

Parking Technology Review & Feasibility Study



DRAFT
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Executive Summary: Parking Technology Review & Feasibility Study

Purpose & Background

Technological solutions can help the City of Mountain View (“City”) manage its resources more efficiently. This report reviews and evaluates the state of the parking technology practice that has been implemented and proven successful in various cities and universities, and focuses on creating parking technology solutions that cater to downtown Mountain View’s parking needs.

Part 1 of this report identifies technology tools to improve the efficiency and effectiveness of the downtown public parking system by optimizing parking availability through valuable information, enforcement and on-line services. Importantly, this review includes in-practice examples of each parking technology and associated vendors to evaluate what each product may contribute to the City. Part 2 evaluates the feasibility of four parking technologies that are recommended for the City of Mountain View: real-time wayfinding sign systems, License Plate Recognition (LPR) for enforcement, customer service websites/portals, and integrated parking management systems. This feasibility analysis evaluates:

- Key considerations and concerns;
- Operation and maintenance needs; and
- Estimated costs of each technology option.

The overall goal of this research is to give the City and City Council the complete set of information and tools they need to develop future public parking policies and to decide which parking technologies are appropriate to implement within downtown Mountain View. Steps to reach these goals include:

1. Identify current state of the art practices in parking technology by type.
2. Identify parking technologies that would create a more efficient parking management system for downtown visitors and employees.
3. Evaluate the costs and benefits of technology options and, when possible, apply the costs as they would relate to the City of Mountain View.
4. Provide the City of Mountain View with options and recommendations for how parking technology would best address the City’s current parking needs.

Parking Technology Needs

This assessment takes into account the current state of Mountain View’s downtown public parking system—as studied in depth in the 2013 Mountain View Downtown Parking Permit and Alternative Parking Analysis as well as the 2011 Downtown Mountain View Parking Study. These studies provided the background and data needed to identify areas where parking could be improved.

Currently, very little technology is used to manage parking in the Downtown, yet increases in efficiency could improve traffic congestion as well as increase the capacity of current parking resources without having to construct new parking. Areas where technology could improve parking efficiency and customer service benefits include:

- Parking resources are constrained. Parking facilities are currently at capacity and the City would benefit from parking technology that would increase the efficiency of the current supply of parking.
- Downtown parking permits must be purchased in person at City Hall. The City could benefit from a streamlined permit purchasing program that allowed users or employers to purchase permits online.
- Perceived lack of parking enforcement encourages individuals to violate parking restrictions and appears to lessen the value of employee permits. The City would benefit from technologies that would improve the efficiency of the parking enforcement officers, allowing them to provide more targeted enforcement with the same amount of labor.
- Garages and lots are often full. The City would benefit from including parking occupancy counts and electronic signage that informed drivers when a garage is full, saving the driver time and reducing the congestion created by circling for parking.
- The City currently relies on physical parking permits. Parking technology could eliminate the need for physical parking permits and instead link permits to license plate information. With this system, the cost and resources needed to manage physical permits could be eliminated.
- The 2013 Downtown Parking Permit Survey showed that there is some confusion and lack of communication about the parking permit program. Parking technology could help maintain regular communication and disperse information to customers. An improved permit program could also encourage more parkers to purchase permits, therefore decreasing re-parking.

Because of these areas identified for improvement, the following technologies considered are the most promising for Mountain View: (1) parking management technologies that improve the ability of City officials to view and collect data on parking facilities; (2) parking information technologies that provide better guidance and wayfinding to users, thus reducing car trips and congestion; (3) parking enforcement technologies that increase the efficiency of enforcement officers; and (4) parking payment technologies that would streamline the permit purchasing and citation payment process.

Parking Technology Products

Individual Parking Technology Options

Parking technologies are organized by individual parking technology solutions and integrated parking management systems. Each of these technologies are evaluated in depth within Part 1 of this report as well as individually addressed in Part 2 with cost estimates. The recommended parking technology options include:

- Real-time wayfinding signage that offer dynamic and real-time parking information about parking availability in garages.

- Vehicle detection technologies for enforcement include License Plate Recognition (LPR) and alternative Vehicle Recognition (VR). These technologies can be used for mobile vehicle detection (for enforcement).
- Customer website applications offer online permit purchases and payment, personal logins and account information viewing, citation payment and appeal process, and a platform for parking outreach.
- Parking management software that offers parking reports, staff management, integration with LPR and permitting to help manage and increase the efficiency of the parking system.

Integrated Parking Management Systems

CDM Smith found that parking technology options are frequently packaged into a single system by parking technology vendors, with an integrated parking management software system that receives data from the wayfinding and vehicle detection technologies. This allows municipalities to select the most appropriate parking technologies and vendors for their respective needs. While the parking technology vendors often use the same state-of-the-art parking technology hardware, they each have personalized integrated parking management software systems.

Once the state-of-the-art technologies were identified, management systems that integrate all of the parking technology options and provide technological solutions for an integrated parking management system were reviewed. These integrated systems can offer several options, including:

- Connected parking management and information database that provides constant feedback and tracks progress on the success of parking management and enforcement.
- Parking management software systems that enhance and maximize enforcement labor resources by tracking violators, mapping key locations with high violation rates, implementing handheld devices, and connecting technology to a larger enforcement database.
- Online customer website that improved convenience and service by allowing users to login and view their personal information, purchase parking permits, pay citation fees, and update their own information.

An initial screening process for parking technology vendors occurred at the California Public Parking Association (CPPA) Annual Conference and Tradeshow on November 6-8, 2013. Technology vendors who could best provide the established benefits were sought out and evaluated based on the quality of the products they offer as well as their commitment and service. CDM Smith has identified and evaluated the most successful vendors and integrated parking management systems for the City of Mountain View's downtown parking management needs:

- T2 Systems: The benefit of T2 Systems is that the company has the most experience relative to similar vendors with over 20 years of providing parking technology services. They have a very robust system that has been tested and tried in a variety of settings (municipal, collegiate, hospital, airport, etc.). The main drawback of T2 is that their system is more costly relative to other systems.

- **NuPark:** The benefit of NuPark is that they are enthusiastically seeking a municipal pilot and because of this, they may offer superior customer service and their products at a discounted rate. Additionally, NuPark works closely with a consulting firm, Solutions 4 Cities, which could help with community outreach. The main drawback of contracting with NuPark is that they have mostly university setting experience and have not collaborated with municipalities until now.
- **Aparc:** Benefits of the Aparc integrated parking management system includes a very well designed and easy-to-use user-interface. Additionally, Aparc has worked locally with the City of San Leandro, so they have Bay Area experience. The main drawback of collaborating with Aparc is that their system is new and issues with parking management software are still being rectified.

Parking Technology Costs

The costs for the four recommended parking technologies are evaluated in-depth as individual products in the cost analysis (**Table 0-1**). This analysis shows that across all of the systems, the capital costs for a real-time wayfinding signage system are most expensive. Additionally, expected increases in revenues offer additional benefits from two of the products evaluated: vehicle detection for enforcement as well the customer website portal. These assumed increases in revenues are due to expected enforcement efficiency (estimated at a 60-80% increase, but cited by some cities as high as 800% increase in enforcement coverage area), as well as increased permit sales from offering additional purchasing convenience which are likely to encourage more occasional parkers to purchase day passes.

Table 0-1 summarizes the costs of each system, simplifying or averaging cost estimates from various vendors and municipal sources. Real-time wayfinding and vehicle detection technologies can include maintenance subscriptions for annual costs (estimated at \$15-20,000), yet these are optional; the City can also create their own operation and maintenance plan. On the contrary, the customer website application and the parking management software typically include annual subscription costs, and varying design, start-up and training costs.¹ This annual subscription cost for the customer website may differ significantly if the City decides to manage the website in-house.

Table 0-1: Summary of Technology Costs for Recommended Technologies

	Vendor source	Capital costs ¹	Annual subscription costs	Annual amortized Costs ¹	Annual change in revenues ²	Annual Net Change
Real-time Guidance Signs						
Option 1: 1 sign showing total "spaces available"	TCS	\$75,000	\$0	\$7,500	\$0	(\$7,500)
Additional scrolling LED display	TCS	\$10,000 ³	-	-	-	-
Occupancy sign with additional scrolling LED display	TCS	\$85,000	\$0	\$8,500	\$0	(\$8-9,000)

¹ Because they currently only have institutional clients, NuPark is likely offering free training, design and set-up services due to their desire to have a municipal pilot City.

Option 2: One occupancy sign at the structure's main entrance and one level-counting sign within the structure						
With overhead sensors	TCS	\$145,000	\$0	\$14,500	\$0	(\$14,500)
With Single Space Sensors	TCS	\$190,000	\$0	\$38,000	\$0	(\$38,000)
With Single Space Sensors	Streetline	\$200,000	\$0	\$40,000	\$0	(\$40,000)
Enforcement (LPR/VR) Systems						
Option 1: License Plate Recognition (LPR)						
Genetec hardware and software	Genetec	\$60,000	\$0	\$6,000	n/a	n/a
Enforcement vehicle	n/a	\$30,000	\$0	\$6,000	n/a	n/a
Option 1: License Plate Recognition (LPR) total	Genetec	\$90,000	\$0	\$12,000	\$41,000 ²	\$29,000
Option 2: Vehicle recognition (VR)						
AutoChalk hardware and software	Autochalk	\$100,000	\$0	\$10,000		
Enforcement vehicle		\$30,000	\$0	\$6,000		
Total	Autochalk	\$130,000	\$0	\$16,000	\$55,000	\$39,000
Additional enforcement add-on technology						
Mobile device, software & printer	T2	\$1,900	\$0	\$380	n/a	n/a
Handheld enforcement device	T2	\$3,500	\$0	\$700	n/a	n/a
Laptop and accessories for vehicle	Sentry	\$9,500	\$0	\$1900	n/a	n/a
Customer Website (including website design and set-up)						
Option 1: Customer website selling parking permits	NuPark	\$0 ⁵	\$11,500	\$11,500	\$25,000 ⁴	\$13,500
	T2	\$35,000	\$10,300	\$13,800	\$25,000	\$11,200
	Aparc	\$20,000	\$0	\$2,000	\$25,000	\$23,000
Option 2: Customer website selling parking permits and providing citation payment, information, and appeal	NuPark	\$0	\$16,500	\$16,500	\$25,000	\$8,500
	T2	\$38,000	\$13,300	\$17,100	\$25,000	\$7,900
Parking Management Software⁶						
Parking management software	NuPark	\$0 ⁵	\$18,500	\$18,500	\$0	(\$18,500)
Parking management software	T2	\$35,500	\$14,500	\$18,000	\$0	(\$18,000)

¹ Includes installation; does not include subscription for year 1. Amortized costs includes both capital and subscription costs, amortized over the product lifecycle. Product lifecycle is typically 5-10 years, depending on technology.

² Expected increase in enforcement revenues are based on a 60-80% increase in parking enforcement citation revenues (baseline citation revenues based on 2012 data).

³ Approximate, ranges depending on size and design.

⁴ Expected 20% increase in permit sales due to customer website.

⁵ NuPark has reduced initial fees due to their desire to have a municipal client as a pilot.

⁶ The parking management software does not need to be implemented for all the systems to work. However, some enforcement systems recommend software from the vendor (specifically T2's Flex product). Vendors claim cost savings with a combined LPR, customer website, and management software system. Annual costs for the software include the annual subscription fees only. Savings may be applied and revenue gained depending upon the overall elements of the package (signage, LPR, website, etc.)

Key Findings and Next Steps

Four types of technologies that are reviewed based on benefits to the City as well as costs and feasibility are recommended for the City as systems that would increase the utilization efficiency of parking in downtown as well as improve customer service within parking, including: (1) real-time wayfinding signs, (2) vehicle detection technologies for enforcement, (3) customer web applications, and (4) integrated parking management software. However, the City must decide on whether they want to implement all of the technology recommendations, some, or none. The City may take a phased approach based on available funds and downtown parking needs overtime.

The costs for each of these systems vary significantly: from high capital costs and low annual costs (for a real-time wayfinding system) to low capital costs and annual subscription costs (for software or website administration). Additionally, the feasibility of each system varies. While each system has proven successful and is recommended as a technology that would benefit the City, the integrated parking management system would only be beneficial if one or more additional technologies were implemented as well. This is because the benefits of this software are based on increasing the use of other technology options.

Part 1: Parking Technology Review

1.1 Introduction and Overview

In order to ensure that the City's public parking continues to function at a high level and work towards improving the efficiency of this system, the City proposes to utilize parking technology solutions that will aid in designing a more effective and efficient system. Implementing downtown parking technology will also allow City Council to meet one of its major goals for Fiscal Year 2013-14, which is to use technology to enhance customer service, efficiency, and advance the mission of the organization.

This report provides the City with options and recommendations for how parking technology would best address the City's current parking needs. Technology tools are evaluated based on their ability to improve the efficiency and effectiveness of the downtown public parking system by optimizing parking availability through better information, enforcement and on-line services. Importantly, this review of best practice technologies includes examples of each parking technology and associated vendors to evaluate how each product addresses the City's downtown parking needs. Overall, this research aims to give the City and its City Council the complete set of information they need to develop future public parking policies and to decide which parking technologies are appropriate to implement within Downtown Mountain View.

