# Japan Case Study

Best practice in Japan: Mobile Location Information for Emergency Callers

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# Issue and revision record

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| Version 1.0 | April 19th 2010 | Phil Skeffington | Alan Whitelaw | R Hewlett | Initial release |
| Version 1.1 | April 19th 2010 | Phil Skeffington | Alan Whitelaw | R Hewlett | Updates with additional information from interviews |



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# Content

# Executive Summary

The Japanese mobile market is characterised by a demand for high end devices. 3G handset penetration is 62% and NTT Docomo, the largest cellular operator in Japan anticipates withdrawing 2G handset sales in 2012.

GPS handset penetration is an impressive 95% of 3G handsets, driven by demand for commercial location based services.

The Japanese require that location information be provided by mobile operators for E112 services, and have set a **non-mandatory target** for location information accuracy of 15m radius available with a TTFF of 15s wherever there are “open sky” conditions. This was driven by concerns for public safety and not commercial reasons.

The choice of positioning technology was left to the discretion of the mobile operators, amongst other things the addition of GPS to handsets increases the cost of those handsets and so this was left to the mobile operators to decide. The Ministry of Information and Communications (MIC) did not want to cause an unnecessary increase in handset price. The target was introduced in April 2007. No such accuracy enhancement was requested for 2G.

The Japanese operators have determined that GPS alone is insufficient to meet the target and that the solution requires both network based and GPS positioning techniques. Japanese operators have implemented both Cell-ID and OTDOA where “open sky” conditions don’t exist. This provides location information but is not accurate to the 15m accuracy target. This provides accuracy with higher reliability than systems currently deployed in Europe. The Japanese mobile operators have also implemented “hybrid” or multi-mode positioning techniques where the system is intelligent enough to select the appropriate positioning technique for the context.

MIC does not currently enforce the target, mobile operators are expected to carry out their own measurements to determine if they meet the target. All location equipment and systems were deployed at the operators’ own expense.

In Japan it is only the mobile operators who provide mobile caller location information, providers of location based services do not provide this.

It should be noted that in Japan, IP phones, those with an associated PSTN number, must provide location information to emergency services.

# 1. Introduction

The consultation phase for improved location accuracy started in July 2003. By April 2007 a target to provide the emergency services with mobile caller location which is accurate to 15m radius and available within 15s was set. The choice of technology was left to the operators, however, this level of accuracy and speed means that the solution must involve the use of GPS or similar.

The case for improving the accuracy was driven by concerns for public safety.

In 2005, of 9.39 million calls received by police organizations, 5.54 million, or about 60%, were from mobile callers. In the case of many of these calls individuals were unable to describe where they were located. An “Emergency Location Reporting System,” was put in place to make people feel safer and more secure in an emergency.

The Emergency Location Reporting System automatically notifies the receiving organization of the caller location when a call is made to an emergency number (110, 118 and 119) from a 3G mobile telephone or an IP phone. With telephones that are equipped with GPS, the GPS information is relayed, and with phones that are not equipped with GPS, base station information was sent. In locations where GPS cannot be used the cell address information was forwarded to the emergency services.

## Commercial Background

Japan is one of the leading mobile internet markets. The MIC has a programme in place to stimulate the development of 4$^{th}$ generation mobile communications system in order to create the world’s most advanced IT environment [3]. The Japanese have decided to focus on the development of easy to use terminals as an area where they can excel and lead on innovation.

In addition the i-Japan strategy focussing on 2010-2015 will support the transition to IP telephony

Japanese 4G roll-outs are already in process with both WiMAX and LTE network rollouts scheduled to occur during 2010.

# 2. Funding & organisation of emergency services

The cost of implementing the changes to mobile networks was borne by the mobile operators themselves, no funding programme was provided by MIC.

There was a need for the emergency services to prepare for the availability of greater location information. In particular the preparation of technology (location information acquisition equipment) at control centres to accept the mobile location information.

The Committee on Advancing Emergency Services (Special-Interest Group of Information-Communication Technology), was responsible for ensuring that the capabilities in the emergency services and the mobile operators for mobile caller location were developed in tandem.

In terms of developing future systems to support cross emergency services collaboration and the provision of video and stills to the emergency services, MIC has no plans to date.

# 3. Location accuracy

In Japan the emergency services must be provided with mobile caller location. Mobile operators provide location information which is accurate to a radius of 15m and available with a TTFF of 15s wherever there are “open sky” conditions and best efforts otherwise. This level of accuracy and speed means that the solution must involve the use of GPS or similar.

