Paper for Consideration by HSSC12

Dual-Fuel ECDIS – Definition of Capabilities

Submitted By:	S100 Working Group Chair
Executive Summary:	"Dual Fuel ECDIS" is proposed as the mode of operation during the transition to S-100 for type approved ECDIS. This paper defines several aspects of Dual Fuel ECDIS operation and proposes a working definition for consideration by IHO Member states. This paper was initially considered at S100WG5 and has been updated with recommendations from the working group.
Related Documents:	S100WG5-7.5, IHO S-52, IHO S-57, IHO S-101, IHO S-64, IEC 61174, IMO Performance Standard for ECDIS
Related Projects:	Development of S-100 enabled ECDIS.

Introduction / Background

IHO has committed to a "Decade of S-100" in which to roll out S-101 ENC production and add S-100 (+S-98 and S-101) to the IMO/IEC standards base legitimising their use for primary navigation of commercial vessels under the SOLAS convention. An extract from the IHO paper to IMO NCSR shown below neatly summarises the proposed transition period during which ECDIS equipment will be expected to support both S-101 and S-57 in a "Dual Fuel" mode.

20.	In order to maintain ECDIS devices already installed on SOLAS vessels which are technically not ready nor required to be upgraded to S-101 ENC compatibility, and to comply with the applicable IMO regulations pertaining to existing navigation equipment, identical coverage will be provided for S-57 ENCs and S-101 ENCs for a transition period until there is no significant number of legacy systems in the field and all ECDIS in operation have become S-101 compatible. This situation is expected near the end of the decade, but will be continuously monitored to enable a decision to be made by the responsible IMO body.

21.	As a consequence, new ECDIS systems to be brought into the market at the time when S-101 ENC coverage starts (2024) will have to be capable to process both transfer standard formats: S-57 ENCs and S-101 ENCs.

22.	Safety of navigation will be maintained by cartographic content of both S-57 and S-101 standards. From the user's perspective, presentation of cartographic and functional features to meet the IMO mandated content in a mixed environment of S-57 ENCs and S-101 ENCs in one ECDIS device will be seamless and presented under the identical presentation regime for charted features and navigational objects.

Figure 1: IHO Paper to NCSR

It is noted, therefore, that during the transition period to full S-100/S-101 services, there will be both S-57 and S-101 ENCs available for use and thus the concept of "dual fuel" has been introduced to cover this ECDIS operation. However, one of the key issues is that the "dual fuel" concept can have many different meanings and thus a working definition of "dual fuel" should be available when discussing this concept at a working level.

Analysis/Discussion

At the S100WG5 meeting in March a paper was put forward, S100WGF5-7.5 (Annex A) that provided proposals contributing to the concept of the Dual-Fuel ECDIS and showed that its operation, data handling and user experience can be made consistent and logical in accordance with the structures in the current, relevant standards. The paper also tries to explain how the "identical presentation regime" and "seamless" operation referred to in the IHO NCSR paper can be achieved in practical terms given the differing nature of IHO S-57 and IHO S-101.

After much discussion amongst the technical experts drawn from data producers, OEM's and member states the working group agreed to the following points regarding "dual fuel" ECDIS operation:

Fundamentals

- SOLAS places an obligation on member states to produce and promulgate ENC data to support mandatory carriage of ECDIS. Currently that mandate is fulfilled by the production of S-57.
- The addition of S-100 to the IMO PS will allow S-100 data (specifically S-101 as a minimum) to <u>also</u> satisfy the carriage requirement.
- Member States will provide data to satisfy SOLAS conforming to IHO standards referenced by the IMO Performance Standard for ECDIS.

Principles:

The principles of a dual fuel ECDIS (DF-ECDIS) should be:

- It should allow unambiguous and standardised import and use of both S-57 and S-101 data. In addition, a selection of S-100 compliant data products should be able to be imported and used to enhance user functionality and safety.
- ECDIS behaviour should not be any less "safe" (as defined by the IMO PS) regardless of whether S-57 or S-101 data is in use and taking into account any ENC scheming differences and/or overlaps. The requirements of the IMO PS should be met in all eventualities.
- User Experience should never be negatively impacted by the introduction of any S-100 compliant data to the ECDIS.

Portrayal and ECDIS behaviour.

One of the key observations from the OEM community was "we've been doing dual fuel for years". The concept of ECDIS supporting multiple product types, whether Raster/Vector or DNC/ENC or data overlays has been in existence for many years and the Dual Fuel ECDIS concept is merely an extension of such operations to multiple ENC "formats" to support the introduction of S-100 to the type approval regime.

The S100WG noted the following in regards to portrayal and ECDIS behaviour:

1. Display of S-57 and S-101 ENC will NOT be identical.
2. Behaviour of the ECDIS between S-57 and S-101 will NOT be identical.

