DEVELOPMENT OF A REGIONAL GIS PORTAL WITH TRANSIT DATA

Corresponding Author:

Erik C. B. Olsen, Ph.D.
Town of Blacksburg
Blacksburg Transit
2800 Commerce Street
Blacksburg, VA 24060 USA
eolsen@blacksburg.gov
540-961-1185
Fax: 540-951-3142

Catherine M. Howey
Virginia Tech
Department of Geography
115 Major Williams Hall
Blacksburg, VA 24061 USA
howeycm@vt.edu
540-231-6886
Fax: 540-231-7557

Graham M. Owen
City of Virginia Beach
Planning Department
2405 Courthouse Drive
Virginia Beach, VA 23456 USA
gowen@vbgov.com
757-385-4298

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ABSTRACT

The New River Valley (NRV) Metropolitan Planning Organization (MPO) recently launched a project creating a regional GIS portal in support of transit planning initiatives. The purpose of the project is to improve connections between transit providers and other modes of transportation, and to assist on-going and future transportation planning efforts at the local and regional scale. The project was conducted in two phases. Phase I included meetings with stakeholders to assess regional needs and to discuss transit-planning processes, GIS technologies, and existing data sources. Several stakeholder agencies collaborated to share transit-related data, which was cataloged and edited for public consumption. Phase II made transit data available to the public. The MPO partnered with the NRV Planning District Commission (PDC) to host the transit data on a FTP site. Using ArcGIS Online, an interactive web map was created featuring route and stop layers for the four fixed-route providers in the region. The project provided an outlet for important discussions between regional transit stakeholders and led to increased communication and collaboration between agencies. A regional transit GIS portal was created to share transit data featuring links to the FTP site, web map and additional resources regarding the MPO project.

INTRODUCTION

Transit services in Virginia's New River Valley (NRV) developed over the last several decades in response to the need for public transportation. Increased urbanization in the Blacksburg-Christiansburg-Montgomery County area made public transportation more of a recognized necessity. However as demand has increased, these services have expanded in a decentralized manner; expansion has taken place in response to local needs, instead of responding to the needs of the region. With regional expansion and increased demand, there has been growing recognition among the region's service providers that coordination and inter-network connectivity could be improved. This case study illustrates how the NRV has started a process that will benefit transit providers in the region and improve efficiency for transit patrons.

Geographic Information Systems (GIS) are a proven resource for public transportation service planning operations purposes (*1, 2*). In particular, the spatial analysis and database management capabilities of GIS make them well suited for transit operations and decision support applications. The primary cost incurred in a GIS application is for the development and maintenance of high-quality spatial databases. Due to this cost, public transportation agencies want to utilize these databases to support a wide array of applications. As desktop GIS software and computer hardware become more powerful, and as computing moves towards web-based applications, GIS can be used to develop applications for "real-time" transit operations. For example, an early GIS-based prototype system was developed and tested to support the scheduling and dispatch functions of an on-demand flex-route transit service (*2*). The system used GIS data to map current transit services and look for overlaps in service. Similar systems can also be used to evaluate fixed routes as well. In an effort to provide efficient transfers between systems and routes, and potentially to identify common locations for transit hubs, such systems can help to improve intra-agency data coordination and sharing, and to increase system productivity (*3, 4*).

This paper describes an on-going regional GIS project that aims to create a unified transit route and stop mapping scheme throughout the NRV region of southwestern Virginia. The motivation for the project was based upon a desire among transit stakeholders to improve regional coordination and connectivity, to reduce duplication and increase efficiency of public transit services, and to improve communication among service providers. The initial result of the project has been development of a regional GIS portal featuring transportation data provided by several service providers. In addition, the project served as a catalyst for in-depth discussions with stakeholders, resulting in improved communications about transit service and increased collaboration upon which future projects can build. In describing the GIS portal, project objectives included stakeholder coordination, data collection and analysis, documenting processes, making data available, and building a foundation for future web applications. The story behind the project continues with an overview of relevant efforts.

EFFORTS TO IMPROVE COORDINATION

Ongoing efforts to coordinate transportation services have been taking place for several years within the region. An early NRV transit study concluded that coordination of transportation efforts between agencies should prevent duplication in services (*5*). The need to "reduce duplication and increase efficiency" was later emphasized in a coordinated services plan (*6*), supported at the state level via the Virginia Department of Rail and Public Transportation (DRPT).

