

Telecom Connections

Esri • Fall 2011

GIS for Telecommunications

Movin' on Up RCN Expands to Northeast Corridor and Chicago Markets

Expansion across its big-city markets raised a key network documentation challenge for RCN Telecom Services, LLC, based in Princeton, New Jersey.

RCN is a competitive broadband service provider that delivers all-digital and high-definition video, high-speed Internet, and premium voice services. Its services are made available to residential and small-medium business customers under the brand names RCN and RCN Business Services, respec-

tively. RCN's primary service areas include Washington, D.C.; Philadelphia and Lehigh Valley, Pennsylvania; New York City, New York; Boston, Massachusetts; and Chicago, Illinois.

All services are provided through an advanced hybrid fiber-coaxial network, a platform that increases high-definition availability for improved picture quality to cable TV customers and enables cable modem speeds that challenge industry standards. These capabilities—and the company's culture of in-

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novation—are supporting the organization's successful expansion in its strategic Northeast Corridor and Chicago markets.

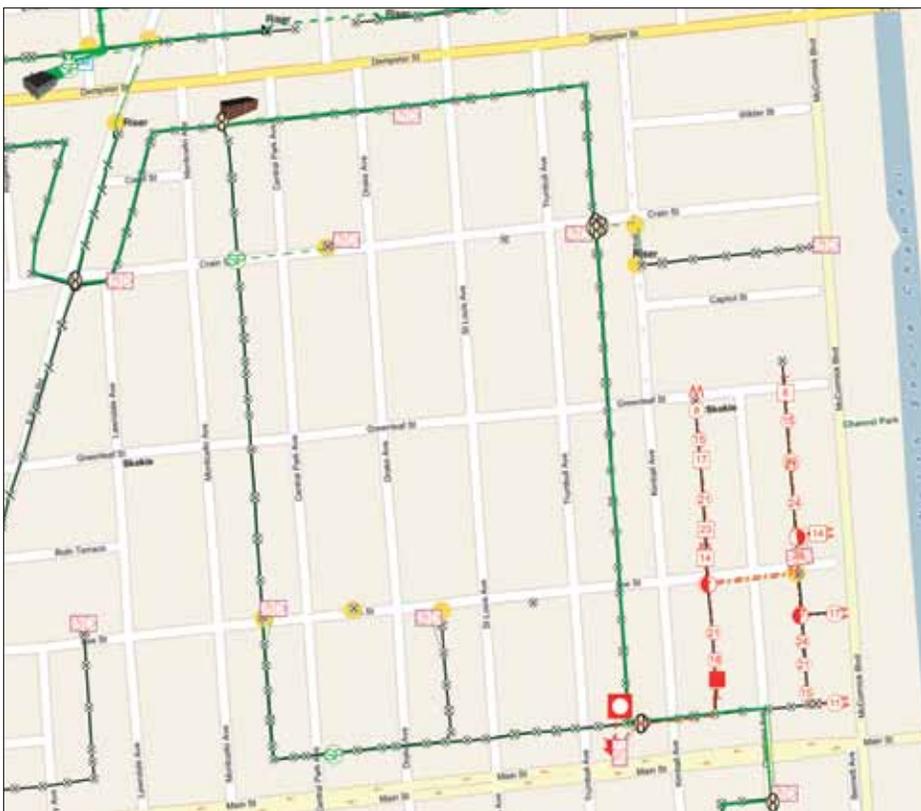
In preparing for this expansion, RCN operators noted that the company's fiber-optic networks were documented through various and multiple systems including CAD maps, stick drawings, splice diagrams, and splice sheets.

"For all the service territories, there must have been hundreds, even thousands, of CAD documents," said Chris Augustine, RCN network engineering manager.

Augustine explained that RCN staff wanted to move away from paper and toward a GIS-based solution. The GIS had to be able to tell network personnel where the fiber-optics were physically located, how much was available, and how many nodes there were for any hub site. Such information was necessary to streamline asset management and customer service.

After evaluating several vendor products, RCN selected Telvent's Fiber Manager solution, an extension of Telvent ArcFM Enterprise GIS that is based on the Esri ArcGIS platform. Augustine and his team found that the GIS solution made it easy to enter, update, and work with network connectivity.

"Esri technology, the industry GIS leader, was one of the reasons we zoomed in on the ArcFM GIS and Fiber Manager solutions," said Augustine. "We also found Telvent's Fiber



RCN can view its network elements such as the hub site (upper left), fiber-optic-fed commercial buildings (top center), the fiber-optic network out to the node, and the coaxial facilities out to the taps in front of the customer's home.

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Good Vibes at the TelUG Meeting

This summer, the Telecommunications User Group (TelUG) held a special meeting the Sunday before the kickoff of the 2011 Esri International User Conference (Esri UC).

It was a distinct opportunity for industry professionals to share a day devoted to discussing mutual challenges and sharing successful solutions. Attendees were also able to explore new and proven ArcGIS tools. Esri development staff, eager for feedback, had a chance to better understand specific telecommunication company needs.

“There are a lot of common issues to explore and discuss,” said Deborah Salazar, GIS project manager for Time Warner Cable, who attended the TelUG meeting. “It’s interesting that we have similar challenges. Many of us have a fairly recent GIS launch, massive datasets made even more complex with legacy CAD formatting, and a lot of immediate operational needs. And, we are in an economically healthy business niche. For GIS, this is a good place to be, with lots of work ahead.”

Salazar went into the TelUG meeting with a specific goal—to talk to people about financial modeling—and found the conversations to be insightful as well as useful.

