Building a Wireless Broadband Infrastructure to Support Maritime Applications

ipro 305

Advisors: Prof. Cindy Hood &
                  Dennis Hood

Sponsor :   Air2Access™
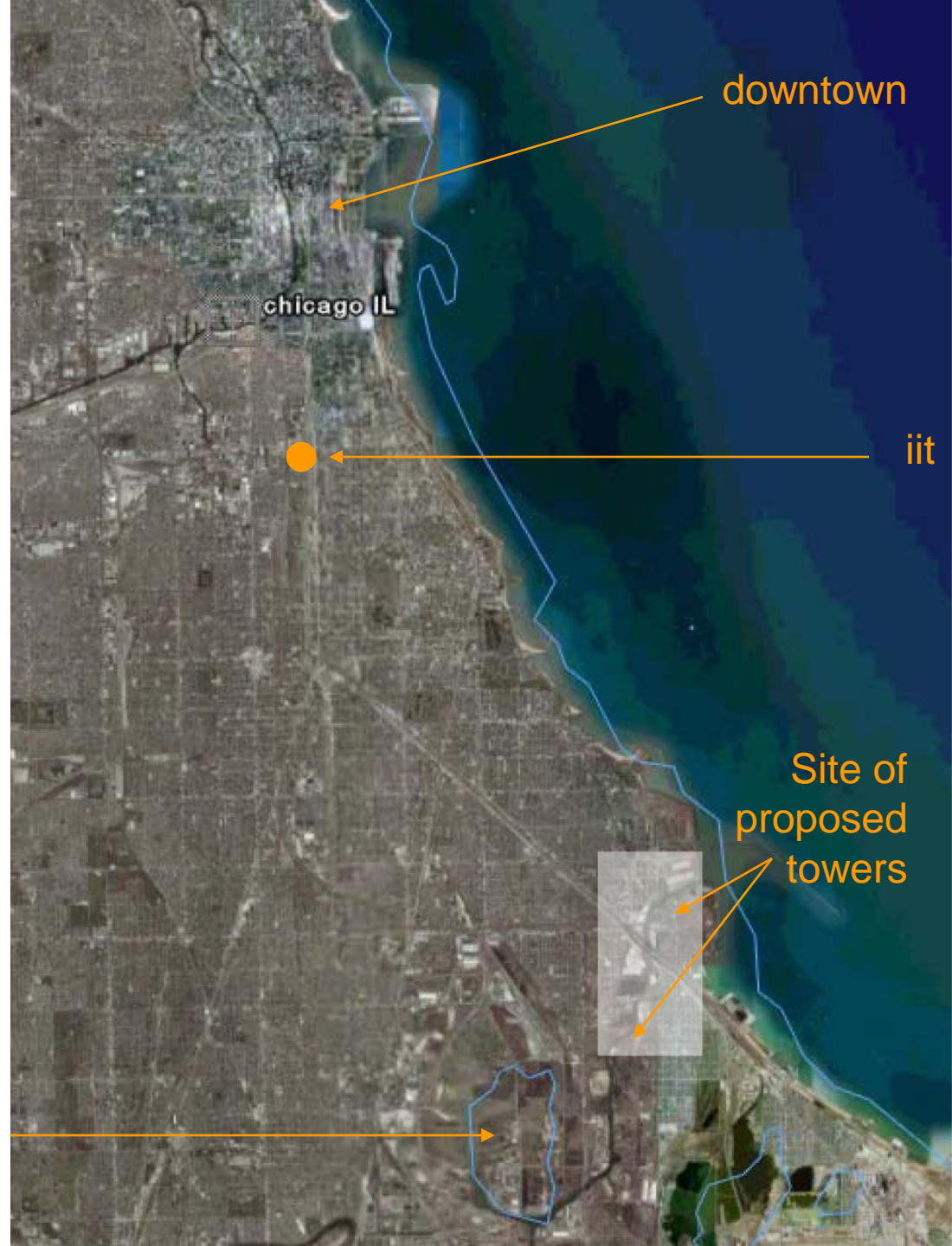   www.Air2Access.com

ILLINOIS INSTITUTE OF TECHNOLOGY

ipro 305 **Purpose**

- Research possible solutions to expand Air2Access's business offerings

- To determine desirable location along the Calumet River for a wireless infrastructure

- Make recommendations to Air2Access

downtown

iit

Site of proposed towers

International Port of Chicago

ipro 305 **Team Structure**

Project Manager
James Hendrickson

Application Team
Jason Tenenbaum - Team Leader
Talha Yousuf
Ike Emelogu
Brian Chung

Infrastructure Team
Joe Dietz - Team Leader
Jack Calzaretta
Brian (Eun Kook) Kim
Dan Czuchra

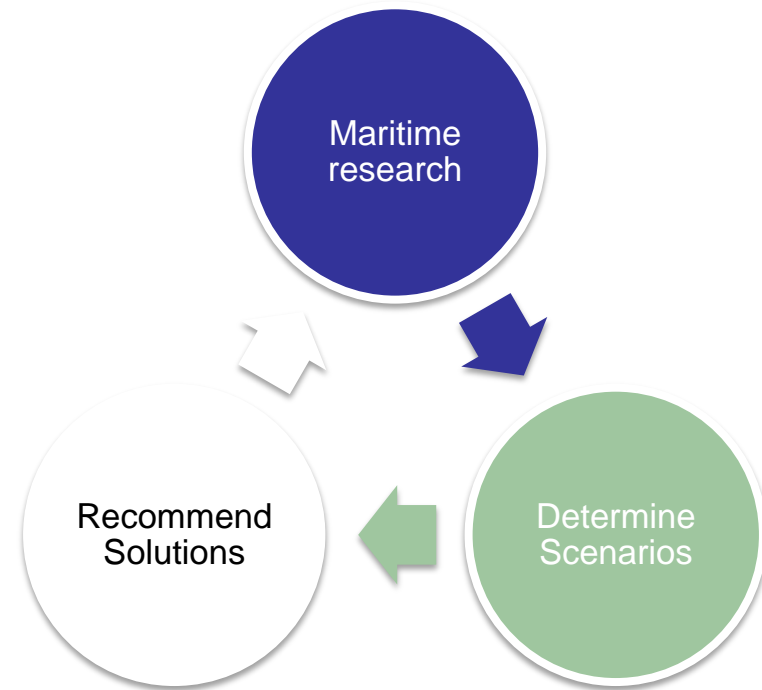**Background- Maritime Security**

- 9/11 Commission Report
- MTS Task Force

- Maritime Transportation Security Act (MTSA)

- Importance to U.S.
  - Economic
  - National Security

- Security Vulnerabilities
  - Port facilities
  - Ships
  - Maritime crimes

ipro 305 **Application Team**

- Air2Access desired to identify scenarios of potential problems

- Conducted maritime environment and market-space research

- "Scenarios" Purpose:
  - Identify potential solutions to maritime stakeholders
  - Determine key functional and technical requirements
  - Identify target customer base and potential partners
  - Provide a recommendation for services Air2Access can provide

- Recommended solutions

1. Visually tracking hazardous cargo

2. Coordinating emergency response communications during a combined land and river chemical fire

3. Securing a ship docked and unloading at a riverside terminal facility

4. Avoiding collisions between commercial & recreational traffic

ipro 305 **Monitoring Hazardous Cargo**

Scenario Description

A vessel loaded with hazardous cargo enters the river and must be continually monitored as it travels along the river to ensure safety of the cargo and surrounding area.

