NAVDAT vs NAVTEX
Myths & Misconceptions

9:00 am EST, 15:00 CET

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KENTA
A nautel COMPANY

Agenda

- Introduction
- The NAVDAT Opportunity
- Planning for NAVDAT…
  - Things to consider
  - Possible misconceptions
- Questions and answers

Hermann ZENSEN
Sales & Marketing
KENTA

John Whyte
Head of Marketing & Product Strategy
Nautel

Philipp Schmid
Chief Technology Officer
Nautel

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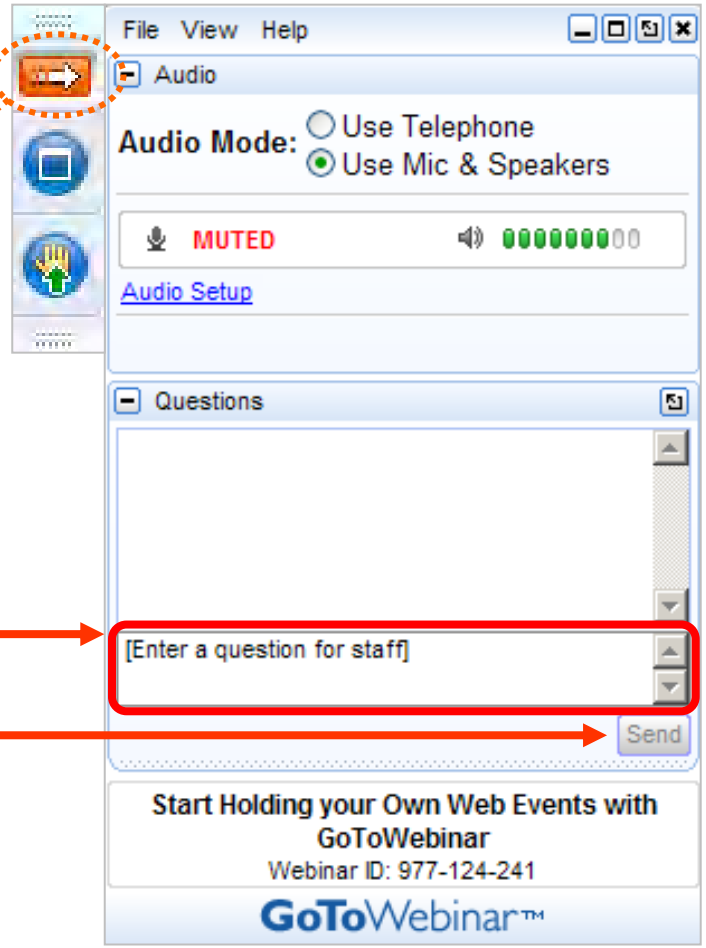
Questions & Answers

Click on  *to open/close webinar panel*



Enter questions here

…then press **Send**

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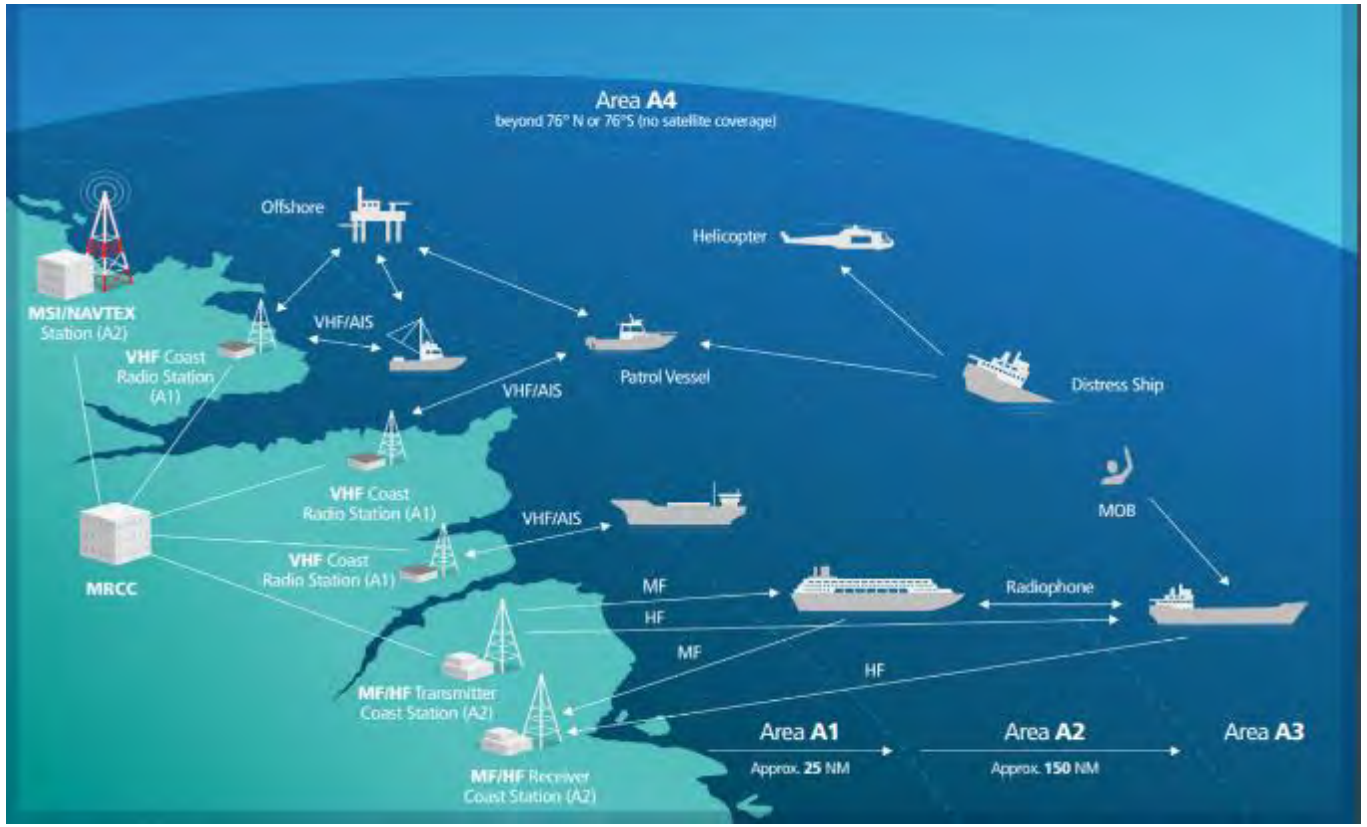
KENTA Technologies & NAUTEL: Shared passion for maritime communications



Nautel HQ, Halifax, Canada

Nautel Maine, Bangor, US

Kenta Technologies, France

20,000 Deployments

Five Decades

CIRM

IALA

RTCM

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Nautel + Kenta Expertise

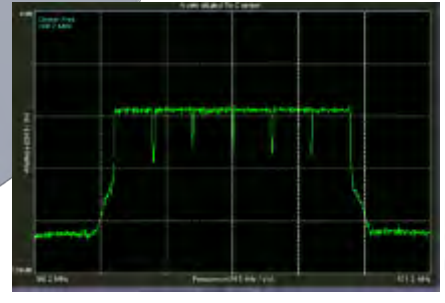
World's Largest

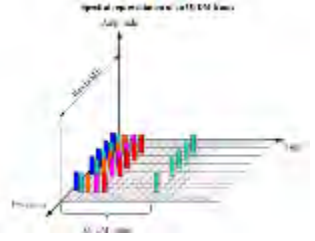
NAVTEX Supplier

NAVDAT

High Power Transmitters

Digital Transmission





NAVDAT

2 Minute Overview

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The El Faro Disaster and Hurricane Joaquin

El Faro departed Jacksonville, Florida, under the command of Captain Michael Davidson, bound for San Juan, Puerto Rico, at 8:10 p.m. EST on September 29, 2015, when then-Tropical Storm Joaquin was several hundred miles to the east. Two days later, after Joaquin had become a Category 4 hurricane, the vessel likely encountered swells of 20 to 40 ft (6 to 12 m) and winds over 80 kn (150 km/h; 92 mph) as she sailed near the storm's eye. Around 7:30 a.m. on October 1, the ship had taken on water and was listing 15 degrees. The last report from the captain, however, indicated that the crew had contained the flooding. Shortly after that, *El Faro* ceased all communications with shore.[5][4]

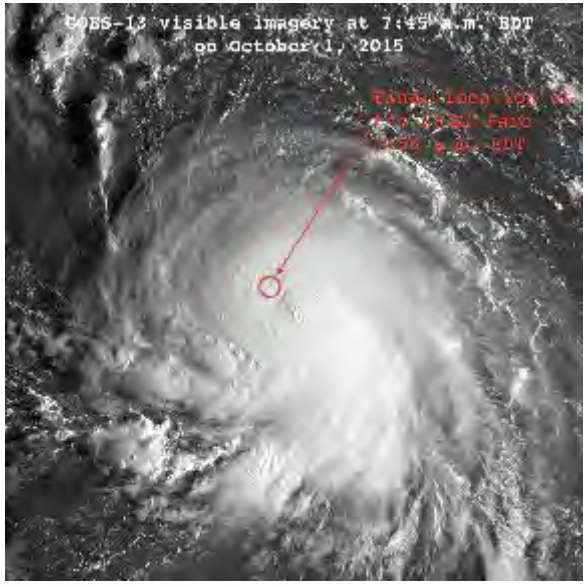

Figure 38. Tropical cyclone track forecast cone and watches/warnings graphic issued for Joaquin at 2300 on September 29. Orange circle shows Joaquin's current position. H inside small black circles indicates forecast intensity of 74-110 mph (64-95 knots)

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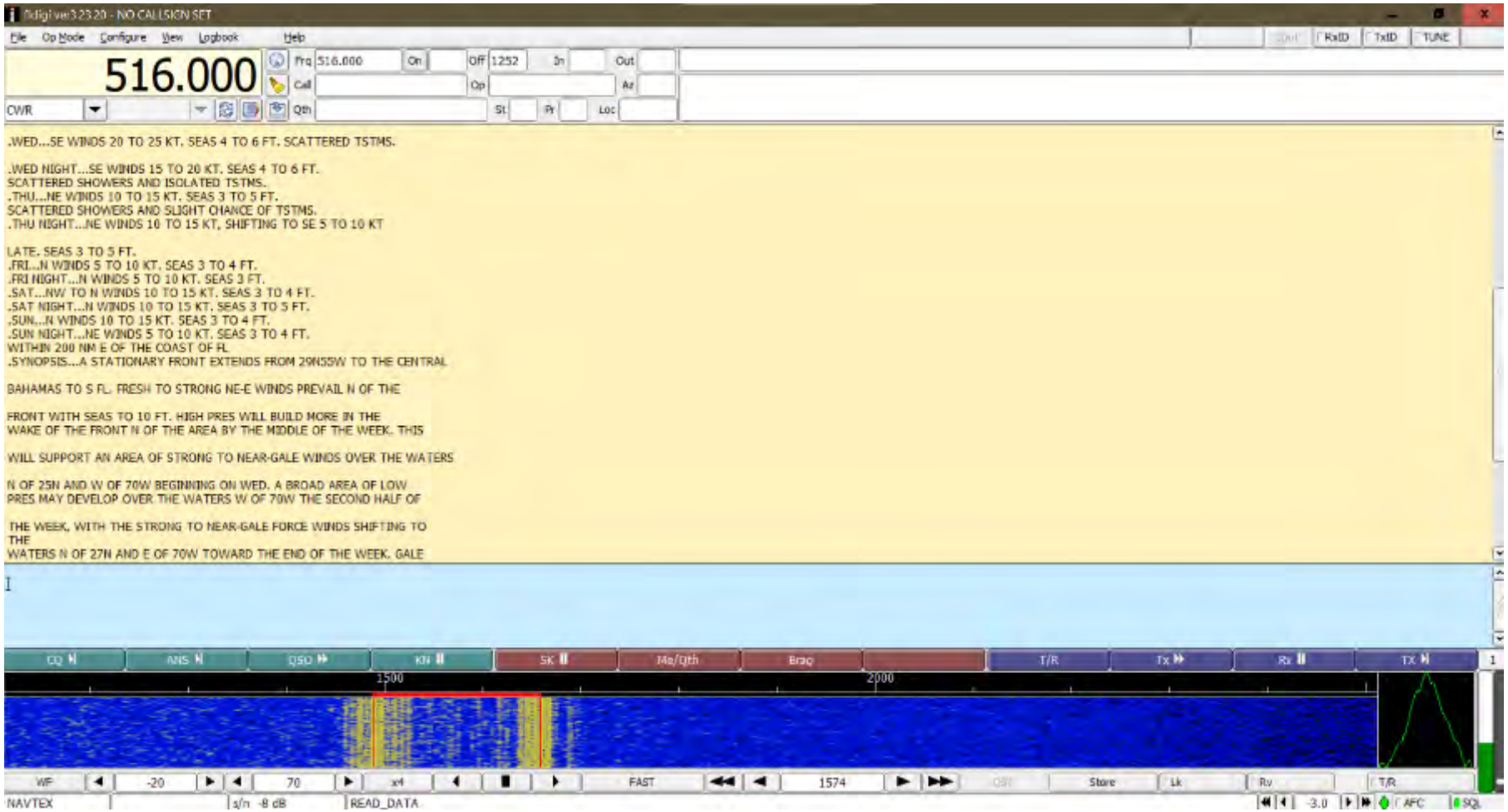
Todays NAVTEX Captured Forecast in Nova Scotia

Bermuda Transmission



* Small frequency offset needed for SDR

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The promise of NAVDAT: Better data and content

The way forward now, and in line with the strategic implementation plan on e-navigation*, is to introduce **digital communications**.

The gap-analysis of e-navigation identified the need to present information in **graphical format**.

* See MSC.1/Circ.1595

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Advantages of NAVDAT

- **Enhanced Range & Reliability:**
  - Offers greater transmission range and reliability compared to NAVTEX.
- **Higher Data Capacity:**
  - Capable of transmitting a larger volume of data, allowing for more comprehensive safety messages.
- **Multimedia Capability:**
  - Supports various data formats, including text, images, and potentially video, enhancing the clarity and understanding of safety messages.
- **Flexibility:**
  - Adaptable to various frequency bands and can be integrated with existing maritime communication systems.

