Rujukan Kami : JUPEM 18/7/2.148 (***86***)

Tarikh : ***6*** September 2005

Semua Pengarah Ukur dan Pemetaan Negeri
Semua Pengarah Ukur Topografi
Semua Ketua Seksyen

PEKELILING KETUA PENGARAH UKUR DAN PEMETAAN
BIL. 9 TAHUN 2005

GARIS PANDUAN MENGENAI PENGGUNAAN PERKHIDMATAN *MALAYSIAN RTK GPS NETWORK* (MyRTKnet)

1.0 TUJUAN

Pekeliling ini bertujuan untuk memaklumkan penubuhan *Malaysian RTK GPS Network* (MyRTKnet) oleh Jabatan Ukur dan Pemetaan Malaysia (JUPEM) serta memberikan panduan mengenai penggunaan produk dan perkhidmatannya bagi kerja-kerja ukur dan pemetaan.

2.0 LATAR BELAKANG

Penggunaan teknologi *Global Positioning System* (GPS) bagi kerja- kerja ukur dan pemetaan di Malaysia telah bermula sejak tahun 1989. Sehingga kini, pelbagai kaedah dan teknik pengukuran GPS telah digunakan sesuai dengan kehendak dan tujuan sesuatu pengukuran itu dijalankan. Perkembangan dan kemajuan teknologi GPS seterusnya pula telah membolehkan pengukuran dilaksanakan dengan lebih tepat, cepat

dan efisien melalui kaedah *Real Time Kinematic* (RTK). Namun demikian, ketepatan pengukuran yang boleh dicapai dengan menggunakan kaedah tersebut semakin berkurangan dengan bertambahnya jarak di antara alat penerima GPS dengan stesen rujukan. Ini disebabkan kesan perubahan atmosfera terhadap cerapan yang dibuat oleh alat penerima GPS serta kesan selisihan sistematik.

Menyedari tentang permasalahan ini dan untuk mempertingkatkan perkhidmatannya kepada pengguna-pengguna GPS, terutamanya bagi membolehkan pengendalian ukuran GPS secara lebih cepat dan tepat, JUPEM telah mewujudkan MyRTKnet. Dalam hal ini, pengguna-pengguna GPS yang berada dalam lingkungan jaringan MyRTKnet mampu menentukan kedudukan mereka ke tahap sentimeter dalam masa hakiki dengan menggunakan data-data yang dibekalkan oleh MyRTKnet. Dengan adanya kemudahan yang disediakan ini maka pengguna-pengguna GPS akan memperolehi pelbagai manfaat, terutamanya yang berhubungkait dengan penentuan kedudukan yang tepat secara *real time*.

3.0 PENGENALAN MyRTKnet

MyRTKnet merupakan satu sistem prasarana yang dibentuk oleh jaringan stesen-stesen rujukan GPS dan Pusat Kawalan yang diselenggara oleh JUPEM, juga sistem telekomunikasi bagi membekalkan data-data GPS yang diperlukan, terutamanya untuk menghasilkan maklumat kedudukan di lapangan dalam masa hakiki.

Jaringan ini terdiri daripada 27 stesen kekal GPS yang berjarak di antara 30 hingga 150 km (kecuali bagi Sabah dan Sarawak yang berjarak lebih kurang 1500 km). Stesen-stesen ini dibina khusus untuk mengutip data GPS secara berterusan yang kemudiannya disalurkan kepada Pusat Kawalan di Seksyen Geodesi, JUPEM melalui talian telekomunikasi jalur lebar.

Pusat Kawalan MyRTKnet pula bertanggungjawab bagi menerbit dan menyebar data pembetulan GPS kepada pengguna bergerak dalam masa hakiki. Dalam hubungan ini, maklumat kasar kedudukan pengguna yang dihantar ke Pusat Kawalan melalui penggunaan telefon selular akan terlebih dahulu dirujuk kepada beberapa stesen rujukan kekal GPS di dalam jaringan di mana pengguna itu berada. Segala pembetulan efemeris satelit dan kesan atmosfera bagi kawasan jaringan tersebut akan seterusnya dimodelkan dan maklumat pembetulan data GPS akan disalurkan kepada pengguna berkenaan bagi membolehkan penentuan kedudukan tempat cerapan.

