Assisted GPS (A-GPS) Application Note

80000NT10066A Rev. 3 – 2012-11-02

Making machines talk.

APPLICABILITY TABLE

	SW Version
HE910 Family	**12.00.xx3**
HE910 [1]	
HE910-GA	
HE910-EUG	
HE910-NAG	

NOTICE: *the present document describes the features and the AT commands relating to the software version showed in the Applicability Table. To get more information about the AT commands covered by the present Application Note and their syntax, see the HE910 AT Reference Guide referring to the software version indicated in the table.*

[1] HE910 is the "type name" of the products marketed as HE910-G & HE910-DG.

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1. Introduction

The present document provides the reader with a guideline concerning the use of the Assisted GPS (A-GPS) developed on the Modules of the HE910 family. The document also deals with the Standalone GPS (S-GPS) in order to give to the reader an ease way to compare the AT commands used to set up and manage the two GPS solutions.

1.1. Scope

The present Application Note covers the Control-Plane Network and the Secure User Plane Location (SUPL) standards created by two different standardization bodies: the 3GPP and the OMA respectively.

1.2. Audience

This document is intended for those users that need to develop applications dealing with Location Request.

1.3. Contact Information, Support

For general contact, technical support, to report documentation errors and to order manuals, contact Telit Technical Support Center (TTSC) at:

TS-EMEA@telit.com
TS-NORTHAMERICA@telit.com
TS-LATINAMERICA@telit.com
TS-APAC@telit.com

Alternatively, use:

http://www.telit.com/en/products/technical-support-center/contact.php

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:

http://www.telit.com

To register for product news and announcements or for product questions contact Telit Technical Support Center (TTSC).

Our aim is to make this guide as helpful as possible. Keep us informed of your comments and suggestions for improvements.

Telit appreciates feedback from the users of our information.

1.4. Document Organization

This document contains the following chapters addressing the listed main topics:

Chapter 1: introduction, scope, target audience, contact and support information;

Chapter 2: document history;

Chapter 3: brief GPS introduction;

Chapter 4: S-GPS and A-GPS Solutions;

Chapter 5: Abbreviations and acronyms.

1.5. Text Conventions

Danger – This information MUST be followed or catastrophic equipment failure or bodily injury may occur.

Caution or Warning – Alerts the user to important points about integrating the module, if these points are not followed, the module and end user equipment may fail or malfunction.

Tip or Information – Provides advice and suggestions that may be useful when integrating the module.

All dates are in ISO 8601 format, i.e. YYYY-MM-DD.

1.6. Related Documents

[1] HE910 Hardware User Guide, Telit document: 1vv0300925

[2] HE910 Family Ports Arrangements User Guide, Telit document: 1vv0300971

[3] HE910 AT Commands Reference Guide, Telit document: 80378ST10091A

[4] WGS84 Implementation Manual, Eurocontrol and ifEN

[5] NMEA-0183 Standard for Interfacing Marine Electronic Devices

2. Document History

Revision	Date	Changes
0	2012-04-26	First issue
1	2012-05-14	Added sequence diagrams and AT#FRWL command. Updated Applicability Table.
2	2012-10-15	Added note about satellites visibility in chapters: 4.2.2.2.1, and 4.2.2.2.2
3	2012-11-02	Updated chapters 4.1, 4.2.2, 4.2.1.1.1, 4.2.1.1.2, 4.2.2.2.1, and 4.2.2.2.2. Deleted warnings about internal firewall. Deleted “Preliminary” from title page.

3. A brief GPS Introduction

The description of the GPS system is beyond the scope of this document. The reader that is interested to deepen the argument should refer to the dedicated literature, hereafter are only mentioned the basic concepts.

GPS system is based on a constellation of 24 satellites distributed equally among six circular orbital planes; the height of the orbits is about 20200 km. Orbits in this height are referred to as medium earth orbit (MEO).

GPS receiver performs initial position and velocity calculations using an ECEF coordinate system, fig. 1. Because the earth has a complex shape a method to approximate the earth's shape is required.

