Proceedings of ERAD 2006

The German weather radar network: Revolution in software without operational interruption

Th. Hohmann [1], T. Mammen [2], K. Desler [2]

[1] DWD Meteorological Observatory Hohenpeißenberg,Hohenpeißenberg (Germany)
[2] DWD Dept. of Technical Infrastructure, Hamburg, (Germany)

1 Introduction

In 2000 , the German weather service (DWD) decided to replace the fifteen year old computer equipment of its weather radar network, hardware and software, and migrating from the proprietary operating system VMS to an open Linux platform. There where three major objectives : no interruption of any radar longer than one day due to the change, no change at all in scanning, product generation and format, but high flexibility in software structure to match the requirements in the future.

2 Concept

Changing the whole IT- equipment under 'running wheel' has a big skill : the new site systems and the network must run with full performance and availability without start up time. This includes controlling the existing radar hardware,signal processors and maintenance, running the network in a mixed environment during the transition periode and producing bit-compatible products , so that users wouldn't notice, that radars were switched from old to new software.

2.1 Generic RCP and DSP interface

To adapt the choosen radar software packet of the shelf to DWD specific radar equipment without rewriting a lot of code, a generic interface is used. Based on a description file, generic radar functions can be defined and mapped to dedicated bits and protocol structure.

Correspondance to : Thomas Hohmann .
Thomas.Hohmann@dwd.de

This also covers hardware changes in the future without the need of source code changes.

2.2 Network function

To test all network functions before going in operational mode, a method of building a 'shadow network' was choosen. All sites were equipped with the new computer hardware and software as soon as possible even though not all componentes were not yet implemented.
The radar application software on all sites was set up in simulation mode. All modules were started and tested, except the driver modules. They were not connected to the real radars, but to a software pattern insertion process.
Since all internal communication is achived by TCI/IP sockets and streams, setting dedicated ports could be used to build a closed network for simulated data. This prevents interaction with any module in operational mode.This technique was also used to run in parallel incompatible versions during development.

2.3 Product generation

To keep the impact of all the changes as small as possible for actual users, bit compatible products are needed as one output stream. To achive this without beeing tied to the past, product generation is organized in stages: data acquisition – preprocessing – generic product generation – postprocessing, all separat processes. Using this scheme, the product generator can be designed according newest developments, generating only the contents of a product, i.e image arrays or lists. Then, using a configurable link list, this contents will be attached to a dedicated postprocess, which adds the desired frame and packs it up in the format needed.This gives the flexibility to produce as much different formats as needed, without having to rerun time consuming product generation algorithms again.

3 Implementation

The implementation process consisted of three phases. Two of them were in parallel : setting up a single radar for testing communication with the real radar (control , status and maintenance) and setting up the whole network in simulation mode to test the framework interprocess communication.The final step then was switching site by site from simulation to operational mode.

3.1 Setting up RCP and DSP

For setup and testing the radar interfaces the research radar at Hohenpeißenberg was the best place. From the basic version up to the final release, all versions were first configured and tested at the research radar. The DSP setup was rather simple, since the number of different types of digital signal processors for radars in the world is rather limited. The drivers for most of them were already part of the software. To build a correct and complete mapping file for RCP commands and status took some time, and a lot of bit testing was necessary. But all functions could be mapped. Here an example of the text file, describing protocol and command of the DWD RCP protocol to switch radiate on :

```
encoding=hex
start=0x80
stop=0xff
heading=Command
value=RADIATION_ON;1-u-bit-string;6:2; off; off,on;Radiation On;
```

The generic command name throughout the software is RADIATION_ON. In DWD this means 1 Bit is used, the second Bit of Byte 6 in the protocol packet starting with 0x80. Hexcode is used.

3.2 Network setup and testing

The behaviour of a greater network, where free addressable message exchange between arbitrary processes is allowed, is hard to predict but a crucial point in operational networks. Performance mostly doesn't decrease linearly when the network grows up. It remains nearly stable to a certain point, but one more station may let collapse the whole network. To avoid not detecting this until operational mode, a 'shadow network' was build up in advance. All sites were already equipped with the new computing components, and all sites where running with operational scans and products configured, except data was simulated and products were not distributed. Adding the ninth node led to the effect we were warried about, caused by memory constraints. They could be debugged and fixed without doing harm to the operational network.

3.3 Products , compatibility versus flexibility

Product compatibility has to aspects. One is the transition period, the other one is undisturbed product supply for actual users.
To allow a soft migration from the old software to the new one during a longer period,where new and old software is running in the network at the same time, new products have to be identical to the old ones . To accomplish this, the old scan and product configuration was translated for the new software : same elevation angles, ranges, processing parameters, resolution and scheduling.According the staging concept, the system generates a set of generic products with eqivalent content to the old ones. This goes than through the post processing module producing a bit compatible product suite as output.
This seems to bee a lot of effort for only refactoring what is already there. But the big advantage to the old software system is , this is only one configuration among many others. Starting from here, totaly new configurations , products and formats can be desiged without causing trouble nor during the transition period neither to actual users.

3.4 Transition period and first experiences

After three years of development and testing, in 2005 time was ready to switch site by site from simulation mode to operational mode.
During a normal maintenance, the old computers were shut down, the serial line to the RCP and the SCSI-line to the DSP were disconnected and reconnected to the new equipment. Simulation mode was stopped, set to normal mode and TCP/IP ports changed. Within half a day the radar came up with the new software, performing exactly the same scans as before. Since all products where reproduced in bit compatible way and product algorithms didn't change , most of the users even didn't realize, that a new generation of computers and software were installed. Also compositing run without disruption.
The transition periode took aproximatly two month for the 16 radar sites.Additional maintenance sites were configured, were only the monitoring part of the software is activated. So we have a network of 24 running nodes now.
It was a very robust method to make changes to the software sytem with no decrease in availability. Even unpredictable events like illness of the personal or very bad wether were no risk for a 100% availability of the whole network. No products, except for normal maintenance, were missing. None of the nearly hundred display system inside and outside DWD failed.
Exchanging the whole IT environment of the radar network to be prepared for the future could be accomplished without interruption of any radar site, without any inconsistency in products or composits.

4 Next steps

Having now a stable network running with the new software, DWD will use the new flexebility to smoothly upgrade different parts of the radar network.

4.1 New formats

The first benefit of the new system is the possibility to add an additional outputstream of existing products coded in BUFR .This makes product exchange much easier in Europe and is the preferred input format for NinJo.

4.2 New products

Another benefit is the availability of new products. Since the new structure allows adding new products by only copying a product module in a dedicated directory and connecting it with a simple ASCII interface . One of the first products added will be single sweeps, coded in BUFR, to transmit volumes already during data collection time.

4.3 New scans

A third advantage of the new software design is the strict modularity and realtime processing. New or additional scans can be setup by configuration, reflecting new scan strategies and DSP parameters. No precalculated tables will be necessary. Products (with or without projection) can be generated directly from the new acquired data. A priority mechanism garanties , that existing scans and products are still comming in time.

5 Conclusion.

The choosen method was very successful. Testing the single site software in detail with a research radar, building a shadow network as early as possible and mapping exactly the old output as starting configuration for the new software. This was robust against any kind of inpredictable events. Consistent and compatible product output from the whole network could be guaranteed at any time.
The now underlaying modern, very flexible and powerful processing structure allows quick realisation of new features. The German weather radar software is fit for the future.