Principle of Separation of S-57 and S-101

The acceptance of the basic principles governing Dual Fuel ECDIS operation and the existence of DF-ECDIS operation led to a more general principle that:

"DF-ECDIS functionality should be <u>split</u> between legacy S-57 data and operations involving S-101. This will "partition" the ECDIS operation wholly between the two fundamental ENC products acceptable under the IMO regime during the transition period"

This basic principle can be used to define how the DF-ECDIS will operate as well as defining the implications for data producers.

ENC Coverage aspects.

The basic idea of the partitioning within the DF-ECDIS strongly implies that the existing ENC "overlap rule" (no overlaps between cells within the same usage band) should be extended to the two ENC formats within the DF-ECDIS.
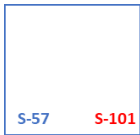
"S-57 ENCs and S-101 ENCs within the DF-ECDIS should not overlap. Overlap would be defined as overlapping coverage (other than equivalent cells) at the same compilation scale (CSCL) and maximum display scale of data coverage features".
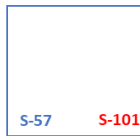
Data without overlaps of this nature would effectively partition the internal SENC into areas of legacy S-57 data and S-101 data coverage features.

Key to this idea is that the ECDIS determines what to load based on the coverage (and, optionally, the S-100 Part 15 permits) presented to it. If presented with data which overlaps it should always import the S-101 data by default.

Therefore if an S-101 dataset partially overlaps with a neighbouring S-57 dataset the S-57 dataset will NOT be imported. A simple example is illustrated in the diagram where the S-101 (in red) are compiled and produced in parallel with existing S-57 ENCs. When presented to the ECDIS the S-101 data is loaded on the DF-ECDIS whereas legacy ECDIS loads the S-57 versions of the data.

Conversely when presented with the following datasets (assumed all to be of the same CSCL/max display scale)
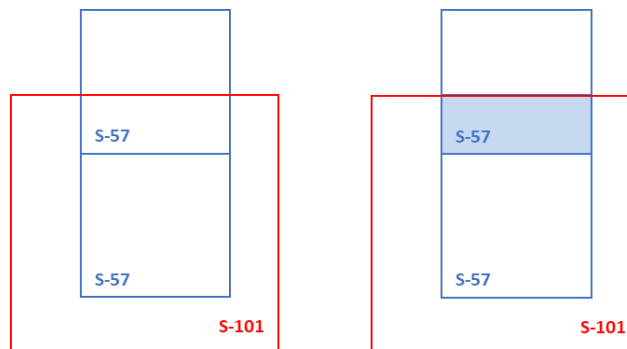
In this case the coverage (left) consists of two S-57 cells and a single S-101 cell which partially covers the northern S-57 cell. In this case the DF-ECDIS would only load the S-101 cell and would not be expected to "truncate" the northern S-57 cell to fill in the rest of the coverage. The area of partial overlap (the southern region of the S-57 cell coloured in blue on the right stops the S-57 cell from being imported to the system.

It would be possible, in this case to fill in the missing area with smaller scale data, as shown in the following diagram:
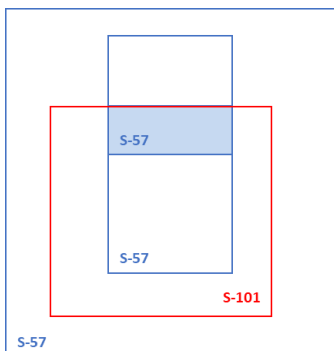
In this case the DF-ECDIS would only load the S-101 data and the smaller scale S-57 data. So the northern half of the S-57 cell is only available at a smaller scale on the DF-ECDIS. While this means the DF-ECDIS may not enjoy full data coverage at the same scale this may well be acceptable to the data producer within areas of minimal depiction.

This offers data producers some options in terms of its coverage then. It is possible to produce S-101 with "different" coverage scheming as seen but it relies on the producer being aware of what the behaviour of both DF-ECDIS and legacy ECIDS will be when presented with combined S-57/S-101 datasets.

For some data producers this may imply "coincident coverage" where the S-101 ENCs are of identical extent to the S-57 ENCs and may well be the easiest option in many cases for scheming new S-101 coverage. However, it does offer options where this may need to be modified based on data producer requirements (i.e. new survey,

rescheming, gridding etc…). In particular, coverage could be aggregated, so in order to take advantage of the updated 10Mb rule for S-101 ENCs, coverage of two cells could be combined into a single S-101 cell.

