Remote wireless control for LAMOST telescope

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ABSTRACT

The R&D of the Chinese 4-m ever-ambitious telescope, Large Sky Area Multi-Object Fiber Spectroscopic Telescope (LAMOST), has advanced towards a new stage, and first light is expected by the end of 2006. As one of national scientific and engineering projects the telescope will become national facility and accommodate maximum accessibility for public reach in general and for the astronomical community in particular. Thus remote or even robotic control of the telescope is put under careful exploration. With the rapid development of IT technology one of the fashions is the mobile telephone carried around by average people mainly for daily communication, and mobile notes application has become a real hit. This paper presents GSM based remote wireless application adapted to telescope control, which can be utilized for greatly enhancing LAMOST' accessibility. The novel technique has recently been developed in LAMOST control lab. Test has demonstrated successful execution of Monitor & Control (M&C) commands for LAMOST through remote wireless mobile. The hardware and software configuration with techniques involved for reliable and secure communication is outlined in this paper too.

Keywords: network control system, mobile telephone, LAMOST, QNX, GSM

1. INTRODUCTION

The advent of the world's first telephone about more than 100 years ago has ever revolutionized the way of communication. However not until 80s of last century had the telephone become popular and entered the average family in China. Since then, in the wake of rapidly development and globalizations of Chinese economy mobile phone communication network has gained remarkable pace and affected Chinese people's life dramatically. Nowadays the mobile (some models are shown in figure 1) is not just communication gadget but a big fashion. People, the youth in particular, carry their mobiles and walk in the street with their heads held high in the elitist of crowd. Meanwhile mobile companies are increasingly positioning their products as a fashion accessory. But is mobile only a fashion accessory? Of course it is not. Its performance and quality level improvement are fundamental factor behind the scene. With only

Figure1: Some mobile models

Advanced Software and Control for Astronomy, edited by Hilton Lewis, Alan Bridger,
Proceedings of SPIE Vol. 6274, 62740W, (2006) · 0277-786X/06/$15 · doi: 10.1117/12.671085

one generation up the mobile underwent update from analogue FM technology with narrow-band circuit to digital modulation offering improved spectral efficiency. And third generation wireless systems currently under development offer substantially higher bit rates ranging from 9.6 kb/s for satellite users, 144 kb/s for vehicular users, 384 kb/s for pedestrian users to 2.048 Mb/s for indoor office environments.

In order to dig the mobile's ability for possible use in astronomical telescope's control system it is important to understand technically what instantly happens when clicking on a hand mobile. The magic lies in the so-called Global System for Mobile communications (GSM).

GSM consists of many subsystems, such as the Mobile Station (MS), the Base Station Subsystem (BSS), the Network and Switching Subsystem (NSS) and the Operation Subsystem (OSS). GSM block diagram is shown in figure 2. The MS includes mobile equipment and a Subscriber Identity Module (SIM). When the SIM is inserted into the mobile equipment, the relevant information is checked and a call is then delivered to the mobile station. The BSS connects to the MS through a radio interface and also connects to the NSS. It is this feature of radio interface that plays an important role in the wireless remote M&C of LAMOST telescope.

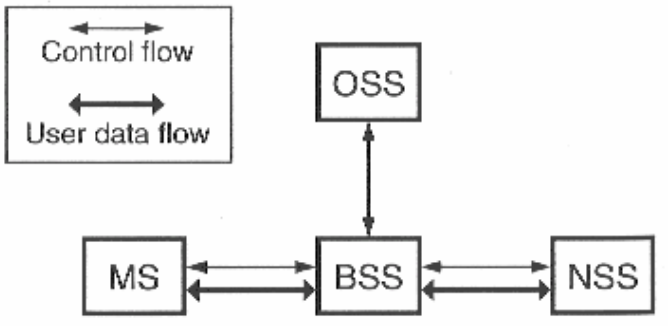

Figure 2: GSM block diagram

All in all, the advancing mobile technology with costing relatively decrease makes it possible for control engineers to imagine the mobile as more than just communication facility for daily life. It could be employed for more broad use in an environment requiring high-tech M&C. This is where and how the LAMOST control group came to explore the potential application that uses the novel gadget for the 4m telescope of LAMOST under development. Started from 2004, the test lasted about one year.