Value Proposition

A hazardous spill in the river could cause unparalleled economic and environmental damage.

Key Question

How does the Coast Guard ensure it can continuously monitor the vessel?

Solution – Monitoring Hazardous Cargo

Live streaming video of vessel along river

Target Customer

U.S. Coast Guard

Solution Offering

- 4 Pan Tilt Zoom (PTZ) cameras
- Approximately 1 mile range between cameras
- Smallest viewable object: 2 sq. ft

ipro 305 Land/River Fire Emergency Coordination

Scenario Description

A barge full of a flammable liquid is unloading its cargo when a valve erupts, spilling the liquid into the water and then igniting.

Value Proposition

Having appropriate resources in place for emergency response for a fire or disaster will help minimize financial losses and property damage, and could potentially save lives.

Key Question

How will emergency first-responders and the property owner coordinate emergency response?

ipro 305 Solution- Emergency Coordination

4.9 GHz Public Safety Radio

Target Customer

United States Coast Guard

Chicago Police and Fire

Solution Offering

- Video surveillance w/ infrared cameras
- 4.9 GHz emergency radio
- Wireless connectivity for high and low bandwidth data transfer
- Water sensors

ipro 305 **Securing a Docked Boat**

Scenario Description

A malicious intruder sneaks onto a vessel docked along a harbor, hoping to gain access to valuable cargo
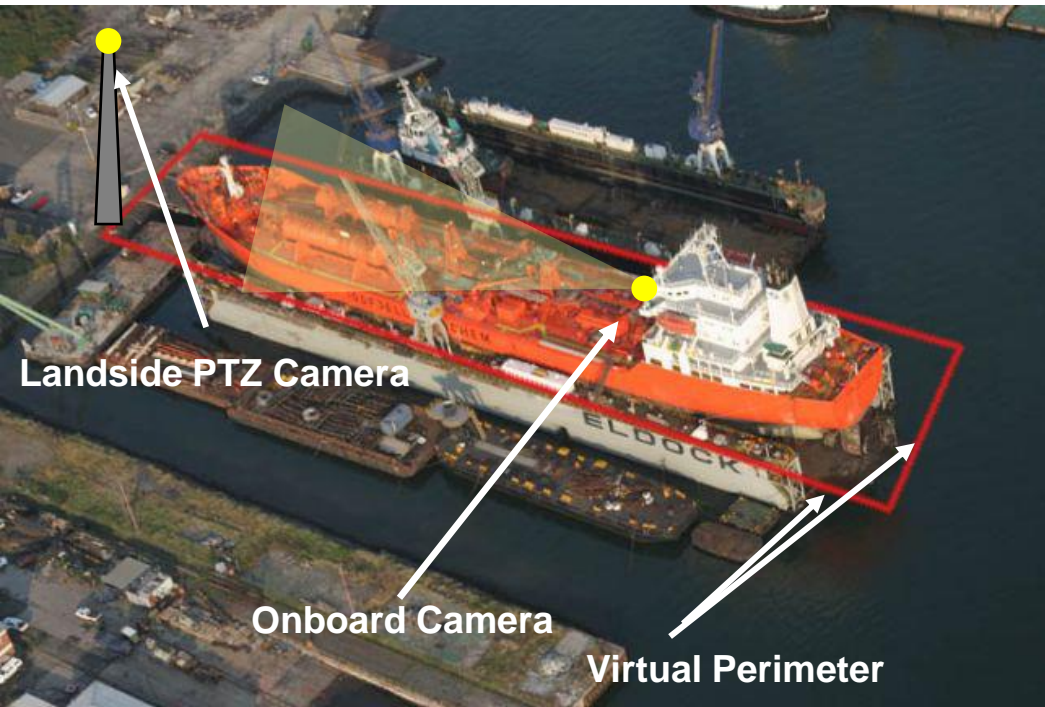
Value Proposition

Securing vessels can reduce lost of capital from stolen goods; deter thieves; and reduce the need for third party security

Key Question

How can the facility owners secure their vessels and quickly alert authorities, while also giving helpful data about the intrusion?

Solution- Securing a Docked Boat

Integrated Access Control & Surveillance

Landside PTZ Camera

Onboard Camera

Virtual Perimeter

Target Customer

United States Coast Guard

Chicago Police and Fire

Solution Offering

- PTZ Cameras at facility
- Access Card
- Other extra surveillance options (virtual fencing, sensors, onboard cameras can all act as other triggers)

ipro 305 **Avoiding Collisions in High Risk Areas**

Scenario Description

A commercial vessel and a recreational boater both approach a sharp bend with low visibility from opposite directions.

Value Proposition

This solution would Increase safe traveling, prevent property and vessel damage, as well as provide onboard visual of traffic in the high risk area

Key Question

What system can be set in place to help ensure the small recreational boat does not collide with the large vessel?

