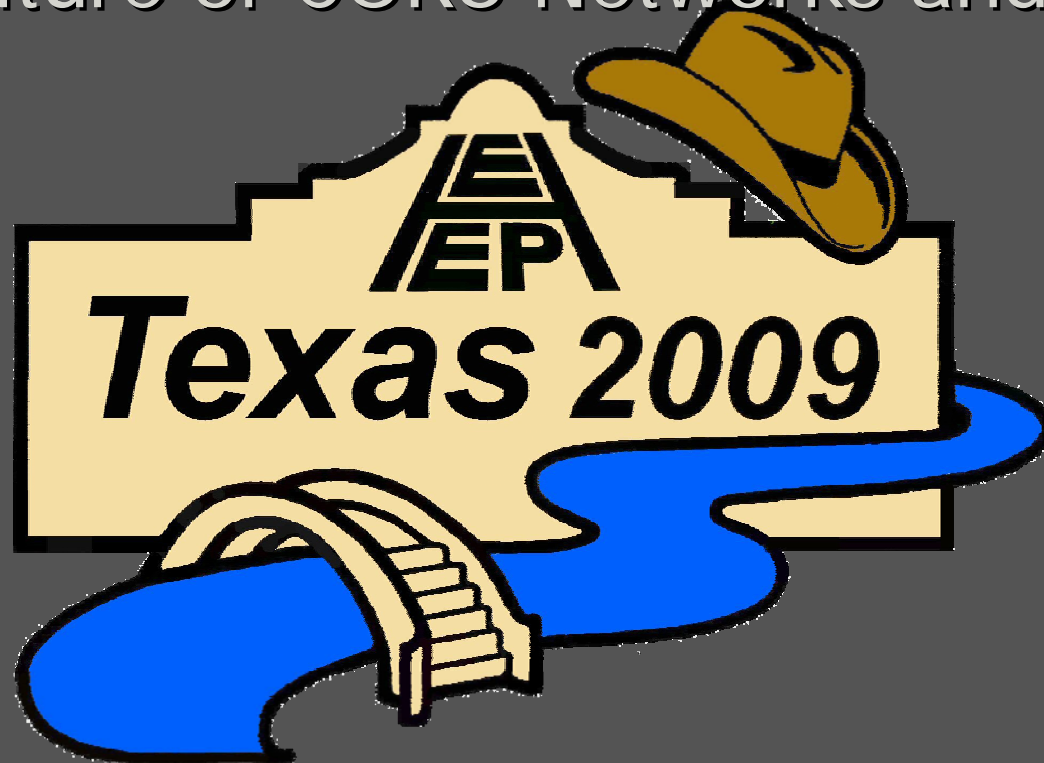




# 2009 IHEEP CONFERENCE

The Future of CORS Networks and AMG



# Background

- Dominick Izzo, PE
- Lancaster Development, Inc.
- Heavy Highway Contractor in Upstate NY
- Member of NYSAGC/NYSDOT – Emerging Technology Committee
- Contractor Advisor to AASHTO TIG on AMG

# Tools for Automated Machine Guidance

- GPS Base Stations - +/- .1 ft
  - Dozers
  - Excavators
  - Rollers
  - Scrapers
- Laser Guided Systems - +/- .03 ft – LPS (Local Positioning System)
  - Dozers
  - Grader
  - Paving

