



FROM MILLIONS OF SQUARE KILOMETERS TO A SINGLE EMITTER

New RF Geospatial Techniques Transforming Situational Awareness Over Land and Sea

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*Unclassified Imagery and Information. Presentation contains no "Technical Data".
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from the Use or Operation of a Defense Article.*

THE STATE OF MARITIME SECURITY

250k+ vessels operating
in the ocean daily

IUU fishing represents
up to 26 million tons of
fish caught annually

The Challenge

Many times, a vessels position is
unknown or inaccurate while
committing illicit activities.

Dark vessels cost the global
economy up to an estimated \$30
billion a year.

The estimated annual cost
of piracy is \$12B/ year

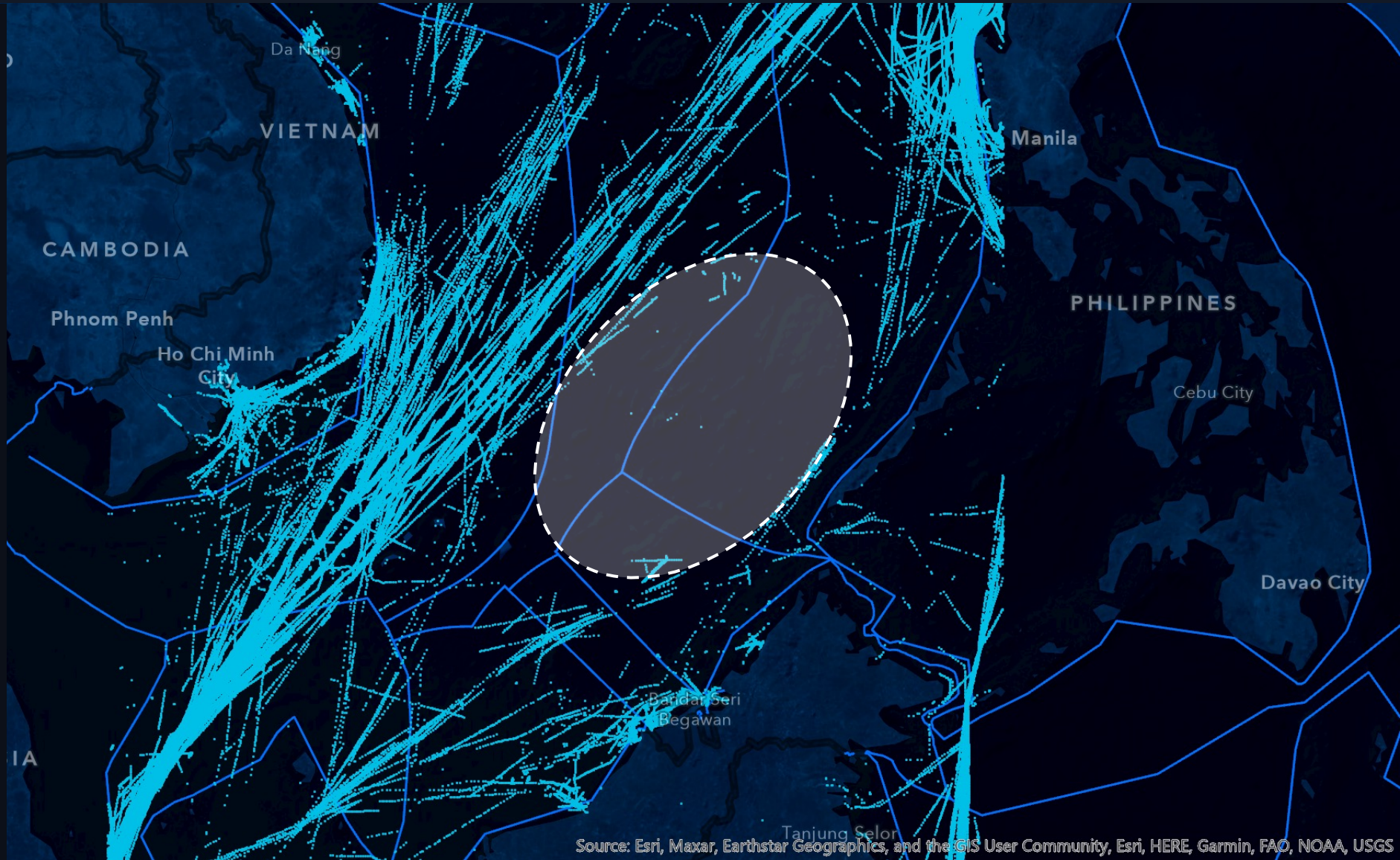
Ships deliver over 80% of
world trade

RELIANCE ON AIS CREATES GAPS IN MDA ANALYSIS

- ✓ Vessel Location
- ✓ Vessel Identification
- ✓ Vessel Characterization
- ✓ All Weather Conditions
- ✓ Large Area of Coverage
- ✓ Persistent Area Monitoring

