HLCONSULTING

Response to

Request for Information on Underground Infrastructure Mapping and Modelling

From

OGC®
Making location count.

Version 1.0

15th of March 2017

Autorisation

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Content

1 Document Information

This is a Response document to the Request for Information on Underground Infrastructure Mapping and Modelling from the Open Geospatial Consortium (OGC).

1.1 Overview

Section 2 contains the "Executive summary".

Section 3 gives an introduction to who we are

Section 4 describe the use cases for underground mapping and modelling

Section 5 highlights architecture, standards and technologies

Section 6 explains the implementation examples

1.2 Abbreviations

AGIV	Agentschap voor Geografische Informatie Vlaanderen
API	Application Programming Interface
AWS	Amazon Web Services
CAD	Computed Aided Design
CDS	Concept Development Study
DWG	Drawing file
FDO	Feature Data Objects
FES	Feature Encoding Specification
GIS	Geographic Information Systems
GML	Geographic Markup Language
GRB	Grootschalig Referentie Bestand (Large Scale Reference database)
HALE	HUMBOLDT Alignement Editor
HLC	HL Consulting
IMKL	Informatie Model Kabel en Leidingen (Cable & Pipe Information Model)
INSPIRE	INfrastructure for SPatial InfoRmation for Europe
KML	Keyhole Markup Language
KLB	Kabel en Leiding Beheerder (Cable and Pipe Maintainer)
KLIP	Kabel en Leiding Informatie Portaal (Cable & Pipe Information Portal)
KLIM	Kabel en Leiding Informatie Meldpunt (Cable & Pipe Information Point of Contact)
Oauth	Open Authorization
OGC	Open Geospatial Consortium
PAV	PlanAanVrager (Plan requestor)
PDF	Portable Document Format
REST	REpresentational State Transfer
SLD	Styled Layer Description
TAW	Tweede Algemene Waterpassing (Belgian Reference Level)
UML	Uniform Modelling Language
VM	Virtual Machine
WFS	Web Feature Service
WMS	Web Map Service
XML	eXtensible Markup Language

2 Executive Summary

The Open Geospatial Consortium (OGC) has launched a Request for Information to gather information in support of a Concept Development Study (CDS) on mapping, modeling, capturing, analyzing and sharing data about underground infrastructure.

HL Consulting, by means of its Managing Consultant, Luc Van Linden (Individual Member of the OGC), has more than 18 years of experience in helping utilities to organise their infrastructure documentation. One the key area's of our activities is to support and organize the automated responses, via our hosted solution HLC kliXresponder, to as-built plan and location inquiries of underground assets for a series of such utilities.

In Belgium the request for as-built information is organised via 2 centralised portals. One being a federal portal, the other one, in Flanders, is a regional portal maintained by the Flemish Government. This last one is called KLIP and given its overall approach, both in terms of process as in the model used for the exchanged data, is a good example and reference to use with respect to this Request Of Information.

We start by providing some high-level background to KLIP, some conceptual approach for the system and the explanation of the model used. Secondly we highlight some of the main challenges for the utilities to become conformant, mainly from a technical point of view. Finally we provide some insight to a technical implementation being used in an automated hosted approach for the daily processing of these inquiries.

Although there is a lot more to be said and explained, we have tried, given the minimum amount of time and material at hand available, to be brief as a starter. Should more information be required we are open to questions or discussions.

3 Description of responding organization: HL CONSULTING

HL Consulting is based in Belgium.

Luc Van Linden, Managing Consultant, has over 20 years of experience in GIS and is more than 18 years active in the utility sector. He has worked 8 years in a telecommunication company, first as senior GIS engineer later as Operations Manager Fiber Infrastructure and Transmission.

As such we have both operational experiences in plan, built, operate, maintain as equally in the field of documentation, as-built management and asset management systems.

We consult in a variety of telecommunications & utility companies directly and indirectly through engineering agencies.

Besides the consultancy, we offer in Belgium a hosted platform, accommodating our utility customers with an automated service to respond to inquiries for as-built information of their underground assets.

Luc is an Individual Member of the OGC, consulting, implementing and using OGC standards such as GML, WFS, WMS, KML, FES, SLD.

Within Belgium, we are mandated by a series of utility companies to attend and contribute to the workgroups involved by one of the online platforms, KLIP (being explained later on).

As such we believe we are in good position to respond to this request of Information.

4 Use cases for underground mapping and modeling

4.1 Introduction KLIP (source Flemish Government)

KLIP, (in Dutch: “Kabel- en LeidingInformatiePortaal” or “cable and pipe information portal”) aims at reducing excavation damage by means of exchanging cable and pipe information before work starts. The first version of this e-government portal, operated by the Flemish Information Agency (formerly known as AGIV, Flemish Geographical Information Agency) was taken into production in 2007, facilitating the process of plan requests towards network operators by a central web site.

