# MAPS™ for LCS System

## Location Services Simulation in 2G, 3G, and 4G

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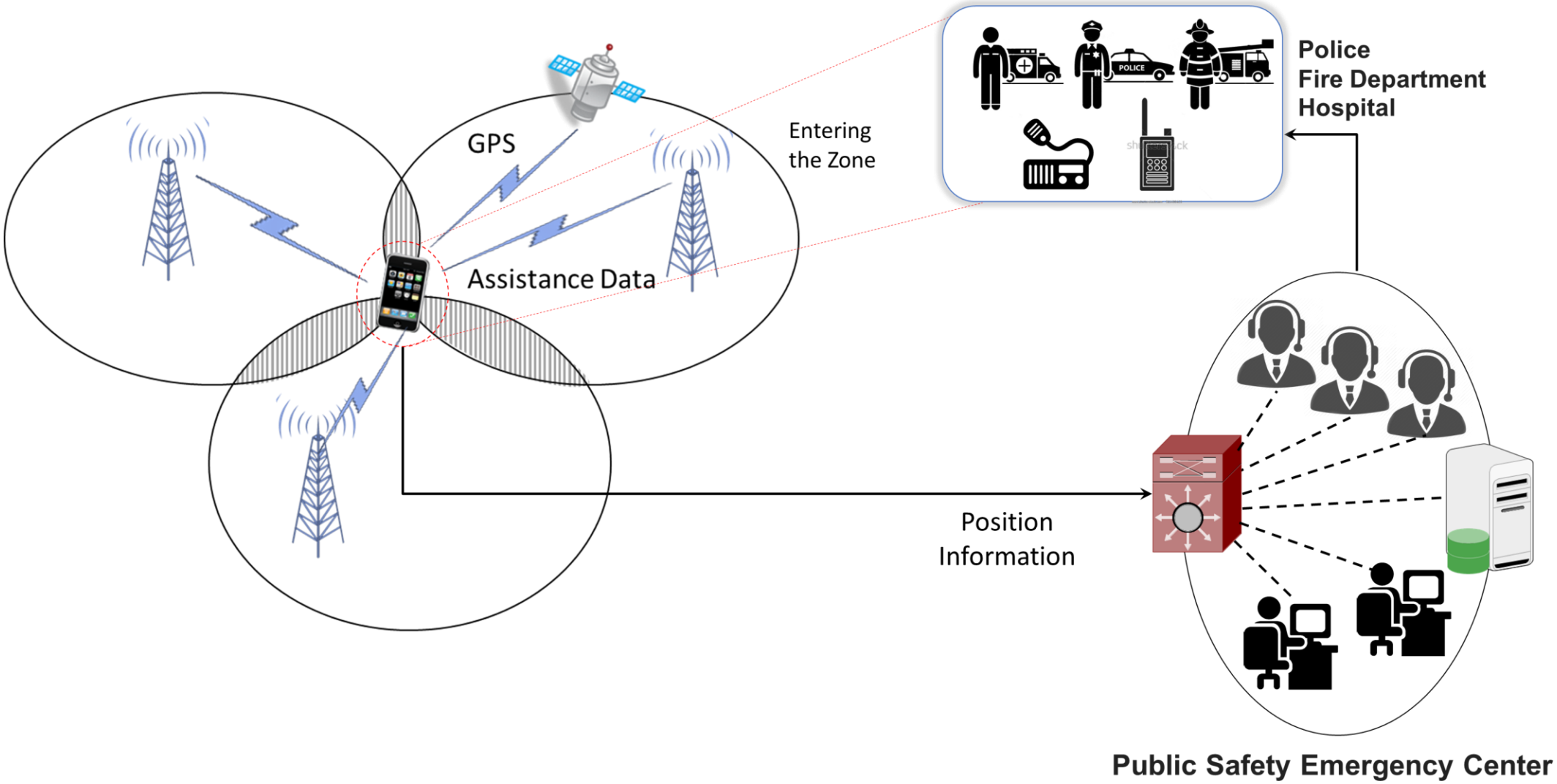
# What is Location Service (LCS) ?

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# Application of LCS

**Public Safety Services**

- Emergency Services, e.g. fire, police, ambulance, etc.
- Emergency Alert Services

**Tracking Services**

- Stolen phones, computers, other devices
- Vehicle tracking

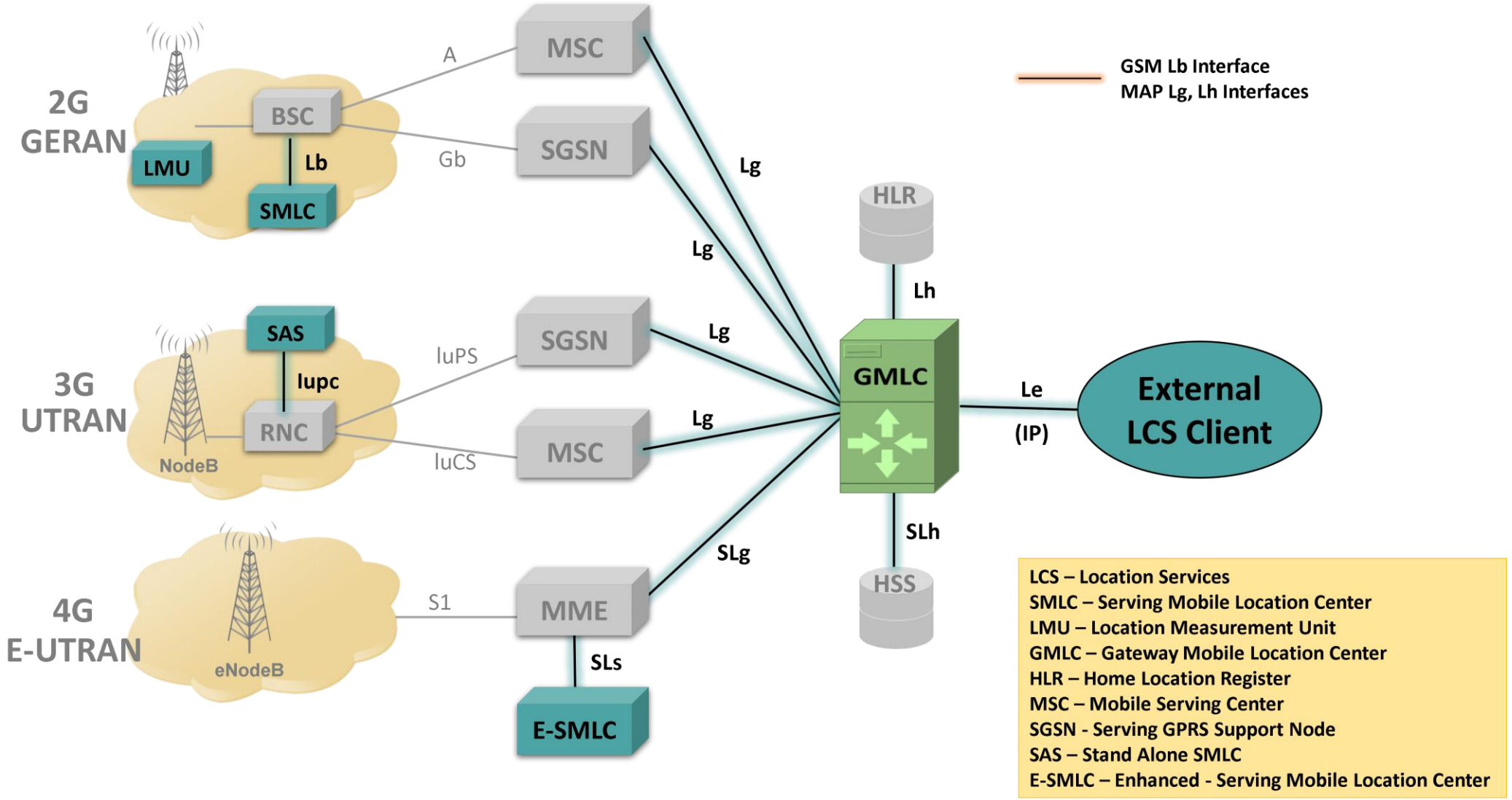
**Location Based Information Services**

- Navigation
- City Sightseeing
- Finding nearest service, e.g. restaurant, bank, food store, etc.
- Mobile Yellow Pages
- Location Sensitive Internet

**Up to date information**

- Temperature, traffic services, etc.

# LCS Network Architecture

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# LCS Functional Entities

- **GMLC - Gateway Mobile Location Centre**
  - Central point of LCS architecture
  - First node an external LCS client accesses in a GSM or UMTS network
  - Request routing information from the HLR (Home Location register) or HSS (Home Subscriber Server)
  - Receives final location estimates from the MSC, SGSN, or MME
- **SMLC/E-SMLC/SAS – Serving Mobile Location Server**
  - Server used for the locations calculation. It can calculate with information from LMU (where it is available), or measures of the network itself, such as TA (Timing Advance)
- **LMU – Location Measuring Unit**
  - Equipment required in each cell to enable the calculation of the OTDOA (based on the network location)

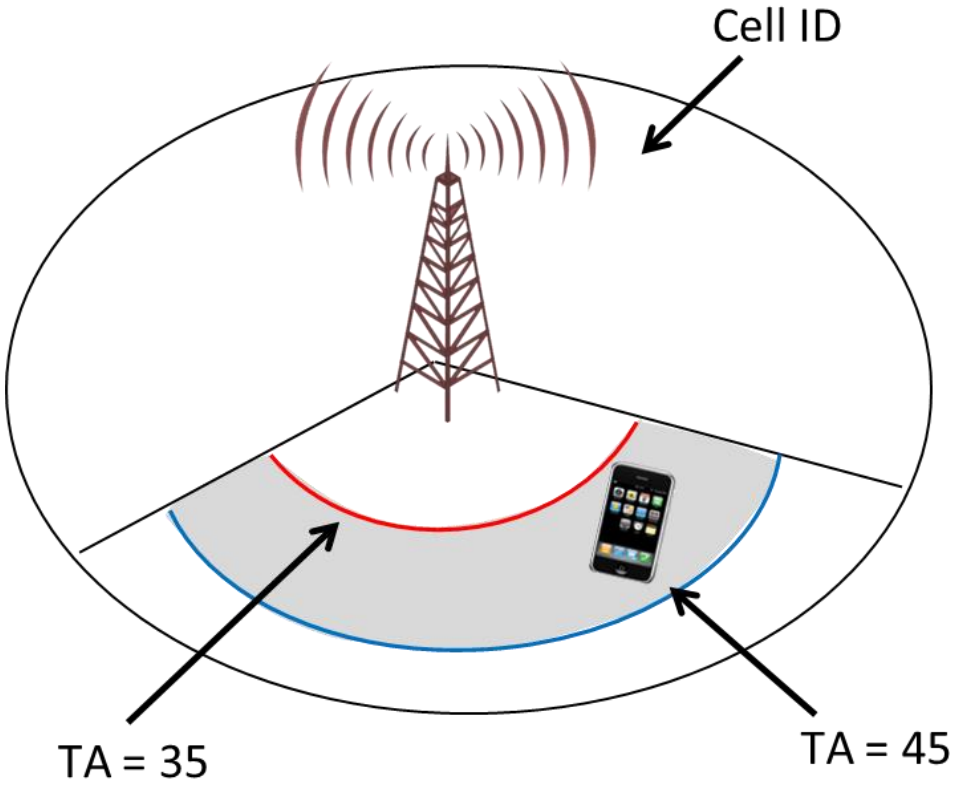
# Standard Positioning Methods

- Cell- ID and TA Method
- Signal Strength Method
- Angle of Arrival Method (AoA)
- Time of Arrival Method (ToA)
- Time Difference of Arrival Method (TDoA)
- Enhanced Observed Time Difference (E-OTD)
- Assisted GPS Method (A-GPS)