Parking Needs

The Parking Technology State of the Practice was initiated by identifying where in downtown Mountain View elements of the public parking system could be improved, and where technology could be best applied. Because of the lessons learned from the City's recent downtown parking studies (described below), this research focuses on technologies that would (1) increase the efficiency and use of current parking supplies, (2) help improve enforcement, and (3) improve the parking permit program. Altogether, priority was given to parking technologies that could improve customer service as well as increase the efficiency and effectiveness of the City's parking facilities.

Recent parking studies

The current state of Mountain View's downtown public parking system was studied in depth in the 2011 downtown Mountain View Parking Study as well as the 2013 Mountain View Downtown Parking Permit and Alternative Parking Analysis. Data collection of parking occupancy during these two studies find that parking demand has increased substantially in recent years and that the public parking system is constrained. Parking demand is especially high during the midday and evening peak periods. High parking demand during these peak periods show that parking facilities sometimes fill up past capacity. As a result of a full parking facility, users may waste time by entering a garage or lot and not finding an open space. Alternatively, users may be idling in order to wait for spaces to open up. Parking demand is also high in particular areas, where parking demand is sustained at high levels throughout the entire day.

Both the 2011 and 2013 Parking Studies addressed parking permits and enforcement. These studies found that permit holders were not an overwhelming portion of total parked vehicle in each facility. The 2011 study looked at re-parking, finding that between 500 and 600 vehicles were re-parking during enforcement hours. Many of these vehicles fit under an employee profile: those who are parked for a

continuous or nearly continuous span of 5 hours or more. This suggests that there are many parkers who are not participating in the permit program but could benefit from this. The 2013 Parking Study surveyed parkers, finding that inadequate enforcement of time restrictions could be a contributing reason for why employees are not using parking permits.

Parking Technology Benefits

There are a variety of parking technologies in the marketplace today, but for the purpose of this report, the following technologies were evaluated based upon the City's needs: (1) parking management technologies that improve the ability of City officials to view and collect data on parking facilities; (2) parking information technologies that provide better guidance and wayfinding to users, thus reducing car trips and congestion; (3) parking enforcement technologies that increase the efficiency of enforcement officers; and (4) parking payment technologies that would streamline the permit purchasing and citation payment process. These parking technologies were selected on the basis that they will meet the parking needs of the City. The technologies were also evaluated by product as well as by vendor.

The following list of benefits that could be realized from parking technologies are organized by management, information, enforcement, and payment technologies. These benefits were compiled to identify potential goals and programs that would benefit the City of Mountain View.

- Provide a connected management system
 - Manage parking through a single database system
 - Receive constant feedback on the success of parking management and enforcement
 - Receive automatically-generated reports on the use of the technology, including customer satisfaction, ease of finding parking, revenue control, and enforcement performance
 - Track enforcement activity and efficiency
- Provide wayfinding, marketing and education
 - Implement a guidance system to direct parkers towards available parking
 - Provide signage that clearly conveys regulations
 - Increase communication to permit users
 - Improve customer service satisfaction
 - Transition into a new system for future changes
- Enhance enforcement and maximize enforcement labor resources
 - Provide an enforcement system that users can rely on
 - Reduce labor needed to enforce large area
 - Increase permit sales with improved enforcement
 - Put a "friendly face" on parking by implementing fair and consistent policies
 - Pinpoint key locations with high violation rates
- Improve convenience and service for users
 - Create an online permit purchasing platform
 - Allow users to easily update and change their personal information
 - Provide straightforward, clearly enforced rules and regulations
 - Implement a fair violation process
 - Allow easy citation payment online or by phone
 - Provide an online portal to communicate to parking users

Parking Vendor Screening

A key element of evaluating the technology applications, costs, and benefits was establishing a relationship with vendors to understand their commitment and service, in addition to the benefits of the product they offer. This is essential for evaluating the full system and ensuring that the resulting application brings the benefits that the technology promises.

The initial screening process for parking technology vendors occurred at the California Public Parking Association (CPPA) Annual Conference and Tradeshow from November 6th through November 8th, 2013. Presence at this annual conference, the largest regional tradeshow for parking technologies, proved successful at meeting dozens of vendors that offered state-of-the-art technological solutions. This was just the first step in evaluating vendors; interviews with clients—both public and private—as well as independent research into the technological benefits are some of the further steps conducted, detailed later in this report.

On-site vendor demonstrations and installation tours took place in February 2014. They included vendor demonstrations from T2 Systems, Aparc and NuPark and installation tours of parking technology in downtown San Jose and downtown San Leandro.

1.2 Parking Technology Options

Real-Time Wayfinding Signage

Wayfinding and parking guidance signage allows drivers to understand and navigate through a parking system with effective signage and information. Recognizable and consistent wayfinding will ensure that drivers can quickly recognize the facility as an available parking location associated with the City's downtown.

A good parking signage system performs multiple functions. It provides effective information and direction for drivers to find their way to parking, communicates parking rules, and helps maintain the image of the community. Best practice examples combine branding—creating a recognizable design that represents a city—with the signage technology to create a more powerful wayfinding system.

Dynamic, real-time information about available parking supply has been utilized in several cities to reduce time spent by drivers searching for a parking space. Real-time wayfinding signage *at garages* can display how many spaces are available in the entire facility or per garage level, displayed as a vehicle enters a garage and allowing them to reduce their search time by continuing directly to areas with parking availability. Real-time wayfinding signage systems include multi-facility signs placed along on the roadside in key decision points in the downtown allowing users to view how many spaces are available in different parking garages and lots. Locating these signs at strategic locations before drivers choose what facility to use will assist parkers in choosing the most convenient option, as shown in **Figures 1-1 and 1-2**.

Figure 1-1: Entrance Occupancy Sign



Sign by Swarco Traffic Americas Inc.

Figure 1-2: Sign at CA State University, Fullerton (directional sign)



Sign by Signal-Tech

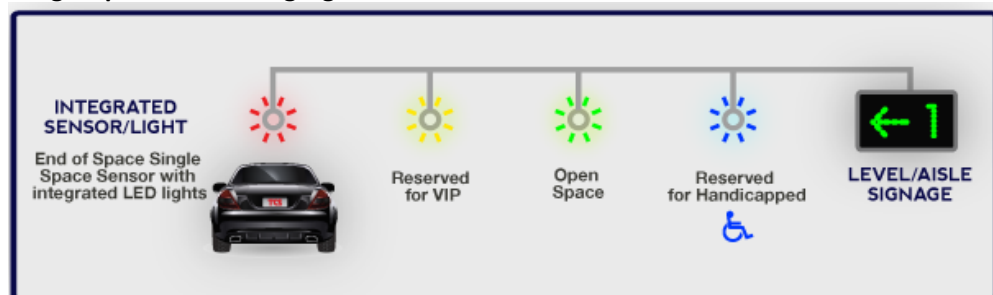
Parking Vendor: TCS International

TCS International is one of the leading wayfinding and guidance system providers. They also work with other vendors—such as Sentry Systems—to provide comprehensive solutions.

TCS International uses sensors installed at each garage entry/exit to detect vehicle entrance and exits (see Vehicle Detection Technologies in the subsequent section). This information is sent to a server that transforms the data into vehicle counts and displays the available spaces on the signage for each garage. Similarly, counting can be completed at each level of a garage to show the spaces per level, rather than just the total number of available spaces in the garage total. This information can also be displayed at an intersection or along a roadway to provide wayfinding for users deciding what lot to patronize. Before choosing their direction, they can see which lots have more available spaces. With direct access to sunlight, these outdoor signage systems can be solar powered to reduce the costs of electricity and power cabling infrastructure. However, this option may not be suggested due to evening and night-time power needs. Additionally, the quantity of power provided by solar may not be enough to power the signage.

TCS International also provides a single-space lighting product, that uses LEDs at the end of each space to show whether it is available, reserved, or unavailable. These are represented with different colored LED lights, as shown in **Figure 1-3**. Costs for TCS International wayfinding products are detailed in Part 2 (Section 2.2) of this report.

Figure 1-3: Single-space Monitoring Lights



Application: City of San Jose

The City of San Jose has a successful real-time wayfinding signage system (**Figure 1-4**). The wayfinding system is the first wireless city-wide implementation of a parking guidance solution and is one of the largest Wi-Fi implementations of variable message signage systems installed in North America. The system architecture features internally illuminated, stainless steel roadway signs with a combination of dynamic and variable message displays, for real time monitoring and a consistent branding of Downtown San Jose’s public parking system.

Figure 1-4: City of San Jose’s Dynamic Signage (entrance occupancy sign and directional sign)



Vehicle Detection Technologies

Vehicle Detection Technologies can be used to detect vehicles entering and exiting a parking facility, or for “digital chalking” enforcement. Digital chalking consists of recording information about a vehicle’s position and parked time without using the traditional chalking methods. The recorded information identifies the vehicle via License Plate Recognition (LPR) cameras or an infrared sensor and is stored digitally. When the officer passes the vehicle a second time after the time restriction, they are alerted when they pass a vehicle within the same location.

Vehicle counting in order to provide real-time occupancy information also implements vehicle detection technologies, and can be combined with several methods, including: space-by-space sensors, loop detector sensors, and vehicle detection cameras. This section identifies four types of vehicle detection technologies as well as three different products that would most benefit the City’s needs. These are:

Vehicle Detection Technologies

1. Individual Space Sensors
2. Loop Detector sensors
3. License Plate Recognition (LPR) cameras
4. Digital Image sensors

Vehicle Detection Products

1. Genetec’s AutoVu system
2. ParkAssist’s M3 LPR cameras
3. Tannery Creek’s AutoChalk image sensing system

Individual Space Sensors

Increasingly, various cities around California such as San Francisco have installed sensors within the pavement of individual parking spaces in order to monitor parking occupancy and turnover (**Figure 1-5**). These remote sensors are embedded in the pavement and can detect a vehicle parked in the space. The sensor sends the occupancy and turnover data wirelessly to a parking management software system. This information can be used to study detailed time-of-day demand and/or to allow users to locate available supply by sending the data to a mobile application, as described subsequently.

Figure 1-5: Embedded Parking Sensor



Loop Detectors

Another method of counting vehicles entering and exiting a garage is through the use of loop detectors. In order to count vehicles and display parking availability information, loop detectors at the exits and entrances of garages, detect each time a vehicle passes over them. Application of loop detectors would be particularly beneficial to the City as a lower-cost alternative to individual sensors. This method of counting vehicles entering and exiting parking facilities can be used to collect the data for displaying occupancy and availability information for real-time wayfinding and guidance systems. This information can be displayed on mobile applications or on electronic signs along roadsides or within garages, as described in the next section.

Figure 1-6: Genetec LPR Camera



License Plate Recognition Cameras

The License Plate Recognition (LPR) camera detects a vehicle entering and exiting a parking facility and record the license plate information of an entering and exiting vehicle. This system allows enforcement to view how long each vehicle is occupying a particular parking facility. However, many citizens are concerned about the privacy of their information; this will be discussed in detail within Part 2's Feasibility Study. The City of San Leandro uses Genetec LPR cameras to automatically detect vehicles entering and exiting garages (**Figure 1-6**).

LPR systems can also aid enforcement by replacing conventional chalking methods. Parking enforcement officers can employ LPR cameras to track vehicle arrivals/departures and their estimated parking durations more efficiently. Each LPR camera reads the license plates and sends this information to a parking database. With the license plate recognition, enforcement officials receive information about the activity of the vehicle, which is also recorded to provide back-up for any dispute cases. The database automatically receives information through the city's permit program, excluding permit holders from being ticketed.

Parking Vendor: Genetec/AutoVu

Genetec's AutoVu platform is the most well-known LPR system. **Figure 1-7** shows a dual mounted Genetec LPR camera on a GO-4 enforcement vehicle.

Most of the integrated parking management system vendors reviewed in this report (i.e., T2, Aparc, and NuPark) use Genetec's technology as part of their integrated package (**Figure 1-8**). A competitor to Genetec's technology is AutoChalk. Genetec's AutoVu system acts as a basic option

Figure 1-7: Genetec LPR Camera



for improving enforcement without some of the other functionality and options that other vendors offer.

Figure 1-8: Enforcement Officer's View of Genetec's LPR



With the AutoVu system, an enforcement officer must scan vehicle license plates as they drive by parked automobiles, which conducts “digital chalking.” The officer can conduct enforcement without physically leaving the vehicle. Additional benefits of the system include:

- The Show Due Prompt system will direct an officer to an area where the time limit since the last enforcement round has expired, directing officers to areas that are due for verification.
- Genetec’s back-office management platform will generate a report of information such as the officer routes, number of license plate violation hits, and types and number of citations issues.
- License plate scans allow enforcement officers to automatically detect vehicles that are registered through the national wanted vehicle database.
- Any license plate data, such as long-term permits or daily passes, are sent to the database in real-time, and can be wirelessly downloaded for system updates. GPS locations allow parking management to track where enforcement vehicles are currently located. This is helpful if enforcement officers need assistance right way.

Genetec touts a 900% increase in enforcement officer coverage since installing the AutoVu system in the City of Aspen.² Their publications also state that the number of violations and vehicle re-parking incidents has dramatically reduced since implementing the system. The photographic evidence helps clear any questions or disputes about a parker's ticket.