The use of KLIP by plan requesters and network utility operators is mandatory by law since 2009. Although the insurance sector reported a significant reduction of damages throughout the years, some important issues were raised. Network operators were still sending their information all in a separate way:

on paper, CD-rom, stick, emailing pdf-scans or other…

on different scales…

with different geographical reference systems…

on different background maps.

It still took a long time for excavators to interpret all these information sources in order to ensure safety during the excavations.

Since the new KLIP Digital Phase portal was put into production in April 2015, a new and completely digital era has arrived. This fully scalable solution with cloud-based services facilitates the digital exchange of network information through KLIP.

As of January 1, 2016, this exchange is supported by law through an updated KLIP-decree, making this digital exchange mandatory, obliging the use of the IMKL model (in Dutch: “InformatieModel Kabels en Leidingen” or “Information Model regarding cables and pipes”).

This vector model is based on the INSPIRE data specifications on Utility Services. With 200.000 annual plan requests the excavation and engineering sector sees **benefits** on two fronts:

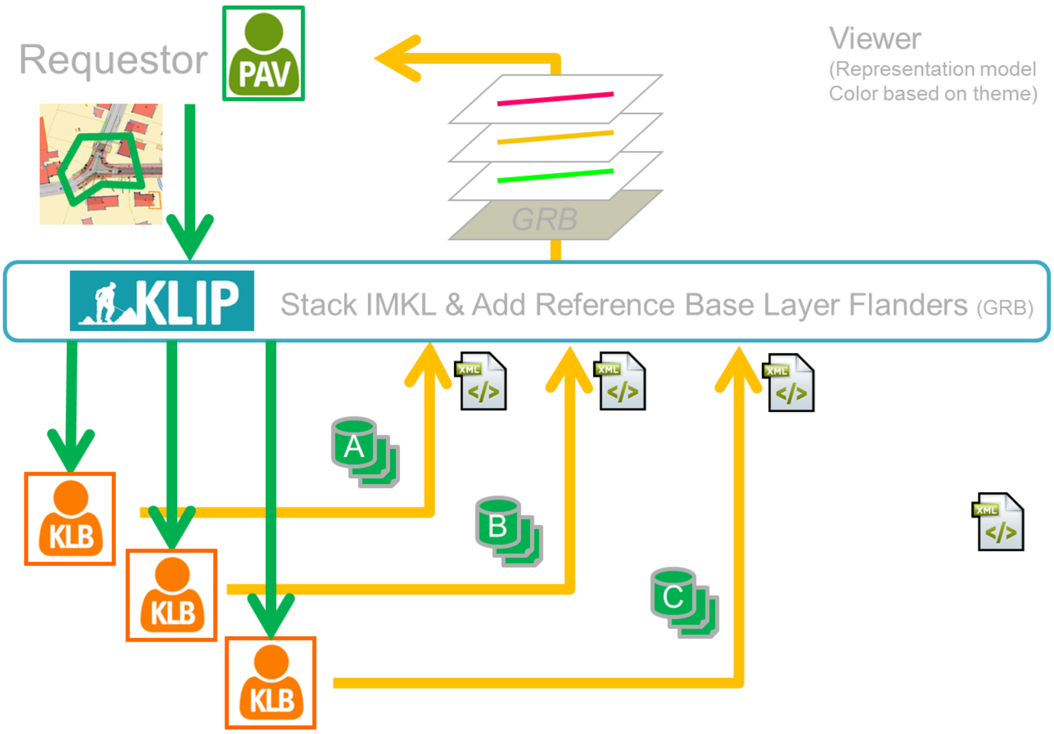
- a reduction of interpretation time (and costs) of 60% on average and a financial saving of millions of euro’s. saved by both governments and the private sector!
- Furthermore, plan requesters can download digital information snapshots to use for electronic steering of excavation or drilling operations. Although utility network companies had to make important investments to adapt to the updated law, they optimized the governance of their own information system. Major cost savings are realized through the automated request answering process. The roll out of the updated system means that all the costs incurred by printing and physical delivery of plans to the excavators have vanished.

4.2 KLIP conceptually

This platform centralizes all the plan requests and distributes them back to the utility companies (KLB). These in their turn have to exchange their underground network information in a single uniform datamodel IMKL (Informatie Model Kabel en Leidingen).

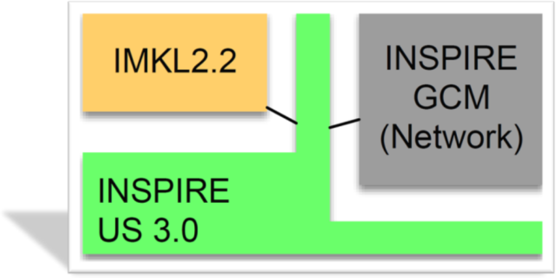
The KLIP portal superimposes the supplied information of all underground utilities per request in a single view according a common representation model. This way the requestor has a single view on the underground assets within the area of the request.

