Towards a uniform quality of sub-surface utility infrastructure locational data

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Abstract: It is a fact that the available sub-surface space is quickly filling up and that the risk of damage to infrastructure and the environment is increasing steadily. On the other hand, a large number of technological advancements have greatly improved the quality of the implementation and management of underground pipeline and cable assets. These advancements not only span equipment to install pipelines, ducts and cables, but also the GIS technology, sub-surface locating systems and other geo-referencing technologies give the user more information to base a decision on. But is *more* information also *better* information or is it a false sense of security? As I have experienced worldwide, the latter is often true because most asset managers 'do their own thing'. So who can and should take action in the chain op sub-surface pipeline and cable installation, maintenance and management to evolve towards a uniform quality of asset data? This presentation will assess the each stakeholder's role and responsibility in the chain and suggest a possible solution towards creating a uniform quality of data over the next couple of decades.

1. INTRODUCTION

If you wish to gain an understanding of the complexity of underground utility infrastructures and space utilization you should participate in the planning and engineering process of a new pipeline and cable installation in an urban area. The number of stakeholders involved in underground infrastructure projects grows exponentially as its location becomes more urban. The key stakeholders in such a project are:

1. The initiator of the project, usually the *pipeline or cable owner*. The initiator may contract out the engineering of the project to a third party so they will be considered as one.
2. *Call-Before-You-Dig desks*
3. *Other utility owners* who have infrastructure in the direct vicinity of the project.
4. Higher level *authorities and regulators*.
5. The *municipality* in which the project is planned.
6. The *contractor(s)* performing the work.

Of course there are several smaller stakeholders, such as the general public, but for the purpose of this paper only the key stakeholders are considered.

Not surprisingly, each key stakeholder has a different agenda and the varying agendas is one of the root causes of the current generally poor state of underground geographic information. In the latter half of the last century, many national and local authorities have allowed utility sectors to self-regulate the manner and extent of maintaining orderly and safe operations, including the detail of underground geographic information. Of course some general regulations about right of way and coverage needed to be met, but there was hardly any specific regulation for data accuracy and exchange formats. As a result each utility sector defined regulations as close as possible to their own agenda and usually this meant minimal cost and minimal liability rather than long-term coherent planning. Furthermore, within a utility sector the format of data collection and storage was not defined.

As the underground got busier and the number of incidents and accidents increased, authorities gradually imposed tighter regulations to improve safety and reduce damage. However, regulatory authorities often lack the resources to verify that regulations and permit requirements are met and/or to maintain a sophisticated GIS platform to store underground information. Materialization of a regulatory change was (and still is) therefore too

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slow. In addition, regulations tend to focus on new installations rather than existing pipelines because retroactive inspection is often too expensive and/or technically not feasible. Also, imposing regulations for locating existing pipes and cables will create competitive disadvantages in liberalized markets. For example, a former incumbent telephone operator usually owns a vast amount of legacy network dating from the days that the company was state owned and was obliged by law to connect the entire country or region regardless of the return on investment. New telecom operators are not burdened with such a vast legacy network and therefor would have a competitive advantage.

Despite the efforts made by GIS system developers, technology developers, contractors, regulators and pipeline and cable owners, it appears that the past is weighing heavily on defining a transparent and coherent solution for the future. A minimum requirement is a shift in approach whereby the past is treated separately from the future. Once this shift is accepted then 'all' that is needed is one entity in the chain of pipeline and cable installation to implement a coherent and non-discriminatory process of collecting and storing as-built data for all underground pipes and cables. This regulation must be fair, economically viable and technically possible. The question is: who in the chain can do and afford this task?

2. OBTAINING EXISTING UTILITY INFRASTUCTURE DATA

One of the key steps in the planning and design process of new pipes and cables is obtaining information about existing utility infrastructures. Many countries have implemented a centralized point of contact where planners and contractors can (and in most cases *must*) request information about existing utility infrastructures in the vicinity of planned pipe or cable installations. Examples of such centralized points are One-Call in the US, Klik in the Netherlands and Klip in Belgium (hereafter as a group referred to as Call-Before-You-Dig-Desks).

