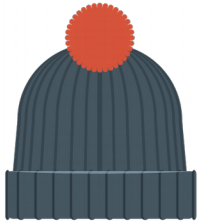
# How the Internet of Things is Improving Service and ROI for Emergency Services, Businesses, and Local Government.

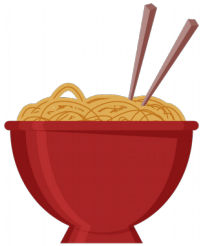
**Aaron Koning**
FME Server Product Manager
Safe Software

# Overview

Exploring the **Internet of Things**



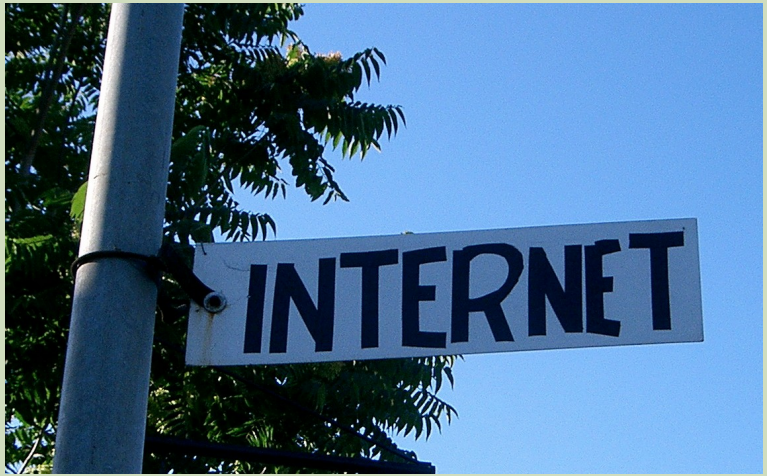
**Snowplows** - tracking location, displaying, analysing statistical information



**Food Trucks** - tracking location, providing real-time geofence analysis and notifications

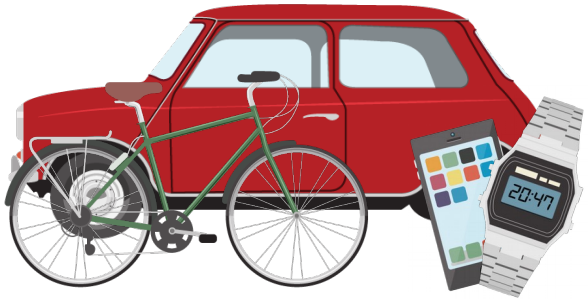
**Police Vehicle** Tracking - tracking location, providing real-time conflation of the route and directions

