TSG-SA Working Group 1 (Services) meeting #2
Edinburgh, Scotland 8th - 12th March 1999

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Agenda Item: 8.3

Source: **S1 (TSG_SA_WG1)**

Title: Liaison to T1P1.5 on Location Services

Document for: Action

TSG SA1 requests the T1P1.5 Location Services SWG to consider the attached report on a discussion that took place in SA1 on an ARIB request to include current ARIB requirements in UMTS documentation for Release99. SA1 asks T1P1.5 in its capacity as partner experts on Location Services to consider the attached information from ARIB and inform SA1 of its recommendation on whether and how to accept this information into UMTS documentation.

TSG-SA Working Group 1 (Services) meeting #2
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TSGS1#1(99)205

Agenda Item: 8.3

Source:

Title: Report on Location Services Discussion

Document for: Information

During discussion of Contribution 161 from ARIB, changes were proposed to UMTS document 22.05 to reflect ARIB requirements for Location Services. While the material was considered too large for an addition to 22.05, it was considered as a separate annex or report on this subject. The relevant material from Arib is attached to this report.

Appendix 1

Consideration on Implementation of Location Services

Table of Contents

1. Introduction.

From the view point that characterizes a 3G Mobile System as providing services with a higher quality than in 2G Systems, it is expected that 3G Mobile Systems provide new wireless mobile-specific services such as a high quality location service. It is also expected that the accuracy of such a location service can be made higher than in 2G systems. The main reasons for this is the high chip-rate that provides an inherent high resolution for time-based measurements, and the fact that there are no backwards-compatibility constraints in the radio access network part, including no previously existing mobile stations.

Applications using the location service are categorized into several types with different requirements on accuracy, reliability, security and so on. Some examples of such applications are emergency call positioning, fleet dispatch business, guidance of city-sightseeing and so on.

One positioning-based application that requires a high accuracy and reliability is positioning of emergency calls. Although positioning of emergency calls can easily be done through the subscriber-number for fixed-line calls, it is not as easy for mobile calls, for obvious reasons. Since authorities are the users of this application, there may be regional or national requirements to provide a location service in mobile cellular systems, for the sole purpose of positioning emergency calls.

The future 3G Mobile System should provide a location service with high accuracy, reliability and security.

To do this, it is highly important to consider the basic items for the support of a high-quality location service already from the beginning of the standardization process. If this is not done, it may be difficult to make changes in the functional entities and interfaces at a later stage.

2 Types of Location Applications

There are many applications that could utilize subscriber location service. One obvious example is the location of emergency calls, but there are many more. Some examples of applications based on location services are listed below.

Emergency service: Emergency service would identify the user’s location to the appropriate service organization sending assistance.

Location based information service: Area information around the user’s location, such as restaurant, sightseeing, hospital, pharmacy, weather forecast information, etc. The registered user can finish his check-in automatically when he enter the airport area.

Location sensitive billing: There may be an interest from operators, to base the charging on the geographic location of the subscriber. For instance, allowing cheaper calls from the subscribers residence.

Fleet management: Fleet management can be used by a transportation company to keep track of where each vehicle of the fleet is currently located.

“Where are you” applications: Keeping track of e.g. child, elderly, disabled person, employee, etc.

Tracking of valuable assets: Supervision of high security transports. This could be transportation between banks etc. This application could also be used to track down stolen terminals or any object that has a terminal attached to it, e.g. stolen cars.

Navigation: Indication of current position, navigation to the destination.

Real time traffic update: Offering a traffic information around his position such as traffic jam, road construction, accident, etc.

Location statistics for network planning: A way for operators to collect statistics about the usage of their network. This information could be used for improvements and tuning of the network, e.g. whether to add micro cells.

Location statistics for dynamic network control: Similar as above with the difference that there might be parameters in the network that could be tuned in real time to improve the performance of the system.

N.B.: This listing is neither exhaustive, nor systematized. The name of service is not exclusive.

Each location service will put certain accuracy requirements. In the figure AP1-1, some possible applications are listed together with their expected accuracy requirements.

