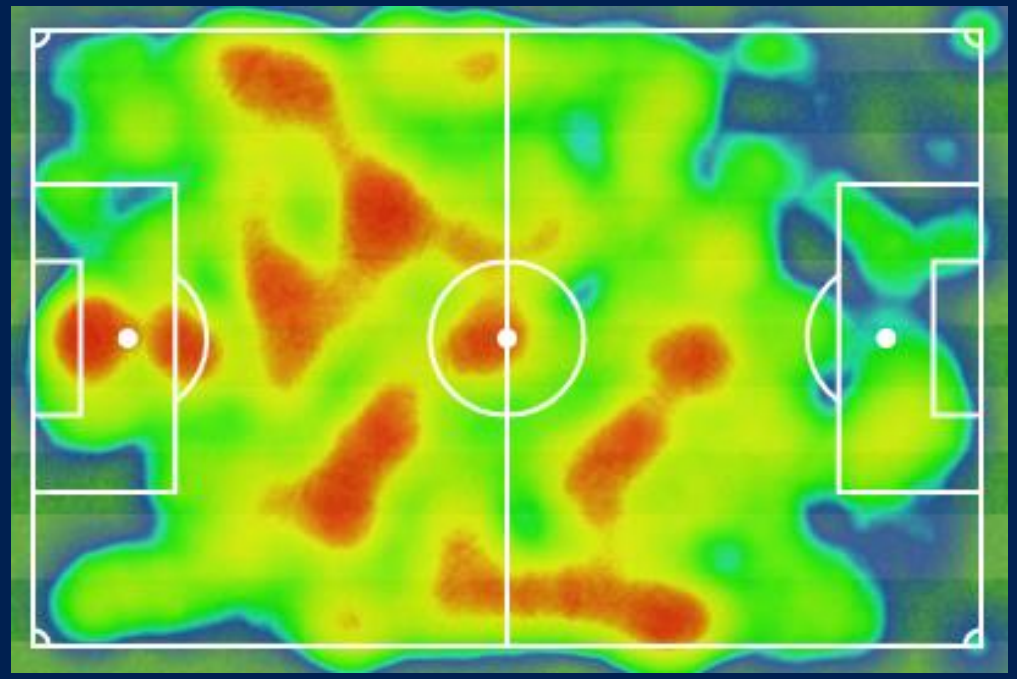
Pushing the Boundaries of IoT
- Some Insights & Samples-