# Exploring the


# Internet of Things

# What is the **Internet of Things**?

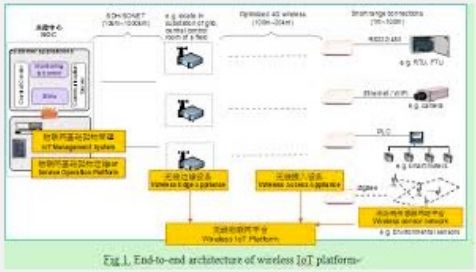



It enables everything to be **smart**

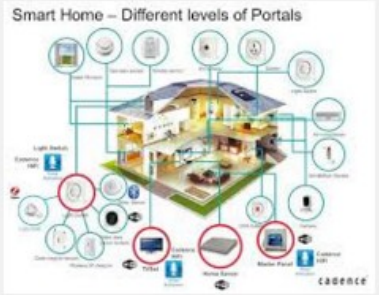
It operates in **real-time**

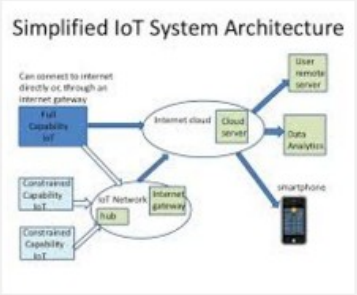
It is a **system**

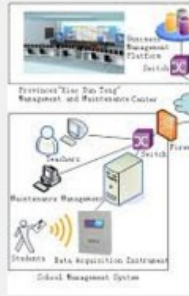
# The IoT system

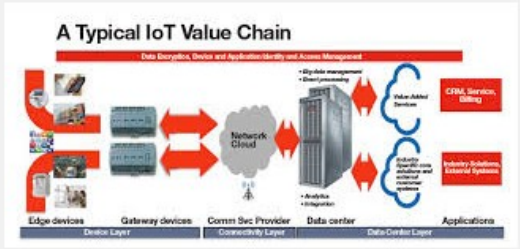


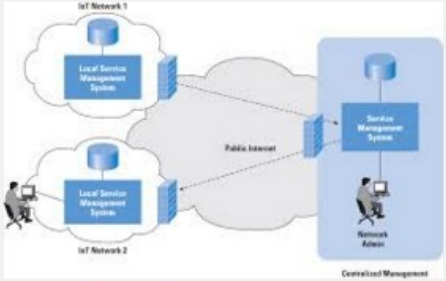




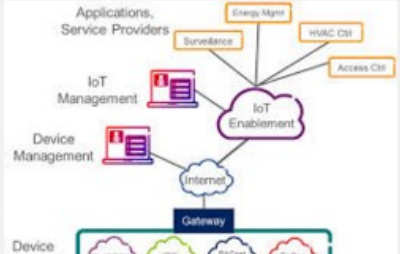







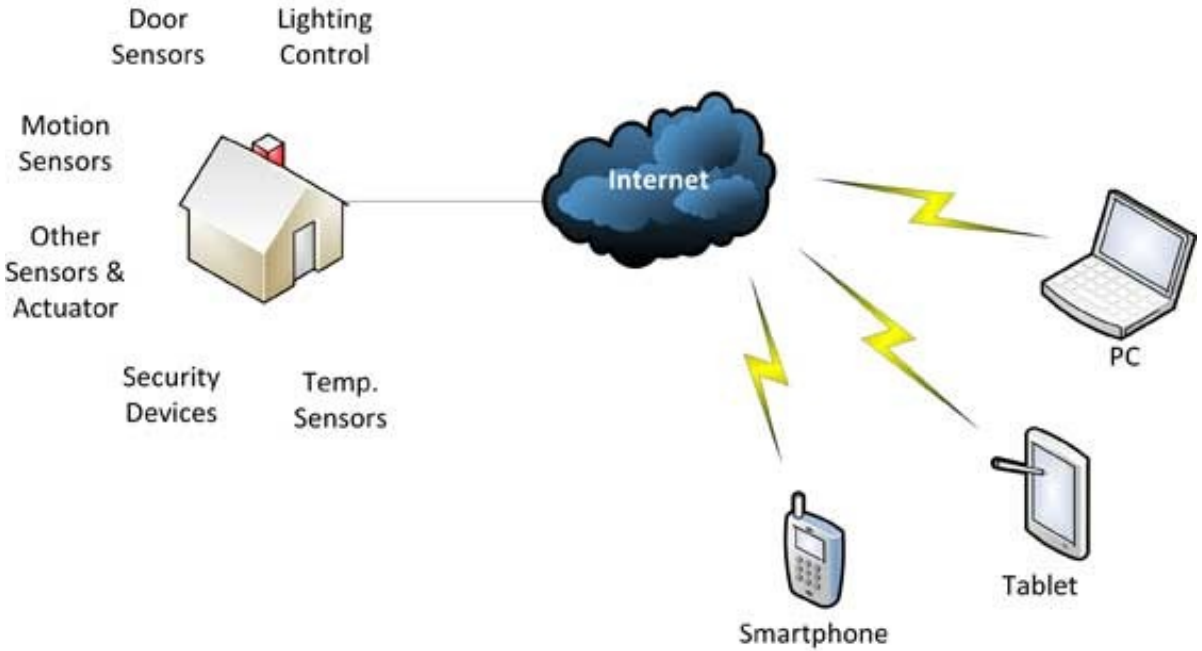




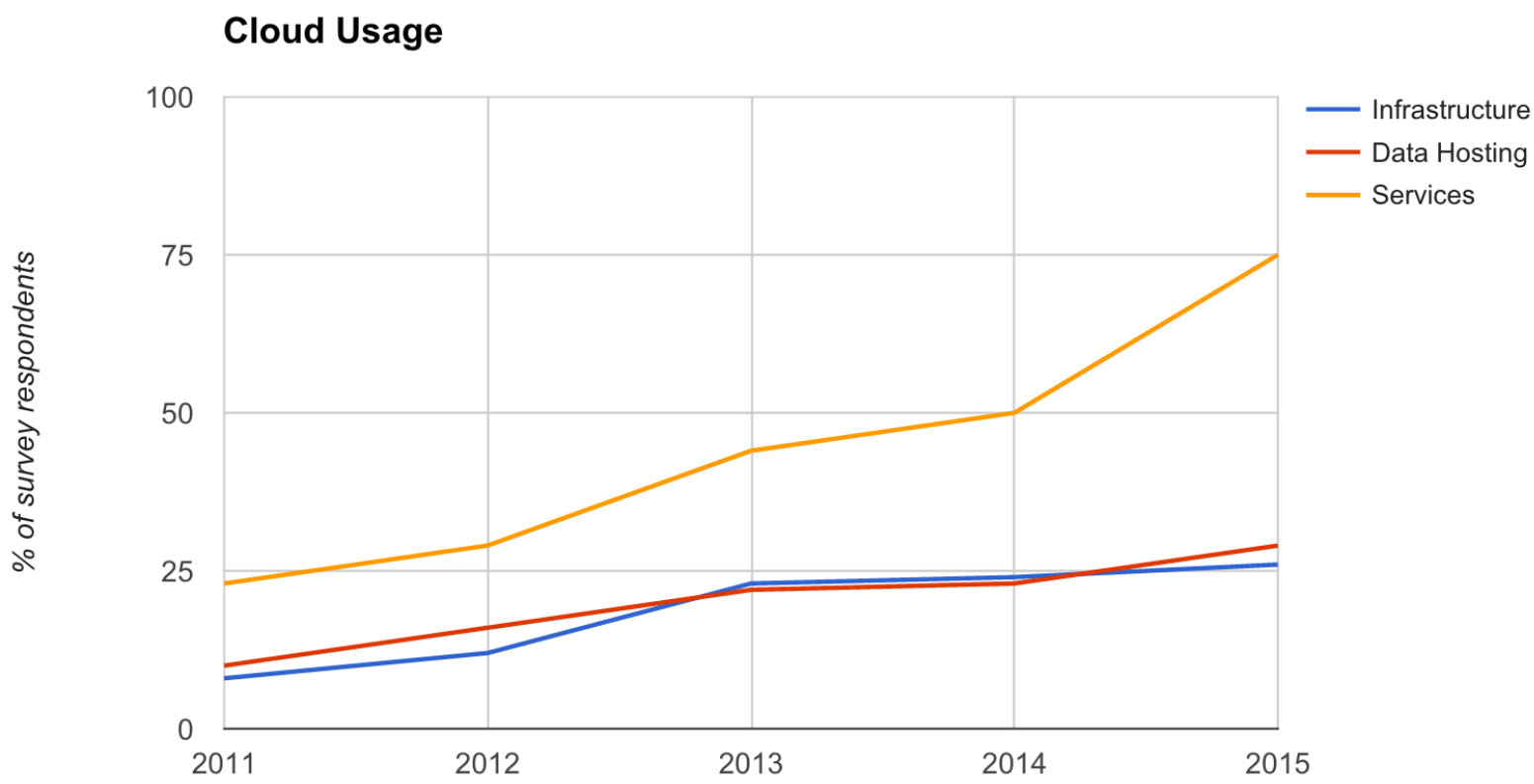


# The IoT system

| **Sensors**<br>data gatherers | **Machines**<br>provide the processing power | **Apps**<br>use the processed data |
|---|---|---|



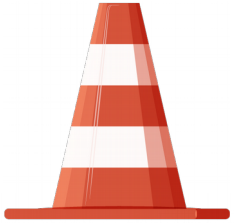
~~IoT Machines~~ IoT Cloud Services



# What problem is solved by the Internet of Things?

Well, it’s more about what it enables and the problems unimagined.

