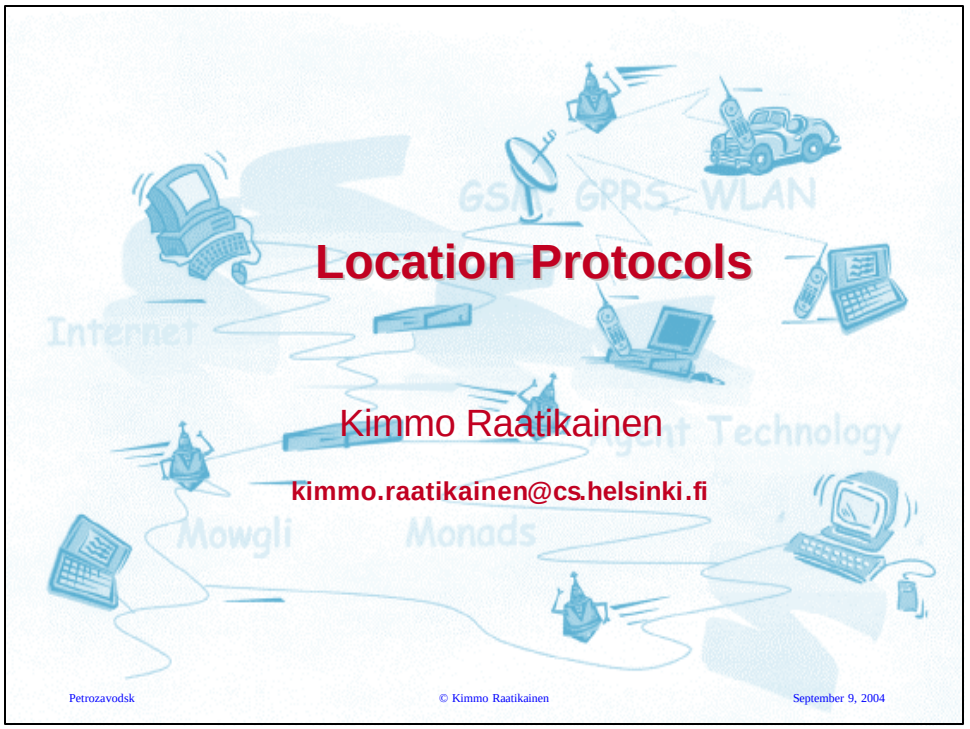

Location Protocols

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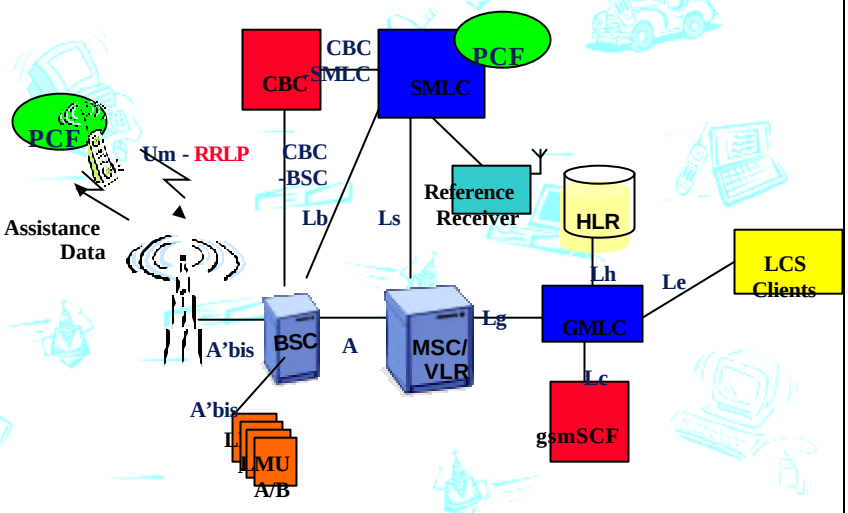
Lession Outline

- Location Technologies
- LIF's Mobile Location Protocol

Handset Based vs. Handset Assisted

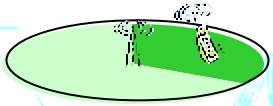
- Handset Based/Network Assisted methods rely upon the Position Calculation Function to be performed in the handset.
- Handset Assisted/Network Based methods rely upon the Position Calculation Function to be performed in the network.
- Both E-OTD and A-GPS have these implementation options.
- Considerations to the operator: signalling load, handset complexity, capacity, subscriber tie-in to operator, privacy risks, … …
- But, to subscriber - both methods can be made to look the same … …

