Chapter 2
Web Mapping Services: Development and Trends

Manuela Schmidt and Paul Weiser

Abstract Web mapping services like Google, introduced in 2005 have altered the online mapping experience. Not only could maps be viewed in a fast and simple way but there was also the possibility to create Mashups through APIs, leading some to proclaim the "democratization of mapping". Addressed here is the development of these mapping services, how they impacted the existing Web mapping environment and possible future areas of development. An emphasis is placed on the technical developments from desktop to mobile applications, as well as the development of base maps and map types from pre-rendered tiles to editable map styles in different viewing modes from bird eye view, 3D, and augmented reality. While the first maps produced with APIs were mostly static point maps, new features have enabled dynamic and interactive applications with "GIS-like" functionalities, often supported by third party implementations.
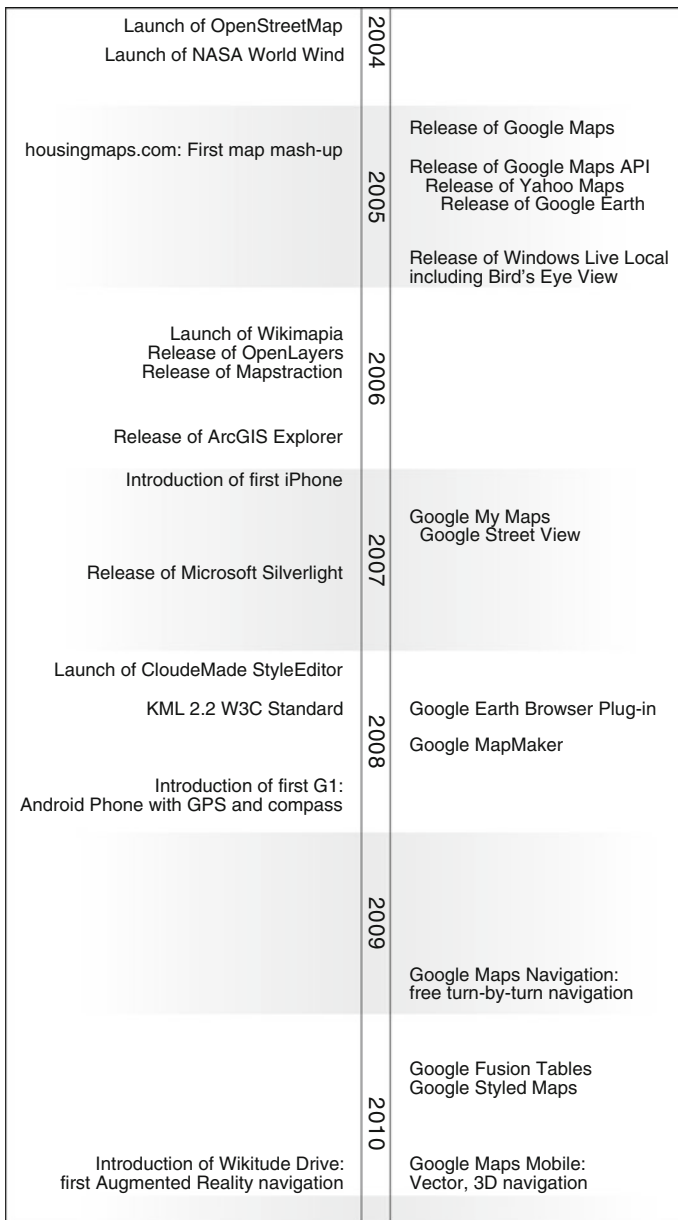
2.1 Introduction

In 2006, a year after the appearance of Google Map Mashups, the free software developer and activist Erle Schuyler summarized the state of map APIs as follows:

> At present, all that these map APIs offer is ultimately a way to put points on a map – what we've [. . .] referred to as "red dot fever". [. . .] Where is the broader palette for telling new and different stories on the Web with maps? Where is the bi-directionality, the interactivity, the Wiki nature? (Schuyler 2006)

Before proceeding, it is good to ask whether much has changed since Schuyler's assessment.