# Positioning Methods

**Cell- ID and TA Method – Network Based**

- An area in which a MS moves freely without updating the location registration, can be estimated using the identification codes assigned to each active (communicating) MS
- The identification codes are Cell Global Identity (CGI), such as Mobile Country Code (MCC), Mobile Network Code (MNC), Location Area Code (LAC) and Cell Identity (CI)
- Positioning error can be reduced by using Timing Advance (TA) which is a measure of the distance between the MS and the BTS

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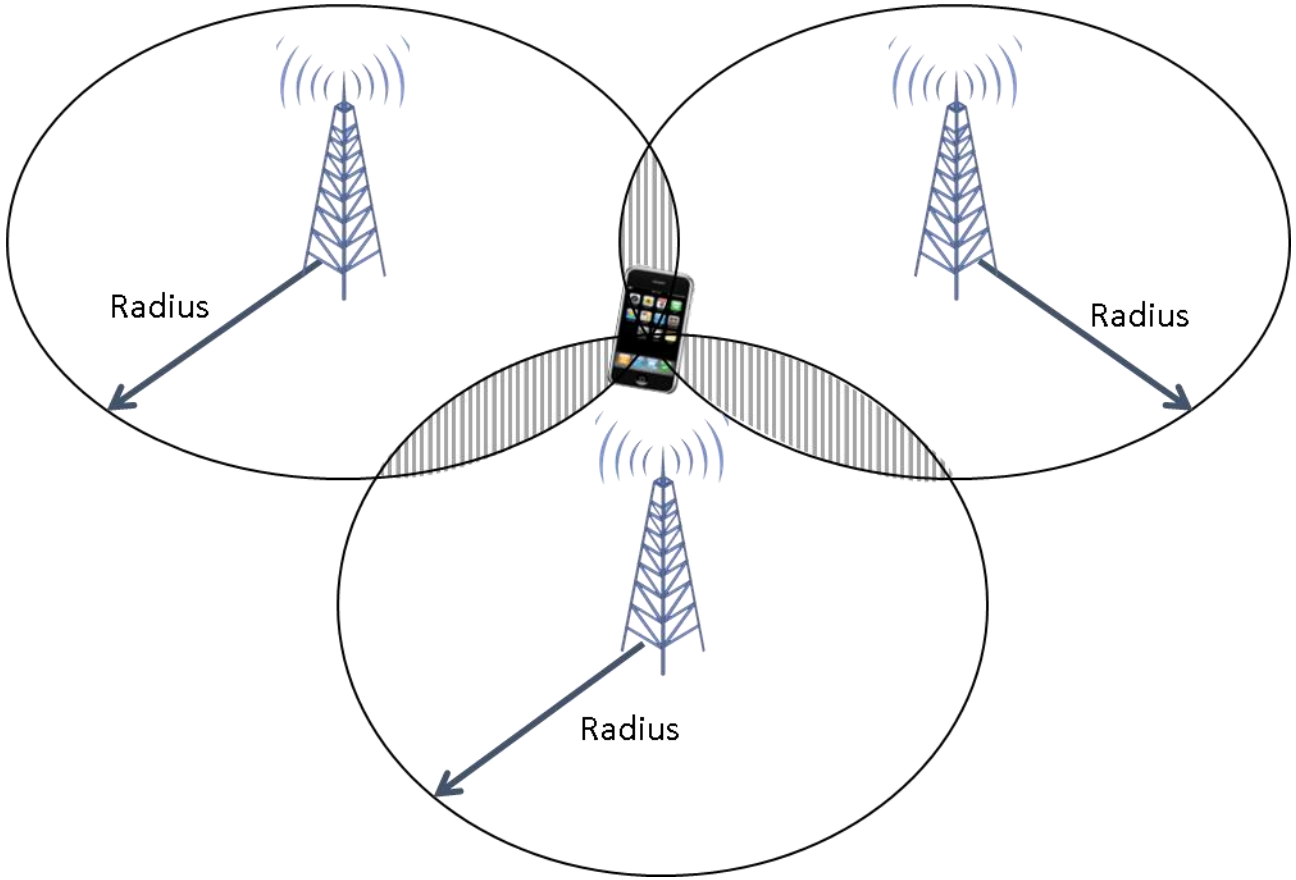
# Positioning Methods (Contd.)

**Received Signal Strength (RSS) Method – Network Based**

- Distance from each BTS and the MS is approximated using the signal strength received by the MS
- MS is located at the intersection point of three circles centered by three BTSs
- Computed knowing the radius of the circles

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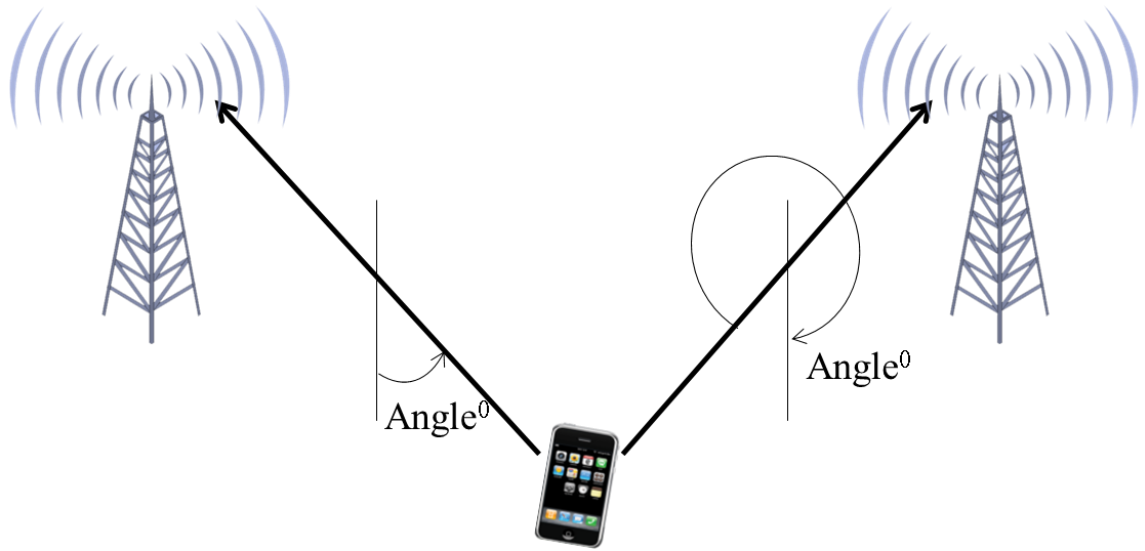
# Positioning Methods (Contd.)

**Angle of Arrival (AoA) Method – Network Based**

- Uses the angle of the signals arriving to the MS from two BTSs
- Reduces the number of required assisting BTSs
- A slight error in measuring the angle, will cause a big error in MS positioning

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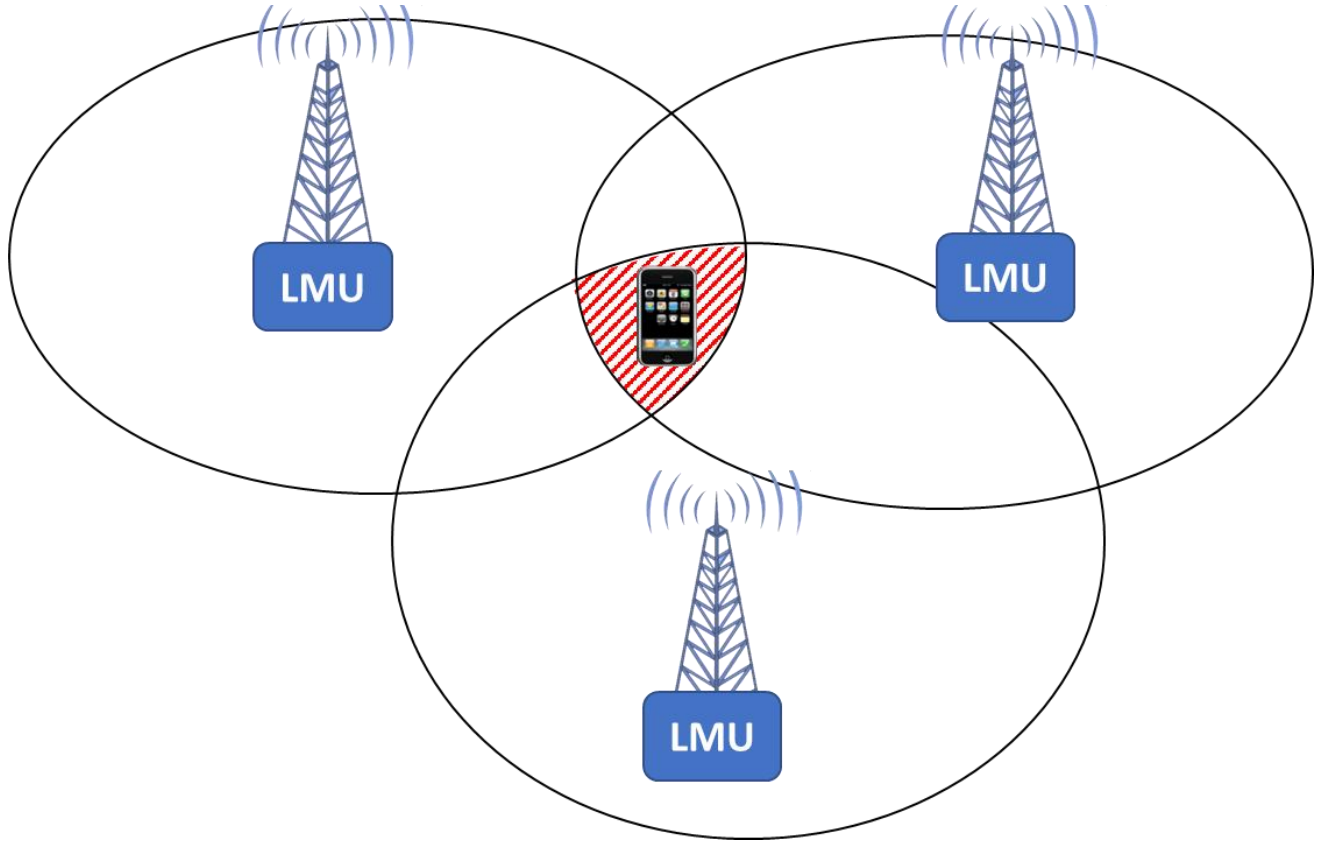
# Positioning Methods (Contd.)

