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SERIES F: NON-TELEPHONE TELECOMMUNICATION SERVICES

Audiovisual services

Requirements for network-based location information conversion for location-based applications and services

Recommendation ITU-T F.747.7

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Recommendation ITU-T F.747.7

Requirements for network-based location information conversion for location-based applications and services

Summary

Recommendation ITU-T F.747.7 defines the scenarios and the functional requirements for network-based location information conversion (NBLIC) for different applications and services. The NBLIC system provides the translation capability through specific algorithms, which can present location information in different formats to fit in various scenarios. The system also provides diverse functions and capabilities, such as interoperability, security, and privacy protection to the retrieved location data and to the converted information.

History

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FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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Introduction

Location-based services (LBS) are widely used. However, the different uses addressed by different applications require dissimilar types of positioning results, and in addition, the various positioning systems provide location information in varied formats. For example, an automobile navigation application in a shopping mall car park usually requires the location information in the format of longitude and latitude, while the indoor positioning system of the mall's parking lot offers the result in Cartesian coordinates. To reduce the number of positioning systems and make full use of the functionality of positioning systems, it is required to remove incompatibilities between the original positioning results and the appropriate results fitting the needs of an application.

A network-based location information conversion (NBLIC) system can be employed to help applications understand the location information written in different formats and coordinates. The location conversion system works either locally or globally, depending on the system structure. It provides translation functions to applications, and translates the positioning results from the original format to the required one. For example, it could translate the Cartesian coordinate positioning result (offered by the parking lot positioning system) into longitude and latitude according to the application's requirement.

Recommendation ITU-T F.747.7 identifies the scenarios and requirements for NBLIC system for location-based applications and services.

Recommendation ITU-T F.747.7

Requirements for network-based location information conversion for location-based applications and services

1 Scope

Location-based services (LBS) are utilized to bring considerable convenience to our daily life. However, due to the dissimilar purposes of LBS applications, the required formats of the location information are often different. The network-based location information conversion (NBLIC) systems are employed, serving as an effective middle-ware to help location information to be accessed and understood by multiple applications and services. This Recommendation describes some typical scenarios and specifies the functional requirements according to these scenarios.

The scope of this Recommendation includes:

– the definition of NBLIC;

– the specific scenarios of NBLIC;

– the functional requirements for NBLIC.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T F.747.5] Recommendation ITU-T F.747.5 (2014), *Requirements and functional architecture of an automatic location identification system for ubiquitous sensor network applications and services*.

[ITU-T Y.2221] Recommendation ITU-T Y.2221 (2010), *Requirements for support of ubiquitous sensor network (USN) applications and services in the NGN environment*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 automatic location identification (ALI) system [ITU-T F.747.5]: ALI system is a set of interacting or interdependent components forming an integrated whole or a set of elements to offer the ALI service.

3.1.2 sensor [ITU-T Y.2221]: Electronic device that senses a physical condition or chemical compound and delivers an electronic signal proportional to the observed characteristic.

3.1.3 sensor network [ITU-T Y.2221]: A network comprised of inter-connected sensor nodes exchanging sensed data by wired or wireless communication.

3.1.4 ubiquitous sensor network [ITU-T Y.2221]: A conceptual network built over existing physical networks which makes use of sensed data and provides knowledge services to anyone, anywhere and at any time, and where the information is generated by using context awareness.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 network-based location information conversion (**NBLIC) agent**: A local server of the NBLIC system that acts on behalf of the central server to provide NBLIC services to a subscriber in the situation when the NBLIC system is deployed in a decentralized mode, or in a hybrid mode.

3.2.2 network-based location information conversion (**NBLIC) client**: A terminal device or application consuming NBLIC services.

3.2.3 network-based location information conversion (**NBLIC) service**: A location associated service that provides the best accessible conversions of the positioning results upon request, and the formats of the converted results are in accordance with the requirements for the location-based applications and services.

