White Paper: **MetroVista™ Applications**

"You'll be astonished what you can do with MetroVista™"

Abstract

Bluesky's MetroVista™ offers the foundation to make smart decisions in rapidly changing urban environments. 3D models are no longer just pretty pictures, they are the key to unlocking the value in the smart city revolution and have at last become a viable replacement for traditional 2D GIS solutions. The CityMapper's simultaneous data gathering capabilities provide all the necessary outputs to deliver traditional 2D aerial ortho products or highly detailed static obliques, dense LiDAR point clouds or grids, and once combined, 3D city visualisations that are both aesthetically stunning and technically accurate.

James Eddy
Technical Director
Bluesky International Ltd.

White Paper: **MetroVista™ Applications**

Executive Summary

As our cities change and become more complex, they require more planning, design and management and additional protection from security threats. With the advent of smart cities, BIM, connected communities and the IoT, geography and location are playing an increasingly important role; traditional methods of mapping them are outdated. Mapping in 2D has served its time and in this new age it is rapidly becoming inadequate. Traditional 3D models are useful but are expensive to produce, cumbersome to use and often not realistic. The new paradigm in geospatial data for city management is 3D mesh models. These detailed interactive and intelligent 3D models accurately depict any landscape and are easy to view, use, and seamlessly stream over the internet. Each building is fully rendered to give unprecedented detail. There are a diverse range of applications for mesh models including urban planning, architecture, public engagement, defence & security, utilities, telecoms, insurance, as well as tourism, modelling and visualisation.