**Time of Arrival Method (ToA) – Network Based**

- Triangulation is used in the Time of Arrival (ToA) method to measure the propagation delay of transmitting to multiple BTSs
- ToAs are measured using an additional hardware called Location Measurement Unit (LMU) installed in BTSs
- All LMUs and the MS must share a common clock reference, i.e., strict synchronization is required

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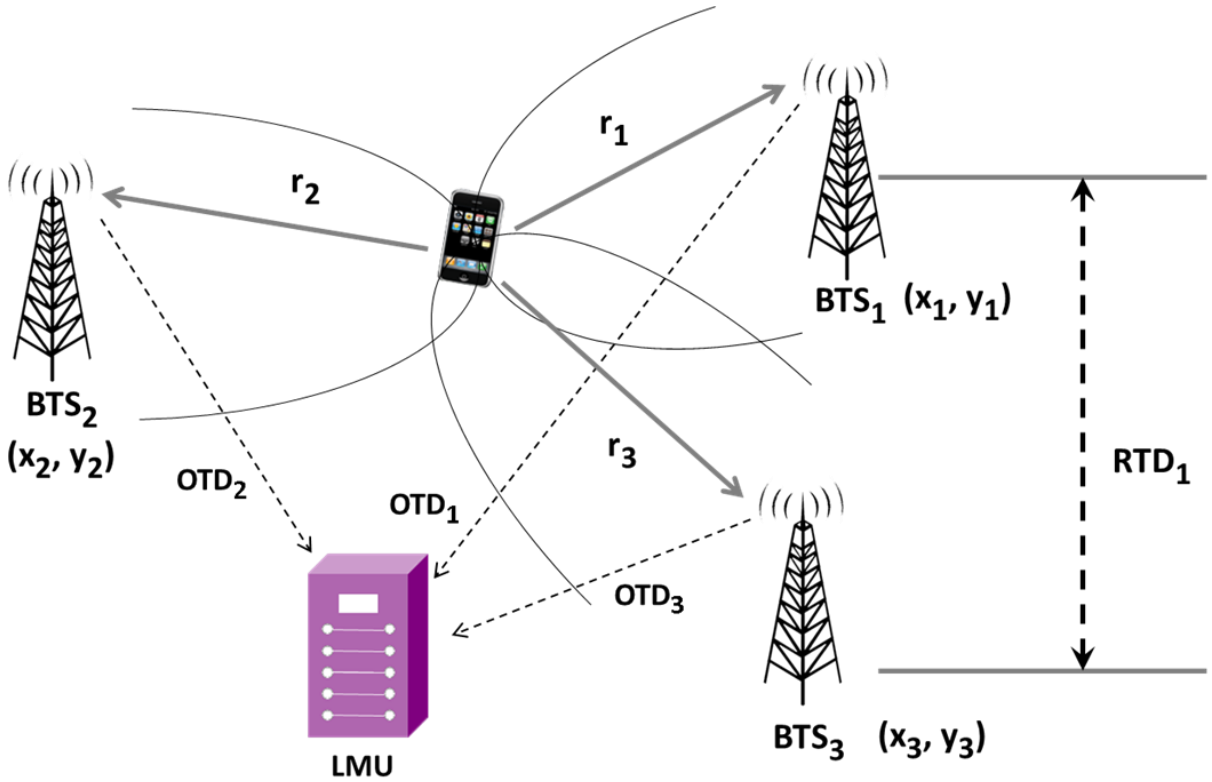
# Positioning Methods (Contd.)

**Time Difference of Arrival Method (TDoA) – Network Based**

Following timing parameters are calculated to compute the final accurate position

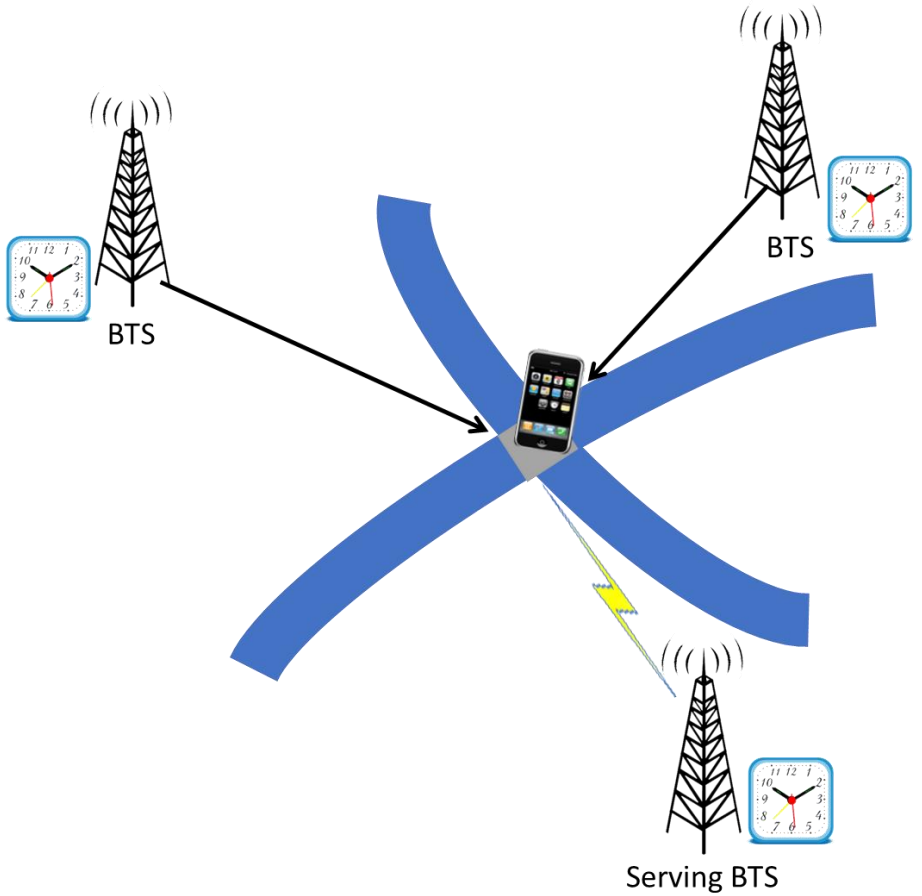
- Real Time Difference (RTD): the synchronization difference between the BTSs
- Geometric Time Difference (GTD): the propagation time difference between the BTSs
- Observed Time Difference (OTD): Time difference measured by the mobile between the receptions of bursts transmitted from BTSs



# Positioning Methods (Contd.)

**Enhanced Observed Time Difference (E-OTD) – Handset Based**

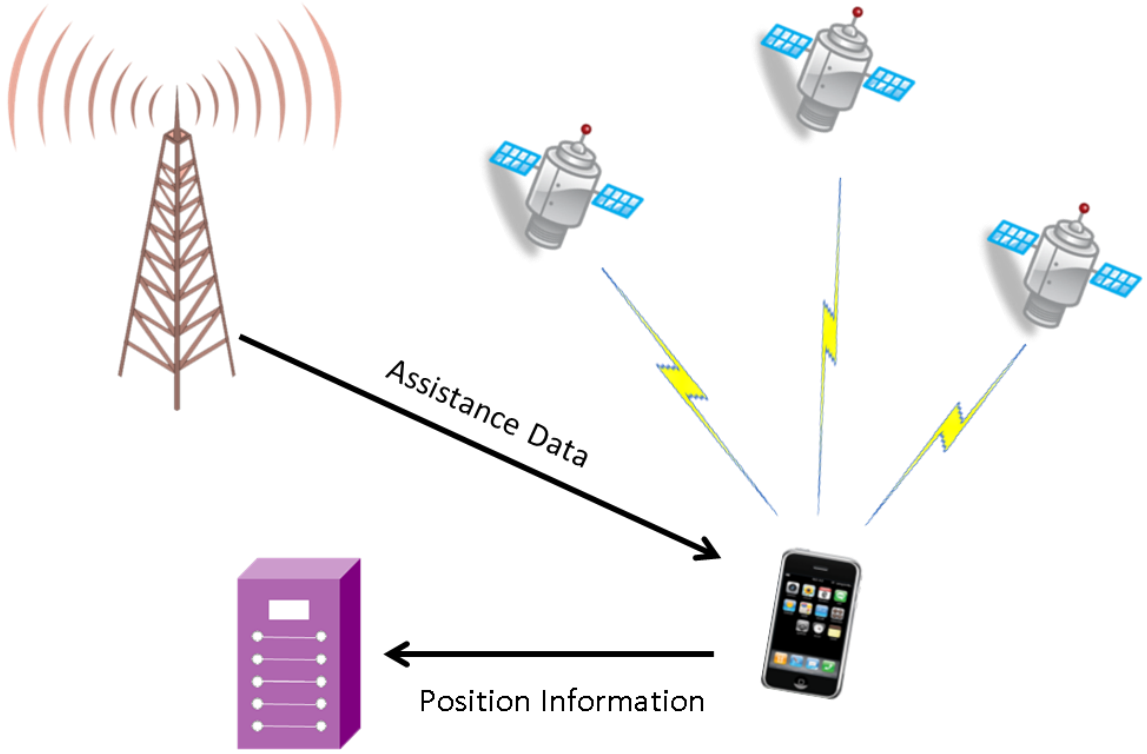
- Mobile listens to bursts sent from neighbouring BTSs
- Mobile records burst arrival times
- Position is triangulated from:
  - Coordinates of BTSs
  - Arrival time of burst from each BTS
  - Timing differences between BTSs



# Positioning Methods (Contd.)

**Assisted GPS Method (A-GPS) – Handset Based**

- Information from satellite is deployed for positioning
- GPS installed in the BTSs or the handsets
- GPS in handsets increases size and power consumption
- A-GPS methods are expensive, but they are accurate
- Requires only one BTS to find outdoor position
- Poor performance in dense urban areas or indoors
- Suggested to be combined with other methods



# Standard Positioning Methods used in 2G/3G/4G

- The standard positioning methods supported within GERAN are:
  - Timing Advance
  - Enhanced Observed Time Difference (E-OTD) positioning mechanism
  - Uplink Time Difference of Arrival (U-TDOA) positioning mechanism
- The standard positioning methods supported within UTRAN are:
  - Cell ID based method
  - Network-assisted GPS methods (A-GPS)
  - Uplink Time Difference of Arrival (U-TDOA) positioning mechanism
- The standard positioning methods supported within E-UTRAN are:
  - Network-assisted GPS methods (A-GPS)
  - Downlink positioning – Received Signal Strength
  - Enhanced cell ID method – Hybrid Methods

# Comparison of Positioning Methods

| Positioning Methods | Accuracy (in meters) | Characteristics | Coverage |
|---|---|---|---|
| Cell-ID & TA | 100-1500 | Network Based | High |
| RSS | 200-500 | Network Based | High |
| AOA | 100-200 | Network Based | Good |
| TOA | 50-200 | Network Based | Good |
| TDOA | 50-150 | Network Based | Good |
| E-OTD | 50-100 | Handset Based | Good |
| A-GPS | 5-30 | Handset Based | Variable |

