

A TOURIST LOCATION BASED SERVICE (LBS) FOR THE CAGLIARI CITY

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ABSTRACT:

Location Based Services (LBS) provide information and data to the user based on geographical position. These services are usually based on a communications network and one or more positioning technologies, combined with geographical information systems (GIS) which collect the information and present it to the end user. An LBS service is implemented within an infrastructure which must contain at least these five elements: a mobile device (e.g. a cell phone or PDA), a communications network (GSM, GPRS, UMTS), a positioning component (GPS receiver), a service provider, and lastly a data provider.

On an international level, both the ISO Technical Committee 211 and the Open Geospatial Consortium (OGC) issued standards and specifications regarding the LBS services. ISO/TC 211 handled the LBS standards in the ISO 19132 (Location based services possible standard), 19133 (Location based services tracking and navigation) and 19134 (Multi-modal location based services for routing and navigation) documents, while the OGC did the same with the OGC 05-016 (Open Location Services) specification.

This work concerns the development of a client-server framework compliant with the OpenLS standard, and built entirely with Free and/or Open Source software. The LBS service is a tourist information application for the city of Cagliari in Sardinia. The client application obtains its position from its integrated GPS receiver and sends it to the LBS server. The server (written in the Python programming language) answers with information on interest points near the client. The system's architecture includes a cartography server (using the GeoServer open source software) for sending map data to the client.

For the needs of this work, we implemented a variant of the Reverse Geocoding operation (part of the Location Utility service). Of all the request described in the standard, thus, the server only answers the Reverse Geocode requests.

1. INTRODUCTION

Tourism is an economical sector in constant expansion, also due to technologies allowing the tourists to request specific information in real time, through the Internet, everywhere in the world. Italy, specifically, was the fifth most visited country in 2009, with 44 million tourist, confirming the trend of the previous years.

These data underline the importance of the work that ICT (Information and Communication Technologies) perform in the service of tourists, through several services and applications they can use in the course of their travels.

Among these services we have the Location Based Services (LBS), a category of services which are accessible using a mobile handset and based on the current geographic location of the mobile device.

The geographic location of the device is determined by using a separate positioning service like, for example, the Global Positioning System (GPS).

Given the user's position it is thus possible, by using an LBS, to locate points of touristic interest such as restaurants, shops, hotels, sites of historical-cultural interest; verify the weather and traffic conditions; book tickets for journey or cultural events; calculate routes; or obtain other touristic information.

The first part of this article will present the common features of the LBS services and their different types; the second part will introduce an experimentation performed by the Geomatics research group of the University of Cagliari for the PRIN 2007 National Research Project "Studio e realizzazione di un servizio Location Based Services (LBS) basato sugli standard OGC (Open Geospatial Consortium) e/o ISO/TC 211 con software di

tipo Free e Open Source (FOSS)" (Study and performed Location Based Service (LBS) based on OGC (Open Geospatial Consortium) and/or ISO/TC 211 standard with free and open source software).

The LBS service prototype thus developed is able to provide touristic information, in real-time, about sites of historical-cultural-architectural interest in the city of Cagliari based on the user's position. The application was developed entirely with free and open source software.

2. LBS SERVICES

2.1 Characteristics

An LBS service is implemented as part of an architecture including at least these five components: a mobile device (e. g. a smartphone or PDA), a communication network, a positioning component (e. g. a GPS receiver), a services and applications provider, and a data provider. (Fig. 1)

The mobile device is used by the user for requesting data. It can be a cell phone, a PDA, a notebook PC, or even a car navigation unit. It can be placed in one of two categories: single-purpose and multi-purpose devices. The first includes devices which are built for a specific purpose and cannot achieve any other. The second includes devices that can also be used for purposes other than LBS, such as cell phones, PDAs etc.

For transfer the user's requests from the mobile device to the service provider and the latter's response back to the former, the communication network is used.