Buat masa ini ketepatan pada tahap sentimeter mampu dicapai oleh pengguna GPS yang berada di dalam kawasan jaringan stesen-stesen rujukan yang padat, iaitu di sekitar Lembah Klang, Pulau Pinang dan Johor Bahru. Tahap ketepatan yang sama juga mampu dicapai oleh pengguna GPS yang berada dalam lingkungan 30 km daripada stesen rujukan MyRTKnet. Sementara pengguna yang berada di luar kawasan liputan yang disebutkan akan hanya berupaya mencapai ketepatan pada tahap desimeter sahaja.

4.0 PERKHIDMATAN MyRTKnet

Amnya, perkhidmatan yang diberikan oleh MyRTKnet adalah dalam bentuk pembekalan data seperti dalam **Jadual 1**. Data-data yang dibekalkan kepada pengguna terdiri daripada data masa hakiki dan juga data *post-processed* di mana penggunaannya bergantung kepada objektif pengukuran itu sendiri. Dalam pada itu, pengguna perlulah mematuhi spesifikasi pengukuran yang telah ditetapkan semasa mengendalikan kerja bagi mendapatkan hasil pengukuran yang baik.

Bil.	Jenis Data	Ciri-Ciri Data
1.	Pembetulan Stesen Rujukan Maya *(Vitual Reference Station (VRS) Correction).*	Masa Hakiki
2.	Pembetulan Rujukan Tunggal *(Single Base Correction).*	Masa Hakiki
3.	Pembetulan *Differential Global Positioning System* (DGPS) Berasaskan Jaringan *(Network Base DGPS Correction).*	Masa Hakiki
4.	Data Maya RINEX *(Virtual RINEX Data)*	*Post Processed*
5.	Data RINEX *(RINEX Data).*	*Post Processed*

Jadual 1: Jenis Data Yang Dibekalkan Oleh Pusat Kawalan

5.0 GARIS PANDUAN MENGENAI MyRTKnet

Maklumat lanjut mengenai perkhidmatan MyRTKnet serta penggunaannya terkandung dalam garis panduan seperti di **LAMPIRAN 'A'**. Antara intisari garis panduan tersebut adalah seperti berikut:

i. Pengenalan kepada MyRTKnet yang meliputi sistem, ciri-ciri serta liputan jaringan stesen-stesen rujukan.
ii. Perkhidmatan yang diberikan oleh MyRTKnet.
iii. Aplikasi dan spesifikasi ketepatan.
iv. Prosedur penggunaan perkakasan, perisian, kalibrasi alat dan perolehan data.
v. Prosedur pendaftaran dan fi yang dikenakan bagi penggunaan perkhidmatan MyRTKnet.

Sekian, terima kasih.

“BERKHIDMAT UNTUK NEGARA”

(DATO’ HAMID BIN ALI)

Ketua Pengarah Ukur dan Pemetaan

Malaysia

Salinan kepada:

Timbalan Ketua Pengarah Ukur dan Pemetaan

Pengarah Ukur Bahagian (Pemetaan)

Pengarah Ukur Bahagian (Kadaster)

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Ketua Penolong Pengarah,
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Ibu Pejabat Jabatan Perumahan Negara

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Lembaga Juruukur Tanah Sabah

Setiausaha,
Lembaga Juruukur Tanah Sarawak

LAMPIRAN A

MALAYSIAN RTK GPS NETWORK (MyRTKnet)

GUIDELINE

JABATAN UKUR DAN PEMETAAN MALAYSIA

2005

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1. INTRODUCTION

Real Time Kinematic (RTK) survey method is the latest innovation of relative positioning whereby multiple receivers are linked by radios simultaneously in collecting observations. The reference station broadcasts its differential data and the roving units receive it through a data port, directly connected to a radio receiver. The roving units can then display position, velocity, time and other information as needed for land, marine and aeronautical applications in precise positioning.

The new generation of RTK known as “Virtual Reference Station (VRS)” is based on having a network of GPS reference stations continuously connected via telecommunication network to the control centre. A computer at the control centre continuously gathers information from all receivers, and creates a living database of Regional Area Corrections. With VRS system, one can establish a virtual reference station at any point and broadcast the data to the roving receivers.

This guideline presents the specifications of the Malaysian RTK GPS Network or MyRTKnet, which includes the system description, features, coverage, applications, products, services and design accuracy. The recommended standard procedures and guidelines for surveying using the facilities are also outlined.

