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A comprehensive study of mapping services in China

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Abstract: The mapping services have been widely used in our daily lives. People can use the services to find their nearest POI (Point of Interests), the shortest travel route from a source location to a destination location, and even life services like booking hotels, calling taxis and so on. Consequently, more and more mapping service providers have emerged in the past years in China, like Baidu Maps, Amap, Sogou Maps, Tencent Maps, Google Maps and Bing Maps. However, there is no existing study on how to select the suitable one for users/developers when they facing so many different mapping service providers. In this paper, we make thorough comparisons and experiments on mobile APPs and Web APIs of the six mapping service providers in China, and present the most three popular native mapping APIs, i.e., Baidu Maps API, Amap API and Sogou Maps API, to give readers a valuable guider for selecting their suitable mapping services.

Key words: mapping services; maps APP; mapping API; comprehensive study; Baidu Maps

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国内网络地图服务比较分析研究

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摘要: 网络地图服务已被广泛应用于日常生活中, 人们使用这些服务来进行定位, 查询最短路线, 甚至预订酒店、打车等. 因此, 过去几年国内也随之出现了越来越多的地图服务提供商, 如百度地图、高德地图、搜狗地图、腾讯地图、谷歌地图以及必应地图等. 然而, 面对如此繁多的网络地图服务, 国内目前还没有关于针对用户和开发人员如何选择合适地图服务的研究成果, 而国外在这方面已有不少相关工作. 鉴于此, 本论文针对六个主流移动地图APP和网络API展开全面的功能和性能对比, 并总结性分析了国内最受青睐的三种地图API, 即百度地图API, 高德地图API和搜狗地图API. 为读者在选择合适的地图服务时提供有价值的参考.

关键词: 地图服务; 地图 APP; 地图 API; 分析研究; 百度地图

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0 Introduction

With the development and ubiquity of GPS-enabled equipments and wireless Internet access, the mapping service becomes more and more popular and important in our daily lives. This is because a user can easily find their nearby POIs (Point of Interests), the shortest route from a source location to a destination location, the public transportation stations and routes, and other life services (e.g., booking hotels, calling taxis, searching Groupons) with the help of mapping services.

Based on the “Report on Mobile Map Marketing in China” in the first half of 2014 published by iiMedia Research on July 18, 2014^[1], the number of mobile users in China was 448 million in 2014Q1 and it reached to 472 million in 2014Q2. According to the data released by Analysys^[2], it is expected that the number of mobile map users in China will be 457 million, 28.7% increased in 2016 compared with 2015, and mobile mapping services will cover 642 million users by 2018 (see Fig. 1). This is because the mapping service not only provides basic functions, like map browsing, POI search, navigation, and so on, but also provides many other useful life services, such as hotel booking and taxi services, which prompts the rapid growth of the mobile map users.

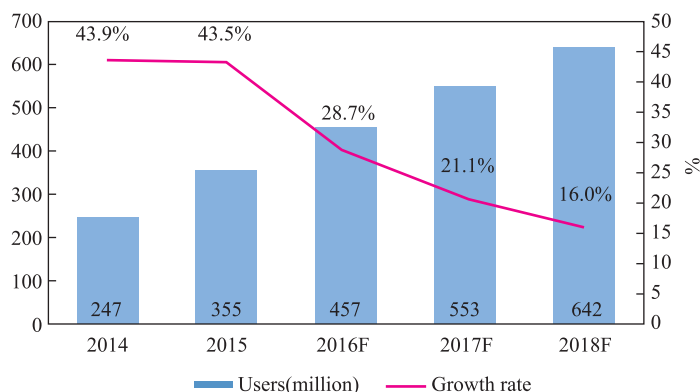


Fig. 1 The number of mobile map users and growth rate in China (from Analysys)