2. MORE POWERFUL ACCESSIBILITY FOR LAMOST

The LAMOST by its completion will be a national facility and also open to worldwide astronomical community. It is obvious that the accessibility to the telescope plays a fundamental role for users physically in many different places. A question might arise that if there is no on-line access and no cable telephone nearby is the user still able to get real time telescope's operating status? The answer is positive if you have brought your mobile with you, which is generally the case. The telescope's operating status including the surrounding meteorological conditions monitored by various kinds of sensors are just your mobile click away. You are able to access not only real time status, but also historical status data stored in the database through database query. Of course you need your authentication for access that is no doubt about it. What is more, if you need more than just status then you might send your command to affect the telescope's maneuver, which could happen in an emergency when without an operator on site. Of course, in this case you have to be scrutinized by the safety guide system for your privilege. The above two examples have unarguably credited the wireless access application for telescopes like LAMOST. The next question is how all this works behind the scene? This is where the wireless telephone, the mobile in our topic, comes in, which nowadays is inexpensive, easy to use with ever increasing performance and security level.

3. LAYOUT OF MOBILE M&C SYSTEM FOR LAMOST

An in depth discussion of the remote wireless system is beyond the scope of this paper. The application of such a technique that combines computer communication and mobile notes is a good example how modern IT technology can leverage new applications like the one in our LAMOST case. The control system of LAMOST is built on QNX Operating System (OS), one of world renowned real time OSs with many features. The precondition for wireless M&C to function is that the Telescope Control System (TCS) needs to be built in the first place with all M&C capabilities so that an operator is able to use commands from the control console to manipulate the telescope or get telescope's status data through local network. The evolution from local to remote control of a telescope does not seem to be quite difficult in principle nowadays. It is about two decades since the internet came into China and boomed ever since. By the end of 2002 we have simulated successfully the remote control of LAMOST through internet with the two test points more than one hundred km apart. Our pursuing for more accessibility of the telescope did not stop there. The remote wireless control of the telescope is logically our next move. The configuration of our mobile control is shown in figure 3, which is quite straightforward. A GSM modem connects to a QNX node in remote wireless control server through RS232. Authorized user can receive an alarm from a mobile note and the server responds by activating the TCS, which again implements the note request and give feedback to the mobile phone. The remote wireless control server is set on one of the QNX OS nodes. The system demonstrated that it could cope with batch mobile notes well.

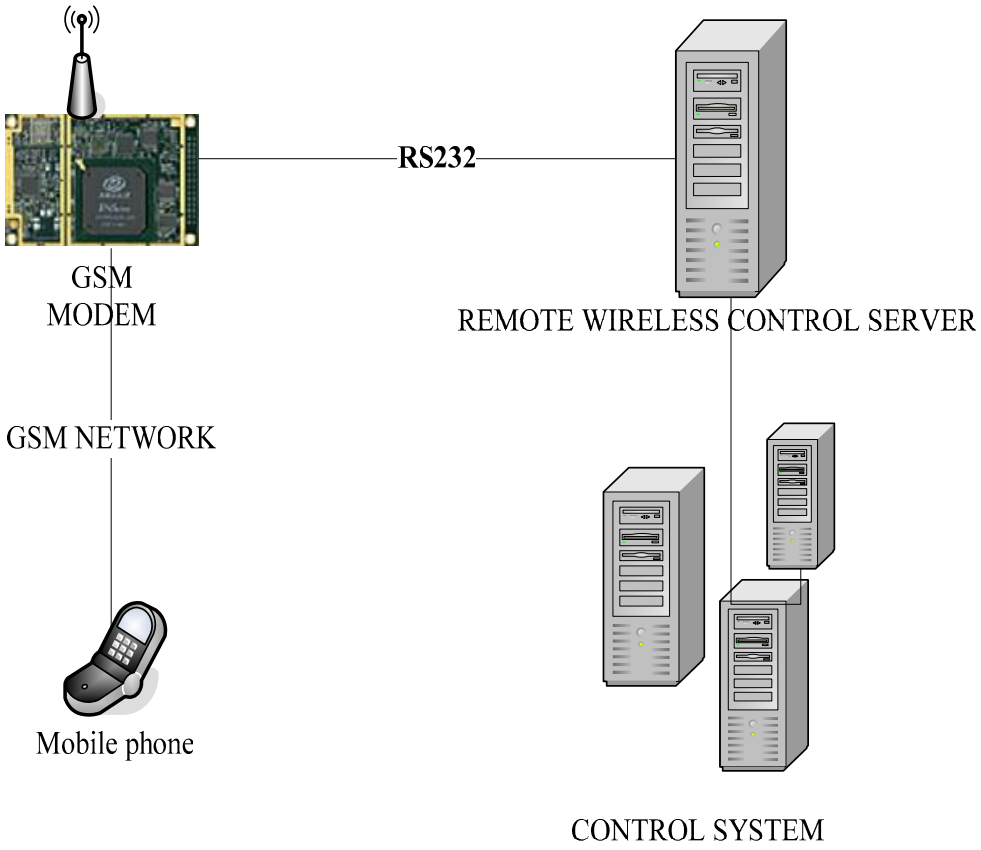

Figure 3: The structure of the remote wireless control system

4. FLOW CHART FOR MOBILE M&C SYSTEM

Figure 4 presents the data flows among the remote wireless control server, telescope control server and the user.