# Okay, but like what uses are imagined?



**Safety** - monitoring critical infrastructure for minute problem indicators.

**Environmental** - measuring resource use so that just what’s needed is used.

**Home** - scheduling and status from appliances, lighting, etc.

# Cool, now *where* does spatial come in?

Sensor arrangements:

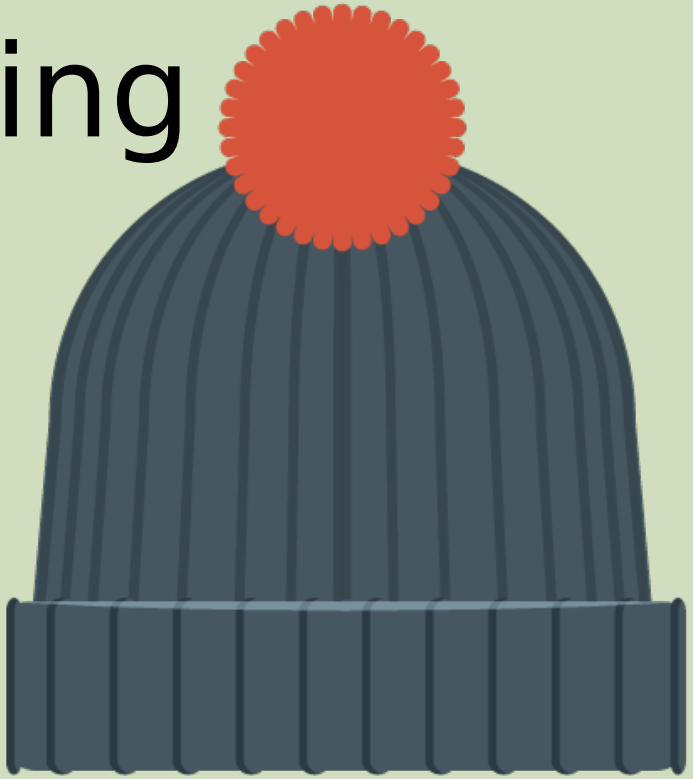
A series of **stationary sensors** - City of Chicago's Array of Things

**Moving sensors** - pedestrians, cyclists, planes, trains and automobiles

Sensor measurements:

Proximity, LiDAR, video (3D), stereo images (3D), location, bearing, elevation.

# Snow Plow Tracking



**Eric Abrams,**
Iowa State Department of Transportation

# The State of Iowa

Dangerous winter driving conditions:

| | |
|---|---|
| Roads | 9400 miles |
| Snow | 30-40 inches per year |

Iowa Department of Transportation (DOT):

| | |
|---|---|
| Snow plows | 901 |
| Brine | 15 million gallons |
| Salt | 200,000 tons |
| Money spent | Tens of millions of dollars |

# Iowa DOT Motivations

Save money

Enhance transparency

Enhance public safety

# Factoid:

The City of Vancouver

has many Snow Plows

# What did they sense?

Collect sensor data:

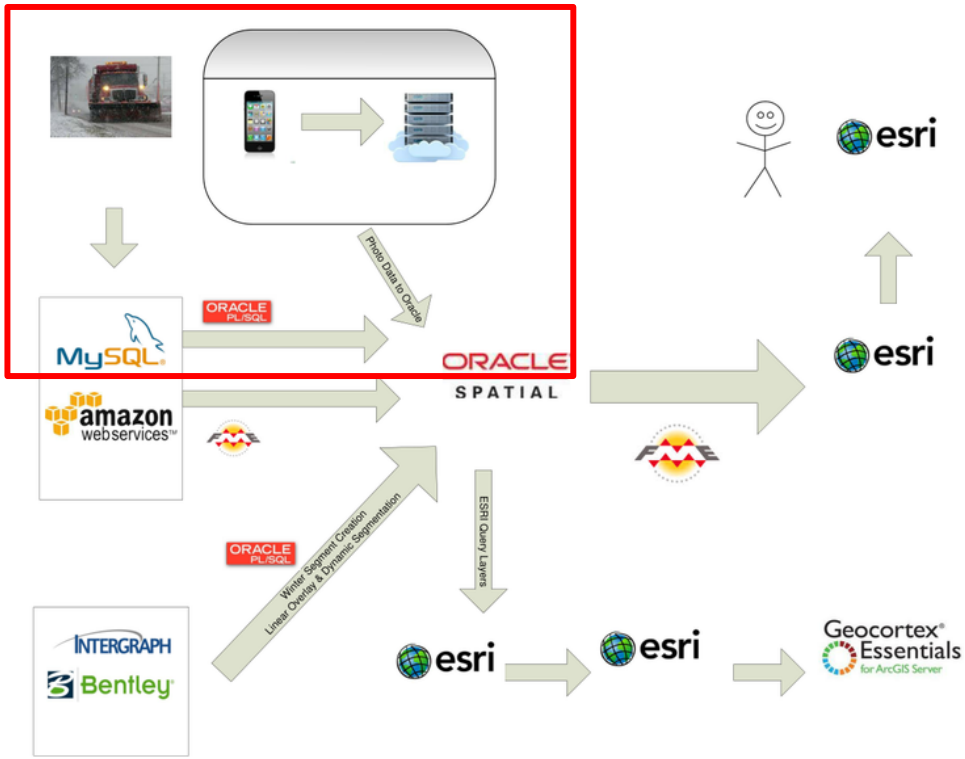
- Plow blade up or down
- Salt application rate
- Brine application rate
- Temperature
- Road temperature
- Location
- Image of conditions

# How did they process the data?

Photos are loaded into Oracle.

Measurements for active plows
loaded into MySQL in the cloud.

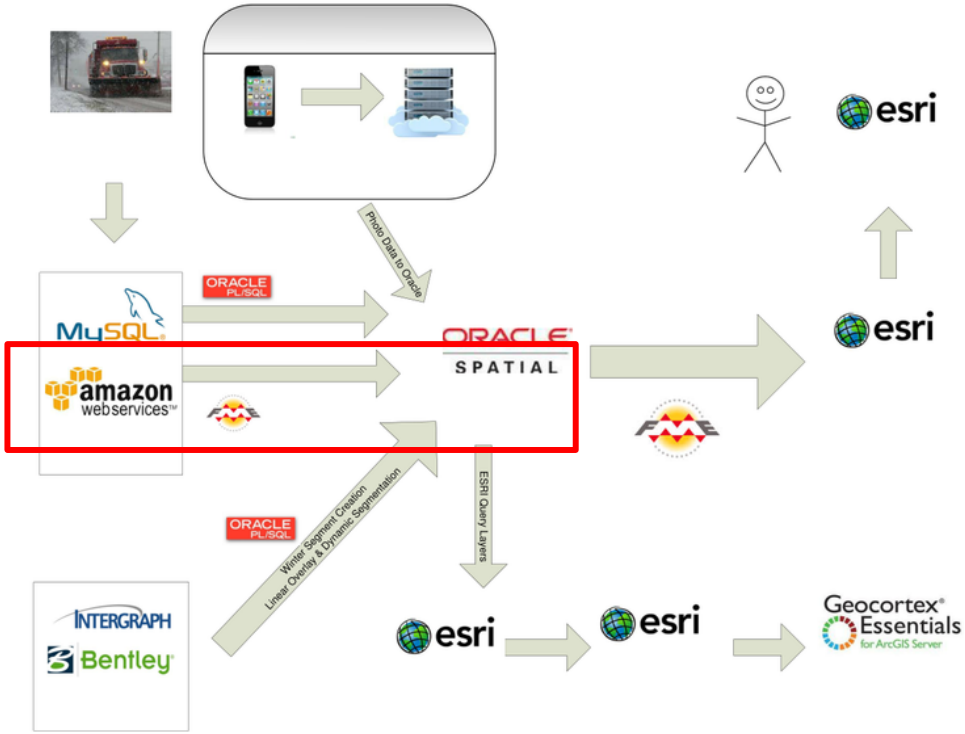
Active plow measurements requested from a MySQL via a web service every minute.



