INTERACTIVE APPLICATIONS IN A HIGHLY AUTOMATED ENVIRONMENT

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Summary: During the last three years KNMI introduced an important new system in the operational forecast production process: the Meteorological Workstation. In this system much data from various sources have been integrated: observations, radar, satellite, model output. The functionality of the system has been growing through this period and is still growing. At the same time new interactive applications, some of them using AI techniques, have been developed for use by the forecaster at his workstation. Sofar applications are being built for short range precipitation and fog forecasting.

In this contribution an overview is given of the current Meteorological Workstation with special attention to the role of the forecaster in the operational production process.

1. HISTORY

One of the starting points in the KNMI meteorological workstation (MWS) project was the use of proven technology. Therefore a commercially available MWS has been purchased from an American vendor: RMS Technology Inc. The system has been customized for KNMI on the basis of KNMI requirements. The system is flexible in the sense that it is relatively easy to make changes or extensions to the system. Flexibility was also one of the requirements. Other basic requirements include use of UNIX operating system and X-windows (OSF/Motif) graphics.

The project started in 1991 while the contract was signed in June 1992. In December of the same year the first MWS was available. In September 1994 MWS's had been introduced at all 16 operational sites. In July 1995 the system has been accepted operationally. In December a project started for the development of an extension to the operational system.

2. CONFIGURATION

Starting with DEC-Ultrix systems the MWS is now running on the DEC-Alpha 3000 series. The system has been built as a client server system: on the ingest server the databases reside and all data-ingest processes are running; on the client the display applications are running. The display machine uses three screens (fig. 1). Ingest as well as display units include at this time 96 Mb of internal memory and 1.4 Gb disks. Display systems are available at all operational sites, i.e. 17 display systems at 7 sites. At each main site two ingest servers are available, whereas at the local services ingest and display applications are running on the same machine. By using the same machines for data ingest and display a high degree of availability is reached. At each site all systems are connected to the local area network (ethernet). Using the network data are retrieved from external databases and the GTS.

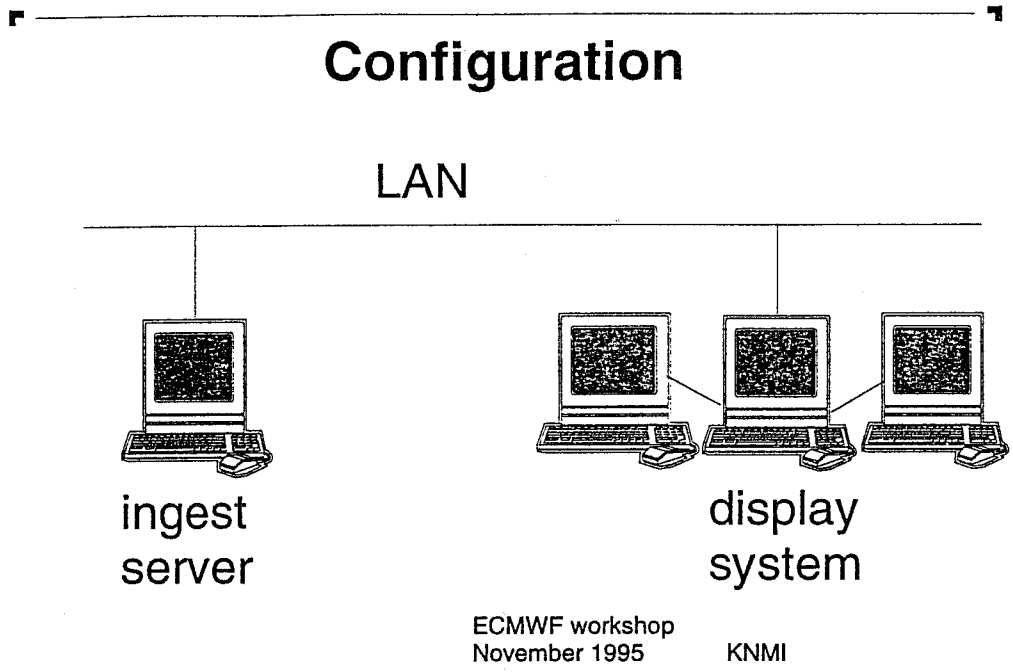

Fig. 1 Client-server configuration

The different sites are connected by a wide area network. The main sites are coupled via double 64 kbit lines. The local services have single 64 kbit connections (fig. 2).

