



Geographic Information Systems for Tracking Vessels on the Inland Waterways

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13 January 2006





Scope

- Link with "***Management Systems for Inland Waterway Traffic Control***" project to address congestion on the Upper Mississippi River (UMR).
- Our focus:
 1. Identify GIS and vessel tracking applications for inland waterway transport on the UMR.
 2. Document appropriate technologies to implement a vessel tracking system.
 3. Develop a prototype GIS-based vessel tracking system to assist in implementing an appointment or scheduling system.



Questions

1. Is vessel tracking feasible on the UMR?
2. Should GIS-based tow tracking be deployed on the UMR?

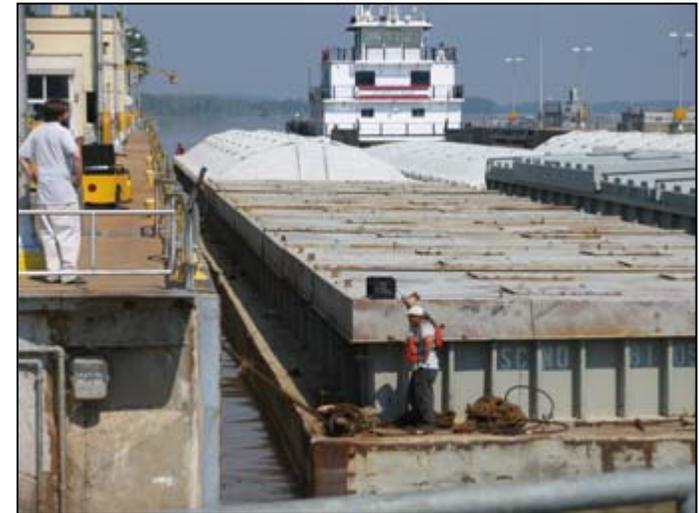
Locks are 600' or 1200' long.
Tows are up to 1200' long (16 barges).





Real-time Tracking of Tows

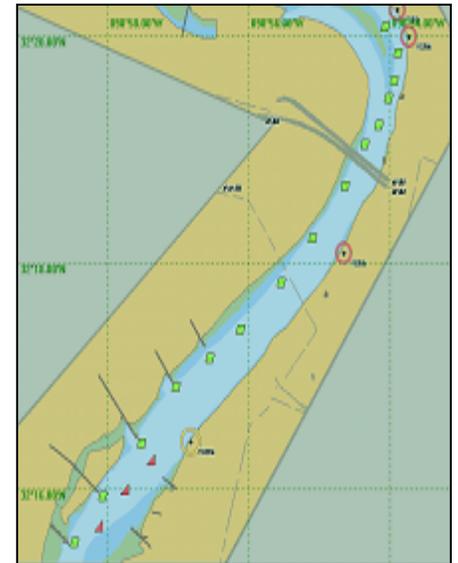
- Provides more accurate locations of tows.
- Allows lockmasters to better manage lockages.
- Supports implementation of an appointment or scheduling system.
- May provide collateral benefits: Safety, Security, Environmental Protection, Operations.





Vessel Tracking

- Technology for tracking tows in real-time is well developed.
- Vessel tracking is well established in many locations, including the UMR.
 - Examples: Tow operators, U.S. Coast Guard, St. Lawrence Seaway, Europe, Port security, Fisheries enforcement, etc.
- *Static* Geographic Information Systems (GIS) are widely used by a range of public and private organizations on the UMR for a variety of purposes:
 - Navigation; Safety and security; Environmental protection.



Vessel Tracking Examples

- Tow operators.
- U.S. Coast Guard.
- St. Lawrence Seaway.
- RIS in Europe.
- Other Examples:
 - SmartLock.
 - VIPS.
 - Panama Canal.
 - Vessel Monitoring Systems (VMS).





Tow Tracking

- Large operators track their own tow boats.
 - Some use commercial systems (e.g., BOATRACS).
 - Others have proprietary systems.
- The U.S. Coast Guard tracks all hazardous cargoes on the UMR (IRVMC).
- Neither the Corps nor the Coast Guard have real-time tracking of all commercial vessels on the UMR-IW.





