Developing Data Resources for the 21st Century: New Uses for Archived Intelligent Transportation Systems (ITS) Transit Data

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16. Abstract

This report is broken into four sections. Section 1 provides a very brief description of transit in early American cities, describes the second generation of transit and the role of government planning and concludes with the third generation of transit, based on the notion of "choice" riders. Section 2 describes the introduction of new technologies for managing bus systems provides a new source of data. Harvesting, archiving, geocoding, and combining these data with Geographic Information Systems (GIS) data offers a new way for planners and researchers to understand transit participation. Section 3 is case study of the Capital District in Upstate New York, with a special illustration using the City of Troy, New York. Section 4 concludes the report with a discussion of the progress being made to better understand the activity patterns of those using transit for daily activities.

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Disclaimer Statement

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INTRODUCTION

Transportation is a derived demand for a service to move us from one activity to the next. Our opportunity set of places to go and activities to participate in are dependent on the type of movement patterns available. The first trips were made by foot and were limited by the shear distance people could tolerant walking. Early technological advances in transportation provided urban dwellers with the opportunity to take transit trips to and from a limited set of origins and destinations. With the invention of the automobile and the advent of mass production assembly line efficiencies, people were able to afford individualized transportation services. This freedom allowed them to go virtually where and when they wished – giving those with automobiles many more choices both in time and space to participate in activities.

Transit was not capable of competing with the flexibility available with an auto, both in time and location choices. Transit became popular again with policy makers as a way to cope with mounting air quality and congestion problems associated with increased auto use. Several recent planning efforts to attract "choice" transit riders are based on the notion that attractive pedestrian-friendly landscapes and special transit-oriented features will encourage riders.

This report will look at the opportunity to understand the role of transit in the 21st Century. It includes a case study in the Capital District of Upstate New York – with a spatial example using the City of Troy, New York. The Capital District Transportation Authority (CDTA) provides transit services for the Capital District Counties and has recently incorporated Intelligent Transportation Systems (ITS) into their operations. The ITS data has been archived and provided for this research as a data resource. The archived ITS data has been geocoded at the bus stop level and mapped for analysis using Geographic Information Systems (GIS) technologies available to the Department of Geography and Planning at the University at Albany. The results provide the opportunity for new understandings of transit ridership patterns based on the examination of the data at the bus stop level.

This report is broken into four sections. Section 1 provides a very brief description of transit in early American cities, describes the second generation of transit and the role of government planning and concludes with the third generation of transit, based on the notion of "choice" riders. Section 2 describes the introduction of new technologies for managing bus systems provides a new source of data. Harvesting, archiving, geocoding, and combining these data with Geographic Information Systems (GIS) data offers a new way for planners and researchers to understand transit participation. Section 3 is case study of the Capital District in Upstate New York, with a special illustration using the City of Troy, New York. Section 4 concludes the report with a discussion of the progress being made to better understand the activity patterns of those using transit for daily activities.

SECTION 1: In the Beginning – Public Transport for Daily Activities

Transportation planners with an infrastructure systems focus seem to neglect the complexity of the system that drives transportation decisions – the household. Lawson (1998) illustrates the nature of a "home production" framework that recognizes out-of-home activities as the key element to understanding travel on a daily basis. Finding the role of transit for daily activities is necessary if the service is to be used effectively and efficiently within an urban environment.

FIRST GENERATION TRANSIT: EARLY TECHNOLOGIES. Technology moved America from a "walk-to-work" world with innovations to facilitate transportation. Individual mobility had been limited to one's tolerance for walking. Muller (1995) refers to the years 1890 through 1920 as the "electric streetcar era". During this period, the first suburban residential units were built along radial trolley corridors. They extended several miles beyond the original pedestrian and horse cart boundaries of American cities. The transit service brought "new" real estate within easy walking distance of the new trolley lines, making it seemingly unnecessary to provide lateral track connections. The result was a continuous corridor of residential and commercial activities, with grided residential neighborhoods developed on both sides of the tracks.

Muller (1995) points out that the quality of the houses and incomes levels of the residents increased as the trolley moved away from the central core areas of the city. The inner city portions of the trolley lines were the first truly "mass transit" systems as the trolleys provided low-fare travel for all the residents within walking distance of the lines. The service was easy to understand and served the daily activity needs of these residents. The ability to move from one activity location to another remained constrained to the properties along the transit corridors. The patterns were understood by the transit patrons as they made decisions to go to work, go shopping, or go out for recreational activities. The wealthier residents at the ends of the lines still worked and shopped within the core of the city, but were able to escape to the "bucolic suburbs" for their home life.