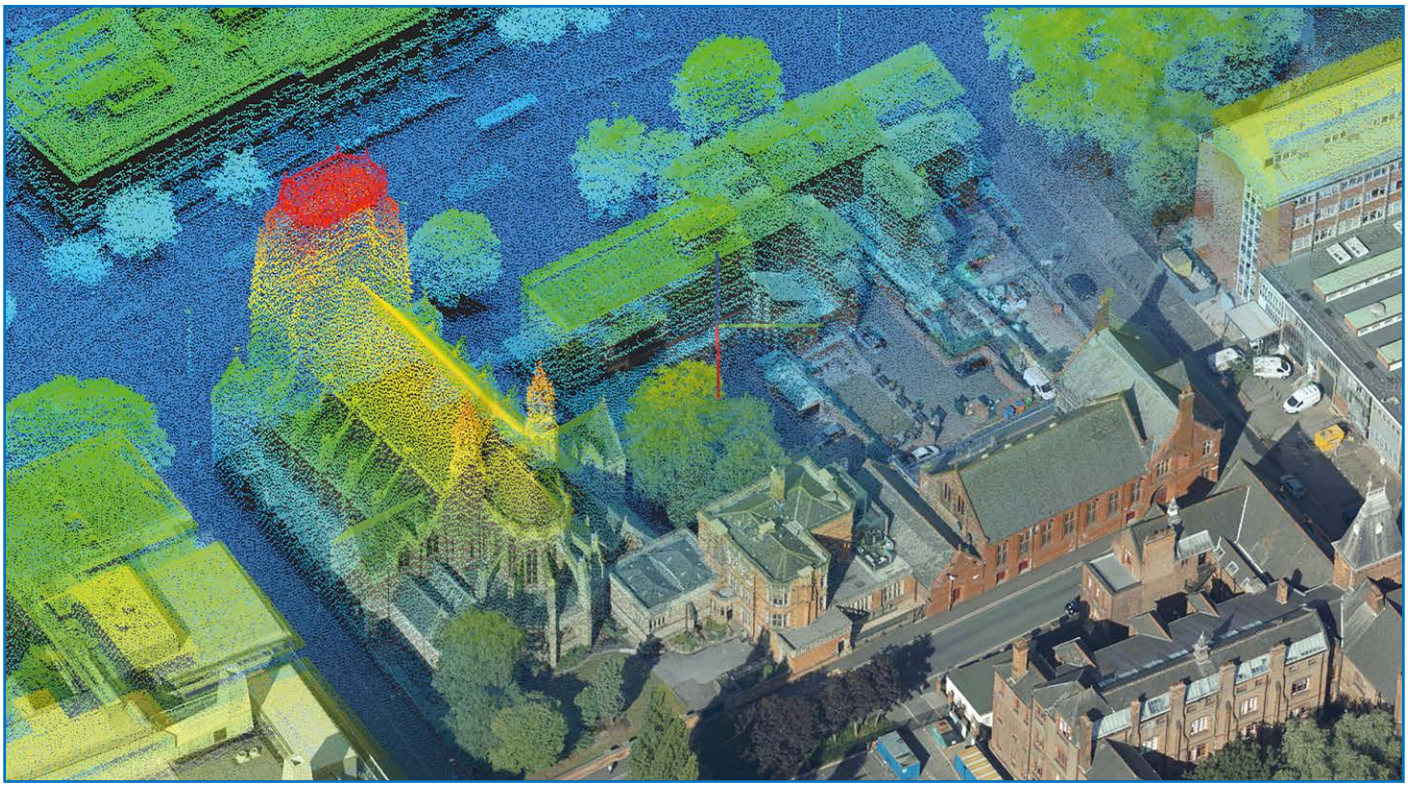

Figure 1 *- Bluesky's MetroVista™ (created from LiDAR and aerial photography)*

The Problem

Two centuries ago only 3 percent of the world's population lived in cities. At the dawn of the 20th century, it was just 14 percent. Today, it's exploded to more than half the world's population, and by the year 2030, more than five billion people (six out of every ten human beings) will live in cities and urban centres. In the UK already over 90% of the population live in cities or metropolitan areas, a figure that is set to continue to rise in the coming decades. We have become a very urban-centric race.

Cities are fascinating and diverse places; they generate wealth and can improve living standards while providing the infrastructure, networks, density, and interaction that make us more productive and more creative. They are the key to social and economic development, bringing together all the inputs required for economic growth.

However, metropolitan areas also bring with them a raft of serious problems and complications – from social, economic, security and health concerns – making the managing of cities a continuous challenge.

Figure 2 *- A traditional 3D model created from stereo aerial photography*

Figure 3 *- Bluesky's MetroVista™ full city model*

As cities grow and develop land is always at a premium, so the answer has been to build vertically, making cities very multifaceted three-dimensional environments. In order to effectively manage such a complex environment, it is now necessary to take this third dimension into account. Those responsible for such tasks have, until now, had to work with either 2D maps or with expensive and cumbersome 3D models.

Traditional 3D models of existing buildings and cities used, for example, in the architectural world, are usually produced manually from stereo aerial photography. These models are still very much in demand, but they are expensive to produce and require specialist software to view and edit. They are created by drawing the lines and edges, then connecting them to produce planes or surfaces. However, in order to make them realistic, they need rendering with photographs, assuming such photos are available. This can be an incredibly intensive process often uneconomical for larger areas.

Figure 4 *- Bluesky's MetroVista™ full city model*

The Solution

In order to create a 3D model of entire cities, many users are turning to an alternative type of 3D model – the polygon mesh. These types of models are not new and have been used in computer graphics, gaming and the animation industry for many years. However, they are relatively new to the geographic data arena. As the underlying technology is established, they have already been optimised so we can load, view and explore entire cities with no loss of performance, no matter how many terabytes of data there is. Imagine a realistic 3D, fully rendered, accurate, 5cm resolution model of the entire of London, or any other great city viewable in a simple web browser over a standard internet connection. Those days have arrived, in the form of MetroVista™ a new suite of products aimed at making maps in which the third dimension becomes a reality.

What is a Mesh Model, and how do Bluesky create them?

A mesh is a group of edges, lines and faces that define the shape of a three-dimensional object. The faces often consist of triangles, quadrilaterals, or other simple convex polygons; hence they can be referred to as a polygon mesh. As they are usually triangles they can be referred to as a Triangular Irregular Network (TIN). The triangles are connected by their common edges or corners. The smaller the triangles, the denser the mesh and the more detailed the 3D object.