M. Schmidt (✉)
Institute of Geoinformation and Cartography, Vienna University of Technology,
1040 Vienna, Austria
e-mail: manuela.schmidt@tuwien.ac.at

Launch of OpenStreetMap Launch of NASA World Wind	**2004**	
housingmaps.com: First map mash-up	**2005**	Release of Google Maps Release of Google Maps API Release of Yahoo Maps Release of Google Earth Release of Windows Live Local including Bird's Eye View
Launch of Wikimapia Release of OpenLayers Release of Mapstraction Release of ArcGIS Explorer	**2006**	
Introduction of first iPhone Release of Microsoft Silverlight	**2007**	Google My Maps Google Street View
Launch of CloudeMade StyleEditor KML 2.2 W3C Standard Introduction of first G1: Android Phone with GPS and compass	**2008**	Google Earth Browser Plug-in Google MapMaker
	2009	Google Maps Navigation: free turn-by-turn navigation
Introduction of Wikitude Drive: first Augmented Reality navigation	**2010**	Google Fusion Tables Google Styled Maps Google Maps Mobile: Vector, 3D navigation

Fig. 2.1 Development of web mapping services depicted by some exemplary services and tools

One way to answer this question is to explore the stages of development of Web mapping services. Figure 2.1 shows a time-line depicting the release of important tools of Web mapping services on the one side and the introduction of related tools, projects, and products on the other. The following section will focus on

cartographic aspects by discussing the different map and content types as well as map styles. Section 2.3 gives an overview on advances in API technology by highlighting the aspects of widespread usage, mobile usage and expert usage of Web mapping services. The final chapter gives a short summary and discussion.

2.2 Development of Online Maps

When Google published its Web mapping service in 2005, it was the first free service providing a global coverage of satellite map views (Purvis et al., 2006). Other companies followed offering satellite as well as road map views. They usually also provided a hybrid view, i.e., the combination of a road network and satellite views. Most road network data, however, was restricted to areas covered by commercial data providers. We argue that maps have changed considerably since that. The following paragraphs give an overview of the new types of maps and new approaches to map content and styles.

2.2.1 Map Types

Parallel to the launch of 2D web mapping services, 3D desktop applications like NASA World Wind and Google Earth were introduced. Shortly after, Microsoft integrated the 3D terrain view in the browser, at some places complemented with 3D buildings; however, a proprietary plug-in was needed to access this version. In 2008 also Google published a plug-in offering Google Earth's 3D capability in a browser (Google 2008a). In addition to 3D and different aerial views, another street map view created considerable controversy: panoramic, street-level imagery called "Street View" (Google) or "StreetSide View" (Bing).

An early innovation in addition to the basic map, satellite, hybrid view, was the "Bird's Eye View" integrated in Windows Live Local (now: Bing Maps) (CNet 2005), not only giving top-down aerial views, but images taken at an oblique, 45° angle, allowing for a view on the front and back sides of buildings. The drawback of this feature, however, is that only areas with a high population are covered.

Concerning the map itself, an improvement to the standard map view was the Google Maps "Terrain" view introduced in 2007 (Google 2007b), that displays physical features, i.e., shaded relief representation.

Most map services allow users to integrate new custom map types. This requires pre-rendering of the host titles and their storage on a server. Third party tools and open source scripts appeared that support the rendering of tiles from different data sources and their hosting on a cloud-server. Figure 2.2 compares the map type choices of Google Maps in 2005 to those in 2011. However, some of the options do not refer to map types, but to image or real-time data overlays, such as "Photos" or "Traffic".

Fig. 2.2 Simple map type
control in the first Google
Maps release in 2005 for map,
satellite and hybrid view (**a**).
Extended map type control of
Google Maps in January 2011
(**b**). Map types include real-
time data overlays such as
traffic
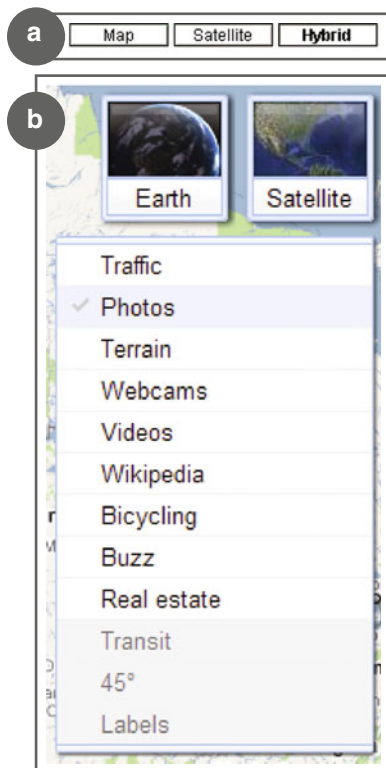
2.2.2   Map Content