The City of Napa has also implemented Genetec's AutoVu system. Like the City of Mountain View, the City of Napa does not charge for parking in their downtown and has time restrictions. With the new technology, the parking officials were able to move more quickly and had less predictable routes, more than doubling the number of violations they enforced. Aaron Medina of the City of Napa's Police Department reported that 2,198 time-limit violators were cited in 2004; after AutoVu implementation, 5,269 time-limit violators were cited.³

Parking Vendor: Park Assist

Park Assist uses LPR cameras to monitor parked cars within a lot or garage and sets up guidance systems to direct parkers. The LPR cameras, which can detect license plate information from a distance up to 100 feet, are set up throughout the garage to monitor the parking spaces. The camera system can also detect overstayed vehicles and distinguish between permit holders and non-permit holders. Their system, called the M3 Park Assist System uses cameras to capture each car within an individual space, specific software to process the image, and a management platform to deliver the information. The benefit of having such detailed site information includes guidance, data collection, and expanded use of available spaces. When users can be guided directly to empty spaces, no space is left unused and it is quicker and more convenient for parkers to locate their space, thereby reducing congestion and circling in garages. Park Assist works mainly with private garages such as Santana Row in San Jose, but has also worked with the City of Seattle.⁴

The M3 Park Assist System offers several benefits:

- The camera system reads license plates, allowing it to identify permit holders automatically. The license plate is matched to each parking location, allowing it to automatically detect separate zones where permit-holders are allowed.
- The M3 system uses red and green lights, one installed for every four spaces, within parking garages to guide parkers to available spaces (**Figure 1-9**).
- The M3 Park Assist system also includes a mobile application for users to locate their cars in case they forget where they parked.
- With detailed sensor information, signage showing the number and location of available spaces can be displayed (**Figure 1-9**).

² "City of Aspen, Colorado Installs Genetec's AutoVu IP License Plate Recognition to Enhance Parking System." Genetec Case Studies, available at: <http://www.genetec.com/solutions/resources/city-of-aspen-parking-system>

³ Personal communication with Aaron Medina and Martha Manriquez, City of Napa

⁴ The City of Seattle's parking system consists of private garages that partner under the City's *ePark* brand. (<http://www.seattle.gov/transportation/epark/>).

- Real-time reports that monitor demand and vehicle stay-time. The system will send an email to enforcement officers when vehicles have overstayed a specified time restriction. Permit information can be built into this, specifying locations where permitted vehicles are allowed to stay longer.

Figure 1-9: M3 Park Assist Guidance System (with per-level occupancy signs)



Digital Image Sensors

Digital image sensors, as utilized by the City of Santa Barbara through the AutoChalk system (detailed below) record vehicle identification information such as exact location, length, and color. This information is then used to detect if the same vehicle is parked in a location after the restricted time-limit. With this system, license plate information is not stored; yet parking violators can still be identified.

Parking Vendor: AutoChalk by Tannery Creek Systems

The AutoChalk system uses two different types of vehicle sensing—a digital imaging sensor as well as LPR—that include cameras mounted to an enforcement vehicle and scan parked cars while driving down street blocks with the flow of traffic (**Figure 1-6**). Because officers are using a vehicle driving with the speed of traffic rather than on foot or in a patrol vehicle for chalking, a single officer is able to complete significantly longer routes more efficiently.

Figure 1-10: AutoChalk Vehicles in Fredericksburg, VA



Vehicle detection for AutoChalk can be completed with a digital image sensor system. The sensor records the exact length, color, and location of the parked vehicle; once the vehicle repeats its rounds after the 90 minute time-restriction, it checks to see if the same exact vehicle is in that location. When a

violation is detected, the enforcement officer is notified to stop. This prevents individuals from wiping chalk off their tires or rolling their vehicles to a new position to hide the chalk marks. In California, tickets must be placed on vehicles at the time of the violation. The system is completely computerized and all information is stored in the office's Oracle database.

In addition to the City of Santa Barbara (described in detail below), AutoChalk has been implemented in the cities of Fredericksburg, VA, Calgary, Madison, WI, and Santa Rosa, CA.⁵ According to Tannery Creek Systems Inc., parking compliance improved with a 20% decrease in parkers exceeding time limit restrictions in Fredericksburg, VA. Additionally, the Fredericksburg's parking officer was able to scan vehicles at a faster rate, allowing a single officer to expand his/her enforcement area from just downtown to the entire city.⁶

Application: Santa Barbara, CA (implemented 2009)

David Straede, the technical lead for City of Santa Barbara's AutoChalk system was consulted with to ascertain the benefits and drawbacks of the AutoChalk program.⁷ Overall, the system has been successful, with the largest benefit being a reduction in the liability and injury rate of enforcement officers. Rather than chalking—which involves leaning out of the enforcement vehicle and physically marking the tire of parked vehicles—the enforcement officers simply need to drive past vehicles to check for violators.

Issues and solutions that the City of Santa Barbara encountered with initial implementation of the AutoChalk system, and have since been rectified with the AutoChalk system include:

1. The system is meant to be installed on full-sized automobiles, not the enforcement cars. Santa Barbara has had to work around several issues to install the camera and software onto the small, three-wheeled enforcement vehicles. Because these systems are bumpier, the cameras are not as accurate. However, AutoChalk worked with the City of Santa Barbara to correct the issue.
2. LPR does not work if the vehicles are parked too close together. Instead of using LPR software from AutoChalk, the City of Santa Barbara implemented a dual GPS and a digital image sensor system. With this system, it does not matter if vehicles are parked too close to each other in order for the LPR cameras to read the license plates.
3. The GPS locator does not work if streets have too many trees on them. After encountering this problem, the AutoChalk vendor installed ground radar to overcome this problem. The ground radar sends information to the sensors about how far away the last GPS signal is, extrapolating location information.

The City of Santa Barbara tested both a Genetec system and the AutoChalk system. For their respective needs, the AutoChalk system was the best option. Mr. Staede's experiences with the two systems was

⁵ Individuals consulted about their experiences using AutoChalk include: Richard Verbel, Fredericksburg, VA, David Nye, Fredericksburg, VA, Janet Reisner, City of Santa Rosa, and David Straede, City of Santa Barbara, CA

⁶ Personal communication with Richard Verbal, senior parking enforcement officer in Fredericksburg, VA.

⁷ David Straede, IT System analyst and technical lead for AutoChalk for the City of Santa Barbara. Personal communication on November 25, 2013.

that enforcement vehicles could not exceed approximately 15 mph before losing accuracy with the Genetec system, yet the enforcement vehicles can exceed 40 mph with the AutoChalk system.

Mr. Straede stated that the costs for the yearly maintenance contract and the system overall are well worth the reduced liability for enforcement officers alone. This is a priority for the city as they have had enforcement officer injuries due to hand-chalking. Mr. Straede believes that there are benefits to officers driving full-sized vehicles rather than the smaller enforcement vehicles due to the efficiencies created.

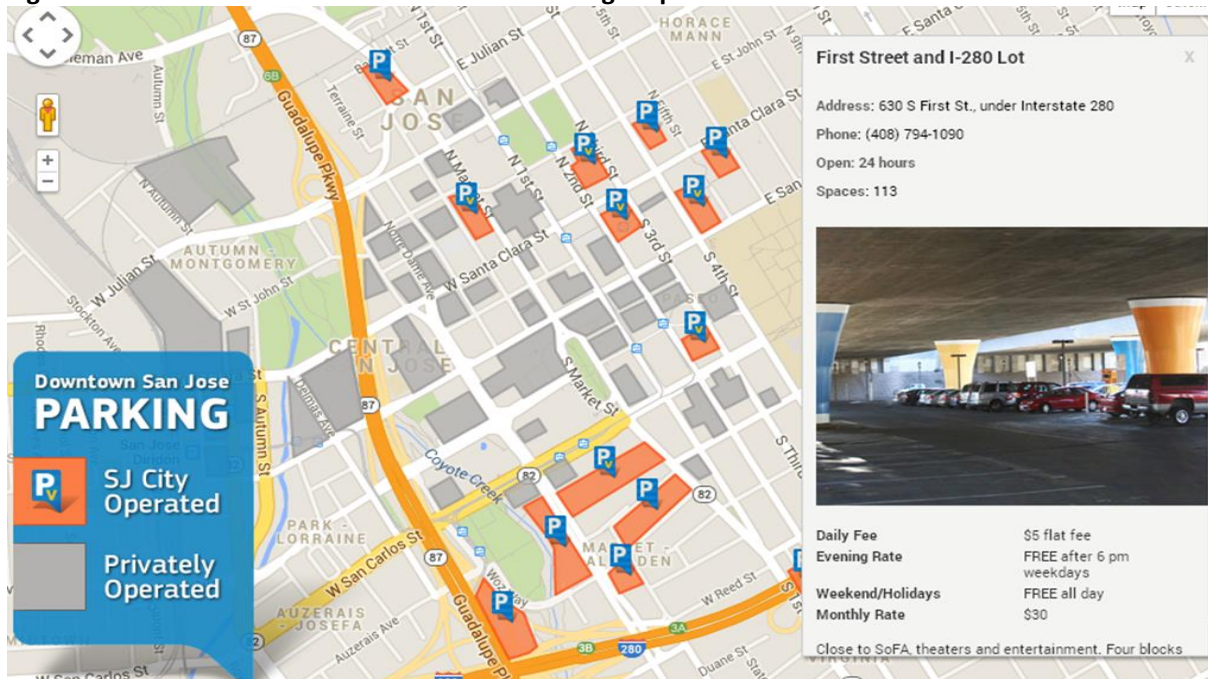
Web and Mobile Applications

Interactive Maps of Parking Information and Supply

Cities, such as San Jose and San Francisco offer real-time and/or interactive maps available online. Users can click on a location and view the number of spaces, regulations, and other information about that lot or garage. They are real-time when the locations update to show information about availability and occupancy of these locations. This allows parkers to view how crowded a particular location is from their desktop or smart phone.

The City of San Jose offers an easy-to-read interactive parking map of 13 City-operated off-street parking garages in their Downtown area (**Figure 1-11**).⁸ This map is not real-time, but still offers up-to-date information about parking facility rates and regulations at the user's request. In order to receive more information about a particular facility—such as the address, size, hours of operation, and rates—users click on the blue pin of interest.

Figure 1-11: San Jose's Interactive Off-Street Parking Map



Real-time Parking Availability Information

⁸ Accessed September 3, 2013 at: <http://sjdowntownparking.com/parking-map>

There are several applications available on-line via mobile phone or desktop applications that send real-time information to parkers about the availability of parking spaces in an off-street garage. SurePark® is an example of this technology that provides parking users with up-to-the-minute parking availability information. The system offers parking users three methods for retrieving parking availability information, including voicemail messages, text messages, and through a website.

The Minneapolis-St. Paul International Airport (MSP) has been using SurePark technology since 2007 to display the availability of its parking lots (**Figure 1-12**).⁹ Customers can download the SurePark app, visit the MSP website, request a text message, or call 1-877-FLY-PARK to listen to the information about space availability.

Figure 1-12: MSP International Airport’s Real-time Lot Information



Similarly, the Cities of San Francisco, Los Angeles, San Mateo, and Redwood City are currently implementing technology that give users real-time information about the availability and overall supply of parking both on-street and off-street. In addition, cities are using Streetline, Inc. and other embedded parking sensor technologies to implement this technology, which requires sensors to be installed in order to record vehicles arriving and departing from parking spaces (**Figure 1-13**).

Figure 1-13: Streetline, Inc. Application in Redwood City, CA¹⁰

Step 1: Enter your address below to get started!

San Mateo County History Museum

Redwood City, CA, USA ✓

Step 2: Choose Map Size

500x360 500x650 640x480

960x720 Custom Size Width Height px px

⁹ Minneapolis Saint Paul International Airport, MSP. SurePark: parking availability. Accessed September 11, 2013 at <http://www.mspairport.com/parking/surepark.aspx>

¹⁰ (www.theparkerapp.com/parkermap/)

Texas A&M University provides another example of parking facility information available online through a desktop or mobile application. **Figure 1-14** shows Texas A&M’s information available on their website, with real-time space availability at three of their parking garage locations. They offer users the opportunity to download the ParkMe App, explained further in the next section.

Figure 1-14: Texas A&M’s Real-time Parking Information

Hourly Visitor Parking

Real-Time Availability

Central Campus Garage 191
 University Center Garage 346
 West Campus Garage 244

ParkMe App

Get real-time occupancy, rates, hours of operation and accepted payment types for several visitor parking facilities right on your **smartphone or desktop!**

[iPhone app](#) [Android app](#)

Mobile Applications

Mobile applications for parking information are becoming increasingly popular. San Francisco released a mobile application with real-time parking prices in 2011 for their SFPark program. Additionally, San Francisco has partnered with some of their private facility operators to provide parking data to ParkMe, a parking mobile application with a large presence in California, but also offers parking information world-wide.

Based in Santa Monica, California, the ParkMe mobile application provides information about parking locations, availability, and prices. This information can be provided directly to ParkMe by businesses, cities, or parking facility operators. ParkMe currently has over 1,800 cities that include parking data, some of which provides real-time updates on occupancy and availability, and some is operator reported occupancy data and availability. The application includes a map showing locations with data as well as detailed information (shown in **Figure 1-15**) when the location is selected. In addition to the mobile application, the information can be doubled as an online “widget,” embedded on any city website. ParkMe is currently active in Santa Monica and Walnut Creek, CA.

