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16. Abstract <p>Because there is an increasing interest from motorists to have access to real-time information while en-route to a particular destination, advances in Intelligent Transportation Systems (ITS) have focused on the dissemination of real time information. As central business districts, airports, transit stations, and shopping centers continue to become more crowded during peak times, demand for real-time parking information is increasing. University environments are no exception to this rule. With decreasing parking supply and increasing enrollments and faculty and staff numbers, universities are beginning to realize the importance of properly allocating available parking. Intelligent Parking Systems (IPS) can provide the positive guidance necessary to help university patrons find available parking quickly and safely; more specifically, patrons of the University of Texas at Austin, UT.</p> <p>An Intelligent Parking System (IPS) could help the University of Texas reallocate parking and reduce congestion and illegal parks. Also, the university's master plan is biased towards a system that provides university "wayfinding," which can complement IPS. Variable Message Signs (VMS) have been considered by the university to provide "wayfinding" and parking information; however, VMS are expensive and will further clutter university street corners currently overridden with signage.</p> <p>The best university IPS application should provide real-time parking information, reduce congestion, and reallocate parking for all university patrons creating more efficient use of university parking supply. Because IPS should be consistent with increased efficiency, patrons should not have to pay increased parking fees for the university's implementation of IPS. The University of Texas should consider IPS implementation in conjunction with parking policy changes for successful deployment.</p> <p>In order to meet the efficiency demands, the Intelligent Parking System needs to be utilized; if not utilized, IPS will have little or no affect on the university's parking problems. The real challenge for the University of Texas is to begin to develop a parking system that meets the demands of the students, faculty, staff, and visitors that utilize university garage and surface parking. Current parking policy may hinder IPS effectiveness, however, if progressive changes are made to university parking policy, IPS could have positive effects on the supply and efficiency of parking at UT.</p>					
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# **Developing an Intelligent Parking System for the University of Texas at Austin**

by

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Design and Implementation of an Intelligent Parking System for a Major Activity  
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## EXECUTIVE SUMMARY

Because there is an increasing interest from motorists to have access to real-time information while en-route to a particular destination, advances in Intelligent Transportation Systems (ITS) have focused on the dissemination of real time information. As central business districts, airports, transit stations, and shopping centers continue to become more crowded during peak times, demand for real-time parking information is increasing. University environments are no exception to this rule. With decreasing parking supply and increasing enrollments and faculty and staff numbers, universities are beginning to realize the importance of properly allocating available parking. Intelligent Parking Systems (IPS) can provide the positive guidance necessary to help university patrons find available parking quickly and safely.

The University of Texas at Austin is an excellent example of a major university facing parking problems. Located in the central business district of Austin, Texas, the university is faced with providing appropriate parking for students, faculty and staff, and visitors in a crowded, growing city. Supply reductions and increased enrollments coupled with driver perceptions have already strained the crowded parking infrastructure. With the implementation of the “pedestrian friendly campus” as introduced in the university’s master plan, parking supply will be cut even lower. The university has already eliminated 150 faculty spaces on Speedway between 21<sup>st</sup> and 24<sup>th</sup> Street.

An Intelligent Parking System could help the university reallocate parking and reduce congestion and illegal parks. Also, the university’s master plan is biased towards a system that provides university “wayfinding,” which can complement IPS. Variable Message Signs (VMS) have been considered by the university to provide “wayfinding” and parking information; however, VMS are expensive and will further clutter university street corners currently overridden with signage.

Implementation of Advanced Parking Management Systems (APMS) software at the university would cost approximately \$45,000, which is relatively inexpensive compared to the over nine million dollar cost of the university’s newest parking garage. APMS software would permit the collection of parking availability information from all university garages in a central location. After the information is collected, the method of dissemination would be a matter of university choice.

Internet and cellular applications seem like excellent alternatives to bulky, expensive VMS. Increased use of wireless technologies coupled with the recent advances in wireless applications for transportation may suggest that digital information dissemination is the answer to transportation information gaps.

The best university IPS application should provide real-time parking information, reduce congestion, and reallocate parking supply. In order to meet those demands, the Intelligent Parking System needs to be utilized by university patrons; if not utilized, IPS will have little or no effect on the university's parking problems.

Focus groups can be used to identify parking issues facing university patrons as well as the appropriate IPS application to meet those challenges. During the fall semester, 2000, two parking focus groups were held at the university. The focus group participants identified parking issues including supply, permit costs, student car storage, and safety of on-campus parking. Through discussion, participants individually ranked IPS applications to deal with the issues facing the university. All focus group participants identified VMS outside of university garages as the best IPS application for today (because of current parking allocation) through a ranking scheme on focus group feedback forms. They also noted that both Internet and cellular applications would be the best alternative for the future if the university was willing to restructure current supply allocation and permit structures.

According to focus group participants, "wayfinding" is most applicable for campus visitors, but would have little effect on the chosen routes of students, faculty, and staff. If "wayfinding" was to be implemented for visitor use, participants sited university kiosks as the best way to guide campus visitors to destination.

Also, focus group participants identify IPS implementation as a valuable tool to reallocate university parking only if current parking policies (including permit and time-of-day restrictions) were updated. They believe that IPS will have little or no effect on university parking without these proactive policy changes.

## ABSTRACT

Because there is an increasing interest from motorists to have access to real-time information while en-route to a particular destination, advances in Intelligent Transportation Systems (ITS) have focused on the dissemination of real time information. As central business districts, airports, transit stations, and shopping centers continue to become more crowded during peak times, demand for real-time parking information is increasing. University environments are no exception to this rule. With decreasing parking supply and increasing enrollments and faculty and staff numbers, universities are beginning to realize the importance of properly allocating available parking. Intelligent Parking Systems (IPS) can provide the positive guidance necessary to help university patrons find available parking quickly and safely; more specifically, patrons of the University of Texas at Austin, UT.

An Intelligent Parking System (IPS) could help the University of Texas reallocate parking and reduce congestion and illegal parks. Also, the university's master plan is biased towards a system that provides university "wayfinding," which can complement IPS. Variable Message Signs (VMS) have been considered by the university to provide "wayfinding" and parking information; however, VMS are expensive and will further clutter university street corners currently overridden with signage.

The best university IPS application should provide real-time parking information, reduce congestion, and reallocate parking for all university patrons creating more efficient use of university parking supply. Because IPS should be consistent with increased efficiency, patrons should not have to pay increased parking fees for the university's implementation of IPS. The University of Texas should consider IPS implementation in conjunction with parking policy changes for successful deployment.

In order to meet the efficiency demands, the Intelligent Parking System needs to be utilized; if not utilized, IPS will have little or no affect on the university's parking problems. The real challenge for the University of Texas is to begin to develop a parking system that meets the demands of the students, faculty, staff, and visitors that utilize university garage and surface parking. Current parking policy may hinder IPS effectiveness, however, if progressive changes are made to university parking policy, IPS could have positive effects on the supply and efficiency of parking at UT.



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# CHAPTER 1. INTRODUCTION

## 1.1 BACKGROUND

For over thirty years, traffic information has been provided to help motorists make en-route decisions. In more recent years, the development of Intelligent Transportation Systems (ITS) and Advanced Traffic Management Systems (ATMS) have begun to improve transportation through the use of technology.<sup>1</sup> Along the same lines, Intelligent Vehicle Highway Systems (IVHS), systems that “acquire, analyze, communicate, and present information to assist surface transportation travelers in moving from a starting location (origin) to their desired destination,” can now be utilized for en-route assistance as well as traffic data collection.<sup>2</sup> And finally, technology is beginning to recognize the importance of post-trip information dissemination by providing information on the location and availability of parking. Real-time information can be accurately provided to motorists through Intelligent Parking Systems (IPS) to reduce congestion in or near parking areas, insufficient utilization of the available parking space stock, road congestion caused by space-searching traffic, access problems and safety hazards caused by illegal parking, and environmental strains.<sup>3</sup>

Vehicle users must store their vehicles at trip end for varying lengths of time. Studies have shown that the average passenger car is at motion for only 500 hours and at rest for more than 8,000 hours per year.<sup>4</sup> In many locations, especially high-density traffic areas such as central business districts (CBDs), shopping centers, university campuses, and airports, parking supply cannot meet parking demand; or at least the perception of the public is that parking is inadequate at these venues.

## 1.2 PROBLEM STATEMENT

The University of Texas at Austin is an excellent example of a major trip attractor facing parking inadequacies. Located in the central business district of Austin, Texas, the university is faced with providing appropriate parking for students, faculty and staff, and visitors in a crowded, growing city. Throughout the 1990's, the population of Austin, Texas grew 41%.<sup>5</sup> Also, enrollment at the University of Texas continues to increase reaching 47,500 undergraduate and graduate students in the 1999-2000 school year.<sup>6</sup> During the 1999-2000 school year, the

University of Texas also employed over 20,000 faculty and staff members.<sup>7</sup> Therefore, the university can be seen as a work, school, or recreational trip attractor for over 67,500 people on a regular basis. This number does not consider university visitors, guest lecturers, or meeting attendees that can generate another 500-1000 or more trips per day.<sup>8</sup>

Although the university may attract 67,500 person trips during any given day, there only about 14,000 total parking spaces on campus.<sup>9</sup> These 14,000 parking spaces are further restricted by permits and time of day, however, the ratio of university patrons to total parking is about 5:1.

Supply reductions, increased enrollments, and increased faculty and staff hiring coupled with driver perceptions have already strained the crowded parking infrastructure. With the implementation of the “pedestrian friendly campus” as introduced in the university’s master plan, parking supply will be cut even lower.<sup>10</sup> Alternatives such as ride sharing and transit usage are applicable to lowering parking demand on the university campus. The simple fact remains, however, that special needs of university patrons demand automobile usage and on-campus parking. Therefore, the university may need to expand its parking program to include IPS.

There are IPS deployments in the United States and abroad providing parking information to travelers before they begin their trip or while they are en-route. (Five different U.S. deployments are examined in the literature review in conjunction with one international post-deployment study.) Although many agencies and developers of IPS envision the systems functioning continuously, the current movement is more in the direction of IPS utilization for special events and major shopping holidays in large Central Business Districts (CBDs). The systems have a lot in common whether operating in the United States (for example Saint Paul, Minnesota) or abroad (Frankfurt, Germany) and are intending to solve the real-time information dilemma with variable message signs serving as “wayfinding” devices. The concept of “wayfinding” has addressed real-time parking information by providing guidance pathways to guide motorists to available parking.<sup>11</sup> (Specific projects may have different implementations for “wayfinding,” however, the term is used throughout parking literature to describe any form of positive guidance. “Wayfinding” may simply involve static maps or zones for specific destinations or entire real-time systems as in the MnDOT deployment described in 1.3.1.1.) Current projects are looking to first implement and evaluate special event VMS “wayfinding” systems, and then expand the systems further to include things like continuous operation and real-time information access on the internet.

This project addresses the concept of providing post-trip parking information during the pre-trip or en-route stages under the topic of Intelligent Parking Systems in the university environment. The University of Texas at Austin will be examined as a case study for university IPS because of its increasing parking demand in a defined, controlled environment. The goals of IPS research at UT are (1) define parking demands and deficiencies, (2) suggest IPS alternatives to address demands/deficiencies, and (3) recommend the best IPS alternative from a user perspective through university surveys and focus groups.

### **1.3 LITERATURE REVIEW**

In order to develop an Intelligent Parking System that will accommodate the goals and demands of ITS in the twenty-first century, it is important to understand the state-of-the art. An in-depth literature search was conducted to locate IPS systems in the design, implementation, and evaluation stages. The studies located can be classified into the following topics: (1) venues utilizing IPS, (2) basic IPS system requirements, and (3) IPS evaluations. The venues utilizing IPS range from universities to airports. The specific projects chosen to review for each particular venue reflect the state-of-the-art in the United States and Europe giving a good background of what current intelligent parking systems entail. Because the state-of-the-art is generally uniform among projects (in design, implementation, or evaluation), the basic system requirements are reviewed from all papers in part (2). Part (3) explores the overall perception of IPS systems from motorist to operator perspective. Part (3) also explores the nature of human factors in any behavior changing system (such as an IPS) and how they relate to ITS utilization.