Marcel Tilly
MSR ATL Europe
Senior Program Manager

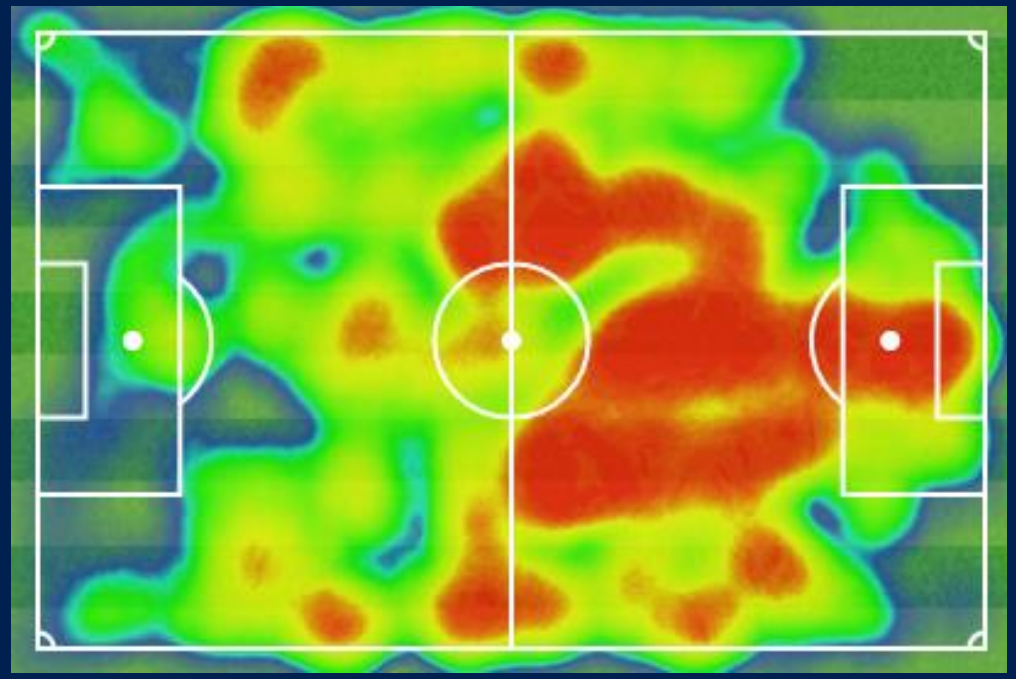
Microsoft

Hoffenheim 2

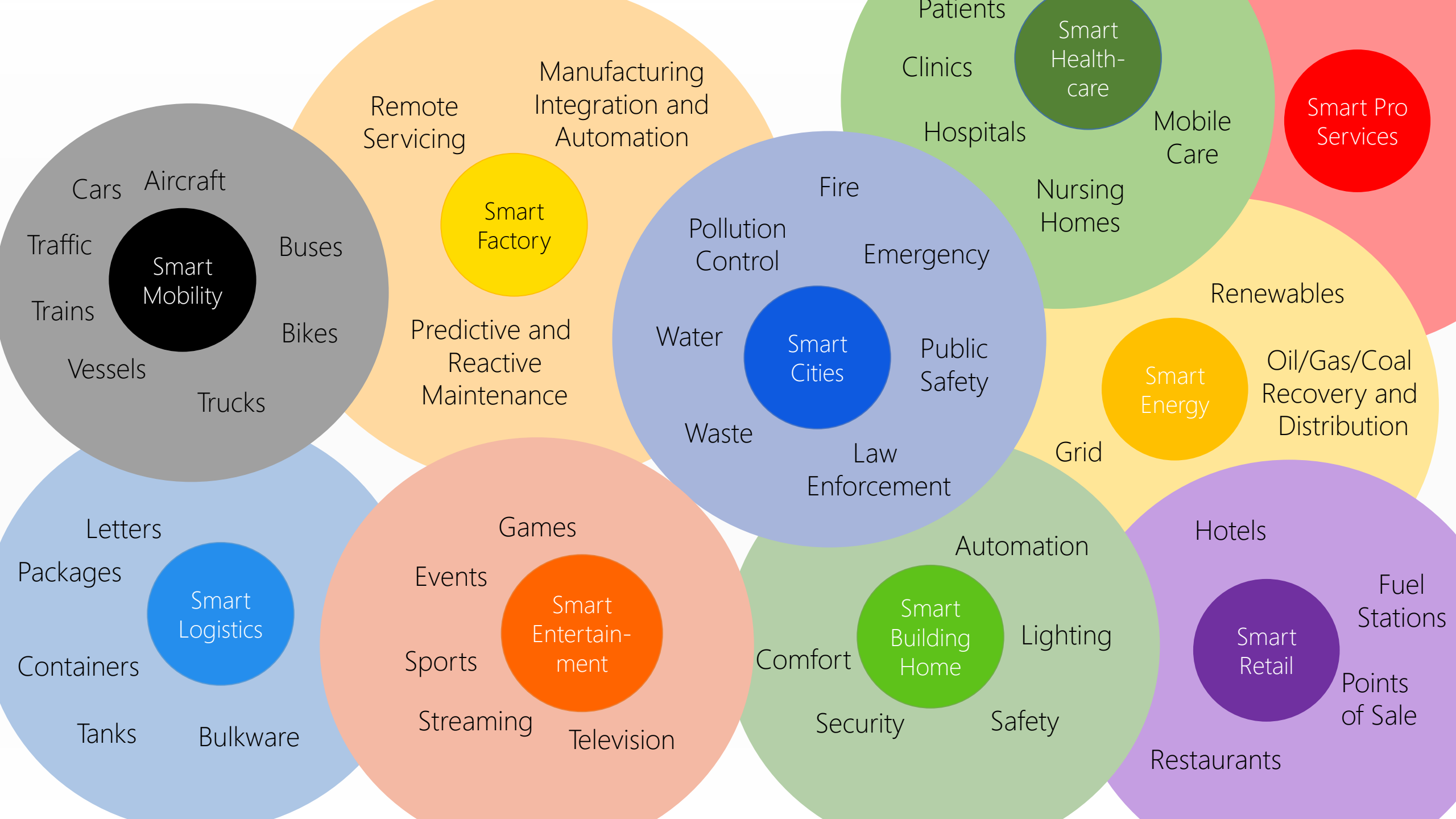
Schalke 1



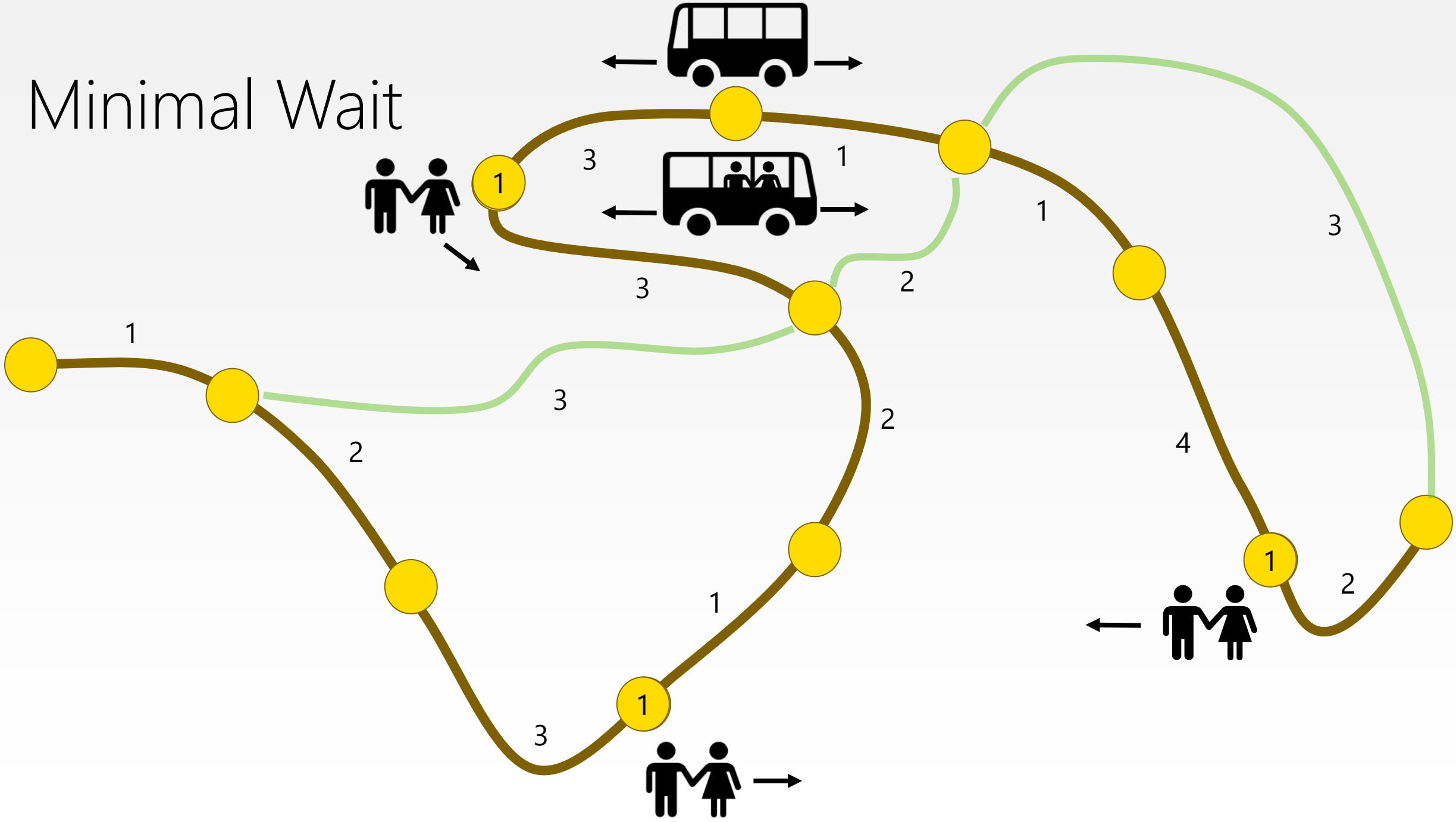
Hoffenheim



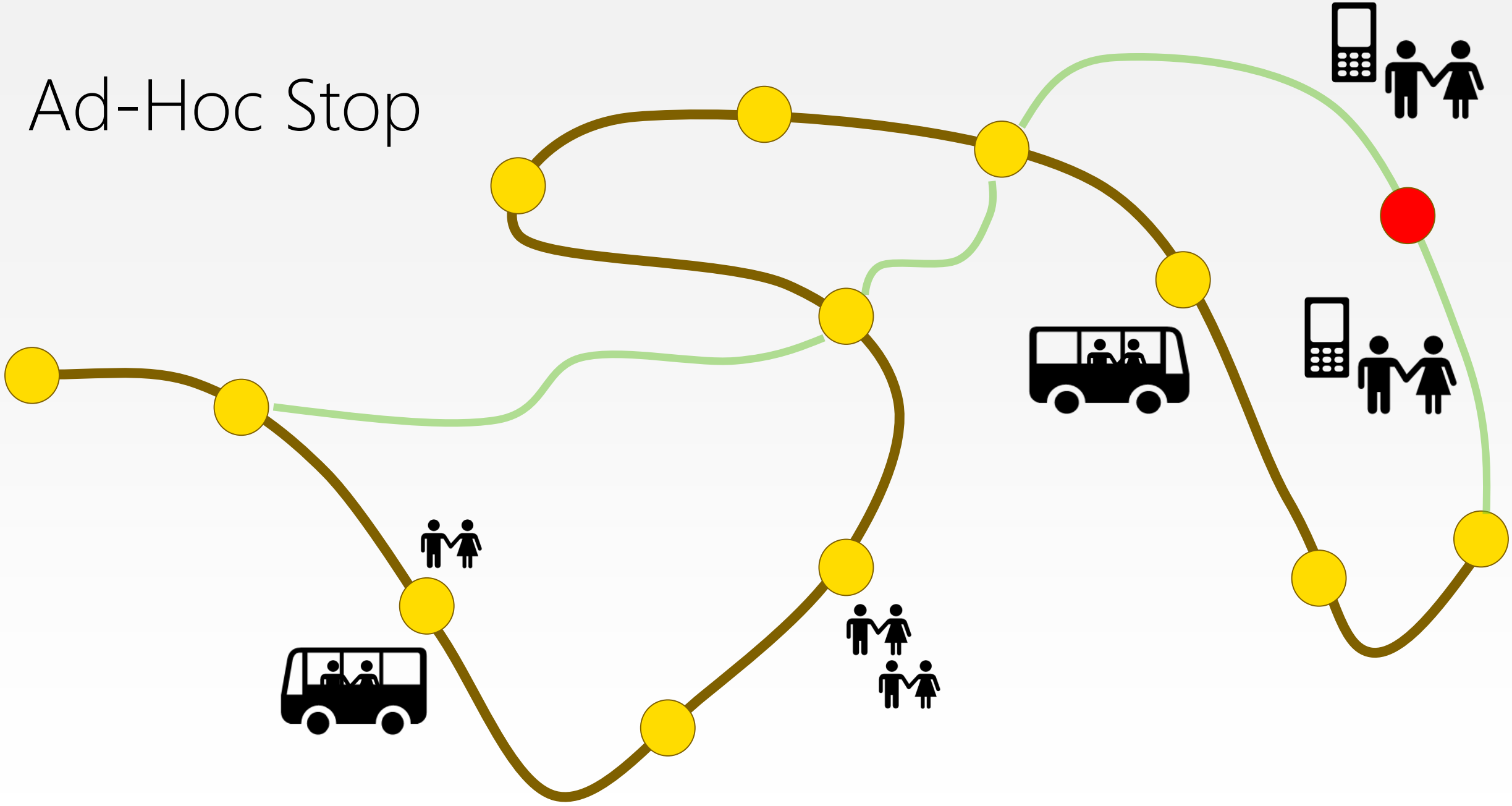
Schalke


Smart Mobility
Cars
Aircraft
Traffic
Buses
Trains
Bikes
Vessels
Trucks
Smart Factory
Remote Servicing
Manufacturing Integration and Automation
Predictive and Reactive Maintenance
Smart Health-care
Patients
Clinics
Hospitals
Mobile Care
Nursing Homes
Smart Pro Services
Smart Cities
Fire
Pollution Control
Emergency
Water
Public Safety
Waste
Law Enforcement
Smart Energy
Renewables
Oil/Gas/Coal Recovery and Distribution
Grid
Smart Logistics
Letters
Packages
Containers
Tanks
Bulkware
Smart Entertain-ment
Games
Events
Sports
Streaming
Television
Smart Building Home
Automation
Comfort
Lighting
Security
Safety
Smart Retail
Hotels
Fuel Stations
Points of Sale
Restaurants

