The last mile – challenges and opportunities in the dissemination of navigation information to end users

ERDC
Engineer Research and Development Center

Brian Tetreault

Navigation Systems Specialist

3rd Biennial Research & Development Conference: Innovative Technologies for a Resilient Marine Transportation System

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US Army Corps of Engineers®

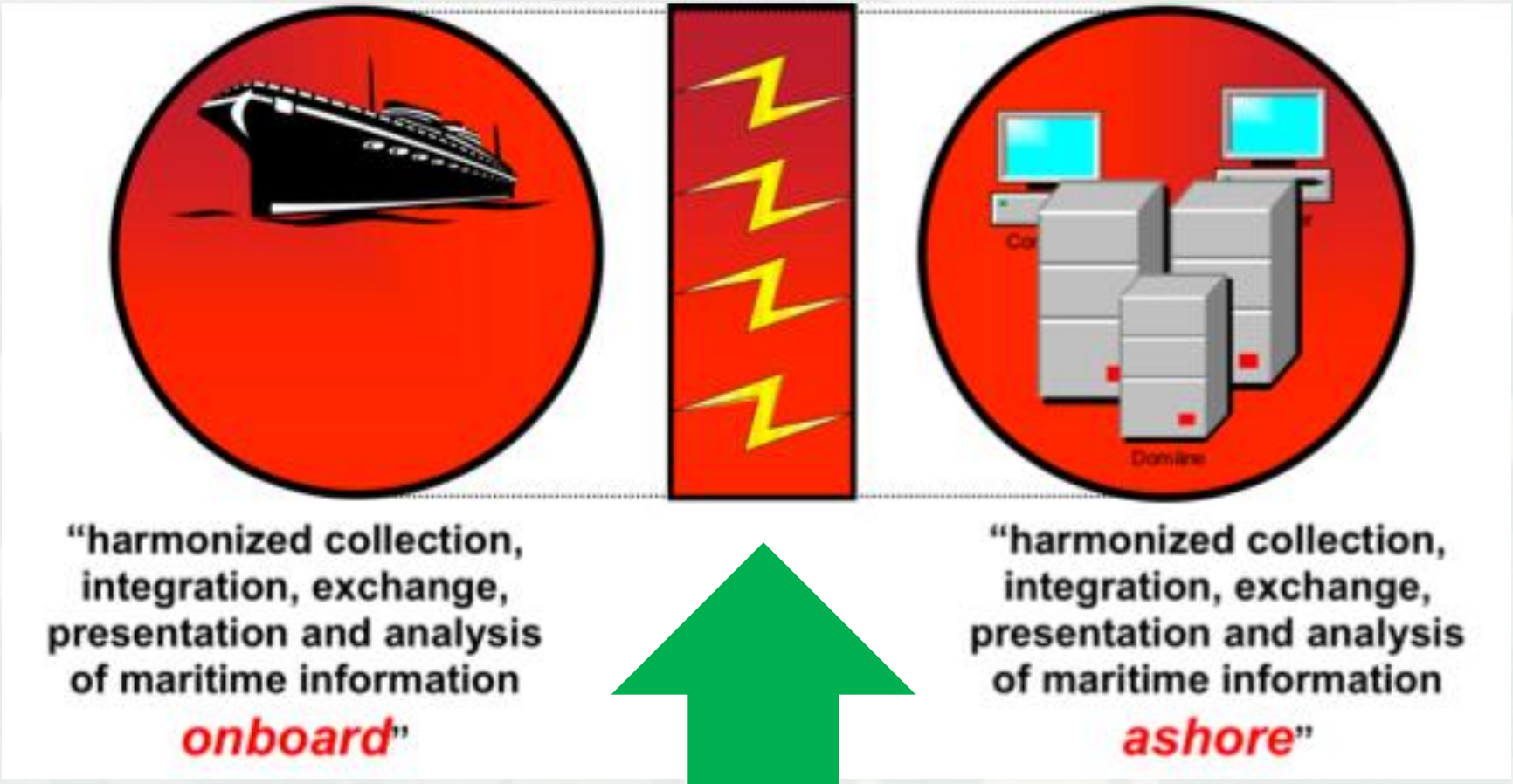
NAVSYS
Navigation Systems Research Program

The Promise of e-Navigation

"e-Navigation is the harmonised collection, integration, exchange, presentation and analysis of maritime information onboard and ashore by electronic means to enhance berth to berth navigation and related services, for safety and security at sea and protection of the marine environment"

- Improve the quantity and quality of data and information
- Ensure interoperability between existing and developing disparate systems
- Identify and fill information and communications gaps

“Three sides of the coin”



Analog navigation

- Paper charts
- Manual positioning
- Voice communications
- Visual aids to navigation