Tow Positions & Diagram

INGRAM BARGE COMPANY

Current Boat Positions

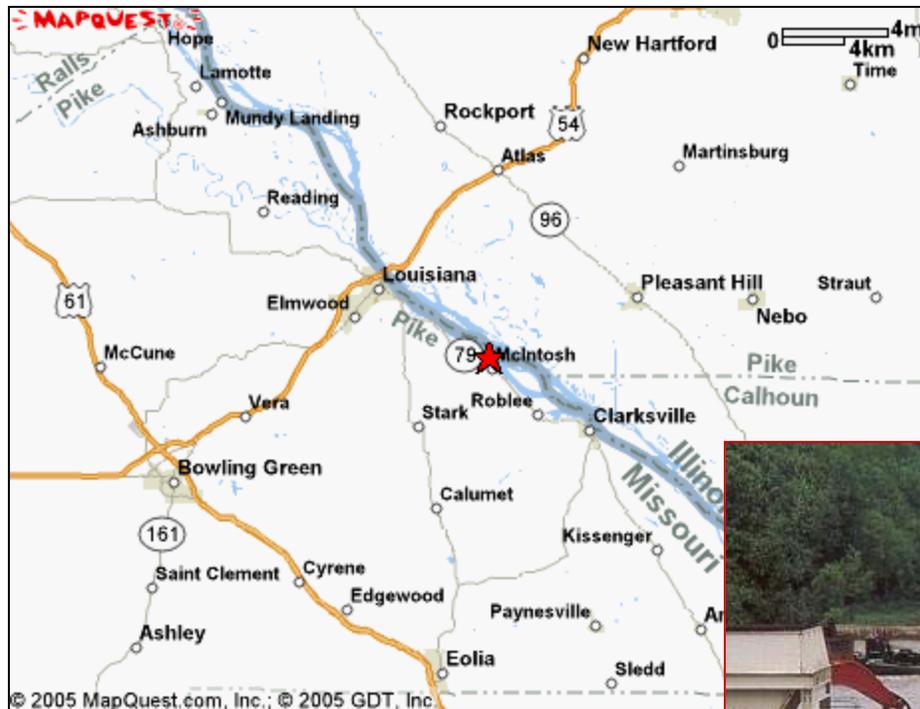
Sort by: [River](#) | [River Position](#)

BOATNAME	RIVER	Start of Day		Latest Position		
		MILE	AS OF	RIVER	MILE	AS OF
A. J. MORRIS	LMR	941.0	04/21 05:00	LMR	938.3	04/21 15:53
A. STEVE CROWLEY	TEN	20.4	04/21 05:00	CUM	91.2	04/21 15:45
ADDIS	LMR	137.0	04/21 05:00	LMR	136.3	04/21 15:56
ALICE I. HOOKER	LMR	95.1	04/21 05:00	LMR	135.2	04/21 15:15
ALLEN L. MARTIN	TEN	10.1	04/21 05:00	CUM	32.3	04/21 15:53
ALVIN C. JOHNSON	OH	960.1	04/21 05:00	OH	934.4	04/21 15:34
ANDREW BENEDICT	OH	76.1	04/21 05:00	OH	92.4	04/21 15:18
ASHLEY	LMR	136.0	04/21 05:00	LMR	133.1	04/21 15:57
B. JOHN YEAGER	LMR	895.1	04/21 05:00	LMR	936.2	04/21 15:56
BILL BERRY	UMR	398.1	04/21 05:00	UMR	346.6	04/21 15:25
BRUCE R. BIRMINGHAM	UMR	53.4	04/21 05:00	UMR	81.5	04/21 15:04
C. A. JOHNSON	BARC	1.4	04/21 05:00	TEN	23.5	04/21 15:05

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MBL416/ CORN	MEH5111/ CORN	SC304/ CGFP
Cairo Waterf Destrehan, L	Cairo Waterf Reserve, LA	Cairo Waterf Destrehan, L
JIMB0108/B CORN	EFC198/B SCRAP I/M	DE8225/ CORN
Cairo Waterf	Cairo Waterf Blytheville, Myrtle Grove	Cairo Waterf
MEH5002/ SPEC CORN	MEH2175/B SCRAP I/M	MEH2168/B SPEC CORN
Cairo Waterf Reserve, LA	Cairo Waterf Blytheville,	Cairo Waterf
EFC508/V CORN	MEH94116/V S COILS	MEH2014/V CORN
Cairo Waterf Reserve, LA	Cairo Waterf Houston, TX	Cairo Waterf Convent, LA
	TSA	

Internet Mapping...





Zoomed In





U.S. Coast Guard

- Tracks hazardous cargoes on the UMR via Inland Rivers Vessel Movement Center (IRVMC) in St. Louis (since 2003).
- Tracks all commercial vessels at vessel traffic service (VTS) locations.
 - AIS (Automatic Identification Systems).
- Expanding AIS throughout all navigable waterways.



Homeland
Security

U.S. COAST GUARD





IRVMC

- Tracks all certain dangerous cargoes (CDCs) in “near-real time”.
 - Explosives, Poisonous gases and liquids, Ammonium nitrate and certain fertilizers, Radioactive materials, Certain liquefied gases.
- Uses regulated navigation areas, including UMR-IW.
- Have GIS display of vessels throughout U.S.
- Position updates hourly and as required from tracking data provided by operators.
- Focus is on safety and security.





IRVMC "Tracking"

- Owners and operators of covered barges hauling CDCs are required to report (via email, phone or fax) position and other information to the IRVMC:
 - Name of barge and towboat,
 - Name of loading, fleeting and terminal facility,
 - Estimated arrival and departure times at various points,
 - Planned route, and
 - Significant departure from previously reported information.
- Reporting is required in advance of specified actions, at specified geographic locations, and whenever directed.