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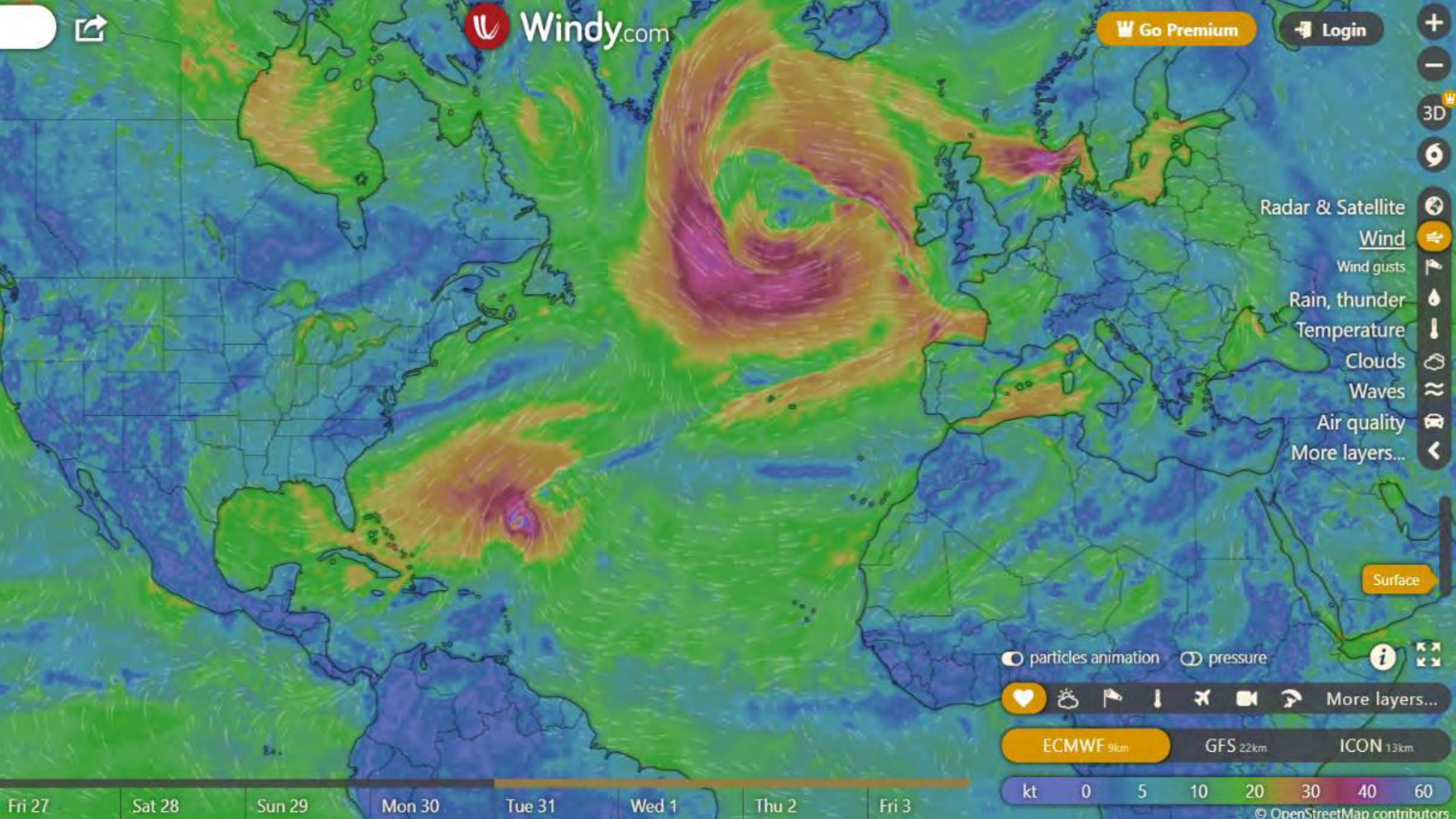
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Wind gusts
Rain, thunder
Temperature
Clouds
Waves
Air quality
More layers...
Surface
particles animation
pressure
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GFS 22km
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Sun 29
Mon 30
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Fri 3
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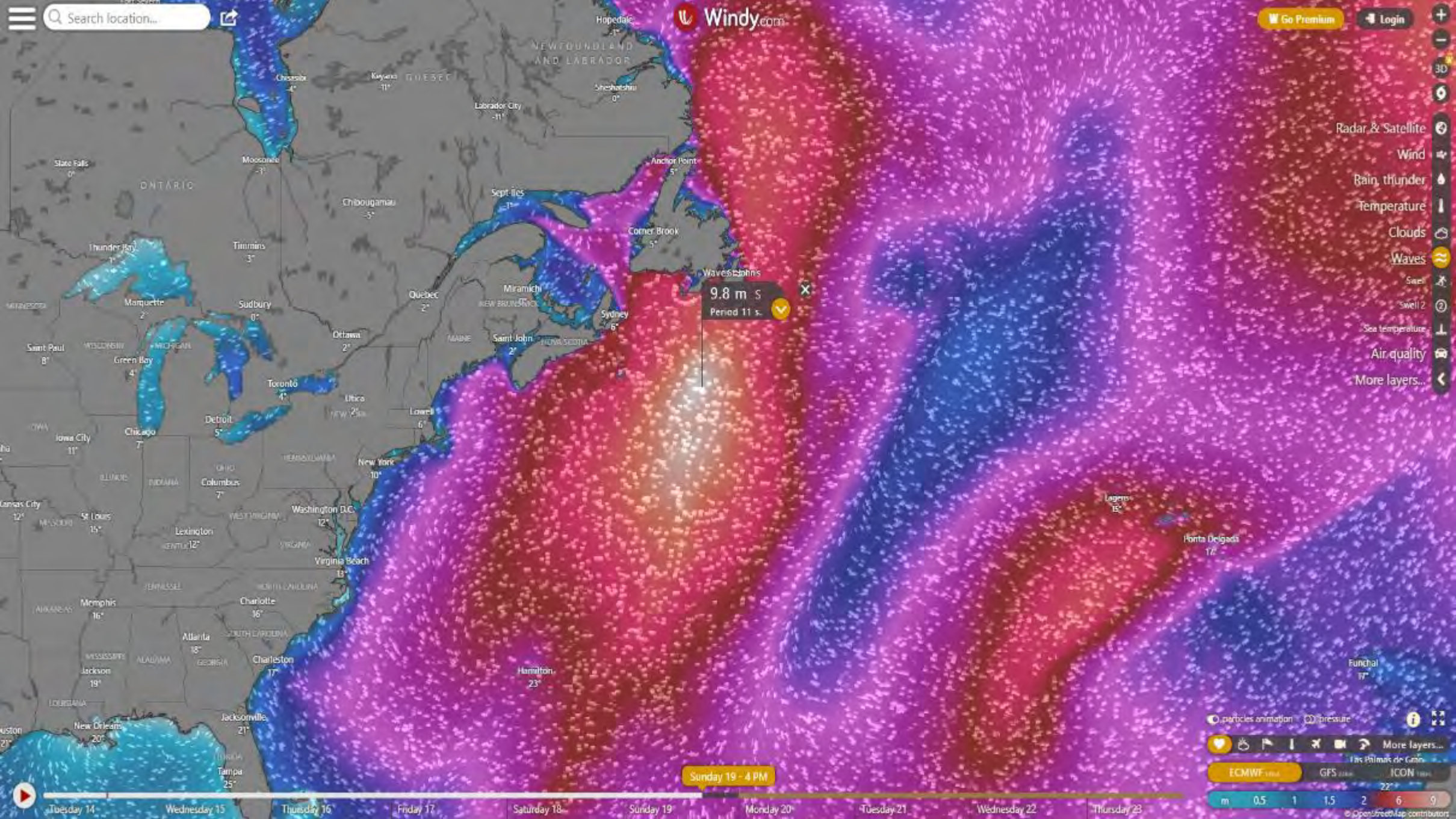
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Go Premium
Login
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Wind
Rain, thunder
Temperature
Clouds
Waves
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Sea temperature
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Hopedale
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Moosonee
Anchor Point
Sept-Îles
Chibougamau
Corner Brook
Timmins
Thunder Bay
Marquette
Sudbury
Quebec
Miramichi
Sydney
Ottawa
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Toronto
Utica
Lowell
Detroit
Chicago
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St Louis
Washington D.C.
Lexington
Virginia Beach
Memphis
Charlotte
Atlanta
Charleston
Jackson
Jacksonville
New Orleans
Tampa
Hamilton
Lagens
Ponta Delgada
Funchal
Las Palmas de Gran...
particles animation
pressure
More layers...
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GFS
ICON
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Sunday 19 - 4 PM
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Thursday 23
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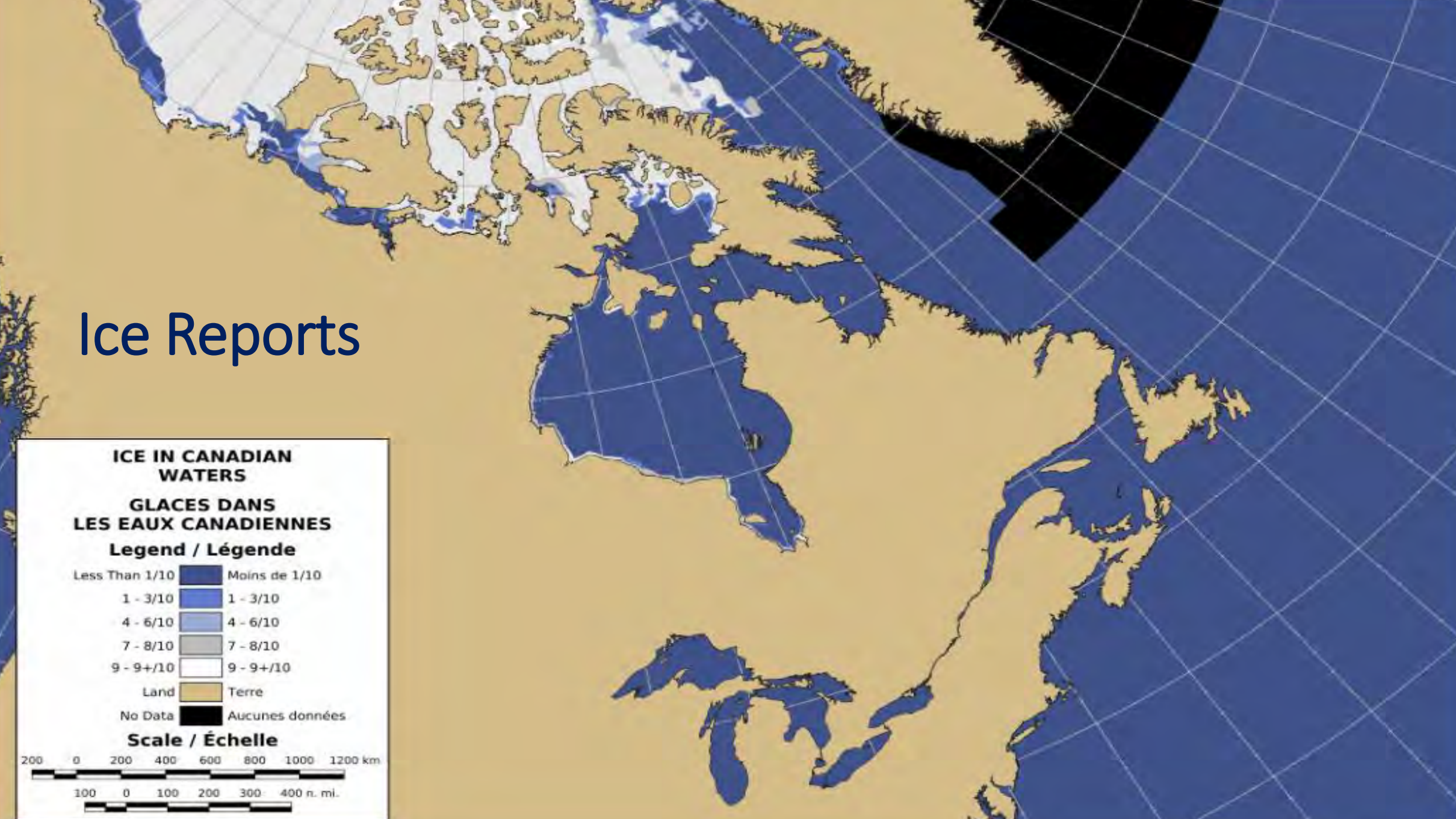
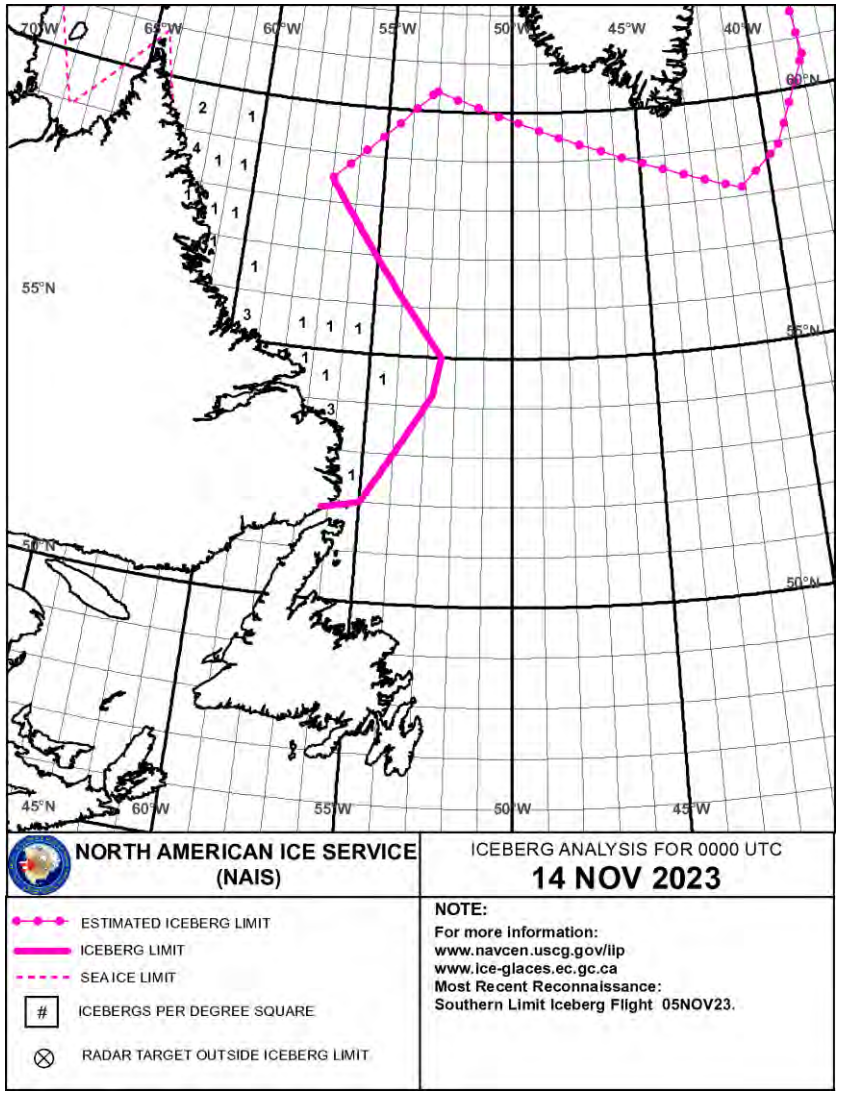
Ice Reports


ICE IN CANADIAN WATERS
GLACES DANS LES EAUX CANADIENNES
Legend / Légende
Less Than 1/10
Moins de 1/10
1 - 3/10
1 - 3/10
4 - 6/10
4 - 6/10
7 - 8/10
7 - 8/10
9 - 9+/10
9 - 9+/10
Land
Terre
No Data
Aucunes données
Scale / Échelle
200 0 200 400 600 800 1000 1200 km
100 0 100 200 300 400 n. mi.