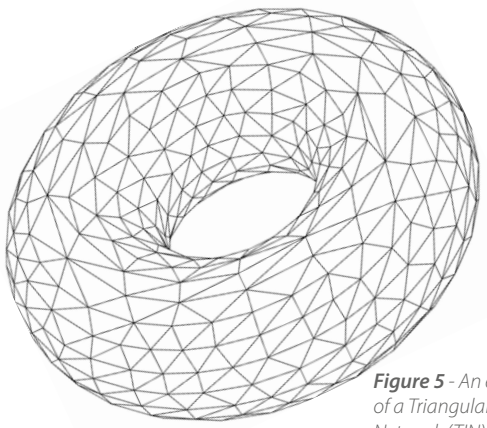

Figure 5 *- An example of a Triangular Irregular Network (TIN)*

As the object is composed of a series of flat polygons it is a simple process to add colour or even an image to the face and thereby creating a photorealistic 3D object. The 3D object can be an entire city, and the images use to make it realistic are vertical and oblique aerial photos.

In order to create a photorealistic mesh as accurately as possible, it requires some crucial ingredients; aerial photography (vertical and oblique) and LiDAR. Bluesky are able to capture all the data required in one aerial survey using a new type of hybrid sensor. The sensor comprises five cameras and a laser scanner within one unit, known as the CityMapper.

Figure 6 *- Leica's CityMapper sensor*

The sensor captures three main types of data simultaneously, which means that all three datasets will work independently or can be fused to make enhanced products. The first dataset is vertical (or nadir) aerial photography, in both true colour and near infrared, this data can be used to produce true-ortho. The second dataset is oblique aerial photography, which are aerial photos taken from an angle, showing the sides of the building rather than just the top. There are four oblique cameras; one facing forward, one backwards and one to each side; this arrangement gives us full 360-degree oblique coverage in one flight. The third dataset captured is high-density LiDAR, using a powerful laser scanner, which is used to accurately measure the height of the terrain and objects on the ground, such as trees and buildings in high detail.

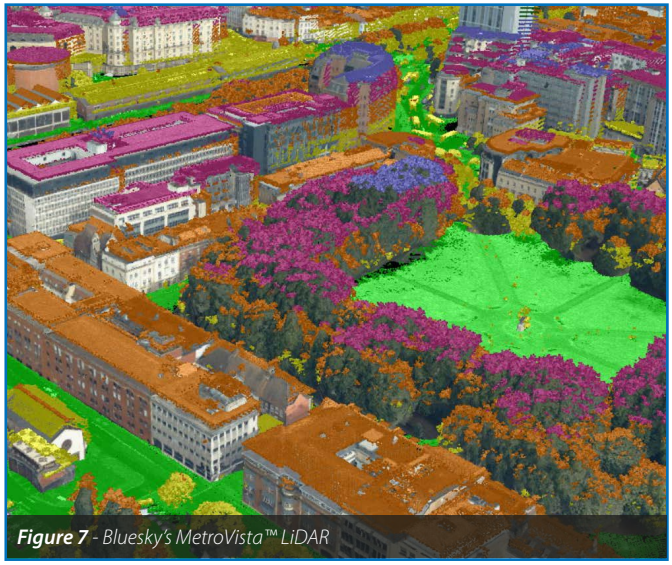

Figure 7 *- Bluesky's MetroVista™ LiDAR*

None of these three data types is new, but the fact they are acquired simultaneously is. Each one is coincident with the others, showing the same landscape as each other at the same time. With all this corresponding data it is possible to very quickly produce the most accurate and detailed 3D cities as mesh models, with minimal manual interaction. It can be fully automated, cutting production time down significantly. This data also opens many avenues for machine learning and AI applications. It is possible to stream these models over the internet, and view, query, analyse and even edit them. Owing to technological development it is now possible to more easily handle this Big Data, opening the use up to a wider and less specialist audience.

