CORS Installation Procedures
What It Takes to Install a CORS

Our Goals in this session:

- Identify the components that make up a CORS SYSTEM
- Relate a professional procedure for installing a reliable high performance CORS
- Demonstrate this procedure in use during a recent CORS installation

We want to prevent you from making mistakes that will impact your system’s performance

CORS = Continuously Operating 24/7
Reference Station Data you can depend upon
What are the components of a CORS installation?

- Planning and Preparation
  - Hardware
  - Monumentation
  - Software
  - Communications
  - Toolkit
  - Knowledge

- System Installation
- Installation Report
CORS Hardware

- **Electronics Component**
  - GPS Receiver
  - Network Router
    - Device Server
  - Uninterruptible Power Supply (UPS)
  - Electrical Surge protection
  - Equipment Location
    - Enclosure
    - Shelf
  - Computer?
  - Internet power switch

- **GPS Antenna Component**
  - GPS Antenna
  - Location
  - Monumentation - Mounting

- **GPS Antenna Cable Component**
  - Routing
  - Lightning protection
  - Grounding

- **Radio Component (optional)**
Which components don’t come from Trimble?

- **Electronics:**
  - **UPS** - Uninterruptible Power Supply – Size for load and duration
    - Source: Any Computer Store
    - Brands: APC, Belkin, Tripp Lite, ...
  - **Router** – Interface between GPS receiver and computer network
    - Source: Any Computer Store
    - Brands: Linksys, D-Link, Belkin, Netgear, Cisco, ...
  - **Device Server** – Converts from serial communications to Internet Protocol network comms.
    - Source: Online Computer Stores (CDW.com, Amazon.com)
    - Brands: Lantronix, Comtrol, Moxa, ...
  - **Electrical Surge Protection** – AC Power, Ethernet, Serial
    - Source: Online Computer or Comms Stores (CDW.com, Tessco.com)
    - Brands: APC, Tripp Lite, Polyphaser...
Which components don’t come from Trimble?

- **Electronics:**
  - **Grounding System** – Ground rod and wire to fully engineered system
    - Source: Communications Retailers, Grounding Specialty Shops (Tessco.com)
    - Brands: Polyphasor, Harger, Wireless Solutions
  - **Custom Coaxial Cables** – Very long or very short lengths
    - Source: Communications Retailers (Tessco.com, DavisRF)
    - Brands: Times Microwave, Amphenol, RFS Cablewave, Belden, Andrew
  - **Lightning Protection** – Surge suppressors to engineered systems
    - Source: Communications Retailers, Lightning Protection Specialty Shops (Tessco.com)
    - Brands: Polyphaser, Harger, Huber+Suhner
  - **Mechanical Components** – Hardware, Brackets, Metal Parts, Consumables
    - Source: McMaster-Carr (mcmaster.com), Grainger (grainger.com), Allied Electronics(allied.com), Newark Elec., Corner Hardware Store, Fabrication Shop
    - Brands: Various
Monumentation

- General Requirements
  - Clear sky view
    • 100 meters (328’) unobstructed view to the horizon 360 degrees
  - No nearby Signal reflectors
    • 1.5 meters (5’) above horizontal surfaces
  - No nearby signal transmitters
    • 300 meters (984’)
  - Stability
    • Thermal Expansion
    • Wind Loading
    • Soil Expansion/Contraction
  - Conditions must not change with time
Monumentation

- Pillar Mount
  - Concrete
  - Metal
Monumentation

- Drilled-Braced Monument
  - Extremely Stable
Monumentation

- **Building Mount**
  - Rooftop attachment
  - Wall side attachment
Which components don’t come from Trimble?

- **GPS Antenna Monumentation:**
  - Building Mount – Custom fabrication or standard parts
    - Source: McMaster-Carr (mcmaster.com), Grainger (grainger.com), Corner Hardware Store, Fabrication Shop
    - Brands: Various
  - Ground Pillar – Custom fabrication and/or concrete
    - Source: McMaster-Carr (mcmaster.com), Grainger (grainger.com), Corner Hardware Store, Fabrication Shop, Local Concrete Contractor
    - Brands: Various
  - Drilled-Braced Monument – See SCIGN site (www.scign.org)
    - Web Search: SCIGN Drilled-Braced Monument
Recon the Site

- **How do we get access?**
  - Arrangements for keys before arrival
  - Access to roofing
  - Security passes issued
  - Building tenants notified
  - Scheduling constraints

- **Consider this in your long-term service plan**
Recon the Site

- What are the major considerations?
  - Determine the GPS electronics location
  - Determine GPS antenna location
  - Determine the GPS antenna cable route

- Is the site a suitable location for a CORS?
Recon the Site – GPS Antenna Installation