Base maps are based on a mixture of public data commercial data. The two major
data provider are NavTeq and TeleAtlas. However, these data are costly, quickly
outdated and restricted to specific areas covered by the data acquiring companies.
Large companies have invested large sums of money to purchase smaller com-
panies to acquire their data (e.g., Nokia acquiring NavTeq (Nokia 2007), Microsoft
acquiring the Imagery and Remote Sensing Company Vexcel (Microsoft 2006)).
For an easier and cheaper data acquisition, Google introduced a tool called Map
Maker in 2008, that enabled users to contribute data themselves (Google 2008b).
This tool was only available for areas with no or little commercial data coverage,
e.g., India, Pakistan, Iceland. Within a short time, large areas were mapped in this
crowd-sourcing manner.

     This user-generated approach is also used in a project called OpenStreetMap that
tries to build a free map database of the world. Until now, many Web mapping
service providers shied away from using OpenStreetMap data, because of unclear
license terms and a claimed lack of quality assurance. However, studies quality of
OpenStreetMap data in comparison to commercial data vendors (e.g., Haklay 2010;

Neis et al., 2010) show little difference. Applications using OSM data have proved successful with an increasing competition in the online map market. Big players like MapQuest (2010) and Microsoft (Bing 2010) are starting to use Open-StreetMap as a source for their base maps. In additions, they also offer tools to contribute data back to the OpenStreetMap project, showing the increasing relevance of open and crowd-sourced data also for commercial purposes.

Point and feature overlays also gained importance in web mapping services. Content overlays can be differentiated into those that can be displayed on request (as shown in Fig. 2.2) and content that is included in the base map, e.g., POIs, companies, restaurants, etc. For Google Maps this content is managed in Google Places. Other content overlays originate from sensors (e.g., traffic, webcams, weather), user-generated content platforms (e.g., photos, Wikipedia, video) or business directories (e.g., real estate). Custom content overlays are created through APIs (see Sect. 2.3).

2.2.3   Map Styles

One of the key elements that made web mapping services successful was their pre-rendered raster tiles (Smith 2008). While this ensured fast loading, it had the disadvantage of lacking flexibility in terms of style and content. In the beginning, the base maps always looked the same. A small change to that paradigm was discovered by developers who used hard-coded filters to colorize, de-saturate or blur map tiles. For more than optical modifications, custom map tiles had to be used. As described in Sect. 2.1 this usually implied that the user had to own the geo data, be able to configure and render the data and host the rendered tiles on their own servers.

In 2009 the tool "StyleEditor" by CloudMade (2009) was introduced that allowed the user to style the map. Consisting of a browser application with a GIS-like interface, the user can create individual styles by selecting map features from the OpenStreetMap database and assigning visibility and design. The resulting individualized map styles can be used in combination with a Cloudmade API or downloaded as raster tiles for use in combination with other mapping APIs.

It was expected that such a custom styling tool would be freely available for open geo data, as it accesses to underlying vector data. Interestingly, in late 2010, Google also published a similar tool called "Styled Maps" within their Google Maps API v3. With a so-called "Wizard", users could select feature types and determine the style in terms of visibility, hue, lightness and saturation. While this tool is still an advanced and rarely used option, it enables the programmer to not only change the look-and-feel of the base map, but also its features. Nevertheless, both mentioned tools are still restricted to fairly simple style changes within their range of geometric features.

2.3   Advances in API Technology and Features

2.3.1   Mapping for the Masses

The first map mash-up was created in April 2005 by Paul Rademacher, a 3-D graphic artist who combined housing data from Craigslist with the newly available Google Maps. This started a new chapter in Web mapping dominated by so-called "programmer-mapmakers" (Plewe 2007). Web mapping services delivered simple, attractive and intuitive interfaces; APIs allowed for data mash-ups. However, at this time, generating a map mash-up required the technical knowledge of creating a Web site and combining the public service with contributed data, thus limiting the mapmakers to web developers. This has changed, at least with the publication of Google My Maps announced as "Map-making: So easy a caveman could do it" (Google 2007a). Maps could be created with a simple drag and drop interface, allowing anyone to add placemarks, text, photos and videos to simple mash-ups, which could be saved, embedded and forwarded as a KML file. Also, Google Earth enabled users to create and contribute geo content, such as simple 3D buildings, easily. Also, CloudMade and other vendors started providing similar services. Plewe (2007) identified these new players in the mapping market as "consumer-mapmakers", who were enabled by consumer-oriented or citizen-oriented services to share their personal geography with the world, without having to have programming or design skills.

