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## **ARTEMIS network user interface**

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# **ARTEMIS NETWORK USER INTERFACE**

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## **Abstract**

The FAO office in Rome operates a remote-sensing ground station, ARTEMIS (Africa Real-Time Environmental Monitoring Information System), that provides information - derived from METEOSAT and NOAA data - for regional and national institutions in Africa concerned with early warning for food security. Officers of these institutions receive the information from ARTEMIS routinely. However, for ad-hoc requests and to retransmit images that had not been received properly, the officers often have to send a request to the ARTEMIS operator for a specific ARTEMIS product. Because of the large amount of manual actions to be taken to handle the requests, automation of the request procedure has become necessary. The automation has recently been realised by the development of the ARTEMIS NUI (Network User Interface), satisfying the requirements for flexibility, accessibility and shorter response times. Also, the operator workload has decreased.

ARTEMIS products can now be requested by selected users by issuing a formatted product request to ARTEMIS, using e-mail.

## **1 Introduction**

### **1.1 ARTEMIS**

ARTEMIS is an acronym for Africa Real-Time Environmental Monitoring Information System. The objective for ARTEMIS is to establish near real-time production of information on food security in Africa, particularly by providing information on rainfall and vegetation/crop development. With this information, the progress and status of the growing season can be closely monitored and areas with possible crop failures, as well as potential locust breeding areas, identified in an early stage.

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### 1.2 System responsibility

ARTEMIS is located at FAO Headquarters in Rome, Italy. It is managed by the Remote Sensing Centre, which is part of the Sustainable Development department of the FAO.

### 1.3 Concise system outline

ARTEMIS consists of an HP-1000 computer system with associated equipment (status January 1996):

- HP-1000 computer with A900 processor
- PDUS (Primary Data User Station) for reception of METEOSAT satellite information
- Approximately 3 GByte of hard disk space
- Tape drives
- Optical disk drive
- RAMTEK visualisation system
- Colour printer
- Plotter
- Hard copy camera

#### 1.4 ARTEMIS products

ARTEMIS derives ten-day (dekad) and monthly products from METEOSAT and NOAA remote sensing data. Currently the following products are delivered routinely each ten-day period (dekad):

- DERF - estimated rainfall
- DCCD - cold cloud duration
- DNDVI - normalized vegetation index

and the following products each month:

- MERF - estimated rainfall
- MNRFD - number of rainfall days
- MNDVI - normalized vegetation index

Other types products are available on an experimental basis.

The METEOSAT data is received and processed by ARTEMIS. NOAA data is delivered on tape, either raw data to be processed by ARTEMIS or preprocessed data.

#### 1.5 ARTEMIS users

ARTEMIS information is used routinely by FAO for its Global Information and Early Warning System (GIEWS) on food and agriculture and for desert locust plague prevention. Furthermore, in Africa routine users are located at regional and national institutions dealing with food security.

### 1.6 Operational availability

In 1987 and 1988, the detailed design, development, integration and validation of the system took place at the National Aerospace Laboratory NLR in the Netherlands, under contract from the FAO. ARTEMIS has been operational at FAO since 1988, almost without any serious interruption. During these years, a large database has been accumulated with historical information on agrometeorological parameters.

### 1.7 Distribution of products

The distribution of ARTEMIS product has become widespread during the last years. In the beginning, mainly hard copies were produced and sent to the local and regional users. However, soon after e-mail became readily available, an increasing number of users were served by sending them the data by electronic means.

The e-mail distribution started with dissemination to Harare: one intermediate user serving around 20 end-users with 12 images per month, of around 200 kbyte (uncompressed) each. As soon as this operated properly, FAO started to provide Accra (FAO Regional Office) with ARTEMIS products, 16 images per month of 1.1 Mbyte each (uncompressed).

## **2 Network User Interface**

### 2.1 General

The growth of the demand for ARTEMIS products revealed bottlenecks in the handling of ARTEMIS products. This observation has induced the requirement for automation of ARTEMIS product generation. This is the primary objective for the NUI project.

The increasing use of ARTEMIS products also resulted in an increasing workload of the ARTEMIS operator. A second goal for NUI, therefore, is increased support for the ARTEMIS operator.



## 2.2 Limiting conditions

Although automation was desired, stringent requirements apply with respect to the required remote infrastructure. Any solution should employ asynchronous, small bandwidth communications only. Considering WWW, telnet, ftp and e-mail as commonly used communication means, only e-mail (electronic mail) can satisfy these requirements.

The use of networks, at least in Africa, is expensive. Since the size of the ARTEMIS products is quite large, compression should be used to minimise the load on the network.

ARTEMIS products are used on a variety of computer platforms, so the ARTEMIS compression utility should generate information that can be decompressed by a commonly used and readily available decompression utility.