# How did they process the data?

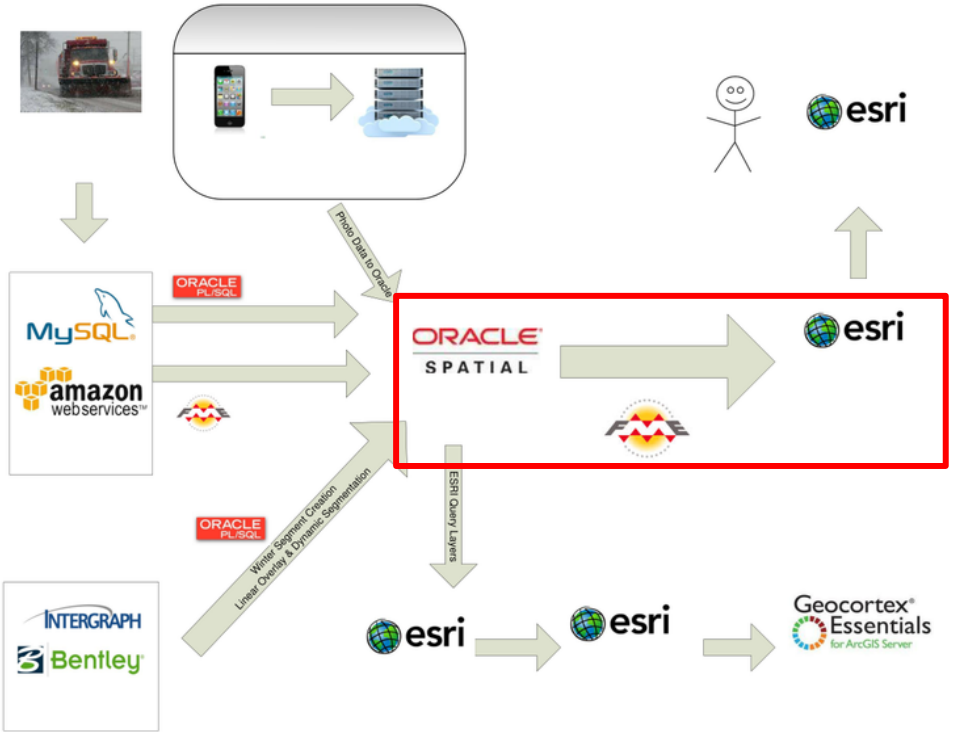
Complete set of measurements
is read from MySQL and loaded
into Oracle every 30 minutes.

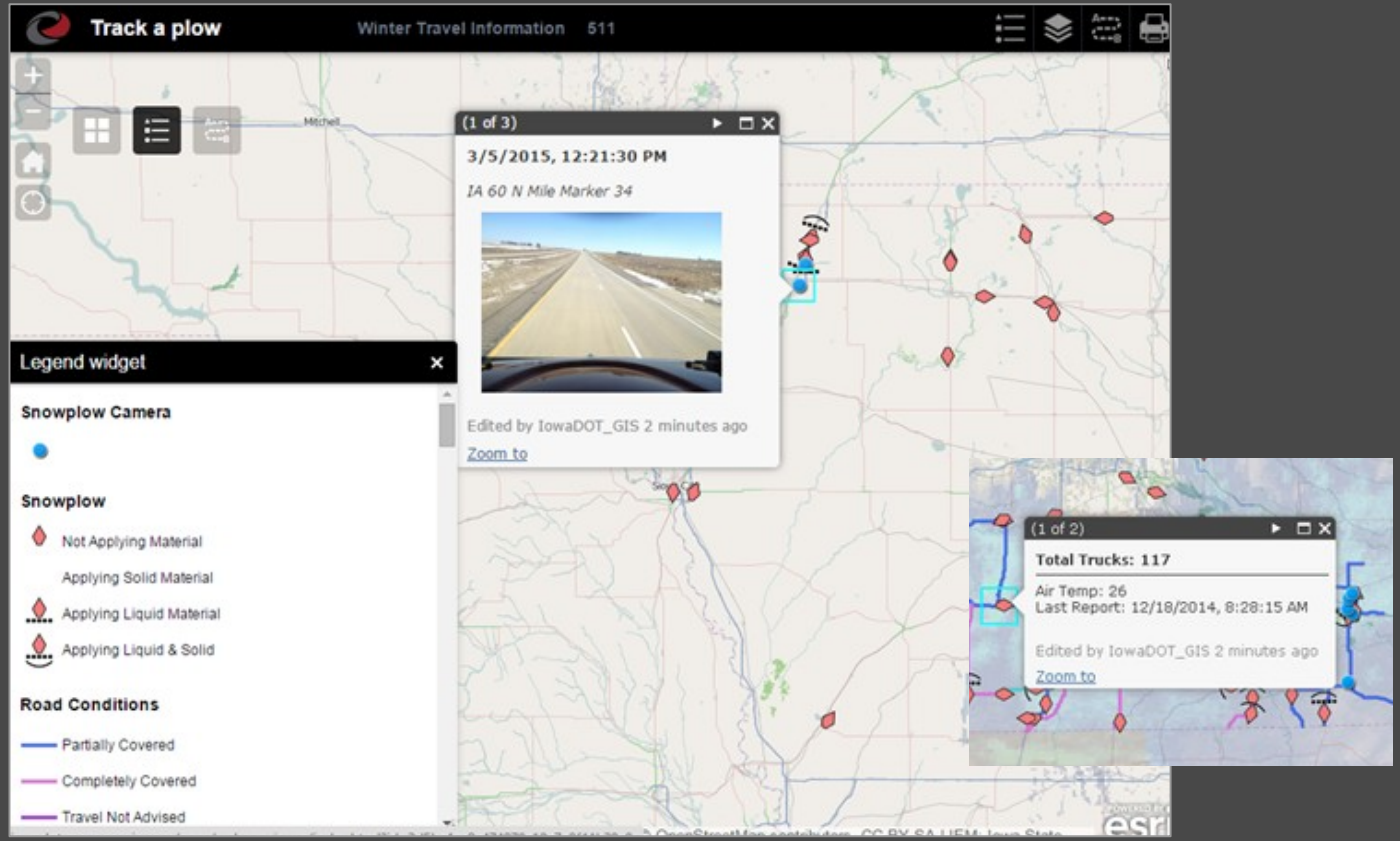
Statistics are generated to show
usage per road over time.

