A CABLE OPEN DATA EXCHANGE MODEL (CODEM) FOR MAXIMISING THE USAGE OF GEOGRAPHIC INFORMATION SYSTEM (GIS) WITHIN SUBSEA CABLE INDUSTRY

Alban Crusson (ASN), Alec Bost (FUGRO), Baptiste Verdier (ORANGE MARINE), Béatrice Legrée (ASN), Benjamin Marsh (ASN), Brian Perratt (OCEANIQ), Edouard Gouyon (ORANGE MARINE), Emilie Boulay (ASN), François-Xavier Abrial (ASN), Gwennael François (ORANGE MARINE), Hiromitsu Todokoro (KDDI), Kuroda (KDDI), John Wrottesley (ICPC), J. Ma (HMN), Joyce Chan (EGS), L. Shi (HMN), N. Liedkte (FUGRO), Michael Clare (NATIONAL OCEANOGRAPHY CENTRE UK), Michael Orr (SUBCOM), Nikolai Liedtke (FUGRO), Sergio Hernando (SUBCOM), Vincent Shu (HMN),William Shen (EGS).

François-Xavier ABRIAL
Marine Business Development Manager
Alcatel Submarine Networks
1 avenue du Canada,
91940 LES ULIS, FRANCE
email:Francois-Xavier.Abrial@asn.com.

Abstract: GIS platforms are key software which are becoming increasingly more essential in the effectiveness and efficiency during lifecycle of projects within the subsea cable industry (the “Industry"), from conception through to installation, operation & maintenance.
Therefore, there is a need for agreeing on a specific standard of digital data format that is easily accessible on both commercial and open GIS platforms, to better enable the sharing of data between the various actors of the Industry. This poster presents the proposed standard, named the “Cable Open Data Exchange Model (CODEM)”
An initial workgroup has already developed and demonstrated at the Suboptic 2023 in Bangkok the feasibility of CODEM by associating survey data and cable information into a single package. The workgroup has since then carried on with a larger contribution (see contributors list) for progressing on the most versatile package that is “open” for use on non-commercial GIS software, and therefore not limited to users being restricted to buying licenced access to commercial GIS software. This therefore ensures equality between all actors and stakeholders within the Industry to access the GIS data. One result from these meetings is an agreed upon, replicable data model which marine survey companies conducting the cable route surveys can populate and deliver directly to their clients.
We would like to propose that the Industry adopt this new standard. This joint poster will present the outcome of this work and decisions made for establishing a convenient format. This could trigger an additional paragraph within the current ICPC recommendation, or a new recommendation dedicated specifically to GIS data and the CODEM format standard.

1. INTRODUCTION

At the ICPC plenary in April 2022, an initial workgroup developed and demonstrated the feasibility of CODEM by associating survey data and cable information into a single package. In the months since, the workgroup has enlarged (now with 11 entities) and made progress on the most versatile package – one that is "open" for use on non-commercial GIS software and therefore is not limited to users that are required to buy licenced access to commercial GIS software. This ensures equality to access the GIS data across the entire Industry. The workgroup was also able to agree upon a replicable data model, which marine survey companies that are conducting cable route surveys can populate and deliver directly to their clients.

We propose that the Industry adopt this new model. This joint paper will present the ongoing work and decisions made for establishing a convenient format. This could trigger a new ICPC recommendation dedicated specifically to GIS data and the CODEM format model.

Geographic Information System (GIS) platforms are becoming increasingly enhancing the effectiveness and efficiency throughout the complete lifecycle of projects within the subsea cable industry, from conception to installation, operation, and maintenance. GIS are software that enable superimposition and interrogation of geospatial datasets (see Figure 1) for rapid and pertinent spatial analysis to support project-based decision making, for example to optimise engineering, to identify routing constraints, or assess where to perform a grapnel run during a repair operation. It is not necessarily the company supplying the initial cable system that will maintain the GIS until End of Life and there may be multiple end-users. Therefore, if there is a model accessible to all companies and stakeholders involved in a cable system, providing all of them with access to the same information on their screens, potentially with the same symbology, this will improve interactions between all parties.