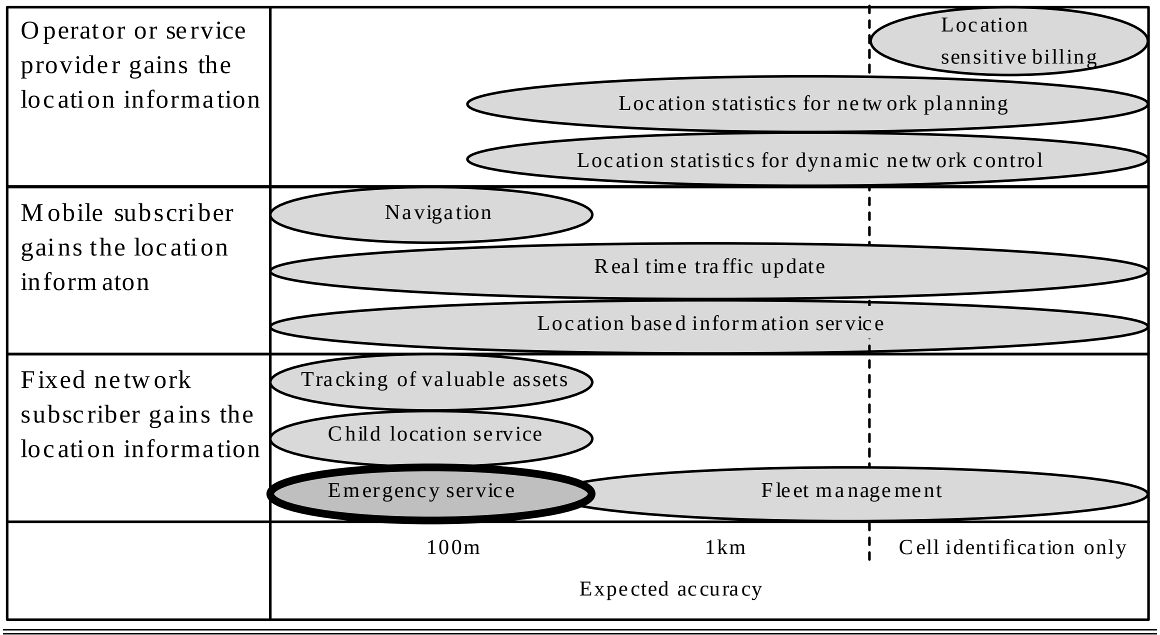

Fig. AP1-1 Accuracy Image of Location Services

3. Image of Location Services

3.1 Modularity Image of Location System

Figure AP1-2 shows general system configuration. It is considered that the location System consists of two major part, Positioning Measurement System and Location Services Access Point (LSAP). Both system obtain necessary information for location service, e.g. location data of mobile terminal, through a 3G Mobile System network.

It is considered that the location system can support the location service by these functional module which is implemented into a 3G Mobile System independently.

Positioning Measurement System : This system has a function to identify the location of mobile terminal by adopting applicable measurement method, for example, Angle of Arrival (AOA), Time of Arrival (TOA), Time Difference of Arrival (TDOA) or using third parties' positioning system such as GPS (Global Positioning System). In some case, combination of these method may be adopted.

Location Services Access Point (LSAP) : It is an access point which provide the location data, e.g. location of the terminal and terminal ID information obtained by the above Positioning Measurement System, to a location service provider or legal authorized party.