At the present, coordination of transit services is facilitated primarily through the New River Valley Metropolitan Planning Organization (MPO), often in conjunction with the New River Valley Planning District Commission (PDC). In another coordination report by the PDC, recommendations also included the need to reduce duplication (*7*). Based on input from regional transit leaders and staff, the PDC report outlined a concept of seven regional transportation commuter routes and a network of vanpools operating on semi-fixed routes. This effort provided an opportunity to kick-start discussions among transportation providers. In addition, the report recommended the formation of “a PDC-MPO collaboration,” which was preceded by an earlier collaboration investigating the infrastructure of truck, rail, and air freight transportation systems (*8*), and later by the development of a bicycle pedestrian master plan (*9*).

Recent Regional Transit Efforts

The PDC also conducted a study (*10*) that analyzed how to coordinate regional transit with the goal of increasing regional transportation options. Several key issues were analyzed in the context of this goal including expanding funding and resource allocation, and the desire to maintain independent systems and improve regional coordination. As a result of the study, the Regional Transportation Coordinating Council (RTCC) was established in the NRV and continues to meet quarterly to discuss regional transportation planning issues. The RTCC functions to facilitate collaboration between the MPO and PDC as well as among transit operators and funding partners throughout the area. The RTCC provides a forum for staff to coordinate on transportation projects that affect multiple stakeholders. Other efforts have also taken place including coordination among several transit providers to share bus stops, and in some cases, to share amenities such as bus pull-offs, shelters, and poles, e.g., (*11*) via the MPO.

The recommendation from the PDC study (10) of developing a coordinated transportation plan using GIS will help stakeholders to identify the needs and priorities of services for the region. This process of developing and maintaining a coordinated plan will also help to maximize the programs' collective coverage by minimizing duplication of services, identifying unused capacity, revealing opportunities for increased coordination of transportation services within and to the region, and may also address the concern of stakeholders of the unpredictable nature of state and federal funding for transit (*6, 10, 12, 13*). A GIS mapping inventory is included among several identified tools and strategies to consider as part of a coordinated plan (*6, 12*).

NRV Regional Transit GIS Project

As a step toward improved regional connectivity, discussions took place about the need to inventory transit bus stops and routes within the region. The idea was to develop a single source of GIS data. While GIS data has been inventoried and used by some service providers for many years, the MPO recently approved funding for a regional GIS project, which started in January 2014. Thus, the aim was to create a unified transit-mapping scheme throughout the MPO region. The purpose of this project was to address the issue of improving regional connectivity between the providers, local governments, and universities within the region. The project was initially developed with the intent of analyzing and collecting transit and GIS information from regional fixed route providers; however, throughout the project it became clear that an expanded, regional scope would be beneficial, including services that are outside of the MPO boundary. Given the regional nature of the transit networks in the area, the scope of the project was expanded to include all of the municipalities that exist in the PDC area. In addition, data for nearby localities such as Roanoke were included to facilitate additional regional connections.

METHOD

Collecting regional transit data was not simply a web query for data files. A series of steps took place following goals and objectives so that a comprehensive dataset could be gathered. The first round of stakeholder meetings established a solid foundation for the needs and desires of those involved in the project. Prior to the launch of this project, a common sentiment that echoed across all stakeholders was a desire to improve connectivity between systems and communication more generally. Another common desire was to improve transit connectivity with other modes of transportation including bicycles, pedestrians, and vehicles. Also, given the regional focus, some stakeholders expressed a desire for the project to work in coordination with on-going regional planning efforts at the MPO and PDC level. In response to these sentiments, project goals were to improve connections between transit providers and other modes of transportation, and to assist on-going and future transportation planning efforts at the local and regional level. Due to the nature of the MPO project, it was conducted in two distinct phases to meet desired objectives. The first phase included stakeholder coordination, data collection and analysis while the second phase focused on the logistics of making transit data accessible and building a foundation for future web tools.

Phase I

The first phase of the project emphasized communication and collaboration between transit and GIS stakeholders. Several meetings were held with stakeholder agencies to assess regional transit planning needs. During meetings transit operators discussed services provided as well as existing

GIS processes and technologies, which were carefully documented to better understand current and future planning needs. Transit providers and existing data sources are described in the following section.

Stakeholder Meetings

Each stakeholder offered invaluable input about the data they collect and their GIS data requirements. The region's transit providers include Blacksburg Transit (BT), Pulaski Area Transit (PAT), and Radford Transit (RT). In addition, Roanoke's Valley Metro has operated the Smart Way Commuter bus between Blacksburg and Roanoke for over a decade. Figure 1 illustrates a map of regional transit routes and stops in the NRV.

