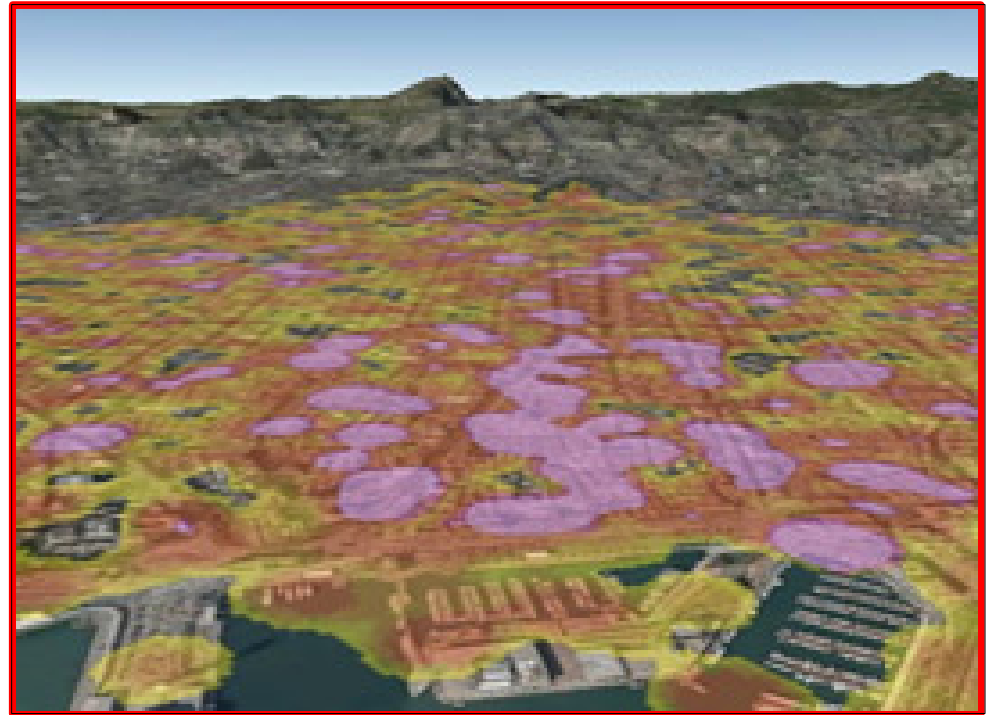# SKYHOOK°

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Massively Scalable Indoor Positioning: The Skyhook Solution

Christopher Steger

Skyhook Positioning Overview

- WiFi-Based Positioning

- Metro-Scale

- Worldwide Coverage

Skyhook Positioning Overview

- WiFi-Based Positioning

- Metro-Scale

- Worldwide Coverage

- "Beacons of Opportunity"

- No ownership or control

- Asynchronous downlink signals

- Support any WiFi-enabled devices

Skyhook Positioning Overview

- WiFi-Based Positioning

- Metro-Scale

- Worldwide Coverage

- Data Gathering
  - Driving surveys
  - User feedback

- Example Use Cases
  - Smartphone apps
  - Sony PS Vita games
  - MapQuest turn-by-turn navigation

Skyhook Positioning Overview

- WiFi-Based Positioning
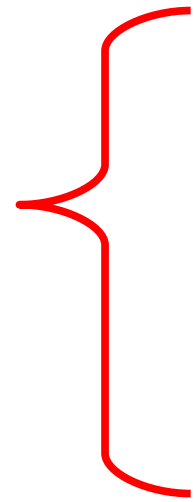
- Metro-Scale

- Worldwide Coverage

- Tens of countries

- Hundreds of cities

- Thousands of drivers

- Millions of kilometers driven

- Tens of millions of users

- Hundreds of millions of access points

Metro-Area vs. Indoor
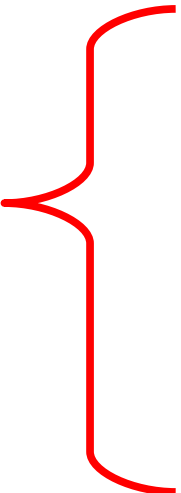
Metro-Area vs. Indoor

- **Surveying**

  - Driveability
  - GPS/INS equipment
  - Operator skill level
  - Maps/Floorplans
  - Owner interest
  - Single-ownership
  - Deterministic dynamics