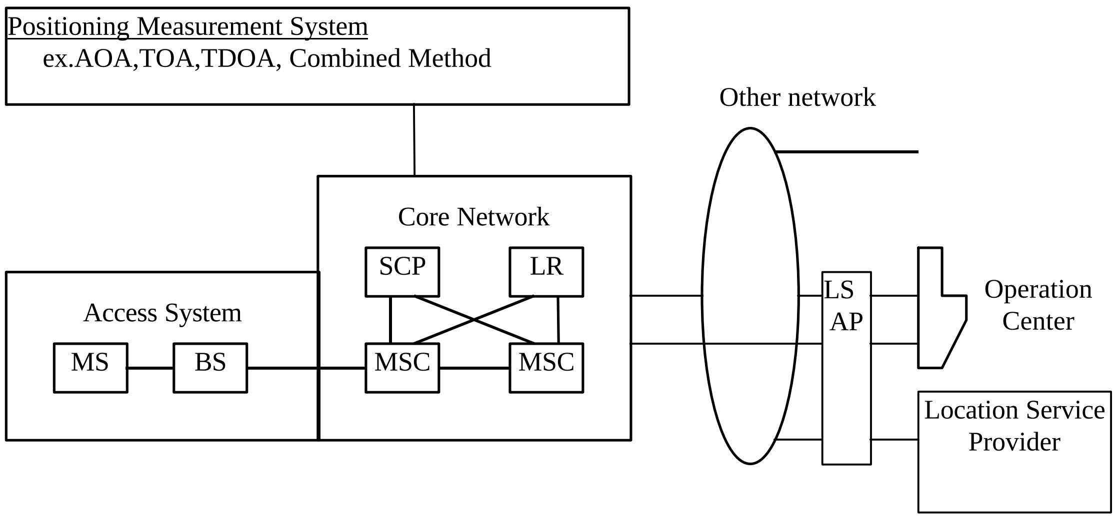

Fig. AP1-2 Modularity Image of Location Services

3.2 Image of Mobile Positioning Network

The Mobile Positioning System's role is to determine the location of wireless stations within the coverage area, maintain a database of this information for the subscriber, and provide the location data to location service applications through an open interface.

Image of Network Model

As an example, figure AP1-3 below presents a Mobile Positioning architecture for the creation of location based services as one of examples. The presented network interface model utilizes the Wireless Intelligent Network model to introduce the Mobile Positioning System. The diagram shows the mobile positioning functional entities and an example mapping to physical network elements. Other mappings can also exist.

In this Figure, the new functional entities are shaded in the darker gray. The light gray represent a new mobile positioning network element for which the function could reside.
Each of the new functional entities, new network entities are described below :

New Functional (Network) Entities

Location Determination Function
The function of the Wireless IN (WIN) Distributed Functional Model that is responsible for the collection and the reporting of the geographical location of the Radio Terminal Function.

Location Determination Technology
A hardware and/or software component in the network, in the handset or in some combination of the two that collects and reports position related data of a subscriber. There are many options for Location Determination Technology and it is considered beyond the scope of this annex.

Mobile Position Function
The function in the WIN distributed functional model that is responsible for aggregating position data from the Location Determination Function, maintaining a database of current locations of RTFs, and making the location information available to the Service Control Function.

Mobile Position Register
A network element that performs the Mobile Position Function in the WIN Distributed Functional Model. The MPR may or may not be located within, and be indistinguishable from the VLR or MSC.

BSS

CCF : Communication Control Function
HLR : Home Location Register
LDF : Location Determination Function
LDT : Location Determination Technology
LRCF : Location Registration Control Function
MPF : Mobile Position Function
MPR : Mobile Position Register

MSC : Mobile Switching Center
RRC : Radio Resource Control
RFTR : Radio Frequency Transmission and Reception
SCF : Service Control Function
SCP : Service Control Point
SSF : Service Switching Function

4. Position Measuring Methods

Various Positioning methods for Location Service are Summarised in Appendix 1-1 from survey of position estimation methods.

Appendix 1-1 shows positioning methods by horizontal axis and those principles, observation configuration, source observation information, accuracy of information, observation error, required observation time, also merits, difficulties, application examples, applicable environments etc. by vertical axis.

Typical positioning methods are:

(1). AOA (Angle of Arrival)
(2). TOA (Time of Arrival)
(3). TDOA (Time Difference of Arrival)
(4). Distributed Receiving System (Monitoring Post)
(5). Distributed Transmission System (Sign Post)
(6). Combined Location Techniques

AOA measures angle of arrival of incident radio wave by using directive beam antennas or non-directive antenna array with array signal processing in Base Station or Mobile Station.

TOA measures propagation delay of radio wave, and TDOA uses time differences of propagation delay to multiple Base Stations as in the case of Hyperbolic Navigation System.

