IIC TECHNOLOGIES

Arctic Grids:

Update 3

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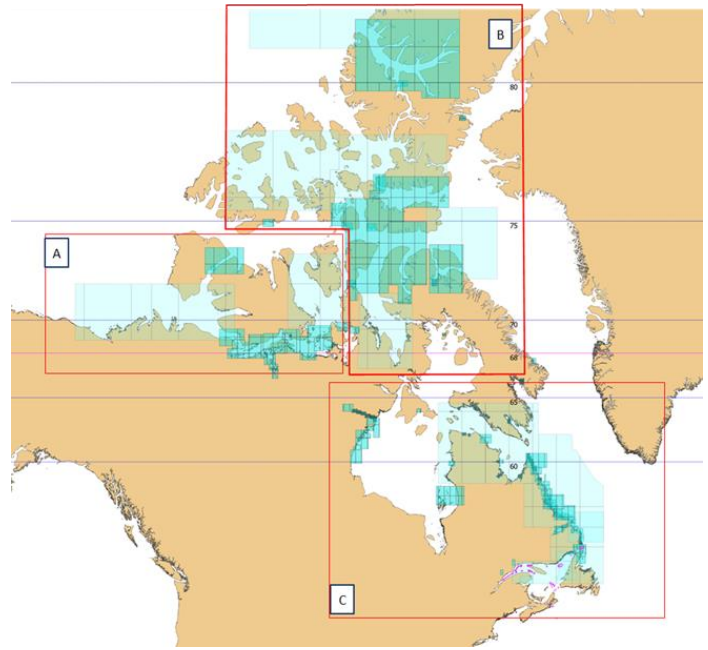


Progress so far

- Initial version of report released 0.9.5
- SOW map as per below
- Will cover
  - The main sections
  - Some of the background.

3.1. Analyse and Review the conceptual grid scheme in the table below. The proposed scheme would have no overlap at specific usage band. Validate the 3 proposed grid schema for each coverage areas:

Level/usage	scales	Coverage of the arctic area south of 68N*	Coverage 68N to 80N	Coverage North of 80N
overview	< 1:150001	4° X 4°	8° X 4°	16° X 4°
transit	1:22001 to 1:150000	1° X 1°	2° X 1°	4° X 1°
Port	>1:22001	0.1° X 0.1°	0.2° X 0.1°	0.4° X 0.1°

*: the Canadian arctic areas are presented in Annex 1, and include the North of 68N, and also other south of 68N areas considered as Canadian arctic regions.

3.2. Are the Usages (scale bands) proposed in section 3.1 suitable for the Northern areas, based on current products (ENC and/or paper), type of navigation, future needs?

3.3. Compare CHS current products coverage (ENC and/or Paper Chart) to the proposed cells of the 3 levels/usages grid. For each level/usage of the grid:

3.3.1. Identify cells that would contain data and at which scale;

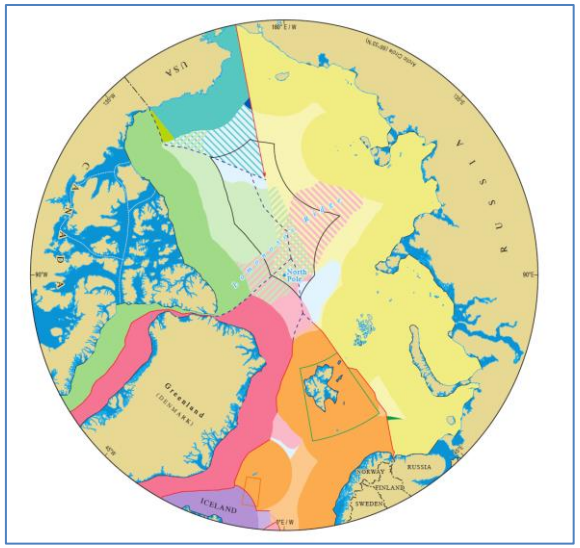
3.3.2. Identify multiple scale coverage on each level/usage.