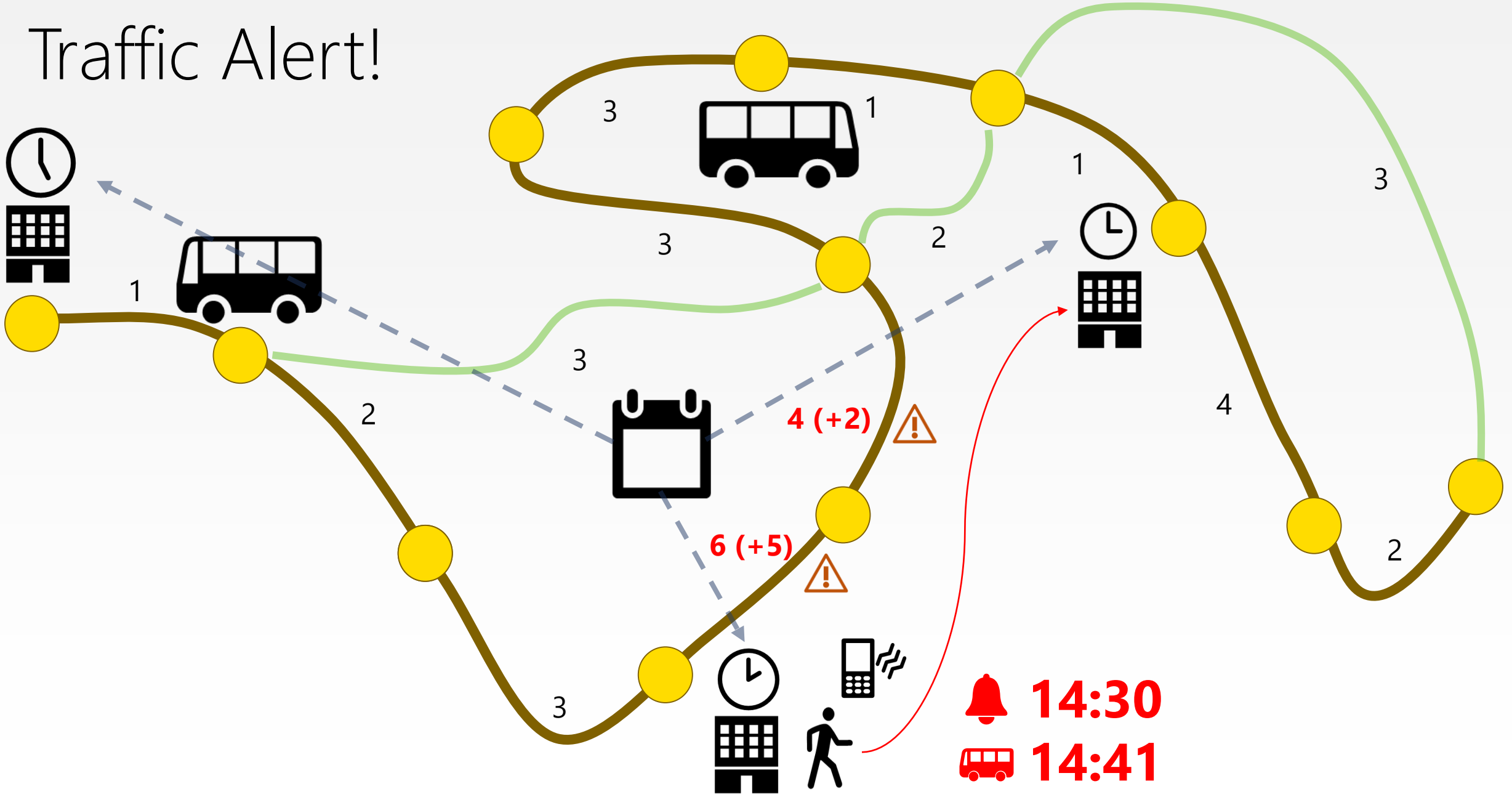
Minimal Wait



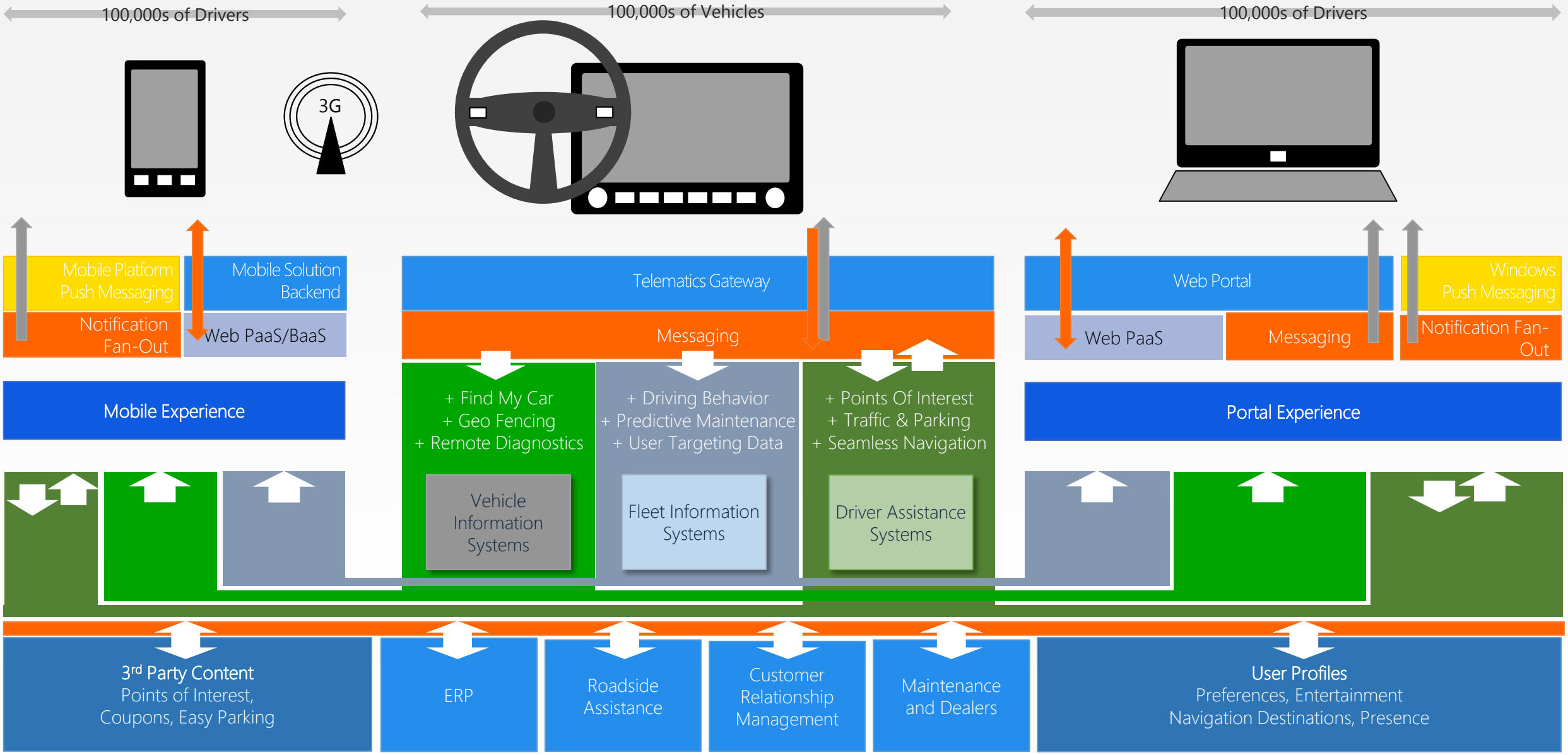
Ad-Hoc Stop



Traffic Alert!



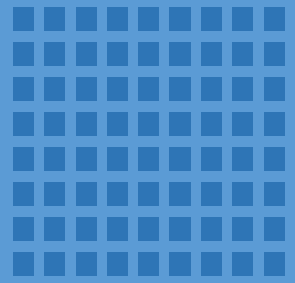
Scenario Architecture – Vehicles



Scenario-Enabling Technologies

Data Storage, Analysis, and Machine Learning

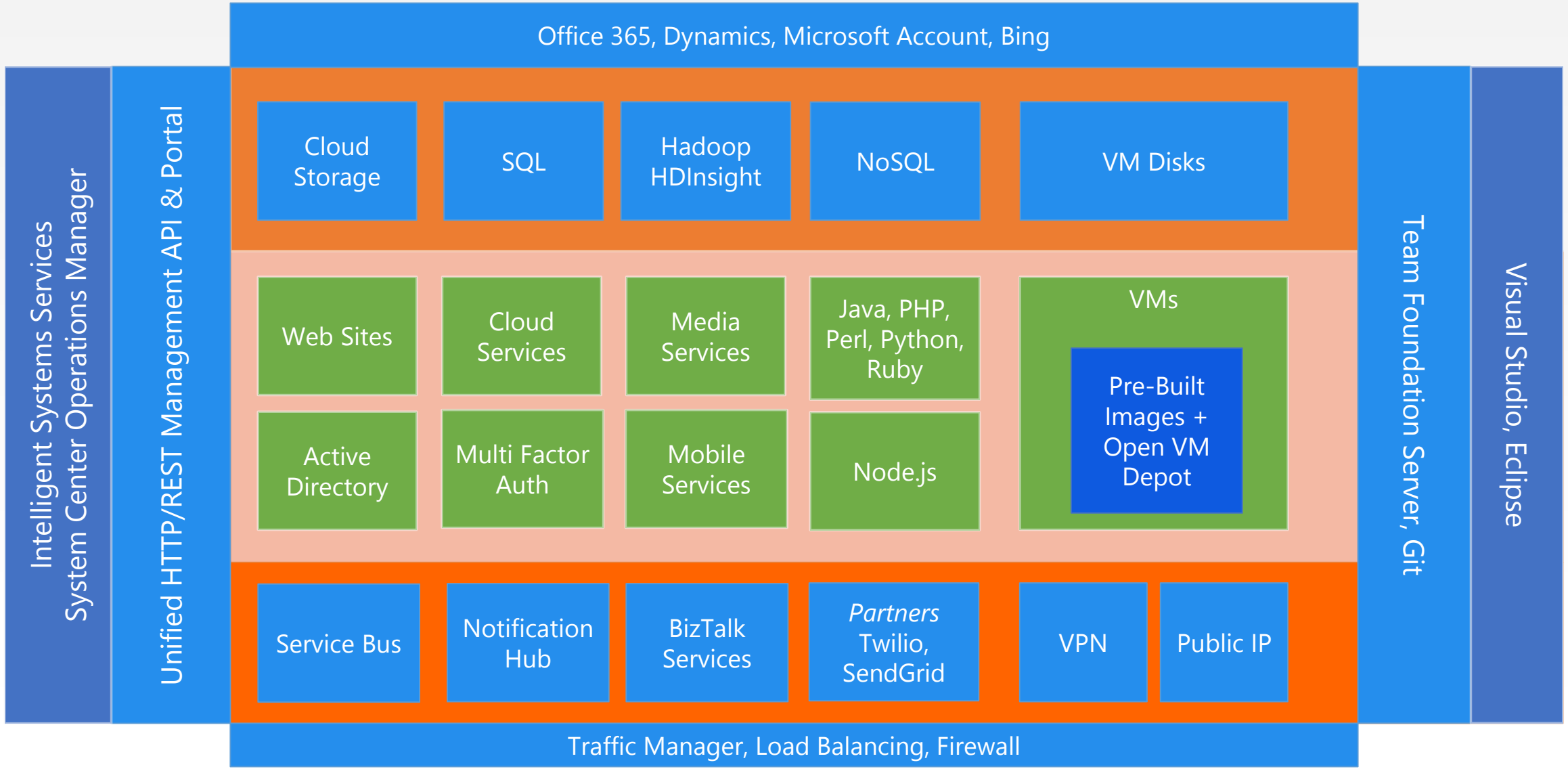
Service-Assisted Trustworthy Communication