Call-Before-You-Dig-Desks typically provide a list of contact persons for those utilities which are present in the area while at the same time informing the utility's contact person that a specific query was made by the requestor. The utility owner is obliged to send a map to the requestor identifying the location their assets and it is up to the requestor to draw an integrated map of the underground. This sounds good and efficient but there are a number of problems:

1. Call-Before-You-Dig -Desks do not guaranty that their database is complete. In other words there could be other utilities in the ground that they do not know about.
2. The maps sent to the requestor in most cases explicitly state that the information provided is no guaranty of completeness nor accuracy.
3. There often is no standard for data exchange and as a result the requestor has to merge a variety of formats to obtain an overall view.
4. There is no information about abandoned pipes and cables.

Problem 2 poses an obvious paradox: on the one hand utility companies do not want their assets damaged yet they are unwilling to guaranty the completeness nor accuracy of the information they provide to third parties. Of course there is the liability issue but with a multitude of locating technologies available today the how much longer that card can be played for justifying such general disclaimers?

One of the main reasons for utilities to continue to add the no-guaranty disclaimer to the information they provide to third parties is because their GIS-platforms contain a mix of old and new assets. Accuracy of asset location is dependent on the state-of-the-art of surveying technology at the time of installation. Older assets were often referenced to physical objects such as houses, curbs and other landmarks. If these reference points have disappeared over time and the paper map was not updated at the time of the change, the actual location of the asset is likely to be lost. More importantly, most paper maps contained 2D information only, the depth was assumed to be a fixed depth beneath the (no longer existing or remodeled) surface. Also, underground utility lines are frequently put in the ground not according to design but wherever it has been easiest and cheapest to

build them. Positional data of underground infrastructure that are included in the post-completion project hand-over are often “as-designed” not “as-constructed” and are notoriously unreliable.

In order to enter analog data into modern GIS platforms many paper maps have been converted to digital data manually. This which begs the question how the analog data was dealt with in areas where the surface level had changed, let alone the error of simply the width of the original line on the map! I refer to this type of data as *digitized data*. The problem with digitized data is that in a GIS platform it looks like data obtained using modern digital technologies and there usually is no accuracy label associated with it. The innocent user of such data cannot distinguish the difference between accurate an inaccurate piece of data and hence the standard policy of utilities to add a disclaimer based on the lowest common denominator in the GIS platform. Without pressure from regulatory bodies to change this practice I do not see why utilities will voluntarily discontinue this practice, I wouldn’t.

So a GIS- platform may be state of the art, the data stored therein is most likely not.

Problem 3 should also be relatively easy to solve in the next decade or so because most GIS-platforms can save data in an open exchange format. I have all too often heard from contractors that they treat the obligation of contacting a Call-Before-You-Dig-Desk as a ‘tick-the-box’ activity for insurance purposes. Particularly for smaller jobs where the budget is tight already many contractors prefer to dig carefully rather than to spend resources on integrating the feedback received from other utilities into one coherent map. And given the no-guaranty disclaimers on the maps received I understand the contractors’ reasoning, in most cases they get blamed anyway if they hit another utility, even if the information provided by that utility is grossly incorrect.

Problem 4 is an interesting one. Many utility owners only keep a record in their GIS platform of operational assets. Pipes and cables that have been abandoned tend to be deleted from the GIS-platform yet often remain in the ground. All too often work has to stop to investigate ghost pipelines that are uncovered which later turn out to be abandoned assets. Some regulators have recognized this growing issue and have defined regulations to remove abandoned pipes and cables but this is not always possible and this is not always desirable. The fact remains that if abandoned pipes and cables are left in the ground someone must keep a record of them.

Call-Before-You-Dig-Desks, with a few exceptions, do not manage an integrated GIS-platform containing data from all utilities. Even if they did, they would be reluctant to share the data with third parties because they do not know if it is accurate or complete so they could be held liable if something goes wrong. Furthermore, for obvious reasons network owners are reluctant to have third parties share their network information amongst each other without their knowledge.

Despite the fact that each stakeholder fully understands the benefit of improving the quality and transparency of network data, in most countries and states there is not one group of stakeholders that can step up to the plate and provide a full solution. What is clear is that change must be driven by regulation and that self-regulation must be kept to a minimum.