Furthermore, during implementation of the automation the operational status of ARTEMIS was not allowed to degrade significantly.

## 2.3 NUI development

To realise the automation, an e-mail server has been implemented on the ARTEMIS HP-1000 computer, together with some associated developments. The elements of NUI can best be illustrated by figure 3.

The NUI elements indicated in figure 3 will be described below.

2.3.1 Product request To use the e-mail server, product requests have to be made, which use a fixed structure. An example of a product request is shown:

---

```

begin
  -- user identification section -----
  UIC=1234
  -- options section -----
  split_file_size=100
  target=PC
  -- product requests section -----
  point_list,dndvi,africa,960301,namibia.spf
  map,dccd,africa,960301,eth.sdf
  database_list
  product_request
  product_request
  ..
  product_request
end

```

---

The structure of the product request generally use the same structure as is required for retrieval from the ARTEMIS database containing the products.

The product request consists of three sections:

- User identification section, in which the User Identification Code is specified.
- Options section, in which several options applicable for further processing, are specified, The options are described in the element descriptions for which they are meaningful.
- Product request section, in which the actual product requests are made, each consisting of one line.

There are three major type of product requests:

- "map", resulting in an thematic map returned to the user. Several options may be specified as parameters to the "map" command, controlling e.g. the method of processing and display format. The example described below only presents the most basic options.

---

Example: **map,dccd,africa,960301,eth.sdf**

This command will return a **map** of a 10-day period (**DCCD**, **D** for dekad) for the parameter Cold Cloud Duration (**DCCD**), using the thematic map of **Africa**. The dekad image is used which contains the date **960301** (i.e. March, 1 through March, 10 1996). The map is a subarea extraction for the region **Ethiopia** (**sdf**: subarea definition file).

---

- "point\_list", resulting in a list of values for specific geographic locations to be returned to the user. Several options may be specified as parameters to the "point\_list" command.
- "database\_list", resulting in a list of available thematic maps in the ARTEMIS database.

---

Example:

**point\_list,mndvi,africa,960301,namibia.spf**

This command will return a **point\_data\_list** of a monthly period (**MNDVI**, **M** for month) for the parameter Normalised Difference Vegetation Index (**MNDVI**), using the thematic map of **Africa**. The monthly thematic map is used which contains the date **960301** (i.e. March 1996). The results are listed for all locations defined in the file **namibia.spf**.

---

When the e-mail message with all three sections is completed, it is sent to artniu@fao.org.

2.3.2 Reception The e-mail arrives at the central FAO mail gateway, which routes the e-mail to the ARTEMIS computer. The message then is received by the operating system mail program ("sendmail") and routed to the e-mail server developed for ARTEMIS, NUI.

2.3.3 Validation NUI verifies that the user is authorised to request a product, by checking whether the "From:" e-mail address is in the list of authorised users and whether the specified UIC (User Identification Code, specified in the user identification section of the e-mail message) corresponds with the corresponding UIC in the list. If not both checks are positive the e-mail is ignored completely, except that the operator is informed of the identification failure. By not giving any information to an illegal access attempt, a possible intruder will not get any clues on the way the system responds. If the user is authorised, processing continues. Only the operator is informed.

2.3.4 Process preparation If the user is authorised, NUI creates a command file on disk containing all information required by ARTEMIS. This is realised by parsing the product request lines into the command file, which will be read by the ARTEMIS database manager (refer §2.3.5).

NUI maintains a buffer (NUI-buffer) of at least 25 MBytes for most recent requested products. If the requested product already exists on disk, the procedure skips ARTEMIS further processing and initiates the transmission, starting with the uuencode phase (ref §2.3.9). Processing of requests then is considerably faster. Products on disk are stored in compressed format, to maximise the capacity of the buffer and to prevent repeated compression of the same product.

2.3.5 Process initiation After preparation of the command file, NUI issues a command: "Execute command file" to start the ARTEMIS processing required.

2.3.6 ARTEMIS Processing After initiation, the ARTEMIS database manager operates autonomously with the information in the command file. The result is that the requested product is stored as a data file on disk.

The database contains Thematic Maps, which each cover the complete African continent for a specific agrometeorological parameter (e.g. NDVI, number of rainfall days). Processing based on the product request acts on these Thematic Maps and may include formatting, masking and subarea extraction. The result is designated "Thematic product".

The processing required to create the original Thematic Maps in the database is called thematic processing. Thematic processing requires about 50% of the available processing resources ( $\pm$  12 hours a day). Thematic Maps are approved (by the operator) before they are stored in the database. Therefore NUI only can use approved Thematic Maps for generating products.

Thematic processing requires a higher priority than the processing of product requests. In order to eliminate the risk of NUI-related processing delaying the thematic processing, NUI was developed to process the e-mail requests sequentially, enforcing that a specific product request procedure is completed before processing of the next request starts. Furthermore, the processing of product requests has a lower system priority than thematic processing.