Currently, the most popular mapping service providers in China are Baidu Maps, Amap (also known as Gaode Maps), Sogou Maps, Google Maps, Bing Maps and Tencent Maps. Analysys recently released another report on mobile map market of the fourth quarter of 2015 in China^[3]. It shows that Baidu Maps ranks the first with 70.8% market share in active users, Amap ranks the second with 23.7% market share, and Sogou Maps ranks the third with 5.8% market share. Besides the coverage rate of active users, the number of service start-up and the using time are another two crucial metrics. According to the report, among those mapping service providers, Baidu Maps still ranks the first with 66.2% market share in service start-up, followed by Amap and Sogou Maps, which own 22.4% and 3.2% respectively. Furthermore, Baidu Maps is also in the leading position in terms of the service using time as high as 64.4%. Amap and Sogou Map possess 23.3% and 3.3%, respectively. Even though Google Maps and Bing Maps are very popular in English-speaking countries (especially in U.S.), they are not that famous in China (as shown in Section 3.2). This is because they do not have sufficient

map data as local mapping service providers, and provide very limited life services. Even for native Baidu Maps, Amap, Sogou Maps, and Tencent Maps in China, they may have different types of users. For example, Amap is famous for its accuracy and good route suggestions, so it is widely used in navigation area; while Tencent Maps is famous for its street views, so it is very attractive for travelers. Therefore, it is necessary to do a study on how to select suitable mapping services.

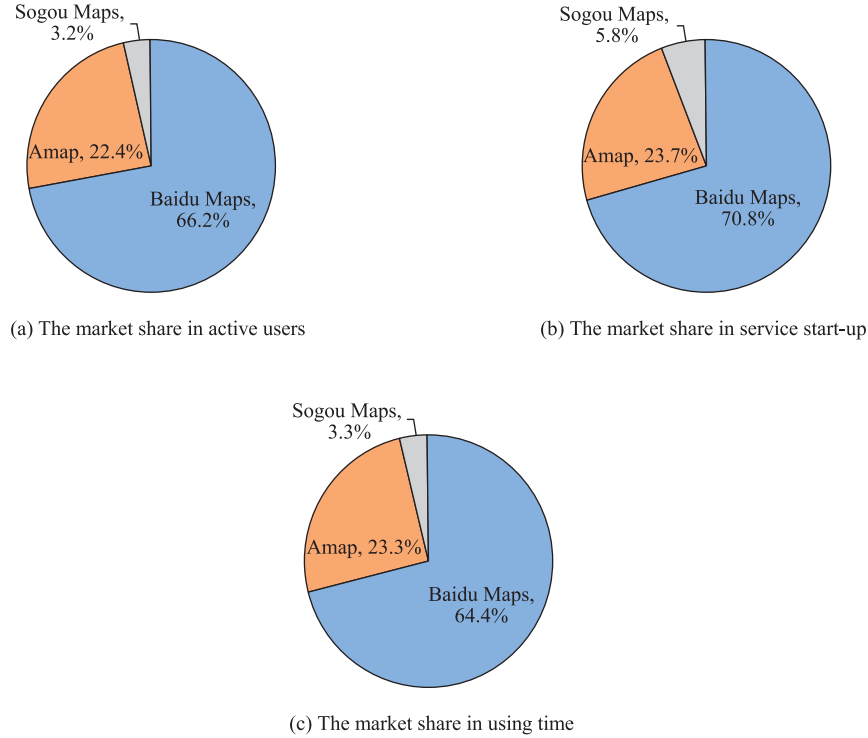


Fig. 2 The market shares of Baidu Maps, Amap, Sogou Maps in China (from Analysys)

In this paper, we study how to select right mapping services for users, especially for developers who want to build applications or web sites based on mapping APIs. We first make comparisons on six popular Maps APPs, including Baidu Maps, Amap, Sogou Maps, Tencent Maps, Google Maps and Bing Maps. Then, we focus on mapping API comparisons with comprehensive experiments and analysis. In the end, we introduce and summarize the most three popular mapping APIs in China, i.e., Baidu Maps API, Amap API and Sogou Maps API, to give readers (especially developers) a valuable guider for selecting their suitable mapping services.

The remainder of this paper is organized as follows. Section 1 highlights related work. Section 2 describes Maps APP comparisons. Section 3 gives comprehensive comparisons of Maps APIs. In Section 4, we introduce three popular native mapping APIs in China. Finally, Section 5 concludes this paper.