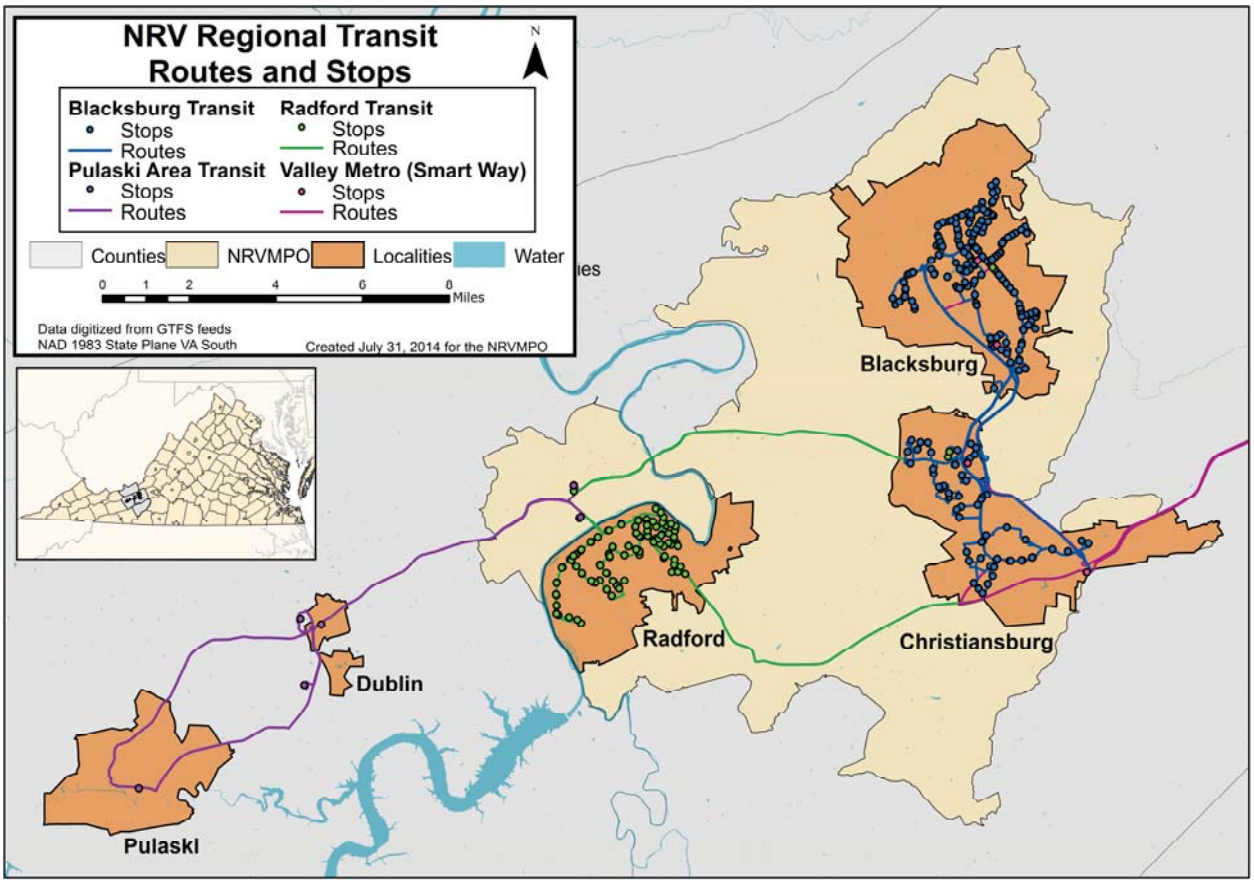

Figure 1 Map of Regional Transit Routes and Stops – New River Valley, Virginia

Blacksburg Transit, started in 1983, is a department of the Town of Blacksburg and is the largest transit system in the NRV, with fixed route and demand response networks in Blacksburg and Christiansburg including a deviated (1/2 mile radius around designated stops) fixed route network in Christiansburg. A vast majority of BT's ridership is made up of Virginia Tech students. The Blacksburg network is a hub and spoke system centered on the campus and downtown Blacksburg, with spokes extending out to several neighborhood "sub-hubs" in the town. The Christiansburg network follows a more circuitous, point-to-point route that more easily allows for deviations.