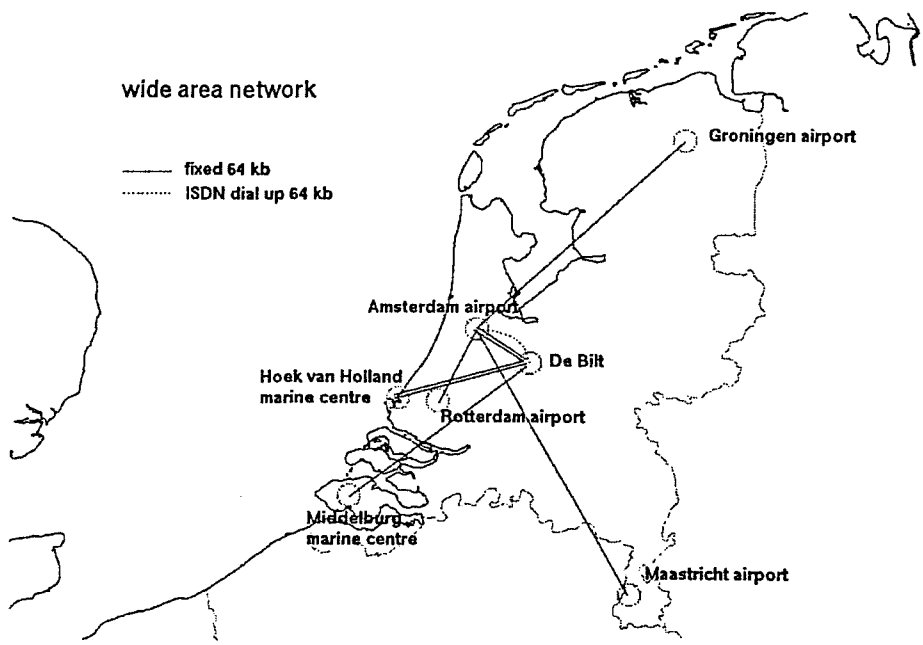

Fig. 2 Wide area network

The ingest process is split into two phases. In the primary process observations and imagery from satellites and radars is received by active transmission from the datasource. The modeldata are retrieved by a "grabber" process running on the primary ingest machines. At predefined times the grabber is looking for new model data. Then, during the secondary process, data-copiers disseminate the data to the

other ingest servers after which the data is stored in the MWS databases (fig. 3).

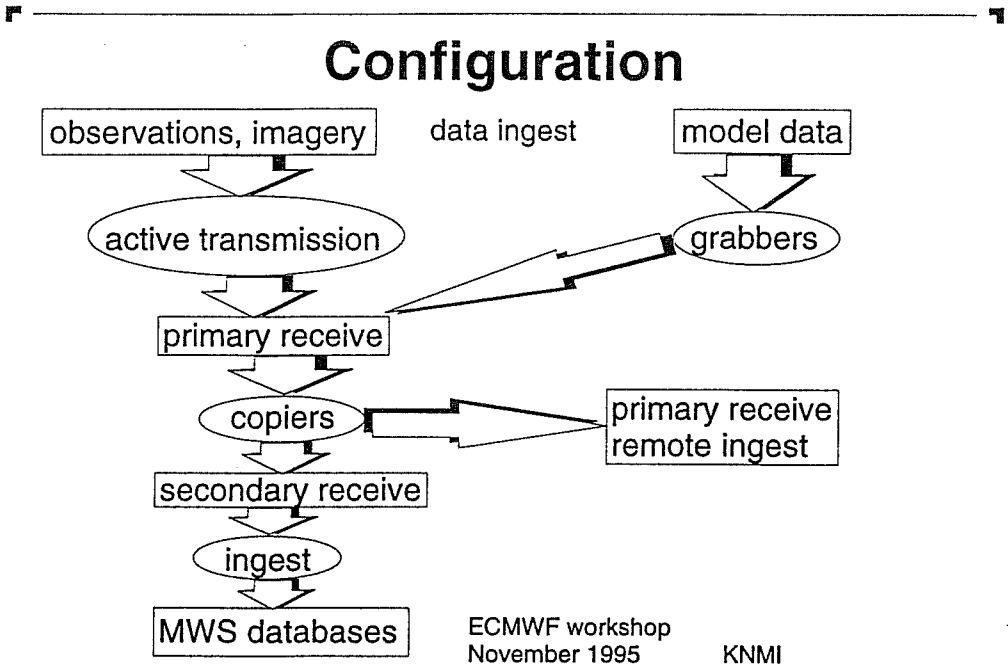

Fig. 3 Two phases data ingest process

3. FUNCTIONALITY

3.1 **Datasources**

The following datasources are available in the MWS:

