Smart Parking and the Connected Consumer
Opportunities for Facility Operators and Municipalities

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Executive Summary

The world’s first parking meter was installed in Oklahoma City on July 16, 1935. Since that time, drivers have been rummaging for change and ticking off the minutes remaining before time to feed the meter. In some cities, maintaining parking meters costs more than the money they are able to collect. Cities such as Washington DC, Chicago and others have initiated programs to allow drivers to pay for their parking through their mobile phones. Some cities have even contemplated removing the parking meters, reducing their numbers to a select minimum number spots to ensure cash-only customers can still find a space. After nearly a century, the question is whether the coin-operated parking meter becomes an artifact of the past, akin to the public telephone booth. This report suggests that we are still a long way off from seeing the disappearance of the parking meter, but that progress is rapid in development of smart parking solutions. Parking operators will see considerable cost savings from smart parking, while connected consumers will likely become accustomed to paying more for parking in exchange for added convenience of automated electronic payment and guidance to available parking spots.

It is estimated that nearly 30% of urban congestion is created by drivers cruising for parking. Uncertainties that generate such congestion include searching for on-street parking availability, facility availability, and cost-comparison “shopping” between parking alternatives, which are all complicated by the need to minimize walking distance or make timely appointments or connections. Smart parking services are designed to get drivers door-to-door to their ultimate destination without searching and the uncertainty related to cost, travel time, payment, and other practical considerations. In exchange for this convenience, smart parking service providers take advantage of consumers’ (and/or parking operators’) willingness to pay a marginal markup over existing parking fees, or, where parking is free and subsidized, over the costs to operate the facility (typically on a per-spot basis).

Many smart parking solutions companies seek to establish popular centrally hosted, cloud-based services that can achieve massive scales of deployment, over thousands of facilities and potentially millions of parking spaces. Operations at such a scale are designed to drive down smart parking service costs, on a per-spot basis, down to a bare minimum. Smart parking solution providers have been aggressively working with hundreds of operators to build out such scale, though finding the right mix of technology to accommodate every type of facility (e.g. city on-street and off-street, campus, hotel/shopping, airport/transit) and service model has been one of the greatest challenges facing the industry.

Facility owners can greatly benefit from smart parking. Many municipalities with valuable parking assets are cash-strapped and face declining capital and operating budgets, and stagnant revenue growth from parking fees. Municipal on-street parking is typically free or priced 10 to 15 times less than the average garage rate in many congested urban centers. Given this underpricing of street parking, adoption of smart parking solutions is likely to gain considerable momentum with municipalities. There is also likely
considerable pent up consumer demand for the convenience offered by smart parking solutions—for example, in dense urban areas where convenient parking is scarce, consumer sentiment is shifting towards smartphone “location based services” apps, which can navigate users to any number of points of interest on foot or in transit. More progressive municipalities have been at the forefront of understanding how investments in smart parking technology and customer service can both meet the needs of the driving public and improve operators’ bottom-lines.

Besides municipalities, real estate investment firms, large institutions such as airports, universities and hospitals, and commercial parking operators have also invested billions in parking assets and operations, but until recently have not been able to generate much value for customers or unlock dramatic new sources of revenue or cost savings. Smart Parking is one obvious way of lowering operations costs and gaining revenue through increased occupancy. More speculative revenue growth potential in the future is the bundling of parking fees with merchant transactions and other services. Differentiating parking service offerings by bundling parking with reservations or events tickets, promotions and advertising, or even some concierge services (valet, vehicle oil change, etc.) may be one potential long term approach to growing the value of a given parking facility as both as a revenue generator and a real estate asset.

The Opportunities and Challenges for Smart Parking

Parking is an estimated $24-25 billion industry which is highly fragmented but experiencing a growing trend towards consolidation and outsourcing of parking operations and services. Depending on widely varying estimates, there are between 100 and 800 million parking spaces in the U.S. (Jaffe, 2011). According to ITS America estimates, roughly 20 million of these are “for-fee” spaces, somewhere between twenty to three percent of a very large aggregate U.S. parking lot. While growth in new parking construction starts (e.g. “greenfield” parking facilities) is slow, adoption of electronic payment and parking customer convenience applications in existing “brownfield” facilities show promise. It is estimated that well over 50% of for-fee facilities accept some form of non-cash payment, and the remainder intend to convert to cashless payment options shortly.

Adoption of smart parking technology—especially parking customer convenience applications—appears to be at an early stage. For a very long time, parking has been an arms-length, cash-only business, with very little emphasis on using technology to improve operational efficiency or customer service. In the past, parking operators have typically known very little about the customer’s needs, preferences or frustrations. Smart parking technology includes electronic parking payment systems (or in operator
parlance, Permit and Enforcement (P&E), Mobile Parking Payment, and /Parking Access and Revenue Control (PARCS), or P&E and PARCs, and variations such as Mobile Parking Payment), and parking customer convenience applications (also known as Parking Usage Recognition and Customer Service, or PURCS). Electronic parking payment systems provide features such as scalable, cloud-based permit application and issuance (e.g. print from home), cashless financial transaction management, report generation, and enforcement data such as outstanding citation payments. These cloud-based PARCs may also begin to interface with point-of-sale terminals located at the parking facility access gates or at parking meters or other “pay-stations.” The newest innovation, mobile phone parking payments processing, attempts to supplement, and in rare cases, even replace traditional point-of-sale transactions at facilities and on curbside metered parking.

The deployment of cashless payment systems will allow operators to better measure of performance and financial accountability, as well as serve as a foundation for other value-added services. Parking customer convenience applications leverage electronic payment data to predict driver access to individual spots by time and location and in-sync with a wide variety of different on-line enabled activities: online reservations, appointments, deliveries, and tourism/entertainment passes. Even strictly off-line, mundane or transient activities such as errands, shopping, and commuting can be bundled with navigation-to-block/guidance-to-spot applications and parking electronic payment. To support these traditional off-line use cases, parking applications will likely need channel partners that can create convenient and well-designed mobile apps to grab consumers’ attention. In order to do this, smart parking providers will need to establish reliable application programing interfaces (APIs) that enable service partners to provide consumers access to smart parking services online through a variety of channels, including: the web, mobile phone apps, connected personal navigation devices and car telematics services.

Post-trip connections and “parking validation” offers (e.g. business, shopping medical appointments’ and airline and other transit connections) can be bundled with parking activities that constitute a specific parking facility service model. From an operations perspective, parking facilities include four major facility-parking service models, consolidated into a few broad categories and roughly ordered here from highest to lowest “level” of customer service requirements: 1) Airport and Hospital, 2) On-street Municipal, 3) Universities and Large Retail/Hotel/Event Venues, and 4) Commercial Parking Garages and Municipally Operated Facilities.

Growth in smart parking solutions is likely to be seen early in municipalities as they have traditionally kept parking fees low and can use an upward adjustment of fees as a justification for investing in new technology to improve customer convenience. The most enticing market opportunity for long term revenue growth in smart parking, however, is Commercial Parking Garages, which to date are relatively untapped and constitute a vast majority of parking entities. For commercial parking facility
service models, bundling parking transactions with local merchants’ offers may provide an additional source of revenue through advertising. In addition to merchant offers, car-oriented services may also be bundled with parking transactions in the long term, such as car valet, washes, repairs and maintenance, car-sharing, and electric vehicle charging. These bundled services may drive up occupancy over time, especially for commercial facilities focused on commuters.

For smart parking service providers, the low hanging fruit in the marketplace is electronic parking payment systems, especially Mobile Parking Payments and Permit and Enforcement applications, which are generally more scalable across facilities. Electronic parking payment systems make the payment process for operators more efficient by reducing revenue leakage (e.g. reduce unaccounted transactions) and lowering operating costs through transaction automation, reporting and enforcement. However, many electronic parking payment services such as traditional Parking Access and Revenue Control Systems are constrained by the need to integrate a wide variety of existing hardware, which significantly reduces the scalability of solutions. The need to integrate hosted Parking Access and Revenue Control Systems with “brownfield” facility hardware, such as enduring meters, access gates and pay-stations represents the major constraint on the scalability by creating an incremental cost and complexity. Scalability of any cloud based smart-parking system also must address the issues of maintaining security and integrity of transaction data as a larger parking system may be a more attractive target for hackers seeking to profit from data collected or the notoriety in disrupting the system. In essence, scalable solutions must guarantee continuity of operations, maintenance and supervisory control of systems such as gates and pay stations, and customer service support channels for those who may need extra help. Smart parking vendors have aggressively addressed these issues and have been relatively successful in tackling these constraints.