3. IT IS NOT ALL DOOM AND GLOOM

The issue of managing the underground data is not new and has been on the agenda of many local and national authorities for some time. A number of cities and countries have allocated funds to implement plans and processes to tackle the challenge.

Some examples [1] on a city-level are:

- **Tokyo, Japan** – Many years ago Tokyo developed the mainframe-based Road Administration Information Center (ROADIC) system which was deployed first in Tokyo and then in most major cities in Japan. The ROADIC system provides an accurate map of all underground infrastructure including

telecommunications and utilities.

- **Sarajevo, Bosnia** – Over 40 years ago as part of the permitting process, Sarajevo mandated the recording the location of all utility and telecommunications infrastructure in the city. Initially this was done manually on paper maps. Several years ago Sarajevo began converting these maps to digital format running on Oracle Spatial.

- **Las Vegas, USA** - Over half a decade ago the head of Public Works at the City of Las Vegas foresaw significant potential in 3D modeling city infrastructure. At that time the city had had little experience with 3D modeling but recognized that a local consulting firm had a broad range of in-house capabilities in engineering including public works and 3D subsurface utility engineering, survey including laser scanning, GIS, building information modeling (BIM), and visualization that could help the city take advantage of new areas of technology. At the same time the City and other public agencies conducted workshops to identify and understand the problems they were facing where 3d infrastructure mapping could contribute to a solution.

- **Calgary, Alberta** – A number of years ago the City Government passed a by-law which mandated that all utilities and telecoms working within city limits must provide data showing the geolocation of their infrastructure to the city's Joint Utility Mapping Project (JUMP). JUMP provides a single database that shows the geolocation of all underground utilities.

- **Penang, Malaysia** – Penang-s Sutra D'Bank(Penang State Government Subterranean Data Bank is maintained by a joint venture company EQUARATER (PENANG) SDN BHD (EPSB) formed by Equarater Sdn Bhd and the Penang Development Corporation. Sutra D' Bank's customers are utilities or any other party undertaking excavations in areas under the jurisdiction of the state government.

- **Sao Paulo, Brazil** – The City of Sao Paulo's GeoCONVIAS project integrates data from 20 to 30 utilities which operate in the city of Sao Paulo. **Rio de Janeiro, Brazil** - The City of Rio de Janeiro has a similar project GeoVias funded by the government of the City of Rio de Janeiro and four utilities.

Some examples on a national level are:

- **France** – French National Institute of Geographic and Forest Information (IGN), referred to a large ten year, multi-billion euro project involving IGN and France's utilities to map all of France's underground utility infrastructure in 3D to an accuracy of 40 cm (about 16 inches). For this purpose the Decree defines three levels of cartographic accuracy for underground structures;
    - Class A: if the maximum uncertainty of location indicated by the utility operator is less than or equal to 40 cm.
    - Class B: if the maximum uncertainty of location indicated by the utility operator is greater than that for Class A and less than or equal to 1.5 meters.
    - Class C: if the maximum uncertainty of location indicated by the utility operator is greater than 1.5 meters, or if the operator is not able to provide the location.

  The Decree states that uncertainty in the geographical location of a structure is considered likely to jeopardize the construction project or significantly impact the technical or financial conditions of its implementation when the geolocation of the structure is classified in accuracy classes B or C. For structures falling in this category, the utility operator is required to initiate a process to reduce this uncertainty to achieve the goal of class A as quickly as possible.

- **The Netherlands** - The Dutch Call-Before-You-Dig system, called KLIC, has been in place since 1967. The objective of the system is to prevent damages to the utility network and to ensure the safety of excavators during excavations. In 2010 the Netherlands switched to a digital information system (KLIC-Online) that works in a similar way except that everything could be done online. With (the now mandatory) KLIC-Online the turnaround time was reduced to hours.