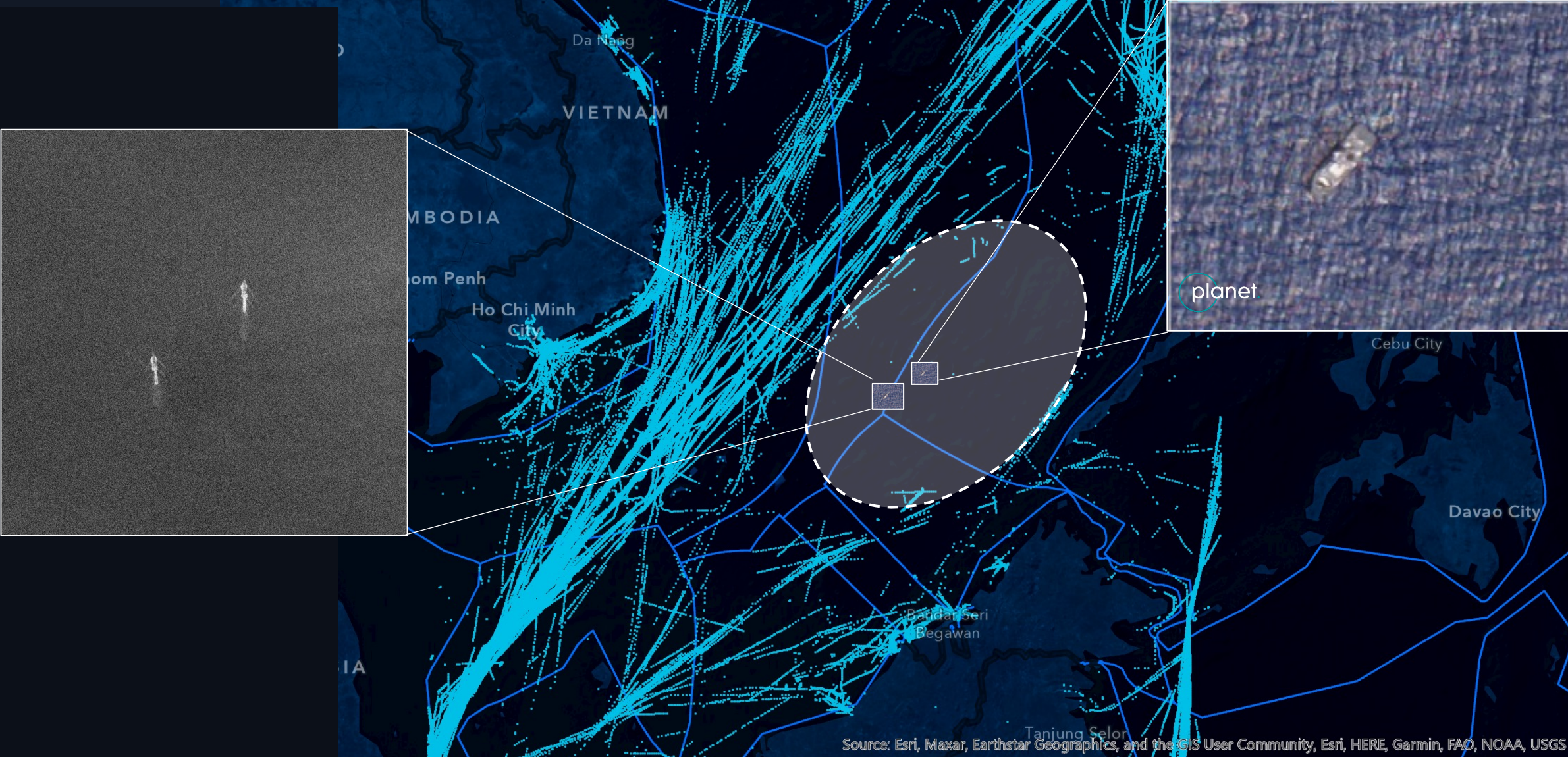
✗ Uncooperative Vessels

● Third Party S-AIS



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community, Esri, HERE, Garmin, FAO, NOAA, USGS

ELECTRO-OPTICAL AND SAR

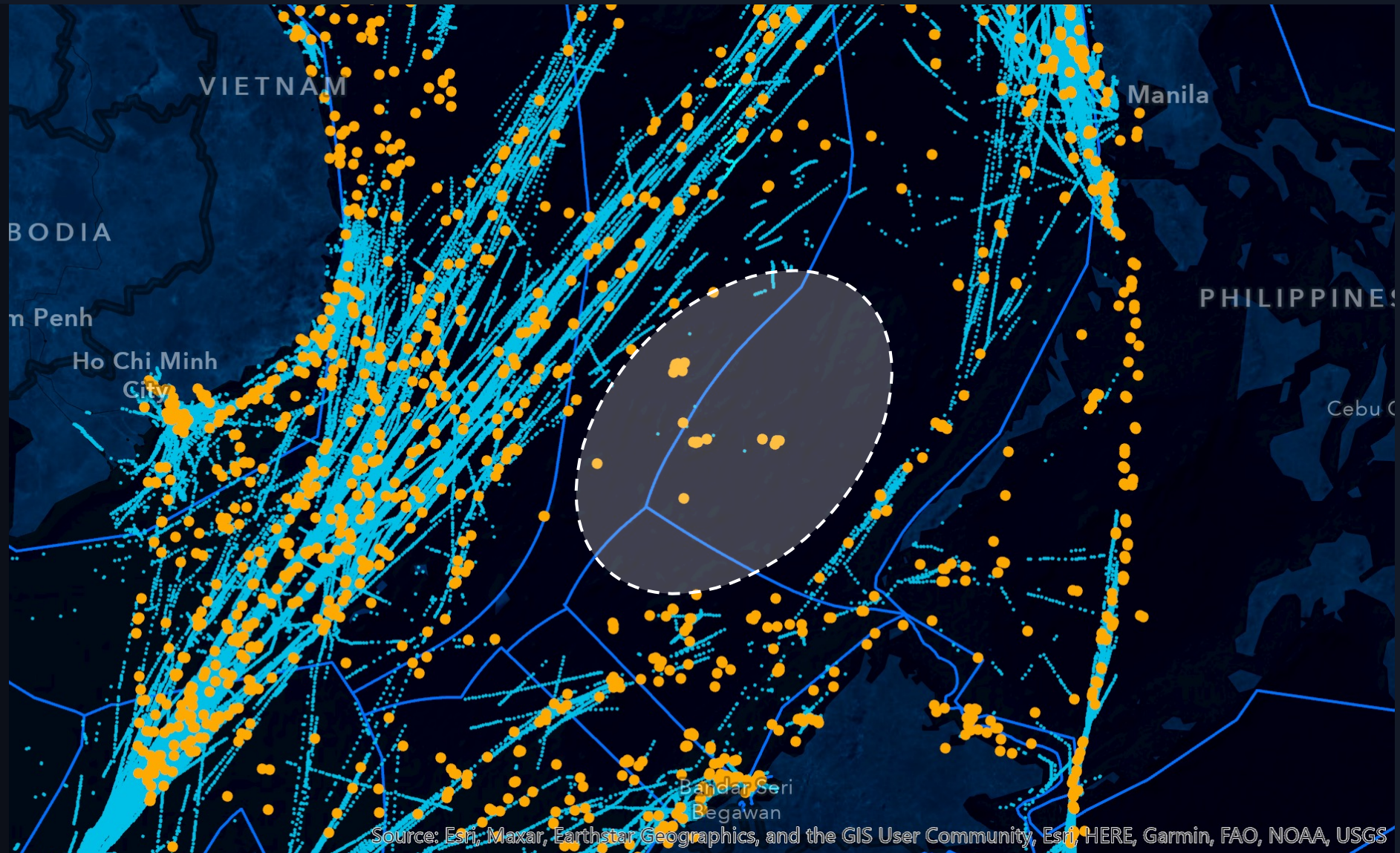


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RADIO FREQUENCY DATA

- ✓ Vessel Location
- ✓ Vessel Identification
- ✓ Vessel Characterization
- ✓ All Weather Conditions
- ✓ Large Area of Coverage
- ✓ Persistent Area Monitoring
- ✓ Uncooperative Vessels