U.S. Coast Guard VTS Centers

- Vessel Traffic Services (VTS) Centers





VTS Centers

- Vessel Traffic Services Centers:
 - Provide monitoring and navigational advice for vessels in confined and busy waterways.
 - Shifting from safety and navigation emphasis to security.
- Integrate data broadcast from vessels and from land-based sensors at central location.
 - Vessel data: AIS
 - Land-based sensors: radar, VHF, infrared, closed circuit TV.



Sensors transmit data back to the VTS center.



AIS

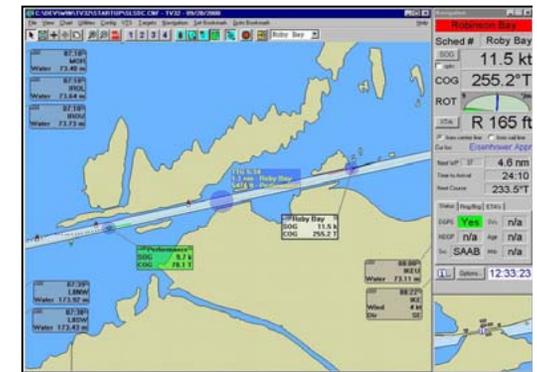
- **Automatic Identification Systems.**

- Developed by IMO to improve VTS operations and maritime safety and to protect the environment.



- Includes ship-to-ship, ship-to-shore and shore-to-ship communications.

- Automatically broadcasts position, ID, and other static, dynamic, and voyage related data.
- Receives data from other AIS units.





VTS Display



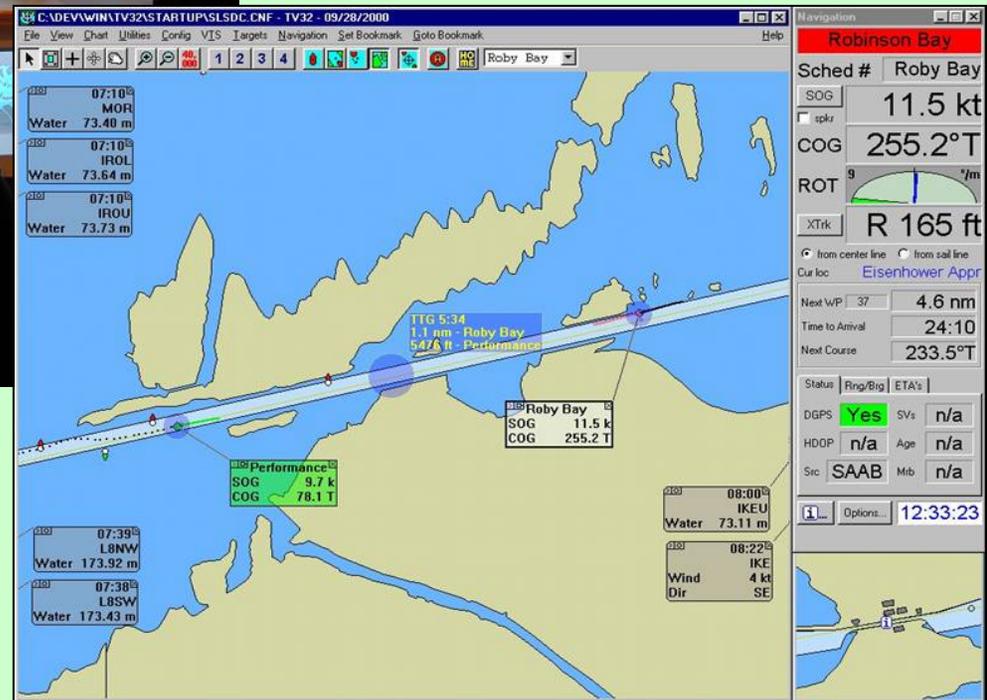
St. Lawrence Seaway

- 15 locks: 740' long, 80' wide, 30' deep.
 - Montreal–Lake Ontario: 7 locks.
 - Welland Canal: 8 locks in 27 miles from Lake Ontario to Lake Erie.
- 3 Seaway Traffic Control Centers:
 - Bi-national cooperation.
 - AIS implemented starting in 2002.





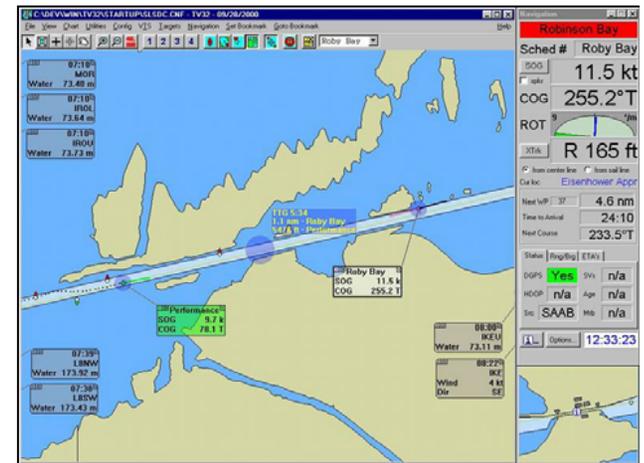
St. Lawrence Seaway





Seaway Traffic Management

- Traffic Management System (TMS):
 - Manages data for all transits and vessels.
 - Broadcasts safety and navigation information to vessels.
- AIS integrated into TMS in 2002.
 - Vessels also report at call in points.
 - Cost = \$2.1 million.
 - Savings = \$300,000/year.
- Do **not** schedule or re-sequence vessels at locks.
 - Little variability in lockage times (all lockages are one ship!).
- Traffic management still relies heavily on voice transmissions.