A meeting with the Town of Blacksburg's GIS Coordinator produced a project goal of establishing a minimum data reporting standard across all transit providers. This minimum data standard known as the General Transit Feed Specification (GTFS) serves as the baseline transit data structure for Google Maps and other web mapping applications. BT already uses GTFS for its own web tool, which uses a script originating in the onboard automatic vehicle locating (AVL) system. A real-time web application called BT4U predicts bus locations based on recent schedule history, allowing customers to more accurately plan trips. This system was developed in-house and has the capacity to include and display data from other transit agencies if provided in the appropriate format.

Pulaski Area Transit, established in 2005, operates a deviated fixed-route between the Town of Pulaski and Fairlawn, as well as a demand-response system one mile outside of town limits and within Pulaski County. PAT also offers transportation services to the Town of Dublin and New River Community College. Federal and state programs help fund PAT along with contributions from the Town and County of Pulaski among other local sources. The demand response system is for the general public. Approximately half of PAT's funding is derived from 5311 (Non-Urbanized Area) grants while DRPT and the Town and County of Pulaski contribute the remaining portions.

The PAT system does not currently host a web tool but uses GTFS through its partnership with Ride Solutions and Trillium Transit to provide route and stop updates. The GTFS feed is updated when PAT submits route or stop changes to Ride Solutions. During the summer of 2014, PAT installed GPS systems on all PAT buses. The phone and radio-based system offers real-time data, and provides a variety of reporting and vehicle location features to facilitate passenger pick-ups. The system is offered through Verizon and allows dispatchers to locate and coordinate service more efficiently in an affordable manner.

NRV Community Services operates RT, which started services in 2011, and provides a mostly fixed route network in the City of Radford and nearby community of Fairlawn with limited service to Blacksburg and Christiansburg. The RT system extends throughout Radford, serving both Radford University and neighborhoods outside of the university area. NRV Community Services also provides subscription trip service branded as Community Transit, with service in the City of Radford as well as Pulaski, Montgomery and Floyd Counties.

Since operations began in 2011 the RT system has grown rapidly in terms of ridership and the number of routes and stops offered. Radford Transit uses an onboard AVL system, which feeds into a NextBus web tool to predict bus locations. The RT system has also partnered with Ride Solutions and Trillium Transit to develop GTFS and the agency's data is publicly available on a Trillium Transit open access site, e.g., (*14*). However, the real-time data derived from the NextBus system is proprietary, raising concerns regarding the development of a real-time regional web application.

As previously mentioned, additional regional services include Roanoke's Smart Way Commuter bus operated by Valley Metro, a regional connector linking Blacksburg and Christiansburg to destinations in the Roanoke area including the Roanoke-Blacksburg Regional Airport. Valley Metro also operates the Smart Way Connector bus, which provides a link from various locations

in the NRV (Blacksburg and Christiansburg) and Roanoke Valley to the passenger rail Amtrak station in Lynchburg, VA. From there, customers can make rail or bus connections to Washington, D.C., North Carolina, and cities in Virginia including Charlottesville and Richmond.

Two private bus carriers, Homeride of Virginia and Megabus, also offer inter-regional connections from Blacksburg and Christiansburg to other locations throughout Virginia and also provide interstate connections to Washington, D.C., Knoxville, Atlanta, and New York City. These carriers stop on the Virginia Tech campus and the Interstate 81 Exit 118 Park-and-Ride lot respectively, and provide a much needed service for Virginia Tech and Radford University students traveling to and from locations in and around the Commonwealth.

Several organizations also provide van and shuttle service for seniors and people with disabilities in the region. Organizations providing human service transportation in the region include Giles Health and Family Center, Goodwill Industries of the Valleys, LogistiCare, NRV Agency on Aging, NRV Senior Services and NRV Community Services. Also, Helping Hands Transit, a Floyd-based private operator, provides senior transportation and taxi services to locations in the region. Several of these organizations have received FTA 5310 (Elderly and Disabled Persons Program) grants in recent years to purchase vehicles and coordinate human services, indicating a growing demand for paratransit paired with increasing capacity for service provision. A complete description of these agencies and services can be found in the regional coordinated plan (*6, 12*).