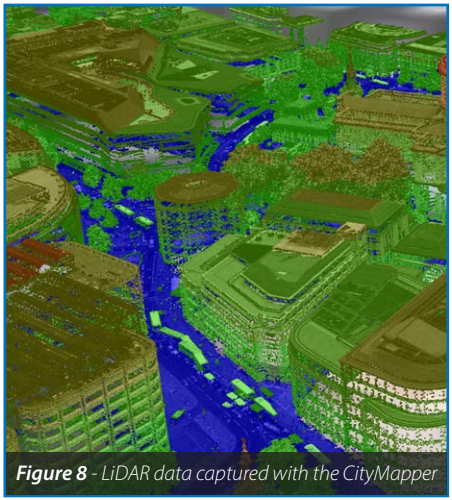

Figure 8 *- LiDAR data captured with the CityMapper*

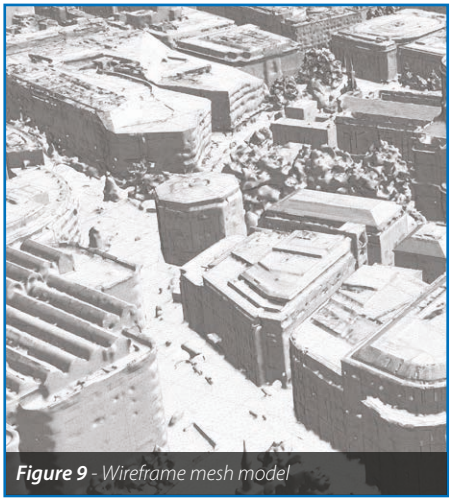

Figure 9 *- Wireframe mesh model*

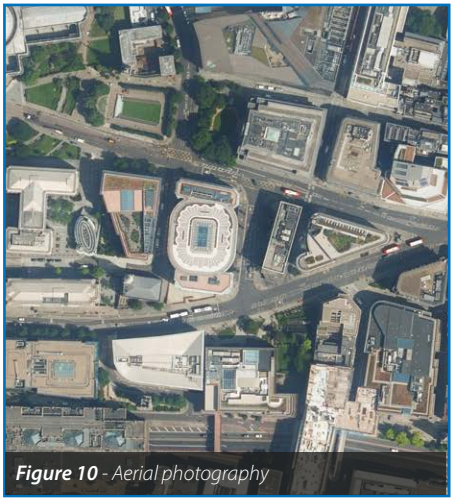

Figure 10 *- Aerial photography*

Mesh models were traditionally regarded as purely visual 3D models with no intelligence. They are used extensively in media and gaming, where intelligence is not required.

However, mesh models produced from the CityMapper are fully photogrammetric and therefore triangulated to give georeferenced data which can be as accurate as up to 10cm. Therefore, the data itself is as accurate as other geographic mapping and can be used for accurate 3D measurements as well as spatial analysis such as line of sight, shading, flood modelling and proximity analysis.

It is now also possible to attribute mesh models with other information, for example one can 'classify' every building in a mesh model and attribute them with data such as address or BIM information. This allows users to query any building, or other feature in a city, and return the associated intelligence.

There are many software packages in which it is possible to open, view and even edit mesh models. For example it is possible to 'remove' a building and replace it with a proposed architectural model, which is an invaluable public engagement tool.

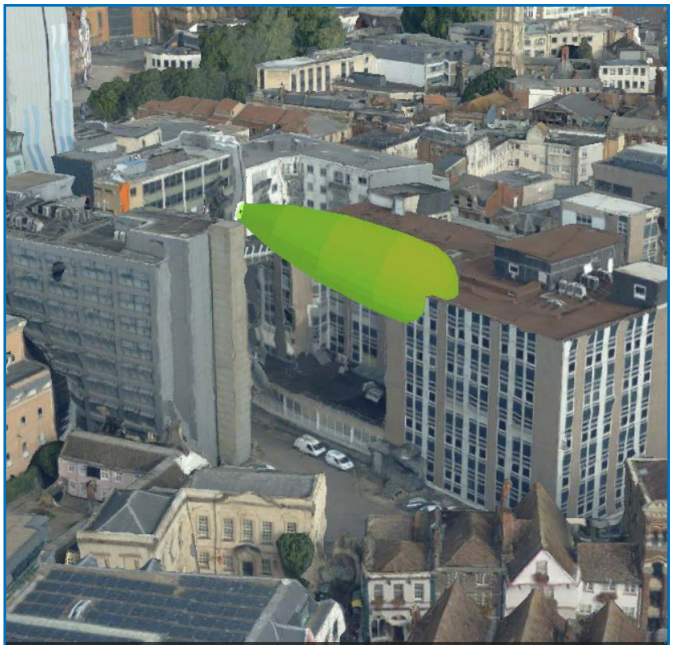

Figure 11 *- Bluesky's MetroVista™ - Showing mobile phone mast safety zone*

Applications for Mesh Models

The applications of such mesh models are wide and varied, covering a multitude of market sectors, including government, defence, security, utilities, insurance, telecoms, property, architects, tourism and gaming to name but a few. The varied applications include visualisations, proximity analysis, risk assessment, line of sight, scenario modelling, visual impact, navigation, design and master planning. These applications assist in many of the challenges facing those responsible for the management, security and development of our urban environments.

