# Location-Aware IoT

## CONCORDIA INSTITUTE FOR INFORMATION SYSTEMS ENGINEERING

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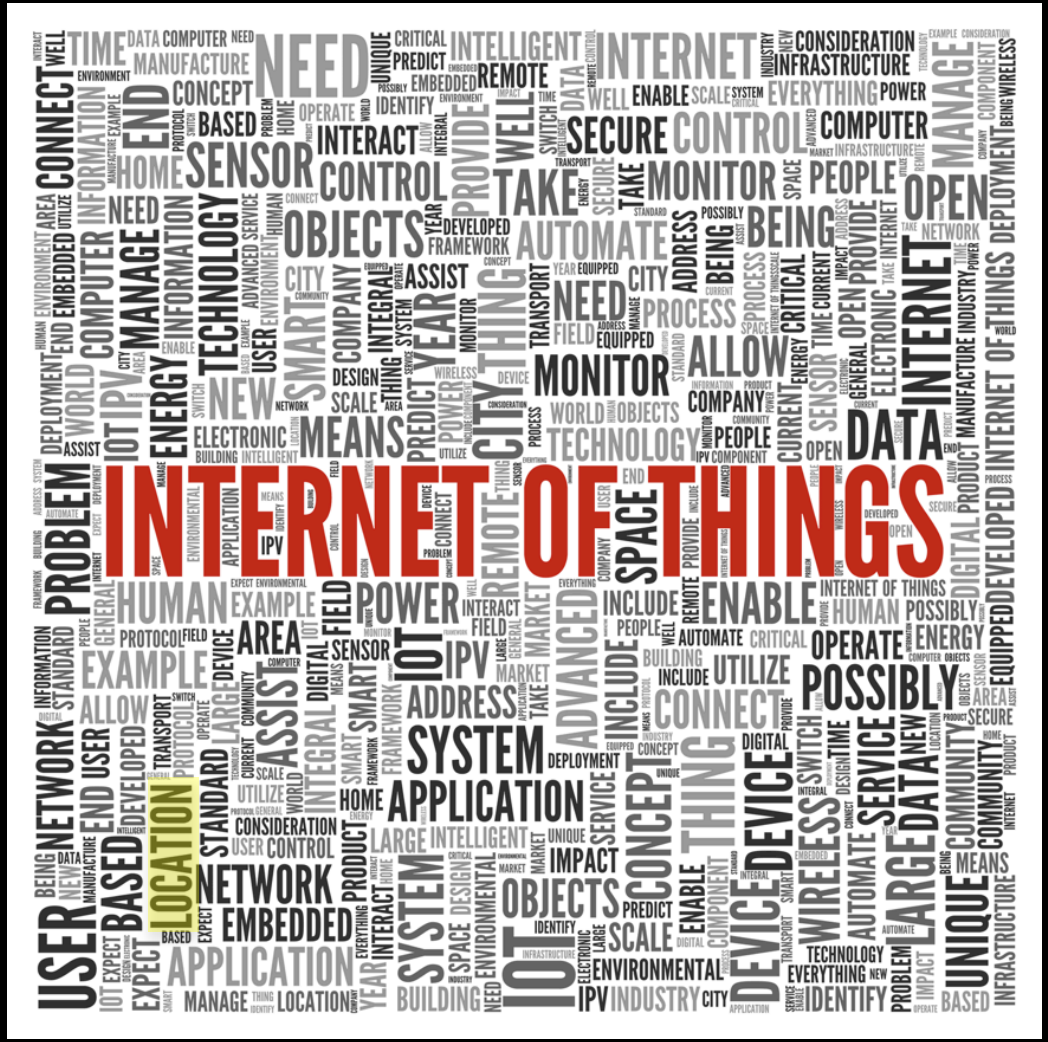
*"Billions of devices"*

*"Big data"*

*"Analytics"*

*but...*

**Where is it?**



# Agenda

- Background
- Evolution of location technologies & indoor positioning challenge
- BLE & beacons in IoT
- Location-aware IoT infrastructure
- Q&A

# Personal Background

B.Eng., M.Eng. EE. McGill

Since 1990, career tracked the evolution of mobile data networks, smart devices & positioning technologies.