Figure 1-15: ParkMe Mobile App



1.3 Integrated Parking Management Systems

This section focuses on integrated parking management systems including parking management, information, enforcement, and payment functions. The system is made of individual parking technologies (i.e. technologies that were mentioned in Section 1.2 such as embedded street sensors) and are integrated so that information is shared and collected into one parking management software system. The systems are customizable according to the client’s parking needs.

The vendors described below were selected because their products have proven to be successful in the field and would help the City of Mountain View provide a more efficient downtown parking management program. Each of these vendors work in partnership with other technology providers who focus on a specific parking technology such as TCS and Genetec described in Section 1.2. The vendor then combines

those products with their own technology to create an integrated parking management system. This is done to offer a wider range of services and products, yet still ensure that the state-of-the-art technology is used as part of the integrated system. While all vendors offer an integrated parking management product with similar offerings, they differ in design, specifics of the software, and price (detailed in Part 2, section 2.5). Three integrated parking management systems vendors are analyzed in this section:

- T2 Systems
- Aparc
- NuPark

Parking Vendor: T2 Systems

T2 Systems is the most comprehensive and experienced provider for parking technology options that incorporates all of the functionality options that the City could benefit from most.¹¹ T2 has been operating for 20 years and provides services to nearby areas such as the University of California, Berkeley, San Jose State University, and the City of Modesto as well as municipalities across the country, such as Houston, TX, Boulder, CO, Iowa City, IA. Their services come “a la carte,” so that a simplified system can be customized to a user’s needs. The T2 products that could most benefit the City include:

- Integration with several wayfinding providers, such as TSC International, to provide dynamic real-time space availability wayfinding and signage and/or simple, non-electronic wayfinding.
- Handheld devices for enforcement officers with T2 technology for monitoring length of stay and permit usage and alerting officials to violators. As an alternative to tablets the T2 enforcement software is also available for tablets or laptops.
- A customer web portal for purchasing permits, changing vehicle registration for permit information, enter a request and adding multiple vehicles to a single permit.
- A customer web portal for viewing history of warnings and citations, paying citations, entering a first-level appeal, and viewing information and photos regarding a specific violation.
- Genetec/AutoVu LPR technology and database system that creates permit records, coordination with permit-holders license plate data and electronic permits, tracks permit usage.
- A management dashboard that is customizable by the City, allowing operators or city officials to manage and view data and information regarding lot usage and enforcement statistics.
- A la cart or all-inclusive citation processing package that includes call center services, administrative hearings, mailing, processing, etc.

¹¹ Laura Lierz was consulted about T2 Systems. As the Sales and Business Development Manager for the Western U.S., Lierz has been working for T2 for 14 years. Ms. Lierz provided City of Mountain View staff and CDM Smith’s representatives with a vendor presentation on T2 are parking technology solutions.

Parking Permit System

T2 offers an integrated parking permit system that manages the permit process from start to finish. Their web services and development will provide an application via the City's website to allow users to create an account and log-in when needed (example of T2-hosted website shown in **Figure 1-16**). This will provide the platform to purchase permits and register them to specific license plate numbers with the customer's information. Customers can then pay for the permit with credit card or send in a payment. This aspect of permitting is integrated into T2 Systems' management software so that the City can use T2 Systems dashboard to view and track all permit sales and information in real-time.

Figure 1-16: Example of a T2-hosted Website (*purdue.t2hosted.com/cmn/index.aspx*)

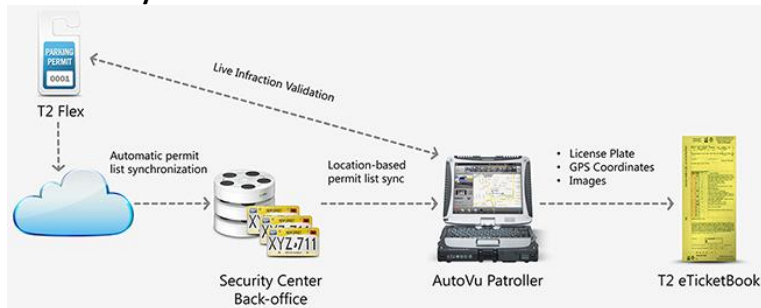
The screenshot shows the Purdue University website interface. At the top right, there is a navigation bar with "Welcome [Log in](#) / [Sign up](#)" and a shopping basket icon labeled "Shopping Basket (0 items, \$0.00)". The Purdue University logo is prominently displayed on the left. Below the logo is a dark blue navigation bar with links for "Home", "Main", and "Campus Parking Map". The main content area features a section titled "Parking Account Main" with a list of links: "Purchase a Permit", "Apply for a 2013-2014 C Permit", "Pay Citations", and "View Your Citations". At the bottom, there are three columns of footer information: "Parking Facilities" with the address "1404 W. State Street, West Lafayette, IN 47905"; "Contact us" with the text "An equal access / equal opportunity university"; and a disclaimer: "If you have trouble viewing this site due to a disability, please contact the Webmaster." The T2 Systems logo and contact information are located in the bottom right corner.

Even though electronic permits are registered through license plate numbers and don't require additional identification, paper, sticker or hang-tag permits can be issued as well. This may provide a good transition stage before implementing a paper-less permits system.

Enforcement and Citations

T2 offers a packaged citation service that will include letter services, letter payment and processing, citation processing, as well as collections. However, each of these services are also available separately for cities that want to continue managing parts of their citation, but may need not have the full labor available in-house.

The "eTicketbook" is a software system for handheld devices, tablets, smartphones, or laptops. The "eTicketbook" system integrates with the LPR system and manages the citation process, and will auto-fill elements of the citation based on the user's license plate, making the citation process quicker for officers. GPS tracking of enforcement officer routes via their handheld devices (**Figure 1-17**) can be included to allow easy management of routes as well as re-organization to follow high-violation areas.

Figure 1-17: Genetec’s AutoVu System with GPS Coordination

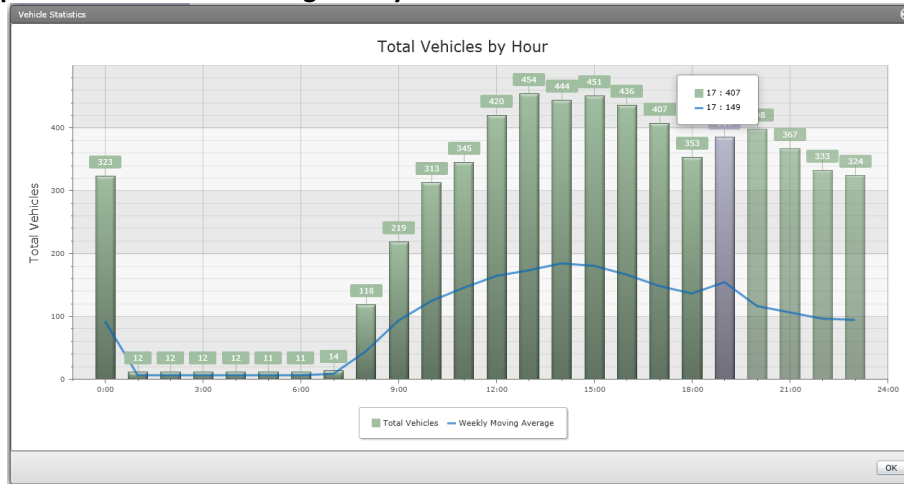
If physical citations are given, officers can also enter the information into the eTicketBook software program, and then print it directly from their vehicle with a USB printer (**Figure 1-18**). This eliminates the need to re-enter the information, reducing the chance of an entering error. With Genetec’s LPR integration, when the officer is alerted of a violating vehicle, the license plate information is automatically entered into the eTicketBook system for the officer to continue filling out if they chose to issue the citation.

Figure 1-18: T5 Systems Handheld Enforcement Device and USB Citation Printer

Parking Vendor: Aparc

Aparc is a third-party vendor for Genetec’s AutoVu technology that offers a real-time software system for managing parking, technology for aiding and improving enforcement, and an online customer service platform where customers can purchase parking permits or pay citations. Aparc’s system has fixed cameras—using Genetec’s technology—to view all spaces at all times, so that a constant inventory and monitoring of vehicles can take place. For example, **Figure 1-19** shows a display of lot usage by hour for an example facility.

Figure 1-19: Aparc's Platform for Viewing Facility Use



Aparc's system offers the ability to see where enforcement officers are located, how many vehicles they have monitored, and how many citations they have dispensed. Staff can easily view reports and statistics showing this data, including changes over time in the ticketing process. This information could point out specific locations or seasonal times where violations are particularly high. These reports can help inform decisions such as seasonal staff hiring, or enforcement route choices. Preferential route planning using this option will allow a small amount of enforcement labor to be allocated to areas where they are most needed.

Parking managers or operators can also input permit information which is taken into account during enforcement. The online permit management system for visitors (**Figure 1-20**) allows users to purchase permits easily and pay with credit cards online. The information is integrated in real time and no printed materials are needed because the permits are based on license plate information.

Aparc offers an online citation payment portal for users. Users can pay citations and view their citation history via a front-office portal that Aparc customizes specifically for each client. This portal is set up on the City's website and users view login to view their information.

Figure 1-20: Aparc's Online Permit Management System

Pay Monthly Parking

This payment page is for current monthly parking clients only.
If you would like to apply for monthly parking please go to the [Apply](#) page or phone us at (604) 682-6744.

* Please enter all fields

Invoice Information

Customer Code: *

Invoice Date: *
(mm/dd/yyyy)

Invoice Number: *

Car Park Number: *

Contact Information

Company Name: *




Contact Name: *

Phone Number: *

Email Address: *

Credit Card Information

Payment Details

Credit Card Type: *

Credit Card Number: *

CVV# * [What's this?](#)

Name on Card: *

Expiration Date: * / *

Payment Amount: [Canadian Dollars] *

Aparc offers the option to have an “appeal” button, so users can directly question the citation. The appeal button leads users to a page that shows the timestamp and information of the citation, as well as photographs that are taken by the enforcement officer and automatically uploaded to the portal. This system discourages unjust appeals. Because the site is set up with the City’s website, users feel like they are interacting with the City, not a third-party. To pay a citation, the user can also take care of the citation by calling and paying through the phone to a clerk with access to the payment portal.

Parking Vendor: NuPark

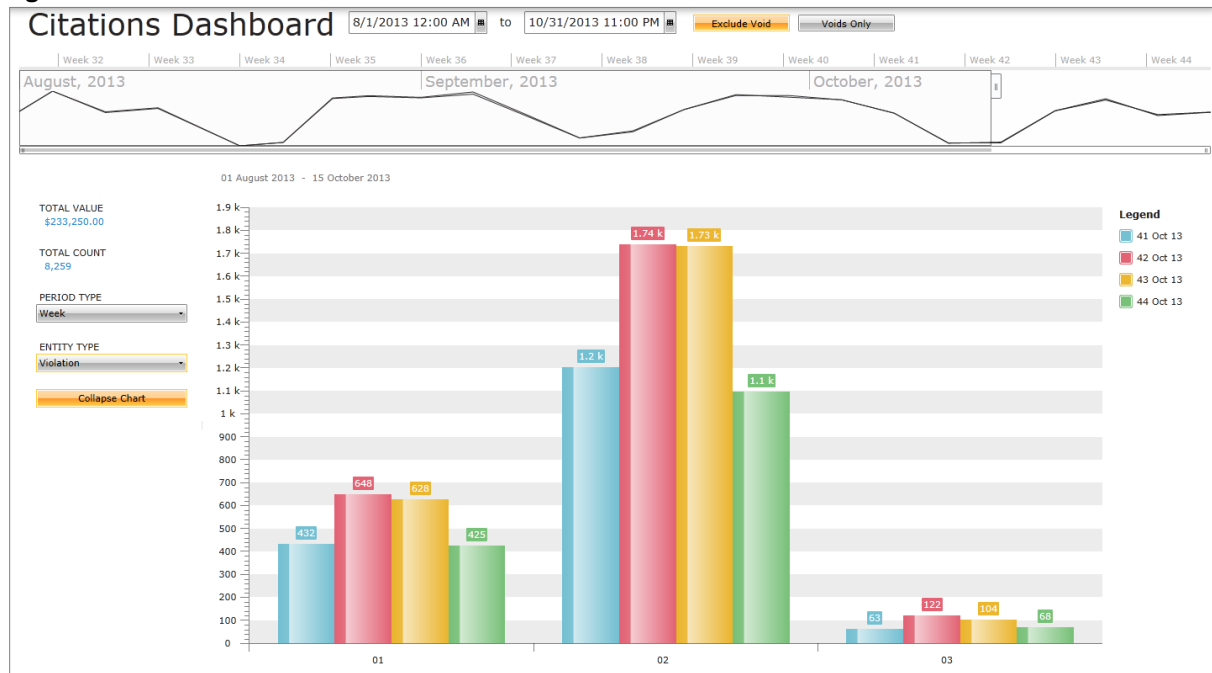
The NuPark combined system offers an all-in-one permit and citation management system. For enforcement, NuPark’s most successful system uses Genetec LPR technology mounted on enforcement vehicles to patrol vehicles. The LPR technology is linked to a database that will enforce vehicles that over-stay time restrictions, but check for license plates that are registered with permits. The license plates will be linked to information determining the vehicles past records as well, which allows officers to issue warnings based on previous violations. The system can be used traditionally, where officers issue citations on-site, or the system can be used electronically, where officers email or mail citations. This latter option increases the speed of patrolling an area and also increases the safety of the enforcement officer. NuPark’s system includes handheld devices for enforcement officers customized for the task. **Figure 1-21** shows views of the handheld tablets enforcement officers use.