3.2.4 network-based location information conversion (NBLIC) subscriber: A user authorized to use the NBLIC service.

3.2.5 network-based location information conversion (**NBLIC) system**: A set of interacting or interdependent components forming an integrated whole or a set of elements to offer the NBLIC services, which contains one or more databases consisting of a collection of the location information and the associated conversion parameters.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ALI	Automatic Location Identification
CDMA	Code Division Multiple Access
GPS	Global Positioning System
GSM	Global System for Mobile communications
HRPD	High-Rate Packet Data
IoT	Internet of Things
LBS	Location-Based Services
LTE	Long Term Evolution
NBLIC	Network-Based Location Information Conversion
NFC	Near-Field Communication
QoS	Quality of Service
QR	Quick Response
SMS	Short Message Service
TD-SCDMA	Time Division-Synchronous Code Division Multiple Access
USN	Ubiquitous Sensor Network
UWB	Ultra-Wide Band
WCDMA	Wideband Code Division Multiple Access

WiMAX Worldwide interoperability for Microwave Access

WLAN Wireless Local Area Network

5 Conventions

In this Recommendation, the following conventions apply.

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus this requirement need not be present to claim conformance.

The keywords "can optionally" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

6 NBLIC scenarios for location-based applications and services

The network-based location information conversion (NBLIC) service is defined to translate a positioning result into a desired format. The NBLIC service could be:

– part of a positioning system, such as the coordinate conversion function of automatic location identification (ALI) systems (defined in [ITU-T F.747.5]) for Internet of things (IoT) applications;

– integrated in entities within distributed positioning systems; or

– a stand-alone service.

As a result, there are different levels of the deployment of NBLIC functionalities. The following clauses describe the scenarios that are based on the different deployments of the NBLIC functionalities.

6.1 Centralized location information conversion model

This scenario is illustrated in Figure 1 and it describes the situation where the NBLIC service is deployed in a centralized server of the stand-alone service, or in a centralized positioning system as its function entities.

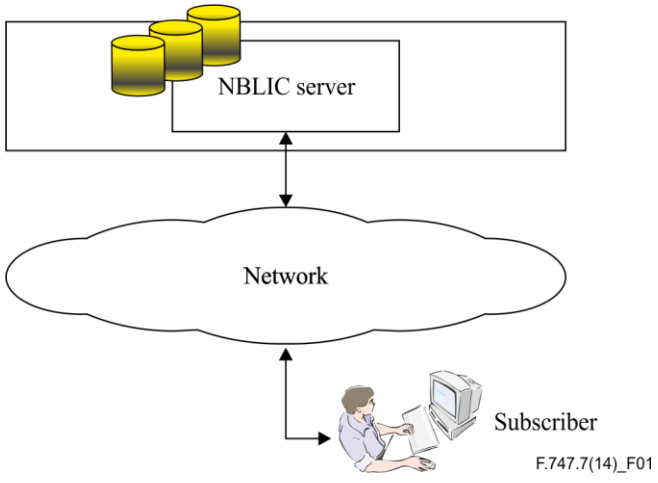

Figure 1 – Scenario for location translation conversion using NBLIC services via centralized model

***Description**:* This is the scenario where all the location conversion information is stored in a single centralized server or a handful of centralized servers.

***Pre-conditions**:* In the centralized model, all the conversion information is held in the centralized server. The centralized server authorizes the subscribers to use all the information stored in the NBLIC system.

In this scenario:

1. The subscriber's client sends the request to the centralized server of the NBLIC system.
2. Upon receiving the request, the centralized server looks up the subscriber from the authorization entity, and then authorizes the subscriber if it is a NBLIC subscriber.
3. After the authorization, the NBLIC system replies to the subscriber with a "successful authorization" message.
4. The subscriber's client sends a conversion request, which also includes the original location information, to the centralized server.
5. The NBLIC system translates the location information to the required format, and returns the result to the subscriber.