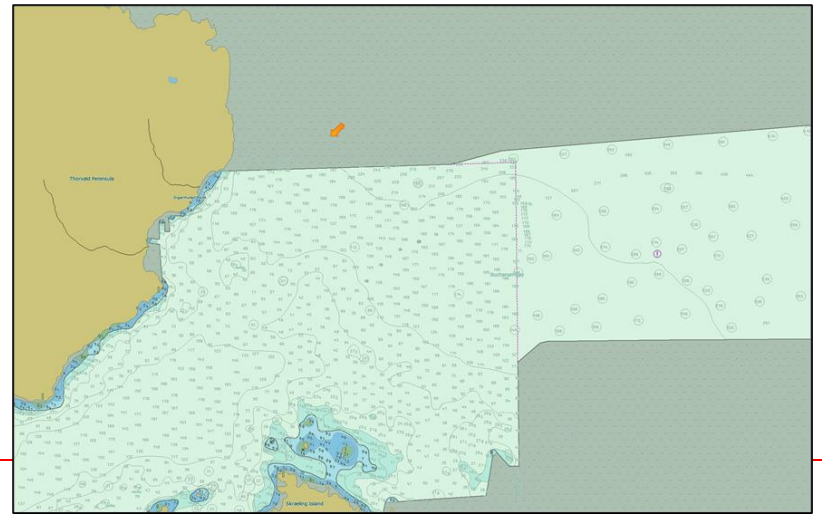
3.4. Compare CHS' conceptual northern grid in section 3.1 (schemes, usages and scales bands) to proposed grids (schemes, usages and scale bands) from members and associate members of the Arctic Regional Hydrographic Commission with similar northern coverage (detail comparison). What could be the best approach for CHS in an scheme alignment strategy?

SOW	Deliverable.
3.1	Section 6
3.2	Section 5
3.3	Section 6, Section 7
3.4	Section 8, Section 10

Background – The Region, Data and Stakeholders

- Focused on regional characteristics, navigational practice and existing data, primarily ENC.
- Other publications and regulatory sources:
  - Sailing Directions
  - Arctic passage Planning Guide
  - Guide to Ice Navigation
  - Legal Sources and Treaties
- Analysis of charts, pubs, region/politics, past cooperation
- Unique and fundamental challenges for navigation
- Steadily increasing activities for environmental / scientific
- Tests many ENC encoding conventions and rules





- **"Soundings in sloped figures are spot soundings taken through the ice by the Defence Research Board 1963-1969"**
- **"Much of the information on this chart is of a reconnaissance nature and mariners should exercise caution when navigating in these waters"**

Grid Analysis

- Grid cut to ENC coverage
- Numbers of Cells and Overlaps

Usage	Min	Max	Avg
Overview (<150k)	61,429 km^2	2,170,303 km^2	348,031 km^2
Transit (>=150k and < 22k)	18[1] km^2	78,406 km^2	9,819 km^2
Port(<= 22k)	0.13 km^2	1,618 km^2	213 km^2

ENC Sizes

Compilation Scale	Number of cells	Usage
<150k	**17**	Overview
>=150k and < 22k	**110**	Transit
<= 22k	**194**	Port

1. **Overview – 54 grid cells.**
2. **Transit – 245**
3. **Port – 991**

3.1. Analyse and Review the conceptual grid scheme in the table below. The proposed scheme would have no overlap at specific usage band. Validate the 3 proposed grid schema for each coverage areas:

Level/usage	scales	Coverage of the arctic area south of 68N*	Coverage 68N to 80N	Coverage North of 80N
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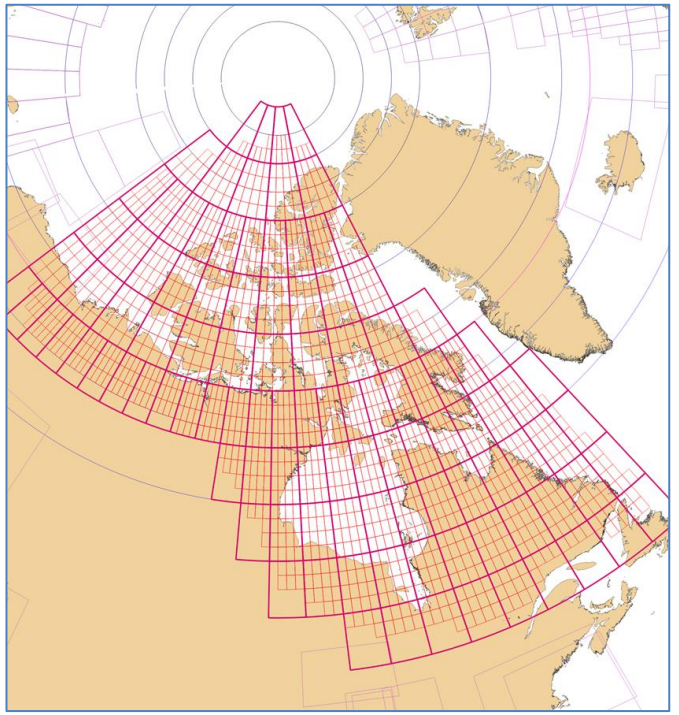
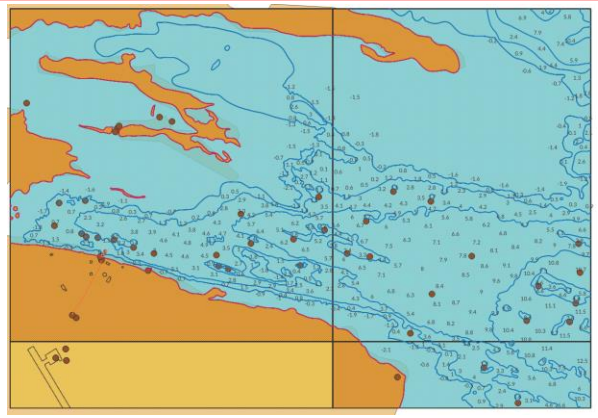
Grid Sizes



Usage	Min	Max	Avg
Overview (<150k)	55,680 km^2	136,295 km^2	101,662 km^2
Transit (>=150k and < 22k)	3,914 km^2	9,127 km^2	6,405 km^2
Port(<= 22k)	41 km^2	93 km^2	64 km^2

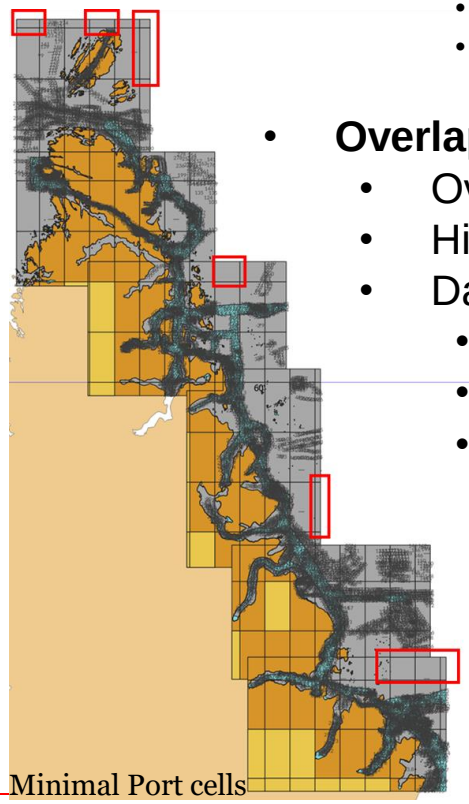
Grid Analysis - edge cases

- **Minimal Depiction**
  - Some grid cells have little detail in them
  - E.g. no DEPARE, DRGARE or only UNSARE
  - Combination of automatic search and manual inspection
  - Approx. Totals:
    - Overview – 50
    - Transit – 200
    - Port – 800

