for instance Oltenia and the belonging counties – if the client is a customer of a particular Regional Meteorological Centre) and for Bucharest (if the client is a customer of the National Weather Forecasting Centre – NWFC), for the mountain area and the seaside, for Europe) as well as graphic forecasts for locations in Romania and in Europe, as well as for mountain and seaside resorts;

- the graphic forecast from the previous day, valid during the current day;

- messages dedicated to all the customers, and the message dedicated to the current user only;

- nowcasting messages (or warnings of imminent, severe weather); from that page, one can navigate to a map of Romania where the thermal comfort index or the cooling index state is displayed, and to radar images for Romania and the area around Bucharest;

- graphic forecast for cities grouped by historical regions of Romania (if a customer of NWFC);

- graphic forecast for cities, displayed on the map of the national territory of Romania;

- geographic and administrative map of a selected locality – both in the Google Maps and Microsoft Virtual Earth systems;

- the text of the forecast, in a format fit for printing;

- current thermal comfort index (during the summer) and the cooling index (during the winter). These maps are created by operators when the information is considered to be of immediate public interest

- a table rendering the current weather in the county capital cities and in other locations. The displayed weather parameters are: temperature, cloudiness, atmospheric pressure, current weather phenomenon, wind speed and direction, snow depth and sea water temperature;

- a table representing the weather state in the locations with weather stations belonging to each Regional Meteorological Centre;

- a map displaying current weather in the county capital cities, which displays the air temperature and the weather phenomenon, or cloudiness, recorded at the station;

- image files (*wallpapers*) and freely available software applications – all created by the author of this paper;

- multimedia content on the Internet;

- a news list from a RSS channel of the National Meteorological Administration;

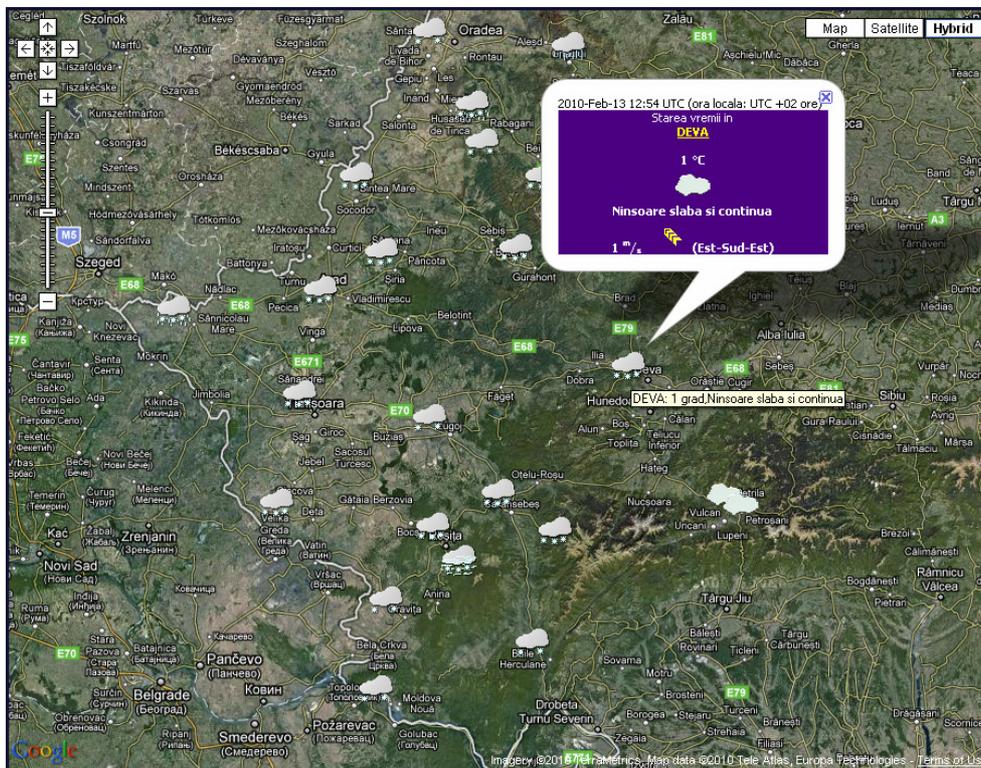


Figure 5. Current weather in Banat and Crisana, rendered graphically in Google Maps.

In the tables, the name of each city or location is placed inside an Internet link element that would lead the user to a page displaying the geographic area around that locality, using the Google Maps system (figure 5). On that page, the region thus displayed can be resized, so as to notice details, depending on the scale of the representation. The user may also display, in satellite or administrative mode, areas from around the entire Earth.

Table-form sections can be hidden and re-displayed with a click on the images corresponding to each forecast.

Before displaying other products, the page displays: the time the page was accessed, the severe weather warning message at national level (if there is one at that time) and a link to the page with nowcasting warnings (if there are some). The message dedicated to that customer only that is accessing the page is displayed immediately after.