2. MALAYSIAN REAL TIME KINEMATIC GPS NETWORK (MyRTKnet)

MyRTKnet is a new nation-wide GPS network and system infrastructure developed for GPS users to provide RTK and DGPS services with unmatched accuracy and coverage for positioning applications across the country. As a wide-area satellite based service, the broadcast MyRTKnet corrections can be obtained anywhere in Malaysia using a custom-built MyRTKnet GPS receiver. The positioning data from MyRTKnet reference stations is optimised for Malaysia, resulting in

superior centimetre-level accuracy with most GPS receivers. Compared to existing solutions, MyRTKnet provides better coverage and performance, a superior technology platform for continued accuracy improvements, plus the assurance of working with a national GPS network infrastructure that ensures spatial integrity.

2.1. SYSTEM DESCRIPTION

Currently, MyRTKnet have 27 RTK reference stations forming the network, covering the whole of Peninsular Malaysia and two major cities in Sabah and Sarawak (**Figure 1**). The stations track GPS signals and send them via dedicated data lines to a central network server at JUPEM Geodesy Section, which manages and distributes GPS correction data to subscribers in real time. Subscribers receive data on their own devices via wireless technology using internet-based infrastructure.

The service provided by MyRTKnet offers the flexibility of enabling both RTK and DGPS operations. While RTK operations are limited to 30 km from MyRTKnet reference site, the DGPS operations can extend further, advisably to 150 km. Both real-time operations however require reliable mobile phone coverage. Clear communications between the control centre and rovers via cell phone modems eliminate problems associated with radio broadcast.

MyRTKnet will broadcast continuously, 24 hours a day, a 1 Hz dual-frequency data sampling rate using standards of the Radio Technical Commission for Maritime Services (RTCM) and/or other industry standard formats. **Figure 2** shows the conceptual diagram of MyRTKnet.

Figure 1 : MyRTKnet Stations Distribution

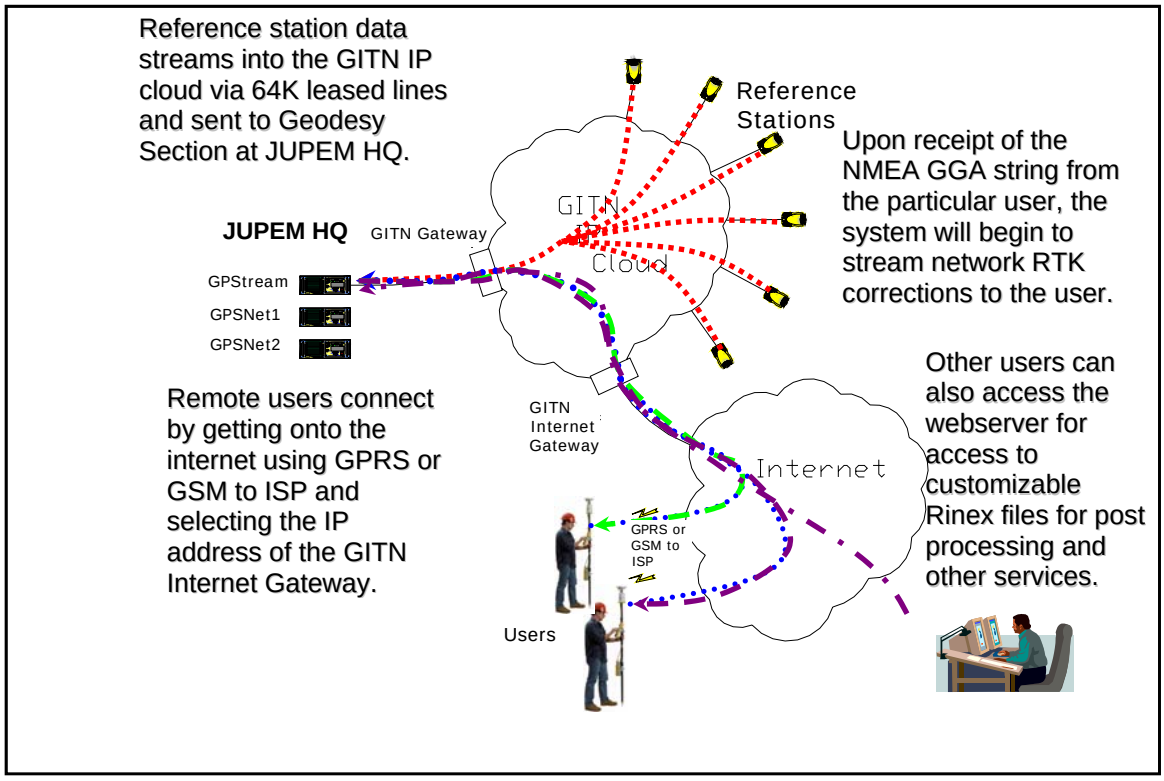

Figure 2: Conceptual Diagram of MyRTKnet System

2.2. FEATURES

MyRTKnet reduces physical infrastructure costs whereby the need to establish one own's master GPS is obliterated and should increase productivity with the use of highly portable GPS systems.

