



**ENCWG  
Presentation**

**ENC  
transformation**

**S-101 transition**

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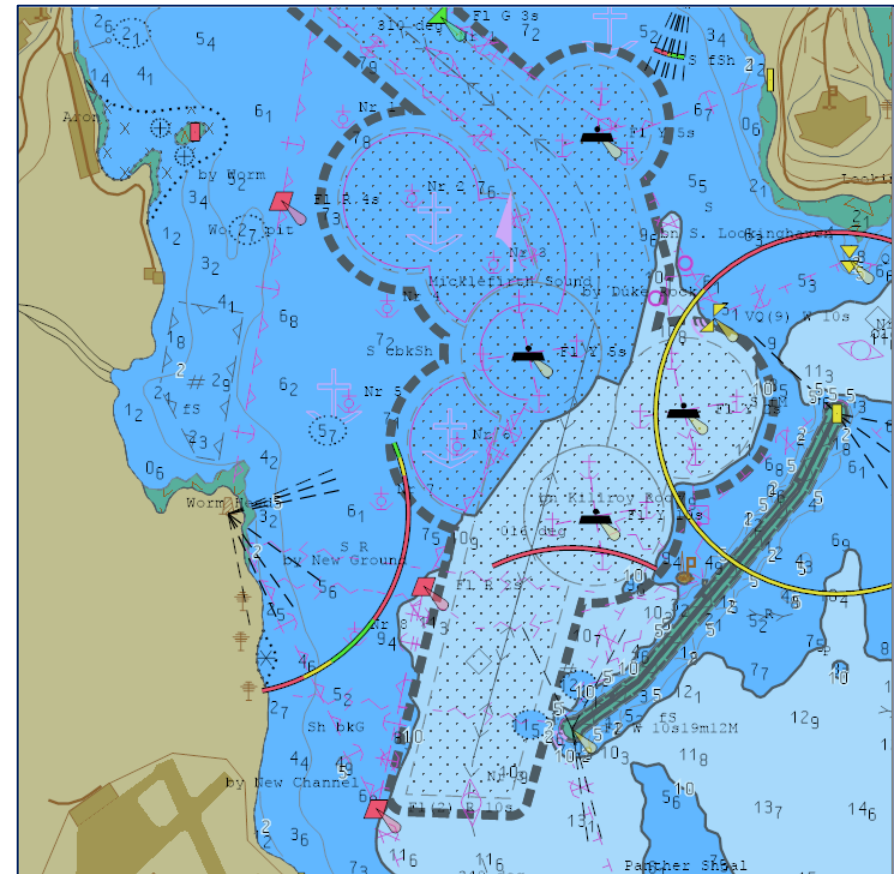
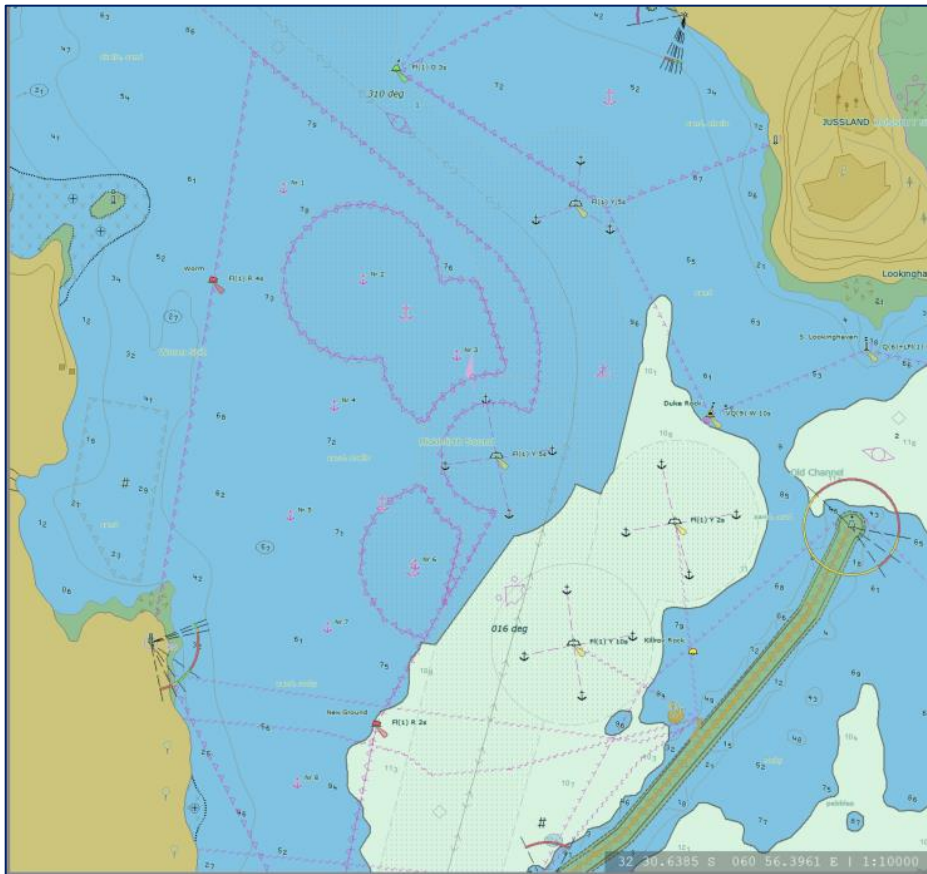
# Summary and Contents

- Background
  - IIC produced report 2018-2019 on ENC “conversion”
  - Asked “how to optimise current ENC encoding to better convert to S-101”
  - Used current IHO S-101 catalogue and DCEG
  - Report produced and circulated within S-100WG
- Now
  - Decade of implementation has commenced
  - S-100WG meeting has scoped out dual fuel ECDIS operation and implications for producers
  - S-64 and S-58 implementations are under way
  - Initial implementations are available of S-100 conformant COTS packages.
- This presentation
  - Will review the outcomes of the initial study and highlight for info their relevance for producers.
  - Look at some of the technical implications of S-57 alongside S-101

# Original Methodology

- Systematic methodology
- Looked at whole of ENC “content” as defined by S-57 object and attribute catalogue and UOC encoding guidelines
- Take into account member state variations/restrictions from UOC – i.e. local encoding guides
- Test out current tools.
  - ESRI Converter, S-57 to S-101
  - SPAWAR viewer and data inspector
  - Latest S-101 feature catalogue
  - S-57 UOC, S-101 DCEG