Smart Parking may over time evolve to be the first working component of a “smart-city operating system.” Such a smart-city operating system parking component would ideally offer a “service-oriented architecture” that is provisioned to enable the plug-in of hardware and software for city services over time. In the interim, however, there are still a number of constraints that prevent smart parking from achieving a true service-oriented architecture. On the supply side, demands on brownfield parking operators to realize short-payback on their investment in smart parking technology are indicative of an industry with very low operating margins. It is also revealing of an industry full of operators with considerable sunk hardware infrastructure investment left to recoup, and a willingness to defer new investments in smart parking technology.

For brownfield facilities seeking to reduce costs by leveraging existing hardware, many will find themselves faced with a similar dilemma—expensively integrate hosted smart parking solutions now, or defer investment until new smart parking revenue opportunities arise or the new hardware components get cheaper. With few new ancillary revenue opportunities, such as merchant advertising, promotional
offers and other destination services, there will continue to be a limited ability of smart parking vendors to incentivize reluctant adopters in the beginning. Until smart parking service providers begin matching parking facilities with local merchants’ offers will there not be enough momentum and revenue incentive for many parking facility operators to begin fully investing in smart parking solutions. This matchmaking process will take some time and likely require smart parking partnerships with intermediaries, such as many newer online brokers (eg. OpenTable, Fandango, Ticketmaster, Car2Go, Groupon, Living Social among many, many others).

Smart parking technology is ultimately not only about driving up productivity and service in operations, but demonstrating long term value to customers that in turn will learn to expect more and therefore will be willing to pay more. For quite some time Infrastructure-dependent services, especially in the transportation sector, have been notoriously slow in improving asset productivity—particularly in reference to maintenance, operations and customer service. Some of the more progressive parking facility owners understand that new parking services are a way to enhance the value of the underlying infrastructure asset (e.g. real estate appreciation, or in the case of municipalities, improvements in road network productivity and urban mobility), not just a way to satisfy the short term goal of trimming costs. More enlightened operators, typically professional management companies, strategically invest in technology and marketing to drive up parking occupancy rates and revenues over time, ultimately in an effort to gain sizable appreciation in the capital asset over the long term. Parking management companies, and even some municipalities, are developing the business acumen to look at parking operations as a means to this greater end.

**Anticipating Connected Consumers’ Needs – Trip Activity and Parking**

Key challenges for Parking Usage and Customer Service (PURCS) providers is to grow in scale (e.g. in numbers of operators, cities, regions, customer accounts) and in service scope (e.g. in number of services, such as occupancy, reservation, etc..) in order to attract users first, then to demonstrate impact of their services on operators’ occupancy rates and revenue over time. In order to do this, PURC providers must be in tune with customer needs.

The customer tends to want to begin and end their trip without uncertainty about the details or burdensome planning and searching. Some of the details include which route to take, when to leave given traffic or weather, which parking facility to select based upon price, walking distance to final destination, and other intangibles. Some niche needs may also include valet parking availability, transit and airport connections, or electric charging station or car/ride sharing availability. Most personal
navigation devices can guide drivers to the correct block, but cannot take them the last several yards to an empty parking spot.

Companies such as Streetline, ParkMe, Park Assist, ParkingCarma, ParkMobile, Parking Panda, among other PURCS service providers, deliver either mobile electronic payment and/or electronic occupancy of both municipal on-street and (commercial and municipal) off-street parking a number of ways. PURCS providers collect real-time through parking occupancy sensors, or where sensors are not practical or cost-effective, by modeling and predicting occupancy through analysis of past parking transactions over time and other historical transportation data. PURCS providers may even ask parking facilities to manually collect data if necessary. Some PURC providers offer an online application (available through the web or in a mobile device app) to allow parking attendants to manually enter parking occupancy and space availability, and local point-of-interest information so that it can be made widely available to the driving public.

The generic value proposition for many new transportation technology startups is to match underutilized mobility “assets” to consumers’ unmet needs. Companies like Uber match idle limousines by time and location with consumers that need taxi services in a particular location at any given moment. Peer-to-Peer car-sharing (e.g. Wheelz, Relay-Rides,) or car-pool/ride- sharing (e.g. Avego, SideCar, Lyft, Tickengo), match those who need transportation with idle cars or with rides to a particular common destination. Many of these matchmaker services take a small percentage of each transaction they have brokered and may even employ yield management techniques that are able to change pricing in response to spikes in demand or drops in supply. In the same way, parking technology service companies such as StreetLine, ParkMe and others work in a similar manner, matching parking spaces to drivers looking for spaces.

For smart parking to really take off, a vast number of customer interfaces and distribution channels for parking information need to be established. PURCS providers may provide a number of their own interfaces directly to customers, such as web service, mobile app, and they may also license their data and services to channel partners such as search engines, personal navigation devices manufacturers (e.g. TomTom, Garmin), or even telematics service providers (e.g. OnStar). Interfaces are not only designed for customer-direct and partner channels, but also parking operators and retailers. Application Programing Interfaces (API’s) or embedded web widgets can be integrated into on local retailers website, marketing emails, or map search engine results to give customers insight into their parking options before they begin their trip.

Once channels to the customer are established, PURCS may need implement customer relationship management services, often leveraging parking payment accounts.
established to facilitate non-cash transactions, may also establish user preference profiles to manage customer communications — for example triggering alerts to inform customers of their reservation, parking slot locations with navigation, meter renewals and parking validations; credit card expiration and other account charges and changes. For parking accounts, opt-in personalized offers from local merchants to account holders, such as discounts on products and services, can be offered with the benefits shared between the merchants, parking operators and parking customers. It is not difficult to imagine that specialized merchant brokers, such as Open Table for restaurant reservations, Ticketmaster for concerts and sporting events and Fandango for movie tickets might bundle parking along with these event reservations.

There are more speculative trends for location-based services that may impact future parking customer convenience applications. Some technology analysts and investors speculate that location-based social networking applications may in the future be to measure the a user’s propensity to consume based upon both user’s location, profile and purchasing history. Online retailers or search engines such as Amazon or Google may data mine a given consumer’s (who have opted-in) purchasing history for tastes and preferences, and match it against inventory query results from local brick-and-mortar retail stores. Online retailers’ applications would then communicate to consumers their proximity to potential deals. For example, a user that match a particular retail purchasing profile (e.g. self-identified cigar aficionado), and who are parked in a particular facility close to a given retailer (e.g. cigar store), may be offered an automatic discount on items that are overstocked. In this scenario, parking could conceivably trigger “check-in” and initiate the special offer.

Analyzing diver behavior to solicit recommendations may extend to mobility service as well, and improve the utility of navigation services. Where drivers are engaged in more mundane daily activities rather than special trips to an event they may have been initiated on-line, such as the purchase online of plane tickets or dinner reservations, navigation systems may suggest parking destinations on the fly. Navigation systems in mobile phones or cars could potentially analyze travel patterns over time (more transient, trip-chained errands such as shopping, or other trips that occur on a frequent basis) to predict, or rather anticipate post-trip needs while the driver is en-route. This kind of system would automatically offer suggestions on where to park as the driver begins to slow down to arrive at his or her destination. Such a system would be more akin to parking guidance than turn-by-turn navigation, as the driver knows the destination, but does not know where necessarily to park. Parking facilities that thus advertised parking availability through PURCS would be at an advantage over others that did not in terms of attracting customers on the fly.

The key question for parking facility operators is how to attract customers and drive occupancy and revenue upward. There is little question that providing information of parking availability would help,
but establishing a given facility as a bona-fide destination in navigation systems could make a major
difference in attracting more customers. For that reason, it is important for facility operators to not be
too shy about sharing information with PURCS solution providers, as their ability to aggregate data and
disseminate it across distribution channels to consumers is unmatched.

**Supply and Demand for Parking Services**

The parking industry, defined as parking facility management, billing and collection, enforcement, and
other ancillary services, is a $24-25 billion dollar industry according to several sources (Marketdata
Enterprises, 2005; IPI website). The commercial parking lots and garages industry includes about 3,000
companies with combined annual revenue of more than $8 billion.

The parking industry can be characterized as mature, with low levels of concentration, industry
regulation, and barriers to entry. Industry revenue is predicted to increase by an average rate of 4.2
percent per year between 2011 and 2016, as key demand factors such as employment and discretionary
income increase. Overall, industry profitability is expected to increase from 8.8 percent in 2010 to
around 12.0 percent in 2016, if cost-cutting measures such as technology adoption and consolidation
continue (IBISWorld, 2011).

Key suppliers of parking infrastructure are the commercial leasing and apartment rental industries
(IBISWorld 2011). The infrastructure supply and management service chain also includes Real Estate
Investment Trusts, large non-profit institutions such as hospitals and universities, quasi-governmental
organizations such as port authorities and other transportation facility operators, city municipalities,
facility and parking management companies, parking management equipment suppliers, parking
systems integrators, software and hosted, or “cloud” services suppliers.