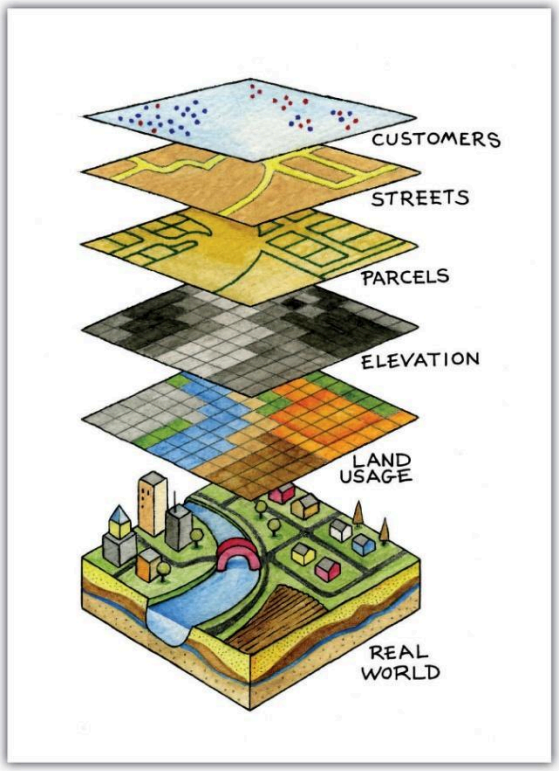

Figure 1: A Map Overlay Combining Information from Point, Line, and Polygon Vector Layers, as Well as Raster Layers to conceptually portray a GIS [1]

Typically, one set of data provides all corridor information recorded during the survey campaign, while a second set of data is focused on the cable system and associated engineering. Once delivered and accepted by the end customer, the first set of data is rarely amended. The second set of data related to the cable system is generally more dynamic, as it is updated as a result of any modifications to the cable engineering or repairs during the cable life.

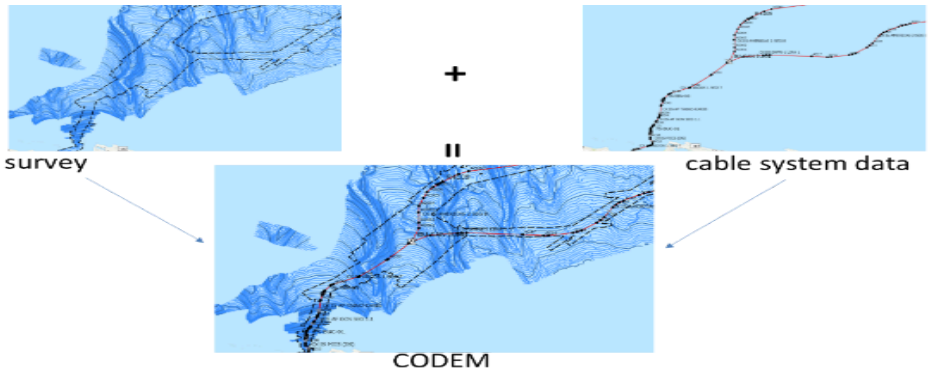

Figure 2: CODEM is composed of 2 main subsets: survey data & cable system data

The Cable Open Data Exchange Model is an exchange format, which does not constrain the native data structure of each company. The "Open" characteristic ensures that the data can be opened on different software platforms either for direct use and analysis, or to export the data for use in a company's native structure. For this first issue it is most likely that the following GIS systems will be used as they represent the vast majority of GIS users:

- A proprietary (or licensed) software namely ArcGIS from ESRI
- An open software namely QGIS (at the time of writing the latest Long-Term Release is 3.34)

The intention of this workgroup is not to substitute the Open Geospatial Consortium nor any similar organisation. The model will use an existing and proven format at the time of issuance. Then over the years, if an existing new format becomes necessary and beneficial to the model, this could evolve using a more advance proven solution.

2. DEMONSTRATOR PACKAGE

To facilitate the progress of the workgroup a demonstrator has been created.
As an implementation of the CODEM RPL Exchange Format described as far, a sample GeoPackage based on a fictional system, called DEMOSTHENE, has been created.

Demosthene is composed of 3 segments located in the Mediterranean Sea, connecting mainland Italy, Sicily, and Tunisia.

Figure 3: Demosthene system

Demosthene exchange file stores three fictional RPLs that represent the possible use cases met by the format:
•DEMOSTHENE_S01_BMH SABAUDIA TO BU SICILY_PR01_14-DEC-23: this RPL contain a fictional repair off the coast of Italy along with PRIB burial
•DEMOSTHENE_S02_BMH TUNIS TO BU SICILY_AL01_02-SEP-23: this RPL consists of an As-Laid RPL without burial.
•DEMOSTHENE_S03_BMH SICILY TO BU SICILY_AL01_05-SEP-23: this RPL consists of an As-Laid RPL with plough burial, providing an example of burial data.