Urban Planning – view existing urban layout, and insert proposed developments by editing the mesh to remove existing buildings. Fantastic tool for public engagement, and options planning. Study the impact on light and shadows at different times of the year.

Figure 12 *- Buildings attributed by postcode*

Smart Cities & BIM – provide a 'real world' context and base dataset to assist effective administration and planning.

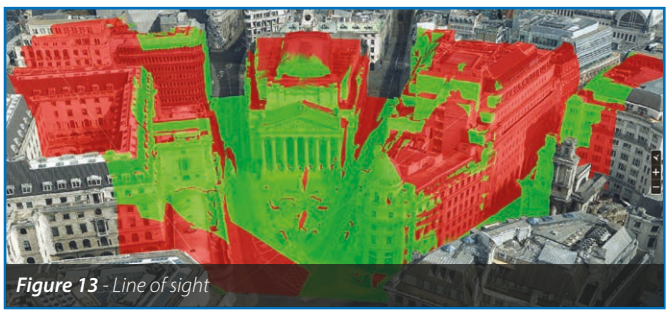

Figure 13 *- Line of sight*

Architecture – view proposed developments in their true context within their accurate virtual locations. How do they fit with the existing environment? How does the proposal affect the surrounding buildings? Present your ideas to stakeholders in an interactive context.

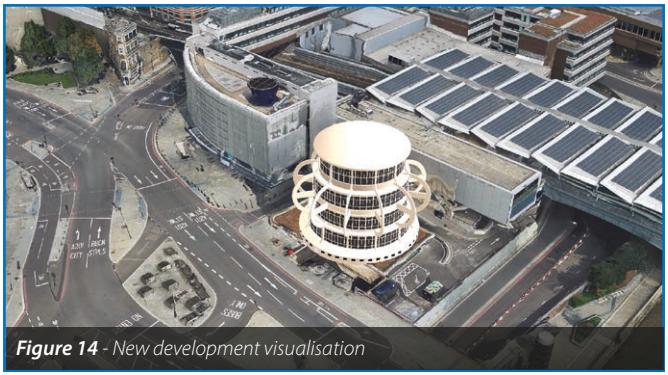

Figure 14 *- New development visualisation*

Defence & Security - as cities grow, they become increasingly complex to manage in terms of security. Understanding the 'lie of the land' in a realistic 3D environment is a must for those tasked with maintaining public safety. Scenario modelling, line of sight, access and assessment, are all possible with MetroVista™. It is also useful for emergency services, as the detail of each building (not only the number of storeys, but the exact location of windows, doors and roof detail) are all visible.

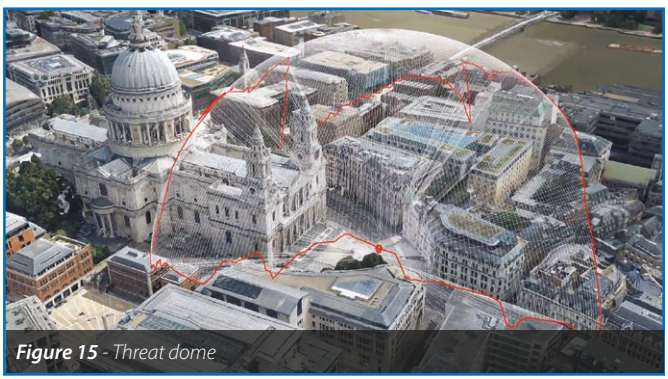

Figure 15 *- Threat dome*

Utilities – both underground and overhead assets can be planned and managed using MetroVista™. Accurate measurements can be made during the planning process, saving many hours of field survey, therefore offering significant cost savings.

Figure 16 *- Powerlines*

Telecoms – with the advent of 5G understanding the geometry and materials that make up complex urban environments is crucial for effective network planning. 3D urban mesh models will be necessary to ensure mobile operators plan and develop the most efficient network, taking line of sight and signal attenuation into account.

