Analysis on Weather Forecast Software Project Management at Provincial Level

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Abstract

The concrete characteristics and special needs of provincial weather forecast system which took Doppler radar data as key source, combined with multi-kind data, based on operational network and forecast environment were discussed. Result shows that multi-type source, huge amount of data, short running cycle, and high flexibility to enhance are basic features of weather forecast system. The keys to software project management such as operational demand investigation, primary features of developers and developing measures were analyzed at provincial meteorological agency.

1. Introduction

With the rapid development of Chinese economy and society in recent decades, the modernization pace of meteorological service accelerated dramatically. China Meteorological Administration (CMA) initiated an ambitious project to setup a 126-Doppler radar network for the first stage in 1998, shortly after the number was updated with 156 covering most area of the huge mainland of China, in order to improve the monitoring and forecasting capability[1] and now the project sees a great result. China became one of the meteorological satellite operators in the world with the operational series of polar orbited FY-1 and solar orbited FY-2 in recent years. The advanced detection equipments other than radar and satellite, such as lightning detector, auto-weather station, wind profiler, lider, mobile weather office and many other specific observation networks such as acid rain and dust-aerosol etc. have been setup for operational use. The meso-scale numeric forecast models have been widely applied individually in regional, provincial offices even in prefecture branch as well to solve the different weather problems in the so diverse country in climate, geology and topography, thanks to the powerful high performance computers[2,3]. The high speed communication network connects meteorological services in China to enable them access the abundant data issued from national meteorological, climate and meteorological satellite centers in Beijing, European Center Medium range Weather Forecast in Reading, England, those in Washington, Tokyo, Berlin and etc. also. The Chinese forecasters are enjoying the huge amount (about 30.5G each day in provincial meteorological center) of information that had been dreamed decades ago.

Meanwhile the meteorological demands from all fields of society increased greatly, the amount of weather information for the area and time increased several to dozen folds respectively and the forecast interval decreased several times in provincial meteorological office, so the task in a certain working period rocketed maybe hundreds times, that is a great challenge the forecasters. For some special purpose such as meteorological service for Beijing Olympic Games in 2008, the task is 40 times higher than routine average.

Because of the structure of human resources of CMA, many green hands rushed into the forecaster position after the pause of enrollment years ago, the pressure looks more serious for them.

Under this situation, the manager and all the staff of meteorological software project must carefully analyze the operational demands, the forecaster's factor, the hardware performance and software environment to develop powerful and convenient tools to help the forecasters in daily use[4,5], especially in provincial office.

2. Developing team

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2.1 Software developing

Software developing is, in the view of operational service, try best to promote automatic level and working efficiency, to reduce the amount and difficulty of work. So taking the convenience for client first, a good developer must think everything about the software as a user, must pursue perfection and study new techniques, accumulate experiences, to promote his or her own in software developing[6].

The work of software developing is to conduct logic analysis, scheme planning, carrying out, and code writing, with high request of logic thinking, concept abstracting, plan organizing, language expressing. The software project needs cooperation, team work, learning, comprehension and practice for all the participants. The chief of the project must have good capability of instruction, coordination and communication. It is very important to pay great attention to the software developers in meteorological service, particularly in provincial agency.

2.2 Developing personnel

There is generally no fulltime or professional software developer position at provincial meteorological level, neither for communication nor for forecast. Even though there are IT professionals usually working in meteorological communication center or section, it is pretty hard to understand the weather theory, principal and routine forecast duty for them. So the work of forecast system developing always falls on the forecasters and becomes one of the most important tasks.

2.3 Disadvantage

The problem is that, the forecasters only get very limited knowledge about computer languages such as FORTRAN, C, and BASIC during their college education, the phenomenon of lacking of professional training on IT, language skill and knowing little about the theory and method on software project developing is very common for the forecasters.

It is very important to teach the forecasters basic concepts, rules and skills of software developing continually, in fact it is a very hard work for most of forecasters, especially those wrote a lot of codes but never carefully thought about how to improve it, and those with poor capability of IT experience. As the formers often involve in software developing and they are the main body of the software developing team, their capacity determines the result directly.

Software developing is a hard work which requires teamwork, so the chief of a meteorological software project at provincial level must think a lot of training on developing, especially the large and medium projects. On the other hand the forecasters themselves must attach great importance of software developing, must carefully summarize no matter success or failure. It is a good way also to select the promising forecasters to study for IT degree.

2.4 Advantage

Other than the deficiency above, the forecasters have their own advantage for meteorological software developing. They have comprehensive knowledge of forecast theory and operational service, sound background of weather and climate, clear understanding of service demands, familiarity of software working environment, generally there is no mistaking of principle. They take direct methods in software developing with pertinence and after a period of practice, they can develop medium and small software at a pretty high speed, it is very convenient for them to provide maintaining service.