The NRV Agency on Aging (AOA) provides non-emergency medical trips for seniors and those with disabilities, including free services for those below the poverty line, and provides transportation and nutritional services to seniors and those with disabilities in the NRV via New River Valley Senior Services (NRVSS). Unlike most of the other providers NRVSS is able to provide trips outside of the PDC region, regularly scheduling trips to locations such as the University of Virginia Medical Center in Charlottesville, VA. Verizon-based GPS systems were also installed on all their vehicles, which are operated in cooperation with PAT.

Regional Transit GIS Index

Once the first round of project meetings was complete, GIS data was collected from stakeholders and organized for future web applications. Geographic features, location boundaries as well as bicycle, pedestrian and other transportation datasets were collected for the project. Updated GTFS feeds were also downloaded from online data exchanges and route and stop layers were created for each transit provider. Once compiled, all GIS data was projected to the same coordinate system for future web display and metadata was added to describe each dataset. GIS layers were also converted to Keyhole Markup Language (KML), another file format for display in Google Earth. As datasets were collected from stakeholder agencies, they were simultaneously organized into folders and cataloged in a regional transit GIS index. This index features detailed information regarding each dataset and was shared with all transit stakeholders.

The City of Radford, which coordinates with RT, provided geographic, building and bicycle/pedestrian infrastructure layers for the project. In combination with the transit layers obtained from Trillium Transit this allows for an intermodal or “multimodal” approach to trip

planning. Figure 2 shows the utility of such an approach in the City of Radford near the Radford University campus by combining all available modes of transportation into one map.