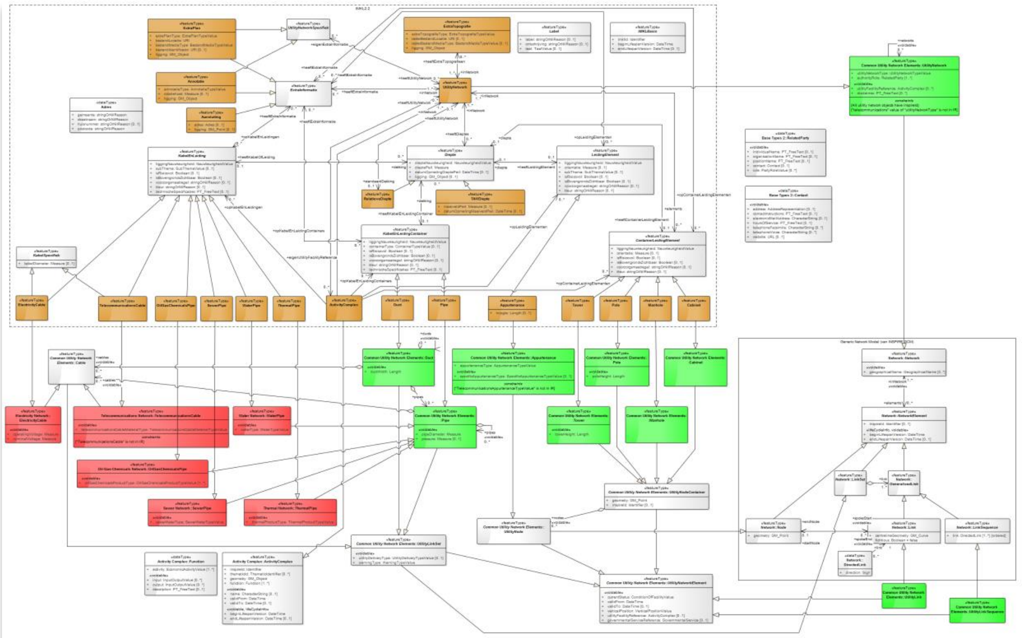
Only network objects are supplied for the underground networks. These need to fit the single large scale reference database for Flanders. It is the KLIP portal that presents the required information on top of that background map.

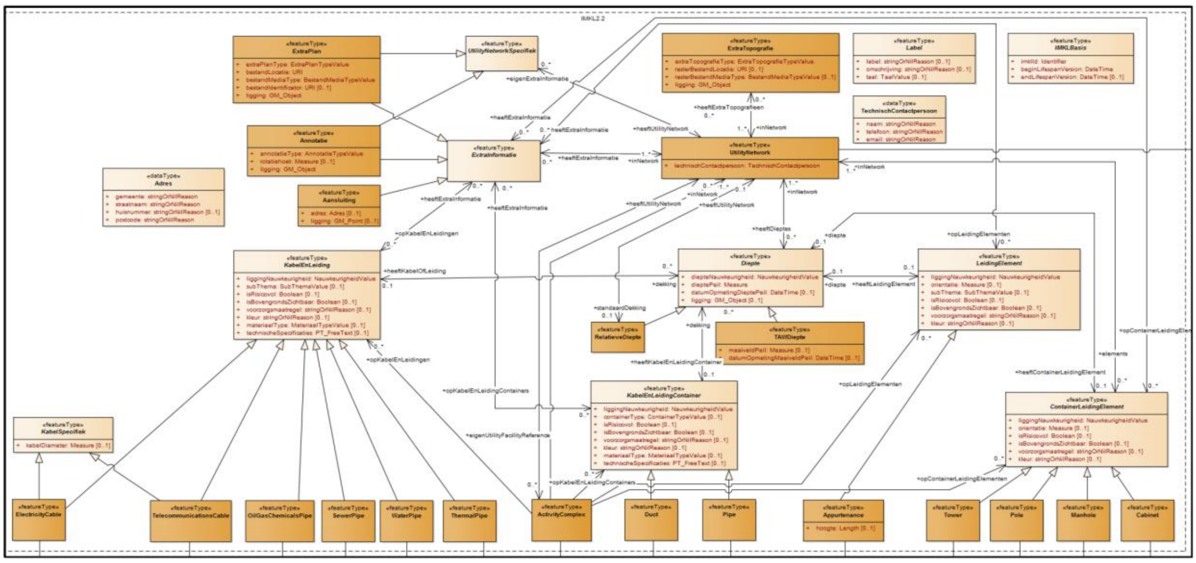


4.3 The IMKL Model

This single uniform datamodel IMKL (Informatie Model Kabel en Leidingen, “cable and pipe information model”) is an INSPIRE based conceptual model, containing all the underground assets defined as objects.