Europe - RIS

- RIS: River Information Services
 - "a concept for harmonized information services which supports traffic and transport management in inland navigation, including interfaces to other transport modes."
- Broad geographic and functional scope:
 - 30,000 km of waterways in 11 countries.
 - 11,500 vessels (mainly self propelled).
 - 77.5 billion ton-miles in 2003.





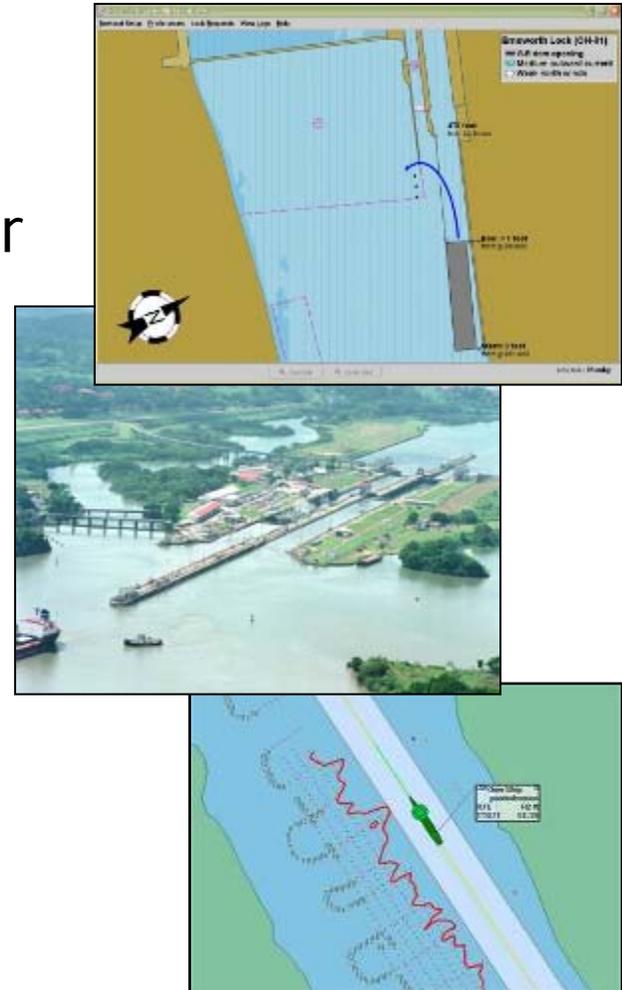
Comprehensive Approach

- Uses common systems to link:
 - Pilots and tow companies.
 - Lock, harbor and terminal operators.
 - RIS operators.
 - Waterway authorities.
 - Emergency responders.
- Also used for:
 - Law enforcement.
 - Statistical data collection.
 - Waterway charges and port fees.
- Broader than U.S. Coast Guard IWS (Intelligent Waterways System) initiative.