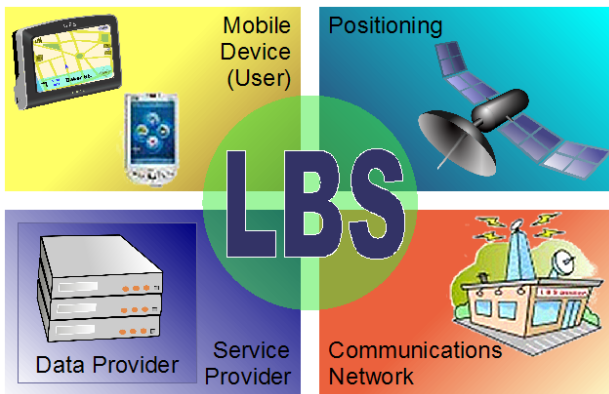


Figure 1: LBS infrastructure

The network may be a Wireless Wide Area Network (WWAN) such as e. g. the GSM and UMTS networks, a Wireless Local Area Network (WLAN) such as IEEE 802.11 or a Wireless Personal Area Network (WPAN) such as Bluetooth.

The positioning component is used for locating the mobile device. The user's position can be obtained through the mobile communications network (e. g. by cell triangulation), or through a GPS receiver. If the user's position is not automatically determined by a positioning component, it must be manually send by the user. His location will then be identified by his address (street name, street number, town), by his postal code or other.

The services and applications provider is the component which offers the LBS application itself to the users. It is responsible of all the application data processing; it can own the database or it can use the DB of an external Data Provider. The types of data involved in an LBS application are both geographical data (maps, georeferenced satellite images, digital terrain models, etc.) and traditional databases (yellow pages, touristic information, weather forecasts, hotel and restaurant guides, etc.).

2.2 LBS types

Currently on the market there are many categories of LBS different for features and functionality. The figure 2 shows a scheme of the LBS services.

The navigation services are characterized by the presence of a mobile user, and are aimed at answering requests concerning indications of particular directions and/or routes, for route optimization, or to avoid delays. Among these services we may distinguish those called "In vehicle guidance" and "Pedestrian guidance". In the first case, the user moves on the vehicle, in the second case he moves on foot.

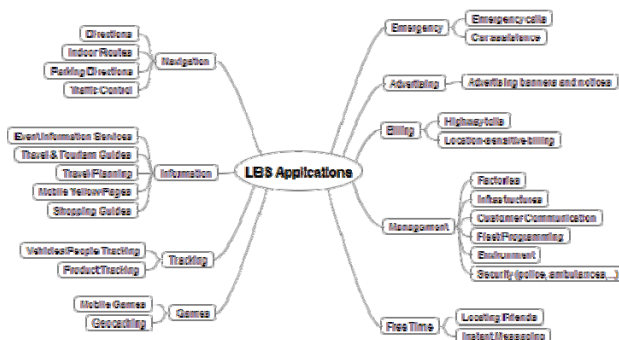


Figure 2: Types of LBS services

The general navigation services answer the question "where is that service or object more close to my position?". The yellow page services, the tourist information services (map, search of museum or tourist site, etc) and general utility services as for example those providing local meteorological information or the traffic condition belong to this category.

Emergency services are able to localize the citizens using them in case of accident, when lost at sea or mountain or in the case of old persons in difficulty. In this service types the most important features are the location and its precision. Regarding this, many states are imposing standards to the emergency services relatively to response time and service localization precisions (in the USA the E911 service has already issued its directives).

The tracking and management services were born to manage paths and activities of moving persons or items (express courier, taxi service, freight). Also the relief activity in case of emergency is one of the possible application for this category.

The billing services are applications used as charging methods on a geographic base like, for example, the payment of bus tickets in function of the effective route made by the user.

At last we have, the community services, that ensure the contact of the user and their family environment and community. Examples of this kind of service may be: *People finding* (es. "find the friend", "where is my son?"); *location-based chat*; *location-based games*.

2.3 The LBS standards

At the international level both ISO/TC 211 and the Open Geospatial Consortium (OGC) issued guidance and standards for the LBS services. The ISO/TC 211 took interest in the LBS standard with the documents 19132 (Location based services possible standard), 19133 (Location based services tracking and navigation) and 19134 (Multimodal location based services for routing and navigation), while the OGC has dealt with the LBS by issuing the OpenLS¹ standard. The OpenLS standard defines the base services, the ways to access to them, and the abstract data types that together compound the structure for an open service platform, the so-called *GeoMobility Server*. The server works as a application server, answering to the service request. It should be noted that the request can arrive to the GeoMobility Server from a mobile user, from an Internet user or from another application server. The base services defined in the 1.1 OpenLS specific are divided in five types:

- **Directory Service** (Spatial Yellow Pages): this service provides to the members an Internet directory where to find one specific location, product or service (or the closest one).

