The Future of Wireless Parking

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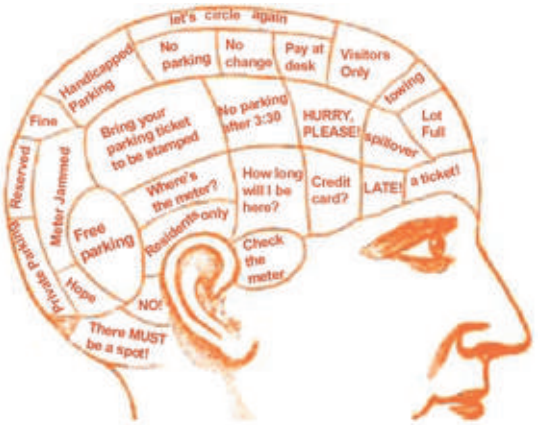
Just as pay-and-display machines are displacing single space meters, and pay-on-foot systems are replacing manned kiosks, cell-pay and on-board meters are beginning to disrupt curb-side and other ground-based infrastructure altogether. How far can wireless technologies go? What is the end-game for parking technology?



On July 16, 2005, the parking meter celebrated its 70th birthday. While we've come a long way in 70 years, stationary meters, whether single-space, Pay-and-Display, or Pay-on-Foot, still dominate the automated payment services arsenal for parking – certainly in North America. A good case can be made that this is about to change.

An invention that few contemplate and most motorists dislike, the parking meter has clearly entered a phase of rapid change and innovation. What is driving this innovation and what might the parking meter look like in 2011, on its 76th birthday?

Pressure for Innovation

Innovation is usually driven by economics, and parking is no exception. The cost of creating and managing parking spaces, whether surface lots or parking ramps, continues to rise. Given the current state of massive urban sprawl, the long relative decline in public transit use, and the unrelenting growth in the fleet of private automobiles, we are struck with a problem of rising demand and declining supply (or increasing cost of supply). Just as fuel prices will continue to rise, so too will the costs of renting parking spaces.

What does this pressure mean to an already complex but under-managed parking industry? With every form of tolling technology, there are different time and cost rules for the motorist, varying and often multiple payment methods, different types and levels of enforcement technologies. Pricing is far more irregular and capricious than fuel pricing. Parking abuse, spillover, tickets and towing further exacerbate costs and deny enjoyment of use. Right now in many parts of our cities, parking is an unpleasant adventure. Will I find a spot? Will I have the right change? Should I drive around and find a cheaper lot? How long I should pay for? Will I have a ticket when I return? Will my car still be there?

I am hard-pressed to think of other purchasing experiences that are this unpleasant, and I doubt many motorists think about customer service and parking in the same context.

Parking is generally managed from a local operations perspective. There are few regulations that control pricing or service levels among municipally-controlled parking, privately operated lots, residential lots, retail courtesy parking, free-but-time-limited street parking, etc. The resulting inconsistencies provide incremental complexity that costs all of us. It costs operators more to manage, residents and small retail businesses more in spillover, the environment more in circling-induced congestion and emissions – and, no surprise here, motorists more to use.

There are logical reasons we arrived at this state, but the fact is that we still design payment technologies to address local operational problems: How can the number of meters needed be reduced? How can the costs of meter collection and maintenance be reduced? How can losses from employee and motorist fraud be reduced? How can acceptance of credit or debit cards be enabled? (Amazingly this appears to the only management objective – besides location – that is considered a customer service issue!)

The Bigger Picture: Municipalities

A local design view ignores wider municipal perspectives of parking demand management. As opposed to the private parking operator who simply needs to avoid liability while maximizing revenue from each managed lot, a municipality is concerned with managing on-street spaces to support commerce, residential street spaces that allow for cleaning and snow-removal (and storage) while still supporting residential and visitor parking, raising general revenue, and a host of other mobility-related issues such as emergency services access or parking infractions in no-parking or free-but-time-restricted areas.