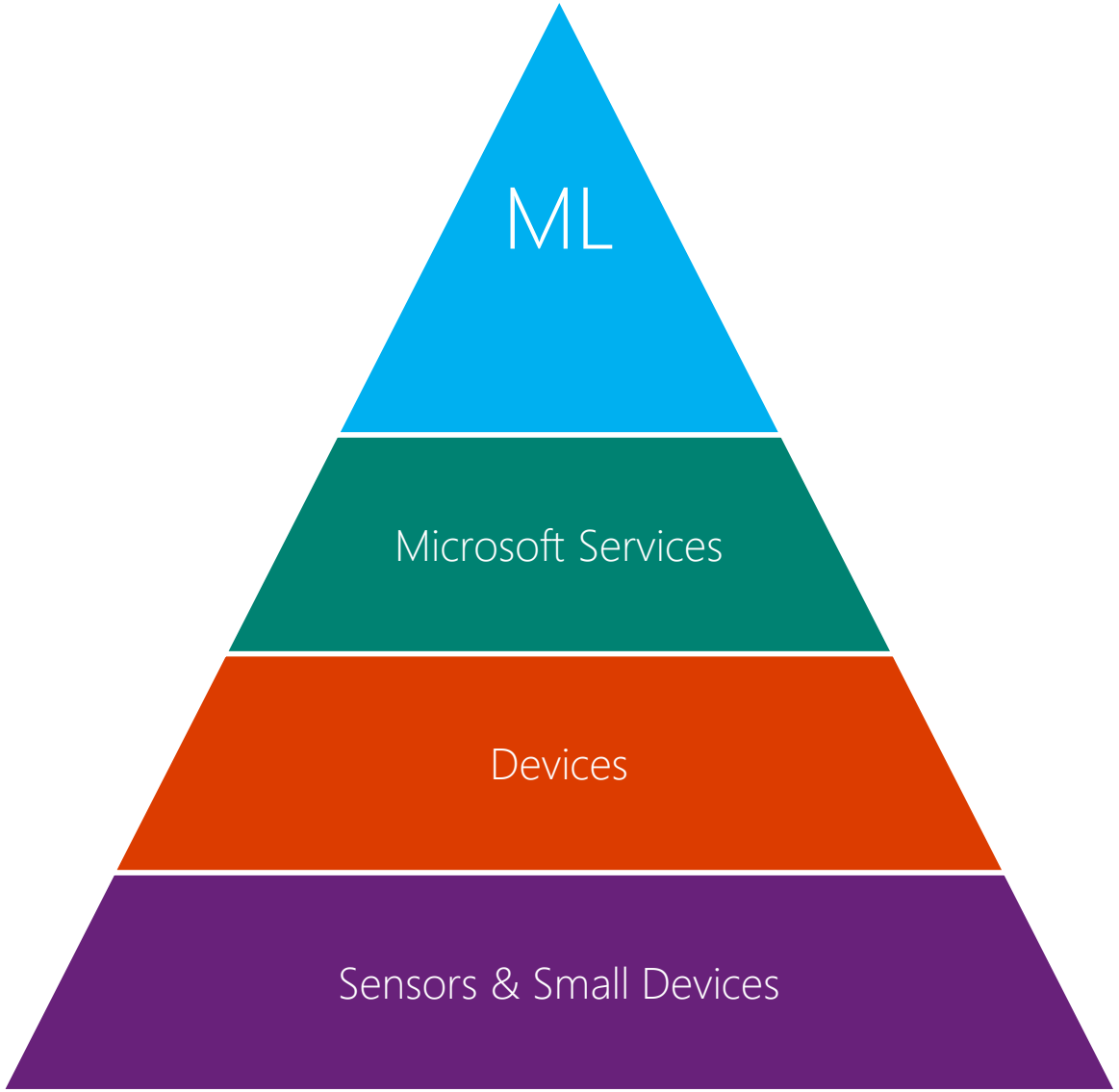
Actor-Based High-Scale Computing

Federated Identity and Access Control

Microsoft Azure as IOT Platform



Microsoft Research



Current Research

IoYT

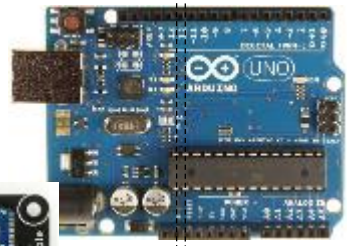
Current Research

How far can we walk this line?

Windows
Intel /ARM
> 1GB RAM

Compact-Windows
ARMv7 Architecure
ARM Cortex A
256MB RAM

Sensors, Hubs, Wearables, future devices
ARM v7 architecture
ARM Cortex M3
min. ~20MB
Limited hardware (no MMU,
no EFI, ….)



Sensors
ARM Cortex M0 class, MIPS
Not limited to ARM v7
Very limited memory

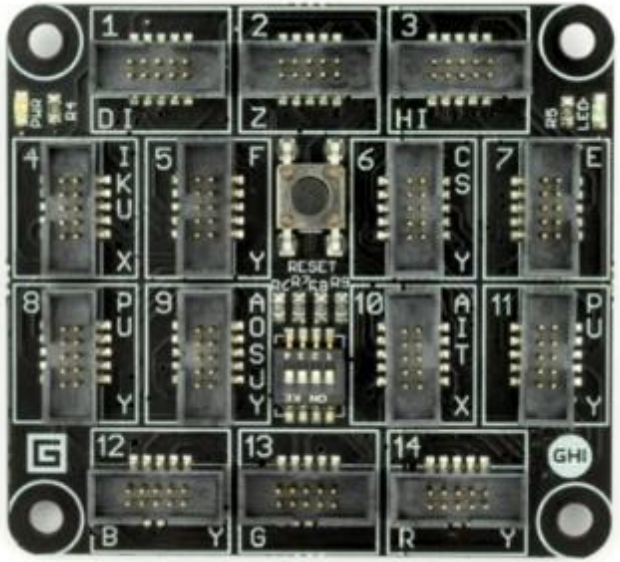
Microsoft

The .NET Gadgeteer Hardware

Microsoft .NET | Gadgeteer

At the heart of every Gadgeteer project is a mainboard.

A mainboard is made up of a programmable processor, and a number of sockets that Gadgeteer modules can plug into.

