Small Cell Cabinet-to-Pole Installation

This case study provides an analysis of a small cell site installation from cabinet to pole for a major U.S. mobile carrier.

By "Bobby Mack" McClung and Christopher Ortega

The landscape of the mobile networks industry is changing rapidly as the focus of networks moves from coverage for voice communications to capacity to provide data to handsets and user devices. One of our customers, a national U.S. carrier, has reported the use of mobile data per customer has doubled each year for the past three years and is projected to expand even more quickly over the next several years. All of the current major U.S. carriers, a group we call VAST (Verizon Wireless, AT&T Mobility, Sprint and T-Mobile US), have experienced similar data-use growth patterns.

As a result of these technology changes, the deployment strategy and technologies, once designed with roadways and traffic counts in mind, have changed and new technologies are necessary to meet the exponentially rising demand for mobile data. Because the wireless communications radio-frequency spectrum is a finite resource, the network edge devices, or devices like routers that provide entry into the carrier's network, must be moved closer to the end users. As a result, the carriers are placing radio equipment in closer proximity to the customer.

For indoor applications, distributed antenna system (DAS) networks, small cells and distributed radio access networks (DRANs) are being used with multiple antennas and access points placed throughout the building. For outdoor applications, small cells and DAS are being deployed on a large scale to meet capacity demands. Small cell deployments, the most prevalent among these solutions, are generally defined as low-power radios systems with modules and routers that are placed close to the end user. AWS Communications has long been a leader in DAS design and installation, and we have also built a competency to use with the deployment of small cells.

The AWS team performs the design, permitting and construction services for one of the first small cell installations in Houston.

Educating a New Workforce

It is clear to the 5G forum that there is a shortage of workers with the skills needed to place 5G sites and the associated small cells. AWS Communications is helping to meet this challenge. The AWS team and I are honored to have been invited to sit on the ETA 5G Certification Curriculum Committee. The eight-member committee is tasked with developing curriculum and industry best practices for the design, construction and testing of new 5G networks. This is one way that providers and carriers in the 5G industry are working to meet the challenge ahead of the curve and ensure these networks are built swiftly and correctly.

Cabinet to Pole

Large-scale deployment of small radios on utility poles is a new technique for VAST. Although the deployment methods for fiber optic cable (for backhaul) and network equipment do not change much to support small cells, the last portion of the build is a relatively new operation for most carriers. AWS refers to the last portion of the build as the cabinet to pole, or C2P. The C2P installation is the installation of fiber-optic cable, usually less than 20 feet, and wireless network equipment from the vault optical network hand-off, usually in a vault or conduit, to the pole to which the antennas, and often other wireless network equipment, will be mounted.

This case study will focus on AWS's experience providing C2P installation for one of the world's largest carriers. For this installation, AWS performed all excavation and work necessary to install the conduit, vault, cabinet and riser at the utility pole. Because there were no other contractors available to provide this under sidewalks, AWS was engaged in formulating and executing a solution for the C2P construction. Our contracted scope did not include installation of fiber-optic cable, coax lines, antennas, modules or radios. The underground path required 2-inch to 4-inch conduit (SCH40, SCH80).

Assumptions, Strategy

As with most new projects, the AWS Small Cell Team's strategy had to evolve quickly to meet the customer's demands and develop an efficient installation methodology. This case study will examine the underlying volume and work assumptions that formed the deployment strategy.

First, we considered the volume of site and the resources necessary to meet this volume. We originally prepared to provide multiple crews for an assumed volume of sites as follows:

- Week 1
  - 10 sites per week
  - 100 percent sidewalk mitigation
- Week 2
  - 10 sites per week
  - 50 percent sidewalk mitigation

- Weeks 3-4
  - 15 sites per week
  - 5 to 10 percent sidewalk mitigation
- Weeks 5-6
  - 25 sites per week
  - 5 to 10 percent sidewalk mitigation
- Weeks 6-8
  - 30-40 sites per week
  - 5 to 10 percent sidewalk mitigation

Labor Type

Because of the laborious nature of hand excavation and low site volumes, team leads with excavation experience and unskilled laborers were deployed on Day 1 with plans to augment the unskilled labor positions with local labor. Automated, nondestructive methods were not practical because of high mobilization and operation costs relative to the low volume of sites in the scope.