As long we continue to approach the design of payment technology from a local operations perspective, we will continue to design meters that users need to walk to and pay at, except that these meters will keep getting incrementally better. Worse, we will continue to deny ourselves viable solutions to dozens of other parking management issues.

We need to address larger municipal-sized management issues such as spillover, circling, and wide-scale pricing management as an access or a congestion control mechanism. And let's make it easier for the motorist while we're at it. Making parking an unpleasant experience does not manage vehicle use. Proper pricing does.

Enter On-board Parking Meters

To a minor degree, we are already starting to see a departure from fixed payment services infrastructure as meters move on-board the vehicle. Barely noticed in North America, but deployed to some extent in Europe and Asia, on-board meters can be pre-paid and then set to track parking time and debit accordingly. These help manage residential parking in Europe and may conceivably help municipal parking managers to reduce the use of on-street meters. Some can be deployed to provide parking-by-the-minute (surely a fairer approach) but they are generally inflexible with respect to adjusting parking rates by location or time of day. Without time- and location-dependent pricing, these meters have limited utility.

Cell-pay technology, already a few years old is also slowly making in-roads. While the motorist has to supply the meter (a cell phone), many already own one. The motorist need not stand in the rain to start the clock, nor leave a meeting to "feed the meter", but as a replacement for the manually operated curb-side meter, it still goes only half-way – the motorist remains responsible for being aware of the meter by carrying and attending to his cell phone. There is still plenty of room for innocent error and fraud – mostly because the on/off control of the meter remains under human control.

GPS

Pricing flexibility can be built into an on-board metering system when GPS positioning becomes reliable in densely built-up and high-foliage urban areas where parking is at its highest demand. Indeed solving this problem provides the foundation for a hands-free meter that can prevent most human error and, with modest intelligence, fraud as well.

Depending on a number of hard-to-defeat factors such as multipath, shadow and scatter, GPS positioning signals often bounce around several tens of meters from the "actual" position of a fixed antenna, as might be mounted in a parked vehicle. Indeed, without special processing, even the consistency of a 15-minute-average position from hour to hour can wander around an area of a few tens of meters in diameter. Until this problem is solved, a GPS-based meter could not reliably distinguish between payable municipal street parking and an adjacent, privately operated parking lot.

Fortunately for the future of the wireless parking meter, four near-horizon technologies address this problem.

Sensitive GPS Receivers. One of the major problems for GPS in urban canyon is that there are often blind spots that cause gaps in the ability of a receiver to sense a sufficient number of signals to calculate a position, causing it to lose lock. A new class GPS receiver chips, "sensitive GPS" means that the effect of shadow will be reduced and there will be far fewer gaps in the receipt of positioning data. It also means that positioning technology will usable within parking garages as well as in open sky. This still leaves the data too noisy for parking accuracy, but there will be more information for intelligent filters to work with.

Galileo. A new system of positioning satellites is being deployed by the EU over the 2006-2011 timeframe. When Galileo is complete, this will double the number of space vehicles reporting their position to a dual GPS/Galileo receiver at any one moment. While multipath will still affect these signals, this will provide yet more signals for subsequent filtering.

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GPS Modernization. Not only will the accuracy of Galileo signals be more reliable than current GPS (civilian) signals, but the US GPS is itself undergoing a modernization program that will rival and in some aspects leapfrog this. These improved signals will become available over the 2010-2013 timeframe. A sensitive, dual GPS/Galileo receiver would then be remarkably more powerful than GPS-only is currently.

Multipath Mitigation. Unfortunately, in a high-accuracy, reliable-repetition parking meter application, all of these billions of dollars of technology are still defeated to an extent by "multipath error", ground-level signal disturbances caused by buildings, trees, and passing vehicles. The good news is that progress is being made to better manage the error budget for this type error. The Ryerson University Multipath Mitigation (RUMM) Lab in Toronto is specifically addressing solutions applicable to a short-duration (under 15 minutes) stationary receiver situated in urban environments. The goal is 1.5 meter accuracy, 99% of the time, in a majority of urban locations.