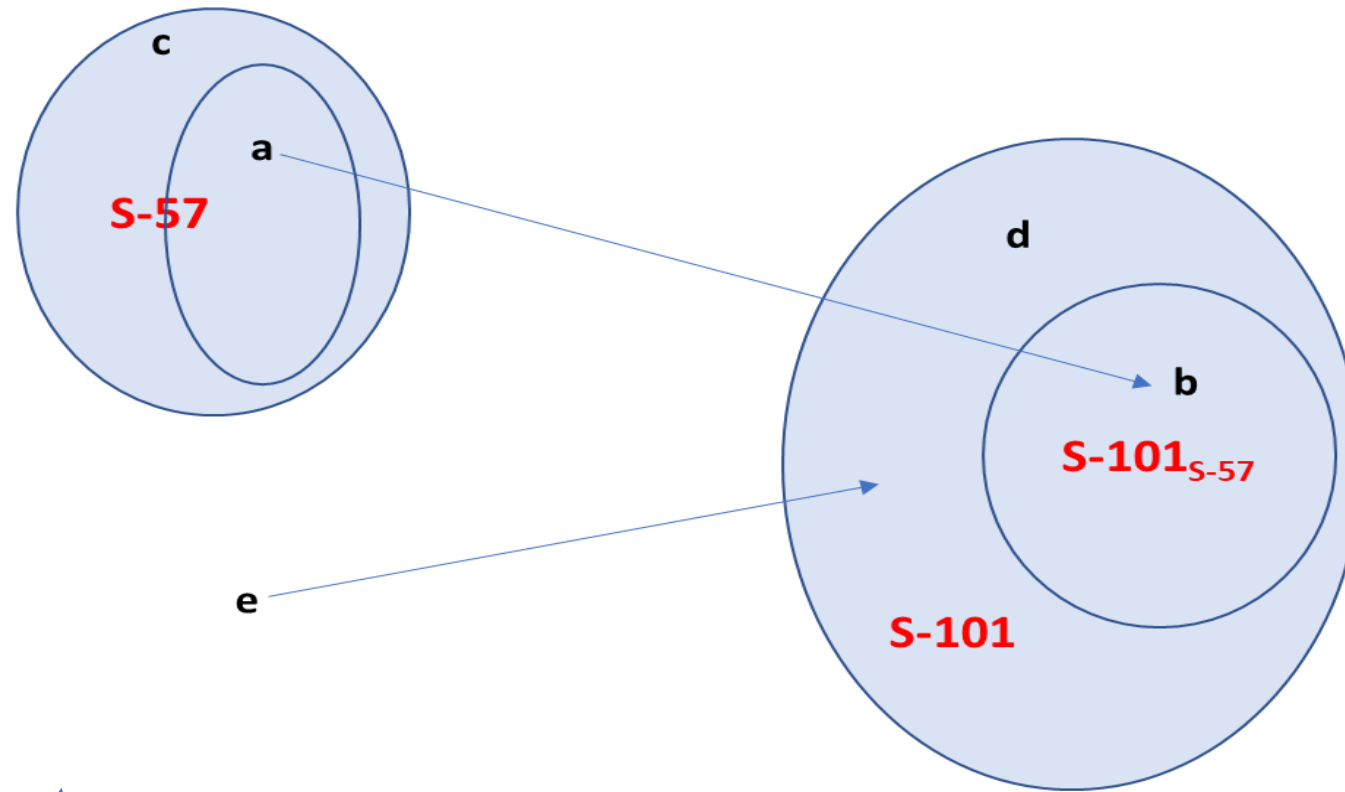
# Overview.



## The Short Version:

- Basic conversion and tools support S-57 to S-101 transformation
- There are complexities to get conformance with UOC/DCEG – some detail given here
- Data conversion is dependent on the capabilities of the “converter”
- No equivalent to S-58 exists to independently verify conversion

# Basis of Original Study - Feature Categories



Real World Features

(a) Things in S-57 which can be translated into an S-101 equivalent without loss

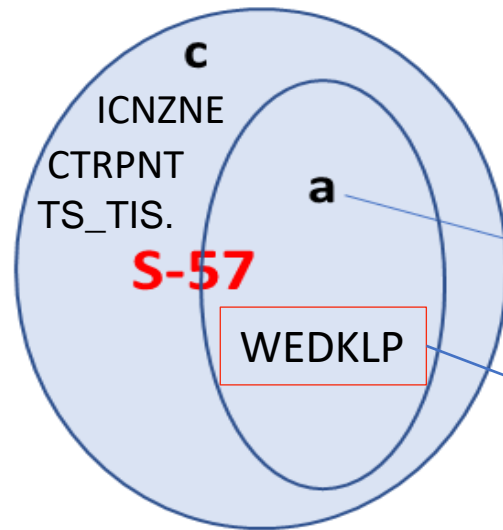
(b) The domain of features defined by the S-57 source

(c) Anything in S-57 which can't be (or doesn't need to be) translated into an S-101 equivalent

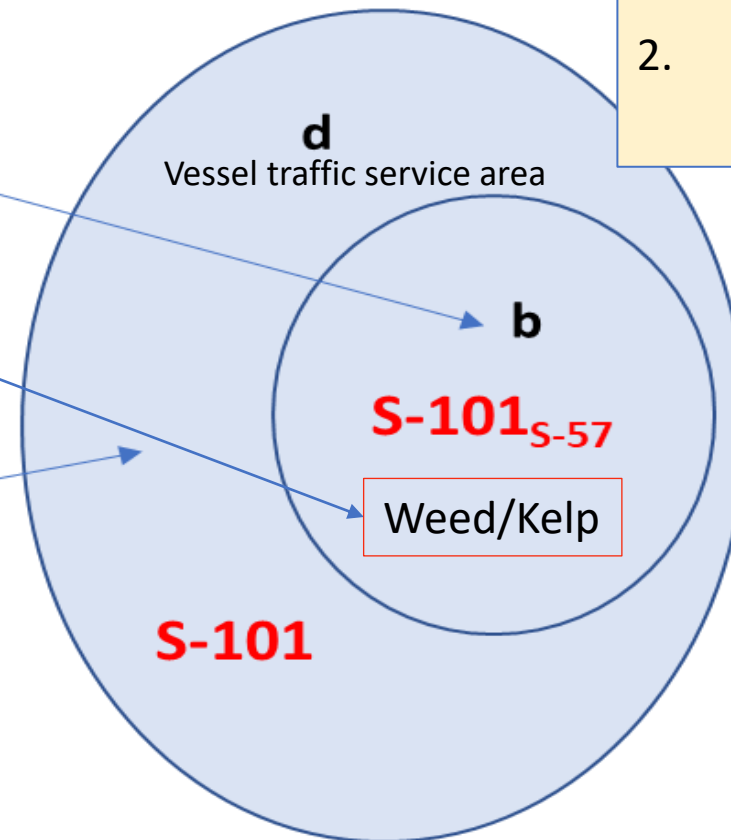
(d) Features defined in S-101 which have no complete defining mechanism in S-57

(e) Real world features which previously had no concrete representation in S-57 which are now expressible in S-101 (encoded into features (d)).