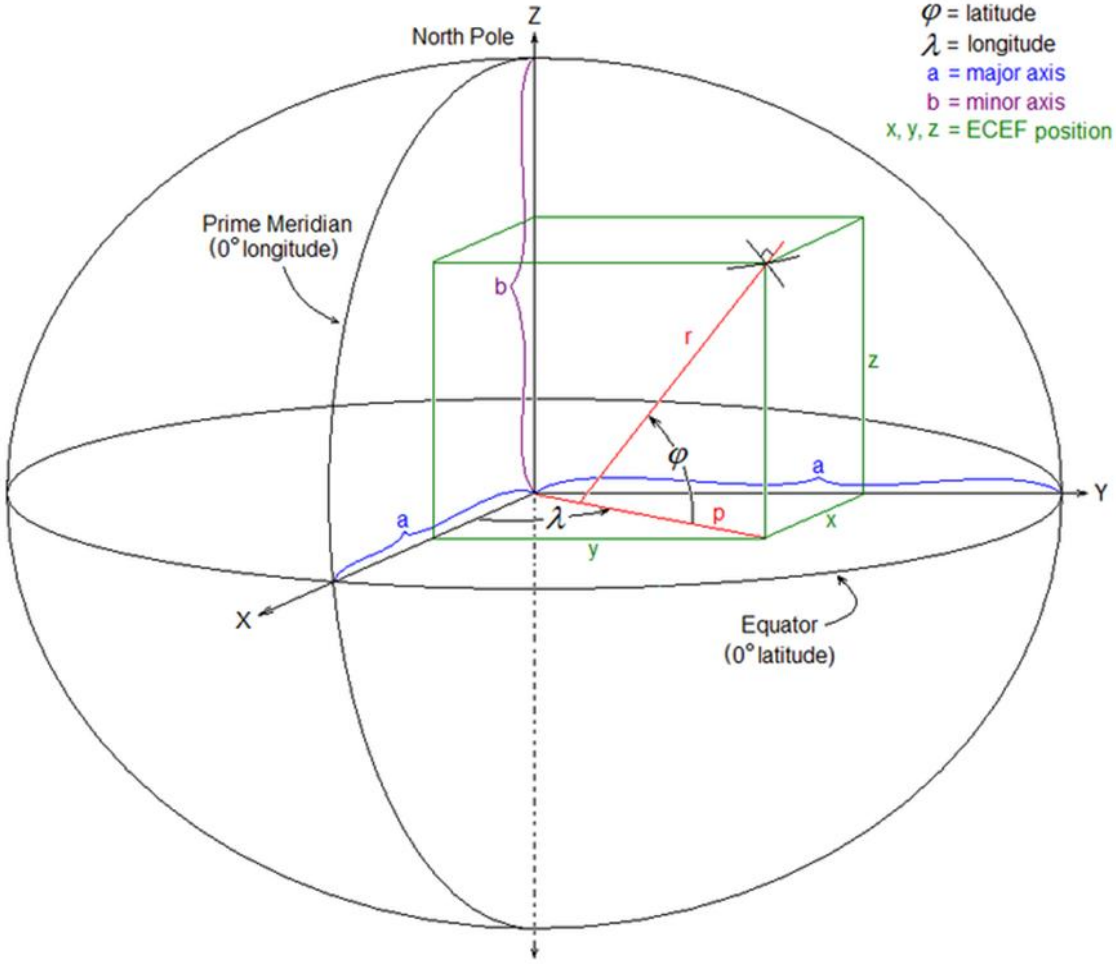


fig. 1: ECEF coordinate system [from Wikipedia]

The use of a geodetic reference (reference ellipsoid) allows for the conversion of the ECEF coordinates to the more commonly used coordinates of Latitude, Longitude and Altitude (LLA).

GPS receiver, used by GPS Telit solution, uses (by default) the geodetic reference (datum) WGS 84 [4] which provides a worldwide common grid system that may be translated into local coordinate systems or map datums. Many reference ellipsoids are used throughout the word. The main reason for choosing a reference datum other than WGS 84 is to minimize the local differences between the geoid and the ellipsoid separation or other mapping distortions. Local map datums are a best fit to the local shape of the earth and not valid worldwide.

4. GPS Solutions

Nowadays there are several Positioning Techniques to provide the localization of targeted MS. One of them is the A-GPS Positioning Technique based on the help of a cellular network deploying an A-GPS server.

At this point, it is advisable to introduce the definition of: Time to First Fix (TTFF):

TTFF indicates the time and process required for a GPS device to get adequate satellite signals and data to provide accurate navigation.

A GPS uses the following sets of data to provide accurate position

- GPS satellite signals,
- Almanac data,
- Ephemeris data.

If a GPS device has been turned off for a long period of time, when it is turned on it will take longer to acquire these data sets and get a "Time to First Fix". One way to speed up TTFF is to use the A-GPS Positioning Technique.

A "cold" start indicates the scenario in which the GPS must get all data in order to start navigation, and may take up to several minutes.

A "warm" start indicates the scenario in which the GPS has most of the data it needs in memory, and will start quickly, a minute or less.

The following chapters address the GPS solutions supported by the Telit modules belonging to the HE910 family. Before dealing with the A-GPS service, a Standalone GPS solution is described. The figure below shows the functional entities covered by the document.

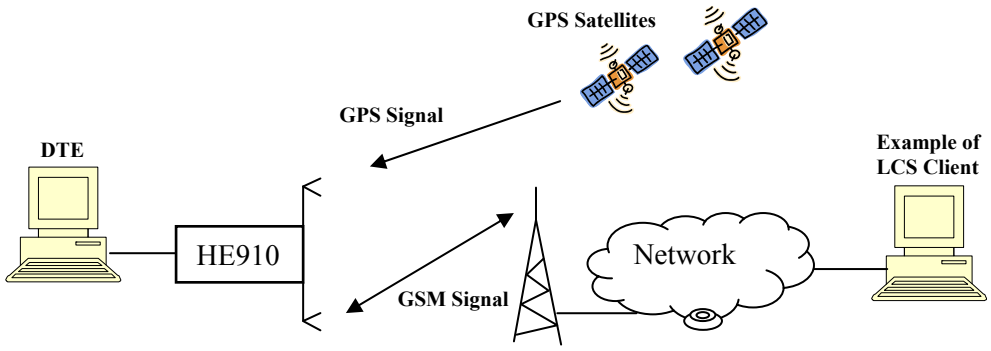


fig. 2: GPS

4.1. Standalone GPS (S-GPS)

Standalone GPS indicates that the GPS receiver, installed on the module, performs its First Fixing activity without, for example, assistance data coming from cellular network. The GPS receiver gets the position data directly from GPS satellites in its line of sight. The S-GPS is sometime slower to compute its First Fix; this phenomenon is evident in very poor signal conditions, for example in a city where the satellites signals are corrupted by the multipath propagation.

Assume that the HE910 module is connected to a DTE by means of the Main Serial Port (USIF0) and no USB cable is plugged in, refer to [1], [2]. To set up the GPS receiver in standalone mode the user must enter the following commands, refer to [3]. The module is powered down.

Switch on the module.

Delete the GPS information stored in NVRAM. It is the history buffer between the GPS device and the module. This action is not mandatory; it must be performed only if you need to clear the buffer:

AT$GPSNVRAM=15,0

OK

Enable unsolicited messages of GPS data (NMEA format), refer to [5]. Only Global Positioning System Fix Data (GGA) sentence is enabled:

AT$GPSNMUN=1,1,0,0,0,0,0

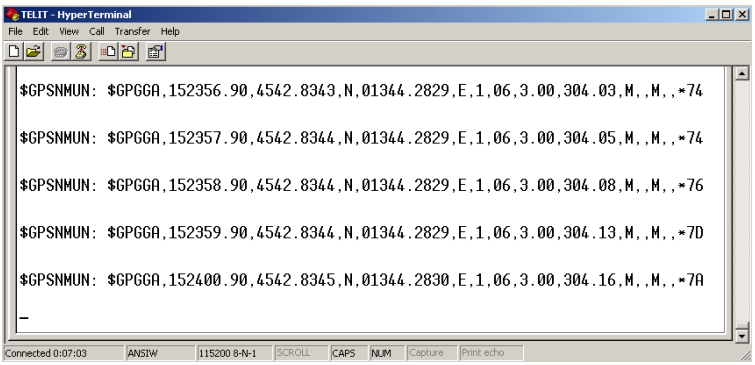
OK

Start the GPS receiver in Standalone mode:

AT$GPSP=1

OK

After a time interval depending from the environmental characteristic where the GPS receiver operates (outside, inside, city, etc.), the NMEA sentence GGA appears on the DTE, see the figure below.



Now, you can stop the display of the GGA sentence entering the following command:

AT$GPSNMUN=0,1,0,0,0,0,0

OK

You can read the current fix using the following command:

AT$GPSACP

$GPSACP: 152324.000,4542.8396N,01344.2874E,3.00,310.0,3,000.00,0.00,0.00,200412,

05

OK

The HE910 modules family provides another AT command to start the autonomous GPS mode:

AT$GPSSLSR=2,3,,,,,1

OK

It is equivalent to the AT$GPSP=1 command.