1. NORTH AMERICAN ICE SERVICE (NAIS)
   ICEBERG BULLETIN 140001Z NOV.
2. ICEBERG LIMIT ALONG TRACKLINE JOINING
   51-51N 056-13W, 52-00N 055-00W,
   54-15N 052-45W, 55-00N 052-30W,
   58-30N 057-00W.
3. ESTIMATED ICEBERG LIMIT ALONG
   TRACKLINE JOINING
   58-30N 057-00W, 60-25N 053-05W,
   58-10N 041-10W, 58-55N 039-30W,
   60-40N 037-55W, 62-30N 038-15W,
   65-10N 027-40W.
4. SEA ICE LIMIT ALONG TRACKLINES
   JOINING:
   A. 59-32N 063-45W, 60-28N 064-15W,
      60-54N 064-29W, 58-56N 067-40W,
      61-12N 069-20W, 62-54N 074-24W,
      62-26N 080-53W, 61-38N 080-34W,
      58-31N 079-03W, 57-58N 077-07W.
   B. 54-54N 078-52W, 59-35N 093-46W,
      62-57N 088-32W, 61-36N 083-00W,
      63-47N 079-46W, 65-32N 082-19W,
      66-06N 079-27W, 64-23N 079-08W,
      61-57N 068-49W, 62-11N 068-00W.
   C. 61-59N 066-00W, 62-10N 064-00W,
      65-00N 061-30W, 66-30N 058-15W,
      68-30N 058-53W.
5. MOST RECENT RECONNAISSANCE:
   SOUTHERN LIMIT ICEBERG FLIGHT 05 NOV 23.
6. REPORT POSITION AND TIME OF ANY ICEBERGS
   SEA ICE OR STATIONARY RADAR TARGETS THAT
   MAY LIKELY BE ICE TO THE NEAREST CANADIAN
   COAST GUARD MARINE COMMUNICATIONS AND
   TRAFFIC SERVICE STATION OR
   USING INMARSAT CODE 42.
7. FOR MORE REPORTING INFORMATION OR TO
   DOWNLOAD SHAPEFILES AND WEEKLY PREDICTIONS,
   GO TO WWW.NAVCEN.USCG.GOV/IIP.
8. CANCEL THIS MSG 150001Z NOV 23.



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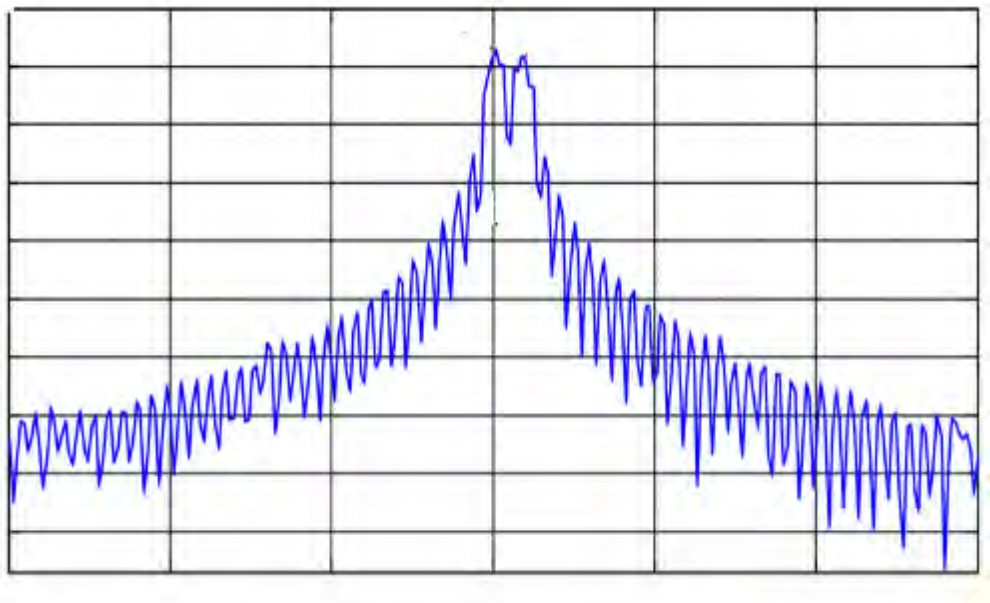
Planning for NAVDAT: Things to consider

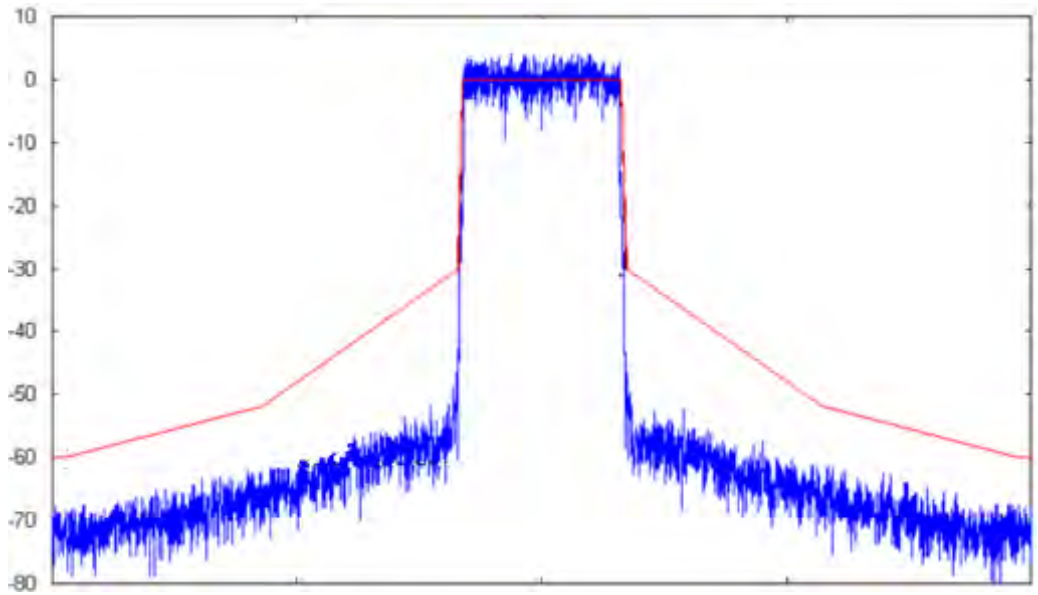
1. “Existing NAVTEX infrastructure can be reused for NAVDAT”

Typical Spectra: NAVTEX and NAVDAT

300 Hz NAVTEX



10 kHz NAVDAT



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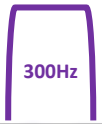
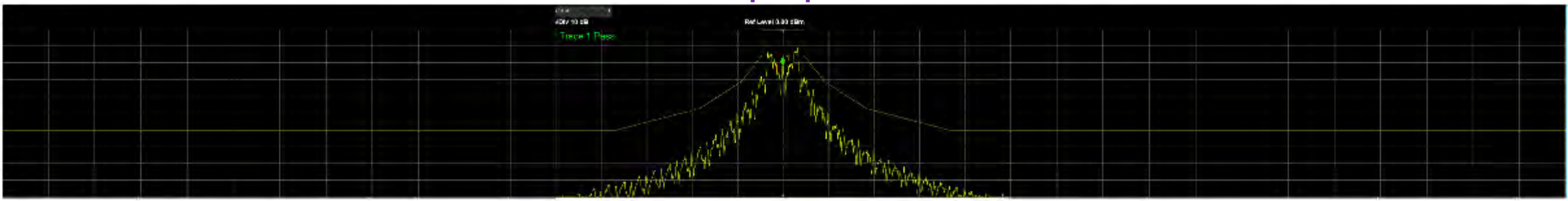
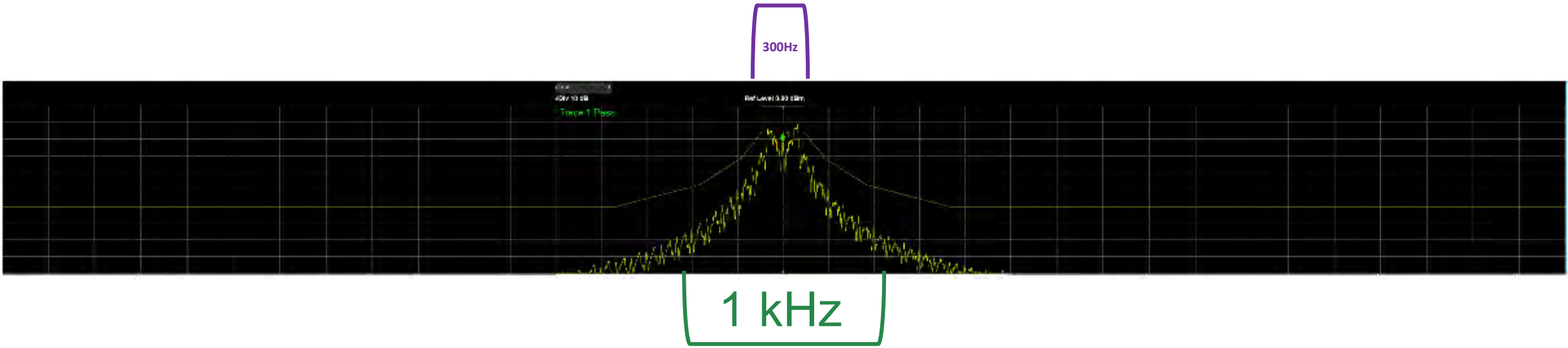
NAVTEX vs NAVDAT Bandwidth Requirements



Typical NAVTEX Spectrum



NAVTEX vs NAVDAT Bandwidth Requirements



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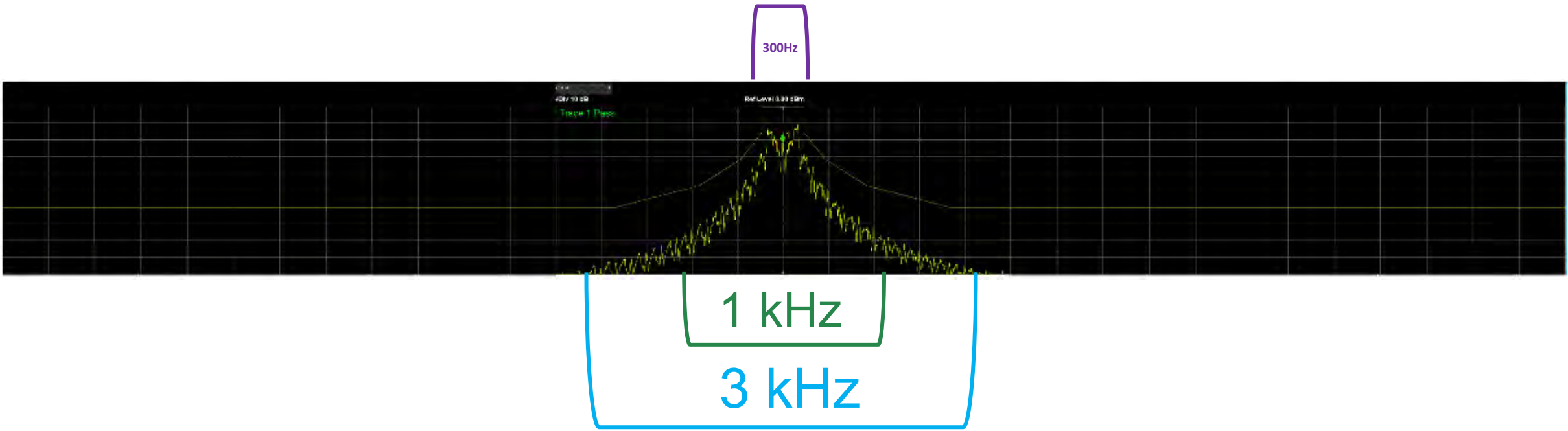
NAVTEX vs NAVDAT Bandwidth Requirements



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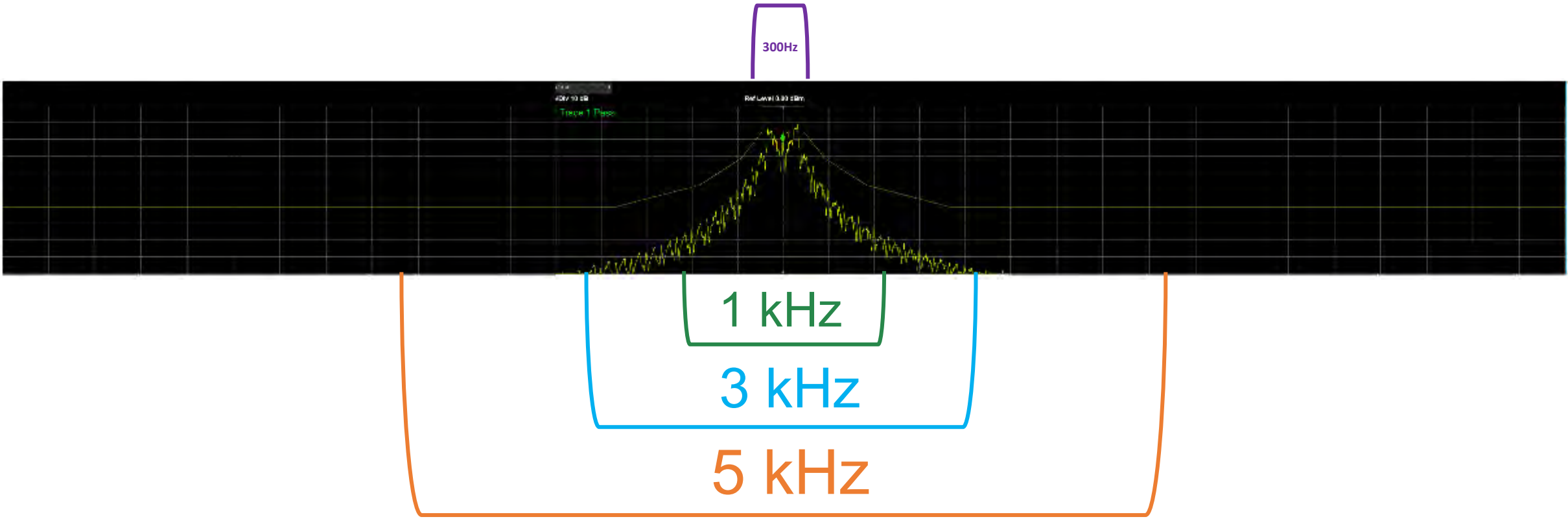
NAVTEX vs NAVDAT Bandwidth Requirements