# Company Background

## RX NETWORKS INC.

- Assisted-GNSS & hybrid positioning software & services
- Over 1.2 billion smartphones, tablets, personal navigation devices, and wearables
- Unique expertise from embedded software to high-availability, cloud based service delivery
- Customers & Partners: semiconductor vendors, device OEM, mobile operators
- Being sold to BDStar of China, ~Q3'2017

## FATHOM SYSTEMS INC.

- Wholly owned subsidiary of Rx Networks (to be spun-off once Rx is sold)
- Focused on IoT BLE location for asset tracking and location-enhanced marketing
- Connected, location-aware BLE network infrastructure, management & analytics
- Customers & Partners: asset tracking enterprises, device vendors, big-data platform vendors

# 1990-97: Connectivity & Integration

*mobile data "is here"*

**Mobitex / CDPD.**
**GPS receivers.**
**Massive h/w & s/w integration efforts.**

**Super expensive.**

# 1998-2001: Devices & Mapping

Embedded OS start to evolve – ARM support for Linux
Mapping options emerge for enterprises and consumers.

symbian

montavista™

Windows Embedded CE

**More data connectivity options.**

**Integration remains challenging & expensive.**

**Off-board GPS.**

# 2002-2005: Mandated Location

## FCC triggers changes – E911

**Network positioning (CellID/TDOA).**

**Early integrated GPS positioning.**

**Nokia dominates.**

**Assisted-GPS takes root.**


# 2006-2014: Location-Aware Mobile OS

## A consistent consumer experience sets in (outdoors).

**Nokia vanishes, Apple changes the game.**

**Main focus: speed up GPS & save power.**

**Positioning still comes from discrete sources: A-GPS / WiFi / CellID.**

**OS gains rich location sub-systems with maps, geo-fencing, notifications.**

**Indoor support remains a challenge.**

# 2015– : Hybrid, Sensors & Indoor Focus

## Maintain a seamless outdoor → indoor user experience

**New FCC indoor positioning mandate.**

**Push towards “always-on” positioning. Hybrid approach, fusing sources (A-GNSS, WiFi, CellID, Sensors, BLE, Beacons, Terrestrial Ranging eg NextNav).**

**Vendors vying for adoption in INS, magnetic, RF fingerprinting techniques.**

**Indoor experience not yet seamless & generally requires costly venue setup & maintenance.**

# IOT LOCATION CHALLENGE

*Outdoor: well served.*

*Indoor: compromises*

**Accuracy.**

**Responsiveness.**

**Battery power.**

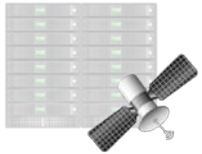
**OS capabilities.**

**Connectivity.**

**Indoor? Outdoor?**

**And… *costs.***

**A-GNSS**



Not an option for indoor mobile devices.

**CellID**
**Wi-Fi**

5-10m (Wi-Fi), 10-150m (CellID).
Position by inference (database lookup).
Significant OPEX for limited performance gains.

**Sensors**

1-5m. Requires known start and battling drift beyond ~30s.

**Beacons**

1-10m. Relative position, absolute by inference (database lookup).
Efficient proximity detection native in OS.

**UWB**

cm-level. Emerging high-accuracy. Shifts burden on precise detector/gateway location.

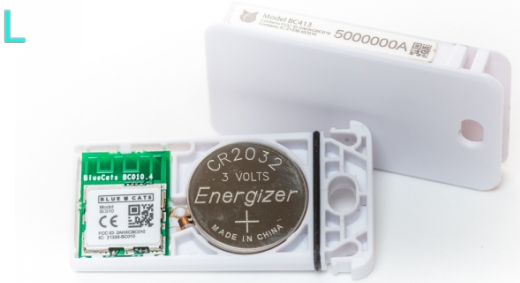
# SO WHAT ABOUT BLE BEACONS?