# S-57/S-101 Categories



**e**  
fibre optic cable

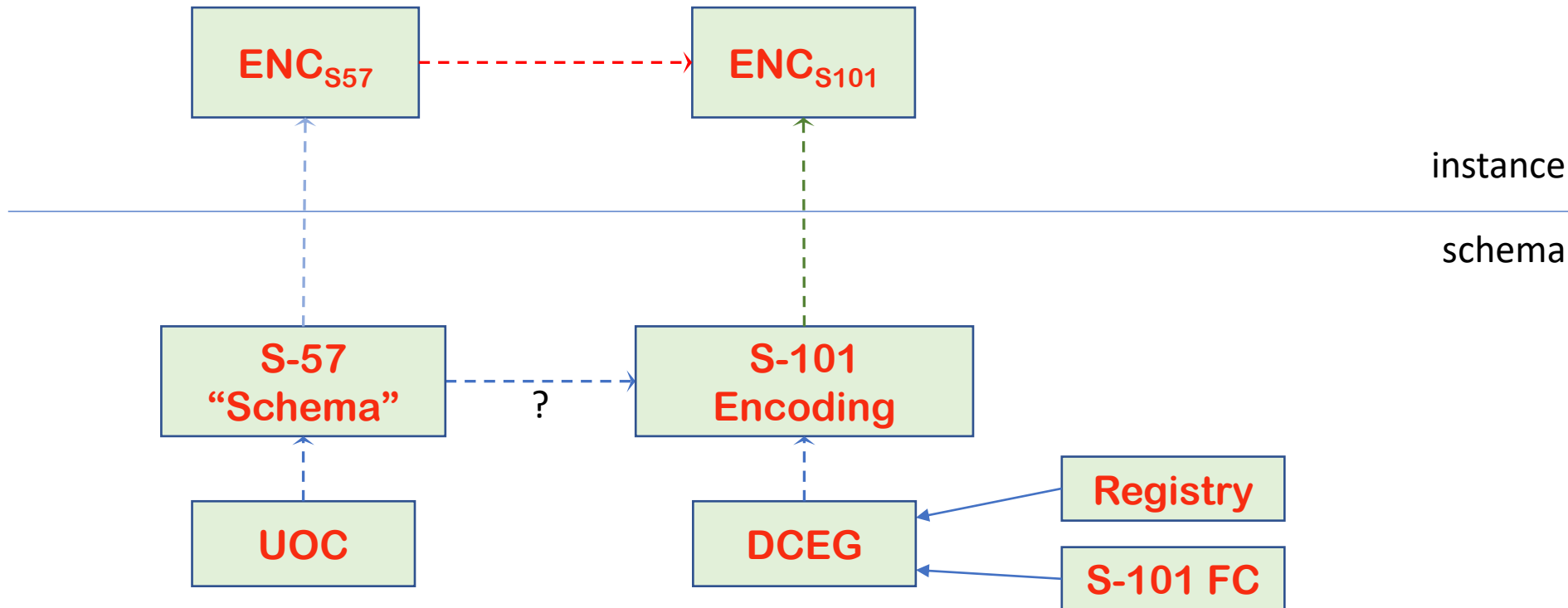


Note: the content of the sets here are not just Features and Attributes. Also includes:

1. Geometric Primitives
2. Feature/Attribute Combinations.

# Why is the UOC important?

- It's not sufficient to talk about “conversion” one-to-one for ENC.
- The UOC to DCEG “transformation” is what determines what S-101 content is and whether it is “valid” and “safe”
- UPC, together with member state encoding guides define S-57 ENC instances (cells). Transforming those encoding schemas into and S-101 version is key.
- So consideration of how the UOC/DCEG are implemented is an essential part of establishing a co-production framework

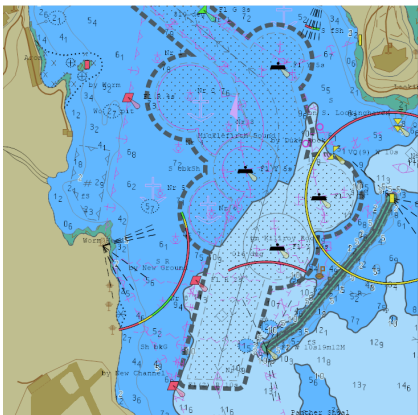
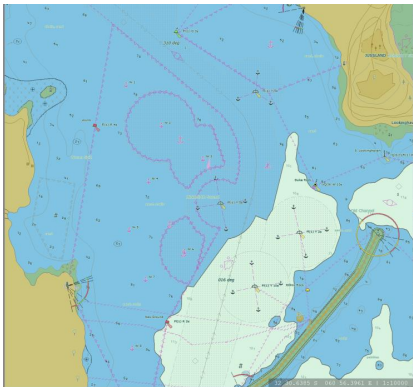


# Simple transformation of a feature.

S57f <sub>1</sub>	S101F <sub>1</sub>
<pre>CANALS: {   OBJNAM = Snapper Creek Canal   SCAMIN = 259999 }</pre>	<pre>Canal: {   featureName:   {     displayName=0     language=eng     name=Snapper Creek Canal   }   scaleMinimum=259999 }</pre>



# Feature and encoding comparison - Erebus



Erebus 0.9.3

File Tools Create Export Help

Obstruction

R958 FRID 100/210 MagneticVariation 550/951249373/12345

R959 FRID 100/204 MagneticVariation 550/605833349/12345

R960 FRID 100/211 MagneticVariation 550/312191268/17978

R961 FRID 100/187 MagneticVariation 550/811097202/17978

R962 FRID 100/188 MagneticVariation 550/607284841/17978

R963 FRID 100/13 Obstruction 550/541762174/1

R964 FRID 100/14 Obstruction 550/11804414/50

R965 FRID 100/15 Obstruction 550/11805261/50

R966 FRID 100/16 Obstruction 550/11805521/50

R967 FRID 100/17 Obstruction 550/11804573/50

R968 FRID 100/18 Obstruction 550/11804385/50

R969 FRID 100/20 Obstruction 550/140649637/12345

R970 FRID 100/21 Obstruction 550/11803111/50

R971 FRID 100/22 Obstruction 550/430984997/12345

R972 FRID 100/23 Obstruction 550/829526518/12345

R973 FRID 100/19 Obstruction 550/11805259/50

Obstruction:

{

expositionOfSounding=2

qualityOfVerticalMeasurement=9

reportedDate=1974----

valueOfSounding=2.7

waterLevelEffect=3

defaultClearanceDepth=182.8

surroundingDepth=182.8

}

geometry:

{

id = 110/199

orient = null

}

}

(150/5)

additionalInformation informationProvidedFor

{

NauticalInformation:

{

<NATC>valueOfSounding</NATC>

<ATIX>1</ATIX>

<PAIX>0</PAIX>

<ATIN>1</ATIN>

<ATVL>2.7</ATVL>

<NATC>waterLevelEffect</NATC>

<ATIX>1</ATIX>

<PAIX>0</PAIX>

<ATIN>1</ATIN>

<ATVL>3</ATVL>

<NATC>defaultClearanceDepth</NATC>

<ATIX>1</ATIX>

<PAIX>0</PAIX>

<ATIN>1</ATIN>

<ATVL>182.8</ATVL>

<NATC>surroundingDepth</NATC>

<ATIX>1</ATIX>

<PAIX>0</PAIX>

<ATIN>1</ATIN>

<ATVL>182.8</ATVL>

</ATTR>

OBSTRN

R551F 100/7 COALNE 550/11801597/50

R552F 100/8 COALNE 550/11801640/50

R553F 100/9 COALNE 550/11803169/50

R554F 100/10 COALNE 550/11801099/50

R555F 100/11 COALNE 550/11801632/50

R556F 100/12 COALNE 550/11801899/50

R557F 100/14 OBSTRN 550/541762174/1

R558F 100/15 OBSTRN 550/11804414/50

R559F 100/16 OBSTRN 550/11805261/50

R560F 100/17 OBSTRN 550/11805521/50

R561F 100/18 OBSTRN 550/11804573/50

R562F 100/19 OBSTRN 550/11804385/50

R563F 100/20 OBSTRN 550/11805259/50

R564F 100/21 OBSTRN 550/140649637/12345

R565F 100/22 OBSTRN 550/11803111/50

R566F 100/23 OBSTRN 550/430984997/12345

R567F 100/24 OBSTRN 550/829526518/12345

R568F 100/25 UWTROC 550/351859814/12345

R569F 100/26 UWTROC 550/11805953/50

OBSTRN:

{

EXPSOU = 2

INFORM = Submarine volcano action

QUASOU = 9

SORDAT = 1974

SORIND = US,US.graph.Chart 526

VALSOU = 2.7

WATLEV = 3

}

geometry:

{

id = 6E02000000

ornt = null

}

<FRID>

<RCNM>100</RCNM>

<RCID>22</RCID>

<PRIM>1</PRIM>

<GRUP>2</GRUP>

<OBJL>86</OBJL>

<RVER>1</RVER>

<RUIN>1</RUIN>

</FRID>

<ATTF>

<ATTL>93</ATTL>

<ATVL>2</ATVL>

<ATTL>102</ATTL>

<ATVL>Submarine volcano action</ATVL>

<ATTL>125</ATTL>

<ATVL>9</ATVL>

<ATTL>147</ATTL>

<ATVL>1974</ATVL>

<ATTL>148</ATTL>

<ATVL>US,US.graph.Chart 526</ATVL>

<ATTL>179</ATTL>

<ATVL>2.7</ATVL>

<ATTL>187</ATTL>

<ATVL>3</ATVL>

</ATTF>

# A slightly more complex transformation

S57f <sub>2</sub>	S101F <sub>2</sub>
<pre>BOYSPP: {   BOYSHP = 1   CATSPM = 27   COLOUR = 1,11   COLPAT = 1   INFORM = Danger shoal   OBJNAM = Miami Springs Boat Club Shoal Buoy   SORDAT = 20050628   SORIND = US,US,reprt,7thCGD,LNM 26/05   STATUS = 8   SCAMIN = 179999 }</pre>	<pre>BuoySpecialPurposeGeneral: {   buoyShape=1   categoryOfSpecialPurposeMark=27   colour=1   colour=11   colourPattern=1   featureName:   {     displayName=0     language=eng     name=Miami Springs Boat Club Shoal Buoy   }   status=8   scaleMinimum=179999 } additionalInformation provides {   SupplementaryInformation:   {     language=eng     text=Danger shoal   } }</pre>

# Categories of transformation

- Types of transformation
- Dictionary – where a feature or attribute acronym maps to a single equivalent
  - LNDARE -> Land Area
  - VERLEN -> Vertical Length
  - SNDWAV -> Sandwaves
- More complex dictionary – where a feature or attribute maps to more than one equivalent
  - OBJNAM ->Feature Name
- Increasing levels of complexity
  - Multi feature or multi-attribute
  - Conditional

S57f <sub>1</sub>	S101F <sub>1</sub>
<pre>CANALS: {   OBJNAM = Snapper Creek Canal   SCAMIN = 259999 }</pre>	<pre>Canal: {   featureName:   {     displayName=0     language=eng     name=Snapper Creek Canal   }   scaleMinimum=259999 }</pre>

# Examples: Simple Dictionary Transformation

- Fish Havens

S57f	S101F
<pre>OBSTRN: {   CATOBS=5 }</pre>	<pre>Obstruction: {   categoryOfObstruction=5 }</pre>

11.9.3 Fish havens (see S-4 – B-447.5)

If it is required to encode a fish haven, it must be done using an OBSTRN object (see clause 6.2.2), with attribute CATOBS = 5 (fish haven).

13.10.2 Fish havens (see S-4 – B- 447.5)

If it is required to encode a fish haven, it must be done using an Obstruction feature (see clause X.X), with attribute category of obstruction = 5 (fish haven).

Distinction: Fishing facility; obstruction.

11.13.2 Log ponds (see S-4 – B-449.2)

If it is required to encode a log pond, it must be done using the object class LOGPON.

Geo object: Log pond (LOGPON) (P,A)  
Attributes: NOBJNM OBJNAM STATUS INFORM NINFOM

INT 1 Reference: N 61

16.20.1 Log ponds (see S-4 – B-449.2)

If it is required to encode a log pond (also known as booming ground), it must be done using the feature Log Pond.

- Remarks:
- Seasonal log ponds should be encoded using the complex attribute periodic date range.
  - It is not required to separately encode any posts, piles or other log pond barrier supports.

Distinction:

If only life were always this simple....

# More Complex

```
C_ASSO:
{
  OBJNAM = Los Coronados
  FFPT = 2602C6EC940BE211
  FFPT = 2602C5EC940BE211
  FFPT = 2602C8EC940BE211
  FFPT = 2602BEEC940BE211
}
LNDARE (2602C6EC940BE211):
{
  OBJNAM = North Coronado
}

LNDARE (2602C5EC940BE211):
{
  OBJNAM = Middle Coronado
}

LNDARE (2602C8EC940BE211):
{
}

LNDARE (2602BEEC940BE211):
{
  OBJNAM = South Coronado
}
```

```
IslandGroup:
{
  featureName:
  {
    displayName=0
    language=eng
    name=Los Coronados
  }
}
islandAggregation consistsOf
{
  LandArea:
  {
    featureName:
    {
      displayName=0
      language=eng
      name=North Coronado
    }
  }
}
islandAggregation consistsOf
{
  LandArea:
  {
    featureName:
    {
      displayName=0
      language=eng
      name=Middle Coronado
    }
  }
}
islandAggregation consistsOf
{
}
```

- Examples where multiple transformations are needed
- Simple -> Complex Attribution
- Associations C\_ASSO -> Island Group

# Creation of New Information

- New Features

### 11.13.5 Collision regulations

Some nations have introduced collision regulations (COLREG's) that may include demarcation lines differentiating between inland water rules and International Rules as a result of the Convention on the International Regulations for Preventing Collisions at Sea 1972. If it is required to encode COLREG's, it should be done using a narrow CTNARE object of type area (see clause 6.6) covering the demarcation line, with attribute INFORM and/or TXTDSC containing a short explanation about the regulation, (e.g. cautionary note from the paper chart). The attribute TXTDSC may be used instead of INFORM, or for longer explanations or notes.

### 16.26.1 Collision regulations limit (see S-4 – B-XXX)

If it is required to encode a collision regulations (COLREGs) demarcation line, it must be done using the feature Collision Regulations Limit.

Remarks:

- If it is required to encode the national regulation citation it must be done using the attribute regulation citation.

Distinction: Administration area.

- New Attribution

If it is required to encode a submarine cable, it must be done using the object class CBLSUB.