Handset Based *vs.* Handset Assisted

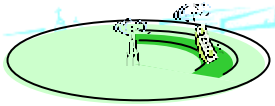


Cell ID + Timing Advance

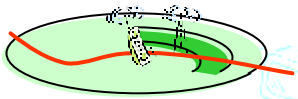
Cell Site only



Cell Site with sector

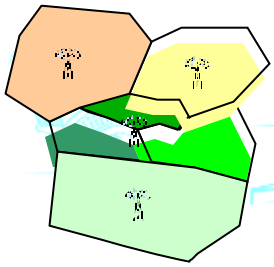


Cell Site with sector and Timing Advance



Cell Site with sector, Timing Advance and Supplementary information

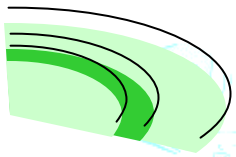
Cell ID and Timing Advance



Actual Cell coverage maps can improve Cell ID positioning

Centre of coverage area will frequently be more accurate that cell site position

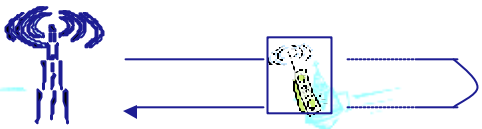
In most cases TA does not bring significant improvements in positioning accuracy over Cell ID



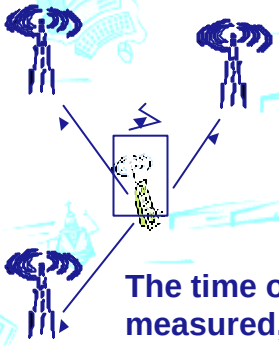
Real improvement from Timing Advance is to spot when MS is no longer using 'nearest' cell e.g. connected to umbrella cell, or neighbour cell

Cell ID and Timing Advance

- Migration to UMTS:
  - In UMTS cells will be smaller
  - Analogy of TA in UMTS is Round Trip Time
  - Soft Handover
  - Round Trip Time is reported in 1/16 chip resolution (~5m).
- However, Timing Advance and Round Trip
  - Time will suffer from variable receiver chain delays in the MS/UE.



Uplink Time Of Arrival

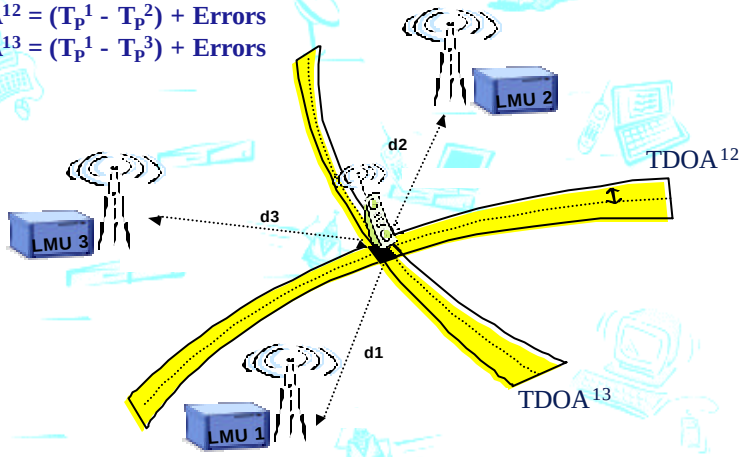


- Uplink Time Of Arrival (TOA) is a timing based method in GSM
- Signals from the handset are detected at geographically dispersed receivers
  - TOA LMUs (usually co-located at BTS sites)

The time of arrival of the received signals is measured, related to a propagation delay and the position of the handset is estimated by triangulation

