Technology, Innovation and Economic Development on the Waterways
The Wireless Waterway - Projects of the Port of Pittsburgh Commission

James McCarville, Executive Director
Port of Pittsburgh Commission
August 2, 2010
Rural Portion US Waterways

- Green Shows = US Census Non-Urban Areas
- Why a Waterway-ITS?
- If we had a W-ITS, What Are the Rural Benefits?
Waterway needs - #1

- Navigation Industry – Real/near real time information on:
  - Lock conditions
    - Currents, wind, out drafts, ice thickness, air and water temperatures, precipitations, tides and river stages, queuing
  - Lock approach paths (good visibility and bad)
  - Navigation tracks
  - Shoaling information and rapid dredging response
  - Predictive draft stowing
  - Equipment and cargo tracking
  - E-invoicing

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Waterway needs - #3

- USCG - Real time or near real time
  - Maritime domain awareness
  - CDC vessel positions
  - Aids to Navigation locations/dislocations
  - Notice to mariners
  - Networking Port Security Cameras
  - Accurate Vessel positioning vis-à-vis:
    - Locks, bridges, air gaps, obstructions, other vessels
Waterway needs - #4

• OEM - Real time or near real time
  • Machine to Machine Engine Maintenance
    • OEM Monitoring/Diagnostics/Repair instructions
    • Centralized lock maintenance sensor monitoring
Waterway needs - #2

- **USACE - Real time or near real time**
  - Automated data reporting (USACE-RIS)
  - Data Standardization for federal agencies
    - USACE, USCG, Commerce, IRS, etc. (FILS)
    - Locations, Commodities
  - Lock queuing/manpower scheduling
  - Bathymetry
    - Rapid dredging response
Waterway needs - #5

- Pilots
  - Consolidated, easy to read displays
  - Layered information
  - Firewalls they can believe in
    - Who needs to see what/Who shouldn’t see what
  - How is data decoded and transmitted to vessels
  - Market products to read data
  - Large bandwidth and spectrum/greater than AIS
AIS System of USCG

Good for Security/Marine Domain Awareness

- CDC vessel position/speed/direction/identification
- Possibly for lock conditions, maybe
- Not too much else! Limited bandwidth

USCG lacks an inland river budget
AIS cannot do everything.

Name of the speaker
Port of Pittsburgh Technology Initiatives

- Upper Ohio River and Tributaries Navigation Technology Pilot Project Authorization (WRDA 2007)
- Carnegie Mellon University Practicum's, in cooperation with USACE-Pittsburgh and Local Towing Industry
  - River-Net
  - SmartLock
  - Wireless Waterway (2009)
River-Net

- Communications architecture mapping between towboats, company headquarters and government agencies
- Forms for transmission of data
As-Is: Current Work Process
As-Is: Current Work Process

Shipping Department

Order

Barge Line

Customer Service

Legend
OMNI: Operation & Maintenance of Navigational Installations
LPMS: Levee Performance Monitoring System
WCS: Waterborne Commerce Statistics
NWS: National Weather Service

USACE
As-Is: Current Work Process
As-Is: Current Work Process
As-Is: Current Work Process
As-Is: Current Work Process

Shipper
Shipping Department

Terminal
Third-party Loader

Tow Boat and Barges
Captain
Towboat
Barge

Barge Line Head Office
Inbound System
Order Queue
Dispatcher

Schedule
As-Is: Current Work Process

Legend
OMNI: Operation & Maintenance of Navigational Installations
LPMS: Leakage Performance Management System
WCS: Waterborne Commerce Statistics
NWS: National Weather Service

Action Information

Pre-shipping
Shipping
Post-shipping

Barge Line
Dispatcher

Hazardous Material

USCG
USCG Officer

Shipping Department

Daily Report
Send

Barge Line Head Office

US Army Corps of Engineers

OMNI Operator

Lock Marker

USACE

Terminal

Inbound System

Hazardous Material

Inbound System

USCG

Officer

Loading

OMNI: Operation & Maintenance of Navigational Installations
LPMS: Leakage Performance Management System
WCS: Waterborne Commerce Statistics
NWS: National Weather Service
As-Is: Current Work Process
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As-Is: Current Work Process

Tow Boat and Barges

Captain

Towboat

Barge

USACE

OMNI

OMNI Operator

Lock

Lock Master

Daily Lockage Info.