Monitoring Post uses Location Registration Information of handsets via each Visitor Base Station’s service area, and Sign Post is such a method as mobile terminals acquire those own position information from deployed multiple transmitting stations.

Combined Location Techniques utilise multiple positioning methods such as combination of both AOA and TOA.

Many development projects related to positioning systems are proceeding worldwide specially in such area as Array Signal Processing and Software Radio, so selection of practical method should be subject to further study.

5. Objectives and Requirements of Location Services

5.1 Objectives of Positioning Measurement Accuracy.

The state of the art technologies should be introduced into positioning measurements location services as possible, because there is great demand for this field of services, so the technologies in this field is improving so fast in near further. One of most accurate positioning measurements required should be the case to identify a calling mobile station under the circumstance of emergency. A 3G Mobile System should be designed as objective to identify the location of a Mobile Station within a radius of no more than 125 meters in 67 percent of all cases. The degree of an accuracy will be calculated through use of Root Mean Square methodology.

This should be applicable to Emergency Services.
Note1- The locating accuracy follow to the FCC's Report and Order, CC Docket No.94-102.

5.2 Position Measuring Algorithm

The position measuring algorithm such as AOA, TOA, TDOA, etc. are not required to be standardized uniquely at this time, because improvements of technologies in this field are rapidly achieved to realize accurate positioning measurements and much higher quality of location services in future. The standardization at this time will limit any applications of future technologies improvements.

5.3 Requirements on Air Interfaces

A 3G Mobile System has a unique opportunity to standardize superior location services because wideband systems such as Wideband CDMA has a sufficient inherent accuracy of around 0.1?s for time-based measurements superior to those of 2G Systems. If this opportunity is not taken, this could become a significant disadvantage for such systems.

An issue to be considered is the problem of non line of sight which is common to all mobile cellular communication. Another major issue in a CDMA system is the near-far problem, i.e. for MS to "hear" neighboring BTS when close to its active BTS. This is also referred to as hearability.

The following is the non-exhaustive list of requirement topics for further study:

- Solution for the non-line-of-sight problem
- Solution for the hearability, for example, MS transmission radio power control,
  i.e. MS should be equipped to select and use the channel with the strongest cellular signal whenever an emergency call is to be placed.
- Time-based measurement requirements

5.4 Requirements on Network.

In order to support the requirements of these location services, the addition of new location network functions and network entities will be required. New and modified interfaces to the existing wireless network will also be required.

The necessary signaling should be studied for services user such as FCC enhanced 911 emergency rule-making (FCC's Report and Order, CC Docket No.94-102), e.g. cell ID (currently used in spite of more Accurate location information in future), calling MS ID, call back function, tracking of calling MS, accept roaming MS, MS without authentication. The use of MS for making emergency call to the police without a valued UIM should be studied.

5.5 Requirements on Service Access Points.

In order to support various location services and allow to provide those services by services provider, it is required to specify the related interface reference point and general data format of coordinates. To protect a user privacy against illegal user, applicable authentication and encryption scheme should be adopted at inter-system exchange of those location data.

In addition, the external service provider may prefer to access and communicate with the MS via Internet. To support it, regarding to the interface and data protocol related to the location service, it is expected to consider a compatibility and interworking with TCP/IP.

5.6 Security.

In order to protect the privacy of a 3G Mobile System user, access to location information must be restricted to specific applications authorized by the 3G Mobile System user and the administration concerned.

5.7 Reliability

Wireless Location Services are based on the measurements of radio wave propagation phenomena, it is well known that there are some limits of performance as much as other wireless services, because there may be some cases that radio waves may not received someplace due to poor radio propagation environments.

But especially from the view point of the wireless emergency service, It is very important for the concerned operators and organizations to make an effort usually to improve the service quality as one of public safety services.

6. Conclusion

Location service in a 3G Mobile System is one of characteristic aspect to be provided as mobile specific services like new generation of mobile telecommunication system, because 3G Mobile System users should require more safety and use location information as natural atmosphere.

Technological aspect of location serves shall be rapidly improved so that positioning measurement algorithm should be left to many competitors to realize accurate positioning.