URBAN EXPANSION AND EMERGING AUTO DOMINANCE. The transformation of the landscape that occurred with the addition of the automobile to the set of choices available for travel has been well documented (Lewis 1997). Daily activity patterns for many Americans included an ever-expanding set of destinations for working, shopping and enjoying leisure activities. Transit systems, trying to compete using rubber tire technologies, still could not offer the range of location and time choices available by automobiles. Factors contributing to an auto-oriented environment included:

- increased auto owners made possible by credit programs;
- government sponsored programs for funding highway building;
- government and private sector loan programs for residential construction and home purchases;
- changes in manufacturing technologies from vertical operations to horizontal assembly-line operations;
- expansion in shopping opportunities and economies of scale in wholesale purchases; and
- development of large, regional commercial entertainment centers.

The effects of these changes lead to an increase in the standard of living and quality of life for many households with increased activity choices. At the same time, racial prejudice impacted choices in the urban housing markets (Abbott 1987) and African-American household members realized that mobility could provoke hostility (Lewis 1997).

Even with the ability to purchase a vehicle, minorities were unable to get their car repaired, buy gas or oil, or find food or shelter while on a road trip because of racial prejudice. Facing these problems greatly reduced activity choices for low income, minority populations.

SECOND GENERATION TRANSIT: PLANNING AS A PRIORITY. During World War II, the concentration of resources towards the war effort found many workers using mass transit. Prior to this time, transit planning was conducted by private entities. As ridership declined, in the face of few resources available for restoration, rehabilitation of facilities and/or equipment, some urban areas created transit authorities to take over and operate unprofitable transit systems. To access funding for transportation projects, urban transportation planning was required (see Weiner 1997).

A key data resource for such planning was the decennial census. First conducted in 1790 to collect demographic data, the set of survey questions was expanded in 1960 to include questions regarding place of work and auto ownership on the long form version. It took many years after the initial collection for the data to be made available, however.

To meet the mandates for funding, transportation planners and researchers developed the Four-Step process. It was an aggregate approach that used a set of procedures incorporated into almost all transportation planning models used by planning agencies. Many of these models remain in place to this day. The fundamental flaw in these models is the lack of information of individual activity choices, impossible to incorporate in aggregate models (Lawson 1998). Within the Four-Step modeling process, transit ridership was determined in the third step – Mode Choice (Pas 1995).

The overwhelming success of system expansion for auto travel with the construction of the interstate highway system and intracity street networks lead to a request for the establishment of reserved lanes for buses.[1] In 1974, lobbyists for the transit industry succeeded in garnering federal funding for transit operating costs with the passage of the National Mass Transportation Assistance Act. The Act created a new requirement that the Department of Transportation establish a data reporting system for transit financial and operating information (Weiner 1997)[2]. Yet, these data contained no spatial information and did not relate transit services to movement between activities.

Even with all the attempts to incorporate transit into mainstream transportation planning, Fielding (1995) acknowledges that transit realistically competes with auto travel for only a few types of trips. These trips include: journeys to the Central Business District (CBD) where roadways are congested and parking spaces are expensive and hard to find; short trips from neighborhoods to the CBD; trips to suburban shopping malls and colleges; and for trips within higher-density neighborhoods where the service is frequent and stops are easily accessible.

Downs (1992) found, using 1990 census data, that users of transit for work trips were those who have no vehicle available for their household; lived in the central city and worked in its CBD; or lived in a densely settled community. Pisarski (1996) also reports that transit users were more likely to not own a vehicle. In addition, he found that they were more likely to be renters, be central city residents, be female and non-White. It should be noted at these findings are highly leveraged by New York City transit users in the data.

[1] For details on federal programs see (Weiner 1997).

[2] The data program, often referred to as "Section 15" transit data, is now available on-line (see http://www.ntdprogram.com/NTD/ntdhome.nsf?OpenDatabase). The National Transit Database contains system-level operating information on individual transit agencies in the United States.

The value of transit for daily activities depends on where and when transit services are provided. Wachs (1995) clearly warns that transit project planning is not necessarily based on appropriate transit service analyses. Fielding (1995) supports these concerns by pointing out that the skills of local administrators and the help of influential congressional leaders rather than need often drives decisions on transit project funding.

THIRD GENERATION TRANSIT**:** LOOKING FOR "CHOICE" RIDERS. Recent attention in land use planning focuses on "Smart Growth" solutions to pollution and congestion by increasing the use of alternative modes of transportation, primarily transit (Tumlin and Millard-Ball 2003). Unfortunately, the underlying theory that density promotes transit usage appears to be based on a data transformation flaw (see Brindle 1994)[3]. Thornes and Moore (1994) claim planners are attempting to increase transit ridership through design standards and changes in the built environment.

