MF Groundwave Propagation Modelling for Maritime Networks

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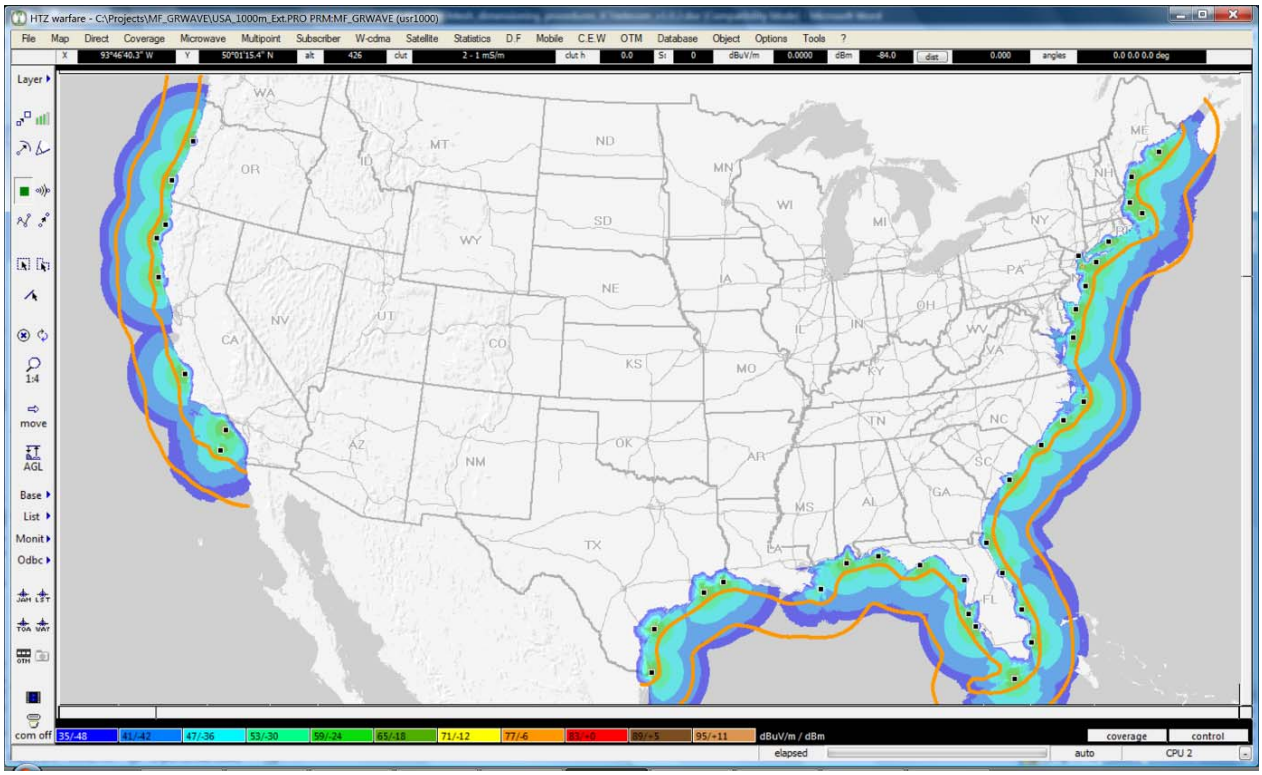
Software solutions in radiocommunications



Introduction to modelling MF band propagation (3 kHZ - 30 MHz) for Maritime Networks with HTZ warfare

For the past seventeen years ATDI has been integrating and developing software for modelling anomalous radio wave propagation for the purposes of RF network design. This includes propagation phenomenon such as ducting, troposcatter and their applications over terrain and water. Over the past five years, ATDI has dedicated significant resources into investigating how to model the propagation characteristics of frequencies below the VHF band. There are many applications to these frequencies including but not limited to:

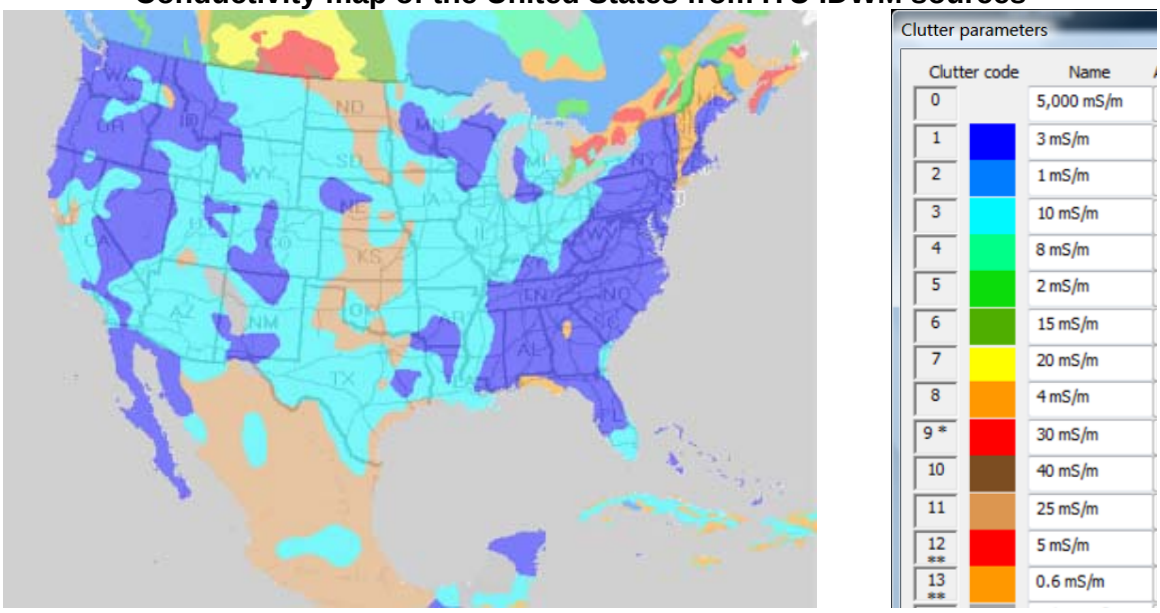
- Aeronautical Navigational Aids
- Automatic Link Establishment for Intelligence gathering
- Emergency communications for Maritime Networks

While ATDI has developed several specific features into its product line for modelling a variety of below VHF band propagation for each of these applications, this document will be the first in a three-part series highlighting how ATDI's flagship RF network design tools model Maritime Communications. This first document will focus on modelling MF Groundwave propagation from ship to shore along coastlines. This paper will focus on developments in the areas of cartographic map data preparation, integration of propagation standards and calibration information and custom reporting options available to users of HTZ warfare for the purposes of modelling Maritime Networks.

Preparation of a Conductivity/Permittivity Map from the ITU IDWM database

In the case of MF propagation, terrain obstruction information provided by the classic Digital Terrain Model used with most RF network modelling packages is of greatly diminished importance. More important, are the electromagnetic properties of the terrain in particular the Conductivity and Permittivity of the ground. These types of maps are usually available from the local national spectrum authority. ATDI's GIS management tool, ICS map server tool can create these maps from any type of source (digitized map, vector map, etc.) in a format compatible for RF analysis with HTZ warfare. ATDI cartographic services can also provide this type of information for any country in the world using the ITU Digital World Map (IDWM) database as a global source of conductivity and permittivity data in all varying regions. Note, that this is the same source for the conductivity map in the FCC 47 CFR 73.190.

