

Trusted Data Communication and Security Issues in RTK GNSS Networks

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Key words: Geoinformation/GI, GNSS/GPS, Data Communication, RTK GNSS Network, CORS-Tr, Data Security, Cyber Security

SUMMARY

There are three main activities of General Directorate of Land Registry and Cadastre. These are Mapping, Land Registry and Cadastre. Geomatic Department is responsible for mapping activities. The most important projects like TUSAGA-Aktif (CORS-Tr), Metadata Geoportal, Orthophoto Production and orthophoto web services and preparation of Turkish NSDI Feasibility Report have conducted and completed by this department's specialists since 2005.

TUSAGA-Aktif (CORS-Tr) System, serves location information at cm level accuracy in Turkey and TR Northern Cyprus in few seconds, where adequate numbers of GNSS satellites are observed and communication possibilities are present. No ground control points and benchmarks are necessary. There are 146 permanent GNSS stations within the CORS-Tr System. Station data are transferred online to the main control center located in the Mapping Department of the General Directorate of Land Registry and Cadastre and to the control center located in the General Command of Mapping. Currently CORS-Tr has more than 8.500 users. Most of them are private companies working for governmental organization.

Providing data communication between control center and both GNSS station and users via trusted and good substructure is important. Additionally protection of the system and data against cyber attacks from domestic and foreign is important. This paper focuses on data communication and security issues of GNSS network named TUSAGA-Aktif.

ÖZET

Tapu ve Kadastro Genel Müdürlüğü'nün, üç ana faaliyet alanı vardır. Bunlar haritalama, tapu ve Kadastro faaliyetleridir. Harita faaliyetleri Harita Dairesi Başkanlığı tarafından yürütülmektedir. TUSAGA-Aktif (CORS-Tr), Harita Bilgi Bankası/Meta Geoportal, Ortofoto Üretimi ve ortofoto web servisleri ve Türkiye Ulusal Coğrafi Bilgi Sistemleri Altyapısı Kurulumu (TUCBS) Fizibilite Raporu'nun hazırlanması gibi önemli projeler bu Başkanlığın uzmanları ile gerçekleştirilmiştir.

TUSAGA-Aktif sistemi ile; Ülkemiz ve KKTC de yeterli sayıda GNSS uydusu görülebildiği ve iletişim imkanlarının mümkün olduğu yerlerde, yer kontrol noktalarına gerek olmadan, bir kaç saniye içerisinde cm doğruluğunda konum bilgisi elde edilebilmektedir. TUSAGA-Aktif sistemi kapsamında 146 sabit GNSS istasyonu bulunmaktadır. İstasyon verileri Tapu ve Kadastro Genel Müdürlüğü Harita Dairesi Başkanlığında bulunan kontrol ve analiz merkezine online aktarılmaktadır. Tusaga-Aktifin 8500 den fazla kullanıcısı bulunmakta ve bunların çoğunluğunu kamu kurum ve kuruluşlarına iş yapan özel sektör oluşturmaktadır.

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1. INTRODUCTION

A CORS is a Continuously Operating Reference Station. CORS can take the place of a traditional base station used in differential GNSS positioning. They can give an instant position to an accuracy a few cm and are used in many industries including Precision Agriculture, Construction, Mining, Surveying and in Scientific Research[1].

Continuously Operating Reference Stations GNSS Network Project called CORS-Tr (TUSAGA-Aktif in Turkish) has begun in 2006 as a research and development project of The Scientific and Technological Research Council Of Turkey (TUBITAK) by supporting financial side, Istanbul Kultur University (IKU) as a project implementer and The General Directorate of Land Registry and Cadastre (TKGM) and General Command of Mapping (GCM) including as joint customers. CORS-Tr project completed in 2009 and operated by TKGM and HGK collectively. Until 15 June 2011, it was operated free of charge for test purposes. Since then it has been operating as a paid service and price is determined by Inter Ministries Mapping Coordination and Planning Committee (BHİKPK) and confirmed by both Ministries who are Environment and Urbanization Minister and Defense Minister.

TUSAGA-Aktif (CORS-Tr) System, serves location information by cm level accuracy in Turkey and TR Northern Cyprus in few seconds, where adequate numbers of GNSS satellites are observed and communication possibilities are present. No ground control points and benchmarks are necessary. CORS-Tr System includes 146 permanent GNSS stations. Station data is transferred online to the main control center located in the Mapping Department of the General Directorate of Land Registry and Cadastre and a second the control center located in the General Command of Mapping.