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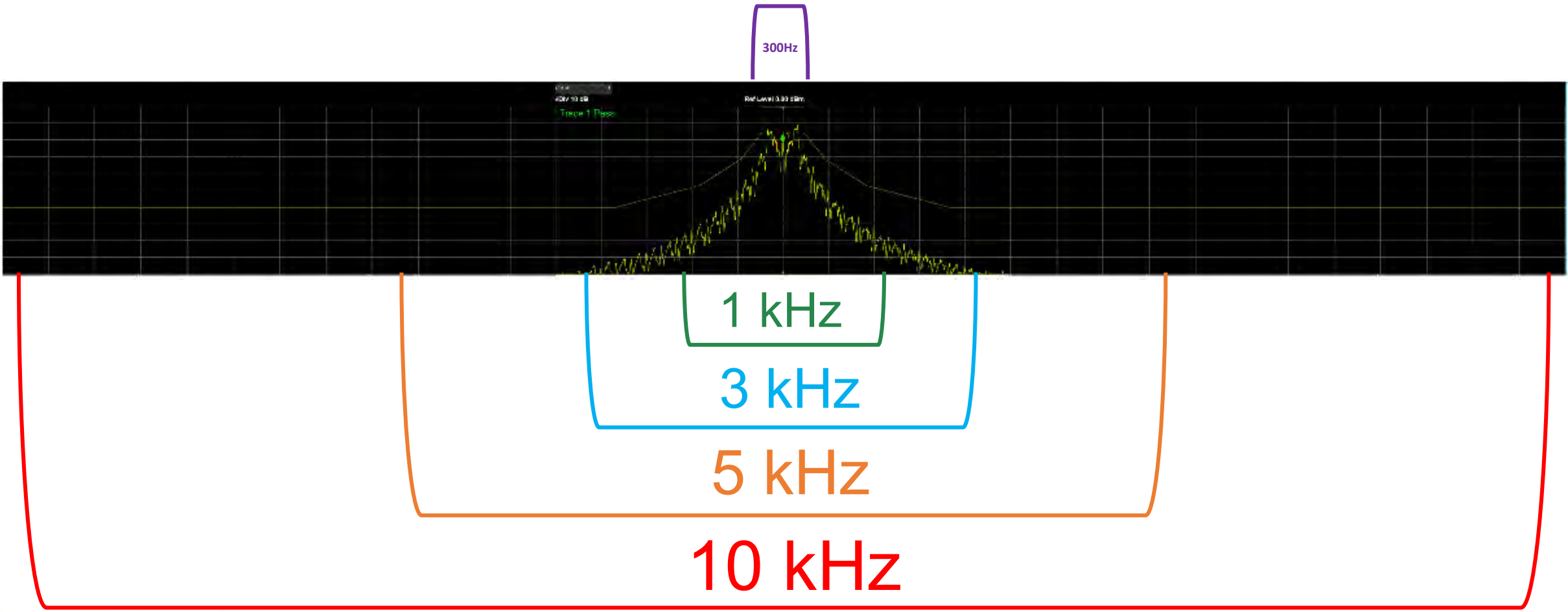
NAVTEX vs NAVDAT Bandwidth Requirements



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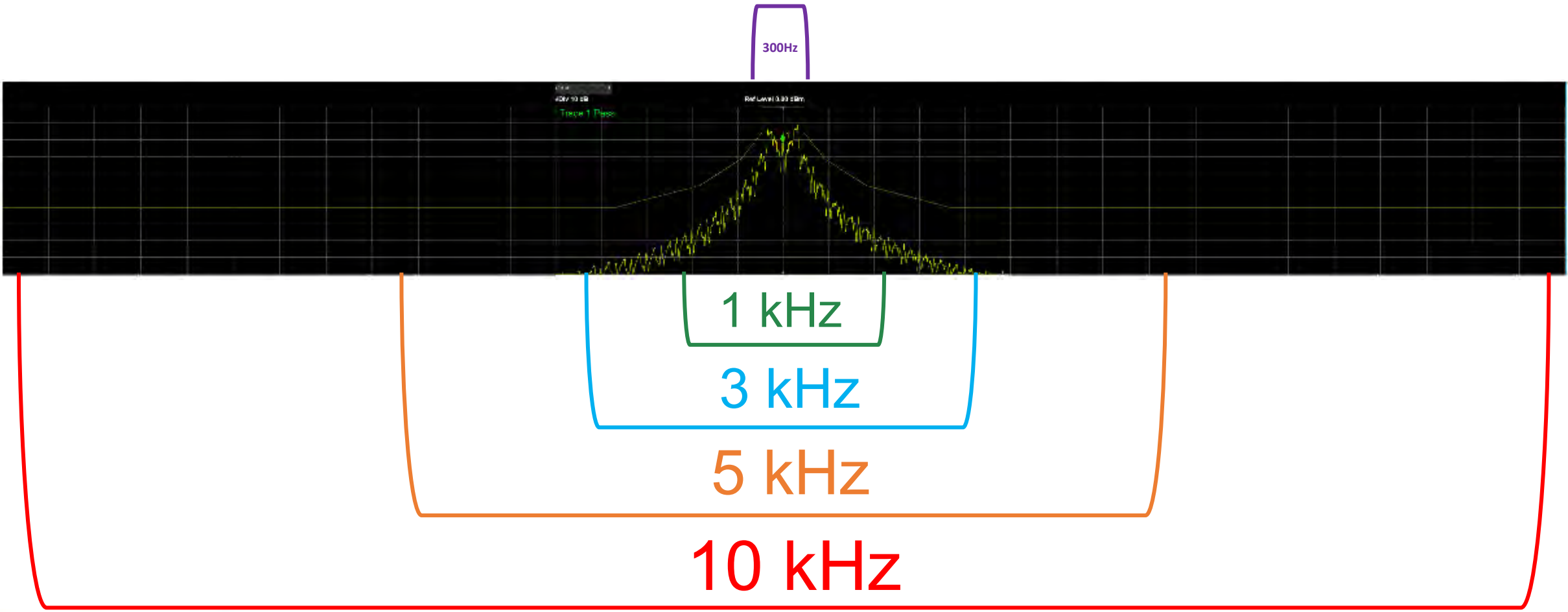
NAVTEX vs NAVDAT Bandwidth Requirements



Significant implications for transmission chain:

- Transmitter, Antenna Tunning Unit, Antenna

Planning for NAVDAT: Things to consider

1. “Existing NAVTEX infrastructure can be reused for NAVDAT”

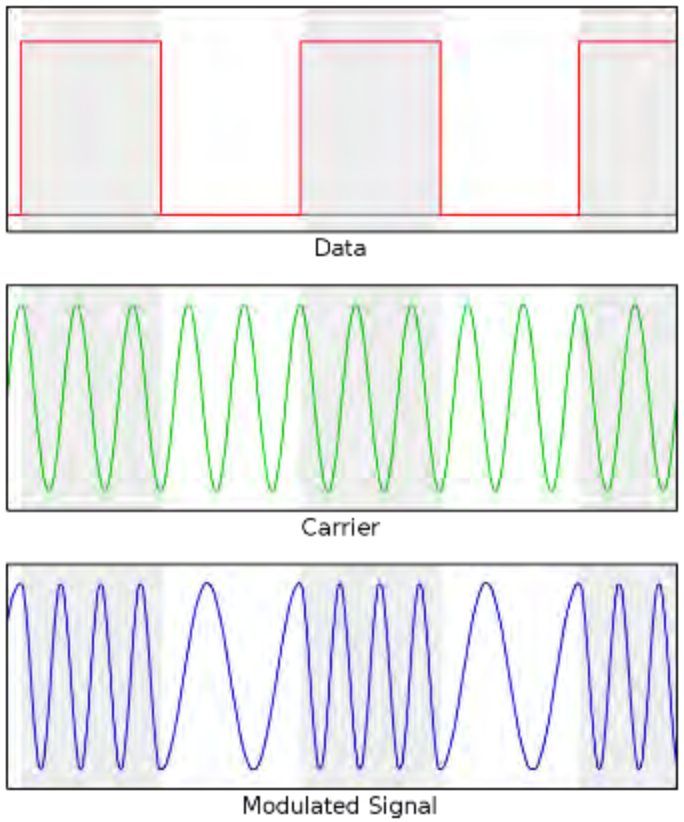
FACT:

- Maybe, but implies possible NAVDAT compromises
- NAVDAT requires much more peak power to transmit its digital signal.
- Existing antenna, ATU, and power supply need to be evaluated
  - can it handle the required peaks?
  - can it handle the broader bandwidth?
  - may need to be upgraded?
  - some may choose to use a separate transmission infrastructure for NAVDAT

Planning for NAVDAT: Things to consider

2. “A 1 kW or 5 kW NAVTEX transmitter can be replaced by similar power NAVDAT transmitter”

NAVTEX Constant Single Carrier Power Envelope



- Single modulated carrier
- Constant power envelope
  - TX Power == PEP Power
- Bit rate: 100 bits/s = 0.1kbit/s
- Binary Frequency Shift Keying with a frequency shift of 170 Hz
- Frequencies: 490 kHz, 518 kHz, (4209.5 kHz)

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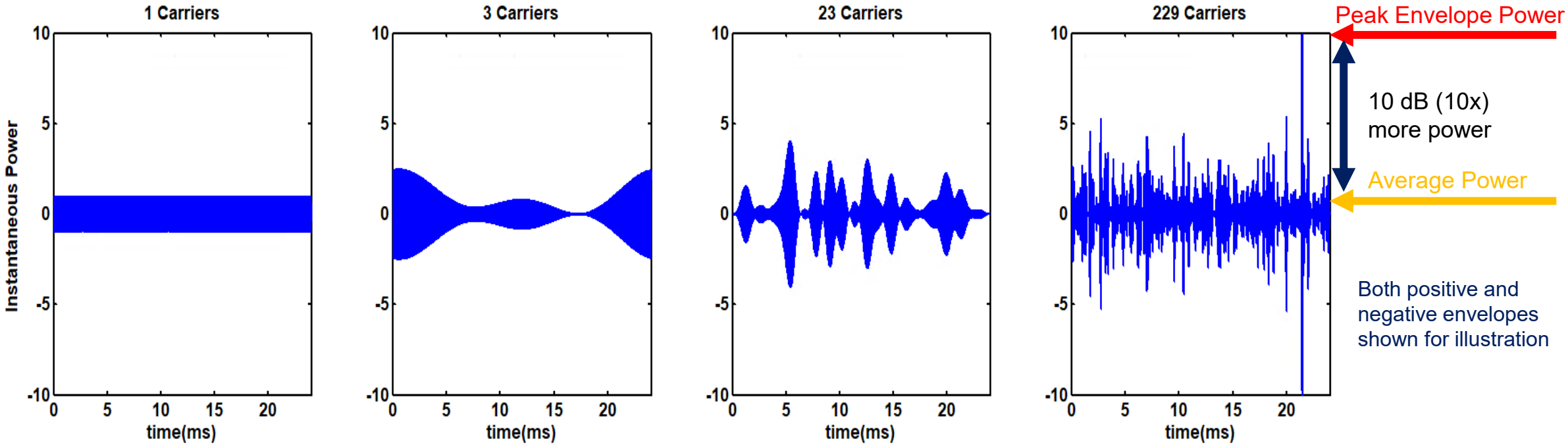
NAVDAT Transmitters Must be Sized for Peak Power



- Size transmitter for varying power envelope up to 10 dB (10x) - conservative
  - Carriers with random phase and amplitude add constructively and destructively
  - Peak to average power reduction algorithms will be optimized in the future
- NAVTEX is a single carrier system: Average Envelope Power == Peak Envelope Power

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Also ensure ATU and antenna can handle peak power

Planning for NAVDAT: Things to consider

2. "A 1 kW or 5 kW NAVTEX transmitter can be replaced by similar power NAVDAT transmitter"

FACT:

- Technically yes, but you'll probably need more power.
- The promise of NAVDAT won't be achieved at NAVTEX power levels
- NAVDAT requires more peak power to take advantage of its higher data capacity.
- If NAVDAT Tx power = NAVTEX Tx power: you'll face a choice:
  - Maintain similar range as NAVTEX but at data rates not much better than NAVTEX

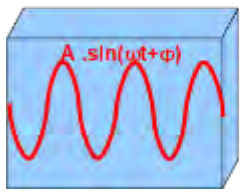
    or
  - Transmit at higher data rates but at a much compromised range
- Rough rule of thumb: 10:1 power
  - Replace a 1 kW peak NAVTEX with a 10 kW peak NAVDAT
  - Replace a 5 kW peak NAVTEX with a 50 kW peak NAVDAT

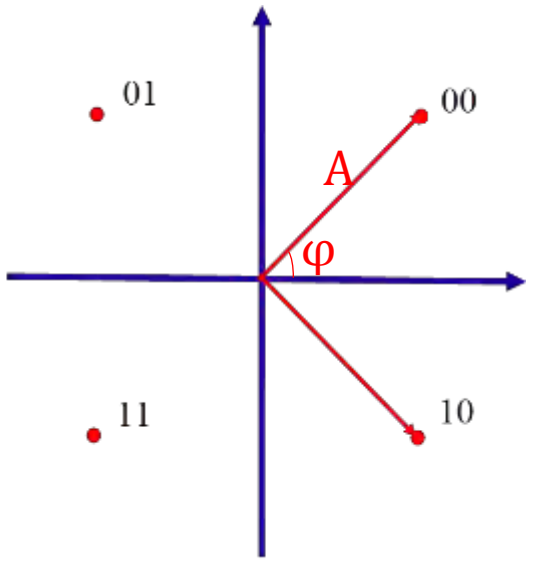
Planning for NAVDAT: Things to consider

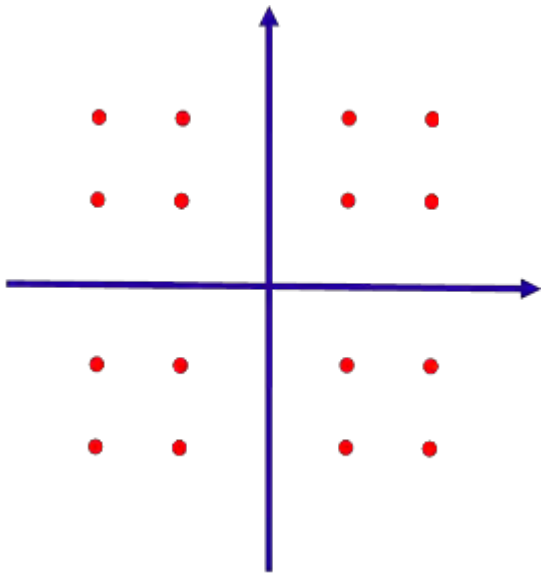
3. “NAVDAT transmits 25 kbps”

