Ridematch System 21
Using Vector-Based Matching To Direct Ridematching Activities
An element of the Illinois GCM ITS Hub

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Abstract

Ridematch System 21 is a real-time matching, Inter-/Intranet-accessible carpool/vanpool enrollment and management tool that was developed by the University of Illinois at Chicago’s Artificial Intelligence Laboratory for the Chicago Area Transportation Study's Rideshare Services program.

This system enables users interested in carpooling or vanpooling to access the region's ridematching engine from their desktops via the Internet for real-time matches with others sharing similar commutes. Ridematch System 21 allows regional vanpool providers to fill vacant seats on existing van routes or develop new routes. Employers can use this system as a managerial aid in coordinating employee transportation plans and identifying employee commuting needs.

The key functional objective of Ridematch System 21 is the maximizing of ridematching effectiveness by predicting rational decision-making by individual users. Route- or travel-path-based matching determined by street address entry or user-defined routes (verbal description and geographic depiction) serve as the primary factors when calculating ridematches for the general public, vanpool providers and employer-based users. Ridematches and identified travel markets are supplemented by up-to-date geographic data reflecting natural and built constraints (rivers, railroads, limits to access) on natural directional flow. This constitutes a major improvement over most existing ridematching software tools that utilize simple radius match routines to bring ridesharers together.

In addition, Ridematch System 21 provides continuous real-time e-mail notification to users upon new applicant matches, as well as user-supplied data for inputs into transportation demand models, air quality benefits analyses and periodic commuter surveys.

NOTE: A previous draft of this working paper was presented at the Northeastern Illinois Metropolitan Committee on Public Transportation Research (MCOPTR) Transport Chicago conference in June, 2002.
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Introduction

Ridematch System 21 is a real-time matching, Inter-/Intranet-accessible carpool/vanpool enrollment and management tool that was developed by the University of Illinois at Chicago's Artificial Intelligence Laboratory for the Chicago Area Transportation Study's Rideshare Services program.

This system is available to individuals, employers and transportation agencies that wish to organize and manage their demand-responsive carpool, vanpool and high occupancy employee transportation programs. The program is housed in the Illinois HUB of the Gary-Chicago-Milwaukee (GCM) Corridor ITS Program (see Figure 1 for coverage area).

CATS, through an Intergovernmental Agreement with UIC, has embarked upon an advanced technology project to improve the communications, matching engine and reporting capabilities of its current carpool and vanpool ridematching programs. The project will also provide a portal to commuters and other travelers seeking information about existing transit and rail services, highway networks, traffic conditions and air travel.

The system provides its users with nearly real-time ridematching.

Ridematch System 21 features the following enhancements:

Communications Environment

- User-friendly formats for data entry, database development, data retrieval and data transfer.
- Efficient data transfer between firms' Internet installations, Intranet stations, the main server and CATS service and management.
- Communication methods such as fax and e-mail for application, notification, reporting and update processes.

Matching Engine Improvements

- Real-time, or as close as possible, ridematching between individuals and among groups of individuals, as well as improved notification of database participants of potential ridematches.
- Access to the system for individuals and managers through current office systems utilizing Windows-styled environments.
- Visual map displays for the purpose of geomatching, geocoding and selecting ridematching areas. Point-and-click geolocating capabilities.
- Vector matching (along route) as well as radius match searching.
Report Writing

- Incorporation of systems word processing, database management and spreadsheet development for basic analysis. Links for data to GIS/ARC or equivalent geographic analysis software for second level analysis.
- Automation of applicant survey and purge operations.
- Improved mass-mailing and document printing capabilities.

Travel Information Links

- Links to other transportation alternate support systems, such as the RTA Itinerary Planning system and Metra schedule information.
- Current highway information systems as contained in the GCM project.
- Preferred air carrier links based on firm.

Figure 1. Gary-Chicago-Milwaukee (GCM) Corridor
Objectives

The daily vehicle miles traveled (VMT) in the Chicagoland region increased by 34% from 1990 to 1999, yet the number of lane miles of roadway used to serve these vehicles increased by only 23%. The result: congested roadways. Congestion cost the Chicagoland economy well over $4 billion in excess fuel and lost wages in 1999. That equates to about $570 per person per year. Trends indicate that congestion is only going to get worse if something is not done.