At present, the Dutch Kadaster, Land Registry and Mapping Agency is in the process of implementing KLIC-WIN, which is an adaptation of KLIC-Online to meet the future needs of the industry as well as to be compliant with the national WION legislation and the European INSPIRE Directive. One of the 34 themes of the INSPIRE standards initiative concerns Utility Services (INSPIRE-US), which obligates public network operators to make their data available online through viewing and download services. INSPIRE-US (Annex III Sub-theme 6a Utility Services) is obligatory for 80% of Dutch network operators. There are some challenges including authentication, authorization, and accounting, how to include the private sector, specifically telecom, and the IT architecture. Different architectures have been proposed including centralized, distributed, and a hybrid model.

The above selected local and national initiatives are encouraging and address at least some of the identified issues but none of them is covering them all. It is important to realize that the initiatives on national level do not specify *how* to achieve the directives and *who* should ensure compliance whereas the initiatives on city level are more specific but the system is often too complex and/or expensive for smaller municipalities to implement.

4. THE AS-BUILT COMPLIANCE AGENCY

In the context of the ongoing privatization of utilities it is no longer obvious that the taxpayer should foot the bill for the cost of the verification of works carried out on (private) utility lines and cables. So it is not the role of the municipality to invest in sophisticated software platforms. The principle of 'the polluter pays', or rather 'the digger pays' should be applied in this case.

Based on the analysis so far the ideal model for a transparent, coherent and uniform quality underground pipeline and cable database would need to meet at least the following criteria:

1. It must include all utilities
2. It must include live and abandoned pipelines
3. It must be available for urban and rural areas alike
4. It must be non-discriminatory towards utilities
5. Incremental costs for the contractor/network owner must be low
6. Accuracy requirements must be technically achievable
7. Data entries must contain a quality label

I believe the solution that addresses the 7 minimum criteria, has minimum impact on the existing permit structure, is virtually free for the municipalities and will ensure that the vast majority of underground infrastructure will carry a quality label in three to four decades, is the establishment of an *Independent As-Built Compliance Agency* (hereafter referred to as the Compliance Agency). The Compliance Agency will implement, maintain, populate and manage a comprehensive GIS platform and will manage the as-built data for a multitude of municipalities free of charge.

To enable the Compliance Agency to commence its activities it is crucial that some minimal changes to the existing permit process are implemented:

- Permits must be amended to contain clear and achievable norms for accuracy and digital format of as-built records. Depending on the technique in which cables and pipes are laid a norm should be specified. Currently, the most frequently used techniques are direct trenching, trenchless technologies and re-habilitation. The current state of technology allows for highly accurate mapping of all three methods.

- Permits must stipulate that as-built information must be presented to the Compliance Agency for review upon completion of the works. The as-built must be presented in a common digital standard. Given the current state of GIS software, uniform digital exchange of data has become fairly simple.
- Permits must stipulate that permit holders must submit to the Compliance Agency the location of pipes and/or cables that have been abandoned or will be abandoned as a result of the permitted works.
- Permits must stipulate that projects are deemed officially completed only upon receipt of a compliance certificate issued by the Compliance Agency.

The Compliance Agency must be set up as an independent body responsible for certifying that as-built data is accurate and compliant with the permit. Once certified, the data will be entered into a centralized Geographic Information System (GIS).

The Compliance Agency will run a server-based GIS platform. Approved third parties, for example one or more municipal officials involved in public works and planning, can access the information in their municipality through a web interface. The big advantage of a server based application is that virtually no IT investment is required at the municipal level.
Should a municipality already have a GIS platform then a predefined interface can optionally be developed that makes it possible to easily exchange data. Conversely, if a municipality in the past received as-built data but does not have an appropriate GIS platform, it can request the Compliance Agency to record these in the central GIS platform.

Optionally, the as-designed or as-permitted route can be entered into the platform so that it can be compared to the as-built position afterwards.

After verification that the works are completed in accordance with the norms and, if applicable, information about abandoned pipes is handed over, the Compliance Agency issues a *Compliance Certificate* for a fee to the permit holder. The Compliance Agency adds the certified data to the central GIS file and notifies the relevant municipal official.

5. THE LEGAL FRAMEWORK

From a legal point of view, the following points must be addressed:

- Amendment of the permit.
- Ownership of the data.
- Use of the data.