#### **1.3.1 Venues Utilizing IPS**

The projects reviewed in this section focus on the following venues or areas: (1) central business district (CBD), (2) University/transit and (3) airport. The central business district systems reviewed are generally utilized during special events only or when two or more special events occur simultaneously downtown. For example, in Phoenix, Arizona, the presence of the Arizona Diamondbacks, Phoenix Suns, Herberger Theater and other cultural and sporting centers require an IPS system that can accommodate 40,000 to 80,000 visitors.<sup>12</sup> In Saint Paul, Minnesota, the system operates when the civic center is expected to draw more than 2,000 visitors or music center is expected to draw greater than 1,000 visitors.<sup>13</sup> In Frankfurt, Germany,

IPS is utilized for holiday shoppers entering the CBD on weekends.<sup>14</sup> Therefore, CBD system designs can have similar goals for special events, but may vary extensively depending on number of people. University and transit systems are lumped together because a case study at Oregon State University is reviewed that is attempting to route a transit shuttle through a parking lot based on the location of the entering motorist's parking space. The system will route the motorist to a space then route the shuttle to them.<sup>15</sup> Finally, airport systems are examined like the IPS utilized in the Baltimore-Washington International Airport in 1991, which routed motorists to empty spaces during an on-going airport construction project.<sup>16</sup>

**1.3.1.1 Saint Paul Advanced Parking Information System.** In Saint Paul, Minnesota, an Advanced Parking Information System was deployed in late 1995 and early 1996 as a test case under the Minnesota Guidestar Program. Minnesota Guidestar provides overall direction for the Minnesota Department of Transportation's (MnDOT) ITS program by providing a focus for strategic planning, project management, and evaluation.<sup>17</sup> The APIS itself was utilized in the downtown Saint Paul area to inform drivers of parking location and availability so that they would have the opportunity to make advance decisions hopefully helping reduce congestion and pollution. In conjunction with the MnDOT Office of Advanced Transportation Systems (part of Minnesota Guidestar), the City of Saint Paul and Department of Public Works, Federal Highway Administration and two public partners came together to fund the \$1.2 million project. Ten parking facilities also entered into an agreement with the city and agreed to be responsible for actual system operation.

Because the downtown receives over four million visitors annually (for events at the Civic Center, Ordway Music Theatre, and other social and cultural events), MnDOT saw a need to effectively guide these visiting motorists to available parking spaces. Coupled with the fact that many of the attendees to the events are newcomers to the city, the overall perception of all downtown motorists was that there was not enough available parking.<sup>18</sup> The goal of MnDOT is to eventually utilize the system continuously however, the APIS was only deployed during events in which the Civic Center attracted greater than 2,000 visitors, the Music Center attracted greater than 1,000 visitors, or a combination of events occurred simultaneously.

The focus of the Saint Paul operational test system was "wayfinding."<sup>19</sup> "Wayfinding" is a general term that describes any positive guidance routing motorists to available parking.

MnDOT utilized “wayfinding” as a positive guidance tool to route motorists from a key travel point to a defined zonal area, and then to a specific garage. “Wayfinding” was utilized because parking was available, but many visitors were unaware of garage and lot locations. MnDOT developed the concept of “wayfinding” into an entire “wayfinding system.” Variable message signs (VMS) are the backbone of this “wayfinding system” and were designed to allow the transmittal of real time information. The VMS were designed to display single “word messages” such as FULL, CLOSED, and OPEN or full matrix messages by method of two different types of electronic signs. The electronic signs tell garage status while static signs provide directional guidance at strategic locations. Colors of both types of signs are crucial to “wayfinding”. The selected design used different colors for each “zone” that was established surrounding the event venues. This color scheme was carried throughout the electronic and static sign types therefore; signs of the same color uniformly designated each parking facility. MnDOT’s chosen color scheme for each zone allows future expansion of the system without having to add more colors.

The system operates using loop detectors, ticket splitters or cash registers as vehicle counting equipment located at each garage or lot. A controller interface is also required since the equipment is not capable of calculating a “space available” number. This interface counts and calculates space availability as each car enters or exists the lot in real time. This number is then transmitted via modem to a central computer at the city. The central computer then sends the required signal along to the variable message signs with the help of MnDOT’s Microsoft-based Ramp Management Software. The operator controls the system from the central computer and, at any time, has the ability to read and modify sign messages, correct parameters, check the state of an entire mounted electronic sign mast or parking facility, and take appropriate action as required. (The technical aspects of the system are described more thoroughly in 1.3.2.)

**1.3.1.2 Phoenix Event Parking and Traffic Information System.** In Phoenix, Arizona, an Intelligent Parking System is in the design stages, which is similar to the system deployed in Saint Paul in that it provides special event guidance. The system is part of AzTECH, a regional ITS plan currently deployed in the Phoenix area. More specifically, it is an extension of a previous traffic information dissemination plan called Sunburst, which was implemented and operated by the city police for simultaneous downtown events. The new plan will address the need for motorists to receive real-time parking information, the need for information

dissemination, and the need for specific venues to provide information as patrons leave a particular event.<sup>20</sup> The Arizona Department of Transportation (AZDOT), City police, Event Control Center (ECC), Transportation Management Center (TMC), Downtown Partnership, event venues, barricade providers, and local radio (KTAR Phoenix) will join together to operate this joint plan. The new Sunburst Plan will be implemented in three phases with the total estimated cost of all phases (without estimated operating costs) of about \$5 million.

In downtown Phoenix, the Phoenix Suns, Arizona Diamondbacks, Hergerberger Theatre, and other events, cultural centers and sports teams attract a large number of visitors daily who join the 20,000 people who work in the central business district and thousands who live there. The city has estimated that for any given year, there will be several days when any of those activity centers (or combinations thereof) will attract over 100,000 visitors to downtown. Also, Phoenix hopes to accommodate visitors and those unfamiliar with the city like the “Snowbirds,” retirees who generally live in Phoenix from September through April. Because of the large visitor attraction, Phoenix again is looking to accomplish “wayfinding” with its event parking system as it has “the need for a system that systematically and simply guides event patrons to available parking without relying on previous knowledge of the area.”<sup>21</sup>

Unique to the Phoenix design is its special response to ingress and egress traffic for special events. Different traffic management tactics are used to manage continuous ingress traffic two to three hours before the event and egress traffic, which departs immediately following the event. For both ingress and egress traffic, however, variable message signs (VMS) will be used to disseminate real-time information. Some existing freeway VMS will be used and additional VMS will be placed downtown along with their static counterparts. In realizing the importance of educating the population on the system, pre-trip information will be provided via maps, radio and television broadcasts, and newspaper articles. Venues will provide information for passengers at a particular event for egress success.

The Sunburst plan operates similarly to the MnDOT IPS, but on a much larger scale. The original plan was a multi-event control plan implemented by police and the city street transportation department for simultaneous downtown events. The new plan will implement a series of traffic operation scenarios based on zones with variable message signs (VMS) used as the information dissemination medium. Sensors in parking garages and regional freeways in conjunction with cameras will provide the traffic and parking information. Traffic volumes and

space availability volumes will then be transmitted electronically to the traffic management center (TMC), which serves as the master control center. The TMC will have primary control over all field equipment and information transmitted to VMS and operators. In addition to relaying the real-time traffic and parking information, the system involves actual operation from individual parties. As information is being disseminated electronically to ingress and egress traffic, barricade providers will deploy barricades for traffic routing and police will report to set locations to direct traffic, monitor traffic conditions, and monitor and report accidents.

The system has not yet been deployed however, Phoenix has considered pre-deployment studies to determine motorist needs and desires for such a system. These issues are discussed more thoroughly in section (3) of this literature review.

**1.3.1.3 Seattle Center Advance Parking Information System.** The Seattle Center Advanced Parking Information System is the intelligent parking program of the larger Seattle Smart Trek Model Deployment Initiative. Smart Trek is Seattle's \$13.7 million project designed to increase the overall efficiency and performance of the areas roadways and transportation systems to meet growth demands.<sup>22</sup> Twenty-five Northwest public agencies and private companies have joined together to invest in the integrated ITS infrastructure. The intelligent parking portion of Smart Trek entails both a downtown application (discussed in this portion of the literature review) and an airport application. The downtown or central business district intelligent parking system will provide information to direct traffic to three major parking areas in a manner that is safe and efficient resulting in minimum traffic congestion and neighborhood disruption. It will also provide parking and trip planning information to travelers before they leave for the Center via pager, cellular phone, Internet, and cable television traffic updates so that they can make informed travel choices.<sup>23</sup>

The Seattle Center itself is another major cultural and sports event center as it has hosted the World's Fair in 1963 and continues to attract visitors to the theatre, opera, and special events including the Seattle Supersonics Basketball team home games.

The Seattle Center began its development of a real-time parking information system based on its conceptual design goals in conjunction with the regional Smart Trek goals. The initial concept for the intelligent parking system illustrates the basic architecture of the system, which includes the following five basic elements:<sup>24</sup>

1. Parking facility-monitoring subsystem: monitors the ingress and egress of vehicles at all three parking facilities.
2. Parking information signs: provide parking lot occupancy and directional information to drivers at decision points near the Seattle Center.
3. Communications subsystem: facilitates communication between the central computer, vehicle detector system, and the parking information signs.
4. Central computer system: calculates lot occupancies from vehicle detectors, commands signs to show required message, allows operator intervention.
5. External interfaces: facilitates communication between the central computer and external systems including Smart Trek VMS.

The regional vision focuses mainly on the actual information dissemination.<sup>25</sup> In order to assist travelers with pre-trip mode selection, route selection, and departure time selection, and en-route mode selection, route selection and destination adjustment, Smart Trek will make information available to the following partners: University of Washington Cable TV, commercial radio, and local transit authority.

As in the other CBD systems analyzed in this literature review, one of the primary elements of the Seattle intelligent parking system is variable message signage. Both the location of the sign and its timely message display are key factors in influencing motorists to utilize the system. Locations of VMS were carefully chosen. Preferred traffic routes (routes patrons of Center events are encouraged to use) were first defined. Then, VMS were placed only at decision points along the routes. As previously mentioned, the central computer will control the actual messages displayed on the signs which will include a Seattle Center Logo showing that the signage is for Center patrons, directions from the sign to open parking areas, relative occupancies of several individual parking facilities, and any other directed small text message.

**1.3.1.4 Oregon State University: Smart Parking Lot with In Time Shuttle.** Oregon State University is currently working on an intelligent parking system whose purpose is to study the efficiency of large parking lots by providing a computer system that dynamically routes a shuttle.<sup>26</sup> Shuttle route is determined by the placement of customers returning from the terminal while incoming motorists are simultaneously assigned a parking space near the drop off point of

returning passengers. The system proposes to increase the efficiency of both the shuttle and the motorists and travelers times.

Currently, the Smart Parking Lot with In-Time Shuttle (SPLITS) simulator is a computer program that takes variable inputs and simulates the actions of shuttle buses transporting customers to and from the lot. The output will be studied to help determine shuttles needed to minimize traveling time. Although the program is not currently working in a real-time system, researchers at OSU believe that it can operate as a real-time system with some programming enhancements. While providing more efficient shuttle service, the deployment of SPLITS will also offer real-time information on the status of the lot itself including capacity information of the lot and capacity information of the shuttles.