- Make notes! Take Pictures!
  - Dimensions
- How will you mount the Antenna?
  - Bracket fabrication
    - Stability
    - Clear sky view
    - Installation practicality
      - Safety, long-term maintenance
    - Attachment
      - Fasteners, Welding
    - Offsite fabrication required?
      - Tradesmen – welder, mason, carpenter, roofer
      - Building penetration for mechanical bracket
  - Concrete forms?
- Tools required?
  - Lift truck
  - Tall ladder
Recon the Site – Electronic Components Installation

- Make notes! Take pictures!
- How could the electronic parts be installed?
  - Enclosure or table top?
  - How to mount the equipment box?
    - Wall, studs, fasteners, cable runs, access
    - Structural modifications required?
  - Offsite fabrication required? Shelves, brackets
  - Network and power outlets
    - Is there commercial power at the site?
    - Do I need a new network connection?
  - Personnel – Will we need utility representatives on site during the installation?
Recon the Site – GPS Antenna Cable Route

- Make notes! Take pictures!
  - Lengths
    - Actually measure along the proposed route
    - Holes needed through interior walls?

- Building penetration for the antenna cable to get to the GPS
  - Where? Wall? Roof? Existing penetration?
  - Leaks are bad

- 30m of cable is supplied – Times Microwave LMR400
  - Is this enough? Consider bends, turns, bulkheads, need for securing
  - Need longer cable?
    - Goal – no preamps
    - Commercial cables are available that will enable up to 300’ lengths
      - Times Microwave LMR600
      - Sources: Tessco, DavisRF
Plan the Installation

- The pieces of the puzzle have to fit
  - Revise your plan while on site
  - Revise your plan off site after reviewing pictures and sketches
  - Revise you plan based on available components
  - Go back and measure again with new plan

- Check List:
  - Antenna can connect to the GPS receiver
  - GPS receiver can connect to power and a network
  - GPS antenna will be stable
  - Installation will be pleasing to the landlord and safe for you
Plan the Installation

- Order the parts
- Have parts fabricated
- Arrange the contractors
- Arrange site access
- Get Permits

- Spend the majority of the installation time planning and preparing. The actual installation should take 24 man hours or less on site.
CORS Installation

- Install the CORS
  - Take components to the site
  - Install the components according to your plan
Site Reports

- Installation reports (site reports) are not optional. They are a part of your deliverable to the customer.
- Installation reports will be used for troubleshooting when necessary.
- Document all serial numbers.
- Include photos and diagrams of the site.
- Document site contacts.
Put Theory Into Practice:

A Real CORS Installation
A Real CORS Installation

- A survey company wants to install a CORS at their building in Norfolk, Virginia
- This CORS will stream data to RTKNet software
Determine the GPS electronics location

- Shared space designated “Electrical Room”
  - Excellent security
  - Good environmentals – temperature controlled
  - Easy physical access
  - Reliable electrical power
- Large plywood mounting plates on wall
- Located close to the roof
  - Room’s unfinished ceiling is roof decking
  - 30m Antenna cable is sufficient
- Network connection already within the room
- Ground bar located in the room
Site Recon

- Determine the GPS Antenna Location
  - Rooftop mount was the general plan
  - Building is 2.5 stories with a steel frame and brick siding
  - Easy access via internal ladder
  - Secure location
Site Recon

- Determine the GPS Antenna Location
  - 360 degree clear sky view
  - No nearby signal reflectors
  - No nearby transmitters
Site Recon

- **Determine the GPS Antenna Location**
  - Vertical structural steel available for attaching mount
    - Very stable
    - Can be drilled
  - Minimal multipath
    - Mount 3m above HVAC air handlers
  - Roof can be penetrated
    - Rubber membrane
    - 4” thick foam board
    - Corrugated steel decking
Site Recon

- Determine the GPS antenna cable route
  - Cable can be attached to superstructure on rooftop
    - Can run through conduit over walkway
  - Cable can follow other cables in the electrical room
  - Roof will need a penetration
    - Easy inside access for drilling
  - Grounding point is available!
  - A 30m cable will work well
Preparation for Installation

- Plan the installation based on site inspection
- Order all required components
- Design any custom parts
- Have custom parts fabricated
- Schedule contractors
- Schedule with property owner
Preparation for Installation

- Site was inspected and found to be good for a CORS
  - The antenna must have minimal visual impact
- The installation was planned
- A NetRS with Zephyr Geodetic antenna was ordered
- A custom GPS antenna mount was fabricated
- Various components and supplies were ordered
- Permission was granted to work on the site and to access the roof
- A temporary electronic access card and key were acquired
- Contractors were scheduled
- Tools were gathered
CORS Installation

You have a good idea where everything will go….now start humping it inside!