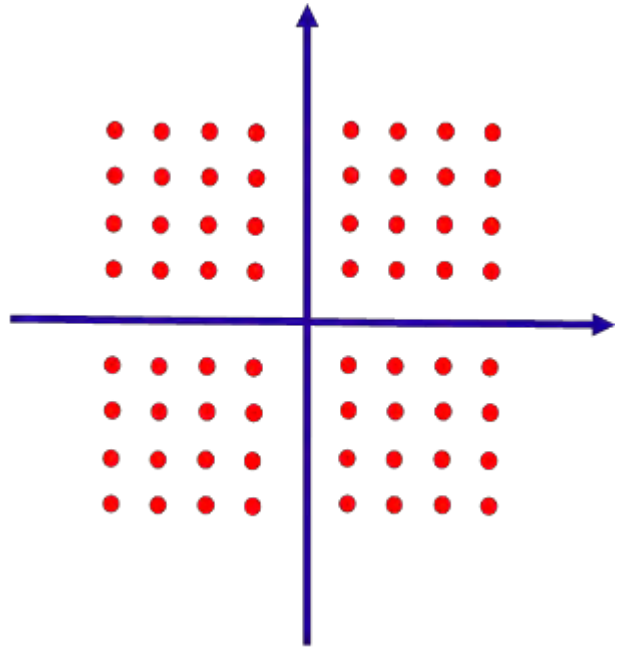
NAVDAT Low, Medium, High Data Rate Modes

Up to 229 carriers (sine waves)









4 QAM
2 bits per carrier/symbol
Robust waveform
~14 dB SNR
6.4-9.6 kbps

16 QAM
4 bits per carrier/symbol
~18 dB SNR
12.7-19.1 kbps

64 QAM
6 bits per carrier/symbol
Highest data rate
~22 dB SNR
19-29 kbps

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ITU-R M.2010-2 Bit rates

Flexible Configurations

TABLE 24

LDPC parameters of data stream for mode A

Bandwidth (kHz)	Number of subcarriers	Number of pilots	Number of data subcarriers	Modulation	TIS and MIS	Information bits	Channel coding	Information rate (kbits)
10	228*14	38*14	190*14	4-QAM	100	2560*2	(2560,5120)	6.36
10	228*14	38*14	190*14	4-QAM	100	2560*2	(3840,5120)	9.56
10	228*14	38*14	190*14	16-QAM	100	2560*4	(2560,5120)	12.72
10	228*14	38*14	190*14	16-QAM	100	2560*4	(3840,5120)	19.12
10	228*14	38*14	190*14	64-QAM	100	2560*6	(2560,5120)	19.08
10	228*14	38*14	190*14	64-QAM	100	2560*6	(3840,5120)	28.68
5	114*14	271	1325	4-QAM	100	1224*2	(1224,2448)	3.02
5	114*14	271	1325	4-QAM	100	1224*2	(1836,2448)	4.55
5	114*14	271	1325	16-QAM	100	1224*4	(1224,2448)	6.04
5	114*14	271	1325	16-QAM	100	1224*4	(1836,2448)	9.10
5	114*14	271	1325	64-QAM	100	1224*6	(1224,2448)	9.06
5	114*14	271	1325	64-QAM	100	1224*6	(1836,2448)	13.65
3	68*14	159	793	4-QAM	100	692*2	(692,1384)	1.69
3	68*14	159	793	4-QAM	100	692*2	(1038,1384)	2.555
3	68*14	159	793	16-QAM	100	692*4	(692,1384)	3.38
3	68*14	159	793	16-QAM	100	692*4	(1038,1384)	5.11
3	68*14	159	793	64-QAM	100	692*6	(692,1384)	5.07
3	68*14	159	793	64-QAM	100	692*6	(1038,1384)	7.665
1	22*14	4*14	252	4-QAM	100	152*2	(152,304)	0.34
1	22*14	4*14	252	4-QAM	100	152*2	(228,304)	0.53
1	22*14	4*14	252	16-QAM	100	152*4	(152,304)	0.68
1	22*14	4*14	252	16-QAM	100	152*4	(228,304)	1.06
1	22*14	4*14	252	64-QAM	100	152*6	(152,304)	1.095
1	22*14	4*14	252	64-QAM	100	152*6	(228,304)	1.59

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Planning for NAVDAT: Things to consider

3. “NAVDAT transmits 25 kbps”

FACT:

- Yes but…

the data rate you achieve depends on

- Bandwidth
- Power
- Modulation type and channel coding

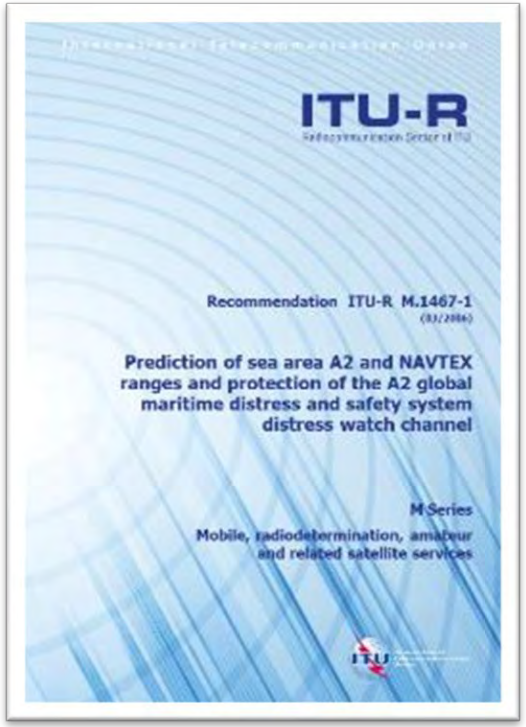
And impacts coverage

- Data rates can vary from 0.22 kbit/s to 28.68 kbit/s

Planning for NAVDAT: Things to consider

4. “NAVTEX and NAVDAT have comparable range and coverage”

NAVTEX Coverage Planning

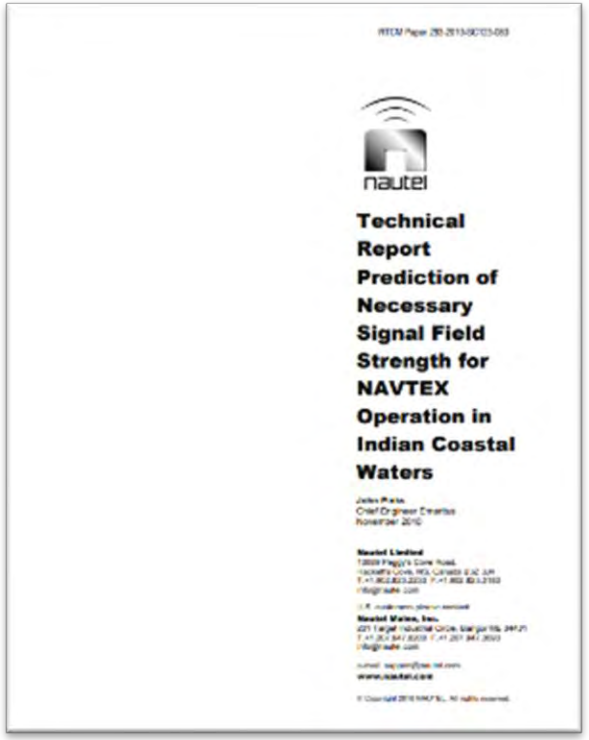


Recommendation ITU-R M.1467 provides guidance to administrations for predicting **sea area A2** and NAVTEX coverage areas by taking into account variations in the propagation conditions.

Reception is limited by:

- Shipboard / manmade noise
  - Vessel RX dependent
- Atmospheric Noise, varies by
  - Geography
  - Time of day
  - Season

- Nautel India Example:
  - 100 uV/m – 40 dBU Signal Strength
  - **3 kW** TX => **389 nm** range



http://rtcm.info/sc123/293-2010-SC123-08.pdf

Frequency:	490 kHz and 518 kHz
Bandwidth:	300 Hz
RF full bandwidth signal/noise ratio:	8 dB
Mean Tx power below peak:	0 dB
Fading margin:	3 dB
IMO Reference:	Resolution A.801(19)
Availability required:	90%

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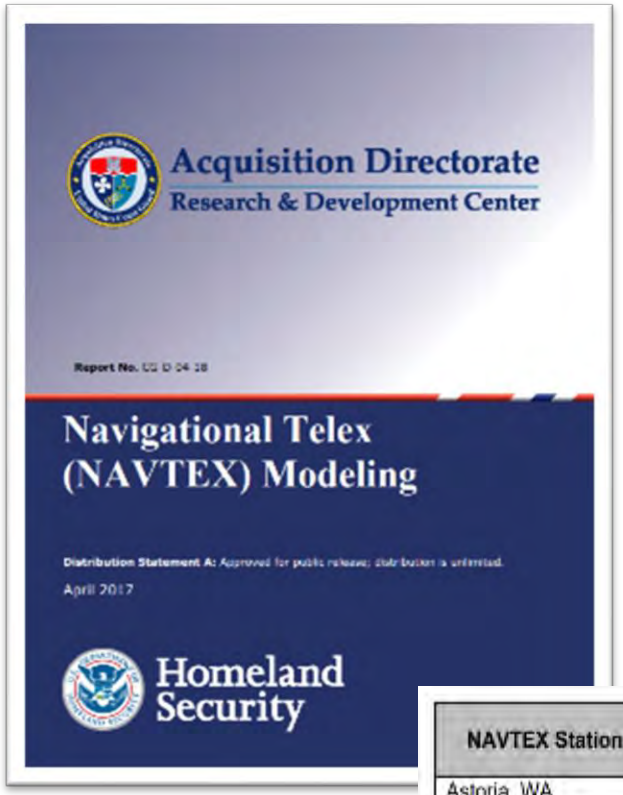
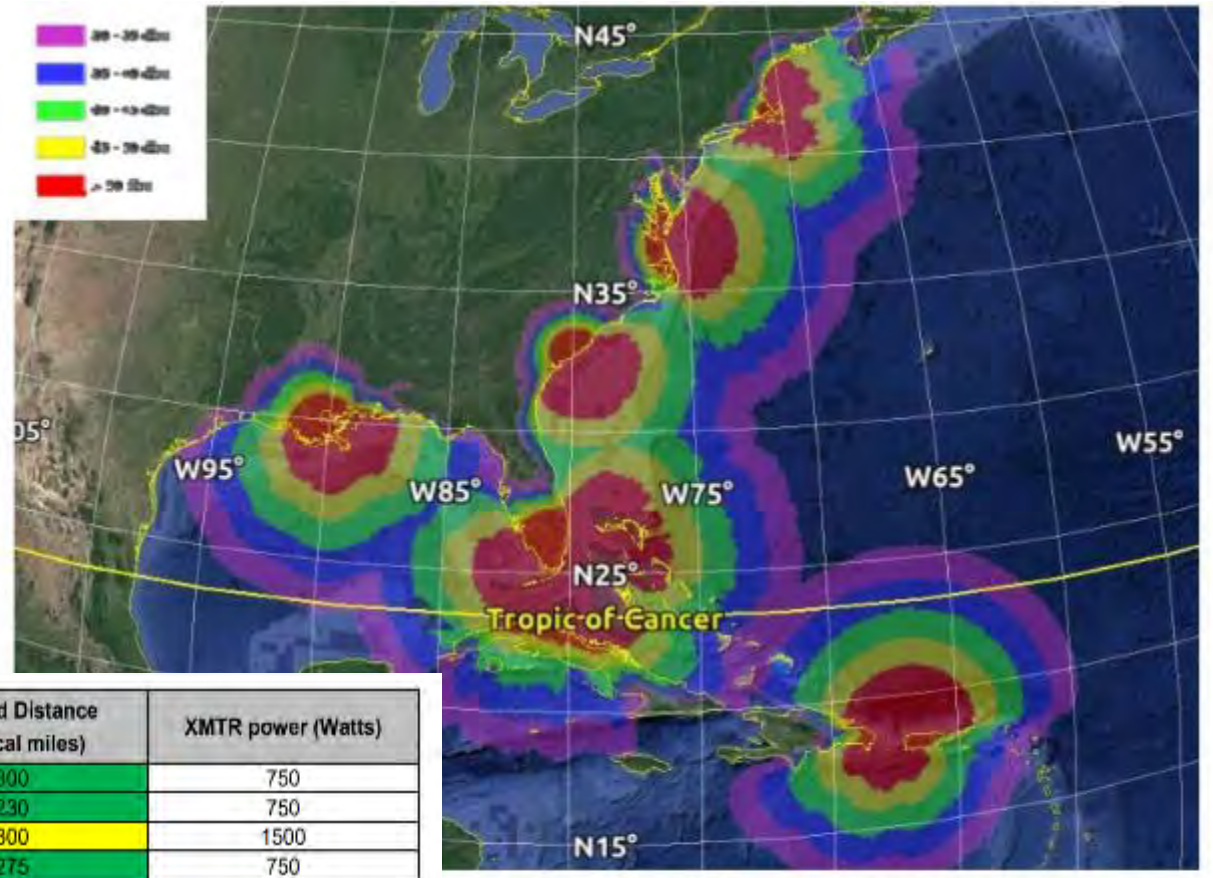
NAVTEX Coverage: How much Power do I need?



https://apps.dtic.mil/sti/pdfs/AD1057724.pdf



NAVTEX Station	Published Distance[5] (nautical miles)	Modeled Distance (nautical miles)	XMTR power (Watts)
Astoria, WA	300	300	750
Boston, MA	200	230	750
Cambria, CA	350	300	1500
Charleston, SC	200	275	750
Guam	250	275	750
Honolulu, HI	350	275	1500
Isabella, Puerto Rico	200	275	750
Kodiak, AK	200	200	750
Miami, FL	240	325	1500
New Orleans, LA	200	300	750
Portsmouth, VA	280	275	750
San Francisco, CA	350	300	1500

recast for the east coast CG maintained NAVTEX stations.