6.2 Decentralized location information conversion model

This scenario is illustrated in Figure 2 and it describes the situation where the NBLIC service is deployed in the distributed servers, or in a distributed positioning system as its function entities.

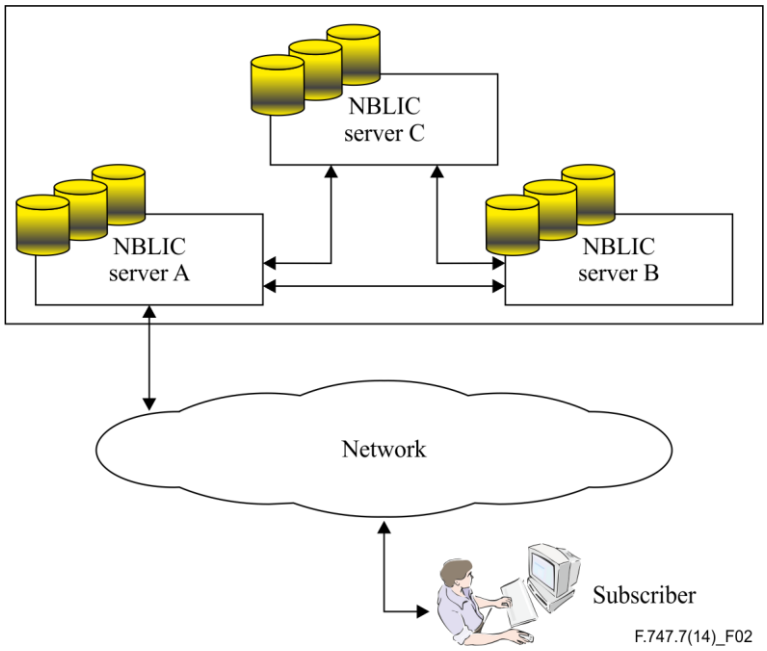

Figure 2 – Scenario for location translation conversion using NBLIC services via a decentralized model

***Description**:* This is the scenario where all location information conversion is fully decentralized across distributed positioning systems. Distributed search algorithms often use the flooding query method to look for the appropriate NBLIC server.

***Pre-conditions**:* In the decentralized model, NBLIC servers A to C each store a part of the conversion information and acts as an agent for the NBLIC system. Each server contains the full conversion information for a particular geographic area, i.e., NBLIC-A for area A, and NBLIC-B for area B. The subscriber, who moves from area B to area A, wants to translate the location information. All or some of the subscribers are authorized to use the NBLIC services.

In this scenario:

1. The subscriber in area B moves to area A. It sends the request to server A asking for NBLIC services.
2. Upon receiving the request, NBLIC server A sends the request to NBLIC server B in order to authorize the request.
3. After the authorization, NBLIC server A replies to the subscriber with a "successful authorization" message.
4. The subscriber's client sends a conversion request to NBLIC server A, which includes the original location information.
5. NBLIC server A translates the requested location to the required format, and returns it to the subscriber.

6.3 Hybrid location information conversion model

This scenario is illustrated in Figure 3 and it describes the situation where the NBLIC service is deployed in several servers, or in a distributed positioning system, as functional entities. Compared with the scenario described in clause 6.2, in this scenario, a central server is introduced to cooperate with the distributed servers (agents) to provide the NBLIC services.