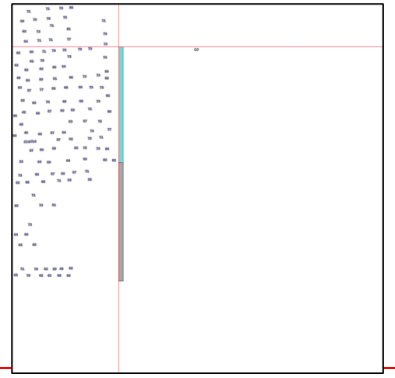


Minimal Depiction is not always clear

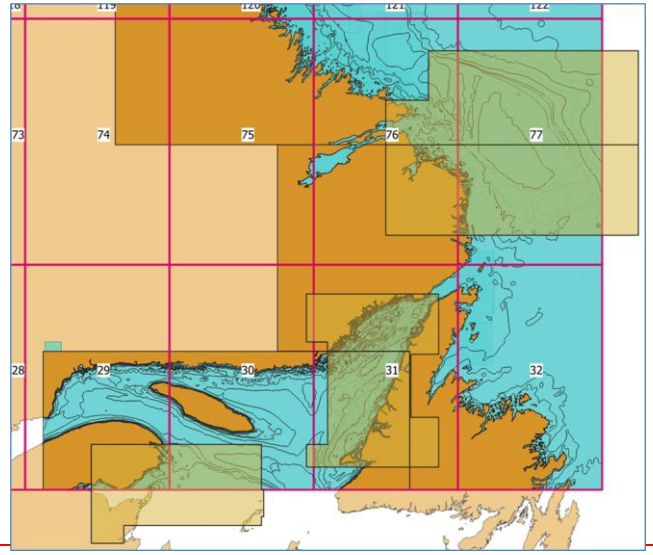
- **Overlaps**
  - Overlapping cells within the same usage band
  - Highlighted for Small Scale
  - Data outputs lists for all usages (grid cells affected)
    - Overview - 5
    - Transit - 49
    - Port - 166