There are two level of parking customers: business customers and retail. The first is businesses, many of
which are either office, apartments, or retail establishments, that require parking for their workforce,
apartment tenants, or customers and bundle parking into other services or benefits. At the parking
retail level, the service chain for parking facilities ends with “renters” of parking spots.

Aggregate demand for parking services is driven by disposable income per capita and other factors such
as average fuel prices. *Disposable income per capita* increased slightly (0.4 percent) over the last year
(Department of Commerce, 2011). While rising fuel costs have decreased automotive travel by 1.4
precent (Department of Transportation, 2011). Airline passenger travel has also decreased by 9.8 percent, but is rebounding. Sports patronage has also declined in this period (IBIS 2011).

When looking at demand for parking services at a particular facility, occupancy is driven by a number of different factors. Parking fare is either a discretionary or relatively non-discretionary purchase, and typically depends on the purpose, importance and urgency of the trip and the existence of alternatives. One factor is the existence of substitutes to parking, such as transit, taxi, or even some non-transportation options such as shopping online, teleconferencing and telecommuting. The last factor is parking “quality,” such as relative proximity of a given facility to a desired final destination (e.g. on- vs. off-airport facilities) and ease of access without extensive search costs (e.g. need to cruise for longer periods to find convenient on-street parking). Non-discretionary purchases may include business trip parking, commuting trip parking, or other activities that are either critical and time-sensitive.

Relatively discretionary parking purchases may include retail parking, and parking and attendance at some sporting and entertainment events that are not time-sensitive. Discretionary trips typically generate transient parking, whereas non-discretionary trips tend to generate regular demand patterns, such as morning to evening commuting and parking. Business customers generally fit regular patterns, whereas retail customers are typically transient parkers.

Outside of built-up urban areas, parking facilities are generally free to customers and therefore supply of parking spaces is not typically determined by consumers’ willingness-to-pay. Planners and zoning regulators generally rely upon standards that introduce biases, resulting in excessive supply (Litman, 2006). Conventional standards are based on an “85th percentile curve,” meaning that 85 out of 100 parking sites will have more parking that is actually needed, even during peak periods. For example, a University of Iowa study found parking supply exceeded peak period parking demand by 16-63% at various commercial centers (Litman, 2006). However, there is some evidence that this trend may be shifting with the introduction of parking “maximums” for new facilities rather than “minimums” in some cities.

Drivers suffer from either an overabundance or dearth of parking. Where there is overabundance, supply for spots outstrips the number of vehicles, cities become less compact out of both necessity (more space for needed surface parking) and through the effects of long term urban sprawl. Long term sprawl occurs where single mode dependency on the automobile is reinforced because of difficulties cities encounter in encouraging or maintaining thriving high density residential and business communities. The cost of “free” parking is instead incorporated into the prices of goods sold, general taxation or other indirect cost recovery mechanisms that cannot adjust to changes in traffic patterns or parking demand and other urban economic development trends.
For a vast majority of brick-and-mortar commercial firms, parking is bundled and viewed as cost of doing business. In suburban areas, rarely is parking seen as a separate source of revenue or a line of business services that might be ancillary to purpose the trip, such as car fueling, car wash and maintenance, package pickup or drop-off, or other conveniences.

Where there is a dearth of parking in high density urban areas, however, the demand for on-street parking far exceeds the supply for the most convenient spots during particular peak times. This is primarily because municipalities, if they charge at all, do not charge a “market clearing” price. (A theoretical market clearing price would be one that would potentially incentivize price sensitive parkers to substitute more convenient on-street parking for less proximate off street parking, or rarer, potentially forego driving all together by using transit for longer trips, or by walking or bicycling for shorter jaunts). On-street parking is typically free or priced ten to 15 times less than garage rate in many congested urban centers. (Shoup, 2004) One way of raising the price of parking is by reducing supply of on-street parking. Some cities like Washington DC are currently reducing the number of on-street parking spots available to non-resident (transient) parking customers in an effort to encourage more trips by transit, biking or walking in dense downtown areas.

The Overall Size of the Parking Market

There are nearly 255 million vehicles in United States, and at any given time, there are an estimated 100-800 million spaces, a possible maximum of three spaces for every registered vehicle. Estimates for the number of spaces are hard to find. According to UCLA urban planning professor Donald Shoup, "[Parking] is the single biggest land use in any city. It's kind of like dark matter in the universe, we know it's there, but we don't have any idea how much there is."(Shoup, 2004).

One possible reason that it has been difficult to measure the amount of parking is the fact that most of it is free, and there has been little market incentive on the part of the private sector to measure it. The cost of “free” or non-metered parking is typically passed unmeasured through enterprises and municipalities and is invisibly transferred to consumers and taxpayers in the form of higher prices for goods and services, or higher taxation. Governments typically do not collect data on parking, or if they do, do not aggregate data to any higher level, such as state or national level statistics. The Federal Highway Administration (FHWA) collects data on elements, such as public road mileage, numbers of bridges, number of vehicle registrations and licensed, motor fuel use and tax revenue, by a number of different attribute categories, but does not collect data on parking infrastructure or parking investment or revenues.
“Free” parking facilities represent the vast proportion of all facilities. Assuming a national parking lot of 500 million spaces, ITS America estimates that there are approximately 20-40 million permit, or metered parking spaces in the US, representing less than ten percent of all parking. (ITS America Research, 2011) This estimate appears, on the surface, to be consistent with the estimate by Shoup and others that nearly 90 percent of vehicle trips end in free parking. (Shoup, 2004)

There are approximately 40,000 parking garages (multi-spot facilities) that charge fees in the United States, according to the International Parking Institute. Growth in new facilities, however, is limited. While nearly 1,200 multi-level parking structures were constructed during the late 1980s, there was a major slowdown in the 1990s due to oversupply. It appeared to even out by the year 2000, with only approximately 450 new facilities constructed in the United States (Marketdata, 2005).

The bottom line is that new facilities are not a fast growth area for parking access technologies. The majority of growth opportunities for parking management services and new technologies appear to be in retrofitting and updating existing for-fee garages or on-street facilities. ITS America, however, could not identify any national figures on the percentage of facilities and spots that charge (metered or permit) for parking. America believes that at a minimum 30 percent of existing charging parking facilities, or approximately 12,000 facilities, may be immediate suitable candidates for electronic payment (P&E, PARCS) or parking customer convenience (PURCS) solutions. (ITS America Research, 2011)

The number of new parking facilities in the US is growing slowly, but that growth is typically outside of built-up urban areas where it is more common to find for-fee parking infrastructure. Growth in parking applications is likely to be found in converting existing “for fee” access controlled or metered facilities. Growth in parking technology in particular is driven by infrastructure monetization, in which non-essential public operations and/or assets such as parking facilities and services are put out for long term concessions. Cities like Chicago, that have significant on-street metered parking and even off-street paid facilities have put out concessions to secure private capital for upgrades of outdated metered parking systems. The city’s goals with the metered on-street parking and off-street parking facilities’ concessions were consistent with previous concessions such as the Chicago Skyway. They were to establish a long-term reserve fund, to retire previous debt, and shift risks from the city to private sector operators that were more capable of managing them. Generally parking technologies in these contexts are designed to boost revenues and economize on operating expenditures to increase free cash flows that are used split between the concessionaire and the public entity.
Parking Industry’s Revenue Potential and Cost Structure

Parking revenue is driven either by increased occupancy, from cost savings from reducing labor and other expenditures, or from reduction in revenue leakage. In large cities with high demand in central business districts (CBDs), an individual space generates $4,000 to $8,000 per year (National Parking Association, 2005). Similarly, the median daily rate for a space in these urban, high-density areas is approximately $14 (North America CBD Parking Rate Survey Highlights, 2005).

Table 1 breaks down this cost structure for a facility that generates $4000 in revenue per space annually, or approximately $10 per day in parking fare. Profit generated from the space is 10 percent, or around $400 per year.

Table 1: Cost Structure Facilities Yielding Annual $4000 per Spot.

<table>
<thead>
<tr>
<th>Cost Structure (IBIS 2011)</th>
<th>Percentage</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit</td>
<td>10%</td>
<td>$404</td>
</tr>
<tr>
<td>Rent</td>
<td>44%</td>
<td>$1,768</td>
</tr>
<tr>
<td>Utilities</td>
<td>4%</td>
<td>$168</td>
</tr>
<tr>
<td>Depreciation</td>
<td>1%</td>
<td>$40</td>
</tr>
<tr>
<td>Other</td>
<td>9%</td>
<td>$376</td>
</tr>
<tr>
<td>Wages</td>
<td>28%</td>
<td>$1,104</td>
</tr>
<tr>
<td>Purchases</td>
<td>4%</td>
<td>$140</td>
</tr>
<tr>
<td>Revenue per space (NPA)</td>
<td></td>
<td>$4,000</td>
</tr>
</tbody>
</table>

Assuming a 10 percent profit margin for all facilities, an addressable market (non-free parking) total of 40 million spots, and an average daily parking fare of $10 per day ($4000 per year), this results in a total industry profitability of $28 billion, which is consistent with industry studies suggesting nearly a $24 billion value to the industry.