WARNING: refer to AT$GPSSLRS command: if the last optional parameter (<interval>) is omitted, autonomous one shot NMEA streaming of data is selected.

4.2. Assisted GPS (A-GPS)

Generally speaking, Assisted GPS indicates that the GPS receiver installed on the module can perform its First Fix using assistance furnished by entities deployed by Cellular Network.

4.2.1. C-Plane Network

Two functional entities must be added to the network to make it supporting the A-GPS Service: Serving Mobile Location Center (SMLC) and a Gateway Mobile Location Center (GMLC). This solution was proposed by the standardization body 3GPP.

4.2.1.1. Mobile Originated Location Request (MO-LR)

In this scenario the Location Request is started by the module itself. Two modes are available:

- MS-Assisted
- MS-Based

4.2.1.1.1. MS-Assisted mode

In MS-Assisted mode, the module requires suitable GPS data to the network in accordance with the current used mode. With the help of this data, the A-GPS receiver, installed on the module, receives signals from the visible satellites and sends the measurement to the network. The network calculates the position and sends it back to the module. See the following example to perform the First Fix. Assume that the module is powered down.

Switch on the module.

Set the location's Quality of Service (QoS):

AT$GPSQOS=100,50,25,0

OK

Delete the GPS information stored in NVRAM. It is the history buffer between the GPS device and the module. This action is not mandatory; it must be performed only if you need to clear the buffer:

AT$GPSNVRAM=15,0

OK

Enable unsolicited messages of GPS data (NMEA format). Only Global Positioning System Fix Data (GGA) sentence is enabled (optional):

AT$GPSNMUN=1,1,0,0,0,0,0

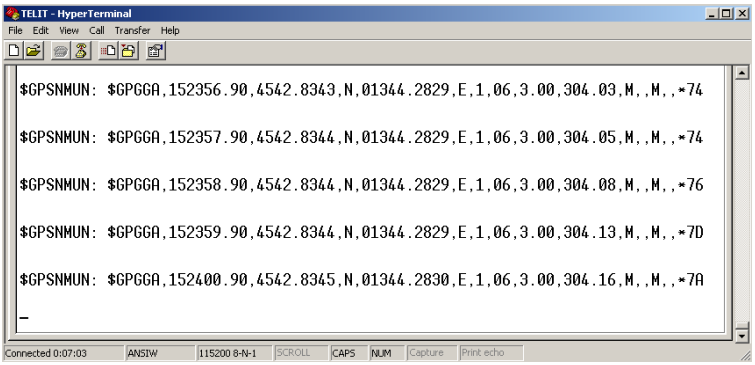
OK

Start the MO-LR using the MS-Assisted mode to calculate the First Fix:

AT$GPSSLSR=0,0

OK

After a short time interval the NMEA sentence GGA appears on the DTE, see the figure below.



Now, you can stop the display of the GGA sentence entering the following command:

AT$GPSNMUN=0,1,0,0,0,0,0

OK

You can read the current fix using the following command:

AT$GPSACP

$GPSACP: 152324.000,4542.8396N,01344.2874E,3.00,310.0,3,000.00,0.00,0.00,200412,

05

OK

The sequence diagram below depicts the basic flow to accomplish a MO-LR / MS-Assisted Mode. In this example are not enabled the unsolicited messages of the GPS data in NMEA format.

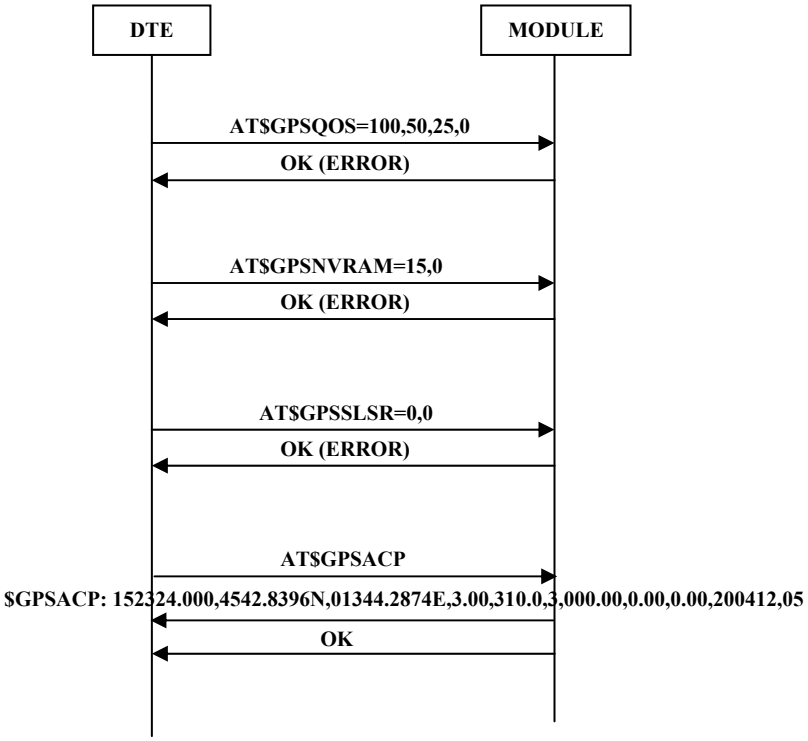


fig. 3: C-Plane / MO-LR / MS-Assisted Mode

4.2.1.1.2. MS- Based mode

In MS-Based mode, the module requires suitable GPS data to the network in accordance with the current used mode. With the help of this data, the A-GPS receiver, installed on the module, receives signals from the visible satellites and calculates the position. See the following example to perform the First Fix. Assume that the module is powered down.

Switch on the module.