It provides high performance solution well-suited to real-time data collection needs of Malaysian users. The network, which includes the provision of redundancy at the data collection, transmission and processing layers, has a high degree of service reliability. At the same time, a web site is made available to download GPS data for post-processing solutions.

Amongst others, the network has the following characteristics:

- Nation-wide coverage
- Supports real-time 3D positioning
- Compatible with global reference system (in the GDM2000 system)
- Enables attainment of sub-meter accuracy (± 0.3m) with mapping grade GPS receivers
- Enables attainment of cm-level accuracy (± 1 cm) with dual frequency GPS receivers

2.3. COVERAGE

The present coverage of MyRTKnet includes three dense networks that provide centimetre accuracy around Lembah Klang, Pulau Pinang and Johor Bahru, (**Figure 3**) and a sparse network covering the whole nation. Other areas in the vicinity of 30 km radius from the permanent reference stations will also provide centimetre accuracy. This coverage is expected to be further

densified in the years to come as JUPEM endeavours to provide better extent of the facilities to GPS users.

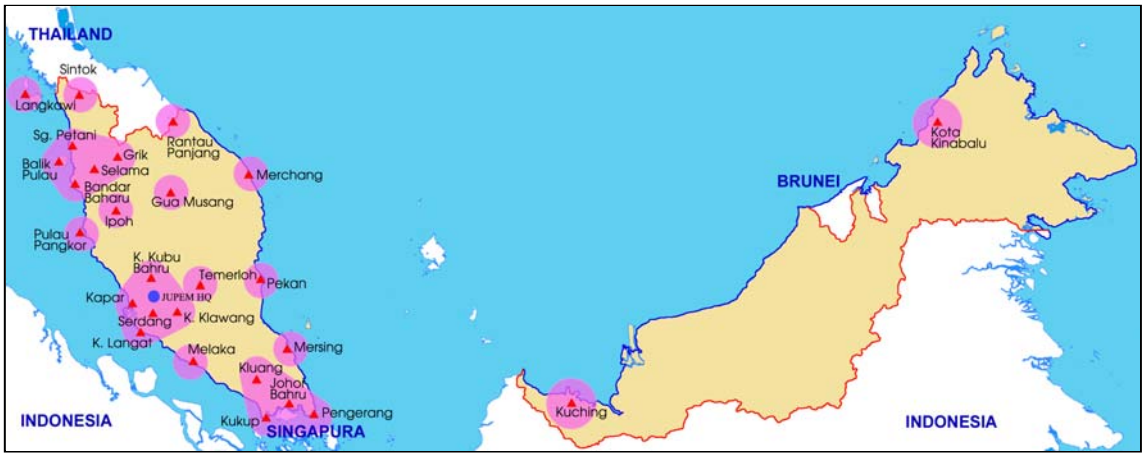

Figure 3 : MyRTKnet Coverage

2.4. MyRTKnet SERVICES

MyRTKnet provides various levels of GPS correction and data. Their use will depend on the technique and application to be employed by the users. Virtual Reference System (VRS) data, Single Base data and Network Base DGPS data are meant for real time applications whereas Virtual RINEX and RINEX data are for post-processed applications.

2.4.1. Virtual Reference System (VRS) Data

VRS is an integrated system which links and utilizes data from permanent reference stations to model errors throughout the coverage area. This model is used to synthesize virtual reference stations near the user's location which then provide a localized set of standard format correction messages to the roving receiver.

To enable the modeling, the rover must provide its approximate position to the control centre. This is done via cellular modem using the standard NMEA GGA string. The control centre automatically receives this positioning information, interpolates and applies corrections for ephemeris, tropospheric and ionospheric errors and generates the virtual reference station for that individual rover. It then produces a set of standard format correction messages as if they were coming from the virtual reference station and transmits them via cellular modem back to the rover.