All the Japanese operators provide GPS handsets, the progress towards 3G technology appears to be more advanced than in Europe. There are already plans by Japanese operators to withdrawing 2G handsets.

Hybrid solutions using A-GPS in open skies and other positioning techologies where there are not are in use by all operators.

As there is a commercial market for LBS, the operators have both control plane and user plane (SUPL) solutions. The networks apply the appropriate solution in the appropriate circumstance, so that costly resources are only used if greater accuracy, faster TTFF etc. is needed.

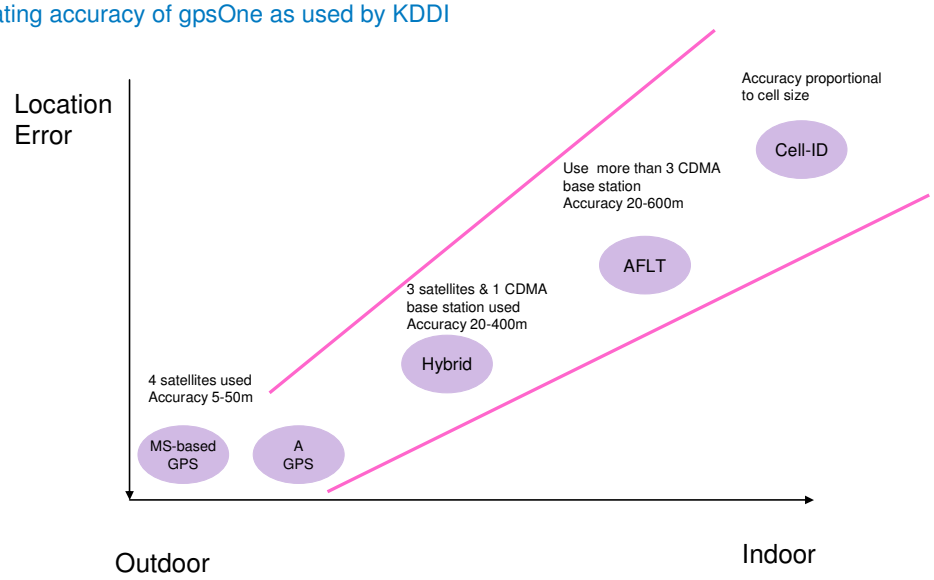
## 3.1 KDDI LBS solution

KDDI offer three types of positioning

- MS-Assisted (measurements largely network based with assistance from the mobile) using gpsOne (launched 2001)
- MS-based (launched 2003) and
- standalone GPS solution (launched 2007).

GPS gives the best accuracy in “open sky” conditions, but is less **reliable** than network-based methods (eg Cell-ID, OTDOA (AFLT)) when the user is indoors. With Qualcomm’s gpsOne solution KDDI can automatically select the best positioning technique to suit the environment. Thus maximising the accuracy **and** reliability in all conditions.

Diagram illustrating accuracy of gpsOne as used by KDDI




Source: Source adapted from Ariizumi 2008

Note AFTL is an alternate name for OTDOA, when used in CDMA rather than W-CDMA networks.

## 3.2 NTT Docomo LBS solution

NTT Docomo has the largest market share and launched the first 3G network, FOMA (based on W-CDMA standard). As long ago as 2005 some FOMA handsets were equipped with GPS.

In Japan, a browser based LBS called i-area (2nd Image) was launched by Docomo in 2001. In 2002, Docomo made location data available to web sites that are not Docomo partners. Users must specifically “opt-in” to the having their location shared with these sites for each session.

NTT Docomo supports LBS roaming using two methods:

- Docomo's advanced SUPL location platform provides a worldwide A-GPS based LBS to Docomo's outbound roamers.
- Docomo's GMLC supports Lr-interface to interconnect with foreign operators’ GMLCs, to enable real-time network-based positioning while roaming. [14]

NTT Docomo uses a Gateway Mobile Location Centre (GMLC), which makes the most effective use of Assisted-GPS (A-GPS) to reduce TTFF compared to the conventional standalone GPS.

From April 2007 NTT Docomo provided emergency services with a two phase location, an approximate position based on Cell location, the second phase uses GPS to get a more accurate fix. NTT Docomo uses MLP and OMA standards for provision of emergency service location information. NTT Docomo has implemented features to ensure that emergency services requests take precedence over non-emergency services location information requests.

Since 2009 NTT Docomo has been using Motorola MALS, which determines the user's location by a combination of mobile network and GPS satellite approaches. Motorola MALS is designed for low latency, high availability and high accuracy of location information. MALS is compliant with the Open Mobile Alliance (OMA) Secure User Plane Location (SUPL) 1.0 standard. It supports, location information for users roaming abroad.