* satellite: Meteosat, Goes and NOAA, all channels;
* radar: Dutch sites as well as mosaics with data from surrounding countries;
* difax: digital facsimile data, mostly originating from the Bracknell database;
* profiles: observed TEMP-data as well as profiles retrieved from model GRIB-data; the latter can be selected from a map with all model gridpoints;
* station plots: plotted SYNOPS, METARS, upper air data from TEMPS, SATOBS, SATEMS, spheric locations from SFLOCS; observed parameters as well as derived parameters from observations (like all kinds of stability indices);
* alphanumeric: all ascii data can also be presented in alphanumerical form; this is mostly used as control;
* modelfields: contoured GRIB-data from various models: ECMWF, UKMO, HIRLAM, VIMOLA (vertically integrated short range model), NEDWAM (Netherlands version of WAM-model), WAQUA (model to predict sea level); standard model parameters as well as derived parameters;
* time series: observed as well as derived from models or combined timeseries;

* vertical cross-sections: from observed TEMP-data as well as from model profiles; arbitrary cross-sections can be selected from a map with all available station-data or model gridpoints respectively;
* trajectories: backward and forward trajectories are computed from modeldata (ECMWF, and, before long from HIRLAM).

3.2 Functions

Apart from presentation data can be manipulated using a set of functions.

* overlays can be produced from all kinds of geographical data (satellite, radar, stations, modelfields, trajectories);
* folders can be produced consisting of a set of information relevant for production of special forecasts or for briefing purposes;
* many projections can be used from the entire globe until a small region; stereographic as well as Mercator projection can be used;
* together with the projections map-backgrounds are available or can be defined to display details about infrastructure like cities, rivers, motorways, railways etc.
* a contouring package is available to contour observational data;
* a drawing package is available to add all kinds of graphical information to a product like fronts, weather symbols, lines, shadings, texts etc.
* many datasources can be animated: radar and satellite but also observations, modeldata and even profiles;
* data can be printed, plotted and sent to other sites; during 1996 the system will be extended with a possibility to create products in standard formats to send to customers;
* standard actions of panning, zooming, distance measuring are also available.

3.3 Features

Some special features should be mentioned here.

* In the background products can be created automatically. In this way products that are needed at standard times can be created without interaction.
* A macro facility is available to pre-programme a series of actions. At an arbitrary time this macro can be used to perform this series of actions. This is a very effective way to speed up the interactive process.
* Within the MWS other applications can be started using a separate window.
* A big deal of all system parameters and defaults can be configured externally using configuration files. In this way also product lists can be extpanded by the system manager: for intstance insertion

of a new model.

4. OPERATIONAL INTRODUCTION

The operational introduction of MWS's at KNMI took place in the period summer 1994 until summer 1995. So the introduction was gradual. After a short training on how to use the system the forecasters needed time to build up experience. Some pioneer users were charged to develop macros and new techniques which were helpful for the other users. The time spent on this developments was needed to root the system in the organization.

5. PRODUCTION PROCESS

The Meteorological Workstation System occupies an important place in the current operational production process. Currently observational data is directly fed into the MWS, while satellite and radar data as well as model output is retrieved from databases. The model databases contain GRIB data from all models in use (see section 3.1) and are filled fully automatically. Human interaction takes place mainly at the MWS where the forecaster does his diagnostic work and makes fundamental forecasts. Final products are produced by a set of applications called "product generators" (fig. 4). Currently these product generators are not fully automatic, forecasters spend an important part of their time on these applications.

