

Animated Cartographic Visualisation of Networks on Mobile Devices

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Extended Abstract

The presentation of networks on maps helps the user to explore, analyse and interpret relations between objects concerning a certain set of facts. Cartographic visualisation must consider several different types of networks with varying complexity. Typical scopes of application are schematic metro maps, street networks or power supply grids.

Visualisation of more or less complex network maps on (desktop) computer screens often becomes a demanding issue, because those screens are offering a rather limited viewport. Although screen size and resolution have increased during the last years, it is still a problem for the user to recognize all details and keep a good overview of the whole network at the same time.

Nowadays presentations on computer screens often are realized by means of web based mapping solutions as shown in *Figure 1*, which allow interactivity like panning and zooming or selecting and filtering the information shown on the map. Here, zooming helps to get detailed information of a certain part of the map. On the other hand, showing only subsections of the network makes it hard to get an overview about the whole set of facts and may lead to misinterpretations. If additional screen space is available, a medium sized conventional overview map can be supportive. A sophisticated approach for the cartographic visualisation of complex commuter relationships between German municipalities is described by Hanewinkel & Specht (2010).

Mobile devices, especially smartphones like in *Figure 2*, are only offering an even smaller viewport. Thus, the task is to find an appropriate compromise between mobility and the ability to show as much information as needed or even possible.



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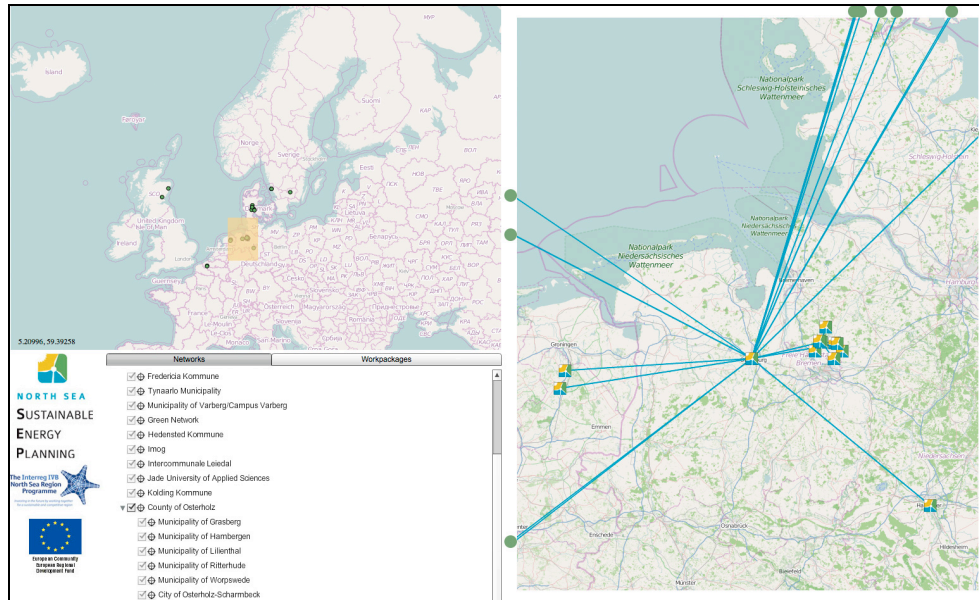


Figure 1. Web mapping application visualising the relations of the member organisations of a research network using the “fringe”. An additional overview map helps with the orientation. (Gollenstede A, 2011).

For the correct interpretation of the network or its subject it is often necessary to get information about qualities or quantities, which can be found outside of the current viewport.

A first approach to a solution is to use a part of the viewport frame border to show graphical objects, which represent the actually invisible objects or the invisible network parts – herein called the “fringe” cf. *Figures 1 - 3*. In the simplest case the fringe can be used to show where the next objects of the network are located and so it can support the user to pan into the right direction. But the fringe can also be used to give information about the number of objects or quantities outside the viewport. Therefore the graphical objects of the fringe can vary in size or colour or both. In the end all the traditional methods of cartography to visualise different kinds of quantities can be used here.

Different techniques for the visualisation of off-screen objects have already been introduced. A typical solution is to use space at the screen border, similar to the “fringe”, to display information about the objects outside the actual viewport.