2.4.2. Single Base Data

This correction is provided for areas within 30 km from any of the MyRTKnet single permanent reference station. The rover will select the reference station required through cellular phone connection and the corresponding differential data will be transmitted from the control centre to the rover.

2.4.3. Network Base DGPS Data

This correction is provided for the whole of Peninsular Malaysia and areas within 150 km radius from Kota Kinabalu and Kuching. This could be utilized in applications such as sub-meter mapping and navigation. Any receiver that is capable of handling Real Time Corrections and cell phone data service can be used to receive DGPS solutions' Real Time RTCM corrections. Distance dependant errors are eliminated for users' observations due to DGPS's array of base station locations.

2.4.4. Virtual RINEX Data

Virtual RINEX data are GPS RINEX format data generated by MyRTKnet system based on approximate coordinates provided by users. These data are the virtual reference station data that will be used as a reference by users for baseline computation.

Within the larger limits of the MyRTKnet coverage stated in para 2.4.3, it provides data for post-processing of static survey sessions, enhancing the positions by an order of one (1) cm limit. The data is available via JUPEM's password protected internet website.

Data can be downloaded at any interval ranging from 0.1 second to 60 seconds specified in JUPEM's website.

2.4.5. RINEX Data

The observed permanent reference station data in RINEX format are available for downloading through the website. These data can be obtained at any interval ranging from one (1) second to 60 seconds for static or kinematic post-processing application.

3. APPLICATIONS

MyRTKnet is well-suited to a wide variety of positioning applications which include:

- geodesy
- mapping and GIS
- surveying including cadastral

- marine
- navigation
- airborne applications
- deformation monitoring
- atmospheric study
- scientific and geodynamic studies

Applications in land surveying are listed in **Table 1**, whereby amongst others the suitability of rapid and real-time GPS methods for such applications has been assessed. As would be evident from the list, Network RTK method is in practically all cases advantageously applicable.

Application	**Static & Rapid Static**	**Stop & Go Kinematic**	**Real Time RTK**	**Network RTK (MyRTKnet)**
Geodetic Control	♦	⊕	∅	♦
Network Densification	♦	⊕	⊕	♦
Cadastral surveys	∅	⊕	⊕	♦
Topographic surveys	∅	⊕	⊕	♦
Large scale mapping	∅	⊕	⊕	♦
Building surveys	∅	∅	⊕	♦
Setting-out	∅	∅	⊕	♦
♦ = well suited	**⊕ = partly suitable**		**∅ = unsuitable**	

TABLE 1: **Suitability of Positioning Methods**

4. ACCURACY

The design accuracy as in **Table 2** outlines minimum performance anticipated from MyRTKnet real-time services. For higher accuracies, users may opt for post-processing approach, by obtaining the MyRTKnet data files (in Receiver Independent Exchange format or RINEX format) which are stored and managed separately by Geodesy Section of JUPEM.

Operation Mode (Instrumentation)	**Design Real-Time Accuracy @ 95% Confidence Level (single-point positioning mode)**	
	Horizontal	**Vertical**
VRS	4 cm	6 cm
Single Base	4 cm	6 cm
Network DGPS	0.3 m	0.6 m

TABLE 2: **Design Accuracy**

It would be evident from the table that centimeter level accuracy would be achievable where VRS services are available, i.e. within a dense network which currently includes areas in the vicinity of Lembah Klang, Pulau Pinang and Johor Bahru. Additionally, such level of accuracy could also be achieved within 30 km off MyRTKnet reference stations (Single Base). Overall performance will be dependent on uninterrupted data communication and GPS system characteristics, including data transmission latency, atmospheric conditions, satellite geometry, baseline length, multipath effects and user instrumentation. Subscribers may adopt a number of field procedures to improve the accuracy including static occupation and careful planning for optimum satellite geometry.

Data latency is the time taken for the user to send his approximate position to the GPSnet server and receive back correction in order to initialize positioning. As tested by JUPEM, the average initialization time was 20 seconds. For the case of Single Base, the time increases with the increase in distance of the rover from the Reference Station; tested case is about 75 seconds for a Rover – Reference Station of 49 km. The common factors affecting time to initialize are rover station satellites geometry and sky clearance.