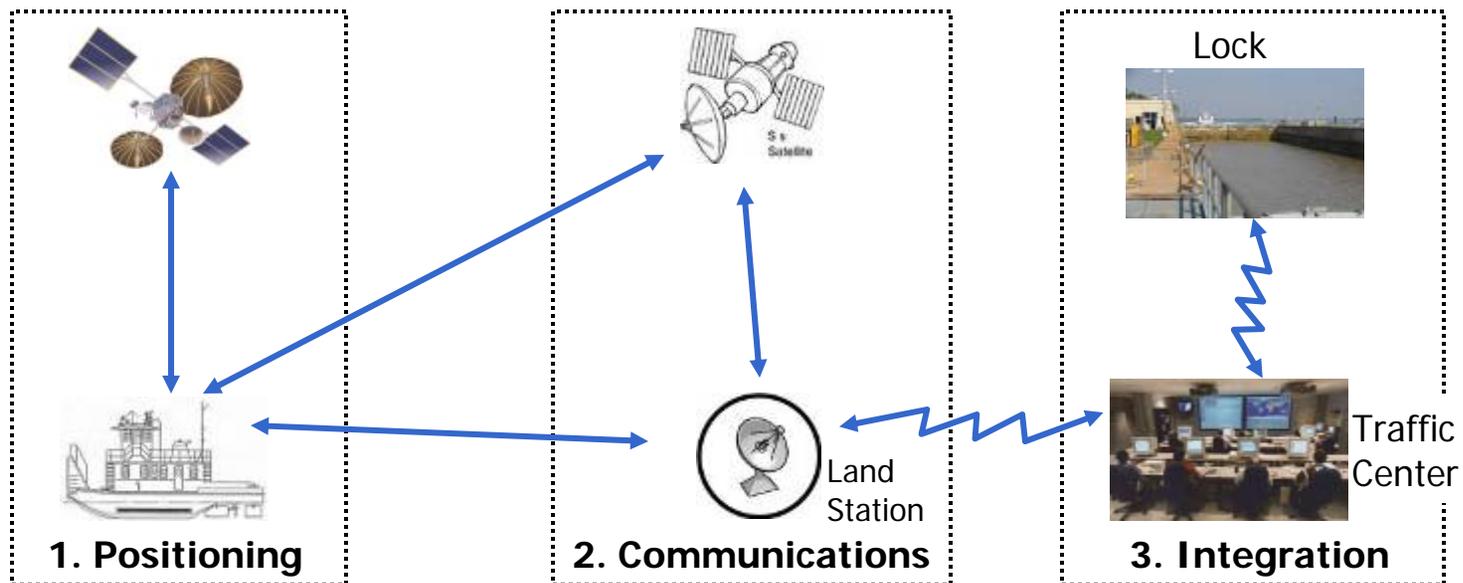
Other Applications

- SmartLock – Pittsburgh
 - Lock navigation aid to assist pilots using differential GPS for high accuracy.
- Panama Canal.
 - 6 pairs of locks.
- VIPS – Vessel Identification & Positioning System
 - Developed by Volpe Center.
 - Focus on port security.
- Vessel Monitoring Systems (VMS) for fisheries.



Vessel Tracking Technologies

1. Find vessel position.
 - From GPS, satellites or shore-based antenna.
2. Communicate vessel position to shore station.
 - Satellite, VHF Radio, AIS.
3. Integrate information for traffic management.
 - Communications and integration software.





Technologies

- Vessel Location.
 - GPS: accuracy to 10 meters.
 - DGPS: accuracy much better.
 - Less accuracy with other systems: BOATRACS ~100 m.
 - Several different satellite systems.
- Many vendors provide packages for vessel tracking and communications.
- AIS.
- Land Communications.
 - Standard telecom methods: Satellite, radio, microwave, land lines, etc.



AIS

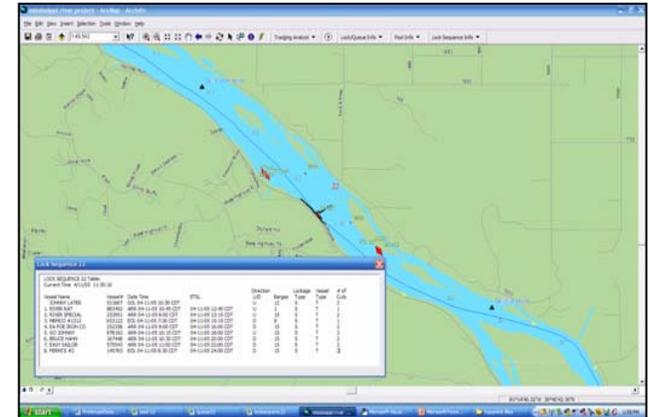
- Ship-to-ship, ship-to-shore and shore-to-ship communications with broadcast radius ~20-30 miles.
- Receives data from other AIS units and automatically broadcasts:
 - **Static** vessel data: ID, length, type, etc.
 - **Dynamic** data: Position, speed, heading, rate of turn, etc.
 - **Voyage** data: Draft, cargo, destination, etc.
- Required in VTS and Vessel Movement Reporting Service (VMRS) areas and on commercial vessels on international voyages.
- May eventually be required on UMR...