Set the location's Quality of Service (QoS):

AT$GPSQOS=100,50,25,0

OK

Delete the GPS information stored in NVRAM. It is the history buffer between the GPS device and the module. This action is not mandatory; it must be performed only if you need to clear the buffer:

AT$GPSNVRAM=15,0

OK

Enable unsolicited messages of GPS data (NMEA format). Only Global Positioning System Fix Data (GGA) sentence is enabled (optional):

AT$GPSNMUN=1,1,0,0,0,0,0

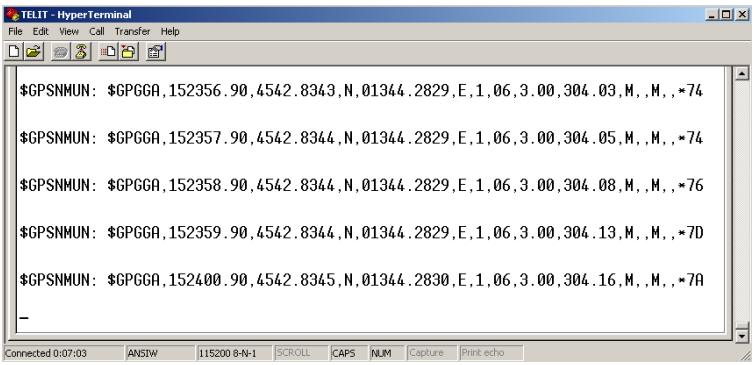
OK

Start the MO-LR using the MS-Based mode

AT$GPSSLSR=0,1

OK

After a short time interval the NMEA sentence GGA appears on the DTE, see the figure below.



Now, you can stop the display of the NMEA sentence, if enabled, entering the following command.

AT$GPSNMUN=0,1,0,0,0,0,0

OK

You can read the current fix using the following command:

AT$GPSACP

$GPSACP: 152324.000,4542.8396N,01344.2874E,3.00,310.0,3,000.00,0.00,0.00,200412,

05

OK

The sequence diagram below depicts the basic flow to accomplish a MO-LR / MS-Based Mode. In this example are not enabled the unsolicited messages of the GPS data in NMEA format.

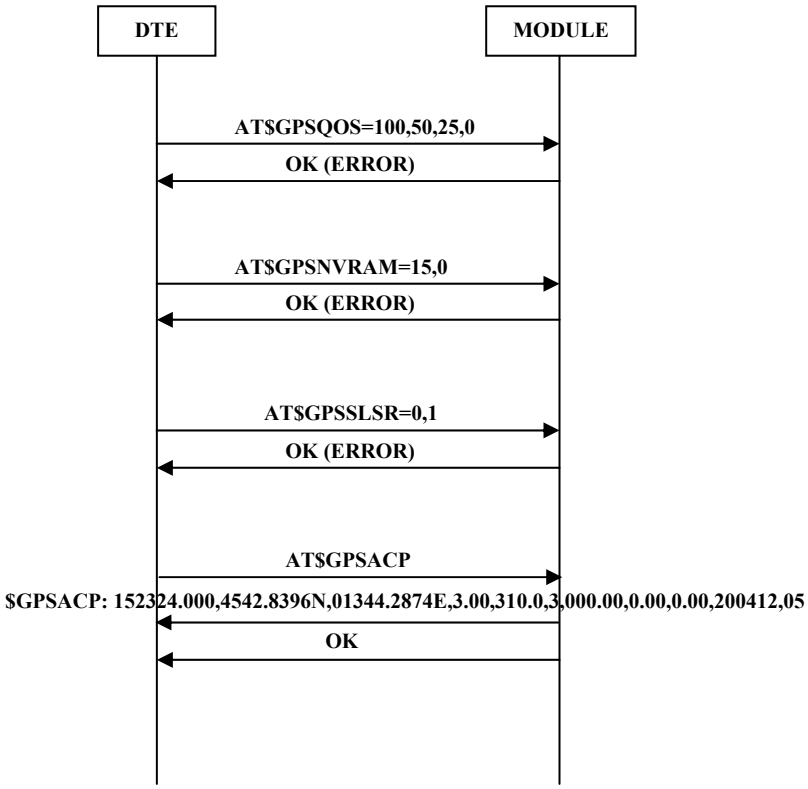


fig. 4: C-Plane / MO-LR / MS-Based Mode

4.2.1.2. Mobile Terminated Location Request (MT-LR)

The network (an external LCS client[2]) can request the current location of a targeted MS from a GMLG. To perform this action the network establishes an MT toward the targeted MS. The MS to detect a possible incoming call must enable the unsolicited $LCSLRMT response with the following commands:

Enable unsolicited $LCSLRMT response:

AT$LCSLRMT=1

OK

When the network establishes the MT, the targeted MS displays on the DTE the following unsolicited message:

$LCSLRMT: <transport_protocol>,<Notif_type>,<Loc_estimate_type>,

<Client_Id>,<Client_Name_Encoding_type>,<Client_Name_Type>,

<Client_Name>,<Requestor_Id_Encoding_type>,<Requestor_Id_Type>,

<Requestor_Id>,<Codeword>,<Service_Type_id>,<reqid>

If the request is accepted enter the following command to notify it to the network (Location Service Client). Use <reqid> to identify univocally the Location Request:

AT$LCSLV=1,<reqid>

OK

Or to reject the request use:

AT$LCSLV=0,<reqid>

OK

[2] Location Services Client description is beyond the scope of this document.

The sequence diagram below depicts the basic flow to accomplish a MT-LR. The example shows an accepted location request.