“I should also say I especially liked the ice-breaker,” Salazar added. “I might not have met a lot of those folks if it weren’t for that activity.”

To build on the camaraderie, Esri staff shared information about how the TelUG can stay connected throughout the year and how to maximize the experience of the Esri UC. Esri experts also shared information about industry trends, advances in ArcGIS for telecommunications, the Resource Center, and enterprise applications.

“We were so pleased by the healthy turnout and energetic group,” said Randy Frantz, Esri director of telecommunications and location-based services (LBS) solutions. “The strength of our telecommunications community and efforts to collaborate will continue to benefit us all.”

Visit esri.com/telug.

Why Join TelUG?

The Telecommunications User Group (TelUG) is a community of people dedicated to sharing information, ideas, and experiences about Esri technology in the telecommunications industry.

By joining TelUG, users benefit from intellectual collaboration with and personal inspiration of their peers. They can discuss challenges about GIS in the telecommunications industry with users from around the world as well as Esri staff.



Free TelUG Webinar Series

Take part in the free TelUG Webinar Series to learn about the latest technology and techniques. We will discuss issues such as 3D imagery for joint use, network decision making, schematics, and mobile rollout. Past presentations can also be viewed online.

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Delivering Broadband to Rural Areas

By Randy Frantz,
Esri Director of Telecommunications and
Location-Based Services (LBS) Solutions

There is a storm brewing in rural America, and it will sweep through the telecommunications industry like a tsunami. However, unlike a real-world tsunami that strikes with little warning, this one—the conversion of the cost-based Universal Service Fund (USF) to a capital Connect America Fund (CAF)—has been on the horizon for several years.

The USF is designed to promote the availability of quality telecommunications services at reasonable rates to high-cost rural areas through subsidies. The program is funded by telecommunication providers through an assessment on interstate and international revenues.

Although the USF has its critics, there is no doubt that the program has delivered affordable telephone service to millions of rural Americans. However, the Federal Communications Commission's (FCC) National Broadband Plan, revealed in 2010, clearly articulated the worldwide shift from voice to broadband services and advocates accelerating the delivery of broadband services to unserved areas of rural America. It is only natural that future funding programs should support this shift.

FCC is proposing the creation of a CAF that would redirect some of the current \$8.7 billion USF to a capital program to build broadband networks in unserved rural areas. These networks, once constructed, need to be self-sufficient and operationally profitable, with reduced subsidies to fund ongoing operations. This shift will significantly alter emphasis from supporting voice services to delivering broadband technology in rural America. Service providers will need to reduce costs and invest heavily in new network technology.

GIS will play a significant role in helping companies deliver broadband services just as it is already playing a role in supporting broadband projects funded through the American Recovery and Reinvestment Act of 2009. Companies that received an award realized that to efficiently operate and maintain these new networks, they needed better tools for market analysis, asset management, and response to customer service requests. By documenting networks in a GIS, operators are able to meet all these goals.

In many ways, GIS is as important as the networks themselves in ensuring that rural areas have access to broadband services. Only if they can be built and operated economically will the networks be constructed and customers connected.

Best regards,

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Fiber Network in View for Benton Public Utility District