Solution- Avoiding Collisions in High Risk Areas

Collision avoidance system

Scanning
Waterways

Visual and Audio
Signals

Target Customer

United States Coast Guard

Solution Offering

• PTZ camera for vessel detection
• Audio warning signal
• Visual warning sign

ipro 305 **Infrastructure Team**

- Main points of focus

    - Determine wireless infrastructure requirements and hardware

    - Identify zoning constraints from the city of Chicago

    - Determine a suitable tower design and site location

    - Provides an infrastructure that will meets the demands of the use case developed by the application team
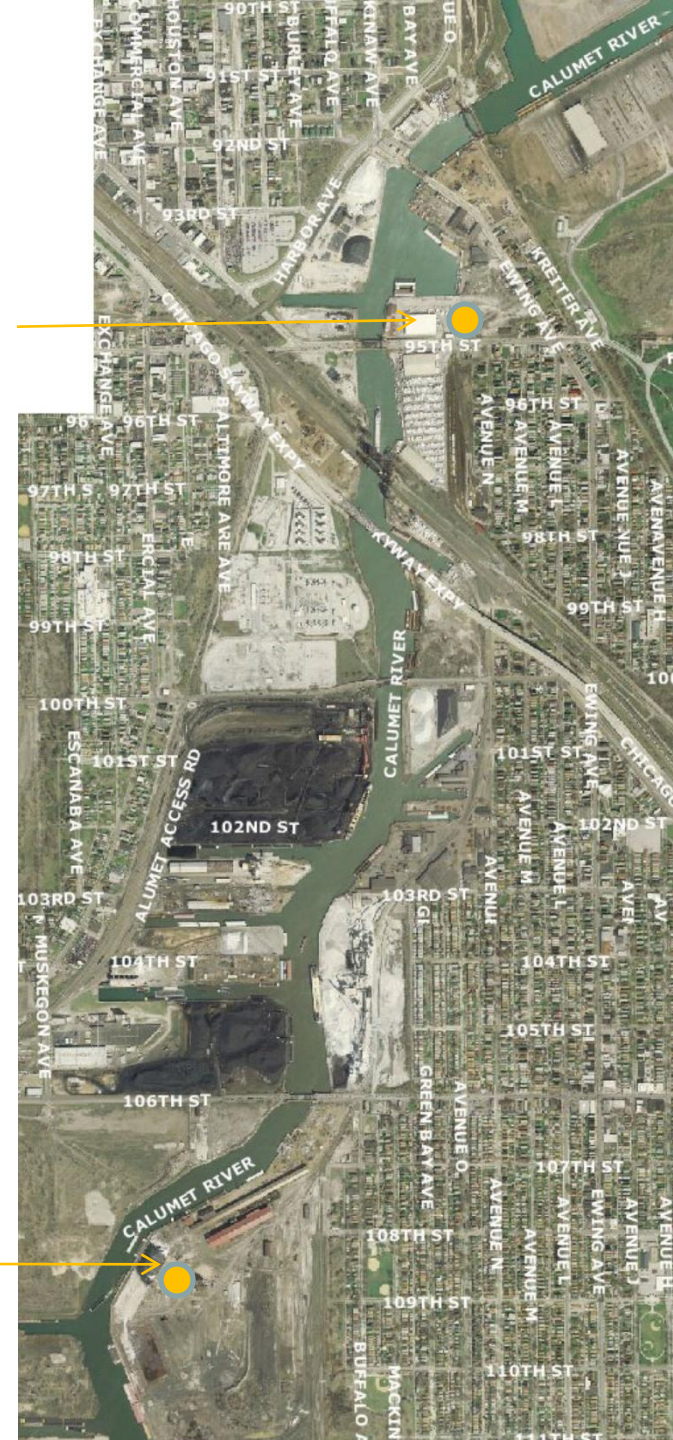
- Recommended final infrastructure design

Coverage

Connectivity

Bandwidth
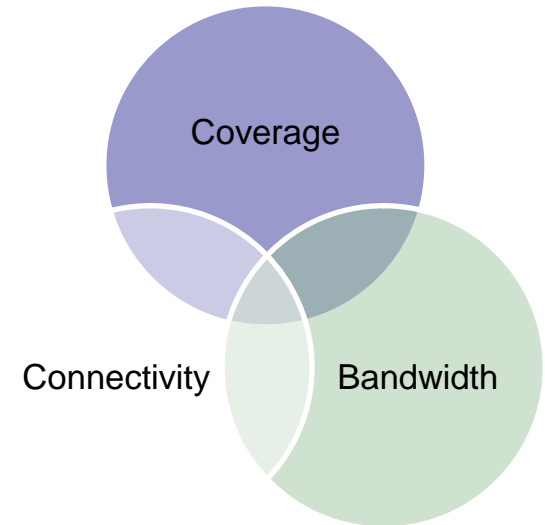
ipro 305 **Site Location**

- Calumet River on the south side of Chicago

- Main access point to the international port of Chicago

- Boat traffic and recreational boating is continuing to rise
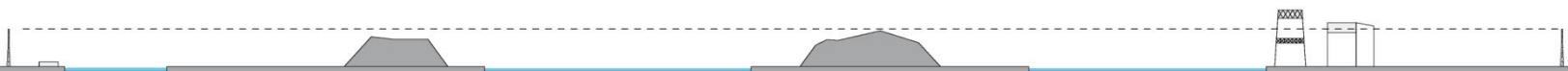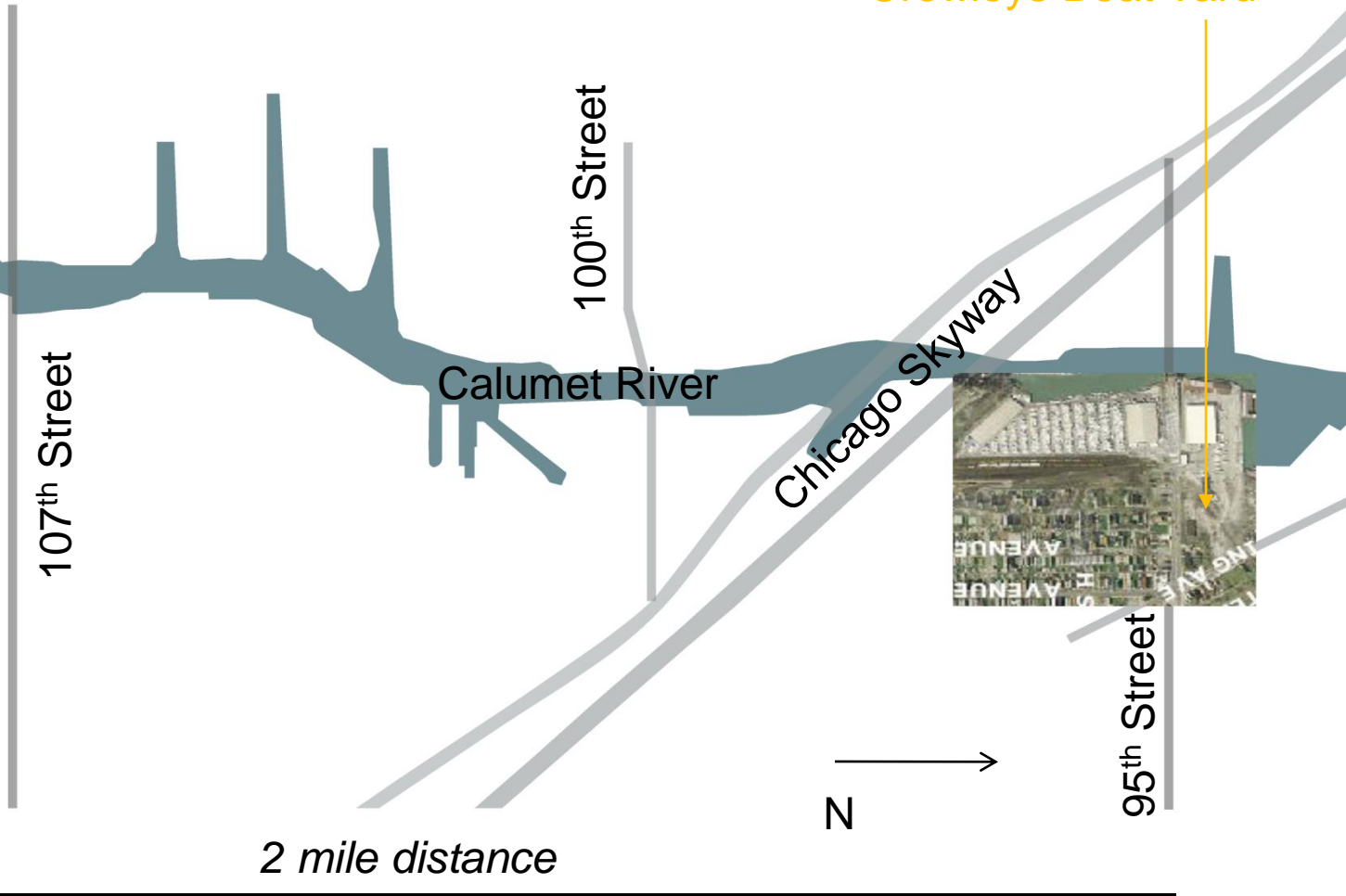