**1.3.1.5 Baltimore/Washington International Airport: VMS Routing.** Variable message sign routing can be a valuable asset for airports. In 1991, because of increased parking delays due to construction at Baltimore/Washington International Airport (BWI), VMS were utilized to provide up-to-the minute parking availability and construction activity information. The signs operated 24 hours per day to accommodate all travelers.<sup>27</sup>

The implementation of VMS at BWI was believed to successfully route 10,000 to 20,000 travelers per day through the changing traffic patterns and to available parking, minimizing time delays. Three VMS displayed signs like “DAILY LOT FULL” or “USE OTHER LOTS” helped the motorist decide which way to go. In that sense, the VMS were not used as “wayfinding” devices. They simply gave standard information and let the motorist make his or her own decision on where to proceed.

Highway advisory radio was an alternative to VMS however, “changeable (variable) message signs have been the best form of communicating timely information to tens of thousands of travelers per day” and “make a substantial contribution, both in terms of safety and providing quick information.”

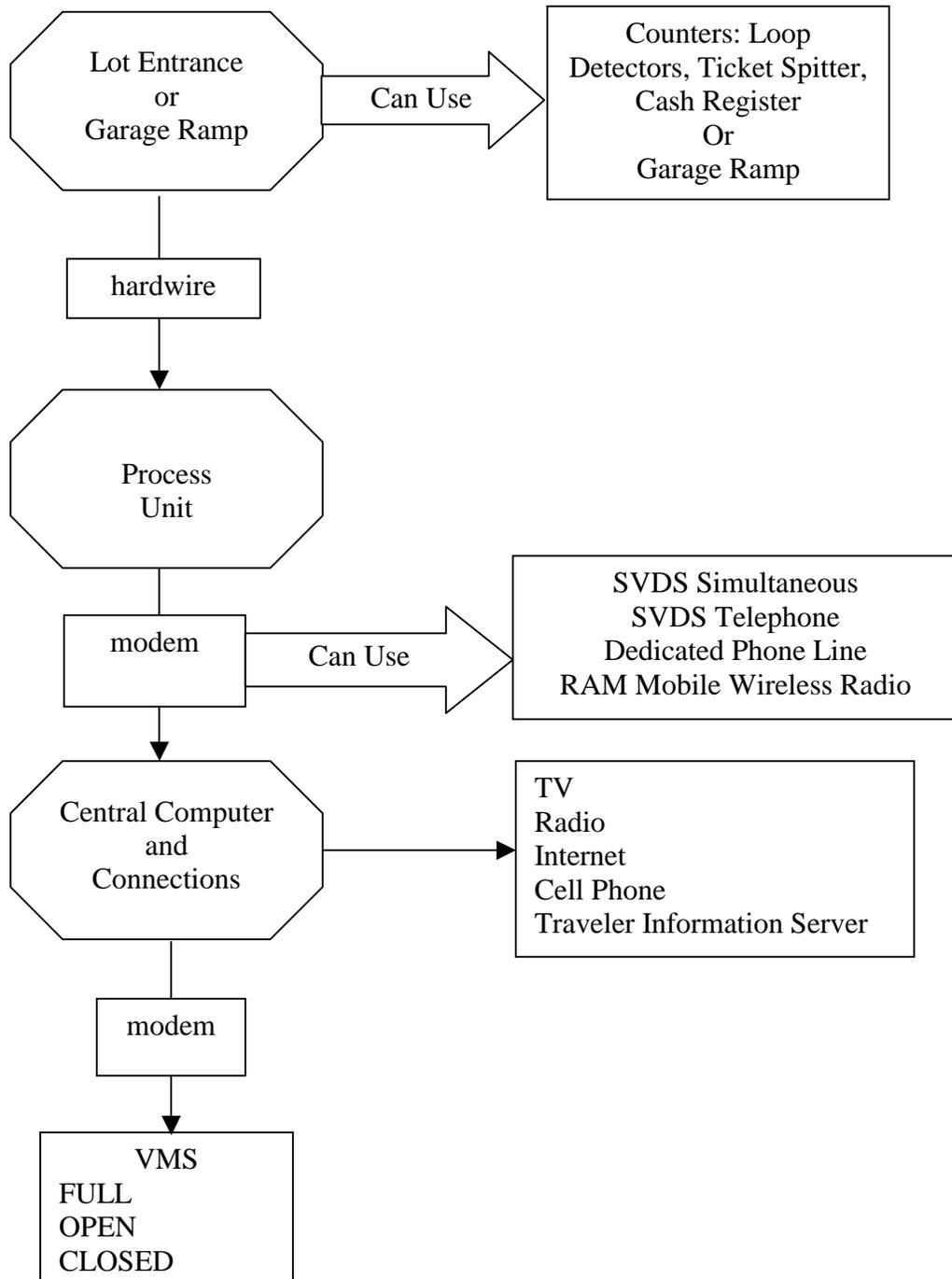
### **1.3.2 Basic IPS Requirements**

Most intelligent parking systems researched in this literature review were utilized or are currently being designed or deployed in a large downtown central business district area. The other specific cases involving university transit or airport applications contain similarities to those CBD applications including the use of variable message signage however, the CBD applications go above and beyond the general use of VMS to manufacture a whole system that relates into the local ITS architecture. The CBD applications also demonstrate the ability to coordinate a real-time system over more than one parking facility. The basic intelligent parking system requirements discussed in this portion of the literature review are therefore based on the state-of-the-art CBD applications discussed in the previous section. These requirements can be easily scaled down to accommodate a smaller venue such as a university transit or airport parking area.

The basic system that coordinates a multiple facility intelligent parking system contains the three main elements of (1) parking facility equipment, (2) central computer and connections, and (3) signage. The parking facility equipment includes the vehicle counters, space monitors and processing units found on site to monitor ingress and egress traffic, which is sent usually by modem to a central computer. The central computer then controls the variable message signage producing the desired LED displays to direct traffic to open garages or other parking areas. The central computer can also be programmed to send simultaneous messages by radio frequency, dedicated phone line, or Ethernet connection to the local radio, television station, or Internet. (Figure 1.1 shows Basic IPS Equipment and Connections.)

**1.3.2.1 Parking Facility Equipment.** The parking facility equipment is used to monitor ingress and egress of vehicles at all parking facility entrances and exits. Electrical relays can be attached to gate closing detectors forming loop detectors allowing only one vehicle to pass through the gate at a time. Gate closing detectors or loop detectors should be installed such that even if the gate is locked in the upright position, the detector still functions and provides the correct count. An on-site processing unit then calculates the number of available spaces based on the pulses sent from the loop

**Figure 1.1: Basic IPS Equipment and Connections**



detector each time a vehicle enters or exits the facility. These counts are then sent to the central computer, which is usually centrally located off-site.

The Minnesota Department of Transportation (MnDOT) researched four feasible processing units or “controller interface units” (as they call them) and finally decided upon a unit manufactured by a company called AGS group.<sup>28</sup> The AGS processor has been deployed in Europe with a successful track record in Europe, can be wall mounted on-site, and is competitively priced at \$3,750 with a \$500 installation fee. Other options include the sophisticated Type170 Signal Controller and Cabinet (\$1,700 with \$850 installation), which requires custom software, a PC based interface (\$3,200 with \$650 installation), which tends to be theft prone and requires custom software, and a processor manufactured by Harstad Company Equipment (\$4,800 complete and installed), which is similar to the AGS processor, but has no documented deployment.<sup>29</sup>

The studies researched in section (1) of this review all involve counting ingress and egress vehicles to determine garage occupancy. Specific space availability is not discussed in such great detail however, closed circuit television (CCTV) cameras may be used to provide this information to the processing unit and then along to the central computer.

Siemens Corporation is addressing the need to provide information on the location of the actual space. It has developed SIPARK, a car park guidance system used internally; a device mounted on the ceiling of the garage scans the spaces at programmed intervals to determine which spaces are available. A programmable interface unit then retrieves parking space information from the BERO device and determines quickly the shortest path to the nearest free space while simultaneously sending signals to aluminum mounted LED's. LED green arrows then positively guide the ingress vehicle to the available space. SIPARK has been successfully deployed in a German shopping center garage of 2253 spaces on three levels.

**1.3.2.2 Central Computer and Connections.** The central computer in an intelligent parking multiple facility application controls the operations of the entire system. Because it should be designed for operator intervention, the central computer also allows parking facility and variable message sign monitoring. Even with an operator present, however, the central computer should be programmed to determine appropriate messages to display on the variable

message signs including facility occupancy information. A Pentium PC with custom software allows the central computer to accomplish this task. AGS Group manufactures a software package specifically geared to intelligent parking applications called Advance Parking Information System (APIS) Software, which was successfully deployed in the Saint Paul APIS Operational Test.<sup>31</sup>

The central computer connections from the individual parking facility-processing unit allow for the transfer of real-time information. The Saint Paul APIS Operational Test explored the following four alternatives for the signal transmission from the facility processing unit to the central computer: SVDS (Simultaneous Voice and Data) phone service multiplexed, SVDS one-to-one line relationship, dedicated regular voice telephone line, and RAM mobile data wireless radio transmission.<sup>32</sup>

SVDS multiplexed phone service was originally the first choice for Saint Paul with an installation cost of about \$26,000 and annual operating cost near \$7,000. This service was to use the existing phone lines at each parking facility to transmit data to the phone company where the data is multiplexed (muxed) or combined. The data was then to be sent to the central computer via a T1 telephone line where the signal was to be de-multiplexed (demuxed) or split. The SVDS multiplexed service proved to have two major problems for MnDOT and therefore was never utilized. SVDS multiplexed service does not work on an existing phone line wired into a PBX system; all facilities in the Saint Paul APIS Operational Test were wired this way. Also, the transmission rate of the processing unit chosen (1200 baud) are much lower than that required at the end of a T1 telephone line.<sup>33</sup>

SVDS telephone service, one-to-one line relationship requires the installation of a new line at each facility and costs about \$20,000 installed with an annual operating cost of \$12,600 and is an alternative to the similar multiplexed service. However, it requires a processor that can transmit faster than 1200 baud to meet the requirements of the speed at the end of the T1 telephone line. RAM Mobile Data wireless radio is an option that eliminates hardwire telephone service (and is necessary for signal transmittal to electronic signs), but at an installation cost of around \$20,000 and annual operating costs upwards of \$46,000 for airtime, proves to be an expensive venture.<sup>34</sup>

Perhaps the most cost-efficient and effective way to transfer the signal from the processing unit in a parking facility to its corresponding central computer is the dedicated regular

voice telephone service. This alternative requires the installation of a new telephone line at each facility. The data from the processing unit is then sent to the phone company where the signals are muxed and sent on via a T1 telephone line to the central computer where they are demuxed. The T1 telephone line requires specific baud rates for transmission so, in the Saint Paul APIS Operational Test, the modem in the processing unit as well as the receiving cards in the central computer were updated.<sup>35</sup>

After the signals are processed by the central computer, (with or without operator intervention), they are sent to the corresponding VMS. In this case, a hard wire will not work for the signal transfer because VMS are usually located throughout the region and their locations may change over the course of deployment. RAM Mobile Data wireless radio allows for signal transmission without hardware.

RAM wireless radio uses a radio communications board, RAM radio link, and a radio antenna located on the sign for successful transmittal. A communications board installed in the workstation processes information from the central computer. A radio modem / wireless transmitter receives the data from the communications board and transmits it to a RAM Mobile Data Systems base station, which in turn transmits the required data via radio broadcast mode to the electronic sign masts. Each VMS is mounted on this mast, which has a small radio antenna located at the top that receives the radio broadcast from the RAM base station. The electronic signs are finally equipped with the electronic signal necessary to display LED messages.

**1.3.2.3 Signage.** The key type of sign in an intelligent parking system is the variable message sign. Variable message signs are changeable LED display signs. They can be static signs with variable message inserts that display number of parking spaces or messages like FULL or OPEN, or full matrix signs that can display any special message to motorists. Both types are utilized to provide for the dissemination of real-time information. Most of this discussion of signage is directed toward electronic signs however; static signs are crucial in a system that provides positive guidance pathways or “wayfinding”.<sup>36</sup> The static signs identify the path to a certain garage after the VMS identify its capacity and should color coordinate for specific regions. Background colors for both static and electronic signs should also accommodate color-blind motorists while fitting aesthetically with the surrounding architecture.