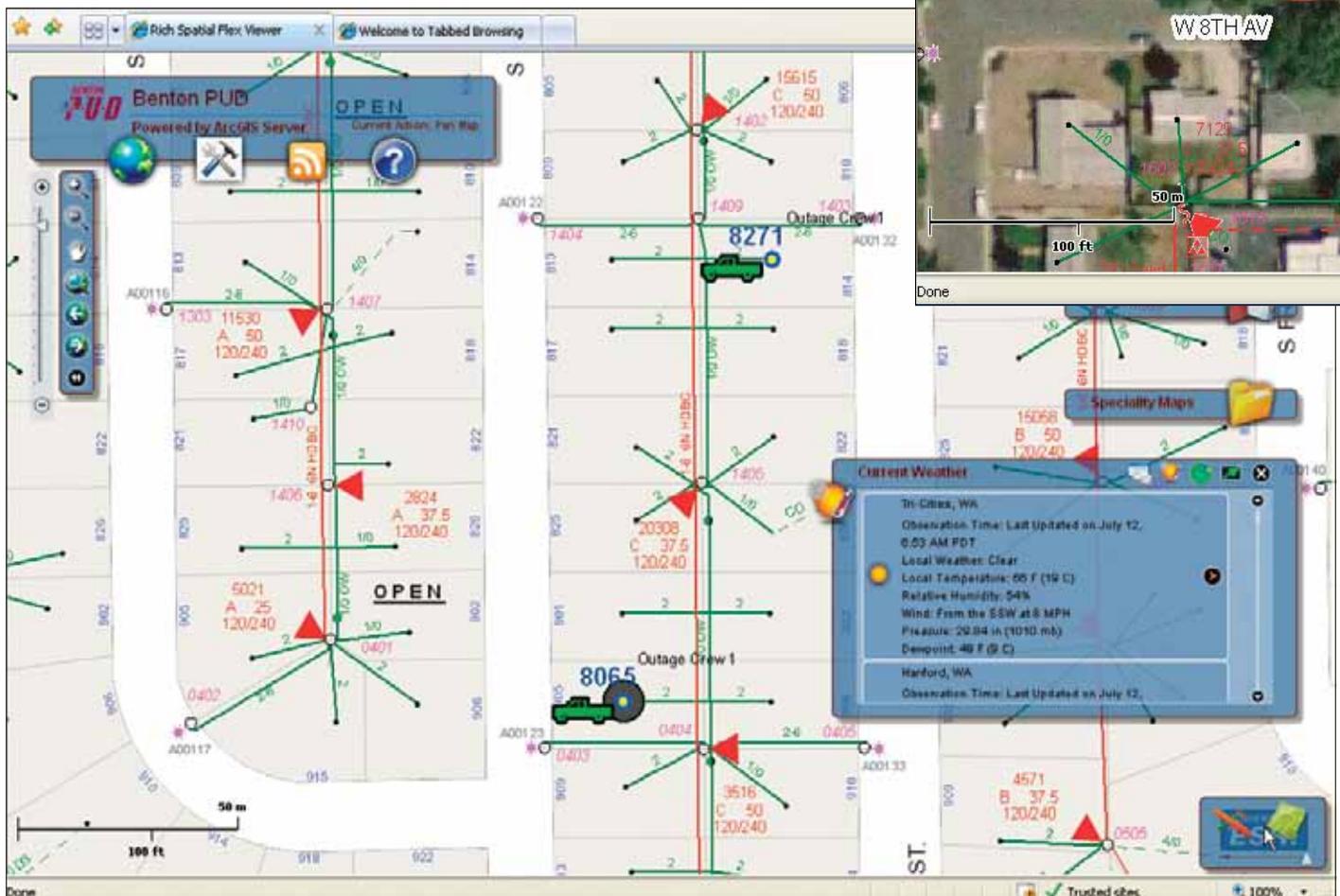
By Jessica Wyland, Esri Writer

Benton Public Utility District (PUD) now has a single, real-time picture of its entire fiber-optic and electric networks available electronically to all staff. That picture includes data stored in a database and integrated from disparate systems such as SCADA and customer information. Additionally, the Benton PUD database offers version management so multiple users can work simultaneously. The system supports network tracing that enables field crews to see accurate asset information and identify affected customers during an outage.

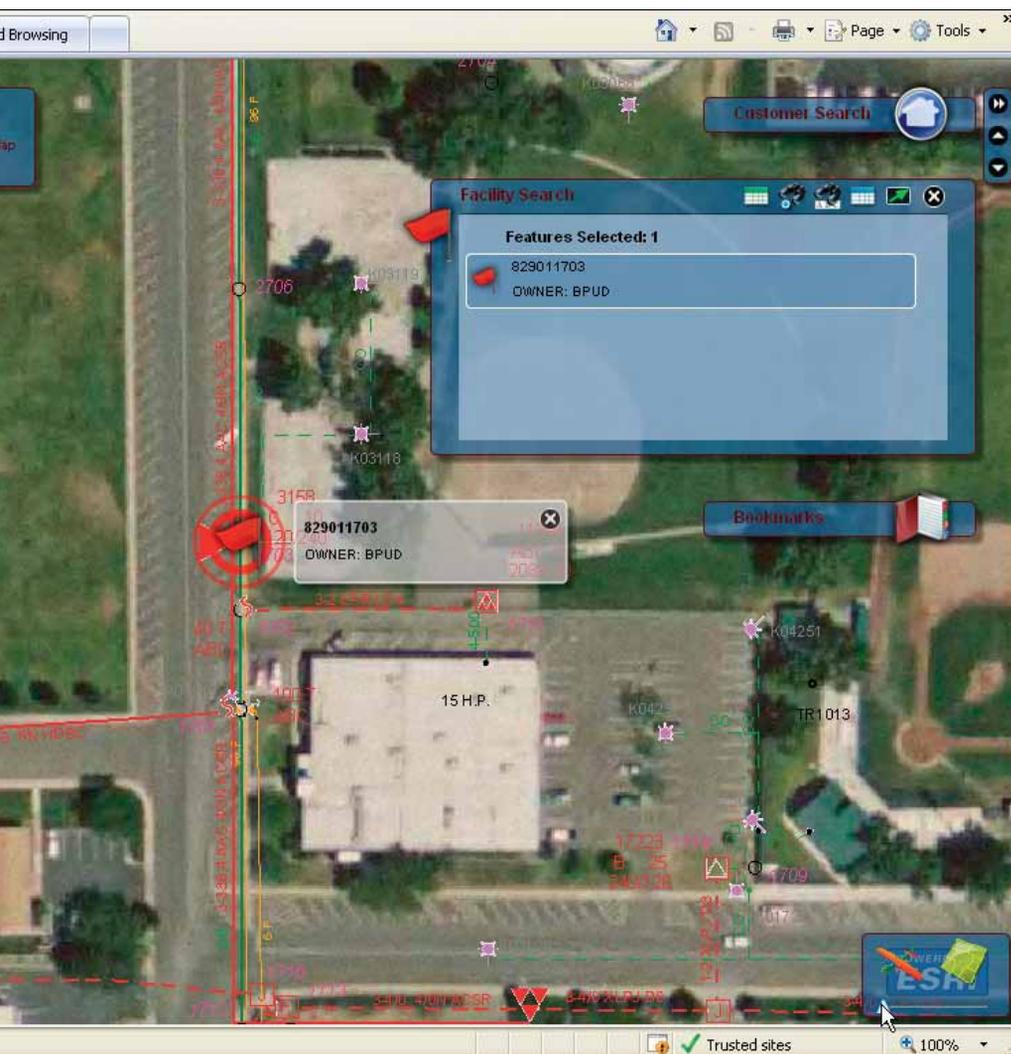
Benton PUD supports broadband services to more than 800 wholesale customers covering more than 900 square miles of service territory as well as transmission and distribution of electric energy to more than 48,000 electric customers.

A municipal corporation of the State of Washington, Benton PUD is headquartered in Kennewick and was established in 1946. The company manages more than 150 miles of fiber-optic cables, 37 substations, approximately 90 miles of 115 kV transmission lines, and 1,590 miles of distribution lines.