Today CORS-Tr System has more than 8500 individual users which can be grouped as Land Registry and Cadastral Offices, Governmental institutions, Licensed Surveyors, Universities and Private Companies. All user have chance to get good services from Geomatic Department via detailed web page, SMS and email message. More over call center (444) support is available in case of any problems on the field twenty-four for seven.

This paper presents trusted data communication infrastructure and security issues of CORS-Tr system in Geomatic Departments.

2. CORS-Tr DATA COMMUNICATION

A GNSS network consists of several GNSS stations interconnected by reliable communications to enable real time computations and control. Each station has a cabinet which contains a receiver, an

antenna, communication devices, small data storage, power supply, accumulator and so on. In most cases a computer is installed additionally for data transmission and control. It also contains a user interface which is required to configure and maintain the network. This may be realized remotely for exaple by radio communication , mobile phones or via internet connection.

In Turkey Turk Telekom Backbone for CORS-Tr data communication is available. CORS-Tr system has VPN tunel between reference station and control center as primary data communication and 3G APN tunnel seconderily. User connection are supported by APN tunnel for three GSM Operators in Turkey.And all RTK correction send to user by APN tunnel. Data communion structure are shown in section 3.3 Networks topic (Figure 3).

3. CORS-Tr SECURITY ISSUES

Cybersecurity is the body of technologies, processes and practices designed to protect networks, computers, programs and data from attack, damage or unauthorized access. In a computing context, the term security implies cybersecurity. Elements of cybersecurity includes[2]:

- Application security
- Information security
- Network security
- Disaster recovery / business continuity planning
- End-user education.

3.1 Applications

In CORS-Tr system, we have Network RTK correction, networks DGPS correction,web online processing services and RINEX datas to provide our users.All application are shown below.



CORS-Tr Main Applications			
RTO	Real Time Output	iScope	Realtime Visualization
TDC	Dynamic Control	TOP	Web Online Proces.
VRSNet	Corrections	TRI	Rover Integrity
TIC	Instrum. Config.	TED	Ephemeris Download.
TDS	Data Shop	TIM	Integrity Manager
TAC	Accounting	TSM	Streaming Manager
Atmo	Atmos. App.	TTG	Transformation Mang.

Figure 1: TUSAGA-Aktif applications

3.2 Information

CORS-Tr system works with 3 SQL databases which are **TPPDB** contains the history of the system, **TPPAccounting** contains the accounting information such as user, subscriptions, sessions,

etc. and *TPPDBRoverIntegrity* is a separate database for the rover integrity results. Additionally we have RINEX datas,control center camera records and callcenter recorded voices.

No	Information Type	Resp. Unit	Backup Period	Where	Keeping Duration	Time Deliver to Achieve
Y1	RINEX 1 Sec.	Geodesy	Weekly	Geodesy	3 Month	-----
Y2	RINEX 30 Sec.	Geodesy	Monthly	Geodesy	1 Year	End of the Year
Y3	Database Logs	Geodesy	Monthly	Geodesy	Endless	End of the Year
Y4	Control Center Camera Records	Geodesy	Monthly	Geodesy	6 Month	-----
Y5	Callcenter Recorded Voice	Data Mang.	Monthly	Geodesy	1 Year	-----

No	Information Type	Resp. Unit	Achieving Period	Where	Keeping Duration	
A1	RINEX 30 Sec.	Data Mang.	Yearly	Data Mang.	10 Year	
A2	Database Logs	Data Mang.	Yearly	Data Mang.	Endless	

Figure 2-TUSAGA-Aktif Information to be backedup and to be archived

3.3 Networks

We have two different networks in Geomatic Department. One of the network is CORS-Tr control center network, called METRO. Other is General Directorate of Land Registry and Cadastre (GDLRC) wide area network,called TAKBIS. This network is under the responsibility of IT department. COSR-Tr network is an independent and special network. There is no connection or relation to TAKBIS network.