- Third Party S-AIS
- HE360 RF Data



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RF IN THE MARITIME ENVIRONMENT

Vessel detection night and day, any weather conditions

Detection of uncooperative vessels (via vessel radar, onboard communications)

Cost-effective for tasking other satellites (EO, SAR)

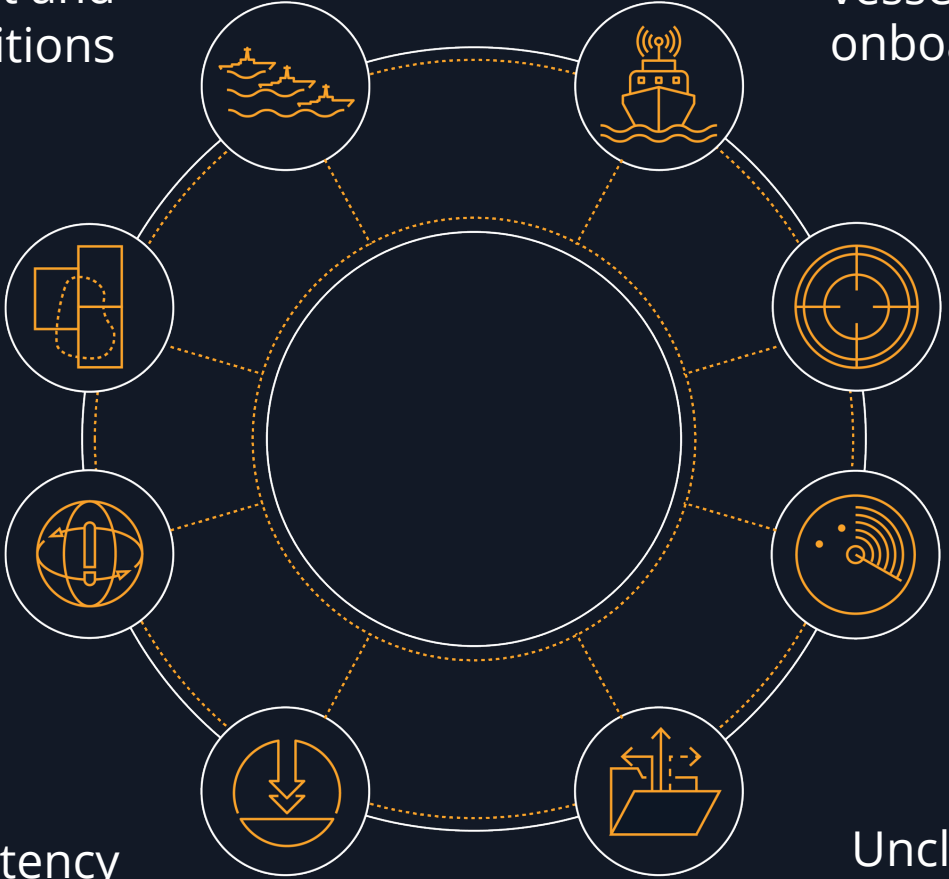
Precision location down less than a kilometers

Increase efficiency of other ISR—MPA, UAS, patrol vessels

Persistent area monitoring (up to 30 x a day)