This cost structure suggests that fixed costs (costs that are fixed over an extended period, such as rent, depreciation, and utilities) for a facility that generates $4000 in revenue per spot annually is approximately 51 percent or $1,976. Most other costs, such as wages, purchases and other costs constitute nearly 41 percent of the cost of owning and operating a facility, or $1,620 (IBISWorld, 2011). Estimates for average annual transaction costs per space is $500 or $1.30 per day per space, or 10 percent of average daily parking fare. (Litman 2010)

For companies with low operating margins, smart parking management systems must reduce wages, purchases and other costs, or increase profitability by reducing revenue leakage, by a magnitude
sufficient to offset the cost of the parking management system within a short period of time. Revenue leakage, which refers to improper revenue collection or theft by cashiers or other parking lot employees (the “silent partners” in the business), varies considerably by the size and type of parking facility. Anecdotal estimates range from 5% up to as much as 50%, with systems that rely on parking validation being particularly prone to leakage (Smart Card Alliance Report, 2006; interviews).

Reducing wages may mean automation of gates, reducing staff needed to man booths to manage fare or other customer service transactions. Revenue leakage is the reducing loss of parking receipts either due to theft or improper revenue collection. In interview with smart parking vendors, the conventional wisdom is that investment criteria for many parking operators consider an investment in smart parking management systems is typically a short payback period, usually three to four years. (ITS America Research, 2011)

Parking Operations and Costs

An average industry cost breakdown provided by IBISWorld suggests that a plurality (44.2 percent) of costs as a share of revenue went towards rent, with labor making up 27.6 percent. However, the cost structure is different for commercial parking operators with management contracts, as they do not make monthly lease payments.

The potential for technology to lower operating costs by displacing labor varies depending on the size of the operation in question. For large facilities that work around the clock and employ dozens of workers, automating part or all of their operations can cut costs substantially. However, for smaller parking garages with only one or two employees, reducing the workforce alone might not justify the costs of investing in technology. The latter tends to be the case for garages that support commuters and are open only during the day; in this case, the payback period for investing in technology will be significantly longer than the 3 to 5 years that is generally desired by operators for recovering their investment.

While it may seem unusual to focus on the payback period when determining whether to invest, this was the metric mentioned in many interviews with industry insiders, and suggests that the industry has tight profit margins. It further suggests the need for an accurate audit of operations among many facilities to determine where there is top-line revenue leakage versus other cost challenges.
Revenue Potential in Reducing Revenue Leakage

Parking has historically been a cash-and-carry business with very little focus on customer experience, with the exception of specialized facilities such as airports or high value retail and hospitality venues. Generally, parking transactions that cater to transient travelers and are typically medium dollar value cash payments are most vulnerable to leakage.

There are increasingly sophisticated revenue and access control systems designed to reduce revenue leakage by reducing employee contact with cash and improving the ability to audit parking revenues collected. Many types of systems exist, although central pay stations seem to be gaining popularity in the United States, along with unstaffed entry-exit systems that speed up payment processing and enable people to move through queues quickly.

Regardless, online connectivity and hosted solutions can aid with effective processing of payments, as well as remote monitoring and reporting. As of 2004, it was estimated that almost 53 percent of facilities that use some form of revenue collection equipment accepted non-cash payment. In addition, 50 percent of those that only accepted cash planned to accept non-cash payments within two years (International Parking Institute, 2004).

Industry insiders suggest that more than reducing operating costs, protection against revenue leakage is a prime consideration in the decision about whether or not to invest in technology. One former parking operator said that installing a PARC system reduced revenue leakage and increased collections in his garage by $800,000 in one year, taking into account installation costs. This suggests that large parking operations have much larger incentives than smaller ones to install parking technology to reduce operating costs and prevent revenue leakage because their return on investment is much higher.

However, even smaller facilities with less than 100 spaces can see a large increase in revenue from installing a PARC system to reduce revenue leakage. For example, when one company installed a PARC system for one surface lot in Charlotte that had been using a permit/enforcement based “honor box” system, they saw revenue triple in the first day alone, even with having to remove several spaces for entry and exit lanes (IPI presentation, 2011).
Major Challenges and Risks in Solution Scalability

Systems integration is the greatest challenges in parking technology, because of the wide variety of hardware and software platforms. The technology that supports P&I, PARC and PURCS systems includes a wide variety of hardware sensors, dynamic messaging systems and traffic control devices, wireless and wireline telecommunications systems, computer clients and servers and hardware drivers and application interfaces. In addition, customers carry a wide variety of devices as well, such as toll-tag or parking tag transponders, license plates (some of which are machine readable), mobile smart phones, and embedded telematics systems. Connecting all of these devices from hundreds of vendors, tying them together into one platform is the greatest challenge in reducing the cost and complexity of smart parking. For existing “brownfield” facilities with older hardware such as gates that must be integrated, deploying smart parking often is so complex that it is likely that a number of operators defer investment until they smart parking solutions.

The variety of infrastructure hardware and software systems that need to be integrated is enormous. These systems include software (local and hosted), and interfaces with hardware in the case of controlled access facilities with gates, or on-street parking with parking meters or paystations, and with other hosted services, such as credit card transaction processors. Sensor hardware may include cameras for license plate recognition to support permit enforcement, vehicle location, vehicle and passenger counts, sparking spot occupancy and facility safety and security monitoring. Other sensors may be inexpensive wireless detectors embedded in the concrete to measure vehicle occupancy or weight. Wallet, fob, or embedded Near-Field communication (NFC) devices or Radio Frequency Identifiers (RFID) transponders may be used to facilitate account-based payment and gate entry/exit, with card/device readers at the point of service.

It is rare to find sophisticated fully integrated, hardware-intensive smart parking systems. The exemplar system would be a “fully automated valet system,” where drivers leave their vehicles on robotic pallets or elevators that will valet the cars to the correct parking space. These robotic pallets will then retrieve the vehicles once the driver is ready to leave. These systems are rare because they are limited to location where plots for parking are scarce and cars need to be stacked close together to be accommodate the limited space and demand. These systems spare no expense, are rare and typically found in greenfield facilities.

Furthermore, the number of mobile devices is quickly evolving, though there appears to be consolidation around a few hardware and software platforms such as smartphones, tablets running either operating systems from Apple, Microsoft, or Google. Wireless mobile device clients, either owned by customers or parking operators, provide customer and operator interface to the entire parking
management system and customer service offerings remotely. For parking operators, mobile devices are typically used by “meter maids” to check for compliance, navigate to violating vehicles and write tickets. For parking consumers, mobile devices determine spot availability (historic and real-time sensor based estimation), make reservations, and navigate drivers to block/guide to spot, as well as manage payments and other services for parking customers. The attraction for use of customer mobile devices is cost to the operator, which is low given that the operator need only provide the app, rather than the hardware. The limitation is that some customers may not have mobile devices, and a backup such as parking tag or cash paystation may still need to be provided.

There are new categories of P&E, PARCS and PURCS providers that provide hosted (cloud-based) services and interfaces to mobile app phones. For electronic payment, the most prominent companies are Park Mobile and Park Now, among others. These payment processors provide permit based electronic payment, typically for a convenience fee. The key to many of these hosted solutions is scalability, the ability of the transaction processor to support over wide geographical, market and service areas, with minimal cost.

**Improving Operations While Maintaining Reliability and Security**

Parking automation requires great effort paid to scalability of the solution to reduce costs per parking transaction. However with scalability and automation, much attention needs to be paid to reliability and security. Parking management systems need to be highly reliable as a downed exit point or a faulty telecommunications line can represent considerable loss in revenue, and customer service problems may risk the operator’s reputation and relationship with the property management company, not to mention damage the credibility of the systems integrator and hardware vendors. Furthermore, electronic payment must go smoothly for customers. Disputed transactions, credit card fraud or theft of sensitive information can also destroy the reputation of the parking operator.