Conductivity map of the United States from ITU IDWM sources

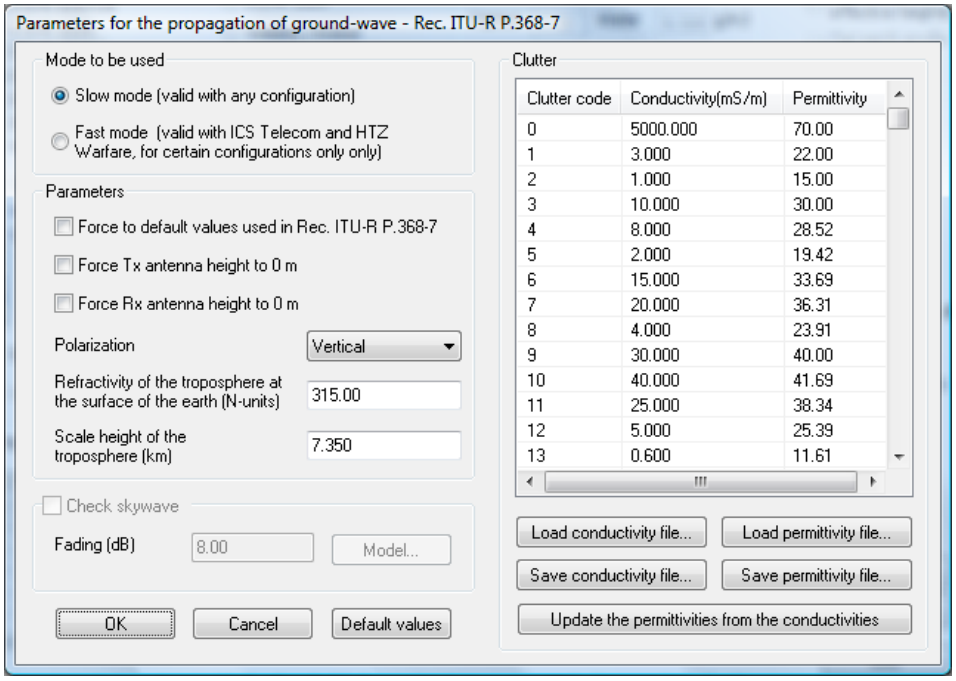


The map above is provided in the form of HTZ warfare's classic clutter layer. Since the clutter layer can serve as a generic skin or blanket of morphological information layered over the terrain model, and can contain user defined propagation characteristics per clutter class/code, this layer was perfect to reuse as a conductivity map layer. The units of each region of conductivity are in milli-Siemens/meter (mS/m) and can be configured as labels of each clutter class/code to give the map distinction in the HTZ warfare interface.

Integration of ITU recommendations ITU-R P.368-9 and ITU-R P.1467-1

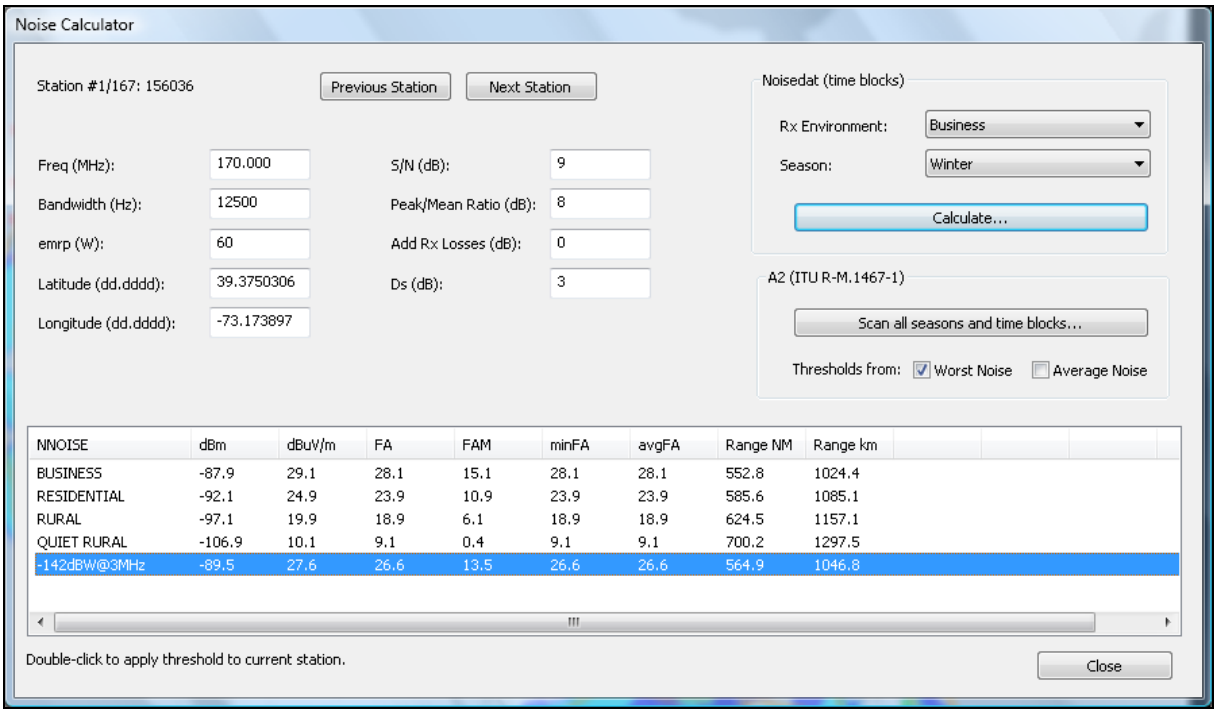
In order to properly model the radio wave propagation of MF signals, ATDI has also integrated the latest ITU recommendations specific to MF Groundwave propagation: ITU-R P.368-9 and ITU-R M.1467-1