In areas where freeway VMS exist, information about parking can be disseminated before the motorist reaches the downtown area. Phoenix, Arizona has the advantage of having freeway

VMS through its existing ITS AzTECH program and plans to coordinate usage with ADOT on major event days.

Another VMS alternative is portable arterial VMS. Portable VMS can be used if an IPS is being phased in over several years until the permanent VMS are in place.

Regardless of the type of VMS used, the electronic portion of the sign must be capable of receiving the transmitted signal from the central computer. MnDOT accomplished the electronic sign transmittal by using more than one sign mounted on a sign mast. Each sign mast contains exactly one primary sign, which integrates all electronics (power supplies, command electronics, communication electronics, and communications apparatus) while controlling all other signs on the mast. An antenna on the top of the sign mast receives the signal from the central computer and sends it to the radio modem on the primary sign. The sign can then transmit the data to other LED signs on the mast or display the message itself.

Different agencies have different sign requirements. MnDOT chooses to display more than one sign per mast. Phoenix chooses to display parking information on portions of existing freeway VMS. But whatever the sign structure, the variable message signs complete the dissemination of real-time parking information.

### **1.3.3 IPS Evaluations**

Intelligent Parking Systems can be grouped into categories of “parking management tactics.”<sup>37</sup> Parking management tactics are “actions taken to alter the supply, operation, and/or parking demand of a jurisdiction’s parking system to further the attainment of local transportation, economic, environmental, and other objectives.” More specifically, IPS alters the operation of the parking systems themselves. Because goals of parking management can range from “wayfinding” to air emissions reduction to increasing transit usage and carpooling, specific goals should be set before an IPS is deployed so that the system may be properly evaluated later. This evaluation section addresses a pre-design strategy used in Phoenix to identify IPS need, the outcomes of evaluations in Minnesota and Frankfurt, Germany of deployed systems, and the human factors involved in choosing an actual parking location.

**1.3.3.1 Phoenix Pre-Design Strategy.** In order to develop an event parking and traffic information system that would work for everyone involved in the new Sunburst plan (from stake

holders to patrons), an in-depth review of previous plans, focus groups, interviews, a trial period, and the National ITS Architecture were employed.

Interviews and focus groups were started in August 1997 leading up to a (then hopeful) 1998 trial run with a stakeholder meeting that addressed project goals and objectives. A meeting survey found that:

1. The top four issues raised by stakeholders included the need for adequate parking supply, better directions and signage for events, improvement of overall transportation system and traffic flow, and development of an advance public information strategy.
2. Stakeholders felt that the best three ways to provide pre-trip information to patrons were newspaper articles and maps, commercial radio, and pocket size maps distributed in utility or tax bills.
3. Stakeholders felt that the best four ways to provide in-route information to patrons were: existing VMS on freeways, new VMS on downtown arterials, additional fixed signage down town and additional fixed signage on freeways.
4. The top two ideas for helping people arriving in the downtown area to find a parking space were options posted at full lots directing patrons to alternate sites and standard signage at all parking facilities.

With this in mind, four focus groups having representatives from neighborhoods, employers, parking facility operators and owners, and venues were set up to get community feedback. From the community feedback, specific needs of the system were determined. Some of the “system requirements” are listed below.

1. Information disseminated to patrons must specifically familiarize them with routes and space locations through chosen media (VMS, radio, etc.)
2. Information must be disseminated to patrons en-route and upon exiting venues.

The City of Phoenix was then able to apply these system needs to the entire design process. This process was implemented to ensure usage and success of patrons and stakeholders.

**1.3.3.2 Frankfurt, Germany: Pre/Post-Deployment Surveys.** In Frankfurt, Germany, a more behavioral survey was implemented to examine if pre-deployment ideas concerning parking guidance information (PGI) system were similar to actual perceptions after the system was deployed.<sup>38</sup> One survey was taken before deployment and two were taken after in the form of a

five-minute interview. The interview established time spent searching for a parking space, driver awareness of and use of PGI, observation of queue lengths, license plate survey (to establish origin patterns), and observation of arrival and departure profiles (encounter of free parking space, average duration of stay). The surveys were conducted during the pre-Christmas shopping season on Thursday and Shopping Saturday. The pre/post-deployment surveys allowed for the tracking of driver awareness over time.

In general, the surveys showed that 50% of off-street parkers and 25% of on-street parkers used the system at some time and, on any given day, an estimated 20% of off-street parkers will use the PGI system to find a space. These numbers are seen as disappointing to Frankfurt PGI system stakeholders.<sup>39</sup>

**1.3.3.3 MnDOT Post-Deployment Survey.** The Minnesota APIS was also evaluated post-deployment to evaluate motorist perceptions. Motorist surveys were distributed in the form of a mail-back questionnaire: 9500 were distributed during special events, 139 total were returned. The summary of the findings reports that the system is perceived as beneficial to the operators and has value to the motorist. However, the findings go on to say that although the signs were found to be easy to follow and travel time on selected routes within the study area seemed to decrease, less than half of the responders who saw the signs used them to find parking.<sup>40</sup> Also, the improvements on the surface transportation system itself could not be directly attributed to the APIS deployment.

**1.3.3.4 Behavioral Aspects of Parking.** All cities designing, deploying, or evaluating systems discussed in this review have sound needs for intelligent parking systems. (These needs were addressed in section 1 of this literature review.) In fact, the city of Phoenix has even taken the need one step further to ensure that the system not only meets the needs of the city, but of the actual motorist by designing the system based on public perceptions. The need is present, but the utilization rates are low and even seen as “disappointing.” And, because the cost of implementing an IPS (like the Phoenix design) can be large, stakeholders should be interested not only in the need for such a system, but the actual use it will really get.

Parking in itself is not a travel motive. It is simply the result of trip making and part of travel behavior.<sup>41</sup> To successfully implement IPS, actual behaviors must be changed and, in order to change human behavior, the attitude regarding alternative choices needs to be changed.

However, it is important to understand that behaviors do not change on a whim. Parking is habitual and habits are hard to break. Motorist perceptions of IPS are positive at first, however, the systems are infrequently used. Only a few drivers really understand the actual system direction while most drivers use the system to check their own decision. Because the driver fails to notice or understand the signs, ignores the sign deciding it is irrelevant to his or her parking decision, doubts sign accuracy, and choose to proceed to a full or almost full facility after evaluating all options, IPS systems are not living up to the vision of their meticulous design.<sup>42</sup>

Most parking choices are made at the pre-trip stage and when travelers arrive at their destination, they are willing to spend large amounts of time searching for a parking space at their chosen location. For IPS to be successfully utilized, motorists must first doubt their existing behavior, and then experiment with alternatives until the new pattern becomes habit and is institutionalized into lasting habit.<sup>43</sup> Motorists must be willing to try something new for IPS to work properly.

According to “Behavioral Effects of RTI Use,” driver characteristics should be given greater consideration for successful IPS deployments. Characteristics such as age, sex, and origin (home town), are important in successful design and implementation.<sup>44</sup> Also, the actual characteristics of facilities chosen for parking, like location, walking distance, traffic situation, occupancy rate, and price in conjunction with the driver characteristics need to be accounted for. Studying the relationships between the actual driver and his or her reasons for traveling have shown, in general, that drivers tend to be very confident in their own abilities with regard to route, in situations of increased uncertainty, they may be more likely to comply, and drivers past experience of guidance is likely to affect their acceptance of current advice.

Because of the behavioral aspects involved in parking as a result of trip making, evaluation studies need to analyze behavior in response to route guidance in both the pre and post-deployment stages. Reasons why drivers stay with a familiar route and reasons for changing routes need to be identified. System familiarity should also be addressed as acceptance of advice directly relates to motorists exposure to similar guidance systems along with motorist familiarity with alternate routes. Ideally, a large number of individuals are sampled in a real-world setting. Past studies can also provide insight however, even if an individual is able to project themselves in a situation, there is no way of knowing if he or she will actually behave in the way stated when faced with the actual situation.

One study suggests that focusing an entire IPS on visitors may be the downfall of design. Normally, 80% of the usage of a parking facility is generated by only 20% (frequent clients) of total customers.<sup>45</sup> If operators tried to maximize use by frequent users, the system may come with more success. Possible ideas include frequent user programs, which include a free parking day in a particular month or a free parking special action day to attract new users.



## **CHAPTER 2. UNIVERSITY PARKING**

### **2.1 BACKGROUND**

University parking has a negative connotation at almost every major school across the country. Located near the central business district of Austin, Texas, The University of Texas at Austin is no exception to that rule. Parking for faculty, staff, and students at the University of Texas at Austin is under allocated while permits for parking are oversold.

The University of Texas Parking Services Department estimates that there are about 14,000 parking spaces available on the UT campus including 9,500 surface parking spaces and 4,500 garage spaces. Parking problems are expected to increase with the elimination of key central campus parking areas as demand increases and supply decreases.<sup>46</sup>

The following sections attempt to provide a background of university parking at UT. Both the UT Department of Parking Services and the UT Master Plan provide the basis of current university parking facilities and programs.

#### **2.1.1 University Permit Holders**

The university provides revenue information on four basic campus permits: Commuter Student “C”, Staff “A”, Faculty “F”, and Resident Permit “R”. Commuter permits, “C”, cost \$80 per year. The university sells 7,000 commuter permits while only 3,000 commuter spaces exist on campus. Staff permits, “A”, cost \$105 per year. The university sells 3,000 staff permits having 1,600 actual staff spaces on campus. Faculty permits, “F”, cost \$345 per year. The university provides 1,600 faculty spaces but sells 2,100 staff permits. Resident permits, “R”, cost \$110 per year. The university provides as many resident spaces as permits sold, 240, therefore, all “R” permit holders are guaranteed a parking space on campus.<sup>47</sup>

Other permits available include O (\$540/year), E (\$80/year), G (\$95/year), M (\$40/year), P (\$345/year), or KR/SR (\$360) permits.