Transactions must be reliable and the design of smart parking systems can be complex depending on the type of facilities. For electronic payment, parking facilities can also be classified according to the application models: those using Permit and Enforcement (P&E) systems and those using Parking and Revenue Control (PARC) systems. P&E systems are generally found in non-gated facilities, such as residential streets or surface parking lots. Permits are issued to each vehicle allowing it access to park in a certain area and enforcement is done to detect violators. While permitting and enforcement can be done manually, from a technology standpoint, P&E systems provide features such as online permit application and issuance, financial transaction management, report generation, and enforcement data.
such as outstanding citation payments. Permit management and enforcement is the dominant model in municipalities, universities, and other parking facilities that have repeat customers that park for longer periods of time.

Gated facilities, on the other hand, limit access to the parking area through the use of gates or credentials, and require payment before the car exits. The service models vary greatly for gated facilities: payment can be done on a one-time basis (transaction-based), or through monthly or annual subscriptions (account-based); payments can also be done using cash or credit cards, with the help of a cashier or a payment machine. PARC systems are used to facilitate interaction between pay stations, gates and payment transaction processors such as Visa and MasterCard.

With hardware including stations that grant entry/exit access, such as gates or credential readers, ticket machines, pay-on-foot terminals to collect fees, cashier booths, and more. PARC software in turn validates access credentials and performs backend transaction management, determining parking fees depending on the time of stay, subscription status, and other variables, while also tracking revenue and providing an auditing mechanism for parking operators. PARC systems are prominent where parking occurs in short time intervals, such as in airports and hospitals. PURCS include additional services beyond PARCs, such as reservation systems and detection systems that can measure occupancy, locate empty and expired spots, and even automate guidance of customer and enforcement vehicles.

New facilities that are being built in the US show a trend towards full automation. Fully automated facilities (with very little or no staffing), usually using pay-on-foot terminals, remote system administration, and centralized back-office monitoring. Central Parking, for example, with the acquisition of Focus Point Parking, has established a fully automated PARCS facility in Texas that can run ten garages per city. Staffing may change even more with the introduction of “call centers” that can support garages and can control all on-site entry/exit points and ticketing and payment terminals. For example, if a driver is having trouble exiting, staff in a call center can remotely open gates (interview with Parking Today).

The next level beyond fully automated facilities is valet automation. These systems essentially pick up cars with elevators and store them in concentrated high density facilities. Valet automation allows you to double the capacity in the same volume, which meets the objective of many cities and property owners who want small, compact development, particularly in high density urban areas.

Lastly, electronic payment transactions must be secure. P&E, PARCS, and PURCS all have hosted (cloud-based) application services with customer-facing interfaces. These are usually internet-based or accessible via mobile phone to purchase permits, make secured meter payment based on credit card or other accounts, or make reservations. Any smart parking system that accepts non-cash payment must
comply with the Payment Card Industry Data Security Standards (PCI DSS). The Payment Card Industry Data Security Standard (PCI DSS) is a widely accepted set of policies and procedures intended to optimize the security of credit, debit and cash card transactions and protect cardholders against misuse of their personal information.

The PCI DSS was created jointly in 2004 by four major credit-card companies: Visa, MasterCard, Discover and American Express. PCI DSS compliance is required in order to process credit card payments and ensure data security and privacy. Achieving compliance can be expensive, close to $100,000, so it makes sense for many owners to outsource these services to vendors who are already credentialed and compliant. Systems at a parking facility that store credit card and other sensitive information must be secured. The major advantage of a hosted solution is the ability to cost-effectively centralize and outsource revenue control, audit, and transaction security to one provider.

The control objectives of PCI DSS are 1) Build and Maintain a Secure Network, 2) Protect Cardholder Data, 3) Maintain a Vulnerability Management Program, 4) Implement Strong Access Control Measures, 5) Regularly Monitor and Test Networks 6) Maintain an Information Security Policy. PCI is neither stringent nor loose, primarily because there is much room for interpretation. Parking merchants must be careful to not to narrowly define the scope of assessment. In particular, the tendency for merchants is to make PCI-DSS compliance and assessment easier by focusing only on a small portion of a merchants network. However, hackers have exfiltrated credit card data by attacking merchant networks and servers that site just outside of the credit card processing domain, then escalating user privileges to the target domain.

Parking merchants should conduct security testing of all of their IT domains, not just the domains described in the PCI-DSS assessment. An unwillingness to address anything that might be out of scope of the PCI DS assessment can be devastating to a parking merchant. Compliance defines minimum standards and goals, but the key is how they are applied by your IT Staff. As the number of PCI-DSS assessments increase every year, the number of compromises have also increased, so merchants must focus not just on PCI compliance.

**Systems Integration: The Problem of Interoperability**

The technology value chain for parking applications is the same as for most hosted services, with the exception of the need to integrate parking facilities hardware such as gates, pay stations or meters. The value chain includes companies that manufacture onsite facility hardware and software, online hosted application services, portable clients for parking operators, and customer devices that interface wirelessly with these hosted application services. By ITS America estimates, there are nearly 150 companies that provide either equipment or services in smart parking. It is uncertain the extent to which
Hardware and software standards are shared across equipment vendors, and the combinations of equipment years and makes at any given existing facility is often unpredictable.

For an engineering service firm or systems integrator evaluating the viability of brownfield facility for a new smart parking retro-fit, much attention needs to be paid to costs and benefits of attempting to leverage existing hardware or buying new. Interoperability between onsite facilities hardware and the application services software for P&E/PARCS and PURCS is one of the largest challenge and a potential barrier to parking technology adoption. Almost all parking facilities have equipment from multiple different vendors installed, which they are likely to want to keep if at all possible. However, hardware may be as much as 50 years old and lack even basic communications capabilities.

Onsite hardware may include gates, credential readers, ticket machines, barcode or QR code scanners, pay-on-foot or in lane terminals to collect fees have software that manages their operation and is designed to run in stand-alone mode should the hosted application go down or communications be cut.

Interfaces between onsite facility hardware and PARCS hosted applications are critical. P&E implementations may bypass onsite hardware such as pay stations, relying on customers to print their passes at home, or simply using their registered license plate number as a proxy for the permit number (also known as “Pay-by-Plate”). However, P&E requires interfaces to operator clients used to report violators back to the P&E hosted application for enforcement and possibly adjudication. These operator clients are usually handheld versions of common mobile devices such as iPhone OS or Android mobile operating system. Hosted application services such as P&E, PARCS, and PURCS allow gated facilities to interact with the transaction processor. It is likely that a middleware layer must be established to allow P&E, PARCS, and PURCS services to communicate with several types of facilities hardware and software. Middleware needed to handle interoperability between the host and facilities hardware can potentially reduce cost savings and solution scalability for existing facilities.

A majority of all parking application projects are with existing garages rather than greenfield facilities. Most often, a parking management company will come in and assess the current hardware that the client has in place. They may recommend a particular solution or vendor, but the client often will want to preserve as much of the existing hardware as possible and update it as it is very expensive to completely replace.

Maintenance is also a critical consideration and effects the chose of hardware when attempting to deploy smart parking in either a new or existing facility. An ITS America interview with a commercial parking operator revealed that hardware sales are regionally focused, depending on the location of distributors. For example, Amano McGann dominates the northeast, because of their strong distribution chain there, while SKIDATA is prevalent in California. The distribution chain is important
because of the need for timely on-site maintenance when hardware breaks down. By implication, this may inhibit higher markups incidentally on system integrators reselling equipment, since they may not provide hardware maintenance and may be at the mercy of regional distributors.

Systems from the largest hardware suppliers such as Federal, Amano McGann, or SKIDATA, for example, sometimes do not function well together. Integration is a considerable task, particularly for systems that run over large geographical areas. The hardware business is low margin, as most equipment is relatively undifferentiated. Therefore, unless companies have a monopoly in a particular region, the bigger business opportunity would be in bundling hardware with more expensive software solutions and selling it as a total system (Peracchio, 2011). Many facility hardware manufacturers, likely for that reason, have PARCS software, though the extent to which their services are hosted and scalable beyond their hardware platforms is unclear.

With very few exceptions, no PARCS applications can be implemented without some facility hardware onsite to restrict access or accept cash or electronic payment. The possible exception is mobile phone parking system that uses a permit-based system (using license plate number as the permit number) to reserve and/or buy metered time for slots. These “hardware-less” systems are appearing, but are complements, not replacements, for traditional hardware access control or slot metering. Until credit card usage or mobile phone penetration reaches 100% of drivers, PARCS will continue to require onsite facility hardware and software integration.

For parking technology providers, there is a need to integrate solutions cost effectively. Multiple hardware, software vendors and systems integrators providing P&E, PARCS, and PURCS applications are jostling for contracts with thousands of garage owners and operators. Commercial parking garages are the largest and most potentially lucrative market. Because most commercial garages in central business districts cater to commuters with monthly or annual subscriptions, revenues may not justify investment in technology unless there is a very short payback period.