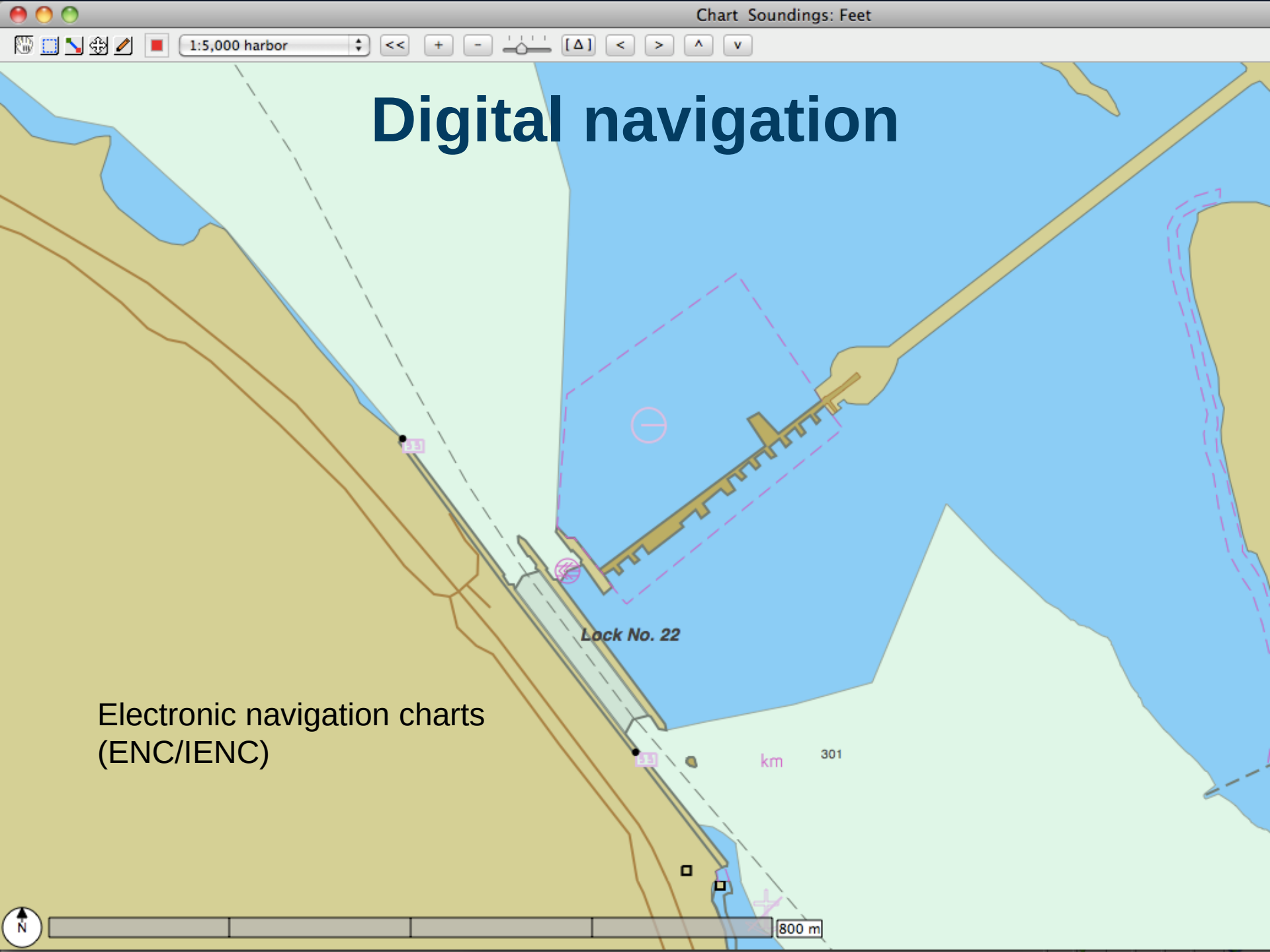


Chart Soundings: Feet
1:5,000 harbor
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Digital navigation
Lock No. 22
km
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Electronic navigation charts
(ENC/IENC)
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27
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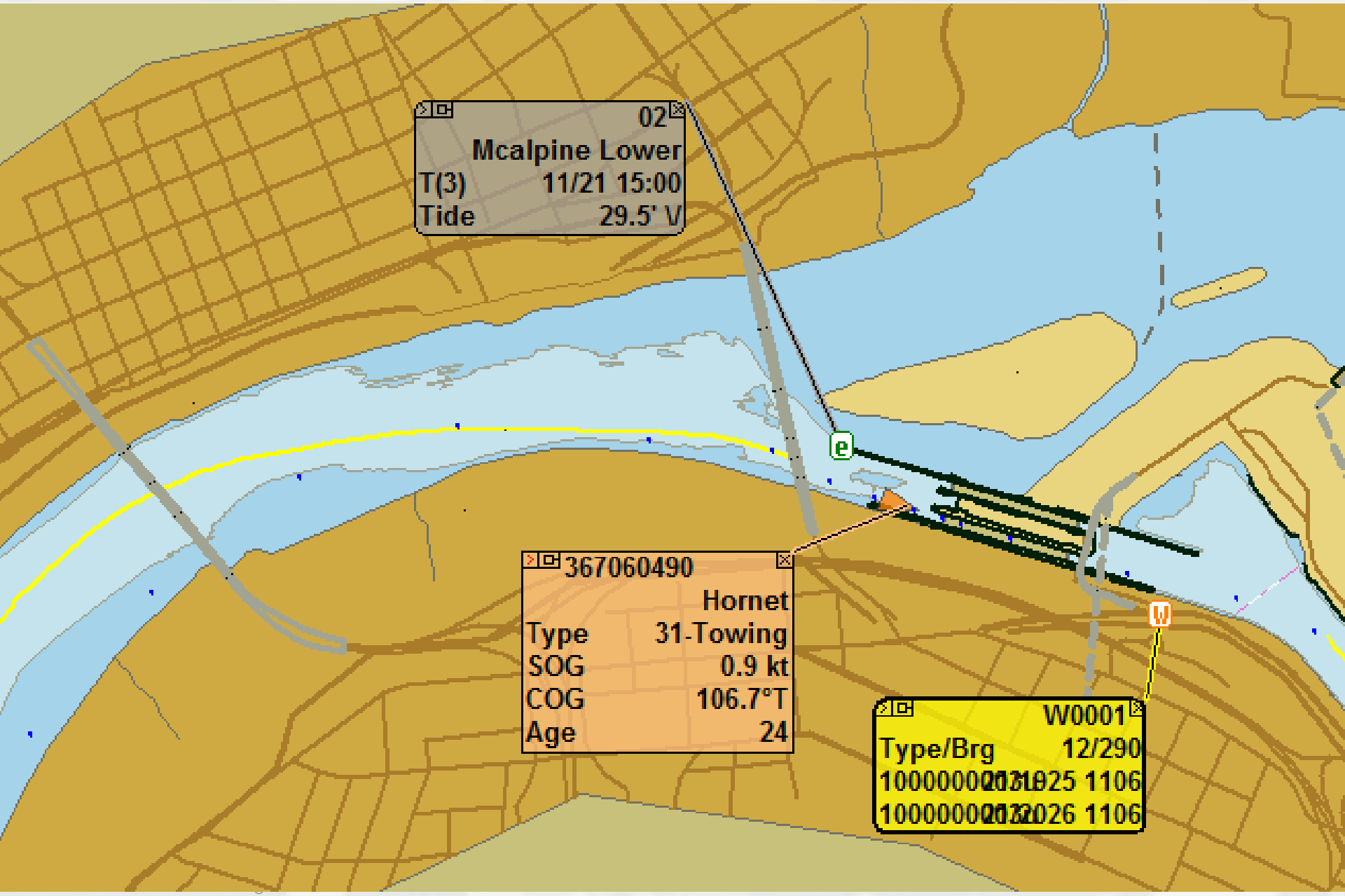
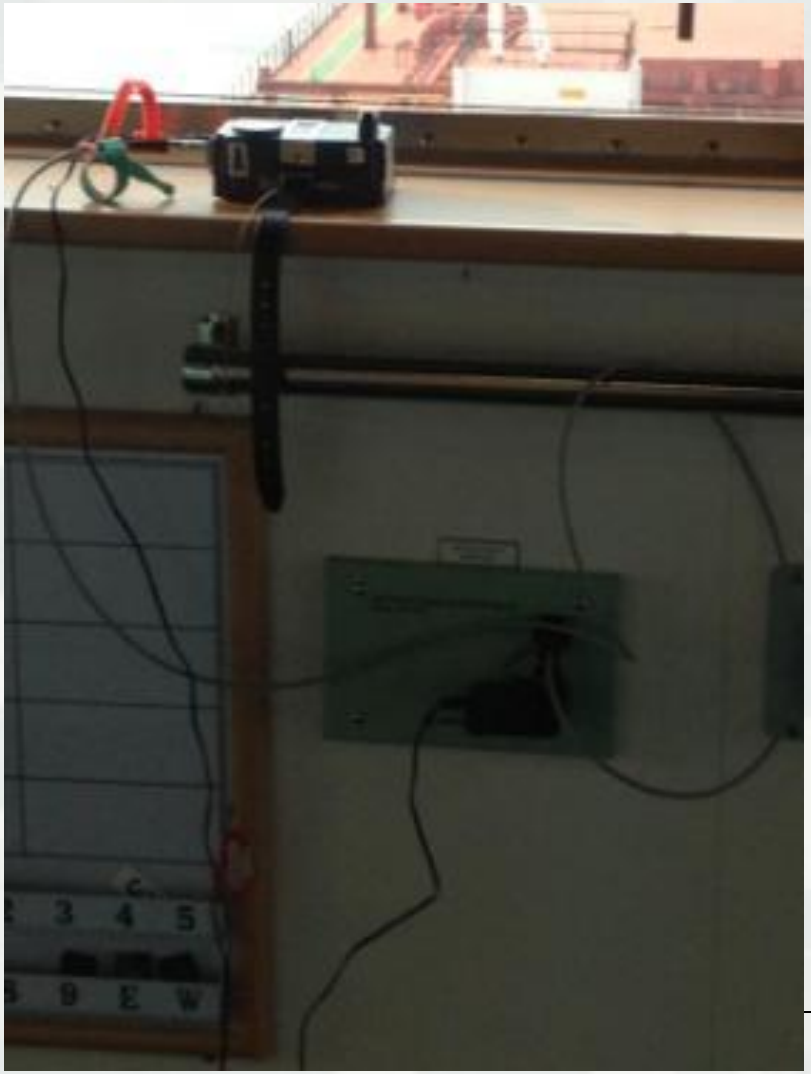

02
Mcalpine Lower
T(3) 11/21 15:00
Tide 29.5' V
367060490
Hornet
Type 31-Towing
SOG 0.9 kt
COG 106.7°T
Age 24
W0001
Type/Brg 12/290
1106
1106

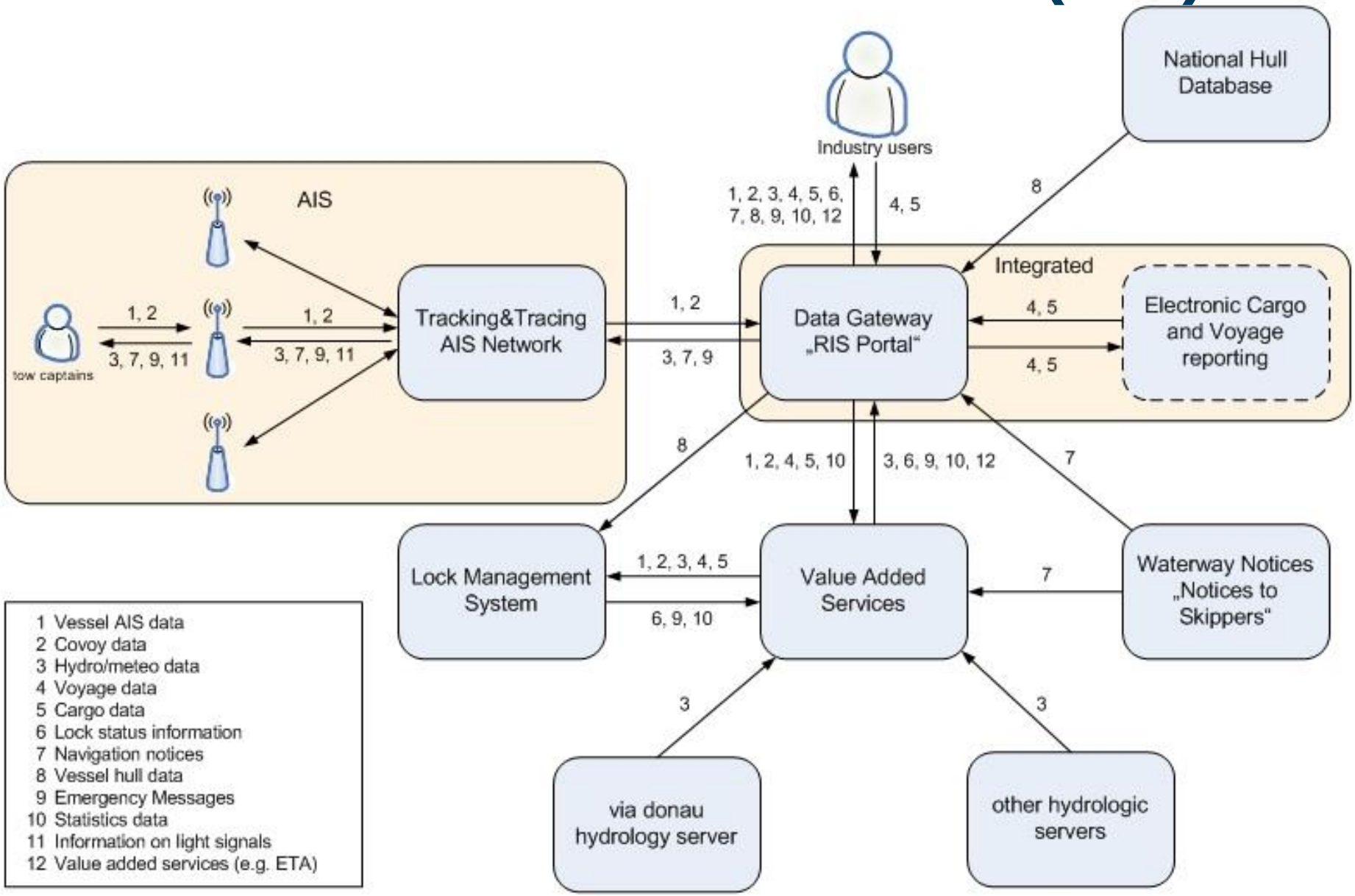
Getting data the last mile
(or few meters)

- Data onboard and ashore is needed elsewhere
- Many users need the same information
- How to get it where it needs to go?
  - ▶ Some methods – part way there
  - ▶ Others all the way, but with limitations
  - ▶ Requirement for long distance and short
    - Around the world and from the radio to the user
- Focus of this presentation is communications capabilities, but data architecture is critical