Recommendation ITU-R P.368-9



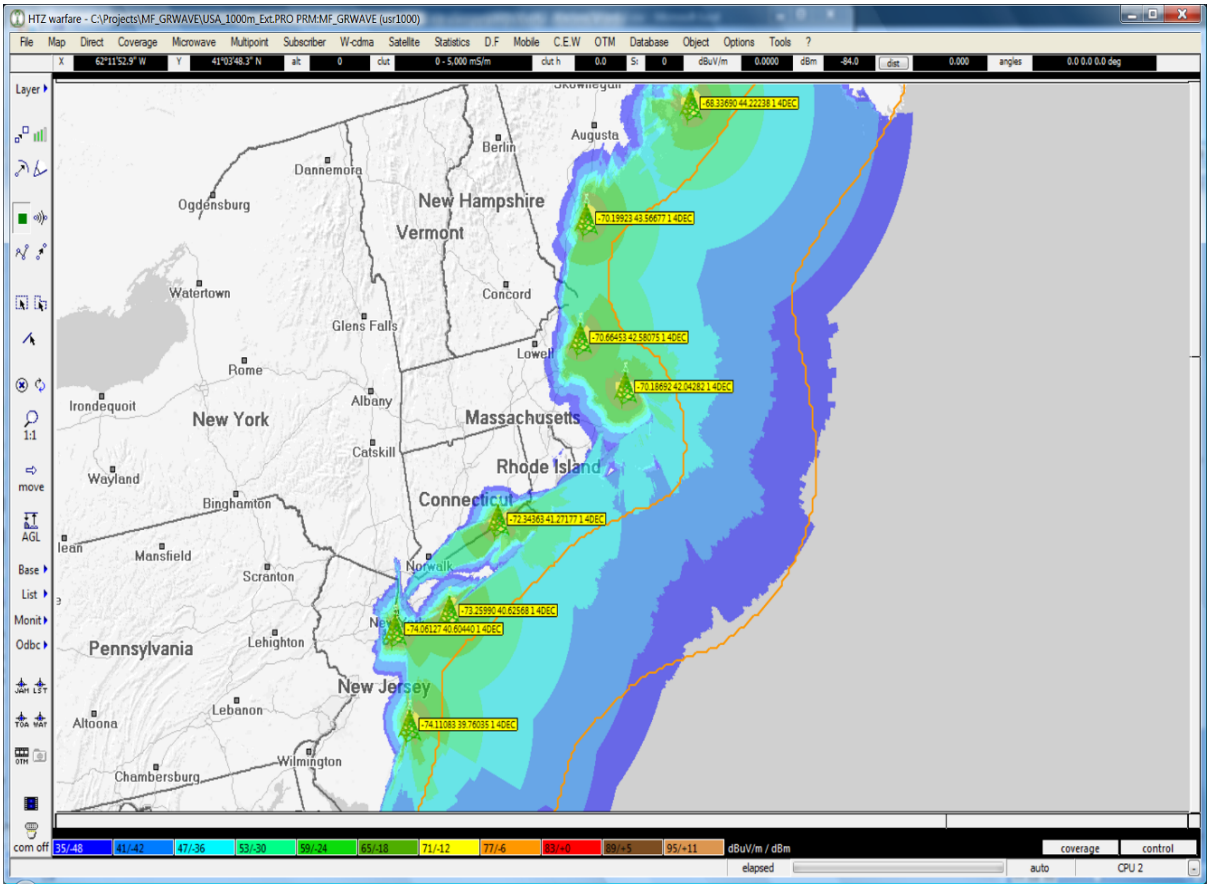
The calculation feature used to generate the field strength received predictions for each pixel on the map is based on the integration of ITU-R P.368-9 into HTZ warfare's propagation engine. The ITU-R P.368-9 model depends on the input of conductivity and permittivity data which is provided by the ITU maps described previously. These values provide the ITU-R P.368-7 Groundwave model with the appropriate attenuation information to model MF propagation over land and sea allowing HTZ warfare to generate MF Groundwave coverage plots.