Customers can use services like digital maps, store locations and pedestrian navigation.

## 3.3 KDDI & others

Docomo‘s largest competitor KDDI (AU), has a GPS based solution on some phones and both KDDI (AU) and the third Japanese operator J-Phone, offer cell-based location services similar to i-area.

Note that Softbank has already stopped selling 2G handsets.

# 4. Regulatory

In the case of emergency callers, the caller's number and location must be sent to the emergency services. This was mandated in April 2007, (although the accuracy levels were not) as part of the revised regulation of telecommunications facilities. The emergency caller is permitted to deny their location information by pre-dialling 184.

The MIC left the implementation technology to the operators.

Since 2007 all 3G phones sold in Japan support GPS.

It was also required that international roaming partners provide Mobile Directory Number to enable call back for emergency services. [Study on Emergency Call Handling in Japan – for international roaming]

Where a Japanese mobile caller is out of coverage of his/her own mobile operator's network there is currently no provision for an emergency call to be placed over a competitor's network.

In 2010 MIC is expected to investigate the use of public phones and how emergency notifications will be handled with respect to IP networks.

# 5. Mobile operator issues

The following mobile operators sell services in Japan:

- NTT Docomo
- KDDI (au)
- Softbank mobile
- Willcom Inc
- Emobile Ltd

## 5.1 Mobile operator technical issues

It was generally agreed in Japan that an appropriate TTFF is less than 10s, and that this and indoor positioning are more relevant than the location accuracy for commercial services.

### Need for multi-mode/hybrid operation

The need for a multi-mode operation was recognised.

A-GPS is not considered to be practical for applications which involved continuous navigation. A-GPS, MS-assisted (use the handset but must also use network based triangulation) solutions provide the fastest TTFF. For subsequent updates an MS-based (GPS only) can be used.

Both NTT Docomo and KDDI use this multi-mode approach. The commercial advantage for the operators here is that once the TTFF has been established subsequent updates in the user's session are MS based, using less of the operator's signalling network

Indoor mapping is essential although no solutions have appeared as yet.

### Synchronisation

Synchronisation was not a problem for KDDI who had a CDMA network and since "UTC time" used by CDMA networks is the same as "GPS time"; no synchronisation problems between the GPS and network based positioning existed.

NTT Docomo initially had problems, the technical differences led to NTT Docomo having a much slower TTFF which resulted in a much lower take-up of their LBS services with respect to KDDI's. (NTT's 3G network is a FOMA, W-CDMA based network).

## 5.2 Mobile operator commercial issues

QZSS was thought of as a programme with the potential to produce greater accuracy of positioning and better positioning in urban environments. These satellites are only usable in the Japanese market. (They operate in a highly elliptical orbit which gives them a high dwell time above Japan and generally high elevations, making them easier to see in urban environments).

Early terminals used in Japanese markets, did not benefit from common user profiles as did those in GSM countries. 3G rollouts are expected to have these benefits; however terminals now being sold (W-CDMA and CDMA standard) are still high end terminals and are generally adapted for the Japanese market, and so cannot be sold elsewhere. This has a negative impact on cost base.

## 5.3 Mobile operator operational issues

Currently there is no national roaming within Japan, and there are no dual mode and multi-band handsets, which will present limitations to the provision of emergency location services to roamers.

# 6. Emergency Services Readiness

A national programme to improve mapping was launched as long ago as 1999. It was recognised as a key requirement for any mobile location based services, both emergency and commercial.

In Japan there is a lack of a centralised building numbering scheme and post codes. This makes the use of maps and other turn-turn navigational aids even more useful than in US or Europe and may explain in part the high take-up rate of LBS in Japan.

QR codes have been rolled out in Japan; these are codes that note points of Interest (POIs). A mobile user can detect these, through use of a camera on the phone, and these are expected to support location identification in the future.

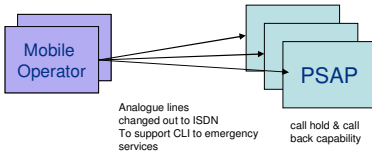
By 2004 the Japanese command & control centres (we refer to them as PSAPs in this report) had established the ability to receive CLI and call back; also “call gapping” features had been implemented on both 2G and 3G networks, to assure the same level of emergency call service from mobile as from fixed switches. For 2G Cell-ID was implemented for location. It was decided that for 3G better positioning methods would be required.

The need for greater location accuracy was driven due to an increase in both emergency call length and response time, tied directly to the increasing number of mobile originated emergency calls.