Figure 1-21: NuPark Handheld Tablet View



One of the system’s key elements is the online interface for customers and parking management. They provide a dashboard for parking officials and other City staff to manage and operate the system from their computers. This software offers the ability to view LPR cameras, see citations in real-time, look over the number of vehicle license plates that are checked each day, and click on individual user-profiles. This dashboard of information, as shown in **Figure 1-22**, makes it easy to get a holistic view of how efficiently and successfully parking enforcement is proceeding.

Figure 1-22: Back-office Citations Dashboard



After issuing a citation, the database checks the regulations that the permit is based on. This citation review process ensures that the GPS location that the vehicle was parked in correlates with the proper citation regulations. This process double-checks the officer's work, and can decrease appeals and increase customer service levels.

NuPark can set up a platform under the branding of the City of Mountain View in order to allow customers to manage their own parking profiles. This online platform can allow customers to pay citations online, purchase permits, register a vehicle, or view/request information.

1.4 Technology Review Summary and Recommendations

Overview of Parking Technology

Both parking technology options and integrated parking management system options were identified in this report as technologies that would benefit the City of Mountain View based on its current parking needs. These include systems such as vehicle detection to improve enforcement, garage occupancy signage that will make more efficient use of the current parking supply, and parking management software systems such as those that improve customer service by offering easy online parking permit purchasing. Altogether, the categories of technologies recommended include:

Parking Technology Options:

- Vehicle detection technologies include License Plate Recognition (LPR), and/or alternative vehicle sensing that detects and records vehicle information for wayfinding and enforcement purposes;

- Enforcement aid technologies such as handheld devices, printers, and enforcement software for mobile devices and laptops;
- Real-time wayfinding signage that offer dynamic and real-time parking information about parking availability in garages and sensors; and
- Web and mobile applications that offer parking guidance, such as online interactive maps of the parking system and mobile applications to help drivers find available parking.

Integrated Parking Management Software Technology:

- Connected parking management software and information database that provides constant feedback and tracks progress on the success of parking management and enforcement;
- Parking management software systems that enhance enforcement and maximize enforcement labor resources by tracking violators, mapping key locations with high violation rates, implementing handheld devices, and connecting technology to a larger enforcement database; and
- Online customer service platforms that improved convenience and service by allowing users to view their personal information, purchase parking permits, pay citation fees, and update their own information.

Recommended Integrated Parking Technology Systems

The three most promising vendors for integrated parking management programs recommended for the City of Mountain View are (1) NuPark, (2) Aparc, and (3) T2 Systems. These systems provide the parking technology management systems and also offer the option of incorporating additional parking technology options. The recommended systems are summarized below.

NuPark

NuPark team is extremely eager to work with a municipal client and therefore have offered a catered service and hands-on help for a discount price, with free additional customer service. They have also offered to run a year-long pilot program. They are likely to spend more resources ensuring that the product they offer to the City of Mountain View is robust, as they will be heavily relying on positive experiences and feedback to market their product as they aim to expand to more municipalities. Altogether, there are likely significant monetary and service benefits to being a “case study” city. While NuPark’s system does offer many benefits, there are also drawbacks. NuPark does not yet have successful *municipality-level* experience. While this is certainly a concern, their system has proved successful at the university level.

Aparc

Aparc is a third-party vendor for Genetec’s AutoVu technology, and provides key system options that would be particularly beneficial to Mountain View’s needs. One of Aparc’s most promising advantages is its simple interface with clearly displayed information within their management system (**Figure 1-23**).

The products and services that NuPark’s system offers are very similar to Aparc’s system—who is currently working with the City of San Leandro. A cost comparison of these two systems would allow Mountain View to weigh the benefits of working as a pilot city for NuPark compared to working with a vendor that has worked with a local municipality.

T2 Systems

T2 Systems has nearly 400 customers in the U.S. and Canada and is highly experienced in providing services for a range of clients. They provide a wide range of services that are customized according to what is needed, rather than automatically providing unnecessary options and tools. Having operated for over 20 years, T2 is the most comprehensive and experienced provider for parking technology options that incorporate all of the functionality options that the City of Mountain View could benefit from most.¹²

The benefit of using T2 Systems over another system is that the City of Mountain View can receive services from an operator that has a multitude of experience in this area. If compared to a newer service, however, T2 Systems might not provide as much one-on-one attention and training, as a service integrator. Additionally, deeply discounted pricing for being an early adopter would not be available.

Figure 1-23: Aparc’s Platform for Reviewing Facility Enforcement Information

Data	Actual
Total Spaces	448
Violations Today	30
Average Citation Delay (min)	24
Missed Violators	25
Potential Lost Revenue (\$)	\$8,000.00
Citations Issued Today	5
Citations Paid Today	1

¹² Laura Lierz, Sales Operational Manager, and Chris Dix, PARCS National Account Executive were contacted regarding T2 Systems and to provide a demo of the product as well as overviews of services. Lierz (llierz@t2systems.com) and Dix (chris.dix@t2systems.com) can be contacted at 317-524-7410 and 317-524-7499, respectively.

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Part 2: Parking Technology Feasibility Study

2.1 Introduction and Overview

Purpose and Background

Part 2 evaluates the feasibility and benefits of four recommended parking technologies for the City of Mountain View: real-time wayfinding sign systems, License Plate Recognition for enforcement, a customer service website application, and integrated management software. Part 2 of the study focuses on:

- Key considerations and concerns;
- Operation and maintenance; and
- Estimated costs of each technology option.

The key considerations and concerns include different technology options, as well as potential concerns from the community and internal staff. Next, operation and maintenance is addressed, such as internally managing processes required for different systems, contracting labor and tasks to third-party providers and ensuring proper communication between parties that may have an interest or role in managing new technology. Finally, estimated costs of each technology have been gathered from vendors as well as municipal sources to create general estimates for systems costs, taking into account expected revenues from enforcement improvements and permit sales where possible.

Overview of Technology Evaluation

Real-time Wayfinding Signs

Real-time guidance systems include several components: vehicle detection sensors that collect and send data, a physical signage system, and LED panels that receive data from the vehicle detection sensors. In order to collect facility occupancy data that is sent to real-time guidance signs, vehicle detection sensors must be installed within a facility. Costs for various vehicle detection sensors are evaluated in this report, including both entrance/exit sensors and individual-space sensors. There are several benefits to individual-space sensors (such as increased accuracy of vehicle counts), yet the cost for this system is generally 150-200% greater than a single entrance/exit sensing system.

There are several key considerations and concerns that need to be addressed before implementing a real-time guidance system. They include costs, relative feasibility of implementing the system in parking lots vs. structures, and whether to operate and maintain the system internally with City staff or by a third party. Additionally, there are aesthetic components of the signs that must be considered when implementing a real-time guidance system. While smaller LED panels (the area of the sign that changes according to real-time information sent) prices are directly related to the size of the panel, it is important to ensure that the sign information is clearly visible. Additionally, branding can contribute to a clear and recognizable wayfinding system. Some key considerations addressed in this Chapter include:

- Choosing the type of vehicle detection sensor,

- Deciding on sign type and placement,
- Evaluating options for counting system accuracy, and
- Ensuring proper sign design and branding.

Vehicle Detection Technologies

LPR systems are becoming more popular and have been implemented successfully in many cities throughout the Bay Area. Genetec's AutoVu LPR system is the most widely used locally. In addition to Genetec's AutoVu LPR, Tannery Creek's AutoChalk system offers the additional ability to identify vehicles who overstay time limits even when the license plates are undetectable.

Mobile LPR enforcement systems consist of LPR cameras affixed to enforcement vehicles, an annual enforcement software subscription, and a laptop, smartphone or tablet device to view the information. In addition to the hardware and software purchasing decisions, the City should also consider some time spent for training staff, as well as potential labor resources used to oversee and administer the system. Finally, contracts for maintenance and equipment warranties are available on an annual basis to cover and address any issues that may arise. Some key considerations addressed in this report include:

- Addressing privacy concerns,
- Choosing of the enforcement vehicle,
- Including public outreach and communication, and
- Choosing the type of system (LPR or Vehicle Recognition).

Customer Website

Prior to implementing a customer website, the City must first decide its overall purpose. Such as will the website need to accomplish one or more of the following tasks:

- Purchasing permits,
- Viewing personal information, paying citations, and appealing violations,
- Communicating with staff, and
- Using customer emails for announcements and permit renewal reminders.

CDM Smith recommends that the City develop a plan for transitioning from the current permit purchasing process to an online-process, allowing period of time where both the old and new purchasing methods are available. In addition, the City should also consider whether a customer website will be implemented in conjunction with other marketing efforts (for example, encouraging day-use permits). Additional key considerations include:

- Including staff management,
- Integrating with LPR/virtual permits,
- Including public outreach and communication, and

- Consider marketing and expanding the permit program.

Integrated Parking Management Software

An integrated parking management system will allow the City to manage multiple technology systems within one platform, as well as view data and trends relating to the performance of parking systems. For example, the City can view trends in enforcement such as the number of license-plate queries and citations given over a period of time and by “problem area.” Additionally, reports of trends in garage occupancy over time and in response to new enforcement or permit policies is available to staff. Altogether, whether or not an integrated management system is valuable for the City is dependent on the types of technologies the City decides to employ. The key considerations of an integrated parking management system include:

- Individual elements of systems (enforcement hardware, customer website, parking guidance, etc.),
- Administration/management of the system, and
- Vendor selection.

Summary of Technology Costs

Technology costs were evaluated by comparing estimates for the capital, annual subscription costs, and amortized costs of each product. Additionally, any expected increase revenues is factored into the analysis by looking at net change in annual revenue. This analysis allows us to get a general sense of how the benefits of each technology, as overviewed in the Technology Review (Part 1, pages 1-21), compare with the costs of each technology. Cost estimates were received from T2, NuPark, Aparc, Streetline, and TCS International.

Table 2-1 summarizes the estimated costs for each technology system. Many technologies have implementation costs as well as annual software subscription costs. These costs are factored in with the amortized costs over the product lifecycle, depending on the estimated number of years the product will be in use. Revenue increases are based on improved enforcement efficiencies (through vehicle detection technologies) and expected escalation of permit sales (customer website for online permit sales). All costs are not official quotes, merely estimates and are rounded to the nearest 100.

While quotes were requested from for all technologies, some vendors were not able to provide cost estimates for each individual system. Additionally, some vendors did not include detailed line-itemed costs for some products. As a result, some estimates required a degree of professional judgment and interpretation for each system’s individual cost. For example, T2 provided cost estimates for a combined enforcement, customer website, and management system. These costs were broken down into individual systems in order to evaluate them side-by-side with other vendors.

NuPark provided a quote that was below other vendors in capital costs, due to their desire to obtain their first municipal client. NuPark, Aparc, and T2 all provided similar costs for the Genetec mobile LPR system, and therefore a rounded average was used as the cost estimate for this system.

Table 2-1: Summary of Costs by Technology

	Vendor source	Capital costs ¹	Annual subscription costs	Annual amortized Costs ¹	Annual change in revenues ²	Annual Net Change
Real-time Guidance Signs						
Option 1: 1 sign showing total "spaces available"	TCS	\$75,000	\$0	\$7,500	\$0	(\$7,500)
Additional scrolling LED display	TCS	\$10,000 ³	-	-	-	-
Occupancy sign with additional scrolling LED display	TCS	\$85,000	\$0	\$8,500	\$0	(\$8-9,000)
Option 2: One occupancy sign at the structure's main entrance and one level-counting sign within the structure						
With overhead sensors	TCS	\$145,000	\$0	\$14,500	\$0	(\$14,500)
With Single Space Sensors	TCS	\$190,000	\$0	\$38,000	\$0	(\$38,000)
With Single Space Sensors	Streetline	\$200,000	\$0	\$40,000	\$0	(\$40,000)
Enforcement (LPR/VR) Systems						
Option 1: License Plate Recognition (LPR)						
Genetec hardware and software	Genetec	\$60,000	\$0	\$6,000	n/a	n/a
Enforcement vehicle	n/a	\$30,000	\$0	\$6,000	n/a	n/a
Option 1: License Plate Recognition (LPR) total	Genetec	\$90,000	\$0	\$12,000	\$41,000 ²	\$29,000
Option 2: Vehicle recognition (VR)						
AutoChalk hardware and software	Autochalk	\$100,000	\$0	\$10,000		
Enforcement vehicle		\$30,000	\$0	\$6,000		
Total	Autochalk	\$130,000	\$0	\$16,000	\$55,000	\$39,000
Additional enforcement add-on technology						
Mobile device, software & printer	T2	\$1,900	\$0	\$380	n/a	n/a
Handheld enforcement device	T2	\$3,500	\$0	\$700	n/a	n/a
Laptop and accessories for vehicle	Sentry	\$9,500	\$0	\$1900	n/a	n/a
Customer Website (including website design and set-up)						
Option 1: Customer website selling parking permits	NuPark	\$0 ⁵	\$11,500	\$11,500	\$25,000 ⁴	\$13,500
	T2	\$35,000	\$10,300	\$13,800	\$25,000	\$11,200
	Aparc	\$20,000	\$0	\$2,000	\$25,000	\$23,000
Option 2: Customer website selling parking permits and providing citation payment, information, and appeal	NuPark	\$0	\$16,500	\$16,500	\$25,000	\$8,500
	T2	\$38,000	\$13,300	\$17,100	\$25,000	\$7,900
Parking Management Software⁶						
Parking management software	NuPark	\$0 ⁵	\$18,500	\$18,500	\$0	(\$18,500)
Parking management software	T2	\$35,500	\$14,500	\$18,000	\$0	(\$18,000)

¹ Includes installation; does not include subscription for year 1. Amortized costs includes both capital and subscription costs, amortized over the product lifecycle. Product lifecycle is typically 5-10 years, depending on technology.