- **Gateway Service:** this is the interface between the GeoMobility Server and the Location Server from the Positioning Service. It is useful for requiring the current position with different modes (es. single or multiple terminal, periodic or immediate position).

- **Location Utility Service** (Geocode / Reverse Geocode): this service carries out a "geocoding" operation, determining a geographic location given an address, name of place, or postal code. The service can determine one complete address (or postal code, or name of place) according to a geographical position.

¹ <http://www.opengeospatial.org/standards/ols>

- Example 1: give one address, find a position.
- Example 2: drive up to an address.
- Example 3: give one position, find the address.
- Example 4: “where am I?”

- **Presentation Service:** this service converts the geographic information in a representation for displaying on the mobile terminal. An OpenLS application may call this service in order to get the map of the area of interest, with or without overlaying the streets geometry, points of interest, areas of interest, localization, position, and/or address.

- Example 1: The user wants to see where his house is on the map.
- Example 2: Planning a travel with his family, the user wants to see how to arrive from his home, in a particular city, to the hotel booked in another city.

- **Route Service:** this service calculates a route for the user. The applicant has to indicate the start point (usually the position given by Gateway Service, but it can be also a specific position, for example their home for the travel planning) and the destination (any location, as for example a place whose he knows only the telephone number or address, or a place found by researching in a Directory Service). Optionally, the user can specify the intermediate points, the favorite route type (faster, shorter, lesser traffic, more panoramic, ecc), and the favorite transportation mode. The information returned may be textual (with the description of turns and distances) or geometric (displayable on the map).

These services are just the OpenLS base services, it is always possible to implement additional services.

3. THE INFO-TURISTIC LBS APPLICATION

The service implemented by the Geomatics team of the University of Cagliari can simulate an info-touristic service on the Cagliari historic center sites of architectural-cultural-historical interest.

Infrastructure and applications consist of:

- a mobile device with GPS receiver and Internet network access. In particular the S8000 Jet smartphone, produced and marketed by South Korean Samsung was chosen.
- a client software for the mobile device
- a LBS server
- a WMS server
- a DB for the developed LBS application data.

In this system, the client communicates both with the LBS server (from which it receives the information concerning the closest point of interest) and with WMS service (to which it requests the map).

The whole application was developed with Free and/or Open Source software and compliant to the OpenLS standard for LBS services.

In particular, for the client software we used the gvSIG Mini open source software developed by Prodevelop, the LBS server

was developed in Python language, and the WMS server was implemented in GeoServer.

In the application we developed, the client requires to the server the informations concerning the closest point of interest. In OpenLS terms this means to make a *ReverseGeocode*² operation. This operation is structured in order to return to the user a single information, for example the street address corresponding to the location of the mobile device. This information can be provided either in “structured form” (*StructuredAddress* element) or in “free form” (*FreeFormAddress*³ element); in the last case it is a string of text where needed tourist information can be include.

Then, the server answers to the *ReverseGeocodeRequest* message. The parameters are indicated in the table 1.

Name	Mandatory?	Data Type	Description
Position	Y	Position ADT	The starting position (lat, long) for the Reverse Geocoder.
ReverseGeocodePreference	N	ReverseGeocodePreferenceType	Describes the preference for the response from the Reverse Geocoder Service: StreetAddress, IntersectionAddresses, or PositionOfInterest (Place and/or PostalCode). If not specified, then the service will return the nearest StreetAddress.

Table 1:OpenLS 1.2, par. 8.3.2.2 “Reverse Geocode service: Primary ReverseGeocodeRequestParameters”, pag. 22.

A more detailed description of the service implementation is made in the following paragraphs.

² OpenLS 1.2, par. 8.3.2.2 “Reverse Geocode Service”, pag. 22.

³ OpenLS 1.2, Annex A.1: OpenGIS Location Services (OpenLS) Core Services Schema, XML/S Profile (Normative), ADT.xsd, pag. 59.