Downs (1997) points out the need to understand both the characteristics of the residential area (i.e., population density; income levels; proximity to central business district; etc.) and those of the public transportation system serving the area (i.e., frequency of service; price; speed; etc.). These notions would call for transportation and land use planners to work together to create the right combination of physical and service factors. At the bus stop level:

- *What are the attributes of improved service or surrounding amenities (i.e., shelters, information on the arrival of the next bus, benches and/or bike racks) that impact the decision to take transit rather*

[3] Brindle revisits the notion of trying to correlate annual gasoline per capita and urban density (persons per ha). He found that with "persons" in both of the data elements, the resulting graph would always be a hyperbole. This is the case even when random numbers are used.

than use a car (substitution) or actually decide to make a new trip on transit (induced travel)?

- *How can data on responsiveness to transit amenities be cost-effectively collected and analyzed?*

As previously mentioned, existing transportation planning tools, such as the Four-Step model, are unable to incorporate "choice" transit rider strategies (see Lawson 1998). Advancements in transportation planning software, such as the Transportation Analysis and SIMulation System (TRANSIMS), are now attempting to incorporate travel decisions at that individual household member level with the context of a regional network (see http://transims.tsasa.lanl.gov). Transit trip choices are to be simulated using a complex set of decision-making patterns -- travelers' travel plans. TRANSIMS is being designed to answer transportation planning question for the 21st Century, including each individual household member's mode preference by location and activity. Although the experimental phase is still on-going in the Portland, Oregon deployment, it is anticipated at the commercial version of TRANSIMS will make it available for metropolitan transportation planners in the future.

- *What data are available to validate or verify the simulation outputs?*

SECTION 2: New Technologies and Transit

The propensity for auto users to make trips surprised many planners who expected capacity expansion would solve congestion problems. Downs (1964) noted the inability to solve congestion through continuous infrastructure expansion, as new facilities intended to relieve congestion, became congested themselves. New travelers demonstrated their latent demand for travel. Transportation Demand Management (TDM) strategies attempted to modify transportation demand to reduce peak period auto trips by eliminating trip, shifting travel to time less congested times, including trying to reduce trips by improved alternatives to driving – carpool and biking, and subsidizing transit fares.

INTELLIGENT TRANSPORTATION SYSTEMS (ITS). To support a system management rather than infrastructure expansion orientation, new computerized control systems were being introduced to transportation operations personnel. The ability to management traffic using new technologies seemed the logical solution to solving congestion and safety issues. To ensure civil and electrical engineers that systems would have interoperability of equipment, the National Intelligent Transportation Systems (ITS) Architecture for the deployment of ITS devices was promoted both by the public and the private sector. Unfortunately, the non-real-time uses of the ITS data were not considered in the development of the architecture[4] (Lawson 2001b).

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[4]By 1997, national interest in considering potential uses for the data streams preserved as archived ITS data and some evidence from a few experimental applications prompted a workshop. The workshop, *ITS as a DATA Resource Workshop*, was held in Washington, D. C., in January of 1998. It was co-sponsored by ITSAmerica and the United States Department of Transportation (USDOT).

With an elevated level of interest in archiving the data streams, a variety of activities resulted from the initial meeting of stakeholders including: the writing of a preliminary requirements document; an addendum to the ITS Program Plan; a listing of the specifications of the new User Service Requirements; and a program hosted by the

As part of the emerging ITS deployments, Advanced Public Transportation System (APTS) technologies are being used to improve service reliability and to achieve cost savings achieved with improvements in transit scheduling and service planning (Khattak and Hickman 1998). Casey (1999) notes that Automatic Vehicle Location (AVL) and Automatic Passenger Counters (APC) systems have been installed by 30 transit operators with more than 50 fixed route bus systems. Table 1 lists the agencies and the metropolitan areas being served.

Tri-Met, providing the transit services for the Portland, Oregon metropolitan area, established a working relationship with researchers at Portland State University and found the archived ITS data streams could be used to better understand operations. The archived ITS data was harvested from Tri-Met's Bus Dispatching System (BDS), installed in 1997.

Becoming fully functional by 1998, the system includes: AVL with a satellite-based global positioning system (GPS); voice and data communication via radio on-board computer and a control head displaying schedule information to operators; two-way pre-programmed messaging between operators and dispatchers; partially deployed APC; and a dispatching center with information consoles (Lawson 2001). Archiving real-time ITS data flows offered new areas for analyses. Table 2 highlights the findings made in Portland, Oregon, using these data. Strathman (2002) attributes the success of the Tri-Met uses of ITS to their agency-wide strategy of taking a "hands-on" approach to project

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Federal Highway Administration (FHWA). From the series of additional workshops, stakeholders contributed to and reviewed the steps towards developing the Archived Data Users Service (ADUS) (Texas Transportation Institute and ITS Joint Office 1999).

ADUS was formally incorporated into the National ITS Architecture (Lawson 2001). The ITS Joint Program Office, the Office of Highway Policy Information, and FHWA continues to sponsor workshops to reconcile data standards and definitions between ITS and existing data systems. A Five-Year-Program Plan for ITS Data Archiving directs the process (Margiotta 2000).