² Expected increase in enforcement revenues are based on a 60-80% increase in parking enforcement citation revenues (baseline citation revenues based on 2012 data).

³ Approximate, ranges depending on size and design.

⁴ Expected 20% increase in permit sales due to customer website.

⁵ NuPark has reduced initial fees due to their desire to have a municipal client as a pilot.

⁶ The parking management software does not need to be implemented for all the systems to work. However, some enforcement systems recommend software from the vendor (specifically T2's Flex product). Vendors claim cost savings with a combined LPR, customer website, and management software system. Annual costs for the software include the annual subscription fees only. Savings may be applied and revenue gained depending upon the overall elements of the package (signage, LPR, website, etc.)

2.2 Real-time Wayfinding Signs

There are several real-time wayfinding signage options that would be beneficial for improving the customer service and increasing the utilization in the City’s parking structures. Real-time wayfinding signage will inform parkers about the availability of spaces, helping to maximize parking capacity (see pages 9-11 for the full review of real-time wayfinding signage). This section will include a discussion on key considerations and concerns before implementing a real-time wayfinding signage system:

- Types of Vehicle Detection Sensors
- Sign Type and Placement
- Accuracy of Counting System
- Signage Design

The costs for a real-time wayfinding signage system vary considerably based on the type of system and sensors that are implemented. **Table 2-2** shows a summary of costs for real-time wayfinding systems, while more detailed costs are evaluated below.

Table 2-2: Summary of Cost Estimates for Real-time Wayfinding Signs

Technology Types	Year 1 Capital/ Installation Costs ¹	Ongoing Annual Subscription Costs
Real-time Wayfinding Signs		
One large occupancy sign—at the parking structure’s main entrance (and accompanying sensors)	\$75,000	\$0
Additional scrolling LED display only	\$10,000 ²	\$0
Sign with additional scrolling LED display	\$85,000	\$0
One large occupancy sign and one level-counting sign—two total signs within the parking structure		
Overhead sensors ³	\$145,000	\$0
Single space sensors (increased accuracy)	\$200,000	\$0

¹ Prices are per-structure with 4-5 levels. Costs for level-counting signage may vary approximately \$5,000 depending on whether the system is implemented on a 4-level or 5-level structure.

² Estimate; actual costs vary depending on size, placement and design.

³ Overhead sensors are placed at the entrances and exits of the garage and can also be placed between levels to give occupancy counts. These are typically 90-95% accurate, so counts should be adjusted to correct for errors on a regular basis.

Real-time Wayfinding Signs: Key Considerations and Concerns

Type of Vehicle Detection Sensors

Choosing the best type of vehicle detection sensor—an element of a wayfinding system necessary to send real-time parking counts to the signs—is one of the most challenging aspects of designing a real-time wayfinding sign system. Several options exist and are commonly used:

- Mounted garage sensors at entries/exits are the most promising of the vehicle detection sensors for garages. These sensors are used successfully in many garages, but are not typically used with outdoor surface lots due to lack of supportive/overhead infrastructure
- Individual space sensors can be installed in garage or surface lots and generally give very accurate vehicle counts. While individual space sensors would be beneficial for giving accurate occupancy information about parking lots, the price and hardware of the technology is anticipated to improve significantly in the next 5-10 years.¹³
- Loop detectors are recommended as the lowest-cost option for outdoor surface lots. However, these could be difficult to maintain within Mountain View's surface lots due to a large number of entrances and exits within the lots. Loop detectors have been known to be less reliable than mounted garage sensors and cameras.
- Overhead cameras are still in the beta testing phase for measuring and tracking parking occupancy. Due to the current cost (\$5,000/week)¹⁴ they are typically used for temporary data collection rather than for permanent installation. Ultimately if the cost decreased, so that permanent cameras could be installed at a reasonable rate, this may be an attractive option for the City's surface parking lots due to their current physical limitations.

While vehicle detection sensors and real-time occupancy signs have been successful in garages, there are more challenges in outdoor lots. This is particularly difficult for the City, given that a large portion of the public parking consists of surface lots. One difficulty of real-time occupancy counts for Mountain View's surface lots is due to a large number of exits and entryways for many of the lots. While individual space sensors could be used instead of loop or mounted sensors, these sensors are significantly more expensive due to the number needed to cover an entire lot. Because of these challenges, it is recommended that a real-time parking information/wayfinding system first be implemented in one or both of Mountain View's two structures before expanding the program to include surface lots.

Sign Type, Placement and Design

Three types of signs are recommended for the City. They include 1) signs at the entrances of garages showing the number of spaces available in a facility – **Figure 2-1, A and B**; 2) interior garage signs showing the number of spaces available per facility level– **Figure 2-1, C**; and 3) a directional sign that serves a dual purpose including occupancy & messaging for redirecting drivers to other available parking areas – **Figure 2-1, D**. Each option has benefits and drawbacks, listed below by sign type.

1. Occupancy signs at facility entrances will notify parkers about the occupancy of a facility before they decide to enter, thereby discouraging parkers from entering a garage that is full. This will decrease the amount of traffic within a facility if vehicles are circling or waiting to find a space. This will also reduce the frustration that comes with entering a full area and not being able to locate available spaces. The drawback to these signs is that the technology is much more feasible for garage structures rather than surface parking lots. It may be frustrating to parkers if the garages are listed as "full," yet no wayfinding is given to direct

¹³ This is also the current life span of an individual sensor.

¹⁴ Estimate for a mobile overhead camera unit was provided by Cyrus Bashegi at OSSI for TBOPS camera.

parkers to available locations. In order to maximize success, all entrances (depending on traffic level) may need real-time occupancy signs.

2. Per-level availability signs allow garage visitors to be guided directly to the parking level with the most available spaces. This requires sensors at each parking level, increasing the cost (approximately \$2,000 per level) of the sensing system. These signs are not relevant to surface parking lots.
3. Roadside wayfinding signs can be placed at specific locations along roadsides where drivers are likely to decide which parking facility to enter. These roadway signs can list parking facilities that have spaces available, along with the number of spaces that are available. Additionally, the nearest 1-2 facilities can be shown, whether or not real-time parking information is available.

Figure 2-1: Real-time Entrance and Per-level Signs



The City should also consider wayfinding and branding approaches when designing parking guidance/wayfinding signs. Ensuring that the real-time occupancy count includes a recognizable and clearly visible sign (including size) is essential to implementation success. There are examples of these types of signs, including the Cities of Seattle and San Jose in **Figure 2-1** above.

Accuracy of Counting System

Accuracy of the counting system ranges depending on the type of vehicle counting system employed. No system is 100% accurate, and therefore occupancy counts are often not exact. Individual-space counting systems are nearly 100% accurate, but are also more costly.

Real-Time Wayfinding Signs: Operation and Maintenance

Operation and Maintenance can be completed under a subscription. For instance, TCS International, provided the delivery, installation, training, and one year of maintenance and warranty for San Jose's parking guidance system. Further operation and maintenance can be contracted out to a third party or conducted by the City themselves. Additional labor time to oversee operation and maintenance tasks should be considered before implementing such programs. The department and individual to oversee this duty should be identified early within the project development.

Real-Time Wayfinding Signs: Costs

Costs for several real-time guidance options were considered. These costs were gathered primarily by TCS International, with some additional sign-specific costs from Signal-Tech. Several real-time guidance configurations were considered:

Parking Occupancy Signs

Downtown Mountain View has two parking structures. They are both located on Bryant St, one at between Villa St. and W. Evelyn Avenue (“Structure 1”) and another at California Avenue and Bryant Street (“Structure 3”). Two large occupancy signs—one at each of the two garages—located at the main entrance to the parking garage were estimated to cost approximately \$75,000 per structure. This estimate is for the full system, including the signage, sensors, installation, training, shipping, and tax—but not an annual subscription for operations and maintenance (see Appendix for breakdown of costs). The majority of this cost is for the installation, shipping, and sales tax—a value estimated at approximately 45% of the total sensor and signage costs. Because economies of scale for shipping, training, design and installation, additional signs at each garage (located at each entrance) can be added to this base cost at approximately \$15,000-\$20,000 per sign.

Providing level-counting signs (see **Image 2-1**) in addition to entrance signs includes per-level sensors. A system that includes occupancy signs as well as level-counting signs (2 signs per garage), using overhead sensors, is estimated to cost approximately \$145,000 per structure.

Individual Space Sensors

Individual-space sensors cost approximately \$400-500 per space for the entire system; the cost for both structures 1 and 3 in the City of Mountain View (718 spaces total) would therefore total approximately \$300,000-\$400,000 (while the costs for a single structure would range from approximately \$140,000-\$175,000). The added benefit to such a system would be increased accuracy (nearly 100%) as well as improved efficiencies in any future garage pricing system. **Table 2-3** includes a summary of the costs for a system with individual space sensor.

Table 2-3: Cost estimates For Real-time Wayfinding Signs

	Vendor source	Capital costs ¹	Annual subscription costs	Annual amortized Costs	Annual change in revenues ²	Annual Net Change
Real-time Guidance Signs						
Option 1: One occupancy sign (one for each structure) showing total "spaces available"	TCS	\$75,000	\$0	\$7,500	\$0	(\$7,500)
Additional scrolling LED display only	TCS	\$10,000²	-	-	-	-
Occupancy sign with additional scrolling LED display	TCS	\$85,000	\$0	\$8,500	\$0	(\$8-9,000)
Option 2: One occupancy sign at the structure’s main entrance and one level-counting sign within the structure						
With overhead sensors ³	TCS	\$145,000	\$0	\$14,500	\$0	(\$14,500)
With Single Space Sensors	TCS	\$190,000	\$0	\$38,000	\$0	(\$38,000)
With Single Space Sensors ⁴	Streetline	\$200,000	\$0	\$40,000	\$0	(\$40,000)

¹ Prices are per-structure with 4-5 levels. Costs for level-counting signage may vary approximately \$5,000 depending on whether the system is implemented on a 4-level or 5-level structure.

² Estimate; actual costs vary depending on size, placement and design.

³ Overhead sensors are placed at the entrances and exits of the garage and can also be placed between levels to give occupancy counts. These are typically 90-95% accurate, so counts should be adjusted to correct for errors on a regular basis.

⁴ Using a 5-year contract option for Streetline products.

2.3 Vehicle Detection Technologies

Vehicle Detection technologies for enforcement consist of License Plate Recognition (LPR) and Vehicle Recognition (VR) technologies (additional information can be found in Part 1). One or both of these two technologies can be used to increase enforcement efficiency. Both types of systems take images to record vehicle information so that they can detect if a vehicle has overstayed the time limitations in an area. Key considerations and concerns reviewed in this report for Vehicle Detection technologies for enforcement include:

- Privacy
- Enforcement Vehicle Choice
- Outreach and Communication
- Alternative Enforcement Systems

Costs for these systems include several components: the LPR hardware, the installation and set-up costs, as well as the vehicle costs. A summary of estimates is given in **Table 2-4**.

Table 2-4: Summary of Cost Estimates For a Vehicle Detection System for Enforcement

Technology	Year 1 Capital/ Installation Costs	Ongoing Annual Subscription Costs
License Plate Recognition (LPR) (Genetec AutoVu)		
LPR system (10-year lifecycle)	\$60,000	\$0
Enforcement vehicle ¹ (5-year lifecycle)	\$30,000	\$0
<i>Total</i>	<i>\$90,000</i>	<i>\$0</i>
Vehicle Recognition (VR²) (Tannery Creek AutoChalk)		
VR (10-year lifecycle)	\$100,000	\$0
Enforcement Vehicle (5-year lifecycle)	\$ 30,000	\$0
<i>Total</i>	<i>\$130,000</i>	<i>\$0</i>

¹ For example, a Honda CRV costs \$22,000-\$30,000 depending on model options (Edmonds.com based on San Francisco location). The higher-end option is the EX-L with Navigation and 4-wheel drive, estimated at a market value of \$29,756.

²The LPR and VR systems are not required to work in concert, but increases in efficiency are gained from both technologies together.

Vehicle Detection for Enforcement: Key Considerations and Concerns

Privacy

Privacy concerns about collecting and retaining the license plate video and data files have led to concerns about LPR enforcement. To address these potential issues, the City would need to confirm its policy regarding license plate data collection and retention. According to City staff, LPRs are in use by the Mountain View Police Department for other police enforcement activities. It should be determined if the current data retention policy is sufficient or if a separate policy would be required for parking-only data. Vendors who work directly with LPR systems have suggested ensuring that the DMV database that connects names and addresses to license plates records is kept separate from the database that is scanning and collecting license plate information from parkers. Additionally, the LPR database can be expunged on a regular basis so that data (license plate number of time stamp) is only kept for a defined time period (e.g., 24 hours).