### **2.1.2 Non-permit Patrons**

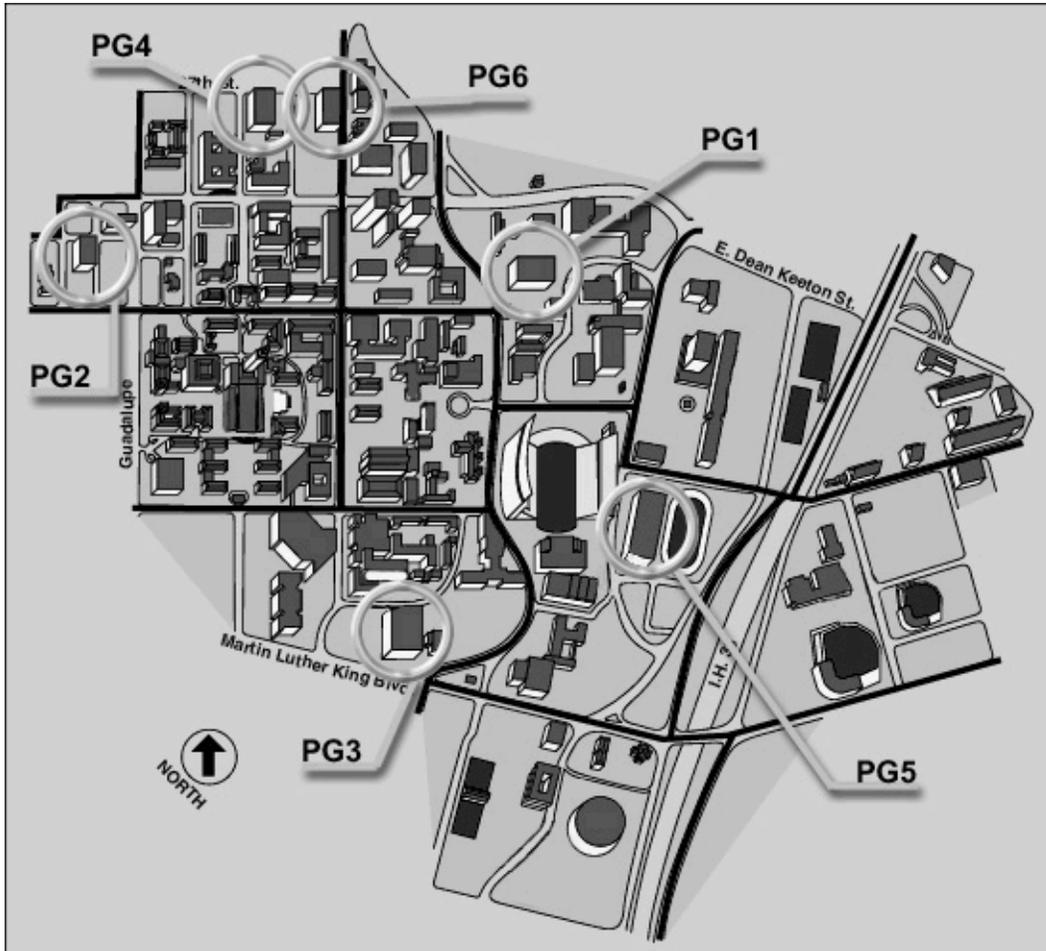
All non-permit patrons of the university are considered campus visitors. Visitors are to park in UT parking garages at an hourly rate or any parking meter on-campus. The Department of Parking Services also recommends on their web site that university visitors park in campus-adjacent privately owned lots if UT garages are full. Official visitors, those conducting university business, may park in “V” visitor spaces on campus if their UT host requests a “V” permit. Surface parking on the UT campus is available mostly for permit holders. The number of campus visitors on any given day is estimated at 5% of total university traffic.<sup>48</sup>

### **2.1.3 Parking Garages**

University parking garages are the applicable venue for IPS implementation. Therefore, it is important to understand garage location, parking allocation, cost, and equipment. (Figure 2.1 shows current university garages Located on a campus map.) In the future, 85% of all campus parking will be in university garages located on the perimeter of campus; in the past, 85% of available parking was in surface lots. But garages are becoming increasingly expensive to build as parking garage spaces cost about \$14,000 per space while surface lots cost less than \$1,400 per space.<sup>49</sup> Because of the amount of garages that will be required to provide university parking and the millions of dollars required to build the facilities, it will be necessary for the garages to operate near capacity to maintain revenue streams. Currently, six university garages bring in two to five thousand dollars per day (or more) from hourly parkers to support the garage costs as well as to subsidize the costs of university parking permits.<sup>50</sup>

All UT garages serve both contract and hourly parkers with the exception of the San Antonio Garage (PG2) located on the West side of campus. This garage serves UT faculty and staff only. The faculty and staff desiring a space in the San Antonio garage must purchase a semester or yearlong garage permit for access to the garage. UT parking services refers to these patrons as contract holders. In UT garages, contract holders may have a paid “pass” to a specific garage however, like all other UT parking areas, more contracts are sold than spaces available therefore, it is possible to hold a garage contract

**Figure 2.1: The University of Texas at Austin:  
Parking Garage Locations**



- PG1: San Jacinto Garage (San Jacinto Street, South of 26<sup>th</sup> Street)
- PG2: San Antonio Garage (San Antonio Street between 24<sup>th</sup> and 25<sup>th</sup> Street)
- PG3: Jester Garage (Speedway and 21<sup>st</sup> Street)
- PG4: North Campus Garage A (University Boulevard and 27<sup>th</sup> Street)
- PG5: Stadium Garage (East Campus Drive and Texas Memorial Stadium)
- PG6: North Campus Garage B (Speedway and 27<sup>th</sup> Street)

and still not have a reserved parking space. However, computer systems currently deployed in university garages help to allocate parking supplies properly in that, for all UT parking garages (except PG2 which serves contract parkers only), usually about two hundred spaces (or more) are open in each garage throughout the day.<sup>51</sup>

Parking garage contracts differ in cost from university parking permits. Faculty and staff contracts are priced at \$290 for the school year or \$25 if paid monthly. Student contract parking is generally priced higher at \$560 for the school year, \$305 for the semester, or \$90 for the summer.

Hourly parking in all UT garages is currently \$2 for the first hour and \$1 for each additional hour with a daily maximum charge of \$5. Hourly parking is available to any individual where applicable including visitors and irregular users not holding a UT parking permit as well as those holding a UT permit to over-sold lots. (Figure 2.2 summarizes location, parking availability, and common destinations for the six university garages.)

#### *San Jacinto Garage: PG1*

Primarily, PG1 serves individuals destined for the College of Engineering, Law School, and the LBJ School of Public Affairs. (The LBJ Library and Performing Arts Center are also accessible from the San Jacinto Garage however; a better location for individuals destined for those two locations may be the Stadium Garage.) PG1 is located on San Jacinto Street just South of 26<sup>th</sup> street therefore; the more common name for PG1 is the San Jacinto Garage. With over one thousand parking spaces (1,028), the San Jacinto Garage is the second-largest campus garage. Nine hundred of these spaces are dedicated to contract parkers however, the use of the Amano Cincinnati parking garage computer system allows the garage staff to fluctuate available daily and hourly parking to upwards of two hundred spaces per day.

**Figure 2.2: The University of Texas at Austin:  
Parking Garage Summary**

<b>Parking Garage</b>	<b>Name</b>	<b>Location</b>	<b>Parking Availability</b>	<b>Common Destinations</b>
<b>PG1</b>	San Jacinto	San Jacinto and 26th Street	contract hourly	College of Engineering, Law School, LBJ School and Library
<b>PG2</b>	San Antonio	San Antonio between 24th and 25 <sup>th</sup> Street	contract	West Campus, West Mall, Communications Area (faculty/staff contract only)
<b>PG3</b>	Jester	Speedway and 21st Street	contract hourly	Jester dorm, Perry-Casteneda Library, East Mall area
<b>PG4</b>	North Campus A	University and 27th Street	contract hourly	Student Services Building, Student Health Center
<b>PG5</b>	Stadium	East Campus across from Texas Memorial Stadium	contract hourly	Texas Memorial Stadium, Performing Arts Center
<b>PG6</b>	North Campus B	Speedway and 27th Street	contract hourly	North Campus

*San Antonio Garage: PG2*

The San Antonio Garage, PG2, is located on San Antonio Street between 24<sup>th</sup> and 25<sup>th</sup> Streets. Although PG2 is convenient to West Campus, Guadalupe Street, the West Mall, the Union, Flawn Academic Center, Main Building, and the Communications area, it is available to faculty and staff only on a contract basis. There are 750 parking spaces in PG2 however, the UT parking garages manager estimates that, on any given day, approximately 200 PG2 contract holders will be turned away as all garage spaces fill up in the morning.

*Jester Garage: PG3*

Located on the corner of Speedway and 21<sup>st</sup> Street, PG3 is adjacent to the Jester dormitory area therefore it is commonly referred to as the Jester Garage. PG3 serves motorists bound for Jester Dormitory, Perry-Castaneda Library, University Teaching Center, Gregory Gymnasium and the East Mall Area.

The Jester garage has been operating on the UT campus since 1997. Currently a “walk-up-and-pay” system is utilized; however, the original payment system of the Jester Garage used university identification cards. Jester Garage is the largest UT garage with 1,595 spaces. Fourteen hundred of these spaces are contracted to faculty, staff, and dorm residents leaving one hundred ninety-five for daily and hourly use. Between The Jester and San Jacinto garages, there are a total of three hundred twenty-three daily/hourly parking spaces however; UT parking services estimates a turnover of over seven hundred non-contract parkers in these garages per day.

*North Campus Garages: PG4, PG6*

North Campus Garage A (PG4) is located on the corner of University Boulevard and 27<sup>th</sup> Street making it an ideal parking site for those accessing the Student Services Building and Student Health center as well as all of the previously mentioned destinations. Garage A offers six hundred fifty contract spaces and one hundred thirty-five open spaces for daily and hourly parking.

North Campus Garage B (PG6) is located on the corner of Speedway and 27<sup>th</sup> Streets. Garage 4B is the newest campus garage offering six hundred contracted faculty staff spaces (\$290 per year) and ninety-five daily and hourly spaces. Some contract spaces are available for

students as well at \$560 for the year and \$305 for the semester. Opening in the fall of 2000, garage North Campus Garage B cost \$9,374,000 to build or \$13,487 per space.

#### *Stadium Garage: PG5*

PG5, the Stadium Garage, which is located on East Campus Drive directly across from Texas Memorial Stadium, is prime parking location for those accessing the stadium, the Performing Arts center as well as the LBJ Museum and Library. (The Performing Arts Center and LBJ Museum and Library are also accessible from the San Jacinto Garage.) The Stadium Garage has twelve hundred spaces total with one thousand used for contract parking leaving two hundred for daily/hourly use.

#### **2.1.4 Parking Garage Equipment and Software**

All UT parking garage facilities are currently equipped with Amano Cincinnati equipment and McGann software. Amano provides the ticket spitters, gate arms, and counter equipment while McGann provides the software and computer system that allows for facility mapping, access control, count monitoring, revenue control, and report generation. The McGann software is a state-of-the-art addition to parking facility monitoring providing garage control from a PC in any office or garage payment booth. McGann Software Systems is a Minneapolis-based company providing software to the parking industry. With over 2000 installations worldwide, McGann Software Systems has become the largest developer of parking software in the industry.<sup>52</sup>

Each UT garage manager has the ability to control their individual garage from their office located at the garage itself using McGann. Through the Interactive Mapping Application, the garage operator sees real-time revenue transactions as well as controls facility devices such as gate arms by pointing and clicking on a garage map. This application also provides monitoring of the ticket dispenser to locate illegal entrants while warning operators when the ticket dispenser is low.<sup>53</sup>

The garage software also includes access control letting garage operators search, sort, and collect records of garage users. In the case of UT garages, this application is most applicable to garage contract holders who own and use “cards” to exit the garages.

Garage count monitors show real-time lane activity in garage entrances and exits. Therefore, the garage operators currently have real-time information concerning the fullness of the garage and space availability. The software provides for remote control of gate arms and alarm messages to specify times when gates shall be closed automatically. A switch time scheduler allows the operator to reverse lanes and open or close lanes automatically at a pre-programmed time of day.