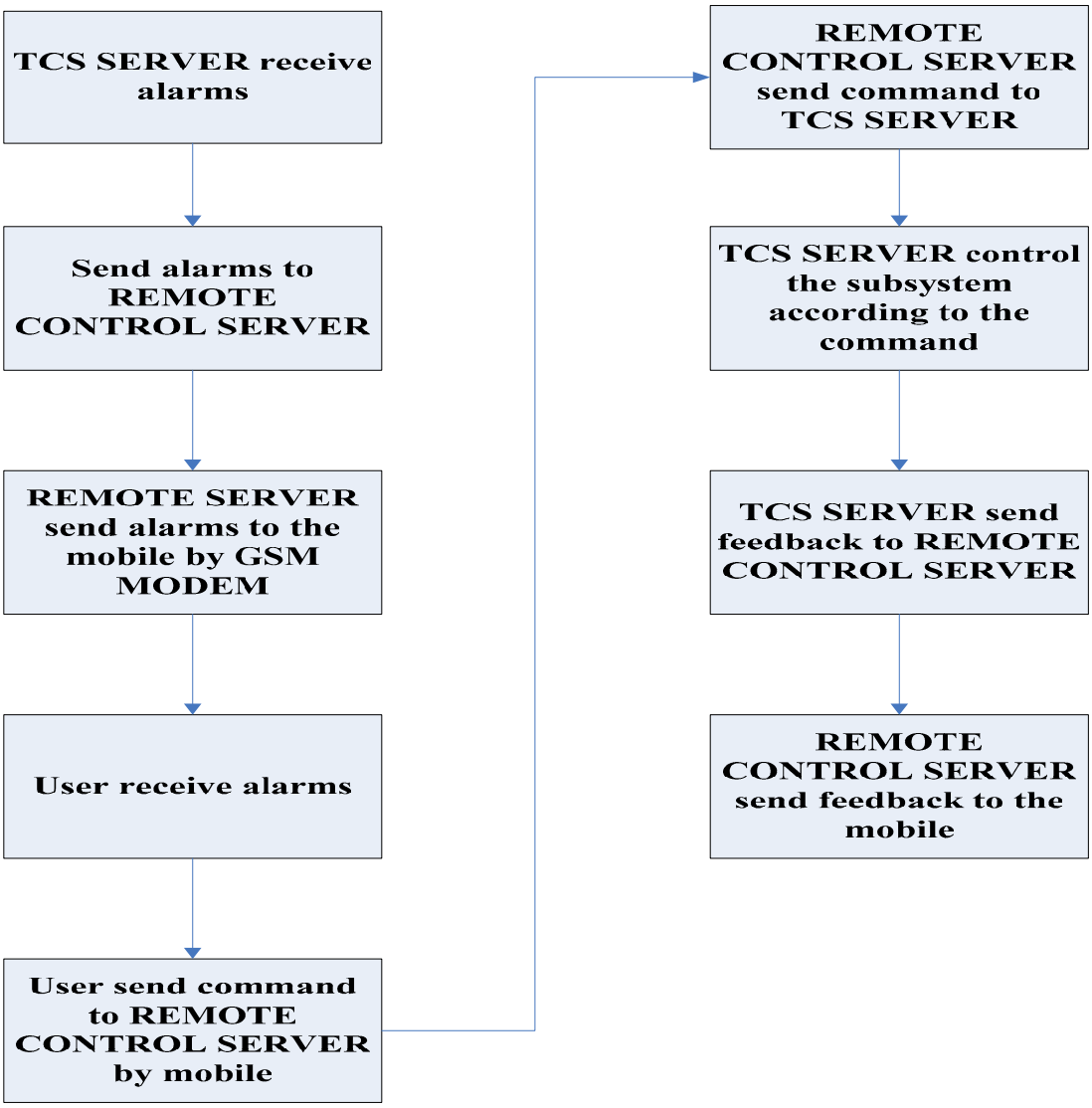

Figure 4: The flow chart of the remote wireless control.