The PSAP was required to support separate lines for receipt of location information, and these had to be wide area Ethernet lines. The Ethernet WAN connects all PSAPs and will support the sharing of information between PSAPs. (Japan has more earthquakes than most and during disasters PSAPs may have to back each other up.)

The voice and location information were linked via the CLI. The location information associated with the voice call had to be delivered to the same PSAP.

Emergency services with CLI receive and call back capability



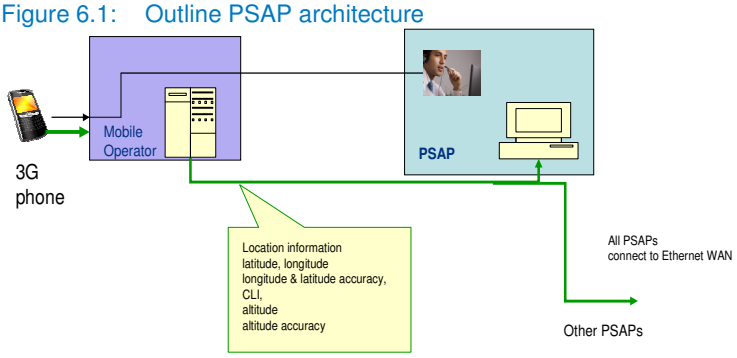

Source: MIC 2004

Extended emergency call and response times

| | 1994 | 2003 |
|---|---|---|
| Call time | 4:52 | 6:27 |
| Response time | 5:45 | 7:17 |

Source: MIC 2004

Figure 6.1: Outline PSAP architecture




Source: derived from MIC 2004

The MIC elected not to define the accuracy requirements when techniques such as OTDOA are used as it depends on density and layout of base stations, similarly the Cell-ID technique has no definitive accuracy levels associated with it.

The PSAP can ask for positioning information whilst still on the call to the emergency caller, and during 20 s following “call ended”. The time from request to completion of location information is 20s.

The PSAPs can interrogate the location report server of the mobile operators, using the IP address of each operator’s report server.

Note that it is only 3G (and later) handsets which support the separation of voices and data channels (for location data).

## 6.1 Schedule for implementation of mobile caller location information

This was agreed amongst the key stakeholders. Marine Safety Agency were able to receive the information from April 2007, with Police (major HQ) capable within a year and Fire services “as soon as possible”.

The 3G mobile networks would have capability to support positioning from April 2007, with all 3G handsets sold after April 2007 having the features to support location determination. A target of 90% of (3G) handsets to be GPS equipped by April 2011.

# 7. Achievements

## 7.1 Vision for VoIP.

NTT expect to have 50% of copper lines replaced by FTTH by 2010, whereas KDDI anticipated moving to an all IP network by 2007.

In Japan VoIP services with an associated PSTN number must provide access to an emergency call service as must VoIP services provided as an adjunct to FTTH. These services must also provide VoIP with an R value > 80 and a latency of less than 150 ms.

VoIP services provided PC-PC or on 050 number ranges **do not** need to provide an emergency call service. These services can provide R>50 and latency< 400m.

Note:

R is the transmission rating factor (combines the impact of a number of transmission parameters onto the impact as perceived by the user) as recommended in standard ITU-T rec.G.107. (The transmission rating factor R can lie in the range from 0 to 100, where R = 0 represents an extremely bad quality and R = 100 represents a very high quality)

# 8. Future Technology Options

The i-japan Strategy outlines 15 areas for ensuring that IT is used in all aspects of Japanese lifestyle.

- medical services
- environment
- IT-based safe and secure society(anti-disaster measures etc)
- ITS
- e-government services
- IT-oriented corporate management
- prosperous lifestyle(telework etc)
- a society that adopts universal designs ultrahigh-speed access covering 10 million households
  - e-commerce
  - e-government
  - human resource development
  - lifestyle
  - small and medium enterprise financing
  - knowledge
  - employment and labour
  - public service (promotion of subtitled television broadcasting etc)
- infrastructure
- a secure IT society(information security measures)
- highly competent human resources
- development of human resource base
- R&D
- international competitiveness
- international contribution

A 3 year emergency plan has been developed aimed at focussing on local and national government use of IT, Health and Education sector use of IT.

# 9. References for Japanese Case Study


1. http://www.cdg.org/members_only/teams/IntRoaming/docs/061128/PlenaryPresentations/EmergencyCallHandling_Matsumoto.pdf

2. Technological Conditions for Provision of Mobile Caller Location Information for Emergency Services

3. MIC: Broadband and wireless workshop number 6; “Evolution of mobile communications and applications, 21/7/2001