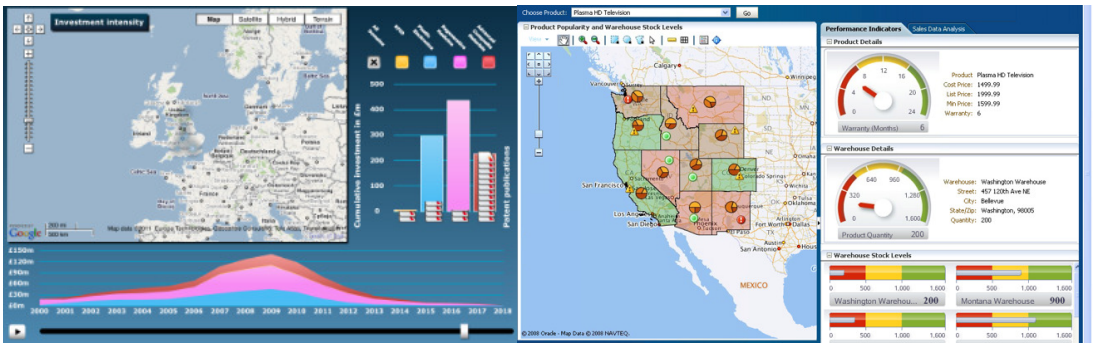
Applying Advanced Visualisation in Network Environments

A report into the application of Advanced Visualisation techniques including Map-based Visualisation within areas such as Network Monitoring and Service Assurance



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Foreword

Global enterprises are increasingly using data and KPI reporting to manage the performance of the organisation and to make informed business decisions. Enterprises have invested heavily in data-warehouses, CRM, ERP and Business Intelligence, all of which pump valuable information to the screens across the organisation. These investments are under-pinning cost competitiveness, efficiency and automation as people become a scarce resource. However, many managers complain of information overload and struggle with the challenge of using these multiple information systems most effectively to gain business value. The key Business Intelligence challenge has shifted from tapping into the underlying data to interpreting and acting upon the information.

While enterprises grapple with this growth in information, the world of the consumer has already evolved an effective solution to tackling the problem of dealing with vast amounts of discrete tasks. Modern consumers are armed with iPads and Smartphones providing visually intuitive one-touch easy-to-access information on all aspects of their personal activities, from email to banking to personal health monitoring and entertainment.

So with so much invested in existing systems, where should enterprises turn to achieve the next level of efficiency and competitive edge? Having witnessed the power that can be unleashed across the organisation by distilling vast amounts of data down into an easy to interpret view, DANU believes that Advanced Visualisation is a simple but powerful tool that makes a real business difference to the performance of the enterprise.

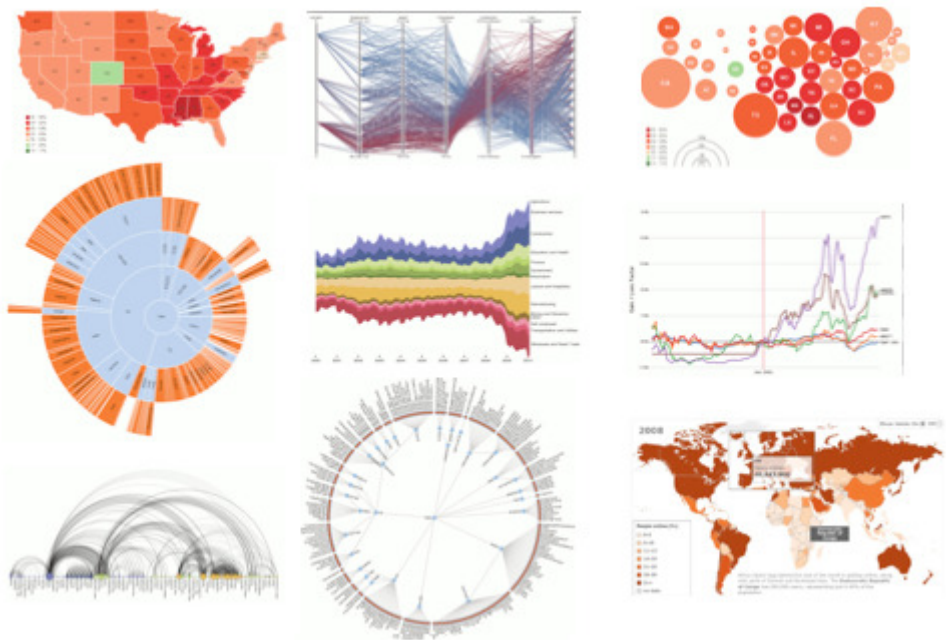
What is Advanced Visualisation ?