Mapping has become a daily routine for many people. For example, users can map their own location by "checking in" at geo-social networks such as Facebook, Twitter or Foursquare. Even though some of these services don't directly produce maps, they create a geo-footprint that can be queried through an API and visualized using most standard mapping APIs.

2.3.2   Maps Going Mobile

Until recently, a major drawback of web-based maps was their limited mobility compared to paper maps (Peterson 2003). Mapping applications were originally intended for desktop computers and fast local broadband connections. This, however, has changed with various recent developments.

Mobile computing hardware has changed significantly. Processor speeds and memory of mobile devices have increased dramatically and are now capable of rendering large vector data in reasonable time. High-end mobile devices are now on par with somewhat older gaming consoles like Nintendo's Wii (TechAutos 2010). Increased battery capacities and ultra-low voltage processors ensure that even more challenging computational tasks do not drain battery-life. Also, fast mobile broadband connections and cheap rates have made ubiquitous and affordable access to mobile mapping applications affordable.

The most important feature, in terms of hardware, is arguably the wide-spread use of reasonable large touchscreens in many mobile devices (Gartner Research 2010). Map interaction using a touchscreen is more natural and intuitive than any other method was. Touchscreen technology offers a direct way of manipulating content and facilitates better hand-eye coordination, thus making it superior over mice or keyboards (Shneiderman 1991).

Recent hardware developments have laid the foundation for the release of mapping APIs tailored to mobile devices offering new features such as car or pedestrian navigation, off-line use of maps, and various location based services. Modularization and optimization of API code enable mobile mapping application that, in terms of speed, can compare to common desktop APIs (Fox 2009).

With many people owning smart phones with a constant connection to the Internet, mobile mapping has become a ubiquitous tool for the masses. One of the most important mapping features in this context is navigation support. One important application Google Maps Navigation, introduced in 2009, was the first free application offering GPS turn-by-turn navigation, including live traffic data and search along the route. While this and all other versions of Google Maps before relied on a strong Internet connection, a new version of Google Maps for Mobile (Google 2010) changed that paradigm by offering vector maps, that were available offline and even allowed for offline rerouting. Applications like these will be strong competitors to traditional navigation systems, offered by Garmin, Nokia, and others.

Another application worth mentioning in this context is Wikitude Drive (2010), which combines the video captured through the phones' camera with driving instructions. In the future, more applications are expected to creatively extend the scope of Augmented Reality in combination with mobile mapping.

2.3.3 Mash-Ups for Experts

The number of features and services available through mapping APIs has increased considerably. While static point, polyline, or polygon overlays have become standard use, more and more dynamic information layers are added to the API's portfolios. Examples are traffic layers, showing real-time traffic information in urban areas, or bicycle layers, providing bike routes and overlays specific to bicycling usage. Other advanced capabilities include:

(1) Directions can be requested for different travel modes. (2) Support for elevation requests. (3) Geocoding, reverse geocoding and direction requests are usually restricted to a certain number of requests per day; otherwise a commercial license needs to be acquired. (4) Newer API versions also allow for customized base maps and for integrating custom map types, that can even use other projections than Mercator's, as long as they are rectilinear. (5) "Google Fusion Tables" allow for the online gathering, sharing and visualization of data tables. Even though this tool is still in development, it seems like a promising development for the

organization and visualization of thematic data. (6) The integration of third party tools has become easier and it is now possible to query databases for places, people, or businesses and display the results on the map.

With mapping tools performing tasks like geocoding, base map customization and data analysis, mash-ups are clearly moving towards specialized and expert GIS-like applications.

2.4 Summary and Discussion

The major mapping API providers continue to maintain and extend their mapping portfolio. However, some of the services have not survived. The existing map services have attracted millions of users – both desktop and mobile. The scope of web mapping applications has widened from easy-to-use consumer-oriented tools to highly specialized applications with GIS functionalities. We see new companies as well as old players trying to keep pace by using new technological concepts, different licenses and revised business models.

From a cartographic perspective, we can expect interesting developments from tools like the above mentioned. Map mash-ups until now assemble data on top of base maps, which are usually pre-designed by professional cartographers or designers. Tools like "Styled Maps" allow everybody to design base maps. On the one hand, this will enable unique and exciting new mash-ups – on the other hand, this might lead to bad and unreadable maps in some cases. Cartographic tools like ColorBrewer (www.colorbrewer2.org, Brewer 2010), which supports (non-expert) map makers to select suitable color schemes for maps, will be increasingly important.