Increasing the efficiency of the road network is one way of reducing traffic congestion and improving air quality. Increasing the average number of occupants per vehicle through car/van pooling and mass transit provides a means for making more efficient use of roads. This project seeks to increase the amount of car/van pooling in the Gary-Chicago-Milwaukee (GCM) corridor by making the process of finding car/van pool partners as easy and accessible as possible.

The six-county northeastern Illinois region has been served by the POOLMATCH system since 1988. Unfortunately, this system is accessible only at the facilities of select employers in the region via dial-up modem or through the Share the Drive “hotline” at CATS. In 1994, the Poolmatch system was upgraded in anticipation of the Employee Commute Options (ECO) program. CARAVAN, a freestanding version of POOLMATCH that is installed at selected employers, was a further upgrade requested by the business community as part of the TMA of Lake-Cook's Rideguide program.

Both of these systems have one major flaw: accessibility. With the proliferation of desktop systems connected to the Internet, it is now possible to reach many more potential applicants than through traditional outreach programs. Today's connected business environment translates into the first goal of the Ridematch System 21 project: increasing accessibility to a regional ride-sharing database through the use of Internet tools and technologies.

CATS had previously employed a ride matching system developed by Crain and Associates. The Crain system supported a dial-in centralized subsystem called POOLMATCH and a stand-alone subsystem called CARAVAN.

POOLMATCH supported remote access through a dial-up modem. The POOLMATCH database contained applicants from multiple employers, transportation service agencies, and the general public. Any applicant that called the ride share phone hot line was entered into the POOLMATCH database.

CARAVAN was designed to be installed onsite at the facilities of various employers in the Chicagoland area; it allowed those employers to maintain a local database of employees seeking ride matches. Both subsystems matched new applicants to their respective databases and printed out the prospective ride share partners onto a form letter that could be sent to the applicant.
The POOLMATCH/CARAVAN system has a number of shortcomings that have been addressed by the Ridematch 21 Project, including: the ability of the system to allow applicants to directly register themselves via the Internet, the ability to generate better matches through vector and route-to-work searches and an easily updateable GIS base from which the match engine can work.

In summary, Ridematch System 21 provides the same capabilities as the POOLMATCH/CARAVAN system, with the following major enhancements:

1. Better accessibility for the general public via a Website dedicated to ridesharing.
2. Automated links to Metra and PACE for users better served by those agencies.
3. Better matching capabilities using route comparisons and a more detailed GIS.
4. Remote administration for rideshare services employees and vanpool administrators via the Website.
5. Ability to conduct automated surveys via electronic mail.
6. Automated purging, which results in reduced administrative duties.
System Architecture

The system has been designed for use in the three-state region that consists of Indiana, Illinois and Wisconsin, but can be later expanded for use in other regions or even on a nationwide basis. The administrative tools for this system are designed for use by the rideshare services staff at CATS and other appropriate agencies designated by CATS. The design of the Website takes into account users with small bandwidth dial-up modem Internet access. The Website is also designed to adhere to the appropriate state and federal impaired-user requirements.

The system is designed as a centralized Website that employees can access from home or work over the Internet (see Figure 2). Employers can also access the system over the Internet and may be given additional functionality for batch data entry and modification by the system administrator.

Figure 2. RideMatch 21 System Architecture
The system has been broken down into the following subsystems:

- Administration
- Data Storage
- Matching
- Web
- Reporting
- Survey
- Purging
- Georeferencing
- Vanpool

Each of these subsystems and how they relate to one another is shown in Figure 3.
Matching Subsystem

The matching subsystem is responsible for finding the best possible car and van pools—it (vector matching) makes Ridematch System 21 stand apart from other ride matching systems. The matching subsystem must be able to find matches quickly so that match lists can be presented through a Web-based interface with a delay not to exceed one minute. Matches are found by scanning through the set of applicant records, van pools, and park-n-ride lots to find pools of applicants who would be good potential ridesharing partners.

The matching subsystem must be able to match not only applicants who live and work close to one another, but also match applicants who live along and adjacent to each other’s route to work (on the beginning portion of their trip). Matches will need to be performed every time a new applicant is added or removed, or when an applicant’s status changes (from "driver" to "rider" or vice-versa).