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NAVTEX Coverage Today

Mode		NAVTEX
Bandwidth		300 Hz
Min Field Strength		**40 dBu**
Data Rate		100 bps
Transmitter Power		0.75-1.5 kW
Transmitter Size		0.75-1.5 kW

NAVTEX provides **excellent coverage** at **low power** through superior signal-to-noise ratio

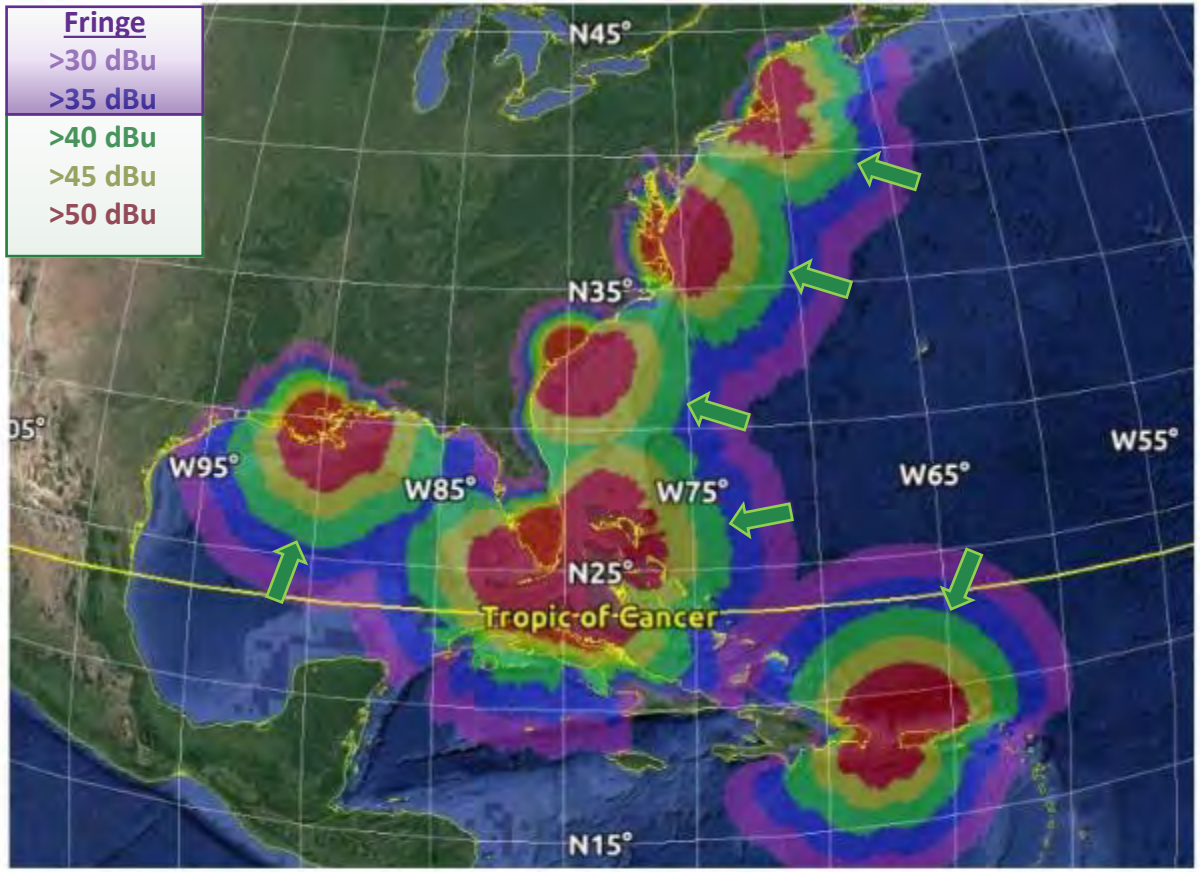

Figure 2. Reduced power forecast for the east coast CG maintained NAVTEX stations.

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Converting NAVTEX Transmitters to NAVDAT

Mode		NAVDAT
Bandwidth	↑	10 kHz
Min Field Strength	↑	52 dBu
Data Rate	↑	19-29 kbps
Transmitter Power	↓	**94 - 188 W**
Transmitter Size	=	0.75-1.5 kW

* 64 QAM with 9 dB peaks

Converting NAVTEX TX that is **NAVDAT Ready** delivers **Too Low Transmitter Power** due to NAVDAT signal peaks; reduced coverage.

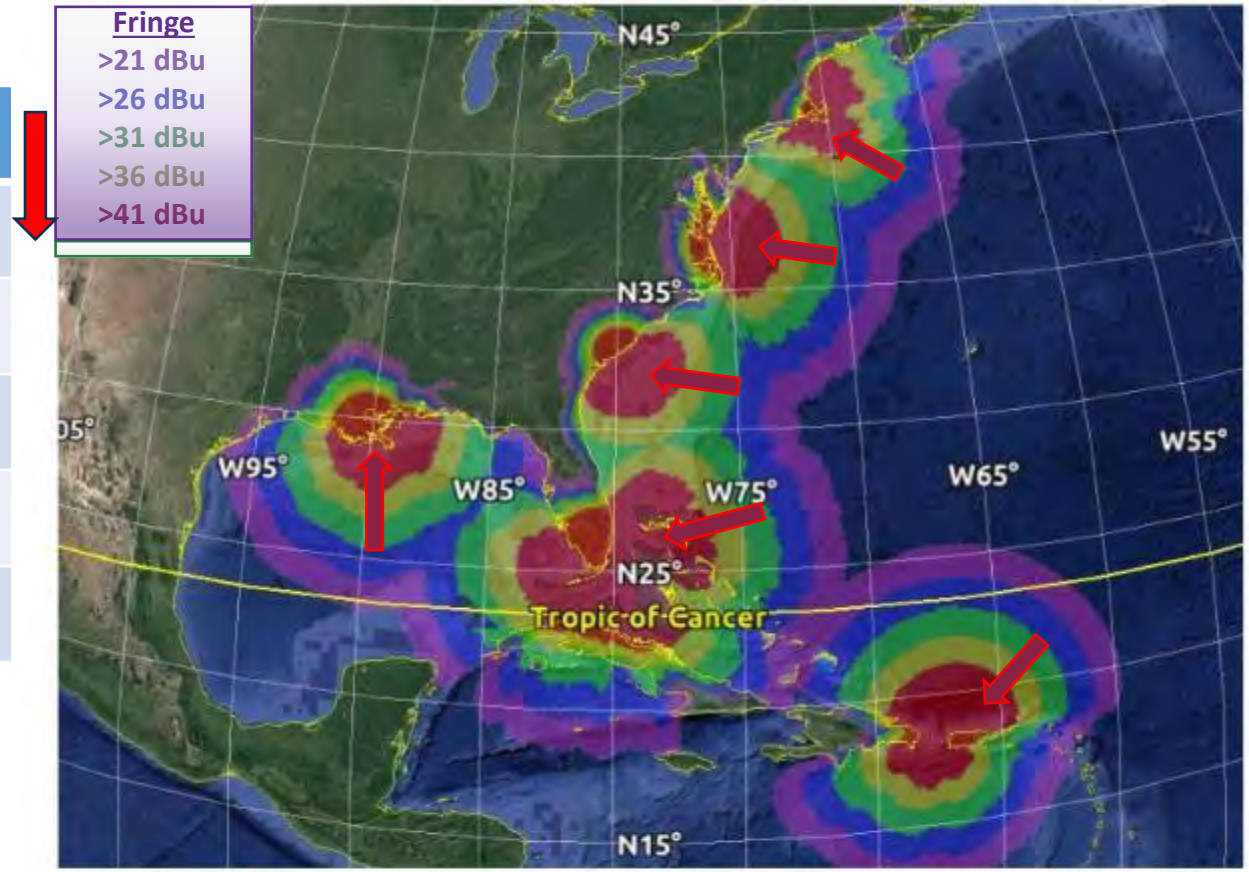

Figure 2. Reduced power forecast for the east coast CG maintained NAVTEX stations.

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NAVDAT High Data Rate at NAVTEX RMS Power

Mode		NAVDAT
Bandwidth	↑	10 kHz
Min Field Strength	↑	52 dBu
Data Rate	↑	19-29 kbps
Transmitter Power	=	0.75-1.5 kW
Transmitter Size	↑	6-12 kW PEP

* 64 QAM with 9 dB peaks

NAVDAT requires better signal-to-noise ratio to achieve high data rate. Bigger transmitter sizes are required even at **same power level** due to NAVDAT signal peaks

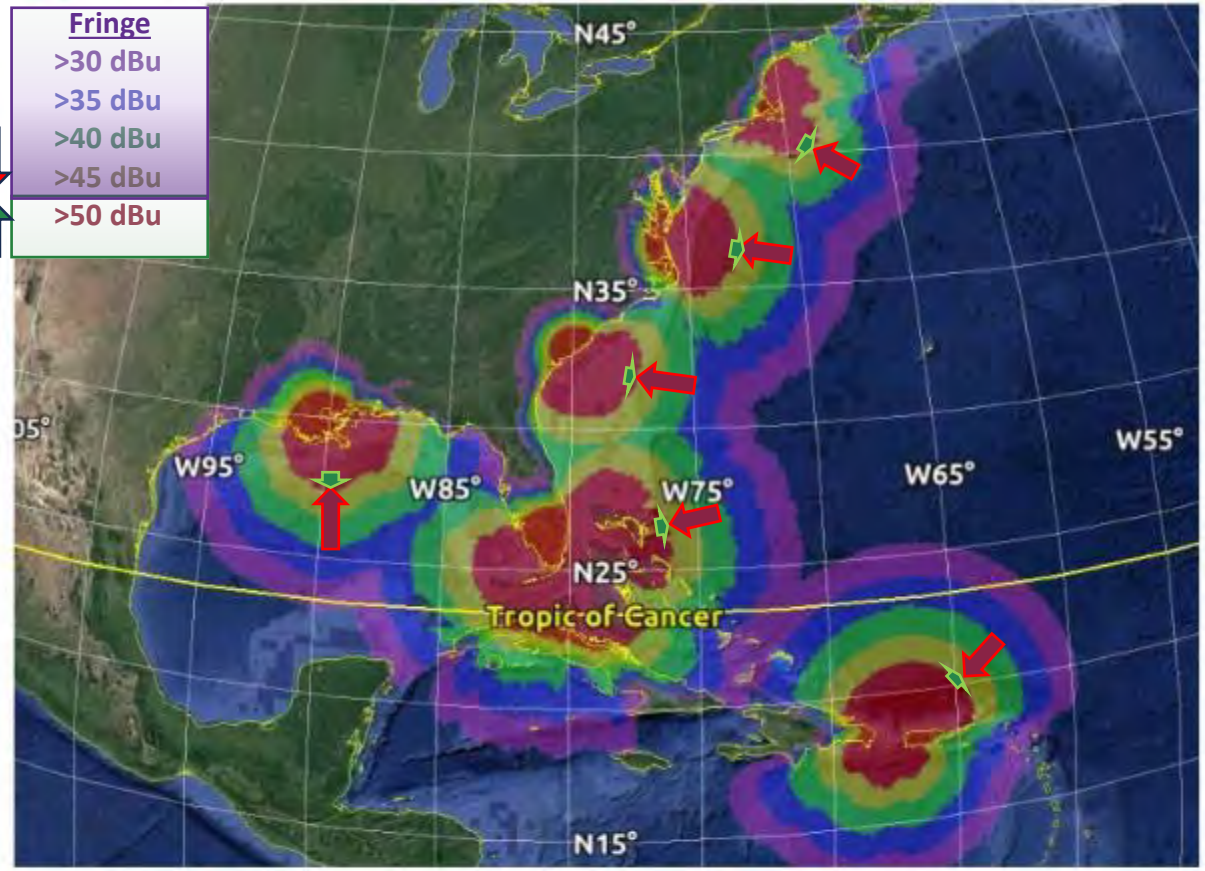

Figure 2. Reduced power forecast for the east coast CG maintained NAVTEX stations.

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Extend **NAVDAT** Coverage: Low Data Rate

Mode		NAVDAT
Bandwidth	↑	1 kHz
Min Field Strength	↓	34 dBu
Data Rate	↑	0.3-1.0 kbps
Transmitter Power	↓	**150 - 300 W**
Transmitter Size	=	0.75-1.5 kW

* 4 QAM with 7 dB peaks

Only **small** improvement in data rate over NAVTEX with **same size** transmitters. **Slightly smaller coverage** compared to NAVTEX.

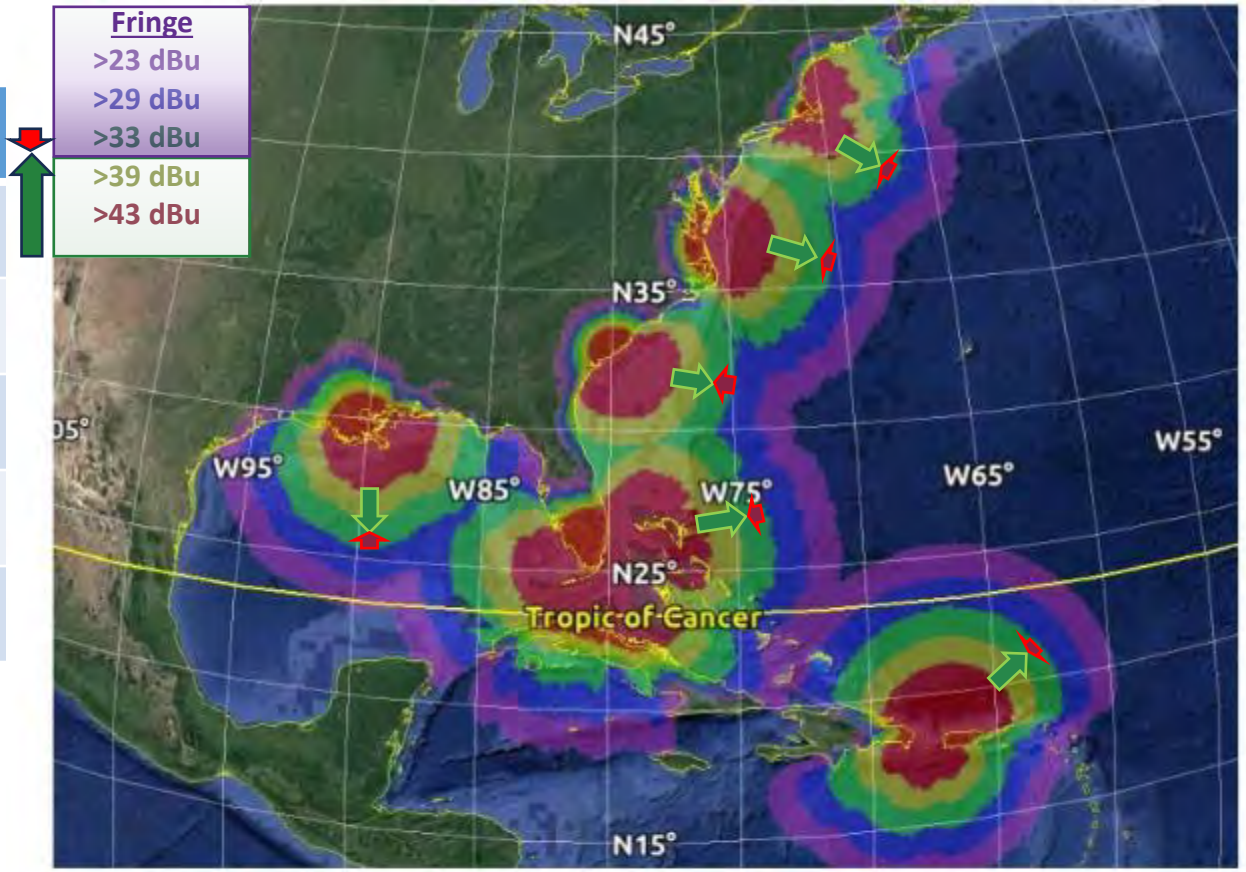

Figure 2. Reduced power forecast for the east coast CG maintained NAVTEX stations.