As for Schuyler's last question: Despite the advances of web mapping within the last few years, there is still a lot of potential to collaborate, to elaborate, to tell stories with creative new methods and to use the data in exciting and useful new ways.

References

Bing (2010) Bing engages open maps community. Online: http://www.bing.com/community/site_blogs/b/maps/archive/2010/11/23/bing-engages-open-maps-community.aspx. Accessed 24 Jan 2011

Brewer CA (2010) http://www.ColorBrewer.org. Accessed 24 Jan 2011

CloudMade (2009) Cloudmade releases style editor. Online: http://blog.cloudmade.com/2009/07/16/cloudmade-releases-style-editor-11/. Accessed 24 Jan 2011

CNet (2005) Microsoft offers a new angle on maps. Online: http://news.cnet.com/Microsoft-offers-a-new-angle-on-maps/2100-1032_3-5986057.html. Accessed 24 Jan 2011

Fox P (2009) Google I/O 2009 – Performance tips for Geo API Mashups. Video: http://www.youtube.com/watch? v = zI8at1EmJjA&feature = player_embedded. Accessed 24 Jan 2011

Gartner Research (2010) Gartner says touchscreen mobile device sales will grow 97 percent in
    2010. Online: http://www.gartner.com/it/page.jsp?id=1313415. Accessed 24 Jan 2011
Google (2007a) Map-making: so easy a caveman could do it. Online: http://googleblog.blogspot.
    com/2007/04/map-making-so-easy-caveman-could-do-it.html. Accessed 24 Jan 2011
Google (2007b) http://googlemapsapi.blogspot.com/2007/12/v294-terrain-and-new-maptypecontrol-
    to.html. Accessed 24 Jan 2011
Google (2008a) http://google-latlong.blogspot.com/2008/05/google-earth-meet-browser.html.
    Accessed 24 Jan 2011
Google (2008b) http://groups.google.com/group/google-map-maker/browse_thread/thread/7ba81462
    f965c1dd. Accessed 24 Jan 2011
Google (2010) http://google-latlong.blogspot.com/2010/12/next-generation-of-mobile-maps.html.
    Accessed 24 Jan 2011
Haklay M (2010) How good is volunteered geographical information? A comparative study of
    openstreetmap and ordnance survey datasets. Environ Plann B 37(4):682–703
MapQuest (2010) http://blog.mapquest.com/2010/07/09/mapquest-opens-up/. Accessed 24 Jan
    2011
Microsoft (2006) http://www.microsoft.com/presspass/press/2006/may06/05-04VexcelPR.mspx.
    Accessed 24 Jan 2011
Neis P, Zielstra D, Zipf A, Struck A (2010) Empirische Untersuchungen zur Datenqualität von
    OpenStreetMap - Erfahrungen aus zwei Jahren Betrieb mehrerer OSM-Online-Dienste. AGIT
    2010. Symposium für Angewandte Geoinformatik, Salzburg, Austria
Nokia (2007) http://www.nokia.com/press/press-releases/showpressrelease?newsid=1157198.
    Retrieved Jan 12 2011
Peterson MP (2003) Maps and the Internet. Elsevier, Amsterdam
Plewe B (2007) Web cartography in the United States. Cartogr Geogr Inf Sci 34(2):133–136
Purvis M, Sambells J, Turner C (2006) Beginning google maps applications with PHP and Ajax:
    from novice to professional. Apress, Berkeley
Schuyler E (2006) Web Map API Roundup. Online: http://mappinghacks.com/2006/04/07/web-
    map-api-roundup/. Accessed 24 Jan 2011
Shneiderman B (1991) Touch screens now offer compelling uses. IEEE Software 8(2):93–94.
    doi:10.1109/52.73754, 107
Smith P (2008) Take control of your maps. Online: http://www.alistapart.com/articles/takecontro-
    lofyourmaps. Accessed 24 Jan 2011
TechAutos (2010) Making sense of smartphone processors: the mobile CPU/GPU guide. Online:
    http://www.techautos.com/2010/03/14/smartphone-processor-guide/. Accessed 12 Jan 2011
Wikitude (2010) Wikitude drive: never take your eyes off the road again. Online: http://www.
    wikitude.org/en/drive. Accessed 24 Jan 2011

http://www.springer.com/978-3-642-27484-8