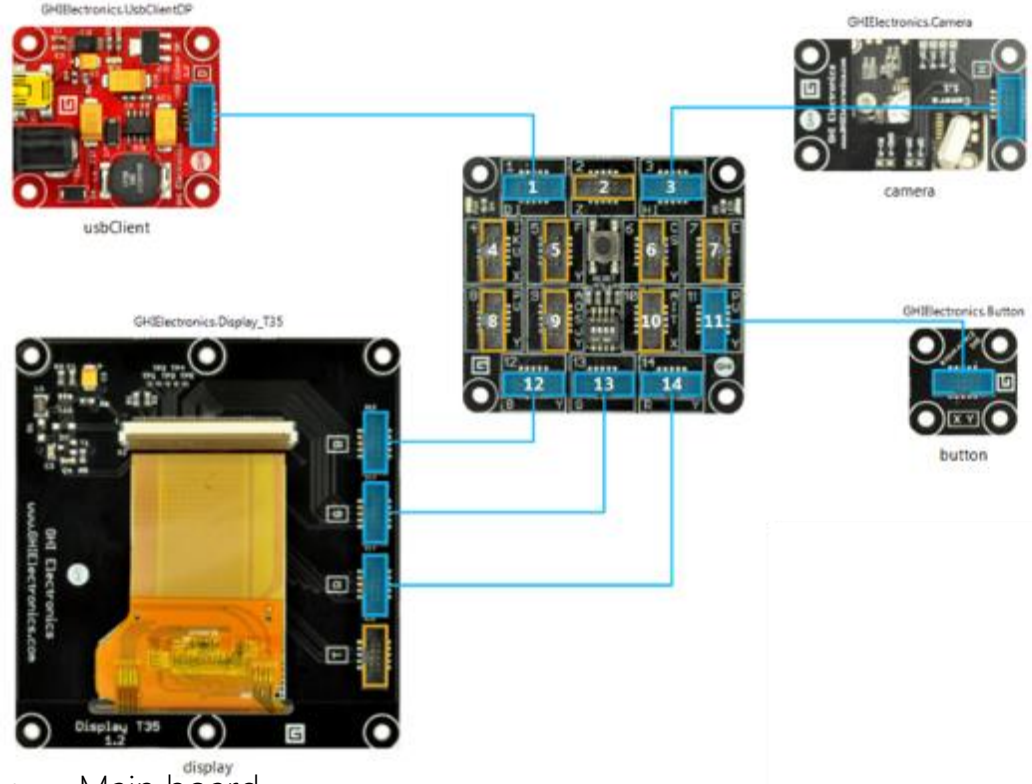


Microsoft

Constructing a Digital Camera

Microsoft .NET | Gadgeteer

What components will we need to make a camera like this one?

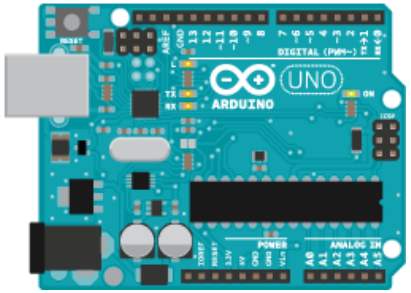


- Main board
- Power board
- Screen
- Button
- Camera module

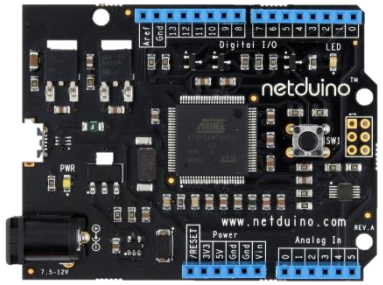
Microsoft

DIY – What is available?

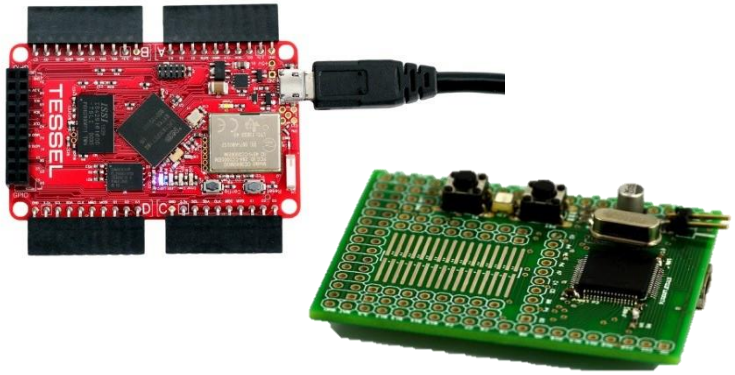
C



.Net



JavaScript



Linux

Python, Mono, C, JavaScript, Haskell, …

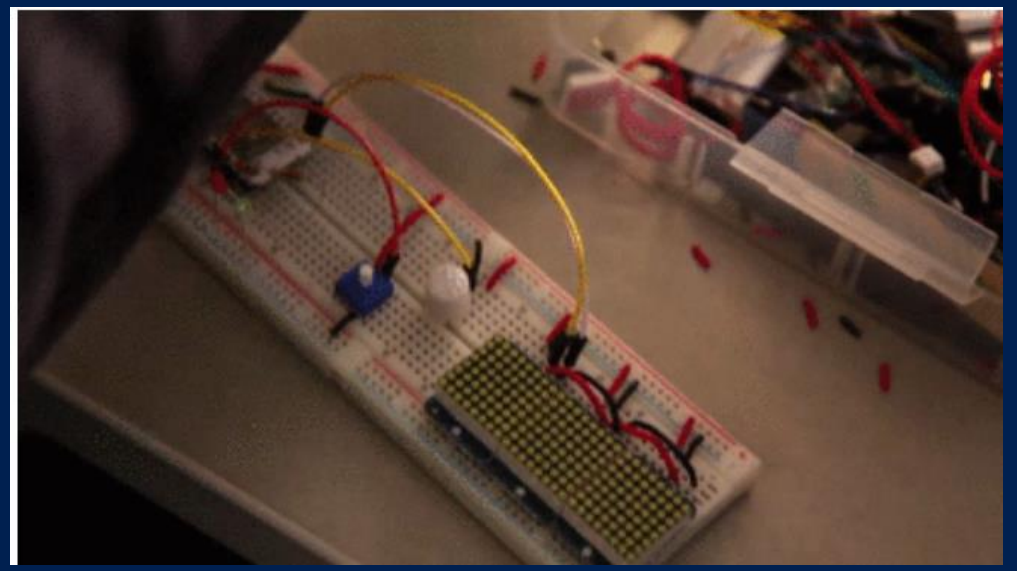
Windows

.NET, C, JavaScript, …

DIY – SPARK

A tiny Wi-Fi development board that makes it easy to create internet-connected hardware.

- The Spark Core served as our connected brain.
- Display the temperature on a few Adafruit 8x8 LED matrices.
- A primary temperature and humidity sensor
- Panasonic PIR motion detector.



www.spark.io

MSR ASIA (Jingbo Shang, Yu Zheng, Wenzhu Tong, Eric Chang, and Yong Yu)
http://research.microsoft.com/pubs/217455/frp0542-zheng-final.pdf

Inferring Gas Consumption and Pollution Emission of Vehicles throughout a City

Congestion and traffic jams cause drivers to waste gas, which on a mass scale causes greater air pollution that impacts on the environment and people's health. This study inferred the gas consumption and pollution emission of vehicles traveling on a city's road network, using GPS trajectories generated by a sample of 32,000 taxicabs in Beijing over a period of two months.

http://urbanair.msra.cn/

Windflow: AI Takes to the Skies

- Research question: “Could we take the information that was already available and use it to predict wind conditions without needing any additional infrastructure?”
- Could airplanes in flight be employed as a vast sensor network to determine atmospheric conditions?
- Could data available today be used to infer winds on a large scale without special plane-based wind sensors and new infrastructure to access and combine signals from planes?