TOA Position Estimation

$TDOA^{12} = (T_P^1 - T_P^2) + Errors$
$TDOA^{13} = (T_P^1 - T_P^3) + Errors$

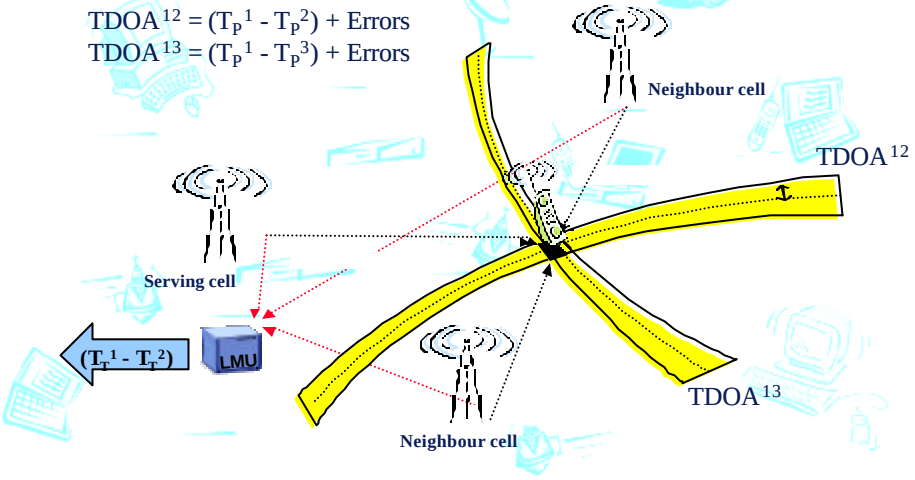


TOA - Pros and Cons

- Does support legacy handsets but …
  - TOA LMUs are complex high cost devices; and require 1 per BTS site
  - There is a built in capacity limit for the TOA system (OK for e.g. emergency requirements but problematic for commercial services)
    - Each time a handset requests positioning, 3+ TOA LMUs will be assigned to measurements from that handset
  - Performance is dependent on traffic in network - interference dominated.
  - Extra interference generated in network by handsets requesting
  - positioning and using forced handover mechanism

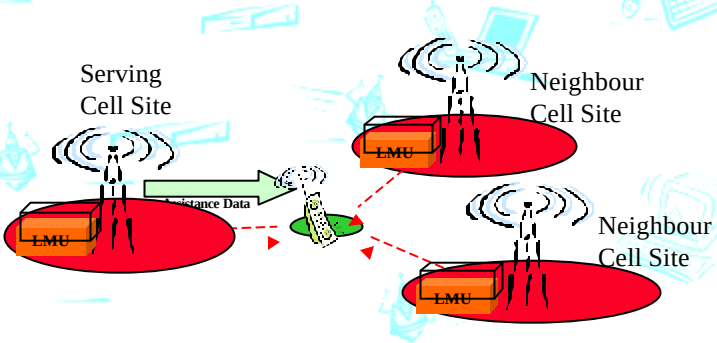
E-OTD Position Estimation

$TDOA^{12} = (T_P^1 - T_P^2) + Errors$
$TDOA^{13} = (T_P^1 - T_P^3) + Errors$



E-OTD Migration to UMTS

- **Basic performance of E-OTD (known as OTDOA) in UMTS is worse than GSM due to near far problem**
- **There is the option to implement Idle Periods at the Node B**



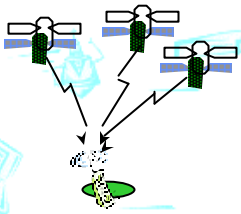
E-OTD Pros and Cons

- Advantages of E-OTD:
  - Minor modification to handset functionality
  - Good positioning performance in high BTS density areas
  - Good indoor coverage
  - Compared to TOA E-OTD LMUs are much simpler and can be deployed at 1 per 3-5 BTSs.
- Disadvantages of E-OTD:
  - High impact on Network Infrastructure - cost, deployment, planning, maintenance.
  - Penetration starts at 0%
  - Uncertain performance in UMTS
  - Poor performance in low density BTS areas

Conventional Global Positioning System

Conventional GPS is a navigation system that utilises transmissions from a constellation of US government satellites.

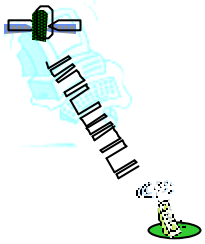
The system has been around since 1978 and is widely used in many non-military applications



Like TOA and E-OTD, GPS is a time based positioning method

Conventional GPS has already been successfully implemented in GSM handsets

Conventional GPS - how it works

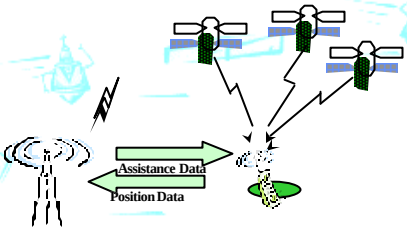


- GPS satellites continuously transmit a bit stream, containing satellite id, GPS time and satellite trajectory models (almanac, ephemeris)
- Almanac - approximate long term model, Ephemeris - accurate short term model

The receiver searches for satellites, then decodes the information transmitted, which enables it to perform position

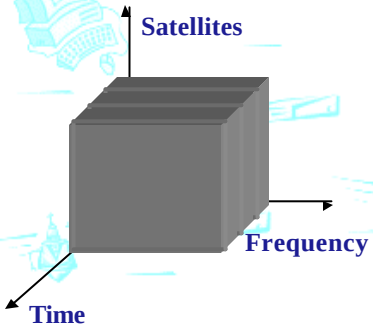
Assisted GPS

- To solve the inherent restrictions with conventional GPS Assisted GPS was proposed (T1P1.5 standards for E911)
- Assisted GPS is based upon providing GPS satellite information to the handset, via the cellular network