This defined operation of the DF-ECDIS is intended to ensure it is never operating with overlapping S-57/S-101 data and that its import and operation can be unambiguous. As the SENC is, effectively partitioned, the general DF-ECDIS operation can be approached from the same perspective, i.e. partitioned between S-101 and S-57.
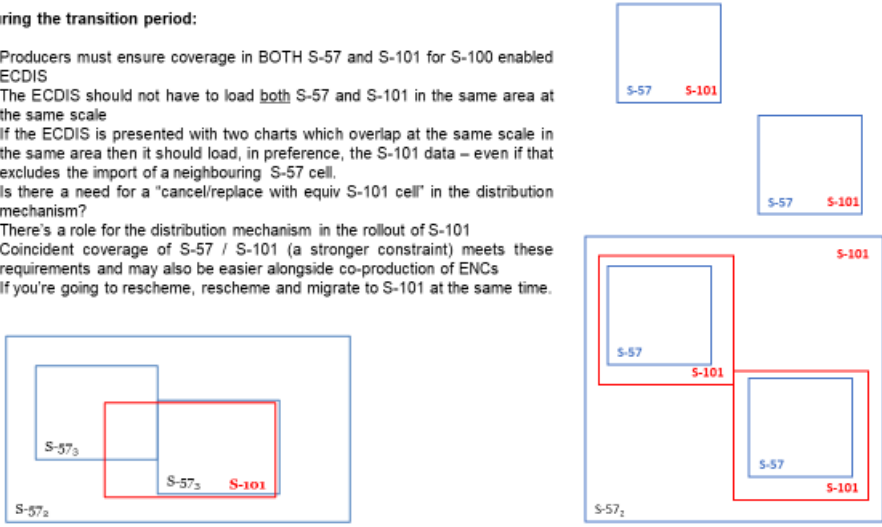

The discussion in the group also suggested that a more formalised "cancel/replace" mechanism, similar to the existing ENC one could be proposed which would give the ECDIS more guidance on which S-57 cells are being "replaced" in coverage by S-101 cells. This would make it clear which cells are intended to replace the S-57 coverage (and eliminate those equivalents from the "overlap" rule).

There is an implicit role for the distribution chain (and RENCs) which should be noted. There are many different roles supporting the operation of DF-ECDIS, notably validation and harmonisation between the two different ENC forms.

DF-ECDIS functionality - Display

Display of ENC should be done "side by side" on the DF-ECDIS. As the SENC is partitioned spatially (and by scale) there is no ambiguity in the operation in terms of which features are being displayed at any point. In particular

1. It is highly unlikely that ENC display will be completely identical between S-57 and S-101. The differences should be minimal but even a simple examination of the respective feature catalogues will show where minor differences exist. The overall principle holds, though, that the user experience absolutely will not be negatively impacted (and the absolute intention is that it is positively enhanced)
2. There may well be a need for a "border" between S-57 and S-101 data visible on screen to the user.
3. No implicit conversion of either data or portrayal model should be done on the DF-ECDIS in any case. The partitioning of the SENC into mutually exclusive S-57 and S-101 coverage should extend, in principle also to display of the data – the S-57 data should use the entire existing S-52 structure and the S-101 data should use the S-101/S-100 portrayal mechanisms.

Conclusions

A general lack of "definition" for DF-ECDIS was noted by the working group. What appears to be required is:

1. More detail is required on how DF-ECDIS is intended to operate, the governing principles (such as those outlined in this paper) and the impacts on data producers, the distribution chain and OEMs who construct ECDIS. This should reference and expand on the provisions within the IEC/IMO formal support for S-100. This could be either through modifications to existing standards or through IHO guidance documentation.
2. The operation of the IHO data protection scheme, which governs the importing of data and most of the "packaging" elements of ENC data should be considered "holistically" by the community supporting DF-ECDIS in order to ensure support for the introduction of S-57/S-101 data to the end users. S-100 Part 15 allows for a much finer granularity in user roles and the ability to distinguish between them within the content of the certificate files embedded in the digital signatures. Separate discussions within the S-100WG meeting reinforced the requirement to use such granularity for dual fuel operations. This should also cover renewal and expiry of certificates by the individual participants of the scheme.
3. A related action is required to locate the type approval-specific elements of display and operation currently with the existing IHO standards base (predominantly S-52 and S-64) and to replicate them within the new testing and product specification defining S-101 ENCs.

Action required of HSSC12

The HSSC12 is invited to:

- Note the contents of this paper as a summary of the current situation in regard to Dual-Fuel ECDIS (DF-ECDIS) for the transition period.
- Note the importance of close interworking between the data producer community, industry bodies supporting data production and the broader IEC/IMO community defining this important transition phase at a working level.
- Agree to the principles of a DF-ECDIS as outlined in this paper
- Consider drafting a governance document that formalizes the guiding principles of DF-ECDIS or incorporate them into the S100 Strategic Implementation Plan.