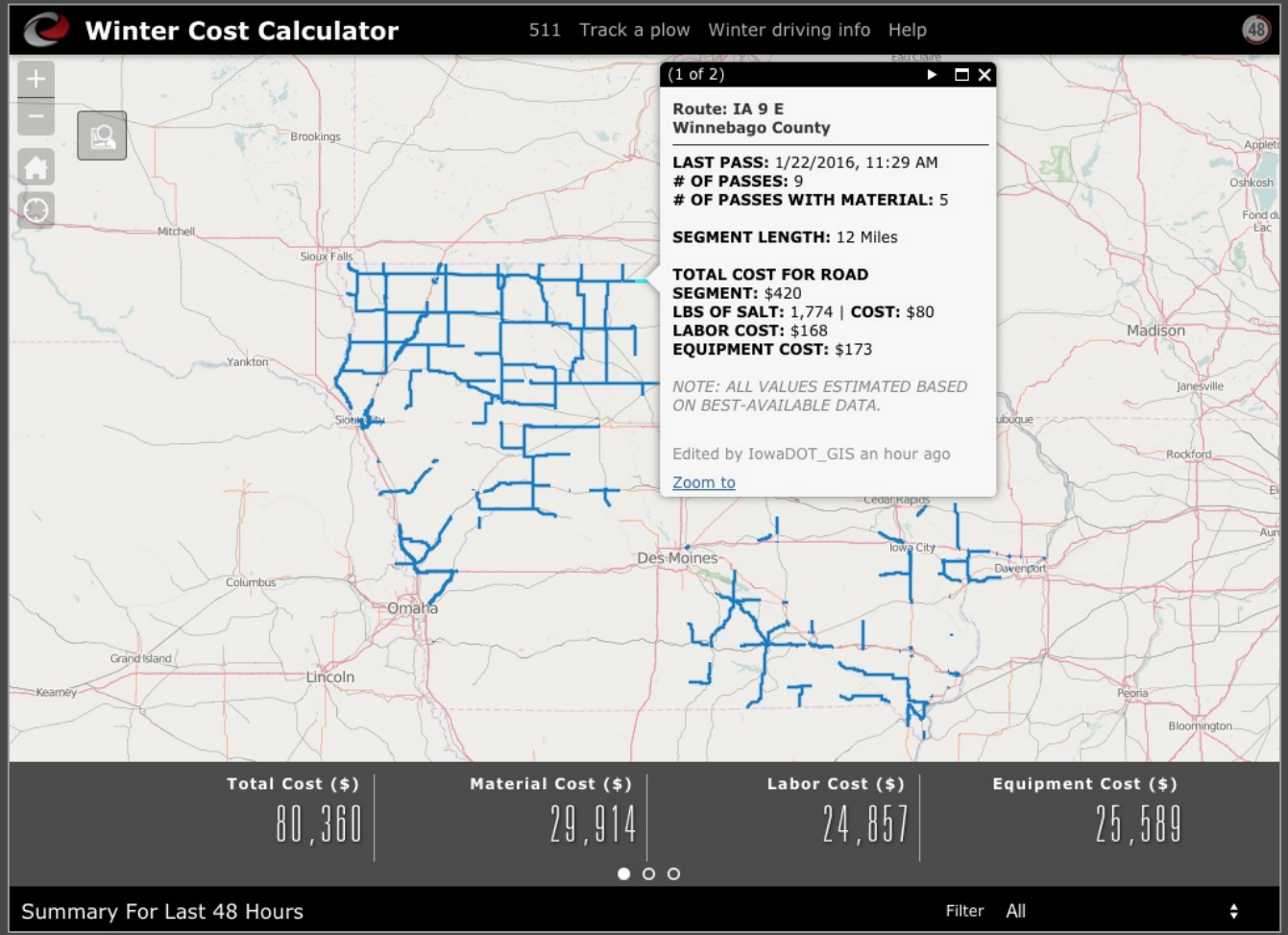


# How did they process the data?

Data is loaded to ArcGIS Server
from active plow measurements,
every minute.




Track a plow
Winter Travel Information
511
Mitchell
(1 of 3)
3/5/2015, 12:21:30 PM
IA 60 N Mile Marker 34
Edited by IowaDOT_GIS 2 minutes ago
Zoom to
Legend widget
Snowplow Camera
Snowplow
Not Applying Material
Applying Solid Material
Applying Liquid Material
Applying Liquid & Solid
Road Conditions
Partially Covered
Completely Covered
Travel Not Advised
(1 of 2)
Total Trucks: 117
Air Temp: 26
Last Report: 12/18/2014, 8:28:15 AM
Edited by IowaDOT_GIS 2 minutes ago
Zoom to


Winter Cost Calculator
511
Track a plow
Winter driving info
Help
48
(1 of 2)
Route: IA 9 E
Winnebago County
LAST PASS: 1/22/2016, 11:29 AM
# OF PASSES: 9
# OF PASSES WITH MATERIAL: 5
SEGMENT LENGTH: 12 Miles
TOTAL COST FOR ROAD SEGMENT: $420
LBS OF SALT: 1,774 | COST: $80
LABOR COST: $168
EQUIPMENT COST: $173
NOTE: ALL VALUES ESTIMATED BASED ON BEST-AVAILABLE DATA.
Edited by IowaDOT_GIS an hour ago
Zoom to
Brookings
Mitchell
Sioux Falls
Yankton
Madison
Janesville
Rockford
Cedar Rapids
Iowa City
Davenport
Des Moines
Columbus
Omaha
Grand Island
Lincoln
Kearney
Peoria
Bloomington
Total Cost ($)
80,360
Material Cost ($)
29,914
Labor Cost ($)
24,857
Equipment Cost ($)
25,589
Summary For Last 48 Hours
Filter
All

View conversation

Retweeted by Statewide Iowa 511

**KWWL Storm Track 7** @KWWLStormTrack7 · Mar 1
Look from @statewideia511 plow. This is on HWY 144 south of Fort Dodge. This heavy snow band is tracking southeast. pic.twitter.com/lNMXLgdBFr

Expand

**Statewide Iowa 511** @statewideia511 · Mar 1
Tow Ban lifted Poweshiek County @ 02:31am (3-1). Current Status at full feature version 511ia.org

Expand

**NWS Des Moines** @NWSDesMoines · 6h
1242am, @iowadot plow showing US 65 completely snow covered from Mason City to the MN/IA border. #iawx #drivesafe pic.twitter.com/uwdw0R8UrL

Expand

**INRIX ®** @INRIX · 10h
RT @KHONnews: Study: Honolulu second worst city for traffic dlvr.it/54BVB7 #808news

# Return on Investment

Save money

A 10% reduction in salt equates to $1.4 million savings.