Many carriers have chosen to reassign tower construction crews to this work. There are two reason AWS did not find this approach feasible. First, the labor costs, and subsequently, the price point for the carrier, that result from reassignment of tower crews become inflated. The cost increase ranged from 48 to 102 percent. This means the carriers must pay a considerable amount over market rates to provide a sustainable margin for vendors like AWS. Second, many of the tower crews are not comfortable working on hand-excavation job sites for extended periods.

Site Classifications

AWS classified the site types based on the type of deployment, materials and skill sets needed to complete the work. Although AWS is well-equipped to manage traffic control in high traffic areas, such as school zones and central business districts, there were no sites that required such measures. As a result, traffic control was not considered in this case study because no sites were performed in high-traffic areas.

Residential, scenic: This type of site is located in a residential area at a location with ornate landscaping and no obstructions.

Residential, scenic with concrete: This type of site is located in a residential area at a location with ornate landscaping and concrete or asphalt in the pathway.

Commercial, scenic: This type of site is located in a commercial area at a location with ornate landscaping and no obstructions.

Commercial, scenic with concrete: This type of site is located in a commercial area at a location with

	Area Type	Landscape Condition	Obstacles in Pathway
Residential, Low Restore	Residential	Normal	None
Residential, Low Restore with Concrete	Residential	Normal	Concrete / Asphalt
Residential, Scenic Restore	Residential	Ornate	None
Residential, Scenic with Concrete	Residential	Ornate	Concrete / Asphalt
Commercial, Low Restore	Commercial	Normal	None
Commercial, Low Restore with Concrete	Commercial	Normal	Concrete / Asphalt
Commercial, Scenic Restore	Commercial	Ornate	None
Commercial, Scenic with Concrete	Commercial	Ornate	Concrete / Asphalt

ornate landscaping and concrete or asphalt in the pathway.

Initial Work

AWS allocated two crew members and one staff member during the initial week. In order to train unskilled laborers for the projected volume, six crew members, a logistics manager and a supervisor were deployed in the second week of work.

During the deployment, AWS was used to source only installations with concrete obstructions where the pathway crossed under a sidewalk. About 85 percent of the sites were classified as "residential, scenic with concrete." Others were classified as "residential, low restore" and "commercial, low restore" site installations. Several of these required management of roadway and pedestrian traffic, but it did not significantly affect operations.

Method Profile

Initially, AWS was requested to use a pneumatic boring tool, which is commonly called a missile because of its shape. The boring tool works by using a pointed steel alloy housing with a weight inside that is activated by compressed air. The compressed air nudges the boring tool forward with each vibration.