The company selected Esri's ArcGIS technology because of its ability to provide staff in the office and field with an accurate picture of the electric and fiber-optic networks. Benton PUD was able to integrate ArcGIS with other internal and external systems using a real-time service-oriented architecture (SOA) that includes SCADA; the off-site after-hours call center; customer information; light and transformer asset data; financial and FERC accounting data; and time, labor, and work order information. Now, users access any necessary



A real-time display of data from the outage management system shows a single customer outage, identifies that the customer called the after-hours call center, and notes that Benton PUD has assigned a crew to the incident.



In this screen shot, a Facility Locate widget helps Benton PUD locate a specific transformer along with pertinent data. This widget allows users to search for nearly every type of electric and broadband facility in the geodatabase including poles, vaults, switches, lights, and sectionalizers. Aerial photo transparency can be adjusted by a slider bar in the lower left corner using a widget available from ArcGIS Online. All widgets used by Benton PUD are developed by Esri or the user community and can be downloaded for free.

data, bring it to ArcGIS, and work with a personal or enterprise geodatabase.

One person on a mobile device can send updates to asset or customer data in the field as another person analyzes this information on the desktop using web browsers. ArcGIS also comes equipped with the version management and network tracing capabilities that Benton PUD desires.

Using Esri's ArcGIS technology, Benton PUD is saving time and money with a single, real-time picture of its entire fiber-optic and electric networks available to all staff simul-

taneously. Disparate systems are integrated, and the database system supports both version management and network tracing.

"During the year following implementation of ArcGIS, we saved \$240,000 in labor and materials," said Chris Folta, Benton PUD manager of applications and integration. "The intangible return on investment is how quickly we can access data and turn it into actionable information. The operations team can see, at any time, the current state of the electric and fiber-optic networks, the location and scope of engineering projects, where outage crews are

working, and how customers are affected by interruptions to the system."

Utility field crews and office staff can now access the most current information from a mobile or desktop computer. In the field, workers are able to trace the network to see, for example, which customers would be out of power if they opened a switch. Aerial photographs and GPS data bolster the utility's customer and asset information. With a completely electronic system, the utility no longer prints copies of network maps—a change that saves time and resources.

Benton PUD's data is kept in sync in near real time. Before upgrading its technology, the company averaged a five-week turnaround time for information update on the map. Now, the average is three days.

"We have been able to lower the duration of customer outages, improve crew response time, and reduce labor and overtime costs that were a result of inaccurate information in the legacy paper maps," said Folta. "Instead of looking for physical copies of work order and mapping information, staff can use the GIS tools to find the information they need. The field crews go out each day with an updated facility map that includes customer information, usage history, and work orders to accomplish their tasks."

RF Cleanup

By Mark Reddick, Esri Technical Marketing

Wireless carriers rely on accurate RF propagation predictions for network modeling and planning. Engineers use this data to identify areas with poor quality of service, limited capacity, or an underserved population.

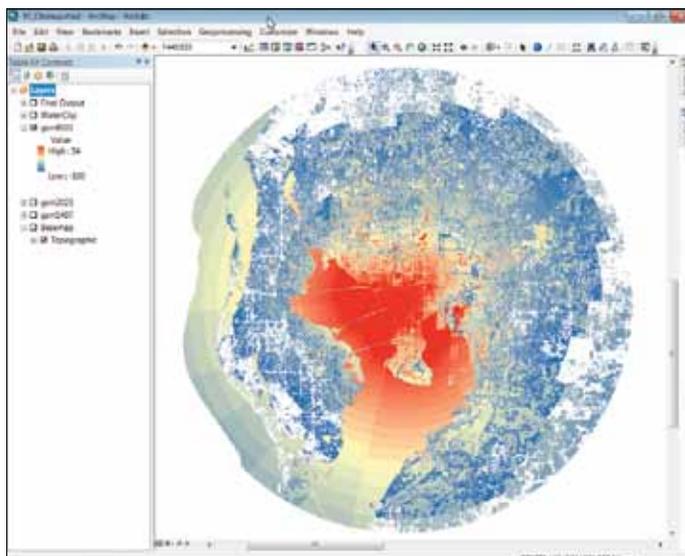
While RF prediction data is generated at a granular level for engineering purposes, it is ultimately reused and exposed to roaming partners, external organizations, and the general public via coverage locator apps. Many other users do not understand the intricacies of RF propagation well enough to gain value from engineering-level information. Also, exposing this level of detail outside the organization is not in the best interest of companies wishing to keep an edge over competition.

The challenge for carriers is to communicate coverage areas in a way that is accurate and clear but does not reveal too much competitive information. GIS can help by providing standard geoprocessing tools to create automated processes that clean up radio signal propagation data. Most companies look for the following criteria in wireless data they share:

- Three or five bands of signal strength measurement representing fair, good, very good, excellent
- Smoothed output so there is no pixelation or “bins” in the output
- Outlier removal, or the removal of individual pixels or small groups of extraneous pixels
- The removal of coverage areas over water

How GIS Can Deliver These Results

Take, for example, a single tower location prediction. This article will look at the individual geoprocessing tools needed to get the desired effects on the data. The picture below shows the output result for a single signal strength prediction for a Global System for Mobile Communications (GSM) tower location. The prediction shows areas of stronger signal in red and weaker in blue. The complete set of values (-100 to 56) is shown and represented in



the output. One of these GRID files will exist for each tower location with other aggregated files that combine potentially thousands of such predictions into one GRID.