1 Related Work

Mapping services are not only very useful and popular in our daily lives, but also very important in industrial and academic. Typical example using mapping services is spatial (or GIS/mapping) mashup. A spatial (or GIS/mapping) mashup^[4-9] provides a cost-effective way for a Web or mobile application that combines data, representation, and/or functionality from at least one mapping service and other local/external services to create a new application.

In [4-6], the authors proposed k -NN query processing algorithms based on spatial mashups, where the distance metric (i.e., travel time) is retrieved from mapping services. Since accessing travel time from mapping services is much more expensive than accessing data from local databases^[10], grouping^[4-5], direction sharing^[5], shared query execution^[4-5], pruning techniques^[4-6], and parallel requesting^[6] are employed to reduce the number of external requests to mapping services and provide highly accurate query answers. In [9], route logs are employed to derive tight lower/upper bounding travel times to reduce the number of external Web mapping requests for answering range and k -NN queries. In [7-8], the authors focused on shortest travel time path queries for location based services (LBS), where the shortest travel time path information retrieved from mapping services as LBS providers may lack of real-time traffic information to compute them. They utilize waypoints in an external route request to reduce the number of such expensive requests to mapping services. In [11], the authors proposed a cache to store path information retrieved from mapping services to reduce those external path requests and also reduce the query response time to users.

Therefore, we can see there are a large number of applications or research works based on mapping services. Based on the latest statistics of Programmable Web^[12], the mapping (or spatial) mashup is the most popular one among all types of mashups including search mashups, social mashups, etc. Typical mapping services in China are Baidu Maps, Amap, Sogou Maps, Google Maps, and Microsoft Bing Maps. Even though mapping mashup is the most popular type and more and more applications and Web sites have emerged out, there is no existing work on giving a comparison or summarization of mapping services in China. On the contrary, there exists several works on comparing popular mapping services in U.S., such as Google Maps, Apple Maps, Bing Maps, MapQuest Maps, etc. For example, the authors in [13] gave a thorough comparison in the aspect of the user experience of current popular mapping services, including maps in landscape, portrait, different zoom levels, navigation/directions mode and so on. Particularly, they discussed static presentation consistency issues^[14] and dynamic presentation consistency issues^[15] in smartphone mapping applications, respectively, which serve as a mobile map application design guider for developers and researchers.

Since all of those research work^[13-15] are focus on non-Chinese mapping services, e.g., Google Maps, Bing Maps, and MapQuest Maps, which are not widely used in China. In our previous work (i.e., the conference version paper)^[17], we design a questionnaire and analyze the results, and then briefly introduce the three popular mapping APIs in China. In this paper, we mainly focus on the comparisons and analysis of the popular Maps APPs and APIs.

2 Maps APP Comparison and experimental results

In this section, we conduct a thorough comparison about mobile Maps APP, including Baidu Maps, Amap, Sogou Maps, Tencent Maps and Bing Maps, with respect to the widely

used mapping services (Section 2.1) and service response time (Section 2.2).

2.1 The services provided by Maps APP

This section summarizes the most common services (including POI service, different kinds of route search, traffic display, satellite view, and so on) that provided by the six mobile Maps APP. As shown in Table 1, except for Bing Maps, all of the other mapping service provider support iOS and Android system in China. Baidu Maps APP provides all kinds of the list services for its sufficient map data and advanced technology. Even though Amap is very popular in phone navigation scenario, it does not support 3D map view and street view image. Despite that Sogou Maps and Tencent Maps are not as well known as Baidu Maps and Amap, their APPs still provide sufficient mapping services. However, Google Maps APP does not provide enough services in China as it provides in other countries, e.g., street view image.

2.2 The service response time provided by Maps APP

A set of experiment was conducted to test the service response time provided the six Maps APPs in this section. iPhone 5s is utilized as the testing device, and each Maps APP has been tested with respect to the APP first loading time, POI search response time, route search response time and zoom in/out response time, as shown in Table 2. From the result, we can see Baidu Maps and Amap APPs are much fast than Sogou Maps and Tencent Maps APPs. Please note that even we can download Google Maps APP from application stores, but it has no response at all when we try to conduct a POI/route search based on our experiments. The reason for this is that probably the servers of Google Maps are not in mainland of China. Therefore, we suggest that it would be better for users to choose the Chinese native mapping service providers, like Baidu Maps, Amap, Sogou Maps and Tencent Maps, instead of foreign ones for their unstable services.