Geo object: Cable, submarine (CBLSUB) (L)  
Attributes: BURDEP - if the buried depth varies along the cable, the cable must be encoded as several objects.  
CATCBL - 1 - power line.  
4 - telephone.  
5 - telegraph.  
6 - mooring cable/chain.  
if encoded, the value of CATCBL must be one of the above.  
CONDTN - 1 - under construction (during laying).  
5 - planned construction (planned laying).  
if encoded, the value of CONDTN must be one of the above.  
DATEND DATSTA DRVAL1 DRVAL2 NOBJNM OBJNAM  
STATUS - 4 - not in use (disused).  
~~VERDAT~~ INFORM NINFOM

Remarks:

- Where a cable is disused, it should be encoded with the attribute STATUS = 4 (not in use (disused)), and the attribute CATCBL should not be encoded.

	Acronym	Value		
Buried depth	(BURDEP)		RE	0,1
Category of cable	(CATCBL)	1 : power line 6 : mooring cable/chain 7 : ferry 8 : fibre optic cable	EN	0,1
Condition	(CONDTN)	1 : under construction 5 : planned construction	EN	0,1
Feature name			C	0,*
Display name			(S) BO	0,1
Language		ISO 639-1	(S) TE	0,1
Name	(OBJNAM) (NOBJNM)		(S) TE	1,1
Fixed date range			C	0,1
Date end	(DATEND)	ISO 8601: 2004	(S) TD	0,1
Date start	(DATSTA)	ISO 8601: 2004	(S) TD	0,1
Status	(STATUS)	1 : permanent 4 : not in use 13 : historic 18 : existence doubtful	EN	0,*
Scale minimum	(SCAMIN)	See clause X.X	IN	0,1



# New Attribute Types

## 13.2 Coastguard stations (see S-4 – B-492)

If it is required to encode a coastguard station, it must be done using the object class CGUSTA.

Geo object: Coastguard station (CGUSTA) (P)  
Attributes: DATEND DATSTA NOBJNM OBJNAM PEREND PERSTA STATUS  
INFORM NINFOM

Remarks:

- The CGUSTA must only be used to describe the function of the coastguard station, independent of the building or structure itself. If it is required to encode the building or structure in which the coastguard station operates, it must be done using an appropriate object class (e.g. BUISGL, LNDMRK).
- Maritime Rescue and Coordination Centres (MRCC) are part of a constantly manned communications watch system. If it is required to encode a MRCC, it should be done using CGUSTA, with attribute INFORM = *Maritime Rescue and Coordination Centre*. The name of the station may be populated using the attribute OBJNAM, e.g. *MRCC Swansea*.

stations were usually situated so as to have a commanding view and may therefore be visually prominent and make good fixing marks, the buildings may still be encoded as **Building** or **Landmark**.

- The **Coastguard Station** must only be used to describe the function of the coastguard station, independent of the building or structure itself. If it is required to encode the building or structure in which the coastguard station operates, it must be done using an appropriate feature (for example **Building**, **Landmark**).
- Maritime Rescue and Coordination Centres (MRCC) are part of a constantly manned communications watch system. ~~If it is required to encode a MRCC, it should be done using **Coastguard Station**, with the Boolean attribute is MRCC = *True*. The name of the station may be populated using the complex attribute feature name (sub-attribute name), for example *MRCC Swansea*.~~
- Each VHF-channel should be indicated, using the attribute communication channel (see clause X.X).

Distinction: Building; rescue station.

Remarks:

- Each VHF-channel should be indicated, using the attribute COMCHA, in square brackets by 2 digits and up to 2 characters (A-Z); e.g. VHF channel 7 = [07], VHF channel 16 = [16]. The indication of several VHF-channels is possible, with each value being separated by a semicolon; e.g. VHF channels 7 and 16 = [07];[16].

# Deletion of Old Information

- Some Features have been deleted
- Many feature/attribute combinations have been prohibited (after extensive consultation)
- Coincident point features – still needed?

*Boatshed.* If the service being provided by the structure is known, object classes **SMCFAC** (see clause 4.6.5) or **HRBFAC** (see clause 4.6.1) may also be encoded.

- If it is required to encode an offshore building, landmark or silo/tank, an ECDIS Base Display object (e.g. **PILPNT**, **LNDARE**, **PONTON**) must also be encoded coincident to ensure the feature is always displayed on the ECDIS. Where fitted, lights should be encoded as described in clause 12.8, with the **BUISGL**, **LNDMRK** or **SILTANK** being used as the structure object for the **LIGHTS** equipment object(s) (see clause 12.1.1).
- For encoding offshore windmotors, see clause 11.7.4.

*Facility* (see clause 4.6.1) may also be encoded.

- For buildings located in or over navigable water, the Boolean attribute **in the water** must be set to *True* to indicate that the feature is to be included in the ECDIS Base Display. Where such structures are located over the water it is not required to encode any supporting structures (for example piles, stilts).
- The complex attribute **vertical clearance fixed** must not be populated, unless the building is located over



- INFORM attribution is extensive in most member state data
- Covers many categories:
  - Structured Text as specified in UOC
  - Specified by UOC, no fixed structure
  - Determined by member state local UOC guidance (e.g. Fibre optic cables)
  - Ad Hoc.

• The text "Discoloured water" on the source indicates the probable existence of shallow water. This should be encoded using a **CTNARE** object with attribute INFORM or TXTDSC containing a cautionary note (see clause 6.6).

- Could be used as source for new features / attribution for a suitably configured converter?

# Using INFORM!

- INFORM is popular! (66k attributed features on a sample of ~900 cells).
- Formatting not standardised. Sometimes recommended by UOC
- Some new S-101 content is already in INFORM. Could be parsed out and used to create new features/attributes.
- Examples:
  - COLREGS
  - Discoloured Water
  - Fibre Optic Cables
  - Attribution of Major Lights
  - Berths - Maximum Permitted draft information

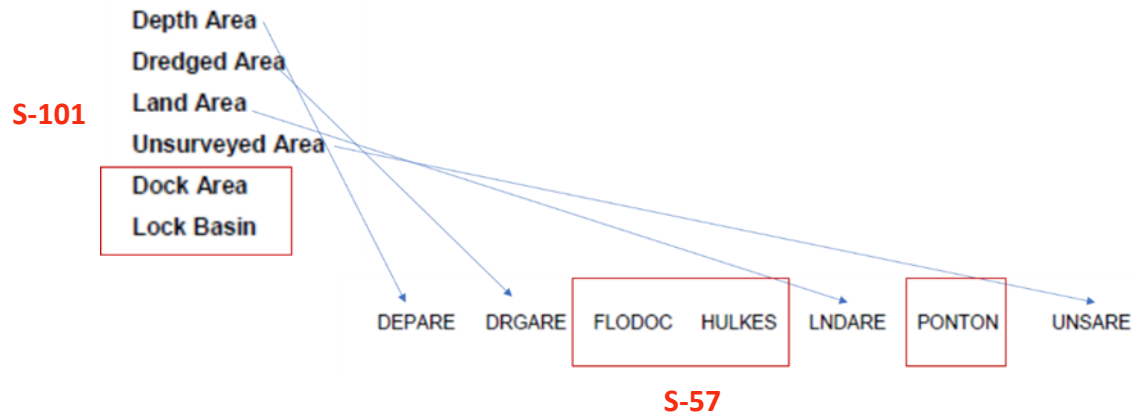
e.g. Discoloured Water - now a feature in S-101

- The text "Discoloured water" on the source indicates the probable existence of shallow water. This should be encoded using a **CTNARE** object with attribute INFORM or TXTDSC containing a cautionary note (see clause 6.6).