But standardized issue of Air-Interface and Network-interface should be prepared for better location services from the beginning of a 3G Mobile System development to accelerate technological improvement from the view point of Characteristic that a 3G Mobile System shall bring us more cultural world.

Emergency services are most prior matters to be standardized from the beginning of standardization process, and that the most important public services inevitable to be taken into the consideration of standards. It must be also required some kind of regulatory issues such as a prohibition of calling and that an emergency calling MS may select and use the channel with the strongest cellular signal whenever a emergency call is placed like FCC rule-making.

Finally, this version of requirements should be improved stage by stage in standardization of a 3G Mobile System in future and a 3G Mobile System is wished to be succeeded as social wireless telecommunication infrastructure.

7. References

(1)FCC/CC Docket No. 94- 102, June 12, 1996.

Appendix 1-1: Location Estimation Techniques

Method	AOA (Angle of Arrival)	TOA (Time of Arrival)	TDOA (Time Difference of Arrival)	Distributed Receiving Monitoring Post	Distributed Transmission Sign Post	Combined Location Techniques
Principle	Draw a base line from incidence angle of arriving wave to the target position. Determine the target position in two dimensions (x,y) from intersection of two base line vectors.	Measure the propagation time of the wave and calculate distance (d_i) between transmitter and receiver. The intersection of circumferences of circle c_1 and c_2 which centered at known points and radiuses are d_1 and d_2 will be the target position in two dimensions.	Obtain receiving time difference by measuring each receiving time of synchronized signals which are transmitted from plural transmitters. Locuses of which positions have same receiving time difference value of synchronizing signals from two transmitters will be hyperbolic curves which focuses are on two transmission position. Describe two hyperbolic curves of the same receiving time difference. The intersection will be the target position in two dimensions.	Monitoring Post Receiving - Measure the receiving signal strength (RSS) of reverse link at monitoring post. Determine the position by relation of receiving strength and post position. (electric field/signal measurement, receiving area positioning)	Sign Post Transmission - Measure receiving signal strength (RSS) of forward link. Determine the position by relation of receiving strength and post position. (electric field/signal measurement, receiving area positioning)	(Combination of each method) Example; AOA + TOA Determine the position (x, y) on a single base line from base line to the target position which is obtained from incidence angle of arriving wave and distance (d) to the target position which is calculated by propagation time.
Observation structure	Measure the incidence angle of arriving wave at least two base stations (or, at a terminal, measure incidence angles at least from two base stations). Array antenna required.	Measure the plural numbers of (at least two) propagation time of receiving signals at terminal or base station. In the case that clock of high accuracy is equipped in the base station and the terminal, inter-BS synchronization is not required.	Measure the plural numbers of (at least three) arrival time difference of forward signals from base station. Inter-BS synchronization is required since forward signal shall be synchronized.	Measure receiving signal strength (RSS) of reverse link at monitoring post. The functions of RSS measurement and terminal identification are required in each post. Inter-BS synchronization is not required.	Each sign post transmits unique identification code. The terminal measure it and report the result to the base station. Inter-BS synchronization is not required.	(Combination of each method described in the left columns) Example; AOA + TOA Measure the incidence angle of arriving wave and propagation time at single base station or terminal. Array antenna and clock is required.
Information to be observed	Incidence angle of receiving wave	Propagation time of receiving wave	Arriving time of waves which were emitted in a same time	Receiving signal strength (RSS) of reverse link at monitoring post	Receiving signal strength (RSS) of forward link at terminal	(Combination of each method described in the left columns) Example; AOA + TOA incidence angle of arriving wave and propagation time of the wave
Accuracy of information	- In the case of the direct wave, the incidence angle of receiving wave indicates almost correct direction because refractive index in the atmosphere is 1.0003.	- Coherent detection is possible by autocorrelation characteristics of PN sequence in a time of 1/x of Tc. If chip rate is 4.096 Mcps, Tc is about 244 ns and timing	- About fluctuation of EPD in propagation path, same as TOA in the left column.	- In the case determine it by the post which have maximum strength of receiving electric field, it is limited in area judgment which indicated by the radius	- Same as the Distributed Receiving Monitoring Post in the left column.	Combination of accuracy shown in the left columns. There is a case, by the combination, that the error is reduced or countervailed. Example; AOA + TOA

