MOBILE MAPPING TO IMPROVE WATER UTILITY SERVICES IN COCHABAMBA, BOLIVIA

GEOSPATIAL INFORMATION IS CRUCIAL TO PROPERLY MANAGE COMPANIES WHOSE ASSETS ARE FULLY DEPLOYED ON THE FIELD, AS IN THE CASE OF A WATER UTILITY. IN MOST CASES, GATHERING THIS DATA, WHICH IDEALLY SHOULD BE ACCURATE AND UP TO DATE, IS DELEGATED TO 'SOME TIME IN THE FUTURE'. THE FACT THAT UNTIL RECENTLY OBTAINING DATA IN THE FIELD WAS A RISKY, COSTLY AND TIME-CONSUMING TASK MAY EXPLAIN WHY IT WAS ALWAYS PUSHED FORWARD.

AMIDST THESE AND OTHER CONSTRAINTS/OBJECTIONS, CIVIS NEEDED TO PROVE THE ADVANTAGES OF USING MODERN MOBILE MAPPING TECHNOLOGIES TO HELP A WATER UTILITY COMPANY TO BUILD ITS GEOSPATIAL INFORMATION DATABASE, ALMOST FROM SCRATCH.

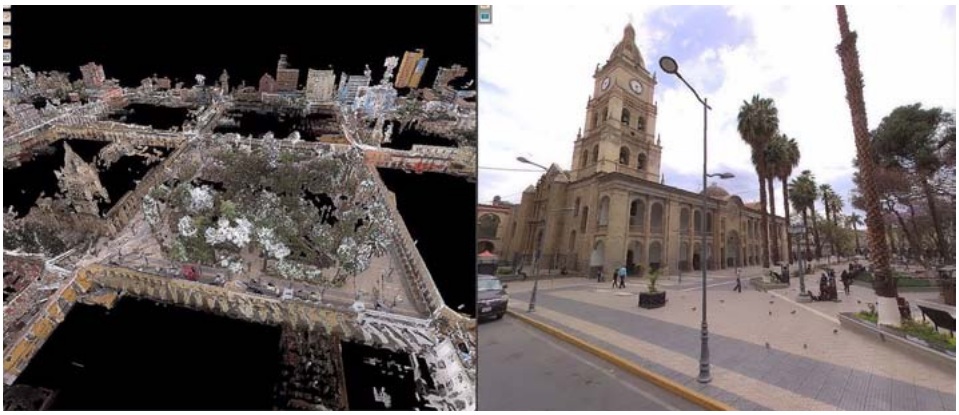
Water War

The world is running out of fresh water. The continuous depletion of water sources (reservoirs, underground, etc.) caused by climate change, amongst other variables, has turned the spotlight onto water utility management, which must ensure the supply of water to a growing population. A decrease in supply coupled with an increase in demand seems to be the name of the game in the water world for the years to come.

SEMAPA, a water utility company located in the city of Cochabamba (Bolivia), is no stranger to this phenomenon. It is charged with supplying water to some 1.000.000 inhabitants, but due to scarcity of water and funds, it can only reach two thirds of the target population. Leaving the rest, mainly in the poorest neighbourhoods, to find a water supply solution by themselves. This is achieved at a higher price and with water of dubious purity from trucks and also with self-managed little water cooperatives.

Cochabamba is known worldwide for the famous 2002 'Guerra del Agua' (Water War), a conflict that erupted in response to an increase in local water rates, following the privatization of the municipal water utility. The private consortium that won the contract, which was dominated by the United States-based Bechtel Corporation, had doubled and tripled water rates.

What looked like just another conflict among many others in Bolivia, ended rather violently. The national government declared martial law in Cochabamba, the third-largest city in Bolivia. A good part of the population was in the streets, battling police and soldiers. Finally, the price increase was fully revoked, the consortium's 40-year contract annulled and, unfortunately, many people were wounded and a seventeen-year-old student died. It is being said since then that the protesters **won the war but lost the water.**



Cochabamba's main square in 3D and spherical views, within Orbit 3DM Feature Extraction

Challenges

Since the end of this conflict, water has been incorporated as a human right in Bolivia's Constitution, and it became a thorny issue whenever any increase in water rates is discussed. As a matter of fact, water rates are heavily regulated and none of the water utilities in the country has the right to modify them without central government consent. Besides, the water rate structure is designed to subsidize water-access to anyone, no matter their income level.

Spherical picture of location with good urban infrastructure

Area with very deficient urban infrastructure. The water barrels in front of the house are used to receive water from water trucks, two times per week

Though right from a social standpoint, perspective looks complicated – to say the least – from the water utility investment needs.