S-57 UOC

S57CTNARE	S101DiscolouredWater
CTNARE: { INFORM = Discoloured Water }	DiscolouredWater: {  }

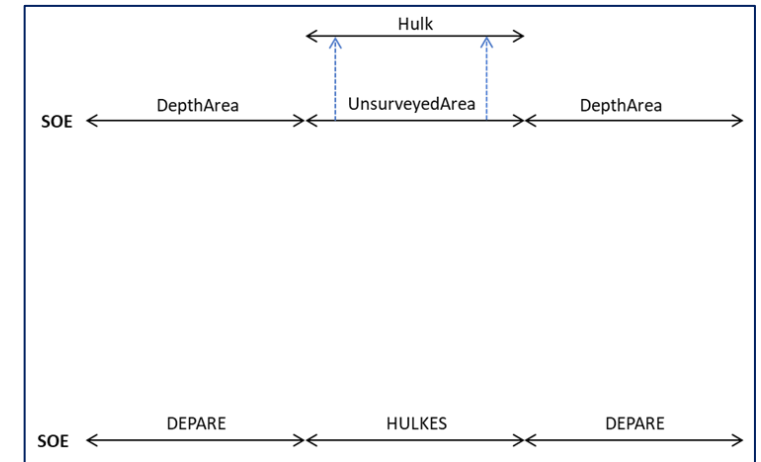
# Changes to Group 1 – Skin of the Earth



## Group 1 – Skin of the Earth changes:

- Because the features comprising Group 1 have changed, any conversion requires new Group 1 features to be added to SOE and non-SOE features to be lifted out (and replaced with a valid SOE feature).
- Will require rules or manual inspection to get the best results on translation
- Simple translation to UNSARE/Unsurveyed Areas could be a remedy
- Needs examination and testing.
- No Safety implications.
- Complex but automation is possible (including updates). Could use INFORM attribution to control a converter
- Can optimise conversions by pre-defining replacement underlying geometry
- **Could require geometry processing for complex cases (needs study) – this could be avoided by suitable encoding (and INFORM)**

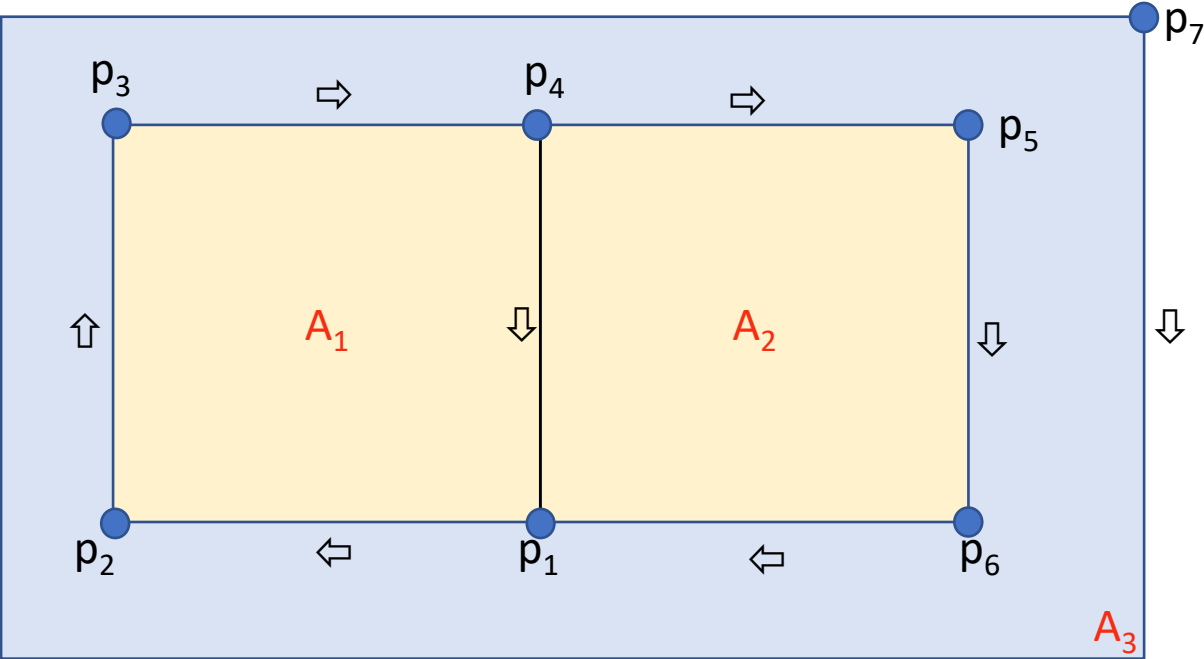
S-101



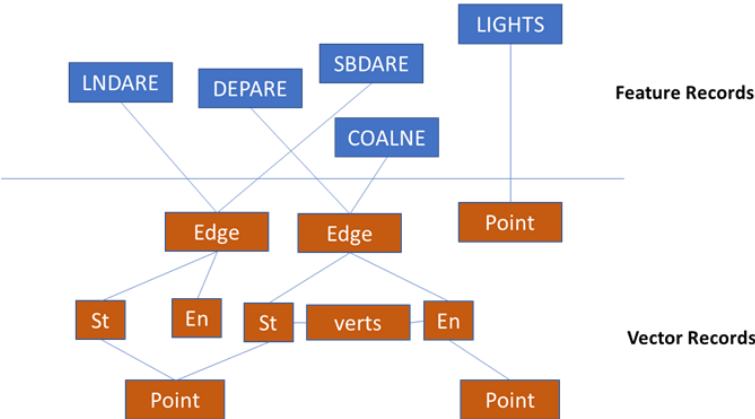
# Initial Conclusions – S-57 to S-101 Geometry Conversion

- Geometry conversion
- Largely the geometry model is compatible – S-101's Level 3a topology introduces a level of further abstraction
  - Composite curves
  - Surfaces
- Geometry associations in features
  - S-57 – sequences of oriented curves
  - S-101 – Sequences of oriented surfaces, curves or composite curves
- S-101 is MUCH more efficient but is also backwards compatible with S-57
  - Isolated / Connected points have disappeared. There are only points/multipoints (sounding arrays)
  - Geometry attribution dealt with differently (via association)

# Geometry Model Differences



**P = Point**  
**E = Edge**  
**CC = Composite Curve**  
**Sf = Surface**  
**A<sub>n</sub> = Feature Polygon**  
**↔ = Reversed**