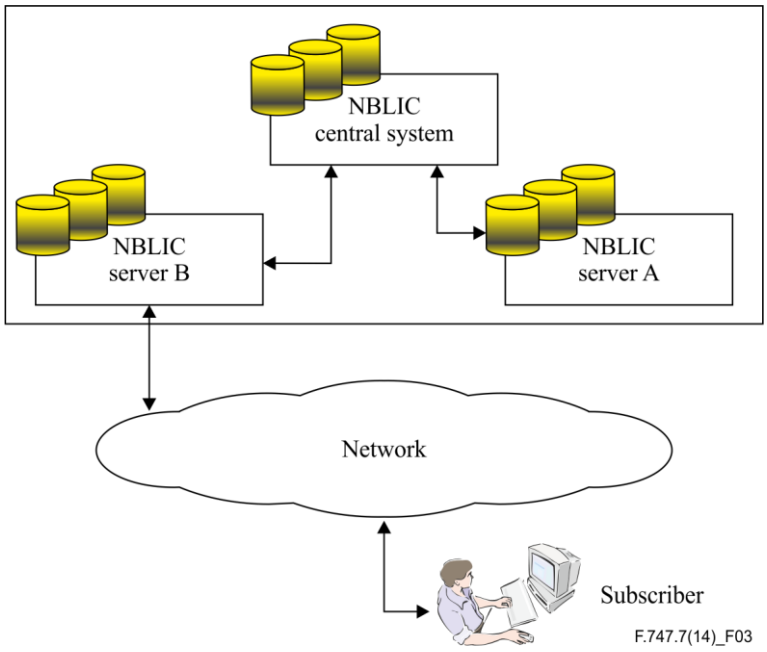

Figure 3 – Scenario for location translation conversion using NBLIC services via a hybrid model

Description: This scenario is where both a central NBLIC server and decentralized servers exist in the system. All location information conversion is stored in the central NBLIC server, while each decentralized system stores a part of the information related to its geographic area.

Pre-conditions: In the hybrid model, the NBLIC functions are distributed amongst the decentralized positioning systems and a central server. Each NBLIC distributed server (agent) has a part of the conversion information related to its geographic area. NBLIC-A has the whole NBLIC information for area A and NBLIC-B for area B, etc. The central NBLIC has all the NBLIC information. Subscriber A wants to translate some location information. All or some of the users are authorized to use NBLIC services.

In this scenario:

1. A subscriber in area A moves to area B. A request is sent to server B of the NBLIC system.
2. Upon receiving the request, server B sends the request to the centralized NBLIC server in order to authenticate and authorize the request.
3. After authorization, server B replies to the subscriber with a "successful authorization" message.
4. The subscriber's client sends a conversion request to server B, which includes the original location information.
5. Server B sends the request to the centralized NBLIC server.
6. The central NBLIC server translates the request location into the required format, and returns it to server B.
7. Server B returns the translated location information to the subscriber's client.

7 Requirements for the NBLIC services framework

7.1 High-level requirements

7.1.1 Interoperability

INT-01: The NBLIC architecture is required to allow co-existence with existing location information translation standards, such as geocoding standards and other related standards specified by other standards development organizations (SDOs) such as open geospatial consortium (OGC) [b-OGC 08-062r7], 3rd generation partnership project 2 (3GPP2) [b-3GPP2 IP-BLS], [b-3GPP2 MAP-LS], 3GPP [b-3GPP LCS]. The introduction of a NBLIC system is required not to have any negative impact on the operation and performance of existing standards.

INT-02: The NBLIC architecture is recommended to support seamless location information translation requests from moving subscribers. For example, if a subscriber's client contacts a server of the NBLIC system and then moves, the subscriber will receive the same format from multiple servers.

INT-03: The NBLIC architecture is recommended to support the ability for the different scenarios (the centralized, decentralized and hybrid scenarios) to provide the NBLIC capabilities to the network.

INT-04: The NBLIC is recommended to provide the capability to negotiate features between NBLIC elements. An example would be to revert to an earlier version of the system, if reversion is allowed by the NBLIC provider and the requested service is available in the earlier version.

7.1.2 Translation determination

TRA-01: The NBLIC architecture is required to support location translation procedures, which it performs in collaboration with the target NBLIC clients and the NBLIC functional entities resident within the possible positioning systems.

TRA-02: All translated data from the NBLIC system is recommended to be time-stamped.

TRA-03: The NBLIC system can optionally support the specification of the desired quality of service (QoS) in a NBLIC client location request, including, but not limited to, accuracy and response time.