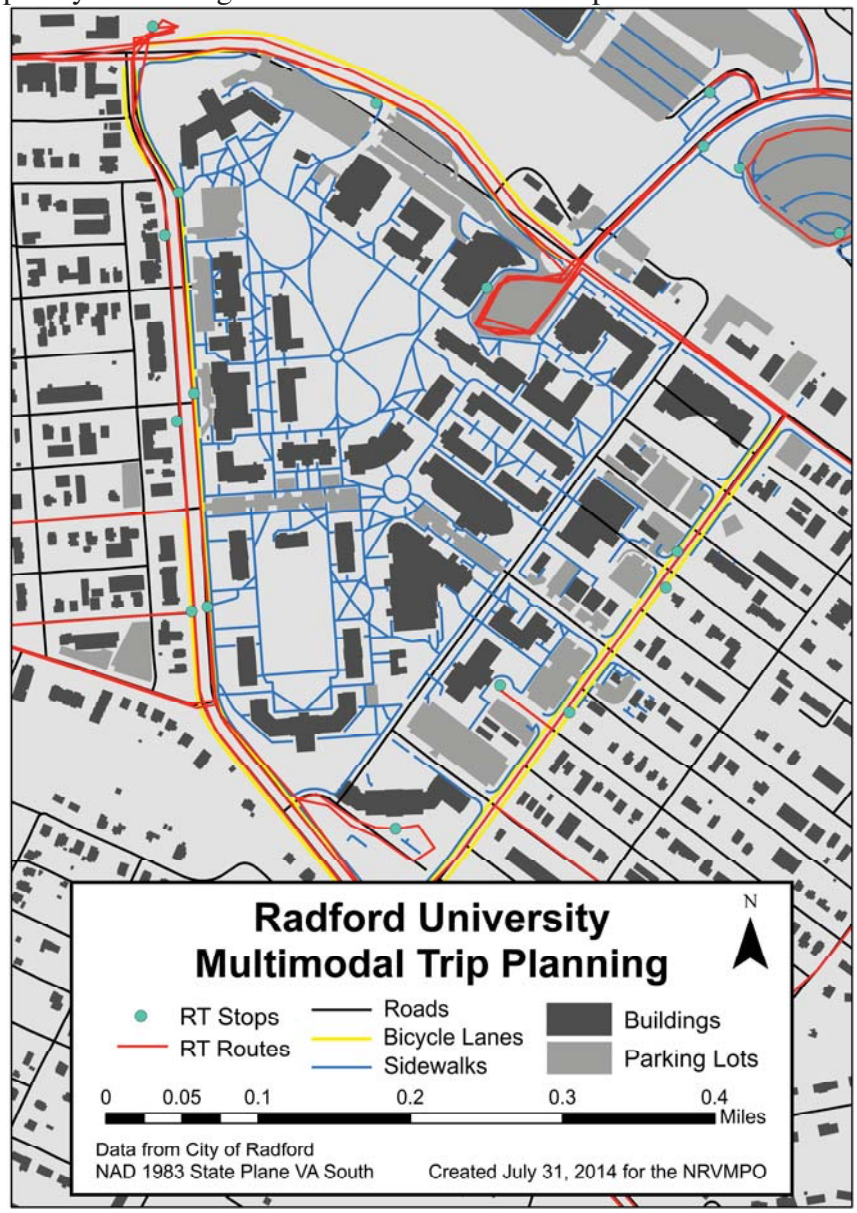

Figure 2. Multimodal Connections in the Radford University Area

Through the data collection process it became clear that a more efficient means of sharing data was needed than already in place. Stakeholder meetings produced a general desire to establish a transit File Transfer Protocol (FTP) site, which could more-easily facilitate file archiving and sharing between agencies and the public; the prospect of a web map was also suggested. The second phase of the project focused on the development of web tools to make transit data available to not only stakeholders, but also the general public.

Phase II

The second phase of the project sought to make the collected data more available to the public through a regional transit GIS portal. The MPO reached an informal agreement for data hosting

with the PDC and transit GIS data was first published on a FTP site and made available through a public login (*17*).

A web map (*18*) featuring route and stop layers for the four fixed-route providers in the region was then created using the PDC's ArcGIS Online subscription account. Other data are also available were also collected such as passenger rail, station, freight, and even sidewalk and water layers. The interactive map allows users to toggle between base maps, alter layer visibility in the legend, change viewing extent and select individual layers to display attribute information. The web map was demonstrated to transit stakeholders at an RTCC meeting, and to both the MPO Technical Advisory Committee and the MPO Policy Board meetings. Adjustments were made to the web map based on user feedback and it was then made available to the public. A regional transit GIS portal, hosted on the PDC's website (*19*), was created to display the web map, a link to the FTP site, and additional information regarding the MPO project (visit the web portal at: http://www.nrvpdc.org/nrvmpo/transit/). Figure 3 illustrates an example of the web map showing stops and routes in Blacksburg and Christiansburg. Figure 4 shows an example of the web map highlighting a single stop in the PAT system area and displaying more information.