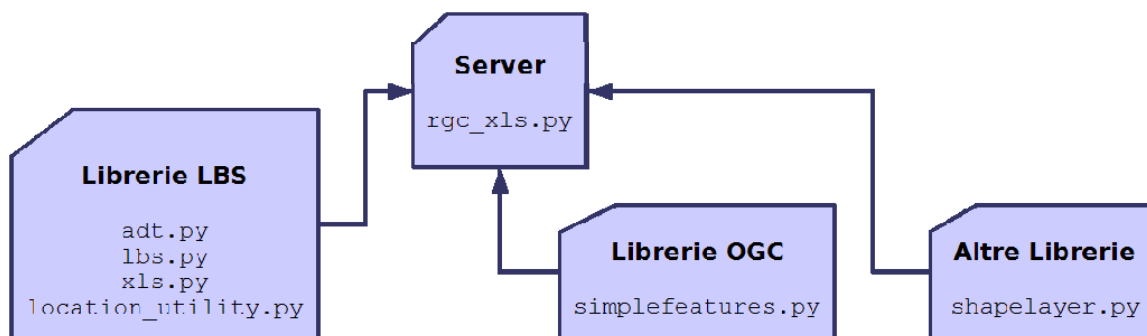


Figure 3: Scheme of the LBS server

3.1 The LBS Server

The server was developed in the Python⁴ programming language, build on several modules those the research unit had developed for other projects. Among these, the shapelayer library was used for reading the database of the points of interest (ESRI Shapefile format), while simplefeatures implements part of the “Simple Features Specification⁵” OGC standard, and also defines a Locator class which can execute simple spatial queries (proximity and inclusion). These two modules are independent from each other, and communicate by using the “Python Geo Interface⁶” protocol.

The adt.py module contains, among all those defined in the specification⁷, the Abstract Data Types required for the ReverseGeocode operation.

The lbs.py module contains classes and constants common to the entire LBS librari, for example the exception classes and the XML namespaces.

- Location
 - Address
 - AreaOfInterest
 - BoundingBoxOfInterest
 - CircleOfInterest
 - PolygonOfInterest
 - PointOfInterest
 - Position

Figure 4: Hierarchy of the classes in the `adt.py` module

The xls.py module contains the classes for interpreting the request messages and building the response messages in XLS,

the XML format used in OpenLS for client-server communications.

Lastly, the location_utility.py module implements the Location Utility Service, for the part concerning the Reverse Geocoding operation.

The server, named `rgc_xls.py` (from “Reverse GeoCode”), is a Web Application following the WSGI (Web Server Gateway Interface⁸) standard, which allows to use several compatible Python application servers. In this case we used the `wsgiref` (reference implementation of a WSGI server) module of the Python standard library.

The program starts by loading into memory the points of interest as a Feature Collection, and constructing a Locator object (defined in `simplefeatures.py`) associated to them. Then it passes control to the WSGI server, which awaits for requests. When a `ReverseGeocodeRequest` is received, it is interpreted for extracting the GPS position. The Locator object selects from the Feature Collection the points of interest which are nearer than a predefined search radius to the given position. For each point of interest, a `FreeFormAddress` object is constructed and initialized with its attributes. The address objects are then encapsulated in the `ReverseGeocodeResponse` which is sent to the client.

3.2 The LBS Client

The client software is based on the open source GIS `gvSIG`⁹, developed by the Generalitat Valenciana with the contribution of the European Union. `gvSIG` is written in the Java programming language, which allows it to run on different operating systems and even different device architectures, as long as they have a compatible Java Virtual Machine (JVM). It is distributed in two “official” versions: for PCs and for mobile devices with a JVM following the CDC¹⁰ (Connected Device Configuration) platform. There is also a “customized” version, named `gvSIG Mini`¹¹ and developed by Prodevelop, for CLDC¹² (Connected Limited Device Configuration) devices; most PDAs and smartphones are CLDC devices.