# Use of GPS for Machine Control

## Conventional GPS Base Stations

- Building Mount
- Post Mount
- Tripod



# CORS

## Continuously Operating GPS Reference Stations

Real Time GPS Data

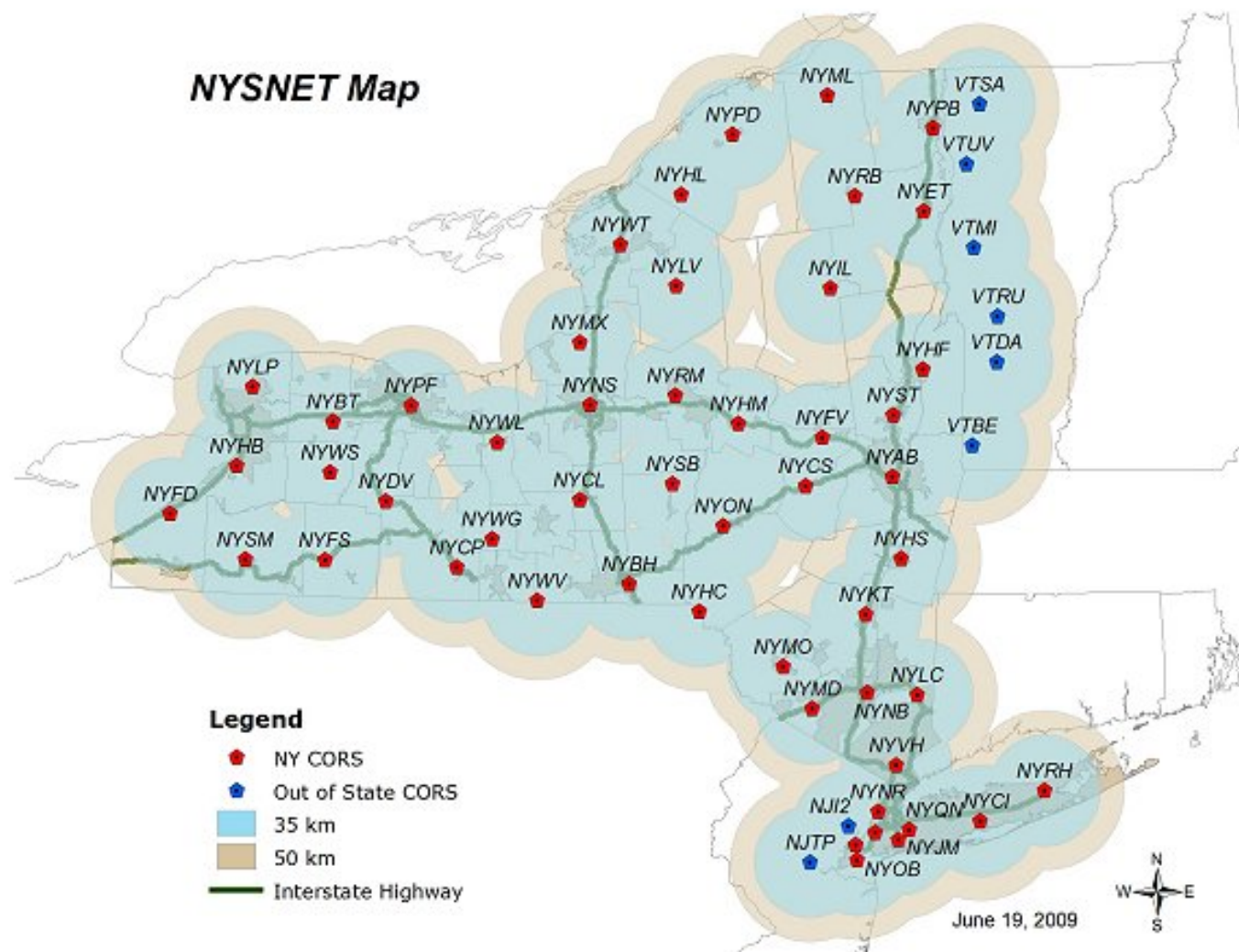
# What is CORS

- CORS is a network of GPS Base Stations coordinated by the National Geodetic Survey
- The CORS system enables positioning accuracies that approach a few centimeters relative to the National Spatial Reference System, both horizontally and vertically
- The GPS reference data used for post processing is typically acquired via direct download from the Internet

# CORS Locations



# NYSNet



# NYSNET



# NYSNet



# NYSNet

## ■ Data Accuracy

- Accuracy is dependent upon equipment and procedures
  - NYSDOT recommends testing the accuracy of all RTN product at each project site
  - Testing should include connections to local coordinate system and datum

# NYSNet

## ■ Data Reliability

- The NYSNet RTN is dependent upon a real time data stream through the NYSDOT IT network
- If the network connection to a particular site is down, the RTK processing software can deliver data from the nearest site

# NYSNet

## ■ Reference Station Datums

- NYSDOT CORS positions are based on the North American Datum of 1983, CORS adjustment NAD83(CORS96)(EPOCH 2002.0)
  - Users must determine appropriate connections to local coordinate systems
- NYSDOT CORS are not directly connected to the North American Vertical Datum of 1988(NAVD88)
  - Users must determine appropriate connections to local datums

# Uses of CORS in Construction

- Traditional Use of CORS by NYSDOT
  - Survey and Stakeout
    - Preconstruction Survey for Design
    - Post Construction Survey