They observed that $6.40 is saved per $1 spent on this system.

Enhance transparency

Instantly see expenditures for your road, your area, the entire state.

Enhance public safety

See what areas have been services.

# Food Truck Tracking

**Christian Heisig**
con terra


# The Dilemma

Food trucks arrive to business parks at **different times** each day.

Typically they **honk to alert** patrons of their presence.

Sometimes patrons don’t hear the honk and worse, some areas **forbid honking**.

# Motivation

# Survival

*(or at least sustenance)*

**Or perhaps it's just not wanting to hear your colleague complain nonstop about missing his or her favorite japanese hot dog fusion lunch that they were looking forward to but couldn't have because of the loud air conditioning that is blasting at full power in the middle of winter I mean why can't they figure that out anyway if we can land on the moon we can figure out how to regulate air flow and don't get me started...**

**... please get this person a Japadog ASAP.**

# Solution

Send a **notification to your phone** when the Food Truck has arrived.

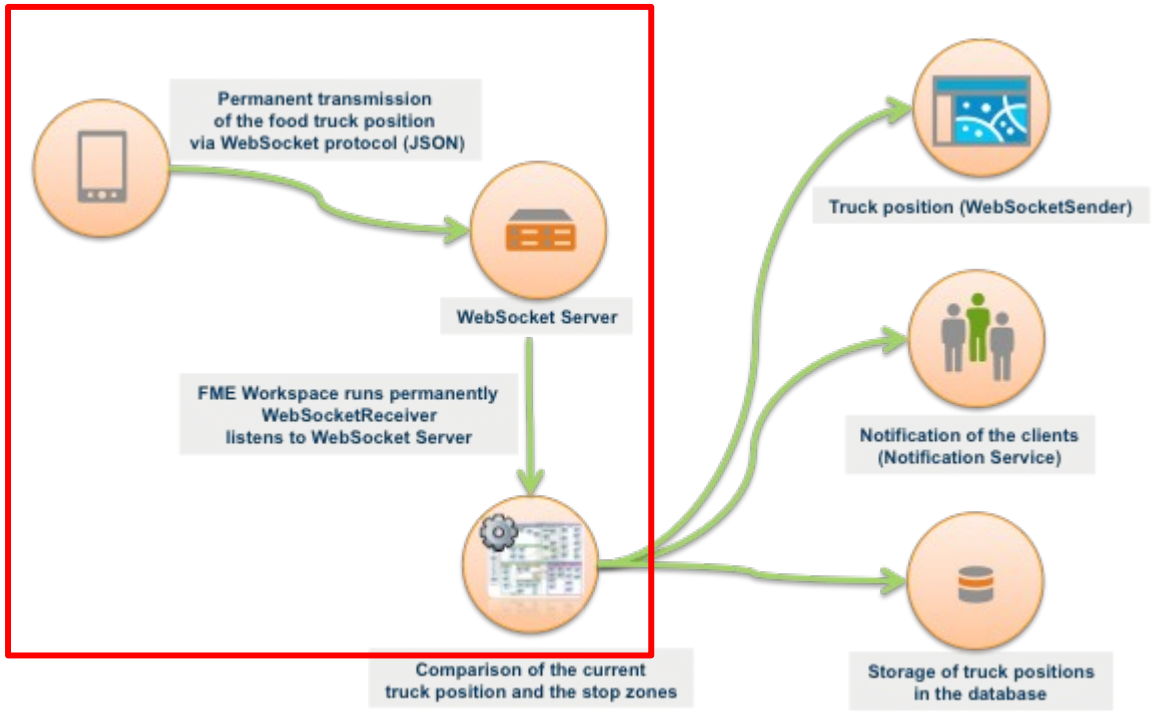
# What did they sense?

Food Truck location

# How did they process the data?

Location of the Food Truck is sent to a transformation service.

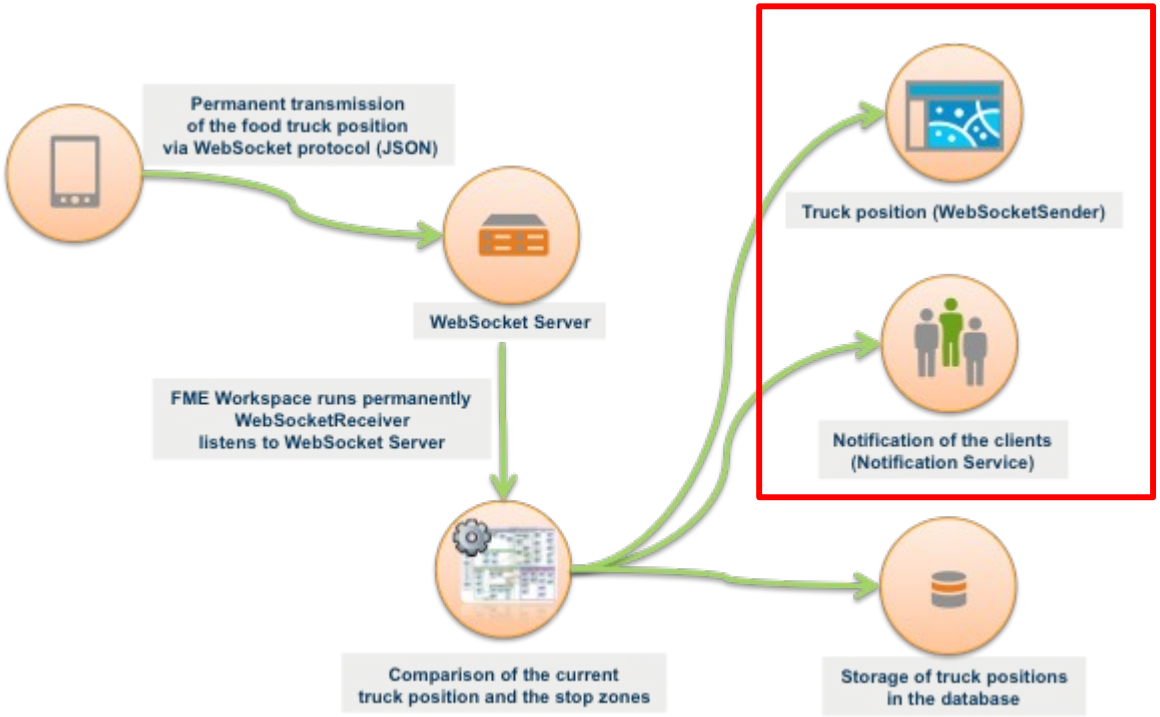
The location is compared to a list of known stop areas.