- Cooperation

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Metro-Area vs. Indoor

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Standardization

- Allow venue owners to improve coverage

- Provide support for different systems

- Control ownership and accessibility

- Remove barriers to entry for venue owners

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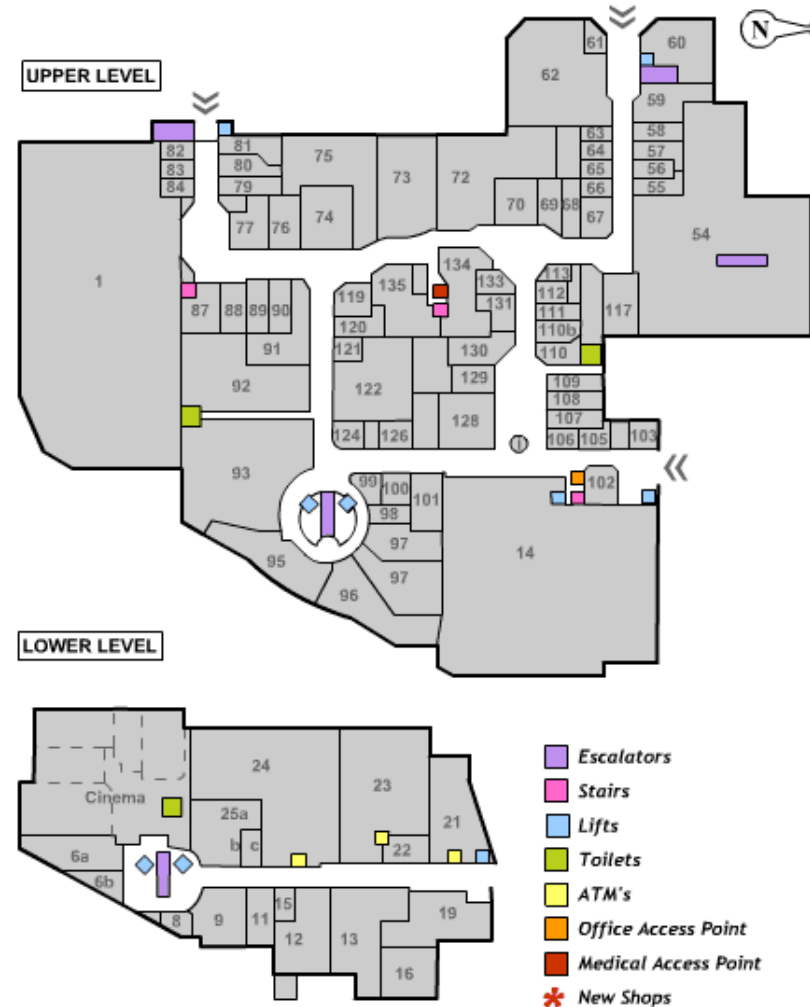
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Indoor Positioning Requirements

- Accuracy
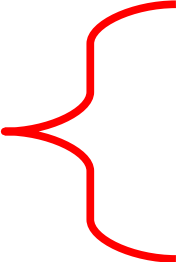
- Scalability

- Compatibility

- Ownership

Indoor Positioning Requirements

- Accuracy

- Scalability

- Compatibility

- Ownership

{
- Venue detection
- Aisle/section level
- Minimize surveying
- Minimize installation
- Downlink signals
- Active scanning
- No venue crossover
- Limited feedback

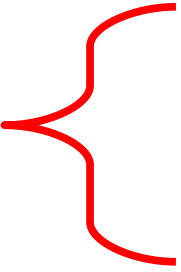# Indoor Positioning Requirements

- Accuracy

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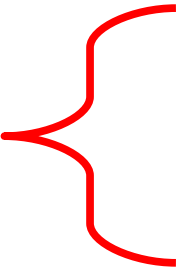- No venue crossover
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Indoor Positioning Requirements