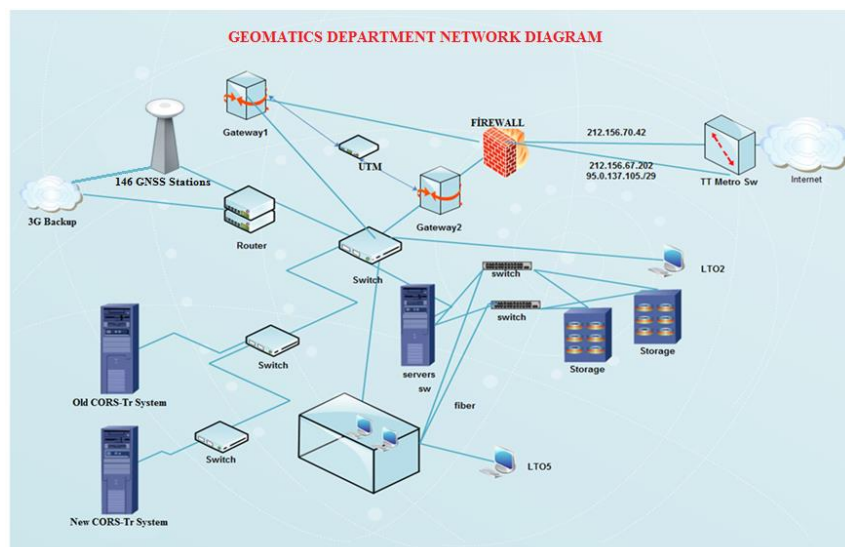


Figure 3- Geomatic Department Network Design

3.4 Our Experience and Business continuity planning

Of course CORS softwares including operating system and hardware, normally has their own firewall and some security issues with many applications. But we faced many problems since CORS-Tr established and these problems are briefly described below.

Lack of IT Personnel: Only Surveying Engineers and Surveying technician available to operate CORS-Tr system, user membership and payment issues and to supporting users. There isn't any IT personnel to control system in case of technical problems. High qualified personnel deals with technical problems such as system freezing, communication band saturation or even exchange of broken hardisk.

DDOS Attacks: In year 2013 summer season which always are done very dense mapping application on the field by using CORS-Tr, we faced very hard DDOS attack by unknown source. DDOS attacks was continued approximately 3 months, everyday between 10 am and 12 am.

Awareness of Internal Users: Internal system users who use computers that has virus, malware, trojan, etc. Internal users who used virus contaminated USB to connect system servers or unsafe remote desktop connection caused danger for the system. Unfortunately Institutional antivirus system was unable to protect CORS-Tr system. Internal user's awareness on security issues should be increased.

Awareness of External Users: Some external users has arranged their GNSS instrument settings to send more than five request in a second to connect CORS-Tr system. These request was interrupted other user connections and oversized data communication band. Some external users shared their own password and user name with other users which cause conflict between the users. An other problem caused by external users is unnecessary attempts for connection. Although their term has finished many external users, try to connect to the system.

4. IMPROVEMENTS

Measures taken to establish trusted service in CORS-Tr system usage in terms of security requirements after experienced problems are:

- Two specialised Computer Engineer and a specialised Electric and Electronic Engineer to operate CORS-Tr technical side employed.
- UTM security device purchased for prevention from DDOS attacks. No DDOS attack detected since 2013.
- Directive about personal computer maintenance including software related security risks issued. Then data backup and archiving directive with our employees in Geomatic Department issued.
- GNSS reference station data and information are stored in a SQL1 database. User information and activity log data are stored in a SQL2 database. These two database and other related data are started to backed up every day regularly according to department directive.

- Data communication band with enlarged from 20 GB to 50 GB after the realisation of unexpected external user dense connection activity.
- VPN tunnel established between reference station and control center as primary data communication and 3G APN tunnel secondary. Reference stations data storage capacity increased.
- Current software updated to latest version including required moduls such as Realtime Visualization,Atmospher,Transformation Generator and Online web Processing.
- New hardware provided according to updated software requirements.
- Main applications like Network RTK correction, networks DGPS correction and provision of RINEX data to the our users and SQL databases are protected by extra security software for cyber attacks.
- In CORS-Tr network,server and end points are protected by a software from inside and outside cyber attacks.
- User awareness of CORS-Tr usage by 444 call center, SMS message, Social Media and Local trainings was increased. And also customer satisfaction are surveyed regularly.

5. CONCLUSION

At the beginning of TUSAGA-Aktif project we thought that project was considered geodesy related works only. Today we understood that TUSAGA-Aktif is a not only geodetic related works but also Information and Communication Technology works.

As a result today CORS-Tr have trusted data communication infrastructure, protected information and services by updated software and hardware including security devices and has more powerful user support.

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