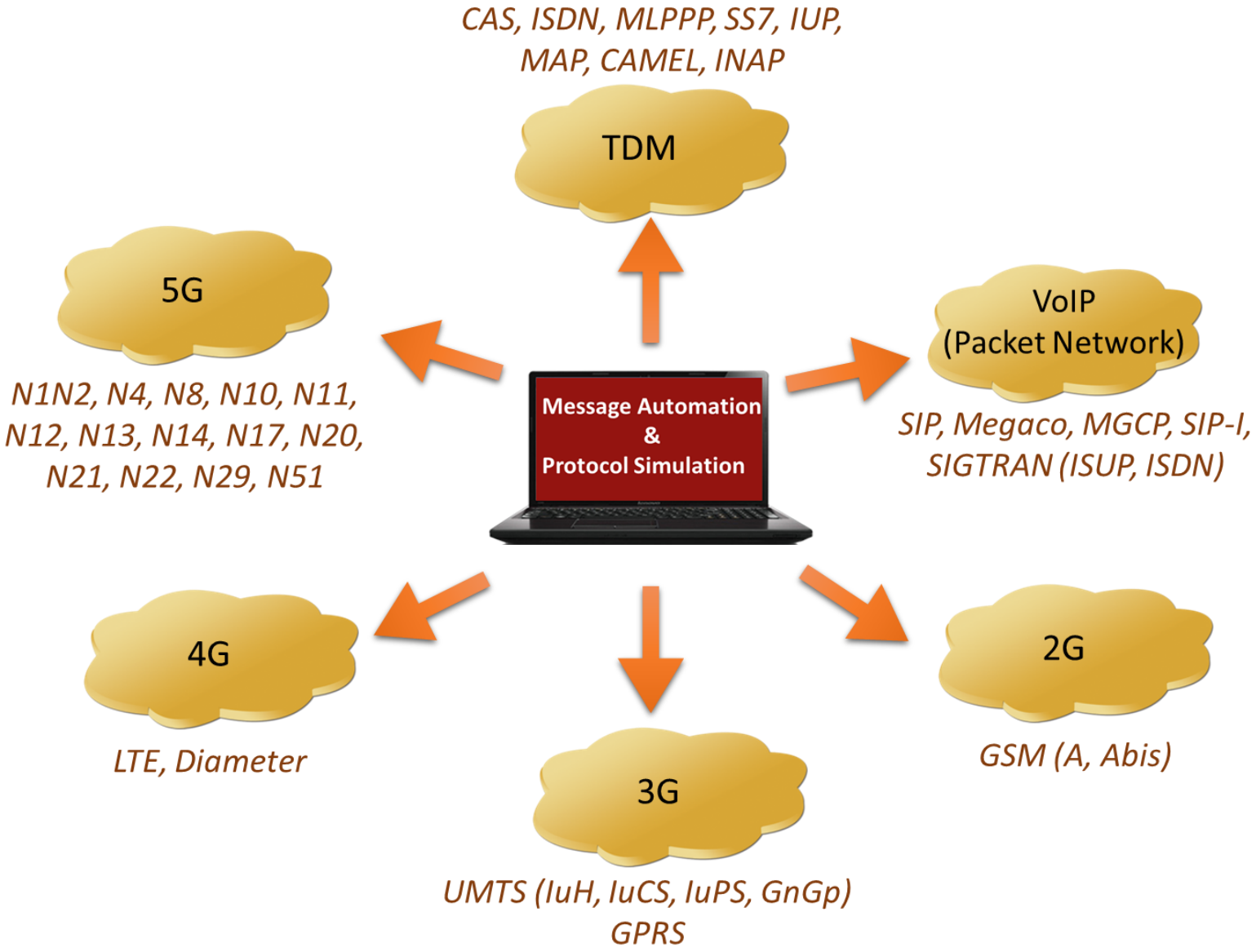
# MAPS™

## MA - Message Automation

## +

## PS - Protocol Simulation

# Supported Protocols / Interfaces

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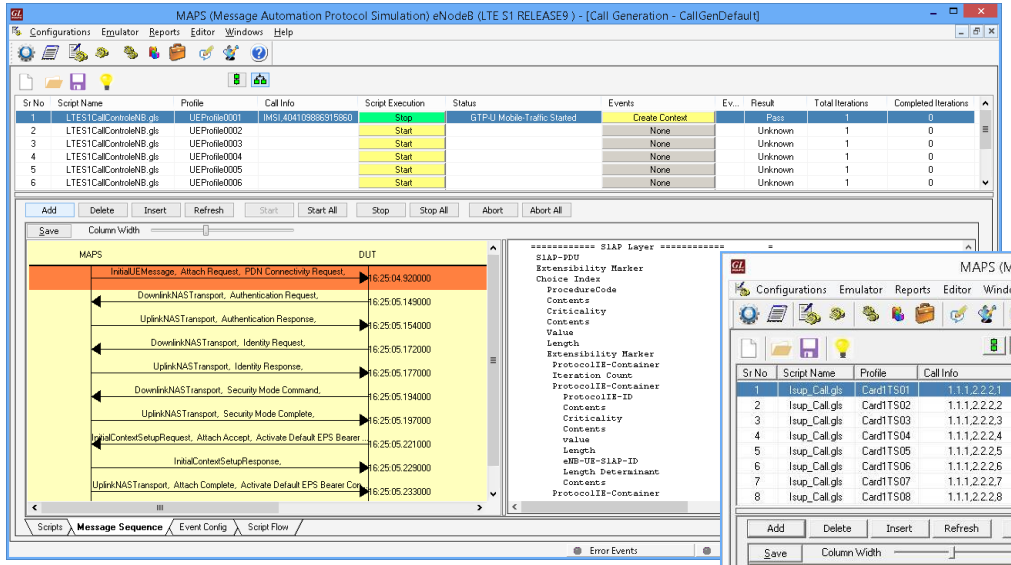
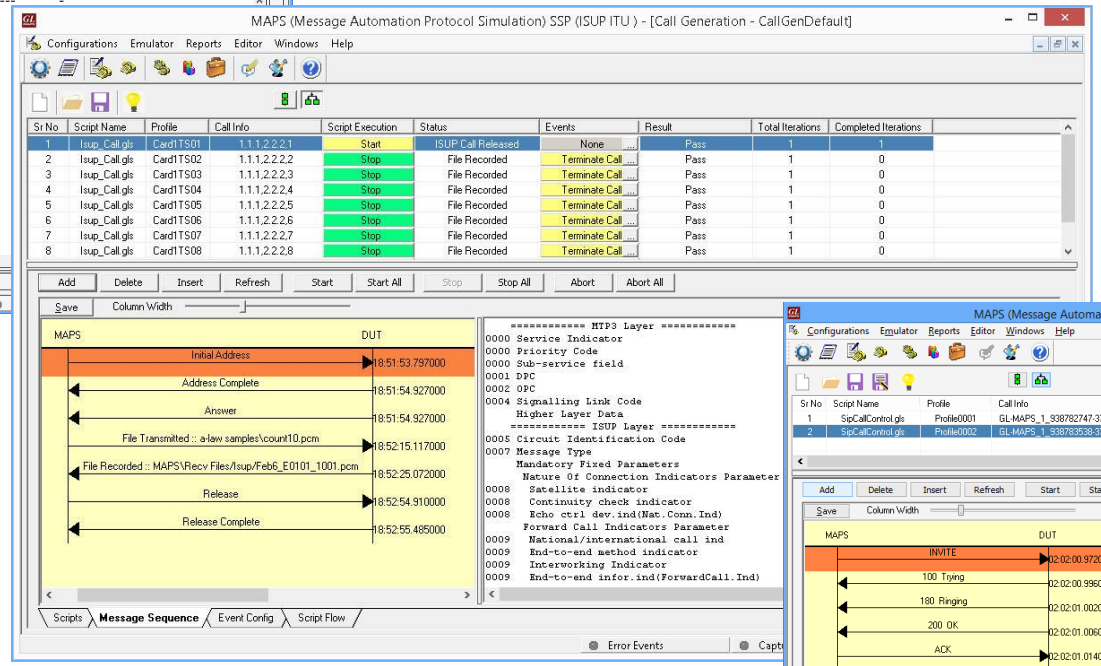
# Common Protocol Emulation Framework

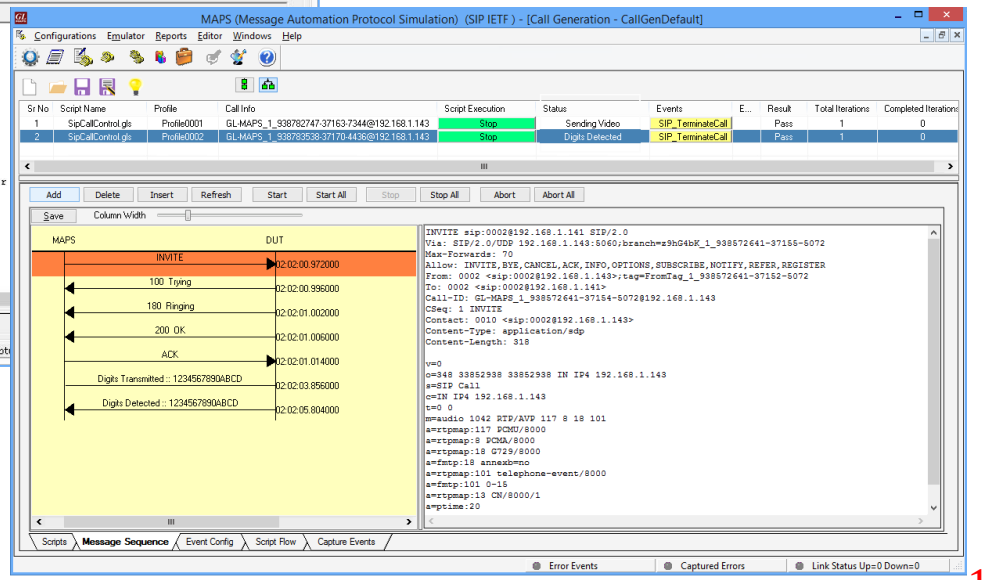
## LTE Simulation




## SS7 Simulation




## SIP Simulation

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# Common Features

- Multi-protocol, Multi-interface Simulation
- Script based and protocol independent software architecture
- Auto generate and respond to signaling messages
- Traffic Handling Capabilities (requires additional license)
- Automated Bulk Call Generation / Stress Testing
- Easy script builder for quick testing to advance testing
- Customization of test configuration profiles
- Unlimited ability to customize the protocol fields and call control scenarios

# High Density (HD) Traffic Simulation

- IP variants of MAPS can be run on any modern Windows server
- A typical i7 platform will be able to handle ~2000 concurrent RTP sessions through a conventional server-grade NIC
- We also offer an HD (High Density) appliance which
- can deliver up to 20,000 concurrent RTP sessions per U of rack space