S-57	S-101
$E_0 = P_1 - P_2$ $E_1 = P_2 - P_3 - P_4$ $E_2 = P_4 - P_1$ $E_3 = P_4 - P_5 - P_6$ $E_4 = P_6 - P_1$	$E_0 = P_1 - P_2$ $E_1 = P_2 - P_3 - P_4$ $E_2 = P_4 - P_1$ $E_3 = P_4 - P_5 - P_6$ $E_4 = P_6 - P_1$
$A_1 = E_0 + E_1 + E_2$ $A_2 = E_3 + E_4 + \leftrightarrow E_2$	$CC_1 = E_0 + E_1$ $CC_2 = E_4 + \leftrightarrow E_2$
	$Sf_1 = CC_1 + E_2$ $Sf_2 = E_3 + CC_2$
	$A_1 = Sf_1$ $A_2 = Sf_2$

# Changes to UOC encoding

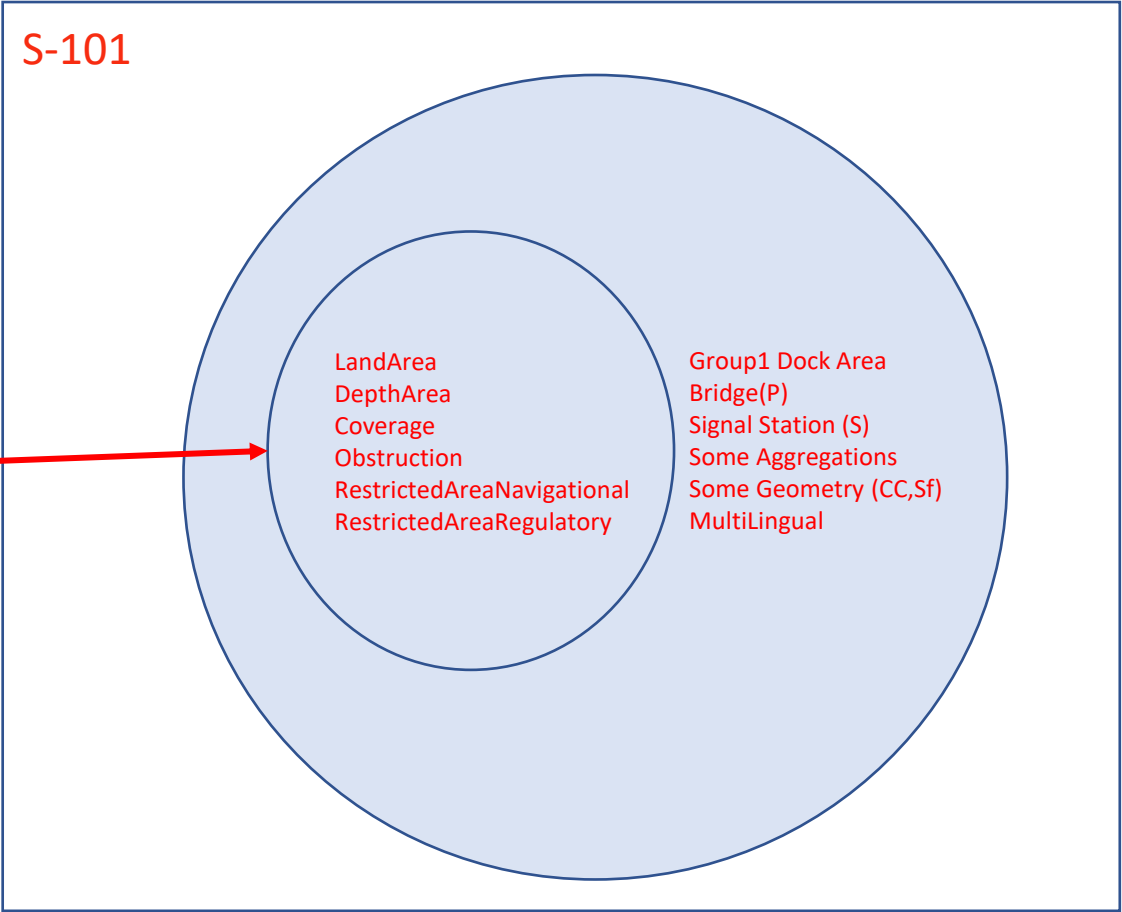
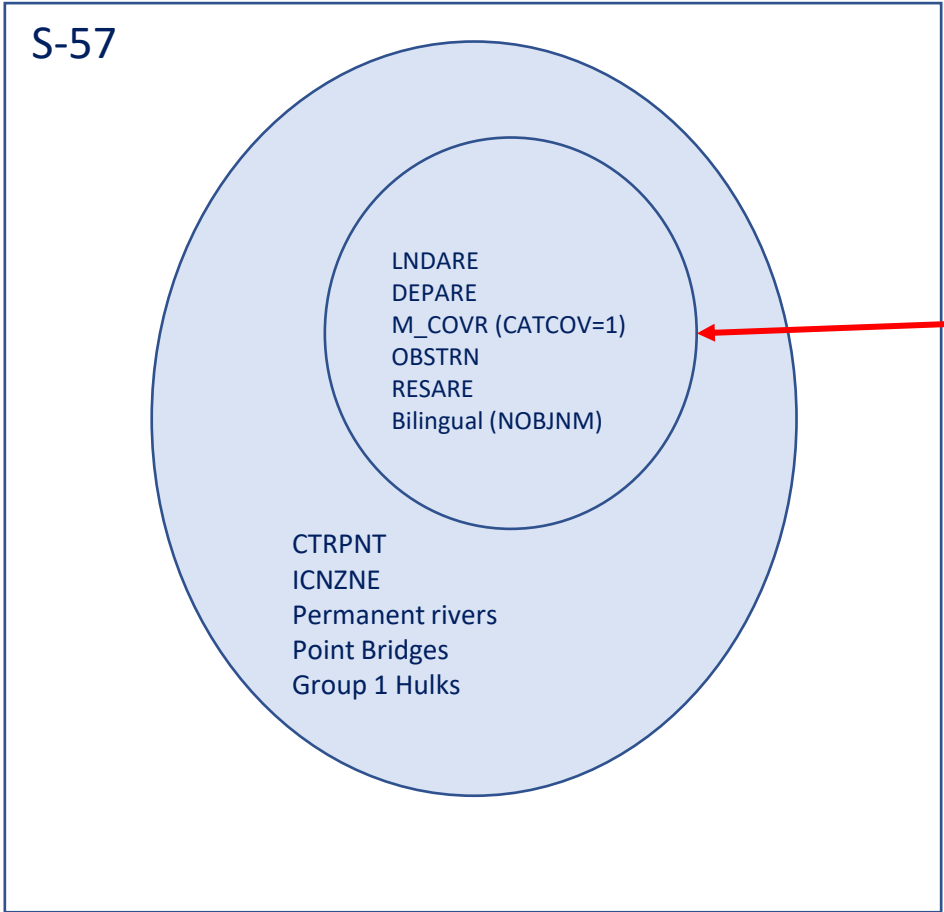
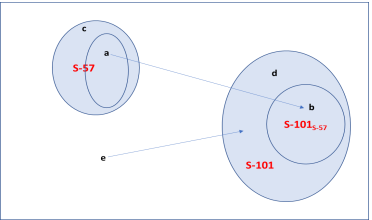
Total features	Feature	Enumeration (allowable / prohibited under UOC)	Attribute
12720	<b>UnderwaterAwashRock.</b>	<b>boulder[18],rock[9],</b>	<b>natureOfSurface</b>
2026	<b>Landmark.</b>	<b>permanent[1],</b>	<b>status</b>
1505	BeaconSpecialPurposeGeneral.	lattice beacon[4],	beaconShape
1250	Coastline.	sandy shore[3],stony shore[4],coral reef[9],	categoryOfCoastline
698	BeaconLateral.	lattice beacon[4],	beaconShape
290	CableSubmarine.	telephone[4],	categoryOfCable
290	<b>SiloTank.</b>	<b>permanent[1],</b>	<b>status</b>
192	<b>Daymark.</b>	<b>painted[9],</b>	<b>natureOfConstruction</b>
130	BuoySpecialPurposeGeneral.	private mark[13],	categoryOfSpecialPurposeMark
116	BeaconSpecialPurposeGeneral.	private mark[13],	categoryOfSpecialPurposeMark
109	<b>River.</b>	<b>permanent[1],</b>	<b>status</b>
84	UnderwaterAwashRock.	deeper than the range of depth of the surrounding depth area[3],	expositionOfSounding
55	Obstruction.	foul ground[7],	categoryOfObstruction
55	<b>BuoySpecialPurposeGeneral.</b>	<b>other system[10],</b>	<b>marksNavigationalSystemOf</b>
53	<b>SlopeTopline.</b>	<b>dune[3],hill[4],</b>	<b>categoryOfSlope</b>
22	<b>Building.</b>	<b>permanent[1],</b>	<b>status</b>
21	<b>ProductionStorageArea.</b>	<b>permanent[1],private[8],</b>	<b>status</b>
18	<b>Landmark.</b>	<b>windmotor[19],</b>	<b>categoryOfLandmark</b>