Similarly to the iPhone, it can be difficult to explain Advanced Visualisation to those who are used to interpreting data from multiple systems with unstructured linkage and navigation. At its simplest level Visualisation can be defined as *"the principle of mapping data variables to visual features such as position, size, shape, and colour to convey meaning and understanding".* As computers and their graphics capabilities have advanced, so too has the potential for what can be achieved through visualisation, both in terms of the quantity of data that can be analysed and in terms of the images that can be rendered to visualise the results of that analysis.

Academics, researchers and designers are continually striving to formulate new and creative methods for representing and visualising large and complex data sets. Reference [1] provides a good summary of visualisation techniques ranging from the classical visualisation approaches that have been used over the last decades to the more advanced methods that are starting to appear today.

The goal of visualization is to aid our understanding of data by leveraging the human visual system's highly tuned ability to see patterns, spot trends, and

identify outliers. Furthermore, visualisation is a means of making data more accessible to a wider group of people by providing visual representations of the data that may help in engaging more diverse audiences in exploration and analysis.



Why use Advanced Visualisation now ?

Ultimately, organisations such as those that provide Network Services strive to achieve (a) maximum utilisation of costly network resources, (b) better operational efficiencies to reduce costs (c) increased service quality and customer satisfaction and (d) service, product and process innovation, all of which should combine to deliver positive financial results.
While Advanced Visualisation is just one element of any overall solution, as a technology and an approach it has the potential when applied correctly to make significant improvements across all these areas within a Network Operator. In its application, it can deliver a vastly improved end user experience by presenting information in a manner that is better understood at multiple levels of abstraction, allowing meaning to be derived more easily. A good solution will provide the information overview and the detail with multiple levels of abstraction in between, and it will take advantage of advanced user interface concepts allowing the end user to move easily from abstraction level to abstraction level, from overview to detail and back again.

Furthermore, advancements in computer desktop processing capabilities and in the software toolsets that are used to design Advanced Visualisation GUIs have brought us to the point where visualisation ideas that were considered futuristic are now very much achievable today.

Where is Advanced Visualisation best applied ?

While there is a role for Advanced Visualisation across most application domains, it can be very effective in areas where there are *large data volumes* that need to be analysed and presented to users in a manner that conveys meaning. For example, in today's Telecom networks it is necessary to process huge volumes of usage and performance related data for operational monitoring and historical analysis purposes. Ultimately the results of this analysis and its underlying data must be presented to the end user in order that they may derive knowledge and act upon it. One of the most important elements of this 'presentation' is the ability to navigate through the data moving from high level views to the underlying details, drilling in and out, drilling across from one dimension of data to another. It should be possible to process these large data sets and extrapolate and visualise answers to questions such as "how much usage do I have", "where is the most/ least usage", "how is quality/ performance", "where is the best/ worst performance", "are there weak spots", "are things getting better/ worse", "where are things getting better/ worse" and so forth.

While these questions may be answered in many ways, there is a role for Advanced Visualisation in providing an answer that is apparent at a glance, is easy to understand by a wide audience and not just domain experts, and as a result facilitates better monitoring, analysis and decision making support.

Being Smart

As with any technology or approach that might be considered de rigeur, there will always be the risk that it is used for the sake of itself - and in the case of Advanced Visualisation as a 'looks good' pleaser for senior management - rather than as a means of delivering real business value.

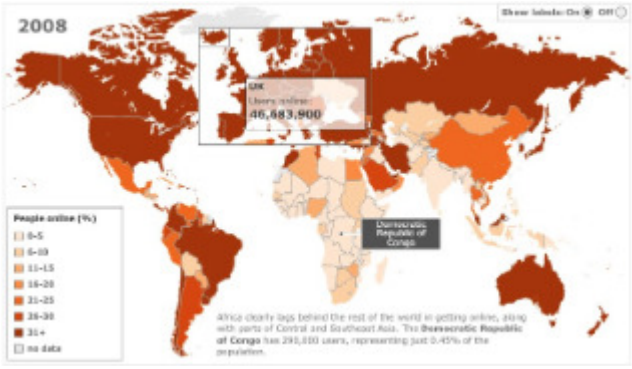
The smart application of Advanced Visualisation requires a detailed understanding of the underlying data being analysed combined with a working knowledge of the end user community and their requirements. Implementing a smart solution includes determining which questions to ask, identifying the appropriate data and selecting effective visual encodings to map data values to graphical features such as position, size, shape, and colour. The challenge is that for any given data set the number of visual encodings—and thus the space of possible visualization designs—is extremely large.