Tab.1 Services provided by Maps APP (last checked: April 21, 2017)

	Baidu Maps	Amap	Sogou Maps	Tencent Maps	Google Maps	Bing Maps
iOS support	✓	✓	✓	✓	✓	×
Android support	✓	✓	✓	✓	✓	×
POI search	✓	✓	✓	✓	✓	×
Driving	✓	✓	✓	✓	✓	×
Route search Public transit	✓	✓	✓	✓	✓	×
Bicycling	✓	✓	×	✓	✓	×
Walking	✓	✓	✓	✓	✓	×
Zoom in/out	✓	✓	✓	✓	✓	×
Traffic display	✓	✓	✓	✓	✓	×
Satellite view	✓	✓	✓	✓	✓	×
3D map view	✓	×	✓	✓	×	×
Street view image	✓	×	×	✓	×	×
Voice support	✓	✓	✓	✓	✓	×
Offline Maps download	✓	✓	✓	✓	✓	×
Personal setting	✓	✓	✓	✓	✓	×
Report (e.g., traffic, wrong POI)	✓	✓	✓	×	×	×

Tab.2 Service response time provided by Maps APP

	APP loading time (first time)/s	POI search response time/s	Route search response time/s	Zoom in/out response time/s
Baidu Maps	5.2	2.8	3.3	0.5
Amap	7.5	2.2	2.3	0.7
Sogou Maps	9.9	3.6	3.9	2.5
Tencent Maps	9.4	8.7	4.5	1.6
Google Maps	N/A	N/A	N/A	N/A
Bing Maps	N/A	N/A	N/A	N/A

3 Maps API Comparison and experimental results

In this section, we first summarize the situation of common Maps APIs supported by current popular mapping services; then, we conduct a set of experiment to show the Maps loading and API response time of those selected mapping services.

3.1 Maps API comparisons

Table 3 summarizes common Maps APIs of the most popular mapping services which are available in China. From the comparison results, we can see Baidu Maps provides all of the common Maps APIs, which ranks the first. Tencent Maps, Google Maps and Bing Maps rank the second. Sogou Maps ranks the last, i.e., only supports five Maps APIs. Please note that Street View Image API of Google Maps is not available in China, even though it is very popular in a lot of other countries.

From the result, we also can see that all of the mapping services provide JavaScript API, Static Maps API, Places API, Geocoding API, and Directions API. However, only two and three mapping services provide Street View Image API and Distance Matrix API, respectively. This is because to provide Street View Image API needs high deployment cost, and to provide Distance Matrix API needs high computation cost.

Tab.3 Maps API comparisons (last checked: April 16, 2017)

	Baidu Maps	Amap	Sogou Maps	Tencent Maps	Google Maps	Bing Maps
JavaScript API ¹	✓	✓	✓	✓	✓	✓
Static Maps API ²	✓	✓	✓	✓	✓	✓
Street View Image API ³	✓	×	×	✓	×	×
Android SDK ⁴	✓	✓	×	✓	✓	✓
iOS SDK ⁵	✓	✓	×	✓	✓	✓
Places API ⁶	✓	✓	✓	✓	✓	✓
Geocoding API ⁷	✓	✓	✓	✓	✓	✓
Directions API ⁸	✓	✓	✓	✓	✓	✓
Distance Matrix API ⁹	✓	×	×	×	✓	✓

1. **JavaScript API:** let you embed a dynamic Maps image on your web page with the technology of Javascript, CSS and HTML.
2. **Static Maps API:** let you embed a Maps image on your web page without requiring JavaScript or any dynamic page loading
3. **Street View Image API:** let you embed a static (non-interactive) street view panorama or thumbnail into your web page.