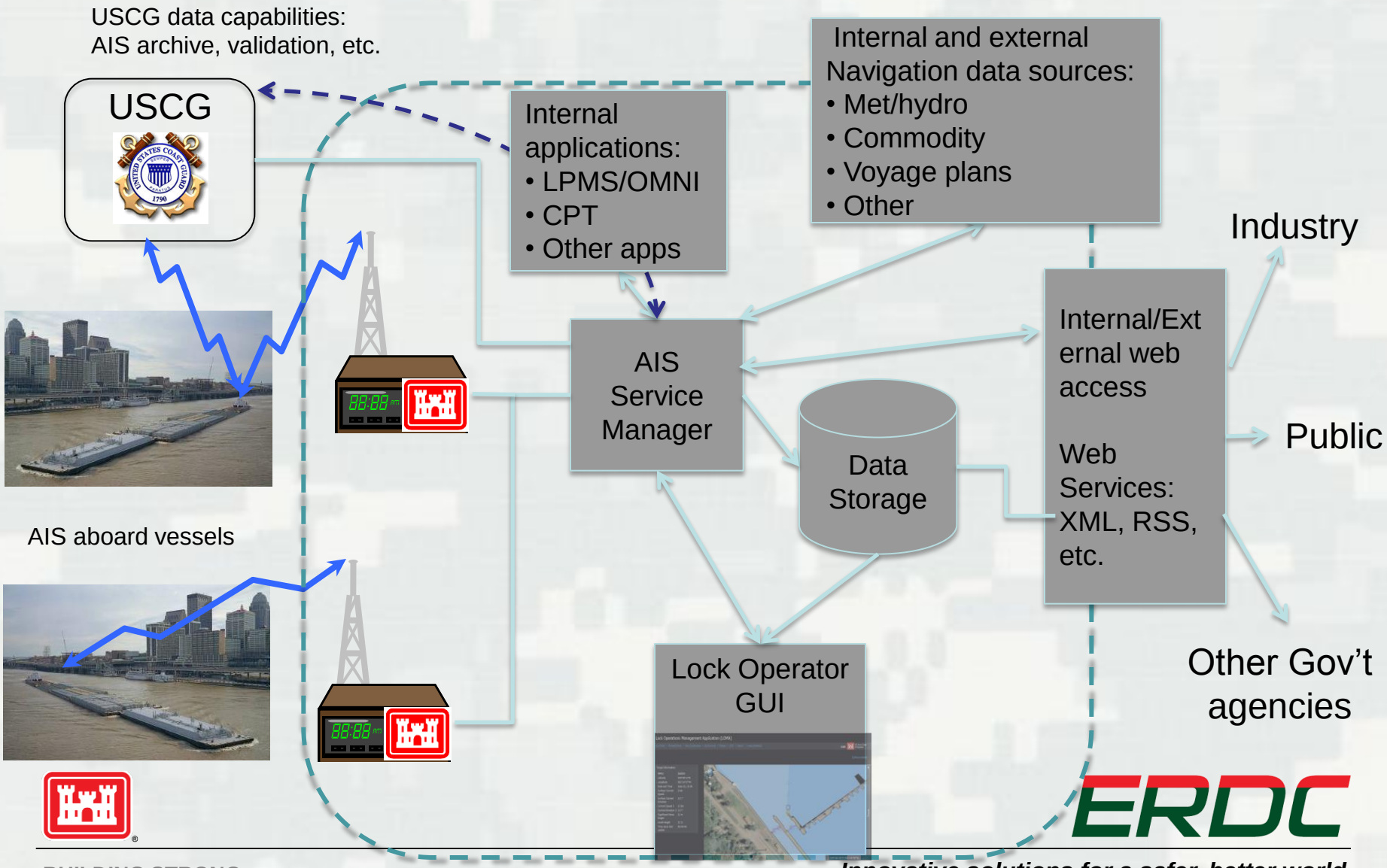
Ship-to-ship & ship-to-shore
Onboard ship:



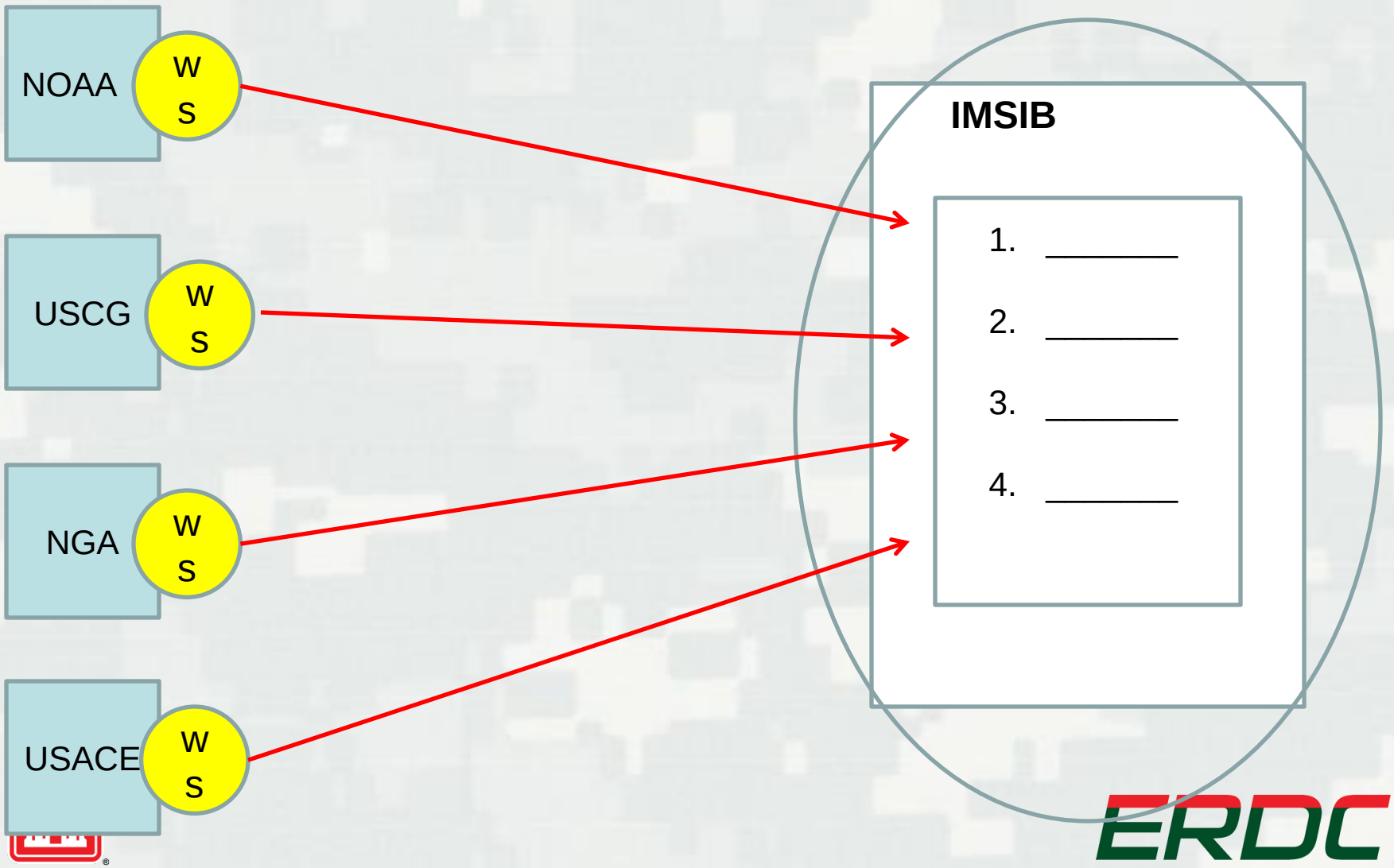
River Information Services (RIS)



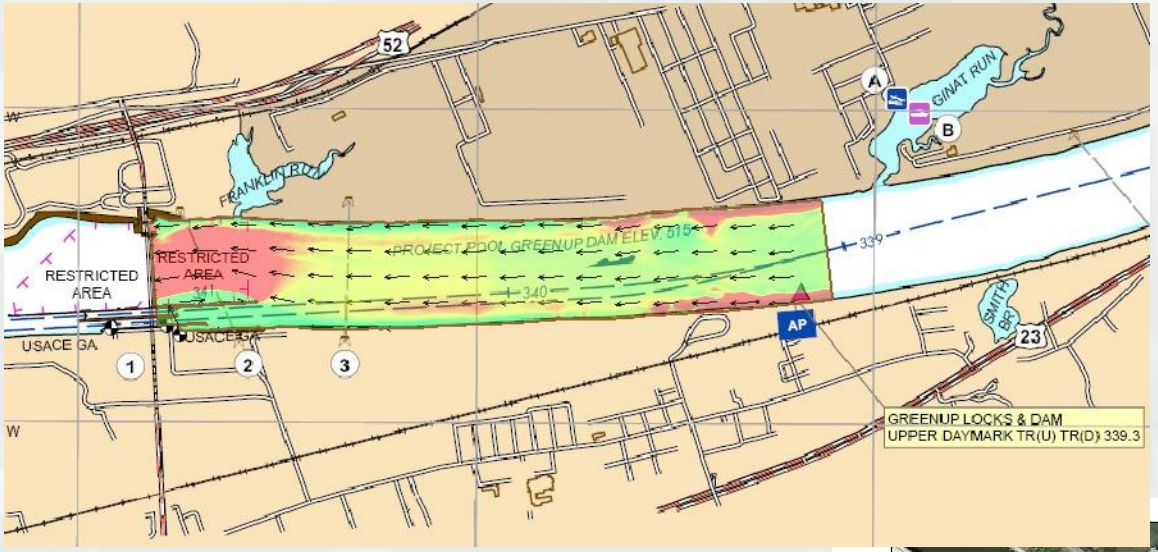
Lock Operations Management Application (LOMA)