	- In the case that mixture propagation path of land and ocean, i.e., coast line etc., is included, coast line error is generated. When the angle (α) of coast line and direction of wave is 10 degrees, the refraction of about 2.2 degrees is generated on the intersection with coast line.	detection is possible in every 50 ns. - In the case of direct wave which generates EPD (Extended Path Delay) in propagation path, propagation delay by atmosphere, in 3 km of propagation path length, is about 3~4 ns by dry atmospheric pressure and about 1 ns by steam pressure. The propagation delay fluctuates by atmospheric pressure and saturated steam pressure. In the case of Multipath, when reflected wave/diffracted wave passed through it, the delay by reflection/diffraction is included. Refer to annex-1 on the amount of delay.		which is covered by each post.		Combination of accuracy of information of AOA and TOA in the left columns.

Method	AOA (Angle of Arrival)	TOA (Time of Arrival)	TDOA (Time Difference of Arrival)	Distributed Receiving Monitoring Post	Distributed Transmission Sign Post	Combined Location Techniques
Measurement error	Depends on the bearing error of array antenna	Depends on the frequency stability of reference oscillator of both transmitter and receiver.	Same as the left column	Depends on the measurement error of receiving signal strength	Depends on the measurement error of receiving signal strength	Combination of those errors shown in the left columns. There is a case, by the combination, that the error is reduced or countervailed. Example; AOA + TOA Addition of AOA and TOA in the left columns.
Required time period of measurement	Depends on the ability of array antenna. However, since it is judged by electromotive force generates in antenna element which is driven by arriving wave, it is expected that observation on signal of several phases is required.	In the case of terminal measurement (and on WB-CDMA), coherent detection is required by averaging correlation output of forward link signals for several code cycles and detect the maximum correlation output.	Same as the left column	It is desirable to conduct the measurement in every several seconds to obtain the median restraining the effect of fading.	It is desirable to conduct the measurement in every several seconds to obtain the median restraining the effect of fading.	The greatest common divisor of time which is necessary for each of combined methods.
Requirements for observation	Observation by plural numbers of station (at least two stations) is mandatory.	Observation by plural numbers of station (at least two stations) is mandatory.	Observation by plural numbers of station (at least three stations) is mandatory.	Measurement by single station is acceptable in the case that arrangement of monitoring post is closed.	Measurement by single station is acceptable in case that arrangement of sign post is closed.	By the combination, measurement by single station is acceptable. (Example; AOA + TOA)
Observation Instruments	- array antenna which measures incidence angle - CPU to analyze base line basing on the data which observed in each station	- Clock to measure propagation time. In the case of SS, it is possible to use existing receiving unit (synchronization circuit). - CPU to analyze base line.	- Clock to measure (judge) arrival time of wave. In the case of SS, it is possible to use existing receiving unit (synchronization circuit). - CPU to analyze hyperbola.	- RSS measurement circuit (included in the existing receiver)	- RSS measurement circuit (included in the existing receiver)	Instrument which is needed for each of combined method.
Advantages						
1) measurement instrument	No special equipment is needed to add to terminal when conduct measurement at base station.	No additional equipment is needed to antenna system both in base station and terminal.	No additional equipment is needed to antenna system both in base station and terminal.	No special equipment is needed to add to terminal.	No special equipment is needed to add to terminal.	(Depends on the combination)
2) radio	Available without depending on radio system.	In the case of DS-SS, receiving time detection with high accuracy is possible.	In the case of DS-SS, receiving time detection with high accuracy is possible.	Available without depending on radio system.	Available without depending on radio system.	Available without depending on radio system. (depends on the combination)
3) restriction in synchronization	Reference clock with high accuracy is not required. (synchronization of base stations is also not required.)	If transmitting side can keep synchronization of stations with high accuracy, restriction of time accuracy	Since arrival time difference is necessary information, this error does not effect to estimation of hyperbola if the error of arrival	Reference clock with high accuracy is not required. (synchronization of base stations is also not required.)	Reference clock with high accuracy is not required. (synchronization of base stations is also not required.)	Reference clock with high accuracy is not required. (depends on the combination)