5. SOFTWARE FOR REMOTE WIRELESS CONTROL

5.1 Configuration for the GSM modem

As it was mentioned above that a GSM modem is connected to the remote wireless server through RS232, the GSM modem needs to be initialized with proper setting. Figure 5 shows how to send mobile notes with feasible settings of the interface by our application, and figure 6 shows how to receive mobile notes by the modem respectively.

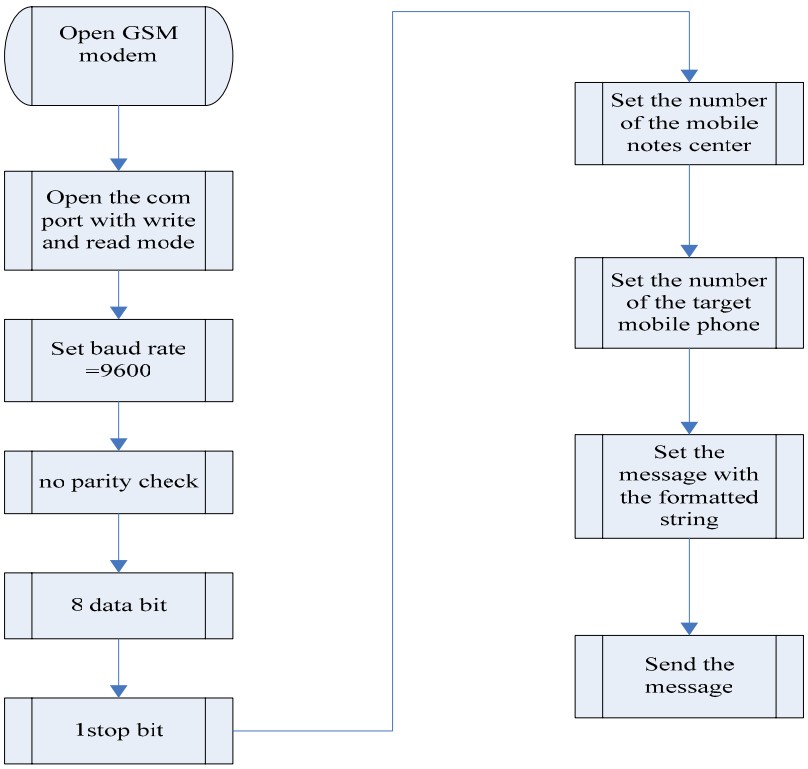

Figure 5: Send mobile notes to mobile phone

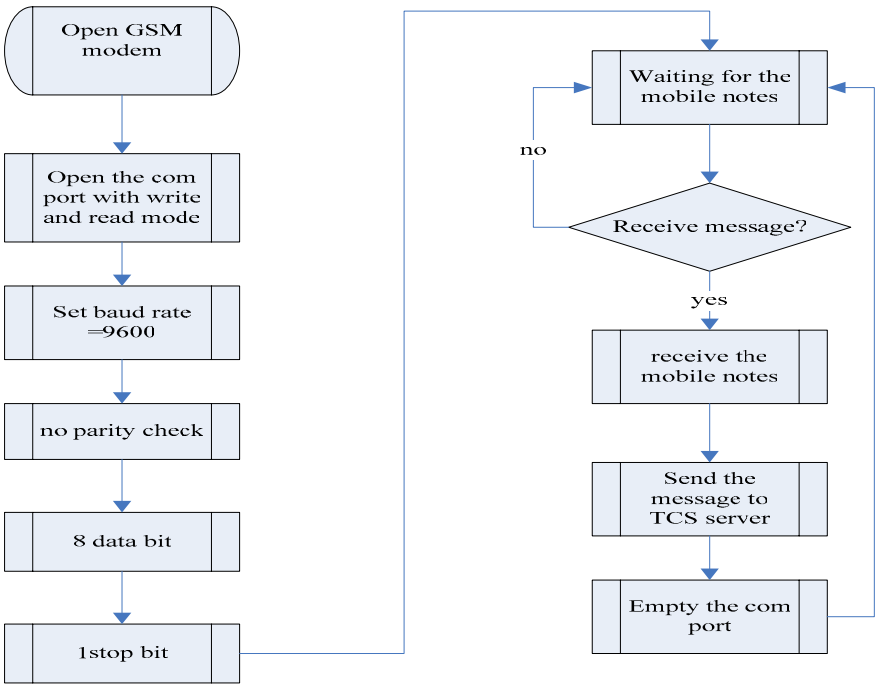

Figure 6: Receive mobile notes by GSM modem

5.2 PDU structure

AT Command is the protocol between GSM modem and computer, which is developed by Siemens, Motorola and HP. Every AT Command is with a prefix AT+. There is a feedback for every command. There are three modes to send mobile notes, BLOCK mode, TEXT mode and PDU mode. PDU mode is widely used now. PDU is a data package which contains the source and target address, data type and text. Our application is based on PDU mode. The above Figure 7 shows the send structure for PDU, and figure 8 presents the receive structure for PDU respectively.