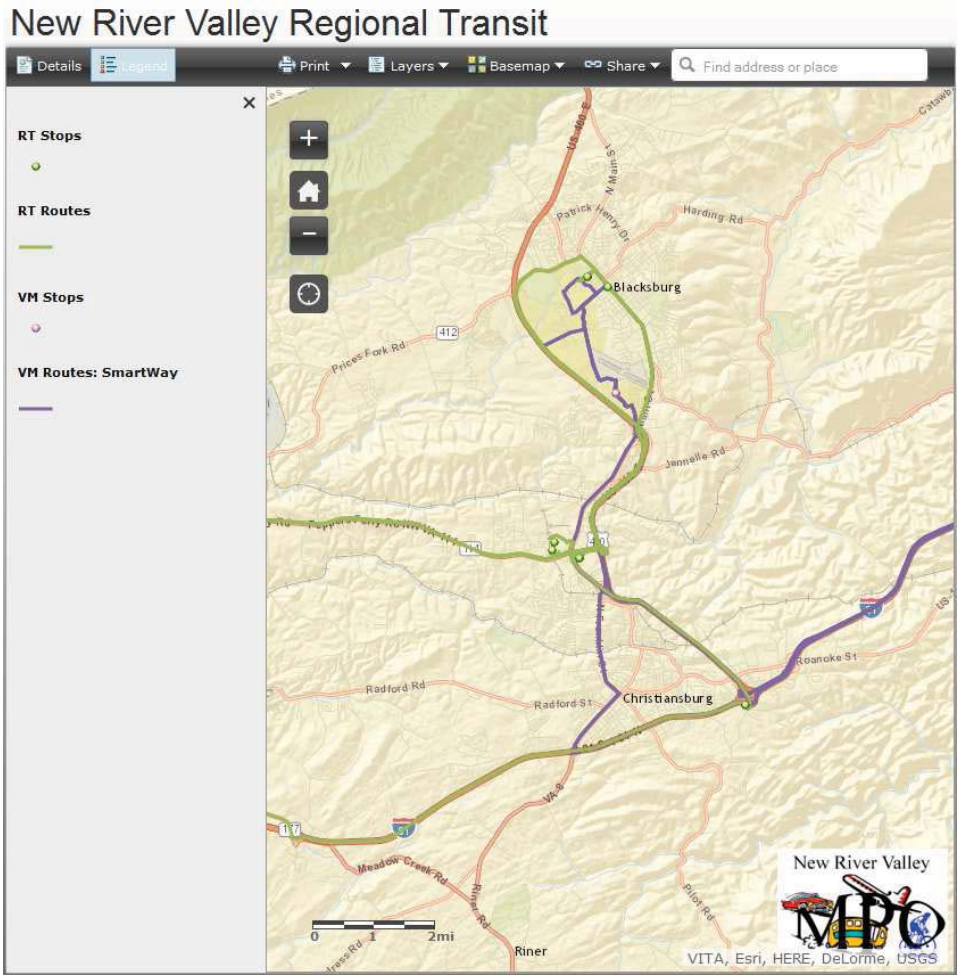

Figure 3. Example of a Web Map showing stops and routes in Blacksburg and Christiansburg

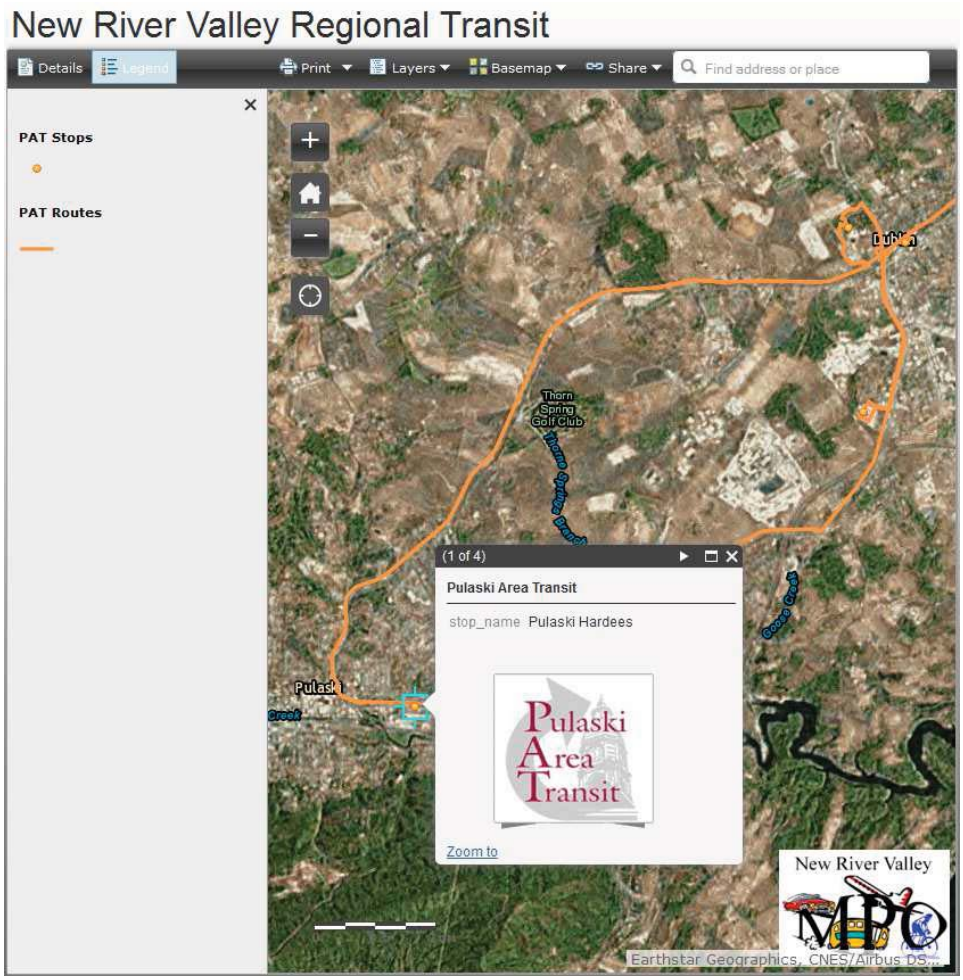

Figure 4. Example showing a Pulaski Area Transit Bus Stop

RESULTS

The overall result of this effort has been to collect existing transit data that can be used to identify and improve transit connections among various transportation modes, and to assist with future transportation planning efforts within the region. Over the last year, the project helped to identify existing GIS processes, inventoried over 140 GIS datasets, and produced a web portal for transit stakeholders. This portal may also serve as the foundation for future web applications. The web portal is a single website where GIS and KML transit files are available, providing the user with the ability to access both an FTP site and web map using ArcGIS Online. An additional benefit from the project was that it served as a catalyst for in-depth discussions with stakeholders, including both staff and decision-makers, about the need for continued collaboration in regional transit planning initiatives.