Table 1. Transit Agencies Using AVL and APC Technologies*

Transit Agency	**Vehicles in Fixed Route Service**
Sun Tran (Tucson)	203
Alameda Costa Contra Transit District (Oakland)	705
LA County MTA (LA)	2278
Omnitrans (San Bernardino)	153
San Diego Transit Corp. (San Diego)	307
San Mateo County District (San Carlos)	314
Santa Clara County Transit Authority (San Jose)	471
Regional Transit District (Denver)	800
Connecticut Limousine (Milford)	150
DART First State, Delaware Transit Core (Dover)	154
Central Florida RTA (Orlando)	225
MARTA (Atlanta)	704
PACE Suburban Bus (Arlington Heights, ILL)	640
Transit Authority of River City (Louisville)	280
Metro Transit (Minneapolis)	900
New Jersey Transit (Newark)	1900
Capital District Transportation Authority (Albany)	232
New York City Dept. of Transportation (New York City)	1150
Westchester County DOT (White Plains)	352
Central Ohio Transit Authority (Columbus)	306
Metro RTA (Akron)	141
Miami Valley RTA (Dayton)	244
Lane Transit City Bus (Eugene)	116
Tri-County MTD (Portland)	700
SEPTA (Philadelphia)	1476
DART (Dallas)	1200
MTA of Harris County (Houston)	1112
Via Metrop[olitan Transit (San Antonio)	494
King County Metro (Seattle)	1343
Milwaukee County DOT (Milwaukee)	550

*Source: Center for Urban Studies, Portland State University, based on Casey (1999).

Table 2. Studies Conducted by Tri-Met and PSU*

Authors	Findings
Strathman et al. (1999)	Defining performance measures Collecting baseline data prior to implementation of BDS
Strathman et al. (2000)	Evaluation of initial performance impacts including: • 9% improvement in on-time performance; • 18% reduction in running time variation; • 3% reduction in average running time; • 4% reduction in headway variation; • Improvements produced $3.5 million annual savings based on passenger waiting and in-vehicle travel times; and • Savings due to primarily to enhanced information to dispatchers and operators.
Strathman et al. (2001)	Evaluation of efforts to improve bus spacing in downtown bus mall corridor found information flowing from dispatchers to field supervisors of impending delays – prompting control actions that resulted in 16% reduction in passenger load variation.
Dueker et al. (2001)	Estimation of delays due to lift activity and bridge closures to improve Transit Tracker arrival time predictions.
Kimpel et al. (2000)	Estimation of transit utilization using passenger data; service attributes; American Community Survey demographic variables in route segment corridors approportioned using GIS.
Kimpel et al. (2002)	New uses for ITS data included: • Validation procedure using on-board cameras compared to APC boarding, alighting and load counts; and • Development of sampling procedure to replace manual passenger counts with APC, potentially saving Tri-Met $50,000 per year.
Strathman et al. (2002)	Construction of distributions of running times by route and time period found: • Of Tri-Met's 104 routes, 81 had excessive running time, recovery, and layover times; • Operator differences account for most of the running time variations; • Running times are inversely related to operator experience; and • Bus bunching during peak periods is due to a mix of operators with varying experience on a given route.

*Based on Strathman (2002).

management for the design and implementation of the BDS. Individuals in charge of BDS deployment had diverse and substantial operations experience.

GEOGRAPHIC INFORMATION SYSTEMS (GIS). To date, the most common use of GIS by transportation planners has been primarily to inventory infrastructure information and display model results. O'Looney (2000) cites the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, as spurring transportation planners towards additional uses for GIS. In addition, Allen (2003) sees GIS becoming a major factor in planning.

Strathman (2002) notes that Tri-Met BDS data has been steady more integrated with GIS. However, he also points out that visualization of bus performance information, combining the full power of GIS with the high quality archived BDS data, is underutilized. There is scant evidence that other systems recognized the valuable resource "harvested" from the real-time data systems.

The AVL system produces data streams that are geocoded using the latitude and longitude coordinates broadcast from the GPS system on-board the buses. Although dispatchers were only interested in real time applications of BDS, using a project team with other interests resulted in the development of uses for recovered data and appropriate archiving procedures integrated in to the design of the system. In addition, the vendor wanted a good result to promote additional sales.

SECTION 4: CASE STUDY

CAPITAL DISTRICT, NEW YORK.   The Capital District of Upstate New York is comprised of four counties: Albany; Saratoga; Schenectady; and Rensselaer. The major urbanized areas form a triangle between in the cities of Albany, Schenectady and Troy. The area has a rich history with its relationship to the Erie Canal (Lawson 2002) and the early settling of the United States.