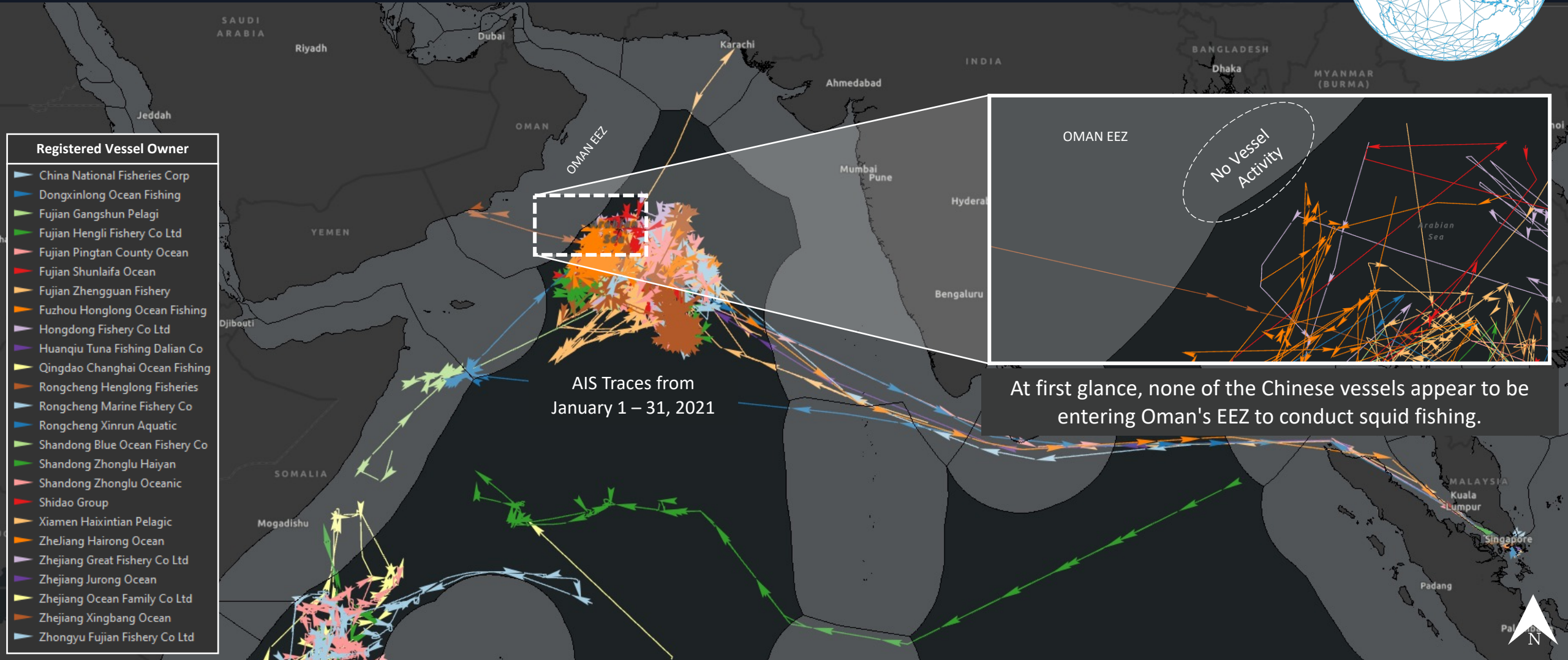
Low latency

Unclassified and shareable for partner nation programs

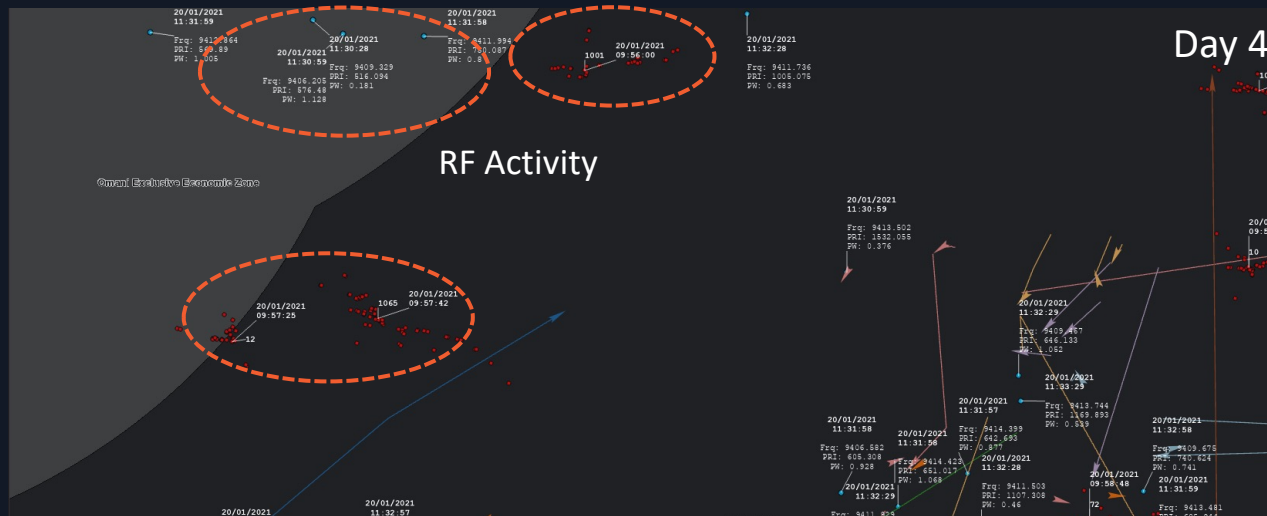