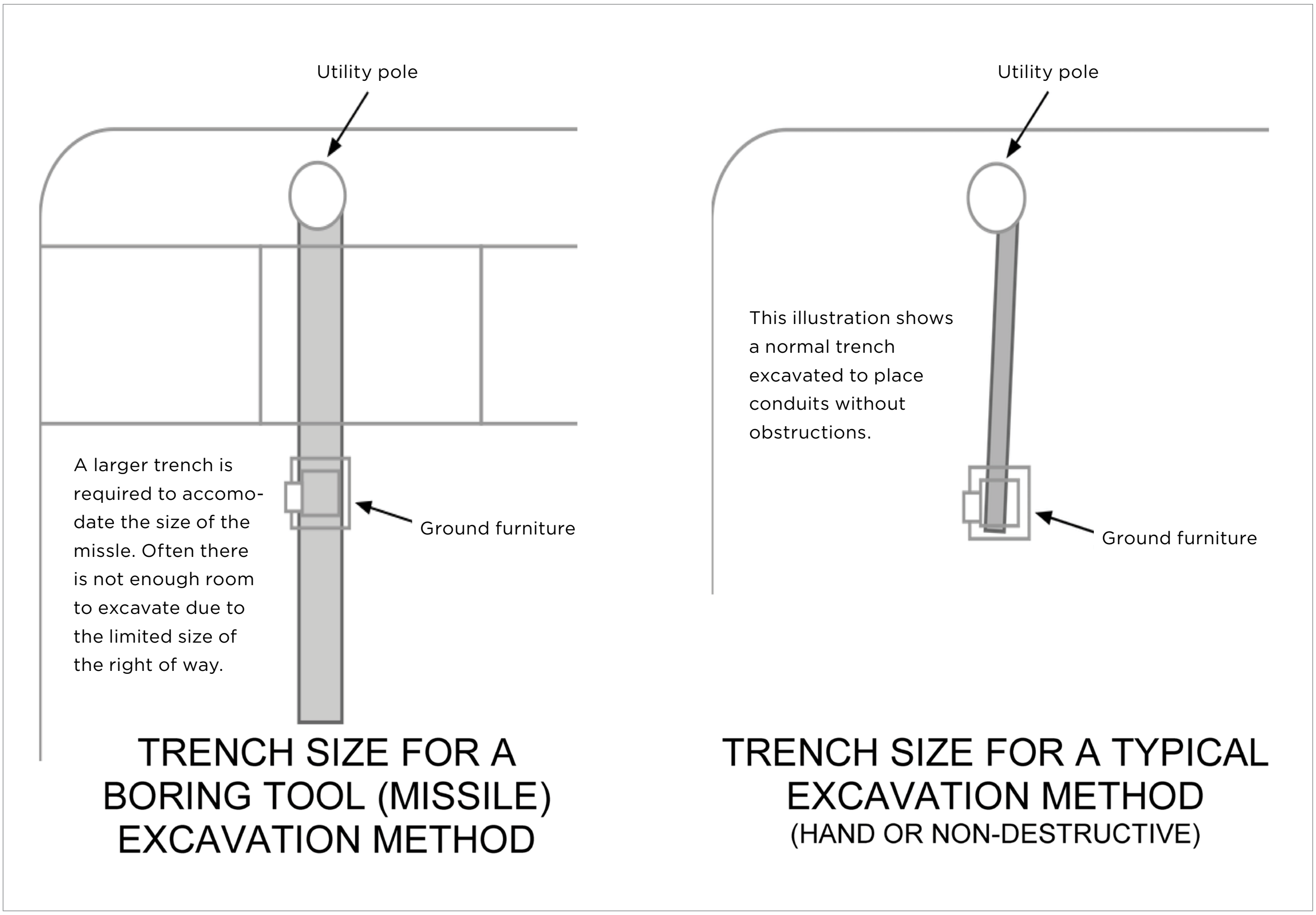
In order to operate the tool, a pit must be hand-dug to provide space to deploy the missile at the proper depth. The pit had to be large enough to accommodate two missile shots with 6-inch to 12-inch spacing.

Corrective, Preventive Actions

Unfortunately, the missile was not a practical method for installation. Often, there was insufficient space in the right of way to place the missile. Also, because the size of both conduits combined was too large for the diameter of a missile, two bore shots were required. There are 5-inch missiles that can bore a hole with an adequate diameter, but they require a greater depth to avoid cracking the concrete surface.

Because of project logistics delays, the sites were dispatched on the evening before they were ready to be deployed, and no more than four

Examples of pneumatic boring tools, which are commonly called missiles because of their shape.



sites were planned at a given time. Unfortunately, the low site volume did not justify the increased cost to deploy faster, nondestructive excavation methods. As a result, AWS was asked to cut and restore concrete on all project sites where the pathway crossed concrete, greatly increasing the cost per site.

A New Approach

Because the volume of sites was decreased and all sites awarded to AWS needed to cross a concrete structure, the labor and method profiles were adjusted drastically. The crew size was trimmed to three, including one supervisor and two unskilled laborers. Also, the methodology was changed to cut and restore concrete by hand after some trial and error to find the most efficient and cost-effective methods.

Production Notes

There were some notable items that were necessary to increase organizational efficiency. This case study will briefly touch on these items and spend more time discussing the concrete work, which was a significant factor behind project cost and time consumed.

Materials staging: Staging equipment at a warehouse or other facility is necessary to prevent damage or loss and would have significantly decreased AWS deployment time. In the beginning of the deployment, materials were distributed to AWS on the morning or evening ahead of each installation. Once materials were being distributed well ahead of schedule, the project efficiency increased by over 20 percent.

