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Perspectives and Challenges to Deliver Ubiquitous Indoor Positioning

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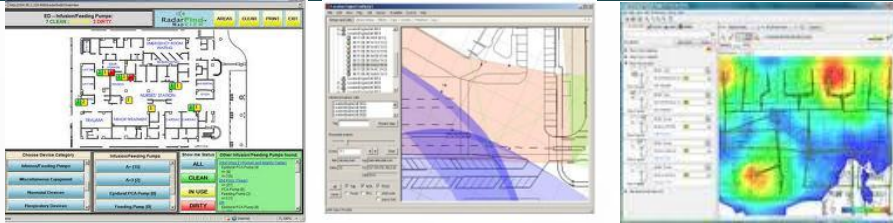May 7th 2012

Indoor Position is the Next Frontier in Location

Significant benefits, Significant challenges to overcome

| Location Technology | Beacon Information | Map Information | Infrastructure Information Update | Business & Legal Challenges |

Indoor Positioning

Location Technology

INFRASTRUCTURE	HANDSET

Breadth and Scalability

- Site-specific techniques available today, but:
  - These are closed systems requiring substantial local investment
  - Carriers, handset manufacturers, silicon vendors and applications developers are motivated by platform solutions that scale inexpensively and quickly

Quality of Coverage

- Urban Wi-Fi databases do exist today in the industry to address scalability; however:
  - Accuracy remains relatively poor compared to GPS and it is difficult to build high-quality applications due to uncertainty
  - Existing databases offer limited indoor coverage and provide poor basis for precise ranging technologies

A-GPS
- Significantly improves outdoor responsiveness, but fails to provide genuine indoor coverage

Cell ID
- Widely available with good indoor coverage but fails to deliver on accuracy

WLAN RSSI
- Improved indoor performance over Cell ID but measurements are poorly correlated with range and highly susceptible to environmental changes

MEMS
- Sensors now widely available in many consumer devices; however:
  - Relatively power hungry and susceptible to noise
  - Require an initial position fix
  - Must be run continuously to maintain orientation

UWB
- Excellent performance when high resolution ranging is combined with angle of arrival measurements; however:
  - It requires infrastructure upgrades
  - Devices do not support technology today

Many indoor positioning solutions are available but none offer a - highly precise, economical, low-power, robust, and repeatable performance

Beacon Location or RF fingerprinting

Knowledge of and access to accurate beacon information is critical

- **A-priori knowledge**
  - From venue owners
  - Very diffuse or unavailable information
  - Not always accurate
  - Operator mistakes

- **War driving/War walking**
  - Tendency to have all AP aligned on the road
  - Too inaccurate
  - Limited hearability for indoor beacons

- **Systematic survey**
  - High cost
  - Ground reference
  - Turn-around time

- **Crowd-Sourcing**
  - Coverage as large as the user wanderings
  - Very fast update and very fast growth
  - Legal aspects
  - Ground reference
  - Access to mobile measurement engine
  - Needs centralization point

Map Information

In-building maps need to be precise and accurately geo-referenced

QUALITY

- Geometric exactitude
- Geo-referencing exactitude
- Richness of information (POIs)
- Information hierarchy
- Timely updates

AVAILABILITY

- Fragmented sources
- Non-standardized formats
- Vast variances in quality (raster to vectorized)

Infrastructure Information Update

Availability of updated and accurate consolidated information

ISSUES

- Map/Beacons information outdated after 6 months

- Very fast turn-around time on shelf assignments

- No single owner

- No centralized control of changes

- Loss of service value in user's view

- Loss of return on investment in venue owner's view

SOLUTIONS

- Interconnection of Databases

- Periodic surveying

- Crowd-sourcing (active or passive)?

Business and Legal Challenges
Need to be addressed and overcome for broad adoption

BUSINESS	LEGAL

BUSINESS

- Enablement of Eco-System:
  - Enabling venues w/o enabled mobiles
  - Enabling Mobiles w/o enabled venues
- Co-existence with OS vendors who introduce solutions at the app layer
- Application Developers
  - Requirement for simplified APIs
  - Ability to use any map with positioning technology
  - Justification to create apps for the early adopters of indoor location and scale deployments
- Readiness of Venues
  - Upgrading infrastructure to ensure most optimum accuracy
  - Coordinating the site readiness of multiple venues to take advantage of indoor location
  - Sharing the information on maps and APs for indoor location enablement

LEGAL

- Still GNSS-inherited perception: "it should be free"
  - How will consumers assign a value to the benefits of indoor location?
- What is the role of the Operator for indoor location? Will this evolve into an indoor location E911 requirement?
- With new eco-system expansion, how is monetization going to be shared?
  - Who owns the customer and indoor location experience?
  - How will new entrants make money? (AP vendors, Venues, Advertisers)
- Privacy
  - How are privacy aspects handled where the consumer is willing to trade-off their location for the value that indoor location delivers?

Conclusions

- Indoor location should happen much quicker than outdoor location:
  - Sophistication of users of mobile devices and demand for location ubiquity
  - New entrants "trying to be first" and secure the customer/experience
  - Many location-based apps can be improved quickly to provide additional benefits
  - Existing infrastructure and mobile technology should encourage rapid market launches

- Industry challenges will slow adoption if they are not addressed by the community

- A universal solution (i.e. accessible to any user, without mobile upgrade) will be key for fast adoption by users

- Standardization of maps and other ancillary information will accelerate the deployment

Ecosystem and partnerships are a viable solution

Thank You