



Wired in San Diego

Mapping Bandwidth Bay

Using Internet-based GIS, the City of San Diego, California, has made locating downtown broadband network access as simple as surfing the Net.

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With more than 70,000 strand miles of backbone and end-user fiber-optic and copper cable beneath hundreds of miles of streets, San Diego, California, is one of the most wired cities in the entire United States. The city's extensive bandwidth and its beautiful bay-front setting have earned it the nickname Bandwidth Bay.

The city is hoping its comprehensive infrastructure — which enables everything from small start-ups to large tech firms to move in, plug in, and go to work — will continue to attract business. Drawn by just such advantages, as well as tax incentives, several Internet companies, including Yahoo!, Simplenet, Cayenta.com, and Collegeclub.com, have already relocated to downtown.

But where is the network? Who owns it and how can it be accessed? These are impor-

tant questions often asked by businesses or individuals considering a downtown site. Readily connecting to a broadband can be critical to the successful operation of a business, enabling it to access, provide, or share products and services across the Internet.

A project sets sail

In downtown, or Centre City, a dozen service providers own the network, and another dozen firms manage the many commercial and residential buildings that are wired to it.

To provide information about San Diego's infrastructure, those with a stake in the economic development of the city — including the downtown San Diego Business Partnership, Centre City Development Corporation, and the City of San Diego — launched

Glossary

HTML: Hypertext markup language

SanGIS: San Diego Geographic Information Source

XML: Extensible markup language

the Bandwidth Bay project (www.bandwidthbay.org). Bandwidth Bay provides information about opportunities and incentives to developers, realtors, businesses, and individuals.

As a Bandwidth Bay partner, the City of San Diego (www.ci.san-diego.ca.us) developed an interactive, Internet mapping application for viewing, querying and printing key information about downtown and the supporting broadband network. As far as we know, this is the first application of its kind in the country. Its development was requested by the city's chief information officer and the city's GIS manager.

Unfurling Fiber Map

The Bandwidth Bay Fiber Network mapping application, or Fiber Map, is based on a multicomponent commercial software product that provides a foundation for presenting GIS and mapping services across the Internet.

Fiber Map took about two weeks to create using a commercial off-the-shelf GIS package. It was based on a prototype developed several weeks earlier. Both the prototype and the final application were designed and programmed by the GIS coordinator for the city's planning department.

First, the application developer created four digital layers of wired buildings and fiber network information. The spatial information showing the building footprints was screen digitized from 1-foot resolution aerial orthophotography that the city had acquired for a previous mapping project in 1999.

Next, the developer created a database containing nine information fields for each of the buildings. This database was populated by relating three tables and spreadsheets provided by Bandwidth Bay staff. For graphic purposes, another building layer was also created to show only the building footprint and name.

The digital layer of wired streets was also created by interpreting TIGER file maps that a city affiliate had created in 1999. This interpretation was necessary to identify and extract much more spatially accurate street centerlines from the city's landbase. Added to these centerlines was a new database identifying which of the eight Internet service providers has infrastructure under each segment of roadway. The next new layer contained the URL for those providers.

Fiber Map also includes nine other information layers. Many of these layers had been previously created by the city's planning and other departments, as well as the County of San Diego. The developer accessed these layers through the city's local area network connection to the SanGIS (www.sangis.org).

SanGIS is a joint powers agency formed by the City and County of San Diego to

serve as a digital geographic data warehouse. Most digital geographic information that has been developed by either entity is provided to SanGIS for easier public access. The fiber network and building information that the city digitized for Fiber Map, for example, is available through SanGIS.

Much more than just a fiber network mapping application, Bandwidth Bay Fiber Map provides a host of queries for listing

FIGURE 1 When users launch the Fiber Map application, they first see a general view of downtown San Diego with shaded community planning areas and the fiber network layer overlaid.