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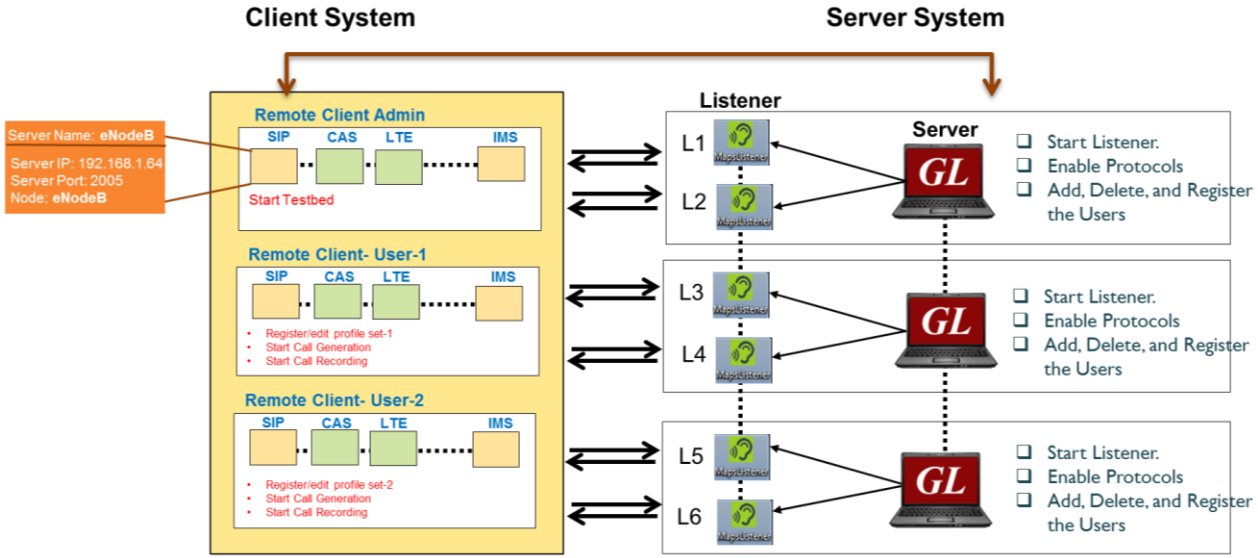
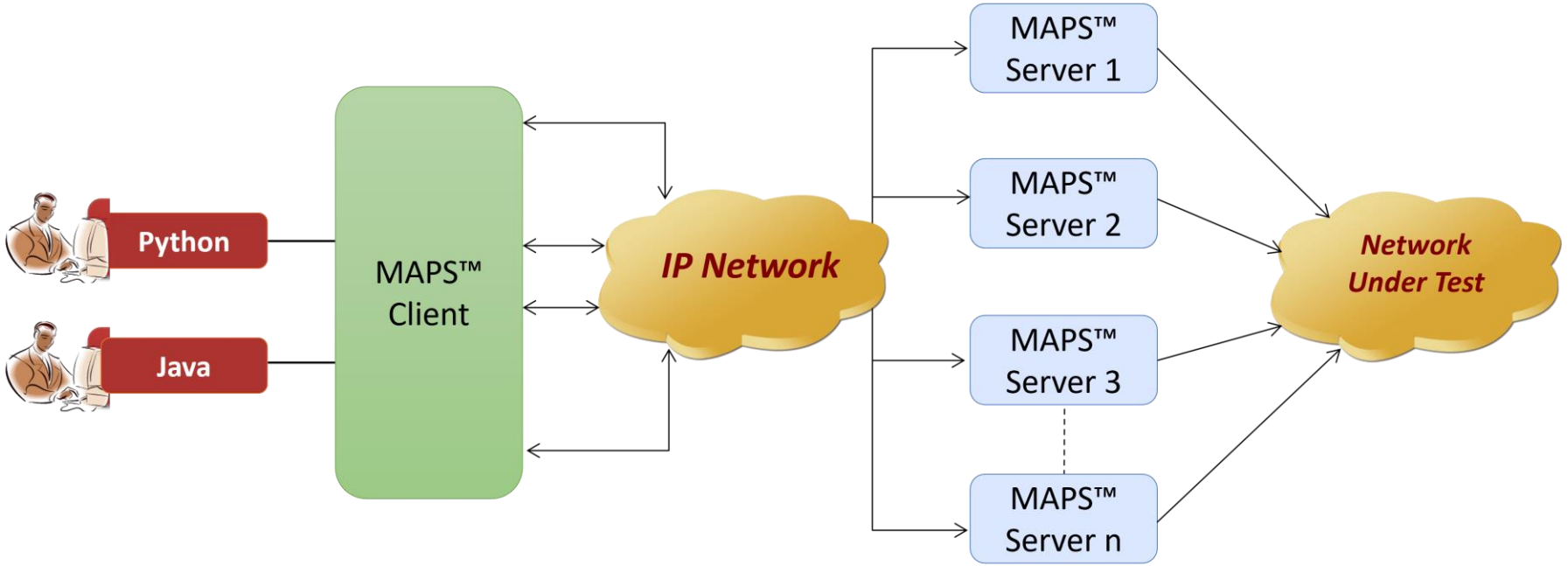
# Remote MAPS Controller

- Multi-node and multi-interface simulation from a single GUI
- Suitable for testing any core network, access network, and inter-operability functions
- Single Licensing Server controlling server and client licenses (no. of users)
- Unlimited number of remote client user can be defined at the server
- Admin privileges to control Testbed and access to configuration files for each remote client user
- Remote Client users has privileges to perform all other functions - call simulation, edit scripts/profiles, and view statistics
- Simultaneous traffic generation/reception at 100% on all servers



# MAPS APIs




- API wraps our proprietary scripting language in standard languages familiar to the user:
  - Python
  - Java
- Clients and Servers support a “Many-to-Many” relationship, making it very easy for users to develop **complex test cases involving multiple signaling protocols**

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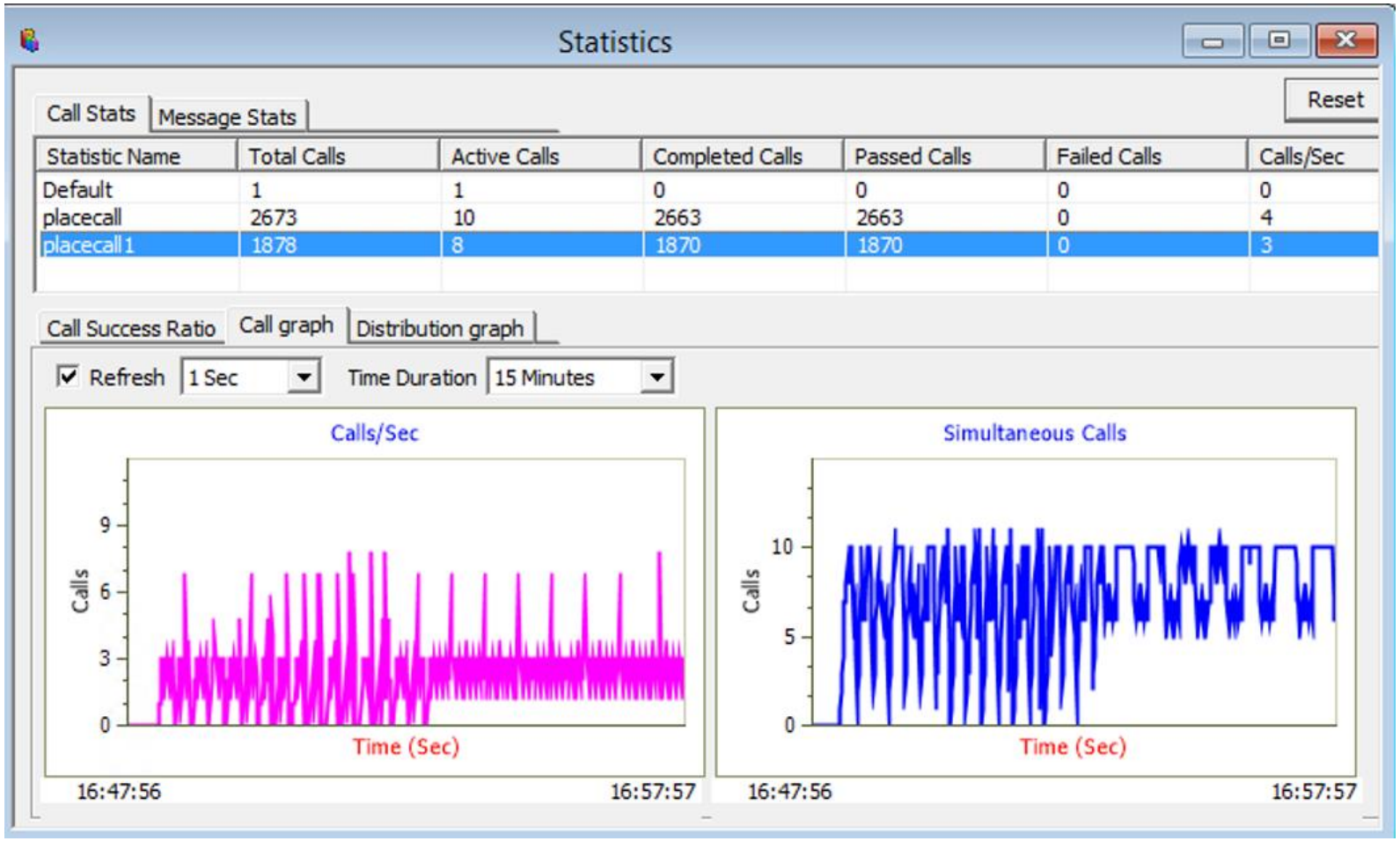
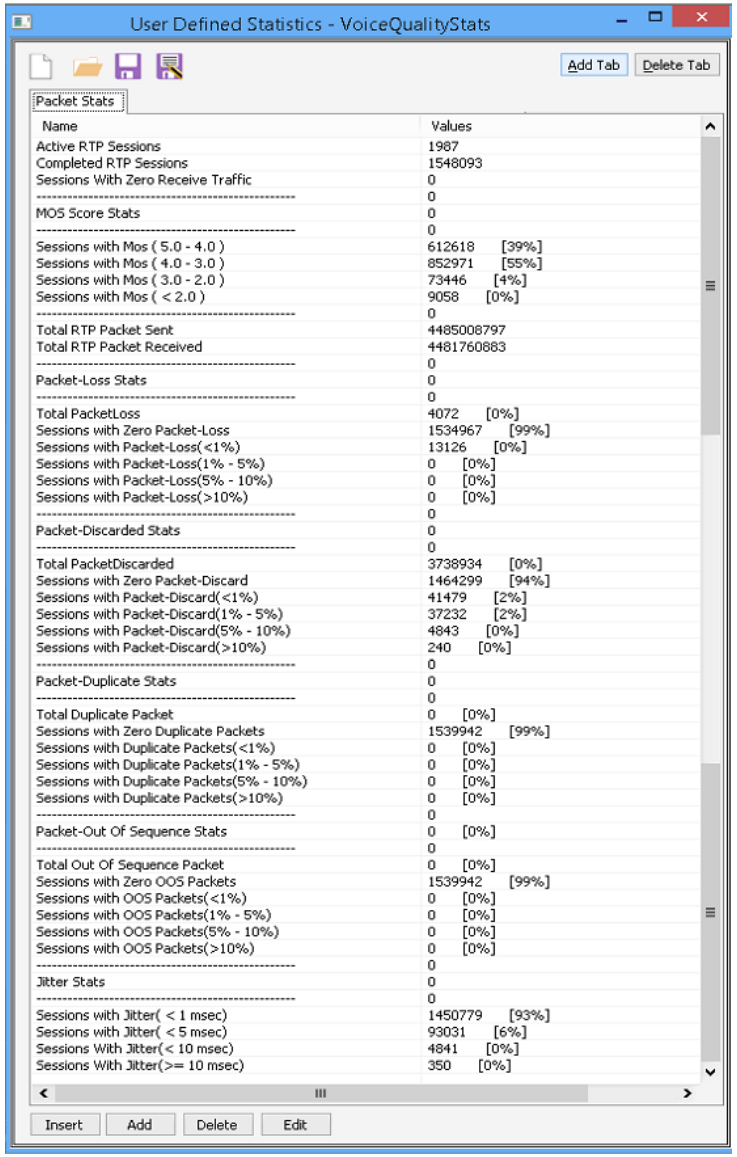
# Statistics and Reporting