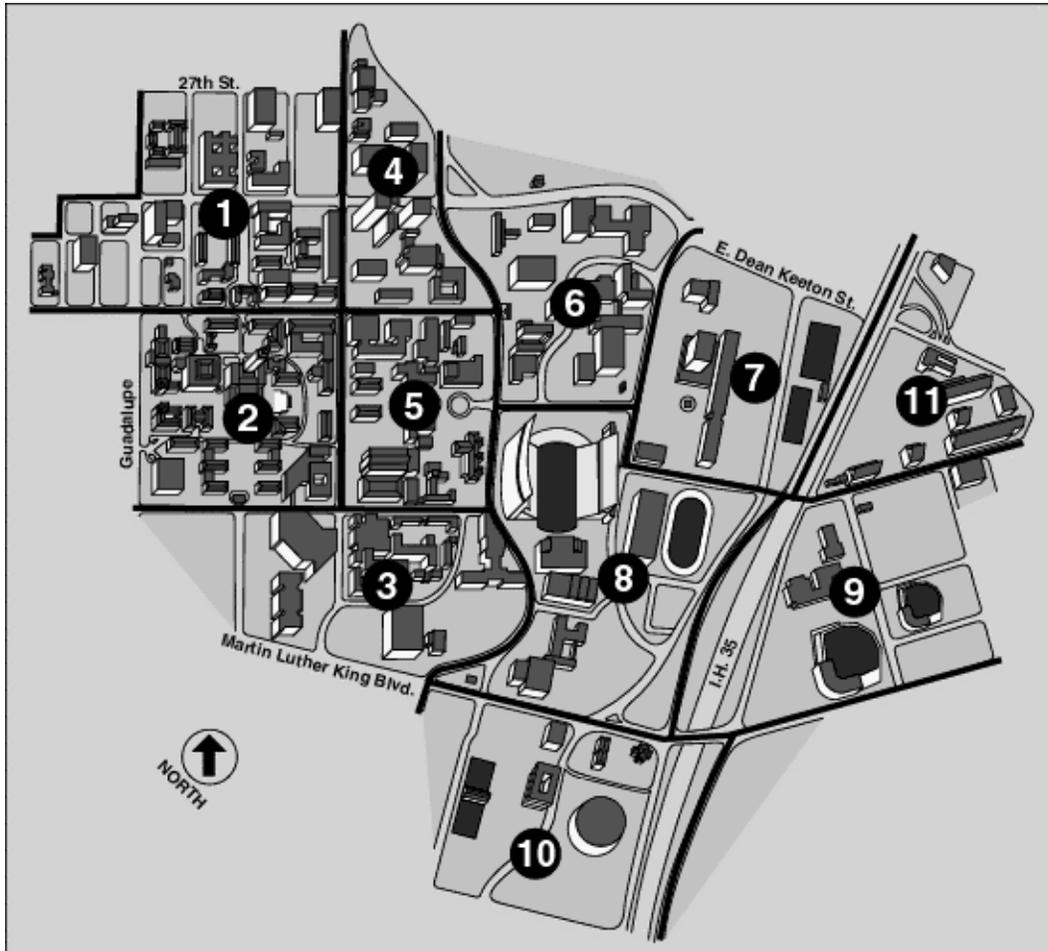
Other McGann applications in use at UT include real-time revenue control providing revenue information from all UT garages and report generation to export spreadsheets and databases of garage operations

### **2.1.5 University Parking Programs**

**2.1.5.1 Parking Services Web Page.** The university does provide services to increase parking awareness. The parking services web site (<http://www.utexas.edu/business/parking.html>) provides answers to frequently asked questions including permits and contract information, locations of university garages, and information regarding garage and lot closures for special events and football games. Faculty and staff also receive email updates from parking services concerning garage and lot closures.

**2.1.5.2 Campus Destination Zones.** Currently, the university divides its parking areas into eleven sections based on the principle destination in each area or zone. For example the zone “tower area” designates the central portion of campus between Speedway and Guadalupe with the North boundary being 24<sup>th</sup> street and the South boundary being 22<sup>nd</sup> street. The zones are designed to help university patrons find the garage appropriate for their desired destination. Although there is no formal real-time method of disseminating information to guide patrons to these zones, the Parking Services web site provides campus maps by zone as well as parking availability and restrictions within all zones. (Figure 2.3 shows university destination zones as well as nearby parking garages.)

**Figure 2.3: The University of Texas at Austin:  
Main Campus Parking Zones**



- |                            |                          |
|----------------------------|--------------------------|
| 1. Communication           | 7. LBJ School and Museum |
| 2. Tower                   | 8. Law School            |
| 3. Perry-Castañeda Library | 9. Disch-Falk            |
| 4. Engineering             | 10. Erwin Center         |
| 5. East Mall               | 11. Physical Plant       |
| 6. Law School              |                          |

## **2.2 THE FUTURE OF UT PARKING**

### **2.2.1 Parking and the UT Master Plan**

According to the University of Texas Master Plan, “The entrance to campus represents a point of transition, the symbolic gateway to the college community.” These gateways can serve “both as placemarkers and as locations for obtaining information about the university, its history, and its activities.” “Wayfinding and signage, consistent and easily visible, will contribute to a sense of place and define these points of transition.”<sup>54</sup>

The university vision is consistent with the development of a system that provides real-time information to UT faculty and staff, students, guests, and visitors. An integral piece of such a “wayfinding” system could provide parking information including garage status and garage location with respect to desired campus destinations. Developing an intelligent parking system and/or campus “wayfinding” system could serve as the first step towards a more thorough system giving electronic information of activities and historical sights.

The Campus Master Plan recommends a more “pedestrian-friendly” campus.<sup>55</sup> Beginning August 15, 2000, Speedway Street between campus lot F11 and 24<sup>th</sup> Street will be closed to through traffic. All parking on Speedway between 21<sup>st</sup> and 24<sup>th</sup> Streets will be removed losing approximately 150 faculty assigned spaces.<sup>56</sup> (See Figure 2.4 for location of central parking elimination.) Future plans call for more central campus vehicle elimination further decreasing parking.

### **2.2.2 Parking Demand/Deficiency**

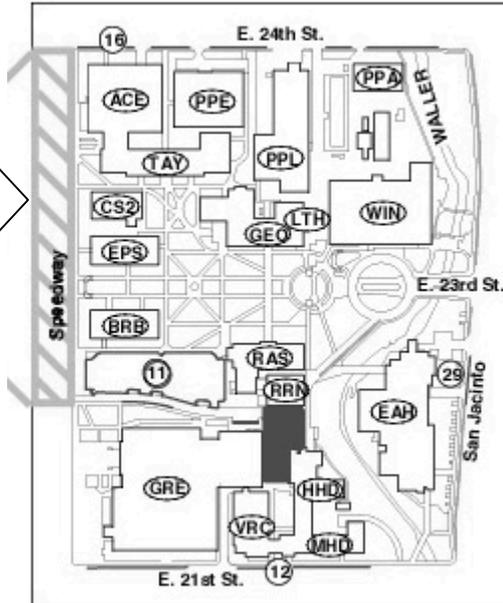
The University of Texas at Austin attracts over 65,000 trips daily.<sup>57</sup> Of these 65,000 trips, Capital Metro buses including the UT Shuttle capture 43,000. The rest of the individual daily campus trips use vehicle, walk, or bike modes. Therefore, even with parking space availability data, it is difficult to quantify exactly how many automobile users cannot find on-campus parking.

One way to quantify individuals unable to find university parking is to look at the university permit structures. According to the statistics produced by UT parking services, parking permits are oversold by about 43%.<sup>58</sup> That means for every 100 students, faculty, and staff who have paid for a place to park on the university campus, 43 show up for class or work and cannot find a permit space; however, the university continues to oversell parking spaces knowing that

the permit space supply cannot begin to meet the needs of patrons. Permit patrons tend to stay in their spaces from early morning to early evening hours to avoid losing their permit space.<sup>59</sup> These individuals probably can, however, still find an available space in university garages.

**Figure 2.4: The University of Texas at Austin: Central Campus Parking**

Closed to Thru Traffic  
All Surface Parking



LEGEND:		SYMBOLS:	NOTES:
Class "A" Permit	Class "P" Permit	Entry Control Station (Open 7:30 A.M. to 4:00 P.M. Mon.-Fri.)	No Parking Allowed in Lots (80) (37) (41) and 2500 Red River from Midnight to 6:00 A.M. Daily
Class "C" Permit	Inner Campus Drive	Emergency Phone	
Class "F" Permit	Metered Parking	Parking Lot	
Class "G" Permit	Any Valid U.T. Permit (Except Class "M" Permits)		
Class "R" Permit	Parking Garage		

Turnover in university garages is much faster than for permit parking spaces.<sup>60</sup> Also, garage technologies allow garage managers to reallocate hourly parking based on contract levels providing more spaces to hourly parkers when less contract parkers are present. University Parking Services estimates that 200-300 garage spaces are available every hour.<sup>61</sup> The problem is that individuals who have already paid for a university permit are unlikely to want to pay again for hourly parking.<sup>62</sup>

The University Master Plan also suggests that parking supply will continue to decrease. Central campus space elimination (including elimination of Speedway parking between 21<sup>st</sup> and 24<sup>th</sup> Street) will further strain the university parking situation.<sup>63</sup>

As parking decreases, the number of students enrolled at UT continues to increase. UT undergraduate enrollment reached over 37,000 undergraduate students in 1998 and 1999, the highest undergraduate enrollment in UT history.<sup>64</sup> Graduate students total about 10,500 bringing the total student population at the University of Texas to over 47,000. The student population is important to university parking aside from its impact on university trips (67,500 person trips including all students, faculty, and staff) because of student car storage. As more students (including freshmen) desire their vehicles while the semester is in session, the university will have to continue to provide a limited amount of parking for students to store their vehicles. Even if on-campus storage parking is increased, there will still be an excess of 5,000 cars parked on streets adjacent to campus.<sup>65</sup>

These statistics suggest that surface and permit parking will not be able to handle the increased parking demand; the future of university parking lies in garages circling the campus perimeter. In fact, the amount of university parking available in UT garages will increase to 85% while surface parking will fall to 15% of the total supply; this is a complete flip-flop of past allocations: 15% garage, 85% surface. But because of the perception of inadequate parking at UT, university patrons sometimes do not consider garages as an option for parking because of questions of garage location and space availability.<sup>66</sup> Moreover, current permit structures may impede efficient use of university garages as empty spaces may be restricted by permit or personal attitudes toward hourly parking costs.

### **2.2.3 UT Parking Study**

The University of Texas is currently conducting a transportation study through Walker Consultants. The study will formally define parking statistics at UT as well as suggest alternatives for improving campus transportation. The study is expected to be complete in the spring of 2001.



## **CHAPTER 3. UNIVERSITY IPS OPTIONS**

If an Intelligent Parking System were to provide a solution to the university's on-going parking problems, the system must fit the university's budget while providing a service that is user-friendly, meets patrons needs, and is safe and efficient. The following sections identify viable IPS options for university applications.

### **3.1 ADVANCED PARKING MANAGEMENT**

Regardless of the media used to distribute real-time parking information, the idea of collecting the pertinent information remains the same. Basically, parking garage information would be transmitted from each individual garage to a central location by a wireless connection. Then, when properly formatted, that data can be transferred to VMS, computer and Internet applications, cellular phone applications, as well as radio and television stations. Therefore, the most important aspect of IPS implementation may be the actual gathering of the data. Then, the medium of information dissemination becomes a matter of university and patron preference.

UT parking garages are currently equipped with computer software and equipment that provides real-time information at each individual garage. Therefore, it is possible for a garage operator to know space availability in his or her garage using a PC located in the garage office. The garages are not, however, manageable from a central location. It is currently impossible for real-time information from all garages to be provided to one garage operator, as it is impossible to transmit this information to VMS or other media.

UT currently uses McGann parking software in all of its garages; McGann also makes another product called Advanced Parking Software. The Advanced Parking application coupled with the Central Management application would allow the garages to run from a single operator in a central location or central computer.

The Advanced Parking application works with the Central Management application. Information from each individual garage is transmitted by Ethernet connection to the central computer, which is equipped with the Advanced application.

The Advanced application also provides Accounts Receivable, Reporting, Access, Count and Credit Card applications. From a central location, one operator can study finances and daily revenues of all garages as well as pull contract information for a specific parker. Credit cards can be used in conjunction with Automatic Vehicle Identification (AVI) technology to provide

seamless entrance/exit transitions however, the system can also be set up to read UT identification cards.

Because UT garages currently utilize the McGann Software Systems Central Management System, upgrading to the Advanced Parking Management System would cost about \$45,000.<sup>67</sup> (IPS deployment would also require a vision to reallocate parking at the university in conjunction with a plan to coordinate IPS into the current university parking system.) This is a small price for such powerful software considering that UT parking garages cost anywhere from five million to ten million dollars to build.

### **3.2 CAMPUS ENTRANCE VARIABLE MESSAGE SIGNAGE**

Once the APMS system is implemented, campus entry Variable Message Signs can be placed to provide parking information to travelers en-route to a university-parking garage at or near the garage itself. This could provide garage information to individuals already destined for that particular garage while helping direct those motorists who are unsure of parking locations. Ideal locations for campus VMS located at or near UT garages include Red River and MLK, Speedway and MLK, Speedway and Dean Keeton, and Red River and Dean Keeton.