Baudisch & Rosenholtz (2003) proposed a technique of indicating off-screen objects by using a visual effect named “halo”. Based on this work Gustafson et. al. (2008) introduced a technique called “wedge”. They devel-

oped an algorithm for a clutter-free screen border displaying multiple off-screen objects. At the same time also usability aspects on mobile devices have been taken into account. Hanewinkel & Specht (2010) concentrated on aspects of high quality cartographic output. Here, the indicator has been named “orbit” and is used on desktop and web based applications.

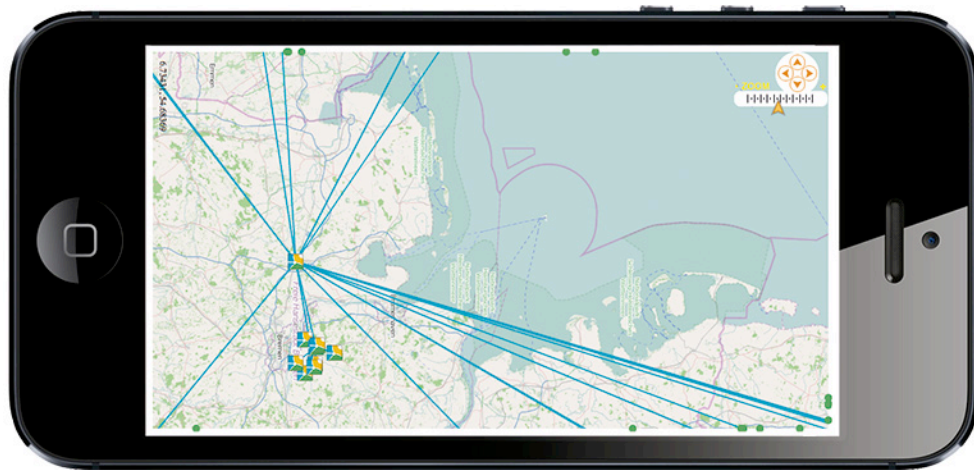


Figure 2. Mobile application visualising the network shown in *Figure 1* (Gollenstede A, 2014)

Panning and zooming require a constant actualisation of the fringe. The fringe objects constantly move and change size and colour when necessary. Depending on the complexity of the network data a large amount of calculations need to be executed on the mobile client to animate the fringe.

In addition to the fringe other types of animation can be used to support the user and to give an easy access to the network, e. g. showing animations of the edges, which are interconnecting the nodes of the network.

If objects related to the network vary in time and place, a “live” animation of the network elements and the fringe is required. Representations like moving buses on a street map or a schematic metro map require a continuous update and animation of almost all elements on the mobile screen. Then, the fringe can additionally contain information about the expected arrival of the next bus, as illustrated in *Figure 3*, or the stations still to go for the passengers.

Another possibility to avoid overcrowded small screens and to ease the interpretation of networks is the simultaneous use of different levels of generalisation on the map screen. Then, the degree of generalisation should be

small in the centre of the viewport and increase to the border of the viewport.

Alternatively, Wolff (2013) mentions different deformation methods of the map centre e. g. the fisheye view, which can help to dissolve overcrowded areas. Similar approaches are well known from printed city maps of the German publishing house Falk.

When geometric networks have to be visualised, graph drawing and cartography are combined (Wolff 2013). In this case certain visualisation tasks, like generalisation of the network, can be solved with algorithms of graph theory.



Figure 3. Sketch of a mobile application visualising a schematic public transportation network. The fringe displays the expected arrival of the next buses to come for two selected routes. The background shows parts of the off-screen network. (Gollenstede A, 2014; map: <http://www.vwg.de>)

Current work in progress at Jade University does not focus on the development of new algorithms, e. g. in the field of graph theory. Instead the main emphasis lies on increasing the quality of the cartographic visualisation of networks on mobile devices.

In a first step different basic approaches are currently implemented and will be optimised for a proper cartographic presentation on mobile terminals. For these devices, especially the limited viewports are taken into account.

As a second step the development and test of more sophisticated methods of visualisation and animation of networks on mobile devices will be tackled. Cartographic variables are to be analysed systematically in order to improve the functionality of the fringe as well as enhancing the comprehensibility.

Furthermore, the project analyses, whether the used algorithms are suitable on mobile devices with regard to the still limited performance compared to desktop applications.

Finally empirical test beds are planned to evaluate how users deal with those different ways of presentation.

References

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