- SIMPLE, BATTERY-POWERED BLE DEVICES EMITTING A UNIQUE ID AND ADVERTISING PAYLOAD AT A PRESET INTERVAL AND POWER LEVEL.
- BEACONS CREATE SMALL, DISTINCT “BLUETOOTH BUBBLES”.
- SMART MOBILE OS ENABLE APPS TO REACT WHEN IN RANGE OF A SPECIFIC BUBBLE, LIKE DISPLAY A “*YOU ARE HERE*” MAP, EXTEND AN OFFER, COLLECT DATA OR GIVE INFO ABOUT A POINT OF INTEREST.
- THERE ARE PROTOCOL VARIANTS – iBEACON AND EDDYSTONE.

# Emergence of BLE Beacons in IoT

## BEACONS ARE NOT JUST FOR RETAIL

- ABI predicts 600M/yr in 2021
- ~500M are for IoT (e.g. asset tracking)
- <6M are for retail…
- Low-cost, low-power, standard protocols
- Same technology powering consumer devices like phones & wearables




*Coin beacon: bluecats.com*

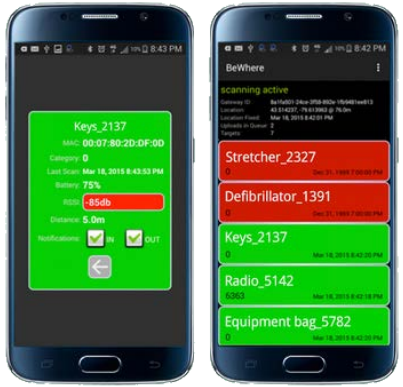
*Cow stomach sensor: wellcow.co.uk*


*Smart pallet: palletech.co*

# Locating IoT BLE Devices

## 1: USING MOBILES

- Vendor apps act as bridge between data logged by BLE IoT device and backend systems.
- More of an "ad-hoc" approach.
- Simple, but presents range, location and availability issues.




*bewhere.com*

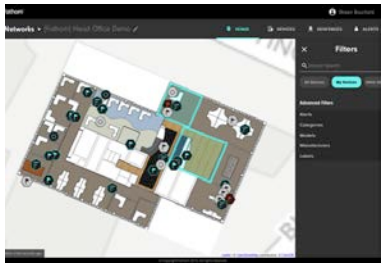
## 2: USING GATEWAYS

- Dedicated beacon/BLE gateway device connected to the cloud acts as permanent bridge to backend systems
- More of an infrastructure approach.
- Requires dedicated equipment, multi-protocol, power.
- For most vendors, location is just a proximity range rather than an absolute position.

*kontakt.io*

# Locating IoT BLE Devices with Fathom

## A LOCATION-AWARE GATEWAY INFRASTRUCTURE



### Fathom Control

- Cloud-based management UI (AWS)
- API for integration and data analytics
- Subscription-based access

### Fathom Hubs

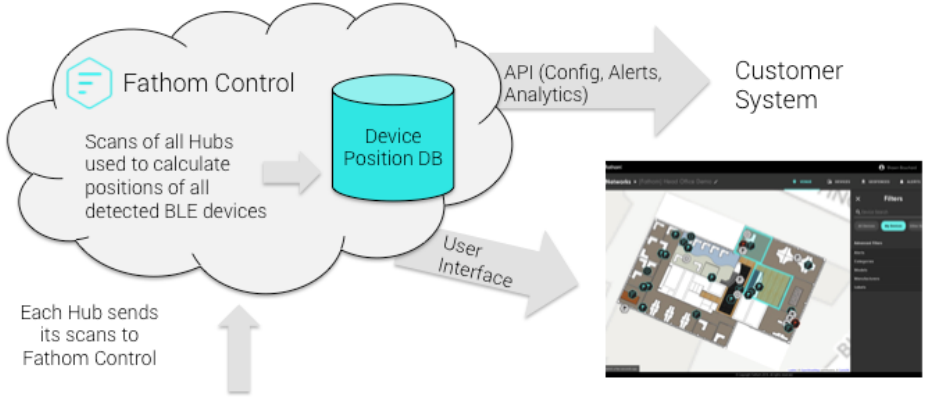
- Venue infrastructure equipment that establishes a location detection "umbrella" for any nearby BLE devices