## Call Statistics and Graph




## User Defined Statistics



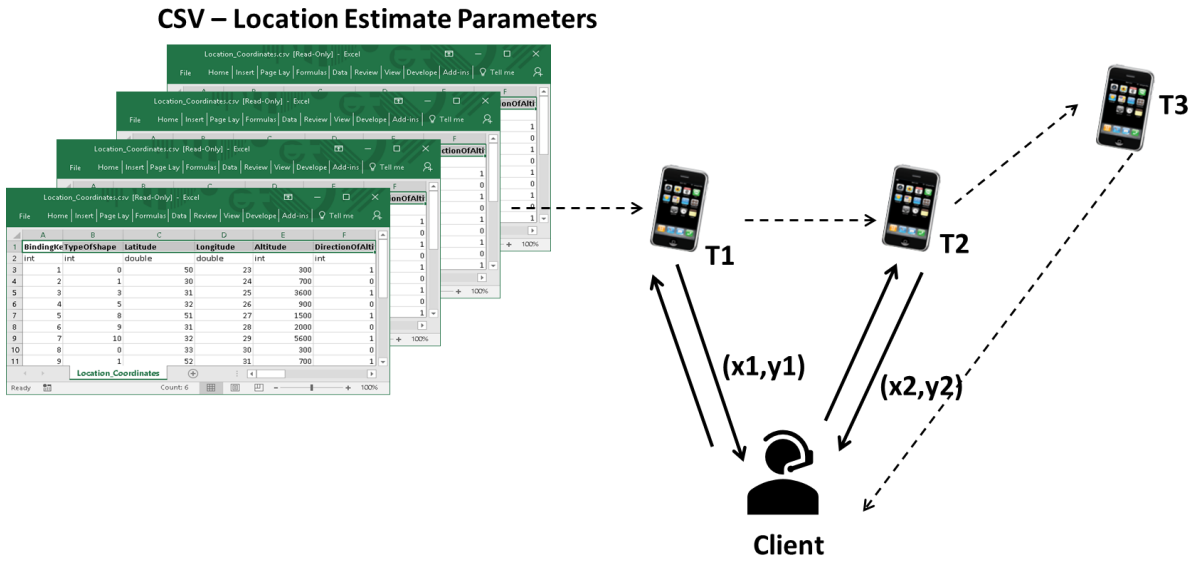
# GL's MAPS™ in LCS Network

# Supported Interfaces

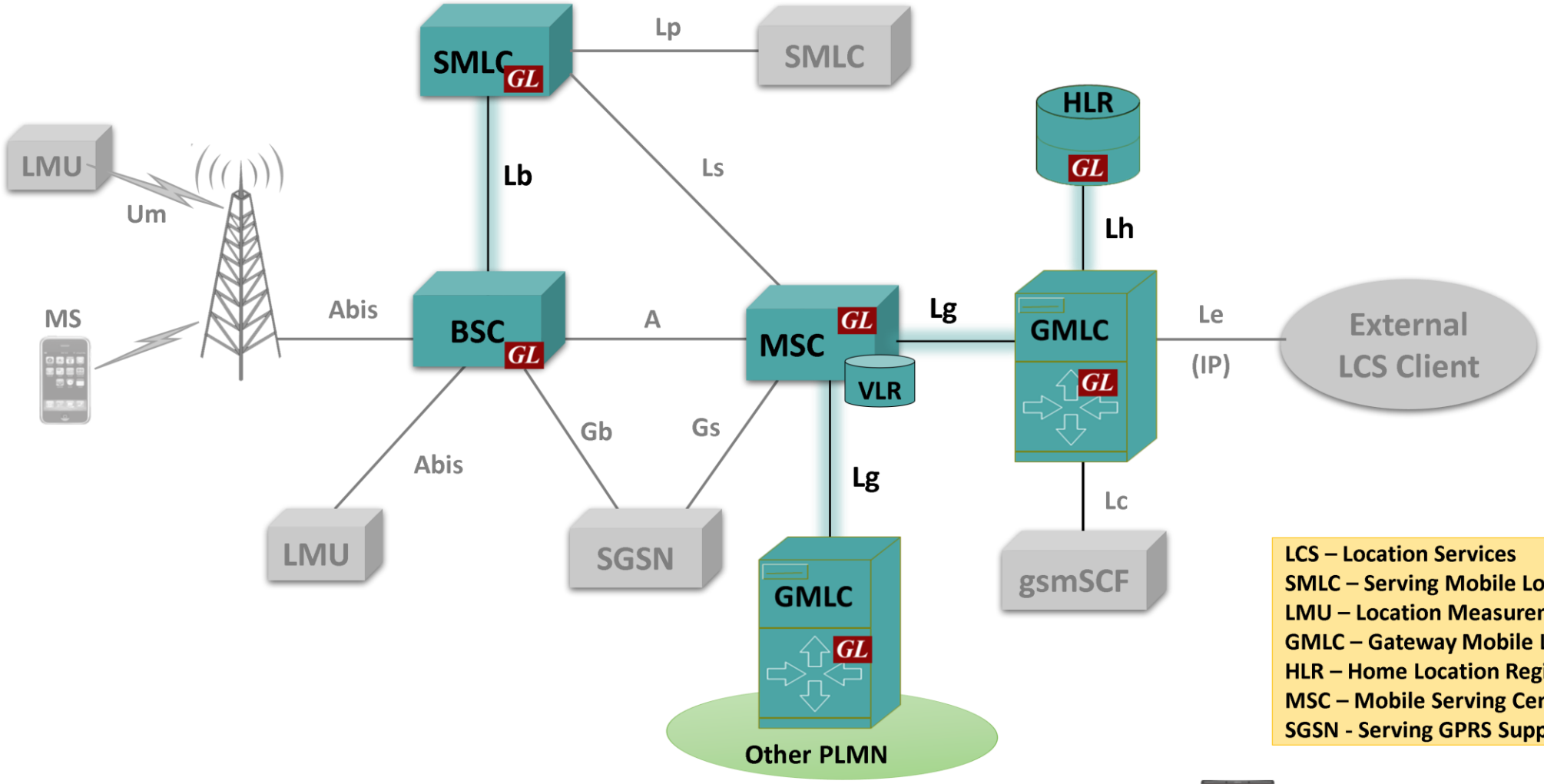
- **Lb Interface**
  - MAPS™ supports Location Service (LCS) based GSM Lb interface
  - Between the BSC <-> SMLC is Lb interface
- **Lg, Lh Interfaces**
  - MAPS™ MAP IP supports Location Service (LCS) based Lh and Lg interfaces
  - Between the GMLC <-> HLR is Lh interface and between GMLC <->MSC/SGSN is Lg interface
- **SLs Interface**
  - MAPS™ supports Location Service (LCS) based LTE SLs interface
  - Between the MME <-> SMLC is SLs interface
- **SLh, SLg Interfaces**
  - MAPS™ Diameter supports Location Service (LCS) based SLh and SLg interfaces
  - Between the GMLC <-> HSS is SLh interface and between GMLC <->MME is SLg interface

# Location Service Simulation

- MAPS™ supports simulation of different Positioning methods and Position Estimation of a Mobile Stations (MS) in universal coordinates
- Location estimate parameters such as Type of Shape and coordinates can be input through conventional user profiles or can be fetched from a CSV file
- Co-ordinates indicate different position of MS at different intervals of time
- Report is sent either periodically at specified time duration or at once when requested



# LCS in 2G Architecture




LCS – Location Services
SMLC – Serving Mobile Location Center
LMU – Location Measurement Unit
GMLC – Gateway Mobile Location Center
HLR – Home Location Register
MSC – Mobile Serving Center
SGSN - Serving GPRS Support Node

GL MAPS™ MAPIP Emulator (Lg, and Lh)
MAPS™ Lb Emulator

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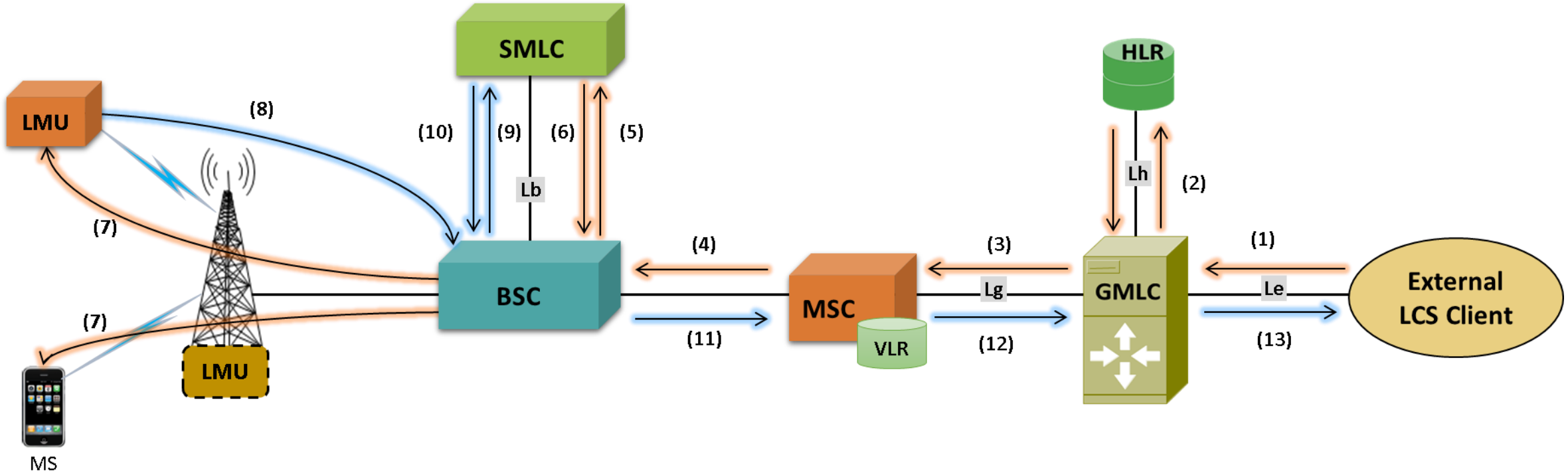
# 2G - Procedures