4 <http://www.python.org/>

5 <http://www.opengeospatial.org/standards/sfa>

6 <http://trac.gispython.org/lab/wiki/PythonGeoInterface>

7 OpenLS 1.2, Annex A.1: OpenGIS Location Services (OpenLS) Core Services Schema, XML/S Profile (Normative), *ADT.xsd*.

8 <http://www.python.org/dev/peps/pep-0333/>

9 <http://www.gvsig.gva.es/eng/inicio-gvsig/>

10 <http://java.sun.com/javame/technology/cdc/>

11 <https://confluence.prodevelop.es/display/GVMN/Home>

12 <http://java.sun.com/javame/technology/cldc.jsp>

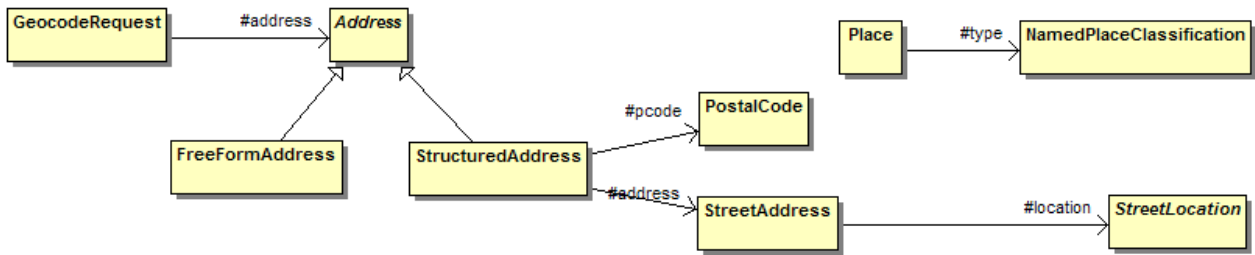


Figure 5: libOpenLS_mini: classes implementing the data types

Although the CDC devices are by definition more powerful than CLDC ones, they usually don't come with a pre-installed JVM, and there is no standard JVM for this platform: the choice is between J9 (by IBM) and PhoneME (open source). But these two JVMs are not fully compatible with each other; thus, software test on the CDC platform requires at least two test devices, one for each JVM. On the other hand, CLDC devices usually have a pre-installed JVM; also, most "smartphone" class devices (the kind of devices the prospective users would probably own) fall in this category. For these reasons, we decided to develop the client for the CLDC platform and to integrate it in gvSIG Mini.

Since gvSIG Mini is developed for the Java ME (Micro Edition) platform, the client was written in the Java language. The development environment (IDE) was NetBeans by Sun (now Oracle), specifically the versions 6.7 and 6.8, since the gvSIG Mini sources and their dependencies are distributed with a pre-configured NetBeans project.

The first step was to develop a Java ME library, independent

from both gvSIG and the hardware platform, to manage the communication with the LBS server following the OpenLS standard. This library was named libOpenLS_mini and may be divided in two parts: one implementing the OpenLS data types related to addresses and their representation, the other managing the XLS format and the communications with the server. The library is completed by some support classes, including the hierarchy of exceptions. Figures 3 and 4 show the UML diagrams containing the most important classes.

The LBS functionalities were added to gvSIG by deriving some of the core classes, and placing the calls to libOpenLS_mini objects and functions inside the derived classes. This was done because, unlike both the PC and Mobile versions of gvSIG, gvSIG Mini was developed as a single "monolithic" application instead of having a "plug-in" based architecture – which would make implementing extensions easier, but also increase the complexity and memory requirements (which must be kept lower on a CLDC device). Despite this, some gvSIG Mini classes, not intended for derivation, kept some members "private" in order to prevent the derived classes from accessing