Figure 4 demonstrates the actions of the matching system. The figure shows the contents of the applicant database with four applicants who live near one another: A, B, D and E. They all work at the same location, and all take a similar route to work: Residential road to Road 1 to Road 2 to Expressway 3 to Road 4. Applicant E takes a residential road to Road 2 to Expressway 3 to Road 4. When applicant A is first added to the system (assuming B, D and E are already registered), this applicant’s route would be compared to the routes for B, D and E. Applicant B would need to travel off-route x miles to pick up A. If x is less than B’s maximum off-route driving preference, then A and B could carpool together and B would appear on A’s match list. Applicant B would also be notified (if her notification e-mail preference is set) via e-mail of a new potential rideshare partner. Applicant B would have also known about applicants D and E if y and/or z were less than B’s maximum off-route driving preference through previous match lists and/or e-mail notifications. If y and z were less than A’s maximum off-route driving preference, then A would also receive a match list with D and E on it.
Figure 4. Vector Matching Example
Web Subsystem

The Web subsystem is the primary interface with the public at-large. The subsystem provides a means for users to register themselves with the system and obtain a list of potential rideshare partners.

The interface could potentially be utilized by millions of users and must be as easy to use as possible. Assistance is available within each data entry field at all times. The system supports both Spanish and English.

The “home” page contains links to other parts of the Web subsystem, such as: news, user registration, surveys and existing user logon. The registration page prompts users for details that will allow the matching subsystem to find potential rideshare partners. The data from the registration page is stored in the data storage subsystem. Potential matches are presented to the user in the form of three maps—the first showing the pickup location, the second showing the route to be taken and the third showing the drop-off location. The maps support zooming and scrolling, and as many streets as possible are labeled to make identifying locations as easy as possible. The georeferencing subsystem will generate the maps to be used here. Confidentiality will be maintained by showing the pickup location of applicants as a "nearby intersection" if it is a home address.

Users who have already registered can logon to the system and obtain updated lists of potential car/van pool partners or existing car/van pools looking for riders, modify their account records or remove themselves from the system. Administrators also logon to the system from the home page; they have additional links that allow them to make batch data entries and perform other administrative functions.
**Home Page**

The home page for the system can be accessed at [http://www.sharethedrive.org](http://www.sharethedrive.org); it features “Breathe-Easy” man as a mascot for helping new users navigate through the Website's many input screens (see Figure 5).

![ShareTheDrive Home Page](image)

**Registration**

Currently, the registration process is a ten-page questionnaire that requires the user to enter the following information:

- Home address
- E-mail address
- Password
- Work address and phone number
- Route to work
- Work Schedule
- Commuting Preferences
- Survey

Users with privacy concerns may enter a nearby intersection for their home or work address. Only users' e-mail addresses and a general map of the user’s location is displayed to potential matches.

The route to work is entered as a series of street names. The current design calls for the user’s home street to be displayed, along with a list of all streets that intersect it. The user
can then select from the list which street they turn on to. The Website then displays the list of all streets that intersect this second street. This process continues until all streets from the home address to the work address have been filled in. The system then stores this route for use in matching against other applicants.

Figure 6. Schedule Input Form

The work schedule is input as a usual Monday to Friday schedule. The Website then allows users to modify the schedule on a weekday-by-weekday basis, entering any deviations from their normal schedule (see Figure 6).

Once the user completes the registration process, she/he is shown a list of potential matches. This list includes the match's e-mail address and a map of the match’s home and work locations. If the user does not match with anyone currently in the system, her/his information will be held for use in future matches (see Figure 7).
Purging Subsystem

The purging subsystem is responsible for the automated maintenance of applicant records in the database. It is necessary to have these records periodically checked, and to have inactive accounts manually or automatically removed from the system. This is accomplished by scanning through all accounts and sending e-mail messages to all users who have not accessed their accounts within the past six months. This e-mail notifies affected users that their accounts are about to be removed from the system and allows...
them to reply if they do not wish to be deleted. Accounts that have had six months of inactivity, and whose users do not respond to the e-mail message, are deleted (see Figure 8).