The trend in the parking industry across all of these segments is outsourcing of parking operations to parking management companies through the use of management contracts, or in some cases, leases. Parking management companies excel in providing a customized solution for a client’s needs, and have existing relationships with many vendors to determine the best fit for each client. They can also offer competitive pricing based on these relationships. For airports, hospitals and hotels, services like valet are often added to enhance the customer experience and provide a “personal touch.” For airports and municipalities, more automated services are key to increasing occupancy rates and reducing revenue leakage. Permitting is essential for university clients.

There are many disparate suppliers involved that are required to make a parking management system operate effectively. Systems Integrators often act in a consultant role for clients such as universities or
airports who need assistance in choosing hardware and software solutions that will meet their requirements and are able to integrate seamlessly. These companies will act as resellers of hardware and any other equipment that they do not produce themselves. Larger companies with purchasing departments can likely procure hardware at lower costs due to economies of scale, and then mark up products to achieve higher profits.

There appears to be few companies that are truly a one-stop solution when it comes to providing parking management hardware and software. Larger integrated solution providers may partner exclusively with certain suppliers of hardware and software to show a seamless interface. For example, Amano McGann had a separate marketing initiative for their service with M3 Sensors to offer parking guidance systems. There may be a trend among larger companies to partner with acquire outright smaller elements of the parking market so they can get closer to becoming this type of “one-stop shop.”

For example, Siemens partnered with Streetline and Republic ITS to provide a “go to market” smart parking platform including a wireless sensor network, which they note will enable them to improve customer service and expand in the market (Aparc, 2011). Siemens also acquired Aparc, which bills itself as the premier distributor of Automated Access Revenue Control Systems, as a way to further expand into the parking services market.

Xerox provides a range of transportation services, including a division for parking management. While they have traditionally focused on on-street parking, they also manage off-street parking for several airports in the United States as these tend to have the highest potential for revenue. However, there are signs that they may be looking to expand into universities and other market segments (interview with Peracchio). They also have the resources to continue to acquire companies to expand their suite of services.

Even parking companies are vertically integrating, becoming their own suppliers. Larger parking companies with hundreds of facilities may have the scale to do this cost effectively. For example, Central Parking, arguably the largest commercial parking operator in the United States, acquired Focus Point Parking to provide an in-house web-based parking management program instead of relying on partnering with outside vendors. Other companies that appear to supply both PARCS and P&E services include Clancy Systems, Complus Data Innovations, and Street Smart. There are a number of P&E and PURCS suppliers that also provide hosted solutions.
How do Parking Service Models Effect the Choice of Technology

According to Harvard Business School, construction is a $4.6 trillion global industry, yet construction firms have had little incentive embrace technology to improve the productivity of their assets. According to HBS, while most other industry sectors have made productivity gains averaging 80% since the 1960s, the construction industry has become 20% less productive over that span. (Harvard Business School, 2010)

Parking facilities, especially greenfield facilities, however can be designed to improve productivity a number of ways, to include maximizing occupancy, managing parking turnover, and minimizing customer vehicle-to-door travel time. However, even understanding parking patterns may improve land use and commercial development of adjacent facilities. Anonymized and aggregate data collected by from multiple parking operators PURCs may be licensed or sold to commercial developers to understand potential traffic around retail or other unique sites to improve planning and future development.

Even brownfield facilities can be retrofitted with pay stations, enforcement and occupancy sensors and other smart parking technology to help operators improve the efficiency of their facility based upon the desired parking service model. From an operations perspective, parking facilities include four major business parking service models, bundled and ordered here by “level” of customer service: 1) Airport and Hospital, 2) Municipalities, 3) Universities and Retail/Hotel/Event Venues, and 4) Commercial Parking Garages. The largest market revenue segment is Commercial Parking Garages, followed by Airports and Municipalities (ITS America Research).

There are a number of distinct market segments for parking, each with their own service model, opportunities for growth, and technology needs. This section examines each market segment and provides an overview of segment operations and technology adoption, in order of revenue potential.

The Airports and Hospitals Parking Service Model

Airports and hospitals usually outsource parking operations, and airports in particular tend to have separate budgets for operations and technology. Airports offer several types of parking facilities: surface lots and garages, hourly and long-term, as well as valet. Both airports and hospitals operate predominantly with PARC systems, but they also require permit management and enforcement for staff.

Airports and hospitals generally have the highest average revenue per parking stall. The revenues are based on the ability to charge premium rates because of the high value placed on on-time arrivals to make flights or medical appointments, and the complexities of navigating very large facilities on foot to reach the customer’s final destination.
Parking facilities are for airports are the largest of any service segment, with an average of 2,800 spaces (NPA, 2005). There are around 350 airport parking facilities in the United States (ITS America Research). Parking facilities for hospitals are also large, second only to airports and universities, with an average 920 spaces per garage (NPA, 2005). Hospitals are the large parking segment in terms of numbers of facilities, with nearly 6000 facilities. (ITS America Research, 2011)

Since medical appointments and airline seats are time-sensitive or perishable, medical and airport facilities must ensure that patrons know how to arrive at the facility and know which garage or site at which to park at for convenient access to the clinic or terminal; additionally, they must often have ancillary services to bring customers to their assigned point of service (clinic information kiosks and shuttles for airports). Parking prices are generally higher the closer they are to the terminal and they are measured in smaller increments, with shorter-term parking commanding the highest rates per hour.

Airports must compete with off-airport parking providers and in some limited cases with off-airport hotels, though many of these firms must share revenue as a part of their zoning permit or license. Medical facilities may face very limited competition from private parking operators or from low-cost or free on-street municipal parking.

Of all the off-street parking segments, the airport segment is the most likely to invest in technology, because of the high dollar value of parking – losing a single ticket can be worth $100 or more – and because parking is the third largest revenue source after usage fees for airlines and food concessions in the airport. Airports therefore spend millions of dollars on technology and experience a very high return on their investment (XEROX). Due to the complicated rate structures at airports (hourly, daily, long-term) and the high value of daily transactions, PARC technology improves the efficiency of revenue collection and helps prevent revenue leakage and fraud. For example, license plate recognition can be used when a customer loses his or her parking ticket to prove that they have been in a lot for a week rather than for 30 minutes.

Additional technology requirements for airports include being able to track occupancy in real time to direct customers to empty parking spaces and to operate parking shuttles. Higher security requirements around airports also require extensive use of closed-circuit television, which can be leveraged to manage permit enforcement.
The Model for Municipalities – Public Facilities and On-street Parking

A major division in the parking industry is between on-street and off-street parking, which have very little overlap in either operations or technology. Municipalities largely focus on on-street or metered parking, although they are also likely to control a small percentage of off-street lots in urban areas.

Municipal operations are focused on parking enforcement (meters) and permit management (for residential parking). Municipalities have traditionally operated their own parking facilities, using meters with no communications capabilities and limited payment options (coins). In recent years, as municipal budgets have shrunk, cities have begun paying attention to parking policies both to increase revenue and to manage congestion. Parking facilities run by municipalities are smaller than all other segments, with an average of 795 spaces (NPA, 2005). There are around 2,500 municipal parking facilities in the United States (ITS America Research).

This has resulted in two major trends: cities have been raising metered parking rates to be more in line with market demand, and cities have been outsourcing parking operations to commercial parking operators. In general, municipalities outsource their parking operations when the technology gets more complicated and when there are multiple technologies at play, for example, when a city has parking sensors, pay-by-phone meters, and coin-operated meters deployed together. Limited city budgets and workforce make it difficult to deal with the amount of data and backend software that is required to integrate these technologies together, so they turn to companies such as Xerox (XEROX).

In recent years there has been considerable growth in the demand for technology for on-street parking. Price increases render coin-operated parking meters inconvenient both for customers who need to carry change, and for collection crews who need to travel long distances to empty meters when they get full (XEROX). The new technologies that have developed as a result of this include pay-and-display meters, also known as multi-space meters, where customers can pay with cash or a credit card and display a ticket in their windshield.

Many cities are installing pay-by-phone options that increase revenue and have been shown to have high adoption rates in pilot studies (interview with DDOT). These technologies, while nascent in the US, are already prevalent across Europe (XEROX).

Another trend gaining traction is the installation of sensors in parking spaces, which enables operators to determine occupancy rates that can be used for dynamic pricing, and also to increase revenue through targeted enforcement. It has been estimated that only 10 percent of an enforcement officer’s time is spent writing tickets when they patrol an area by foot at random (DDOT). The US Department of Transportation has funded congestion parking programs such as ExpressPark in Los Angeles or SFPark in
San Francisco. These have resulted in a lot of technology being “put into the ground,” such as occupancy sensors, which is the newest parking technology to have entered the market.