5. STANDARD PROCEDURES AND GUIDELINES

5.1. HARDWARE FOR ROVER GPS SYSTEM.

In order to receive MyRTKnet corrections, users need to have a GPS rover system, which should consist of the following:

- GPS receiver with firmware and controller
- Data-logger
- Mobile phone with GSM or GPRS service

The hardware requirements to enable the use of various services of MyRTKnet are listed in **Table 3**.

Item	Services	Requirements
GPS Receiver	VRS	Dual frequency with firmware and controller supporting VRS correction.
	Single Base	Dual frequency with firmware and controller supporting VRS correction.
	Network Base DGPS	Single frequency or better with firmware and controller supporting VRS correction.
	Virtual RINEX Data	Single or dual frequency GPS carrier phase receiver.
Data Logger	VRS	Runs WindowsCE and supports PPP connections to ISP or to GPRS.
	Single Base	Runs WindowsCE and supports PPP connections to ISP or to GPRS.
	Network Base DGPS	Runs WindowsCE and supports PPP connections to ISP or to GPRS.
	Virtual RINEX Data	Data Logger not required
Mobile phone with GSM or GPRS service	VRS	Mobile phone required
	Single Base	Mobile phone required
	Network Base DGPS	Mobile phone required
	Virtual RINEX Data	Mobile phone not required

TABLE 3: **Hardware Requirements**

5.2. SOFTWARE FOR ROVER GPS SYSTEM

Current GPS Rover System possesses the required software that enables real-time communication in between the data logger and the GPS receiver as well as the downloading of correction data through internet protocol. In the case where it is not provided, NTRIP support software is required. This support software can be downloaded from JUPEM website at http://www.geodesi.jupem.gov.my. Additional post-processing software is required when user makes use of Virtual RINEX and RINEX data.

5.3. EQUIPMENT CALIBRATION

A GPS system calibration program is a prerequisite for demonstrating "competence" and for assuring that GPS-derived coordinates are of high quality. The test shall be used to verify the precision of the receiver measurements (and hence its correct operation), as well as to validate the data processing software. The results of such testing should be retained by the user and made available for audit on request.

The GPS equipment tests that are to be conducted for the purpose of use in GPS survey (apart from using MyRTKnet) have been provided for under Director General of Survey and Mapping Circular No. 6/1999. Requirements to be fulfilled in performing the tests needed for using GPS equipment in conjunction with MyRTKnet are as follows:

a) The test shall be performed before any GPS survey project using the services of MyRTKnet is carried out.

b) The test can be carried out at JUPEM’s GPS/EDM Test Base or Primary GPS Network stations within the MyRTKnet coverage.

c) The test shall be carried out by connecting any mobile receiver to a data cell phone and data collector (as recommended by the GPS manufacturer).

d) Cut-off angle of fifteen degrees (15°) should be applied.

Standard procedures for testing rover GPS systems are as listed in **Table 4**.

Method	Requirement
VRS	• Static mode with observation interval of five (5) seconds for 10 epochs of five (5) times initialisation. • Track at least five (5) satellites with a GDOP of less than six (6). • Observations have to be carried out on at least six (6) pillars. • Maximum allowable discrepancy: 30 mm in horizontal component and 60 mm in vertical component.
Single Base	
Network Base DGPS	• Static mode with observation interval of five (5) seconds for 10 epochs of five (5) times initialisation. • Track at least four (4) satellites with a GDOP of less than six (6). • Observations have to be carried out on at least 6 pillars. • Maximum allowable discrepancy: 50 cm in horizontal component and 1 m in vertical component.

TABLE 4: Procedures for Testing of Rover GPS Systems

5.4. DATA ACQUISITION

Guidelines for data acquisition using network RTK such as MyRTKnet are as listed in **Table 5**.

Item	VRS	Single Base	Network Base DGPS
Network Coverage	Within dense network or max. 30 km outside the dense network.	Within 30 km of the single base reference station	Whole of P. Malaysia or within 150 km of Kota Kinabalu & Kuching
Observation Sessions	*Static* mode with observation epoch of five (5) seconds of 10 epochs.	*Static* mode with observation epoch of five (5) seconds of 10 epochs.	*Static* mode with observation epoch of five (5) seconds of 10 epochs.
Satellite Geometry	Min. 5 satellites in view for the entire session.	Min. 5 satellites in view for the entire session.	Min. 4 satellites in view for the entire session.
Sky Coverage	At least 90%, with telescopic antenna poles of up to 10 m being allowed.	At least 90%, with telescopic antenna poles of up to 10 m being allowed.	At least 90%, with telescopic antenna poles of up to 10 m being allowed.