3. SURVEY DATA PACKAGE

The workgroup initially investigated which convenient format could be used beyond the

model in use nowadays which are still largely dedicated to paper production of NorthUp and Alignment charts. Of relevance to this investigation is the Seabed Survey Data Model (SSDM) V2 created by the International association of Oil and Gas Producers (IOGP) [2]:

- The SSDM is an industry model for the storage and management of seabed survey data;
- SSDM V2 is extremely robust and widely used by major Oil and Gas operators for various geospatial applications;
- The model is already designed for use within the Esri geodatabase architecture and SeabedML.

Those data are recorded during survey operations, and there is no reason to modify them except under exceptional circumstances, therefore the model needs only reading / consultation on as many GIS platform as possible with the same level of display for all users.

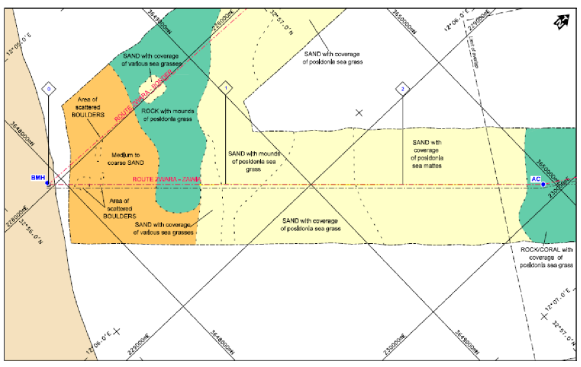

Figure 4: seabed geotechnical data

The Seabed Survey Data Model (SSDM) is based on geographic representations of objects mapped from seabed survey , their attributes, sources, and relationships.

The Cable Open Data Exchange Model survey subset (CODEM_survey) is an adapted version of the SSDM model developed by the IOGP. This has been presented to IOGP who is supporting this initiative. The CODEM_survey model is designed to serve the submarine cable industry by providing a common survey data format across the industry. No feature classes, attributes or domain values have been removed from the original SSDM model, only additions have made been made. The CODEMsurv workgroup is grateful to the IOGP for their hard work in producing SSDM without which we would not have been able to build from such a strong foundation.

SSDM is represented by 8 abstract classes and 38 concrete classes grouped in 4 feature datasets (Survey Measurements, Seabed Features, Shallow/Intermediate Geology and Environmental Samples). Concrete classes in a feature dataset share a common coordinate reference system. The grouping of the datasets allows companies to set topology rules, relationship classes, and geometry networks as required by their business processes.

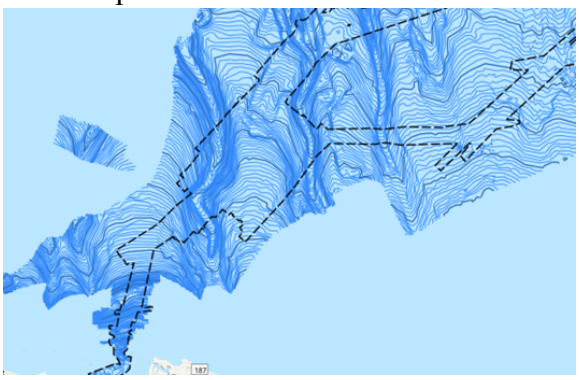

Figure 5: Seabed bathymetry & corridor

The above has allowed the workgroup to define an exhaustive Data dictionary covering all the needs for survey records. After inspecting each element, the workgroup has added 27 domain values mainly in “Line_Seabed_Feature” (see Table 1) & “Polygon_Sediment” (see Table 2)

IOGP2073 Boundary - Others	IOGP2073
IOGP2074 Inferred Boundary - Sediment	IOGP2074
CODEM2080 Megaripple crest	CODEM2080
CODEM2081 Cable IS	CODEM2081
CODEM2082 Cable OOS	CODEM2082
CODEM2083 Cable Unknown	CODEM2083
CODEM2084 Cable Other	CODEM2084
CODEM2085 Pipeline IS	CODEM2085
CODEM2086 Pipeline OOS	CODEM2086

Table 1: Example of CODEM additional domain values beyond SSDM for Line_Seabed_Feature