(1) – Location Service Request
(2) - Identify Subscriber
(3) - Route to Identified Subscriber
(4) - Forward to BSC
(5) - Forward to SMLC
(6) - Request to Calculate
(7) - Request forwarded to MS/LMU

(8) – Positioning Parameters are sent to BSC
(9) – Request to Calculate
(10) – Subscriber Location Report to BSC
(11) – Forward Report to MSC
(12) - Forward Report to GMLC
(13) – Forward Report to Client

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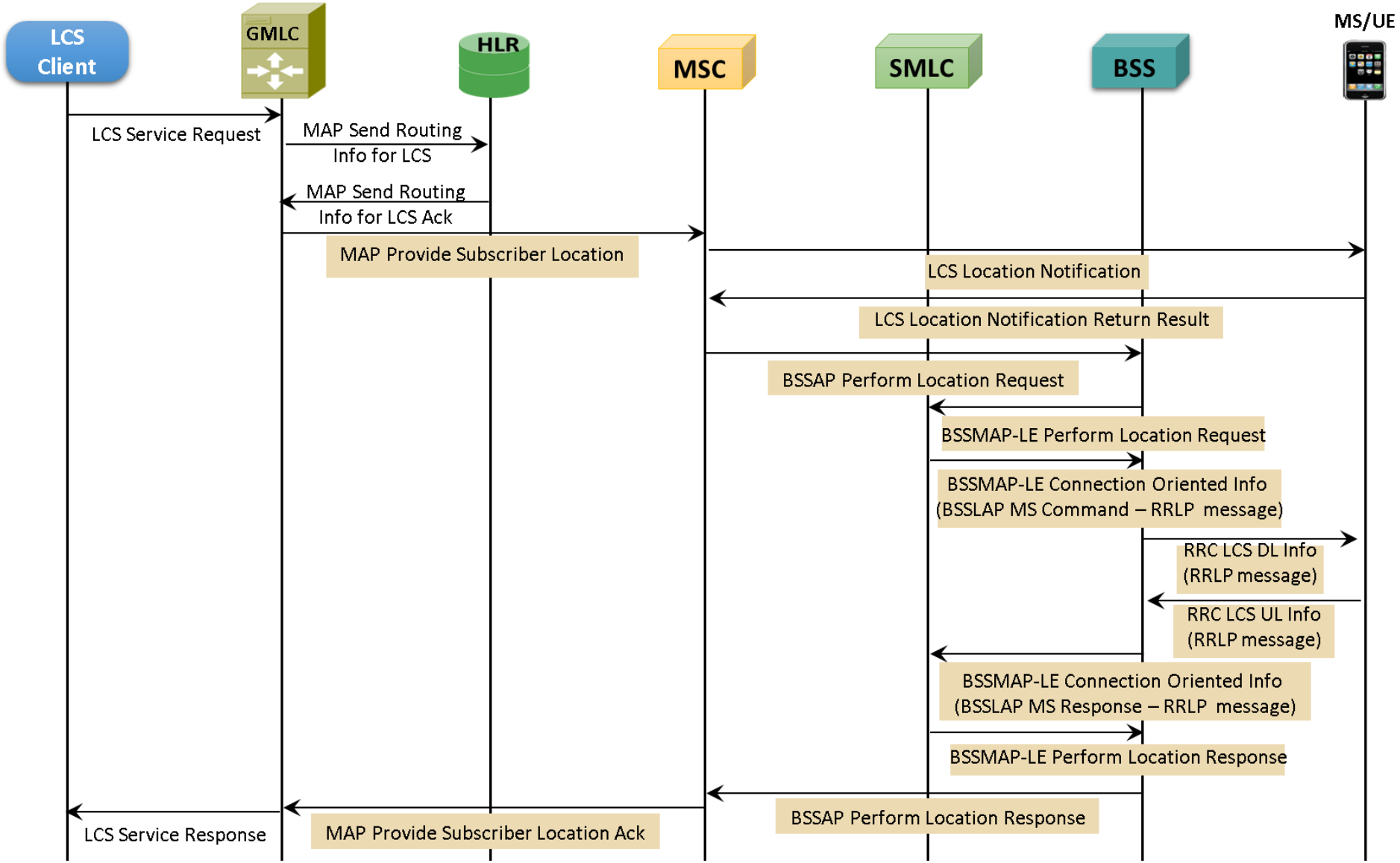
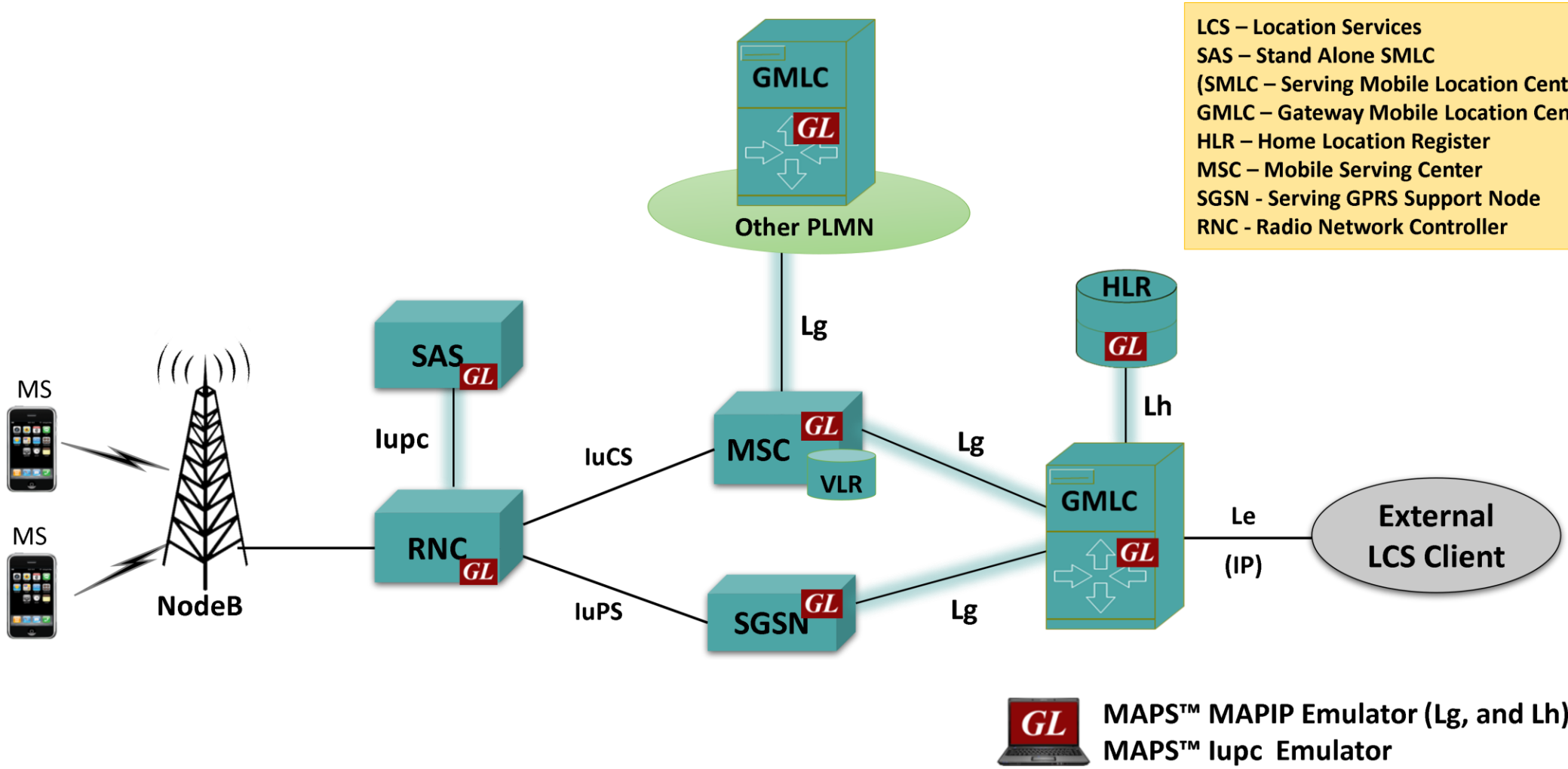
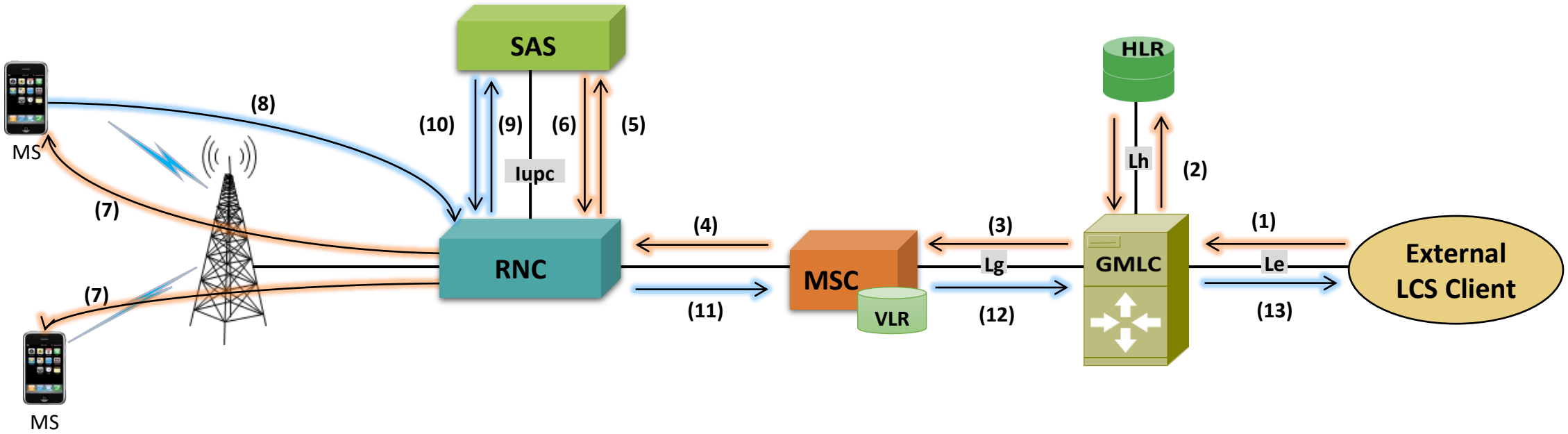
# 2G - Typical Call Flow



# LCS in 3G Architecture



# 3G - Procedures




(1) – Location Service Request
(2) - Identify Subscriber
(3) - Route to Identified Subscriber
(4) - Forward to RNC
(5) - Forward to SAS
(6) - Response from SAS
(7) - Request forwarded to MS

(8) – Positioning Parameters are sent to RNC
(9) – Request to Calculate
(10) – Subscriber Location Report to RNC
(11) – Forward Report to MSC
(12) - Forward Report to GMLC
(13) – Forward Report to Client