4. **Android SDK:** let you embed Maps into you native Android app.
5. **iOS SDK:** let you embed Maps into you native iOS app.
6. **Places API:** make your app or web stand out with detailed information about POI places across a wide range of categories.
7. **Geocoding API:** convert addresses into geographic coordinates (like latitude and longitude), and convert geographic coordinates into addresses.
8. **Directions API:** calculate directions (the shortest route) between locations based on a certain mode, e.g., driving, walking, and cycling.
9. **Distance Matrix API:** provide travel distance and time for a matrix of origins and destinations, based on the recommended route between start and end points.

3.2 Maps loading and API response time

In this section, we conduct a set of experiment to compare Maps loading time and common API response time of the selected mapping services, as shown in Table 4. In general, we can see that Baidu Maps not only provides all kinds of Maps APIs, but also have the least loading and response time in average compared with the others. However, different mapping services may have different advantages. For example, Sogou Maps has the least web loading time, even though it provides the least number of Maps API. It would be suitable to utilize Sogou Maps for a web application if it wants to provide fast mapping display for its users. Therefore, developers can select the suitable mapping services based on their application requirements.

Tab. 4 Maps loading and API response time

	Web loading time/s	Android Web loading time/s	iOS Web loading time/s	Places API response time/s
Baidu Maps	1.2	1.84	1.66	0.38
Amap	1.83	2.11	1.7	0.92
Sogou Maps	0.59	N/A	N/A	0.86
Tencent Maps	2.17	2.48	2.6	0.77
Google Maps	0.92	1.88	1.93	0.43
Bing Maps	0.88	1.64	1.52	0.32
	Geocoding API response time/s	Distance API response time/s	Directions Matrix API response time/s	
Baidu Maps	0.46	0.54	2.52	
Amap	1.03	0.76	N/A	
Sogou Maps	0.73	0.79	N/A	
Tencent Maps	0.95	0.85	N/A	
Google Maps	0.58	0.39	2.58	
Bing Maps	0.49	0.47	2.1	

4 Popular mapping APIs

4.1 Baidu Maps API

Baidu Maps is a desktop and mobile web mapping service application and technology provided by Baidu, offering satellite imagery, street maps, street view and indoor view perspectives, as well as functions such as a route planner for traveling by foot, car, or with public transportation. Android and iOS applications are available.

On April 23th 2010, Baidu Maps officially announced to open mapping API, which is free for majority of developers. Baidu mapping API is a set of application interface based on Baidu Maps services freely for developers, including JavaScript API, Web Service API, Android SDK, iOS SDK, Positioning SDK, Internet of Vehicles API, LBS Cloud and many other development tools and services. It provides basic functions of the map, such as display, search, positioning, reverse-geocoding, geocoding, routing, LBS cloud storage and retrieval. It is suitable for PC client, mobile client, servers and other equipment and it is also the map application development under multiple operating systems. Table 5 shows all of the types of Baidu Maps API, developers can choose the right APIs based on their applications. What is more, Baidu Maps APIs also have the maximum access times and access frequency to avoid abuse as shown in Table 6.

Tab.5 Types of Baidu Maps API

Web development	Common JavaScript API
	JavaScript API high-speed edition
	Web component API
Android development	Android map SDK
	Android location SDK
	Android navigation SDK
	Android panorama SDK
iOS development	iOS Map SDK
	iOS navigation SDK
	iOS panorama SDK
Service API	LBS Cloud
	Web Service API
	Static imagery API
	Panoramic static API
	Internet of vehicles API
	URI API
	Bird's Eye
Tool support	API console
	LBS cloud visualization controller
	Coordinate collection
	Map generator
	Map card
	Groupon plug-in
	Zero-cost switching tool
	Map editing tools
	Development sources

4.2 Amap API

Amap is the China's leading provider that devotes itself to digital map contents, navigation and location-based solutions. The company entered the global excellent market of NASDAQ in America. Amap possesses the three class-A qualifications whose high-quality electronic map database has become its core competitiveness. The three class-A qualifications are surveying and mapping qualification of Navigating Electronic Map qualification class-A qualification, mapping aerial photography qualification class-A qualification and Internet mapping service class-A qualification.

The LBS open platform of Amap is subordinated to the Alibaba, which is a leading e-commerce company in China (even in the world). In October 2013, Amap cooperated with Ali Cloud to issue the LBS cloud strategy together. Amap LBS cloud platform has already connected with the Ali cloud platform. Since Amap has been the first batch of Internet Service

Provider to provide mapping API, it nearly has 10 years of LBS technology experience. In addition, Amap LBS open platform owns more than 300,000 developers and partners and its services are called by over 10,000 applications every day.