Besides sensors, license plate recognition is gaining prominence for detecting occupancy and enforcement. These programs are data-driven and use occupancy data to determine rates in different neighborhoods, to record parking turnover, and to pass on information about violators to enforcement officials. Additionally, the occupancy data is relayed to web interfaces and smartphone applications for end users to access (XEROX).

While some cities operate off-street parking assets in addition to metered or residential street parking, even those that do not, like Washington, DC, are still interested in knowing the parking availability in private garages as a way to provide parking guidance and reduce congestion from people circling to find available spaces.

Opportunities for entry into the municipal segment are mixed. Many of the larger integrated solution providers are already competing in this market. Municipalities do have some amount of residential parking which requires P&E solutions; however, cities are generally much more focused on the high revenue metered parking area.

The Large Institution – Education, Retail, Hospitality and Entertainment Service Models

Universities and retail organizations are generally lower revenue operations, as the goal of these institutions is to keep parking accessible to employees, students, and patrons rather than in maximizing revenue.

Universities, shopping malls, major office parks, and other large facilities are similar to hospitals and airports in that effort needs to be made to direct patrons to the correct facility. However, as trips are not time-sensitive, the amount that can be charged per stall is not as high, and premium rates can only be commanded based on other customer needs, such as convenience or other services. Universities and office park facilities differ from shopping malls and other commercial facilities in that they have a large pool of frequent customers, usually students, faculty, and staff.

Parking facilities run by universities are larger than all other segments except for Airports, with an average of 1600 spaces (NPA, 2005). There are around 2500 parking facilities in the United States (ITS America Research). Between commercial parking lots, retail venues, and event venues, there are
approximately 1,000 facilities in the US, with an average of 800 spaces per garage (ITS America Research 2011, NPA, 2005)

Both of these facilities must also compete to a very limited degree with free or inexpensive on-street parking. Organizations such as universities and shopping malls often enhance the convenience of parking as a way to differentiate their core offerings (e.g. top-flight education or most attractive retail shopping experience) from their competitors.

Event centers such as stadiums are similar to hospitals and airports in that there is a premium based on time and convenient location. However, demand is not uniform and the customer frequency is not as steady as a university or an office park. For major sport events, the existence of season ticketing and bundling of parking stabilizes revenues and represents opportunities for providing ancillary services and even enhancing revenues.

When retail parking is not free, a PARC system is generally used, whereas universities and office parks gravitate towards permits and enforcement because of their large base of steady customers (students, employees). Events are also usually permit/enforcement-based models, because of a large surge in entry and exiting before and after events, which makes it difficult to accommodate expeditiously if all transactions need to be ticketed and charged. Many event facilities charge a flat fee to park for the duration of the event, which is collected upon entry.

There is a sense that parking in this market segment is underpriced, and the opportunity could be very large if prices are raised to market level. However, that could prove difficult given retailers’ sensitivities to the effects of parking fee increases on their customers. Similarly, universities and offices want to keep rates reasonable for students and employees as long-term customers.

Universities and office parks are largely permit and enforcement systems, with students and employees making up the bulk of their parking usage. Surface lots are typically permit based, with limited number of multilevel facilities with both permits and PARCS for transient visitors. Since universities have accounts of students and employees, integration with other billing (tuition or campus-cash) or payroll systems is sometimes a requested service. Exclusive retail and hotels use valet integrated with PARCS or PURCS and may need to integrate with hotel billing or retail validation systems. Events typically use P&E and occasionally integrate with PURCS.

Opportunities for entry into the university segment are mixed. Universities parking divisions can be bureaucratic, have little in-house IT expertise, and they are not or are not motivated always to maximize revenue or improve customer service. Generally, however, universities do need a systems that
increases efficiency and provides better customer service for permitting, enforcement, and event management. P&E solutions are that are entirely hosted are attractive for those with little in house IT expertise, and very scalable across institutions since they do not require integration with gates or pay-stations. Furthermore, because of this scalability, P&E solution providers may expand to support smaller academic institutions, which number in the thousands. A number of smart parking vendors move down market to smaller academic institutions, such as high schools, as a way to enhance revenues while leveraging their existing cloud based infrastructure to keep their costs to a minimum.

The Commercial Parking Garage – Service Models for Stand-Alone Operators

Commercial parking garages represent the largest market in terms of revenue. However, Commercial Parking Garages are the most highly competitive and fragmented market with generally lower profit potential. It is concentrated at the very top, consisting of a few nationwide companies that generate about 75% of the revenue (First Research, 2011). However, it also consists of thousands of small, privately-held local and regional operators (Marketdata Enterprises, 2005). Around 90% of parking facility management companies operate a single facility, with each facility attracting five to ten bids each time operations are contracted out (XEROX).

Commercial parking garages are generally owned by building owners who tend to contract out their parking operations. Due to city zoning laws, most high-rise buildings in urban areas are required to have a specific number of parking spaces, often in the basement or on the first few floors of the building. This results in building owners also becoming parking garage owners. These owners sign contracts with parking operations companies. Between commercial parking lots, retail venues, and event venues, there are approximately 1,000 facilities in the US, with an average of 800 spaces per garage (ITS America Research 2011, NPA, 2005)

Operating companies like Standard Parking identify facilities that appear to be underperforming in terms of occupancy and revenue, relative to their location and nearby amenities, and sign long-term operating agreements with the facilities owners. Their hope is that they can enhance operations and attract occupants while taking a cut of the expanded parking revenues. The facility owner gets a cut of enhanced revenues, plus any appreciation in the value of the real estate asset as result of capital improvements or increased future revenue potential of the facility. Parking operators can also bundle or charge separately for other services in their role as a complete operational service provider. These services can include maintenance and security, to name a few.

Because most garages in central business districts (CBDs) cater to commuters with subscriptions or permits, the result is lower revenues than for transient facilities such as airports or hospitals. High
customer repeat frequency, and to a lesser degree uniformity of demand, are also factors in the provision of ancillary services. High frequency customers do not need mobile phone parking reservation, guidance-to-stall, last mile shuttle or valet. However, other convenience services such as auto servicing (maintenance, oil change, car wash, fueling, electric vehicle charging, repair etc.) or personal concierge services (e.g. dry-cleaning) might be suitable given the regular customer contact and parking day long “dwell” times. The ability to increase parking charge is limited by the reference pricing of other nearby commercial facilities. However, premium pricing (or more favorable longer term customer contracts) may be achieved through differentiating services, making such concierge and other perks available under favorable terms or lower prices.

Many CBD off-street facilities use both P&E and PARCS in areas where retail and major employers co-exist nearby. If only major businesses and commuters dominate, P&E is more prominent, since the bulk of parkers would tend to be commuters with monthly or annual subscriptions in this case.

Historically, there has not been much technology investment made in off-street parking garages in the U.S., and this has not changed significantly in the last few years. This could be due to the nature of the business in the U.S. as a cash-and-carry monthly operation for commercial operators and also the availability in the U.S. of low-cost labor to staff the garages.

Most commercial parking garages, especially those in CBDs, cater primarily to subscription parkers (daily commuters), with lower margins making investment in costly technology a less attractive option than in higher value market segments such as airports. Required payback periods for commercial facilities are generally shorter, typically one to two years (interview with Carl Walker, 2011).

Again, because of ability to increase parking charge is limited by the reference pricing of other nearby commercial facilities, the only way to increase revenue is by differentiating services, at least for subscription (monthly, yearly) customers. However, many commercial operators may use PURCS, specifically reservation and spot guidance to also attract transient parkers that might otherwise choose on-street parking. This may drive up occupancy and potentially reduce dependence on subscription customers, which are incidentally lower margin customers. This strategy is key for facilities located in mixed use business and retail areas where there is a mix of subscription and transient parkers.

Opportunities for entry into the commercial parking garages segment are mixed. When garages are run by an individual or a company that controls only a single facility, it is not likely that the operator will decide to invest in technology. However, we see an opportunity for technology solution providers by targeting garages that are owned by large commercial parking operators. These operators choose garages with high revenue potential and revamp the operations by bringing in technology. If solution
providers can establish relationships with these operators there could be a growth opportunity given the number of facilities.

**Service Model Requirements and the Choice of Technology**

Not all parking facilities are equal in terms of service requirements. The four broad parking service model segments are: airports & hospitals, municipalities, universities & retail, and commercial parking garages. *Airports & hospitals* offer the highest revenue opportunity, due to large numbers of regular and transient parkers and their ability to charge patrons high rates. Parking rates are rising fastest for *municipal operators* that focus largely on on-street parking, where the utilization of technology is growing as cities increase metered rates and install multi-space meters that can process credit card transactions to make up for budget shortfalls. *Universities and retail* organizations are generally lower revenue operations, as the goal of these institutions is to keep parking accessible to employees, students, and shoppers rather than to maximize revenue. Finally, *commercial parking garages* seek to maximize revenue according to market demand, but must compete with large numbers of operators in concentrated central business districts and other urban areas.