The Capital District sits at the current crossroads of I-87 and I-90. Although considered part of the Rust Belt due to its ties to the early manufacturing sector, change may be on the horizon.   Recent interest from high-tech and bio-tech firms; the success of the recently remodeled airport; and proximity within a few hours drive-time of Boston, MA and New York City, all contribute to a new future for the Capital District.

With respect to changes in mode usage to work over the last decade, public transit has decreased significantly in Rensselaer County, nearly a 40% reduction as indicated in Table 3.

Table 3. Percentage Change in Means of Transportation to Work (1990 - 2000)

Means of Transportation	United States	Albany County	Saratoga County	Rensselaer County	Schenectady County
Workers > 16 years old	11.5%	-3.7%	12.6%	-1.7%	-4.2%
Drove alone	15.3%	4.4%	17.9%	5.8%	-0.7%
Carpooled	1.7%	-23.2%	-17.3%	-22.0%	-29.6%
Public Transit*	0.0%	-27.8%	-14.4%	-39.7%	-6.7%
Bicycle or walked	-14.3%	-30.2%	14.2%	-25.2%	-17.4%
Motorcycle or other	-0.2	-50.9%	-21.8%	0.0%	2.5%
Worked at home	22.8	23.7%	45.8%	11.6%	53.8%

* Includes taxi

Source: Census Bureau, Census Transportation Planning Package (CTPP), 2003

<u>The Capital District Transportation Authority (CDTA).</u> The CDTA is the only public transportation facility in the Capital District. CDTA has a fleet of 225 regular route vehicles with 34 paratransit vehicles, covering an area of 2300 square miles with a population of approximately 769,000.[5]

To meet federal passenger sampling requirements; receive funding from the Federal Transit Authority; and to analyze where passengers board and alight, the CDTA purchased Automated Passenger Counters (APCs) for eighteen buses in their regular fleet. The APC system records the number of riders boarding and leaving the bus at each stop. The APC system consists of a computer with infrared sensors at both the front and rear doors, working in conjunction with the on-board GPS.

As a person passes the infrared beam, the APC system determines whether the action is on to or off of the bus. Passenger counts are recorded onto a floppy disk, replaced on a weekly basis. When operating properly, the equipment has an accuracy rate of approximately 95%. The data retrieved from the floppy disks is post-processed using a series of Statistical Package for Social Science (SPSS)[6] routines.

Woodruff (2003a) notes that recently CDTA ridership has dipped. CDTA Chairman, David Stackrow, recognizes the need to attract discretionary riders. Technology, including new fare boxes and related equipment, would help riders avoid current problems with transfers (Woodruff 2003b).

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[5] See http://www.cdta.org
[6] See http://www.spss.com/

Proof-of-Concept Application for the City of Troy, New York

Can archived ITS transit data be used with GIS to better understand bus stop level activity patterns? CDTA supplied sample data for the Capital District – containing data for the City of Troy, New York for this applications test. Plans are underway to make improvements in the bus shelters and other transit amenities in Downtown Troy to encourage new riders. As an older industrial city, Troy faces a number of planning challenges including urban revitalization, population retention, and historic preservation. At the same time, the City's unique urban form (linear with many small activity areas and easily identified activity patterns), making it an excellent Proof-of-Concept platform. To provide a context for the archived ITS transit data, a variety of GIS data files were assembled.[7]

Figure 1. illustrates the type of maps developed using readily available data. There is, however, not enough information in the attributes of these shapefiles to perform any type of analysis at the level of detail needed to understand "choice" transit decisions. Average household and housing characteristics reported for census tracts or even census blocks may be too aggregate in nature. The desire to evaluate bus stop level amenities for their effectiveness in increasing transit ridership requires more detailed data.

The GIS-ITS data illustrates the locations of boardings (ons) and alightings (offs) relative to street designations and tax parcel information (see Figure 2). These data do not, however, include any details on amenities planned by CDTA. In its original form, the GIS-ITS data also does not provide any detail on the volume of transit activity at bus stop locations, only that some activity took place.

[7] Sources include: ESRI (http://www.esri.com)(*Data available for entire country*); NYS GIS Clearinghouse (http://www.nysgis.state.ny.us) (*Only for New York State);* and CUGIR: (http://cugir.mannlib.cornell.edu)(*Only for New York State*).