The interface of the web application is highly ergonomic, with additional options for the management and structuring of the displayed information:

- the users may place in the memory of the computer that they are working on the texts of forecasts for Romania, for Bucharest, for a specific area of interest and for the mountain area - either separately, or all of them

together. This procedure has been implemented in order to make the forecasts' text available in a simple format, to be further processed by the client with any text editing software;

- the image and background colour of the page, as well as the colour of the displayed text can be modified through selecting one of more than a dozen options.

The user is given control over the format of the page, as sections displaying the graphic forecast can be shrunk and expanded as the client wishes to see or print some of the texts and tables only, containing specific forecasts. The page can display specific forecasts only, for instance the forecast for the seaside area only, or the forecast in graphic format for cities.

As such, the user can easily navigate amidst the products, as they are grouped intuitively and the interface looks the same on any decent Internet browser.

Those who wish to print the page can resort to two keys – one that creates a page containing the forecast in text format only, and one that displays the symbols or icons for weather phenomena in intense colours (a method useful mostly to those who use colour printers). The facility to hide / re-display the graphical forecast for cities is mostly useful to those who wish to print just the text, not the tables containing said forecast.

The Internet address of the page where the current weather in County capital cities is (as of 2010, and authentication is required in order to access it):

<http://anm.meteoromania.ro/meteoinfo/infovremearomania.aspx>

This page contains:

- links guiding the user to pages with the weather state at the stations belonging to each Regional Meteorological Centre;

- an image guiding the user to the latest satellite image of Europe, received from METEOSAT-9 (channel IR 12.0);

- an image guiding the user to the *Meteoalarm* website, where the severe weather situation at European level is being presented depending on current warnings of national forecast centres;

- an image guiding the user to the (composite) radar image of Romania;

- an image guiding the user to the radar image obtained with the radar at the Bucharest site, located at the National Meteorological Administration compound;

- an image guiding the user to the current state of the Sun, as presented by NASA (information supplied by the SOHO satellite).

8. AUTOMATED PROCEDURES

The software system made of its web application and its satellite software applications performs automatical analysis and dissemination procedures for the information supplied from the outside and for that which is transported within it. As such, the system is eliminating the need of manually disseminating the information, and is also reducing the time needed for dissemination.

These procedures are:

8.1. Recognizing and composing the set of forecast products directed to each customer;

8.2. Making available, on web pages, the set of forecast products directed to each customer, which are made available on express (manual) request from the user – forecast texts, customised messages, tables and maps containing the forecast in graphic format;

8.3. Making available, on web pages, values of certain parameters that describe current weather in Romania;

8.4. Making available, on web pages, severe weather warning messages at national and local level, giving the users the possibility to fetch them both by express request and automatically.

9. SATELLITE SOFTWARE OF THE MAIN WEB APPLICATION

9.1. Software application for displaying current weather in Romania on an Internet (web) site

This console application (or program) – that is, without a graphical interface, can run on any computer which is able to access the server where the web application is located. The program runs regularly, every 10 minutes, fetching the values of certain essential meteorological parameters from an observational database at NMA, where they are stored after they are being measured corrected either at the weather station itself, or at the operational centres where they are processed.

The result of operations performed by this program materializes in XML files containing the names of the analysed weather stations, the names and values of the parameters of interest in each location (air temperature, atmospheric pressure, wind speed and direction, cloudiness and current weather phenomenon, snow depth and sea water temperature). Those files are transferred via FTP into a directory on the web application server.

A web page, part of the web application, processes these automatically-generated files in order to display them on the Internet site where the web application resides. There are separate files, dedicated to the weather

stations within each region monitored by a Regional Meteorological Centre, and the web application supplies seven such pages where the weather stations are grouped depending on which RMC they belong to (six pages for the six RMCs and one page displaying current weather in the county capital cities and a few mountain weather stations).

9.2. Software application for integrating meteorological observations made at weather stations (current weather) in software applications of third parties

Currently, this console application supplies the customers acting in television customised XML file which is containing data on current weather in those locations that the customers are interested in. The structure of these files allows them to be used in other software applications, in order to display the information in other formats – either on television, or on web sites the clients own or otherwise manage.

This program can be expanded at any time, so that it can serve all of the clients who use the same software applications developed by a third party.

9.3. Software application for integrating the forecast in programs of third parties

Currently, this desktop application (with a graphical interface) is offering, on a daily basis, to customers in the visual media one customised XML file containing the forecast for cities and other locations, a file whose structure allows it to be used by a software application made by a third party, for graphical presentation on television of various sets of meteorological information.

This program depends on the parent-web application, in the sense that it uses the XML file containing the forecast for localities in Romania, as elaborated on the current date (of the computer the program runs on). Transmission of the final file is performed via FTP protocol, on a site with characteristics specified by the client.

This program can be expanded at any time, so as to serve all the clients who use the same software application developed by a third party.

9.4. Software application for integrating the forecast in software applications operated by the forecast verification department

This console-type program depends on the parent web application, using the coded forecast proposals of Regional Weather Forecasting Services. The program runs automatically and produces files in a format intelligible to the software applications necessary for the verification of the forecasts for different regions and localities.