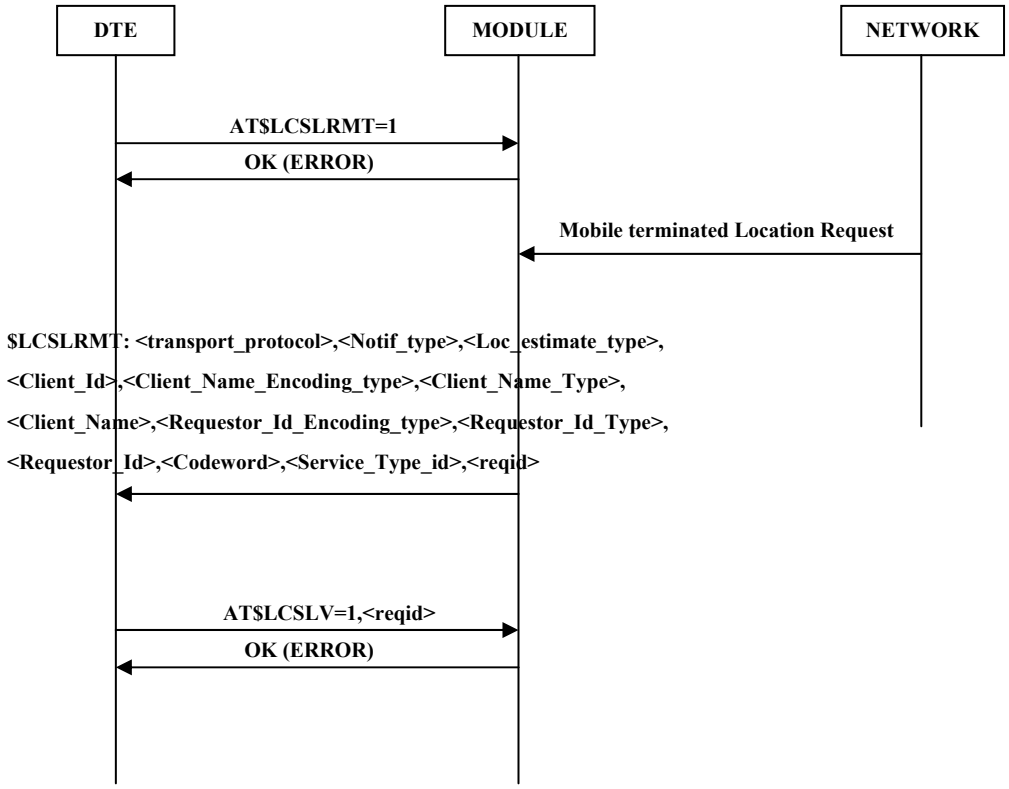


fig. 5: C-Plane / MT-LR

4.2.2. Secure User Plane Location (SUPL)

This Location Service architecture is composed of two basic elements: a SUPL Enabled Terminal (SET) and a SUPL Location Platform (SLP). The SET corresponds to the module, more specifically to the SUP Agent that handles location transactions between the SET and the SLP. The SLP provides all A-GPS data services. This solution was proposed by the standardization body OMA.

Two scenarios are available about the Location Request:

- Network Initiated Session
- SET Initiated Session

Before dealing with the Sessions mentioned above, it is needed to enter the following AT commands to configure the Telit module. The used hardware configuration is showed on fig. 2. It is advisable to point out that in this configuration example is not indicated the SUPL Server; it is responsibility of the user to select one. Assume that the module is powered off.

Switch on the module.

Set the module current time:

AT+CCLK=” year/month/day.hour:minute:seconds±time zone”

OK

Delete the GPS information stored in NVRAM. It is the history buffer between the GPS device and the module. This action is not mandatory; it must be performed only if you need to clear the buffer:

AT$GPSNVRAM=15,0

OK

Enable unsolicited messages of GPS data (NMEA format). Only Global Positioning System Fix Data (GGA) sentence is enabled (optional):

AT$GPSNMUN=1,1,0,0,0,0,0

OK

Load Transport Layer Security (TLS) Certificate if a TLS SUPL session is used. As already stated, it is responsibility of the user to select the SUPL Server furnished by the desired Location Service Provider.

AT$LTC="<certificate in Hexa format MAX 300 >",<total Length of the certificate>,<Seq Number>,0

OK

Define the context that will be used by the LoCation Service (LCS). It must be in accordance with the selected Network Provider:

AT+CGDCONT=<cid>,”IP”,<apn>

OK

Lock <cid> for SUPL use:

AT$LCSLK=1,<cid>

OK

Set the selected SLP address and port number (default 7275):

AT$LCSSLP=<slp_address_type>,<slp_address>,7275

OK

Configure the SET ID, for example IMSI:

AT$LCSTER=1

OK

Enable unsolicited $LCSLRMT notification (used only by Network Initiated Session):

AT$LCSLRMT=1

OK

Enable unsolicited $LICLS notification (used by Network and SET Initiated Sessions):

AT$LICLS=1

OK

Set the location's Quality of Service (QoS):

AT$GPSQOS=50,50,100,0

OK

The sequence diagram below depicts the basic flow to configure the Telit Module to operate in one of the two sessions: Network Initiated or SET Initiated Session. In this example are not enabled the unsolicited messages of the GPS data in NMEA format.

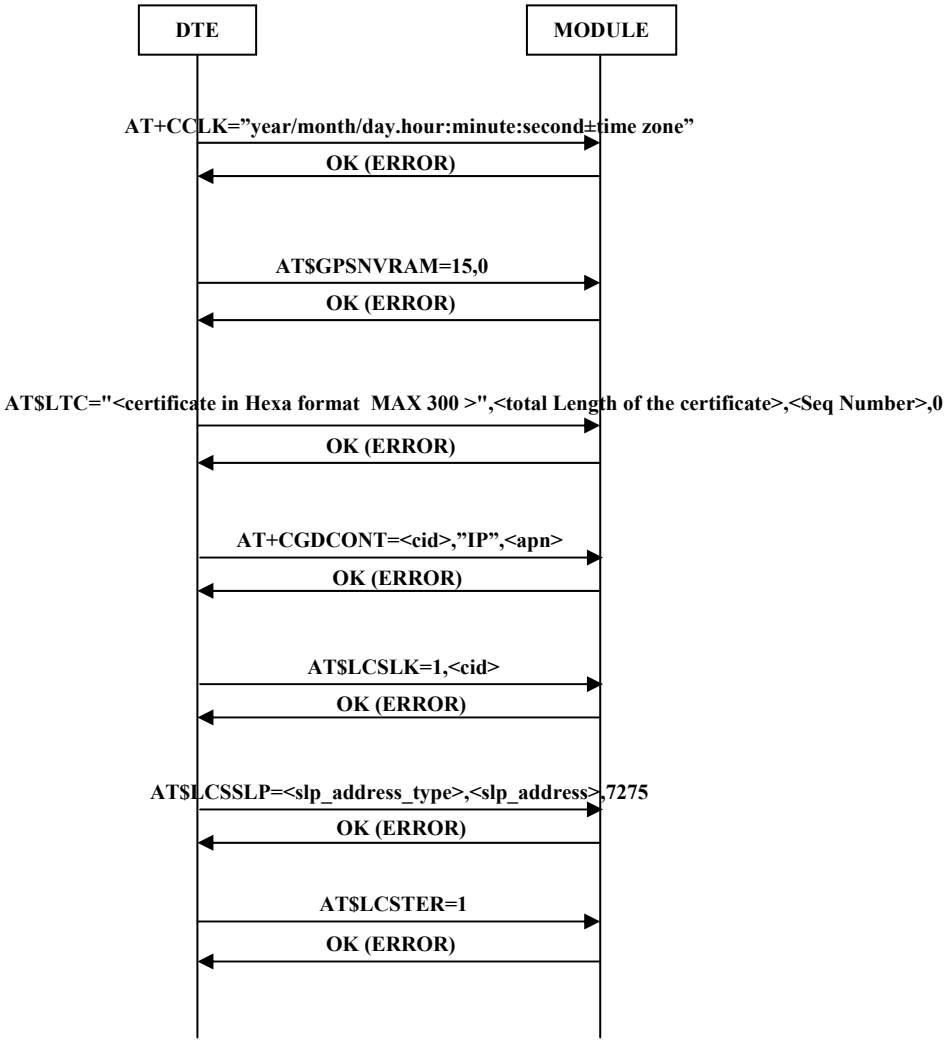


fig. 6: Module configuration for Network or Set Initiated Session (con’t)