In order to make sure that the receive sensitivity of each radio network element is configured appropriately, with respect to their immediate environmental conditions and time of year, HTZ warfare has also integrated a NOISDAT calculator derived from ITU-R M.1467-1.

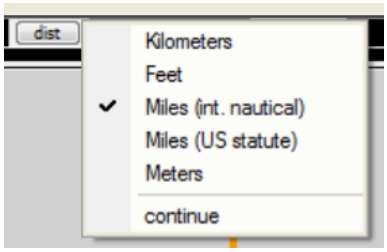


The NOISEDAT Calculator takes into consideration the operating frequency, bandwidth, signal-to-noise ratio, 90% fade margin and estimated radiated power as well as specifications of the receiver environment and season to model the variability in Noise contribution to radio propagation in the MF band.

Essentially, the NOISEDAT calculator serves as a reference to model the expected Noise Rise and respective threshold degradation at a given site of interest. ATDI has even integrated consideration for A2 sea region in order to generate an output based on ITU-R M.1467-1 NOISEDAT calculation to give the predicted receive sensitivity in dBm and dBµV/m as well as range in nautical miles and kilometers. This information is used to calibrate HTZ warfare's propagation engine appropriately for ship to shore (reverse coverage) calculations.

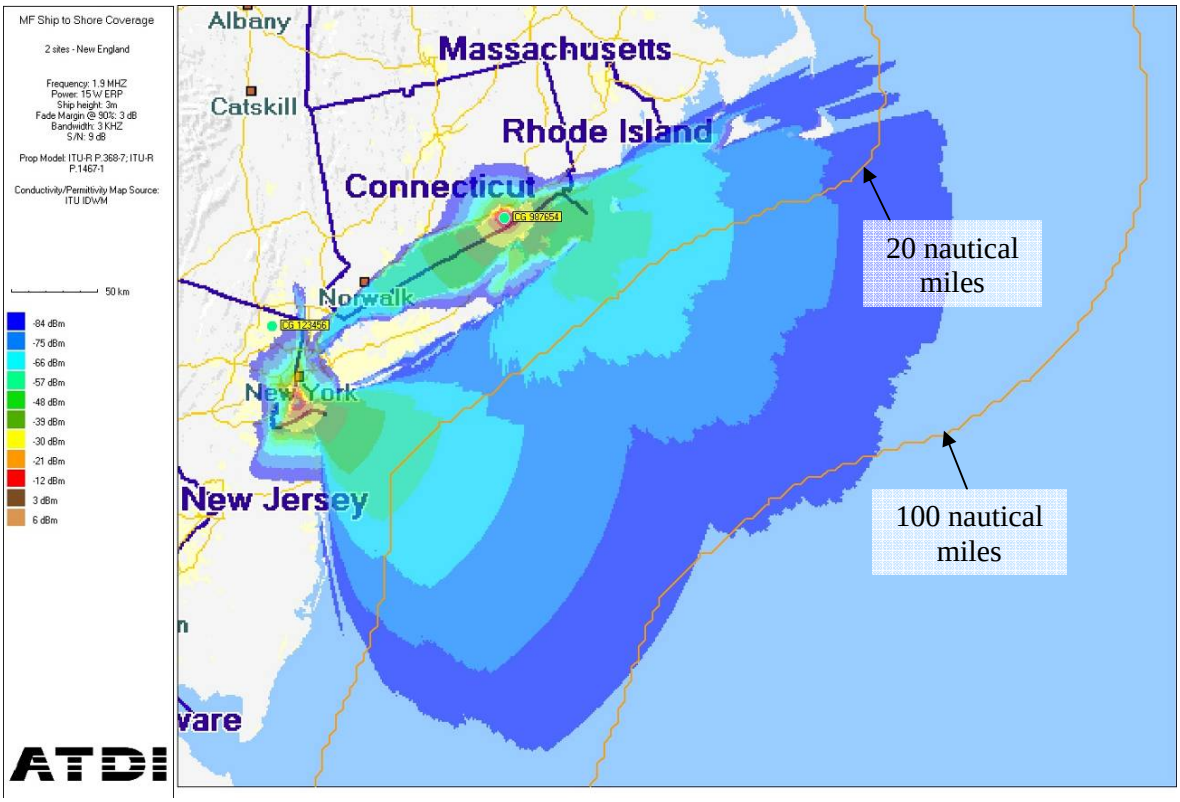


HTZ warfare also offers features to measure distances between stations and the limits of their coverage in various units including nautical miles as well as US miles, feet and kilometers:

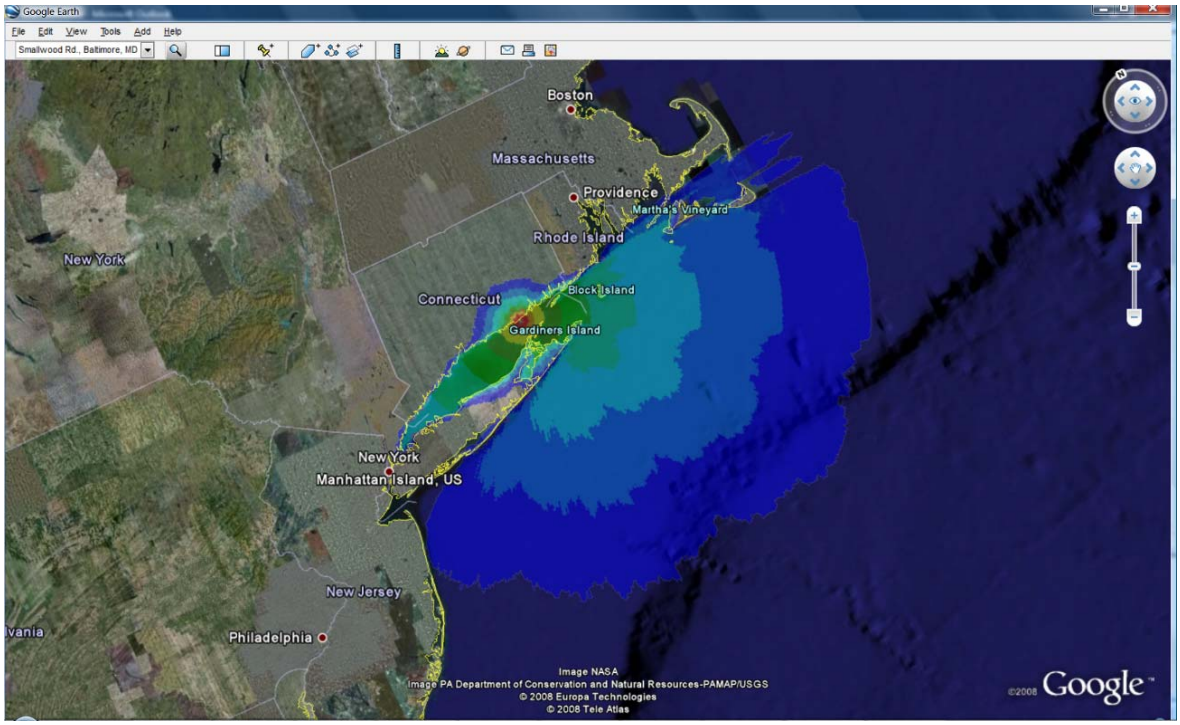


Reporting options specific to modelling Maritime Networks

ATDI tools also includes reporting features specific to modelling Maritime Communications including the ability to generate nautical mile boundaries from the coastline or from the locations of the shore stations:



ATDI tools also include options to export results to popular formats/interfaces including Google Earth:



Conclusion

ATDI continues to refine its modelling processes for MF Groundwave propagation studies in response to emerging requirements from the spectrum authorities of Coast Guards and Naval agencies all over the world. ATDI's strong association with the ITU, and expertise in integrating ITU recommendations into its product line allow ATDI to be the world leader in translating complex propagation phenomenon to simple, intuitive graphics that can be understood by the various policy makers and stake holders involved utilizing and managing a country's spectral resources.

In upcoming parts of this series on modeling Maritime Communications, we will focus on newly developed features for generating probability of coverage per season and frequency for HF Skywave propagation as well as modeling HF antennas and ultimately VHF coverage and traffic analysis for Maritime Communications. Make sure to subscribe to ATDI's monthly newsletter at www.atdi.us.com to keep up with any new developments.

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