Spoils: The timing of dumping spoils is critical. AWS found it was most efficient to keep a dump trailer with enough capacity to time dump trips before available work hours. Most dump sites open between 5 a.m. and 6 a.m., and only one staff member is required for these dump trips.

Site planning: In most cases, the crews were finished by 1 p.m. But because no other sites were available, the crews could not move on to perform work elsewhere.

Exothermic welding: In wet climates, exothermic weld modes should

	Average Daily Sites per Crew (per geographic area)	Minimum Cx Volume Recommended (per geographic area)	Risk of Damages (exist utilities/property)	Cost per Installation
Non-destructive (such as hydrovac)	5.25	45	very low	lowest
Hand-dig excavation	2	10	medium	high
Machine-assisted excavation (no machine digging)	2.25	15	medium	highest
Machine-dig excavation	4.5	25	high	low

be used. During rainy days or days with high humidity, the one-shot style of field welds were not successful

Concrete management: The customer initially required AWS to leave staff to watch concrete dry and divert pedestrian traffic. This was found to be an expensive solution to a low-risk problem. Instead, an elaborate barricade and adequate signage was able to effectively prevent disturbance by pedestrian traffic.

Concrete Work

In all cases, full sections of sidewalk concrete were cut and separated from the structure per city ordinance. After that, several demolition methods were trialed to ascertain the most effective and efficient practice.

Concrete Breaker

First, a hand-held concrete breaker (jackhammer) was used to break each concrete section. This method was effective. But the concrete breaker did not have a significant effect on labor time or laborers' fatigue. Also, this method added extra risk of injury and equipment costs.

Machine-mounted breaker

Second, a machine-mounted breaker was used to break each concrete section with mechanical removal. In these cases, a bucket could be used for removal of large concrete debris. Although this method offered a significant reduction in fatigue, the AWS teams noted the movement of machinery and time of excavation actually increased by 7.8 percent over a weeklong period. There were also several work locations where the machinery was not used because it could not access the work area without risk of damage to property.

> "All of the current major U.S. carriers, a group we call VAST, …have experienced similar data-use growth patterns."

Cut-and-Bust Method

Finally, because of the size of the patches that need to be replaced and typical locations, the most effective demolition method was found to be the cut-and-bust method. In these cases, the crew simply made two or three additional cuts into the concrete. The additional cuts added about 20 minutes of cutting time and about 35 percent more use on each of the saw blades. But it significantly reduced labor time, equipment costs and labor fatigue when compared with the other methods. This method emerged as the most effective type of demolition for sites that require cut and restoration of concrete.

Recommendations

After extensive study and examination, AWS has compiled a list of recommendations for carriers and providers to successfully complete cabinet-to-pole (C2P) installations with maximum efficiency and quality.

- Release adequate volume sites (often limited by permit and material availability) for construction in batches of no less than 45 continuous site builds for maximum efficiency.
- Use nondestructive methods for

excavation, such as a water and vacuum excavation (hydrovac), as appropriate. Please note that compressed air methods (air knife) may not be appropriate in residential areas, near parking areas, or in areas with high pedestrian or vehicle traffic.

- Distribute materials to support at least one week's project activity ahead of installation.
- Plan for excavation waste and excavation spoils to be transported outside of work hours.

Find a ready source of water to be filled outside of work hours.

Excavation Methods

The table on page 26 compares each of the excavation methods available.

Nondestructive: The preferred methods are the nondestructive methods that can increase production a great deal and have the lowest risk of damage to existing utilities and property. Also, the cost of installation is lower than all other methods. This method requires the most volume to become efficient.

Hand-dig excavation: This method is most commonly used by carriers and service providers for C2P installation. This method has a fairly low cost of installation. But the site production volume per crew is lower than any other method. Notable, but manageable risks to existing utilities and property remain.

Machine-assisted excavation: This method has similar benefits and limitations to the hand-dig method, but only offers a marginal increase in production. In this method, a machine is used only for concrete demolition and removal of concrete and spoils.

Machine-dig excavation: This method offers a significant production advantage and limits labor costs. However, this method significantly increases the risk of damage to existing utilities and property. In many municipalities, this method is prohibited because of increased risk of damages. ■

"Bobby Mack" McClung is CEO of AWS Communications. His email address is bmack@awscom.net. *Christopher Ortega is an engineer at AWS Communications.*