In the past decade, SEMAPA has been compelled to prioritize its investments, mostly in the expansion of its water and wastewater pipe network. Leaving aside the investments needed in systems to efficiently manage and maintain these networks and the whole infrastructure in general.
As an illustration of this situation, their commercial system was running on Novell, an operating system that was discontinued over 20 years ago. They also had some outdated and incomplete spatial information running on isolated PCs, using an open-source GIS.

In this context, they decided that the time to invest in intangible solutions and systems had come, such that the entire organization will modernize its operations. Towards this end, they launched a competitive bidding to find a company that brings to the table a viable solution to update, visualize, manage and measure their field assets and pipe network information, knowing that:

- they had serious budgetary restrictions;
- assets and pipe network were stretched out over an area covering around 3.000 hectares;
- the starting point was an outdated and most probably inconsistent database about field infrastructure.

Solution

To submit a bid, we needed to devise a solution that, whilst satisfying these constraints, should also prove to be cost- and time-effective. We knew that – without a unified platform on which geospatial information pertaining to the different assets (pipelines, valves, pumps, reservoirs, service connections, water meters, etc.) could be loaded, distributed, updated and/or consumed – **all efforts would have ended with the same current analogue problems but in a digital format.**

Data capturing

By experience, we were aware that Mobile Mapping technology could speed up geospatial data capture and production, and that LiDAR point clouds integrated with 360° high-resolution imagery would provide the functionality and feel of reality on the desktop. This would speed up adoption by users with limited IT knowledge and experience, which in the end would be one of the project success keys.

We decided that data acquisition would require the combination of high-resolution images and 3D point clouds to allow detailed observations, feature extraction and measurements. At this point, the outline of our plan was :
1. to start a mobile mapping data collection, incorporating 360o imagery and LiDAR point cloud; and
2. to integrate mobile mapping deliverables into their open-source GIS.

Data processing

Given that the data production side of the equation was already solved, we needed to find the platform to integrate and manage the data, knowing that this platform should at least allow them:

1. to publish mobile mapping data through a web browser for browsing imagery, point cloud, performing detailed measurements and basic feature extraction;
2. to merge with their GIS, and probably also allow to load other sources of information, such as satellite imagery and eventually orthophotos;

3. to use geoidal heights;
4. to deliver all the content in Spanish;
5. to have the possibility to access information through mobile devices;
6. to shorten their learning curve, so they can quickly start using the delivery products and incorporate them into their own workflow;
7. to work seamlessly on computers with very low computing power and within an intranet.

To satisfy this 'wish list', we headed straight in one direction, as all these requirements could be met by the Orbit GT portfolio. And, more specifically, Orbit 3DM Content Manager and Orbit 3DM Publisher, as we will explain below.

Eventually, with all the pieces of the puzzle in place, we submitted our bid, hoping that both scope, schedule and cost would satisfy the client. They did, and we were awarded the contract.

Implementation stage

We started data capture using a Topcon IP-S2 hardware system. The target area covered the whole spectrum of urban development. Starting from areas with first-class urban infrastructure, to areas with a non-existent or fully underdeveloped urban infrastructure, and some others in between.

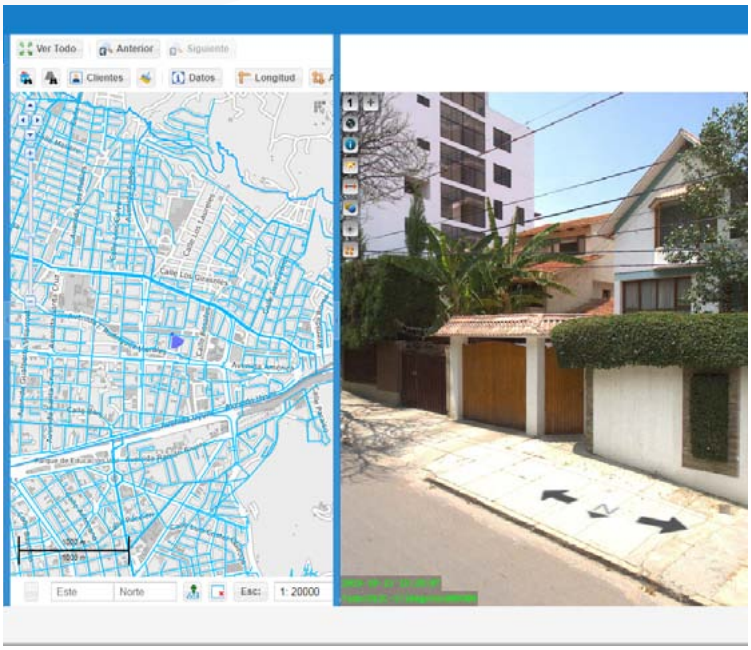
The first one was covered at a brisk pace. The in-between zone presented some challenges, mainly due to the placement of overhead telecommunication cables and advertising billboards at elevations far below of what is allowed. This forced us to stop the car many times per hour, in order to avoid not only cutting these cables, but also damaging our equipment.

