OpenScienceMap

Open and Free Vector Maps for Low Bandwidth Applications

Falko Schmid
CapacityLab
University of Bremen, Enrique-Schmidt-Str. 5
28359 Bremen, Germany
schmid@informatik.uni-bremen.de

Hannes Janetzek,
Michael Wladysiak, Bo Hu
University of Bremen, Enrique-Schmidt-Str. 5
28359 Bremen, Germany
{jeff, s_uzwbaz, docallan}
@informatik.uni-bremen.de

Categories and Subject Descriptors

H.4 [**Information Systems Applications**]: Miscellaneous; D.2.8 [**Software Engineering**]: Metrics—*complexity measures, performance measures*

General Terms

Measurement, Performance

1. MOBILE MAPS AND ICT4D

Maps are used for manifold tasks in ICT4D projects: to find ways, to allocate places for building measures, to identify available natural resources like lakes or forests, to map entities of interest like cadastral borders, or document the state and development of measures implemented in the field. Often it is necessary to work with always up-to date maps and to share collected knowledge with others. Outdated maps can entail wrong decisions, e.g., navigation can fail because of the seasonal unavailability of mapped ways, or can take significantly longer due to missing street network data. Incomplete or incorrect classified landuse or natural feature data can result in wrong apportionment of land. The solution to this problem are always up-to-date and updateable online-maps on mobile devices displaying the information that matters for a particular project. In many cases this information is not provided by available map services and needs to be collected and put on the map. OpenStreetMap[1] (OSM) provides open and free geographic data collected by volunteers or donated by mapping agencies. OSM is the natural choice in ICT4D contexts, as everyone can use OSM data and can contribute any kind of spatial data to OSM.

However, ICT4D projects often face another challenge: the low bandwidth of the available networks. This problem requires the careful implementation of data sparse technology and concepts to make mobile data usage possible at all (see e.g., [1]).

[1]www.openstreetmap.org

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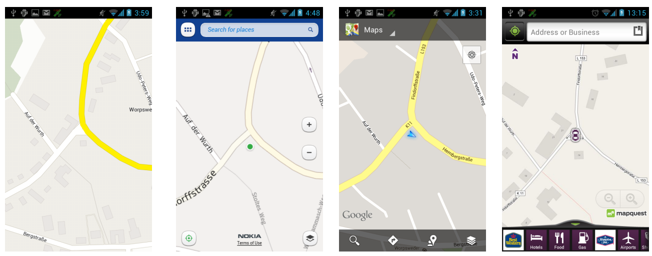
1.1 Raster vs. Vector Maps

There are basically two different technologies to display map data: by means of raster or vector data. Raster maps consist of precomputed images. With raster data it is practically impossible to analyze, modify, or select the displayed data without additional server communication. Vector maps, i.e. geographically annotated geometry offer all possibilities to work with the data directly on the client and without any server communication. Vector data can be rendered on the client according to specific requirements of different user groups (e.g., different languages), all entities can be manipulated in arbitrary ways (e.g., corrected if wrong), or enriched with new information.

1.2 OpenScienceMap: Vector Maps For Low Bandwidths

We develop OpenScienceMap[2] (OScieM)[2] as an open and free vector map service and framework. OScieM consists of a map data server, the vector data itself, and the client-side renderer for Android[3] 2.3 and higher. All components of OScieM are built upon open source software, OScieM is open source itself. The server is a public service, the data is based on the openly available OSM data, the client is a high-performance OpenGL renderer.



(a) (b) (c) (d)

Figure 1: Comparison of the three maps on equivalent zoom levels (1 in this case) for Worpswede: OpenScienceMap(a), Nokia Maps (b), GoogleMaps (c), MapQuest (d)

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2. ANALYSIS OF MAP DATA SIZES

At the time of writing this article, OScieM is the only free and open vector data framework (server, data, client)

[2]http://www.OpenScienceMap.org
[3]http://www.android.com

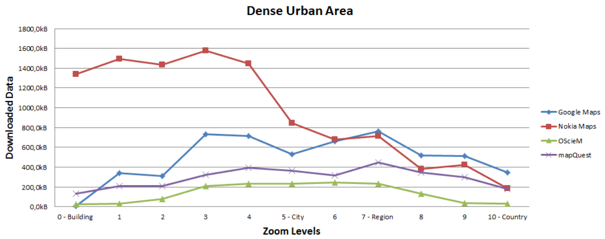

Figure 2: Data packet comparison for rendering a dense urban area

available. OScieM features highly-efficient data encoding, making it suitable for online map usage in areas with even lowest bandwidth coverage. To demonstrate the efficiency of OScieM, we compared it with three prominent mobile map services. We selected GoogleMaps[4] as a example for vector maps and Nokia Maps[5] as an example for raster maps, and MapQuest [6].