3. Basic characters of weather forecast software project

Under the new circumstance there are significant characters of weather forecast software:

3.1 Multi-type and huge amount of data

The available data for daily operational forecast increase greatly, take radar data as an example, the raw volume scan data up to 20M can be generated every 6min by the new generation radar which works 24h a day. Considering the data of satellite, automatic weather station, lightning detector and numeric weather prediction model, the data amount is enormous.

3.2 Temporal urgency of data process and analysis

The social and economic value of weather lies in the leading time, especially those for the disastrous weather events. The life span of meso-scale weather is usually about dozen or a hundred minutes, to monitor and issue the warning about the weather events only within this urgent period can effectively mitigate the loss caused by the disasters[7,8].

3.3 Feature of robust and reliability

Because of the complex procedures of detection and communication, it is impossible to guarantee the fully integrality of the various data in time, and it is very important to ensure the working capability of the operational weather forecast system even with insufficient data.

3.4 Openness and flexibility

The meteorological service is developing rapidly and the new equipments, new data are increasing fast, so the new methods, new systems are setting up and updating. The operational weather forecast system connects with others closely, and affected greatly in return, openness and flexibility are crucial for the life span of the software.

3.5 Maintenance

It is very common that only the developer himself or herself can maintain the software in provincial meteorological agency, and many systems can not work soon after the finish of the developing. It is of great importance to promote the feasibility of maintaining with clear documents and understandable variables, constants and structure.

4. keys to management

4.1 Comprehensive system analysis

The basis of the accomplishment and also the first to do about the software project is a comprehensive system analysis that is often neglected in realty. Most of the developers in provincial meteorological agency always hush to work without thorough think after getting a task. Then they meet lot of unanticipated troubles and lead to one after another frustration, even catastrophes. As a good developer, one likes to study, prepare carefully to get a smooth and quick work. In the process of system analysis, one should thoroughly analyze working platform, operation system, communication network, developing tools and the former relevant work, analyze the sources, directions, exits and intensity of data stream, analyze the generation methods, output paths, display modes of products, analyze the hardware expenses such as the storage and using time of memory and disk. This work needs not only comprehensive but in detail as well. Taking the working platform as the example, except the technical parameters, one should know if there are other operational systems in this platform, if there are, next questions are what the basic condition for those systems is, how they use the computer resources, when they work and how long the working periods are, what the concrete mode of resource occupation is, what the relevant software is required for them, is there any special configuration etc. Without careful investigation, the existing operational systems may encounter the troubles and the forecast work may be affected even the new system is developed.

4.2 Meticulous developing plan

It is crucial to work out a meticulous developing plan in accordance with the result of system analysis for efficiency of developing. We should try our best to control the deficiency and inherent shortage, try best to avoid reworking and modifying. Complex software is a delicate, fragile crystal labyrinth of logic, a single deficit may lead the collapse of the logic palace. Most of the developers prefer writing new code to modifying the existing programs even that is of themselves sometimes. With an excellent plan, the developing work can get progress step by step, otherwise may rewrite, delay, patch, and restart. Developing plan should be as fine as possible, at least to the level of form, because the different forms with different organization relations and different ways to realize. For every form, many opinions should be collected to make out the best choice. All the possible technical difficulties should be considered, for example the functional shortage of a certain language, and to work out proper scheme according to the experience and technical preparation.

4.3 Measure

Only with the excellent characters can a meteorological software system meet the operational demands, the characters include: openness, portability, reliability, readability, modifiability, expansibility, simplicity, consistency and agility etc. Technique measures should be taken to ensure the quality of the software.

4.3.1 Openness and portability

Operational software system must keep changing to follow the development of the operational service. The soul of the software is arithmetic and one of the keys to realize the arithmetic is variables. Forecasters generally think that the variables only exist inside the program but it is unilateral and incomprehensive. As the program must works on a certain platform and be

affected by its environment, we must take the working platform as variables, include the hardware and software to guarantee the openness and portability. The common bad example of openness and portability is the software working errors caused by input or output paths and files, as a matter of fact it is very easy to solve by taking them as variables or send the parameters into the program. There are two ways: one is to set command line parameters, and the other is to set configuration file of key variables and constants which is easier. The key variables and constants kept in the configuration file separate from the code of program and it is very convenient to modify without the code rewriting or program compiling.

4.3.2 Reliability

It is crucial for an operational software system to be robust enough to guarantee the daily business. The reliability of software system lies in several aspects such as the resource finity of memory and hard disk that means the resource can not be consumed endlessly. Take a real-time dynamic monitor software system as an example, it often keeps running and is triggered at any time, if only the expense of memory accumulates the big trouble will occur, so it is very important to release the memory when it is not necessary. The space of hard disk is relatively huge but the expense for operational use is also colossal. For a robust system, the space should be checked before use. The other problems such as divided by zero, file access error are fatal and cause the collapse of the system. It is the effective way to test in advance and set abnormal exits to avoid the failures.