Vessel Tracking Lockage Information System

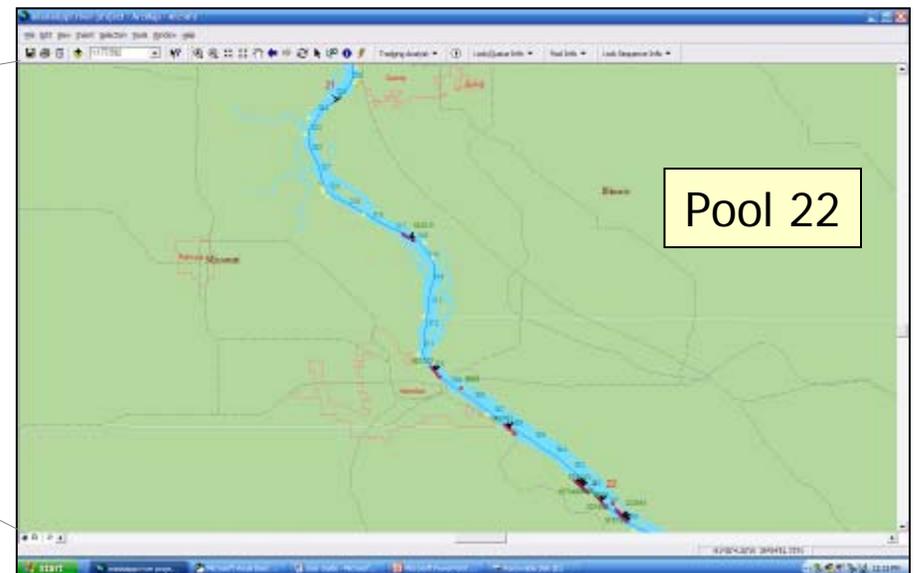
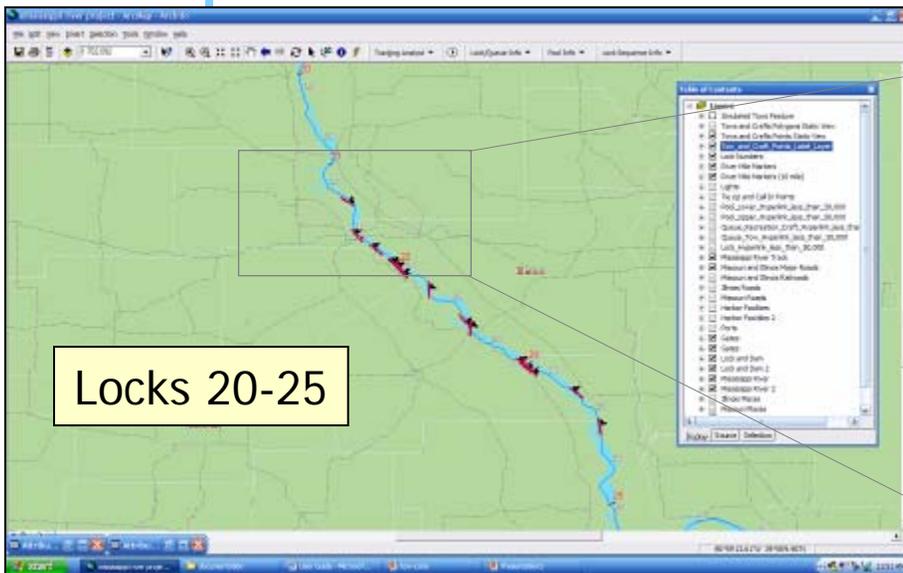
- Collect, manage and display appropriate information for a scheduling system.
 - Integrates tow tracking and traffic/lock management.
- Geographic scope ranges from one lock and adjacent pools – to multiple locks and pools.
- Vessel position data may be:
 - From existing sources (OMNI).
 - Near-real time locations (e.g., hourly) (IRVMC).
 - Real time locations (St. Lawrence Seaway).





Vessel Tracking Prototype

- Provides sample displays and dynamic vessel tracking to demonstrate the functionality possible.
- ArcGIS software from ESRI with Tracking Analyst extension for vessel movements.
- Scope depends on traffic management system.
 - Local focus at a single lock.
 - Regional/system focus with multiple locks (~100 miles).





Lock 22

mississippi river base map 2 - ArcMap - ArcView

ALM - Windows Picture and ...

Task: Modify Feature Target:

1:24,883

302

22

Lock & Dam

P22

I

Q1

QR

P24

301

River View

Fort Mason

State Highway 79

Microsoft Excel - tow9

	A	B	C	D
1	Name of Vessel	West Virginia		
2	Coast Guard Number	567003		
3	Company	ACBL		
4	Year Built	1967		
5	Pilot Name	ACBL_Pilot1		
6	Horse Power	5600		
7	River Mile	261		
8	River	OHR		
9	Mile Direction	U		
10	Number of Loaded Barges	17		
11	Number of Empty Barges	0		
12	Number of CDC Barges	0		

Sheet1 Sheet2 Sheet

91°14'56.55"W 39

Start mississippi river base ma... Microsoft Excel - tow9 ALM - Windows Pictur...