TRA-04: The NBLIC architecture can optionally support triggered NBLIC requests, such as event-based NBLIC requests, or the requests triggered by some other conditions.

7.1.3 Security

SEC-01: The NBLIC architecture is required to ensure that any location information that is exchanged is secure, and thus is not accessible to unauthorized access, i.e., unauthorized disclosure or usage. Loss or corruption of location data is to be prevented.

SEC-02: If the NBLIC system provides the ability for the client or the agent to store the conversion information, the data is required to be stored in a secure manner, and is recommended to be available for retrieval by authorized applications.

SEC-03: The NBLIC system is required to deliver its content in a trustworthy and reliable manner, e.g., location information is required to be protected against eavesdropping or modification of the data traffic.

SEC-04: It is recommended to be possible to authenticate the NBLIC agent, the NBLIC network and the subscriber's client.

SEC-05: The NBLIC architecture is recommended to provide mechanisms to prevent denial of service attacks.

7.1.4 Privacy

PRI-01: The NBLIC system is required to ensure that data is protected in all transactions, consistent with the user's privacy preferences, except for emergency or lawful purposes depending on local/regional regulations.

PRI-02: NBLIC applications, agents, networks and clients can be a part of several domains. If the NBLIC services are available in several domains, the NBLIC architecture is recommended to support synchronization using secure mechanisms (e.g., encryption).

PRI-03: If the policy owner has defined different privacy settings for different data, the NBLIC architecture can optionally support a privacy check after each translation, to make sure the data is satisfying the different settings.

7.1.5 Implementation

IMP-01: The NBLIC architecture is recommended to support value-added commercial applications within its technical limitations.

7.2 System requirements

SYS-01: The NBLIC architecture is required not to impose any requirements on the underlying network service. It is required that NBLIC does not modify the reference architecture or functionality of the underlying network technology.

SYS-02: The NBLIC architecture is recommended to be compatible with all underlying network technologies. For example, air interface standards (such as global system for mobile communications (GSM), code division multiple access (CDMA), wideband CDMA (WCDMA)/time division-synchronous CDMA (TD-SCDMA), long term evolution (LTE), high rate packet data (HRPD), ultra-wide band (UWB), wireless local area network (WLAN), worldwide interoperability for microwave access (WiMAX), USN) and related transport media (packet data services, short message services (SMS), etc.) are recommended be supported.

SYS-03: The functions introduced by the NBLIC system are recommended to be either hosted in existing function elements of location-based service systems, or in completely new physical entities. The NBLIC system is recommended not to impose any modifications on the reference architecture or functionality of existing positioning technologies.

SYS-04: The NBLIC architecture and specifications are recommended not to prevent the client from choosing different NBLIC service providers.

Appendix I

NBLIC use cases

(This appendix does not form an integral part of this Recommendation.)

The following content describes the possible use cases in the NBLIC system:

I.1 Translation scenarios and procedures

Geographic representation is the demonstration of position, which includes common geographic coordinates of longitude, latitude and elevation, Cartesian coordinates, streets addresses, shop names, postal codes, country codes, Maidenhead locator systems and area codes, etc. The following use cases describe circumstances during which NBLIC services could be employed.

I.1.1 Translation from vague geographic representations to precise ones

In this use case, the subscriber requires location in a more accurate format than what had been previously provided, which means the previous location result does not meet this requirement. As a result, the subscriber's client has to repeat the positioning process and send the new location information to the NBLIC system to ensure everything works smoothly. In other words, the NBLIC works with different positioning systems to provide the best available location information. The following use case describes this circumstance.