# How was the data used?

Patrons are sent **notifications** if they signed up for a stop where a Food Truck is located.

The Food Truck positions are displayed on a **web map**.



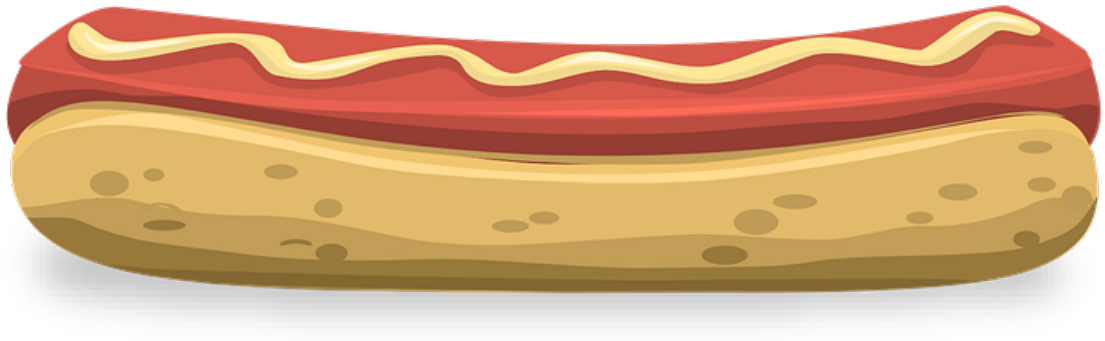
# Benefits

Patrons **choose** what food trucks and stops they care about.

Patrons know **immediately** when they can eat.

Patrons can see what **options** are available at anytime.

Food Truck businesses have a new method of **advertising**.



# Challenge

On-Premises **enterprise software is too costly** for the tight margins of the Food Truck industry.

# Alternative - consumer app concept

Swarm by Foursquare

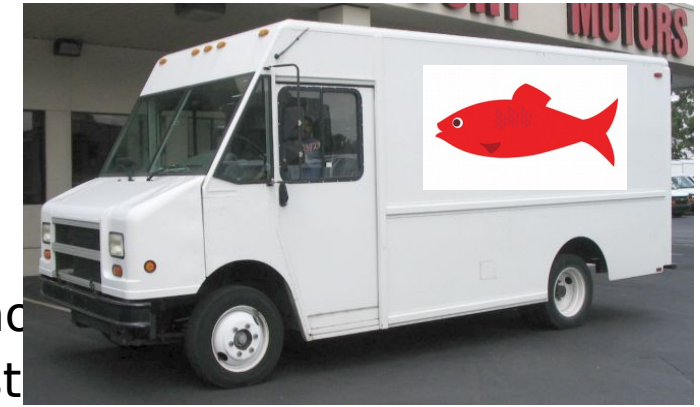
An app for check-in

Notification signup built in

Might forget to manually check-in, but there are apps that auto check-in based on location.

# Consumer app challenges

Food Trucks sometimes drive by stops on their way to others, before returning later.



Need to track speed or duration in stop zone

If a Food Truck leaves, there is no way to kno there is no check-out. No concise map or list current options.

Need to track if in the stop zone. Real-time is a better experience.

No control over the service which may change or at worst, shutdown at anytime.

# The right fit

A service that can **consume, process and serve data *for your needs*** with all the benefits of the cloud including cost savings.

An Integration Platform as a Service (**iPasS**) enables the development of these purpose-built services.

# Police Vehicle Tracking

**Dr. Martin Huber,**
Condesys Consulting


# Police Department in Germany

50 police vehicles

Existing system in place - vehicles send their locations to a server every 1 minute.

Vehicles are heading to destinations that are unknown to the control center.

# Goal

**Enhance the control center** by allowing staff to reroute or advise the driver if there is congestion along their route.

This will require **predicting the route** the vehicle is likely to travel **without knowing the destination.**

# Challenge

First they need to know where the vehicle has been.

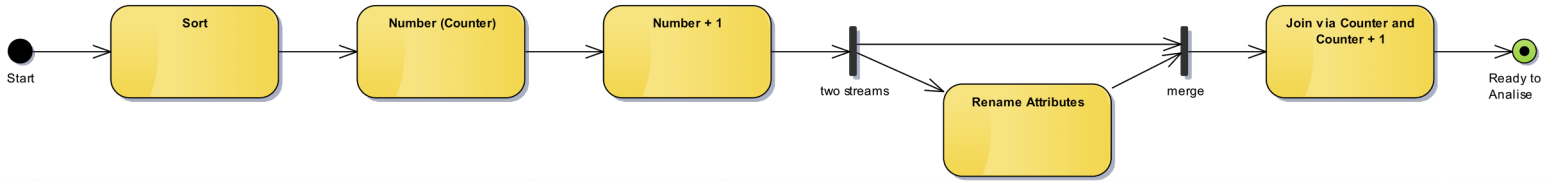
GPS is not always the most accurate.

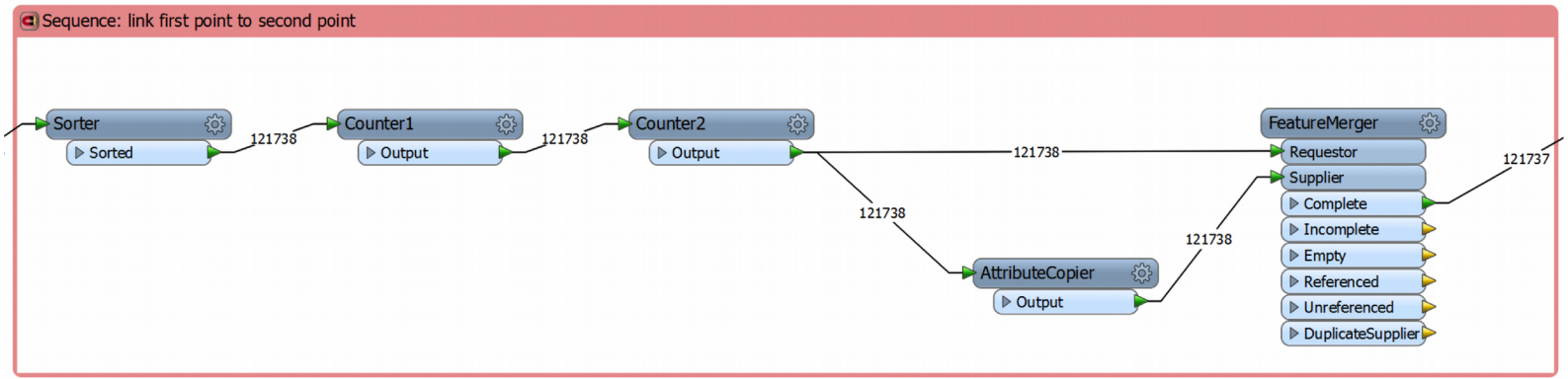
# How did they process the data?