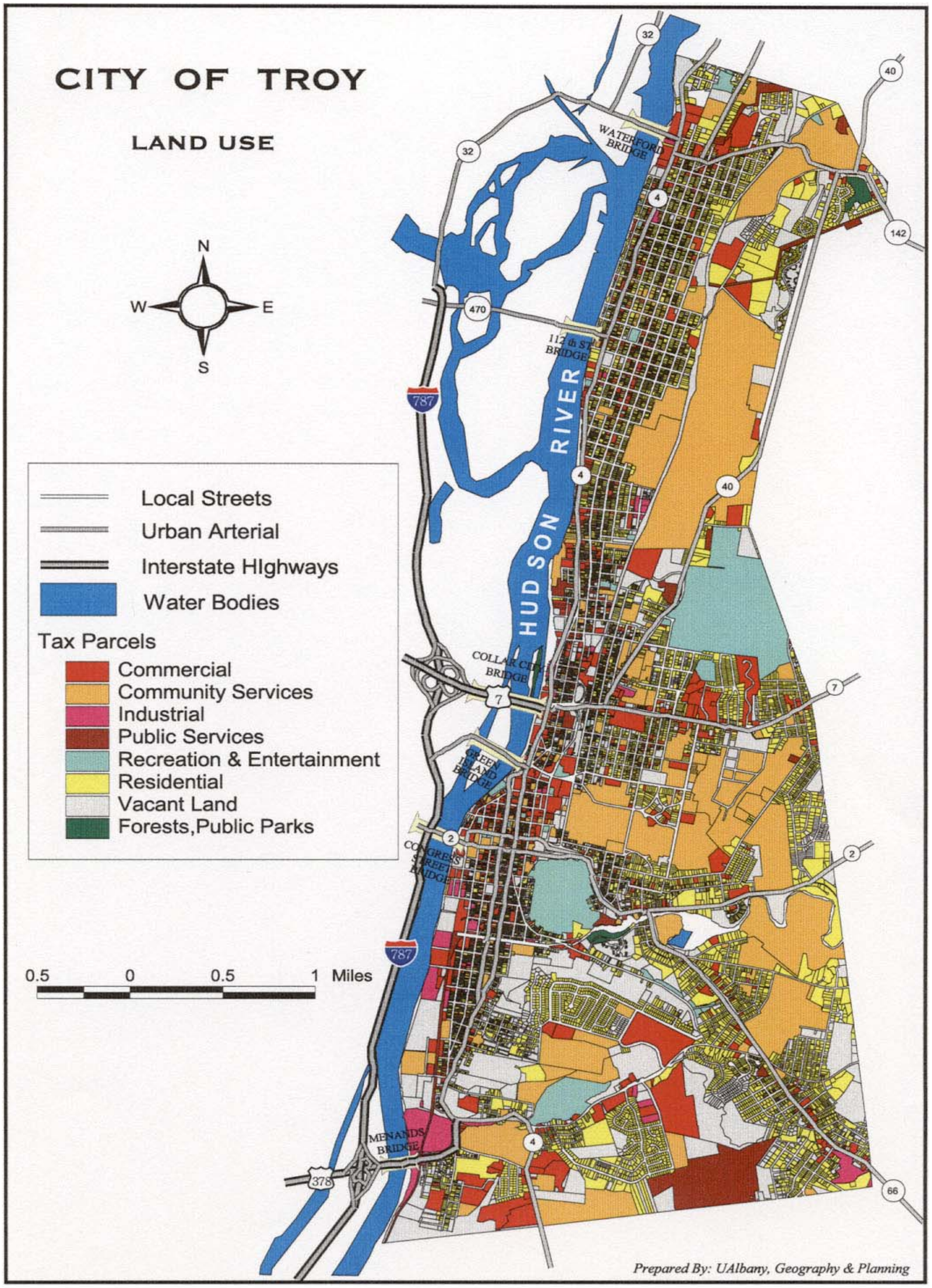

Figure 1. Map of Troy Land Uses

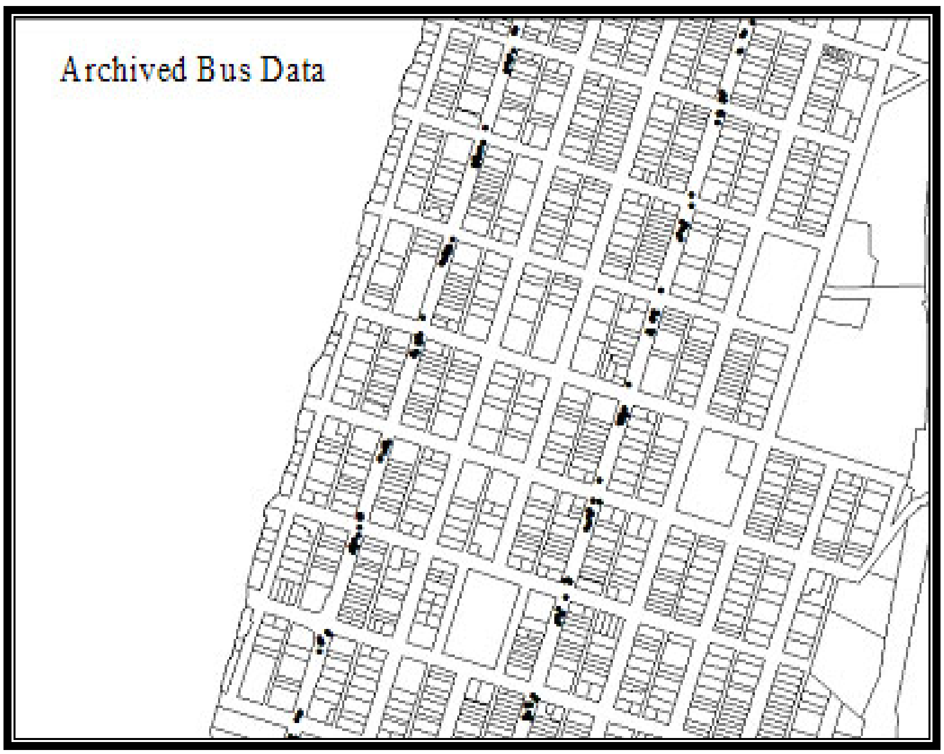

Figure 2. Geocoded Boardings in Downtown Troy, New York

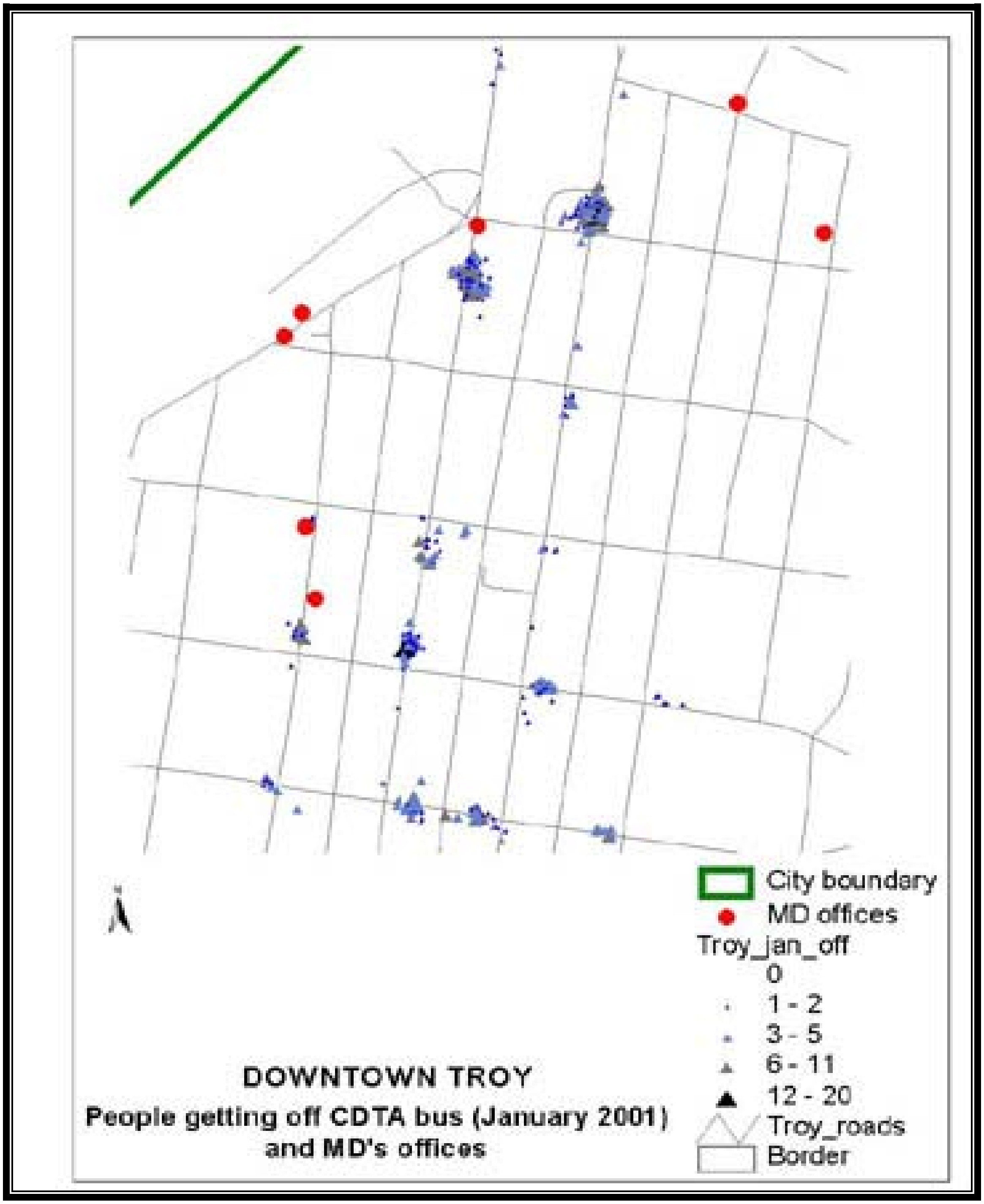

Figure 3. Alightings Near Medical Facilities in Downtown Troy

Additional GIS resources are under development at the University at Albany. These resources are sponsored by a variety of other grant opportunities including: the Ford Foundation, the Historic Albany Foundation, and the New York State Department of Health. Using these resources, in combination with the archived ITS transit data provides information for the third series of maps. Figure 3. is an example of combining the archived ITS transit data, using four categories (1 - 2; 3 – 5; 6 – 11; 12 – 20) of number of persons getting off of the bus at individual bus stops and medical office locations. The exact time when persons arrived is available in the data. These manipulations of the data help illuminate transit rider activities, but there is still very little information on the characteristics surrounding the bus stop. There is also no information on whether these transit riders were intending to go the doctors.

DISCUSSION. The application for the City of Troy, New York, clearly shows the potential for using the archived ITS transit data and GIS resources. It is possible to isolate individual bus stop level activity by location, direction, and time of day. It is not possible, however, with the existing GIS data to examine bus stop level amenities. It is also not possible to test various aggregation techniques with these data as the deployment data is too sparse.

The next step will be to incorporate the details of the surrounding bus stop level amenities. Such information could be gathered manually, through site visits. It may, however, be more cost-effective to incorporate the computer-aided design (CAD) design drawings for the bus stop level amenities. In addition, photographs of the transit amenity can be linked to the GIS shapefile. A classification scheme for the types of amenities and extend of landscape impacts will be needed to facilitate the mapping of these amenities and changes over time.