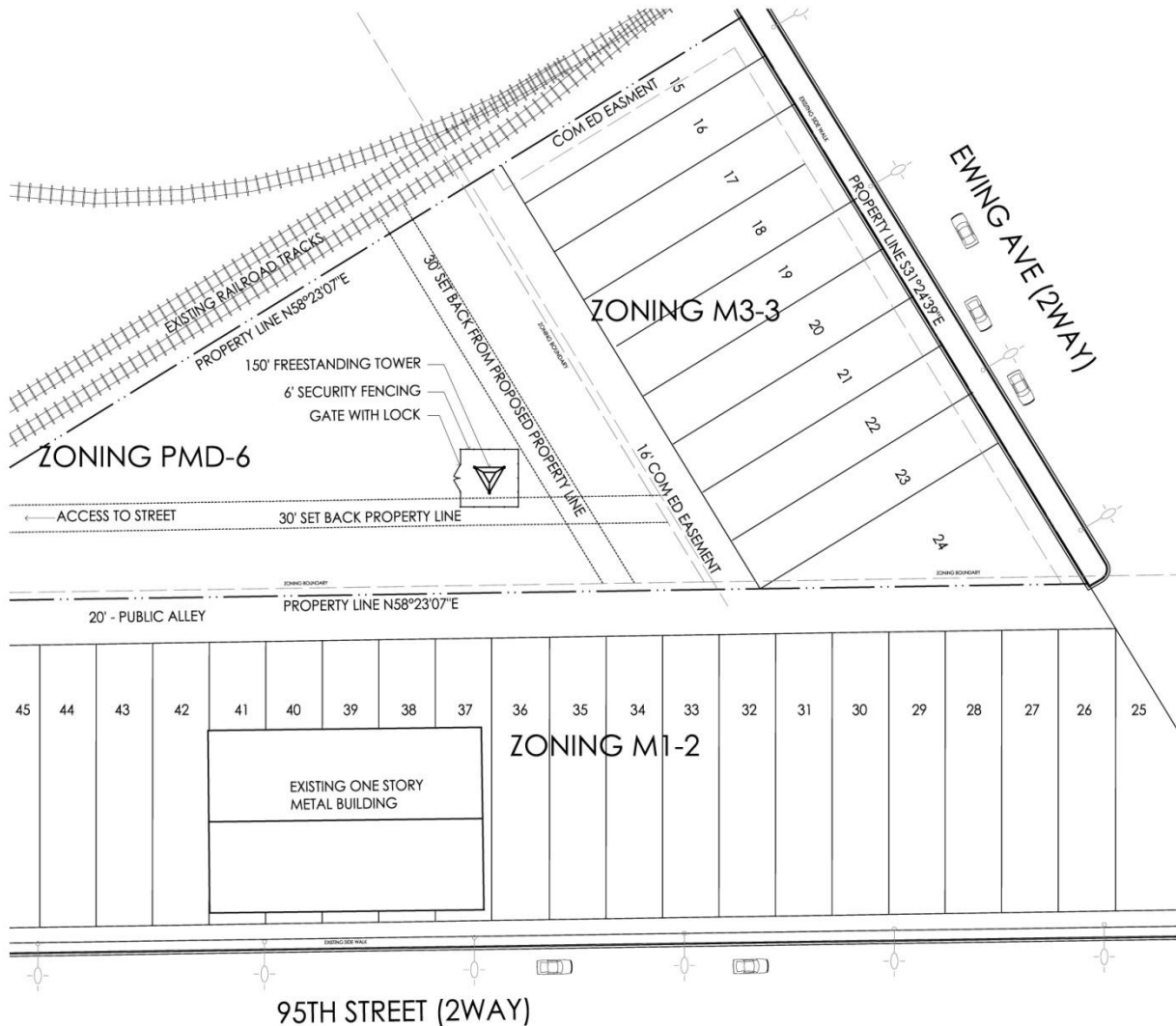**95th St Site**

113th St Site

ipro 305 **Site Proximity**

Primary Site
3434 East 95th Street
Crowleys Boat Yard

CALUMET RIVER

100th Street

107th Street

Calumet River

Chicago Skyway

Secondary site
11300 South Burley
Ave.
(formerly known as)
US Steel

95th Street

N

2 mile distance
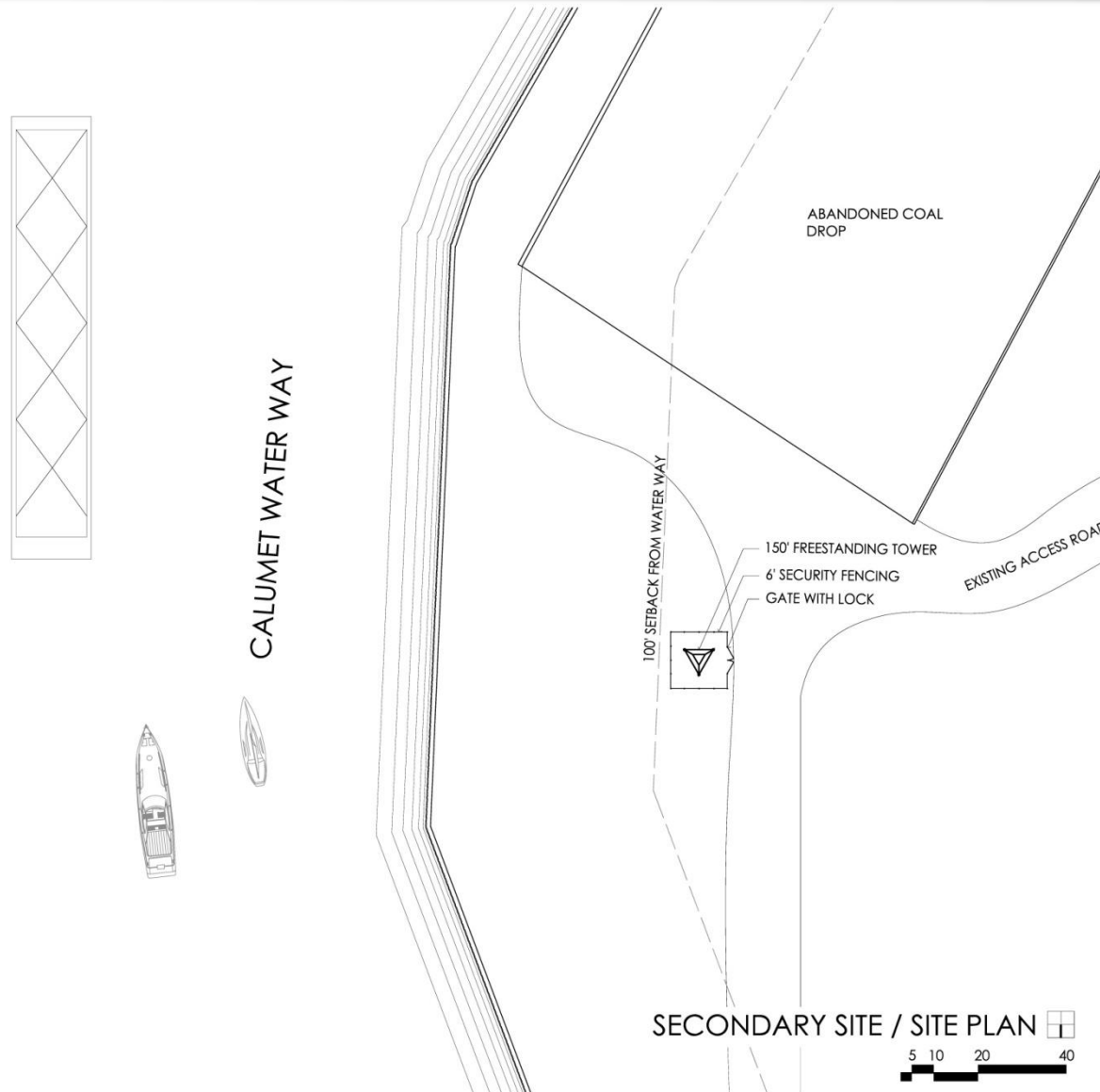
PRIMARY SITE / SITE PLAN

- The tower was placed in accordance to the existing set backs per the 2007 Chicago Zoning Ordnance

- The set backs that are imposed on this site are 30' from the property line

CALUMET RIVER

ABANDONED COAL DROP

CALUMET WATER WAY

100' SETBACK FROM WATER WAY

150' FREESTANDING TOWER
6' SECURITY FENCING
GATE WITH LOCK

EXISTING ACCESS ROAD

SECONDARY SITE / SITE PLAN

5 10   20   40

- The tower was placed in accordance to the existing set backs per the 2007 Chicago Zoning Ordnance