4.4 The IMKL encoding

The supplied network information in such an IMKL package is encoded according to the Open Geospatial Consortium (OGC) GML 3.2.1 standard.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- <gml:FeatureCollection xsi:schemaLocation="http://mir.agiv.be/cl/AGIV/v1/xmlns/IMKL2.2 IMKL2.2_rc_12062014.xsd" xmlns:us-net-wa="http://inspire.ec.europa.eu/schemas/us-net-wa/3.0" xmlns:us-net-th="http://inspire.ec.europa.eu/schemas/us-net-th/3.0" xmlns:us-net-tc="http://inspire.ec.europa.eu/schemas/us-net-tc/3.0" xmlns:us-net-sw="http://inspire.ec.europa.eu/schemas/us-net-sw/3.0" xmlns:us-net-ogc="http://inspire.ec.europa.eu/schemas/us-net-ogc/3.0" xmlns:us-net-el="http://inspire.ec.europa.eu/schemas/us-net-el/3.0" xmlns:us-net-common="http://inspire.ec.europa.eu/schemas/us-net-common/3.0" xmlns:imkl="http://mir.agiv.be/cl/AGIV/v1/xmlns/IMKL2.2" xmlns:gmlexr="http://www.opengis.net/gml/3.3/exr" xmlns:gmd="http://www.isotc211.org/2005/gmd" xmlns:base2="http://inspire.ec.europa.eu/schemas/base2/1.0" xmlns:base="http://inspire.ec.europa.eu/schemas/base/3.3" xmlns:base_net="urn:x-inspire:specification:gmlas:BaseTypes:3.2" xmlns:net="urn:x-inspire:specification:gmlas:Network:3.2" xmlns:act-core="http://inspire.ec.europa.eu/schemas/act-core/3.0" xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:gml="http://www.opengis.net/gml/3.2" gml:id="HLC_1">
  - <gml:featureMember>
    - <imkl:Pipe gml:id="pi_D4C">
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        - <base_net:Identifier>
            <base_net:localId>pi_D4C</base_net:localId>
            <base_net:namespace>be_HLC_klipDF_ZoneA</base_net:namespace>
          </base_net:Identifier>
        </net:inspireId>
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        <net:link xlink:href="http://mir.agiv.be/data/INSPIRE-US/v3/UtilityLink/be_HLC_klipDF_ZoneA:ul_D4C"/>
        <us-net-common:currentStatus xlink:href="http://inspire.ec.europa.eu/codelist/ConditionOfFacilityValue/functional"/>
        <us-net-common:validFrom nilReason="Not applicable" xsi:nil="true"/>