Minimal Port cells

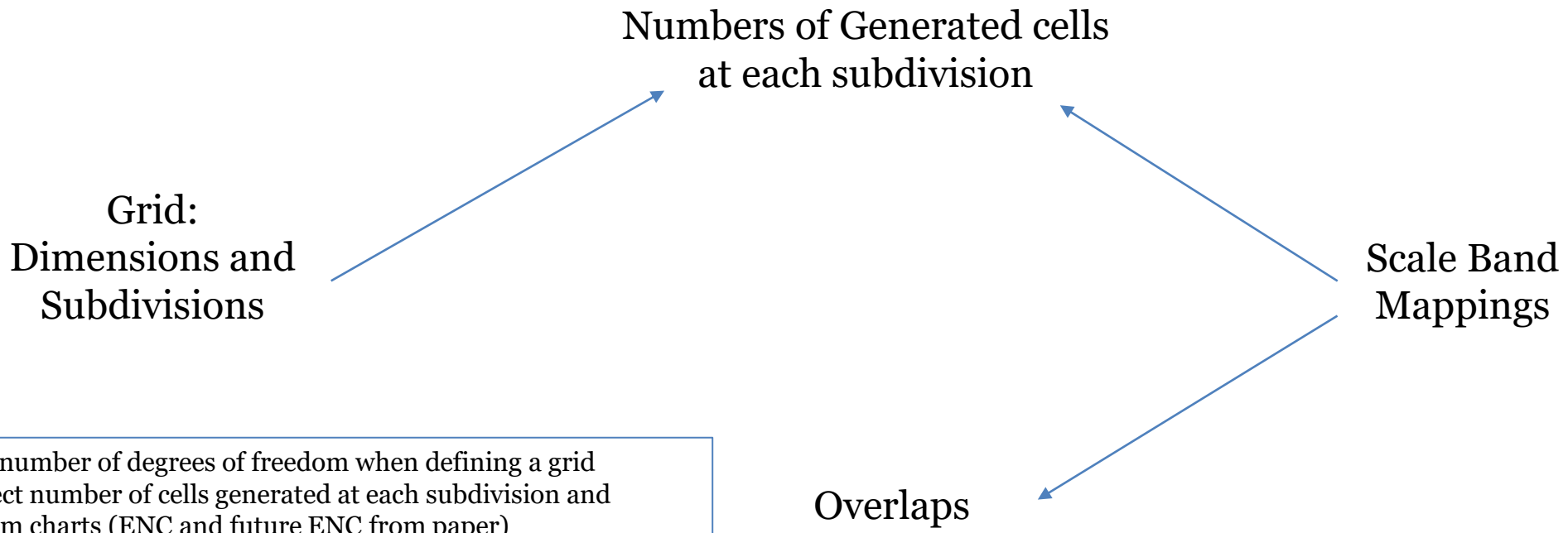


Sliver 1888



Overlaps - Overview

Grid Optimisation

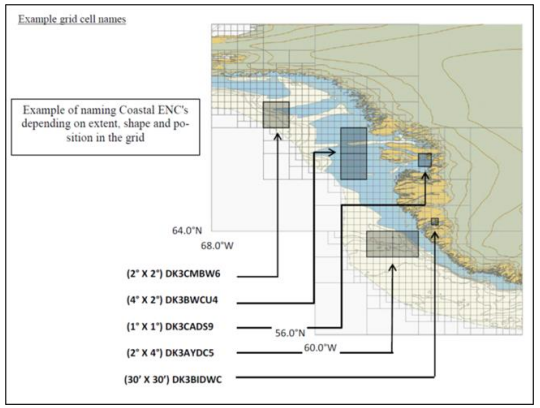


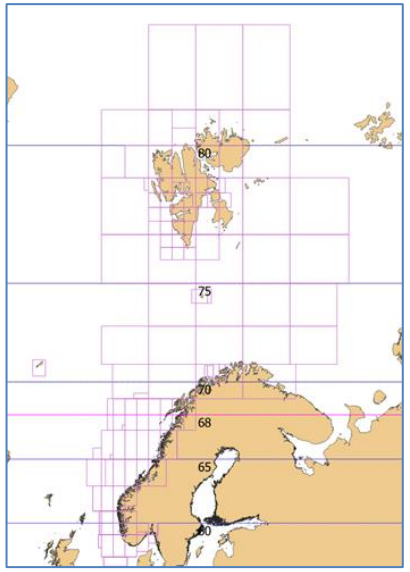
- There are a number of degrees of freedom when defining a grid
- Choices affect number of cells generated at each subdivision and overlaps from charts (ENC and future ENC from paper)
- Overlaps = possible recompilation or inclusion as M_CSCL or DataCoverage
- Number of cells = Overhead of management
- Tradeoff between optimising for size of portfolio and recompilation/coverage
- Which is the bigger concern? Numbers of cells or recompilation effort in dealing with overlaps?

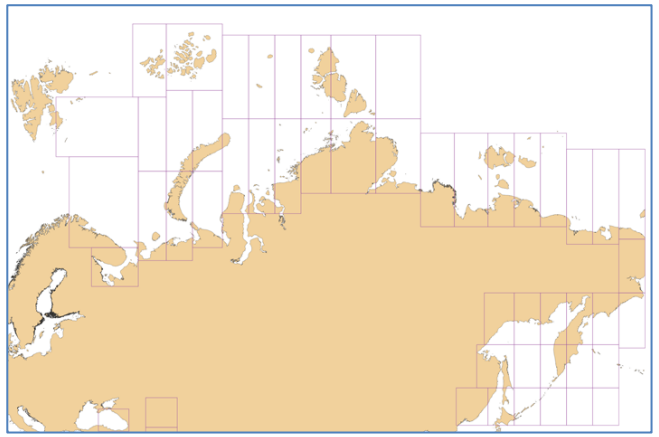
e.g: With scale boundaries at 22k and 150k = 54:245:991 cells (Overview, Transit and Port) but with boundaries at 27.5k and 100k = 57:163:1467 cells. Overlaps reduced from 11 to 7 in the Transit usage band but increase from 16 to 19 in the Port band.

The Regional Perspective

- Analysis of members and associate members
- Wide variety of approaches to grids
  - Norway – long established (S57 v2.0)
  - Denmark (Greenland) – documented, partially implemented
  - US – new, published, being rolled out.
  - Russian Federation – some gridding at small scales
  - Iceland – no grid
  - Italy – no grid
  - Finland – no grid