- The set backs that are imposed on this site are 100' from a public waterway

ipro 305 **Tower Design**

- The Tower was designed by Antenna Systems & Solutions from Schaumburg, IL

- This prototype tower is designed for 150' and 110 mph winds

- The base of the tower is 13' and tapers to 3' at the top of the tower
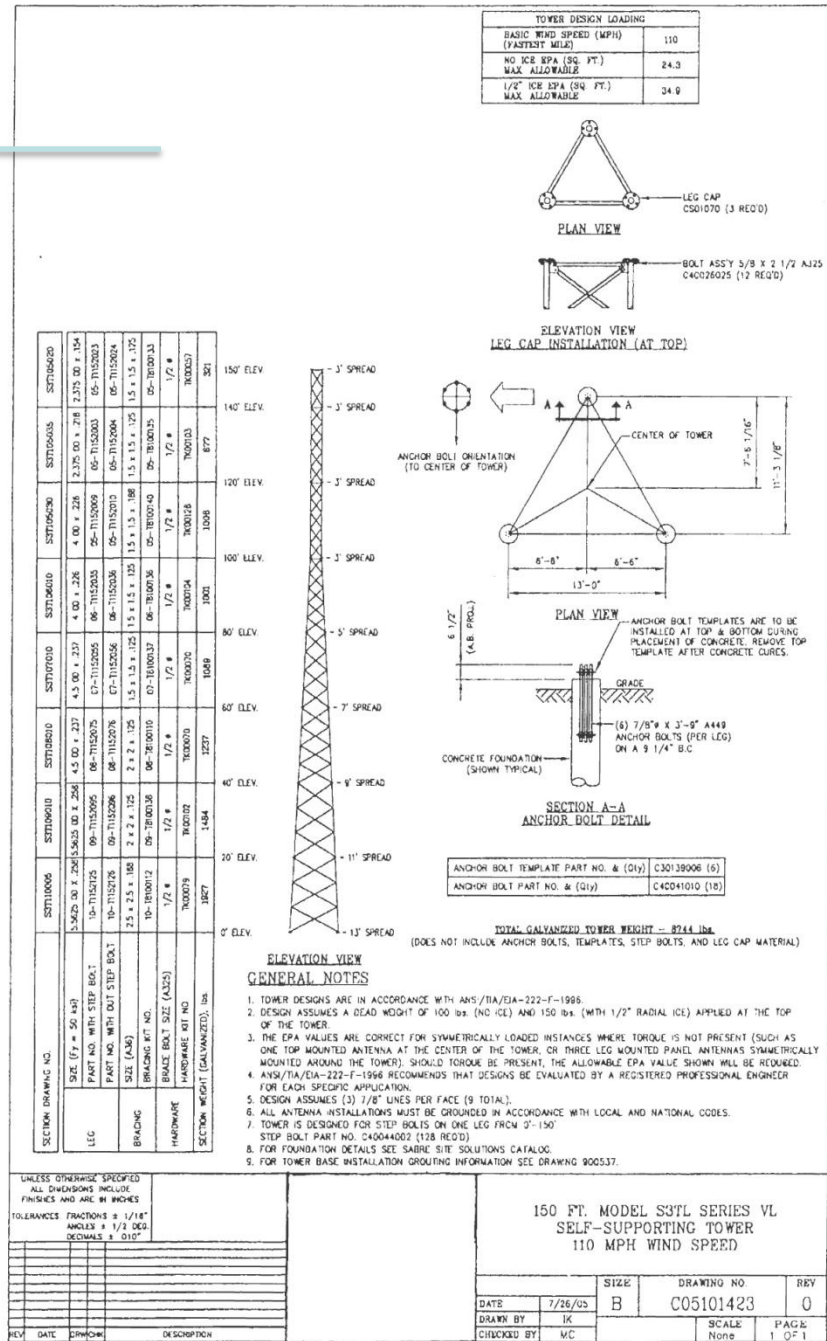
ipro 305 **Project Goal**
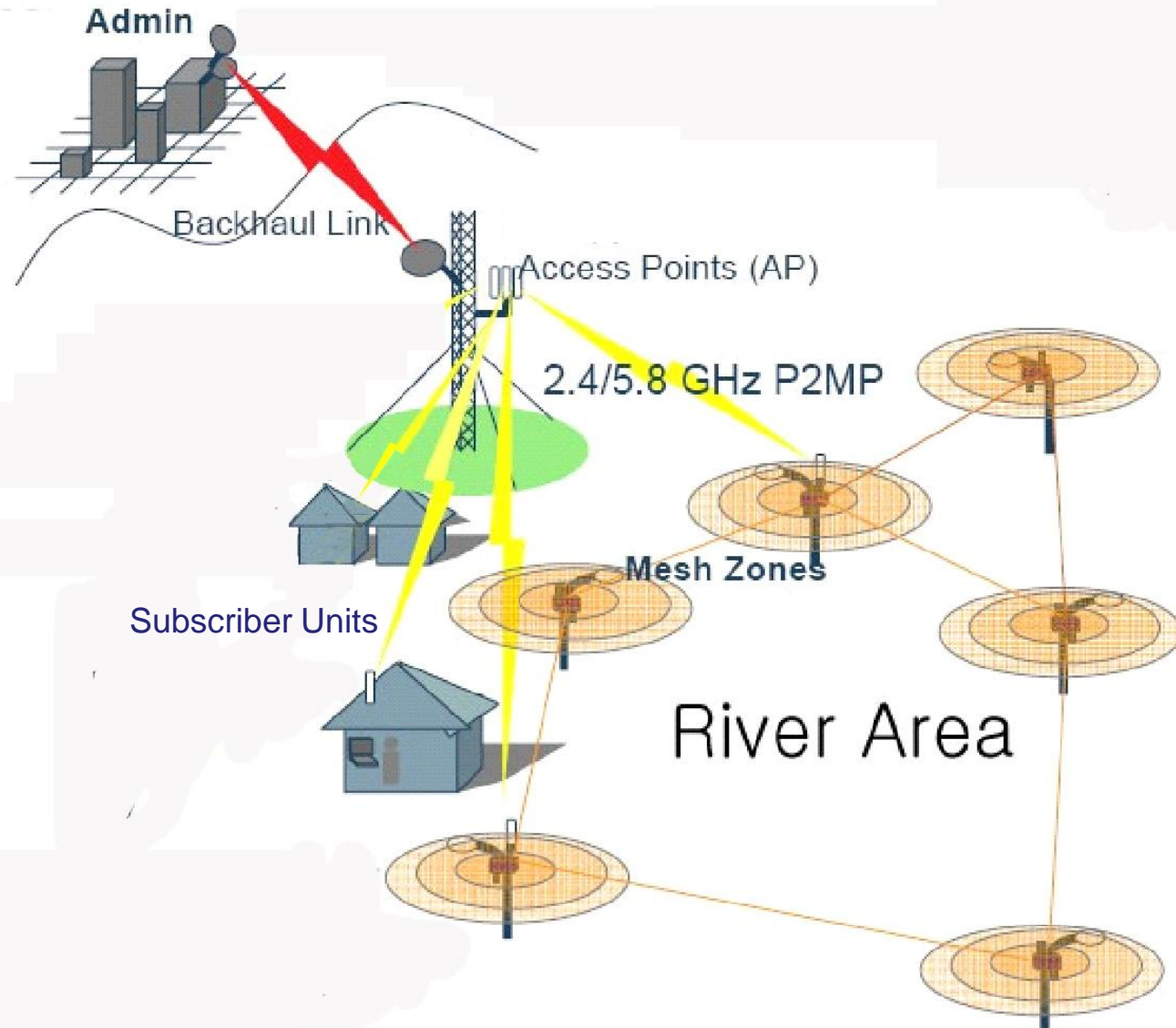
ipro 305 **Tower Deployment – Proxim Option**

Access Point (AP)

Tsunami MP .11 5054

Data Rates: Up to 54 Mpbs full duplex *(5.24-5.35Ghz,15 channels)*

Range: 1-10 Miles depending on antenna

Supports 250 subscribers

Point-to-multipoint

Tsunami GX-200

Data Rates: 200 Mbps Aggregate; 100 Mbps Full Duplex *(5.724-5.84Ghz)*

Range: LOS up to 32 Km

PTP Backhaul

PTZ
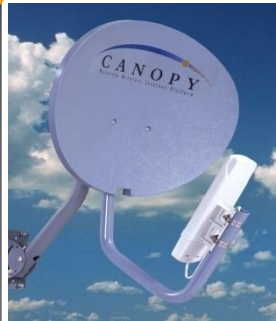
proxim
WIRELESS NETWORKS

ipro 305 **Tower Deployment – Motorola Option**

Up to 6 AP per one Backhaul

Access Point (AP)

PTP-100

Data Rates: Up to 14 Mpbs *(2.4, 5.1, 5.4 and 5.8 GHz)*

Range: LoS – up to 35 miles

DES and AES Encryption

Point-to-multipoint

PTP-400

Data Rates: Up to 43 Mbps *(5.8 and 5.4 GHz)* Up to 35 Mbps *(Public Safety 4.9 GHz)*