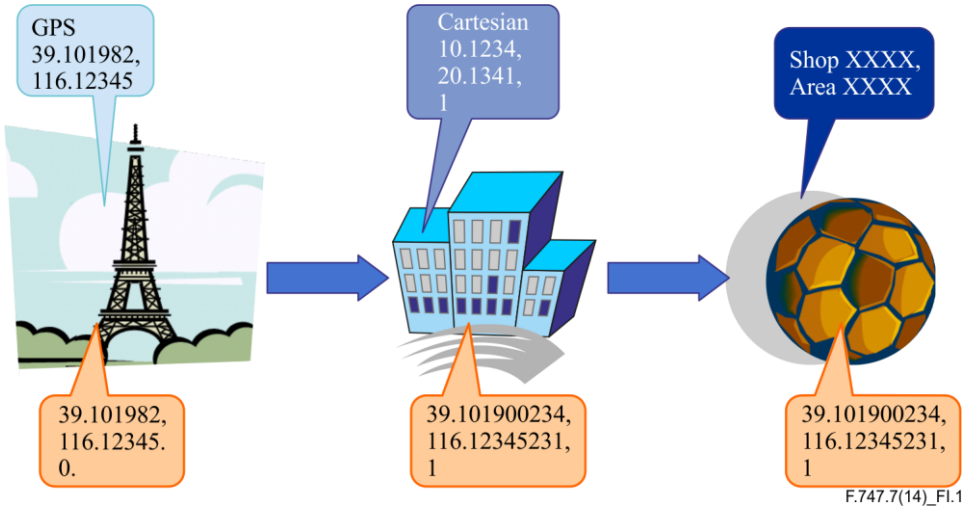

Figure I.1 – Use case for translation from vague geographic representations to precise ones

Figure I.1 illustrates the case that the application requires translation of a vague positioning result to a precise one. A shopping mall application helps customers find the desired goods, and requests the positioning result in the form of longitude, latitude and floor number.

The customer looks for a football in shop A. Before she enters the shopping mall, she drives on the road, and receives longitude 39.101982, latitude 116.123456 from a global positioning system (GPS) device. The NBLIC system translates the location information to 39.101982, 116.12345,0 ("0" here means outdoor), and returns it to the application to help with route-planning. When she enters the shopping mall, the indoor location system provides the location information in Cartesian coordinates, which is 10.1234, 20.1341, 1 (here "1" means indoor, 1st floor). Upon receiving the conversion request, the NBLIC system then translates the positioning result from Cartesian coordinates to the required form of 39.101900234, 116.12345231, 1 (by offsetting from the reference point), to help the application find the customer's position. After entering the shop, it also provides information on the location of the desired goods, and helps the customer find them quickly. The position information of

the goods is usually defined in the terms of "shop A, area AA" by the sensor positioning system in the shop. As a result, the NBLIC system translates this to 39.101900234, 116.12345231, and 1 (according to the index of the shop area location database).

In this use case, the application requires the same format from the different positioning systems. Due to the different accuracy requirements, the NBLIC system is recommended to work together with the applications and the available positioning systems, to obtain a more accurate positioning result, and to provide the most suitable result.

I.1.2 Translation from precise geographic representations to vague ones

In this case, the application requires a rough location representation, which means the previous location result meets the requirement. Consequently, the application does not have to redo the positioning process, and could use the existing results to do the translation and to reply to the application.

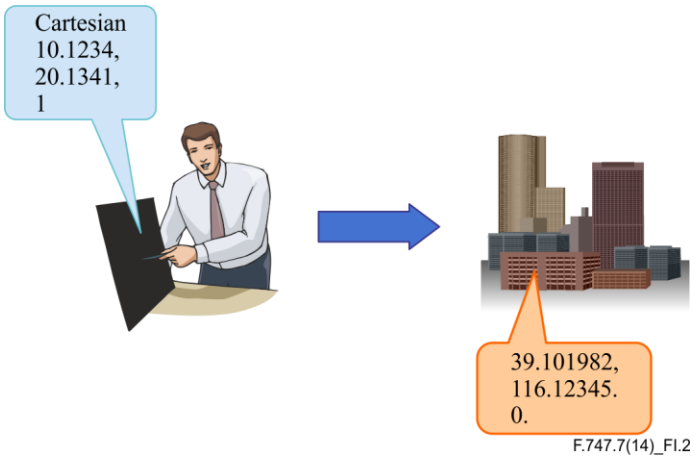

Figure I.2 – Use case of the translation from precise geographic representations to vague ones

Figure I.2 illustrates the use case. A school application is created to help students to find their classroom in the school building, and the other application is to help them to find the suitable cafeteria in the same area. The find-classroom application requires the location information in the form of Cartesian coordinate, while the other application asks for the position result in the form of latitude and longitude.