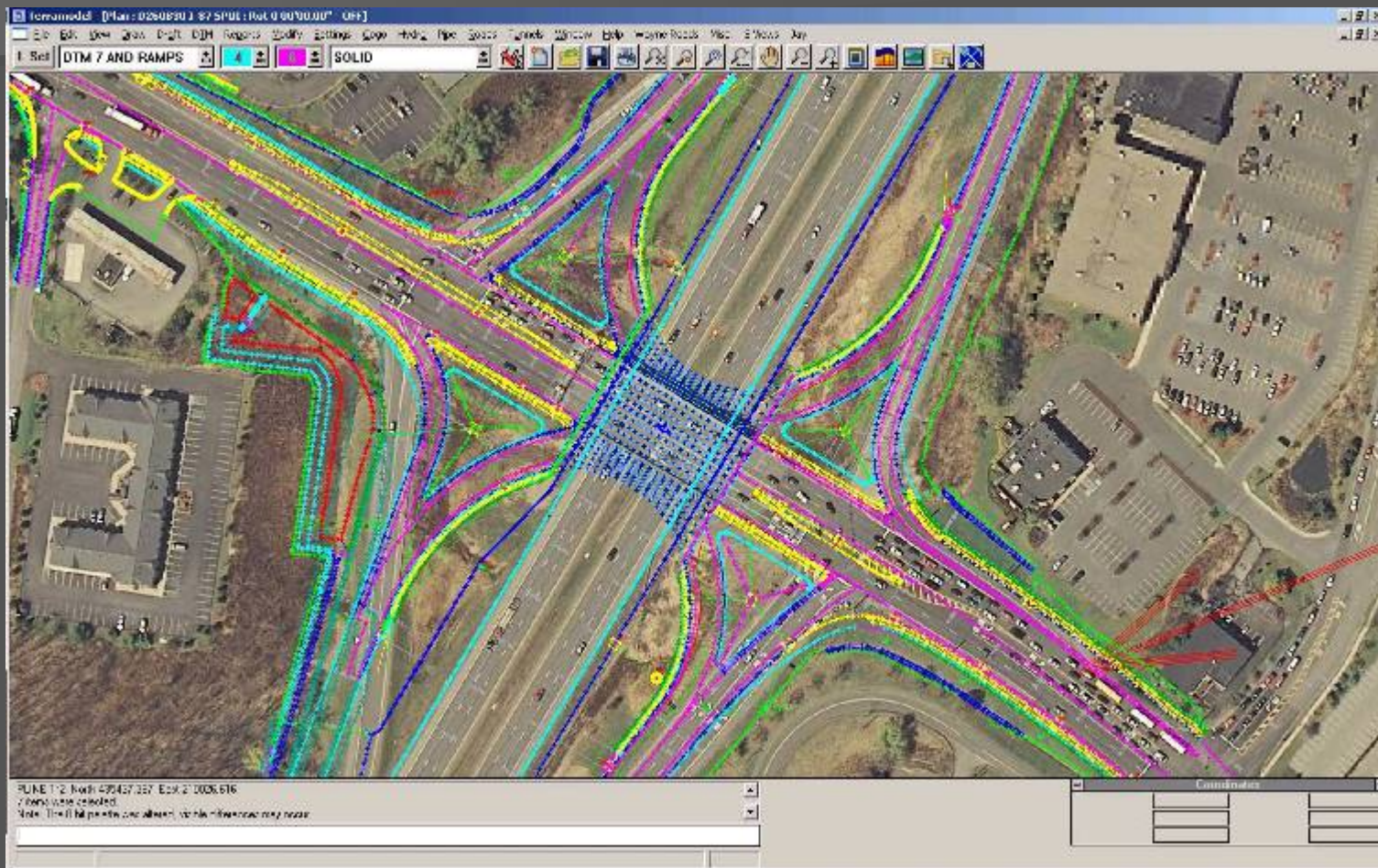
# Expand Role of CORS in Construction

- Construction Project Ideal to CORS Use
  - Project with minimal earthwork
  - Includes utility work
  - Bridge
- Construction Layout
- AUTOMATED MACHINE GUIDANCE

