# INFORMATION SYSTEM FOR THE SAFETY OF CONSTRUCTION OF RAPID TRANSIT SYSTEMS

**Gwan-Shyong Wang[1], Der-Cherng Tang[2], Richard N. Hwang[3]**
**I-Chou Hu[4], Fuh Gwo Wang[5]**

*[1]Kaohsiung Mass Rapid Transit Department, Kaohsiung*
*[2]Kaohsiung Mass Rapid Transit Department, Kaohsiung*
*[3]Moh and Associates, Inc., Taipei*
*[4]Moh and Associates, Inc., Taipei*
*[5]Moh and Associates, Inc., Taipei*

ABSTRACT: It is vitally important to maintain the safety of construction of rapid transit systems which usually call for deep excavations in densely populated areas with very poor ground conditions. It is equally important to protect adjacent structures and properties along the routes during construction and instrumentation and monitoring are routinely carried out to achieve the purpose. This paper discusses how traditional instrumentation program shall evolve to take advantages of the rapid advancement of modern technology.

Keywords: instrumentation, Rapid Transit, MRT, construction, alert, database, monitoring, computer, safety

## 1. INTRODUCTION

Rapid transit systems in major cities are inevitably constructed in densely populated areas and the ground conditions encountered are usually poor. Among all the problems, safety of constructions, per se, and protection of adjacent structures, utilities and facilities along the routes are of primary importance. It is desirable to receive early warnings so contingency measures can be implemented in time whenever adverse situations are developing. Instrumentation and monitoring programs are routinely carried out nowadays for this purpose and they are indeed proved to be useful.

With the rapid advancement in computer technology, the prices of computer hardware have continuously dropped while the capacity and speed increased drastically year by year. It is now possible to store an tremendous amount of data in storage devices for various purposes and memory is no longer a limitation. Numerous software packages are now available for retrieving and utilizing these data at unprecedented speeds. Many of these packages allow multiple users to gain the access to data stored in servers in the networks at the same time. This ensures that the data shared by all the parties are unique and current.

With all the developments mentioned above, it is time to explore how instrumentation and monitoring programs can be improved for better performance.

## 2. NETWORKING

As a first priority, a network shall be established to facilitate data sharing among project owner, designer, contractor and subcontractor, etc., at the very beginning of the project. The network is not solely for the purpose of maintaining the safety of constructions, but also serves as a backbone of communication among all these parties. It can be a local-area-network (LAN) with dedicated lines or a network formed by using internet as trunk lines. Confidentiality of information can be maintained by a combination of firewall server management, the use of digital certification, including user authentication, and encryption of messages.

## 3. INSTRUMENT AUTOMATION

In the past, instruments were mostly read manually. Human errors were frequently made during the process of reading taking, notes taking, calculating the results and filing for records. It is not only time consuming but also inappropriate in the sense that accidents might occur because of the delay in process.

With the low costs of hardware, it is possible to monitor most of ground response and performance of structures using automatic instruments. Furthermore, many wireless communication techniques, in case

necessary, enable data to be transmitted to remote data loggers which can then relay these data to the data center where they are processed. The entire process would take only a few minutes at the most, in stead of days for the cases of manual operation.

## 4. DATA PROCESSING

Data received are checked at the data center to see if they are within the expected ranges. Contractors are requested to verify the accuracy of data and make necessary adjustments if there are good reasons to believe that the data are erroneous. Warnings will be issued whenever data exceed their tolerable ranges after their reliability has been confirmed. It is recommended that, as a usual role, manual interruption by operator is enabled so that false alarms due to irregularity in readings can be avoided.

## 5. BROADCASTING OF WARNING

It is important for all the parties, including site office, district project office, headquarters and quality assurance office, as depicted in Fig. 1, who are responsible for actions to receive warnings before it is too late. Internet serves as the best communication channel for the purpose if all these parties are sparsely located. Warnings can be broadcast through the emailing system to these parties with essential information attached. Of course, designer and contractor will be informed as well so contingency measures can be prepared. All the people concerned can gain the access to the databases stored in servers located at the data center for supplemental information no matter where they are. This will shorten the response time from hours to minutes and this is extremely helpful in emergency situations. Not only that, all the parties can respond to the emails and report the actions they are taking so that the commander at the headquarters will have the full control of the situation.

## 6. CLOSE-CIRCUIT-TELEVISION AND VIDEO CONFERENCE

Field problems can be monitored by close-circuit-televisions (CCTV), and the pictures taken can be sent via internet to the parties concerned so the situation can be better understood and taped for record. Video conferences can be held to work out solutions quickly. In the traditional ways, it would take at least a couple of hours to call a meeting and a couple of hours more for decisions to be made. The problems could have deteriorated beyond control by this time.