Figure 8. Purging Flowchart
ITS Element: Integration into GCM Gateway Architecture

The UIC AI Lab was the primary developer of the Gary-Chicago-Milwaukee (GCM) Corridor Transportation Information Center (C-TIC); it has also developed its successor, the Gateway. The Gateway project brings together numerous sources of traffic information in the 16-county GCM corridor. Discussions between CATS and the Illinois Department of Transportation have yielded a proposed modification to the region's GCM Gateway ITS architecture wherein a regional Rideshare agency will be connected to the Illinois Transit Hub, along with RTA, CTA, Pace, Metra and Amtrak. Ridematch System 21 enables the regional Rideshare Services entity to serve the public as a provider of non-SOV transportation information. The Illinois Transit Hub is a subcomponent of the Illinois Hub of the GCM Corridor's central Gateway hub (see Figure 9: Proposed Gateway System Architecture with Rideshare Services).

Rideshare Services' contribution to the Illinois Transit Hub is analogous to that of the RTA. The RTA, while not providing transportation services in the form of vehicles and other capital equipment directly to the public, does provide the public with the RTA Travel Itinerary Planner Website for individual route planning and transit service information. Ridematch System 21, managed by the regional rideshare services (agency), will provide the public, employers and agencies with a way to find ridematches for carpools and vanpools and to identify opportunities for higher occupancy transportation services.

In addition, since most rideshare development takes place at the subregional level, the Transit Services category of the Subregional TMC receives the additional notation "Share the Drive carpool/vanpool development". The "Share the Drive" slogan, alongside the 5-occupant car logo, is the public's most visible symbol of rideshare services; it is featured prominently on nearly 200 road signs in the six-county Chicago region.
Figure 9: Gateway System Architecture with integration of Rideshare Services

Proposed RIDESHARE SERVICES
Carpool and Vanpool Matching

Gateway Hub
Central
Illinois Hub
Wisconsin Hub

Rideshare Services
Beyond Ridematching: The ITA

The ITA (Intelligent Travel Assistant) is envisioned as a compact portable device with the ability to plan multi-modal routes for its users. The traveler will enter a desired destination into the ITA, and the device will formulate several plans for getting the user to his/her destination. The ITA will utilize wireless Internet technology to send and receive traffic information and transit schedules, and to arrange for payment of fares. A Global Positioning System (GPS) will be used to track the user’s current position for use in route planning, and also as a means of assessing in-transit traffic. A spatio-temporal database management system will be used to efficiently track ITA positions in real-time.

![Figure 10. Intelligent Travel Assistant Concept](image)

Until recently, it was impossible to bring enough people together to make a difference in the amount of congestion on the roadways. But with the advent of the Internet, wireless communications and global positioning systems, the necessary ingredients are in place to bring about a solution to the congestion problem: the ITA.

The ultimate goal of the ITA will be the fusion and development of a number of key technologies into a device that will increase the efficiency of our transportation network through increased use of mass transit and ride sharing. To this end, a prototype system is planned that will include: a) dynamic ridesharing; b) spatio-temporal database management; c) wireless communications; and d) a management framework. This testbed will be equipped with a small number of ITAs and will ensure that the effects of noise, error and limited resources are properly addressed. The prototype will point the way towards a system that will ultimately become capable of powering millions of devices.

The ITA will build off existing projects currently being developed by the University of Illinois at Chicago (UIC) Department of Computer Science's Artificial Intelligence (AI) Lab. The UIC AI Lab's Gateway project brings together numerous sources of traffic information in the 16-county GCM corridor that could be an invaluable data source for the ITA. The AI Lab is in an excellent
position to merge the technologies from the Internet ride sharing project, the Gateway traffic information center project, and other research into an integrated device that could have a tremendous impact on the transportation scene of tomorrow.

The design of the ITA will include participation in the design of standards for wireless data transmission, traffic information dissemination and smart-card-like fare payment. In addition, a multi-modal route planner, traffic prediction algorithms and spatio-temporal databases will need to be designed. Traffic prediction algorithms will be necessary to obtain the best possible routes, since traffic patterns change over time. Two focus groups will also be conducted to determine the public’s perceptions of such a device. The focus groups will determine: a) how much the public would be willing to pay for such a device; and b) how many people would use it. The results of the focus groups will be used to refine the design of the device and to determine the overall impact the device will have on reducing traffic congestion. A focus group will also be held with interested government agencies and private sector companies to generate support for the idea and to refine the requirements of the system.

References