        <us-net-common:verticalPosition nilReason="missing" xsi:nil="true"/>
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        </net:centrelineGeometry>
        <net:fictitious>false</net:fictitious>
        <us-net-common:currentStatus xlink:href="http://inspire.ec.europa.eu/codelist/ConditionOfFacilityValue/functional"/>
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        <us-net-common:verticalPosition nilReason="missing" xsi:nil="true"/>
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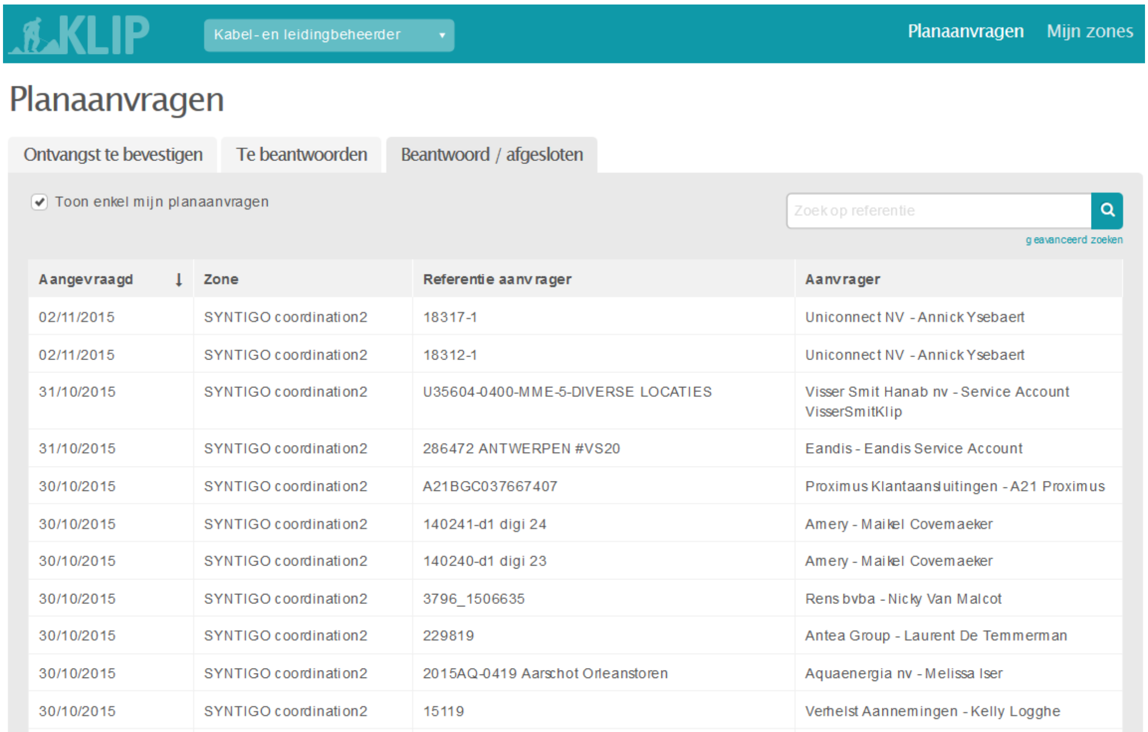
    </gml:featureMember>
```

4.5 The representation model in the KLIP viewer

The portal facilitates both for the requesters (PAV) as for the utility owners (KLB) a login to consult all the request being made and addressed.



KLIP | Kabel- en leidingbeheerder | Planaanvragen | Mijn zones

Planaanvragen

Ontvangst te bevestigen | Te beantwoorden | Beantwoord / afgesloten

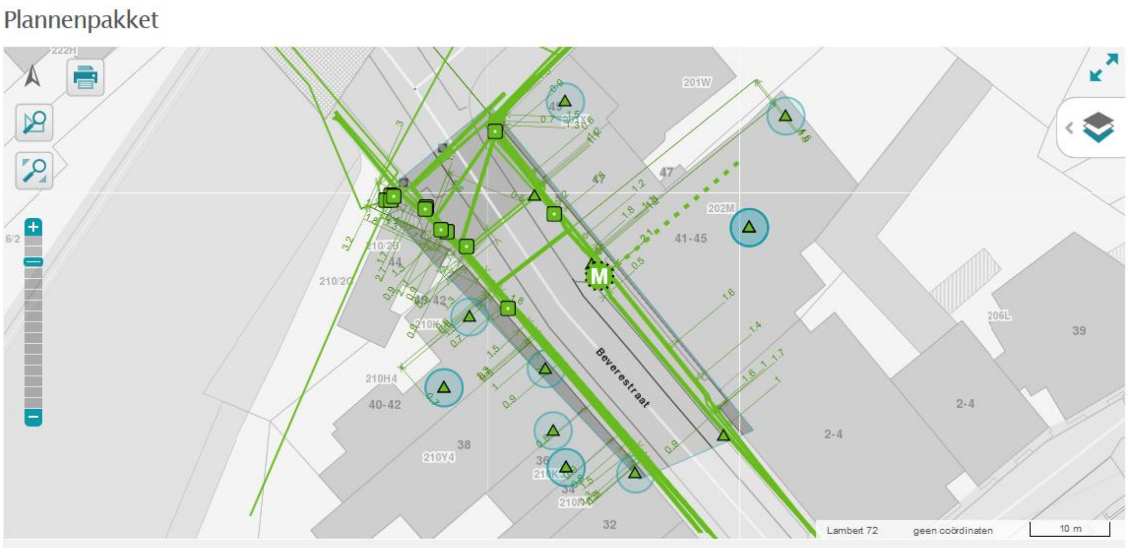
Toon enkel mijn planaanvragen

Zoek op referentie

geavanceerd zoeken

Aangevraagd	Zone	Referentie aanvrager	Aanvrager
02/11/2015	SYNTIGO coordination2	18317-1	Uniconnect NV - Annick Ysebaert
02/11/2015	SYNTIGO coordination2	18312-1	Uniconnect NV - Annick Ysebaert
31/10/2015	SYNTIGO coordination2	U35604-0400-MME-5-DIVERSE LOCATIES	Visser Smit Hanab nv - Service Account VisserSmitKlip
31/10/2015	SYNTIGO coordination2	286472 ANTWERPEN #VS20	Eandis - Eandis Service Account
30/10/2015	SYNTIGO coordination2	A21BGC037667407	Proximus Klantaansluitingen - A21 Proximus
30/10/2015	SYNTIGO coordination2	140241-d1 digi 24	Amery - Maikel Covemaeker
30/10/2015	SYNTIGO coordination2	140240-d1 digi 23	Amery - Maikel Covemaeker
30/10/2015	SYNTIGO coordination2	3796_1506635	Rens bvba - Nicky Van Malcot
30/10/2015	SYNTIGO coordination2	229819	Antea Group - Laurent De Temmerman
30/10/2015	SYNTIGO coordination2	2015AQ-0419 Aarschot Orleanstoren	Aquaenergia nv - Melissa Iser
30/10/2015	SYNTIGO coordination2	15119	Verhelst Aannemingen - Kelly Logghe

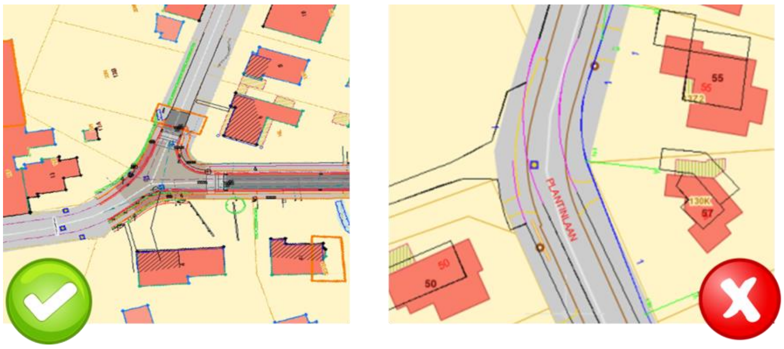