Range: non-LoS up to 6 Miles, near-LoS up to 25 Miles, LoS up to 124 Miles

P2P Backhaul

PTZ
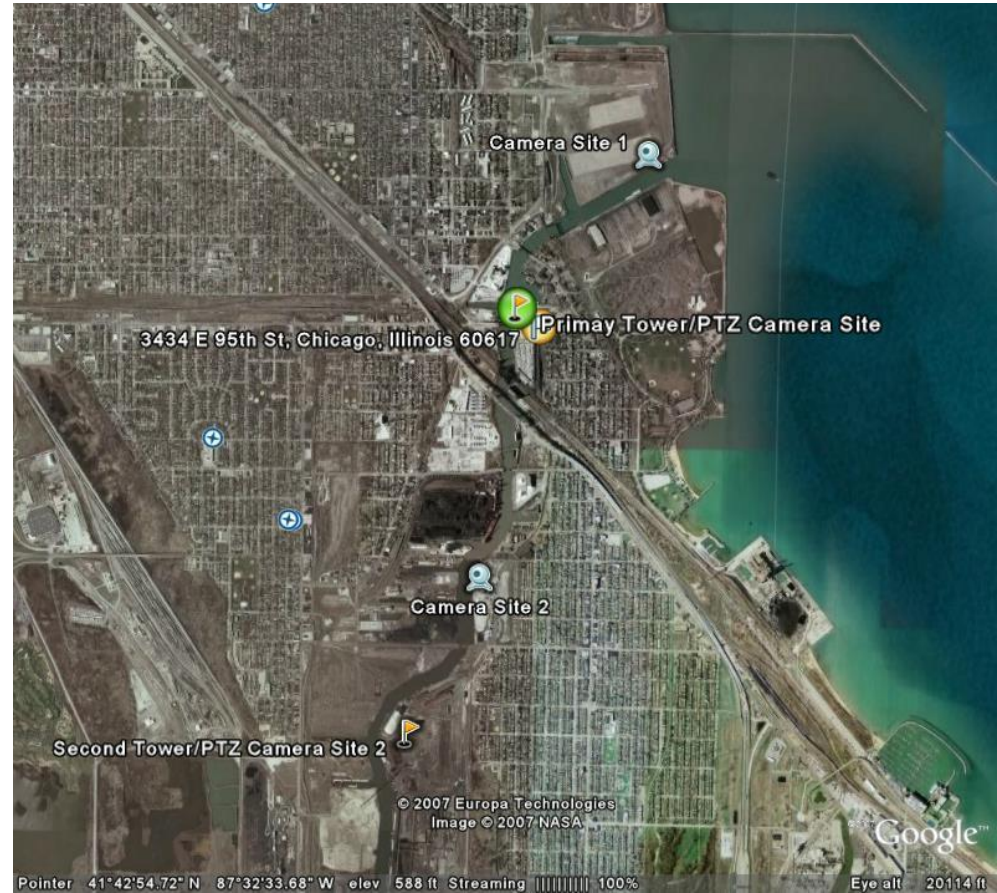
MOTOROLA

ipro 305 **Bandwidth Demands**

- 3-4 mile coverage requirement
- Mostly from cameras
- 2 thermal/infrared cameras
- 4 Point, Tilt, Zoom (PTZ) cameras

PTZ 3 Mbps   Thermal 8 Mbps

Final Recommendations

Required Components:
- 2 Towers of 150 and 175 ft
- 2 Proxim Tsunami GX-200 Backhaul radios
- 8 Proxim Tsunami MP.11 5054's
- 2 thermal/infrared cameras
- 4 Point, Tilt, Zoom (PTZ) cameras

Backhaul - Tower to tower radios 5.724-5.84Ghz

Subscriber to mobile units - 5.24-5.35Ghz

Subscriber to stationary units - 5.24-5.35Ghz

surveillance cameras

typical barge

typical barge

typical barge

113th street site

support tower

support tower
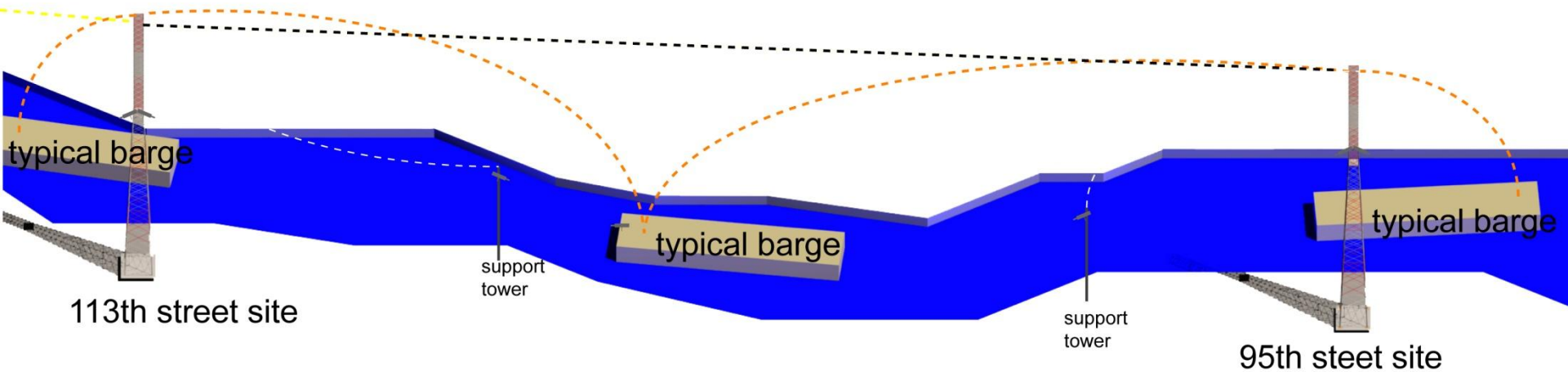
95th steet site

ipro 305 Thank You's

- **John A. Pope** Chicago City Alderman

- **Marilyn Engwall** Project Manager, Department of Planning and Development

- **Ryan Woody** Antenna Systems & Solutions, Inc.

- **James Patla** Senior Firmware Engineer, Motorola

- **Simon Beemsterboer** Site Owner

- **Dan Bochnovice** Site Owner

- **Bill Shipley** CEO – Air2Access

- **Udayan Das** Graduate Assistant

- **Cindy and Dennis Hood** Faculty Advisors

Questions?

ipro 305 Bandwidth

• Support for all of these systems rely upon a dedicated fiber optic backhaul.

•Fiber is needed for our bandwidth heavy needs due to it's scalability and reliability in providing services to our customers.

•These services will be provided in a turn-key solution by the Comcast Corporation.

•Comcast offers more competitive pricing than AT&T and Novacon.