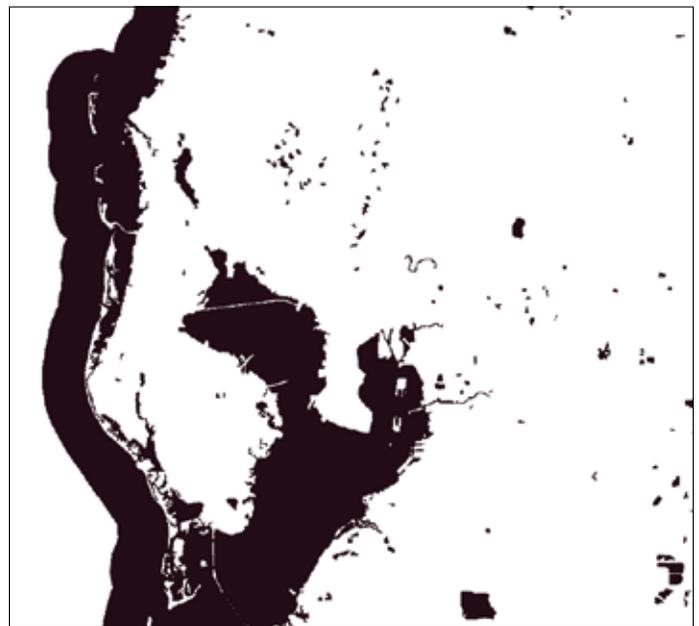
There is no existing standard process to perform RF cleanup. Many different tools in the geoprocessing framework could be used to obtain the same effect. Following is a sample process:

Step 1: Clip Water Features

First, clip the RF coverage, removing all data over water. This is done to comply with Federal Communications Commission (FCC) rules, as coverage predictions over water cannot be verified with a drive test. Using a polygon water areas dataset, generate a raster-based mask.

The **Polygon to Raster** tool converts water polygon features to a raster dataset. Use a significantly small value for the cell size to capture the detail in the water areas.

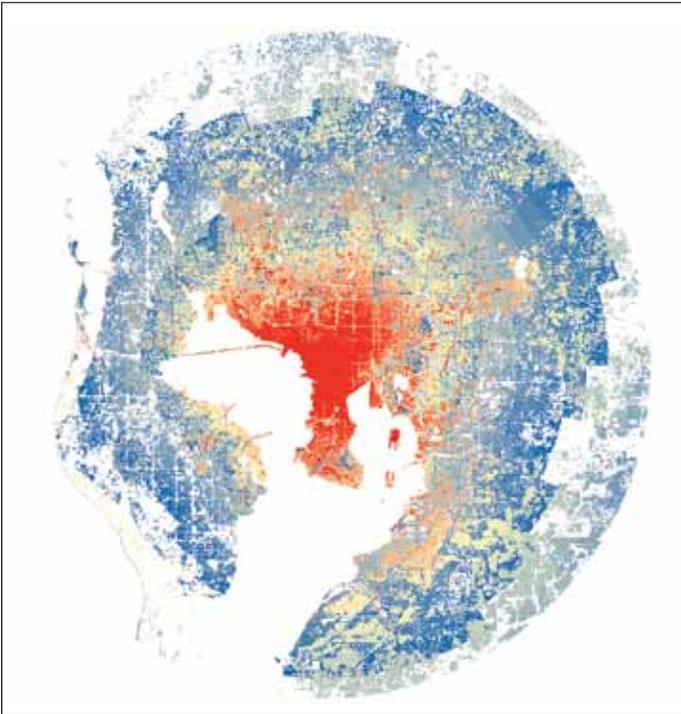
The output of this tool will look something like the following:



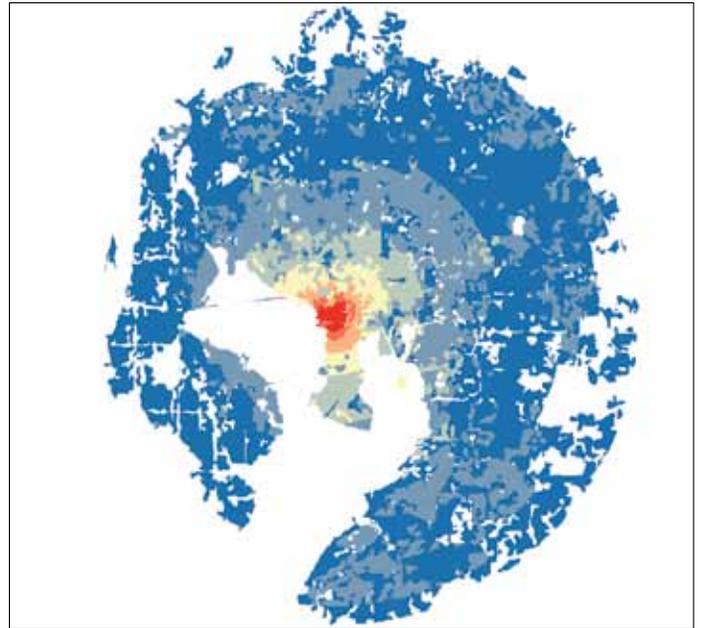
Now, with a water mask, use the Spatial Analyst **Raster Calculator** tool and an equation such as $Con(IsNull("Water Clip"), "prediction")$ to set all “over water” values to NoData for any prediction.

Use the *IsNull* function to identify all areas not covered by the water mask. In the conditional True case, write out the value of the prediction raster. In the False case (i.e., over water), write out the value NoData (through the absence of the last parameter).