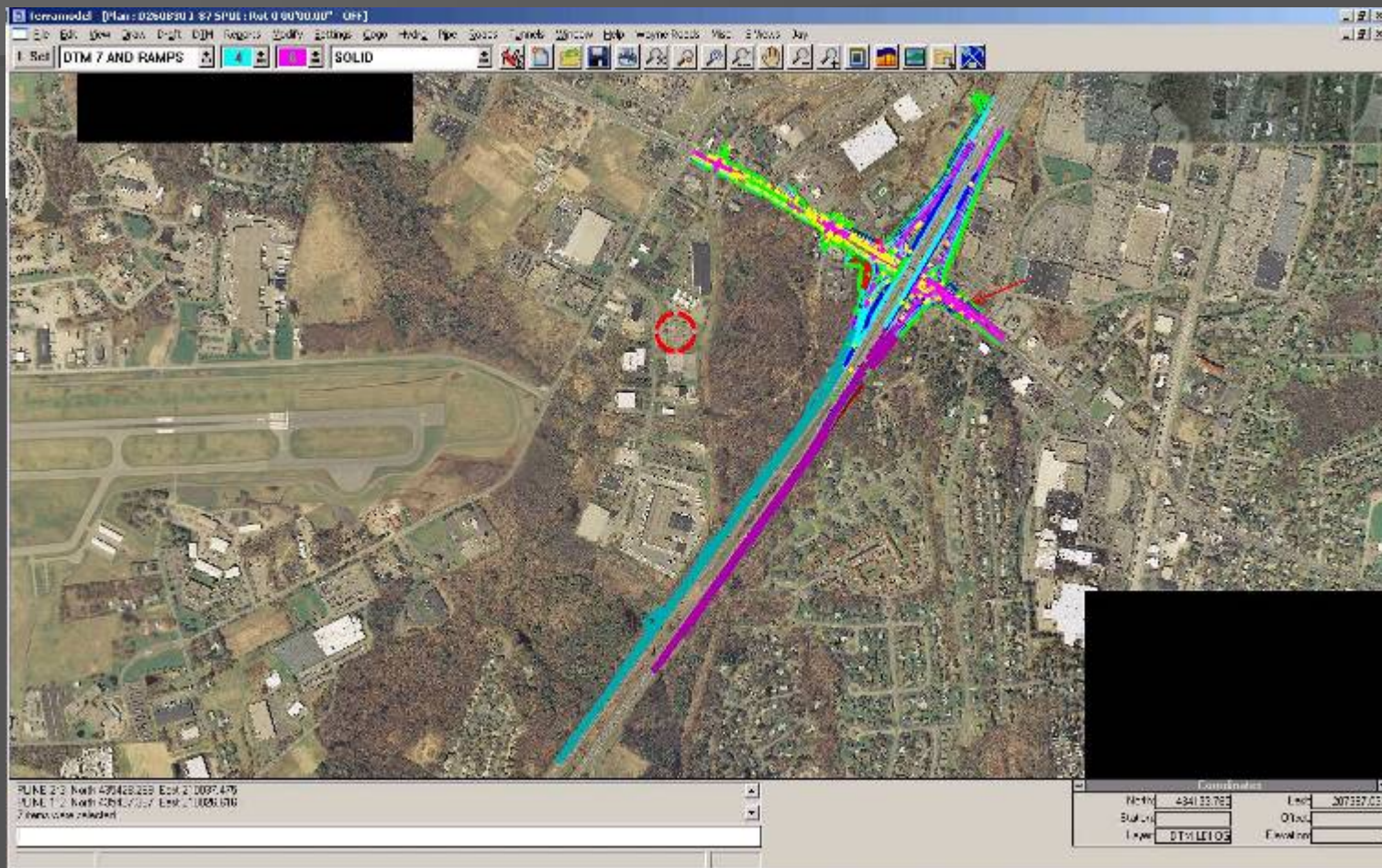
# Expanded Role of CORS in Construction

- NYSDOT Project D260830 Albany County
  - \$37,000,000 Single Point Urban Interchange (SPUI)
  - SPUI on top of the replacement bridge
  - 4 reconfigured ramps
  - New Acceleration and deceleration lanes on Interstate 87
  - Remote location – Wetland Mitigation

# D260830



# D260830



# Implementation of CORS for AMG

- Equipment Needed
- Consulted with NYSDOT and Trimble
- Modem
- Computer
- Radio and Antenna
- Possible 2<sup>nd</sup> Radio to use as a repeater
- Rovers
  - Survey (Contractor and NYSDOT)
  - AMG Equipment

# Modem, Computer, and Radio



# Antenna



# Use of CORS on D260378

- Developed Contract Control Plan
  - Used Base Station as a companion for start of project
  - Calibrated Site with CORS and RTK GPS Base Station to the same points
  - Same model used for both CORS and RTK Base Station Use
  - Robotic Total Station to be used for Bridge components and as Specification required in other work