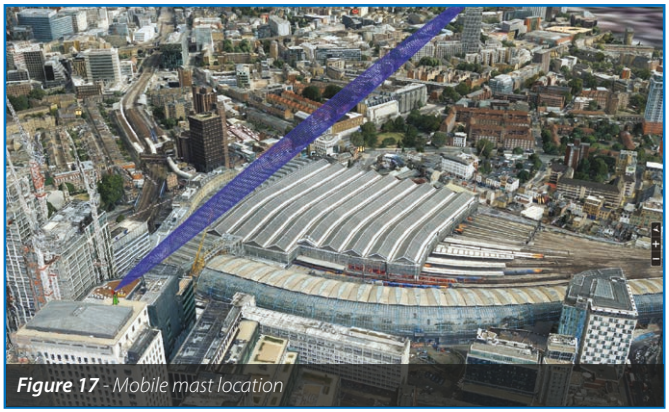

Figure 17 *- Mobile mast location*

Property – the ability to quickly and easily view and assess property location, construction and value.

Figure 18 *- Building attribution & query*

Insurance – visualising the built environment as it exists in 3D and therefore make informed decisions when quoting or loss adjusting property insurance. MetroVista™ can give invaluable information about the location, position, structure and even condition of a property. After an event the data can be used to see the extent of damage or change, particularly in respect of roof detail.

Figure 19 *- 3D measurements*

Flood & Pollution Modelling – understanding the complex 3D nature of a city is crucial in order to carry out accurate computational fluid dynamic modelling of flooding and air flow through different urban landscapes.

Figure 20 *- Flood modelling*

Navigation – The quality of map data with navigation systems has improved significantly since their introduction several years ago. MetroVista™ data combined with 5G technology means that the data presented during a journey is only set to get better.

Figure 21 *- Overlaid with routing data*

Gaming - Provide 3D city models for the increasing number of realistic first-person games and simulators.

Figure 22 *- Villa Park, Birmingham full city model*

Renewable energy – The accuracy and detail of MetroVista™ means that the data can be used in modelling the optimum location and return on investment for both wind and solar renewable projects, as well as the visual impact of a proposed installation. It makes an invaluable public engagement tool.

Figure 23 *- Wind farm visualisation*

Tourism – a digital version of a city is invaluable for tourism, allowing visitors to plan their trip, and for visitor attraction promotion.

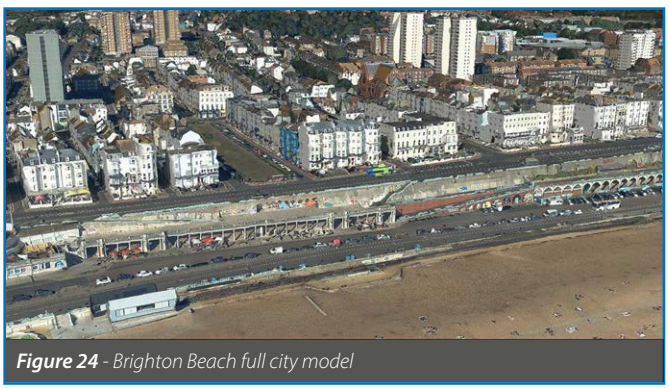

Figure 24 *- Brighton Beach full city model*

Figure 25 *- Bluesky's MetroVista™ (created from LiDAR and aerial photography)*

Conclusion

The way we view the world in the digital environment is changing. With the advent of technologies such as smart cities and autonomous vehicles, we need vastly increased levels of detail in our maps to ensure these technologies are safe and efficient. Previously fully rendered 3D models of entire cities have been very much a luxury, and except perhaps for the 'wow' factor, have not been operationally viable due to their massive data volumes. Mesh models have changed this; it is now possible to have a beautifully rendered, spatially and geometrically accurate model, that is not only visually impressive but can be streamed and ingested efficiently, which contains intelligence, and be queried and analysed, making it a powerful tool for all urban practitioners. The day of the mesh has arrived.

James Eddy
Technical Director
Bluesky International Ltd.

For more information on MetroVista™

Please call 01530 518518 or email info@bluesky-world.com

A selection of the cities available

London

Birmingham

Brighton

Bristol

Cambridge

Nottingham

Oxford

Available to order on the Bluesky Mapshop

www.blueskymapshop.com

www.bluesky-world.com +44 (0) 1530 518518 info@bluesky-world.com