This produces the following clipped raster:

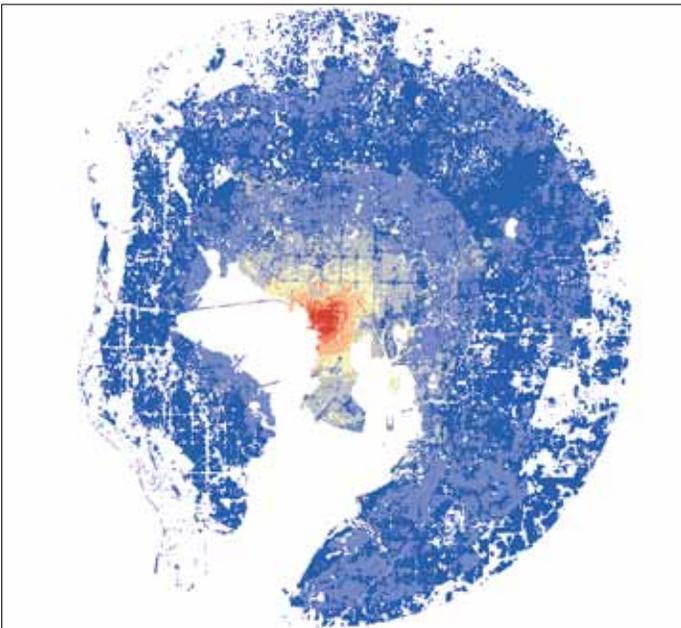


After the first run of Majority Filter, there are fewer outliers; repeated runs of Majority Filter produce a cleaner product.



Step 2: Reduce Detail

The next step is to use the **Reclassify** tool to change the values in the raster. This tool will immediately generalize the data and remove a lot of the details, simplifying the remaining processing for the other tools. In this case, having applied a seven-band reclassification produces the following:



Step 4: Convert to Vector

Converting the raster to vector enables the use of other geoprocessing tools to further refine the output. Use **Raster to Polygon** to convert the raster dataset to polygon features.

This produces output similar to the following, where each polygon delineates an area of equal signal strength:



Step 3: Raster Filter Processing

The **Majority Filter** tool allows replacement of cells in a raster based on the majority of the contiguous neighboring cells. Using the **HALF** option will have a more smoothing effect on the output. This tool can be run multiple times to obtain the desired level of cleanup.

Other feature-based analysis tools can now be used to smooth and generalize the data.

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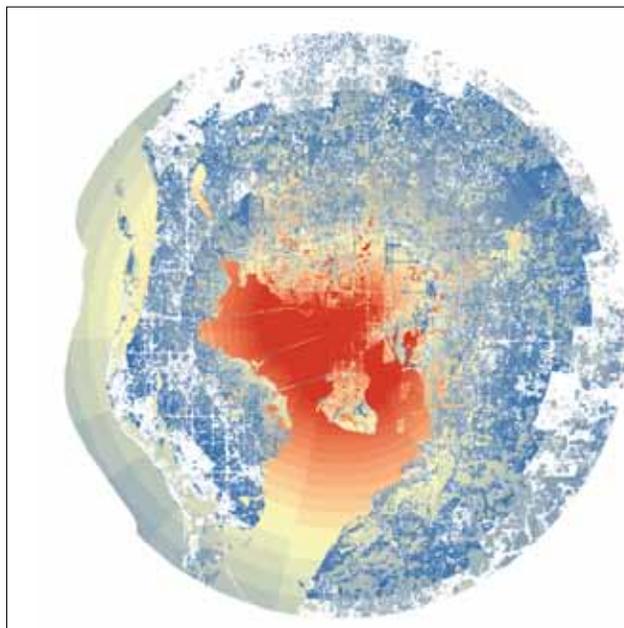
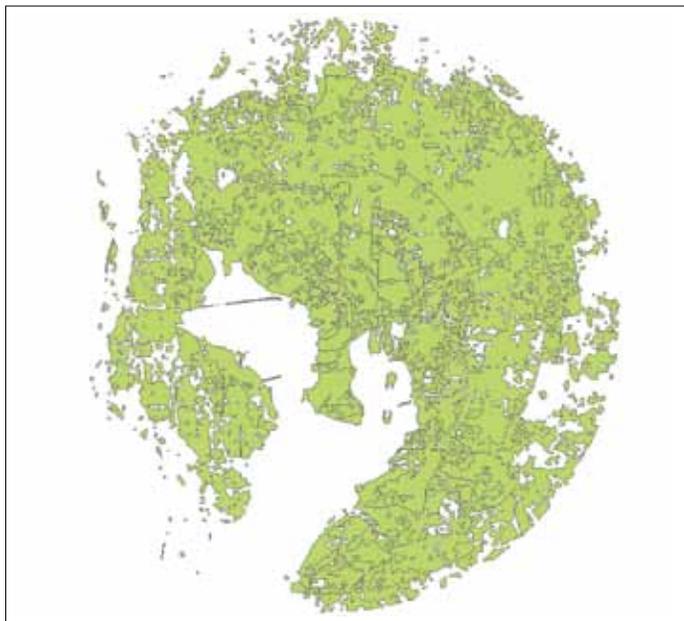
RF Cleanup

Step 5: Eliminate

The **Eliminate** tool gets rid of polygons by merging them with neighboring polygons that have the largest area or the longest shared border. This again can be used to remove those anomalous areas of coverage.

The Eliminate tool requires a selection set to work on. The best option is to eliminate only the smaller areas that represent insignificant details. These can be identified using the **Select By Attributes** tool with an expression such as "Shape_Area" < 250000. Again, it makes sense to run some of the feature-based tools multiple times to increase the level of cleanup.