2.3.7 Thematic Product The result of the ARTEMIS processing is a Thematic Product, that is stored as a disk

file. The name of the file is communicated to NUI, which will take over for preparation of the Thematic Product for transmission.

2.3.8 Compression To minimise the size of files before transmission, the Thematic product is compressed using the PACK algorithm. Initially gzip was envisioned for compression, but this utility could not be made working satisfactorily using the available system resources of the HP-1000 computer.

Nevertheless, at the user side, gzip still can be used for decompression of the product, because gzip is PACK-compatible.

The compression ratio for normal ARTEMIS products is around a factor 2.

2.3.9 Encoding E-mail transmission exclusively uses 7-bit communications, assuming ASCII-only information transfer. To enable binary (8-bit) information to be transported using e-mail, the contents of the binary information need to be converted to 7-bit information. The utility used for this conversion is called uuencode. At the sender side 8-bit information is converted to 7-bit using uuencode. At the receiver side the 7-bit information is converted back to the original 8-bit information using uudecode. To allow transfer to various platforms, the options section in the product requests allows for an option "Target" which identifies the platform on which the product is uudecoded. To guarantee correct decoding, this information is required during encoding.

2.3.10 Segmenting E-mail service providers (especially in Africa) sometimes impose upper limits to the message size for e-mail. To provide adequate means for reliable transmission of the products, it should be ensured that messages are smaller than such a limit. If the message is larger, it needs to be segmented in as many parts as necessary, so that all parts are smaller than the smallest maximum e-mail size of the complete transmission path, which may spread over many service providers.

The user is responsible for specification of a suitable maximum message size in the options section (Ref. §2.3.1). The maximum size specified in the request may not exceed the maximum size imposed by the FAO mail service. Therefore, an upper limit to the maximum e-mail message size is specified by the ARTEMIS operator.

2.3.11 Transmission After the segmenting action, all parts are sent by the sendmail program to the user via the central FAO mail gateway.

2.3.12 Product delivery When products are received, the user performs the inverse actions in the reverse order:

- put the parts together in the correct order (parts sometimes do not arrive in the order they were sent),
- uudecode the complete message,
- decompress the decoded file.

After these action the data is ready to be used.

To support the user during this request process a User Manual has been prepared.

## 2.4 Standard Mail Generator

The product request procedure presented above assumes that the remote user initiates the product request. However, the ARTEMIS operator normally initiates distribution of the products directly after approving the results of the thematic processing. To ease this routine

distribution, a Standard Mail Generator was developed, which was implemented in FORTRAN.

The ARTEMIS operator uses this utility for generating e-mail messages with product requests destined for the remote users. The messages are generated from a list of e-mail message bodies, kept on file by the operator. This list contains product requests with the date parameters not yet specified. In addition to the options available for normal users (in the "options section" of the product request, ref. §2.3.1), the operator is allowed to specify the recipient of the ARTEMIS product in each message body. When the operator issues the applicable command, the date specified on the command line is inserted in all applicable date-parameters and each message is send separately to artniu@fao.org.

In other words, the request is issued by the operator 'on behalf' of the recipient. In this way the ARTEMIS operator is able to perform all routine distribution with a few commands.

#### 2.5 Test and acceptance

The majority of the design and development was performed remotely, i.e. NLR engineers developed code at NLR, then tested the software at ARTEMIS. No serious interruption of the operational status of ARTEMIS has occurred, except one: during the upgrade of the Operating System, required for installation of mail functions. This inevitable interruption only delayed some ARTEMIS activities.

On 23 February 1996, NUI successfully completed the acceptance tests at FAO, Rome.



## 2.6 Requirements assessment

With respect to the requirements stated in the beginning of this section, it can be concluded that all requirements have been met:

- NUI successfully implements the requirement for automation of the product request procedure.

- NUI only requires an e-mail connection which satisfies the demand for low cost communication with poor telecommunications infrastructure.
- Compression has been achieved.
- The workload of the operator has been decreased by installation of the Standard Mail Generator.
- The operational status of ARTEMIS could be continued during the NUI installation.

### **3 Conclusions and future outlook**

ARTEMIS has been enhanced with the capability to automatically respond to product requests, issued by authorised users. Users specify their requests by e-mail, using a structured command syntax.

The product request process only requires an e-mail connection between ARTEMIS and the user, so NUI meets the requirement for low cost communications.

Turn around time for product has been decreased considerably, because no operator interference is required any more.

The Standard Mail Generator decreases the operator workload by enabling the operator to maintain standard list with product requests, in which only the actual dates need to be filled in. This easily is done with a command line parameter.

### **Acknowledgement**

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