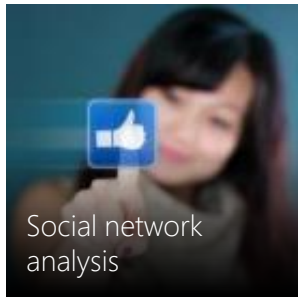
http://windflow.azurewebsites.net/

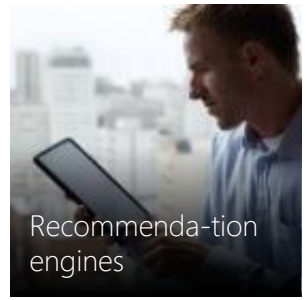
http://research.microsoft.com/en-us/um/people/horvitz/planesenors.pdf

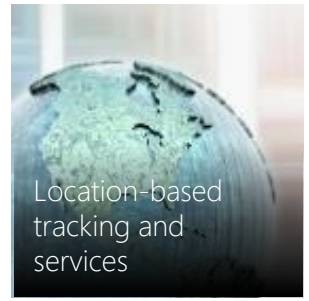
Predictive Analytics

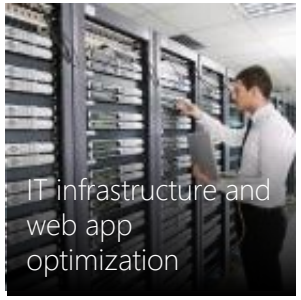
Predicting future performance from historical data

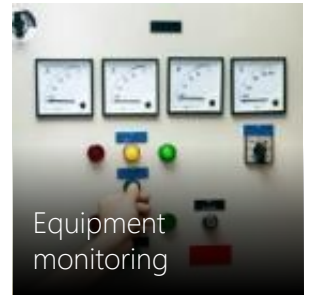
Predictive analytics should address the likelihood of something happening in the future, even if it is just an instant later…

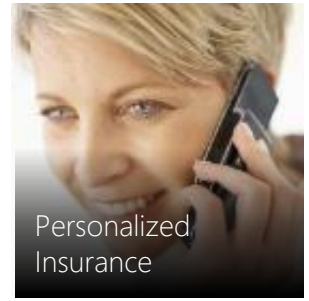












Microsoft & Machine Learning

20 years of realizing innovation

1999 — Computers work on users behalf, filtering junk email

2004 — Microsoft search engine built with machine learning

2005 — SQL Server enables data mining of databases

2008 — Bing Maps ships with ML traffic-prediction service

2010 — Microsoft Kinect can watch users gestures

2012 — Successful, real-time, speech-to-speech translation

2014 — Microsoft launches Azure Machine Learning, making years of innovation available

n Platt,
nguished scientist at Microsoft
earch

"Machine learning is pervasive throughout Microsoft products."

"ATL Europe focuses on Event Analytics from Edge Device to Cloud, a key component of IoT, and incubates resulting innovative technologies, providing short to mid-term impact on Engineering Groups & customers."

Francois Dumas, Director ATL Europe

Towards a edge to cloud

Processing all data centrally is not efficient

Must bring the processing closer to the data source

Deliver insights with low latency

Fast Intelligence	Machine Learning Data Exploration Operationalization	Fast Processing	Fast processing of data Scalability Reliability
Device Management	Reliability Distribution Connectivity	Device Complexity	Heterogeneity of devices

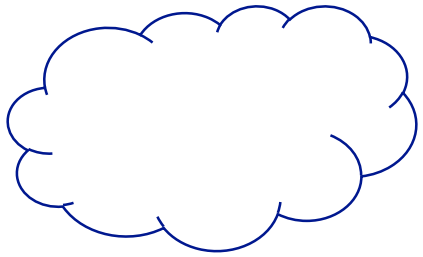
Microsoft

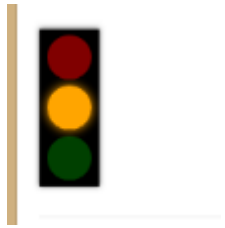
Write Once – Run Anywhere

```
var query= Streams
    .from(RFIDInput)
    .tumblingWindow(5sec.).count()
    .where( sensor.id == 1)
    .join(proximityInput,
       proximityInput.distance < 50;},
       return (RFIDINput, proximityInput))
    .to(incidentOutput);
Streams.deploy(query);
```