		in receiver side is not strict. (because it is possible to eliminate time error according to measurement results)	time measurement is constant. Therefore, restriction of time accuracy in receiver side is not strict.			
4) Others	In the condition to use TOA/TDOA etc. in the same time, measurement by single station is possible.		Locus equation of hyperbola of arrival time deference of wave which is obtained by combination of base stations is easy to conduct estimation treatment since it is possible to keep it as a data in advance in base station side.	(a) If the post arrangement is closed, complicating measurement calculation is not required. (b) If arrangement of base station is very closed (pico-cell structure), the common base station can work as function of monitoring post.	Same as Receiving Dispersion Monitoring Post in the left column	Measurement by single station is possible. (depends on the combination) It is possible to clear hearability problem . (depends on the combination) It is possible to solve hearability problem caused by Power Con. (can not be received in some stations).

Method	AOA (Angle of Arrival)	TOA (Time of Arrival)	TDOA (Time Difference of Arrival)	Distributed Receiving Monitoring Post	Distributed Transmission Sign Post	Combined Location Techniques
Weak point	Array antenna is required for location estimation.	(1) In the case to follow the same system as GPS, inter-BS synchronization with high accuracy is required. (2) Location determination can not be done by single station.	(1) Inter-office synchronization with high accuracy is mandatory in the case of hyperbola method. (2) Location determination can not be done by signals from two stations.	(1) To improve the accuracy, a lot of posts are required. (2) Countermeasure for over reach is needed.	To improve the accuracy, a lot of posts are required.	Study on the most suitable combination of systems is needed.
Calculation	The direction of base line vector is provided by incidence angle θ and it is obtained by answering simultaneous simple equation which has two variables. $f(n) = O(n)$	Answer to simultaneous simple linear equation which has three variables.	The calculation order f(n) equal to $O(n^2)$. Because it calculates the intersection of family of confocal central conics which has parameter λ. (If hyperbolic function F(x,y) are calculated in advance, the above equation can be solved by liner order.)	Only comparison of receiving data	Only comparison of receiving data	(Combination of systems in left columns)
Example of application	Phased array radar	Positioning system using satellite (GPS, GLONASS)	Positioning system for ship (LORAN, Decca, Omega)	Location service in PHS		Radar
Suitable Environment	- Rural and the area where is easy to ensure LOS (Satellite etc.).	- Urban and Sub-urban where observation by plural stations is easily available.	- Urban and Sub-urban where observation by plural stations is easily available.	- Urban and Indoor environment which are in Pico-cell structure.	- Urban and Indoor environment which are in Pico-cell structure.	(Depends on the combination) Example; AOA + TOA Rural environment where error measurement between AOA and TOA (in the left columns) by plural stations is difficult.

Appendix 1-2
A study example on accuracy of measured distance.

1. Assumed combination method of TOA and AOA

1.1 Measuring principle

(1) To measure the position of MS in the cell by several neighboring Base Stations.

(2) Measurement by utilizing information on the distance from the Base Station and information on the bearing.

(2-1) Distance information is acquired by means of a measuring algorithm named by TOA (Time Of Arrival) on the clock basis of the Base Station timing generator.

(2-2) Bearing information is acquired by means of a measuring algorithm named by AOA (Angle Of Arrival) from incoming radio wave.

1.2 Image diagram.

Image diagram is showed fig. AP1-4, a typical cell size is supposed to have a radius of 5km in this case.

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1.3.2 Bearing accuracy

When $\Delta\theta = 1°$ is estimated value, (2πx 5,000m)/ 360° = 87 m (It is necessary to conduct decomposition processing for direct waves and multi-path-propagation waves.)

1.3.4 measured error of MS and BS

In CDMA system, a MS transmits its own frame with adjustment to the initial top of the frame from a Bs, and the BS has to measure the frame from the MS by the accuracy of 1/4 chip (0.25chips) or less and perform chip synchronization.

Namely, both of MS and BS possess the measuring capability on TOA by way of using short code and long code respectively.