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- Ultra-Scalability

- Compatibility

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- Aisle/section level

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- **No** installation

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Indoor Positioning Solution

- No surveying

- No installation

- No characterization

- Minimum overhead

- Submit AP locations

- Owner guidelines

- Adaptive algorithms

- Maximum scalability

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Case Studies

Skyhook Office

- Open plan
- Drywall partitions
- 10 access points
- 480 square meters

Home Depot

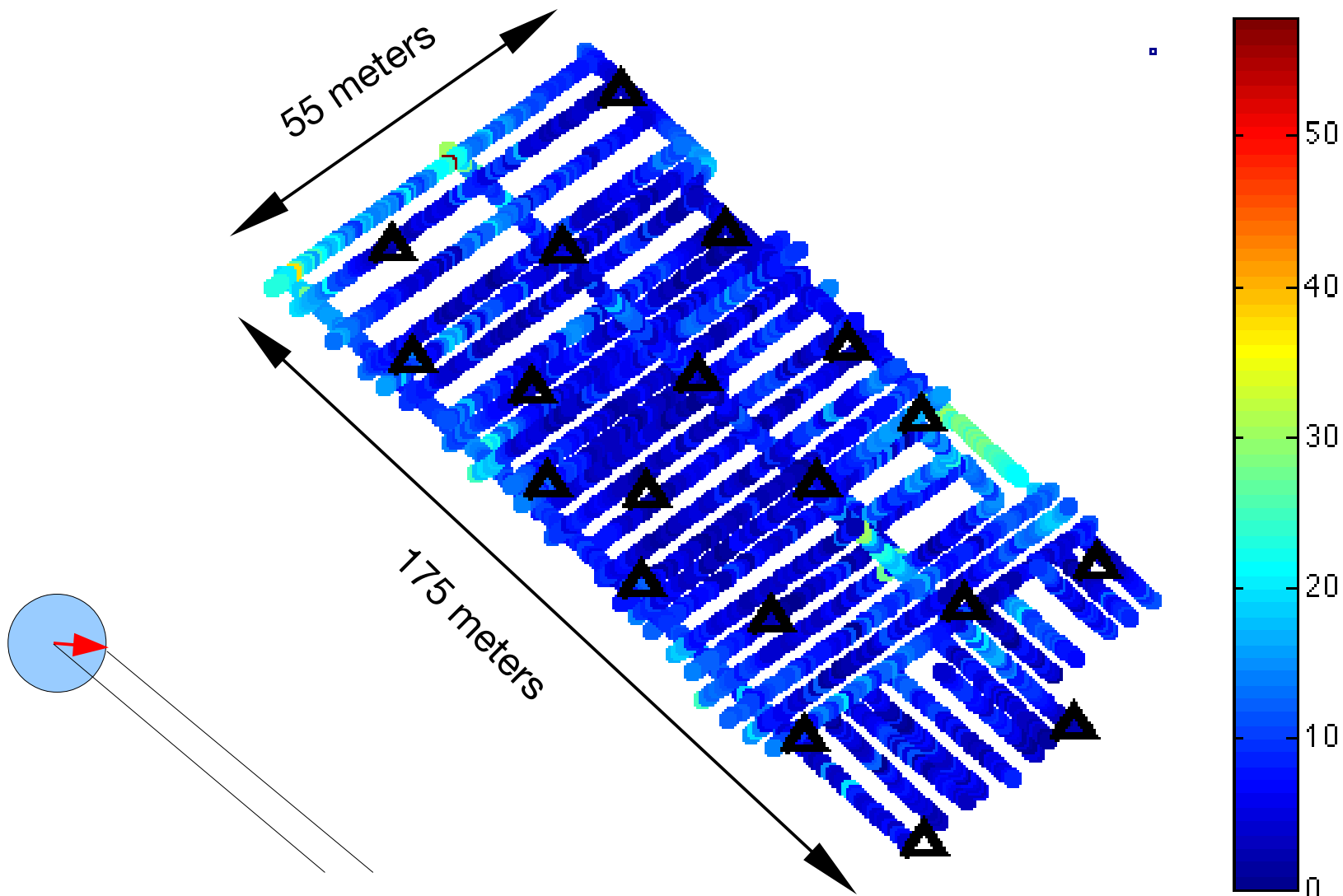- Warehouse