## 7. INFORMATION SYSTEM

For the above to be possible, it is necessary to establish databases in the servers at the data center, containing all the necessary information, including instrument layout, instrument readings, soil data, excavation profile, construction sequence and progress, etc, as depicted in Fig. 2. It is best to integrity all such information into a geographic information system (GIS) which has the ability of storing and linking various types of digital information, such as text, graphic, audio and video, in one package. Web version of GIS packages are nowadays available for remote users to gain the access to the data via internet.

## 8. DISCUSSION

Introduced herein is a concept of modern instrumentation and alert programs for maintaining the safety of constructions using internet as a backbone. There is no reason to limit the application of this concept to instrumentation and alert and the same concept can be adopted in the planning, design and construction phases of all types of civil works. Computerization and the use of internet will not only streamline design and construction process, the databases established will be permanent records for future references.

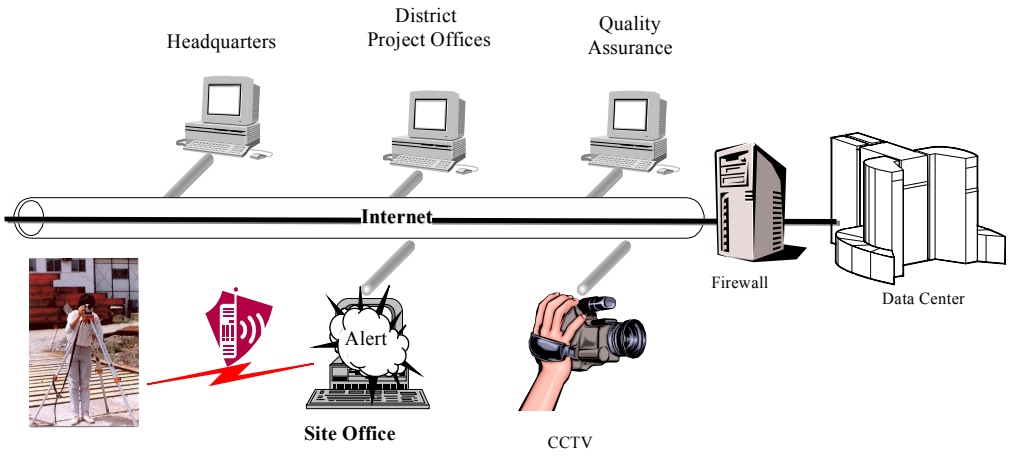


Figure 1 Internet Instrumentation - and - Alert System

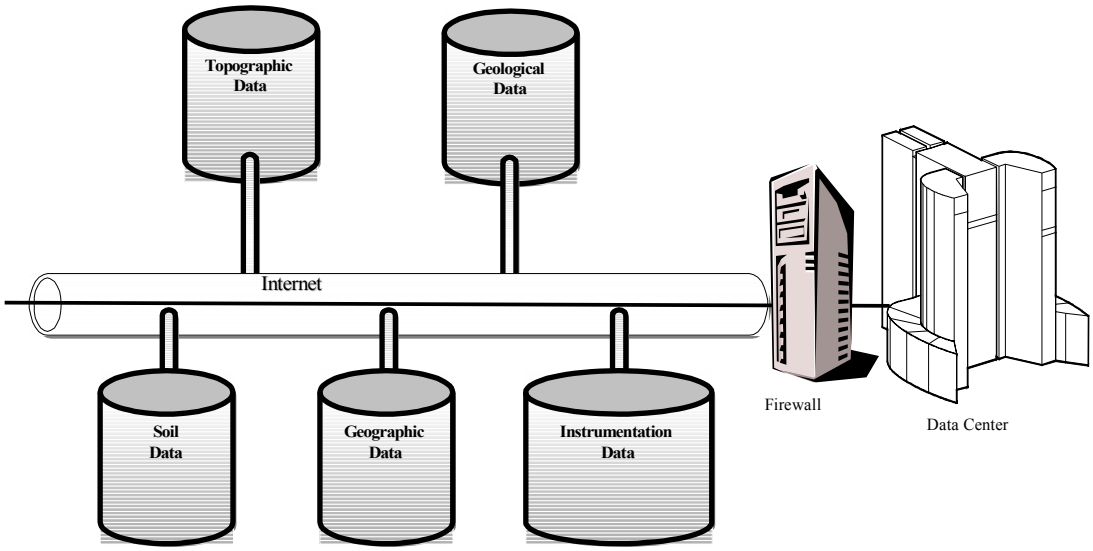


Figure 2 Internet – Information System for Maintaining Safety of Construction