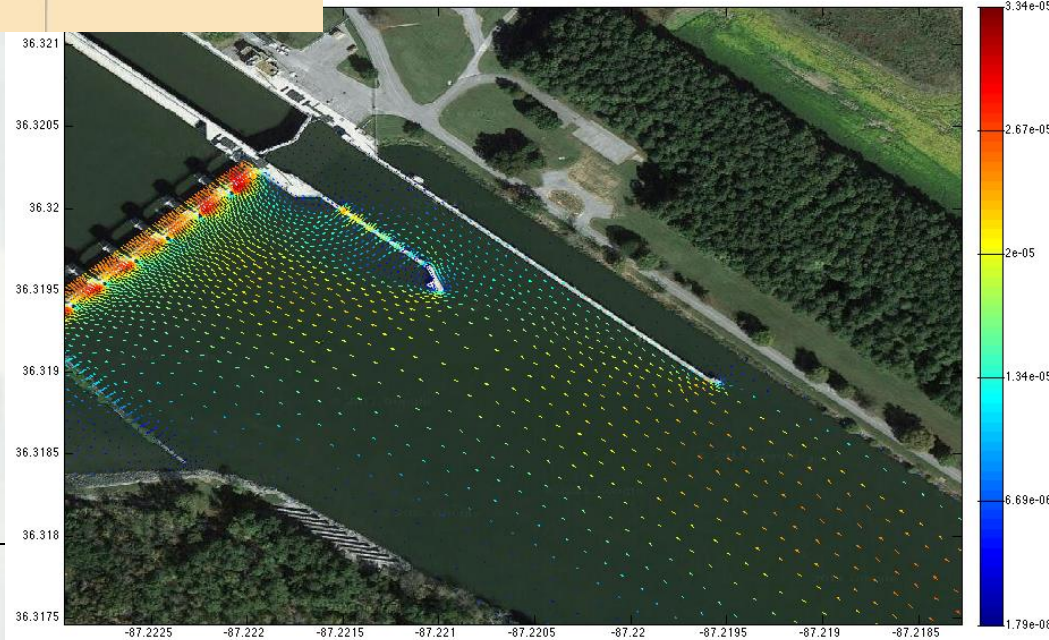


Enhanced Marine Safety Information (eMSI)



Lock approach current modeling





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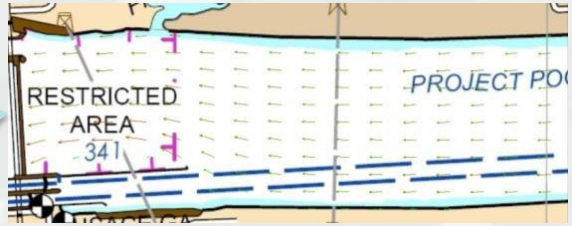
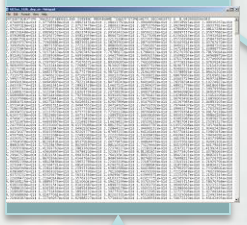
Lock approach hydrodynamic model

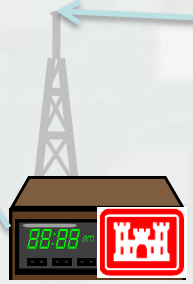


Model output



Convert to ASM

LOMA



AIS units at Locks

Model input:
- Bathymetry
- Structure plans
- Dam discharge
-Surface elevation (pool)

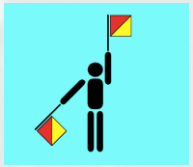
AIS message

Payload

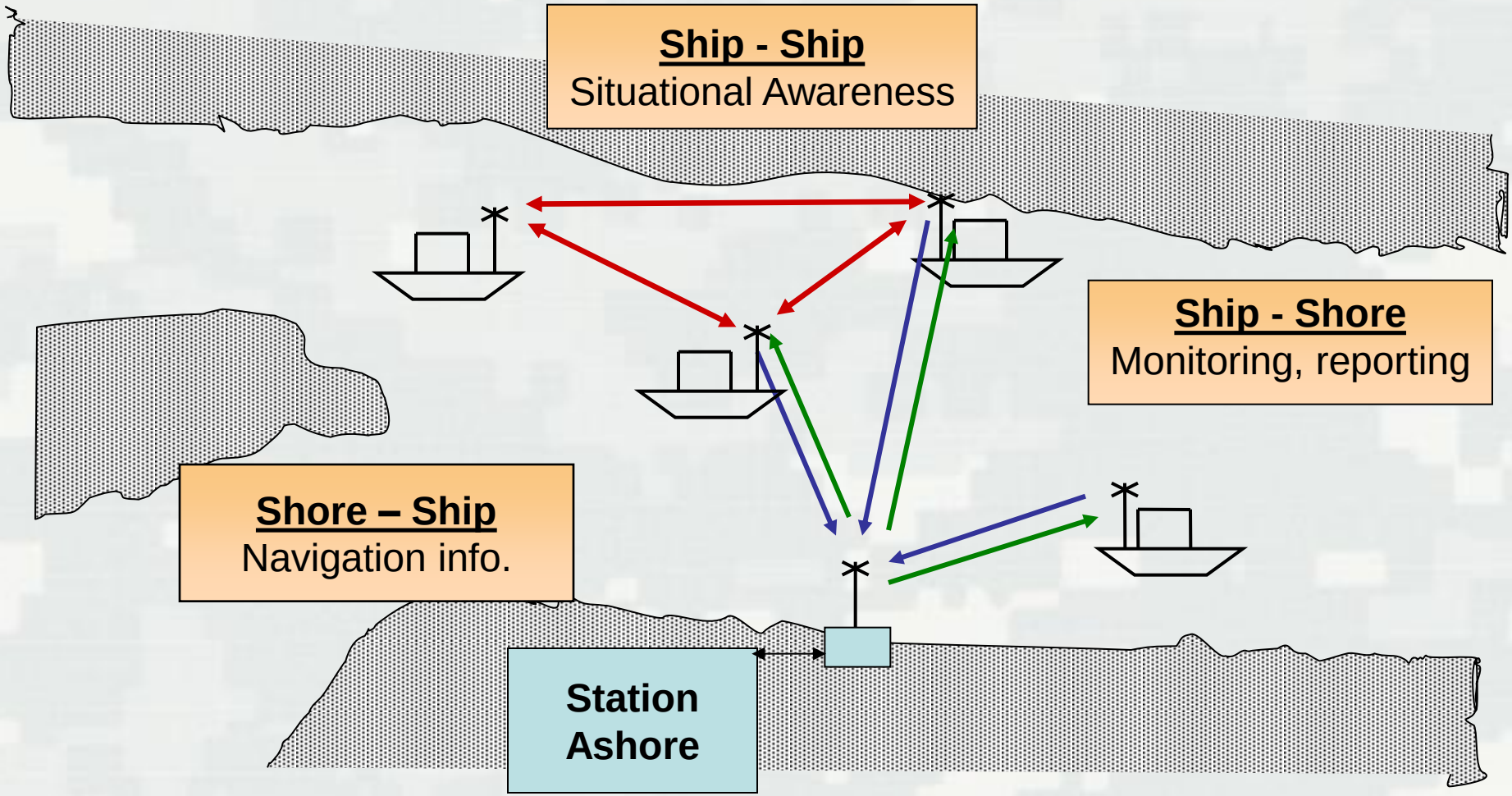
Onboard portrayal

Communications capabilities

- Existing
  - Visual, audio
  - AIS
  - WiFi, WiMAX, network
- Developing
  - VHF Data Exchange System (VDES)
  - Whitespace radio
  - Others?



Automatic Identification System (AIS)