Enforcement Vehicle Choice

Discussions with users of LPR for enforcement have suggested that full-sized vehicles offer several advantages over the smaller GO-4 enforcement vehicles. The main reason for this is more accurate license plate readings given the smoother ride, due to greater vehicle stability.

Outreach and Communication

It is important to start the conversation early when it comes to securing buy-in from stakeholder groups and ensuring that the new system is clearly communicated to users. Time should be spent to craft the project announcement that clearly defines the benefits, as well as the costs, of the changes.

Alternative Enforcement Systems

In addition to LPR enforcement cameras, there is a similar option that provides additional benefits, but is more expensive. Tannery Creek's AutoChalk offers a vehicle recognition system in addition to LPR. This allows vehicles who overstay time limits to be detected even if the license plates are undetectable (such as on-street vehicles who are parallel parked very close to each other). Both systems were reviewed in the Part 1 Technology Review and were found to be successful in many locations.

Vehicle Detection for Enforcement: Operation and Maintenance

Operation and Maintenance costs are highly dependent on the system that the City ultimately selects. Genetec's AutoVu system offers Cloud-based server maintenance to manage the IT infrastructure so systems can be deployed and updated without any involvement with the City's IT staff. A contract for operation and maintenance may be negotiated with a third party vendor, but the City department and personnel who will be the point of contact for the third party should be decided early in the process of deciding whether or not to implement LPR enforcement technologies.

Vehicle Detection for Enforcement: Costs

Return on investment

LPR improves parking enforcement, officer safety, and provides evidence against parking ticket appeals. While increases in enforcement efficiency vary between cities, the city of Aspen, CO has claimed as high as a 900% increase in coverage with LPR.¹⁵ With such increases in efficiency, the cost of a mobile LPR system should be weighed against the cost savings needed to hire additional enforcement officers in order to cover the same area. For a conservative cost analysis, efficiency increases were estimated between 60-80% of the 2012 revenues.¹⁶

Pilot Program

Genetec offers a "Pilot to Purchase Program" of their AutoVu LPR system that allows cities to pilot the Genetec technology at no cost. The pilot lasts for 60 days and includes a full installation of software and vehicle equipment, as well as technical and field support.

¹⁵ <http://www.securityinfowatch.com/article/11173640/license-plate-recognition-is-a-natural-add-on-to-video-and-access-control-systems-that-integrators-already-offer>

¹⁶ These revenues were calculated from 2012 on-street and lot revenues of \$36,367 and \$32,289, respectively.

Costs and Revenues

Table 2-5 evaluates the annual cost of the system and revenues of a Genetec’s AutoVu (or similar) LPR system as well as Tannery Creek’s AutoChalk Vehicle Recognition (VR) system. However, because LPR and VR systems are often provided by third-party vendors, the costs in the table below are estimated based on a range provided by several vendors, as well as unofficial costs given from cities where the technology was implemented. Annual costs assume a 10 year depreciation rate.

The table below also evaluates the annual costs and revenues of the system, assuming that annual revenues from parking citations increase between \$40,000 and \$55,000 per year.¹⁷ These additional revenues from expanded enforcement are balanced with the annual costs (amortized over product lifecycle) to create net-positive estimates for the annual change in revenue. A full cost evaluation can be found in the Appendix.

Table 2-5: Cost Estimates for LPR and VR AutoChalk Enforcement Systems

	Vendor source	Capital costs ¹	Annual subscription costs	Annual amortized Costs ¹	Annual change in revenues ²	Annual Net Change
Enforcement (LPR/VR) Systems						
Option 1: License Plate Recognition						
Genetec hardware and software	Genetec	\$60,000	\$0	\$6,000	n/a	n/a
Enforcement vehicle	n/a	\$30,000	\$0	\$6,000	n/a	n/a
Total		\$90,000	\$0	\$12,000	\$41,000¹	\$29,000
Option 2: Vehicle recognition (VR)						
AutoChalk hardware and software		\$100,000	\$0	\$10,000		
Enforcement vehicle	Autochalk	\$30,000	\$0	\$6,000		
Total		\$130,000	\$0	\$16,000	\$55,000	\$39,000
Additional enforcement add-on technology						
Mobile device, software & printer	T2	\$1,900	\$0	\$380	n/a	n/a
Handheld enforcement device	T2	\$3,500	\$0	\$700	n/a	n/a
Laptop and accessories for vehicle	Sentry	\$9,500	\$0	\$1900	n/a	n/a

¹Enforcement efficiencies are based off a 60-80% increase in enforcement revenues. These revenues were calculated from 2012 on-street and parking lot revenues of \$36,367 and \$32,289, respectively. Therefore, total revenue increases were calculated \$41,194 and \$54,925. Net changes in revenue account for amortized costs over the product lifecycle as well. Product lifecycle ranges from 5 to 10 years.

2.4 Web Applications

Web applications consist of online portals where users can login to a personal account and purchase parking permits, view their personal parking information, pay citations and fees, and appeal citations (an additional example and description can be found in Part 1, Figure 1-16). Key considerations addressed in this report include:

- Administrative Support
- Integration with Other Parking Technologies

¹⁷ These revenue increases assume a 60-80% increase with LPR and Autochalk, respectively.

- Benefits of an Online System

A summary of estimated costs for the initial set-up of a customer web application (including programming, training and design) as well as the annual subscription fees for maintaining such an application are estimated in **Table 2-6**. A more detailed review of costs is given in **Table 2-7**.

Table 2-6: Cost Estimates for Customer Website Applications

Technology	Year 1 Capital/ Installation Costs	Ongoing Annual Subscription Costs
Customer Website		
NuPark ¹	\$0	\$11,500-16,500
T2	\$35,000-\$38,000	\$10,000-13,500
Aparc	\$20,000	\$0

¹NuPark’s costs may be lower due to their desire to obtain a municipal client.

Customer Website: Key Considerations and Concerns

Administrative Support

A customer service website is evaluated with the primary purpose of offering customers the option of purchasing permits online. Aside from purchasing permits, the system allows for viewing, paying, and appealing violation information and citations. The City should evaluate their current permit management and decide if they would like to engage a third-party to manage a new system or if they would like City staff to take responsibility for it. If needed, third party vendors can include work such as printing and mailing the permits.

Integration with other Parking Technologies

With LPR enforcement technology, a virtual permit program could be executed, eliminating the need to print or mail physical permits. This would reduce overall costs in terms of materials as well as labor. If this dual-system is implemented, the City may decide to transition into LPR by first offering both physical and virtual permits (or having the option of a physical permit) to allow customers some time to move to virtual only.

Benefits of an Online System

With online purchasing, there may be increased demand for parking permits. For example, flexible day-pass bundles may be more enticing for those who only occasionally park for longer periods of time, but did not take the extra step to go to City Hall to purchase the permits previously. The City should consider marketing techniques that would be complimentary to an online permit purchasing portal.

In addition to ensuring that potential new customers are informed of the permit program, transitioning to a website interface may be a good opportunity to offer additional permit options, such as a single day-pass with print-at-home (or license plate recognition) option features. **Figure 2-2** shows an example of a single-day on-line parking permit used at Hercules Transit Center.

Figure 2-2: City of Hercules, CA Example – Print-at-Home Permits



Customer Website: Operation and Maintenance

With online purchasing, duties required for maintaining the permit program will change. Rather than handling in-person purchases and cash exchanges, operations will shift towards website management and mailing permits to respective permit parkers, should the City elect to keep the service in-house. Management of the permit program or simply mailing physical permits could be handled by a third-party, or current management could expand to work on tasks required for the new permit program. If the City decides on offering virtual permits, staff resources needed to mail physical permits will not be necessary. A third party permit service will cost approximately \$4-7 per permit to take care of processing permits. However, with LPR technology, there wouldn't be a need for physical permits eliminating the need to mail permits altogether, leaving only fulfillment costs.

Customer Website: Costs

In the cost analysis of the permit program, changes in total costs assume a 20% increase in the number of permits purchased (conservatively assuming baseline revenues do not increase from 2013 levels with the price changes of 2014). In addition to permit purchases, the estimates below include an option for customers to view, pay, and appeal violation information and citations (option 2). **Table 2-7** reviews the annual costs (for NuPark, T2 and Aparc vendors) given a potential increase in revenue assuming that improved convenience of obtaining permits increases the number of purchased permits.

Table 2-7: Cost-Revenue Estimates for a Customer Website

	Vendor source	Capital costs ¹	Annual subscription costs	Annual amortized Costs ²	Annual change in revenues ³	Annual Net Change
Customer Website (including website design and set-up)						
Option 1: Customer website selling parking permits	NuPark	\$0 ³	\$11,500	\$11,500	\$25,000	\$13,500
	T2	\$35,000	\$10,300	\$13,800	\$25,000	\$11,200
	Aparc	\$20,000	\$0	\$2,000	\$25,000	\$23,000
Option 2: Customer website selling parking permits and providing citation payment, information, and appeal	NuPark	\$0	\$16,500	\$16,500	\$25,000	\$8,500
	T2	\$38,000	\$13,300	\$17,100	\$25,000	\$7,900

¹ Costs include travel, materials and labor for set-up and installation. Costs do not include first year's subscription costs.

² Assumes a 10-year lifecycle for website set-up; costs are calculated by adding the installation costs to the annual subscription costs for 10 years, then subtracting the expected annual increase in revenues.

³ NuPark estimates reduced Capital costs due to their desire to have a municipal client.

⁴ Increase in revenue calculated based on estimated increase in permit sales from online purchasing.

2.5 Integrated Parking Management Software

Parking management software is a beneficial integration tool for parking technologies, used to review, manage and monitor a parking system. Parking management software is particularly useful if the City is planning to implement several parking technologies with the possibility of expanding the system in the future (see Section 1, Part 1.3 for more information). **Table 2-8** shows the estimated costs for a

parking management software system (two estimates provided by NuPark and T2).¹⁸ However, these costs are often lower for a combination of options (such as a customer website and a management system).

Table 2-8: Cost for a Parking Management Software System

Technology	Year 1 Capital/ Installation Costs	Ongoing Annual Subscription Costs
Customer Website		
NuPark ¹	\$0	\$18,500
T2	\$35,500	\$14,500

¹NuPark's costs may be lower due to their desire to obtain a municipal client

Management Software: Key Considerations and Concerns

How will the system work as a whole?

If the City decides to employ several technologies, efforts should be taken to integrate these different options into a single management system. For example, an LPR enforcement system and a management software system should be operated by staff that communicates regularly with enforcement. This might be done by establishing a communication protocol via daily check-in calls, by ensuring operation is completed in the same department or by creating a staff position specifically for this purpose.

What elements will the management system include?

Each parking management system is customizable, with options offered a-la-carte. The City may decide to implement a management system to further aid enforcement or may decide to use a single platform for several uses—such as a customer portal/website and reviewing management reports (including occupancy, enforcement, and permits). These elements will depend on the specific program that the City chooses.

Management Software: Administration

Before a management system is implemented, the City should first determine if they have the available staff resources to support and make the system successful. In addition to the number and hours from staff, the City will need to determine which department will be managing the system. If there are multiple departments involved, the City may want to develop a formal protocol on how these groups work together. Third-party vendors, depending on which technologies are chosen to be integrated in the larger management system, could be considered. Additionally, if a full management system is selected, the City should consider hiring a new part- or full-time position to get the most out of the investment. This position could include permit management and program outreach.

In addition to the long-term management plan, time should be allotted for staff training and adjusting to the system. Problems are likely to arise in the earlier stages of using new software, and more time should be set aside for learning the new program.

¹⁸ Aparc, the third vendor reviewed, did not provide estimated costs for the parking management technology.

Management Software: Costs

Costs for an integrated parking management system are highly dependent on the specific technologies and options that the City decides to employ. Estimates for a simple management system range from \$18,000-\$35,500 per year. However, some vendors have offered management systems including LPR enforcement and a customer website, making overall costs lower for the complete system.

Table 2-9 shows broad cost estimates (rounded to the nearest 100) for each system, as collected from vendors as well as cities with similar systems. The estimates are listed for year-1 (implementation costs) as well as the annual subscription cost. Implementation costs include travel, training, design, set-up, and installation. An annual maintenance subscription for the LPR technology is estimated from \$15,000-\$25,000 as additional costs. Note that this does not include taxes.

Table 2-9: Management System Costs

	Vendor source	Capital costs ¹	Annual subscription costs	Annual amortized Costs ²	Annual change in revenues	Annual Net Change
Parking Management Software						
Parking management software	NuPark	\$0 ¹	\$18,500	\$18,500	\$0	(\$18,500)
Parking management software	T2	\$35,500	\$14,500	\$18,000	\$0	(\$18,000)

¹ NuPark estimated that they could provide the technology for a lower cost; this difference is likely due to the company’s desire to gain their first municipal client. Quotes were not received from Aparc.

² Lifecycle is estimated at 10 years.

2.6 Conclusions and Next Steps

Evaluate Benefits of Integration

When deciding on which types of technology to implement, the City should keep in mind that some technologies work better together, while some technologies are relatively independent. In addition, if the City decides to implement parking pricing in the future, several of the technologies evaluated in this report may aid the development and enforcement of such a new program.