Tow Port ID Configuration Tonnage

Pre-shipping

Shipping

Post-shipping
As-Is: Current Work Process
As-Is: Current Work Process
Opportunities for Improvement (I)

- Limited Information Exchange
  - Communication tools
    - Handheld radio
  - Methods
    - Verbal communication
  - Problems
    - Inability to convey accurate and enough data
Opportunities for Improvement (I)

- Limited Information Exchange
  - Communication tools
    - Handheld radio
  - Methods
    - Verbal communication
  - Problems
    - Inability to convey accurate and enough data
Opportunities for Improvement (I)

- Limited Information Exchange
  - Communication tools
    - Wireless Access Point
  - Methods
    - Application level communication
  - Improvements
    - Accurate and real-time data exchange

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Opportunities for Improvement (II)

• Data Collection
  • Information type
    • Towboat operation data
    • Barge operation data
  • Methods
    • Non-formatted data
  • Problems
    • Additional manual data input is required

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Opportunities for Improvement (II)

- **Data Collection**
  - **Information type**
    - Towboat operation data
    - Barge operation data
  - **Methods**
    - Non-formatted data
  - **Problems**
    - Additional manual data input is required

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Opportunities for Improvement (II)

- **Data Collection**
  - Information type
    - Towboat operation data
    - Barge operation data
  - Methods
    - Data collection application
    - Formatted data
  - Improvements
    - Additional manual data input is not required

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Opportunities for Improvement (III)

- **Data Collection**
  - **Information type**
    - Towboat operation data
    - Barge operation data
  - **Methods**
    - Non-formatted data
  - **Problems**
    - Additional manual data input is required
Opportunities for Improvement (III)

• Data Collection
  • Information type
    • Towboat operation data
    • Barge operation data
  • Methods
    • Non-formatted data
  • Problems
    • Additional manual data input is required
Opportunities for Improvement (III)

- **Data Collection**
  - **Information type**
    - Towboat operation data
    - Barge operation data
  - **Methods**
    - Data collection application
    - Formatted data
  - **Improvements**
    - Additional manual data input is not required
Opportunities for Improvement (IV)

- Communication Costs
  - Communication method
    - AirCard service
    - Satellite service
  - Problems
    - Expensive communication
    - Data volume constraints
Opportunities for Improvement (IV)

- Communication Costs
  - Communication method
    - AirCard service
    - Satellite service
  - Problems
    - Expensive communication
    - Data volume constraints
Opportunities for Improvement (IV)

- **Communication Costs**
  - Communication method
    - AirCard service
    - Satellite service
    - Free wireless internet service
  - **Improvements**
    - Inexpensive communication
    - Enough data exchange

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Methodological approach

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<th>Influencing Factors</th>
<th>System Description</th>
<th>Basic Data</th>
<th>Perspectives and Indicators</th>
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Demo

Towboat Data Collection System

Lock Communication System

Report Management System

TIS / VTS

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Proposed Solutions

Waterways Navigation Improvement

Efficient Communication

- Towboat Data Collection System
- Lock Comm. System
- Report Mgt. System
- Traffic Mgt. System

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Proposed Solutions

Waterways Navigation Improvement

“Innovation by putting the towboat in the center of the universe!”

-- David Lichy (USACE)

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Proposed Network Architecture

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Proposed Network Architecture

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Proposed Network Architecture

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Proposed Network Architecture

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SmartLock

- Defined: A virtual lock approach navigation tool
- Value Added: Perfecting the electronic “handshake” between the towboat and the lock operator

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US Patent for SmartLock

“An instrumented navigation system for aiding a towboat and barge configuration in the entry and traversal of a lock located on a waterway or for navigation around other structures, such as bridge piers or docks. The system consists of wirelessly linked computers on the towboat and the lock which display navigational charts showing the position of the tows as the approach and enter the locks. The computers are also linked to sensors which send information, such as the speed and position of the tows, to the computers for display.”
Smartlock Architecture

3-Component System
(each interchangeable)

1. Sensors acquire Tow location, Lock Master sees Tow Traffic
2. Wireless network transmits data to Tow
3. Pilot Sees Vessel Position on ENC Chart

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Tow Approaching Lock, What the Pilot Sees
Pilot Sees the Chamber Approach

- Critical Distances
  - Bow to Guidewall
  - Bow to Bullnose
  - Bow to Guidewall and Stern to Guidewall

- Distance measurements change from Green to Red as the Tow critical points gets closer

- Distances begin to be displayed at 1 mile from the lock
DGPS – Real-time position data
DGPS – Real-time position data