In this large space, there are good examples of proven approaches that work for specific problem domains. The following sections focus on the use of Map-based visualisation, combined with other techniques, as applied to Telecom Network usage and performance related data.

Map-based Visualisation

In our experience the use of Maps and Map-based Visualisation provides a natural framework upon which network performance and service assurance data can be best visualised. The network is geographical in nature, equipment is distributed across this geography and subscribers receive services within it. Location, population, terrain are all factors that can influence Telecom network performance, concepts that are naturally conveyed through the use of maps.

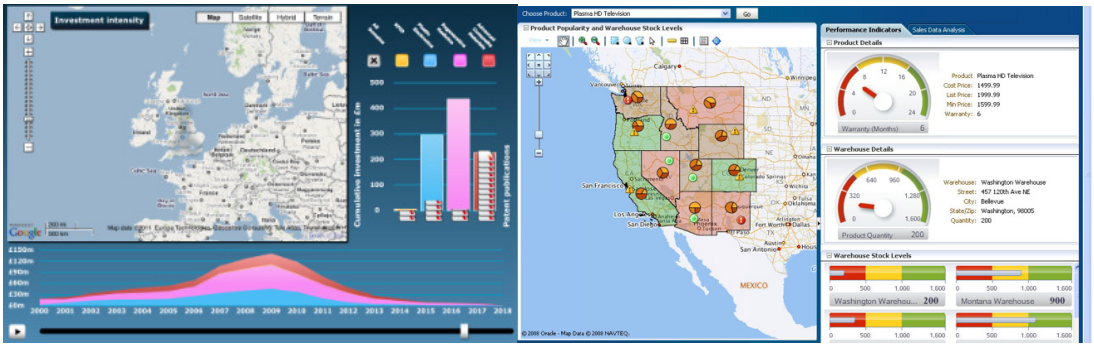
Furthermore, navigating the data as part of the analysis process, moving from overview to detail and back can be achieved in a user instinctive manner by zooming in and out and panning up, down, left and right.



Compound Visualisation

While Map-based Visualisation can play a key role in network data visualisation, we believe that it is best used when augmented with other techniques, producing an Advanced Visualisation that is the compound of several techniques. For example, maps and the overlay of measurement data on them works well to visualise data for a particular point in time, however traditional time series charts are still very effective for showing trends and performance over time.

Also, there is a limit to the amount of detail that can be overlaid on a map in a manner that is distinguishable to the end user, even with the use of 3D maps. Therefore being able to popup charts, tables and other visualisation elements from the Map based framework can deliver the best overall solution.



Choices and Challenges

When implementing a product or solution that includes advanced visualisation capabilities that are based around Maps, the designer faces a number of challenges and choices.

GIS or not

A fundamental question when building a map based visualisation solution is whether to integrate and use a Geographical Information System (GIS). Such systems contain built-in functionality to support the capture, storage, cleaning, querying, modelling and analysis of spatial data. GIS includes built-in capabilities that can reduce the amount of development effort needed when implementing complex Map based visualisation solutions. On the other hand GIS systems can be quite complex, can require a high level of training and may be beyond what is needed for a specific problem domain. Using traditional relational databases with custom logic can be a simpler, more manageable approach in certain cases.

Map Clients and Map Data Access

Traditionally GIS systems were efficient only in the hands of GIS experts and they typically had proprietary user interfaces. In this Internet age GIS systems and their map data are dissolving as monolithic pieces of software into web based services freely available to non GIS experts. The web browser has become the natural client for Map Visualisation and many well known companies now provide both the Map Data (Images/ Tiles) and code libraries that simplify the development of Map-based Client GUIs. When building a map based visualisation solution, the Designer must decide whether to get Map Data (map tiles, satellite images) using these external web services from companies like Google, Microsoft or Yahoo, or whether to implement a Map Server internally to serve up this map data. Both approaches have their advantages and disadvantages which need to be weighed up against the specific situation. For example, while using 3rd party web based map data suppliers like Google Maps and their development tools may be simpler than implementing an in-house Map/ Tile Server and sourcing map data, it may not be an option in the case that Internet connectivity is not always available for the specific solution. See reference [3] for details of 'OpenLayers' which provides a wrapping of the Web Client interface allowing a solution to integrate map tiles from any source.