Another tool, **Eliminate Polygon Part**, performs a similar but stronger removal technique, deleting external outliers and merging internal areas of a defined size.



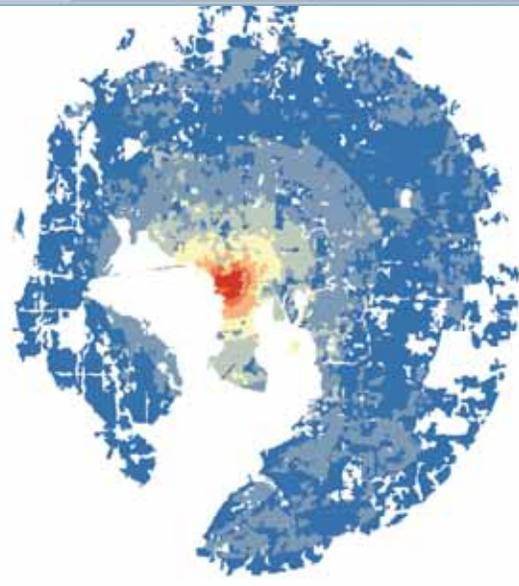
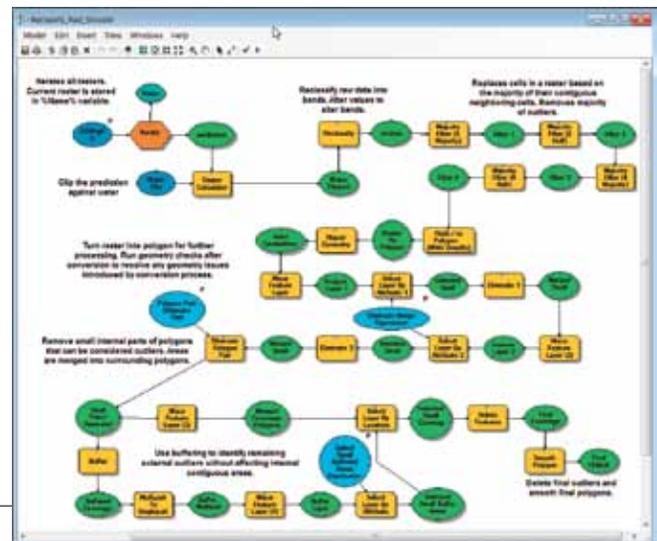
Step 6: Smooth Polygons

Finally, the smoothing process is done using the **Smooth Polygon** tool, which allows control of the level of smoothing applied and tolerances for point fitting or removal.

Applying colors to the classified and smoothed polygons results in a near-ready product (original shown on bottom left) that is more meaningful to general users.

Wrap-up: Process Automation

These tools help companies accomplish goals. To run the tools separately would be a time-consuming, inefficient method. With Esri **ModelBuilder**, users can consolidate and automate this process. ModelBuilder provides a graphic modeling framework for designing and implementing geoprocessing models that can include tools, scripts, and data. The model below includes all the above tools in one easy-to-run process. The model, along with the raw RF and data that has been cleaned up, is available for download at <http://bit.ly/EsriRF>.



Telecom Companies Honored at the Esri UC

Esri acknowledged innovative and intelligent applications of GIS technology with the Special Achievement in GIS (SAG) Awards ceremony at the annual Esri International User Conference (Esri UC) in San Diego, California.

“The SAG Awards highlight extraordinary achievements and efforts to improve our world,” said Esri president Jack Dangermond. “Each year, I look forward to being part of this ceremony. It is a tradition that means a great deal to Esri and to GIS professionals.”

The SAG Awards ceremony was held at the San Diego Convention Center and presided over by Dangermond. Thousands of SAG Award nominations are submitted by Esri staff every year and then personally reviewed and selected by Dangermond.

Organizations being honored at the Esri UC span countries worldwide and industries including agriculture, cartography, climate change, defense and intelligence, economic development, education, government, health and human services, telecommunications, and utilities.

More information about the 2011 Special Achievement in GIS Award winners, including project information and photos, is available at esri.com/sag.



Palmetto Rural Telephone Cooperative, USA
Members of Palmetto Rural Telephone Cooperative accepted a 2011 SAG Award from Esri president Jack Dangermond.



France Telecom/Orange France, France
Members of France Telecom/Orange France accepted a 2011 SAG Award from Esri president Jack Dangermond.



Etihad Etisalat Company (Mobily), Saudi Arabia
Khaled Al-Moammar, MIS president, presented a 2011 SAG Award to Abdulaziz Al-Tamami, COO of Mobily.



SAG Award winners in the telecommunications industry include

Etihad Etisalat Company (Mobily), Saudi Arabia

France Telecom/Orange France, France

Palmetto Rural Telephone Cooperative, USA

Telesur, Suriname

TEO LT, AB, Lithuania

Movin' on Up

Manager to be less complicated for managing and creating fiber facilities data compared to other GIS products we considered.”

Implementation began in 2009 with a small pilot project and was extended through all RCN service territories, with almost 100 percent of the company’s extensive fiber-optic network database completed in late 2010.

Standardized Network Asset Management

All RCN markets now operate with a common and centralized network infrastructure management system that supports efficient communication, planning, and reporting. Operations within each service territory share a central database that is updated to provide more accurate information to everyone.