Variable Message Signs for an intelligent parking application at the University of Texas Campus are seen by some as the next step towards an automated, free-flowing parking system. The manager of UT parking garages, Bobby Stone, sees a garage signage system as “ideal for commuters and visitors” to the university.<sup>68</sup> Stone also recognizes that visitors are unaware of available parking and “perceive parking on campus as a problem” although sufficient parking is usually available in UT garages for non-contract holders. The issue of “parking perception” is again apparent in the Spring 2000 parking surveys where survey participants expressed a concern in the lack of visitor parking on the university campus.<sup>69</sup> Bobby Stone sees VMS as the best choice for a parking system upgrade that will increase parking efficiency, help users find an empty parking space, and continue to follow the vision of the University Master Plan.<sup>70</sup>

According to Stone and University Parking Services, VMS and central garage management would cost upwards of \$300,000.<sup>71</sup> Stone believes that this cost would deter the university from addressing campus VMS as a priority.

## **3.3 WIRELESS APPLICATIONS**

### **3.3.1 Active Server Page Applications**

The Internet provides an excellent medium for the distribution of real-time information. In fact, UT already provides current parking information on the University Department of Parking Services web site. Real time space availability could be added to the UT web page by uploading data from the McGann APMS. Because parking status needs to be real-time or very close to real time, a special Internet application, Active Server Page (ASP), may provide the solution providing real-time parking availability on the Internet without constant manual uploads.

Active Server Page (ASP) is a server-side scripting environment that can be used to create and run high performance Web server applications. Because the scripts (required to make changes on the page) run on the server, the Web server itself does all the work involved in generating the HTML pages that are then sent to Web browsers.<sup>72</sup>

ASP is a programming environment offering a solution for real-time applications. When ASP is incorporated into a web site, real-time information (like parking availability) is viewed each time the user opens or refreshes the web page. For parking availability, ASP will work in the following way: (1) The central computer will be programmed to send parking data to the Web server in a given time interval, say every three minutes (2) The user will bring up the parking site; the page has an .asp extension. (3) The users browser will then request the ASP file from the web server. (4) The ASP will process the request and run the scripts producing an up-to-date HTML Web page. (5) The web page is then sent to the browser where the user views parking availability. If the user hits the refresh button, new real-time information will be sent to the page in the same manner.<sup>73</sup>

The Internet page could also be used as a “wayfinding” system providing maps to available parking and university focal points that users could access from home or even en-route. In fact, Internet applications will soon be accessible from vehicles in the form of wireless handsets. Moreover, makers of hand set applications feel that the wireless handset will be the “most pervasive method of accessing the Internet within the next three years.”<sup>74</sup>

### **3.3.2 Internet Applications**

All other Internet applications for real-time parking require ASP applications; however, it is possible to utilize ASP applications without designing a site specifically for university parking.

The business of providing real-time traffic and parking information on-line is growing in the private sector with the recent Internet additions CurrentTraffic.com, @Road, and traffic.com. Most of these sites provide free traffic information for cities; the university would have the option of providing parking information on one of these sites with a link from the UT parking homepage.

CurrentTraffic.com already provides 23 market areas with real-time service including Houston, Texas for free.<sup>75</sup> The site posts the information that is collected by regional Advanced Traffic Management Systems (ATMS) including congestion conditions and incident reports. The Web sites utilize ASP to collect the information stored on a central computer of the ATMS. With the implementation of APMS in university garages, UT would have the option of utilizing this common environment to post parking availability. Again, the prospect of handset Internet availability makes Internet applications a viable option for university IPS information dissemination.

### **3.3.3 Cellular Phone/Telematics**

Cellular phones provide another option for real-time dissemination of parking information. Cellular phone applications can be web-based providing the same information available on the Internet in a verbal form. Current applications for cellular phone dissemination include emergency roadside assistance, traffic information, directory assistance, and turn-by-turn route guidance. The Intelligent Transportation Society of America (ITSA) refers to these phone applications as telematics.<sup>76</sup>

Whatever the application, the integration of telematics into transportation applications seems promising. A recent study by ATX Technologies, Inc. suggests that one-third of all drivers are already extremely interested in telematics services even though the number of service providers is still small.<sup>77</sup> The prospect of new local and regional telematics services does, however, make cellular phone applications a viable option for dissemination of university parking information.

## **3.4 UNIVERSITY KIOSK CENTERS**

Kiosk centers are an alternative to campus VMS in that they can provide “wayfinding” guidance without requiring users to have access to Internet and cell phone applications. Individual kiosk units are typically composed of a computer, touch-screen monitor, and

sometimes a printer enclosed in a protective casing. Recent deployed ITS incorporating kiosk systems, such as the San Antonio Traveler Information Kiosk Model Deployment Initiative, utilize kiosks to provide area maps, route guidance information, real-time travel conditions, weather updates, local transit information, and airport information.<sup>78</sup>

In order for the university to provide real-time parking on a kiosk information system, the APMS could again be utilized to collect parking information on a central computer. An Ethernet link would be used to transmit parking information to the kiosk computer, which would be uploaded as an ASP file. The kiosk could then display parking information similar to an html file. The incorporation of GIS maps to the kiosk system could be utilized to provide “wayfinding” maps.

If local the local transit authority (Capital Metro) was interested in displaying transit information (local bus routes and/or shuttle bus information) interactively on campus, transit schedules, and route and bus locations could be incorporated into the kiosk system. The university could also utilize kiosk field units to provide visitors with directions and maps as well as faculty, staff, and students with special event information or course schedules.

Implementation of kiosk systems would require a software system. Touch Vision is currently the leader in the Advanced Traveler Information Systems (ATIS) kiosk field having developed an extensive package of transportation kiosk modules designed specifically for use in delivering transportation and traveler information.<sup>79</sup> Once a software package was designed for the university application, the only infrastructure cost would be the personal computers for kiosk sites. The problem with the kiosk system is that it would require drivers to actually get out of their car at a visitor’s center or parking garage entrance to find parking availability. This could actually add to university congestion. Implementation of a university kiosk system would also take coordination with university departments and the local transit authority, which may be too complex for a parking application.



## **CHAPTER 4. PARKING AND IPS PERCEPTIONS**

### **4.1 BACKGROUND**

Although IPS seems like a solution to parking frustrations in the design stages, too often deployed systems do not receive the expected utilization. Driver perceptions of automated systems prohibit travelers from trusting real-time information; instead, they follow the same habitual routine whether it is their morning commute route or the area in which they search for a parking space. The university environment may warrant an Intelligent Parking System, however, because the primary goal of any IPS should be to better serve motorists, the most important criteria for the design and implementation of any intelligent system should be user-based. In this study, focus groups and surveys were utilized to properly define the perceptions of UT parking according to students, faculty/staff, and visitors.

### **4.2 PARKING SURVEYS**

In the spring semester, 2000, two parking surveys were conducted at the University of Texas at Austin for the purpose of this research. The studies were conducted at the busiest university parking garage, Jester (PG3). The two most important characteristics of university parking, according to the respondents of the survey, were walking distance to final destination and parking cost. Survey respondents were also concerned with the amount and locations of visitor parking on campus. Survey respondents, for the most part, were not generally concerned with space availability as most were resident contract parkers guaranteed a spot in the Jester garage. Those parking hourly, however, were mostly commuters without parking permits or commuters with parking permits unable to find a space in commuter parking lots.<sup>80</sup>

### **4.3 FOCUS GROUPS**

During the fall semester, 2000, two focus groups were held to better define parking problems and perceptions at UT. The focus groups included three undergraduate students, one faculty member, one law student, two frequent campus visitors, one infrequent campus visitor,

two former graduate students, and four current graduate students. The students, faculty/staff, and campus visitors present at the focus groups are used to represent the university population.

#### **4.3.1 Focus Group Design**

Focus groups are a powerful method to evaluate or test any new service or idea. In the case of university parking, the focus groups had two main ideas or questions to discuss: 1.) What are the predominant parking issues/problems on the university campus? 2.) Which type of IPS could help solve parking problems and how should it be implemented so that it is user-friendly and effective?

Focus groups are most effective with between six and ten members.<sup>81</sup> The parking focus groups were held with seven members in group one and seven members in group two, respectively.

University parking sparks a lot of conversation and ideas; therefore, one of the challenges of the parking focus group meetings was to keep all participants on task. In order for the groups to stay on task, an agenda was handed out at the start of the meeting. The research was introduced including the six IPS applications discussed in Chapter 3 of this report. Participants were encouraged to ask questions about the research and IPS options presented because they would eventually be ranking the IPS options according to feasibility.

The Campus Master Planner (and UT faculty member) then summarized the parking situation at UT including parking space numbers and costs as well as planning issues facing the campus. Again, participants were encouraged to ask questions about parking issues.

Next, participants helped re-define parking issues with the help of their respective group leaders. The Master Planner led one discussion group while a law student, former university vice-president, and parking board member led the other. The group leaders then prompted group discussion through six discussion topics. Finally, the groups ranked IPS alternatives in conjunction with the most pressing parking issues.

### **4.3.2 Focus Group Issues**

One of the tasks of each group included developing a list of current/future parking issues or issues that relate to the parking supply/demand on the UT campus. The issues that the groups defined included:

- Parking revenue
- Safety, especially at night
- Student car storage/regulating certain groups from driving or parking on campus
- Cost of garages vs. cost of surface spaces; cost of transit
- Number of parking spaces on campus vs. demand and number of permits sold
- Revenue structures for garage parking; should parking garages be free at night?
- Affects of light rail, better transit service, and car pooling programs
- Cost of IPS
- Political issues including structure of permit system and bureaucratic issues associated with IPS implementation

### **4.3.3 Focus Group Discussion Questions**

The following discussion questions guided participants through the focus group.

- How could we solve the problem of mobility in a campus that concentrates parking at the periphery of campus and restricts vehicle penetration of the campus? Could IPS and “wayfinding” help distribute vehicles and pedestrians through positive guidance?
- What operating procedures could be changed to make UT garages more user friendly? How might IPS make university parking more user friendly?
- What are the needs of the bicycle community that can be met in university parking garages?
- Who should the university be accommodating in their development of a parking strategy or intelligent parking system? Are visitors as important as students and faculty/staff?
- Why is the shuttle bus not the solution for student, faculty, and staff access to campus?
- What other modes of transportation could be utilized that do not require on-site parking?

#### **4.4 SUMMARY OF PARKING AND IPS PERCEPTIONS**

Both focus groups agreed that university parking problems are worsening and lack of adequate transit service is part of the cause. Participants also identified light rail as a solution to reducing the number of vehicles on campus. They also agreed that regardless of amount and adequacy of transit available, university-parking structures must change to meet current and future demands.

All participants sited Advanced Parking Management as a viable alternative to help allocate parking. Even if parking information was not disseminated in real time, they believed that having an operator at a central system that could identify supply in all garages could help allocate parking. Even if the operator had to pick up the phone and call garages updating them on the status of other university garages, APMS could fluently connect a less organized system.

For today's parking issues, Variable Message Signs were identified as the best way to disseminate information about parking garages. Participants did not believe, however, that VMS should be used for university "wayfinding." Instead, they suggested a less-elaborate design that included one VMS outside of every university garage giving the status of that particular garage as well as the status of all other university garages. They expressed this as the best idea because they thought that it would be useful for individuals looking for parking garage spaces.

Because of the current method of distributing parking supply and parking permits, participants did not see IPS as a way to help solve the university's current problems. They did express, however, that cellular and web applications would be extremely useful if the university was willing to redefine its permit and supply allocation structure. They believe that the supply would be adequate if no individual or group was guaranteed a particular space. IPS could properly allocate parking such that individuals entering campus were directed to a free space without permit restrictions. Then, as parking garages become the mainstay of university parking, a redesigned shuttle bus system could take them from the open garage to their final destination.