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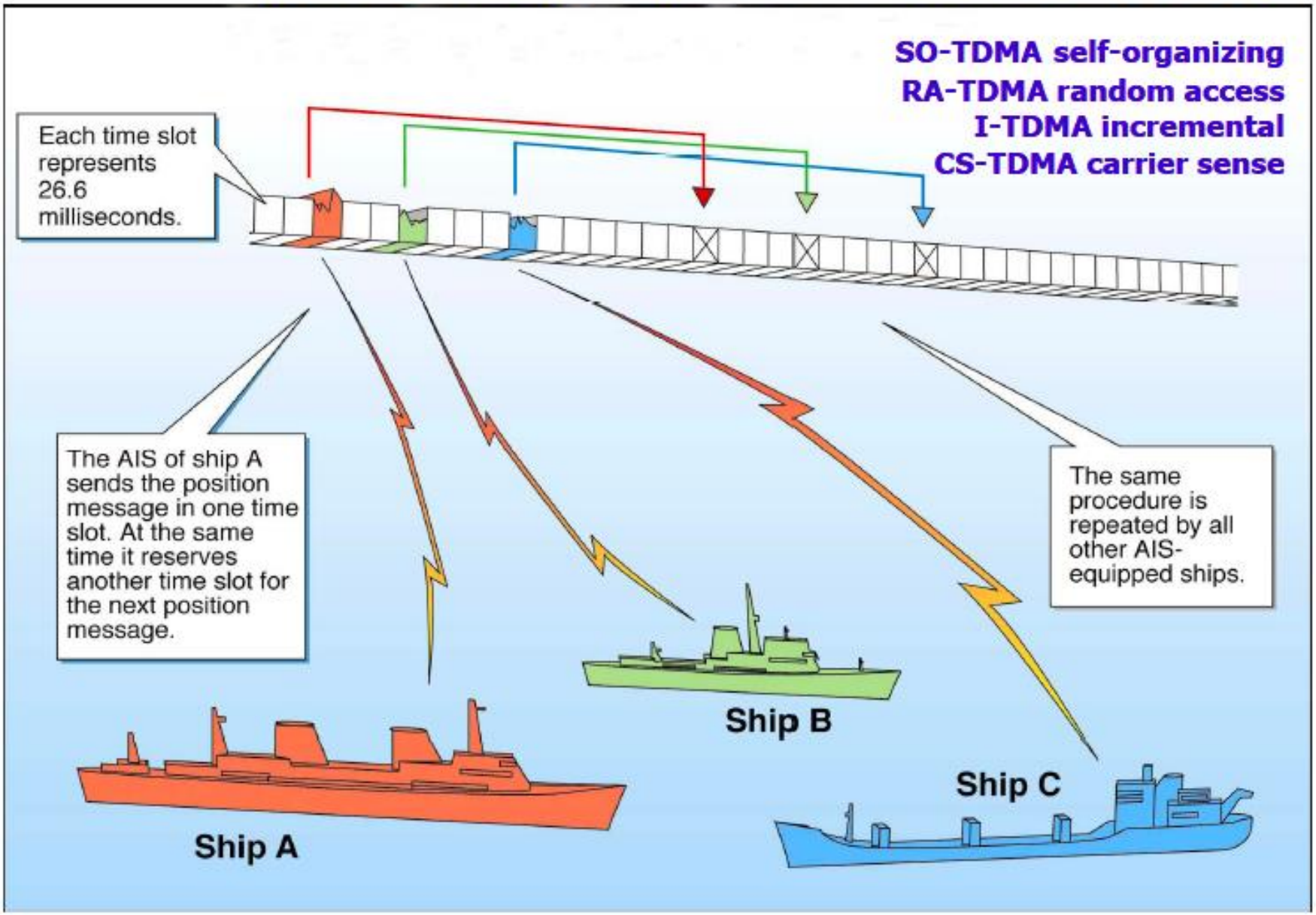
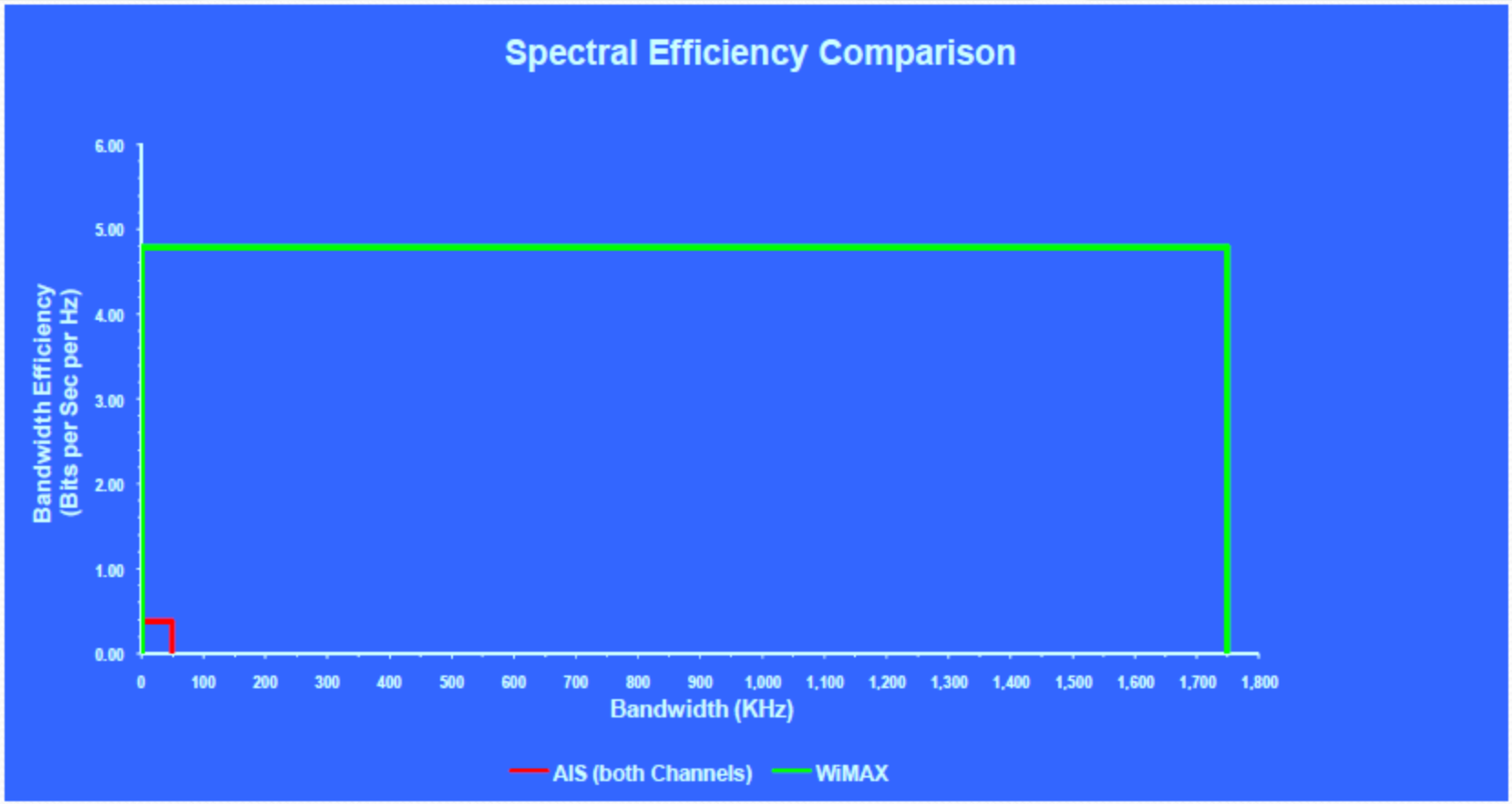


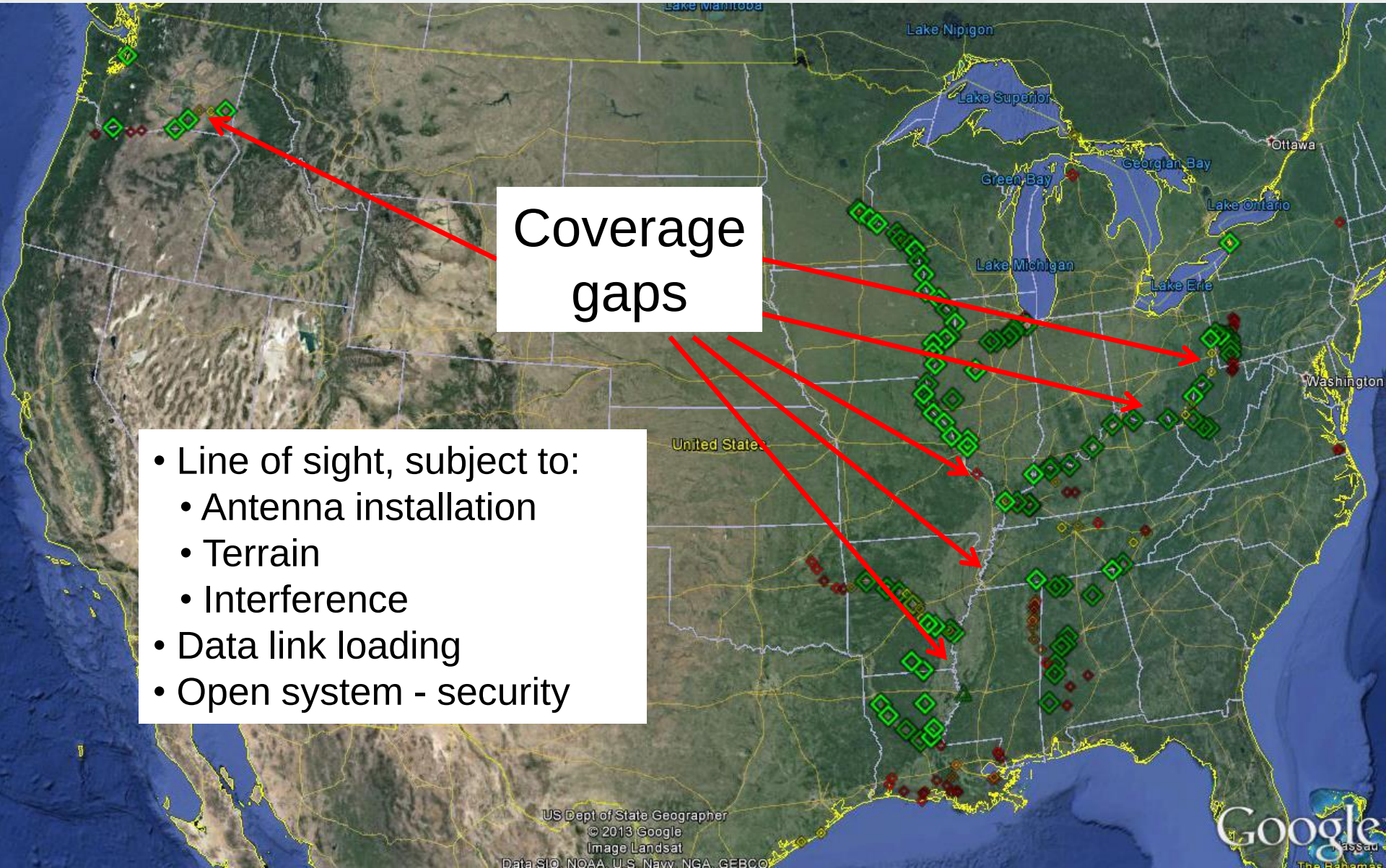


Source – Fred W. Pot, Marine Management Consulting

Port of Pittsburgh Commission

ERDC

AIS transceiver deployment on US inland waterways



Coverage gaps

- Line of sight, subject to:
  - Antenna installation
  - Terrain
  - Interference
- Data link loading
- Open system - security

Other communications methods

Wireless Waterway Components

Wireless-Hybrid Broadband Systems

- Combination of Wireless and fiber backhaul
- High Bandwidth WiFi at each lock/dam
- Multi-Layered Security Schema

Maritime Situational Awareness Portal (MSAP)

- Track vessel info on Google Earth like display
- Inland Electronic Nautical Chart overlays
- Environmental Info Overlays including weather, depth, water quality info

Wireless Waterway Interoperability Test Bed (WWITB)

- Provide an opportunity for technology developers to interact with operational personnel to determine how their technology development efforts and ideas may support or enhance needs of the River Transportation Industry.