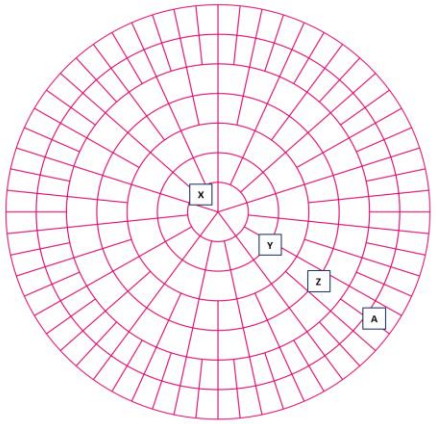






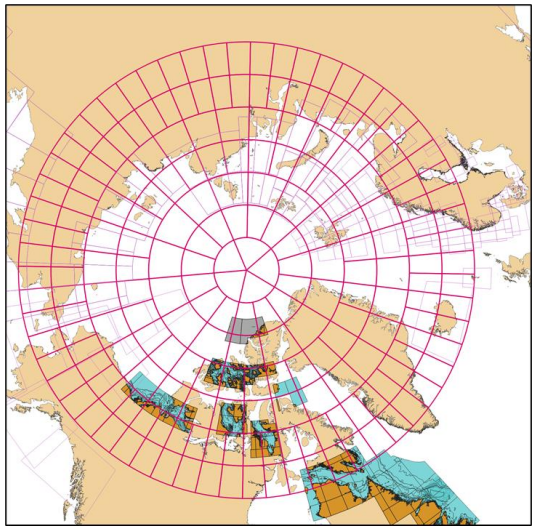
	1	2	3	4	5	6
Norway	Irregular	2x2 8x2 10x2 (+others)	2x2 2x0.5 4x1	0.125x0.125 0.25x0.25 0.5x0.5	-	-
Denmark (Greenland)	-	-	-	0.5x0.5	-	-
Russian Federation	48.45x14 48.45x15	7x7 9x7 12x5 (+others)				-
US	19.2/38.4	4.8 / 9.6	1.2 / 2.4	2/3°x1/3° [Alaska]	0.075	-
Finland	-	-	-	-	-	-
Iceland	-	Single UB2 – [-29,-8.5] [62,68]	-	-	-	-
Italy	-		-	-	-	-

Regional Proposals

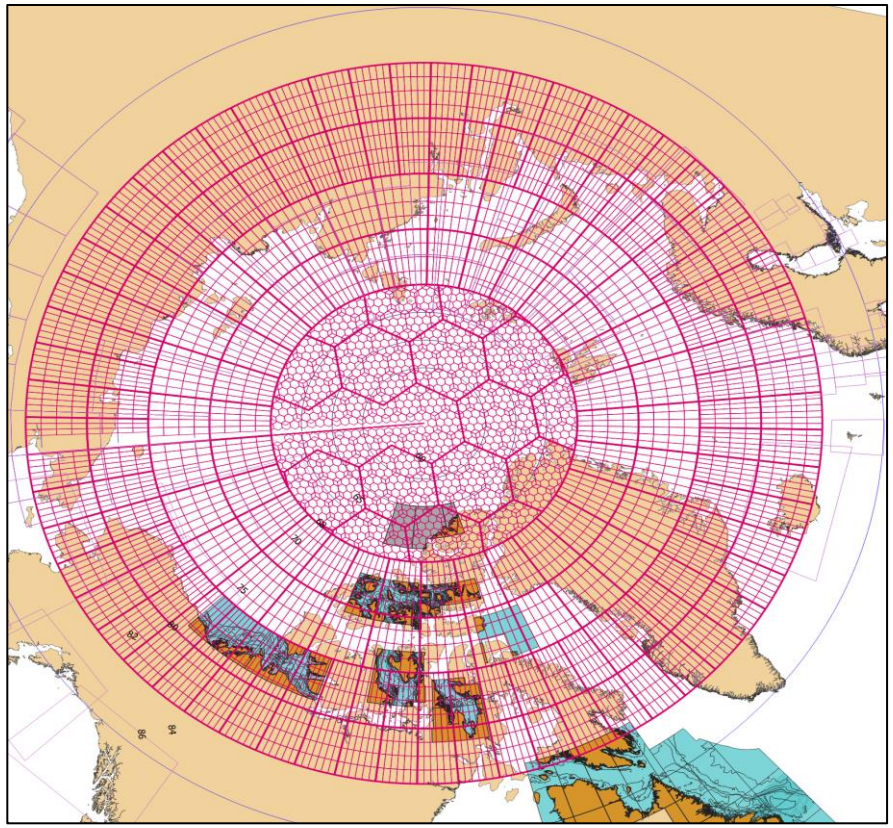


Zone	Latitude °	Width	Height
X	86°	72°	4°
Y	78-86	24°	4°
Z	70°	12°	4°
A	62°	6°	4°
Subdivisions	Subdivide to 1°x1° then to 0.1°x0.1°		