The single request can be consulted equally. Here a request with only telecom information (green).



4.6 Challenges for the Utilities

4.6.1 Fit the common reference large scale base map/database,

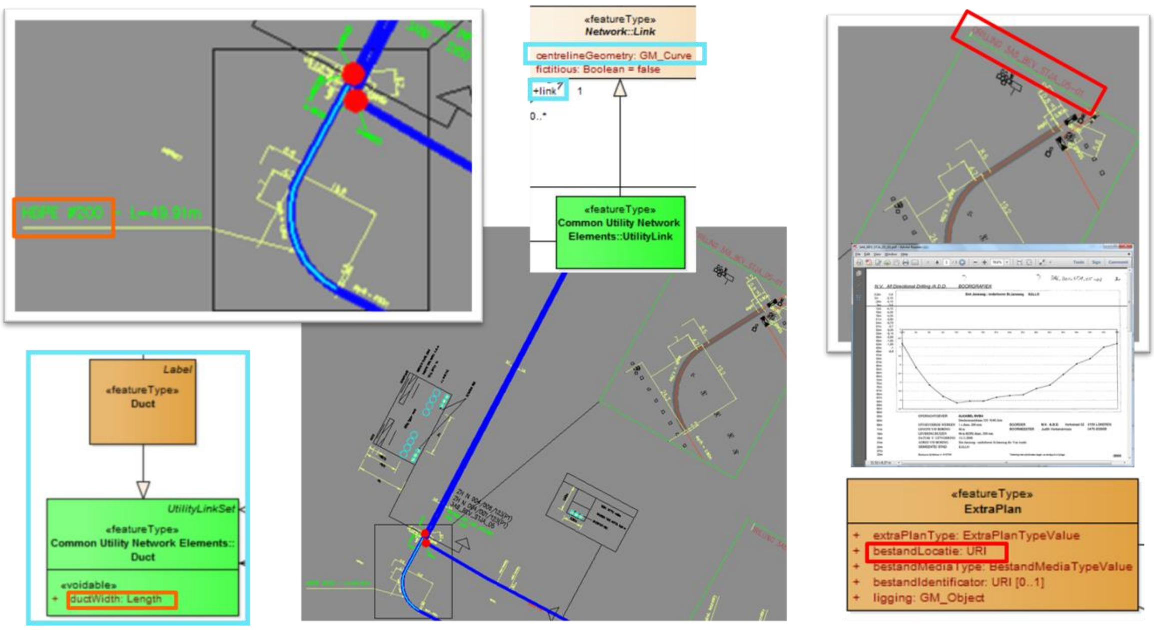
With other words is the network information available as vectors and are these correctly georeferenced?



4.6.2 All are required elements, properties and relationships available in the core datasets?

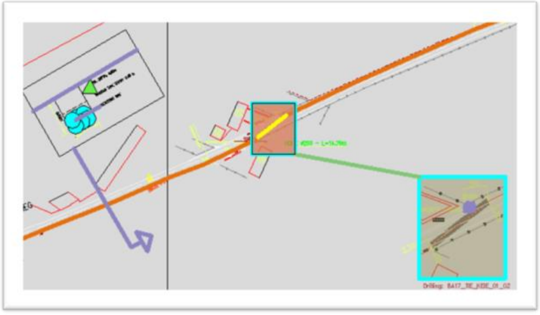
In a lot of cases, these as-built information comes from Cad files and require a CAD to GIS transformation and difficulties to extract or deduct the relevant attributes and relationships.

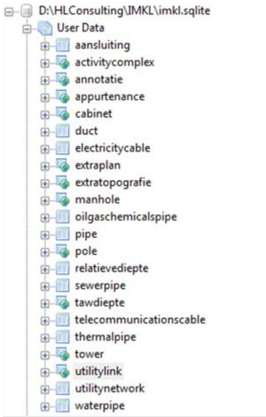
For example, a duct container object (drilling under a road), comes with a drilling profile, usually maintained in a pdf file somewhere on a network drive. In the CAD as-built file, this is text “floating around” somewhere. This text object needs to be correctly tied to geometry in order to have a proper attribution and relationship between the final duct object and the extra-plan object pointing to the PDF document.



4.6.3 Is all source information normalised, well-structured and mappable?

Most CAD files require a thorough scrutiny ensuring they are well normalized. Once this is done, information can be extracted on a manual, semi-automatic or full automatic manner to transfer the elements into the IMKL model. For doing so, a flattened relational database model is implemented.





4.7 Additional points of attention

4.7.1 Unique identifiers

From Inspire, and in practice equally in the GML encoding, all object / features require a unique id. Inspire foresees the uniqueness including a namespace and optionally a version number. GML requires a unique gml_id. As such all objects deducted from the CAD files will be given a unique id.

Additionally, in the model some attributes are modeled as objects, for example a depth. This means that every depth object requires the same constraints for an INSPIRE id and gml_id.

4.7.2 Annotation objects