RFID

Proximity

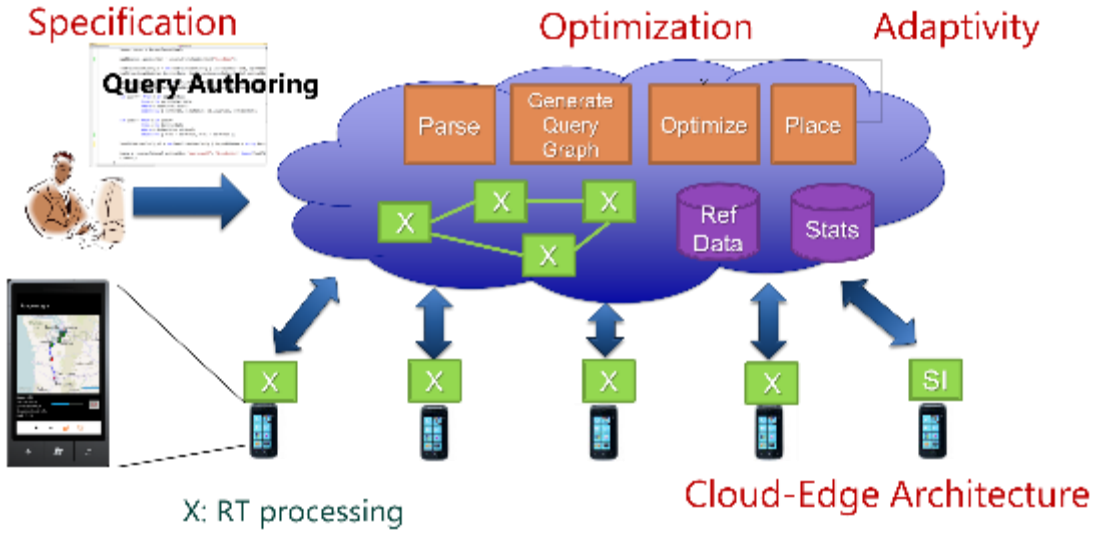




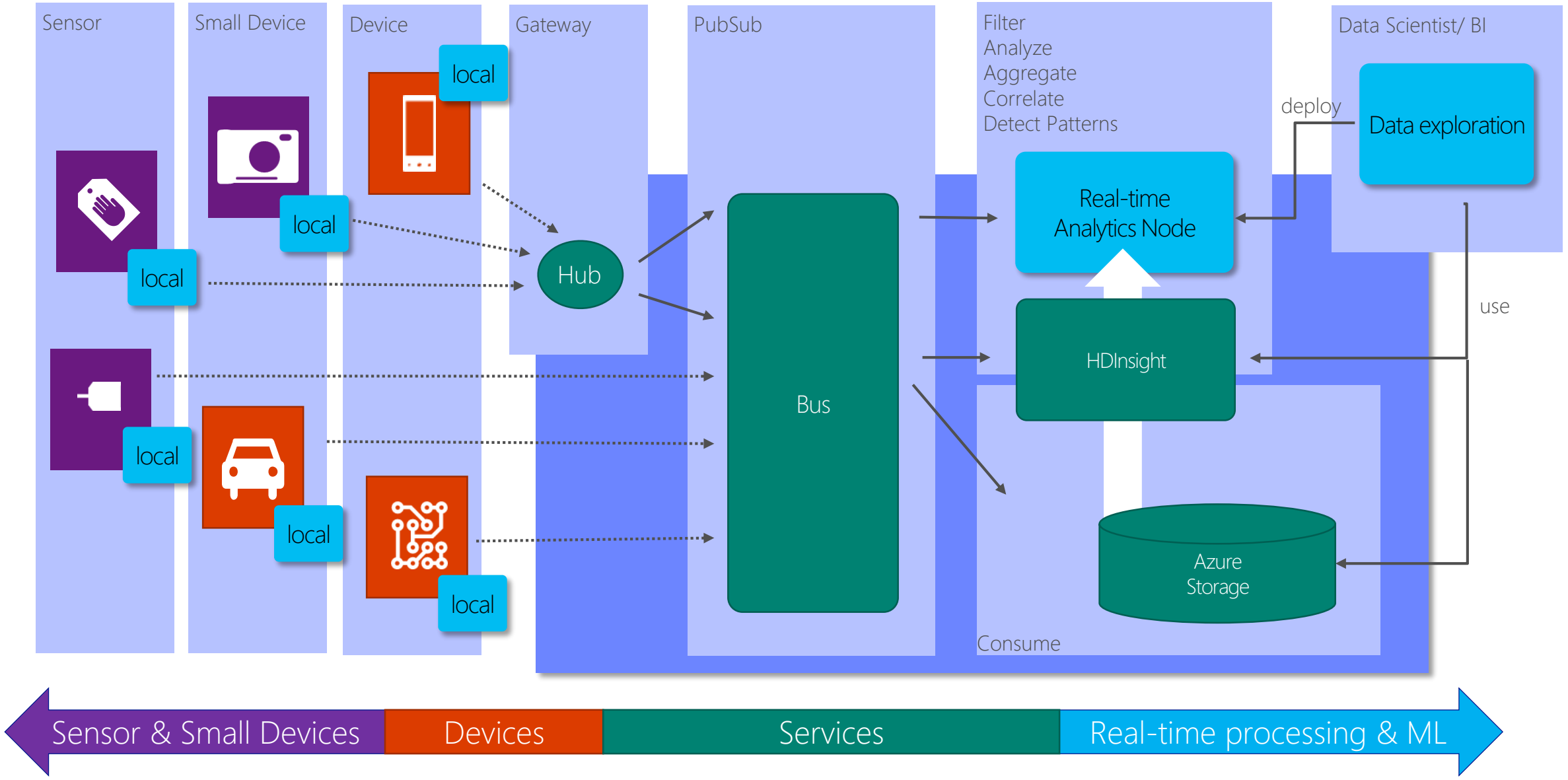
Microsoft

RACE - Query Distribution Sample: Pay as you Drive

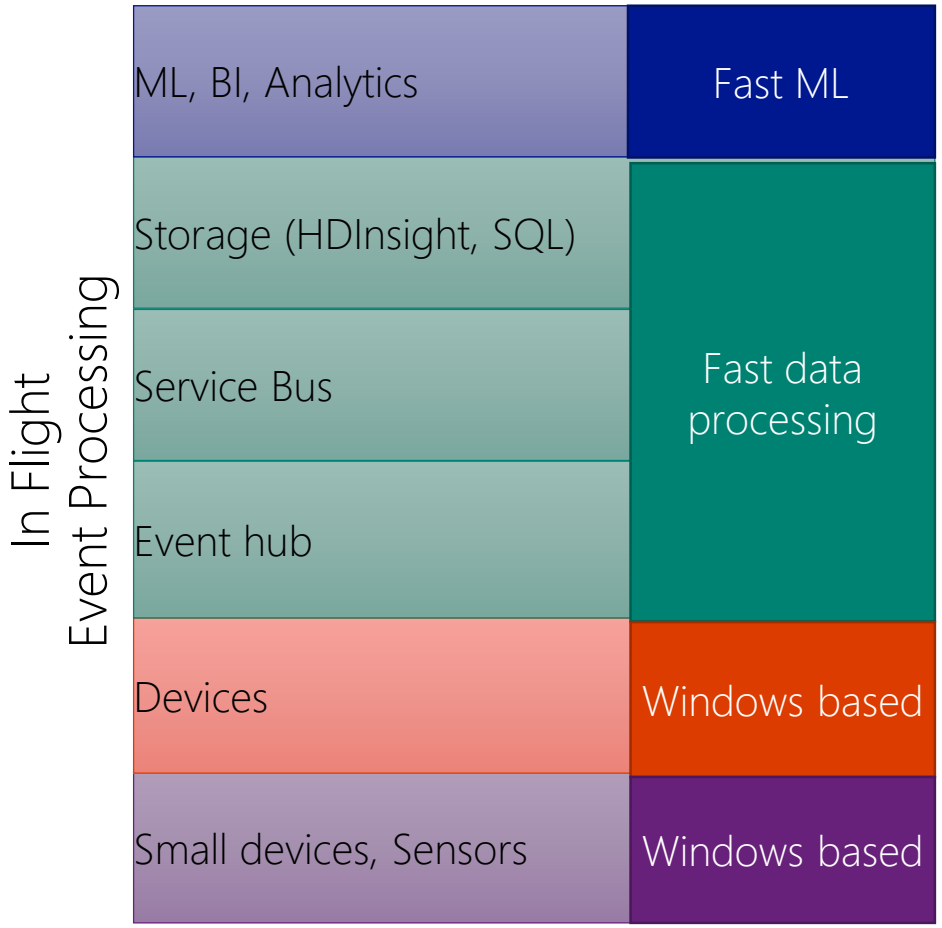
Analyze driving behavior based on relevant car data (e.g. acceleration, breaking), joined with data from the cloud (e.g. road traffic, weather conditions).



Architecture – 10.000ft



Streaming Analytics from Edge to Cloud



Unified Programming Model	• Unified semantics enables logic to run as close as possible to the data source • Real-time processing of event streams from multiple sources • Based on rich declarative query language • Easy to learn, expressiveness when you need • Express and detect complex pattern • Seamlessly transition between historical and real-time data
Data Exploration and Operationalization	• Explore historical data • Operationalize the exact same query in the live system • Find, configure and deploy the right anomaly detection pipeline
Device, Management	• Clean & consistent semantics • Manageability (Data, queries, …)

Microsoft

Microsoft CEO Satya Nadella has talked about the opportunity of connected devices and the more than 200 billion sensors he expects to see.

Thank you!

marcel.tilly at microsoft.com