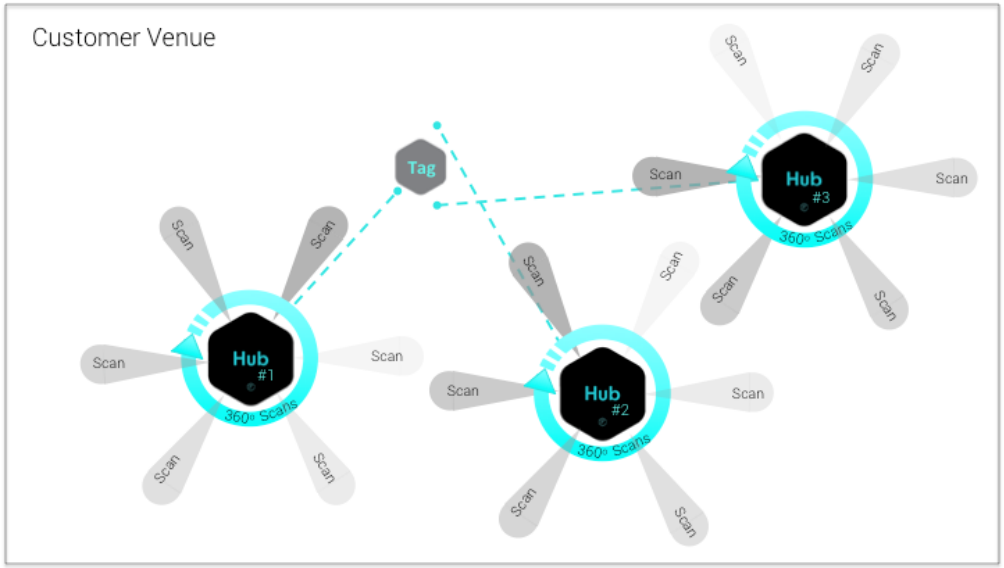
### Fathom Tags

- Industrial grade, remotely manageable beacons optimally integrated for positioning and remote management

## Fathom Hubs

- Advanced antenna array to locate beacons & BLE devices
- Simplified installation - automatic alignment and calibration
- Hubs communicate with each other for optimal positioning of BLE signals
- Collects and reports data for analytics
- Eddystone™ and iBeacon™ compliant
- Remotely manageable
- Ethernet/Wi-Fi connectivity
- Wall-powered or external PoE adapter
- Optional version with GPS/GNSS and environmental sensors (temperature, pressure, humidity)
- 2.5 meter P68 accuracy