Although being absolutely positioned/georeferenced, against the reference large scale basemap, a lot of relative annotations (cad-dimensions) are being used to indicate the distance of the underground infrastructure towards specific topographic features like buildings. This helps the requestor to "read" the plan/map.

In GIS, dimensions as such do not exist as they do in the CAD world. This means that a single cad dimensions in transformed in 6 annotation objects, again each with its unique id constraints:

1 annotation line with 2 arrows, 1 annotation text and 2 help reference annotation lines

4.7.3 Extraplan information

As explained as example earlier on, extra-plans for example for drillings need to be maintained and need to be related to all relevant network objects.

4.7.4 Depth object

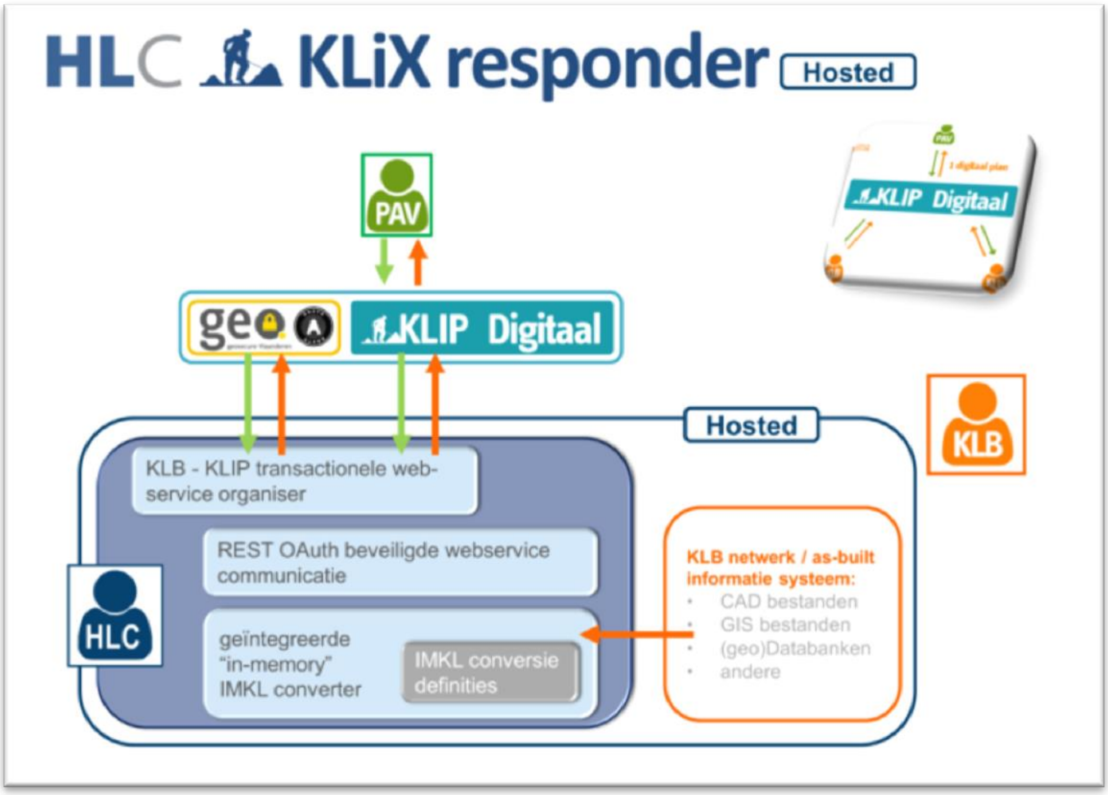
These can be relative (80 cm below surface) or can be referred to the Belgian national reference level (TAW). Clearly, this shows this is not a 3D model, rather a 2D model with some depth indications, not even being 2.5D.

5 Architectures, standards (solution for the Utility's side)

5.1 Example Hosted service to process and respond to all KLIP requests for the Utility Owner (KLB)

The KLIP portal facilitates in a series of secured web-services making it possible to fully automate the process on behave of a network owner. In short, all relevant map-request are polled, analysed and, when applicable, the relevant network information objects are transformed on-the-fly into an IMKL compliant package. This respond-package is uploaded to the portal and a validation report is logged.

This hosted service is offered to a series of utilities to accommodate the automatic responses on a day to day basis.



5.1.1 The KLB - KLIP transactional web-service organiser

This module takes care of all communication and transactions with the KLIP portal based on the KLIP Digitaal (REST) web-service API.

This communication is secured by OAuth 2.0 through the geoSecure service of AGIV using AccessTokens and RefreshTokens.