As for the third area, it was a daily nightmare, with all kind of complications due to topography (slopes up to 50%), nonexistence of streets and very aggressive residents, many of whom thought we were there either for tax- or home property-related issues. Representing about 30% of the project area, this third area took us more than 60% of the data collection time.

The data collected was pre-processed and imported into Orbit 3DM Content Manager, with which we organized the captured 3D data. 3DM Content Manager gave us the necessary tools to clean up multiple passes and LiDAR point cloud data noise, as well as to optimize image quality and make the necessary adjustments required to optimize data for performance before sharing it. Finally, we exported the data set to Orbit 3DM Publisher. As with all the Orbit solutions, these processes ran smoothly and timely.

Our final task was to integrate Orbit 3DM Publisher into their GIS, which we did by using Orbit SDK. Their GIS is a web-based application using PostGis, Geoserver and PostgreSQL. All these are open-source solutions. Not only because of budgetary considerations, but also because public institutions in Bolivia are mandated to migrate to this kind of platform. The integration allowed them to work in only one system, avoiding the annoying and time-consuming task of jumping between two systems all day long, which turns out to be a deterrent that limits the use of a system.

The integration improved user's adoption bringing mobile mapping into what was already a familiar environment to them. Moreover, it facilitated the editing and update of their GIS layers, using imagery and point cloud coordinates. This way their



Integration Orbit SDK + Open Source GIS

Water meters' inventory

goal of having an accurate an updated geospatial information can now finally be met.

Results

In the end, we were able to gather up to 500.000 images, each in an 8,000-by-4,000-pixel resolution, totalling a volume of 3TB. When adding the LiDAR data, the total data volume is about 21 TB of imagery and point cloud data.

Orbit 3DM Publisher has proven to be the ideal solution to share and manage all those terabytes of information effortlessly, easily combining imagery, point cloud, vector and raster data. The client can access a georeferenced LiDAR point cloud and 360o imagery data sets in a web-based environment, without noticing delays due to the huge amount of information that is going back and forth.

Before the project implementation, in the event of a service interruption, quick access to water and wastewater pipeline network data – as well as the ability to locate, diagnose, and respond to the failure – was a challenge. Currently, this information turns out to be at just a few clicks of time and distance away. Thus allowing the staff to focus on the problem's solution rather than on collecting information needed to solve the interruption.

Orbit 3DM Publisher has become an indispensable tool for planning different tasks and field interventions, enabling workers to connect and collaborate in a timely and thoughtful way. More people from different areas within the organization are involved. Together they can analyse the situation and find solutions to different problems in a fraction of the time and cost they needed before the implementation. They can run countless spatial data derivatives and field reality interpretation capabilities as well as measurements of distances, areas and even volumes. Thus facilitating decision-making processes across the entire organization.

Street level content adds value to many other tasks throughout the company. This way they are also improving workflows on quite different domains. For instance, feasibility studies and technical specification definition of water and waste-water pipe network extension jobs.

As for the commercial side of the organization, they can identify inaccuracies on users' categorization (e.g. between residential and commercial). This has a great impact on the water rates that they are allowed to charge to every one of the users. This could translate in an annual revenue growth of at least 7%.

It also has become an effective and objective communication tool with the user base and is avoiding a lot of interpretation conflicts regarding the user's category.

Identifying Private and Commercial users using spherical imagery in Orbit 3DM Publisher

ABOUT THE AUTHOR

Fernando Terrazas, CIVIS's COO, has extensive experience working in the geomatics industry, being one of its leading experts in Bolivia. He has also worked in other countries, including Brazil, Paraguay, Peru, Colombia, Panama, Honduras and Mexico. Fernando was in charge of the project discussed in this article.

He has been working in CIVIS group for nearly 15 years and has extensive experience leading system development teams. Over the last years, he has become a specialist in the development and integration of open-source systems with a GIS component into enterprise-wide systems.

ABOUT CIVIS

CIVIS Bolivia is a leading geospatial company and Orbit GT's Bolivian reseller. Using mobile mapping technologies, CIVIS has covered around 15.000 km of streets in different cities in Bolivia for municipal and utilities clients. In Bolivia CIVIS has extensive experience working with aerial photography, DTMs, DTEs, orthophotos, 3D cartography production as well as geomatics systems development. We have also worked in Brazil, Peru and Mexico.

Located in Cochabamba, Bolivia, CIVIS services clients throughout Latin America.