Research will be needed to develop metrics that statistically describe changing levels of transit participation at specific locations over time. Rather than using an average, it would be more appropriate to examine the variability of activity. In other words, the metric would more likely resemble a standard deviation concept. The differences would indicate how stable the population is by time of day and/or time of year by location. It will require a good understanding of the existing behaviors at a particular location before any new development occurs. Once these metrics are able to accurately describe transit activity at a particular location, tracking and monitoring over time will allow validation or verification of expectations for transit-oriented developments.

Some communities are providing subsidizes to developers of transit-oriented developments (Tumlin and Millard-Ball 2003). It should be possible to verify the level of subsidy that should be granted (requiring pay-back by developers if actual performance fails to occur over a designated period of time) using these data. The archived ITS transit data could also be tested and used to validate simulation models, down to the bus stop level or aggregated up to larger geographies (i.e., route level, Traffic Analysis Zones (TAZs), or districts).

At the same time, the development of "real-time" GIS could also make monitoring and tracking more accurate. For example, if changes are made on the landscape (i.e., construction of new facilities), these developments must be matched in time and space to the archived ITS transit data. Traditionally, GIS data is generated as a large area shapefile. GIS is plagued with "stale" data problems. One solution is the development of a framework for sharing data, including a process for incorporating changes and additions (see Dueker et al. 2000). New York State's Clearinghouse encourages data participants to make available the most recent data. However, changing the nature of GIS may require "pushing" the currently created GIS information to all users would ensure the most accurate information for planning.

As previously mentioned, linking CAD to existing GIS shapefiles on a real-time basis will be necessary to make sure all changes in the landscape are adequately captured and matched with the archived ITS transit data, in addition to site audits using aerial or digital photography.