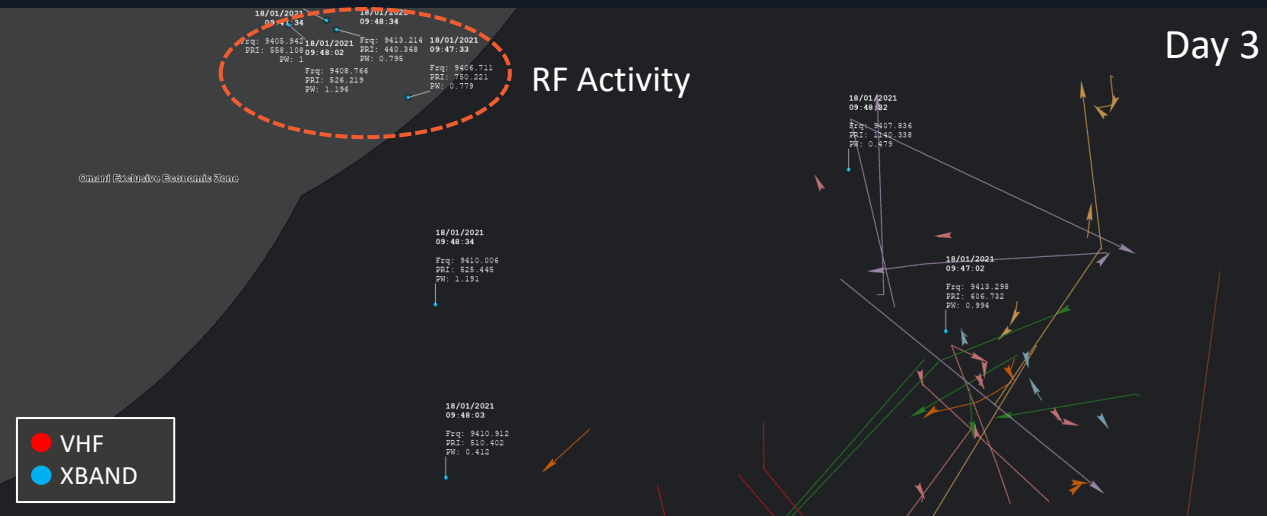
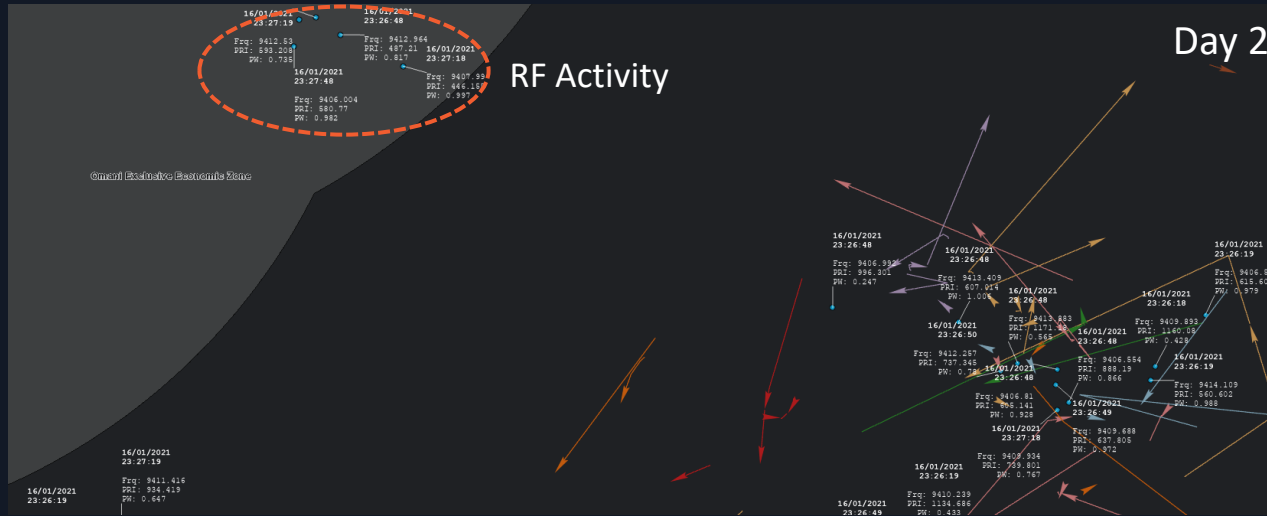
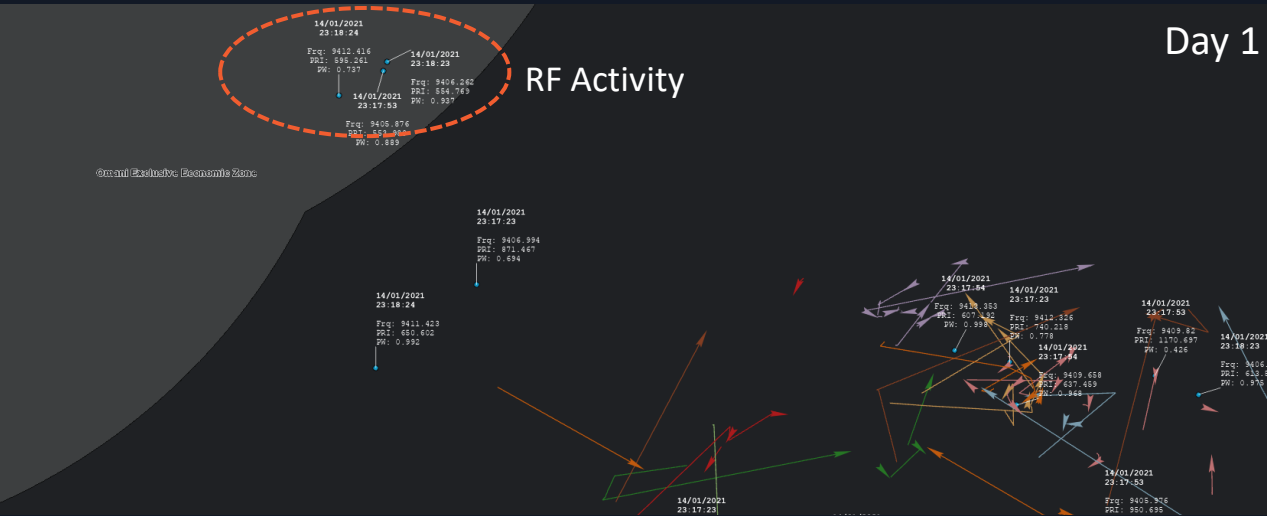