Port of Pittsburgh Commission

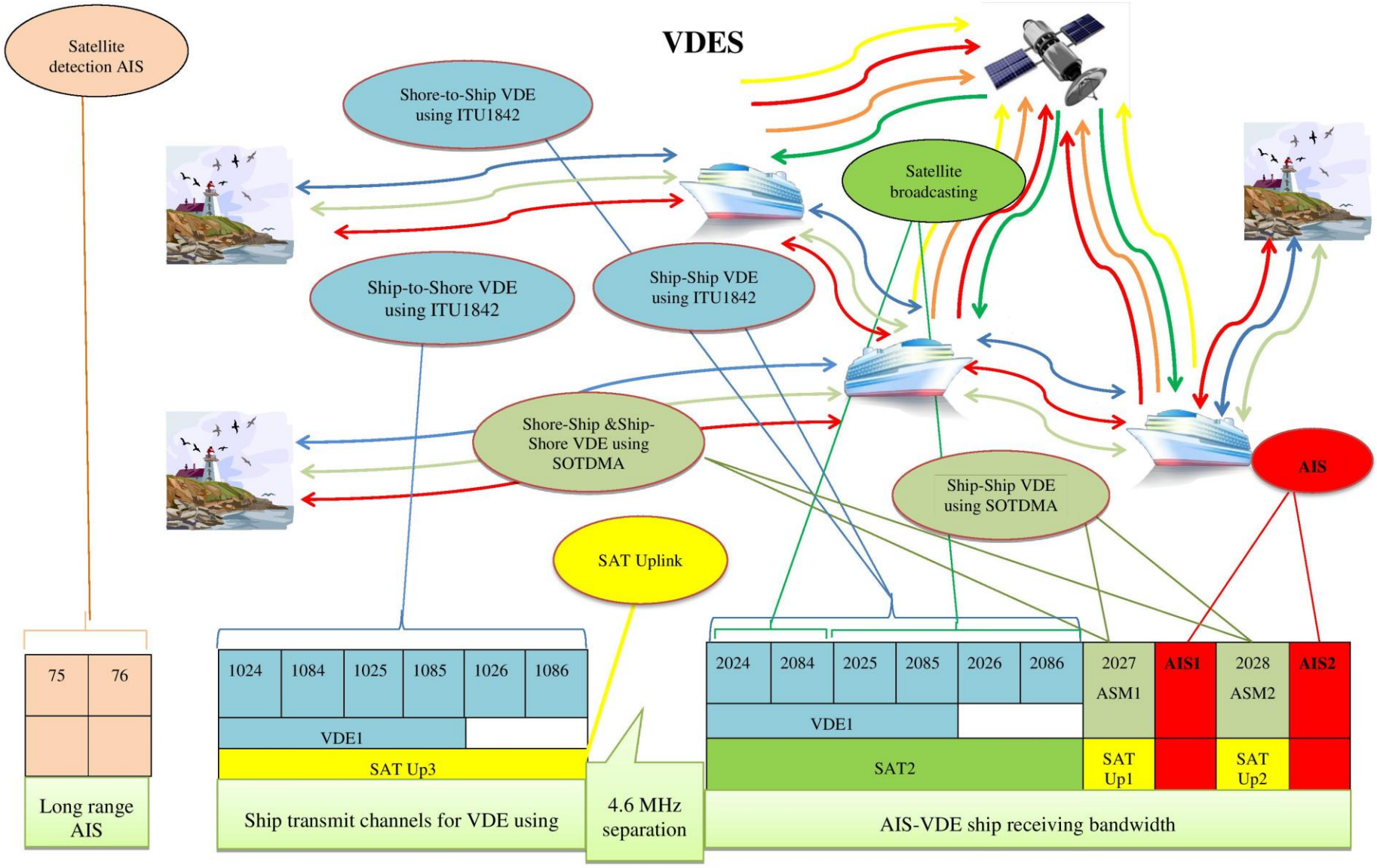
WIRELESSWaterways

PIANC · A.D. 1885 · AIPCN · NAVIGARE NECESSE

Very High Frequency (VHF) Data Exchange System (VDES)

"a digital data exchange system envisaged to offer a globally interoperable and commonly available maritime data communication capability for ship/ship and ship/shore safety of navigation communications including global coverage via a satellite component."

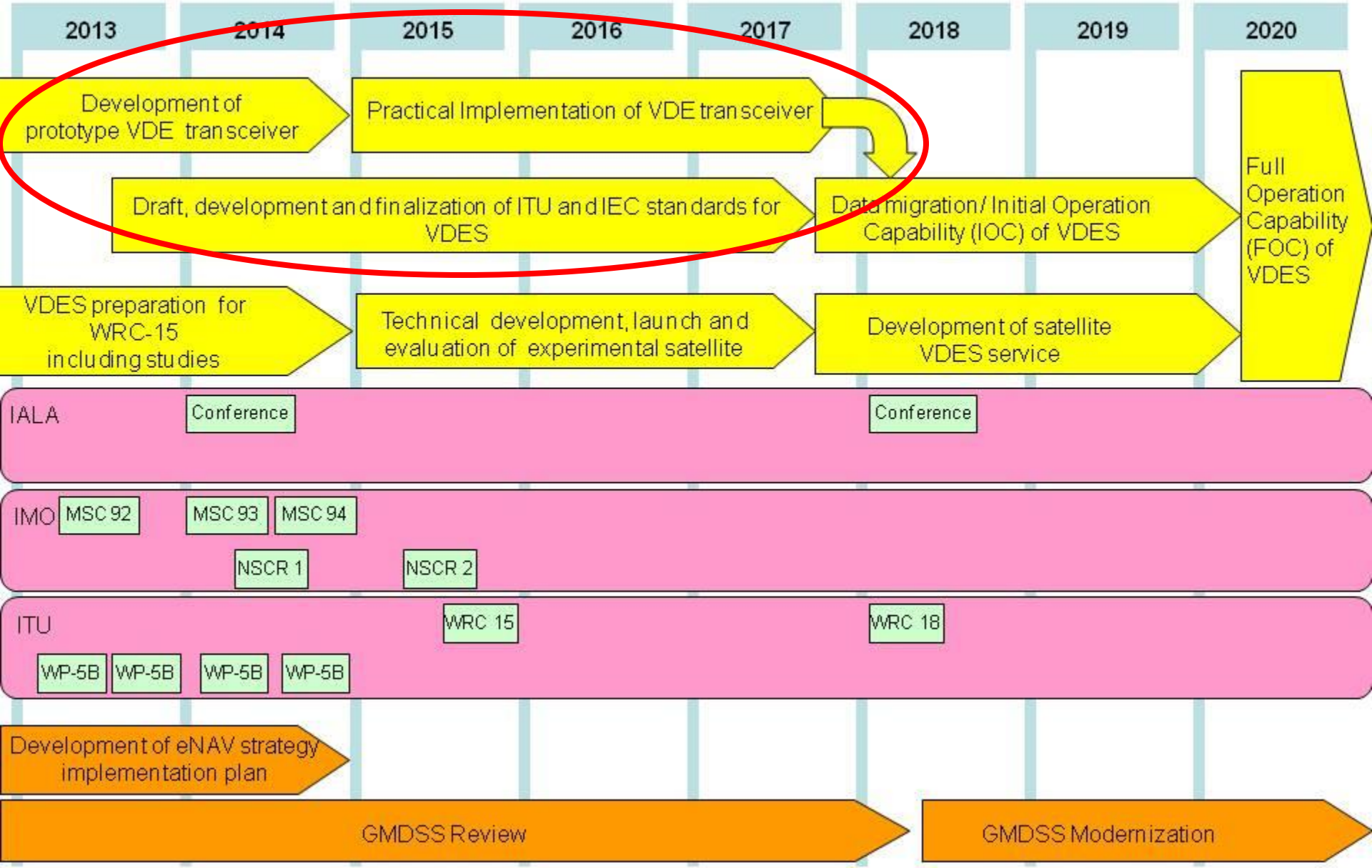
(IALA, VDES demonstration objectives (draft), September 2013)


VDES
Satellite detection AIS
Shore-to-Ship VDE using ITU1842
Satellite broadcasting
Ship-to-Shore VDE using ITU1842
Ship-Ship VDE using ITU1842
Shore-Ship &Ship-Shore VDE using SOTDMA
Ship-Ship VDE using SOTDMA
AIS
SAT Uplink
75
76
Long range AIS
1024
1084
1025
1085
1026
1086
VDE1
SAT Up3
Ship transmit channels for VDE using
4.6 MHz separation
2024
2084
2025
2085
2026
2086
2027 ASM1
AIS1
2028 ASM2
AIS2
VDE1
SAT2
SAT Up1
SAT Up2
AIS-VDE ship receiving bandwidth

VDES Design considerations

- Protect AIS for collision avoidance & identification purposes
- RF transmissions must respect AIS & voice
- In transition to VDES service the capabilities available on ships must be carefully considered
- Balance & prioritization of information delivered by AIS, VDES and the use of other methods

VDES Roadmap



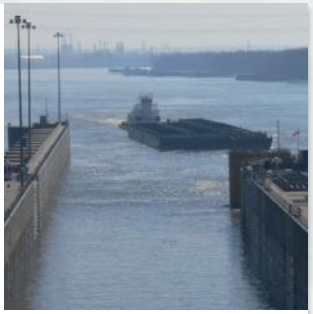
Getting information the last mile…

- Does more info = too much info?
  - How will it be presented in a useful way?
  - Formats, symbology, systems used, etc.
- Carriage requirements
  - voluntary or mandatory?
  - Acceptance of users/purchasers
- Roles of open and proprietary systems
- Prioritization of information delivery
  - Availability, reliability, recoverability

Conclusion

- Identify “disturbances”
  - The promise of e-Navigation: increased information
- Highlight priority areas for research
  - Existing and developing communications
    - How they can work together
    - Compliment, augment, and enhance current capabilities
- Quantify and track MTS resilience
  - Information reliably delivered to those who need it, when they need it, in a form they need, will support MTS resilience

Thank you for your attention!



Brian Tetreault

brian.j.tetreault@usace.army.mil

US Army Corps of Engineers®

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AIS information

What AIS broadcasts

- MARITIME MOBILE SERVICE INDENTIFIER
- UNIVERSAL TIME STAMP (GPS)

Dynamic Data (Messages 1,2 or3)

-every 2-10 seconds per speed and course change

- POSITION & ACCURACY (+/-10m)
- NAVIGATION STATUS
- COURSE OVER GROUND
- SPEED OVER GROUND
- ❖ HEADING
- ❖ RATE OF TURN

Static & Voyage Data (Message 5)

-every 6 minutes or upon change

- VESSEL NAME & CALL SIGN
- VESSEL TYPE & DIMMENSIONS
- ❖ VESSEL IMO NUMBER
- ❖ STATIC DRAFT
- ❖ HAZARDOUS CARGO FLAG
- ❖ DESTINATION & ETA

Aids to Navigation

- POSITION, STATUS, DISCREPANCIES

Safety Related & Binary Applications

- SHORT TEXT MESSAGING < 156 characters
- DATA MESSAGING & BINARY APPLICATIONS

Weather & Hydrological Information-

- NOAA Physical Oceanographic Real Time System
- NWS-Real-time weather buoy (C-MAN station)
- USACE Real-time Current Meter System (RTCM)

Vessel Traffic Service (VTS)-

- Distress Alerts
- Urgent Notices & Warnings
- Traffic Advisories
- Virtual--targets
- Additional Hydro & Meteorological Information

Other possible uses-

- Search and Rescue
- Port Partners
- Lock/Canal operations
- ... endless opportunities!