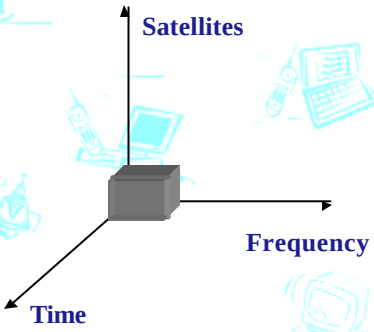


A-GPS gives improvements in
- Time to First Fix
- Battery Life
- Sensitivity
- Cost

A-GPS - improvement in TTFF



conventional GPS

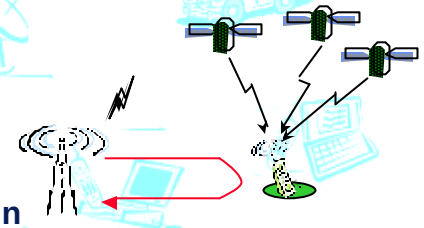


Assisted GPS

AGPS: Handset Assisted vs Handset Based

- Handset Based A-GPS
  - full functionality GPS receiver in handset
  - assistance data is reproduction of satellite data
  - distributed processing, so higher potential maximum LCS subscribers supported
- Handset Assisted A-GPS
  - reduced functionality GPS receiver in handset
  - assistance data sent is minimum required for receiver to acquire satellite pseudo-ranges
  - lower signalling load, but can also work with Handset Based A-GPS assistance data

A-GPS Evolution to UMTS



- **A-GPS is Radio Access Network independent**
  - consistent accuracy.
- **Inherent synchronisation in UMTS system (for soft handover) will bring improvements in assistance data**
  - improvement in time to fix.
- **Resolution of Round Trip Time means node B could act as extra satellite**
  - improvement in availability.

A-GPS Pros and Cons

- Advantages of A-GPS:
  - Low impact on Network Infrastructure
  - Excellent outdoor performance
  - Good evolution path to UMTS
- Disadvantages of A-GPS:
  - Major modification to handset functionality
  - Penetration starts at 0%
  - Improved yet variable indoor coverage

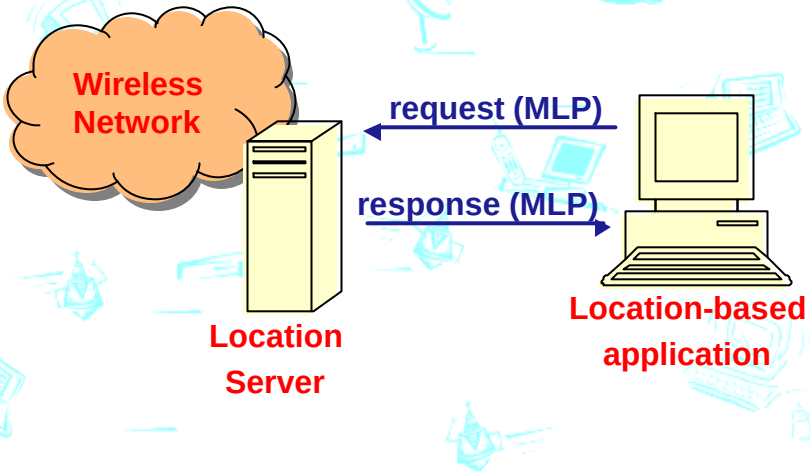
Lession Outline

- Location Technologies
- LIF's Mobile Location Protocol
  - now at Open Mobile Alliance

MLP Overview

- An application-level protocol for querying the position of mobile stations independent of underlying network technology.
- The MLP serves as the interface between a Location Server and a location-based application.
- Possible realizations of a Location Server are
  - the GMLC, which is the location server defined in GSM and UMTS, and
  - the MPC, which is defined in ANSI standards.
  - Since the location server should be seen as a logical entity, other implementations are possible.