We Are Not Alone

Other forces are also at work to change the economic picture for such an ambitious shift from locally-designed ground-based infrastructure to globally-available wireless parking payment services. In addition to constant price erosion as innovation proceeds and demand increases, two other mobility pricing programs on the near horizon appear unstoppable.

Road-User Charging. Several countries in the EU have already moved toward universal or near-universal tolling of heavy goods vehicles and as many more are planning to do so. Indeed, most are also considering universal road-pricing for all vehicles, with Galileo assumed as the base enabling technology. As such pricing programs become mandatory, positioning receivers will become common in all vehicles so that large scale penetration of GPS-based parking meters could come at only an incremental cost.

Pay-As-You-Drive Insurance. Distance-based insurance premiums have passed technical and pilot testing and are already available for young drivers in the UK on a limited commercial basis. This revolutionary approach to calculating motorists' liability premiums has numerous desirable effects and no down-side, except the complexity of collecting journey-distance data. Although many

This parklog example represents a journey between 2 points. The straight line from the start to the end is a proxy to the actual route taken. A search in a GIS database of payable parking spots for the start position (east-most bulls-eye) will show "no-fee", since it is a private driveway, while the destination end will show street parking at a municipal meter with a fee payable by the minute.

A parklog also keeps start and end times, total inter-parking journey distance and a few other items of information for non-repudiation. If congestion/zone pricing were in effect, the price-per-kilometer to the east of the pricing boundary might likely be lower than the price to its west and would also reflect the time of the journey (congestion). A simple GIS function can bisect the proxy fairly into the two zones, scale these to the actual sub-journey distances and times and compute the road-user charge. As well, a liability insurance premium specific to the risk profile of the vehicle's insured party can be calculated.

claim that odometer readings are sufficient, others want to see specific journeys and times. In any case, the potential use of GPS for this application will also promote the case for GPS-based parking metering in private vehicles.

Skymeter: Three-in-One Payment Services Meter

The way our parking meter is designed, the data required for accurate parking pricing automatically provides data for zone-based road-pricing, as well as insurance pricing. If you have a GPS parking meter, you have all three. Looked at the other way, designing a road-pricing meter or insurance meter this way happens to provide a free-parking meter. This means that cross-incentives are available to each of parking, road-use and insurance metering as provided by the other two pricing regimes.

Such an approach dilutes infrastructure costs over three industries and encourages private investment in mobility payment services. Any particular municipality, parking operator, road authority, or insurance company can subscribe to such services, much as a restaurant applies to be a Visa merchant. As users of this service, motorists can expect to see parking discounts related to loyalty or time of arrival, considerable hands-free parking convenience, and monthly billing to ease expense reporting. Some will also see savings in insurance premiums.

How it Works

Our on-board unit (OBU) receives both GPS and Galileo positioning signals and filters these in a way to provide for very accurate positioning in urban environments – often with sub-meter accuracy. This new process takes advantage of the type of multipath mitigation developed for demanding military or aircraft landing applications. Our OBU requires no programming, data resynchronization, or human intervention after installation. Because it is simpler and has no user interface, both the failure rate and the error rate are minimized.

