TSG-RAN Working Group 1
Hannover, Germany, 30 Aug – 3 Sept, 1999

TSG R1#7 (99)a84

Source: Lucent Technologies

Title: Location services technologies for WCDMA

Document for: Discussion

Agenda item:

1 Introduction

This contribution reviews recent activity on location technologies in 3GPP. In addition, we propose a location technology - UTRAN assisted GPS (UAG) – able to provide accuracy compliant with stated UMTS requirements. It is proposed that UAG compliance is mandatory for all mobile terminals that support positioning, whereas UAG is optional at relevant network nodes. The proposed method does not rely on inter-BS synchronisation and is therefore well suited to implementation in the UTRAN.

Network assisted GPS techniques are also being introduced into GSM; thus, a further advantage is the evolutionary synergy that is provided for UMTS.

Although this contribution describes UAG in the context of GPS signalling, the proposed technology is applicable also to other satellite navigational systems.

2 Review of location service activities in 3GPP

Within TSG RAN, the main activity on location technologies has been within WGs 1 and 2. Within RAN WG1, AH17 has been established only recently. Within RAN WG2, TR 25.923 (currently version 1.1.0) [1] describes a number of candidate technologies for location services (LCS); this work is still ongoing. It is expected that evolving LCS needs will mean that no single technology solution will be sufficient.

The latest TSG SA Plenary approved a new work item, for coordination under TSG S2, on 'location services for UMTS' wherein it is stated that 'the Stage 1 service requirements for location based services in UMTS have to be elaborated based initially on input from GSM 02.71 and the LCS requirements of UMTS 22.105 (version 3.5.0), 23.10 (TS 23.110 version 3.1.0) and 23.20 (TS 23.121 version 3.0.0 and TS 23.920 version 3.0.0)'. The new work item also states that the Stage 1 LCS service description shall be defined by TSG S1. This work is currently ongoing in TSG S1.

TS 22.105 (version 3.5.0) 'Services & Service capabilities' states, under section 8.5:

The precision of the location shall be network design dependent, i.e. an operator choice. This precision may vary from one part of a network to another. It may be chosen to be as low as hundreds of meters in some place and as accurate as 5 meters in other place. It is required that a minimum precision of around 50 metres can be achieved in all types of terrestrial radio environment. Technical issues may constrain the precision to be mobile state dependent as well (mobile idle / mobile in communication). Several design optional features (e.g. size of the cell, adaptive antenna technique, path loss estimation technique...) shall allow the network operator to reach cost effectively the target precision.

Latterly, TSG S2 has discussed coordination of location services across 3GPP, wherein these points are echoed and draft work and project plans, [2], [3], have been produced.

3 UTRAN assisted GPS (UAG) positioning method

Already in 3GPP, a number of technologies for the provisioning of location services have been discussed. Many of these are described in TR 25.923 [1].

We propose here UTRAN assisted GPS (UAG) technology for general positioning of mobile terminals. For brevity, the proposal in this paper is at a conceptual level; Lucent Technologies can make further detailed information available when needed.

GPS has been considered in the past for provision of location services in conjunction with cellular systems. However, as a stand-alone technology, there are a number of disadvantages such as: poor link margin in buildings, costly terminal deltas and slow computation of results. UAG overcomes all these limitations and provides superior accuracy over timing based methods. Since UAG exploits simplified GPS technology in UEs, there is minimal impact at the UE in the key areas of cost, size and battery life.

A 'partial' (reduced complexity) GPS receiver is implemented in the UE and corresponding GPS receivers are deployed in the network. Network GPS receivers may not be required ubiquitously within UTRANs; this can reduce implementational complexity in the network. A network based server combines knowledge of the approximate location of the UE (derived through, for example, cell/sector information from the mobility management platform) with GPS information from a reference GPS receiver to compute, more accurately, the location of the UE.

An assistance signal is transmitted from the server to the UE to enable rapid processing of UE received GPS ephemeris data, which is transmitted on the uplink as a narrowband bit stream. The assistance signal would be transmitted on BCCH (for example). These bit streams are only required during location determinations; therefore, in combination with burst signalling control, narrowband uplink and downlink channels only are required, typically, for several seconds during location reporting periods.

Although the UTRAN and UAG server are required to provide the UE with timing accurate to a few microseconds – depending on the cell size employed, the specified BS frequency drift is 0.05 ppm. Timing drift, due to the UTRAN, over a 1023 chip GPS pseudo-random noise (PRN) correlation sequence is only ± 50 pS, or ± 5 μS over a 100 second period. As the UAG server typically only requires timing accuracy to ± 5 μS over the duration of the correlation measurement, the complexity impact in the UTRAN is minimal.

Major advantages of the proposed approach include:

- low complexity UE implementation: since much of the conventional GPS processing and hardware is removed from the UE;
- extended service coverage in areas of low GPS signal strength: through transmission of UTRAN assistance signals;
- improved accuracy over timing based methods: UAG is not entirely reliant on the characteristics of the WCDMA terrestrial channel; initial studies indicate that 50 metre accuracy is routinely available both indoors and outdoors;
- indoor operation: since operation is not reliant on a permanent adequate GPS link margin; and
- rapid acquisition time: through cellular assistance processing – essential for emergency applications.

4 Impact on standard

Capacity will be required on BCCH and DCCH (for example). It is proposed that UAG compliance is mandatory for all mobile terminals that support positioning, whereas UAG is optional at relevant network nodes. A text proposal [4] for TS 25.231 has been prepared.

5 Conclusions

Various technologies for the provision of location services are being considered within 3GPP. The stated UMTS requirements for location services' accuracy are for a minimum precision of around 50 metres in all terrestrial environments.

UTRAN assisted GPS (UAG) is proposed as a method for the provisioning of location services in UMTS. This technology has a number of benefits including:

- superior accuracy over timing based methods – able to meet stated UMTS location accuracy requirements; and
- low complexity implementation at UEs and within the network.

6 References

[1] TR 25.923 version 1.1.0; TSG RAN WG2; August 1999.

[2] Tdoc TSG S2#6(99)524; '3GPP Project Coordination for Location Services in UMTS'; TSG SA WG2 #6, USA, 26-30 July 1999.

[3] 3G PD 30.lcs; 'Project plan for location services in UMTS'; 3GPP Inter-group coordination aspects; August 1999.

[4] Tdoc R1-99c23; 'Text proposal for TS 25.231'; Lucent Technologies; TSG RAN WG1#7.