Description	Value
IOGP3204 Sandy-clay	IOGP3204
IOGP3205 Rocky	IOGP3205
CODEM3206 Gravelly Clay	CODEM3206
CODEM3207 Gravelly Sand	CODEM3207
CODEM3208 Gravel/Cobbles	CODEM3208
CODEM3209 Sandy Gravel	CODEM3209
CODEM3210 Outcropping Rock	CODEM3210
CODEM3211 Subcropping Rock	CODEM3211
CODEM3212 Boulder Field	CODEM3212
CODEM3213 Hard Ground	CODEM3213
CODEM3214 Sandy Silt	CODEM3214
CODEM3215 Clayey Silt	CODEM3215
CODEM3216 Gravelly Silt	CODEM3216
CODEM3216 Gravelly Silt	CODEM3216
CODEM3217 Coral	CODEM3217
CODEM3218 Fine Sediment	CODEM3218
CODEM3219 Coarse Sediment	CODEM3219
CODEM3220 Very Coarse Sediment	CODEM3220
CODEM3221 Subcropping Hardground	CODEM3221

Table 2: Example of CODEM additional domain values beyond SSDM for Polygon_Sediment

After several analyses, the package for CODEMSurv is an Esri file geodatabase (*.gdb) as it is one of the native structures of SSDM and it can be opened on both mentioned softwares.

In addition to this data structure & classification, CODEM aims to provide a common symbology ensuring a similar display on the end-users software. The principle is to add the generic file (it means it is the same set of file added to any CODEM transmission) dedicated to CODEM_survey style file ArcGIS for the initial package (the solution for QGIS will be deliver in ulterior CODEM package version)

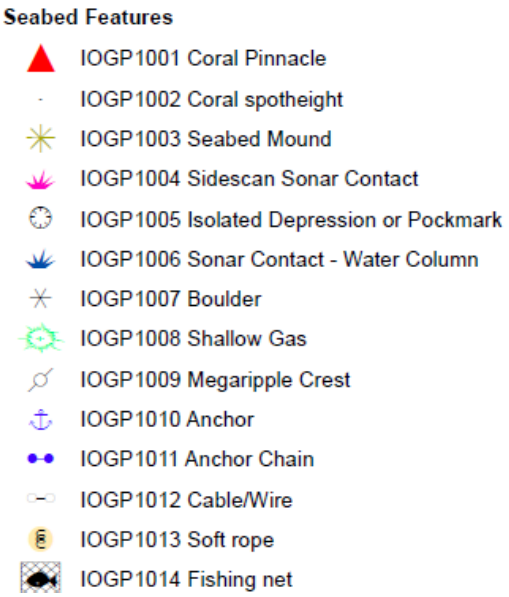

Table 3: Example of SSDM existing symbology

4. CABLE & ROUTE DATA PACKAGE

The CODEM_cable_system data are associated to engineering resulting from survey & desktop study deliverables. They are a richer version in term of data of the Route Position List ("RPL") and due to the GIS facilities can provide more displays. They are often amended throughout the life of the system to give the latest position and status of the

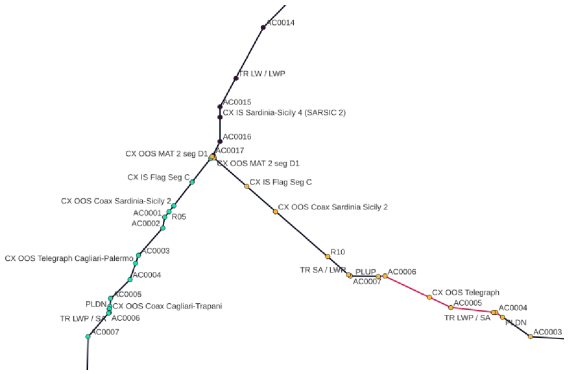

Figure 6: CODEM_cable_system event & cable engineering display cable (DEMOSTHENE).

Therefore, contrary to the survey package, the cable information needs to be easily amended. Moreover, the structure of data needs to accommodate multiple version/issue as depending on the context it can be extremely dynamic. Similarly to CODEM_survey, CODEM_cable_system needs to be visualised on as many GIS software as possible with the same display for each user.

As illustrated in Figure 5, the cable suppliers involved in the early workgroup have gathered & harmonized all pertinent data, which now needs to be agreed within the extended workgroup. The aim is to implement:

- Overhead table allowing traceability of RPL version;
- Table for the event point;
- Table for Cable engineering (including toggle when buried);
- Table for burial point (resolution as private agreement between initial supplier & end customer);
- Table for depth profile related to considered RPL.