Invalid GPS locations need to be removed:

A network is created from the points.

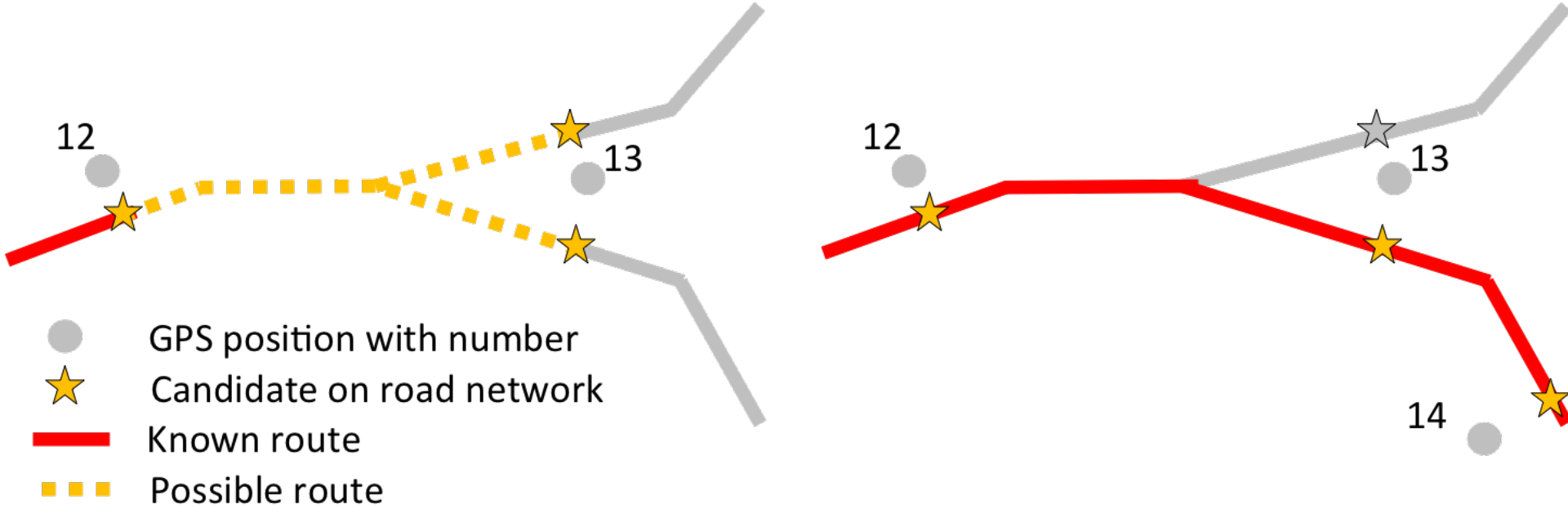
Speed is calculated for each segment. Absurd speeds indicate invalid points.



# How did they process the data?

Reported GPS locations need to be attributed to a single road.



# How did they process the data?

Predict the future route using fuzzy logic including variables such as **change in direction**.

Gemäss Kapitel 3.2, Annahme 3, gilt die Abweichung aus der Trendrichtung als erstes Indiz für den künftigen Wegverlauf. Dafür wird das Azimut von $p_{nm}$ bestimmt und mit der Trendrichtung verglichen. Die Folgende Klassierung wurde empirisch festgelegt:

**Tab. 1 Klassierungselement ‚Richtung'**

| Klasse | Abweichung | Bemerkung |
|---|---|---|
| 1 | <= abs(45°) | Entspricht der Trendrichtung unter Berücksichtigung der allgemeinen Unsicherheit in den Daten. |
| 2 | > abs(45°) AND <= abs(135°) | Entspricht einer bewussten Richtungsänderung. |
| 4 | > abs(135°) AND <= abs(180°) | Entspricht der entgegengesetzten Richtung, beispielsweise bei einer Kehrtwende. |

# How did they process the data?

**Distance** is another variable used to predict the vehicle's future route.

Folgt man Annahme 1 und 2 in Kapitel 3.2, so stellt die Distanz zwischen Ausgangspunkt und Ziel einen weiteren wichtigen Indikator für die Zielprädiktion dar. Je weiter ein Knoten vom Ausgangspunkt entfernt ist, desto unsichererer wird die Prognose, beziehungsweise desto unwahrscheinlicher ist der Knoten ein potenzielles Ziel. Das Klassierungselement ‚Distanz' ergibt sich aus $p_{nm}$, wobei die Klassengrenzen auch in diesem Fall empirisch definiert wurden:

**Tab. 2 Klassierungselement ‚Distanz'**

| Klasse | Länge $p_{nm}$ | Bemerkung |
|---|---|---|
| **1** | <= 200 m | - |
| **2** | > 200 m AND <= 400 m | - |
| **3** | > 400 m AND <= 600 m | - |
| **4** | > 600 m | - |

# Results

The results of processing the data through the prediction model are a series of most likely routes with probability indicated visually.

The call center now has a tool that they can use to assist colleagues in the field.

# And then

This project was an interesting proof-of-concept, but what does it indicate?

It’s interesting to consider that simply sensing things and relating them to known data may not be the end of the Internet-of-Things.

Having this additional wealth of **measurements** combined with the computing power of the **cloud** can make for some unbelievable **real-time predictive analytics**.

# Super Roomba

Imagine your Roomba running a **predictive model** to determine:

**best path to take**, days of the week and time-of-day to operate

based on:

a pattern of day-to-day **measurements** and observations such as electricity use and obstructions

*Self Aware Roomba note:*

*I detect extra load and obstructions when the cat and baby are awake. Wait until they are asleep from now on.*

# How the Internet of Things is Improving Service and ROI for Emergency Services, Businesses, and Local Government.

**Thanks for listening!**