Ownership of the obtained data is still a sensitive issue. Utility companies often argue that only they can be the sole owner of the locational data. That is an understandable argument when data needs to be exchanged with parties that intend to carry out excavation activities near their infrastructure. However, if the regulations require network owners to provide accurate locational data to the land registry, they also become owner of the data.

The key legal question is what a party can do with this data, in particular when it comes to making data available to third parties. Regardless of whether an authority may or may not share proprietary information it is usually not in the interest of the authorities to provide locational data to third parties because authorities will want the work to be carried out as safe as possible so the network owners of nearby infrastructure must be made aware of a pending excavation. The Call-Before-You-Dig desks will therefore continue to function as is.

But ... we need to differentiate between active cables and pipes and abandoned cables and pipes. If a few decades municipalities will have the most extensive active file of abandoned cables and pipes so it is not

illogical that they are going to be party when a contractor registers a planned work with a Call-Before-You-Dig desk. This service can also be fulfilled by the Compliance Agency on behalf of the municipality.

6. THE FINANCIAL FRAMEWORK

The cost for the participating municipalities is limited to the costs involved in adapting the license and consulting the central GIS platform. These additional costs are expected to be more than offset by an increased efficiency in the permit application process.

Setting up and managing a central GIS platform by the Compliance Agency will be largely funded by the applicants of the permits through a fee charged for issuing the Compliance Certificate. Additional income can be created through charging for access to the GIS database. To make the principle acceptable prices must be kept reasonable and non-discriminatory which is possible because the Compliance Agency can benefit from scale advantages as the number of municipalities it serves rises.

7. CHINA IS IN A UNIQUE POSITION

Reduct has been active in China for over 7 years and finds that a unique situation exists in Chinese market due to the centralized nature of government. Each major city or region in China has a Mapping Institute that, amongst many other tasks, defines the norms and methods of obtaining as-built data and endorses the technologies permitted to obtain them. As a result, the construction sector is already used to some form of compliance protocol with a single entity which is a huge advantage compared to most other countries across the world. So actually, the Mapping Institutes are well positioned to assume the role of a Compliance Agency.

To fully become a Compliance Agency requires one main area of improvement: the verification process. In our experience, some contractors are cutting corners when it comes to applying the endorsed technologies. One suggestion is to amend the regulations in the permit regarding mapping methods and accuracy so that they are tailored to the method of pipe and cable installation (trenching, trenchless, etc.). In addition, there should be regular site inspections to ensure that the regulations are properly followed.

8. CONCLUSION

All stakeholders in utility sectors recognize the benefit of a single coherent method of recording end sharing as-built data of underground infrastructure. However, to reach this goal is not simple because poor legacy network information, competitive (dis)advantages and budget constraints form a threshold. Self-regulation has proven to be ineffective in the past so the only viable option to reach the goal is through regulatory measures. But regulatory measures alone are not likely to yield the desired result in the desired timeframe as particularly the budgets on municipal level to follow-up on the regulations may take many years to be made available.

Therefor I propose to implement As-Built Compliance Agencies to coordinate and manage the implementation of new regulations in such a way that has minimal impact on municipal budget and resources. The Compliance Agency will gradually develop a data base of accuracy labeled as-built data while at the same time addressing the growing issue of abandoned pipes and cables. Additional advantages of this proposal are that the cost to permit holders will be non-discriminatory and can be kept to a minimum through scale advantages of the Compliance Agency. Furthermore, this proposal will provide a solution for urban and rural areas alike.

Will this solution end the practice of the ‘heavy’ disclaimers on shared as-built? Probably not in the immediate future but as data accuracy labeling increases there is good hope that one day the disclaimer can (must?) be removed.

9. ABOUT REDUCT

Reduct is a leading developer of inertial navigation based underground pipeline mapping equipment. With products able to map pipes and ducts with an internal diameter of at least 40mm, Reduct provides innovative solutions for virtually all utilities. For more information please visit www.ductrunner.com or visit us at the China Getlink Llc booth.

References

[1] Geoff Zeiss. “Accelerating World-Wide Initiatives to Map Underground Utilities”, Weblog, May 22 2014.