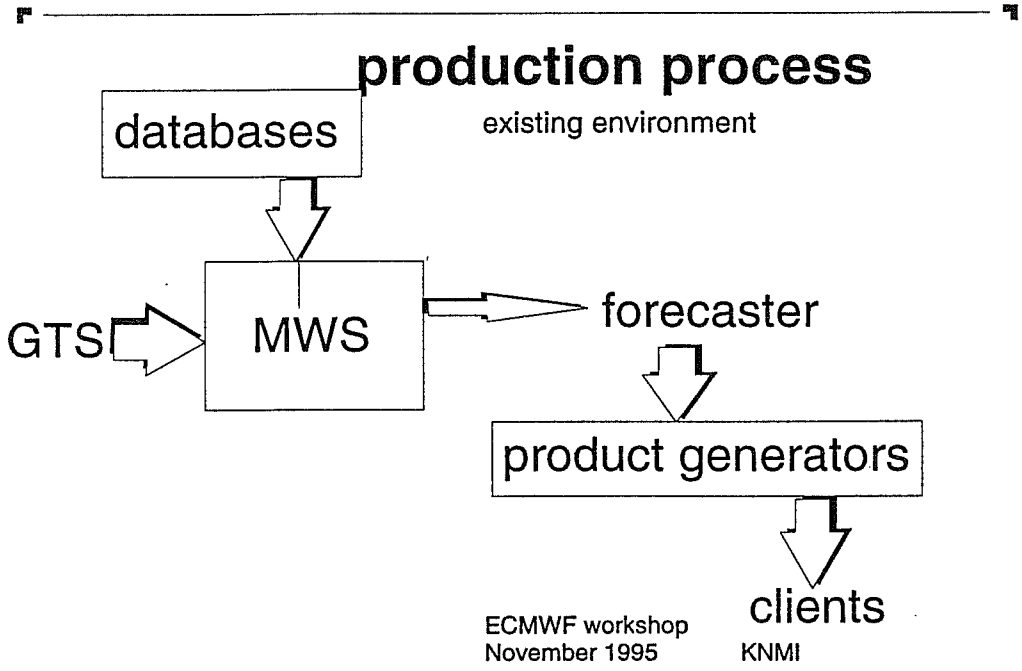

Fig. 4 Production process, current environment

The next few years KNMI will transform its production process in a way to make it still more efficient. Though not all details are already clear the main concept will look like fig. 5. At the data input side the

current databases will be integrated using the NEONS database structure from the Naval Research Laboratory in Monterey, Calif. The MWS will be extended to incorporate interactive tools for the forecaster to make basic forecasts (see section 6). These basic forecasts will be stored in a special database that will be the input for the product generators. Another feature will be the Automatic Text Generator (ATG) that transforms basic forecast numbers into basic forecast texts. The product generators will be automized as much as possible, while their output will be stored in a product database from where distribution to customers can take place.

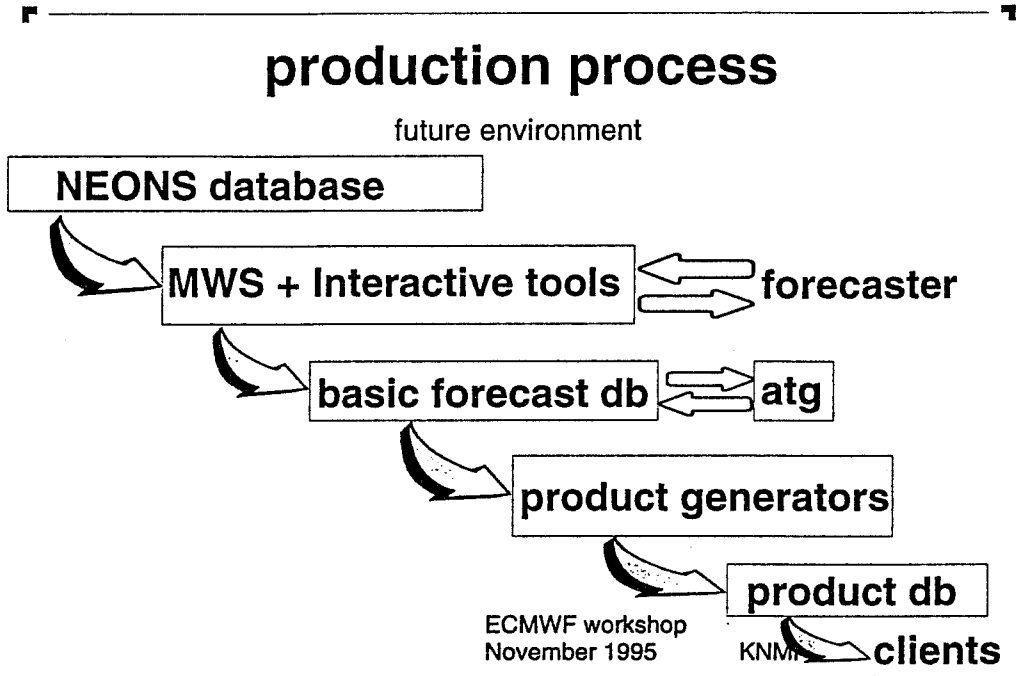

Fig. 5 Production process, future environment

6. NEW DEVELOPMENTS

The developments that will take place with respect to the Meteorological Workstation during the next few years are listed in this section.

* phasing-out of non cost-effective systems
* integration of current systems
* making available of new datasources and datatypes, including graphics metafile, lightning data (Safir system), windprofiler data, aircraft data (AMDAR)
* output to standard output formats: GIF, HPGL, FAX etc.
* enhancement of current functionality
* connection to NEONS database
* enhancement of production tools

* integration of Knowledge Based System for fog forecasting
* integration of Knowledge Based System for short range precipitation forecasting

7. CONCLUDING REMARKS

The KNMI Meteorological Workstation System is a user tailored commercial system. It has been gradually introduced and is now fully operational. It is the focal point of the interactive production process. The technical development of the system still goes on and is expected to go on also the next few years. These new developments are driven by two main causes. Firstly the need to rationalize the operational production process in order to make service to customers as efficient as possible and secondly the importance to make use of new developments in operational meteorology, like new datatypes and new methods. It is believed that the current MWS is capable to manage both kinds of future developments.