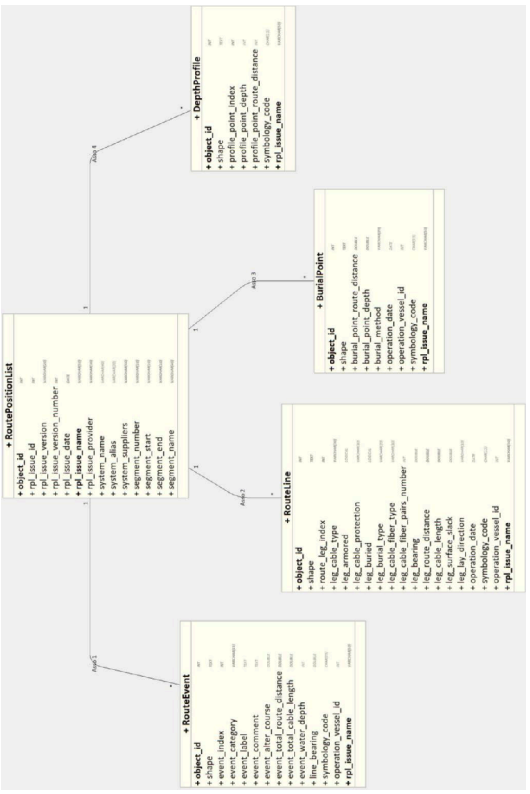

Figure 5: CODEMcable dictionary

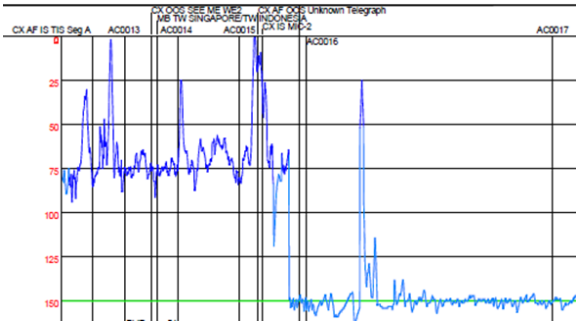

Figure 7: CODEM_cable_system possible burial display with effective burial depth in ordinates and Kilometric points (alter courses events indication) in abscissa

It has been decided to use geopackage (*. gpkg) for all cable system package.

The best compromise for packaging results from various trials and submitted for agreement through all members of the workgroup. With respect to symbology, we will need to decide if we create a generic list allowing to integrate all similar products under a limited list (e.g., Special Purpose

Application = Light Weight Protected = SymbolDeep_Water_protected) or symbology is kept independent for each manufacturer keep it (e.g. {SymbolSPA, SymbolLWP })

5. CONCLUSIONS

For both packages, a data dictionary has been established and overall CODEM will take the following form (see Figure 8) where subsets circled in purple are more static (read only) than the one in red (editing mandatory):

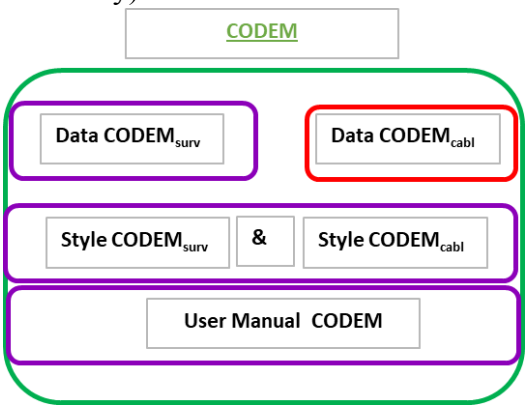

Figure 8: overall CODEM structure

CODEM material:

- File geodabase template for CODEM_survey
- File template for CODEM_cable_system
- Data dictionary for CODEM_survey
- Data Dictionary for CODEM_cable_system
- ArcGIS stylesheet
- Conceptual data model diagrams
- Users' guidelines

At the time of writing the CODEM is not totally finalised, but all the work done so far, and the extension of membership of the workgroup prove that it is conceivable to aim to define a convention agreeable by a significant number of entities and individuals involved in submarine cable industry by the end of 2025 through a dedicated ICPC recommendation. We believe the ICPC is the right choice of organisation to support this concept as it will bring the opportunity to recheck, fine tune or amend, if necessary, at regular interval this convention which will follow the progress of GIS software and associated database improvements. Moreover, the generalisation of data exchange through such process may trigger, at some point in the future, the abandon of deliverable through hardcopies or CAD files. Indeed they may be not needed anymore with the advent of GIS tools for query and spatial analysis.

6. REFERENCES

[1] source: https://saylordotorg.github.io/text_essentials-of-geographic-information-systems/s11-02-multiple-layer-analysis.html

[2] IOGP International association of Oil&Gas Producers https://www.iogp.org/workstreams/engineering/geomatics/seabed-survey-data-model/