- **Real-time Wayfinding Signs:** This system is relatively independent of the other technology systems recommended, but an integrated parking management system could be used for evaluating parking trends over time that are recorded with the same sensors used for wayfinding. For example, reports of real-time occupancy counts over time can be easily viewed with data management software.
- **Vehicle Detection for Enforcement:** While LPR enforcement could be implemented independently from other technologies, vendors do offer discounts for implementing both the enforcement and management software systems. Additionally, LPR enforcement could significantly contribute to potential on- and/or off-street pricing in the future.
- **Customer Service Website:** The customer service website can be implemented independently from other technologies, but increased efficiencies could be realized with LPR enforcement.

With LPR enforcement, customers would not need to receive a physical permit in the mail, but merely enter their vehicle license plate information when purchasing permits online.

- **Integrated Parking Management Software System:** The integrated parking management software is dependent on the other technologies and is not recommended without implementing LPR enforcement, as some of the most significant benefits are from monitoring enforcement. For example, being able to track vehicle query rates and monitor where violations are occurring. Vendors often offer it in conjunction with the customer service website, with a lower price for the combined system, as the backbone of the back-office software system is similar.

Development of RFP and Evaluation of Bids

While a preliminary vendor analysis was completed in Part 1 of this study, an official request for proposals (RFP) will be necessary to outline the City's needs and program specifications for vendors to respond to directly. Proposal packages should include scope, schedule and a detailed cost estimates. The City should take care to include industry performance standards in the RFP so that all vendors must respond to a minimum level of service and related technology requirements.

While technology options were discussed in detail throughout both sections of this report, the City may have unique experiences in personally evaluating the customer service needs and compatibility with the City's management goals. As addressed in the initial evaluation of vendors (Part 1), cost differences should be balanced with experience in assessing the relative benefits and drawbacks of each vendor. It should be noted that the cost estimates evaluated in the feasibility analysis are approximations drawn from informal conversations and preliminary quotes from participating vendors. Since the vendors we talked to are not currently responding to an RFP, we can only expect to use these sources as rough guidelines for the future evaluation of bids.

Summary of Recommendations

Altogether, Part 2 of this report allows the City to take into account the overall big picture costs and benefits of each individual technology and integrated technology package that was recommended for further evaluation in Part 1. Each one of these technological approaches is recommended to the City as systems that would improve parking efficiency and/or customer service. Some of the technologies (specifically vehicle detection for enforcement and the customer service website) will not only provide better service through increase parking efficiency and customer service, but are also likely to increase revenues. **Table 2-10** below gives a summary comparison of the four recommended technologies.

Table 2-10: Summary of Recommended Technologies

Recommended Technology	Efficiency Improvements	Customer Service	Revenue Increase
Real-time Wayfinding Signs	✓	✓	✗
Vehicle Detection for Enforcement	✓	-- (Indirectly)	✓
Customer Service Website	-- (Indirectly)	✓	✓
Parking Management Software System	-- (Indirectly)	✗	-- (Indirectly)

Real-time Wayfinding Signs

- **Efficiency Improvements:** This technology will make empty spaces easier to find, increasing the practical capacity and utilization of spaces.
- **Customer Service:** This technology will help guide parkers and give them information that can save time.
- **Revenue Increase:** None
- **Typical Cost Range:** \$75-150,000 capital costs per garage, \$0 ongoing annual costs.

Vehicle Detection for Enforcement

- **Efficiency Improvements:** This technology will improve enforcement which will provide regular and consistent enforcement will make expectations about violations more dependable.
- **Customer Service:** will help increase turnover near businesses and therefore make it easier for visitors to find parking.
- **Revenue Increase:** Yes; this service is likely to increase citation revenue due to efficiencies gained in enforcement coverage.
- **Typical Cost Range:** \$90-130,000 capital costs, \$0 ongoing annual costs.

Customer Service Website

- **Efficiency Improvements:** This service will increase the use of long-term permits and may free up on-street parking spaces resulting in high-turnover parking.
- **Customer Service:** This service will provide convenience to customers purchasing permits and/or paying citations and appealing violations.
- **Revenue Increase:** Yes; this service is likely to expand permit sales.
- **Typical Cost Range:** \$10-20,000 capital costs, \$10-20,000 ongoing annual costs.

Integrated Parking Management Software System

- **Efficiency Improvements:** This service will increase the use of long-term permits and may free up on-street spaces that are more convenient for high-turnover parking.
- **Customer Service:** No direct customer service benefits.
- **Revenue Increase:** Yes; this service is likely to expand permit sales.
- **Typical Cost Range:** \$20-40,000 capital costs, \$15-20,000 ongoing annual costs

Appendix A

Cost evaluation for several real-time signage types/scenarios

	Unit Cost	Quantity	Cost
One occupancy sign at structure entrance			
Entrance Sign	\$ 12,000	1	\$ 12,000
Sensors, design, and training	\$ 37,000	1	\$ 37,000
Installation, shipping and sales tax	\$ 49,000	0.53	\$ 26,000
Total			\$ 75,000
One occupancy sign at structure entrance with variable message sign			
Entrance Sign	\$ 12,000	1	\$ 12,000
Additional variable message (+\$10,000)	\$ 10,000	1	\$ 10,000
Sensors, design, and training	\$ 34,000	1	\$ 34,000
Installation, shipping and sales tax	\$ 56,000	0.53	\$ 30,000
Total			\$ 86,000
One occupancy sign at structure and one level-counting(2 total)			
Entrance Sign	\$ 12,000	1	\$ 12,000
Level Counting signs & counters	\$ 4,000	4	\$ 16,000
Equipment, design, training	\$ 65,000	1	\$ 65,000
Installation, shipping and sales tax	\$ 99,000	0.53	\$ 52,000
Total			\$ 145,000
Occupancy sign and one level-counting - single space count (nearly 100% accuracy)			
Entrance Sign	\$ 12,000	1	\$ 12,000
Level Counting signs & counters	\$ 3,800	4.5	\$ 17,000
Equipment, design, training	\$ 450	359	\$ 162,000
Total			\$ 191,000

Table Notes

1. Installation costs depend on several factors including local labor rates, prevailing wage, material costs, requirement to work off hours, etc. For Options 1 and 2 total installation costs (labor and materials) were estimated at a percentage of hardware costs. However one can estimate the total turnkey cost of a single space count system at \$400 - \$500 per space.
2. It was assumed that occupancy signs are only installed in 1 entrance per garage.

Appendix B

Cost evaluation for LPR/VR Systems

	Vendor Source	Capital Costs and installation	Annual subscription costs	Amortized costs over product lifecycle	Expected Increase in Revenues	Change in Net Annual Revenues
Option 1: License Plate Recognition (LPR)						
Genetec hardware and software	Genetec	\$60,000	\$0	\$6,000		
Enforcement vehicle	n/a	\$30,000	\$0	\$6,000		
Option 1: License Plate Recognition (LPR) total	Genetec	\$90,000	\$0	\$12,000	\$41,000	\$29,000
Option 2: Vehicle recognition (VR) (AutoChalk)						
Autochalk hardware and software	Autochalk	\$100,000	\$0	\$10,000		
Enforcement vehicle	n/a	\$30,000	\$0	\$6,000		
Option 2: Vehicle recognition (VR) total	Autochalk	\$130,000	\$0	\$13,000	\$62,000	\$49,000
Additional enforcement ad-on technology						
Mobile device, software & printer	T2	\$1,900	\$0	\$380	n/a	n/a
Handheld enforcement device	T2	\$3,500	\$0	\$700	n/a	n/a
Laptop and accessories for vehicle	Sentry	\$9,500	\$0	\$1,900	n/a	n/a

Notes on Vehicle Detection Technology Calculations

1. Genetec LPR Technology system is estimated from \$33,000-\$60,000 by system vendors. The Autochalk system is estimated at \$100,000 based on interviews with planning staff whose City has purchase the system. Vehicles are estimated at \$30,000.
2. Enforcement efficiencies are based off a 60-80% increase in enforcement revenues. These revenues were calculated from 2012 on-street and parking lot revenues of \$36,367 and \$32,289, respectively.
3. Lifecycle for Each product is 5 years, except for the Genetec hardware and software (10 years).

Appendix C

A common system that T2 implements for municipalities is the mobile LPR system combined with the T2 Flex Permit Management (back office) system. This system includes a website for customers to access their personal account, which includes permit sales, citation payments, as well as citation appeals. It also includes the T2 hosting fee and interface to export financial transactions to the City's

financial system. This system includes access to California DMVs for obtaining owner information and holds/releases. With this system, the permit and scofflaw data will export to AutoVu.

T2 Costs for individual systems¹

	Equipment	Quantity	Year 1	Yearly	Lifespan	Amortized over 10 years
Parking management system - up front implementation costs (including travel for implementation and go-live)	\$35,500	1	\$50,000	\$14,500	10	\$18,050
T2 Flex software system and customer Website, including permit sales	\$25,000	1	\$35,300	\$10,300	1	\$128,000
Software to process payments		1	-	\$3,000	1	\$27,000
citation printer (iMZ320) with 3 year warranty	\$630	1	\$630		3	\$210
T2 Flex software (citations via mobile phone)	\$750	1	\$750	\$ -	1	\$750
Genetec AutoVu system	\$60,000	1	\$60,000	\$ -	10	\$6,000
Enforcement Vehicle	\$30,000	1	\$30,000	\$ -	5	\$6,000
Mobile devices for parking citation issuance	\$500	1	\$500	\$ -	3	\$167

¹ Estimates are directly from T2 as well as estimates of individual systems based on combined cost estimates given by T2.

Assuming that the enforcement vehicle has a lifespan of 5 years, the handheld mobile devices and printer has a lifespan of 3 years and the Genetec LPR hardware as well as implementation costs have a lifespan of 10 years, the amortized costs per year are \$46,880.

Appendix D

Cost estimates from NuPark

	Initial Cost	Subsequent Years
Customer Website – Option 1		
Site selling permits. City employees will mail purchased permits to individual or business (assuming no ePermits).	\$11,500 (annually)	
Customer Website – Option 2		
Site selling permits, and a third party processes and mails permits	\$11,500 (annually)	\$2.50 per permit (shipping and handling only). No printing
Customer Website – Option 3		
Site offering the sale of permits as well as the option of individuals to login, appeal, and pay parking citations and receive customer service with city	\$16,500 (annually)	Credit card processing paid by City.
LPR Enforcement – Option 1		
LPR Genetec system for electronic chalking, installed on a vehicle, no management system (vehicle not included)	\$30,000 (Year 1)	\$3,000 per year after Year 1
Integrated Approach – Option 1		

Management system, with customer website option 3 and LPR enforcement system.	\$18,500 Software + \$25,000 Vehicle LPR hardware	\$18,500+ 3% increase on Software, \$2500 hardware. Discount on LPR hardware with integrated system.
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Appendix E

Cost estimates from Aparc

	Capital	Annual subscription for cloud hosted server operating fee	Annual Costs (10-year lifecycle)	Expected Increase in Revenues	Total Annual Costs/Revenues
Enforcement (LPR/VR) Systems					
Option 1: License Plate Recognition (LPR) (Genetec)	\$53,970	\$2,916	\$8,313	\$41,000	\$32,687
Customer Website					
Option 1: Customer website selling parking permits (NuPark)	\$20,000	\$0	\$20,000	\$44,000	\$35,000

Appendix F

Parking Technology Vendor, Sentry Systems

Sentry Systems, an integrated parking management vendor that has operated in several cities throughout California, including Anaheim, Beverly Hills, and Santa Barbara, was also evaluated in detail. However, while Sentry's products are top-of-the-line and have a reputable name and experience in many cities around California, their system is not suited for the City's needs at this time due to the anticipated costs and scale of their systems relative to Mountain View's needs.

Sentry Systems is Genetec's west-coast partner, which was also researched due to its vehicle detection and parking guidance systems technology. While Genetec does not directly provide a local presence of technicians, Sentry has completed several installations around the Bay Area, including the Cities of Vallejo, Petaluma, and Town of Los Gatos.¹⁹

Sentry integrates with TCS International's vehicle detection and parking guidance systems. These systems, as explained in Section 1.2, can help parkers locate spaces or garage levels with the parking available, improving the efficiency of facilities with high occupancy and discouraging customers from

¹⁹ Andrew LaMothe, from Sentry Control Systems was consulted about the details of Sentry's products. References for Sentry include Marty Hennamen (916-804-0336) at the City of Vallejo, CA and Brian Anderson (brain@parkcity.org/435-615-5371), at Park City, Utah.

parking in full facilities. In addition to signage, Sentry uses their parking guidance system INDECT to provide space-by-space LED lighting to direct parkers towards available spaces.

Sentry's SKIDATA system offers management and ticketing. Municipalities in California that have used the SKIDATA system include Anaheim, Beverly Hills, and Santa Barbara. Sentry's SKIDATA focuses on integrating data across many parking facilities, allowing parking management to monitor all systems as one.

Altogether, Sentry's system focuses on gate-operations and revenue control management—two parking program aspects that would not provide key benefits for the needs of downtown Mountain View. While Sentry has a reputable name, top-of-the-line products and experience in many cities around California, their system is not well suited for the City of Mountain View's downtown parking needs due anticipated costs and scale of their systems.