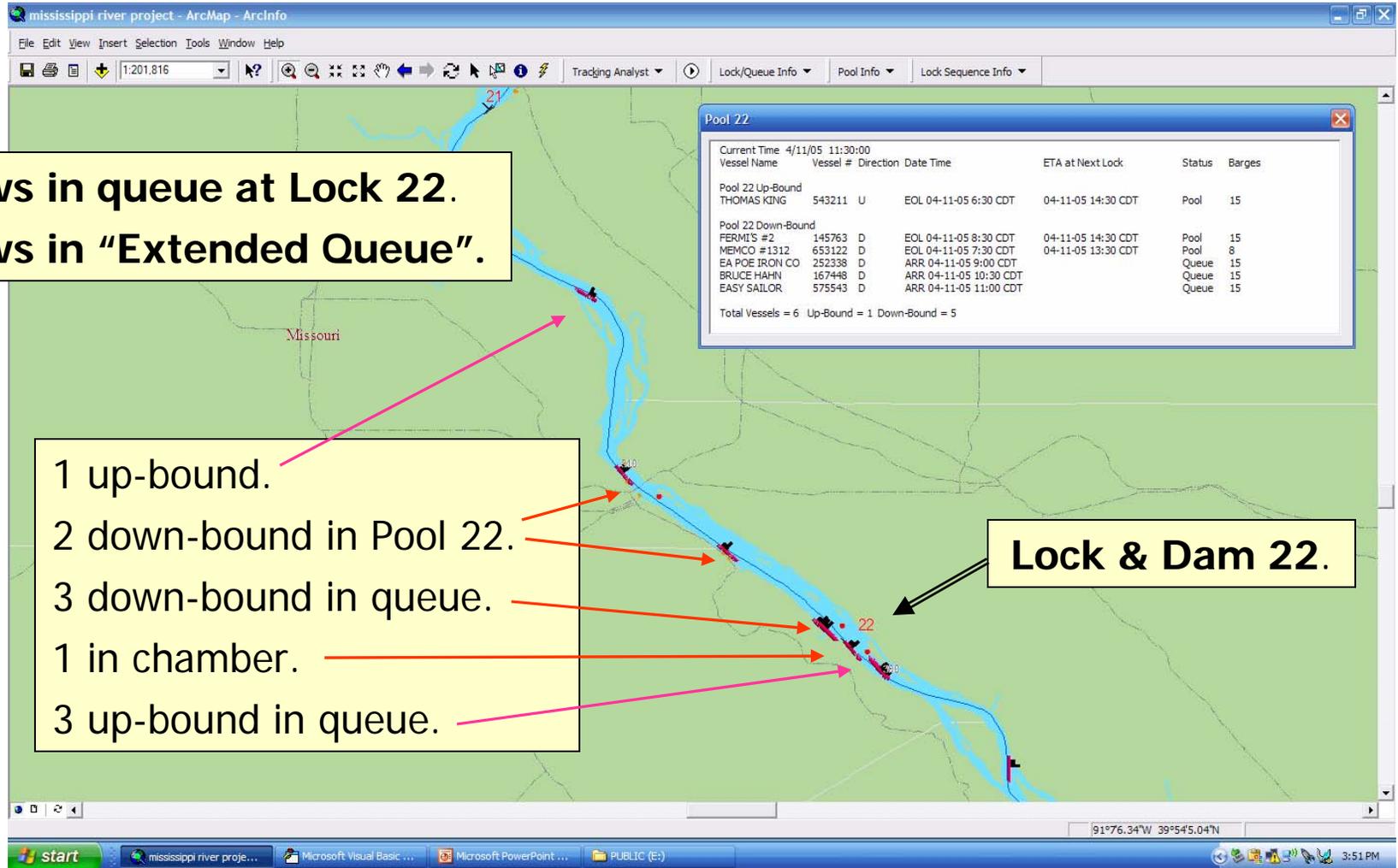


Pool and Queue Data

**6 Tows in queue at Lock 22.
8 Tows in "Extended Queue".**

1 up-bound.
2 down-bound in Pool 22.
3 down-bound in queue.
1 in chamber.
3 up-bound in queue.

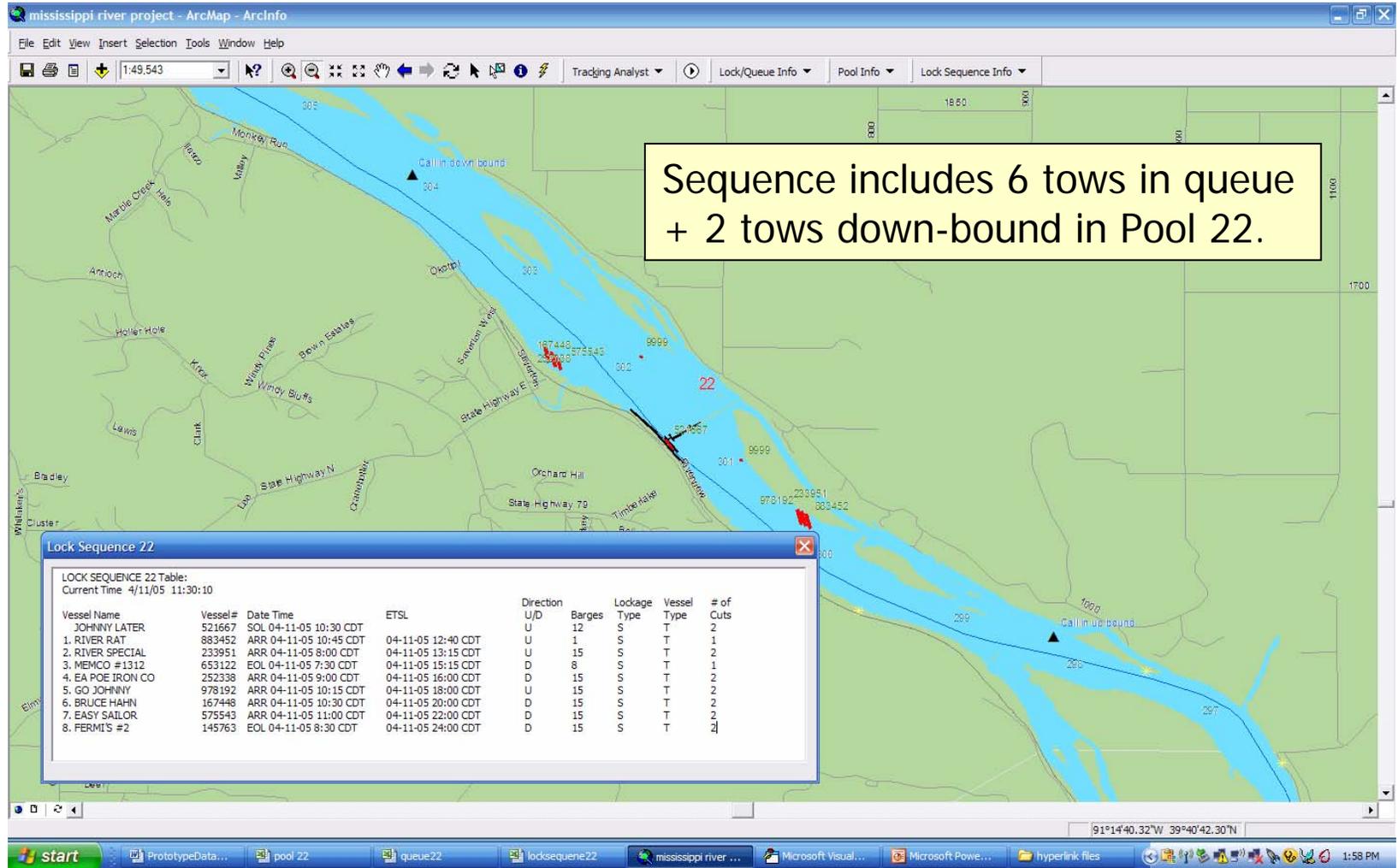
Lock & Dam 22.