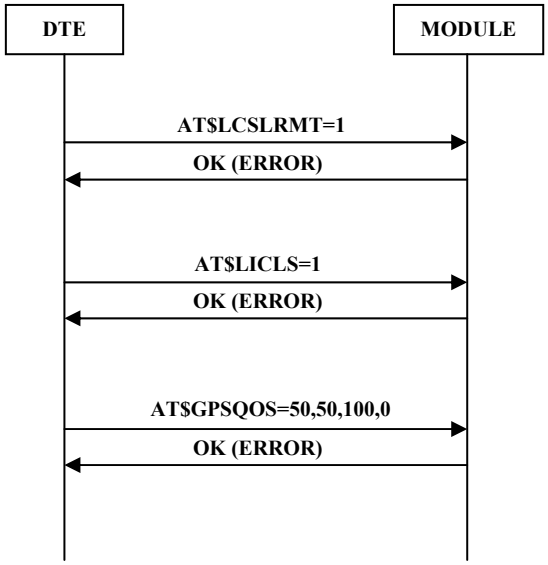


fig. 7: Module configuration for Network or Set Initiated Session

4.2.2.1. Network Initiated Session

It is assumed that you have performed the module configuration described on the chapter 4.2.2. Now, let's suppose that a generic Location Services Client[3] needs to know the Position of the targeted module. To perform this activity, the Location Service Client sends the request to the SUPL Server, which in turn, by means of the cellular network, sends a suitable SMS message to the targeted module. When the module receives the SMS message, you see the following unsolicited message on the DTE:

$LICLS:0

After receiving **$LICLS:0** unsolicited message**,** the module knows that the SUPL Server needs to be connected to it by means of the TCP/IP protocol. Activate the <cid> context locked for LoCation Service (LCS), refer to AT$LCSLK command on chapter 4.2.2.

AT#SGACT=<cid>,1

OK

Now, an unsolicited notification is received:

$LCSLRMT: <transport_protocol>,<Notif_type>,<Loc_estimate_type>,

<Client_Id>,<Client_Name_Encoding_type>,<Client_Name_Type>,

<Client_Name>,<Requestor_Id_Encoding_type>,<Requestor_Id_Type>,

<Requestor_Id>,<Codeword>,<Service_Type_id>,<reqid>

If the request is accepted enter the following command to notify it to the network (Location Service Client). Use <reqid> to identify univocally the Location Request:

AT$LCSLV=1,<reqid>

OK

To reject the request use:

AT$LCSLV=0,<reqid>

OK

Enter the following commands to release the link and unlock the <cid>

AT#SGACT=<cid>,0

OK

AT$LCSLK=0

OK

[3] Location Services Client description is beyond the scope of this document.

The sequence diagram below depicts the basic flow to accomplish the Network Initiated Session. The example shows an accepted location request. The first part of this sequence diagram is showed in fig. 6.

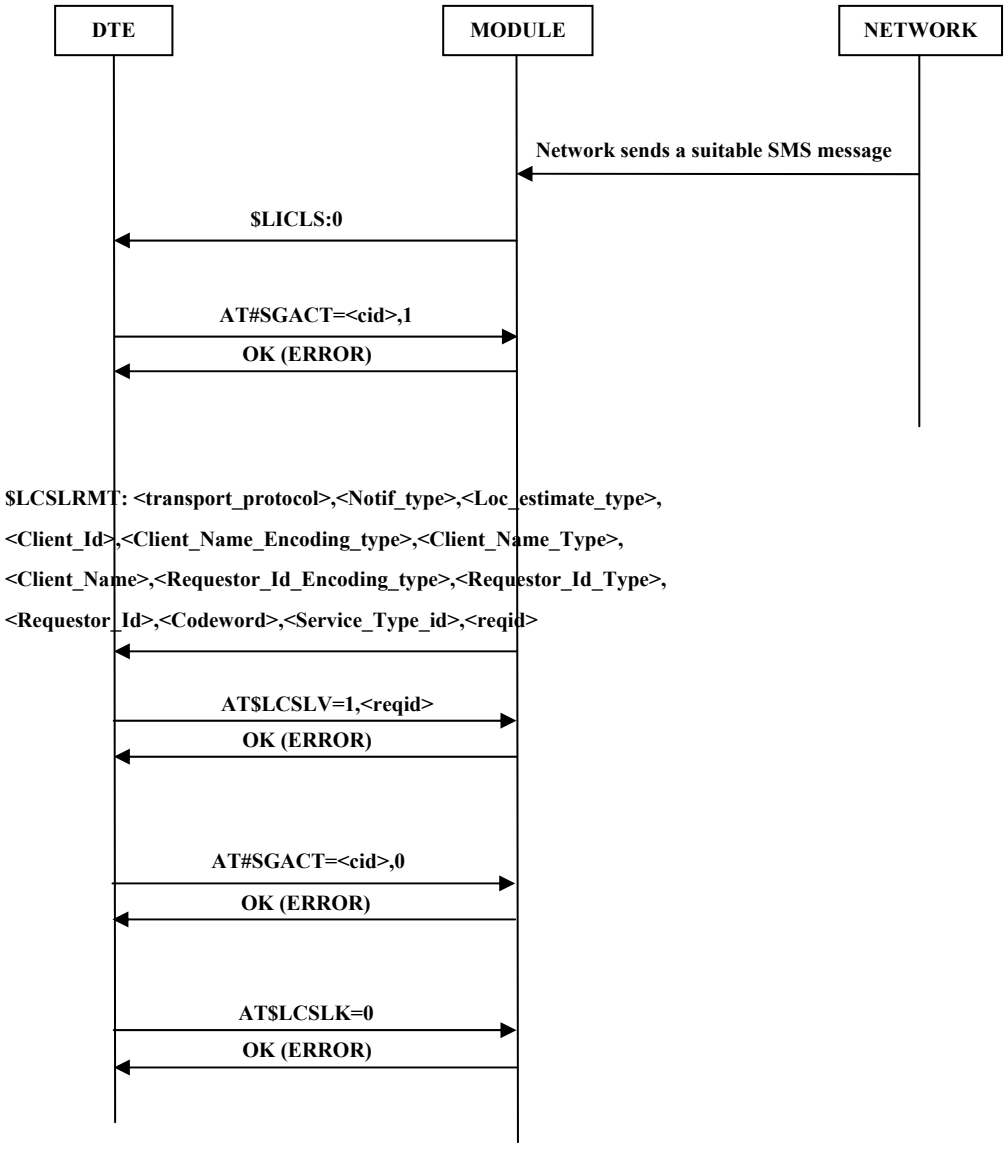


fig. 8: Network Initiated Session (SUPL)

4.2.2.2. SET Initiated Session

The module (SET), on its initiative, connects to an SLP Server by means of an IP network, two modes are available:

- MS-Assisted
- MS-Based

4.2.2.2.1. MS-Assisted mode

It is assumed that you have performed the A-GPS service configuration as described in the chapter 4.2.2. In MS-Assisted mode, the module requires suitable GPS data to the SLP Server. With the help of this data, the A-GPS receiver, installed on the module, receives signals from the visible satellites and sends the measurement to the SLP Server. The SLP Server calculates the position and sends it back to the module.