TRACKING SQUID FISHING NEAR THE OMAN EEZ

Chinese Fleet Fishing in International Waters

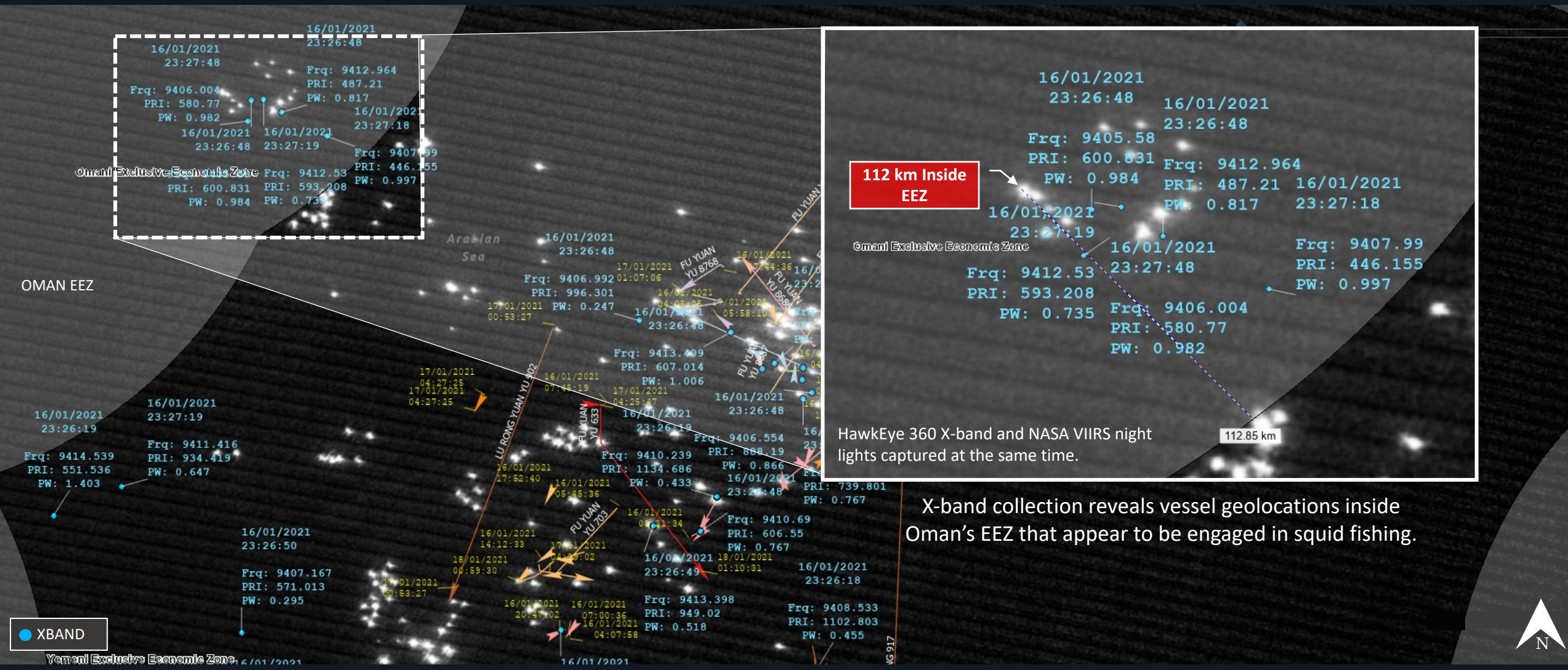


RF DETECTIONS INDICATE ACTIVITY WITHIN OMAN'S EEZ



HawkEye 360 detected a recurring pattern of RF activity not associated with AIS just within Oman's Exclusive Economic Zone.

ANALYZING A SINGLE EVENING OF FISHING



X-band collection reveals vessel geolocations inside Oman's EEZ that appear to be engaged in squid fishing.



NEXT PHASE—UNIQUE SIGNAL RECOGNITION (USR)

- **Detection, geolocation and.....identification of dark vessels**
 - Machine learning techniques + unclassified, commercial RF data
 - Using big data set, multiple expert processing techniques, and robust validation
- **Unique Signal Recognition (USR) technologies open up a wide range of related analytics to assist end users in the maritime environment**
 - Dark vessels tracks; showing recent patterns of activity of a particular dark vessel
 - Enhanced spoofing detection, to include detection of changes in MMSIs

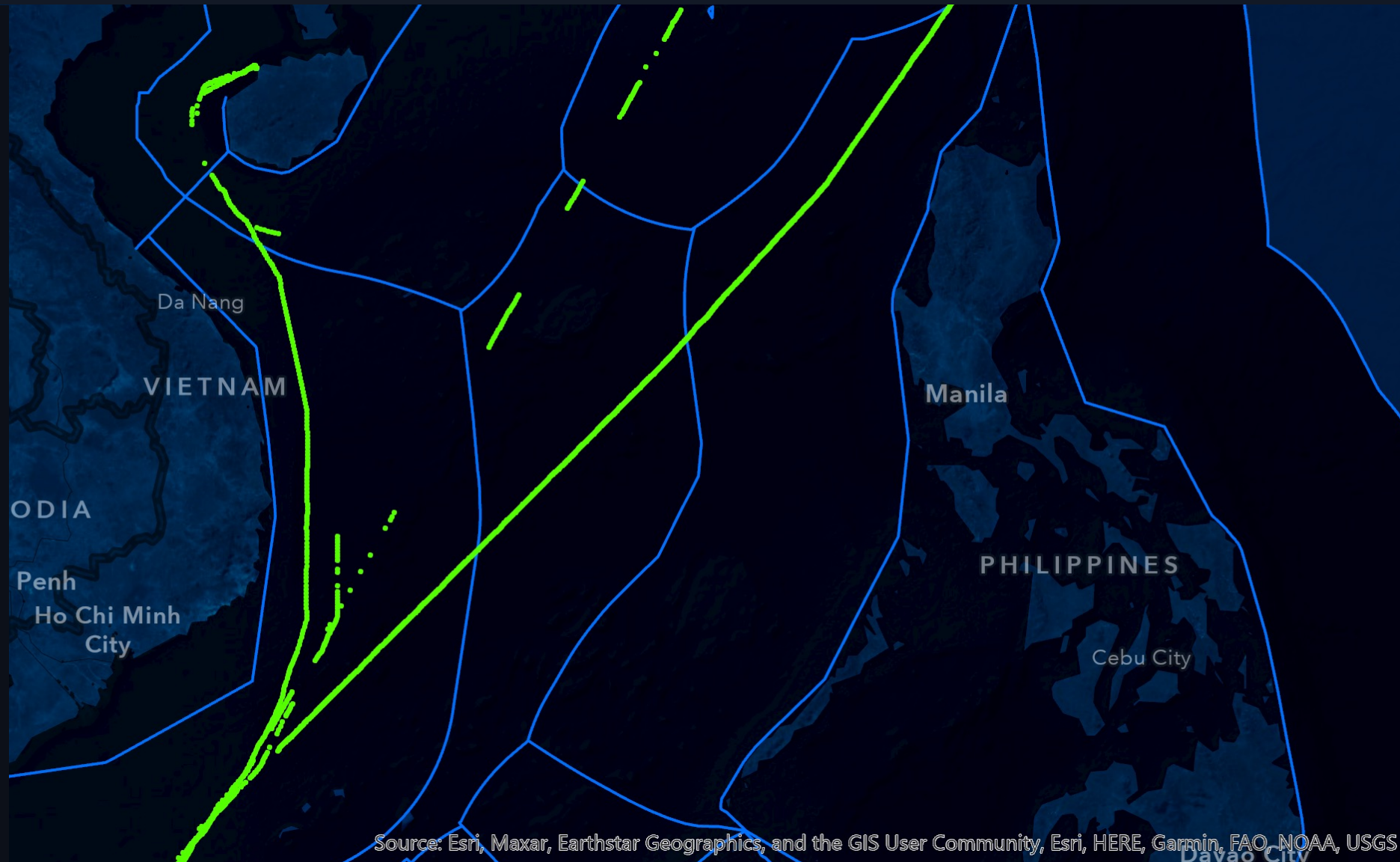


CASE STUDY--AIS TRACKS WITH SIGNIFICANT GAPS

Over the course of a month, this single vessel had numerous dark periods.

During these dark periods, it would be difficult to assess where the vessel had traveled at any given time, rendering most other satellite modalities non-effective.