Pool 22						
Current Time	4/11/05 11:30:00					
Vessel Name	Vessel #	Direction	Date Time	ETA at Next Lock	Status	Barges
Pool 22 Up-Bound						
THOMAS KING	543211	U	EOL 04-11-05 6:30 CDT	04-11-05 14:30 CDT	Pool	15
Pool 22 Down-Bound						
FERMI'S #2	145763	D	EOL 04-11-05 8:30 CDT	04-11-05 14:30 CDT	Pool	15
MEMCO #1312	653122	D	EOL 04-11-05 7:30 CDT	04-11-05 13:30 CDT	Pool	8
EA POE IRON CO	252338	D	ARR 04-11-05 9:00 CDT		Queue	15
BRUCE HAHN	167448	D	ARR 04-11-05 10:30 CDT		Queue	15
EASY SAILOR	575543	D	ARR 04-11-05 11:00 CDT		Queue	15
Total Vessels = 6 Up-Bound = 1 Down-Bound = 5						



Suggested Locking Sequence





Linkages to Traffic/Lockage Management Project

- The information required depends on the traffic/lockage management strategy.
 - Which vessels are included?
 - Single queues; “Extended queues”; Multiple queues?
 - Recreational vessels?
 - What lock and waterway information is needed?
- ***How much does real time or near-real time vessel tracking add for reducing congestion?***
 - How much positional and temporal accuracy is needed on the UMR?
 - How much benefit is produced by extending the geographic scope?



Key Issues

- Clarify responsibility and authority for traffic/lockage management.
- Cost.
- Data issues:
 - Ownership and availability.
 - What is needed? What is available?
 - AIS on the UMR?
 - Accuracy and timeliness.
 - Standards and policies for data collection and reporting.
- Collaborate with all relevant parties on the UMR-IW.
 - Especially U.S. Coast Guard and carriers.



Questions and...

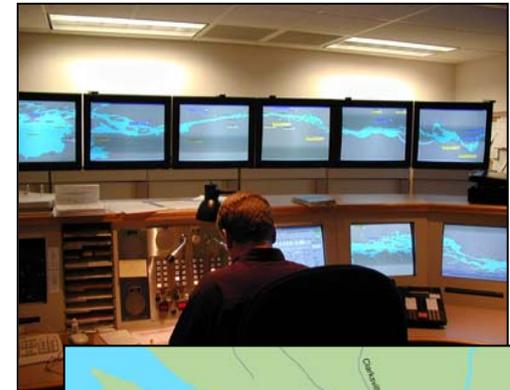
1. Is vessel tracking feasible on the UMR?
2. Should GIS-based tow tracking be deployed on the UMR?





...Answers

- UMR-IW is unique.
- Real time tow tracking is certainly feasible on the UMR.
- Integrating lock scheduling and tow tracking is feasible, but not yet in place.
- Implementing real-time tracking of all tows on UMR-IW involves added costs and responsibilities.
- Vessel tracking may provide collateral benefits: for safety, security, environmental protection and operations.





Questions?

GIS for Tracking Vessels on the Inland Waterways