- Two proposals, Rectilinear and Partially non-rectilinear
- Questions?
  - Area of coverage, how to define region? Limiting Latitude or other defined area?
  - Include pole?
  - Uses – not just navigation e.g. subsurface, research
  - Regional data production (like EAHC?) or just scheming proposal? To replace existing data?
- Assumptions
  - Some negotiation would be required
  - Need to meet stakeholder's needs
  - Politically Neutral. Use dateline as origin and cover entire region.
- Main Points
  - Don't tie Compilation Scale to grid subdivision. Allow flexibility. Use "Usage 0" cells
  - Explore co-production in some regions at some scales (maybe smallest scales, poles). Then producers fill in larger scales. Encourages uptake.
  - Aggregation at largest scales to allow for e.g.0.5°x0.5°.

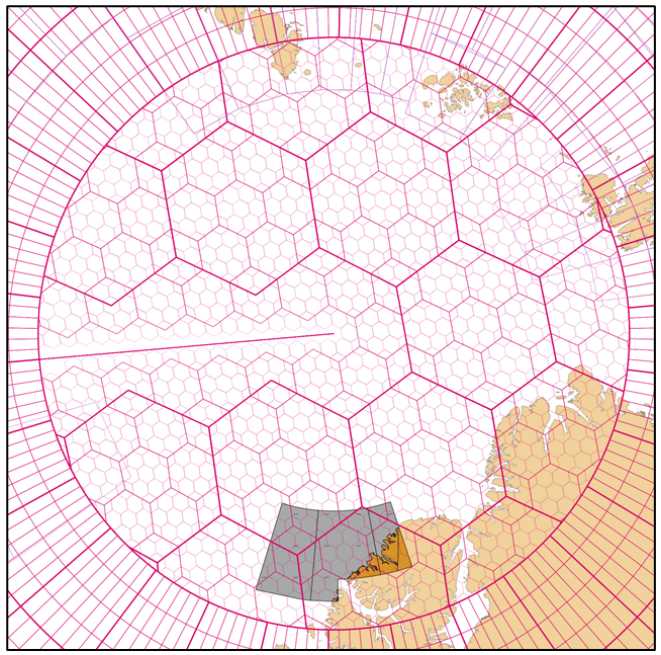


Regional Proposal 2



Zone	Latitude °	Width	Height
X			
Y			
Z	70°	12°	4°
A	62°	6°	4°
Subdivisions	Subdivide to 1°x1° then to 0.1°x0.1°		

- Proposal 2
- Take Rectangular grid from Proposal 1, replace central zones with Hexagonal Discrete Global Grid System (DGGS) at resolutions 8, 6 and 4.
- Defined using DGGRID software, open source, politically neutral.
- Clipped to rectangular grid at edges and around dateline (for ENC purposes)
- Can be clipped at a latitude if need be, or to a region.
- Same principles ('Usage 0', no mandated CSCL, allow aggregation)
- Equal Area for all polar region, Southern part familiar rectangular grid which works at all longitudes.
- Benefits:
  - Novel and Innovative,
  - Serves broader geospatial community
  - Eliminates Skew issues at extreme latitudes



Plan & Questions?

- Plan
  - Complete Report based on any feedback.
  - Deliver completed report + all data for any further analysis

- Questions?
  - More grid analysis against ENCs? Is there a preference for number of grid cells vs overlap processing?
  - Co-Production of S-57/S-101 – take into account?
  - Regional Proposals
    - Scope of area required?
    - More on data production? Arctic ENCs series?
    - Demonstration data
  - Data deliverables – ENC features, grids, coverage and queries?
  - What constitutes minimal depiction or slivers? Region Specific? Sovereignty Charting?
  - Grid Everything?

- Other Areas:
  - More on “other” S-100 products, S-102? S-411 etc?
  - More on Paper? Charting Plan?
  - More on Regional / Legislative / Cooperation?
  - More detailed numbers on each analysis scenario (also in data)