data	explanation
00	The length for the mobile notes center number, “00” presents that uses the default number in the SIM card
11	The head of the message，default is “11”
00	The type of the message，default is “00”
0D	The length of the target number
91	The type of the target number
683187259487F3	The target number after replacement
00	The type of the protocol
08	Use UNICODE coding
A9	The period of validity for the message
08	The length of message
828265E55FEB4E50	The message
1A	End code

Figure 7: The send structure for PDU

data	explanation
08	The length for the mobile notes center number
91	SMSC address format
683108301105F0	SMSC address
84	Basic parameter
0D	The number of the receive address
91	The type of the receive address
683187259487F3	The receive address
00	The type of the protocol
08	The type for the user message
40602090013000	time
04	The length of message
4F60597D	The message

Figure 8: The receive structure for PDU

5.3 The software interface

The software is developed under the QNX OS with Photon Application Builder (PHAB). Figure 9 shows the main window for the remote wireless control. There are several functions list below.

- Set the com port
- Set the baud rate
- Set parity bit
- Set data bit
- Set stop bit
- Receive the message notes
- Send the message notes
- Clear input clipboard
- Clear output clipboard

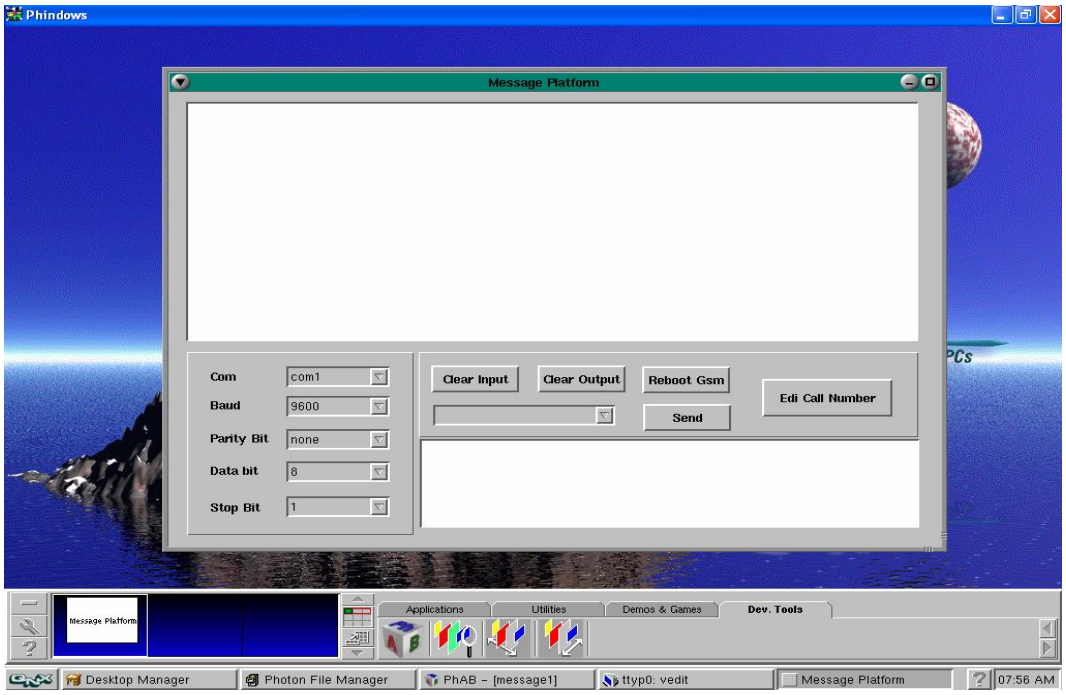

Figure 9: The main window for the remote wireless control

Figure 10 shows the edit telephone number dialog. In this dialog the administrator can add authorized user telephone number.