ID#	ITU-R M.1371 AIS Message Descriptions	AU	AS	IN	Slots
1,2,3	Position Reports – autonomous (au), assigned (as), or interrogated (in)	x	x	x	1
4	Base Station Report – UTC/date, position, slot nr.		x		1
5	Class A Report - static and voyage related data	x	x	x	2
6,7,8	Binary Message – addressed, acknowledge or broadcast	x	x	x	5/2
9	SAR aircraft position report	x	x	x	1
10,11	UTC/Date - enquiry and response		x	x	1
12,13,14	Safety Text Message – addressed, acknowledge or broadcast		x	x	5/2
15	Interrogation – request for specific messages		x	x	1
16	Assignment Mode Command	x	x		1
17	Binary Message – DGNSS Correction		x		1
18,19	Class B Reports – position & extended	x	x		2
20	Data Link Management – reserve slots		x		1
21	ATON Report – position & status	x	x	x	2
22	Channel Management		x		1
23	Group Assignment				1
24	Class B-CS Static Data			x	1
25	Binary Message - single-slot				1
26	Binary Message - multi-slot (STDMA)				5
27	Long-range AIS broadcast message				

AIS carriage requirements

AIS Carriage Regulations 33 CFR 164.46

The following must have a properly installed, operational, type-approved AIS

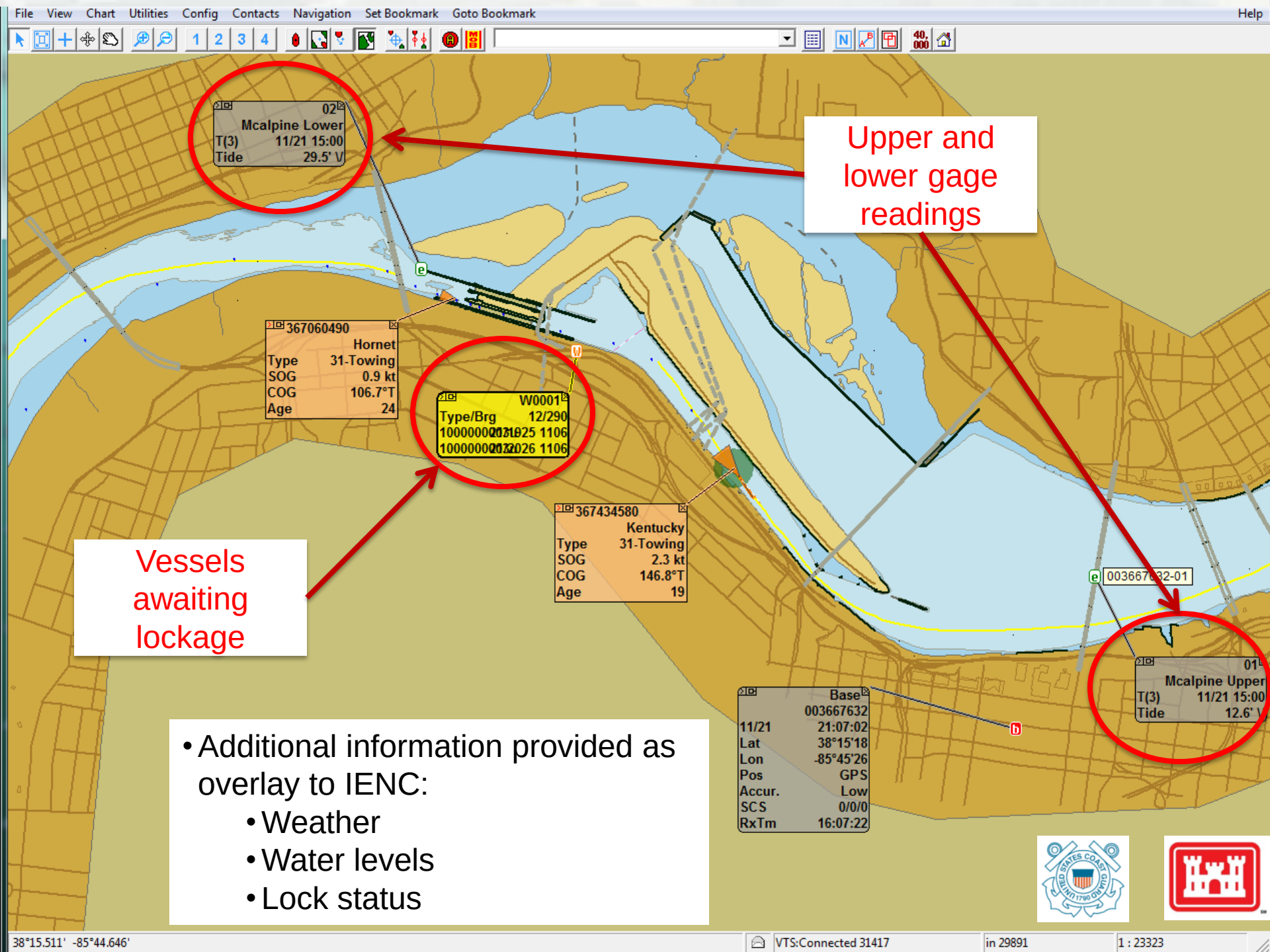
- *On international voyage:*
  - ✓ Tankers, Passenger ≥ 150 GT, all others ≥ 300 GT
    - ❑ Per SOLAS Regulation V/19.2.4
  - ✓ Self-propelled commercial vessels ≥ 65 feet
    - ❑ Except fishing and small passenger vessels (<150 passengers)
- *Within a VTS area:*
  - ✓ Self-propelled commercial vessel 65+ feet
    - ❑ Except fishing & small passengers vessels
  - ✓ Towing vessel ≥ 26 feet and ≥ 600 hp
  - ✓ Vessel certificated to carry ≥ 150 passengers

Vessel affected by AIS rulemaking

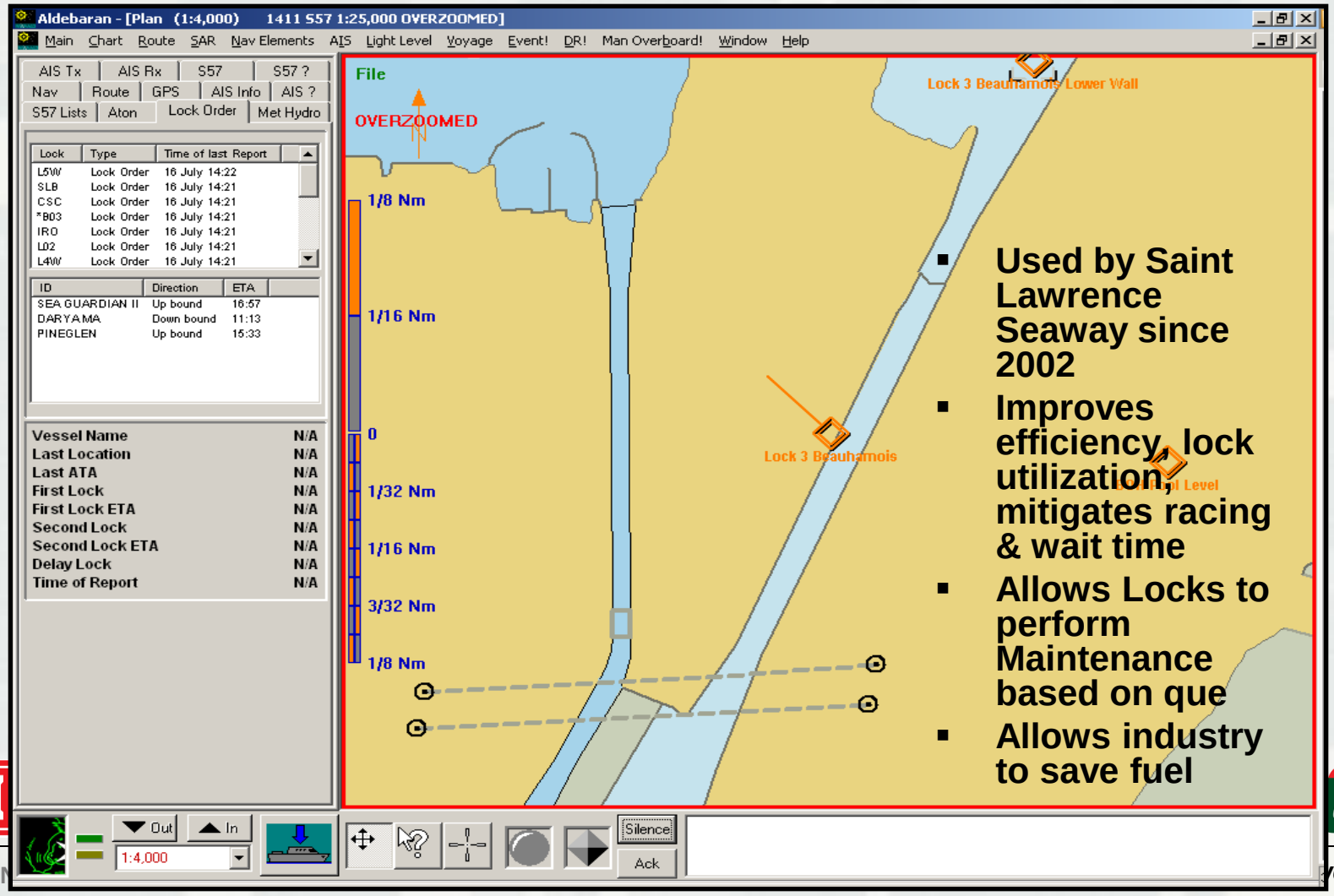
AIS Rulemaking [Changes in **Bold-type**]

- ✓ 10/23/03, current AIS requirement published (33 CFR 164.46)
- ✓ 07/01/03-01/09/04, 3 meetings & comment period re: AIS expansion
- ✓ 10/31/05, agenda entry re: expansion of AIS to **all** navigable waters
- ✓ 12/16/08, NPRM published; 04/15/09, comment deadline (73 FR 78295)
- Proposed compliance date: NLT 7 month after Final Rule
- AIS prices: Class A, $2,800-5,000; Class B, $700-1,500
  - Installation cost will vary by display options & interfacing
  - SOLAS requires interfacing to GPS, THD, ROT, back-up power
- Potentially could effect 17,442 vessels/14,506 small biz's, i.e.
  - Commercial self-propelled vessels of ≥ 65 feet
    - **No exclusions**
  - Towing vessels ≥ 26 feet and > 600 hp
  - Vessels with **≥ 50** passengers (vice 150 for hire)
  - **Hi-Speed vessels with ≥ 12 passengers for hire**
  - **Certain dredges & floating plants, &**
  - **Vessel moving certain dangerous cargoes**