As other retail transactions, from grocery stores to big box retailers have moved to 100% electronic payment, implemented self-check out and customer loyalty programs. Electronic parking payment systems (*Permit and Enforcement/Parking Access and Revenue Control, or P&E and PARCs*), are typically the foundation upon which other parking customer convenience applications (*Parking Usage Recognition and Customer Service, or PURCS*) can be built.

The number of new parking facilities in the US is growing slowly with growth in electronic parking payment systems likely to be found in converting existing charged controlled access or metered facilities. The biggest driver for parking applications is desire on the part of owner/operators to reduce revenue leakage, decrease labor costs, or, depending on the facility service model, raise the level of customer convenience. Interviews with industry consultants indicate that the key criterion for investment electronic payment systems is a very short payback period.

This short payback period requirement is indicative of three potential problems. The first is that parking operating margins are very low, which appears to be the case where there is significant local competition for parking, or a desire to keep parking charges low to encourage or subsidize some other activity (e.g. retail shopping, university attendance). The second is in separation of ownership of facilities from operation, as owners may play different commercial operating companies off one another, keeping leases and service agreements short and making it risky to make longer term investment in electronic payments and parking customer convenience services. When operators are on a month-to-month contract or short lease, the ability to invest in new equipment may be limited.
(interview with XEROX, 2011). Finally, many facilities’ management may lack the minimal managerial and financial controls to understand even roughly the degree of potential revenue leakage and may be too fixated on short payback instead of better measures focused on net present value/internal rate of return discounted cash flow analyses.

The result of short payback periods is that there is a temptation to use existing facility hardware (e.g. gates, ticket dispensers), where it is already in place, which increases the cost and complexity, and reduces the scalability, of a hosted (cloud-based) P&E, PARCS, or PURCS solution. Use of existing hardware means expensive systems integration, middleware and maintenance. The ideal would be a parking application hosted solution that is completely hardware-free and scalable – using customers’ mobile devices to purchase permits or to buy time on meters, for example.

Such an infrastructure-less solution, however, may be years away, as facilities still need to develop and test alternative service channels to accommodate less technology-savvy customers. This is being contemplated by some organizations, such as Washington DC’s Department of Transportation, as they look to shrink infrastructure footprint by reducing parking meters selectively and ensure cash-paying customers can still find a space. Finding the transition path to such parking solutions, however, requires expertise, innovation, and operational planning on the part of many parking operators, which can be elusive in the right combination. Larger “total operations” or turnkey solution providers may be needed to help parking operators over this transitional hump. Furthermore, a larger solution provider may be able to source globally or regionally complete hardware and maintenance packages to compete most effectively.

Parking application services must accommodate a large variety of service models and pre-existing facility infrastructure. The essential advantage of a hosted cloud based P&E, PARCS, PURCS applications that might be run on mobile devices is its scalability to enhance revenues without disproportionately increasing costs. This scalability allows P&E/PARCS to can proceed downmarket to even smaller operators, such as high schools or smaller institutions where their application is completely hosted and scalable, without facility-side hardware/software. Going downmarket, however, may not support entry into higher value-added services such as PURCS.

P&E/PARC/PURCS providers can go upmarket to higher operating margin operators such as airports and hospitals. “High-touch, high-service” airports and hospitals would allow these to expand their service competency to more complex and sophisticated operational models, such as airport/transit intermodal transfers and hospital and resort hospitality services. The scale of these larger facilities would make the cost and trouble of hardware integration more worthwhile, as well as providing the entry point for other services such as PURCS.
Off-street and on-street municipal parking appears to be one of the clearest revenue opportunities given public sector efforts to raise metered rates and shed infrastructure and operating costs. For service providers, municipals offer a unique opportunity to gain expertise and experience in other types of hardware integration such as meters/parking availability sensors. Furthermore, there are also cross-segment opportunities. Entry into the mobile phone reservation, guidance and payment PURCS-type application environment could allow a service provider to gain access to a number of different service model segments simultaneously. For example, it is not difficult to imagine parts of all service model segments setting up reservation systems. Dispersed on-street parking, high volume/turnover off-street facilities, commercial facilities, or facilities that guide customers closer to curbside services (such as airports, hotels) could all benefit from reservation and guidance-enhanced PURCS.

Events and municipal off-street parking segments may also be entry points for mobile phone PARCS/PURCS. For municipal off-street, there are opportunities to provide a truly hosted solution similar to P&E, without hardware integration. For events parking, customer interfaces already exist given existing accounts and relationships between event ticket holders and event vendors, and parking functionality can be an easy add-on to those systems.

Finally, commercial parking garage operators are the largest segment, but they are challenging because of their diversity. Low-to-medium operating margins, low-to-medium level of service, and the variety of ownership and operating management structures make it difficult for a unitary market entry approach. One solution for Smart Parking solution providers is to leverage relationships with operations management companies like Standard Parking, one that they currently support in the university environment, to gain experience and expand into the area of commercial parking garages. Senior management of these larger operators should be more sophisticated in terms of appreciating the potential for investments in technology to increase revenues and reduce costs. Smaller operators may, however, remain problematic, being stuck in a logic loop of short investment time horizons and poor financial analytical capacity.
Conclusion

Demand for smart parking solutions is driven broadly by the problems of urban livability, transportation mobility and environmental sustainably. More concretely, smart parking technology is about enhancing productivity and service in operations: lowering operating costs, while building value for customer to drive occupancy, revenues and facility value. Traditional service channel to the parking customer was the toll-booth and the parking attendant, and has rapidly expanded to over the last decade to incorporate automated pay stations, meters and gates.

Cloud-based, such as mobile phone electronic payment are scalable to potentially thousands of parking points-of-sale, have emerged recently and are the “ideal” infrastructure-less model for smart parking. However, such scalable smart parking systems are constrained by the requirement to serve diverse customer base. Until credit card and mobile phone usage become ubiquitous, reaching nearly 100% of drivers, PARCS systems that can accept cash will continue to operate. As long as PARCs and gated facilities must accept some cash customers, costly onsite facility hardware and software integration with cloud based PARCs services will still be required, reducing the scalability and affordability of smart parking.

However, there is still considerable room to grow smart parking deployment. Fastest early growth areas for smart parking are municipalities, that have historically kept on-street parking is typically free or priced several orders of magnitude less than garage rate in many congested urban centers. Another targeted growth areas for electronic parking payment services are facilities where there are large numbers of transient (non-regular customers) with parking fares are that medium-to-low, potential losses that individually are not large enough to be noticed should unscrupulous employees skim a percentage of cash transactions. Raising fare revenues in line with demand, and reducing revenue leakage are the primary motivation for implementation of early implementation of PARCs systems.

Target growth areas for the long term are smaller institutions and larger more diverse commercial facilities. There are thousands of smaller educational institutions and business that could benefit from the more scalable Permit and Enforcement (P&E) features, that do not need to rely on facility hardware such as gates and costly hardware integration. The largest market however, is commercial parking facilities, which to date has been the most difficult market to enter, and given the fragmentation of owners and operators. However, commercial parking garages, given their customer repeat frequency/long term parking arrangements with customers, may be suitable for value added concierge services or even merchant offers that are arranged through PURCS. These offers may drive up occupancy for commercial providers or provide additional revenue opportunities through local advertising and promotions.
Newer customer service channels are nascent and evolving rapidly from several different technology domains, being built into mobile phones and other devices. Services may be built off of mobile parking electronic payments, but potentially may also launch from local web search, such as social networking services like Yelp, or other cloud based online brokers such as restaurant reservations, events tickets, or car-sharing. Parking reservation and guidance is an extension of traditional navigation and location based services, ones that route drivers not only to their destination block, but guides them the last several yards to available parking spots closest to their intended final destination. All of these services will likely be licensed and fully integrated, or “mashed up,” into a number of online search, social-networking and e-commerce platforms.

The need to better manage parking is growing. Researchers are beginning to estimate the true costs of free parking, in the form of urban sprawl, higher traffic congestion, higher emissions of greenhouse gases like carbon dioxide - specifically the “heat island” effect asphalt in urban areas that may contribute to global warming. Reducing parking’s massive geographical and environmental footprint is a worthy long term goal, and cost-effectively matching demand for parking with its infrastructure supply is one of the key contributions of smart parking. As cities strive to solve the problem of mobility in ever more congested urban areas, wide scale deployment of smart parking will be one of the key tools in a cities’ sustainability toolbox.
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