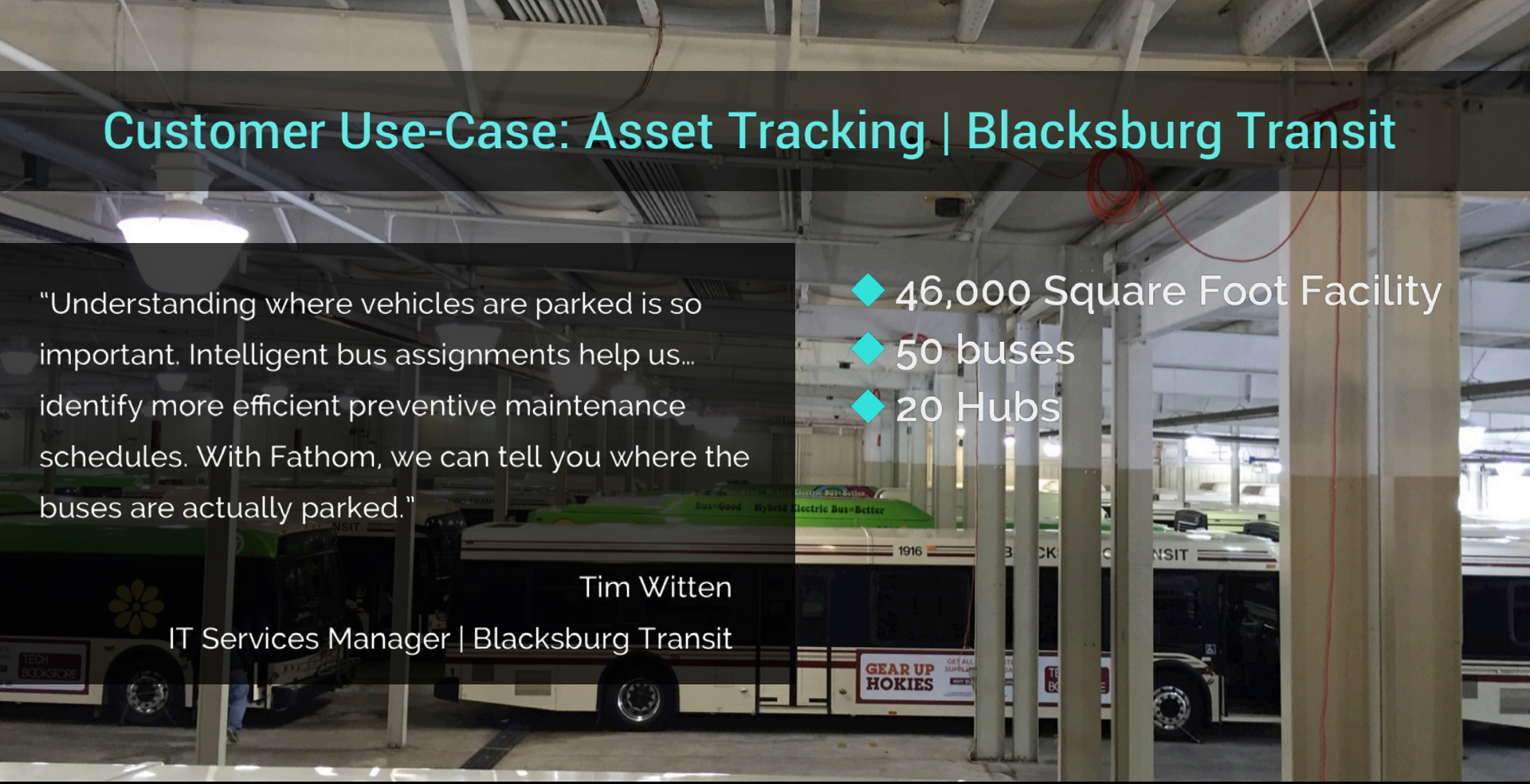



# BLE MARKET OPPORTUNITY IN IOT

- Asset tracking - **market revenues to reach $5.6B in 2021[1]**
- Presence detection and data analytics - **market revenues to reach $5.1B in 2020[2]**
- Reduction in labour intensive efforts to manage bluetooth beacons **(current annual operating costs – $300 per beacon[3])**

[1] Source: ABI Research Report
[2] Source: Markets and Markets Research Report
[3] Source: February 2016 Forrester Research Report

# Customer Use-Case: Asset Tracking | Blacksburg Transit




"Understanding where vehicles are parked is so important. Intelligent bus assignments help us… identify more efficient preventive maintenance schedules. With Fathom, we can tell you where the buses are actually parked."

Tim Witten

IT Services Manager | Blacksburg Transit

- 46,000 Square Foot Facility
- 50 buses
- 20 Hubs

# Blacksburg Transit: Bus Depot

- Fathom engineer walking around depot with standard BLE beacons in hand.
- All positioning & tracking performed by the Fathom system.

# Observations

- There is a BLE IoT “gold rush” underway:
  - BLE consumer technologies enable new, cheap & innovative IoT solutions.
- Enterprise IoT requires high reliability and availability:
  - Is the device still operating? Does it require updating?
  - For several use cases, location is a key data element. Is the device where it should be
  - Reliance on mobile-based gateway techniques should be carefully considered.
- Fathom fills a market gap in the ~2m accuracy range compared to RFID, WiFi and UWB.

- Looking ahead:
  - Multi-mode IoT devices (GNSS / BLE / UWB) for end-end supply chain tracking.
  - Advances in timing & synchronization (i.e. enabling sub-meter ranging with ToF).

# Q&A

fathom™

Location. Context. Intelligence.™

# THANK YOU

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