Open source or not

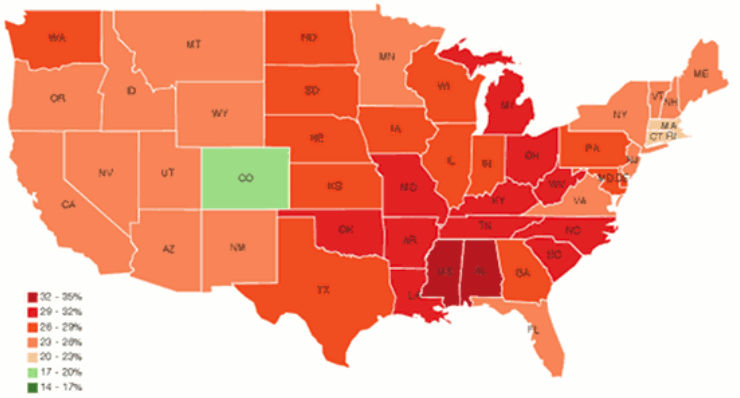
Whether implementing a GIS system or the client technologies and tools for visualising GIS data, both proprietary commercial and open source products can be considered. Reference [2] provides a comprehensive listing of the open source products that are available in order to assist on selection of 3rd party products.

Effective Map Visualisation Techniques

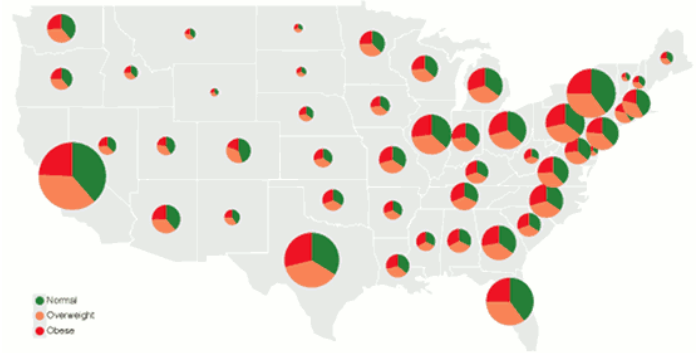
Designing a solution to visualise large data sets overlaid on a map presents certain challenges. For example, there is a limit to the amount of information that a user can absorb visually on one screen and a limit to the number of colours that a user can clearly distinguish between. Our approach includes appropriately limiting the information on one screen while using the concept of zooming in and

out to allow the user to show more or less detail. Achieving the correct amount of detail for each zoom level is key to a successful solution.

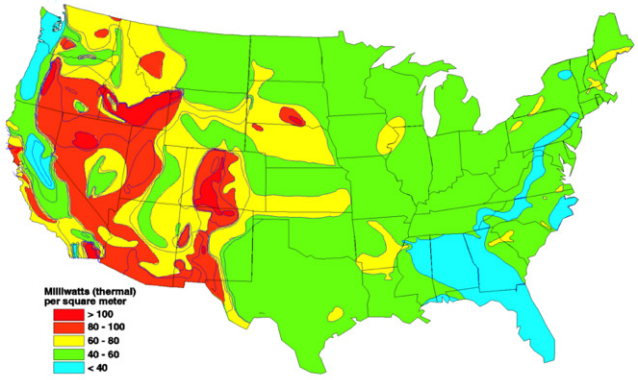
An obvious approach is to build upon existing geographical/ political boundaries such as states, counties, regions and so forth. Such boundary data is typically available within each country and can be easily imported for use into GIS systems.



In the figure above, the use of colour is employed against known geographical regions. An extension of this approach is shown below using clustering to provide more detail per region through the use of pie charts. In the example below the size of the pie chart is used to convey the total value per state, and then the pieces within each pie provide a breakdown by specific categories.



Heat maps are another method that can be used to visualise large volumes of geographical related measurement data.



Conclusion

Our experience has shown that Map-based Visualisation provides an ideal approach for viewing and interacting with network performance and service assurance related data. Advances in computer processing capabilities, the ready availability of GIS services through the web, the proliferation of 3rd party GIS products and advances in GUI capabilities mean that the tools and constituent elements exist today to create Advanced Visualisation solutions that deliver real benefits to network operators. Rather than implementing yet another proprietary OSS product in order to give a newly required contextual view of network performance and service assurance, DANU leverages the existing investments and data silos in the enterprise to combine and present the underlying data in an advanced and intuitive way, unlocking business value.

References

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[2] Open Source GIS - An excellent resource listing open source products
http://opensourcegis.org/

[3] OpenLayers - a web client library/ wrapper that can display map tiles and markers from any source - http://openlayers.org/