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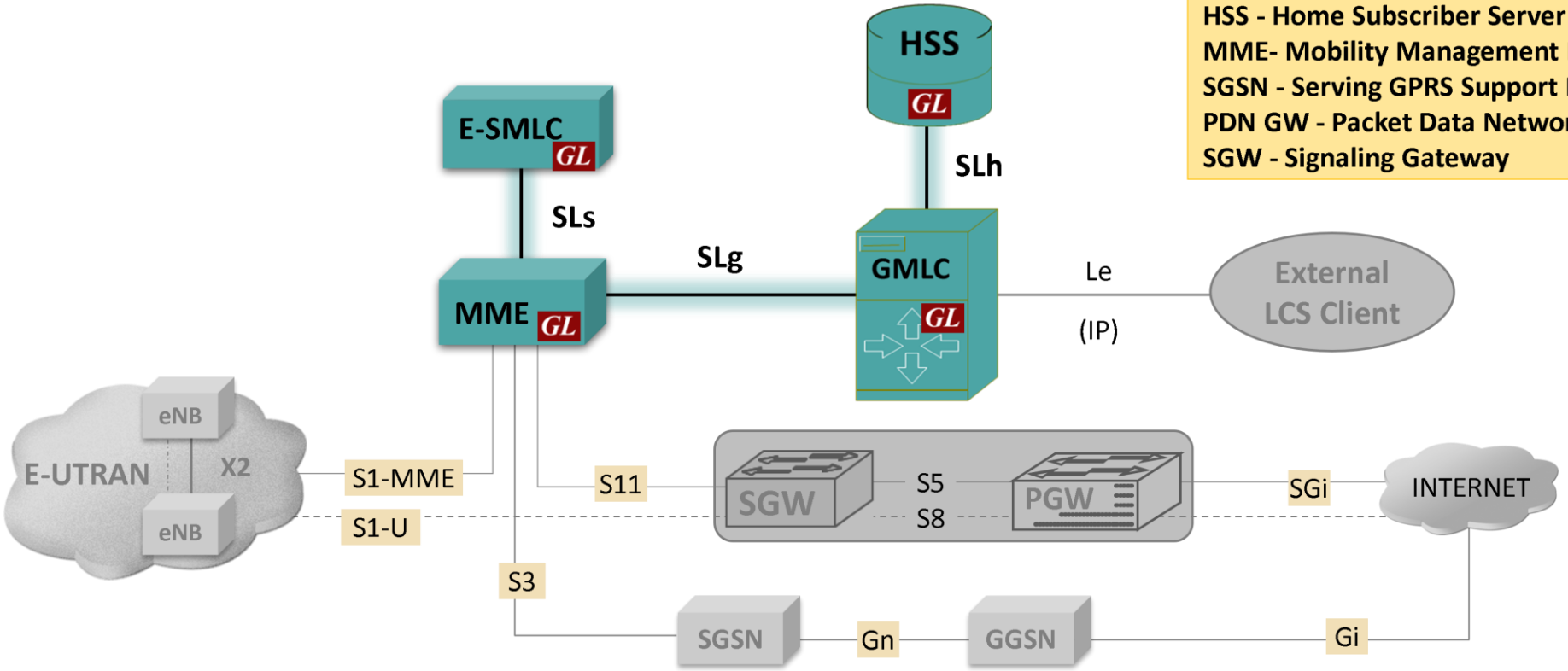
# LCS in 4G Architecture

LCS – Location Services
E - SMLC – Enhanced Serving Mobile Location Center
GMLC – Gateway Mobile Location Center
HSS - Home Subscriber Server
MME- Mobility Management Entity
SGSN - Serving GPRS Support Node
PDN GW - Packet Data Network Gateway
SGW - Signaling Gateway

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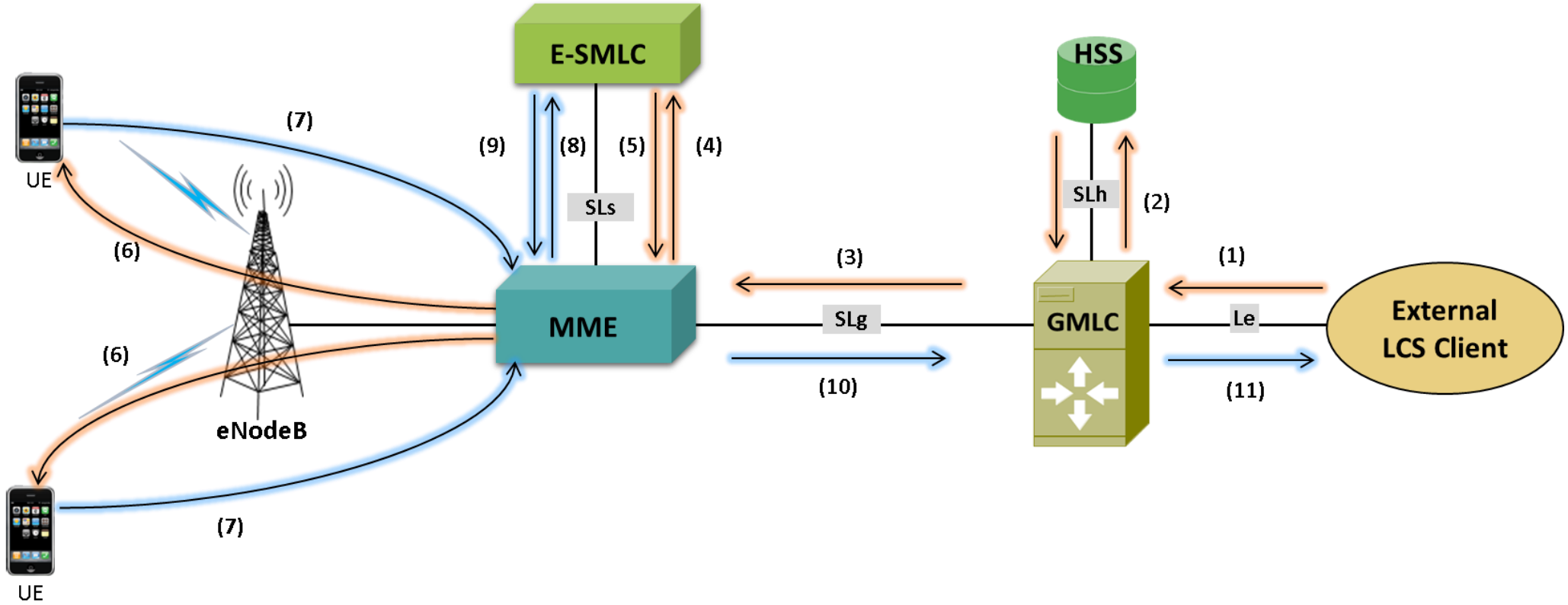
MAPS™ Diameter Emulator (SLg, and SLh)
MAPS™ LTE SLs Emulator

# 4G - Procedures




(1) – Location Service Request
(2) - Identify Subscriber
(3) - Route to Identified Subscriber
(4) - Forward to E-SMLC
(5) - Response from E-SMLC
(6) - Request to Calculate

(7) - Positioning Parameters are sent to MME
(8) – Request to Calculate
(9) – Subscriber Location Report to MME
(10) - Forward Report to GMLC
(11) – Forward Report to Client

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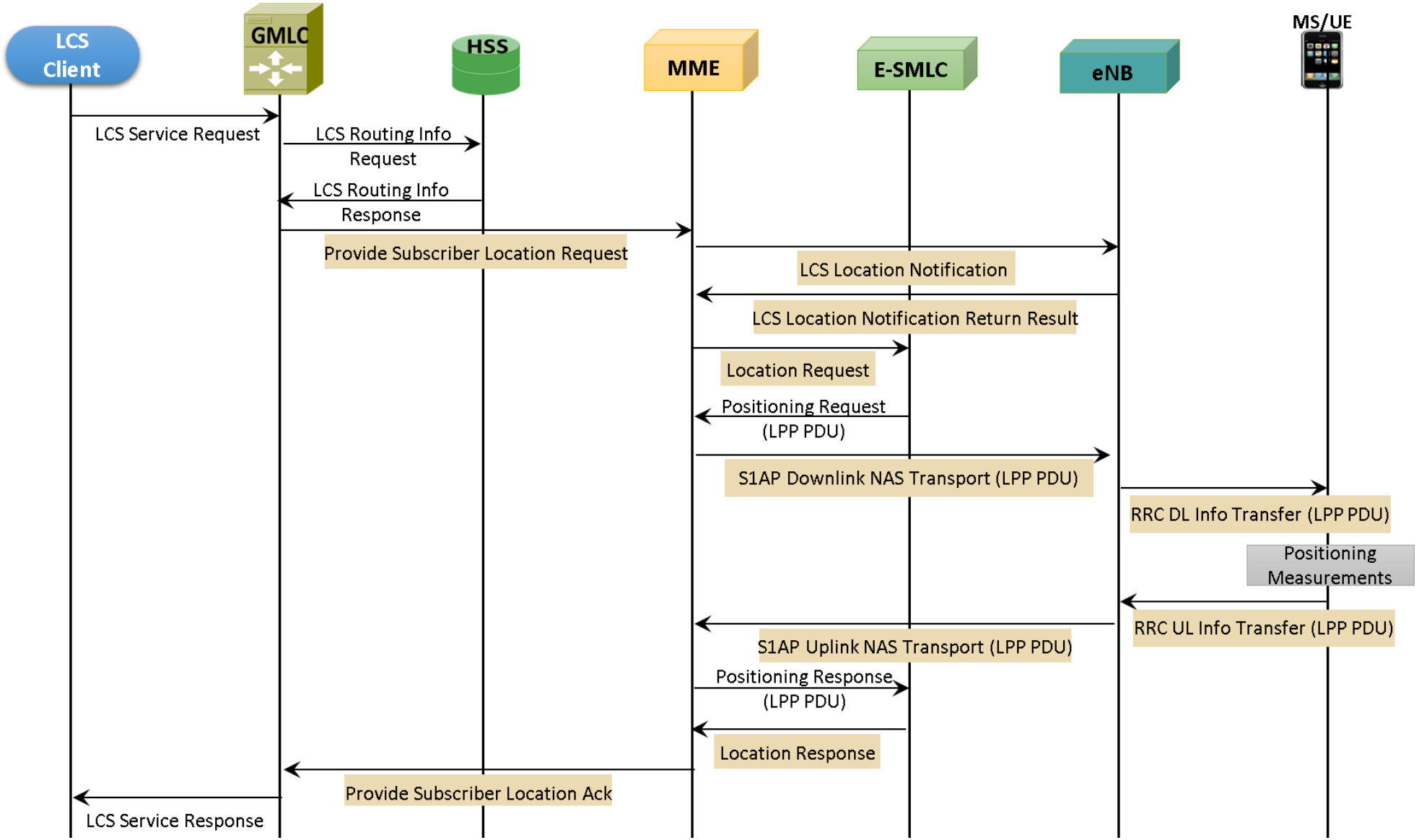
# 4G - Typical Call Flow



# Thank you