9.5. Software application for displaying the forecast for locations in Romania and abroad.

This desktop application allows for an extremely dynamic selection of all the information necessary to plot the forecast for certain localities on a map of Romania.

The operator of this program can specify on any image the coordinates of the locations of interest, their names, the set of symbols for the weather phenomena and the date of the forecast to be displayed in the image. Through a maximum five selections, there can be displayed both the graphic forecast for those locations of interest for a customer, and a forecast text or another message dedicated to that client, superimposed on the final image.

The map containing the forecast can be saved as a file in all the standard graphic formats recognized at user-level (JPEG, PNG, GIF, BMP, WMF).

This program depends on the main web application, because it uses the XML files that contain the forecast for locations in Romania and abroad, that were created on the particular date that is selected by the operator.

9.6. Software application for fetching the XML file containing the current weather in localities preferred by the client.

This desktop application allows for fetching this file and transferring it in other locations on users' computers, in order for them to be further processed. The XML file is containing data on current weather in those locations only that the customer is interested in. Access to this customised file is granted on the basis of authentication data used to access the products supplied by the main web application.

10. OTHER SERVICES SUPPLIED BY THE SYSTEM

The web application has been gradually expanded over three years, encompassing additional services for meteorologists and clients. These services are:

10.1. Archiving meteorological products

Forecasts are automatically archived – both those in text format, and the graphical ones, for cities. Forecasts stored in archives are useful to forecast verification at a later date. The corresponding XML files are compressed in unique files, using the ZIP compression system.

10.2. Electronic mail

Suppliers of meteorological information (meteorologists and any other authorized operator) have access to a page wherefrom e-mails can be sent. Files attached to the text message can also be sent over to customers.

10.3. News in RSS (Really Simple Syndication) format

More and more web sites of television and radio channels, online newspapers etc., are disseminating information over the Internet too, by using the XML format, and following the popular RSS, RDS or Atom models. The web application described here contains also a web page where news can be created for an RSS channel of NMA, that anyone who is using a software application that can access such news channels is able to read these news with meteorological subject (or other subjects).

The RSS news channel address is (as of 2010):

<http://anm.meteoromania.ro/metecoinfo/rssmeteo/meteonews.xml>

We have conceived and made available to the users of the web application such an RSS newsreader software application. The program runs on the Microsoft Windows 2000 operating system and higher versions, and the Internet address wherefrom it can be downloaded on computer is:

<http://anm.meteoromania.ro/metecoinfo/downloads/cititordestiri/SINAPSANewsReader.msi>

10.4. Various software applications and background images

All users of the application can visit two pages where they can download software applications from, and background images (photos and digital graphics), created by the author and made available free of charge.

10.5. Directing the user to various destinations on the Internet

A page of the web application is presenting the user with links to a large selection of web sites, grouped as follows:

- national scientific institutions (National Meteorological Administration, National Institute of Hydrology and Water Management, Ministry of Environment and Forests, World Meteorological Organization, European Centre for Medium-Range Weather Forecasts, National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, United States Geological Survey etc.);
- news sites (ROMPRES, Associated Press, BBC, EFE, Reuters etc.);
- general information sites (Encyclopaedia of the Atmospheric

Environment etc.);

- weather sites (World Weather Information Service, Weather.org, WeatherImages.org, Der Karlsruher Wolkenatlas);
- various scientific sites (Astronomy Picture Of the Day, ScienceWorld, SpaceWeather);
- Internet search engines (AltaVista, Google, Yahoo);
- sites with digital graphics (CGSociety, Renderosity).

10.6. Messages for meteorologists and the author

A page of the application offers the users the possibility to send opinions and preferences to the author and to meteorologists.

11. CONCLUSIONS

We consider that this paper's objective has been reached, since the system presented herein does indeed contribute significantly to the increase in operative efficiency of creating and conveying to various users the meteorological products made by the National Meteorological Administration of Romania. In its current stage, the system distributes a maximum amount of information with a minimum of expenses. The major benefits of using this system are:

(1) Waiting queues for delivering meteorological products to customers in the media have been totally eliminated, and the number of demands by phone that were previously answered to by meteorologists and technicians has decreased significantly;

(2) Severe weather warnings and any forecast product and customised messages are made available for most of the media and for all those interested (mayoralities, prefectures and other authorities) in seconds, after they are being issued.

(3) The quality of products displayed to customers, acting in the media, of the National Meteorological Administration of Romania, has been improved.

(4) The range of products delivered to customers and the general public is permanently enriched, by expanding the web application and creating satellite software applications.

(5) Expenses associated to delivering products to new customers are avoided, by rapid transmission via the Internet, instead of telephone/facsimile.

(6) A new face has been given to the style of information with meteorological specific, a well-known fact being that such information is implicitly rigid in form.

The complex software system that the web application presented here

is at the centre of, has revolutionised the way customised meteorological products are presented to those interested, by their automated composition from general products and their real-time availability to a large number of customers of the National Meteorological Administration.

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