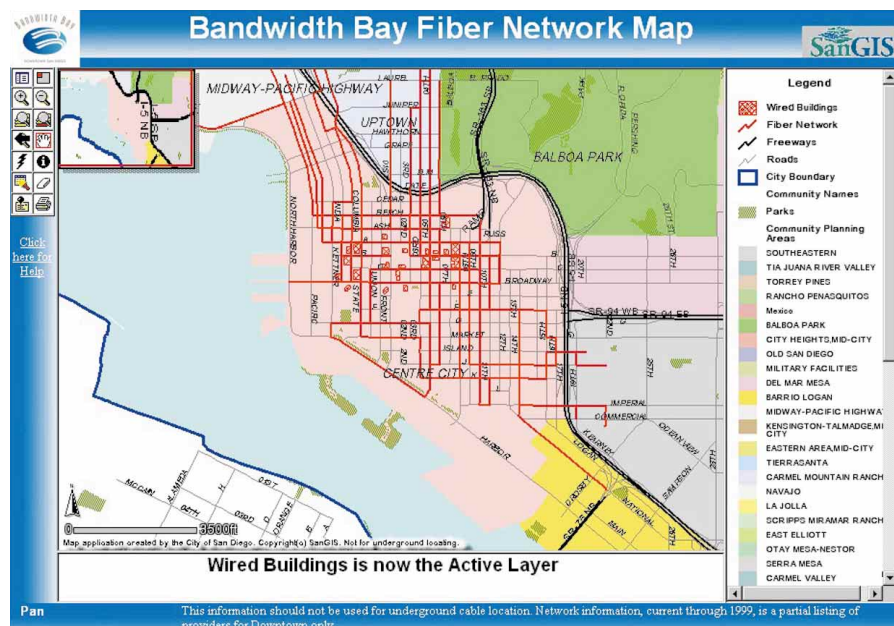
and locating service providers, buildings, property managers, addresses, assessor parcels, aerial orthophotography, hyperlinks, streets, and other information. With direct and visual access to business contact information of the building managers and service providers, Fiber Map makes it much easier for someone to find the best possible downtown location for their new or existing venture. Making this information readily available also benefits building managers and Internet service providers.

Coming aboard

Using a Netscape or Internet Explorer browser, a user can access the Fiber Map front page at <http://www.sangis.org/sangis/intmaps/fibermap.htm>. This page describes Bandwidth Bay and the mapping application. (Visitors can also access this application from the Bandwidth Bay site.) Using the link at the bottom of the front page launches the Fiber Map application.

Loading up. The Internet software uses a combination of HTML, Java script, and XML files in the design and interface of its applications. Being able to customize these files gave the programmer a fair amount of design flexibility. The Bandwidth Bay application began with out-of-the-box commands, but the application developer customized many of the file types to achieve the final interface and functionality of the product.

When Fiber Map first loads, the visitor is presented with a generalized map of the downtown area, as shown in Figure 1. This map has shading of various San Diego community planning areas with roads and the fiber network on top. Map load speed is governed by the browser's Internet connection speed, so phone modem access will be slower than cable modem access. The load speed has been improved, however, by programming it so that new map images are not created or served unless there is an appreciable change in map scale or a change in the list of visible layers.



The fiber network shown on the map primarily represents the end-user network and not the backbone network of the service providers. The backbone network is typically fiber optic, whereas copper cable is used for end-user networking. Note that the network information on Fiber Map is incomplete because not all local service providers have divulged which streets they have cables beneath.

An interface with HTML frames. The Fiber Map application is displayed with HTML viewer frames, and the maps it creates are served up in image format. Using HTML complies with the City of San Diego's Internet accessibility policy. In the top frame the title appears, on the bottom are displayed various texts from queries, on the left side are various tools for navigating and querying the information layers, and on the right is a list of the layers.

Also at the very bottom of the page is a notice stating that the network information should not be used for underground cable locating. Because the focus of this application was not to precisely locate the underground position of the cabling, anyone requiring detailed information would need to make inquiries beyond Fiber Map.

A host of information layers can be mapped and displayed. Any combination of 13 layers can be viewed by selecting the Visible radio button, then pressing the Refresh Map button to see a new map. The list of layers will vary depending on map scale. Because smaller monitors are still commonplace, and in an attempt to reduce

information clutter, some of the information layers are unavailable until a person zooms into the map.

Layers include wired buildings, fiber network, service providers, streets, freeways, city boundary, community planning areas, Centre City development area, parks, property boundary, and current aerial orthophotography. The layers are in shapefile format, except the aerial orthophoto which is a TIFF file with an accompanying geocoded world format file. Table 1 describes the layers and the information that can be viewed with Fiber Map.