●●●● AIS Vessel Tracks

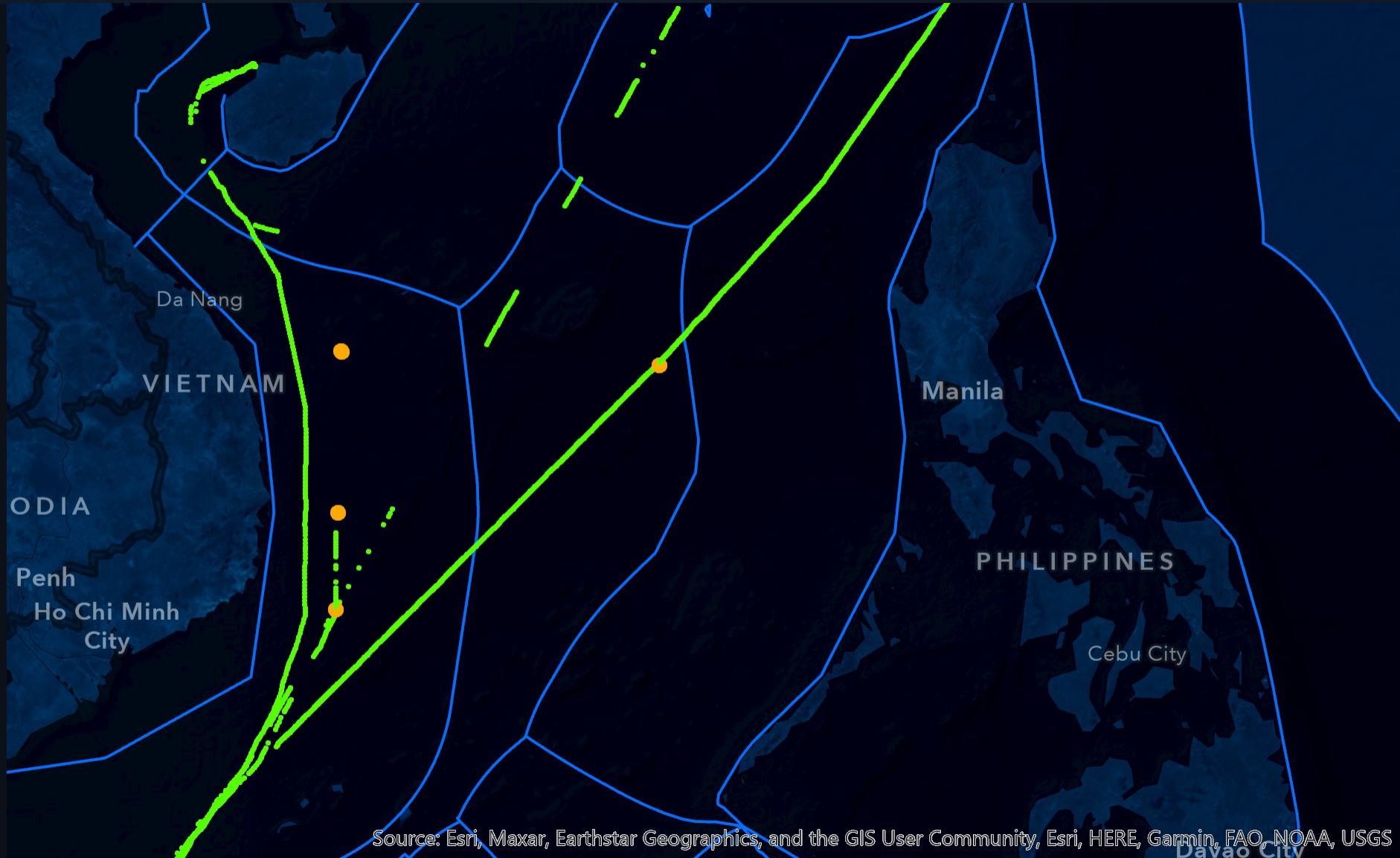


Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community, Esri, HERE, Garmin, FAO, NOAA, USGS

RF SIGNAL RECOGNITION & ASSOCIATION

During those dark periods, our machine learning algorithms were able to determine that the RF geolocation of the 'dark vessel' had the same unique emitter characteristics as the RF emitter previously associated with the vessel while it was broadcasting AIS.

This emitter match provides, with a high level of probability, the identity of the dark vessel.



- AIS Vessel Tracks
- Recognized RF Signals

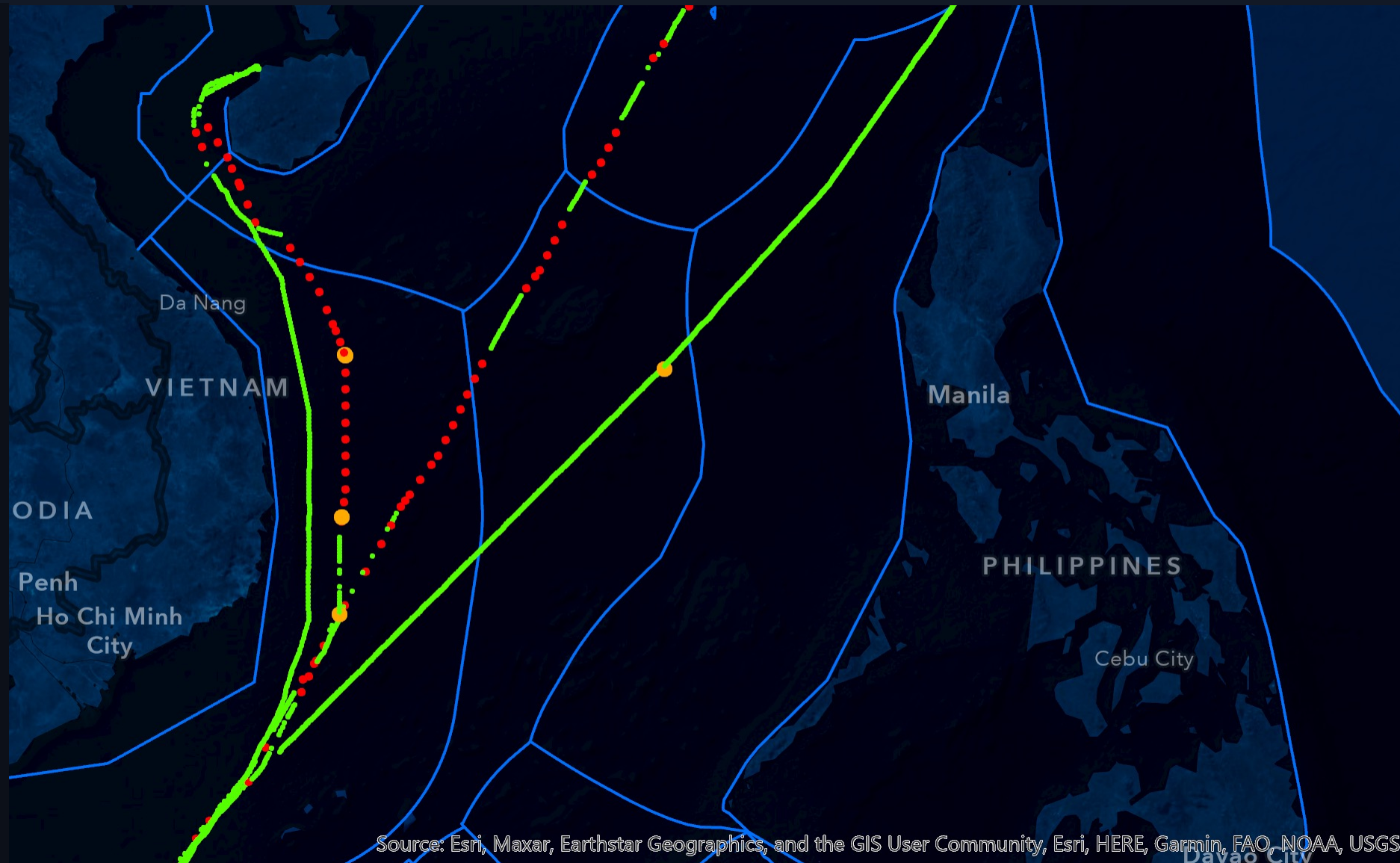
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community, Esri, HERE, Garmin, FAO, NOAA, USGS