SECTION 6. In the End – Using Archived ITS Transit Data to Understand Daily Activities

Although the heyday of transit may have come and gone during the first generation of its existence, transportation planners continue to include transit as part of the set of transportation alternatives available in many communities. During the second generation of transit, only a small portion of the population, mostly those who were unable to buy or maintain an auto, were considered stable users. Now, in the third generation of transit, planners are relying on strategies that will encourage new users to transit – "choice" transit riders.

Cost-effective data is needed to allow planners to easily evaluate the success of their strategies. If analyses of these data indicate that transit system improvements, transit oriented developments and/or other policy recommendations do not generate new transit riders, decision-makers can be alerted. Currently such information is almost impossible to obtain on a routine basis.

Many transit organizations using new high-tech systems for real-time operations continue to ignore the potential value of archiving these resources, wasting an opportunity to better understand their operations. The key to these uses appears to be in the shared mission of the entire transit agency and local planning organizations, insisting all potential vendors agree to make access to the archived ITS transit data a part of their products.

If, in this third generation of transit, local planning organizations want to institute policies to increase transit use, they will need to have data that provides information on both the characteristics of the physical area and the nature of the transit services. Clearly, Tri-Met and Portland State University researchers have demonstrated the uses of archived ITS transit data to better understand transit operations. Now it will be important to use these data “harvests” in combination with high quality GIS resources. Together these new resources will provide planners with an on-going monitoring and analyses tool as part of their strategy for “Smart Growth”.

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