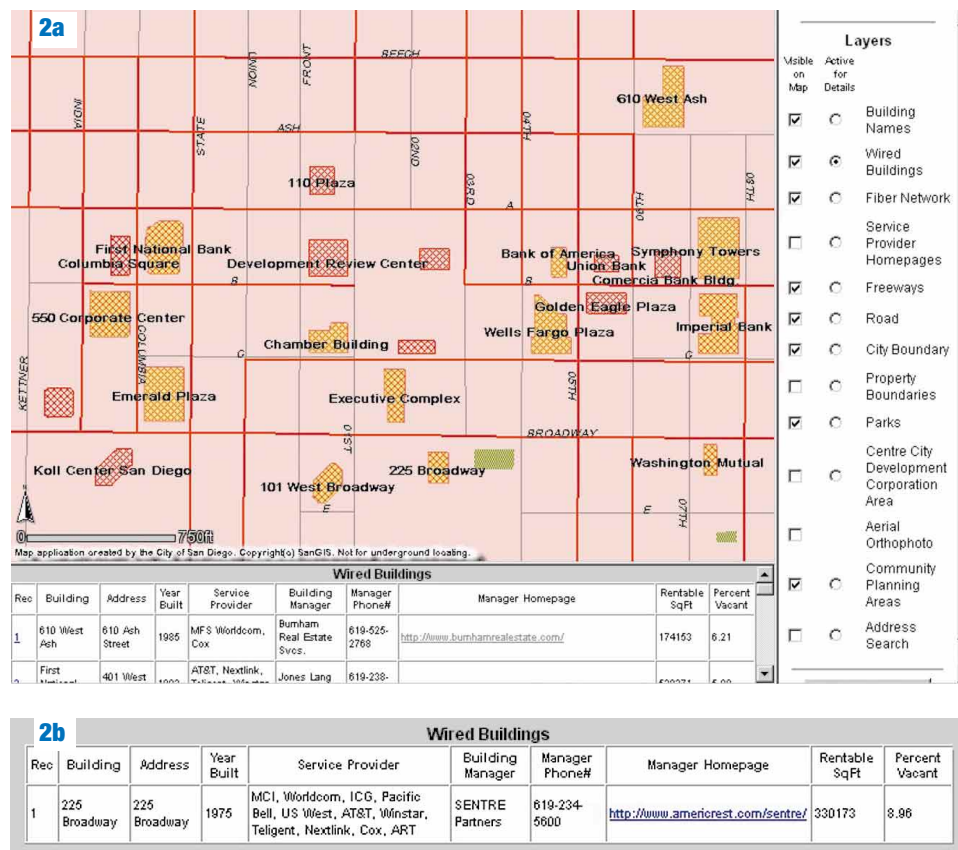
Users can navigate and display information layers with the tools on the left frame. These tools enable visitors to change the details of the layers legend; activate the upper left overview locator map; zoom in or out; pan and/or zoom to the active layer or back to a previous extent; access hyperlinks of an active layer; identify active layer attributes; choose a query, clear a search, locate an address, and print.

The application tool buttons look and function in a fairly common manner. The tools also have Mouse Over text for describing their functions. Several other tools are also available with HTML frames, such as Pan Left/Right and Up/Down, but these are unnecessary because of the panning Hand button. Using HTML coding, a Help button was added beneath the tools. This button presents a screen of hints for navigating and querying the application.

An updated and particularly innovative feature of Fiber Map is a tour guide for

Web Mapping

FIGURE 2 Once a visitor sees the wired buildings highlighted on the map, he or she can determine who to contact by viewing the business attribute information (2a) displayed along the bottom of the page. He or she can also learn who the network service provider is using radio buttons to make layers visible on the map (2b). Red lines indicate the broadband network.



the application. This feature consists of a six-page HTML screen that guides new users through the full functionality of the application. Users can print the guide or view it alongside the application in a separate browser that is launched by pressing the Tour the Map button, which is located just beneath the Click Here for Help button. (The tour guide feature, like the entire Fiber Map layout, is expected to become the city's standard for subsequent Web mapping applications.)

Navigating and querying

To query or search a layer, the layer must be active. Choosing the Active button next to a layer's name allows that layer's attributes to be viewed by selecting one of its elements with the Identify tool. (Note that the radio buttons may need to be displayed by pressing the Legend/Layer List tool button.) The default result of an Identify action is to display all of the layer's attributes and associated names.

TABLE 1 Downtown San Diego Fiber Map information layers

Layer	Viewable Information
Wired buildings	Building name, address, building manager (name, phone number, URL/hyperlink), service providers, rentable square feet, vacancy rate
Wired building names	Building name
Fiber network	Service provider(s), street name
Service providers	URL/hyperlink to downtown service providers
Freeways	Freeway names
Roads	Road names
City boundary	Municipal boundary of the City of San Diego
Community planning areas	City of San Diego Community Planning Area names
Centre City development area	Centre City Development Corp. planning areas
Property boundary	Assessor parcel number
Parks	no attributes
Aerial orthophoto	no attributes

Many of the layers in this application have attribute names that are somewhat cryptic, so most of the attribute names were expanded using Java scripting. Information from some of the layers was also suppressed for privacy, which is why the query of the property layer will return only the tax assessor's parcel number and not the property owner's information.