Consequently, if we can specify

(1) BS chip synchronization accuracy = 0.25 chips.
MS chip synchronization accuracy = 0.25 chips.
Or
(2) (BS+MS) chip synchronization accuracy = 0.5 chips
(Allocation between BS and MS is determined separately),

then

Measurement accuracy by TOA = 76m + 38m = 114m is less than 125m which is specified in FCC docket.

From the mentioned above, it is considered that the required positioning measurement accuracy may be satisfied with under the condition of taking no account of the other fluctuation.

1.4 Method (Study Example)

(1) A mobile equipment returns the answer signal to a Base Station after a timing of delta-t from the synchronization signal by the Base Station.
The mobile equipment measures time delta-t by the regenerative clock of the down-stream signal. (Needless to say, an error may occur in this occasion by fluctuation of clock recovery and jitter etc)

(2) Propagation delay in this occasion is assumed as shown in Figure bellow.

(3) Position information data which can be measured by the Base Station:
Bearing angle , wave angle , $\Delta\tau 1$, $\Delta\tau 2$.

(4) A result of computation by longitude, latitude, and altitude is suitable for the position information. (Map data, Car navigation data).

(5) There is a possibility to improve the accuracy when multiple Base Stations can conduct the measurement. The position can be estimated by means of a center function located at somewhere in the positioning system.

Synchronizati
on signal

1.5 Ba

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dia

CDMA Receiver Units : It is needed one set of the (About 8ch.) Receiver plus demodulator.

Signal Processing Unit is a set of sub-equipment installed such as a TOA and an AOA decomposition processing unit plus data transfer interface.

Appendix 1-3:

Emergency Service

After the investigation of Emergency Service, we found the following requirements issued by FCC.

1. Enhanced 911 (E911) Service Requirements on FCC Rule

1.1 Background

In the United States, dealing 911 is the most effective and familiar way to contact the police and fire department in an emergency, and that is provided by local exchange carriers (LECs). In 911 service, the emergency calls are connected at first to Public Safety Answering Points (PASPs) and then, passed the information to the public emergency facilities.

Since it is introduced in 1968, 911 service has spread across the Nation, now 95 million 911 calls are made each year, or 260,000 every day.

Over the last decade, most 911 systems and PSAPs have been upgraded to enhanced 911 (E911), which adds features that permit more efficient and speedy response by emergency service personnel, for example, passing the caller's telephone number and other useful information based on LEC records. Currently, 89 percent of wireline phones in the United States are served by 911, and about 85 percent of 911 services include some form of E911.

The remarkable point is, in 1994, almost 18 million calls (20% of all 911 calls) were made by the wireless phone. It coincides with the facts that 62 percent of cellular users cited safety and security as their main reason for purchasing a mobile phone. In other words, wireless phone is major part of 911 services in the United States, and in the future, the number of calling 911 from wireless phone is growing rapidly, spurred by the rapid growth in cellular and Personal Communications Service (PCS) subscribers.

In wireless phone, however, the calling location is normally not fixed, particularly at night, the calling person is often not familiar with the reporting point, therefore the location information is the key issue to save lives and property.

From the public point of view, in United States, E911 services is necessary to be provided to wireless phone as same level of wireline phone, the identifying location is the most important issue in this service.

2. The Requirement on FCC Document

2.1 The Accuracy of measuring the calling position.

Under phase II, covered carriers are required to achieve the capability to identity the latitude and longitude of a mobile unit making a 911 call, with a radius of no more than 125 meters in 67 percent of all E911 emergency calls.(effective from October 1st, 2001)

2.2 Main System Requirement

(1) In emergency case, covered carrier must process and transmit to any appropriate PSAPs all 911 calls made from wireless mobile unit even those calls initiated by roaming MS or MS without authentication.

(2)At the same time, the information of a caller's Automatic Number Identification (ANI) and the location of the base station or cell site, is relayed to the designated PSAP. (Phase I)

(3) The function of call-back and tracking is required.

(4) E911 calling process and the transfer connecting have the higher priority.

In the conclusion, due to the fact that the emergency service requests the high accuracy of the location measurement, it is considered a big impact for 3G Mobile Services network function and system design.