More specifically, the types and applicability of Amap API are summarized in Table 7 and Table 8, respectively.

Tab. 6 Applicability of Baidu Maps API

Applicability	Coverage
Browser	IE 6. 0+, Firefox 3. 0+, Opera 9. 0+, Safari 3. 0+, Chrome
Operating System	Windows, Mac, Linux
Facility Type	PC, mobile phones and other mobile clients
Calling Mode	Online calling
	Place API and Place suggestion API 100 000 times/day/KEY
	Direction API 100 000 times/day/KEY
	Geocoding API 100 000 times/day
	Coordinate conversion API no access limit
Access Times and Access Frequency	The number of concurrent users: 1 000–1 500 times/sec to calculate according to the initial JS per second
	Search services: 800 times/sec
	Bus, car service: 600 times/sec
	Geocoding performance: 200 times/sec
	Bandwidth limit: full support for services (due to the small amount of API data)
	Coordinate conversion interface: single IP 50 times/sec (if more than 100 times, returning back to 403 error)
	Static imagery: independent IP 10/sec.

Tab. 7 Types of Amap API

	JavaScript API
	Nephogram API
	Map component
	Static mapping API
	URI API
	Easy map website building
	Android SDK
	Android nephogram SDK
	Android navigation SDK
	Android street view SDK
	Android location SDK
	iOS SDK
	iOS navigation SDK
	iOS nephogram SDK
	Coordinate collection
	Quick map generator
	Map card
	Vector web maps
	Indoor maps
	iOS street view
	Windows phone SDK

4.3 Sogou Maps API

Compared with the powerful API of Baidu Maps and Amap, Sogou Maps only provide

JavaScript API. It makes users to construct map applications with simple operation and abundant functions on their own websites. There are various interfaces that have basic functions for map-construction, including location search, nearby hotspot search, navigation and so on. The provided JavaScript API is compatible with the following browsers:

Tab. 8 Access limits of Amap API

Types	Access limits per day/Key	Access limits per 10 minutes/Key
Geocoding/Reverse-geocoding	100 000	10 000
Place search	100 000	50 000
Inputting hints	100 000	50 000
Navigation	100 000	5 000
Road search	25 000	2 500
Static map	25 000	2 500
Positioning	100 000	5 000

—IE 6.0 + (Windows) and other browsers with IE kernel, such as Sogou Highspeed Browser, Maxthon Browser, 360 Browser and The World Browser, etc.

—Firefox 2.0+ (Window | Mac | Linux).

—Safari 3.1+ (Mac | Windows).

—Chrome (Windows).

—Opera 10+ (Windows).

The data of Sogou Maps are as follows:

—Coverage: the data of Sogou Maps nearly covers 400 medium and large cities, hot tourism cities and 3,000 districts in China, which support for national urban life information, public transportation transfer, and inquiry of driving route. What is more, it provides services of multi-city real-time transportation, satellite images and 3D urban display.

—Updating frequency: mass data acquisition is updated every half year. All kinds of information update on a daily iteration.

—Support for the city real-time traffic status information: it supports four cities currently, including Beijing, Shanghai, Guangzhou and Shenzhen.

5 Conclusion

Mapping services are widely used in our daily lives now. Consequently, more and more mapping service providers have emerged in the past years in China. However, there is no existing work about mapping service comparisons and selection, which is the problem that we have addressed in this paper. We first make fully comparisons of the six popular Maps APPs in China, including Baidu Maps, Amap, Sogou Maps, Tencent Maps, Google Maps and Bing Maps, with respect to the provided services and service response time. Then, we give comprehensive comparisons and experiments of the mapping APIs, including the types of Maps APIs, and Maps Web loading time and API response time. In the end, we introduce and summarize three popular native mapping APIs in China, e.g., Baidu Maps API, Amap API and Sogou Maps API. We hope that this paper can give users/developers a valuable guider when they plan to choose a suitable mapping service.

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