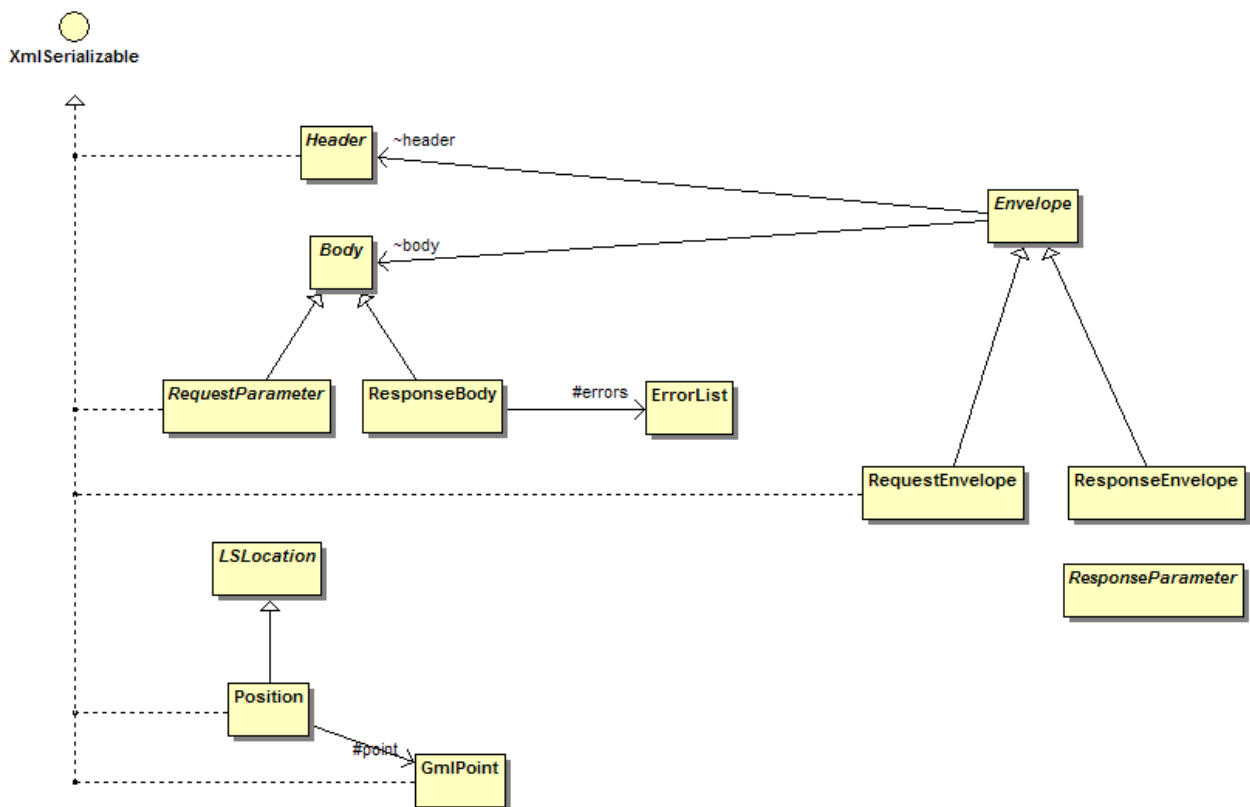


Figure 6: libOpenLS_mini: classes related to the XLS representation

them; it was thus necessary to modify these members by giving them “protected” access.

3.3 Database and Cartography

Cartography used in the Web Map Service is the 1:1000 scale

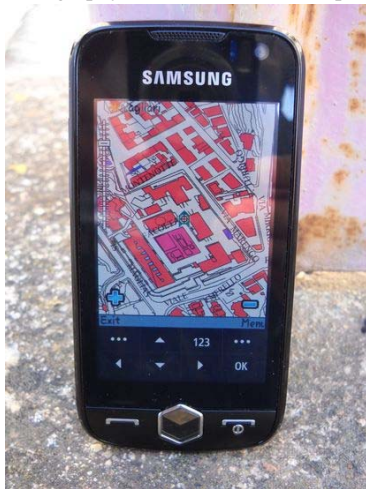


Figure 7: The client displaying the map from WMS

cartography of the city of Cagliari in Shapefile format. Originally in the Roma40 national reference system, it was converted to geographic coordinates in the ETRF89 reference system.

The associated database contains all the information deemed useful for an info-touristic LBS. In particular, the sites of historical-cultural-architectural importance have been selected, and for each of them the following data were

collected:

- Name
- Short description
- URL of a picture
- URL of a Web site of interest
- Address
- Visiting hours
- Ticket price

The map of the area of interest was added to the WMS service, in order to be used as a background layer in the client. The WMS server user was the open source GeoServer, running on the department’s Web server; gvSIG mini was configured to use this data source.

Figures 7, 8 and 9 show some moments of the use of the client. In particular, Figure 7 shows the client displaying the map obtained via WMS; Figure 8 a point of interest, nearer than the search radius; and Figure 9 the information window displayed when the user selects a point of interest.



Figure 8: The client displaying a point of interest

4. CONCLUSIONS

The LBS service developed by the research group of the University of Cagliari is currently available only for obtaining information on sites of touristic interest which a user encounters

while moving through the city. The research group is currently implementing new functions; in particular, it is now studying the Route Service in order to calculate the route from the user’s current location to a requested point of interest.



Figure 9: information concerning a point of interest

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