Attributes. An Identify action produces a table of information, as shown in the bottom of Figure 2. This example shows the attributes associated with the wired buildings layer. Notice also the building manager

URL, which when selected will open another browser window with that URL. Service provider URLs can also be accessed by activating that layer and pressing the Identify tool anywhere in the downtown area.

Figure 2 also shows how the map extent is focused down to the wired buildings, which is accomplished by activating the layer and pressing the Zoom-To-Active-Layer tool button. Most of the wired buildings' names are also visible. Because the building

ing names layer was assigned a maximum scale to reduce map clutter, the names only become visible to the user as the scale is reduced.

Want more? More detailed queries and searches can also be constructed on Fiber Map. Two queries are available on each of the wired buildings and the fiber network layers. For the buildings, the queries let users locate a building by its name or by which service provider is wired into it. Users select these queries from a pull-down menu that appears when the Select tool is pressed after activating one of the two layers.

Web Mapping

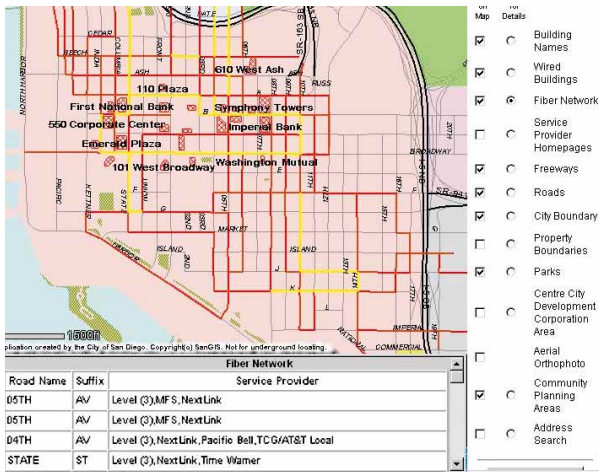


FIGURE 3 A user can segment the broadband network. This screen has been queried to show three or more service providers.

FIGURE 4 The result of an address search for the City Administration Building, this aerial orthophoto provides perspective by including property lines, parks, broadband network, freeways, and surface streets.

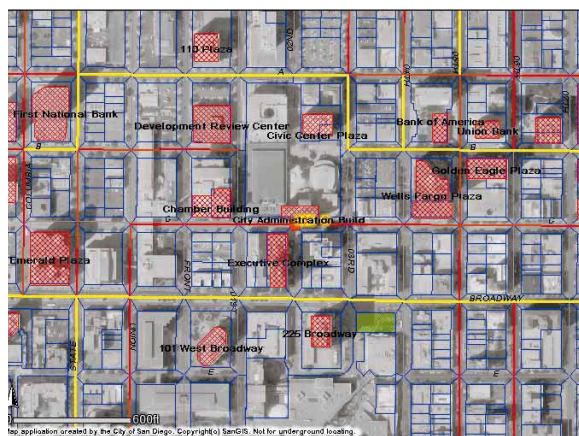
When a successful query is made, a new map and table are automatically displayed. For example, Figure 2a highlights in yellow 13 wired buildings that are serviced by Cox Communications. The accompanying scrollable table provides all of the associated building attributes.

Similar searches are available for the fiber network. One of the searches allows the user to see the streets that are wired by a given number of providers. Figure 3 shows a map of streets containing broadband wiring by three or more service providers and the table lists the names of those streets and providers. This kind of information would be useful to potential office clients looking for competitive pricing for connecting to a broadband network.

Buildings can also be located either through an address search using the Locate Address tool or by visually identifying the building on the aerial photo. Figure 4 shows the results of an address search for the city administration building (202 C Street), as viewed with the aerial photo and property boundaries.

Another fiber network search that users can perform is to locate and view all of the streets that contain wiring from a particular service provider. This would be helpful when trying to determine where to connect to a particular provider and could be of benefit to competing providers.

All of the information generated can be printed using the Print icon tool. A preview of the page will appear in a new browser



window, along with a user-definable title and the color-keyed legend. Visitors can then print using the browser's print button. To save the map, visitors use an Image Capture utility. Finally, tables can be printed using the main browser's Print button.

By enabling businesses to produce custom maps using this Internet application, San Diego is providing an excellent snapshot of its broadband infrastructure and business opportunities. Although the application required a fair amount of HTML, XML, and Java script customization, it started with out-of-the box programming. This highly functional, very interactive GIS-based Web application is now proving itself useful to multiple agencies for boosting local economic development.

Manufacturers

Fiber Map was built using ArcIMS from ESRI (www.esri.com) and was developed on a Hewlett-Packard (www.hp.com) NT workstation. ESRI staff also provided invaluable technical assistance with the installation. ☺