Participants also identified IPS in conjunction with "wayfinding" as useful only to those unfamiliar with the UT campus or campus visitors. For this particular user group, participants identified university kiosks as the best way to disseminate parking information, campus maps and events, and local transit routes and schedules.

## CHAPTER 5. SUMMARY AND CONCLUSIONS

### 5.1 SUMMARY

Because there is an increasing interest from motorists to have access to real-time information while en-route to a particular destination, advances in Intelligent Transportation Systems (ITS) have focused on the dissemination of real time information. As central business districts, airports, transit stations, and shopping centers continue to become more crowded during peak times, demand for real-time parking information is increasing. University environments are no exception to this rule. With decreasing parking supply and increasing enrollments and faculty and staff numbers, universities are beginning to realize the importance of properly allocating available parking. Intelligent Parking Systems (IPS) can provide the positive guidance necessary to help university patrons find available parking quickly and safely.

The University of Texas at Austin is an excellent example of a major university facing parking problems. Located in the central business district of Austin, Texas, the university is faced with providing appropriate parking for students, faculty and staff, and visitors in a crowded, growing city. Supply reductions and increased enrollments coupled with driver perceptions have already strained the crowded parking infrastructure. With the implementation of the “pedestrian friendly campus” as introduced in the university’s master plan, parking supply will be cut even lower. The university has already eliminated 150 faculty spaces on Speedway between 21<sup>st</sup> and 24<sup>th</sup> Street.

An Intelligent Parking System could help the university reallocate parking and reduce congestion and illegal parks. Also, the university’s master plan is biased towards a system that provides university “wayfinding”, which can complement IPS. Variable Message Signs (VMS) have been considered by the university to provide “wayfinding” and parking information; however, VMS are expensive and will further clutter university street corners currently overridden with signage.

Implementation of Advanced Parking Management Systems (APMS) software at the university would cost approximately \$45,000, which is relatively inexpensive compared to the over nine million dollar cost of the university’s newest parking garage. APMS software would permit the collection of parking availability information from all university garages in a central

location. After the information is collected, the method of dissemination would be a matter of university choice.

Internet and cellular applications seem like excellent alternatives to bulky, expensive VMS. Increased use of wireless technologies coupled with the recent advances in wireless applications for transportation may suggest that digital information dissemination is the answer to transportation information gaps.

The best university IPS application should provide real-time parking information, reduce congestion, and reallocate parking supply. In order to meet those demands, the Intelligent Parking System needs to be utilized by university patrons; if not utilized, IPS will have little or no effect on the university's parking problems.

Focus groups can be used to identify parking issues facing university patrons as well as the appropriate IPS application to meet those challenges. During the fall semester, 2000, two parking focus groups were held at the university. The focus group participants identified parking issues including supply, permit costs, student car storage, and safety of on-campus parking. Through discussion, participants individually ranked IPS applications to deal with the issues facing the university. All focus group participants identified VMS outside of university garages as the best IPS application for today (because of current parking allocation) through a ranking scheme on focus group feedback forms. They also noted that both internet and cellular applications would be the best alternative for the future if the university was willing to restructure current supply allocation and permit structures.

According to focus group participants, "wayfinding" is most applicable for campus visitors, but would have little effect on the chosen routes of students, faculty, and staff. If "wayfinding" was to be implemented for visitor use, participants sited university kiosks as the best way to guide campus visitors to destination.

Also, focus group participants identify IPS implementation as a valuable tool to reallocate university parking only if current parking policies (including permit and time-of-day restrictions) were updated. They believe that IPS will have little or no effect on university parking without these proactive policy changes.

## 5.2 CONCLUSIONS

An Intelligent Parking System (IPS) provides a viable plan for re-allocating campus parking at the university of Texas at Austin. Because university garages are currently equipped with computer equipment and connections that count individual garage space availability, adding the “upgrade” to that current software, the Advanced Parking Management System (APMS), is a logical step towards a real-time parking structure. The APMS software (manufactured by McGann Software) would enable all garages to be controlled from a central location while continuously inventorying space availability in all UT garages. At a cost of \$45,000, this upgrade is rather inexpensive considering that all UT garages cost between five and ten million dollars to construct.

University patrons (stakeholders) including faculty, staff, undergraduates, graduate students, frequent visitors, and infrequent visitors, site APMS as an alternative to enhance the current parking structure of the UT campus today. However, the methods of disseminating the real-time parking information collected by APMS differ for the future depending on the university’s willingness to change permit, space availability, and rate structures.

For the university’s current parking problems coupled with current policies, Variable Message Signs (VMS) seem to provide the best solution to disseminating real-time parking information. Installing small VMS directly outside university garages giving parking availability in all UT garages would create a user-friendly atmosphere for patrons.

VMS for university “wayfinding”, however, may not be the best alternative. VMS may be too bulky and require too large an investment. University “wayfinding” would be better addressed by university kiosks. Kiosks could also provide real-time parking information however; kiosks should not be designed solely for parking. Focus groups have identified that “wayfinding” is most applicable to visitors. Because visitors comprise only 5% of daily campus trips, it is questionable if any real-time “wayfinding” system could be a cost-effective.

If the University of Texas did begin to utilize APMS and VMS today, the future of university parking could be filled with possibilities. Internet and cellular phone applications would be excellent alternatives to disseminating real-time parking information. As availability of these technologies continues to increase, increasing numbers of university patrons will desire access to real-time information on-line or over the phone. University stakeholders are unanimous in their opinion that wireless technologies will be utilized for many Intelligent

Transportation Systems (ITS) applications and that they would be receptive to accessing real-time information through these media. Because of the vast range of possibilities for real-time parking dissemination, the University of Texas at Austin should take the initial step of implementing Advanced Parking Management to plan for the future.

The biggest barrier to overcome for the future of IPS at the University of Texas at Austin is not the technology; rather, the structure of parking permits, policies, and rates. IPS can allocate parking, however, if available parking is restricted to those holding a special permit, thousands will still go without a parking space on a daily basis. Also, garage costs will continue to discourage students and faculty who have already paid for a permit from utilizing university garages as an alternative for parking when areas designated for particular permits are full.

Any Intelligent Parking System application utilized by the University of Texas will need to be implemented in conjunction with policy changes to overcome the challenges of current parking structures. Today, Intelligent Parking Systems utilization for university garages will probably have little or no affect on the actual allocation of parking spaces. The application would probably make garage parking more user-friendly for regular garage users, but probably would not persuade non-garage users to try garage parking. If the university is willing to make some changes to long-standing parking policy, however, Intelligent Parking Systems will continue to be a viable alternative for today as well as into the future. In any case, it is important for the university to consider the consequences of both the “do nothing” option for parking policy as well as a proactive approach to integrate technology into the university campus through policy changes. Implementing Advanced Parking Management today while building a vision for the future that unites parking policy with technology will ensure that university patrons use and understand a university Intelligent Parking System. Following those steps, IPS deployment at The University of Texas at Austin will provide real-time campus parking information that will increase efficiency, reduce congestion, and reallocate parking supply.

## APPENDIX A. PARKING SURVEY FORM

Thank you for taking the time to fill out this survey of UT Parking for a research project in the department of Transportation Engineering at UT. Your answers will be used to help predict the impacts of parking technology here at UT.

Please describe your relationship with UT from the following options.

1. Faculty
2. Staff
3. Graduate student
4. Undergraduate resident
5. Undergraduate commuter
6. Visitor / Guest

Do you currently have a UT parking permit?

1. Yes
2. No

If yes, please specify the type of permit you currently have: \_\_\_\_\_

For how many hours approximately did you park your car in this UT garage (today)?

1. 0 – ½
2. ½ - 1
3. 1 – 2
4. 2 – 3
5. 3 or more

What is your primary goal when parking on the UT campus?

1. Minimizing parking cost
2. Minimizing walking distance or walking time
3. Finding an available space, regardless of location or cost
4. Parking in an area that protects the vehicle during inclement weather

About how many times per week do you use UT garages?

1. Sporadic use
2. 1 time per week
3. 2 times per week
4. 3 times per week
5. 4 times per week
6. Daily use

What is your most frequent means of transportation to/from campus?

1. Car – single occupant
2. Car – carpool
3. Capital Metro
4. UT Shuttle
5. Bicycle
6. Walk
7. Motorcycle
8. Other

The approximate destination of your trip on the UT campus is:

- |                             |                    |
|-----------------------------|--------------------|
| 1. Communications buildings | 9. Disch-Falk      |
| 2. Tower area               | 10. Erwin Center   |
| 3. PCL                      | 11. Physical Plant |
| 4. Engineering              | 12. Other          |
| 5. East Mall                |                    |
| 6. Law School               |                    |
| 7. LBJ school               |                    |
| 8. Stadium                  |                    |

If you use UT parking garages for “special occasions” only, please choose the best description of your reason for parking in a UT garage:

1. Work before or after school
2. No available spaces in locations where my permit is applicable
3. Weather
4. Exams
5. Special university engagement (visitor, guest speaker / lecturer, parent)
6. Other
7. None – I use the garages for everyday activities

Please add any comments about UT parking in the space below:

## APPENDIX B. FOCUS GROUP FORM

\_\_\_\_\_ Name

Affiliation w/ UT (student, Faculty/staff, grad student, regular visitor, sporadic visitor, etc.) \_\_\_\_\_

Please list any other groups that your opinion might represent:

\_\_\_\_\_

**A. Please rank** the most ideal method of disseminating “real-time” parking information (in your opinion) for the following groups:  
(1 is the most ideal, 6 is the least helpful for that particular group)

### STUDENTS

- Advanced Parking Management (only)
- Variable Message Signage
- UT Web
- “Common” traffic web site
- Parking information by phone
- University kiosk centers

### FACULTY/STAFF

- Advanced Parking Management (only)
- Variable Message Signage
- UT Web
- “Common” traffic web site
- Parking information by phone
- University kiosk centers

### VISITORS/GUESTS (LECTURERS, ETC.)

- Advanced Parking Management (only)
- Variable Message Signage
- UT Web
- “Common” traffic web site
- Parking information by phone
- University kiosk centers

**B. Please mark the best solution for IPS at UT:**

In your opinion, an Intelligent Parking System at UT would best serve all university patrons if implemented:

- \_\_\_ with the university’s current parking allocations and policies
- \_\_\_ in conjunction with an effort to reallocate parking supply for students, faculty staff, and visitors
- \_\_\_ as a ““wayfinding”” device targeted toward visitors (to include parking availability as well as transit and campus information)– deal with student, faculty/staff parking problems through permit cost changes, supply re-allocation, transit programs, parking garage rate structures, and shuttle bus service upgrades

**C. Discussion Topics**

University Parking Issues

1. Revenue
2. Student car storage (5,000 cars stored on streets)
3. Cost of garages vs. surface spaces (\$1,400/surface space vs. \$13,000/garage space)
4. Cost of transit - \$4 million for Cap Metro service
5. Surface parking spaces vs. garage parking spaces: in the past 85% surface and 15% garage; moving toward 85% garage and 15% surface
6. Number of parking spaces on campus: 16,000; 11,000 – 12,000 faculty/staff
7. Should parking garages be free at night?
8. Would better public transportation help?
9. How would light rail help?

Please add any issues your group sees as important:

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## **Discussion Questions**

Why is the shuttle bus not the solution for student, faculty, and staff access to campus?

What other modes of transportation can be used for access that does not require parking and how do they work?

How can we solve the problem of mobility-impaired access in a campus that concentrates parking at the periphery of campus and restricts vehicle penetration of the campus? Could IPS and ““wayfinding”” help distribute vehicles and pedestrians through positive guidance?

What operating procedures should be changed to make our garage operations more user friendly? How might Intelligent Parking Systems (IPS) make university parking more user friendly?

What are the needs of the bicycle community that can be met in parking garages?

Who should the university be accommodating in their development of a parking strategy or IPS? Are visitors as important as students and faculty/staff?



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