ENC – Navigation

Uses
DGPS – Real-time position data

ENC – Navigation
Uses
DGPS – Real-time position data

ENC – Navigation

Wi-Fi – Multiple Uses
DGPS – Real-time position data

WiFi – Multiple Uses

ENC – Navigation Uses
DGPS – Real-time position data

WiFi – Multiple Uses

ENC – Navigation Uses
XML – Standard Data Protocol

DGPS – Real-time position data

WiFi – Multiple Uses

ENC – Navigation Uses
XML – Standard Data Protocol

DGPS – Real-time position data

SSL – Integrity, Authenticity

WiFi – Multiple Uses

ENC – Navigation Uses
SmartLock Architecture

- well-tested technologies
- multiple uses
- convergence

XML – Standard Data Protocol

SSL – Integrity, Authenticity

WiFi – Multiple Uses

DGPS – Real-time position data

ENC – Navigation Uses

Port of Pittsburgh Commission
SmartLock Problems

• Corps problems – benefits accrued largely to industry
  – 2006 cost, estimated at $20K-$30K per lock for transmitters, responders, hardware, software and wireless networks, sensors (now have new technologies)
  – Highly accurate surveys at locks (now progress)
  – Multiple communication technologies, such as: satellite/cell phone, DGPS/RTK or wireless, WiMax broadband technologies, or beyond LTE or 4G, etc.

• Industry problems - would not invest ($5K/boat) until the Corps deployed (the Corps would not invest until industry demanded it)
• Lacking an official channel to break the logjam
• Lack of a platform to transmit the data
• AIS cannot solve everything we need to accomplish
Spectral Efficiency Comparison

Bandwidth Efficiency (Bits per Sec per Hz) vs. Bandwidth (KHz)

- AIS (both Channels)
- WiMAX

Source – Fred W. Pot, Marine Management Consulting

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Data Distribution Flow

Government Entities
- AIS, Lock Operation and Management etc.
- Weather Forecasting
- Security Camera Videos
- Towboat
- Terminal operators, shippers info. etc.

Other Sources

Centralized Server function as Data Distribution Hub to effectively share and integrate data being collected uniformly.

* Highly sensitive and proprietary information to the towing industry will not be dealt with in this Data Distribution Flow.

• Only receives and circulates non-proprietary industry information collected from reliable Information providers such as non-critical AIS data.

Web EDI

WiMAX Network

Tow boat
Two-way Data Communication

- All data transfer through WiMAX will be safeguarded (Security RSA encryption, IP Sec, PKI)
- All data communication will be directly done without going through Centralized Server.

On-demand applications and storage at Centralized Server could be utilized as a usage base for the small and mid-sized towing companies who do not own their own IT resources.
WiMAX
3.65 GHz
public spectrum
WiMAX

3 miles radius non-line of sight coverage
WiMAX bandwidth 6 mbps
downlink 1.5 mbps
uplink
WiMAX
200 hotspots
1,200 miles nationwide coverage
Wi-MAX COST

200 sites
$20,000,000

- $2.7 million (14%)
- $5.3 million (27%)
- $5.3 million (27%)
- $3.1 million (16%)
- $3.4 million (17%)
• Combines Wi-Max and AIS
• 200 Base stations
• AIS Cost of $61K/unit
• WiMax Cost of $85K/unit
• Range 3 miles radius
• $35 Million Cost Combined for 200 WiMax/AIS
Business Plan

• A Port of Pittsburgh spin-off
  – Lease the operations to a professional communications company
  – Cost recovery program to maintain and build-out expansion for future continuous coverage
Benefits

• AIS Benefits
  – Maritime Domain Awareness - Security
  – Navigation safety communications
    • Wind speed and direction
    • Lock conditions and current velocities
    • Other aids to the mariner

Name of the speaker
Wireless Broadband Benefits

• Industry communications
  – Engine maintenance guidance
  – Updated nautical charts
  – Crew timesheets
  – Security camera streaming video
  – Directives from HQ
  – Training updates

Name of the speaker
Wireless Broadband Benefits

• Communications between the vessel and the government
  – Accurate queuing times
  – Accurate scheduling of lock personnel
  – Approach vectors
• Communications between HQ and government
• Communications between vessels

Name of the speaker
Total Benefits

- The economic value of the waterways is estimated by Dr. John Martin at $137 billion.
- A conservative 1% estimated improvement would be $1.4 billion every year.
- Other benefits:
  - $2M/year in savings from reduced USACE data reconciliation.
  - $400K/year savings in reduced USACE data entry.

Name of the speaker
Conclusion

• Without TIGER approval
  • We remain the cheapest and greenest form of surface transportation. Even without the grant we would have a blueprint for greater efficiency and economic development

• If we had got the TIGER approval
  • We could have had this system constructed within 2 years, bringing inexpensive broadband internet to the waterways
  • It would have driven software development in areas that we do not yet even imagine
  • It would have made the greenest form of transportation greener and the cheapest form even cheaper than it is today.

Name of the speaker
Rural Benefits External to Navigation

- Ready infrastructure for commercial marketing of broadband services for non-navigation purposes
  - Farms, residences, offices
  - Roads, bridges
  - Security

Name of the speaker
Questions

Why Not?