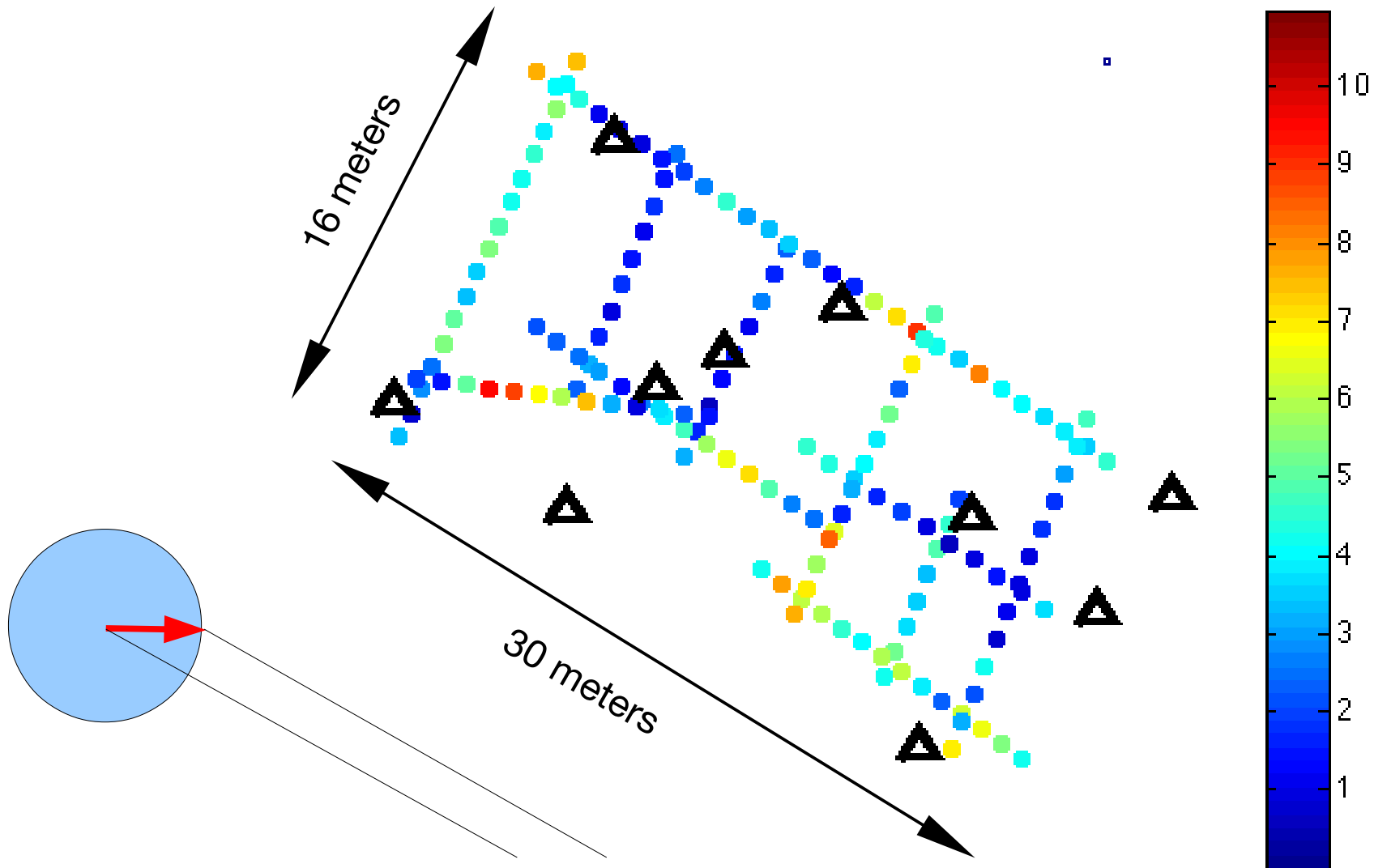- Metal shelving
- 19 access points
- 9625 square meters

Home Depot Results

55 meters

175 meters

Median Error = 6.7 m

Skyhook Office Results

16 meters

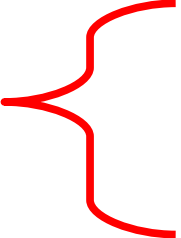**30 meters**

Median Error = 3.5 m

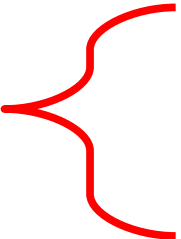# Insights and Outlook

- AP Placement

- AP Density

- Performance

Insights and Outlook

- AP Placement

- AP Density

- Performance

- Footprint coverage

- Perimeter placement

- 2-4x data needs

- ~3x median error

- 3-10 meters error

- Minimal overhead

- Extensible with any available scans

Insights and Outlook

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