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NAVDAT Coverage matching **NAVTEX** Coverage

Mode		NAVDAT
Bandwidth	↑	10 kHz
Min Field Strength	↑	52 dBu
Data Rate	↑	19-29 kbps
Transmitter Power	↑	12-24 kW
Transmitter Size	↑	95-190 kW

* 64 QAM with 9 dB peaks

High Data Rate needs **High Power**.
High power levels are commonplace in other MW applications, such as AM broadcast

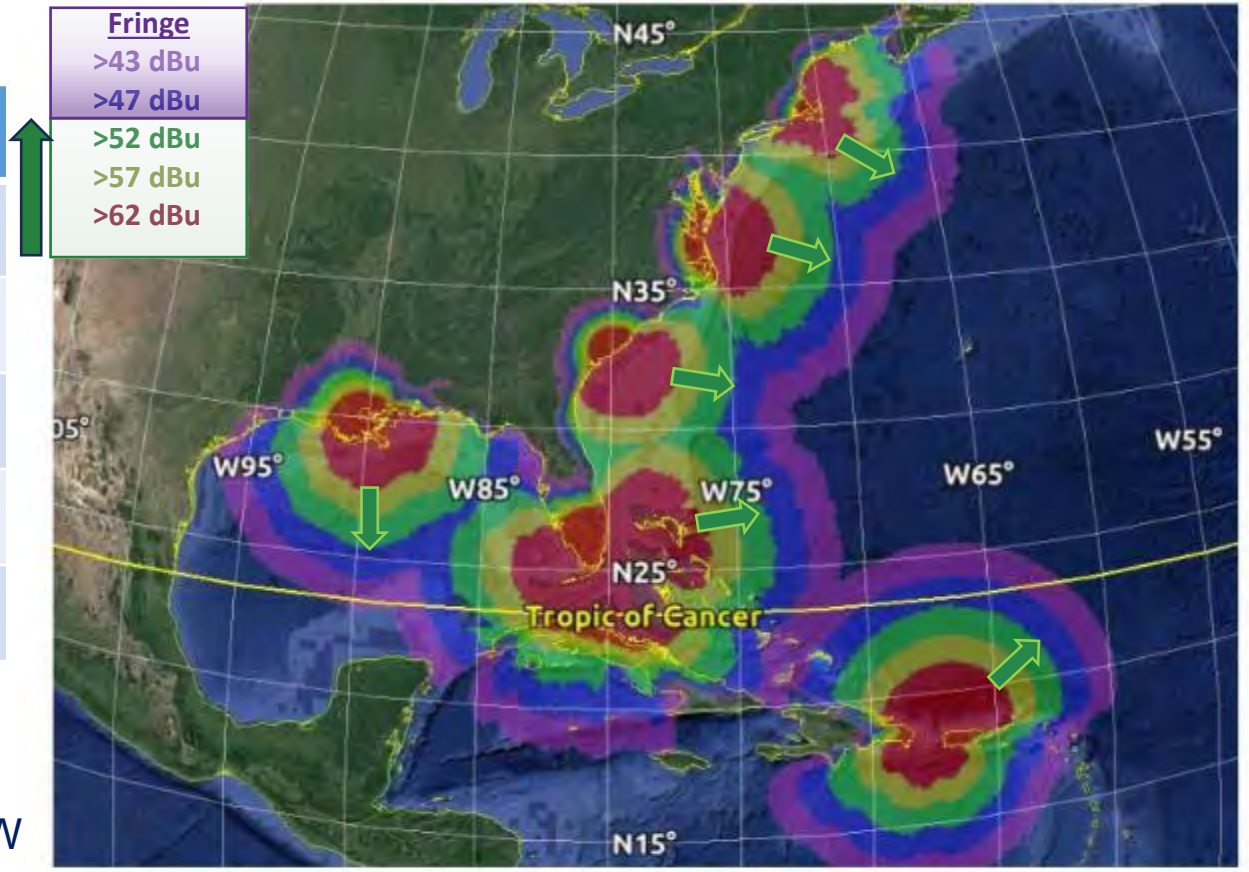

Figure 2. Reduced power forecast for the east coast CG maintained NAVTEX stations.

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What TX Power Level do you Need?

Example: 220 NM (407 km) with 10 kHz Bandwidth

QAM	Data Rate	10 min data block	Weather Charts in 10 min	Average Power	Est Transmitter Size Peak Envelope Power
4 QAM	6-10 kbps	450 - 750 kB	2 - 3	0.7 kW	3.5 kW
16 QAM	12-19 kbps	900 -1425 kB	4 - 7	1.6 kW	10.1 kW
64 QAM	19-29 kbps	1425 -2175 kB	7 - 10	6.4 kW	50.8 kW

More data, more power needed
Less bandwidth, lower transmitter power
Limited by atmospheric and ship board noise
(ITU-M.2443)

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Planning for NAVDAT: Things to consider

4. "NAVTEX and NAVDAT have comparable range and coverage"

FACT:

- NAVDAT achieves NAVTEX comparable coverage at low data rates
  - Low data rates don't deliver on the NAVDAT potential
- Higher power delivers high data capacity at NAVTEX comparable coverage
  - Implies new transmitters, ATUs and antennas
  - Repurpose existing sites or build additional transmission sites?
- Consider use cases and goals to determine appropriate coverage and power
  - Goals: detailed weather maps, ice charts, … ?
  - Your specific requirements will inform your NAVDAT build out

TIP:

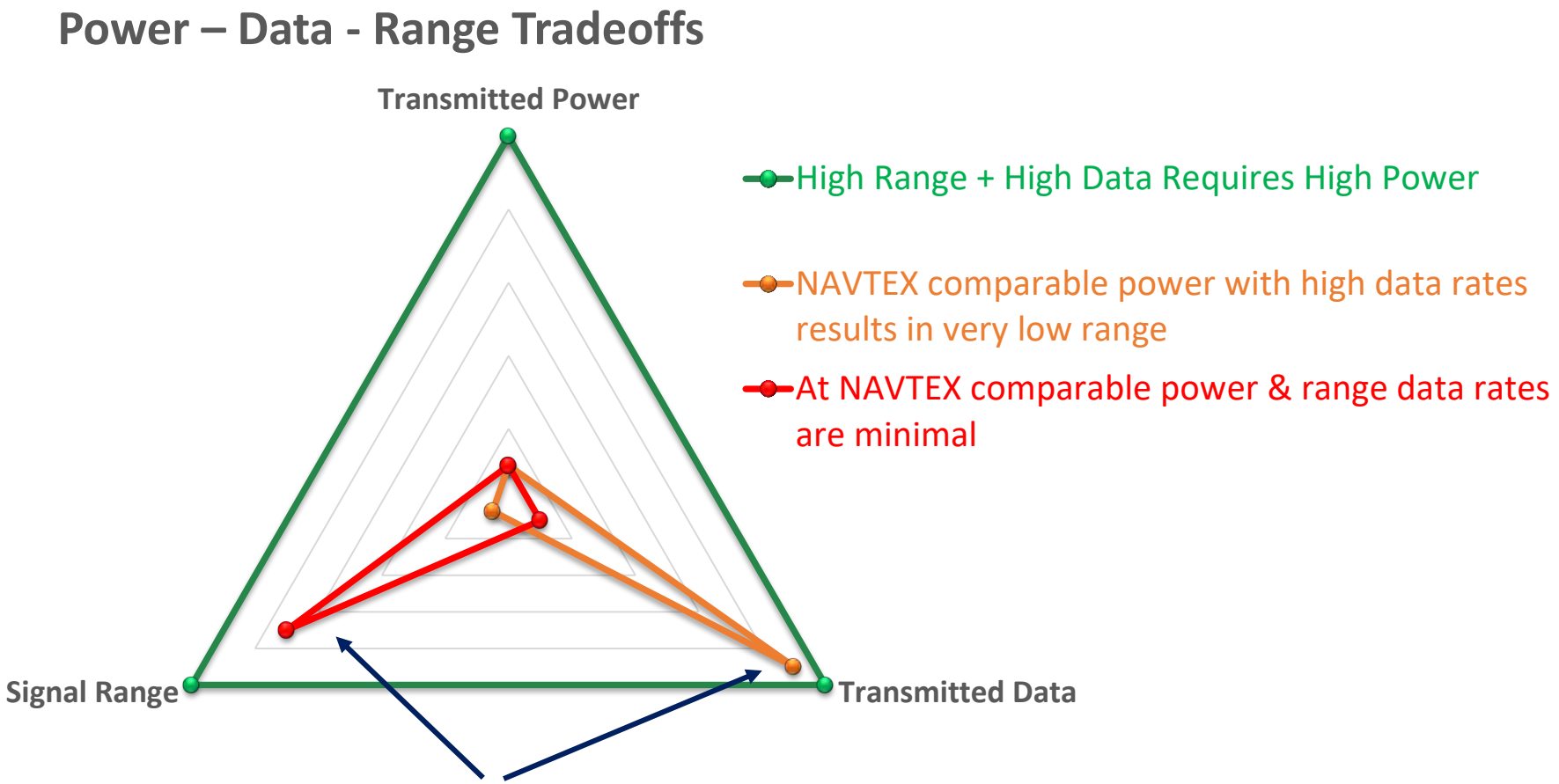
- If you plan for **NAVDAT first**, then NAVTEX can also be supported
- If you plan for **NAVTEX first**, then NAVDAT will be **limited**

Planning for NAVDAT: Things to consider

5. “There are NAVTEX transmitters that can later be converted to transmit NAVDAT”

Trade-offs

- Power
- Range
- Data rates



At NAVTEX comparable power, NAVDAT can provide range or data but not both

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Planning for NAVDAT: Things to consider

5. “There are NAVTEX transmitters that can later be converted to transmit NAVDAT”

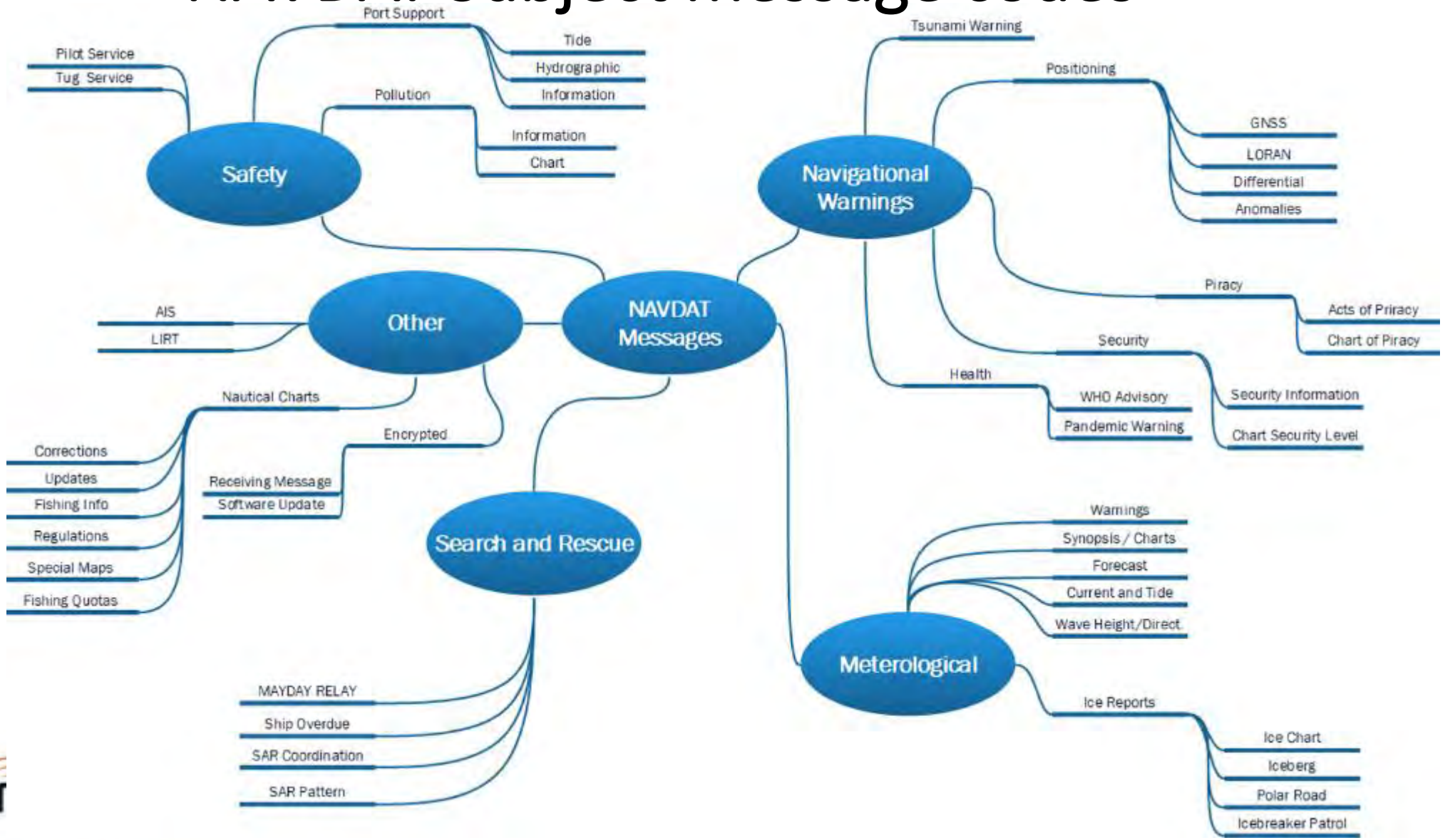
FACT:

- Technically yes…
  - but you may not achieve your data and coverage goals
- There are many issues beyond the Tx upgradability:
  - You may need significantly more power for NAVDAT
  - ATU
  - Antenna

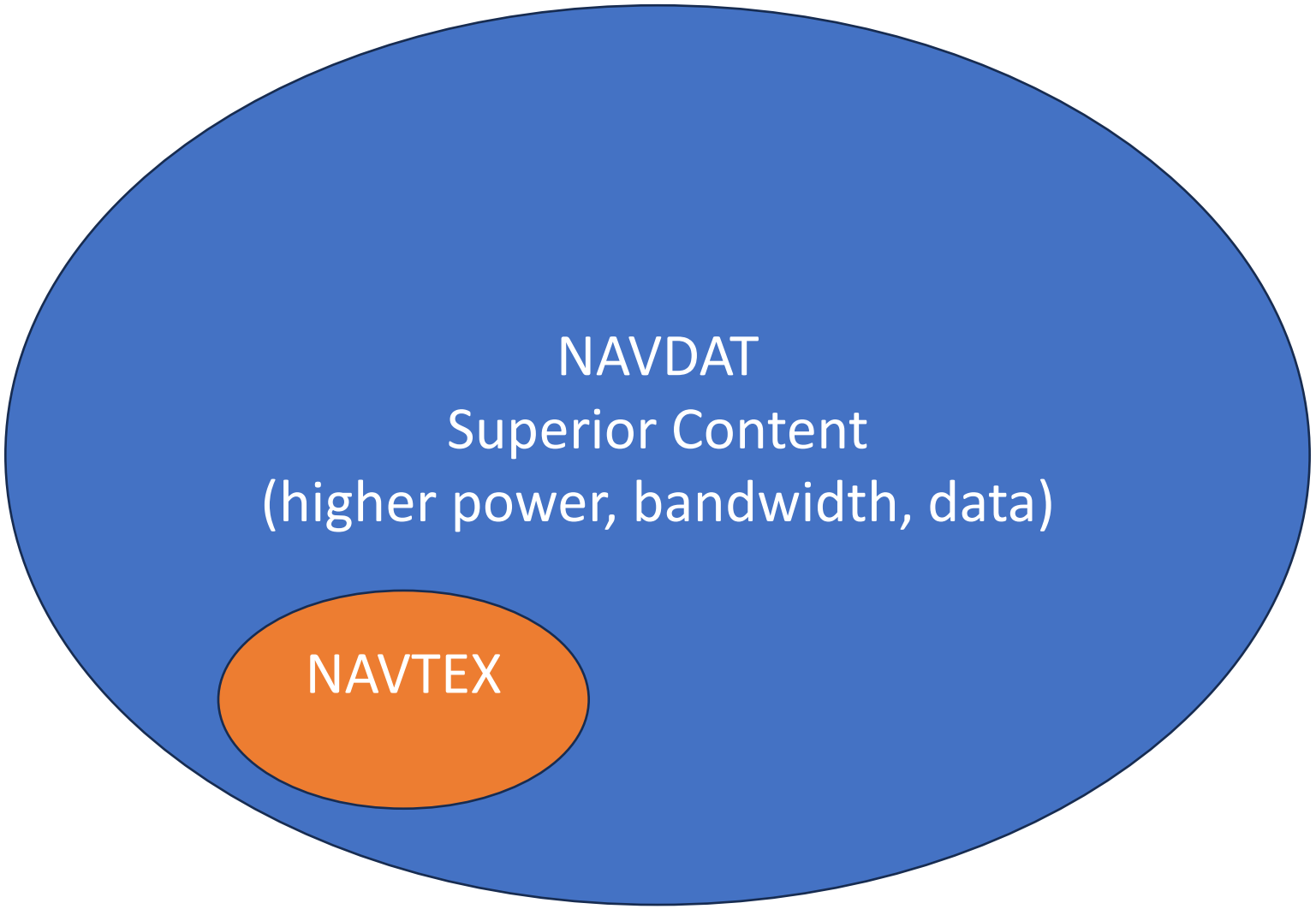
Planning for NAVDAT: Things to consider

6. “NAVDAT will replace NAVTEX”

NAVDAT Subject message codes



NAVTEX NAVDAT relationship



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Planning for NAVDAT: Things to consider

6. “NAVDAT will replace NAVTEX”

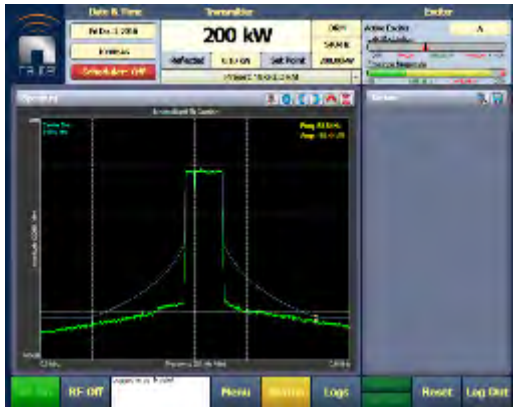
FACT:

- In the future maybe
  - NAVTEX continues to provide critical service
  - May take several years for NAVDAT installations and receivers to be deployed
  - Can expect many years of parallel operation

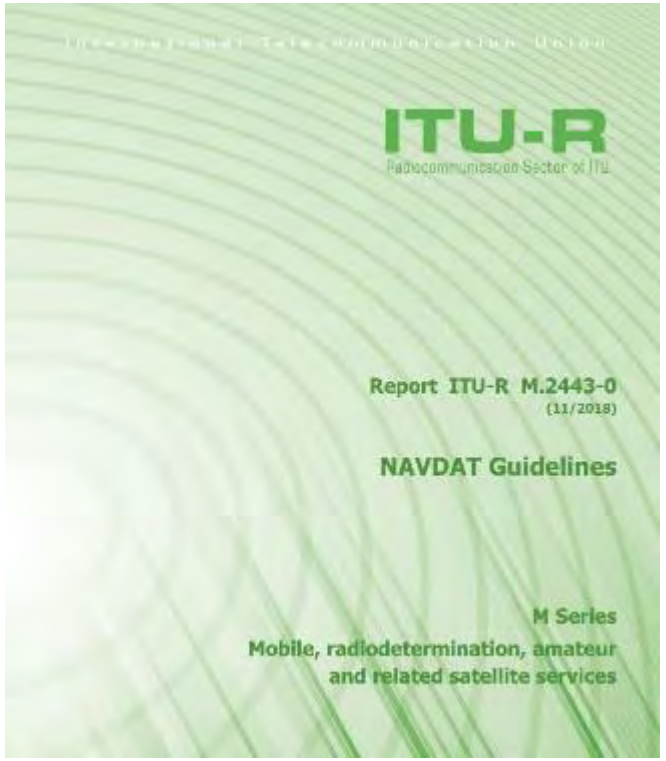
Planning for NAVDAT: Things to consider

7. “NAVDAT is a mature standard”

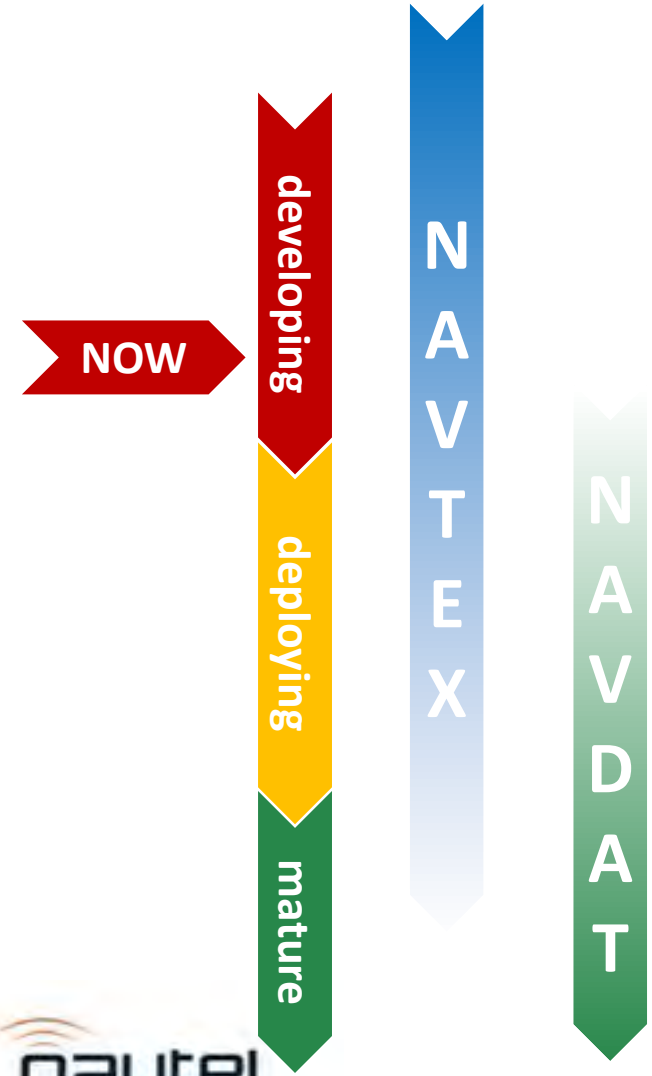
Evolution of the NAVDAT Standard



- Initially inspired by DRM (digitized AM broadcast)
  - Many changes over the last few years
  - 1kHz and 3 kHz bandwidth added
  - Modified Data Encapsulation
  - Structure of the data and signalization channel
  - New modes and guard intervals
  - LDPC channel encoding for the data channel (instead of convolutional)
- NAVDAT is a modern standard adapted for maritime communication



Planning for NAVDAT: Technology Roll Out



- **Standardization** process (2024 and on-going)
- Physical communication layer is well defined
  - **High power NAVDAT transmitters are being developed now**
  - Allows for sea trials now and have started with China and France
  - **More field trials are needed** to better characterize coverage
    - Select high power transmitter test installations
  - Initial experimental receivers required
- Next: **Stakeholder Needs** to be defined in country/jurisdiction
  - Do you need ice reports? Is piracy a major concern for you? ...
  - Other? Standard is extensible with reserved message types
  - Will you rely on real-time MAYDAY RELAYs? If yes, 24hr coverage!!
- Next: **RF Coverage Planning** given geography and data requirements
- Next: **Professional monitoring receiver** development
- Next: Country wide **transmission installations**
  - New sites? New towers? New transmitters?
- Future: Commercial **receiver mass production**
  - Will a **mandate** be required?

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Summary

- NAVDAT needs a system approach….
  - Tx, ATU, Site, antenna
- Service and coverage planning:
  - Relationship: Power, coverage, bandwidth, data rate
  - NAVDAT needs more power to fulfill it’s promise
- NAVTEX will continue for may years
- NAVDAT deployment strategies:
  - Separate NAVTEX and NAVDAT infrastructures

    Or
  - Plan for NAVDAT with specific coverage & data goals that can also do NAVTEX

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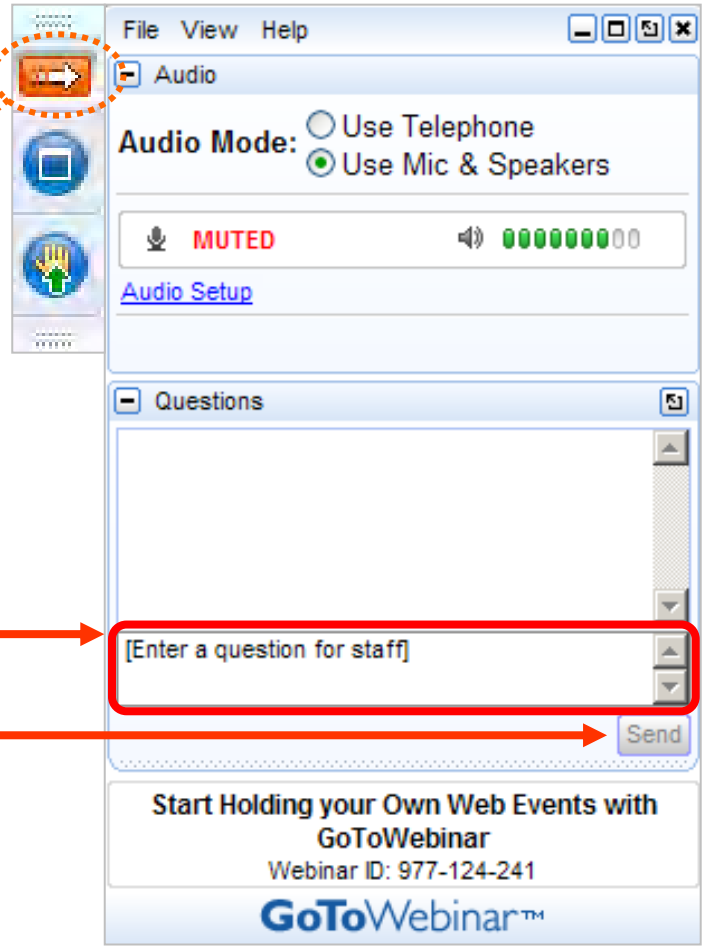
Questions & Answers

Click on  *to open/close webinar panel*



Enter questions here

…then press **Send**

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Thank You!

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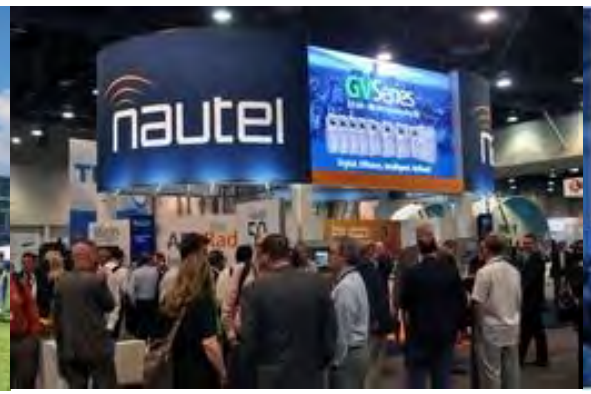

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