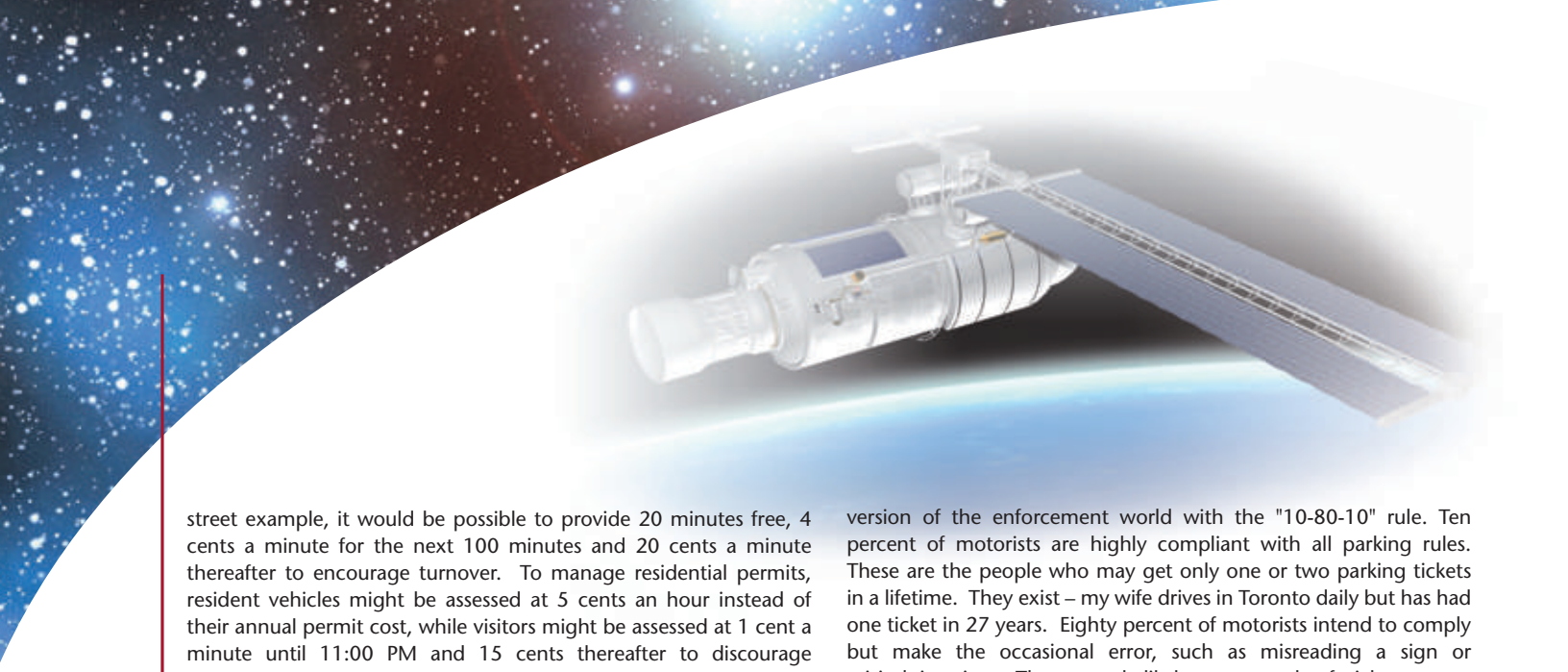
Position data is collected, compressed and stored for a pre-determined period of time, then encrypted and transmitted to a datacenter for pricing determination, and account update. Concurrently, device health diagnostics ensure the OBU is uncompromised.

In its parking-centric version, Skymeter OBUs produce a parklog. This is an extreme form of tracklog compression that discards most data, keeping only highly accurate, time-annotated positions for where a vehicle was parked; strong signal characterization of the parking position for non-repudiation; the actual journey distance between two parking events; and the bounding box for each journey segment. A parklog is used to determine per minute parking tolls and per kilometer road charges on a zone-by-zone and time-of-day basis. This very closely matches zone-pricing that would be calculated from the original full tracklog; and this same calculation applies to pay-per-distance insurance programs. Throughout the process, location information used to calculate a bill is isolated from vehicle and motorist ID information for privacy assurance.

Advantages of Wide-Area Parking Payment Services

Besides a gradual attrition of curbside parking infrastructure and convenience for the motorist, GPS-based parking metering provides a powerful municipal-wide parking and transport management tool.