Necessary loggings (PostGIS) of the requests and the validation reports are taken care of to organise traceability and reporting. These requests and their responses can by all times be consulted through the KLIP portal.

5.1.2 Integrated on-the-fly IMKL transformation

This module will trigger the on-the-fly (ad-hoc and in-memory) transformation to fetch the relevant (per maprequest) network objects (source) and turn them into an IMKL compliant GML3.2.1/XML file (target). This way only those network objects that are in the maprequest are sent into a respond-package.

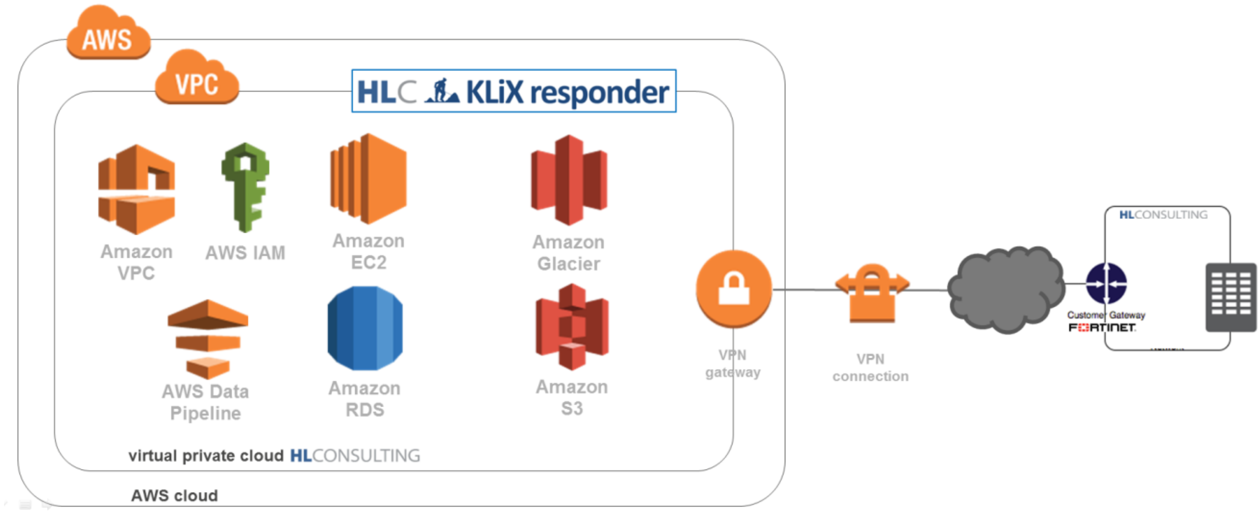
HALE (Humboldt Alignment Editor) from WETRANSFORM is used to perform the mapping from the relational (staging) databse to the IMKL GML encoding. To minimize the number of mappings to be maintained in HALE, we defined a GML application Schema to incorporate inheritance for the relational database schema at the source structure.

5.1.3 Hosted service

The full automated process to respond to the KLIP requests is offered through our HLC KLiX responder hosted service.

With our hosted service running in our private cloud on Amazon Web services (AWS), market leader in cloud computing, we offer our customers the required continuity, sustainability, flexibility, scalability, reliability and security.

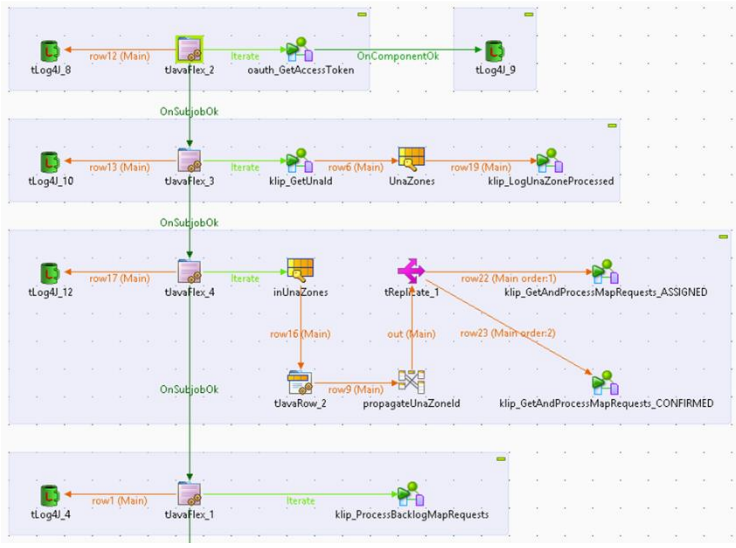
At the same time, the communication from within our premises to the private cloud is secured over a VPN for additional security.



6 Example implementation (solution for the Utility's side) using Open Source technology

Using the webservice API provided by the KLIP portal allows implementing a fully automated service to process all request and respond with conformant IMKL packages.

Following Open Source technology is used



TALEND
Mainstream IT
Open source Data Integration
& ESB platform

TALEND Spatial Extension
OPENSOURCE GEOSPATIAL ETL

https://github.com/talend-spatial

HALE

- defining conceptual schema mappings
- domain experts
- Maintained external to the processing
- Easy to maintain
- Rich capabilities
- Generates IMKL GML 3.2.1