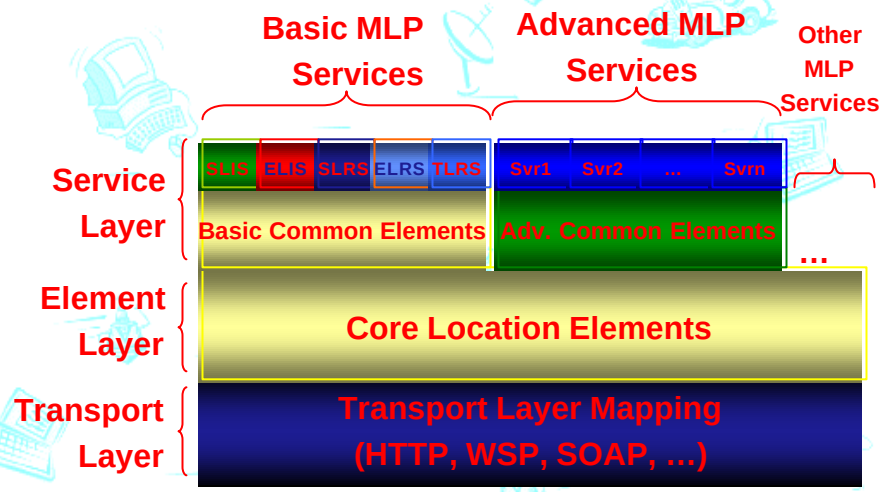
MLP Overview



MLP structure

- In our heterogeneous world, different devices may support different means of communication.
- A ubiquitous protocol for location services should support different transport mechanisms.
- In MLP, the transport protocol is separated from the XML content.
- The transport protocol defines how XML content is transported
  - Possible MLP transport protocols include HTTP, WSP, SOAP and others.

MLP structure



Element Layer

- The Element Layer defines all common elements used by the services in the service layer.
- Currently MLP defines the following set of DTDs making up the element layer of MLP:
  - MLP_ID.DTD: Identify Element Definitions
  - MLP_FUNC.DTD: Function Element Definitions
  - MLP_LOC.DTD: Location Element Definitions
  - MLP_SHAPE.DTD: Shape Element Definitions
  - MLP_QOP.DTD: Quality of Position Element Definitions
  - MLP_GSM_NET.DTD: GSM Network Parameters Element Definitions
  - MLP_CTXT: Context Element Definitions

Service Layer

- The Service Layer defines the actual services offered by the MLP framework.
- Basic MLP Services are based on location services defined by 3GPP, and are defined by this specification.
- The "Advanced MLP Services" and "Other MLP Services" are additional services that either will be specified in other specifications or are specified by other fora that conform to the MLP framework.

Service Layer

- The Service Layer is divided into two sub-layers.
  - The topmost defines the services
  - The lower sub-layer holds common elements which are specific for that group of services.
  - If an element is common to more than one group of services then that element is defined in the element layer.
  - The present specification specifies no element sub-layer.

Services

- Standard Location Immediate Service
- Emergency Location Immediate Service
- Standard Location Reporting Service
- Emergency Location Reporting Service
- Triggered Location Reporting Service

Standard Location Immediate Service

- This is a standard query service with support for a large set of parameters.
- This service is used when a (single) location response is required immediately (within a set time) or the request may be served by several asynchronous location responses (until a predefined timeout limit is reached).
- This service consists of the following messages:
  - Standard Location Immediate Request
  - Standard Location Immediate Answer
  - Standard Location Immediate Report

Emergency Location Immediate Service

- This is a service used especially for querying of the location of a mobile subscriber that has initiated an emergency call.
- The response to this service is required immediately (within a set time).
- This service consists of the following messages:
  - Emergency Location Immediate Request
  - Emergency Location Immediate Answer

Standard Location Reporting Service

- This is a service that is used when a mobile subscriber wants an LCS Client to receive the MS location.
- The position is sent to the LCS Client from the location server.
- Which application and its address are specified by MS or defined in the location server.
- This service consists of the following message:
  - Standard Location Report

Emergency Location Reporting Service

- This is a service that is used when the wireless network automatically initiates the positioning at an emergency call.
- The position and related data is then sent to the emergency application from the location server.
- Which application and its address are defined in the location server.
- This service consists of the following message:
  - Emergency Location Report

Triggered Location Reporting Service

- This is a service used when the mobile subscriber's location should be reported at a specific time interval or on the occurrence of a specific event.
- This service consists of the following messages:
  - Triggered Location Reporting Request
  - Triggered Location Reporting Answer
  - Triggered Location Report
  - Triggered Location Reporting Stop Request

MLP extension mechanism

- The MLP specification has been designed with extensibility in mind.
  - Separate DTDs for definitions that are common to all messages
  - Message extension mechanism allowing the addition of new messages (specific for the HTTP mapping).
  - Parameter extension mechanism allows the addition of new parameters to existing messages.
- Each extension parameters should have a vendor specific prefix in order to guarantee their uniqueness.
- In order to use the extension, the extension DTD has to be explicitly referenced in the XML document.
- The Location Server may ignore any extension that is not recognized and process the message as if the extension is not available.