•The scalability of their services can meet our backhaul needs up to 1 Gb/s.

ipro 305 Camera Details

• The cameras that will provide security are made by AXIS Communications and are models numbers 233D.

•All cameras will display a frames per second (FPS) rate of 30; approximately what the human eye sees

•The PTZ cameras at the tower locations will not be constantly streaming video, but be event triggered by the secrity sensors; taking up a combined total of 2.2 Mb/s.

•If both are left fully streaming at 30 frames per second, they will consume up to 11.4 Mb/s and with all four constantly streaming

ipro 305 Camera Details

• The last two cameras that will make up the surveillance system for the site are Cohu made thermal PTZ cameras.

•These are specifically design to survive harsh environments and track thermal profiles at long distances.

•The 5960 series will best suit our needs for a thermal solution but they do offer more integrated camera options.

•The 6980 series will integrate an IP encoder, but will be released as of summer 2007.

•Both models will use 200mm lenses and take up individually 8

The 5960 model

(This is exclusively a thermal PTZ camera.

The 6960/80 model

(no picture available at this time of the 6980, but they will be physically similar.)

Mb/s: or 16Mb/s for our thermal

ipro 305

• The Application Team has determined that no more than 5 ships will be present on the river using 2 cameras a piece with 3 Mb/s budgeted for them.

•The environmental sensors we will be using take up so little room on the system that only 4 Mb/s will be needed for the entire system.

•In order to compensate for excess load times, we will budget at least 10Mb/s for a buffer

•This will bring the speed of the needed fiber connection to 83-85Mb/s.

An environmental sensor

Traffic to be monitored

Worst Case Scenario

Tsunami GX-200

High speed point-to-point backhaul link

200Mbps Aggregate

100Mbps Full Duplex

Range: 32Km

Frequency: 5.724-5.84Ghz

Tsunami MP.11 5054

Point-to-multipoint link

Each base station can support up to 250 subscribers

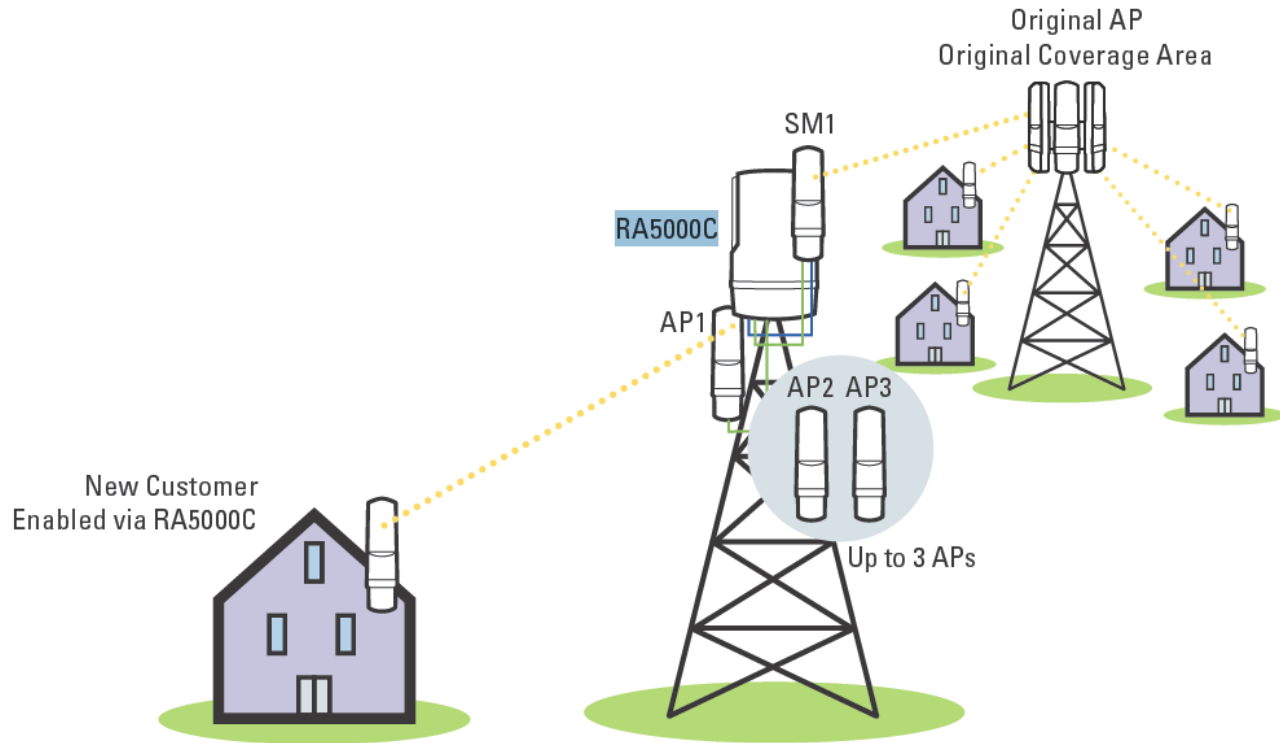Up to 54Mbps full duplex

Range: 1-10 miles depending on antenna type

Frequency: 5.24-5.35Ghz (15 channels)

Coverage Extender

RA5000C

Original AP
Original Coverage Area

SM1

RA5000C
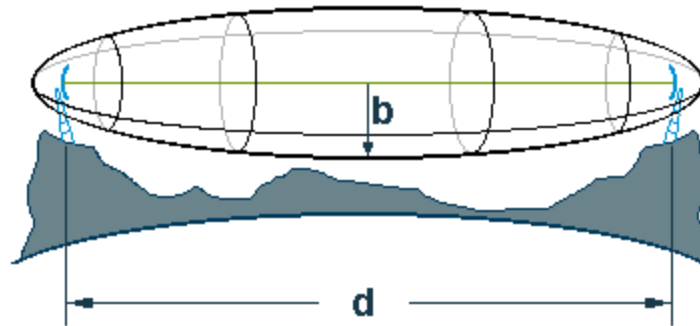
AP1

AP2 AP3

Up to 3 APs

New Customer
Enabled via RA5000C

General Considerations

●Fresnel Loss - The Fresnel Zone is a theoretical area around the line of sight of an antenna transmission that can affect the signal strength. Objects that penetrate the Fresnel Zone can cause fading of the transmitted signal. This fading is caused by the cancellation of the signal due to out-of-phase reflections. An unobstructed line of sight is important, but it is not the only determination of an adequate placement. Even though the path has a clear line of sight, if obstructions (such as terrain, vegetation, metal roofs, cars, etc.) penetrate the Fresnel zone, there will be signal loss. The following illustrates a Fresnel zone.

Motorola Canopy