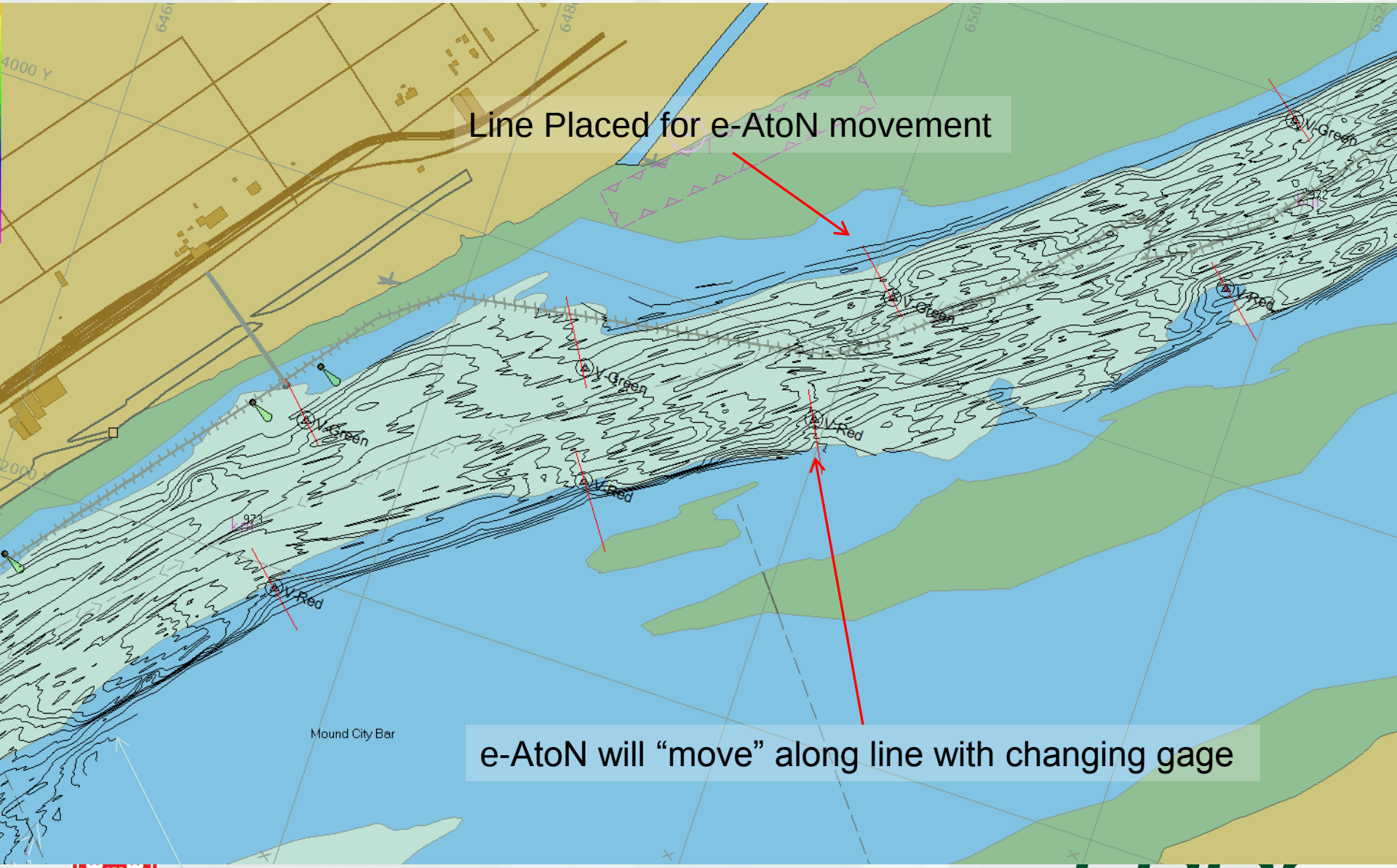
Estimated Expanded AIS Population	
Ships ≥65ft	**2,973**
Freight Ship	298
Industrial Ship	748
MODU	210
OSV	553
Research Vessel	97
School Ship	19
Tank Ship	122
Unclassified	385
Unknown	541
Fishing ≥65ft	**5,520**
Documented	4,571
Undocumented (est.)	949
Towing ≥26ft & ≥600hp	**4,560**
Passenger	**3,235**
≥65ft	2,167
<65' but ≥50 pax	1,062
>30kts & >12 pax for hire	6
Dredges	**35**
Total (U.S.)	16,323
Foreign Flag ≥65ft	**1,119**
Total (All)	17,442


File View Chart Utilities Config Contacts Navigation Set Bookmark Goto Bookmark Help
02
Mcalpine Lower
T(3) 11/21 15:00
Tide 29.5' V
Upper and lower gage readings
367060490
Hornet
Type 31-Towing
SOG 0.9 kt
COG 106.7°T
Age 24
W0001
Type/Brg 12/290
1000000031025 1106
1000000032026 1106
367434580
Kentucky
Type 31-Towing
SOG 2.3 kt
COG 146.8°T
Age 19
Vessels awaiting lockage
003667632-01
01
Mcalpine Upper
T(3) 11/21 15:00
Tide 12.6' V
Base
003667632
11/21 21:07:02
Lat 38°15'18
Lon -85°45'26
Pos GPS
Accur. Low
SCS 0/0/0
RxTm 16:07:22
• Additional information provided as overlay to IENC:
• Weather
• Water levels
• Lock status
38°15.511' -85°44.646'
VTS:Connected 31417
in 29891
1 : 23323

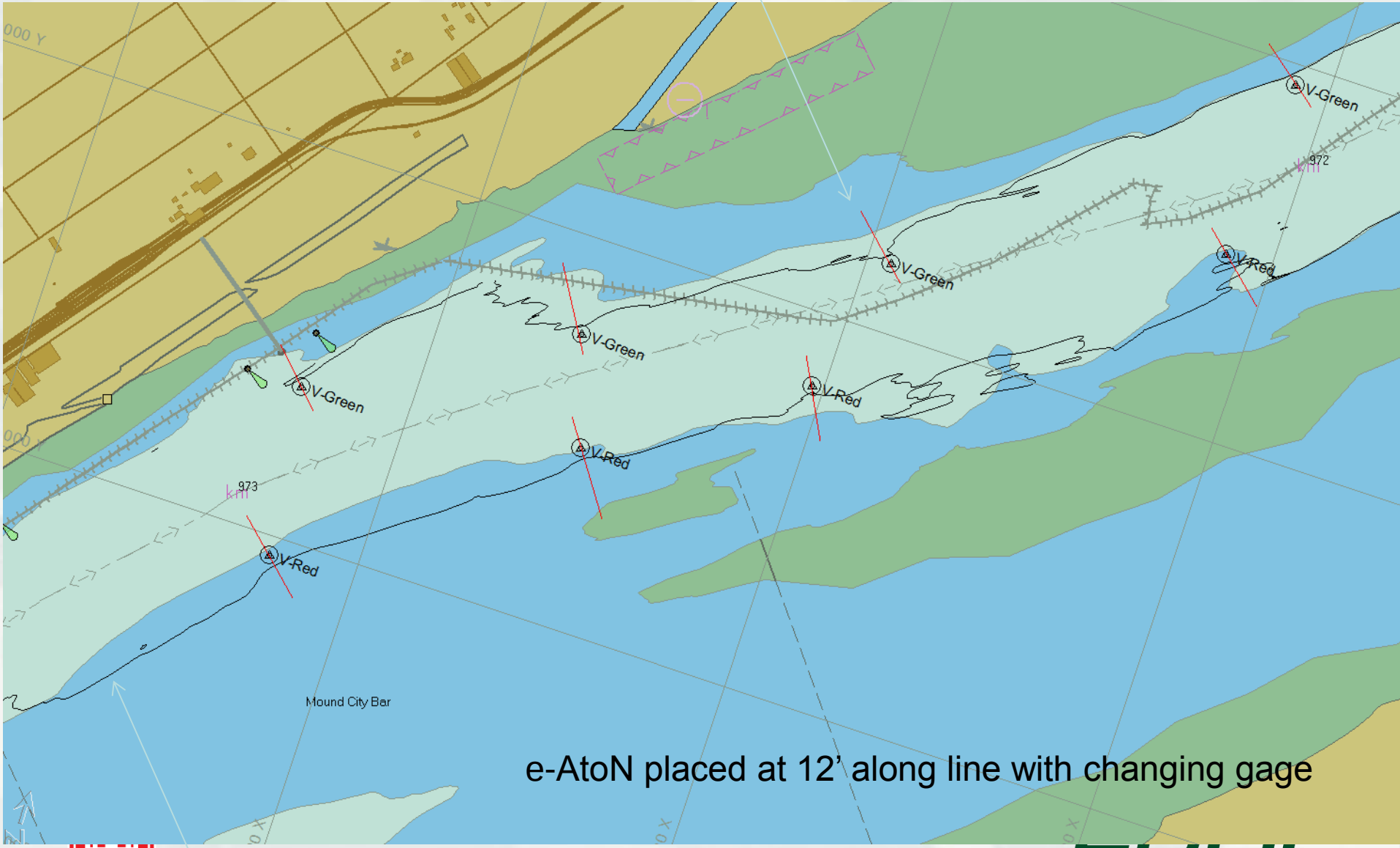
Lock Order Message



- Used by Saint Lawrence Seaway since 2002
- Improves efficiency, lock utilization, mitigates racing & wait time
- Allows Locks to perform Maintenance based on que
- Allows industry to save fuel


Line Placed for e-AtoN movement
V-Green
V-Green
V-Green
V-Red
V-Red
V-Red
Mound City Bar
e-AtoN will “move” along line with changing gage

Line Placed for e-Aton movement



e-AtoN placed at 12’ along line with changing gage