While the main goal of this project has been to collect existing transit data within the New River Valley region, the effort also documented the services of transit agencies. Periodically, each region within Virginia does this through coordinated plans as well (*12*). These plans required and demonstrate that coordination is important to maintain cost-effective transportation solutions so that local, regional and state agencies can work together on future solutions (*13*). As a step

toward improved coordination, and based on input and data files received from each transit agency in this region, the GTFS reporting standard (*16*) was agreed upon, and a GIS web portal was developed to inventory regional transportation data. Plans are in place continued development of the portal with the support of regional stakeholders. An added benefit from this project has been increased communication that has occurred due to the need to meet with stakeholders to understand their systems and to gather their data. In hindsight this seems a simplistic result, but the benefit has already resulted in improved coordination among providers and better intra-agency data sharing via this project. These improvements align with the desire for increased system productivity, e.g., (*4*). Ultimately this project may serve as a foundation for additional planning studies for improving regional connections and minimizing and possibly preventing duplication in services, a long-standing need (*5, 12*).

In relation to other transit efforts, the current project illustrates that by working more effectively together, solutions could lead to both greater efficiencies of services and of spreading costs over several agencies in a fair and equitable manner (*20).* Additionally, as this transit project has been fairly innovative in its approach of coordinating with regional stakeholders, it is our hope that the project will serve as an example of the benefit of coordination, and possibly of how to bring about change to organizations *(21).* Innovative approaches will be needed as challenges for funding and operating transit continue as state and federal funding constraints continue to tighten and become more unpredictable, a concern of regional stakeholders *(10).* Finally, it may be possible to expand this effort further by using these GIS data to measure accessibility to transportation options (*22*), to improve information gathered to better serve transit customers (*23)*, and to identify potential locations for rail transit stations *(24, 25).*

CONCLUSIONS

Reviewing the results of this paper leads to the realization that collecting GIS data from transit providers can have both practical and unanticipated benefits. A practical benefit is the development of a single web portal with various options for accessing and displaying transit data that, with continued maintenance, will serve the region for the foreseeable future. An unanticipated but welcome benefit has been an improvement in communication and coordination within the region. With a relatively small budget, this GIS project served as a catalyst for regional transit improvements.

Challenges

Data challenges remain for the NRV region including varying data standards, and schedules for data updates among stakeholders. While duplication of transit services is not ideal and should be prevented, duplication of data is likely to continue, in that each agency, to some extent, may still need to collect and maintain duplicative data sources for their own uses. However, as the result of this project, the online web portal with its web tool and FTP site should allow easy access to the most up-to-date GIS files, including GTFS-derived route and shapefiles. Another data challenge was the observation that datasets were in varying projections. The result was that additional time was needed to project each file using a standardized coordinate system. As discussed, the World Geodetic System 1984 (WGS84) system was chosen, as it is commonly used in web display of geographic features.

Metadata for each layer was edited to include a description of the file and its source. As this project progresses and more data is collected, it will be important to have thorough metadata records to determine the most current and useful datasets. For project updates it will be most efficient for stakeholders to share their GIS data in a common format, so it is important for stakeholders to come to an agreed upon standard for transportation data including metadata information.

Another unavoidable, but necessary challenge is data maintenance. The MPO project is hosted on the PDC's server, and the agency responsible for scheduling updates for the FTP site, web map, and portal remains to be determined. In addition, as staff changes occur among stakeholders, documentation from this project can assist in "passing the baton" to new staff involved in collecting, updating, and using regional transit data. It is feasible that these data may eventually be used for real-time trip planning across the region as well.

Lessons for Other Regions

A final goal of this paper is to share lessons learned, so that others may understand the benefit of improved communication, coordination, and intra-agency data sharing. The NRV region contains a unique collection of urban fixed-route and deviated fixed-route service, as well as suburban and rural demand-response services. For this reason, this project may contain lessons that can be applied to other regions with a wide variety of transit services and similar network connectivity concerns. In particular, regions with existing rural transit operations that are experiencing increased demand and urbanization may find that review of this GIS project may assist in efforts to consolidate and improve the efficiency of other systems. Areas with established urban, fixed-route systems may also benefit from a regional focus by identifying route duplications between providers and sharing GIS and related data. Such coordination has the potential to lead to improve services, increase efficiency and connectivity, and ultimately to provide more public transportation options for citizens.

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