TABLE 5: **Guidelines for Data Acquisition Using MyRTKnet.**

6. REGISTRATION AND SUBSCRIPTION

All users will have to register with JUPEM in order to subscribe to the products and services of MyRTKnet. To register as an authorised user one can use the On-line Registration Form available at http://www.rtknet.gov.my. Upon registration, each user will receive a Username and Password for access to the services made available. The registration, annual subscription and other related fees are as follows:

a) Registration Fee:
   - Government Department – RM 500
   - Private sector – RM 1,000

b) Annual Subscription of RM 3,000 for the following Real Time services:
   - VRS Correction
   - Single Base Correction
   - Network DGPS Correction

c) Post-Process Data:
   - Virtual RINEX Data - RM 15 per minute
   - RINEX Data - RM 10 per hour

7. EXCLUSION OF LIABILITY

JUPEM has made every endeavour to ensure that MyRTKnet GPS data made available to the public are free from errors and omissions. However, JUPEM does not warrant that the supplied data are free from errors or omissions. JUPEM shall not be in any way liable for any direct or indirect loss, damage or injury suffered by the use of such data.

8. CONDITIONS FOR DATA USE

The data is the sole property of the Director General of Survey and Mapping. They are supplied to registered users and is non transferable. The data must not be sold, given away, traded, let, hired or otherwise dealt with. Users are permitted to use the data in demonstrations and displays, provided a statement acknowledging supply by JUPEM is displayed with the data or any derived product.

Department of Survey and Mapping Malaysia
September 2005

GLOSSARY

Ambiguity

The unknown integer number of cycles of the reconstructed carrier phase contained in an unbroken set of measurements from a single satellite passes at a single receiver.

Baseline

The length of the three-demensional (3D) vector between a pair of stations for which simultaneous GPS data has been collect and processed with differential techniques.

Carrier Frequency

The frequency of the unmodulated fundamental output of a radio transmitter. The GPS L1 carrier frequency is 1575.42 MHz, the GPS L2 carrier frequency is 1227.60 MHz.

Cutoff Angle

The minimum elevation angle below which no more GPS satellites are tracked by the sensor.

DGPS

Differential GPS. The term commonly used for a GPS system that utilizes differential code corrections to achieve an enhanced positioning accuracy of around 0.5 – 5 m.

Ephemeris

A list of positions or locations of a celestial object as a function of time.

Epoch

A particular fixed instant of time used as a reference point on a time scare.

GDOP

Geometric dilution of precision.

Ionospheric Delay

A wave propagation through the ionosphere (which is a non-homogeneous and dispersive medium) experiences delay. Phase delay depends on electron content and affects carrier signals. Group delay depends on dispersion in the ionosphere as well, and affects signal modulation (codes). The phase and group delay are of the same magnitude but opposite sign.

Multipath error

A positioning error resulting from interference between radio waves which have travelled between the transmitter and the receiver by two paths of different electrical lengths.

NMEA

National Marine Electronics Association. Defined a standard (NMEA 0183) to enable marine electronics instruments, communication and navigation equipment to communicate. This standard is used to get time and position data out of GPS instruments in many applications.

Post Processing

The process of computing positions in non-real-time, using data previously collected by GPS receivers.

Rapid Static Survey

Term used in connection with the GPS System for static survey with short observation times. This type of survey is made possible by the fast ambiguity resolution approach.

RINEX

Receiver INdependent Exchange format. A set of standard definitions and formats to promote the free exchange of GPS data.

RTCM

Radio Technical Commission for Maritime services. Commission set up to define a differential data link to relay GPS messages from a monitor station to a field user.

RTK

Real Time Kinematic. A term used to describe the procedure of resolving the phase ambiguity at the GPS receiver so that the need for post-processing is removed.

Static Survey

The expression static survey is used in connection with GPS for all non-kinematic survey applications. This includes the following operation modes :

- Static Survey
- Rapid static survey

Stop & Go Survey

The term of Stop & Go survey is used in connection with GPS for a special kind of kinematic survey. After initialization (determination of ambiguities) on the first site, the roving receiver has to be moved between the other sites without loosing lock to the satellite signal. Only a few epochs are then necessary on there sites to get a solution with survey accuracy. Once loss of lock occurred, a new initialization has to be done.

Topography

The form of the land of a particular region.