NOTE: if the required satellites visibility is not available, no NMEA sentences are provided by the A-GPS receiver.

See the following example to perform the First Fix.

Start the SET Initiated Session using the MS-Assisted mode

AT$GPSSLSR=1,0 ← One shot NMEA streaming of data is selected

OK

The following unsolicited message is displayed on DTE:

$LICLS:0

The syntax of the AT command showed above is equivalent to the following one:

AT$GPSSLSR=1,0,,,,,0 ← One shot NMEA streaming of data is selected

OK

After receiving **$LICLS:0** unsolicited message, the module knows that the SUPL Server needs to be connected to it by means of the TCP/IP protocol. Activate the <cid> context locked for LoCation Service (LCS), refer to AT$LCSLK command on chapter 4.2.2.

AT#SGACT=<cid>,1

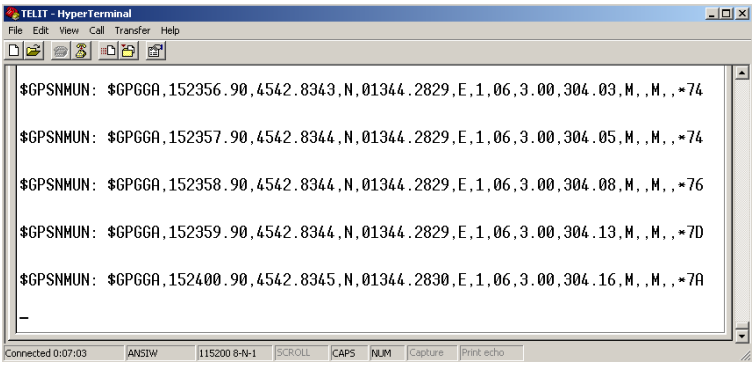
OK

Use the next command to select the continuous NMEA streaming of data:

AT$GPSSLSR=1,0,,,,,1 ← continuous NMEA streaming of data is selected

OK

After a short time interval the continuous NMEA streaming of GGA sentences appears on the DTE, see the figure below.



Now, you can stop the display of the NMEA sentence, if enabled, entering the following command:

AT$GPSNMUN=0,1,0,0,0,0,0

OK

You can read the current fix using the following command:

AT$GPSACP

$GPSACP: 152324.000,4542.8396N,01344.2874E,3.00,310.0,3,000.00,0.00,0.00,200412,

05

OK

Enter the following commands to release the link and unlock the <cid>

AT#SGACT=<cid>,0

OK

AT$LCSLK=0

OK

NOTE: After releasing link and <cid>, you can continue display the NMEA sentences via the AT$GPSNMUN command or read the fix using the AT$GPSACP command

NOTE: to switch from a SUPL session to the autonomous GPS mode, use the following command: **AT$GPSSLSR=2,3,,,,,1.** It triggers the continuous NMEA streaming of data displayed every second. Don't use the **AT$GPS=1** to perform the above mentioned switching action.

The sequence diagram below depicts the basic flow to accomplish the Set Initiated Session / MS Assisted Mode. In this example are not enabled the unsolicited messages of the GPS data in NMEA format. The first part of this sequence diagram is showed in fig. 6.

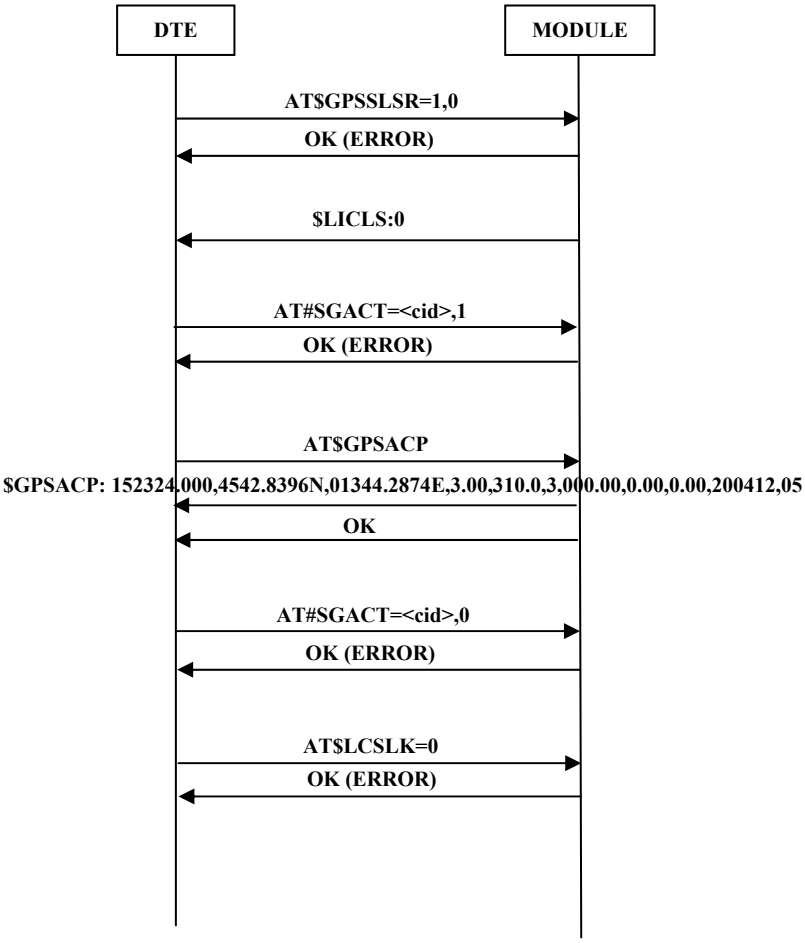


fig. 9: SET Initiated Session / MS Assisted Mode (SUPL)

4.2.2.2.2. MS-Based mode

It is assumed that you have performed the A-GPS service configuration as described in the chapter 4.2.2. In MS-Based mode, the module requires suitable GPS data to the SUPL Server. The A-GPS receiver, installed on the module, receives the signals from the visible satellites and with the help of the data received from the SUPL Server calculates its position.