# CORS Vs. RTK Base

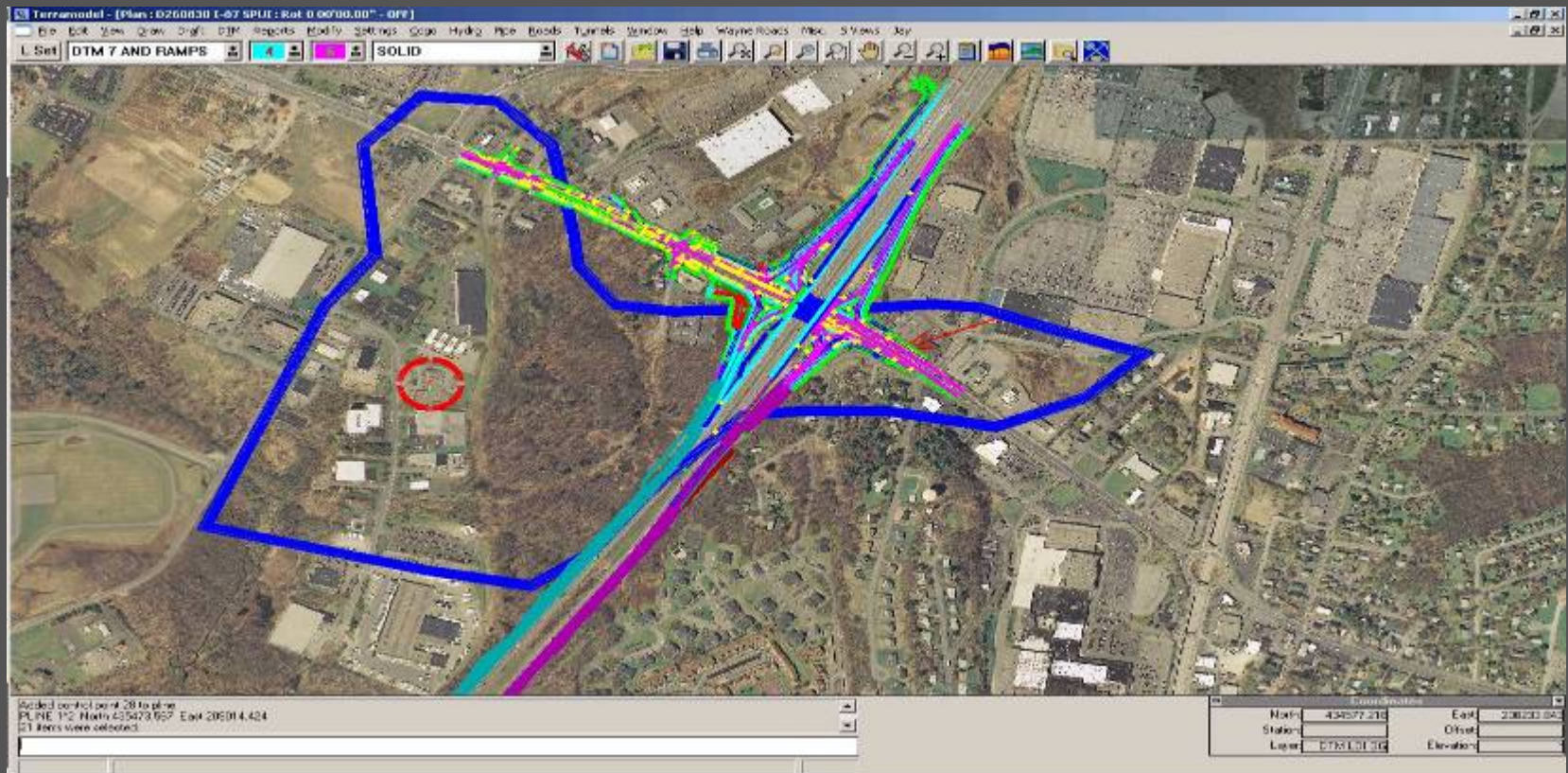
- Tested GPS (survey) accuracy
- Tested Range of GPS signal
- Tested availability of radio signal
- Tested range of radio signal

# CORS Vs. RTK Base Issues

- GPS (Survey) Accuracy was consistent with RTK
- Range of GPS signal was consistent with RTK
- Availability of Radio signal from CORS was and still is inconsistent
  - 65 outages from April 1<sup>st</sup> to September 1<sup>st</sup>