The school application already receives the positioning result from the school indoor location system in the form of 10.1234 and 20.1341 and floor 1. When receiving the translation request from the second location, the NBLIC system finds the previous positioning result meets the accuracy requirement. It then translates the location information into the requested format of longitude 39.101982, latitude 116.123456 (offset from the reference point), and returns it to the application.

In this case, the different applications require different formats. Since the accuracy of the obtained location information meets the requirement, the NBLIC system simply does the translation, and returns the location information in the required format to the application.

I.1.3 Translation from address representations to geographic representations or vice versa

In this case, the application is required to find the geographic information from the associated address representation, such as a street address. The NBLIC system checks the conversion parameters in the database and does the translation.

The reverse process is to find an associated address representation from the geographic coordinate.

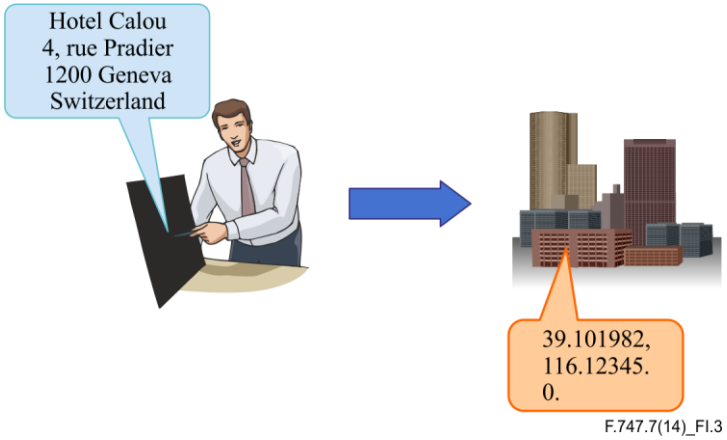

Figure I.3 – Use case of translation from address representations to geographic representations

Figure I.3 illustrates this use case. A navigation application is required to obtain the geographic coordinates of the destination address.

The application sends an address, which is "Hotel Calou, 12 Geneva Switzerland", to the NBLIC system. The NBLIC system checks the database and realizes that the Hotel Calou, is situated on "4, rue Pradier". The length of rue Pradier is 110 m, and it is numbered from 1 to 50. The even-numbered addresses fall on the east side of the road, while the odd-numbered addresses fall on the west side. By checking the database, the NBLIC system realizes that "4, rue Pradier" would be located at the start, on the east side of the street. Therefore, a point would be mapped at that location along the street, perhaps offset a distance to the start of the street, approximate 39.101982, 116.12345 in terms of longitude and latitude.

I.1.4 Translation from digital string representations to geographic representations

In this case, the application needs to find the associated geographic information from digital strings, such as quick response (QR) codes (or near-field communication (NFC) codes). QR codes appearing in magazines or on signs (or NFC tags installed at shops or buildings) may store addresses. A camera phone equipped with a specific application can scan the image of the QR code (or with the help of the NFC reader obtain the information from tags). The code could be linked to a specific location. The application scanning the QR code retrieves the geographic information from the NBLIC system encoded in the QR code, or NFC tag.

Figure I.4 – Use case on digital string representations to geographic representations

Figure I.4 illustrates this use case. The terminal device is equipped with a camera and scans the QR code image. The digital string encoded in the specific QR code is decoded by the application (client) in the terminal device. The application sends the digital string to NBLIC system, then the system checks the database and translates the digital string to geographic information.

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