NOTE: if the required satellites visibility is not available, no NMEA sentences are provided by the A-GPS receiver.

See the following example to perform the First Fix.

Start the SET Initiated Session using the MS-Based mode

AT$GPSSLSR=1,1 ← One shot NMEA streaming of data is selected

OK

The following unsolicited message is displayed on DTE:

$LICLS:0

The syntax of the AT command showed above is equivalent to the following one:

AT$GPSSLSR=1,1,,,,,0 ← One shot NMEA streaming of data is selected

OK

AT this point the module knows that the SUPL Server needs to be connected to it by means of the TCP/IP protocol. Activate the <cid> context locked for LoCation Service (LCS), refer to AT$LCSLK command on chapter 4.2.2.

AT#SGACT=<cid>,1

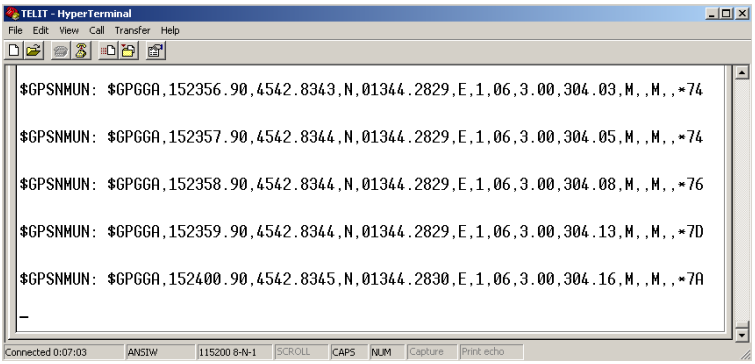
OK

Use the next command to select the continuous NMEA streaming of data:

AT$GPSSLSR=1,1,,,,,1 ← continuous NMEA streaming of data is selected

OK

On a successful completion of the SUPL Positioning Session the continuous NMEA streaming of GGA sentences appears on the DTE, see the figure below.



Now, you can stop the display of the NMEA sentence, if enabled, entering the following command:

AT$GPSNMUN=0,1,0,0,0,0,0

OK

You can read the current fix using the following command:

AT$GPSACP

$GPSACP: 152324.000,4542.8396N,01344.2874E,3.00,310.0,3,000.00,0.00,0.00,200412,

05

OK

Enter the following commands to release the link and unlock the <cid>

AT#SGACT=<cid>,0

OK

AT$LCSLK=0

OK

NOTE: After releasing link and <cid>, you can continue display the NMEA sentences via the AT$GPSNMUN command or read the fix using the AT$GPSACP command

NOTE: to switch from a SUPL session to the autonomous GPS mode, use the following command: **AT$GPSSLSR=2,3,,,,,1.** It triggers the continuous NMEA streaming of data displayed every second.. Don't use the **AT$GPS=1** to perform the above mentioned switching action.

The sequence diagram below depicts the basic flow to accomplish the Set Initiated Session / MS Based Mode. In this example are not enabled the unsolicited messages of the GPS data in NMEA format. The first part of this sequence diagram is showed in fig. 6.

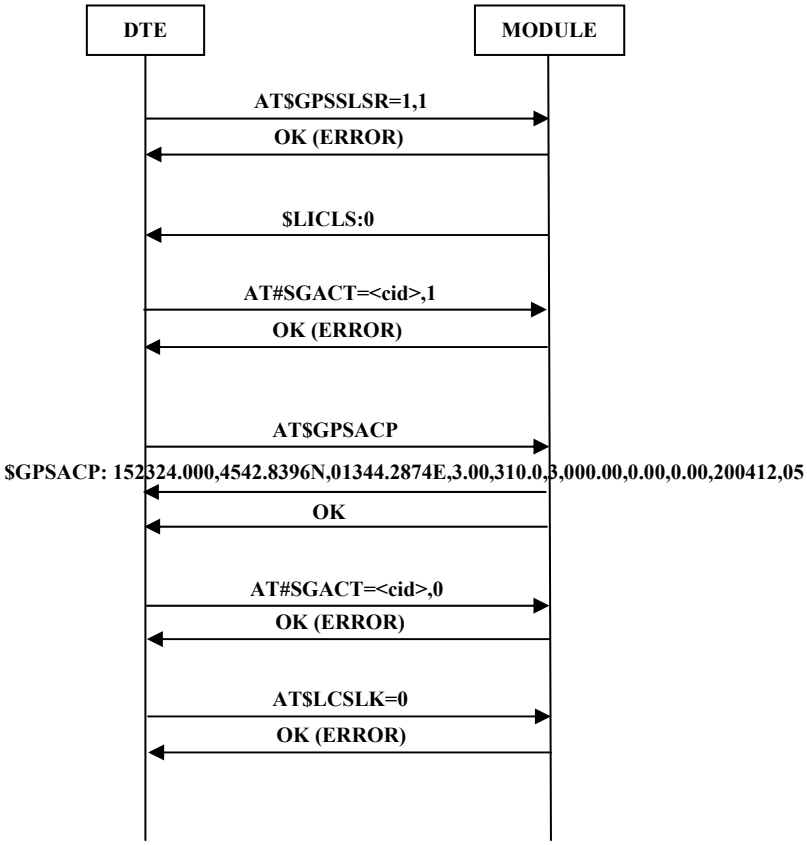


fig. 10: SET Initiated Session / MS Based Mode (SUPL)

5. Abbreviations and acronyms

3GPP	Third Generation Partnership Project
A-GPS	Assisted-Global Positioning System
ECEF	Earth-Centered Earth-Fixed
GMLC	Gateway Mobile Location Center
GPS	Global Positioning System
LCS	LoCation Service
MO-LR	Mobile Originated-Location Request
MS	Mobile Station
MT-LR	Mobile Terminated-Location Request
NMEA	National Marine Electronics Association
NVRAM	Non Volatile RAM
OMA	Open Mobile Alliance
SET	SUPL Enable Terminal
S-GPS	Standalone-Global Positioning System
SLP	SUPL Location Platform
SMLC	Serving Mobile Location Center
SMS	Short Message Service
SUPL	Secure User Plane Location
TTFF	Time To First Fix