Tip: add luggage wheels to your tool kit
Tip: get an intern to help
Installation Procedure

We chose to install in this order

- Electronics cabinet
- GPS antenna cable
- GPS antenna

...........We did it this way so that we could be on the roof during the hottest part of the day.
Install the Equipment cabinet

- **This cabinet came from Tessco**
  - Large size allows for additional equipment
  - Clear hinged front – troubleshooting by the untrained
  - Lockable – no meddling by the untrained
  - 19” rack – don’t forget to buy shelves
  - Landlord friendly - neat
  - Easy to order
Install the Equipment cabinet

- Start mounting – based upon your Recon
  - Pick suitable fasteners – we used butterfly mollys
  - Drill using the supplied template
    • Be sure to level the template
Install the Equipment cabinet

- Drill as needed
Install the Equipment cabinet

- Mount the enclosure
  - 2-man lift!
Review

Completed so far:
- Site recon and installation planning
- Transportation of equipment to the CORS site
- Installation of the equipment cabinet

Still needed:
- Install the GPS antenna cable and accessories
  - Which means a building penetration
- Install the electronic components in the cabinet
- Install the antenna mount and GPS antenna
A Word About Cutting Holes in Buildings

- Always check with the landlord
- When waterproofing systems are in place such as a rubber roof, hire a contractor
- If you don’t know how to make a hole through the material, hire a contractor
- Time the drilling so that you are not doing the job on a bad day or there is potential of rain if you need to leave a hole. Always temporarily patch the holes if you must leave the site.
- Check to see “what’s on the other side” – BEFORE DRILLING
- TIP – *Leaks are Bad*
Let’s Drill Through the Roof

- Contact a roofing specialist – you can’t buy this stuff at Home Depot.
- Measure twice or more – drill once
Roof Penetration

- “Claudio the roofing guy”
Roof Penetration

- The hole was drilled and the Antenna Cable has been roughed into place.
  - TIP - Protect the factory “N” or “TNC” connector with tape or a dummy plug to prevent damage. We used a dummy plug (add to your toolbox)
Roof Penetration

- Claudio works his magic...
  - Prep the area
  - Seal the cable
  - Use an off-the-shelf seal or make one – we made one
  - Use the correct glue
  - Seal edges with the correct sealer
Roof Penetration

- Claudio works his magic...
  - Caution: Flammable
Roof Penetration

- TIP- Secure the cable while curing
While The Roof Seal Is Curing – Move Inside

- Prep the cable ends – we recommend you buy patch cables and avoid terminating cables in the field.
- Connect the cables with the lightning arrestor In-Line
Cabling the GPS Antenna – Lightning protector

- Lightning protector *must* be grounded
- DO NOT mount the unit to the back of the NetRS
- Check [www.polyphaser.com](http://www.polyphaser.com) for tips
Secure the Cabling

- Landlord wants it neat
- Use clips to secure all wiring
- This room may be used by unknowing maintenance people. Secure your installation out of their way. Otherwise it is guaranteed to be damaged.
Populate the Equipment Cabinet

- Planning ahead means you have shelves for all gear
- We improvised shelves from HomeDepot
  - NetRS
  - Router
  - UPS
Populate the Equipment Cabinet

- Orderly wiring
  - Tie Wraps
  - Hook and Loop ties
Populate the cabinet

- **TIP** – Leave the NetRS serial cable in the cabinet for service
Review

So far we have finished:
- Site recon and installation planning
- Transportation of equipment to the CORS site
- Installation of the equipment cabinet
- Routing the GPS antenna cable
- Installing the electronic components

We still need to:
- Install the antenna mount and GPS antenna
GPS Antenna Mount Installation

- The mount was fabricated before CORS installation
  - Welded Steel
- Problem – We realized the mount was too short which would lead to multipath. We contacted a speed shop for pipe and welding services (after hours). (The 1.5 meter rule)
- After modifications, the mount was professionally painted
GPS Antenna Mount Installation

Holes were marked and drilled using ½” drill
- Have sharp bits
- Use cutting oil
GPS Antenna Mount Installation

We used self-tapping screws to fasten the mount to the structure.
GPS Antenna Mount Installation

Attach the Mount
GPS Antenna Mount Installation

Finally, Install the antenna and secure the cable

- *Tip* – tape the cable to protect from UV
GPS Antenna Mount Installation

A Beautiful Moment
GPS Antenna Mount Installation

- The landlord did not want the antenna to attract attention.
Completion of Installation

- Electronic components had to be configured
  - NetRS
  - Router
Thank you
Resources – Supplies and Information

- www.tessco.com
- www.davisrf.com
- www.mcmaster.com
- www.alliedelec.com
- www.newark.com
- www.ngs.noaa.gov/CORS/Articles/Cors_guidelines.pdf
- www.polyphaser.com
- www.harger.com