- Some UOC feature/attribute combinations are prohibited under DCEG/Feature Catalogue
- S-57 didn't "enforce" UOC combinations except through S-58
- DCEG/Feature Catalogue is much more prescriptive
- May require inspection to ensure no implications of conversion

# Geometry Primitives Differences

Feature	Allowable primitives (S-57)	S-101 Primitives
<u>BRIDGE</u>	Point, Line, Area	Curve, Surface
<u>DAMCON</u>	Point, Line, Area	Curve, Surface
<u>GRIDIRN</u>	Point, Area	Surface
<u>DEPARE</u>	Line, Area	Surface
<u>RECTRC</u>	Line, Area	Curve
<u>ROADWY</u>	Point, Line, Area	Curve, Surface
<u>PIPSOL</u>	Point, Line	Curve
<u>TUNNEL</u>	Point, Line, Area	Curve, Surface

# Conversion

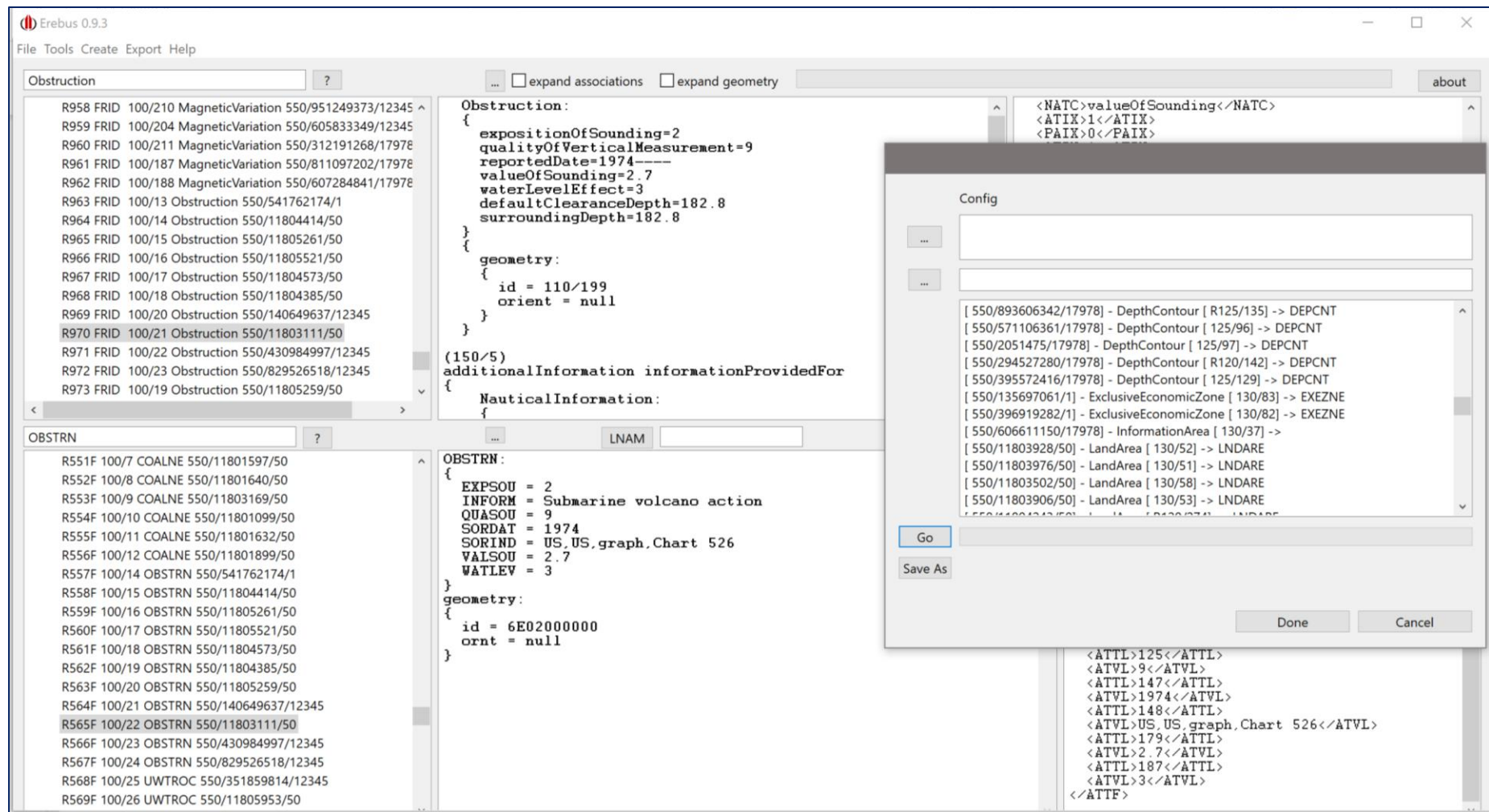




# Moving on from S-57 to S-101 conversion

- The real issue is migration to S-101 co-production (and S-100 adoption) for member states
- S100WG is looking at co-production and how DF-ECDIS will operate. Some of the ideas on “conversion” will shape those discussions. Distribution, validation and testing are still to be defined
- This is an ongoing process.
- Well formed ENCs help, consistently encoded, valid data is the best input to the process.
- As systems mature and S-101 “solidifies” migration paths will emerge. Novel and creative approaches may be necessary to achieve transition

# Retro-Converter and Comparison Development.



a work in progress.



**Thank You.**

**Questions?**

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