2.1 Procedure

All maps are different. They do not contain the same data and they do not offer the same zoom levels. To be able to compare the three maps we selected ten zoom levels as equivalent as possible across all three services. We limited our comparison to those ten zoom levels, as they reflect the kind of information required when working in the field (from building level to country level). One example of equivalent zoom levels is displayed in Figure 1. The three screenshots of OpenScienceMap, Nokia Maps, Google Maps, and MapQuest show the same area in Worpswede on zoom level 1.

We further compared two significantly different areas with different amounts of required data to render them: a dense city environment with rich street network and building data (Manhattan, New York, USA) and a rural area with a high amount of natural features and sparse network data (Worpswede, Germany). For each map and zoom level we then analyzed the data packets required to render the map on the screen of a Samsung Galaxy SII with a resolution of 480x800px. Therefore we had to root the device and use a packet sniffing software (Shark[7]) and packet analysis software (Wireshark[8]). We filtered the network traffic according to the IP-addresses of the map services and compared the data requirements for each zoom level.

2.2 Results & Discussion

The results of our evaluation are displayed in the charts of Figures 2 and 3. The charts draw the packet sizes for each zoom level on the Y-axis, the respective zoom levels on the X-axis. OpenScienceMap always performs best and has in contrast to the other maps a near constant data packet size. GoogleMaps, Nokia Maps, and MapQuest show significant differences across the ten zoom levels. Nokia Maps has at some zoom levels (e.g., zoom level 1 in Figure 2) more than 10× the size of OpenScienceMap. When we compare the download times with low bandwidths in Table 1, we can see the difference this makes. A zoom level of a map downloaded from OpenScienceMap requires only a few seconds even under very constraint conditions, while an equivalent map downloaded with other services can require several minutes. Obviously the data size is driven by the details rendered on the map, but also by the metadata sent from and to the server (such as user profile data). The respective sizes of those aspects of the data are hard to analyze without open insight in the data.

[4]http://www.google.com/mobile/maps/
[5]https://play.google.com/store/apps/details?id=com.fsdn.masc.android
[6]https://play.google.com/store/apps/details?id=com.mapquest.android.ace
[7]https://play.google.com/store/apps/details?id=lv.n3o.shark
[8]http://www.wireshark.org

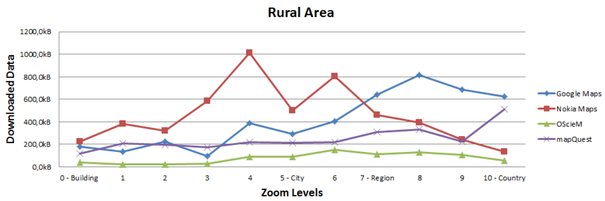

Figure 3: Data packets comparison for rendering a sparse rural area

	Bandwidth			
	14.4 kbps	28.8 kbps	33.6 kbps	56 kbps
20kB	11s	5s	4s	2s
50kB	28s	14s	12s	7s
100kB	56s	28s	24s	14s
800kB	07m35s	03m47s	03m1s5	01m57s
1MB	09m42s	04m51s	04m09s	02m29s

Table 1: Download times for low bandwidths. Compare to the charts of Figures 2 and 3.

3. CONCLUSION

Maps are essential tools in ICT4D projects, and often required in the field under low bandwidth conditions. In these projects the focus often is not solely on using existing data, but also to create new data in the field. OpenScienceMap offers an efficient solution for both requirements. It provides pure vector data, which can be used, edited and enriched directly on the client without any unnecessary server communication. OpenScienceMap further offers efficiently encoded map data. We could demonstrate that the bandwidth consumption of OpenScienceMap is significantly lower compared to alternative services. This makes OpenScienceMap an excellent candidate for ICT4D mapping in low bandwidth areas.

Acknowledgments

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4. REFERENCES

[1] Johnson, D. L., Pejovic, V., Belding, E. M., and van Stam, G. Villageshare: facilitating content generation and sharing in rural networks. ACM DEV '12, ACM.

[2] OpenScienceMap. http://www.OpenScienceMap.org.