Mesh Networked Sensors for Parking Inventory Management

Overview

• Business Background
• Our Deployment
• On-street Measurements
  – Parking and ‘Advice for the Gambling Parker’
  – Network
• A Short Wish List for Mesh Networks
The Importance of Inventory Management

Payment Systems
Enforcement & Workforce Mgmt
Demand Mgmt & Public Information

Actual Parking Demand & Usage
Actual Parking Capacity & Inventory

Consumer Convenience: Using Realtime Data

<table>
<thead>
<tr>
<th>Space 33</th>
<th>Arrive: 9:14am</th>
<th>Check In: 9:19am</th>
<th>Depart: 10:22am</th>
<th>Duration: 1:08</th>
<th>Charge: $2.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space 42</td>
<td>Arrive: 8:17am</td>
<td>Check In: 9:12am</td>
<td>Depart: 5:41pm</td>
<td>Duration: 9:24</td>
<td>Charge: $10.00</td>
</tr>
</tbody>
</table>
System Architecture

Streetline & Partner Applications

API & Data Exchange Interface

Network Management
Application Management
Data Management

WAN

Gateways

Wireless Sensor Mesh

The Bump

- Self-Networking, Calibrating
- Scalable Management & Upgrade
- 5 to 10 Year Life
Our SF Deployment

- Continuous monitoring of ~250 on-street spaces via mesh networked RPM sensors.

Fisherman’s Wharf Deployment
Pier 27 Deployment

Over the Web: Real-time Occupancy Data
Parking geek data

More parking geek data
Advice for the Parking Gambler

• Average # of tickets per meter per month = 2
• Parking Ticket Cost ~ $40
• Monthly meter time cost ~ $400
• Optimistic monthly advantage of not paying for meter time ~ $320
• Odds favor not paying for meter time

Disclaimers:
• Parking control officers are known to periodically swarm areas
• Your results may vary  - pls don’t call us 😊

But what about the networking?
Some Lag Statistics

Near the Gateway

Far from the gateway

More Lag Statistics
Summary of Network and Parking Results

- Parking events detected to date – ~450,000
- Typical Network Latency
  - ~20 seconds
- Path Stability
  - 70%
- Network Reliability
  - 99.75%

Standardizing Network Management aka ‘Stuff I wish we didn’t have to build’

- For manageable deployment one needs:
  - Configuration Management
    - How often does mesh report?
    - Where are things located?
  - Security Management
  - Fault Management
  - Performance Management
    - Event correction/root cause
    - Alarming… but on what?
- Proprietary/custom solution…. OR…
- Leverage conventional solutions!
Network Management: The Bottom Line

- Mesh and non-mesh networks have significant overlap of important performance metrics
  - From a (very) high level, can think of a mesh network as equivalent to a TCP/IP network…
    - there’s lots of tools to manage those...
- A standard network management interface allows the integrator to focus on the application, not the network
  - Obvious analogy: HTML, HTTP
- Is SNMP or ‘SNMP+Mesh’ the solution?
  - There is much to leverage from SNMP, but anything standardized and interoperable would be great.

Acknowledgements

- Dust Networks
- Streetline Team

- PS. We’re looking for talented engineers
The Urban Management Solution