END RESULT- PERSISTENT CUSTODY OF VESSELS

The ability to uniquely identify 'dark vessels' through their signal characteristics, combined with increased revisit rates and low latency, allows users to maintain persistent custody of a dark vessel over time and space, tracking its movements purely based on its RF signals characteristics.

This opens up a new phase in satellite-based RF monitoring over a wide area.

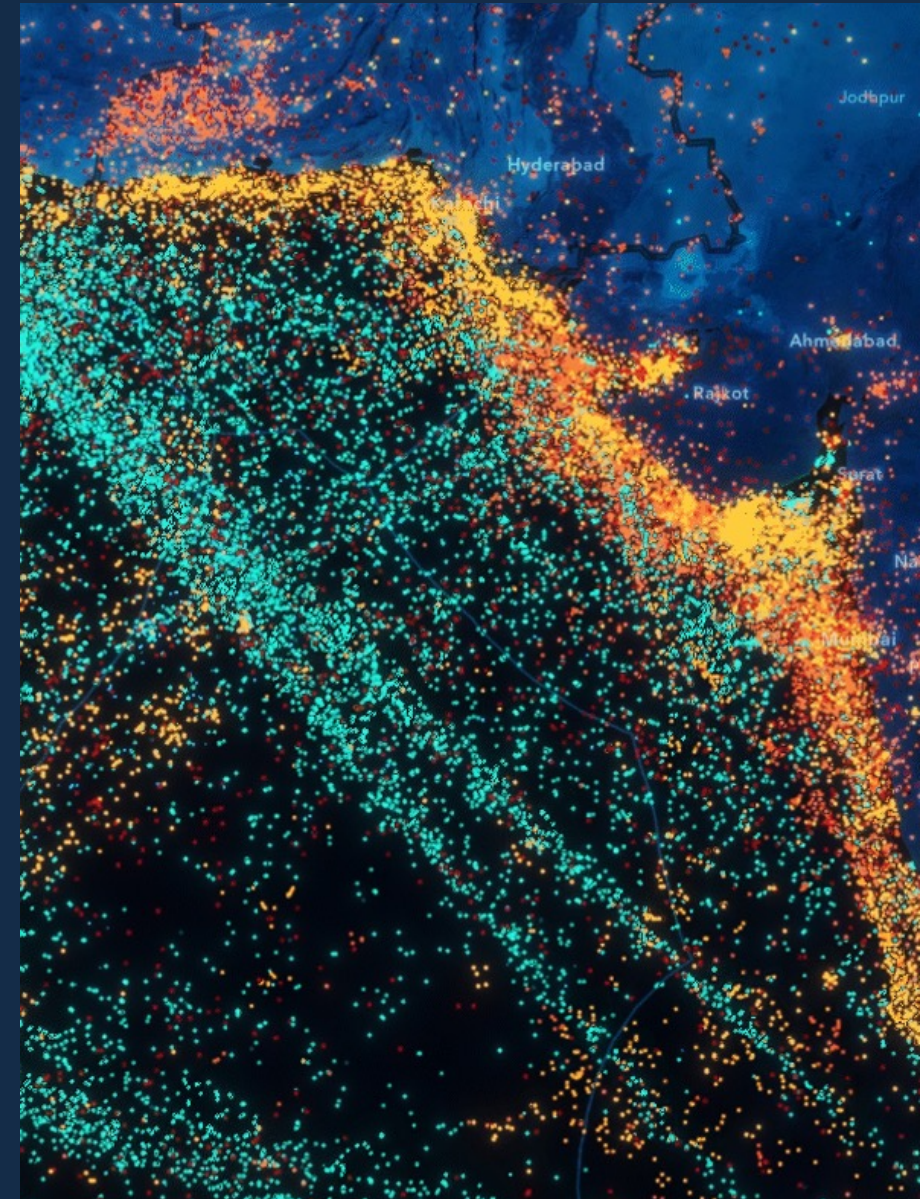
- AIS Vessel Tracks
- Recognized RF Signals
- Probable Dark Path



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community, Esri, HERE, Garmin, FAO, NOAA, USGS

HAWKEYE 360 SUPPORT TO INDO-PACIFIC MDA (IPMDA)

- HawkEye 360 is providing RF data and dark ship detection to support the INDO-PACIFIC Maritime Domain Awareness (IPMDA) initiative
- This program is in its pilot phase, and has been endorsed in open press by the QUAD (India, Australia, Japan and the United States)
- QUAD member states are supporting the provision of our RF data to regional partner nations for enhanced MDA





THANK YOU

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