4.3.3 Readability

Practice shows no matter how thoroughly the plan was made, it is almost impossible to develop a software system without any faults. The forecast system evolves and updates very frequent, so the readability is very important for operational use and maintenance. Even though the developers prefer writing new code to reworking on the program developed by others, they have to take time and endeavor to solve the logic puzzle in most cases. It is obvious if a program keeps running it must face a developer soon or later, and sometimes one have to face his or her own music, so it is very important to obey the strict rule of developing, otherwise oneself and the others will be trapped by irregular work. Unfortunately, many immature amateurs keep their bad habit to leave their hard crabbed riddles instead of improving themselves.

4.3.4 Modifiability and expansibility

For the same sack of operational service development, a software system should be modifiable and expansible for a longer lifespan. The module developing is necessary for modifiability and the different parameters should be carefully considered inside the modules to meet the different situation. Expansibility means the function and items of software system can be readjusted easily, that requests the software can arrange the controls dynamically according to the quantity, content, layout of the controls and standardization the interface.

4.3.5 Simplicity

A software system should take the simplest way to achieve the goal. Generally speaking there are many methods to solve a problem with different cost. The first thing to be simple is to master the controls, functions, methods and properties of the language. Without the complete understanding of the language, it is impossible to work out concise, reliable codes with high efficiency. The next is to compare with the different plans to get an optimal one.

4.3.6 Consistency

Software system developing needs team work, and the consistency is very important for cooperation. With good consistency the project can make progress smoothly, otherwise great expense must be paid in readjusting and system integration. So the project standards should be setup for all the participants with clear definition of all the names of programs, modules, process, variables and constants, and relevant regulations for other purpose such as interface.

4.3.7 Agility

The request for the users should reduce to minimal to provide them with maximal working space under the circumstance of stable running of the software system. For example there may be many items in the configuration file, it should allow for the users to input the notations, empty lines, and to put their parameters at any position without any problem at all.

4.3.8 Error diagnosis and pre-check

For a software system, faults are inevitable, the key is to find out and locate them as quick as possible for diagnosis and debug in time. Some of the developers

often give up the active rights of key faults identification and location, and the low level error messages of operation system or ambiguous messages such as “can not find the file”, “path no exist”, “no right of write” etc. were appeared now and then but no clear effective information. The users have to guess widely and the maintainers have to spend time and energy to pursue and debug, try very hard to find what the problem really is. A good developer should test all the key operations of the software system, particularly in the common subroutines and functions. A program should check all the environment, configuration and command line parameters for running, if there is any error, the concrete information should promote the user together with help.

4.3.9 Document

One of the most significant problems of the forecast system developing is document. There is seldom technical document even after the operational application of system and the help function of the software always too simple to offer effective information, so it is very hard to maintain and improve the system which is a common work at present because of the rapid development of meteorological service. So the developers should pay great attention to the document about the system and all stages of developing should be recorded in detail to provide useful message for update and reconstructing.

5. Conclusion

Facing the situation of new meteorological equipments such as Doppler radar, automatic weather station, lightning detector, wind profiler, together with meteorological satellite and conventional meteorological detection, the rapid daily information increasing and wide forecast service expanding, the characters of forecast software system project developing management at provincial level were analyzed according to the routine practice. The developer personnel, operational demands, and primary principles were investigated in light with the theory of software project. The keys to operational software system such as openness, portability, reliability, readability, modifiability, expansibility, simplicity, consistency, agility and relevant measures were discussed to promote the quality of the weather forecast system at provincial meteorological service.

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References

[1] XU Xiaofeng, “construction and application of new generation of Doppler radar network of China”, China engineering science, 2003, 5(6):7-14.

[2] HU Wendong, DING Jianjun, CHEN Xiaoguang, et al. “An Operational Display and Assessment System of Ningxia Refined Weather Forecast Products”, meteorological science and technology, 2004, 32, (5): 367-371

[3] LIU Jianjun CHEN Xiaoguang, DING Jianjun, et al. “New generation numeric weather forecast system in Ningxia”, meteorology, 2004，35(4):23-28

[4] Bearn D.W. A. E. MacDonald, Designing a Very Short-range Forecasting, Nowcasting, Academic Press, London, 1982

[5] Robert J. Serafin, James W. Wilson, Operational Weather Radar in America: Progress and Opportunity, Bulletin of the American Meteorological Society, 2000, 65(3):1236-1264

[6] Browning K. A. System Design, Nowcasting, Academic Press, London, 1982

[7] HU Wendong, Fréderic CHAVEAU, Maurice MERLET, et al. “Design of Meteorological Disaster Evaluation Query and Display Operational System Based on GrADS in SCEM”, Catastrophe, 2005, 20(2):44-48

[8] HU Wendong, ZHAO Guangping, DING Jianjun, et al. “Develop Strategies and Technical Measures of Short-term Weather Forecast Operational Platform System in Ningxia”, Arid area resource and environment. 2006，20(6)：114-117