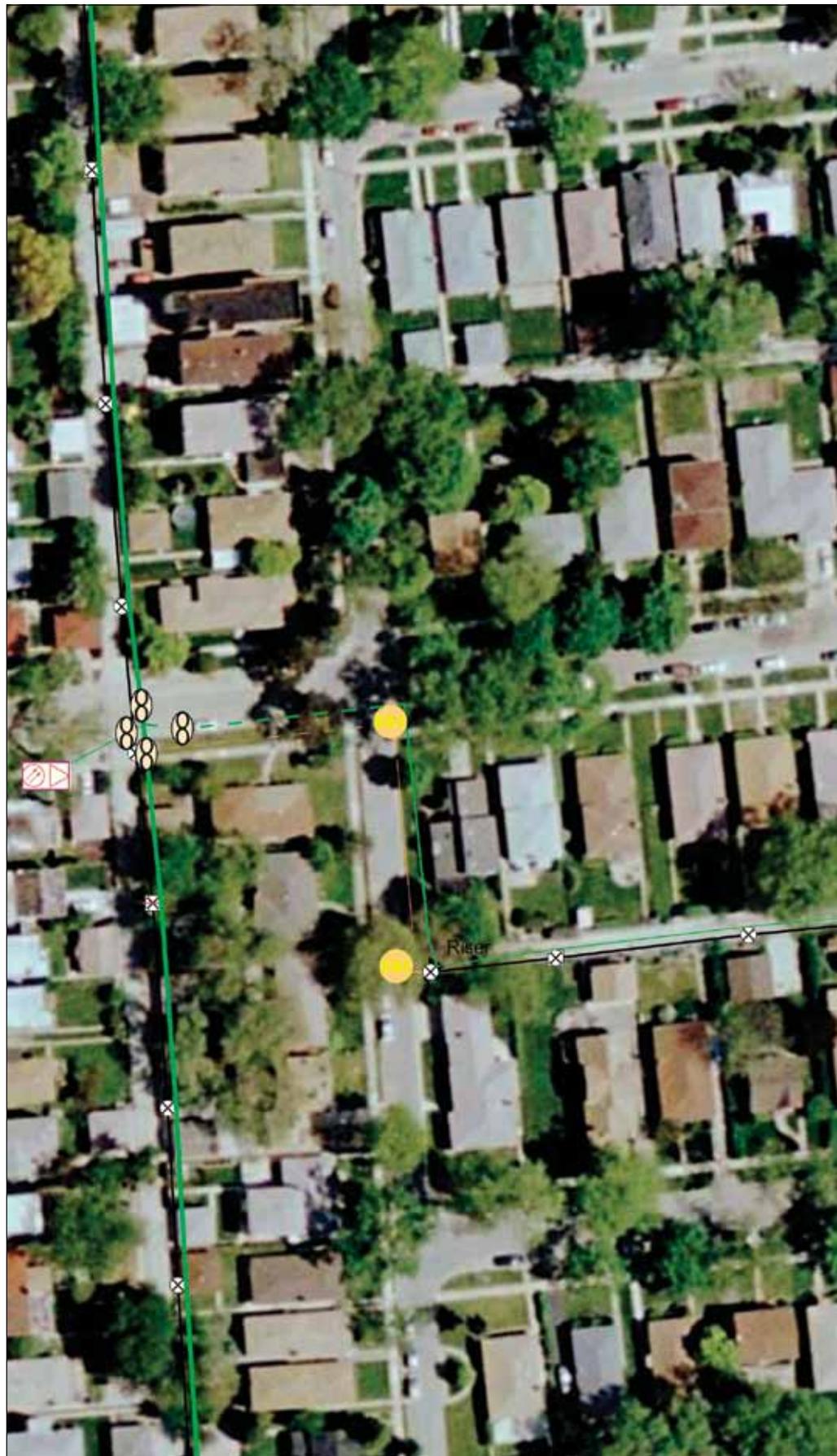
“We can now locate fiber assets from our office,” said Augustine. “We don’t have to spend the time and labor to visit the field to identify and confirm assets.”

Flexible Data Modeling—Adding Coaxial Facilities to Complete the Network

Fiber Manager’s Flexible Data Model sparked RCN’s innovative juices. Working with Telvent, RCN capitalized on the ability to extend the solution to include the coaxial network. The addition of coaxial facilities to the data model was done completely through system configuration and did not require customization.

Now, having modeled its network from MegaPop to node, RCN has begun coaxial modeling from node to tap. This will ultimately create a complete network management system comprising fiber-optic, node, coax cables, taps, amplifiers, mini bridgers, splitters, terminators, and power supplies that will maximize RCN’s investment in GIS technology.

This is the first GIS-based hybrid fiber coaxial (HFC) application of its kind. It offers the unique ability to trace the communications network from the fiber-optic patch panel through the fiber-optic and coaxial network to the tap. It also allows tracing of the RF power network separately. This capability helps RCN realize more accurate and efficient management of each component of the communica-





tions network and optimize maintenance and customer service.

“The segregated tracing allows us to separately monitor two different networks in one system,” Augustine said. “In addition, we can easily track customers and equipment affected by an outage anywhere along our network, from the MegaPop to the customer.”

Customer Database Management

Accurate geodatabase profiling of its fiber-optic networks helps RCN easily identify the proximity of existing network assets to customers and noncustomers. This information has been highly valuable in helping RCN efficiently recruit new customers and assess the cost and returns of potential network expansions.

With improved management of its advanced fiber-optic and coaxial networks, RCN is able to implement network expansion more efficiently, optimize customer satisfaction during the process, and retain customers to stay ahead of the competition.

“The biggest advantage we have found with GIS is a consistent database that tells us where our network is and how it is connected,” Augustine said. “It gives us the ability to put that information in the hands of everyone who needs it.”

Visit esri.com/telecom. For more on Telvent, visit telvent.com.

GIS gives RCN the ability to manage its network assets more effectively by including information about the surrounding areas, such as satellite imagery.



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