# CORS Vs. RTK Base Issues

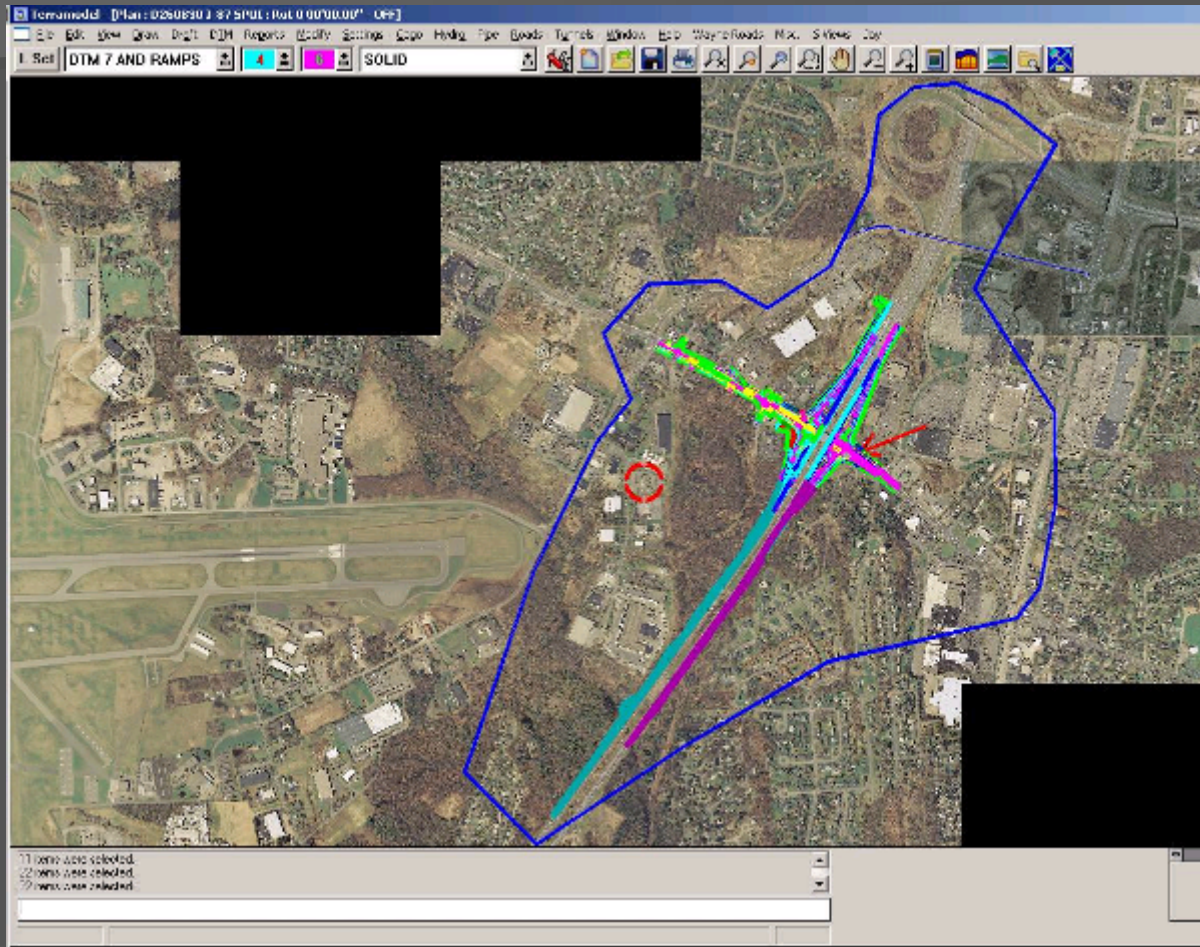
- Radio Signal Strength with CORS was 65% of RTK Base



# Use of Repeater Radio



# CORS Range with Repeater



# AMG in Use



# Improvement of Radio Signal

- Communication difficulties between NYSNet and radio in field office
- Possible error in signal due to NYSDOT IT Firewall
- Possible connection through NYSDOT field office to the Radio would eliminate firewall interference

# Improvement of Radio Signal (con't)

- Use of cell modem on equipment or rovers
  - Range limited by cell reception

# Other Options for AMG

- Use of Virtual Reference Stations (VRS)
- Difference between CORS and VRS
  - CORS requires post processing for centimeter processing
  - VRS is a RTK solution

# Advantage of CORS and VRS

- No need for base station
- Survey crews and equipment security is increased
- No limit to number of rovers
- Range depends on radio equipment

# Acknowledgements

- NYSDOT
- Trimble
- FHWA
- AASHTO TIG for AMG

QUESTIONS?