Pricing Management in lieu of ticketing and towing. Since tolls are calculated in a datacenter and not at the meter, pricing can be more effectively planned and easily updated. As a commercial on-



street example, it would be possible to provide 20 minutes free, 4 cents a minute for the next 100 minutes and 20 cents a minute thereafter to encourage turnover. To manage residential permits, resident vehicles might be assessed at 5 cents an hour instead of their annual permit cost, while visitors might be assessed at 1 cent a minute until 11:00 PM and 15 cents thereafter to discourage overnight parking.

Congestion Management in lieu of road pricing. Wide-area managed parking pricing can be used to manage congestion. Parking could be free within 500 meters of a motorist's residence while tolled everywhere else. Any vehicle that is stationary during peak congestion times could be have its municipal parking account credited (appropriate parking charges still apply). In jurisdictions wherein road-use charges meet more resistance than parking tolls, this provides transport authorities with an earlier control lever on congestion and sorely needed transport financing. Introducing position metering via parking- and insurance-pricing is an attractive waypoint to eventual GPS-based congestion pricing.

Near-zero transaction costs means all parking can be managed. Wireless toll collection means minimal ground infrastructure – only signage and mobile enforcement via license plate recognition (LPR). Hence, Skymeter minimizes both transaction costs and new infrastructure costs for converting untolled parking to tolled parking. If a municipality tolled all or a majority of residential streets, motorists could choose among OBU, annual permit, or parking fines. Applying tolls everywhere, but priced to address only marginal social costs, is not only fair but can be used to manage spillover on streets and in convenience parking at retail shops. None of this can be accomplished with ground-based payment infrastructure that require a sufficient number of bays or sufficient demand to justify tolling deployment.

Lower Enforcement Costs. My first mentor in the parking industry – now COO of the parking authority of a large Canadian municipality – was primarily interested in wireless on-board metering from an enforcement perspective. He outlined for me his version of the enforcement world with the "10-80-10" rule. Ten percent of motorists are highly compliant with all parking rules. These are the people who may get only one or two parking tickets in a lifetime. They exist – my wife drives in Toronto daily but has had one ticket in 27 years. Eighty percent of motorists intend to comply but make the occasional error, such as misreading a sign or misjudging time. These people likely get a couple of tickets a year. Count me as one of these. The last ten percent go out of their way to not pay for parking. While a minority of these are scofflaws, most simply try to park in unpriced areas – usually generating "spillover" problems or tend to underpay meters. I once had a business partner who never paid for on-street parking and simply had his secretary write one check a month to the city. He claimed the money worked out the same, while he saved considerable bother.

The 10-80-10 rule is important for wireless on-board metering. My mentor predicted that voluntary participants in a privacy-assured, wireless parking system would come from the highly compliant 10% and the well intentioned 80% of this equation. This would allow parking enforcement to essentially dedicate resources toward the latter 10%, making enforcement far more effective – an additional and gratifying consequence for this class of wireless metering.

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How long will all this take?

We will continue to see fixed, ground meters for some years, yet. However, since global positioning will certainly play a significant role in road-pricing and likely an important one in insurance pricing, the application of this wireless positioning to parking is unavoidable. The real question is: How long will it take us to understand the new paradigm? After all, a GPS parking meter is not simply a replacement for current metering technology. It is a massive opportunity to bring centralized parking demand management and even congestion management to large urban centers – all with a simple hands-free meter.

Since the requisite positioning technology will start to fall into place in 2008 and be completed by 2011-13, numerous pilots will appear in the 2007-9 timeframe and signage on low-rise municipal streets and in managed surface lots such as are used for mass transit parking will start to appear in 2008-2010. This will be followed by colonization of mid-rise streets and parking garages, and eventually every possible parking circumstance. If the perceptions of fairness and privacy are managed right and early users are rewarded with convenience and discounts that more than pay for the OBU, nothing can stop this.

2011 will be an interesting year for the parking industry. ■