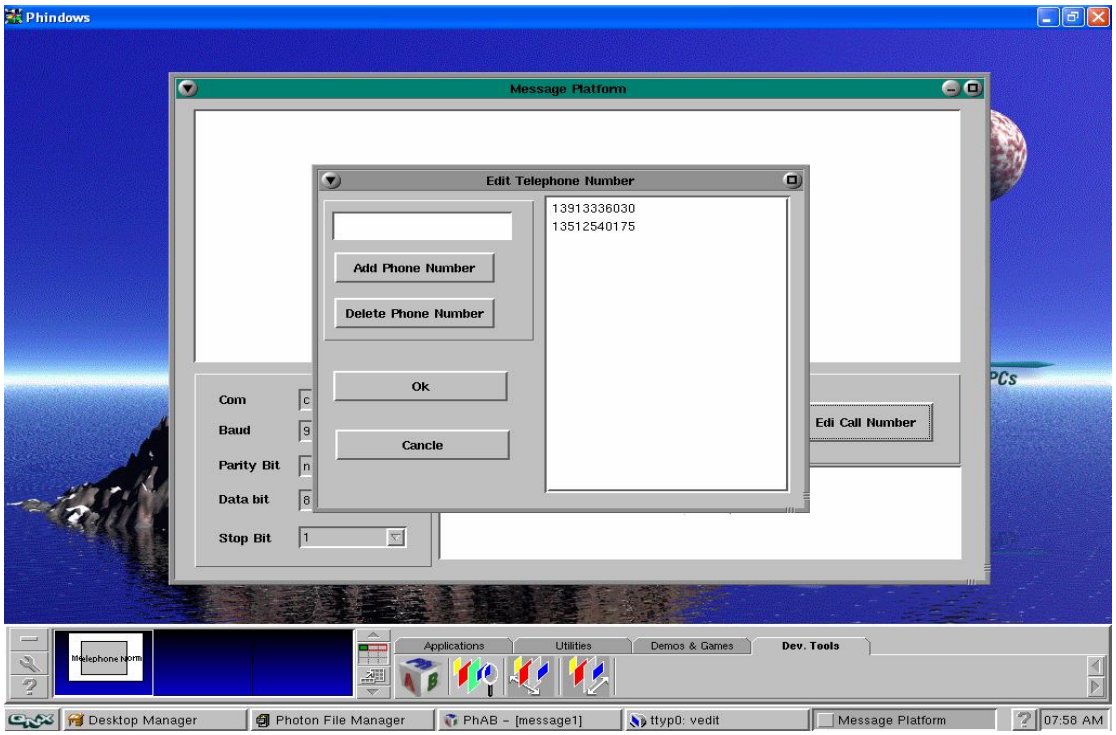

Figure 10: The edit telephone number dialog

6. RELIABLE AND SECURE COMMUNICATION

As the remote wireless control system is based on GSM network. Everyone can send mobile notes to the remote wireless control system. The security for the communication has to be addressed. We take several steps to prevent hackers from logging onto our system. First, there is an authorized user telephone number list in our system. The remote wireless control system only sends and receives the telephone number in the list. Second, the administrator can define the right for every authorized user. Only the privileged user can execute the high level command. Third, every authorized user has a different password. When the remote control server receives the mobile notes from the authorized user it validates the password in the mobile notes.

7. CONCLUSION

China's ambitious LAMOST is being developed and the telescope features largest ever field of view of 5^0 among all existent meter-class level ground astronomical optical telescopes in the world. The large field of view offers the telescope capability of observing 4000 stars simultaneously. All these inevitably call for a sophisticate control system to meet all tough requirements for the distributed and real time, remote and even robot control. The mobile application for the telescope's control system to boost its remote wireless M&C power is one of our endeavors along our way to develop the control system as a whole. With such a vision the LAMOST control group began in 2004 to explore GSM based mobile notes system for the telescope's M&C. Followed with one year of R&D in our lab the test proved that the mobile based technique for telescope's M&C is worth of trying and feasible under pertain circumstances. The test is unique and first ever in China to apply novel mobile technique in remote wireless control system for ground astronomical telescopes. The pilot test has proved rewarding and promising and opened up broader outlook for even further enhancing the telescope's accessibility as modern mobile technique is rapidly advancing, which is able to provide voice, data, the more bandwidth intensive multimedia services, while satisfying more stringent availability and quality of service requirements in all types' environments. Besides fourth generation mobile systems are also on the horizon that will provide broadband wireless access with asymmetric bit rates that approach 1 Gb/s. With this vision in mind we are sure that the responding slowness sometimes shown in our test will eventually disappear.

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